British Standard

BRITISH STANDARD

BS EN
970 : 1997

Non-destructive examination of fusion welds — Visual examination

The European Standard EN 970 : 1997 has the status of a British Standard

ICS 25.160.40

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee WEE/46, Non-destructive testing, upon which the following bodies were represented:

Association of Consulting Engineers
BNF (Fulmer Materials Centre)
British Chemical Engineering Contractors' Association
British Coal Corporation
British Gas plc
British Institute of Non-destructive Testing
British Iron and Steel Producers Association
British Nuclear Fuels plc
British Railways Board
Castings Technology International
Electricity Association
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Power Generation Contractors Association (PGCA) (BEAMA Ltd.)
Railway Industry Association
Royal Society of Chemistry
Safety Assessment Federation Ltd.
Society of British Aerospace Companies Limited
Society of Motor Manufacturers and Traders Limited
United Kingdom Accreditation Service
Welding Institute

This British Standard, having been prepared under the direction of the Engineering Sector Board, was published under the authority of the Standards Board and comes into effect on
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Amendments issued since publication

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

National foreword

This British Standard has been prepared by Technical Committee WEE/46 and is the English language version of EN 970 : 1997 *Non-destructive examination of fusion welds — Visual examination*, published by the European Committee for Standardization (CEN).

EN 970 : 1997 was produced as a result of international discussions in which the United Kingdom took an active part.

This standard supersedes BS 5289 : 1976 which is withdrawn.

Cross-references

Publication referred to	Corresponding British Standard
EN 288-2 : 1992	BS EN 288 *Specification and approval of welding procedures for metallic materials* Part 2 : 1992 *Welding procedures specification for arc welding*
EN 473 : 1993	BS EN 473 : 1993 *General principles for qualification and certification of NDT personnel*
EN 25817 : 1992	BS EN 25817 : 1992 *Arc-welded joints in steel — Guidance on quality levels for imperfections*
EN 30042 : 1994	BS EN 30042 : 1994 *Arc-welded joints in aluminium and its weldable alloys. Guidance and quality levels for imperfections*
ISO 3058 : 1974	BS 5165 : 1974 *Guidance to the selection of low-power magnifiers used for visual inspection*

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

Summary of pages

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

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 970

February 1997

ICS 25.160.40

Descriptors: Welding, fusion welding, welded joints, metals, visual examination, welds, weld defects, dimensional measurements

English version

Non-destructive examination of fusion welds — Visual examination

Contrôle non destructif des assemblages soudés par fusion — Contrôle visuel

Zerstörungsfreie Prüfung von Schmelzschweißnähten — Sichtprüfung

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

This European Standard 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).

It should be noted that a standard covering the general principles of visual examination is under preparation by CEN/TC 138.

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 covers the visual examination of fusion welds in metallic materials. The examination is normally performed on welds in the as-welded condition but exceptionally, for example when required by an application standard or by agreement between the contracting parties, the examination may be carried out at other stages during the welding process.

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 288-2	*Specification and approval of welding procedures for metallic materials — Part 2: Welding procedure specification for arc welding*
EN 473	*Qualification and certification of NDT personnel — General principles*
prEN 12062	*Non-destructive examination of welds — General rules*
EN 25817	*Arc-welded joints in steel — Guidance on quality levels for imperfections*
EN 30042	*Arc-welded joints in aluminium and its weldable alloys — Guidance on quality levels for imperfections* (ISO 10042 : 1992)
ISO 3058 : 1974	*Non-destructive testing — Aids to visual inspection — Selection of low power magnifiers*
ISO 3599 : 1976	*Vernier callipers reading to 0,1 and 0,05 mm*

3 Examination conditions and equipment

The illuminance at the surface shall be a minimum of 350 lx; 500 lx is recommended.

For performance of direct inspection, access shall be sufficient to place the eye within 600 mm of the surface to be examined and at an angle not less than approximately 30° (see figure 1).

