BRITISH STANDARD

BS EN 1290:1998

Incorporating Amendments Nos. 1 and 2

Non-destructive testing of welds — Magnetic particle testing of welds

The European Standard EN 1290:1998, with the incorporation of amendments A1:2002 and A2:2003, has the status of a British Standard

ICS 25.160.40

BSI British Standards

National foreword

This British Standard is the English language version of EN 1290:1998, including amendments A1:2002 and A2:2003.

The start and finish of text introduced or altered by amendment is indicated in the text by tags [A1] ⟨A1⟩. Tags indicating changes to CEN text carry the number of the CEN amendment. For example, text altered by CEN amendment A1 is indicated by [A1] ⟨A1⟩.

As agreed by CEN/TC 121/SC 5 resolution 134/2000 and in accordance with amendment A1:2002, the term "examination" has been replaced by "testing" throughout the document.

The UK participation in its preparation was entrusted to Technical Committee WEE/46, Non-destructive examination, which has the responsibility to:

— aid enquirers to understand the text;
— present to the responsible 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.

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 14, an inside back cover and a back cover.

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February 1998
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Descriptors: Welded joints, ferromagnetic materials, quality control, non-destructive tests, detection, weld defects, magnetic particle testing, surface treatment

English version

Non-destructive examination of welds — Magnetic particle examination of welds

(includes amendments A1:2002 and A2:2003)

Contrôle non destructif des assemblages soudés — Contrôle par magnétoscopie des assemblages soudés (inclut les amendements A1:2002 et A2:2003)

Zerstörungsfreie Prüfung von Schweißverbindungen — Magnetpulverprüfung von Schweißverbindungen (enthält Änderungen A1:2002 und A2:2003)

This European Standard was approved by CEN on 26 January 1998, amendment A1 was approved by CEN on 28 April 2002 and amendment A2 was approved by CEN on 20 November 2003.

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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

Ref. No. EN 1290:1998 + A1:2002 + A2:2003 E

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 1998, and conflicting national standards shall be withdrawn at the latest by August 1998.

This document has been prepared under a mandate given to CEN by the European Commission and the European FreeTrade Association.

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Foreword to amendment A1

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This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

Annex A is informative.

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Foreword to amendment A2

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Contents

1 Scope

This standard specifies magnetic particle testing techniques for the detection of surface imperfections in ferromagnetic welds, including the heat-affected zones, using the magnetic method. Techniques recommended are suitable for most welding processes and joint configurations. Variations to the basic techniques that will provide a higher or lower testing sensitivity are described in Annex A.

Techniques for testing of welds, with geometries in accordance with those shown in Table 1, Table 2 and Table 3, can be used directly from this standard.

Acceptance levels for indications are described in EN 1291.

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 473, *Qualification and certification of NDT personnel — General principles.*

EN 1291, *Non-destructive testing of welds — Magnetic particle testing of welds — Acceptance levels.*

EN 12062, *Non-destructive testing of welds — General rules for metallic materials.*

A1 EN ISO 3059, *Non-destructive testing — Penetrant testing and magnetic particle testing — Viewing conditions.*
(ISO 3509:2001) A1

3 Definitions

For the purposes of this standard, the definitions given in EN 12062 apply.

4 Safety precautions

European, national and local safety and environment protection regulations shall be observed at all times.

Special consideration shall be given to toxic flammable and/or volatile materials, electrical safety and unfiltered UV radiation.

5 General

5.1 Information

5.1.1 A1 *Items to be specified*

Before carrying out magnetic particle testing, the following items, if applicable, shall be specified: A1

a) specific testing procedure;

b) certification requirements for NDT personnel;

c) extent of coverage;

d) state of manufacture;

e) testing techniques to be used;

f) overall performance test;

g) demagnetization;

h) acceptance level;

i) action necessary for unacceptable indications.

5.1.2 *Additional information*

Prior to testing, the following additional information can be required:

a) type and testing of the parent and weld materials;

b) welding process;

c) location and extent of welds to be tested;

d) joint preparation and dimensions;

e) location and extent of any repairs;

f) post-weld treatment (if any);

g) surface conditions.

