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Non-destructive testing — Penetrant testing —

Part 1: General principles

Essais non destructifs — Examen par ressuage —

Partie 1: Principes généraux

ICS: 19.100

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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.

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 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 the European Committee for Standardization (CEN) Technical Committee CEN/TC 138, *Non-destructive testing*, in collaboration with ISO Technical Committee ISO/TC 135, *Non-destructive testing*, Subcommittee SC 2, *Surface methods*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 3452-1:2013) which has been technically revised. Changes from the first edition include a table referring to the testing products.

The main changes compared to the previous edition are as follows:

— clarification of understanding of product family

— new procedure “no developer” added

— technically revised according to the state of the art.

A list of all parts in the ISO 3452 series can be found on the ISO website.

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.

Non-destructive testing — Penetrant testing —

Part 1: General principles

1 Scope

This part of ISO 3452 specifies a method of penetrant testing used to detect discontinuities, e.g. cracks, laps, folds, porosity and lack of fusion, which are open to the surface of the material to be tested using white light or UV-A (365 nm) radiation. It is mainly applied to metallic materials, but can also be performed on other materials, provided that they are inert to the test media and not excessively porous (castings, forgings, welds, ceramics, etc.)

It also includes requirements for process and control testing, but is not intended to be used for acceptance criteria and gives neither information relating to the suitability of individual test systems for specific applications nor requirements for test equipment.

NOTE 1 Methods for determining and monitoring the essential properties of penetrant testing products to be used are specified in ISO 3452-2 and ISO 3452-3.

NOTE 2 The term *discontinuity* is used in this part of ISO 3452 in the sense that no evaluation concerning acceptability or non-acceptability is included.

NOTE 3 CEN/TR 16338 addresses penetrant testing using actinic blue light.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 3452-2, *Non-destructive testing — Penetrant testing — Part 2: Testing of penetrant materials*

ISO 3452-3, *Non-destructive testing — Penetrant testing — Part 3: Reference test blocks*

ISO 3452-4, *Non-destructive testing — Penetrant testing — Part 4: Equipment*

ISO 3452-5, *Non-destructive testing — Penetrant testing — Part 5: Penetrant testing at temperatures higher than 50 degrees C*

ISO 3452-6, *Non-destructive testing — Penetrant testing — Part 6: Penetrant testing at temperatures lower than 10 degrees C*

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

ISO 12706, *Non-destructive testing — Penetrant testing — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12706 apply.

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 Safety precautions

As penetrant inspection techniques often require the use of harmful, flammable and/or volatile materials, safety regulations shall be taken into account.

Prolonged or repeated contact of these materials with the skin or any mucous membrane should be avoided. Working areas shall be adequately ventilated and sited away from sources of heat, sparks or naked flames in accordance with all applicable safety regulations.

The penetrant testing products and equipment shall be used with care and always in compliance with the instructions supplied by the manufacturer.

UV-A sources shall always be maintained in a good condition.

In addition to the need to follow legislation (e.g. optical radiation legislation), care shall be taken to ensure the safe implementation of the method.

5 General principles

5.1 Personnel

Testing shall be carried out by proficient, suitably trained and qualified personnel and, where applicable, shall be supervised by competent personnel nominated by the employer or, by delegation of the employer, the inspection company in charge of testing. To demonstrate appropriate qualification it is recommended that personnel be certified according to ISO 9712 or an equivalent formalized system. Penetrant testing operations, unless otherwise agreed, shall be authorized by a competent supervisory individual (Level 3 or equivalent) approved by the employer.

5.2 Description of the method

Prior to penetrant testing the surface to be inspected shall be clean and dry. Suitable penetrants are then applied to the test area and enter into discontinuities open to the surface. After the appropriate penetration time has elapsed the excess penetrant is removed from the surface and the developer applied. The developer absorbs the penetrant that has entered and remains in the discontinuities and may give a clearly visible enhanced indication of the discontinuity.

Should complementary NDT be required, it is preferable that the penetrant inspection is performed first, so as not to introduce contaminants into open discontinuities. If penetrant inspection is used following another NDT technique or method, the surface shall be cleaned carefully to remove contaminants before application.

5.3 Process sequence

The penetrant process shall be continuous with no undue delays between the stages. If process parameters are not met, surfaces shall be cleaned and reprocessed.

Testing generally proceeds through the following stages:

a) preparation and precleaning (see 8.2);

b) application of penetrant (see 8.4);

c) excess penetrant removal (see 8.5);

d) application of developer (see 8.6);

e) inspection (see 8.7);

f) postcleaning and protection (see 8.8).

See Annex A.

5.4 Equipment

The equipment used for carrying out penetrant testing depends on the number, size, weight and shape of the parts to be tested. The equipment shall be as specified in ISO 3452-4.

5.5 Effectiveness

The effectiveness of the penetrant testing depends upon many factors, including

a) types of penetrant materials and testing equipment,

b) surface preparation and condition;

c) material under examination and expected discontinuities,

d) temperature of the test surface,

e) penetration and development time, and

f) viewing conditions.

Control checks shall be carried out to demonstrate that the correct testing parameters are used. See Annex B.

6 Products, sensitivity and designation

6.1 Product family

Various test systems exist in penetrant testing. The penetrant testing system and the product family shall be selected according to the application. Various factors have an impact on the effectiveness and sensitivity of the process, e.g. the surface roughness and condition, size and shape of the parts to be tested and the sensitivity level of the product family. For example using a high sensitivity penetrant on a rough surface may result in a less sensitive test than using a lower sensitive penetrant.