Remote inspection using boroscopes, fibre optics or cameras shall be considered as additional requirements and be specified by an application standard or by agreement between the contracting parties.

If required to obtain a good contrast and relief effect between imperfections and background, an additional light source should be used.

In case of doubt, visual examination should be supplemented by other non-destructive testing methods for surface imperfections.

Examples of examination equipment are given in annex A.

4 Personnel

Personnel who carry out examination in accordance with this European Standard should:

a) be familiar with relevant standards, rules and specifications;

b) be informed about the welding procedure to be used;

c) have good vision in accordance with the requirements of EN 473, which should be checked every 12 months.

5 Visual examination — General

The extent of the examination shall be defined in advance by an application standard, or by agreement between the contracting parties.

The examiner shall have access to the necessary inspection and production documentation required.

Welds shall be examined in the as-welded condition while physical access is possible, and sometimes it is also necessary to examine after surface treatments.

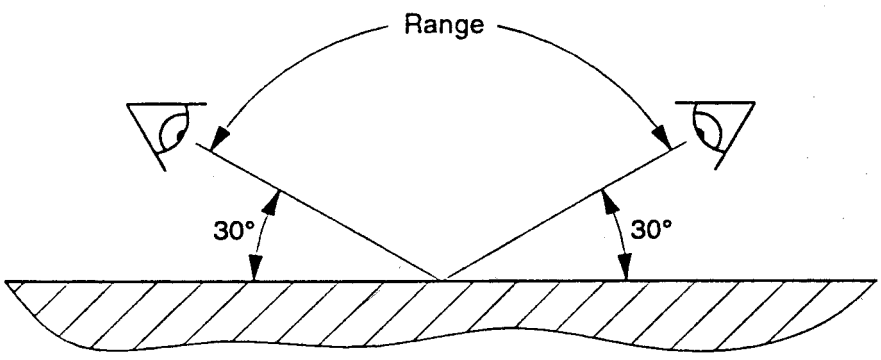


Figure 1. Access for examination

6 Visual examination of joint preparation

When visual examination is required prior to welding the weld shall be examined to check that:

a) the shape and dimensions of the weld preparation meet the specified requirements given in the welding procedure specification, e.g. in accordance with EN 288-2;

b) the fusion faces and adjacent surfaces are cleaned;

c) the parts to be joined by welding are fixed in relation to each other according to drawings or instructions.

7 Visual examination during welding

When required, the weld shall be examined during the welding process to check that:

a) each run or layer of weld metal is cleaned before it is covered by a further run, particular attention being paid to the junctions between the weld metal and the fusion face;

b) there are no visible imperfections, e.g. cracks or cavities; if such imperfections are observed, they shall be reported so that remedial action can be taken before the deposition of further weld metal;

c) the transition between the runs and between the weld and the parent metal has such a shape that satisfactory melting can be accomplished when welding the next run;

d) the depth and shape of gouging is in accordance with the WPS or compared with the original groove shape in order to assure complete removal of the weld metal as specified.

8 Visual examination of the finished weld

8.1 General

The finished weld shall be examined to determine whether it meets the agreed acceptance standard, e.g. EN 25817 or EN 30042 or by reference to prEN 12062. If not specifically included within the requirements of an application standard or by agreement between the contracting parties, the items detailed in **8.2** to **8.5** shall be checked.

8.2 Cleaning and dressing

The weld shall be examined to check that:

a) all slag has been removed by manual or mechanical means. This is to avoid imperfections being obscured;

b) there are no tool impressions or blow marks;

c) when weld dressing is required, overheating of the joint due to grinding is avoided, and grinding marks and an uneven finish are also avoided;

d) for fillet welds and butt welds to be dressed flush, the joint merges smoothly with the parent metal without under-flushing.