Operators can ask for further information that could be helpful in determining the nature of any indications detected.

5.2 Personnel qualification

Personnel performing non-destructive testing in accordance with this standard shall be qualified to an appropriate level in accordance with EN 473 or an equivalent standard at an appropriate level in the relevant industrial sector.

5.3 Surface conditions and preparation

Areas to be tested shall be free from scale, oil, grease, weld spatter, machining marks, dirt, heavy and loose paint, and any other foreign matter that can affect sensitivity.

It can be necessary to improve the surface condition, e.g. by abrasive paper or local grinding, to permit accurate interpretation of indications.

Cleaning and preparation of surfaces shall not be detrimental to the material, the surface finish or the magnetic testing media.

5.4 Magnetizing

5.4.1 *Magnetizing equipment*

Unless otherwise agreed, the following types of alternating-current magnetizing equipment shall be used:

a) electromagnetic yokes;

b) current flow equipment with prods;

c) adjacent or threading conductors, or coil techniques.

Direct-current magnetization or permanent magnets [A1] may be used if specified [A1].

The magnetizing equipment used shall comply with the requirements of relevant European Standards. Prior to the publication of European Standards related to the subject, the corresponding national standards may be used.

Where prods are used, precautions shall be taken to minimize overheating, burning or arcing at the contact tips. Removal of arc burns shall be carried out where necessary. The affected area shall be tested by a suitable method to ensure the integrity of the surface.

5.4.2 *Verification of magnetization*

For most weldable ferromagnetic materials, a tangential magnetic field strength of 2 kA/m to 6 kA/m (r.m.s.) is recommended.

Verification of the magnetic field strength shall be carried out using one of the following methods:

a) a component containing fine natural or artificial imperfections in the least favourable locations;

b) measurement of the tangential field strength as close as possible to the surface using a Hall effect probe. The appropriate tangential field strength can be difficult to measure close to abrupt changes in the shape of a component, or where flux leaves the surface of a component;

c) A1 calculation of the approximate current value in order to achieve the recommended tangential field strength. The calculations can be based on the current values specified in Table 2 and Table 3; A1

d) other methods based on established principles.

NOTE Flux indicators, placed in contact with the surface under test, can provide a guide to the magnitude and direction of the tangential field, but should not be used to verify that the field strength is acceptable.

5.5 Application techniques

5.5.1 *Field directions and examination area*

The detectability of an imperfection depends on the angle of its major axis with respect to the direction of the magnetic field. This is explained for one direction of magnetization in Figure 1.

To ensure detection of imperfections in all orientations, the welds shall be magnetized in two directions approximately perpendicular to each other with a maximum deviation of 30°. This can be achieved using one or more magnetization methods.

