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Non-destructive testing — Penetrant testing —

Part 1: General principles

Essais non destructifs — Examen par ressuage —

Partie 1: Principes généraux

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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 Technical Committee ISO/TC 135, *Non-destructive testing*, Subcommittee SC 2, *Surface methods,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 138, *Non-destructive testing,* 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.

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

— clarification of understanding of product family;

— addition of the new procedure “no developer”;

— technical revision 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 document 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.)

This document also includes requirements for process and control testing, but is not intended to be used for acceptance criteria. It 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 document in the sense that no evaluation concerning acceptability or non-acceptability is included.

NOTE 3 CEN/TR 16638 addresses penetrant testing using actinic blue light.

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 3452-2, *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 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 (e.g. optical radiation legislation) 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, taking into account 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.

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 to 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 penetrant is then applied to the test area and enter 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 non-destructive testing (NDT) be required, it is preferable that the penetrant inspection be 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 corrosion protection (see 8.8).

The process shall be as given in 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;

f) viewing conditions.

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

6 Products, sensitivity and designation

6.1 Product family

Various test systems exist in penetrant testing. The penetrant 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 the testing materials do not necessarily have to be from the same manufacturer, but shall be type tested in accordance with ISO 3452-2.

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. 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 a fluorescent penetrant (I), water as the excess penetrant remover (A), and a dry-powder developer (a), and having a 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 (type I only)

NOTE 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. When parts are not visible during penetrant application (e.g. automated systems), the wettability of the penetrant on the test surface shall be visually checked before testing on a representative sample.

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

7.3.4 In situations where contamination can occur, it is essential to ensure that the penetrant testing products 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 products 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 manufacturer's 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 precleaning, 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 from 10 °C to 50 °C, inspection shall be carried out in accordance with ISO 3452-5 or ISO 3452-6, as applicable.

8.4 Application of penetrant

8.4.1 Methods of application

Penetrant can be applied to the part to be tested by spraying, brushing, flooding, dipping or immersion.

Penetrant shall remain on the test surface throughout the entire penetration time.

8.4.2 Penetration time

The appropriate penetration time depends on the properties of the penetrant, the application temperature, the material of the part to be tested and the discontinuities to be detected.

The penetration time shall be between 5 min and 60 min and shall not be less than the manufacturer's recommended time for the required sensitivity. The penetration time shall be defined in the written test procedure.

8.5 Excess penetrant removal

8.5.1 General

The excess penetrant removal shall be such that penetrant remains in the discontinuities.

8.5.2 Water

When water is used for removal it shall be applied by wiping, immersion or spray. Care shall be exercised to avoid overwashing for example by the use of high-pressure spray, excessive time or excessive mechanical action. When wiping is used, excess penetrant shall be removed first by using a suitable clean lint-free cloth or absorbent paper and subsequently by cleaning with a clean lint-free cloth lightly moistened with water.

8.5.3 Solvents

Excess penetrant shall be removed first by using a suitable clean lint-free cloth or absorbent paper and subsequently by using a clean lint-free cloth lightly moistened with solvent. Any other removal technique shall be technically approved for adequacy and agreed by the contracting parties, particularly when the solvent remover is sprayed directly onto the part to be tested.

8.5.4 Emulsifier

8.5.4.1 Hydrophilic (water-dilutable)

To allow the post-emulsifiable penetrant to be removed from the test surface, it shall be rendered water-rinsable by application of an emulsifier. Before the application of the emulsifier, a water wash shall be performed in order to remove the bulk of the excess penetrant from the test surface and facilitate a uniform action of the hydrophilic emulsifier that will be applied subsequently.

The emulsifier shall be applied by immersion or by foam equipment. The concentration and the contact time of the emulsifier shall be determined by the user through pre-tests. After emulsification, a final wash shall be carried out in accordance with 8.5.2.

8.5.4.2 Lipophilic (oil-based)

To allow the post-emulsifiable penetrant to be removed from the test surface, it shall be rendered water-rinsable by application of an emulsifier. This can only be done by immersion. The emulsifier contact time shall be evaluated by the user through pre-tests according to the manufacturer's instructions.

This time shall be sufficient to allow only the excess penetrant to be removed from the test surface during the subsequent water wash. The emulsifying time given by the manufacturer shall not be exceeded. Immediately after emulsification, a water wash shall be carried out in accordance with 8.5.2.