8.3 Profile and dimensions

The weld shall be examined to check that:

a) the profile of the weld face and the height of any excess weld metal meet the requirements of the acceptance standard (see **8.1**);

b) the surface of the weld is regular, the pattern and the pitch of weave marks present an even and satisfactory visual appearance; the distance between the last layer and the parent metal or the position of runs has been measured where required by the WPS;

c) the weld width is consistent over the whole of the joint and meets the requirements given in the weld drawing or acceptance standard (see **8.1**). In the case of butt welds, it shall be checked that the weld preparation has been completely filled.

8.4 Weld root and surfaces

The visually accessible parts of the weld, i.e. the weld root for a single-sided butt weld and the weld surfaces, shall be examined for deviations from the acceptance standard (see **8.1**).

The weld shall be examined to check that:

a) in the case of single-sided butt welds, the penetration, root concavity and any burn-through or shrinkage grooves are within the limits specified in the acceptance standard over the whole of the joint;

b) any undercut is within the acceptance standard;

c) any imperfections such as cracks or porosity detected, using optical aids when necessary, in the weld surface or heat affected zones comply with the appropriate acceptance criteria;

d) any attachments temporarily welded to the object to facilitate production or assembly which are prejudicial to the function of the object or the ability to examine it, are removed so that the object is not damaged. The area where the attachment was fixed shall be checked to ensure freedom from cracks.

8.5 Post-weld heat treatment

Further examination may be required after post-weld heat treatment.

9 Visual examination of repaired welds

9.1 General

When welds fail to comply wholly or in part with the acceptance criteria, and repair is necessary, the checks detailed in **9.2** and **9.3** shall be made during repair operation.

9.2 Partially removed weld

It shall be checked that the excavation is sufficiently deep and long to remove all imperfections. It shall also be ensured that there is a gradual taper from the base of the cut to the surface of the weld metal at the ends and sides of the cut, the width and profile of the cut being such that there is adequate access for re-welding.

9.3 Completely removed weld

It shall be checked that, when a cut has been made through a faulty weld and there has been no serious loss of material, or when a section of materials containing a faulty weld has been removed and a new section is to be inserted, the shape and dimensions of the weld preparation meet the specified requirements.

9.4 Examination

Every repaired weld shall be examined to the same requirements as the original weld, as specified in clause **8**.

10 Examination records

It is not always necessary to keep a record of the examination. However, when specified, a record should be kept to show that every relevant item of visual examination at each stage has been checked. The following lists the information that should be included in the report:

a) name of the component manufacturer;

b) name of the examining body, if different from a);

c) identification of the object examined;

d) material;

e) type of joint;

f) material thickness;

g) welding process;

h) acceptance criteria;

i) imperfections exceeding the acceptance criteria and their location;

j) the extent of examination with reference to drawings as appropriate;

k) examination devices used;

l) result of examination with reference to acceptance criteria;

m) name of examiner and date of examination.

Where required, welds that have been examined and approved should be suitably marked or identified.

When it is required to have a permanent visual record of a weld as examined, photographs or accurate sketches or both should be made with any imperfections clearly indicated.

Annex A (informative)

Examples of examination equipment

Equipment used to carry out measurements may be selected from the following:

a) straight edge or measuring tape with a graduation of 1 mm or finer;

b) vernier callipers according to ISO 3559;

c) feeler gauge with a sufficient number of feelers to measure dimensions between 0,1 mm and 3 mm in steps of at most 0,1 mm;

d) radius gauge;

e) magnifying lens with a magnification $\times 2$ to $\times 5$; the lens should preferably have a scale, see ISO 3058.

The following equipment may also be needed:

1) profile measuring device with a wire diameter or width $\leq$ 1 mm, where each wire end is rounded;

2) material for impression of welds, e.g. coldsetting plastic or clay;

3) for visual inspection of welds with limited accessibility, mirrors, endoscopes, boroscopes, fibre optics or TV cameras may be used;

4) any other measurement device agreed by the contracting parties, i.e. specifically designed welding gauges, height/depth gauges, rulers or protractors.

