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Steel and iron castings — Liquid penetrant testing

Pièces moulées en acier et en fer — Contrôle par ressuage

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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 of 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 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 4987:2010), which has been technically revised. The main changes compared to the previous edition are as follows:

— isolated non-linear indications are defined in 6.1.2;

— definition of aligned linear indications in 6.1.3 is corrected

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.

This corrected version of ISO 4987:2020 incorporates the following corrections:

— the main title has been corrected from "Steel castings" to "Steel and iron castings";

— in the Scope, the sentence has been corrected to read: "This document specifies a method for the liquid penetrant testing of steel and iron castings".

Introduction

This document complements the general principles of liquid penetrant testing described in ISO 3452-1 with additional requirements of the steel foundry industry.

Liquid penetrant 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.

Steel and iron castings — Liquid penetrant testing

1 Scope

This document specifies a method for the liquid penetrant testing of steel and iron castings.

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 3452-1, *Non-destructive testing — Penetrant testing — Part 1: General principles*

ISO 4990, *Steel castings — General technical delivery requirements*

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

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:

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

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

4 Ordering information

Subject to agreement between the manufacturer and the purchaser, enquiries and purchase orders for castings requiring liquid penetrant 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 liquid penetrant testing is to be performed;

e) the required surface finish of the areas to be tested;

f) the type of discontinuity;

g) the severity level.

The sensitivity can differ depending on the method of liquid penetrant testing selected. Therefore, the severity levels required shall be selected as a function of the liquid penetrants used and the method agreed between the manufacturer and the purchaser.

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

5 Testing

5.1 Operating mode

Testing shall be carried out as specified in ISO 3452-1.

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 purchaser by the time of the acceptance of the order.

5.3 Surface preparation

The surface to be tested shall be clean and free from oil, grease, moulding and coating residues, or any other contaminant which could interfere with the correct implementation and interpretation of the penetrant 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.

Surface treatment or cleaning techniques which may seal or close discontinuities are not allowed.

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 liquid penetrant indications

6.1.1 General

Indications revealed by the liquid penetrant testing can have different shapes and sizes. The distinction between the 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 (SP)

Indications are considered to be non-linear when the length *L* is smaller than three times the width *W*. Indications are considered to be aligned when the distance between non-linear indications is less than 2 mm and at least three indications are aligned. An alignment of indications is considered to be a unique non-linear indication and its length is equal to the overall length *L* of the alignment specified in Table 1. Non-linear indications that are not aligned are considered to be isolated.

NOTE The symbol for non-linear indications is SP (S for surface and P for liquid penetrant).

Table 1 — Severity levels for liquid penetrant testing — Non-linear (SP) indications (isolated)

Characteristic	Severity levels						
	SP 001	SP 01	SP 1	SP 2	SP 3	SP 4	SP 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	0,5	1,5	2	3	5	5
Maximum number of non-linear indications allowed	5	6	8	8	12	20	32
Maximum individual length L_2 allowed, in millimetres	1	2	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 indication (LP)

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

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

Table 2 — Severity levels for liquid penetrant testing — Linear (LP) indications

Characteristic		Severity levels											
		LP 001	LP 01	LP 1		LP 2		LP 3		LP 4		LP 5	
Testing means		Magnifying glass or eye		Eye									
Magnification for observation of penetrant indication		≤3		1									
Length L_1 of 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 (LP) 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

[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.

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

NOTE The symbol for linear indications is LP (L for linear and P for liquid penetrant).

6.2 Severity levels

6.2.1 General

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

6.2.2 Non-linear indications

For the non-linear indications, the severity levels (see 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 indications

6.2.3.1 General

The severity levels for linear indications (see 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 linear individual (I) 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.

6.2.3.2 Section thickness type

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

a) $t \leq 16$ mm;

b) 16 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 as seen in, if necessary, the reference figures given in Annexes B and C. The reference figures 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 (SP) indications (isolated).

Table 2 and Annex C correspond to linear (LP) 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.

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.

Examples of correct terminology are given below:

— SP 2 for non-linear indications with a maximum of 8 non-linear indications, L_1 of 2 mm and L_2 of 6 mm (see 6.1.2, 6.2, and Table 1);

— LP 5c for linear indications and t > 50 mm with L_1 of 5 mm and L_2 of 45 mm for Individual indications or 70 mm for Total indications (see 6.1.3, 6.2, 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 those indications with a length greater than L_1 shall be considered (see Table 1).

The length of these indications shall be measured.

The severity level of the SP indications shall be established using Table 1.

7.1.3 Linear indications

Only the indications with a length greater than L_1 shall be considered. The length L of the isolated indications greater than the minimum length taken into account, defined by the required severity level, shall be measured. The sum of the indications included in a 105 mm × 148 mm frame shall be calculated.

The section thickness t at the testing location shall be measured.

The level of the LP indications shall be established using Table 2.

The lengths of the linear indications greater than the minimum length shall be summated and the result shall be compared to the total (T) length specified in Table 2.

7.2 Interpretation of results

The casting shall be considered to conform with this document when the observed severity level is equal to or better than that specified in the order. If, for any indication type, the observed severity level is worse than that specified in the order, the casting shall be considered not to conform with this document.

NOTE Non-linear indications and linear indications can appear on the same part of the casting.

8 Retesting

Retesting shall be in accordance ISO 3452-1.

9 Post-examination cleaning procedures

Post-examination cleaning procedures shall be in accordance with ISO 3452-1.

10 Test report

When a test report is specified in the enquiry and the order, it shall contain at least the following information:

a) the manufacturer;

b) the purchaser (including the order number);

c) the casting designation;

d) the date and place of the test;

e) the traceability identification;

and, as applicable, any of the following:

— a reference to this document for the acceptance criteria;

— the position of the testing stage in the manufacturing process;

— the surface finish;

— the test method;

— the equipment used;

— the testing materials used;

— the criteria required in accordance with this document;

— the reference to a specification;

— the results (description and location);

— the cartography of the significant indications;

— the decision taken after the interpretation of results;

— the elements required in ISO 4990 (type of document, signature(s) of the authorized persons according to the type of document);

— the certification/qualification, name and the signature of the non-destructive testing operator.

A model of a bilingual test report is shown in Annex D.

