

无损检测 渗透检测 第2部分：渗透材料的检验

安全警示：本文件所涉及的渗透材料所需的化学制品，可能是有害的、易燃的和 / 或挥发性的，因此均应预防，并遵循国家、地方颁布的所有安全卫生、环保法的规定。

1 范围

本文件规定了渗透材料型式检验和批量检验的技术要求和检验方法。本文件涵盖的温度范围为 10 °C~50 °C。在此范围之外可能需要进行 ISO 3452-5 或 ISO 3452-6 规定的其他检验。

ISO 3452-1 详细介绍了现场的过程控制检验。

Non-destructive testing — Penetrant testing —

Part 2: Testing of penetrant materials

SAFETY PRECAUTIONS — The materials required by this document include chemicals which may be harmful, flammable and/or volatile. All necessary precautions shall be observed, taking into account all relevant international, national and local regulations pertaining to health and safety, environmental requirements, etc.

1 Scope

This document specifies the technical requirements and test procedures for penetrant materials for their type testing and batch testing. This document covers the temperature range from 10 °C to 50 °C. Additional tests in ISO 3452-5 or ISO 3452-6 can be required outside this range.

On-site control tests and methods are detailed in ISO 3452-1.

2 规范性引用文件

下列文件中的内容通过文中的规范性引用而构成本文件必不可少的条款。其中，注日期的引用文件，仅该日期对应的版本适用于本文件；不注日期的引用文件，其最新版本（包括所有的修改单）适用于本文件。

ISO 3059 无损检测 渗透检测和磁粉检测 观察条件 (Non-destructive testing—Penetrant testing and magnetic particle testing—Viewing conditions)

注：GB/T 5097-2020 无损检测 渗透检测和磁粉检测 观察条件 (ISO 5577: 2017, IDT)

ISO 3452-1 无损检测 渗透检测 第1部分：总则 (Non-destructive testing—Penetrant testing —Part 1: General principles)

注：GB/T 18851.1-20XX 无损检测 渗透检测 第1部分：总则 (ISO 3452-1:2021, IDT)

ISO 3452-3 无损检测 渗透检测 第3部分：参考试块 (Non-destructive testing—Penetrant testing—Part 3: Reference test block)

注：GB/T 18851.3-2008 无损检测 渗透检测 第3部分：参考试块 (ISO 3452-3: 1998, IDT)

ISO 12706 无损检测 术语 渗透检测 (Non-destructive testing—Penetrant testing—Vocabulary)

注：GB/T 12604.3-2013 无损检测 术语 渗透检测（ISO 12706：2009，IDT）

ISO/IEC 17025 检测和校准实验室能力的通用要求（General requirements for the competence of testing and calibration laboratories）

注：GB/T 27025-2019 检测和校准实验室能力的通用要求（ISO/IEC 17025：2017，IDT）

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

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

ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

3 术语和定义

ISO 12706界定的以及下列术语和定义适用于本文件。

3.1

批 batch

一次投产的具有相同性能和全部用特定标志符号标记的渗透材料产品的数量。

3.2

受检品 candidate

按本文件要求送检的检测产品样品。

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 12706 and the following 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/>

3.1

batch

quantity of material manufactured in one production having uniform properties throughout and with a unique identifying number or mark

3.2

candidate

sample of the testing product submitted for evaluation in accordance with this document

4 分类

4.1 检测产品

渗透检测产品应符合表1给出的型号、方法和方式分类。

4 Classification

4.1 Testing products

Penetrant testing products shall be classified by type, method and form in accordance with [Table 1](#).

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	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.

^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.

表1 检验产品/过程

渗透剂		去除剂		显像剂	
型号	种类	方法	种类	方式	种类
I	荧光	A	水	a	干粉
II	着色	B	亲油性乳化剂	b	水溶性
III	两用（荧光和着色）	C	溶剂	c	水悬性
		D	亲水性乳化剂	d	溶剂型（非水，适用于I型）
		E ^a	水和溶剂	e	溶剂型（非水，适用于II型和III型）
				f	特殊应用
				g	无显像剂（仅适用于I型）

注：对于特殊情况，必须使用符合可燃性、硫、卤素和钠含量以及其他污染物特定要求的渗透检验产品。

^a 方法E涉及到两种产品的使用，即水和溶剂。符合方法A的渗透材料也被认为符合方法E。

4.2 灵敏度等级

4.2.1 总体要求

渗透剂基线灵敏度和产品族灵敏度独立评定；两者之一或两者全部应被执行。

4.2 Sensitivity levels

4.2.1 General

Penetrant baseline sensitivity and product family sensitivity are determined independently; and one or both of them shall be carried out.

4.2.2 渗透剂基线灵敏度

对于渗透剂基线灵敏度，渗透剂与指定的去除剂配合使用，并使用标准参考显像剂进行检测。渗透剂灵敏度等级仅在渗透剂与指定的去除剂配合使用时有效。

4.2.2 Penetrant baseline sensitivity

For penetrant baseline sensitivity, the penetrant is submitted with its designated remover and is tested using a standard reference developer. The allocated penetrant sensitivity level is only valid when the penetrant is used with the designated remover.

4.2.3 产品族灵敏度

通过评估一套完整的渗透产品来确定产品族灵敏度。产品族灵敏度等级仅该整完整的产品时有效。

4.2.3 Product family sensitivity

The product family sensitivity is determined by submitting a complete set of products for assessment. The allocated product family sensitivity level is only valid when this complete set of products is used.