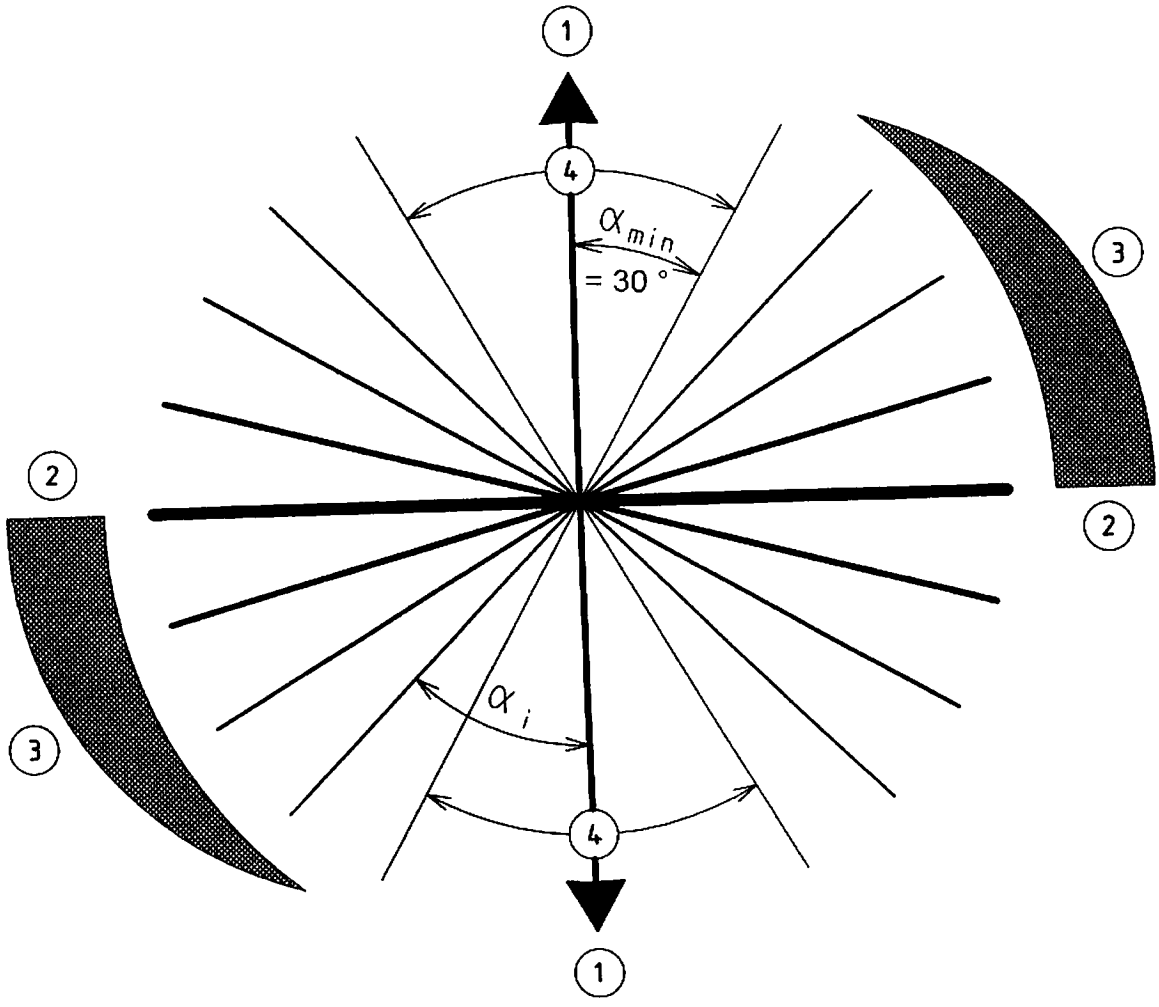
A1 Testing in only one field direction may be carried out if specified. A1

When testing involves the use of yokes or prods, there will be an area of the component, in the vicinity of each pole piece or tip, that will be impossible to test due to excessive magnetic field strength, usually shown by furring of particles.

Care shall be taken to ensure adequate overlap of the testing areas as shown in Figure 2 and Figure 3.

5.5.2 *Typical magnetic testing techniques*

Applications of magnetic particle testing techniques to common weld joint configurations are shown in Table 1, Table 2 and Table 3. Values are given for guidance purposes only. Where possible, the same directions of magnetization, and field overlaps, should be used for other weld geometries to be tested. The dimension, d, the flux current path in the material, shall be greater than or equal to the width of the weld and the heat-affected zone +50 mm, and in all cases the weld and the heat-affected zone shall be included in the effective area. The approximate A1 direction A1 of magnetization related to the weld direction shall be specified.



1 Magnetic field direction
2 Optimum sensitivity
3 Reducing sensitivity
4 Insufficient sensitivity

α is the angle between the magnetic field and the direction of the imperfection
α_{min} is the minimum angle for imperfection detection
α_i is an example of imperfection orientation