A product family is understood as a combination of the following penetrant testing materials: penetrant, excess penetrant remover (except method A) and developer. A product family may be defined by the manufacturer, user or inspection authority and does not necessarily have to be from the same manufacturer.

6.2 Testing products

The products used for testing are given in Table 1.

6.3 Sensitivity

Sensitivity levels shall be determined according to ISO 3452-2. By using specific product families different sensitivity levels may be achieved. Therefore ISO 3452-2 describes penetrant baseline sensitivity and product family sensitivity.

6.4 Designation

The product family to be used for penetrant testing is given a designation comprising the type, the method and the form for the testing products, and a figure which indicates the sensitivity level achieved by testing according to ISO 3452-2.

EXAMPLE A product family comprising fluorescent penetrant (I), water as the excess penetrant remover (A), dry-powder developer (a), and system sensitivity of level 2 gives the following penetrant testing system designation when using ISO 3452-1 and ISO 3452-2: product family ISO 3452-2, IAa Level 2.

Table 1 — Testing products/procedures

Penetrant		Excess penetrant remover		Developer	
Type	**Denomination**	**Method**	**Denomination**	**Form**	**Denomination**
I	Fluorescent	A	Water	a	Dry
II	Colour contrast	B	Lipophilic emulsifier	b	Water soluble
III	Dual purpose (fluorescent and colour contrast)	C	Solvent	c	Water suspendable
		D	Hydrophilic emulsifier	d	Solvent based (non-aqueous for Type I)
		E[a]	Water and solvent	e	Solvent based (non-aqueous for Types II and III)
				f	Special application
				g[b]	No developer

For specific cases, it is necessary to use penetrant testing products complying with particular requirements with regards to flammability, sulfur, halogen and sodium content and other contaminants. See ISO 3452-2.

[a] Method E relates to the use of two products, both water and solvent. Penetrant materials qualified for method A are also considered qualified for method E.

[b] For form g, development time is required, see 8.6.1.

7 Compatibility

7.1 General

The penetrant testing products shall be compatible with each other and the material to be tested. The use for which the part or parts is designed shall also be considered.

7.2 Compatibility of penetrant testing products

Drag-out losses shall be replaced with the same product, which may be from a different batch.

7.3 Compatibility of penetrant testing products and the material to be tested

7.3.1 In most cases the compatibility can be assessed prior to use by means of the corrosion tests detailed in ISO 3452-2.

7.3.2 The wettability of the test surface using the selected penetrant testing product shall be established before testing.

7.3.3 The chemical or physical properties of some non-metallic materials can be adversely affected by penetrant testing materials; their compatibility has to be established before inspecting parts manufactured from, and assemblies that include such materials.

7.3.4 In situations where contamination might occur, it is essential to ensure that the penetrant testing materials do not have a deleterious effect on fuels, lubricants, hydraulic fluids, etc.

7.3.5 For parts associated with peroxide rocket fuel, explosive stores (these include all items containing explosive propellant, initiating or pyrotechnic materials), oxygen equipment or nuclear applications the compatibility of penetrant testing materials shall be given special consideration.

8 Test procedure

8.1 Written test procedure

All testing shall be performed in accordance with an approved written documentation, either specifically prepared or included in the relevant product standard. The written test procedure shall also include all relevant parameters for testing, e.g. temperatures, times, pressures. When generating test procedures the product manufacturers recommendations shall be taken into account.

8.2 Precleaning

8.2.1 General

Contaminants such as scale, rust, oil, grease, paint and water shall be removed — if necessary using mechanical or chemical methods, or a combination of these. Precleaning shall ensure that the test surface is free from residues and that it allows the penetrant to enter any discontinuity. The cleaned area shall be large enough to prevent interference from areas adjacent to the actual test surface.

8.2.2 Mechanical precleaning

Scale, slag, rust, etc., shall be removed using suitable methods such as brushing, rubbing, abrasion, blasting or high-pressure blasting (water or ice pellets). These methods remove contaminants from the surface and generally are incapable of removing contaminants from within surface discontinuities. In all cases care shall be taken to ensure that the discontinuities are not masked by plastic deformation or clogging from abrasive materials. If necessary to ensure that discontinuities are open to the surface, subsequent etching treatment shall be carried out, followed by adequate rinsing and drying.

8.2.3 Chemical precleaning

Chemical precleaning shall be carried out, using suitable chemical cleaning agents, to remove residues such as grease, oil, paint or etching materials.

Residues from chemical precleaning processes can react with a penetrant and greatly reduce its sensitivity. Therefore, chemical agents shall be removed from the surface under examination, after the cleaning process, using suitable cleaning methods.

8.2.4 Drying

As the final stage of pre-cleaning, the parts to be tested shall be thoroughly dried, so that neither water nor solvent remains on the test surface and in the discontinuities.

8.3 Temperature

The testing materials, the test surface and the ambient temperature shall be within the range from 10 °C to 50 °C, except for the drying process (8.2.4). Rapid temperature changes can cause condensation, which may interfere with the process and should be avoided.

For temperatures outside the range 10 °C to 50 °C, inspection shall be carried out in accordance with ISO 3452-5 or ISO 3452-6, as applicable.