8.5.5 Water and solvent

First, the excess water-washable penetrant shall be removed using water (see 8.5.2). Subsequently the surface shall be wiped with a clean lint-free cloth, lightly moistened with solvent.

8.5.6 Excess penetrant removal check

During excess penetrant removal, the test surface shall be checked for penetrant residues that may affect interpretation.

Excess penetrant removal shall be carried out under the conditions specified in ISO 3059 to confirm correct removal.

8.5.7 Drying after excess penetrant removal

In order to facilitate rapid drying of excess water, any droplets and puddles of water shall be removed from the part.

Except when using water-based developer, the test surface shall be dried as quickly as possible after excess penetrant removal, using one of the following methods:

a) wiping with a clean, dry, lint-free cloth;

b) evaporation at ambient temperature after hot water dip;

c) evaporation at elevated temperature;

d) forced air circulation;

e) a combination of methods a) to d).

If compressed air is used, particular care shall be taken to ensure that it is clean and does not affect any penetrant bleed-back that may already have started. It is recommended that a maximum pressure of 200 kPa (2 bar) is used and a distance of around 300 mm or more is allowed between the nozzle and the test surface.

If forced air circulation or a drier is used for drying, the air temperature shall not exceed 70 °C. The drying time shall not lead to a surface temperature higher than 50 °C.

The method of drying the part to be tested shall be carried out such that the penetrant remaining in the discontinuities does not dry.

8.6 Developing

8.6.1 General

The developer shall be maintained in a uniform condition during use and shall be evenly applied to the test surface.

The application of the developer shall be carried out as soon as possible after the removal of excess penetrant.

Care shall be exercised when using water-based developers with water-washable penetrants to avoid removing further penetrant from the discontinuities.

The development time shall be defined in the written test procedure. The development times shall be selected according to the application. The development time shall not be less than 10 min.

The development time begins

— immediately after application, when dry developer is applied,

— immediately after drying of the developer layer, when a wet developer is applied, or

— immediately after drying of the test surface, when no developer is used.

8.6.2 Dry developer

Dry developer may only be used with fluorescent penetrants. The developer shall be uniformly applied to the test surface by one of the following techniques: dust storm, electrostatic spraying, flock gun, fluidized bed or storm cabinet. The test surface shall be thinly covered by the developer; local agglomerations are not permitted.

8.6.3 Water-suspendable developer

A thin, uniform application of the developer shall be carried out by immersion in agitated suspension or by spraying with suitable equipment in accordance with the approved procedure. The immersion time and temperature of the developer shall be determined by the user through pre-tests according to the manufacturer's instructions. The immersion time shall be as short as possible to ensure optimum results.

The part shall be dried by evaporation and/or by the use of a forced-air circulation.

8.6.4 Solvent-based developer

The developer shall be applied by spraying uniformly. The spray shall be such that the developer arrives slightly wet on the surface, giving a thin, uniform layer.

8.6.5 Water soluble developer

A uniform application of the developer shall be carried out by immersion or by spraying with suitable equipment in accordance with the approved procedure. The immersion time and temperature of the developer shall be determined by the user through pre-tests according to the manufacturer's instructions. The immersion time should be as short as possible to ensure an optimum result.

The part shall be dried by evaporation and/or by the use of a drying oven.

8.6.6 Water- or solvent-based for special application (e.g. peelable developer)

When an indication that needs to be recorded is shown with the penetrant inspection process the following steps should be used:

— Wipe off the developer with a clean, dry, lint-free cloth.

— Apply the same penetrant by any convenient means, then follow exactly the same process as initially used, up to application of the developer.

— After excess penetrant removal and drying of the part, apply the peelable developer as recommended by the manufacturer.

— When the recommended development time has elapsed, carefully peel off the developer coating. Indication(s) appear(s) on the face of the coating in direct contact with the part.

8.6.7 No developer (type I only)

Penetrant testing without a developer shall only be performed with specific agreement between contracting parties. The sensitivity shall also be agreed on by the contracting parties and may be based on the baseline sensitivity of the penetrant used.

8.7 Inspection

8.7.1 General

Indications produced by the penetrant method may provide limited information on the shape, depth and dimension of discontinuities. In some cases, it may be advantageous to carry out the first examination just after the application of the developer or as soon as the developer is dry. This facilitates a better evaluation of indications.