4.2.4 荧光产品族

以下灵敏度等级应通过参考产品进行定义：

- 1/2 级灵敏度（超低）；
- 1级灵敏度（低）；
- 2级灵敏度（中）；
- 3级灵敏度（高）；
- 4级灵敏度（超高）。

1/2 级灵敏度只适用于I型方法A。

4.2.4 Fluorescent systems

Sensitivity levels shall be defined by reference products:

- sensitivity level 1/2 (very low);
- sensitivity level 1 (low);
- sensitivity level 2 (medium);
- sensitivity level 3 (high);
- sensitivity level 4 (ultra-high).

Sensitivity level 1/2 applies to type I method A only.

4.2.5 着色产品族

以下灵敏度等级应使用ISO 3452-3规定的的1型参考试块进行定义。

- 1 级灵敏度（普通）；
- 2 级灵敏度（高）。

4.2.5 Colour contrast systems

Sensitivity levels shall be defined using the type 1 reference block in accordance with ISO 3452-3:

- sensitivity level 1 (normal);
- sensitivity level 2 (high).

4.2.6 两用产品族

当两用渗透剂当作荧光产品族使用时，两用渗透剂没有灵敏度等级。但是该类产品可按着色产品族进行灵敏度分类（见4.2.3）。

4.2.6 Dual-purpose product family

There are no sensitivity levels for dual-purpose penetrants when used as a fluorescent system. However, these products may be classified as colour contrast products (see [4.2.3](#)).

5 渗透材料的检验

5.1 人员

检验应由熟练的、经过培训和资格鉴定的人员实施。对于无损检测（NDT）操作（例如灵敏度和可水洗性），除另有约定证明适宜的熟练程度外，宜根据ISO 9712或各方同意的体系对人员进行培训。人员操作授权应由雇主按照书面程序应对检测人员进行操作授权。

5 Testing of penetrant materials

5.1 Personnel

Testing shall be carried out by proficient, suitably trained and qualified personnel. For non-destructive testing (NDT) operations (e.g. sensitivity and washability), unless otherwise agreed to demonstrate appropriate proficiency, it is recommended that personnel be trained according to ISO 9712 or an equivalent formalized system. Operating authorization for personnel shall be issued by the employer in accordance with a written procedure.

5.2 检验设施

5.2.1 型式检验

应按ISO 3452-1的规定对渗透材料进行型式试验，并结合本文件规定的性能要求，确定渗透材料是否符合要求。

5.2 Testing facilities

5.2.1 Type testing

Type testing shall be carried out on penetrant materials according to ISO 3452-1 with exceptions as defined in this document to ensure their conformance to the requirements.

型式试验应由符合质量体系和相关技术能力要求的独立检测实验室进行。检测实验室应符合ISO/IEC 17025规定的要求。如果型式试验由未获ISO/IEC 17025认可的检测实验室进行，则检测活动的管理方式应满足ISO/IEC 17025规定的要求，提供检测结果的置信度，并有记录证实这种置信度。

Type testing shall be carried out only by an independent test laboratory that meet the applicable requirements with respect of a formalised quality system and the relevant technical competencies. Test laboratories shall meet the applicable requirements of ISO/IEC 17025. Where test activities are carried out by laboratories which are not accredited according to ISO/IEC 17025 it shall be ensured that the test activities are managed in a manner which meets the requirements of ISO/IEC 17025, provides confidence in the results, and that records are available to justify the confidence.

5.2.2 批量检验

应对每批产品按ISO 3452-1的规定进行批量检验，以确保该批产品与相应的经型式检验认可的试样具有相同的性能。如果渗透材料采用气雾喷罐进行灌装，其硫和卤素的含量应按6.12的规定进行附加检测。

批量检验应在已建立并持续运行的质量体系下进行。满足ISO 9001要求的质量体系是适宜的。

5.2.2 Batch testing

Batch testing to the requirements of this document shall be carried out on each production batch according to ISO 3452-1 to ensure the batch has the same properties as the corresponding type approval sample. In the case of penetrant material packed in spray cans, the content of sulfur and halogens shall be additionally determined according to 6.12.

Batch testing shall be carried out under a defined and maintained quality system. A system meeting the requirements of ISO 9001 is considered suitable.

5.2.3 过程控制检验

用于监控方法实施的过程控制检验，见ISO 3452-1。

5.2.3 Process and control testing

Process and control tests to monitor the implementation of the method are described in ISO 3452-1.

5.3 报告

5.3.1 型式检验

型式检测实验室（见5.2.1）应出具一份执行本文件的证书和一份详列所得结果的报告。

如果生产渗透材料的成分发生变化，应重新进行型式检验。

5.3 Reporting

5.3.1 Type testing

The testing laboratory (see 5.2.1) shall provide a certificate of compliance with this document and a report that details the results obtained.

If any changes are made to the penetrant material composition, then a new type test and product identity shall be required.

5.3.2 批量检验

渗透材料的制造商应出具一份执行本文件的证书（样例见EN 10204或ISO 10474）。

5.3.2 Batch testing

Manufacturers of penetrant materials shall provide certificates of compliance with this document (for example, see EN 10204 or ISO 10474).

5.4 检验

5.4.1 灵敏度检验

应对每种渗透材料和/或产品族进行灵敏度检验。

型式检验应按6.2进行。

对于批量检验，应与先前批准的保留样品进行对比检验。

此外，对于每种渗透材料，应按5.4.2~5.4.5规定的方法进行检验。

5.4 Tests

5.4.1 Sensitivity test

A sensitivity test shall be carried out for each individual penetrant material and/or product family.