Figure 1 — Directions of detectable imperfections

Dimensions in millimetres

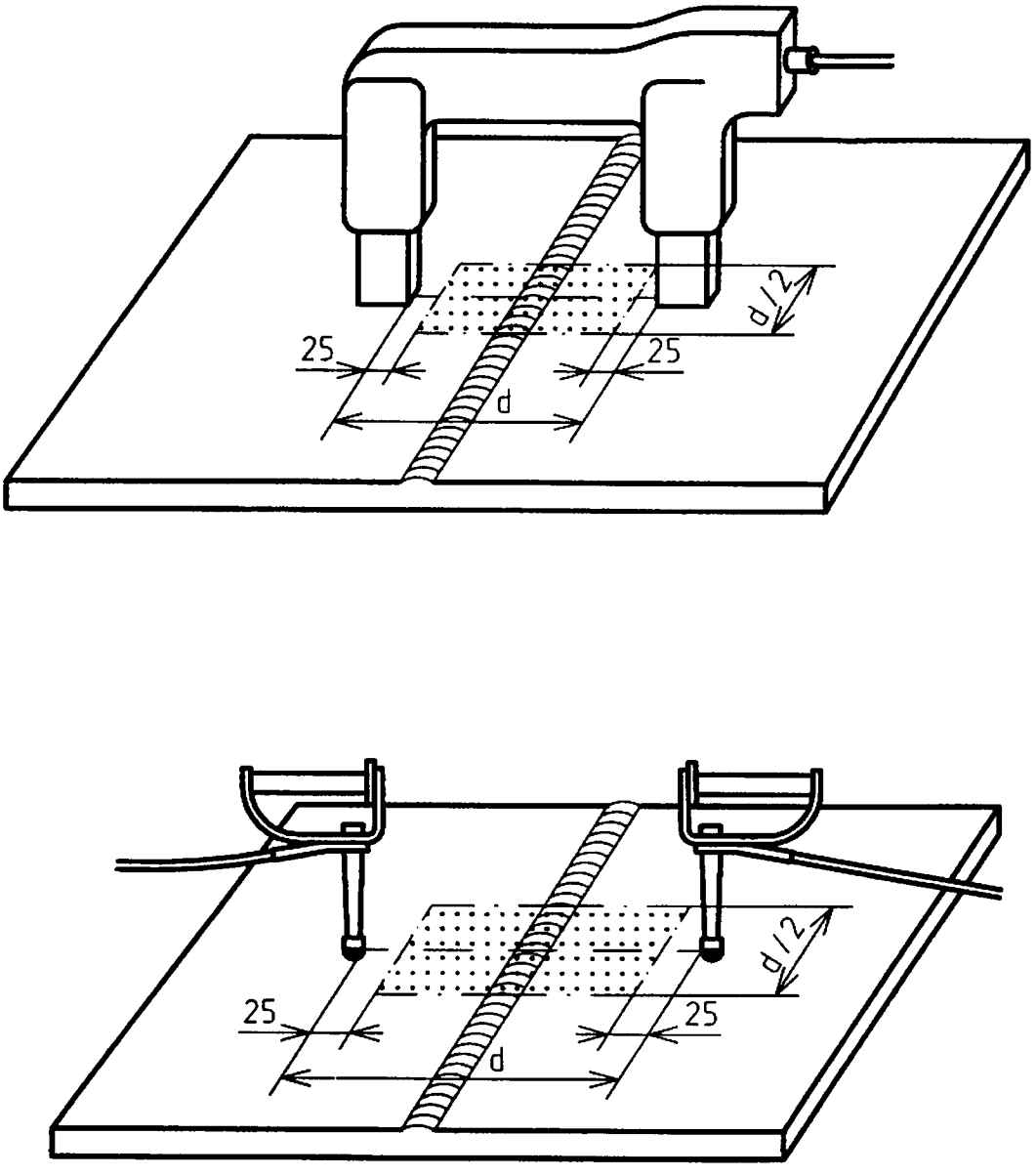
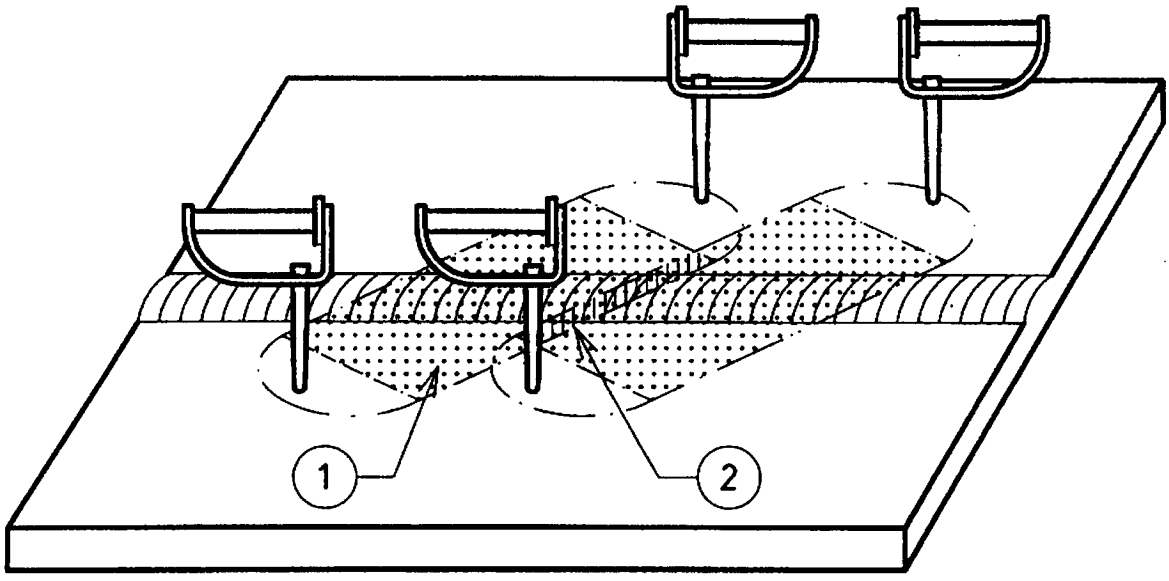


