BS ISO 4986:2020

BSI Standards Publication

Steel and iron castings — Magnetic particle testing

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National foreword

This British Standard is the UK implementation of ISO 4986:2020. It supersedes BS ISO 4986:2010, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee ISE/111, Steel Castings and Forgings.

A list of organizations represented on this committee can be obtained on request to its secretary.

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© The British Standards Institution 2020
Published by BSI Standards Limited 2020

ISBN 978 0 580 97263 8

ICS 77.040.20; 77.140.80

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 29 February 2020.

Amendments/corrigenda issued since publication

Date	Text affected

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INTERNATIONAL STANDARD

ISO 4986

Third edition
2020-02

Steel and iron castings — Magnetic particle testing

Pièces moulées en acier et en fer — Contrôle par magnétoscopie

Reference number
ISO 4986:2020(E)

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Published in Switzerland

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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).

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For an explanation on the voluntary nature of standards, 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.

This document was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 11, *Steel castings*.

This third edition cancels and replaces the second edition (ISO 4986:2010), which has been technically revised. The main changes compared to the previous edition are as follows:

— addition of definition of a cluster of non-linear (SM) in 6.1.2;

— addition of “aligned (AM) indications” in 6.1.3, 6.2.3, 6.2.4, 7.1.3 and Annex C

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

This document complements the general principles of magnetic particle testing described in ISO 9934-1 with additional requirements of the steel foundry industry.

Magnetic particle testing, as well as any other non-destructive testing, is part of a general or specific assessment of the quality of a casting to be agreed between the purchaser and the manufacturer at the time of acceptance of the order.

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Steel and iron castings — Magnetic particle testing

1 Scope

This document specifies a method for the magnetic particle testing of ferro-magnetic steel and iron castings.

It also gives acceptance criteria through severity levels defined by the nature, the area and the dimensions of the discontinuities present.

This document is applicable to all ferro-magnetic castings, independent of the moulding method.

A steel and iron casting is considered to be ferro-magnetic if the magnetic induction is greater than 1 T (Tesla) for a magnetic field strength of 2,4 kA/m.

This document only applies to those areas of the castings specified for testing, as well as the percentage of castings to be tested.

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 4990, *Steel castings — General technical delivery requirements*

ISO 9712, *Non-destructive testing — Qualification and certification of NDT personnel*

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

3 Terms and definitions

No terms and definitions are listed in this document.

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 Ordering information

Subject to agreement between the manufacturer and the purchaser, enquiries and purchase orders for castings requiring magnetic particle testing should include the following information:

a) the area of the casting to be tested;

b) the qualification of the operators who will carry out the testing (see 5.2) or interpretation (see 7.2);

c) the frequency/number of castings to be tested;

d) the manufacturing stage, when magnetic particle testing is to be performed;

e) the required surface finish of the areas to be tested (see 5.3):

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f) if testing is to be performed in only one direction (see 5.1);

g) the method to be used (type of detection media);

h) whether or not the casting is to be demagnetized after testing has been performed (viz. maximum residual field strength values);

i) that test is to be carried out in accordance with ISO 9934-1;

j) the type of discontinuity;

k) the severity level.

The sensitivity can differ depending on the method of magnetic particle testing selected. Therefore, the severity levels required and the method shall be agreed between the manufacturer and the purchaser.

The severity level can vary depending on the method of magnetic particle testing selected and the area of the casting tested (see Tables 1 and 2).

The indications produced by magnetic particle testing can be compared to reference figures. The reference figures are included for convenience only. In the event of a dispute, reference shall be made to the tables.

5 Testing

5.1 Operating mode

The operating mode shall be agreed between the purchaser and the supplier. Unless otherwise specified (see Clause 4), it is necessary to carry out the test by magnetizing sequentially in two directions perpendicular to each other (see ISO 9934-1).

When the direction of stress is known, the test may be performed in one direction only, in order to take into account the most detrimental orientation of the indication.

NOTE The magnetic images are not necessarily corresponding to discontinuities as pseudo-defects can appear.

5.2 Qualification of the operators

Testing shall be performed by personnel qualified in accordance with ISO 9712 or equivalent recognised standards. The qualification level of the personnel shall be agreed between the manufacturer and the purchaser by the time of acceptance of the order.

5.3 Surface preparation

The surface to be tested shall be clean and free from oil, grease, sand, scale, moulding and coating residues, or any other contaminant which can interfere with the correct implementation and interpretation of the magnetic testing results. For small indications, it may be necessary to improve the surface condition. Annex A provides guidance on recommended surface finish for testing based on indication allowed.