Care should be taken to differentiate between true indications and spurious or false indications, such as scratches or changes of section. The operator shall carry out any necessary testing and observations to identify and, if possible, to eliminate the reason for such false indications.

All indications which cannot be confidently discounted as false shall be classified as linear or non-linear and shall be recorded as required by the product standard.

Inspection shall be carried out when the development time has elapsed.

The final evaluation and the indication sizing shall be performed at the end of the development time.

Inspection aids such as magnification instruments or mirrors can be used.

Assessment by the wipe-off technique (see 8.7.3) may assist the inspection.

8.7.2 Viewing conditions

Viewing conditions shall conform to ISO 3059. Additionally, for fluorescent techniques, sufficient time shall be allowed for the operator's eyes to become dark-adapted in the inspection area, at least 1 min before inspection commences.

8.7.3 Wipe-off technique

This technique is used to assist in the assessment of the nature of a discontinuity causing an indication and consists of the removal of the initial indication followed by a further development process. It shall not be used to remedy general inspection process irregularities such as inadequate removal. The exact process may be the subject of a specific agreement between the contracting parties or included within relevant acceptance criteria. Unless otherwise agreed, repeating the procedure is not permitted. Where no indication redevelops, this shall not be the sole evidence for assessing an indication as spurious or non-relevant but can be used to demonstrate that the initial interpretation is correct (e.g. water mark or surface contamination) or to allow the inspector to obtain additional beneficial information by witnessing the growth of the indication during the redevelopment time.

The process is as follows:

a) using a small, clean, lint-free swab lightly moistened with fast-drying solvent, wipe across the surface where the indication is present to remove that indication in a manner that further bleed out will occur if a discontinuity is present;

b) view the area under inspection conditions to ensure the penetrant materials have been completely removed;

c) apply further developer — use a light coating of wet solvent-based (non-aqueous) developer, applied from a distance where the material dries almost immediately on contact, unless otherwise agreed;

d) inspect the area immediately after the application of the developer;

e) inspect again at intervals and at the final development time of 10 min.

8.7.4 Recording

Recording may be done by any adequate method, e.g. written description, sketch, peel technique or photograph.

8.8 Post cleaning and corrosion protection

8.8.1 Post cleaning

After final inspection, post cleaning of the part is necessary only in those cases where the penetrant testing products can interfere with subsequent processing, testing or service requirements.

8.8.2 Corrosion protection

If required, a suitable corrosion protection shall be applied.

8.9 Retesting

If retesting is necessary, e.g. because no unambiguous evaluation of indications is possible, the entire test procedure, starting with the precleaning, shall be repeated.

If necessary, more favourable test conditions shall be chosen for this procedure. The use of a different type of penetrant or a penetrant of the same type from a different manufacturer is not allowed.

9 Test report

The test report shall contain the following information, in reference to this document:

a) information on the part tested:

   1) designation;

   2) dimensions;

   3) material;

   4) surface condition;

   5) production stage;

b) purpose of testing;

c) designation of the penetrant system used, as specified in 6.4, giving the manufacturer's name and product designation as well as the batch number;

   Note Type III penetrants are recorded according to their use. That means a type III penetrant used as colour contrast penetrant is recorded as type II. A type III penetrant used as a fluorescent penetrant (UV-A is used) is recorded similar to type I.

d) test procedure;

e) deviations (if any) from the test procedure;

f) viewing conditions;

g) test temperatures;

h) test results (description of discontinuities detected);

i) test location, date of testing, name of the operator;

j) name, qualification status and signature of the test supervisor.

The layout of a form that can be used for the test report is given in Annex C. It shall include all the details relating to the method which are important for the evaluation of the test results, as well as additional information relating to the parts to be tested, although this data should be modified, as appropriate, depending on the type of part. If another form is used it shall contain all the information detailed in items a) to j).

Annex A
(normative)

Main stages of standard penetrant examination

The sequence of operations to be followed is illustrated for the general case (except form f and g) by Figure A.1.