Figure 2 — Examples of effective testing area (shaded) for magnetizing with yokes and prods



1 Effective area
2 Overlap

Figure 3 — Overlap of effective areas

Table 1 — Typical magnetizing techniques for yokes

Dimensions in millimetres

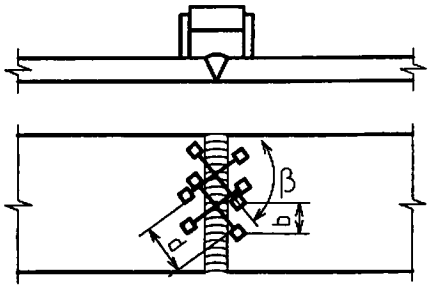
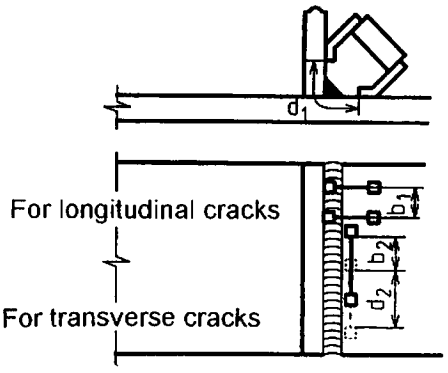
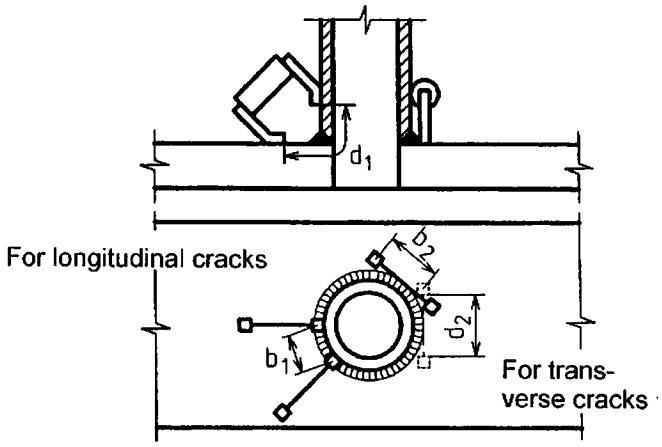
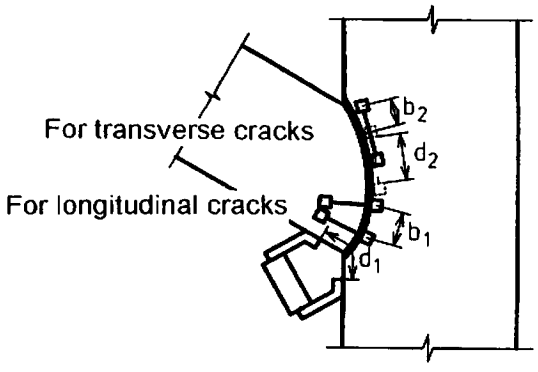
	$d \geq 75$ $b \leq d/2$ $\beta \approx 90°$
	$d_1 \geq 75$ $b_1 \leq d_1/2$ $b_2 \leq d_2 - 50$ $d_2 \geq 75$
	$d_1 \geq 75$ $d_2 > 75$ $b_1 \leq d_1/2$ $b_2 \leq d_2 - 50$
	$d_1 \geq 75$ $d_2 \geq 75$ $b_1 \leq d_1/2$ $b_2 \leq d_2 - 50$