Type testing shall be carried out according to 6.2.

For batch testing, the test shall be carried out by comparison with the previously approved retained sample.

In addition, for each penetrant material, the specified tests in 5.4.2 to 5.4.5 are required.

5.4.2 渗透剂

渗透剂性能应按表2进行型式检验和批量检验。

5.4.2 Penetrants

Type and batch testing of penetrant properties shall be carried out in accordance with Table 2.

表2 渗透剂的性能和检验要求

性能	检验类型	检验方法依据章条
外观	型式和批量	6.1
灵敏度	型式和批量	6.2
密度	型式和批量	6.3
黏度	型式和批量	6.4
闪点	型式和批量	6.5
渗透剂的可水洗性（仅对A方法渗透剂）	批量	6.6
荧光亮度（I型渗透剂）	型式和批量	6.7
UV稳定性（I型渗透剂）	型式	6.8
热稳定性（I型渗透剂）	型式	6.9
容水率（仅对A方法渗透剂）	型式	6.10
腐蚀性	型式和批量	6.11
硫和卤素的含量 ^a	型式和批量	6.12
含水量(方法A和E)	批量	6.20

^a 仅对要求标明“低硫和卤素”的产品。

Table 2 — Properties of penetrants and required tests

Property	Test type	Reference
Appearance	Type and batch	6.1
Sensitivity	Type and batch	6.2
Density	Type and batch	6.3
Viscosity	Type and batch	6.4
Flashpoint	Type and batch	6.5
Washability (method A penetrants only)	Batch	6.6
Fluorescent brightness (type I penetrants)	Type and batch	6.7
UV stability (type I penetrants)	Type	6.8
Thermal stability (type I penetrants)	Type	6.9
Water tolerance (method A penetrants only)	Type	6.10
Corrosive properties	Type and batch	6.11
Content of sulfur and halogens ^a	Type and batch	6.12
Water content (methods A and E)	Batch	6.20
^a Only required for products designated "low in sulfur and halogens".		

5.4.3 去除剂（方法 A 除外）

去除剂性能应按表3进行型式检验和批量检验。

5.4.3 Excess penetrant removers (excluding method A)

Type and batch testing of penetrant remover properties shall be carried out in accordance with [Table 3](#).

表3 去除剂的性能和检验要求

性能	检验类型	检验方法依据章条
外观	批量	6.1
灵敏度	型式和批量	6.2
密度	型式和批量	6.3
黏度（仅对B方法和D方法）	型式和批量	6.4
闪点	型式和批量	6.5
容水率（仅对B方法）	型式和批量	6.10
腐蚀性	型式和批量	6.11
硫和卤素的含量 ^a	型式和批量	6.12
蒸发的残余物/固体含量（仅对C方法）	型式和批量	6.13
容渗透剂率（仅对B和D方法）	型式	6.14
含水量(A方法和E方法)	批量	6.20
其他相关污染物（有特别要求的）	批量	—
^a 仅对要求标明“低硫和卤素”的产品。		

5.4.3 Excess penetrant removers (excluding method A)

Type and batch testing of penetrant remover properties shall be carried out in accordance with [Table 3](#).

Table 3 — Properties of excess penetrant removers and required tests

Property	Test type	Reference
Appearance	Batch	6.1
Sensitivity	type and batch	6.2
^a Only required for products designated "low in sulfur and halogens".		

Table 3 (continued)

Property	Test type	Reference
Density	Type and batch	6.3
Viscosity (for methods B and D only)	Type and batch	6.4
Flashpoint	Type and batch	6.5
Water tolerance (method B only)	Type and batch	6.10
Corrosive properties	Type and batch	6.11
Content of sulfur and halogens ^a	Type and batch	6.12
Residue on evaporation/solid content (method C only)	Type and batch	6.13
Penetrant tolerance (methods B and D only)	Type	6.14
Water content (method B only)	Batch	6.20
Other contaminants on request (as required)	Batch	
^a Only required for products designated "low in sulfur and halogens".		

5.4.4 显像剂

显像剂性能应按表4进行型式检验和批量检验。

表4 显像剂的性能和检验要求

性能	方式						检验类型	参考
	a	b	c	d	e	f		
外观	×	×	×	×	×	×	批量	6.1
灵敏度	×	×	×	×	×	×	型式和批量	6.2
闪点	-	-	-	×	×	× ^b	型式和批量	6.5
腐蚀性		×	×	×	×	×	型式和批量	6.11
硫和卤素的含量 ^a	×	×	×	×	×	×	型式和批量	6.12
固体含量	-	-	-	×	×	× ^b	型式和批量	6.13
显像剂性能	×	×	×	×	×	×	型式和批量	6.15
再分散性	-	-	×	×	×	× ^b	型式和批量	6.16
(载液的)密度	-	-	-	×	×	× ^b	型式和批量	6.17
粒度分布	×		×	×	×	× ^b	型式	6.19
其他相关污染物 (有特别要求的)	×	×	×	×	×	×	批量	-
^a 仅对要求标明“低硫和卤素”的产品。								
^b 如果适用。								

5.4.4 Developers

Type and batch testing of developer properties shall be carried out in accordance with [Table 4](#).