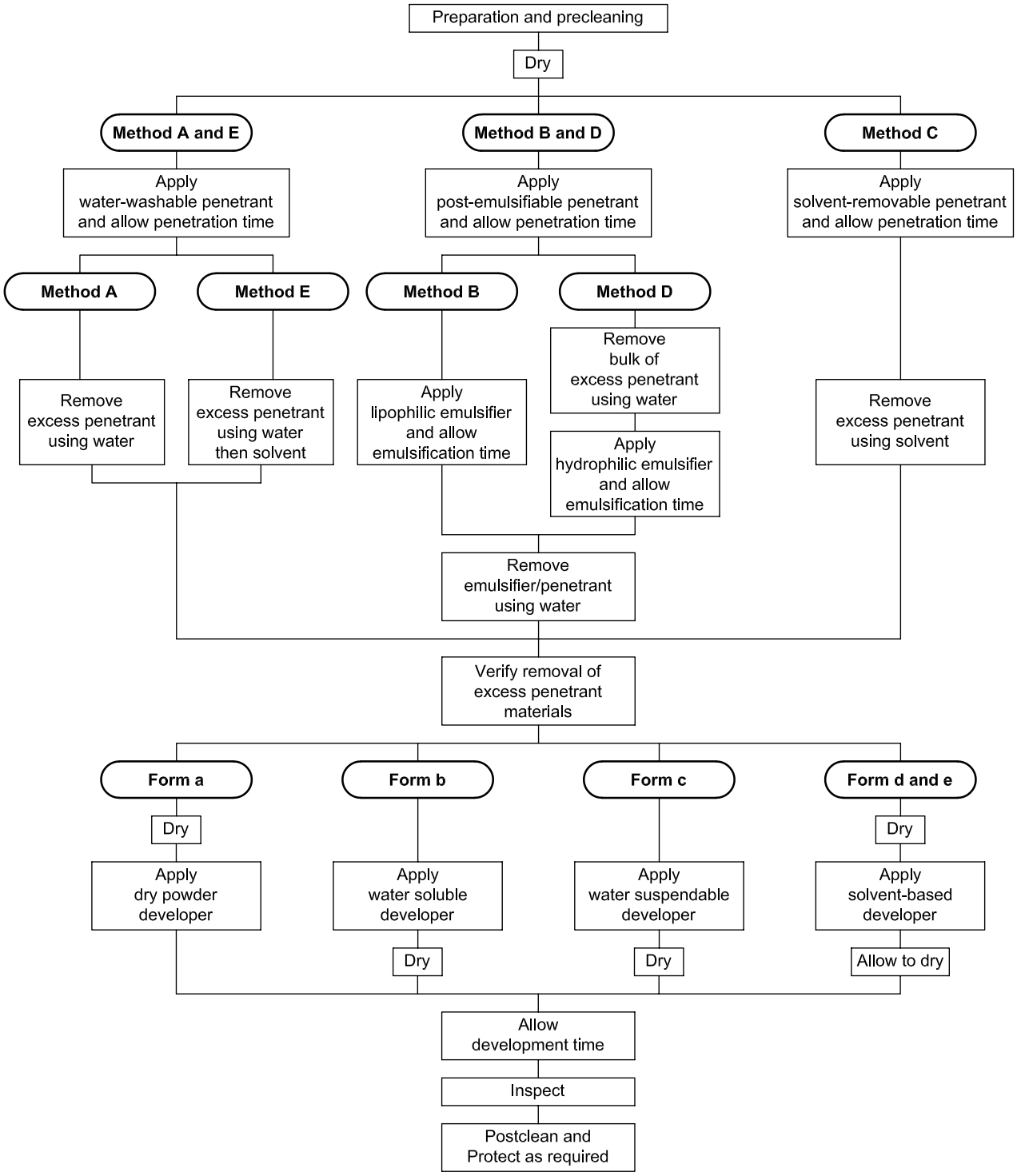

Figure A.1 — Sequence of operations

Annex B
(normative)

Process and control tests

B.1 General

This annex describes process and control tests used to monitor the implementation of the method.

In order to maintain the integrity of a penetrant process, the process as a whole and the individual components of the system shall be regularly checked to ensure that they meet the required standards. This requirement is applicable to process lines where materials are reused. For products supplied in aerosols or thixotropic penetrants, only used for a single inspection, reduced or no testing may be required as determined by a suitably qualified person, e.g. ISO 9712, Level 3.

Table B.1 details the process and control tests to be carried out and their frequency. It is the responsibility of a suitably qualified person, e.g. ISO 9712, Level 3, to decide which tests are applicable to a particular process line. The tests may be carried out at more frequent intervals or additional tests carried out if necessary to ensure correct processing conditions.

