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Non-destructive testing of welds — Magnetic particle testing

Contrôle non destructif des assemblages soudés — Magnétoscopie

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is ISO/TC 44, *Welding and allied processes*, Subcommittee SC 5, *Testing and inspection of welds*.

This second edition cancels and replaces the first edition (ISO 17638:2003), which has been technically revised.

Requests for official interpretations of any aspect of this document should be directed to the Secretariat of ISO/TC 44/SC 5 via your national standards body. A complete listing of these bodies can be found at www.iso.org.

Non-destructive testing of welds — Magnetic particle testing

1 Scope

This document specifies techniques for detection of surface imperfections in welds in ferromagnetic materials, including the heat affected zones, by means of magnetic particle testing. The techniques are suitable for most welding processes and joint configurations. Variations in the basic techniques that will provide a higher or lower test sensitivity are described in Annex A.

This document does not specify acceptance levels of the indications. Further information on acceptance levels for indications may be found in ISO 23278 or in product or application standards.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 3059, *Non-destructive testing — Penetrant testing and magnetic particle testing — Viewing conditions*

ISO 9934-1:2015, *Non-destructive testing — Magnetic particle testing — Part 1: General principles*

ISO 9934-2, *Non-destructive testing — Magnetic particle testing — Part 2: Detection media*

ISO 9934-3, *Non-destructive testing — Magnetic particle testing — Part 3: Equipment*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12707 and ISO 17635 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

4 Safety precautions

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

Magnetic particle testing often creates high magnetic fields close to the object under test and the magnetising equipment. Items sensitive to these fields should be excluded from such areas.

5 General

5.1 Information required prior to testing

Prior to testing, the following items shall be specified (where applicable):

a) specific test 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) any demagnetization;

h) acceptance level;

i) action necessary for unacceptable indications.

5.2 Additional pre-test information

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

a) type and designation 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 may ask for further information that could be helpful in determining the nature of any indications detected.

5.3 Personnel qualification

Magnetic particle testing of welds and the evaluation of results for final acceptance shall be performed by qualified and capable personnel. It is recommended that personnel be qualified in accordance with ISO 9712 or an equivalent standard at an appropriate level in the relevant industry sector.

5.4 Surface conditions and preparation

Areas to be tested shall be dry unless appropriate products for wet surfaces are used. It may be necessary to improve the surface condition, e.g. by use of abrasive paper or local grinding to permit accurate interpretation of indications.

Any cleaning or surface preparation shall not be detrimental to the material, the surface finish or the magnetic testing media. Detection media shall be used within the temperature range limitations set by the manufacturer.

5.5 Magnetizing

5.5.1 Magnetizing equipment

General magnetization requirements shall be in accordance with ISO 9934-1:2015, Clause 8.

Unless otherwise specified, for example, in an application standard, 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.

DC electromagnets and permanent magnets may only be used by agreement at the time of enquiry and order.

The magnetizing equipment shall conform to ISO 9934-3.

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.

5.5.2 Verification of magnetization

For the verification of magnetization, see ISO 9934-1:2015, 8.2.

For structural steels in welds, a tangential field between 2 kA/m to 6 kA/m (r.m.s.) is recommended.

The adequacy of the surface flux density shall be established by one or more of the following methods:

a) by testing a representative component containing fine natural or artificial discontinuities 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) calculation of the approximate current value in order to achieve the recommended tangential field strength; the calculation can be based on the current values specified in Figure 5 and Figure 6;

d) by the use of other methods based on established principles.

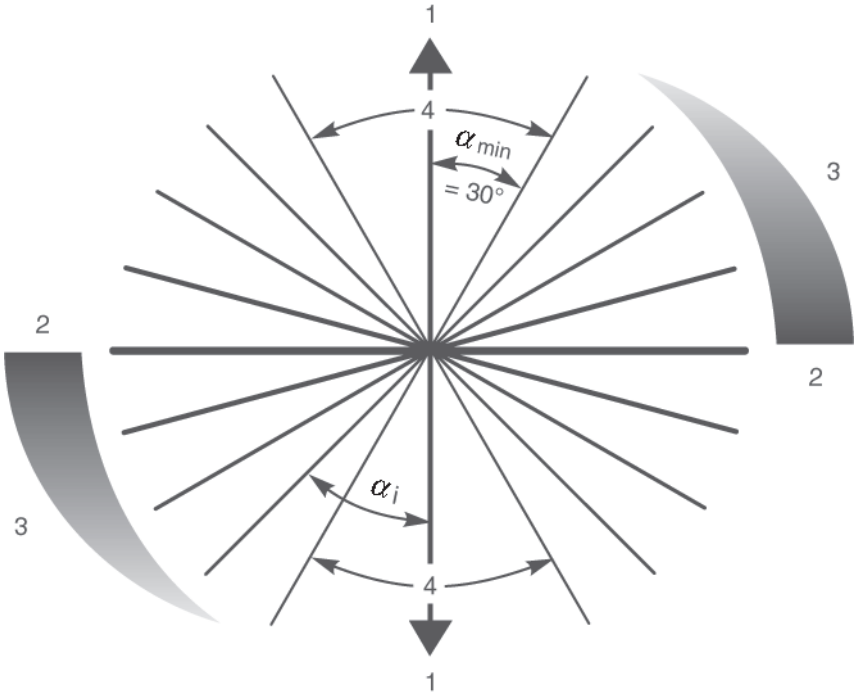
Flux indicators (i.e. shim-type) placed in contact with the surface under test provide a guide to the magnitude and direction of the tangential field strength, but should not be used to verify that the tangential field strength is acceptable.