Table 4 — Properties of developers and required tests

Property	Form						Test type	Reference
	a	b	c	d	e	f		
Appearance	x	x	x	x	x	x	Batch	6.1
Sensitivity	x	x	x	x	x	x	Type and batch	6.2
Flashpoint				x	x	x ^b	Type and batch	6.5
Corrosive properties		x	x	x	x	x	Type and batch	6.11
Content of sulfur and halogens ^a	x	x	x	x	x	x	Type and batch	6.12
Solid content				x	x	x ^b	Type and batch	6.13
Developer performance	x	x	x	x	x	x	Type and batch	6.15
Re-dispersability			x	x	x	x ^b	Type and batch	6.16
Density (of carrier liquid)				x	x	x ^b	Type and batch	6.17
Particle size distribution	x		x	x	x	x ^b	Type	6.19
Other contaminants on request (as required)	x	x	x	x	x	x	Batch	
^a Only required for products designated "low in sulphur and halogens".								
^b If applicable.								

5.4.5 气雾罐批量检验

产品性能应按6.18的规定进行批量检验。

每批的第一件和最后一件容器，以及批序列中间的容器应进行检验。若是按6.12的规定检验硫和卤素的含量时，仅需检验第一件容器。

5.4.5 Batch tests for spray cans

Batch testing shall be carried out in accordance with the product performance test given in [6.18](#).

The first and last containers and a container from the middle of the batch shall be tested. Where testing for content of sulfur and halogens in accordance with [6.12](#), only the first container needs to be tested.

6 检验方法和要求

6.1 外观

被检样品的外观应与型式检验样品的外观相同。

6 Test methods and requirements

6.1 Appearance

The appearance of the sample shall be the same as that of the type test sample.

6.2 渗透剂系统灵敏度

6.2.1 荧光渗透剂（I型）

6.2.1.1 检验规定

6.2.1.1.1 渗透剂（I型）

A方法（水洗型）渗透剂和B、D方法（后乳化型）渗透剂/乳化剂，应采用适当的参考干粉显像剂D-1进行检验。C方法渗透剂，应采用上述针对A、B或D方法材料的任一方法，也可采用适当的参考去除剂R-1和参考干粉显像剂D-1（见表5）进行检验。

6.2 Penetrant system sensitivity

6.2.1 Fluorescent penetrants (type I)

6.2.1.1 Qualification provisions

6.2.1.1.1 Penetrants (type I)

Method A (water-washable) penetrants and methods B and D (post-emulsifiable) penetrants/emulsifiers shall be qualified with the appropriate reference dry developer D-1. Method C penetrants shall be qualified either on the basis of their performance as method A, B, or D materials, or, alternatively, with the appropriate reference remover R-1 and reference dry developer D-1 (see Table 5).

表5 参考材料名称

参考材料	代号	
	A 方法	B、C 和 D 方法
1/2 级灵敏度，I 型，渗透剂	FP-1/2	—
1 级灵敏度，I 型，渗透剂	FP-1W	FP-1PE
2 级灵敏度，I 型，渗透剂	FP-2W	FP-2PE
3 级灵敏度，I 型，渗透剂	FP-3W	FP-3PE
4 级灵敏度，I 型，渗透剂	FP-4W	FP-4PE
1 级灵敏度，II 型，渗透剂	VP-1W	VP-1PE
2 级灵敏度，II 型，渗透剂	VP-2W	VP-2PE
B 方法，I 型，乳化剂	—	FE-B
D 方法，I 型，乳化剂	—	FE-D
B 方法，II 型，乳化剂	—	VE-B
C 方法，去除剂	R-2	R-2
a 方式，显像剂	D-1	D-1
e 方式，显像剂	D-2	D-2
符号说明： FP—荧光渗透剂； FE—荧光渗透剂用乳化剂； W—水洗型； VP—着色渗透剂； PE—后乳化型； VE—着色渗透剂用乳化剂。		

参考产品清单见附录C。

Table 5 — Reference material designation

Reference material	Designation	
	Method A	Methods B, C and D
Penetrant, type I, level 1/2	FP-1/2	
Penetrant, type I, level 1	FP-1W	FP-1PE
Penetrant, type I, level 2	FP-2W	FP-2PE
Penetrant, type I, level 3	FP-3W	FP-3PE
Penetrant, type I, level 4	FP-4W	FP-4PE
Penetrant, type II, level 1	VP-1W	VP-1PE
Penetrant, type II, level 2	VP-2W	VP-2PE
Emulsifier, type I, method B		FE-B
Emulsifier, type I, method D		FE-D
Emulsifier, type II, method B		VE-B
Removers, method C	R-2	R-2
Developer, form a	D-1	D-1
Developer, form e	D-2	D-2
Key		
FP fluorescent penetrant	FE emulsifier for fluorescent penetrant	
W water-washable	VP visible penetrant	
PE post emulsifiable	VE emulsifier for visible penetrant	

The list of reference products is given in [Annex C](#).

6.2.1.1.2 显像剂

除f方式（特殊应用）之外的所有与 I 型（荧光）渗透剂配用的显像剂，应采用4级灵敏度B方法的参考渗透剂和乳化剂系统FP-4PE/FE-B（见表6）进行检验。

应保存根据表5和表6所指定的用来比较每个产品的参考试样。应记录制造商、制造商的参考试样及其批号。

g方式的渗透系统可具有不包括灵敏度的有限能力。

6.2.1.1.2 Developers

For all developing methods, except when using form f (specific application), intended for use with type I (fluorescent) penetrant materials, qualification shall be with the reference level 4, method B penetrant/emulsifier system FP-4PE/FE-B (see [Table 6](#)).

