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Steel castings - Penetrant inspection

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Reference number ISO 4987:1992(E)

Foreword

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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 VIEW bodies casting a vote.

International Standard ISO 4987 was prepared by Technical Committee ISO/TC 17, Steel, Sub-Committee SC 11, Steel castings. ISO 4987:1992

Annexes A, B, C and D of this international Standard are for information -aa77-4f15-914conly. a5aab95f3bc0/iso-4987-1992

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International Organization for Standardization

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Steel castings — Penetrant inspection

1 Scope

This International Standard specifies a test method for determining the acceptance limits of surface discontinuities detected by liquid penetrant inspection, when such an inspection procedure has been contractually agreed upon at the request of the purchaser. It applies to all steel castings, whatever casting process is used.

NOTE 1 It should be remembered that liquid penetrant inspection, like all methods of non-destructive inspection, R forms part of an overall or special assessment which is defined in the contract.

spected. The conditions shall be clearly indicated on the enquiry, in the request for prices and, more particularly, in the order sent to the supplier and accepted by him.

The manufacturing stage(s) at which the inspection is to be carried out shall be clearly defined by agreement between the parties concerned.

For each part of the castings to be inspected, the following shall be indicated:

is ____ the severity level (see table 1);

standards.itch.aj) the type of discontinuity indication (linear or non-linear) (see annex A). ISO 4987:1992

2 Normative references

The following standards contain provisions which inderds through reference in this text, constitute provisions of soof this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 3452:1984, Non-destructive testing — Penetrant inspection — General principles.

ISO 3453:1984, Non-destructive testing — Liquid penetrant inspection — Means of verification.

3 Conditions of liquid penetrant inspection

This International Standard only applies to the parts of castings and the percentage of castings to be in-

The following standards contain provisions which ndards/sEor 7 each 3 part of 5 the 4 casting, the severity level through reference in this text, constitute provisions 0/iso-4 should be separately specified for each discontinuity of this International Standard. At the time of public type. (For surface condition, see 4.3.)

Unless otherwise specified, the severity level applies both to linear or aligned indications and to non-linear indications (clusters).

The test is considered to be satisfactory if the discontinuity indications obtained are of levels below or equal to those selected from table 1 and in accordance with clause 6.

If not, it shall be the responsibility of the founder to bring the casting into conformity with the specification defined above, by a method approved by the purchaser.

In general, there is no limit to the extent of discontinuities acceptable in a casting, provided that in the casting as a whole no area of $105 \text{ mm} \times 148 \text{ mm}^{11}$ contains discontinuities which exceed the severity level specified.

¹⁾ Format ISO A6.

Table 1 — Severity levels for liquid penetrant inspection

This table fixes the number and/or the maximum permissible dimension, diameter or length, in millimetres, within the frame ISO A6 - 105 mm \times 148 mm.

| Sever | ity levels | 001 | 01 | 1 | | 2 | | n | | 4 | _ | 5 | |
|--|---|--|---|----------------------------------|-------------------------|------------------------|-----------------|---------------|-----------------|---------------|-----------------|---------------|-----------------|
| Means of obser | ving indications | Magnifyin | g glass or e ¹⁾ | D P R | e | EV K W | Ø | Ey | Q | Ē | e | Ey | υ |
| Magnification | | > | 3 | | | 1 | | £- | | 4 | | ſ | |
| Diameter (D) or smallest image | r length (L) of the considered (mm) | | uarus 3 | | 31) | 2 | | n | | LC . | | Þ | |
| Non-linear indications | Number of indi- cations://standarc | ds. it ch.Si/c ata | 09/ 3120 4987; 09/ 3120/4 84 | <u>992</u> 'sist/27428 | ad3-aa77- | -4f15-9 1 4 | Ł | | 7 | - 20 | | - 32 | |
| (SR) ²⁾ | Dimensions (mm) | t ≥ | L ≥ | | 3 6 | V | <u>و</u> | V | თ | V | 14 | V | Σ. |
| | Indication type | Isolated or cumu- lative | Isolated or cumu- lative | lso- lated | Cumu- lative | lso- lated | Cumu- lative | lso- lated | Cumu- lative | lso- lated | Cumu- lative | lso- lated | Cumu- lative |
| Linear indi- cations (LR) ³⁾ | Wall thickness δ ≤ 16 mm | o | ۲ | C) | 4 | 4 | Q | w | 6 | 10 | 18 | 18 | 25 |
| or aligned (AR) ⁴⁾ | Wall thickness 16 mm < δ ≼ 50 mm | 0 | - | m | ω | ω | 5 | თ | 18 | 18 | 27 | 27 | 64 |
| | Wall thickness δ > 50 mm | 0 | N | w | 10 | 10 | 50 | 15 | 8 | ß | \$ | \$ | 20 |
| | | Fabrication craft or spe | for air- ace craft: | | | | | | | | | | |
| Examples of ca: castings concer | stings or parts of ned | lost wax | casting | U | Other mect | hanical enç | gineering c | astings ac | cording to | surface fii | nish and al | oplication | |
| | | - special a | appli- | | | | | | | | | | |
| The use of Non-linear i | a magnifying instru indications (SR): <i>L</i> < | ment with a r < 3 <i>b</i> where <i>L</i> | neasuring gra | aticule is p and <i>b</i> the | ermitted. larger ind | ication. | | | | | | | |
| 3) Linear indic | ations (LR): L > 3b | | | | | | | | | | | | |
| 4) Aligned indi | ications (AR): linear | ', or non-line | ar, separated | by a maxi | mum of 2 1 | mm and co | mprising a | it least thr | ee indicati | ons. | | | A |