NOTE Information on b) is given in ISO 9934-3.

5.6 Application techniques

5.6.1 Field directions and testing 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.



Key

1	magnetic field direction	α	angle between the magnetic field and the direction of the imperfection
2	optimum sensitivity	α_{min}	minimum angle for imperfection detection
3	reducing sensitivity	α_i	example of imperfection orientation
4	insufficient sensitivity		

Figure 1 — Directions of detectable imperfections

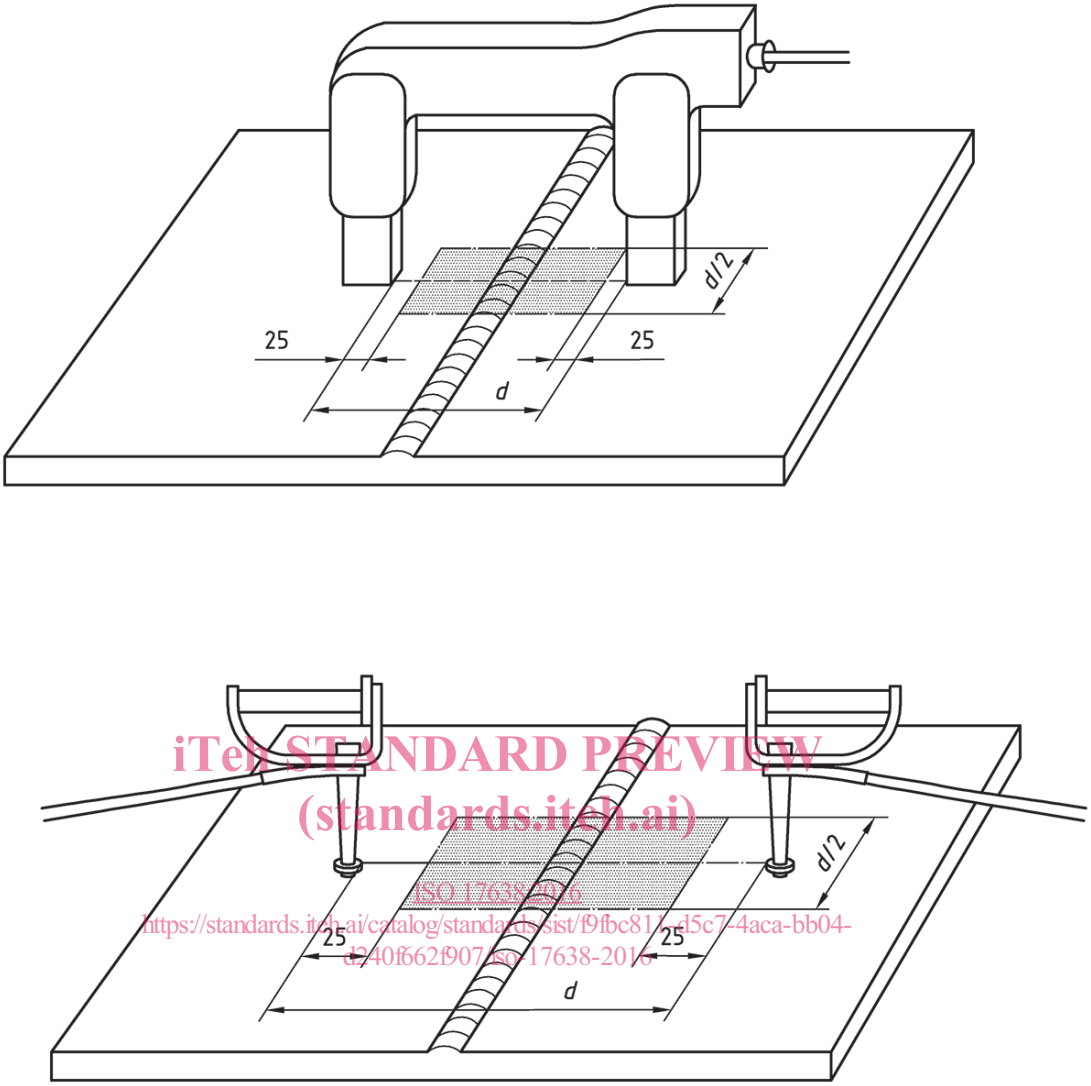
To ensure detection of imperfections in all orientations, the welds shall be magnetized in two directions approximately perpendicular to each other with a maximum deviation of 30°. This can be achieved using one or more magnetization methods.