A reference sample of each product shall be retained for comparison purposes and designated in accordance with [Tables 5](#) and [6](#). The manufacturer, manufacturer's reference and the batch number shall be recorded.

Form g penetrant testing systems may have a limited qualification which excludes sensitivity.

6.2.1.1.3 溶剂去除剂

溶剂去除剂应采用参考渗透剂 FP-4PE和参考显像剂D-1进行检验。

6.2.1.1.3 Solvent removers

Solvent removers shall be qualified with reference penetrant FP-4PE and reference developer D-1.

6.2.1.2 灵敏度

6.2.1.2.1 总体要求

I型渗透剂系统的灵敏度应采用一组试块通过比较受检品和标准参考产品的结果来测定。

6.2.1.2.2 试块

应使用符合ISO 3452-3中 I 型参考块的20 μ m检验试块。

符合ISO 3452-3的检验试块，具有厚度为10 μ m、20 μ m、30 μ m和50 μ m的铬—镍镀层。每种厚度的试块有一对，且带有相似裂纹。荧光或着色渗透剂宜均采用该试块，但同一试块不宜用于两种系统。

6.2.1.2 Sensitivity

6.2.1.2.1 General

Sensitivity of type I penetrant systems shall be determined by comparing results of candidate materials and standard reference products using a set of test panels.

6.2.1.2.2 Test panels

The 20 μ m test panels from the reference block type 1 according ISO 3452-3 shall be used.

Test panels according to ISO 3452-3 have chromium-nickel plating with thicknesses of 10 μ m, 20 μ m, 30 μ m and 50 μ m. For each thickness there is a pair of panels with similar cracks. The test panels should be used either for fluorescent or for colour contrast penetrants. The same panels should not be used for the two systems.

表6 灵敏度与材料配用表

受检品	处理受检品用材料			参考材料		
渗透剂系统						
I 型, A方法, 1/2级灵敏度	—	—	D-1	FP-1/2	—	D-1
I 型, A方法, 1级灵敏度	—	—	D-1	FP-1W	—	D-1
I 型, B方法, 1级灵敏度	—	—	D-1	FP-1PE	FE-B	D-1
I 型, C方法, 1级灵敏度	—	—	D-1	FP-1PE	R-1	D-1
I 型, D方法, 1级灵敏度	—	—	D-1	FP-1PE	FE-D	D-1
I 型, A方法, 2级灵敏度	—	—	D-1	FP-2W	—	D-1
I 型, B方法, 2级灵敏度	—	—	D-1	FP-2PE	FE-B	D-1
I 型, C方法, 2级灵敏度	—	—	D-1	FP-2PE	R-1	D-1
I 型, D方法, 2级灵敏度	—	—	D-1	FP-2PE	FE-D	D-1
I 型, A方法, 3级灵敏度	—	—	D-1	FP-3W	—	D-1
I 型, B方法, 3级灵敏度	—	—	D-1	FP-3PE	FE-B	D-1
I 型, C方法, 3级灵敏度	—	—	D-1	FP-3PE	R-1	D-1
I 型, D方法, 3级灵敏度	—	—	D-1	FP-3PE	FE-D	D-1

受检品	处理受检品用材料			参考材料		
I 型, A方法, 4级灵敏度	—	—	D-1	FP-4W	—	D-1
I 型, B方法, 4级灵敏度	—	—	D-1	FP-4PE	FE-B	D-1
I 型, C方法, 4级灵敏度	—	—	D-1	FP-4PE	R-1	D-1
I 型, D方法, 4级灵敏度	—	—	D-1	FP-4PE	FE-D	D-1
II 型, A方法, 1级灵敏度	—	—	D-2	VP-1PE	VE-B	D-2
II 型, B方法, 1级灵敏度	—	—	D-2	VP-1PE	VE-B	D-2
II 型, C方法, 1级灵敏度	—	—	D-2	VP-1PE	R-2	D-2
II 型, D方法, 1级灵敏度	—	—	D-2	VP-1PE	VE-B	D-2
II 型, A方法, 2级灵敏度	—	—	D-2	VP-2PE	VE-B	D-2
II 型, B方法, 2级灵敏度	—	—	D-2	VP-2PE	VE-B	D-2
II 型, C方法, 2级灵敏度	—	—	D-2	VP-2PE	R-2	D-2
II 型, D方法, 2级灵敏度	—	—	D-2	VP-2PE	VE-B	D-2
去除剂						
C方法	FP-4PE	—	D-1	FP-4PE	R-2	D-1
显像剂						
a方式	FP-4PE	FE-B	—	FP-4PE	FE-B	D-1
b方式	FP-4PE	FE-B	—	FP-4PE	FE-B	D-1
c方式	FP-4PE	FE-B	—	FP-4PE	FE-B	D-1
d方式	FP-4PE	FE-B	—	FP-4PE	FE-B	D-1
e方式	FP-2PE	VE-B	—	FP-2PE	VE-B	D-2