4 Method of inspection

4.1 Operating mode

The general principles and the means of verification of penetrant inspection are described in ISO 3452 and ISO 3453 respectively.

They are supplemented by the specific requirements which appear in annex B.

4.2 Qualification of the operators

The tests shall be carried out and interpreted by technically competent operators whose qualifications shall be agreed upon at the time of the enquiry or order.

4.3 Surface condition

The surface to be examined shall be clean, free from oil, grease, sand or scale or any other condition R which could interfere with the correct interpretation of penetrant indications. It shall be sand or shot CS blasted (round or angular shot), ground or machined in line with the severity level demanded (see 5.2)

in line with the severity level demanded (see 5.2) <u>4987:19</u> able 1 shows the minimum length below which the The required surface finish of the areas of the casting to be inspected shall be subject to agreement⁰/iso-49the respective category.

4.4 Conditions of examination

The inspections shall be carried out with the naked eye or at a maximum magnification of $3 \times$ (see table 1).

5 Acceptance test

5.1 **Discontinuity indications**

Penetrant inspection is a means of non-destructive inspection which is used solely to reveal the presence or absence of discontinuities open to the surface. Penetrant inspection does not enable the nature, shape and the dimensions of the discontinuities revealed to be determined. The discontinuity indications are linear² or aligned³, or non-linear. The dimensions of the discontinuity indications do not directly represent the actual dimensions of the discontinuity. The different types of penetrant indications are listed in annex A.

5.2 Severity levels

Seven severity levels are recognized in accordance with table 1. Depending on the severity level required, it is necessary to carry out the test on a surface corresponding to a given degree of finish (see annex C):

- precision;
- smooth;
- rough.

The maximum permissible length for linear or aligned indications varies with the casting section thickness δ . Three thickness categories are specified:

 $\begin{array}{l} - \delta \leq 16 \text{ mm} \\ \hline \mathbf{D} \mathbf{PREVIEW} \\ - 16 \text{ mm} < \delta \leq 50 \text{ mm} \\ \hline \mathbf{iteh.ai} \\ - \delta > 50 \text{ mm} \end{array}$

Examples of non-linear indications, given to a scale of 1, are shown in annex D. These have been established in accordance with table 1.

6 Interpretation of results

In order to classify discontinuity indications obtained by liquid penetrant inspection of the casting, it is necessary to place a frame measuring $105 \text{ mm} \times$ 148 mm positioned in the most unfavourable location relative to the indications being evaluated. The test is considered satisfactory if the indications being evaluated are less severe or equal to those specified in the order.

Indications are equivalent when they show the same clusters of non-linear indications or the same length of linear indications of similar appearance.

The types of indications are given only as a guide and the classification by severity level is based on the length of the discontinuities, in accordance with table 1.

²⁾ The largest dimension L (length) is at least three times the smallest b (width) ($L \ge 3b$). (See table 1.)

³⁾ See note 4 of table 1.

Aligned and non-aligned indications shall be taken into account for the calculation of the cumulative length.

7 Order

The enquiry and/or order shall specify the following points:

- a) the parts of castings and percentage of castings to be inspected (see clause 3);
- b) the manufacturing stage(s) at which the inspection is to be carried out, as agreed between the parties concerned (see clause 3);

- c) the surface condition for the areas to be inspected (see 4.3);
- d) the type of discontinuity indication and the severity level for each part of casting to be inspected (see clause 3 and 5.2);
- e) the qualification of the operators carrying out the inspection (see 4.2).

8 Additional test for cleaning after inspection

The requirements given in ISO 3452 are also appropriate to this International Standard.

