
Steel and iron castings — Magnetic particle testing

Pièces moulées en acier et en fer — Contrôle par magnétoscopie

iTeh Standards
(<https://standards.iteh.ai>)
Document Preview

[ISO 4986:2020](https://standards.iteh.ai/catalog/standards/iso/406f76d3-bcf6-461a-9a39-5822d6c76eb0/iso-4986-2020)

<https://standards.iteh.ai/catalog/standards/iso/406f76d3-bcf6-461a-9a39-5822d6c76eb0/iso-4986-2020>



iTeh Standards
(<https://standards.iteh.ai>)
Document Preview

[ISO 4986:2020](https://standards.iteh.ai/catalog/standards/iso/406f76d3-bcf6-461a-9a39-5822d6c76eb0/iso-4986-2020)

<https://standards.iteh.ai/catalog/standards/iso/406f76d3-bcf6-461a-9a39-5822d6c76eb0/iso-4986-2020>



COPYRIGHT PROTECTED DOCUMENT

© ISO 2020

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

Foreword	iv
Introduction	v
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Ordering information	1
5 Testing	2
5.1 Operating mode.....	2
5.2 Qualification of the operators.....	2
5.3 Surface preparation.....	2
5.4 Conditions of testing.....	2
6 Acceptance criteria	3
6.1 Definition of magnetic particle testing indications.....	3
6.1.1 General.....	3
6.1.2 Non-linear indications (SM).....	3
6.1.3 Linear indications (LM) and aligned indications (AM).....	3
6.2 Severity levels.....	4
6.2.1 General.....	4
6.2.2 Non-linear indications.....	4
6.2.3 Linear and aligned indications.....	4
6.2.4 Selection of the severity level.....	5
6.2.5 Designation of severity levels.....	5
7 Classification of the indications and interpretation of results	5
7.1 Classification of the indications using Tables 1 and 2	5
7.1.1 General.....	5
7.1.2 Non-linear indications.....	5
7.1.3 Linear and aligned indications.....	6
7.2 Interpretation of results.....	6
8 Cleaning after examination and demagnetization	6
9 Test report	6
Annex A (informative) Recommended surface finish for magnetic particle testing	8
Annex B (informative) Reference figures — Non-linear indications (SM)	9
Annex C (informative) Reference figures — Linear (LM) and aligned (AM) indications	14
Annex D (informative) Model of a magnetic particle test report	29
Bibliography	31

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.

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).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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.

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.

iTeh Standards
(<https://standards.iteh.ai>)
Document Preview

[ISO 4986:2020](https://standards.iteh.ai/catalog/standards/iso/406f76d3-bcf6-461a-9a39-5822d6c76eb0/iso-4986-2020)

<https://standards.iteh.ai/catalog/standards/iso/406f76d3-bcf6-461a-9a39-5822d6c76eb0/iso-4986-2020>

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):

- 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.

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).

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 $16 \text{ mm} < t \leq 50$ 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

ISO 4986:2020

<https://standards.iteh.ai/catalog/standards/iso/406f76d3-bcf6-461a-9a39-5822d6c76eb0/iso-4986-2020>

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:

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

- the length (largest dimension) L_1 of the smallest indication to be considered,
- the maximum length L_2 of the individual (I) linear indications, and
- the total (T) of the lengths of the linear indications exceeding the length L_1 in a frame measuring 105 mm × 148 mm.

6.2.3.2 Section thickness type

Three section thickness types are specified (see [Table 2](#)):

- a) $t \leq 16$ mm;
- b) $16 \text{ mm} < t \leq 50$ mm;
- c) $t > 50$ mm;

where t is the section thickness.

6.2.4 Selection of the severity level

The severity levels shall be selected from [Tables 1](#) and/or [2](#). The reference figures in [Annexes B](#) and [C](#) are drawn to a scale of 1:1 and are given as examples. The largest non-relevant indication is shown in a 26 mm × 37 mm frame corresponding to the ISO format A10.

[Table 1](#) and [Annex B](#) correspond to non-linear (SM) indications (isolated).

[Table 2](#) and [Annex C](#) correspond to linear (LM) and aligned (AM) indications.

NOTE Note that several equivalent severity levels defined in [Table 2](#) are represented by the same reference figure. In certain cases, the equivalence of the figure is only approximate because of slight differences in the parameters in [Table 2](#).

The severity levels cannot be considered in the same progression from [Table 1](#) to [Table 2](#). They should not be considered equivalent as regards severity. The severity criteria and the severity levels can differ from one part of a casting to another.

The choice of the reference figure depends on the section thickness type.

6.2.5 Designation of severity levels

The requirements in the order or in the specifications shall conform to the terminology used in this document. <http://standards.iteh.ai/catalog/standards/iso/406f76d3-bcf6-461a-9a39-5822d6c76eb0/iso-4986-2020>

Examples of correct terminology are given below:

- non-linear indications, level 2: SM 2 for non-linear indications with a maximum of 8 non-linear indications, L1 of 2 mm and L2 of 6 mm (see [6.1.2](#) and [Table 1](#));
- linear indications, level 5: LM 5c for linear indications and $t > 50$ mm with L1 of 5 mm and L2 of 45 mm for individual indications or 70 mm for total indications (see [6.1.3](#) and [Table 2](#)).

7 Classification of the indications and interpretation of results

7.1 Classification of the indications using [Tables 1](#) and [2](#)

7.1.1 General

In order to classify an indication, it is necessary to place a 105 mm × 148 mm frame in the most unfavourable location, i.e. showing the greatest severity for discontinuities.

7.1.2 Non-linear indications

Only indications with a length greater than L_1 shall be taken into account (see [Table 1](#)).

The length of these indications shall be measured.