Table 2 — Typical magnetizing techniques for prods, using a magnetizing current ≥ 5 A/mm (r.m.s.) prod spacing

Dimensions in millimetres

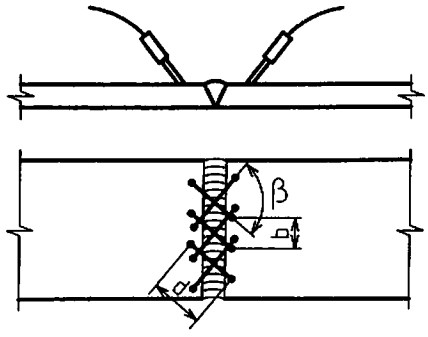
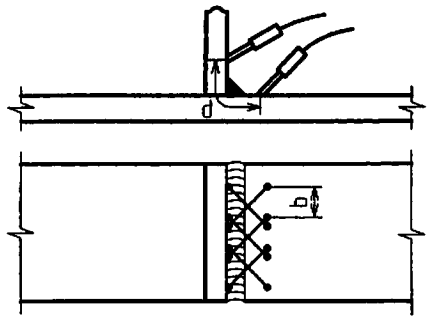
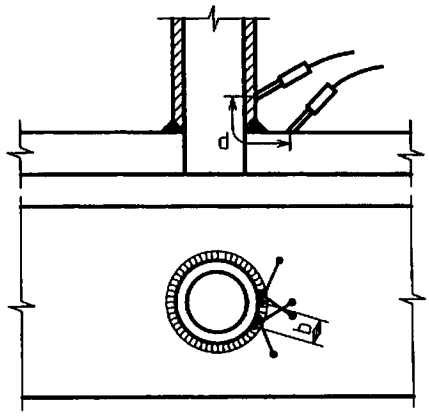
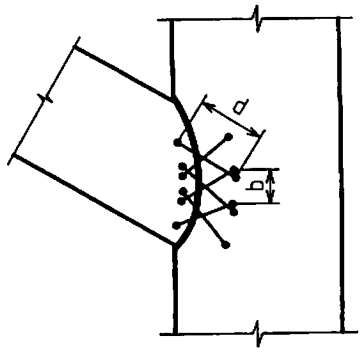
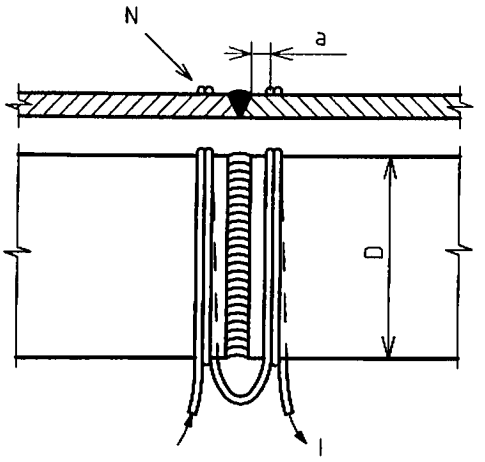
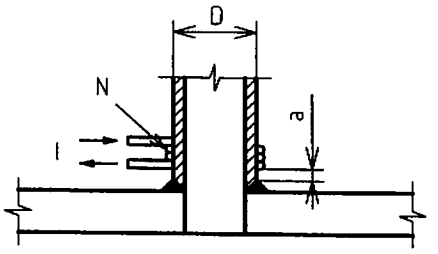
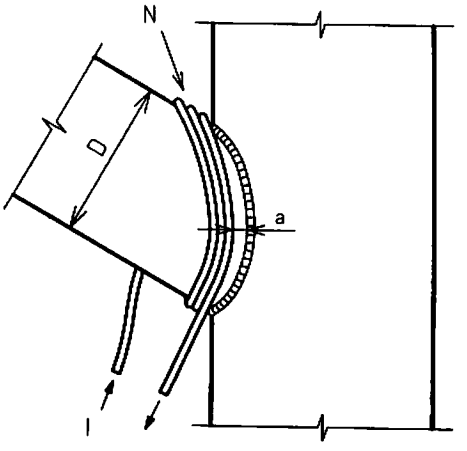
	$d \geq 75$ $b \leq d/2$ $\beta \approx 90°$
	$d \geq 75$ $b \leq d/2$
	$d \geq 75$ $b \leq d/2$
	$d \geq 75$ $b \leq d/2$