The test shall be carried out and the results recorded in accordance with Table B.1 by a suitably qualified person, e.g. ISO 9712, Level 2.

B.2 Records

A separate record of the process and control test results for each working place shall be maintained. Any deviations found shall be reported to the responsible person and the appropriate corrective action taken.

The following information shall be included in the records:

a) company and site;

b) process line identity;

c) date;

d) shift;

e) name and qualification;

f) signature.

Table B.1 — Process and control tests

Control tests	Subclause	Frequency				Recording	
		Start of each work period	Weekly	Monthly	Yearly	Numerical value	Visual assessment
System review							
Materials levels [a]	B.3.1	X					X
System performance	B.3.2	X					X
General review							
Penetrant appearance [a]	B.3.3	X					X
Rinse-water appearance	B.3.4	X					X
Rinse-water temperature	B.3.5	X				X	
Drying oven temperature	B.3.6	X				X	
Working area	B.3.7	X					X
Compressed-air filter(s)	B.3.8		X				X
UV-A lamps	B.3.9	X					X
UV-A irradiance	B.3.10			X		X	
Visible light intensity in inspection booth (fluorescent systems)	B.3.11			X		X	
Visible light intensity (colour contrast systems)	B.3.12			X		X	
Penetrants							
Fluorescent brightness [a]	B.3.13				X	X	
Colour contrast intensity [a]	B.3.14				X	X	
Supplier's overcheck [a]	B.3.15				X		X
Emulsifiers							
Concentration of hydrophilic remover [a]	B.3.16		X			X	
Developers							
Appearance of dry powder	B.3.17.1	X					X
Fluorescence of dry powder	B.3.17.2	X				X	
Water-soluble developer							
a) Concentration	B.3.17.3.1	X				X	
b) Wetting test	B.3.17.3.2	X				X	

[a] Not intended for aerosols.

Table B.1 *(continued)*

Control tests	Subclause	Frequency				Recording	
		Start of each work period	Weekly	Monthly	Yearly	Numerical value	Visual assessment
c) Temperature	B.3.17.3.3	X				X	
d) Fluorescence of solution	B.3.17.3.4	X					X
Water-suspendable developer							
a) Concentration	B.3.17.4.1	X				X	
b) Temperature	B.3.17.4.2	X				X	
c) Fluorescence of suspension	B.3.17.4.3	X					X
Calibration/Verification							
UV-A radiometers	B.3.18				X		X
Luxmeters	B.3.19				X		X
Pressure gauges	B.3.20				X	X	
Reference test block	B.3.21				X	X	X
[a] Not intended for aerosols.							

B.3 Control tests

B.3.1 Materials levels (including refillable spray systems)

The level of material in all test systems shall be visually examined to ensure that there is sufficient material to allow complete coverage of the components to be tested. If insufficient material is in the system, extra material of the same type shall be added or mixed before any other tests are carried out.

B.3.2 System performance

B.3.2.1 General

This test shall be carried out using a type 2 reference test block in accordance with ISO 3452-3. Alternative known defect standards may be used where authorized by a suitably qualified person, e.g. ISO 9712, Level 3. It may be advantageous to also use a component with known natural discontinuities typical of those normally expected.

A record in the form of a permanent replica, photograph or other suitable means, showing the indications, including the background fluorescence, shall be prepared using new, unused materials (penetrant) of the same family and processed using the same parameters normally in use and retained for reference. This record shall be used as a comparison for the practical results obtained using the same test for the daily system performance check. Indications from peelable developers are not the same as those obtained using standard developers. The indications on the type 2 reference test block or on the component with known flaws shall show the same number of indications and pattern as those of the record prepared using the same materials and process sequence. Similarly, the level of background shall be the same as that shown on the record.

Permanent replica shall be scaled approximately 1:1, and the indications shall be easy to compare with test results.

Separate reference pieces shall be allocated to each individual penetrant; for this purpose, an individual penetrant shall be only one product as designated by the manufacturer.

B.3.2.2 Reference test parts cleaning

The test panel or known defect standard used for the performance test shall be maintained in such condition that it detects changes in process parameters. In particular, it is necessary to remove penetrant materials remaining from previous tests. It may be beneficial between uses to store the panel in a solvent or other remover.

No method used shall physically modify the discontinuities.

