INTERNATIONAL STANDARD

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Non-destructive testing of welds — Magnetic particle testing

Contrôle non destructif des assemblages soudés — Contrôle par magnétoscopie

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 17638 was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 5, *Testing and inspection of welds*.

Non-destructive testing of welds — Magnetic particle testing

1 Scope

This International Standard 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 International Standard does not specify acceptance levels of the indications. Further information on acceptance levels for indications may be found in EN 1291 or in product or application standards.

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.

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

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*

ISO 17635, *Non-destructive testing of welds — General rules for fusion welds in metallic materials*

3 Terms and definitions

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

4 Safety precautions

International, national and local safety and environmental protection regulations shall be observed at all times.

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

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 free from scale, oil, grease, weld spatter, machining marks, dirt, heavy and loose paint and any other foreign matter that can affect the sensitivity of the test method.

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.

5.5 Magnetizing

5.5.1 Magnetizing equipment

Unless otherwise specified, e.g., 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.

The use of direct current-magnetization or permanent magnets shall be specified prior to testing.

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

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) 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 Figures 5 and 6;

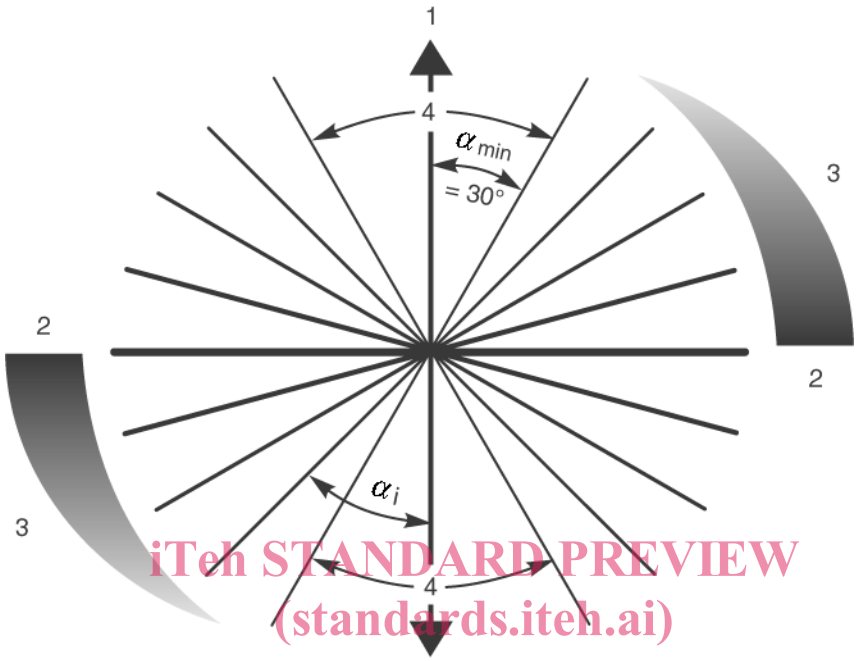
d) other methods based on established principles.

NOTE Flux indicators, placed in contact with the surface being tested, 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.

5.6 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.



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.

Key

1 magnetic field direction
2 optimum sensitivity
3 reducing sensitivity
4 insufficient sensitivity