The surface may be either shot blasted with round or angular shot, or sand blasted, or ground or machined so that the smallest relevant indication required can be evaluated.

The surface to be tested may be painted to provide a contrast before the test.

5.4 Conditions of testing

The testing shall be carried out unaided or at a maximum magnification of 3× under viewing conditions in accordance with ISO 3059.

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6 Acceptance criteria

6.1 Definition of magnetic particle testing indications

6.1.1 General

Indications revealed by the magnetic particle testing can have different shapes and sizes. An overview of types of indications is given in EN 1369. The distinction between linear and non-linear indications is made depending on the ratio of the length *L* of the indication to its width *W*, in the manner described in 6.1.2 and 6.1.3.

6.1.2 Non-linear indications (SM)

Indications are considered to be non-linear when the length *L* is smaller than three times the width *W*. Indications are considered to be clustered when the distance between non-linear indications is less than 2 mm and at least three indications are clustered. A cluster of indications is considered to be a single non-linear indication when its length is equal to the overall length *L* of the cluster specified in Table 1.

NOTE The symbol for nonlinear indications is SM (S for surface and M for magnetic particle).

Table 1 — Severity levels for magnetic particle testing — Non-linear (SM) indications (isolated)

Characteristic	Severity levels						
	SM 001	SM 01	SM 1	SM 2	SM 3	SM 4	SM 5
Testing means	Magnifying glass or eye		Eye				
Magnification for observation of penetrant indication	≤3		1				
Length L_1 of the smallest indication to be considered, in millimetres	0,3		1,5	2	3	5	5
Maximum number of nonlinear indications allowed	—	—	8	8	12	20	32
Maximum individual length L_2 allowed, in millimetres	0	1	3[a]	6[a]	9[a]	14[a]	21[a]

[a] A maximum number of two indications of the designated dimension are permitted.

6.1.3 Linear indications (LM) and aligned indications (AM)

The indications are considered to be linear when the length *L* is greater than or equal to three times the width *W*.

NOTE The symbol for linear indications is LM (L for linear and M for magnetic particle).

The lengths of linear indications greater than the length of smallest indication to be considered shall be added together and the result shall be compared to the total (T) length specified in Table 2.

Indications are considered to be aligned when the distance between two linear indications is smaller than the length *L* of the longest indication. An alignment of indications is considered to be a single linear indication and its length is equal to the overall length *L* of the alignment.

NOTE The symbol for aligned indications is AM (A for aligned and M for magnetic particle).

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Table 2 — Severity levels for magnetic particle testing — Linear (LM) and aligned (AM) indications

Characteristic		Severity levels											
		LM 001	LM 01	LM 1		LM 2		LM 3		LM 4		LM 5	
Testing means		Magnifying glass or eye		Eye									
Magnification for observation of magnetic particle indication		≤3		1									
Length L_1 of the smallest indication to be considered, in millimetres		0,3		1,5		2		3		5		5	
Acceptable indications Individual (I) or Total (T) length		I or T		I	T	I	T	I	T	I	T	I	T
Maximum length L_2 of linear (LM) and aligned (AM) indications allowed depending on the section thickness t, in millimetres[a]	section thickness type a $t \leq 16$ mm	0	1	2	4	4	6	6	10	10	18	18	25
	section thickness type b 16 mm < $t \leq 50$ mm	0	1	3	6	6	12	9	18	18	27	27	40
	section thickness type c $t > 50$ mm	0	2	5	10	10	20	15	30	30	45	45	70

NOTE 1 Only values expressed in this table are valid. Reference figures are for information only (see Annex C).

NOTE 2 The sensitivity can differ depending on the method of magnetic particle testing selected.

[a] No functional relationship exists between each type of section thickness and maximum crack length, relative to a fracture-mechanics study. However, this table is a useful guide where no relevant fracture-mechanics parameters currently exist.

6.2 Severity levels

6.2.1 General

The severity levels are a reference scale, each level depends on the type of indications.

6.2.2 Non-linear indications

The severity levels for non-linear indications (Table 1) are defined by:

a) the length (largest dimension) L_1 of the smallest indication to be considered, and

b) the maximum length L_2 of the indications.

6.2.3 Linear and aligned indications

6.2.3.1 General

The severity levels for linear indications (Table 2) are defined by:

a) the length (largest dimension) L_1 of the smallest indication to be considered,

b) the maximum length L_2 of the individual (I) linear indications, and

c) the total (T) of the lengths of the linear indications exceeding the length L_1 in a frame measuring 105 mm × 148 mm.

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