参考产品清单见附录C。

Table 6 — Sensitivity and removability matrix

Candidate material	Materials for processing candidates			Reference materials		
Penetrant systems						
Type I, method A, level 1/2			D-1	FP-1/2		D-1
Type I, method A, level 1			D-1	FP-1W		D-1
Type I, method B, level 1			D-1	FP-1PE	FE-B	D-1
Type I, method C, level 1			D-1	FP-1PE	R-1	D-1
Type I, method D, level 1			D-1	FP-1PE	FE-D	D-1
Type I, method A, level 2			D-1	FP-2W		D-1
Type I, method B, level 2			D-1	FP-2PE	FE-B	D-1
Type I, method C, level 2			D-1	FP-2PE	R-1	D-1
Type I, method D, level 2			D-1	FP-2PE	FE-D	D-1
Type I, method A, level 3			D-1	FP-3W		D-1
Type I, method B, level 3			D-1	FP-3PE	FE-B	D-1
Type I, method C, level 3			D-1	FP-3PE	R-1	D-1
Type I, method D, level 3			D-1	FP-3PE	FE-D	D-1
Type I, method A, level 4			D-1	FP-4W		D-1
Type I, method B, level 4			D-1	FP-4PE	FE-B	D-1
Type I, method C, level 4			D-1	FP-4PE	R-1	D-1
Type I, method D, level 4			D-1	FP-4PE	FE-D	D-1
Type II, method A, level 1			D-2	VP-1PE	VE-B	D-2
Type II, method B, level 1			D-2	VP-1PE	VE-B	D-2
Type II, method C, level 1			D-2	VP-1PE	R-2	D-2
Type II, method D, level 1			D-2	VP-1PE	VE-B	D-2
Type II, method A, level 2			D-2	VP-2PE	VE-B	D-2
Type II, method B, level 2			D-2	VP-2PE	VE-B	D-2
Type II, method C, level 2			D-2	VP-2PE	R-2	D-2
Type II, method D, level 2			D-2	VP-2PE	VE-B	D-2

Table 6 (continued)

Candidate material	Materials for processing candidates			Reference materials		
Removers						
Method C	FP-4PE		D-1	FP-4PE	R-2	D-1
Developers						
Form a	FP-4PE	FE-B		FP-4PE	FE-B	D-1
Form b	FP-4PE	FE-B		FP-4PE	FE-B	D-1
Form c	FP-4PE	FE-B		FP-4PE	FE-B	D-1
Form d	FP-4PE	FE-B		FP-4PE	FE-B	D-1
Form e	VP-2PE	VE-B		VP-2PE	VE-B	D-2

The list of reference products is given in [Annex C](#).

6.2.1.2.3 检验规程

受检品和参考渗透剂的检验，应采用同一规定规程。参考渗透剂的灵敏度等级应与受检品相同。表7给出了参数示例。每个规程应至少重复3次，结果取平均值。

6.2.1.2.3 Test procedures

The same defined procedure shall be used for testing the candidate and the reference penetrant. The reference penetrant shall be of the same sensitivity level as the candidate. Table 7 gives an example of parameters. Each procedure shall be repeated at least three times and the results averaged.

Table 7 — Typical type I sensitivity test parameters

Penetrant dwell	All methods	Dip and then drain for 5 min at 5° to 10° from vertical.
Pre-wash	Method D	Spray with water for 1 min at (160 ± 16) kPa at (20 ± 5) °C.
Emulsification	Method B	Dip and then drain for 2 min.
	Method D	Immerse for 5 min, no agitation: — for reference system, 20 % concentration; — for candidate system, manufacturer's recommended concentration.
Wash	Method A	Spray with water for 1 min.
	Method B	Spray with water under UV-A radiation until fluorescent background is gone. If not achieved within 2 min, the test has failed.
	Method D	Plunge into water to stop emulsification, followed by spray with water for 2 min.
		For the three methods: pressure at (160 ± 16) kPa in the water pipe nearest to the spray nozzle, temperature at (20 ± 5) °C.
Solvent wipe	Method C	Wipe with a clean rag dampened with solvent; then wipe with clean, dry rag to remove excess solvent.
Dry	Methods A, B, D	Dry for 5 min in a drying oven. The temperature in the drying oven should not be higher than 50 °C.
		Dry after developer application when testing forms b and c.
	Method C	Dry for 5 min at room temperature.
Developer	All methods	Dip for 5 s maximum in form a (dry) developer and allow a minimum dwell of 5 min.

表7 典型 I 型渗透剂灵敏度检验参数

渗透剂保持	全部方法	浸，然后滴沥5min，与垂直呈5°~10°
预洗	D方法	在(20±5)℃下，以(160±16)kPa的压力喷水1分钟
乳化	B方法	浸，然后滴沥2 min
	D方法	浸没5 min，不搅动： ——参考系统，浓度为20 %； ——受检品系统，制造商推荐的浓度
水洗	A方法	喷水1min
	B方法	在UV-A 辐射下喷水，直至荧光背景消失；如果不能在2 min内完成，则检验失败
	D方法	放入水中停止乳化，随后喷水2min
		此三种方法：水管最接近喷嘴处的压力为(160±16)kPa，温度为(20±5)℃
溶剂去除	C方法	用干净的布沾湿溶剂擦，然后用于净的干布擦，以去除多余溶剂
干燥		在烘箱中干燥5 min，烘箱中的温度不宜高于50 °C

	A方法、B方法、D方法	若检验为b方式和c方式时，干燥后施加显像剂
	C方法	在室温下干燥5 min
显像	全部方法	浸在a方式（干粉）显像剂中最多为5 s，允许最少保持5 min

6.2.1.2.4 设备

设备应符合附录B的规定。

6.2.1.2.4 Equipment

The equipment shall be as defined in [Annex B](#).