B.3.3 Penetrant appearance

Check for any abnormal aspects of the penetrant (e.g. milky appearance, change in colour, visible contamination, deposits of water at the bottom or top of the penetrant).

B.3.4 Rinse water appearance

When using recycled water, check for opacity, fluorescence, foam or coloration of the rinse water, the presence of any of which can suggest that the treatment system is not functioning effectively.

B.3.5 Rinse water temperature

Check that the rinse water temperature is within the specified limits.

B.3.6 Drying oven temperature

Check that the drying oven internal temperature in the area of the work pieces (see 8.5.7) is within the specified limits.

B.3.7 Working area

Ensure that the working area is clean and tidy. When inspecting test parts processed with a fluorescent penetrant system, there shall be no reflective surface, e.g. white paper, on the inspection bench or in the immediate vicinity of the inspection area. In addition, there shall be no stray white light sources near to the inspection area.

B.3.8 Compressed-air filter(s)

Ensure that the trap(s) are free of contaminants.

B.3.9 UV-A lamps

Ensure that lamps are functioning correctly, are in good condition and that UV-A filters, where fitted, are intact.

B.3.10 UV-A irradiance

Measure UV-A irradiance in accordance with ISO 3059.

B.3.11 Visible light intensity in inspection booth (fluorescent systems)

Measure, in accordance with ISO 3059, the maximum visible light intensity in the booth.

B.3.12 Visible light intensity (colour contrast systems)

Measure the minimum visible light intensity on the test area in accordance with ISO 3059. Where light levels can vary, e.g. when daylight is involved, the monitoring of the ambient light shall be increased.

B.3.13 Fluorescent brightness

Measure the fluorescent brightness in accordance with ISO 3452-2.

The fluorescent brightness shall be within the range 90 % to 110 % of the reference.

B.3.14 Colour contrast intensity

B.3.14.1 Use standard reference samples of the colour contrast penetrant at 1 %, 0,9 %, 0,8 % and 0,7 % in high-flash kerosene or any other suitable non-volatile solvent.

To prepare the reference samples, it is recommended that dilutions of 10 %, 9 %, 8 % and 7 % are first prepared and then further diluted at 1 to 10.

These reference samples shall be stored in light-proof sealed containers.

B.3.14.2 Prepare a 1 % solution of the penetrant under test in the same solvent as specified in B.3.14.1.

B.3.14.3 Using test tubes, under evenly distributed visible light, compare the colour intensity of the penetrant under test against the reference samples.

Record the level at which the colour intensities are similar.

The colour intensity shall be greater than 80 % of reference.

B.3.15 Supplier's overcheck

A representative sample of the in-use penetrant shall be taken at least once a year and sent to the supplier's or other suitable laboratory for analysis. Otherwise, the penetrant shall be discarded and replaced.

The overchecking laboratory shall issue a report stating that the physical–chemical parameters of the penetrant under test are all within acceptable limits when compared with the nominal values for a new penetrant. It is recommended that the report shows actual values and not only a statement.

It is the responsibility of the supplier to choose which parameters are to be checked.

B.3.16 Concentration of hydrophilic remover

The test is applicable for freshly-prepared solutions and regular tests, which shall be carried out using a refractometer.

The test refractometer shall be calibrated using accurately-prepared solutions of the new hydrophilic emulsifier. At least five solutions shall be used. One shall be the nominal concentration, two shall be above and two below the nominal concentration. The values shall be plotted graphically.

To estimate the concentration of the hydrophilic remover, read the value given by a sample of the freshly-prepared product and determine its concentration from the graph.

All parts of the test shall be carried out at ambient temperature.

Adjust the concentration to the required value. Mix well before rechecking.

Any change in visual appearance shall require further tests to be carried out.

B.3.17 Developers

B.3.17.1 Appearance of dry powder

Ensure that the powder is free flowing, fluffy and not caked.

B.3.17.2 Fluorescence of dry powder

Examine a sample of the powder under UV-A irradiance to ensure that it is free from fluorescence that can affect the process.

As a guide it is not expected that more than 10 fluorescent specks per 10 000 mm^2 (e.g. eight specks on a 100 mm diameter disk) will be visible.