Testing in only one field direction is not recommended but may be carried out if specified, for example, in an application standard.

When using 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. This is usually seen as furring of particles.

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

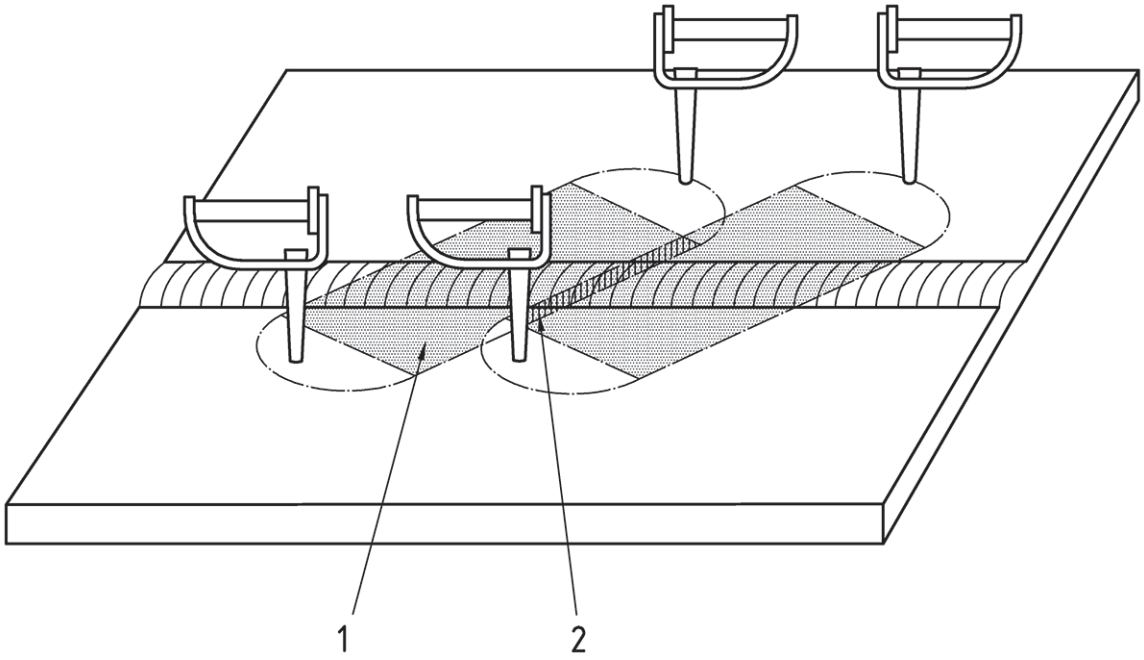
Dimensions in millimetres



Key

d separation between the poles (yoke/prod)