6.2.1.2.5 结果解释

在符合ISO 3059规定的观察条件下，应对试块的整个表面进行目视比较。受检品应显示出与参考产品相似或更好的性能。定量评价应至少比较5个指标。定量评价在使用时应表明，受检品显示的结果应至少达到参考产品性能的90%。

6.2.1.2.5 Interpretation of results

A visual comparison of the full surface of the panels shall be made under viewing conditions in accordance with ISO 3059. The results shall demonstrate similar or better performance than the

reference product. Quantitative measurement shall be made by comparison of a minimum of 5 indications. Quantitative assessments, where used, shall show the candidate material giving a result of at least 90 % of the reference product.

6.2.2 着色渗透剂（II型）

6.2.2.1 检验规定

方法A、B、C和D的渗透剂及其相关的去除剂（如有），应采用参考非水湿式显像剂D-2进行检验。方法C（溶剂去除型）渗透剂也可采用参考溶剂去除剂R-2和参考非水显像剂D-2（见表6）进行检验。

除方式f外的所有与II型（着色）渗透剂配用的显像方法，应采用II型参考渗透剂和方法B乳化剂VP-PE/VE-B进行检验。

6.2.2 Colour contrast penetrants (type II)

6.2.2.1 Qualification provisions

Methods A, B, C and D penetrants and associated removers (if any) shall be qualified with the reference non-aqueous wet developer D-2. Method C (solvent removable) penetrants may also be qualified with the reference solvent remover R-2 and the reference non-aqueous developer D-2 (see [Table 6](#)).

For all developing methods, except form f, intended for use with type II (visible dye) penetrant, materials shall be qualified with a type II reference penetrant and a method B emulsifier VP-PE/VE-B.

6.2.2.2 试块

应使用符合ISO 3452-3规定的I型参考试块中的30 μm和50 μm试块。

6.2.2.2 Test panels

The 30 μm and 50 μm test panels from the reference block type 1 according to ISO 3452-3 shall be used.

6.2.2.3 检验方法

试块首先应采用3级灵敏度的I型（荧光）渗透剂系统进行校准。应清晰记录明显可见的、分布于不小于试块宽度80%的不间断显示的数目。然后应彻底清除所有荧光材料的痕迹，以便后续用于II型渗透剂检验。

用于受检品的试块，应按表8规定的要求进行处理。

每个规程至少应重复3次，结果取平均值。

6.2.2.3 Method of testing

The panels shall be initially calibrated using a type I (fluorescent), level 3 penetrant system. The number of clearly visible indications extending across at least 80 % of the panel width shall be recorded. The panels shall then be thoroughly cleaned to remove all traces of the fluorescent materials and reserved for use with type II penetrants.

Using the candidate material, the panels shall be processed in accordance with [Table 8](#).

Each procedure shall be repeated at least three times and the results averaged.

Table 8 — Typical type II sensitivity test parameters

Penetrant dwell	All methods	Dip and then drain for 5 min at 5° to 10° from vertical.
Pre-wash	Method D	Pre-wash with water for 30 s.
Emulsification	Method B	Emulsify for 30 s.
	Method D	Emulsify for 1,5 min.
Wash	Method A	Spray with water for 1 min.
	Method B	Spray with water under white light until coloured background is gone. If not achieved within 2 min, the test has failed.
	Method D	Plunge into water to stop emulsification, followed by spray with water for 2 min.
		For the three methods: rinse with soft pressure in water pipe nearest to the spray nozzle, temperature at (20 ± 5) °C.
Solvent wipe	Method C	Wipe with a clean rag dampened with solvent.
Dry	Methods A, B, D	Dry for 5 min in drying oven (50 ± 3) °C maximum.
	Method C	Dry for 5 min at room temperature.
Developer	All methods	Spray with reference developer D-2 of Table 5 and allow a minimum dwell of 5 min.

表8 典型II型渗透剂灵敏度检验参数

渗透剂保持	全部方法	浸，然后滴沥5min，与垂直呈5°~10°
预洗	方法D	用水预洗30 s
乳化	方法B	乳化30 s
	方法D	乳化1.5 min
水洗	方法A	喷水1 min
	方法B	在白光下用水喷洒，直到着色背景消失；如果不能在2 min内完成，则检验失败
	方法D	放入水中停止乳化，随后喷水2 min
	—	此三种方法：在水管最接近喷嘴处用软压力冲洗，温度为(20±5) °C
溶剂去除	方法C	用干净的布沾湿溶剂擦，然后用于净的干布擦，以去除多余溶剂
干燥	方法A、B、D	在干燥箱(50±3) °C中干燥5分钟
	方法C	在室温下干燥5 min
显像	全部方法	采用表5中的参考显像剂D-2喷射，允许最少保持5 min

6.2.2.4 结果解释

评估时的观察条件应符合ISO 3059的规定。在进行其他评估时，报告中应说明观察条件。

灵敏度百分比通过以下两个数值的比值获得：

- 用裸眼（如通常佩戴眼镜则佩戴眼镜）观察清晰可见的、覆盖试块宽度至少80%的显示数目；
- 试块按6.2.2.3规定的要求进行首次校准所观察到的显示数目。

此比值乘以100即得到百分比数值。

6.2.2.4 Interpretation of results

For visual assessment, viewing conditions shall be in accordance with ISO 3059. Where other assessment is carried out, the viewing conditions shall be stated in the report.

A sensitivity percentage is achieved by the ratio of two figures:

- the number of indications covering at least 80 % of the panel width, clearly visible to the unaided eye (with glasses if usually worn);
- the number of indications seen when the panel has been first calibrated as per [6.2.2.3](#).

This ratio is multiplied by 100 to achieve a percentage value.