Typical measurement devices and gauges are detailed in table A.1.

NOTE. These devices and gauges are detailed purely as examples of examination equipment. Some of the designs may be registered designs or the subject of patents.

Table A.1 Measuring instruments and weld gauges — measuring ranges and reading accuracy

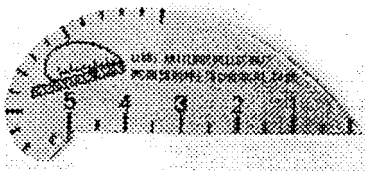
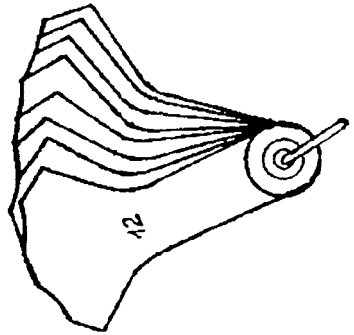
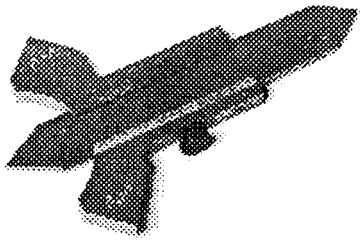
Weld gauge	Description	Type of weld				Measuring range	Reading accuracy	Included or fillet angle	Permissible deviation of included or fillet angle
		Fillet weld			Butt weld				
		Flat weld	Concave weld	Convex weld		mm	mm	degrees	
	**Simple weld gauge** a) Measures fillet weld from 3 mm to 15 mm thickness. The gauge will be placed by the curved part in the fusion faces so as to have three points of contact with the work piece and the fillet weld. b) Measures butt welds reinforcement with the straight part. Because the gauges consist of relatively soft aluminium they wear out rapidly.	×	×	—	×	3 to 15	≈ 0,5	90	small
	**Set of welding gauges** Measures fillet welds from 3 mm to 12 mm thickness; from 3 mm to 7 mm: graduations of 0,5 mm; above 8 mm, 10 mm and 12 mm. The gauge measures by using the principle of three-point contact.	×	×	—	—	3 to 12	according to fan part	90	none
	**Weld gauge with vernier** Measures fillet welds; also reinforcement of butt welds can be determined. The legs of the gauge are so formed that included angles of 60°, 70°, 80° and 90° of V- and single-V butt weld with broad face can be measured. But slight deviations from these lead to significant errors.	×	×	—	×	0 to 20	0,1	90	none

Table A.1 Measuring instruments and weld gauges — measuring ranges and reading accuracy *(continued)*

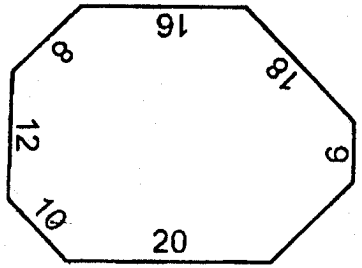
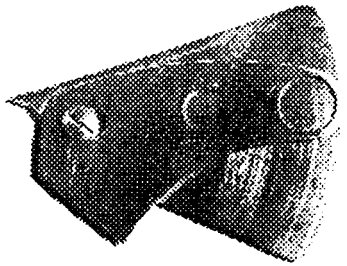
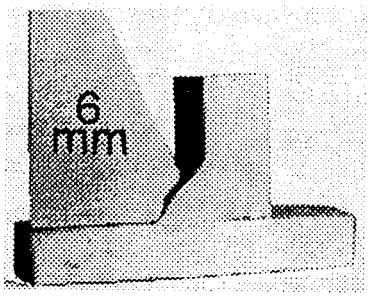
Weld gauge	Description	Type of weld				Measuring range	Reading accuracy	Included or fillet angle	Permissible deviation of included or fillet angle
		Fillet weld			Butt weld				
		Flat weld	Concave weld	Convex weld		mm	mm	degrees	
	**Self made weld gauge** Measures 7 throat thicknesses of fillet welds with an included angle of 90°.	×	—	—	—	0 to 20	0,2	90	none
	**Three-scale gauge** Measures throat thickness and leg length. Can also measure weld reinforcement of butt welds. Easy to use. Also appropriate for asymmetric fillet welds.	×	×	×	×	0 to 15	0,1	90	small
	**Gauge for checking profile of fillet welds** Checking the profile of one shape for one size of fillet welds. This type of gauge needs one model for each size of fillet weld.	—	—	—	—	—	—	—	—