Table 3 — Typical magnetizing techniques for flexible cables or coils

Dimensions in millimetres

 For longitudinal cracks	$20 \leq a \leq 50$ $NI \geq 8D$
 For longitudinal cracks	$20 \leq a \leq 50$ $NI \geq 8D$
 For longitudinal cracks	$20 \leq a \leq 50$ $NI \geq 8D$

N is the number of turns;
I is the current (r.m.s.);
a is the distance between weld and coil or cable.

5.6 Detecting media

5.6.1 *General*

Detection media may be either in dry powder or liquid form and shall comply with the requirements of relevant European Standards. Prior to the publication of European Standards related to the subject, the corresponding national standards may be used.

5.6.2 *Verification of detecting media performance*

Verification of the detecting media shall be carried out periodically to confirm continuing satisfactory performance.

The verification shall be carried out on components having known or artificial surface imperfections, or on pre-magnetized reference pieces.

Indications obtained with the medium to be verified shall be compared against those obtained from a medium having a known and acceptable performance. For this purpose the reference indications may be:

a) real imperfections;

b) photograph(s); or

c) replica(s).

5.7 Viewing conditions

The viewing conditions shall meet the requirements of [A1] EN ISO 3059 [A1].

5.8 Application of detecting media

After the object has been prepared for [A1] testing, the [A1] detecting medium shall be applied by spraying, flooding or dusting immediately prior to and during the magnetization. Following this, time shall be allowed for indications to form before removal of the magnetic field.

When magnetic suspensions are used, the magnetic field shall be maintained within the object until the majority of the suspension carrier liquid has drained away from the testing surface. This will prevent any indications being washed away.

Depending on the material being tested, its surface condition and magnetic permeability, indications will normally remain on the surface even after removal of the magnetic field, due to residual magnetism within the part. However, the presence of residual magnetism shall not be presumed; post-evaluation techniques after removal of the prime magnetic field source can be permitted only when a component has been proven by an overall performance test to retain magnetic indications.

5.9 Overall performance test

Where [A1] defined by specification [A1], an overall performance test of the system sensitivity, for each specific procedure shall be carried out on site. The test shall be designed to ensure a proper functioning of the entire chain of parameters including the equipment, the magnetic field strength and direction, surface characteristics, detecting media and illumination.

The most reliable test is to use representative test pieces containing real imperfections of known type, location, size and size distribution. Where these are not available, fabricated test pieces with artificial imperfections, or flux shunting indicators of the cross type or shim type may be used. The test pieces shall be demagnetized and free from indications resulting from previous tests.