Figure 1 — Directions of detectable imperfections

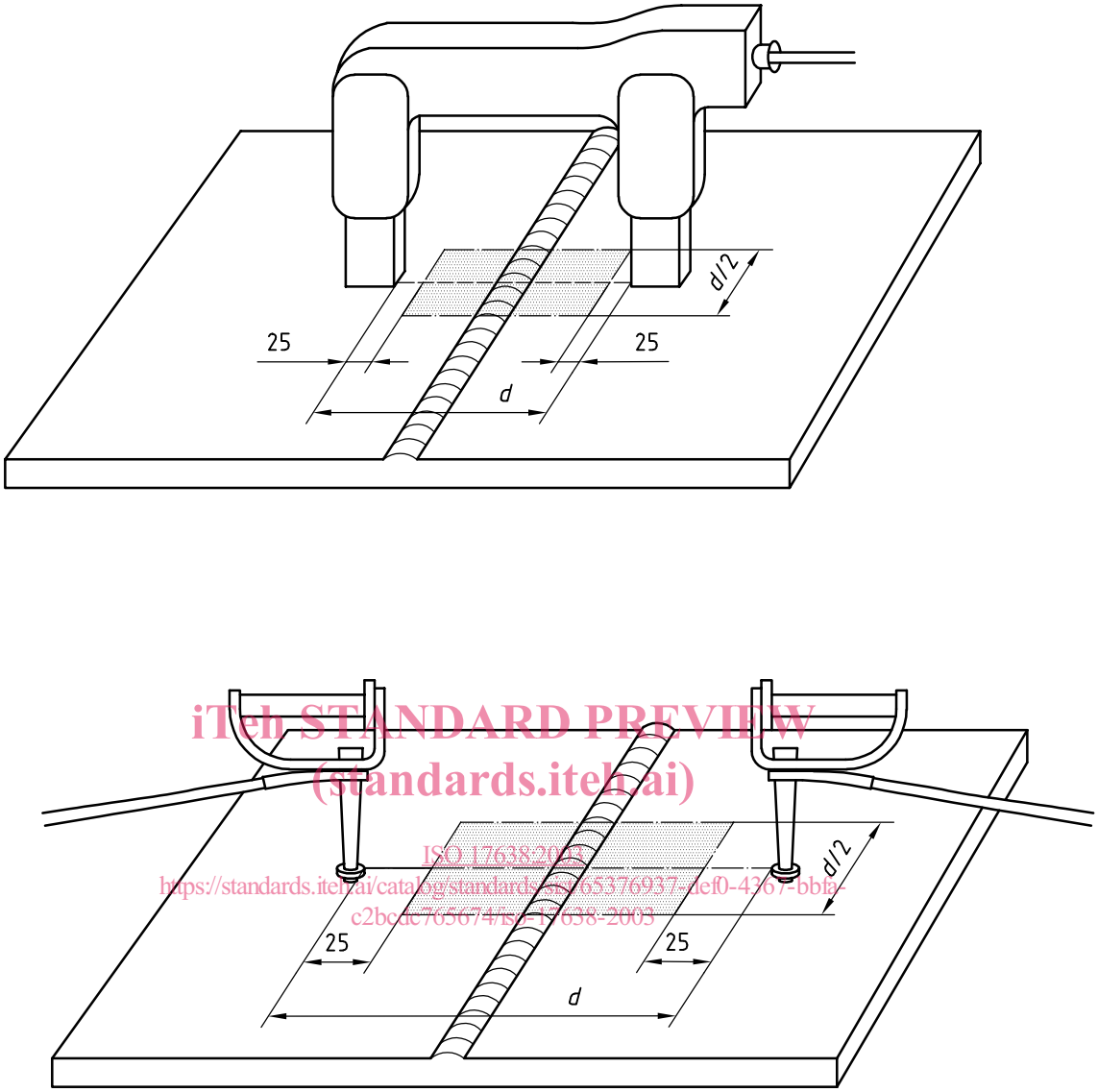
To ensure detection of imperfections in all orientations, the welds shall be magnetized in two directions approximately perpendicular to each other with a maximum deviation of 30°. This can be achieved using one or more magnetization methods.

Testing in only one field direction is not recommended but may be carried out if specified, e.g., 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.

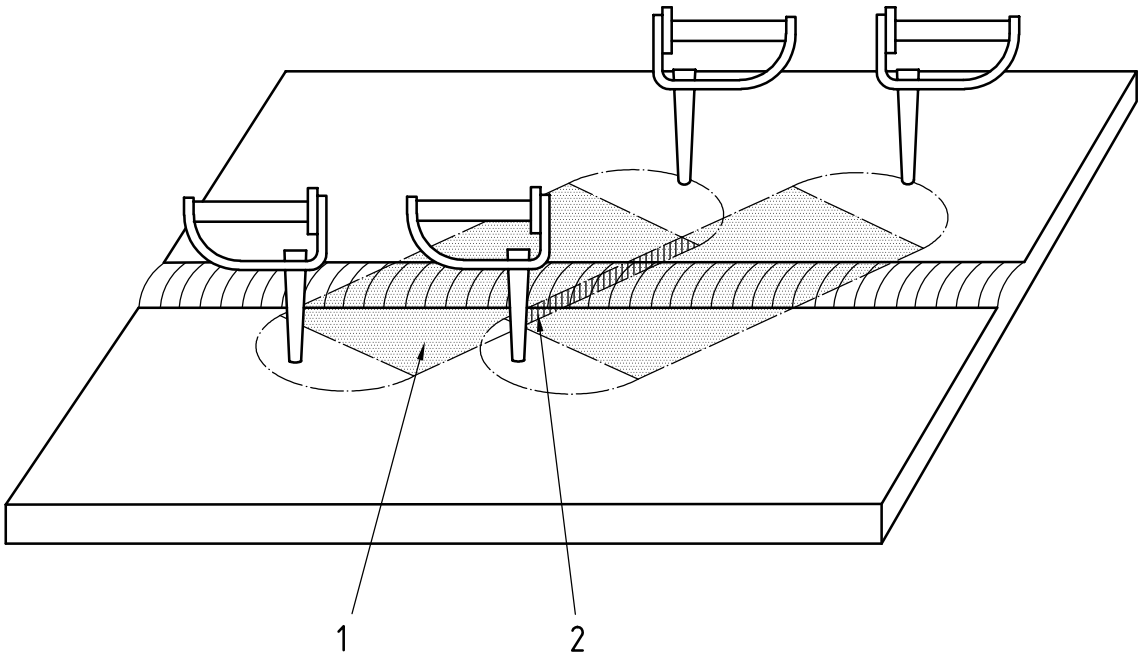
Care shall be taken to ensure adequate overlap of the testing areas as shown in Figures 2 and 3.