B.3.17.3 Water-soluble developer

B.3.17.3.1 Concentration

This test uses a graph of concentration against density produced by the manufacturer to determine the concentration of the developer.

a) Check the level of the tank and bring it back to its original level by the addition of water and mix thoroughly.

b) Take a sample of the contents of the tank and adjust the temperature to 20 °C or to the temperature at which the hydrometer has been calibrated.

c) Measure the density of the sample using a hydrometer.

The density will enable the concentration of the developer to be read from the graph.

B.3.17.3.2 Wetting test

Ensure that the whole surface of the reference test block type 2 used for the system performance check has been evenly coated with the developer.

B.3.17.3.3 Temperature

Ensure that the developer temperature is within specified limits.

B.3.17.3.4 Fluorescence of solution

Examine a sample of the solution under UV-A irradiation to ensure that it is free from fluorescence.

B.3.17.4 Water-suspendable developer

B.3.17.4.1 Concentration

This test uses a graph of concentration against density produced by the manufacturer to determine the concentration of the developer.

a) Check the level of the tank and, if necessary, add water to bring it back to its original level and mix thoroughly to ensure a full and uniform suspension.

b) Take a sample from the tank and adjust the temperature to 20 °C or to the temperature at which the hydrometer has been calibrated.

c) Measure the density of the sample using a hydrometer.

The density will enable the concentration of the developer to be determined from the graph.

B.3.17.4.2 Temperature

Check that the developer temperature is within specified limits.

B.3.17.4.3 Fluorescence of suspension

Thoroughly mix the bath of developer to ensure that the powder is in suspension. Examine a sample of the developer suspension under ultraviolet light to ensure that it is free from fluorescence.

B.3.18 UV-A radiometer calibration

The in-use UV-A radiometer shall have valid calibration stickers or identification in accordance with ISO 3059.

Before using the UV-A radiometer, the operator shall check the stickers for the “valid to” or “calibrate before” dates. The unit shall be calibrated at least once every 12 months.

B.3.19 Luxmeter calibration

The luxmeter shall have valid calibration stickers or identification referring to ISO 3059.

Before using the luxmeter, the operator shall check the stickers for the “valid to” or “calibrate before” dates. The unit shall be calibrated at least once every 12 months.

B.3.20 Pressure gauge calibration

Check that all gauges are set within the nominal values stated by the applicable process procedure. Check that they have valid calibration identification.

B.3.21 Reference test block verification

Changes in the discontinuities contained in the test block will affect results. Therefore, each block shall be retested to demonstrate stability. This may be done by comparison of the results achieved when tested using new, unused materials with the retained replica or photograph (see B.3.2). Any changes shall be assessed by a suitably qualified person, e.g. ISO 9712, Level 3 and appropriate action taken.

Annex C
(informative)

Example test report

Test report

Company name: Reference no.:
Departments: Subreference no.:

Penetrant Testing

Test report no.: ____ Sheet _____ of _____ sheets

Project: Parts:
Commissioned by: Manufacturing no.:
Commission order no.: Drawing no.:

Part to be tested: further details, e.g.:
Weld plan no.: Test follow-up plan no.:
Dimensions: Weld no.: Sheet no.:
Unit no.: Part no.:
Material: Cast no.: Model no.:
Surface condition:
Heat treatment condition:
Pre-treatment:

Test instruction: (e.g. specification, test direction, delivery condition)
Scope of testing:

Penetrant system

Designation: (further details, e.g. free from corrosive constituents, in accordance with ISO 3452-2)

Manufacturer:

Product designation

Penetrant: Batch no.:
Excess penetrant remover: Batch no.:
Developer: Batch no.:

Procedure

Test temperature: Excess penetrant removal (further details, e.g. anticorrosive agents):
Precleaning: Emulsifying time:
Drying: Drying:
Penetration time: Development time:
Postcleaning/protection:

Deviations from the test instructions:
Deviations from ISO 3452-1:

Test results: (e.g. for discontinuities: details of location, types, distributions, sizes and number; sketch)

Test location: Test date: Operator's name:

Evaluation acceptable: unacceptable:
(in accordance with test instructions):
Remarks:

Test supervisor: Certification: Date: Signature:
or
Commissioner/expert: Date: Signature:
or
Test house: Date: Signature:

Bibliography

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

[2] CEN/TR 16638, *Non-destructive testing — Penetrant and magnetic particle testing using blue light*

[3] *Artificial Optical Radiation Directive (AORD) (*2006/25*/EC)*

ICS 19.100

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