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



Key

1 effective area

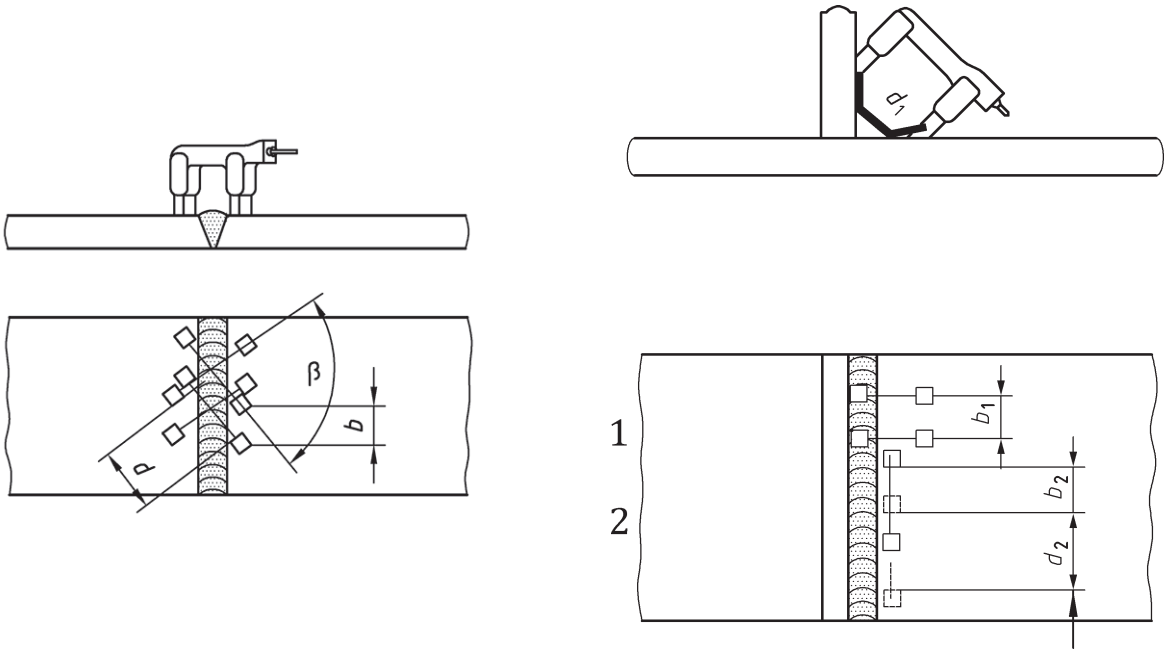
2 overlap

Figure 3 — Overlap of effective areas

5.6.2 Typical magnetic testing techniques

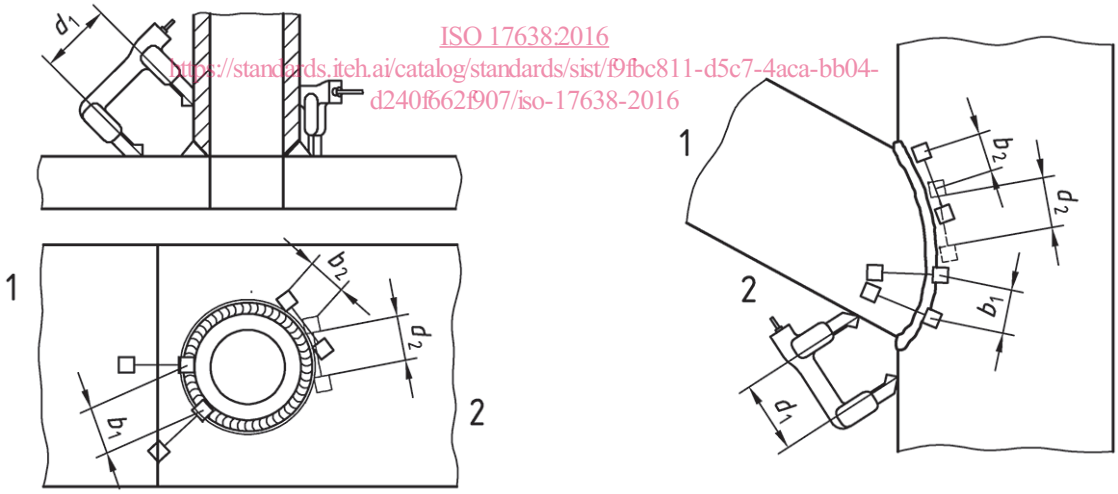
Magnetic particle testing techniques for common weld joint configurations are shown in Figure 4, Figure 5 and Figure 6. Values are given for guidance purposes only. Where possible, the same directions of magnetization and field overlaps should be used for other weld geometries to be tested. The width of the flux current (in case of flux current technique) or of the magnetic flow (in case of magnetic flow technique) path in the material, *d*, 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 direction of magnetization with respect to the orientation of the weld shall be specified.

Dimensions in millimetres



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

$d_1 \geq 75$
$b_1 \leq d_1/2$
$b_2 \leq d_2 - 50$
$d_2 \geq 75$



$d_1 \geq 75$
$d_2 \geq 75$
$b_1 \leq d_1/2$
$b_2 \leq d_2 - 50$

$d_1 \geq 75$
$d_2 > 75$
$b_1 \leq d_1/2$
$b_2 \leq d_2 - 50$

Key

1 longitudinal cracks
2 transverse cracks

Figure 4 — Typical magnetizing techniques for yokes