Table A.1 Measuring instruments and weld gauges — measuring ranges and reading accuracy *(continued)*

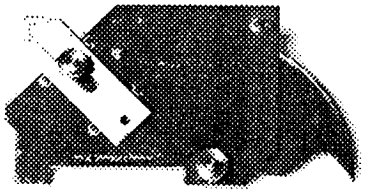
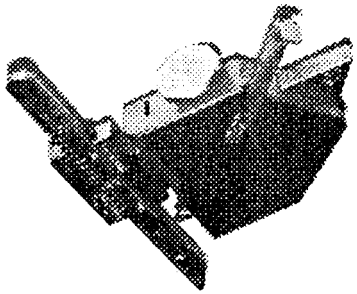
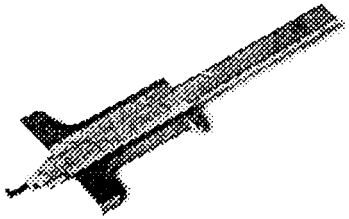
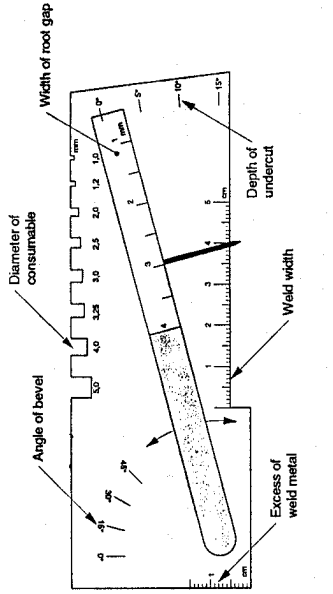
Weld gauge	Description	Type of weld				Measuring range	Reading accuracy	Included or fillet angle	Permissible deviation of included or fillet angle
		Fillet weld			Butt weld				
		Flat weld	Concave weld	Convex weld		mm	mm	degrees	
	**Multi purpose gauge** Measures angle of bevel, leg length of fillet weld, undercut, misalignment, throat thickness and weld reinforcement.	×	×	×	×	0 to 50	0,3	0 to 45 (angle of bevel)	none
	**Universal weld gauge** Measures tasks: – fillet welds: shape and dimensions; – butt welds: misalignment of plates, joint preparation (angle width), weld reinforcement, weld width, undercuts.	×	×	×	×	0 to 30	0,1	—	± 25 %
	**Gap gauge** Measures the width of gaps.	—	—	—	×	0 to 6	0,1	—	—

Table A.1 Measuring instruments and weld gauges — measuring ranges and reading accuracy *(continued)*

Weld gauge	Description	Type of weld				Measuring range	Reading accuracy	Included or fillet angle	Permissible deviation of included or fillet angle
		Fillet weld			Butt weld				
		Flat weld	Concave weld	Convex weld		mm	mm	degrees	
	**Hook gauge for misalignment** Measures the misalignment of the preparation for butt welds on plates and pipes.	—	—	—	×	0 to 100	0,05	—	—
	**Universal butt weld gauge** Measures the preparation and the finished butt weld: 1) angle of bevel; 2) width of root gap; 3) weld reinforcement; 4) width of weld surface; 5) depth of undercut; 6) diameter of consumables.	×	×	×	×	0 to 30	0,1	—	± 25 %

List of references

See national foreword.

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