5.10 False indications

False indications which may mask relevant indications can arise for many reasons, e.g. undercut and changes in magnetic permeability, i.e. the heat-affected zone. Where masking is suspected, the examination surface shall be dressed, or suitable alternative testing methods can be used.

5.11 Recording of indications

Indications can be recorded in one or more of the following ways by using:

a) description in writing;

b) sketches;

c) photography;

d) transparent adhesive tape;

e) transparent varnish for "freezing" the indication on the surface tested;

f) A1 peelable A1 contrast aids;

g) video recording;

h) epoxy or chemical magnetic particle mixtures;

i) magnetic tapes;

j) electronic scanning.

5.12 Demagnetization

After testing of welds with alternating current, residual magnetization will normally be low and there will generally be no need for demagnetization of the object under test.

A1 If the demagnetization is required by specification, it shall be carried out using a specified method and to a defined level.[1)] A1

5.13 Test report

A test report shall be prepared.

A1 The following information should be included in the test report unless otherwise specified: A1

a) name of the company carrying out the test;

b) the object tested;

c) date of testing;

d) parent and weld materials;

e) post-weld heat treatment;

f) type of joint;

g) material thickness;

h) welding process;

i) temperature of the test object, if outside normal ambient temperature;

j) identification of testing procedure and description of the parameters used, including:

- — type of magnetization;
- — type of current;
- — detection media;
- — viewing conditions.

k) details and results of the overall performance test, where applicable;

l) acceptance levels;

m) description and location of all recordable indications;

n) test results with reference to acceptance level;

o) names, relevant qualification and signatures of personnel who carried out the testing.

[1)] For metal-cutting processes, a typical residual field strength value of $H \leqslant 0{,}4$ kA/m is recommended.

Annex A (informative)
Sensitivity aspects

A.1 Surface conditions and preparation

The maximum testing sensitivity that can be achieved by any magnetic testing method is dependent on many variables but can be seriously affected by the surface roughness of the object and any irregularities present. In some cases it can be necessary to:

— dress undercut and surface irregularities by grinding;

— remove or reduce the weld reinforcement.

Surfaces covered with a thin non-magnetic paint, e.g. a primer may also be tested, provided that the paint surface is unbroken and the thickness of the coating does not exceed 50 µm. Above this thickness, the sensitivity of the method decreases and can be specifically determined before proceeding with the testing.

A.2 Magnetizing equipment characteristics

The use of alternating current gives the best sensitivity for detecting surface imperfections.

Yokes produce an adequate magnetic field in simple butt-welds, but where the flux is reduced by gaps or the path is excessive through the object, as in T-joints, a reduction of sensitivity can occur.

For complex joint configurations, e.g. A1 branch connections A1 with an inclined angle of less than 90°, testing using yokes might be inadequate. In these cases, prods or cable wrapping with current flow will prove more suitable.

A.3 Magnetic field strength and permeability

The field strength required to produce an indication strong enough to be detected during magnetic particle testing is dependent mainly on the magnetic permeability of the object.

Generally, magnetic permeability is high in softer magnetic materials, e.g. low-alloy steels, and low in harder magnetic materials, e.g. martensitic steels. Because permeability is a function of the magnetizing current, low-permeability materials usually require application of a higher magnetization value than softer alloys, to produce the same flux density. It is essential, therefore, to establish that flux density values are adequate before beginning the magnetic particle testing.

A.4 Detecting media

Magnetic particle suspensions will usually give a higher sensitivity for detecting surface imperfections than dry powders.

Fluorescent magnetic detection media usually give a higher test sensitivity than colour-contrast media, because of the higher contrast between the darkened background and the fluorescent indication. The sensitivity of the fluorescent method will, nevertheless, decrease in proportion to any increase in the roughness of the surface to which magnetic particles adhere, and can cause a disturbing background fluorescence.

Where the background illumination cannot be adequately lowered, or where background fluorescence is disturbing, coloured detection media in conjunction with the smoothing effect of a contrast aid will usually give a better sensitivity.

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