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Annex A

(informative)

Nature of discontinuities — Types of indication

| Nature of discontinuities | Nomenclature | Indications | Туре | Definition | |
|--|--------------------------|---|--------------------|--------------|--|
| Blowholes | | Non-linear | SR | L < 3b | |
| Pinholes | A | Aligned | AR | <i>d</i> < 2 | |
| Sand spots | 5 | Non-linear | SR | L < 3b | |
| Inclusions | В | Aligned | AR | <i>d</i> < 2 | |
| | | Linear | LR | $L \ge 3b$ | |
| Shrinkage | С | Non-linear | SR | L < 3b | |
| | | Aligned | AR | <i>d</i> < 2 | |
| Tears | D | Linear | LR | $L \ge 3b$ | |
| 1 | Teh STAN | Digned D PREV | EWAR | <i>d</i> < 2 | |
| Cracks | (stand | ainears.iteh.ai) | LR | $L \ge 3b$ | |
| or dono | (2 | Aligned | AR | <i>d</i> < 2 | |
| https:// | tandards iteh ai/catalor | SO 4987:1992 Linear t/standards/sist/27429ad3_aa7 | 7_4f15_9 LR | $L \ge 3b$ | |
| Remains of core support | F a5aab9 | Non-linear ₉₈₇₋₁₉₉₂ | SR | L < 3b | |
| | | Aligned | AR | <i>d</i> < 2 | |
| | | Linear | LR | $L \ge 3b$ | |
| Remains of internal chills | G | Non-linear | SR | L < 3b | |
| | | Aligned AR | | <i>d</i> < 2 | |
| Cold shute | L | Linear | LR | $L \ge 3b$ | |
| | <u>п</u> | Aligned | AR | <i>d</i> < 2 | |
| L = length of indication | I | | | | |
| The second state of the terms of the second state of the second st | | | | | |

b = width of indication

d - distance, in millimetres, between two indications, edge-to-edge

Annex B

(informative)

Liquid penetrant examination test method — Specific requirements for cast steels

- a) The halogens and sulfur content of the products employed shall be less than 1 %.
- b) The impregnation time shall be not less than that recommended by the penetrant manufacturer.
- c) The temperature of application shall be between 10 $^\circ\text{C}$ and 50 $^\circ\text{C}.$
- d) Rinsing with water shall be performed at pressures below 200 kPa (2 bars) and the water temperature shall be less than 40 °C.
- e) Drying shall be carried out with clean and "dry" air at pressures below 200 kPa (2 bars) and at a temperature below 70 °C.
- f) The development time is generally between 15 min and 30 min.

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Annex C

(informative)

Equivalence of surface conditions (as a guide)

| Surface condition | Precision | | | | Smooth | | | | Rough | | | |
|-------------------------------------|--|------------------------------|--|---|-----------------|--|------------------------------|--|-----------------------------|--|--------------------------|-------------------|
| Roughness R_a (µm) ¹⁾ | 1, | ,6 | 3 | ,2 | 6 | ,3 | 12 | ,5 | 2 | 5 | > | 25 |
| Surface preparation | Very smooth grinding Smooth precision | Very smooth shot blasting | Very smooth grinding Very smooth machining Precision | Smooth shot blasting Investment cast | Smooth grinding | Smooth shot blasting Precision cast (ceramic) | Grinding Smooth machining | Smooth shot blasting Precision cast (shell moulded, ceramic) | Grinding Rough machining | Medium shot blasting Careful moulding | Rough preparation | Sand cast |
| BNIF 341-02 |] | iTeh | ST A | ND | 152 ARI |) PR | 2S2 3S2 EVI | 151 EW | 4S2 5S2 | 2S1 3S1 | 153 253 553 653 | 4S1 5S1 6S1 |
| ACI | | — | (sta | inda | rds.i | t81. | ai) | SIS3 | | SIS4 | - | |
| CSC (Cast Surface Comparator) | | e://standau | rds iteh ai∕ | C30 ISO | 4987:19 | 92 C40 st/27429: | | C70 4f] 5-914 | | C90 | _ | _ |
| SCRATA | 1 | | _ a: | 5aab95f31 | oc0/iso-49 | 87- <u>1</u> 992 | _ | A1 | H1 H2 | A2 A3 | G2 G3 | A4 C3 D3 |
| LCA 2 Grinding | 15 | | 16 | | 17 | - | 18 | _ | 19 | | | |
| LCA 3 Shot blasting | _ | N7 (15) | | N8 (16) | _ | N9 (17) | — | N10 (18) | - | N11 (19) | | — |
| 1) The roughness val | ues R _a inc | dicated in | this table | are those | e given b | y the mar | ufacturer | s of small | plates. | | | - |
| S1: As cast or shot bla | asted | | | | | | | | | | | |

S2: Ground