6.2.2.5 要求

应按表9规定的要求确定灵敏度等级。

表9 着色渗透剂灵敏度等级的确定

灵敏度等级	检出的不连续的百分率	
	30µm	50µm
1	不适用	≥90%
2	≥75%	100%

6.2.2.5 Requirements

The sensitivity level shall be determined in accordance with [Table 9](#).

Table 9 — Determination of sensitivity level for colour contrast penetrants

Sensitivity level	Percentage of discontinuities found	
	30 µm	50 µm
1	not applicable	≥ 90
2	≥ 75	100

6.3 密度

6.3.1 检验方法

20 °C时的密度应采用准确度优于±1%的方法测定。

6.3 Density

6.3.1 Test method

Density at 20 °C shall be determined using a method with an accuracy better than ±1 %.

6.3.2 要求

型式检验的结果应出具报告（标称值）。批检验的结果应允许与标称值偏差±5%。

6.3.2 Requirements

This result shall be reported for type testing (nominal value). For batch testing, a tolerance of ±5 % of the nominal value shall be permitted.

6.4 黏度

6.4.1 检验方法

黏度应采用准确度优于±1%的适当方法测定。应记录在某一规定温度下的结果。批检验应在规定的温度下进行。

6.4 Viscosity

6.4.1 Test method

Viscosity shall be determined by a suitable method with an accuracy of better than ±1 %. The result for a defined temperature shall be recorded. Batch testing shall be carried out at the specified temperature.

6.4.2 要求

型式检验的结果应出具报告（标称值）。批检验的结果应允许与标称值偏差±10%。

6.4.2 Requirements

This result shall be reported for type testing (nominal value). For batch testing, a tolerance of ±10 % of the nominal value shall be permitted.

6.5 闪点

6.5.1 检验方法

闪点应采用适当且明确说明的方法测定，渗透材料闪点低于100 °C时准确度优于±2 °C，渗透材料闪点大于或等于100 °C时准确度优于±5 °C。

仅当闪点的标称值在20 °C~110 °C范围内，批检验才应测定闪点。闪点应采用适当的方法测定。

6.5 Flashpoint

6.5.1 Test method

The flashpoint shall be determined by an appropriate stated method with an accuracy of better than ±2 °C for materials with a flashpoint of less than 100 °C, or better than ±5 °C for materials with a flashpoint greater than or equal to 100 °C.

Flashpoint measurement shall only be required for batch testing if the nominal flashpoint is within the range from 20 °C to 110 °C. The flashpoint shall be determined by an appropriate method.

6.5.2 要求

型式检验的结果应出具报告（标称值）。批检验的闪点不应低于标称值减5 °C。

6.5.2 Requirements

The result shall be reported for type testing (nominal value). The flashpoint for batch testing shall be no more than 5 °C below the nominal value.

6.6 可水洗性(方法 A 渗透剂)

用(20±5)℃的温水喷射去除后,残留在ISO 3452-3规定的2型参考试块上表面粗糙度 $R_a=5\mu\text{m}$ 和 $R_a=10\mu\text{m}$ 区域上的剩余渗透剂,不应比在相同条件下清洗同一渗透剂型式检验试样时多。对于I型渗透剂,该检验应在UV-A辐射超过 $10\text{W}/\text{m}^2$ 和最大白光 20lx 下进行。对于II型渗透剂,该检验应在至少 500lx 的可见光下进行。对于III型渗透剂,两项检验均应进行。目视比较新批与相同渗透系统合格批的留样。

6.6 Washability (method A penetrants)

When removed with a gentle water spray at $(20 \pm 5)^\circ\text{C}$ the sample penetrant shall not leave more background on the surface roughness areas $R_a = 5\mu\text{m}$ and $R_a = 10\mu\text{m}$ of reference test block type 2 in accordance with ISO 3452-3 than the type test sample of the same penetrant processed under identical conditions. For type I penetrants, this test shall be carried out under UV-A irradiance in excess of $10\text{W}/\text{m}^2$ and white light maximum 20lx . For type II penetrants this test shall be carried out under visible light minimum 500lx . For type III penetrants both tests shall be carried out. Visually compare new batches with the retained sample of an acceptable batch of same penetrant system.

6.7 荧光亮度

6.7.1 检验方法

I型渗透剂的荧光亮度应按附录A规定的要求进行检验。

6.7 Fluorescent brightness

6.7.1 Test method

The fluorescent brightness of type I penetrants shall be tested in accordance with [Annex A](#).

6.7.2 要求

对于型式检验,受检品的荧光亮度不应低于参考FP-4PE(见表5)亮度的百分率:

- 1/2 级灵敏度渗透剂, 50%;
- 1 级灵敏度渗透剂, 65%;
- 2 级灵敏度渗透剂, 80%;
- 3 级灵敏度渗透剂, 90%;
- 4 级灵敏度渗透剂, 95%。

批检验应与型式检验样品进行比较,偏差应为±10%,且荧光亮度不应低于型式检验要求。

6.7.2 Requirements

For type testing, the fluorescent brightness of the candidate shall not be less than the following percentages of the brightness of the reference FP-4PE (see [Table 5](#)):

Sensitivity level 1/2	penetrant	50 %
Sensitivity level 1	penetrant	65 %
Sensitivity level 2	penetrant	80 %
Sensitivity level 3	penetrant	90 %
Sensitivity level 4	penetrant	95 %

Batch testing shall be carried out compared with the type test sample. The tolerance shall be ±10 %, but the fluorescent brightness shall not be less than the type test requirement.

6.8 UV 稳定性

6.8.1 检验方法

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