Dimensions in millimetres



d is the yoke/prod separation

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



Key

1 effective area

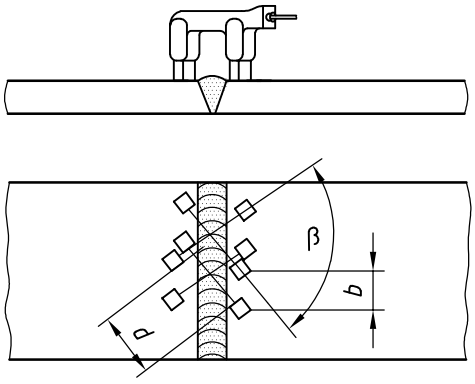
2 overlap

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 Figures 4, 5 and 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 path in the material, d, shall be greater 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.

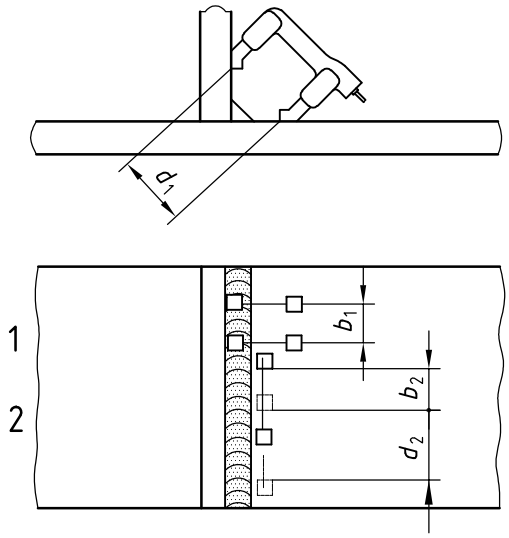
Dimensions in millimetres



$d \geqslant 75$

$b \leqslant d/2$

$\beta \approx 90°$

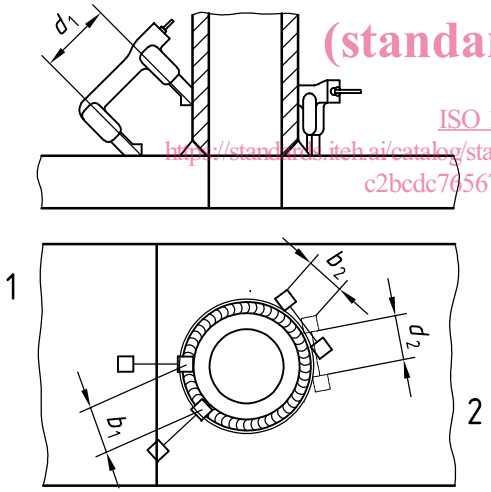


$d_1 \geqslant 75$

$b_1 \leqslant d_1/2$

$b_2 \leqslant d_2 - 50$

$d_2 \geqslant 75$

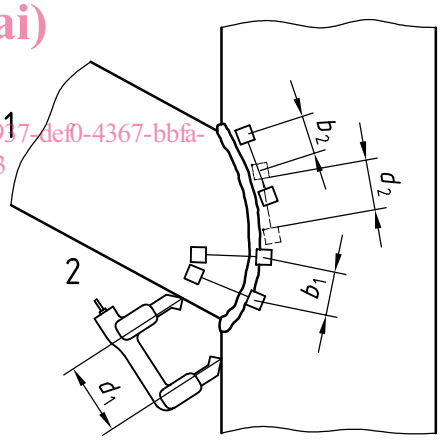


$d_1 \geqslant 75$

$d_2 \geqslant 75$

$b_1 \leqslant d_1/2$

$b_2 \leqslant d_2 - 50$



$d_1 \geqslant 75$

$d_2 > 75$

$b_1 \leqslant d_1/2$

$b_2 \leqslant d_2 - 50$

Key

1 longitudinal cracks

2 transverse cracks

Figure 4 — Typical magnetizing techniques for yokes