



Designation: E 1209 – 99

Standard Test Method for Fluorescent Liquid Penetrant Examination Using the Water- Washable Process¹

This standard is issued under the fixed designation E 1209; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method² covers procedures for water-washable fluorescent penetrant examination of materials. It is a nondestructive testing method for detecting discontinuities that are open to the surface such as cracks, seams, laps, cold shuts, laminations, isolated porosity, through leaks, or lack of porosity and is applicable to in-process, final, and maintenance examination. It can be effectively used in the examination of nonporous, metallic materials, both ferrous and nonferrous, and of nonmetallic materials such as glazed or fully densified ceramics and certain nonporous plastics and glass.

1.2 This test method also provides a reference:

1.2.1 By which a fluorescent penetrant examination method using the water-washable process recommended or required by individual organizations can be reviewed to ascertain its applicability and completeness.

1.2.2 For use in the preparation of process specifications dealing with the water-washable fluorescent penetrant examination of materials and parts. Agreement by the purchaser and the manufacturer regarding specific techniques is strongly recommended.

1.2.3 For use in the organization of the facilities and personnel concerned with the liquid penetrant examination.

1.3 This test method does not indicate or suggest standards for evaluation of the indications obtained. It should be pointed out, however, that indications must be interpreted or classified and then evaluated. For this purpose there must be a separate code or specification or a specific agreement to define the type, size, location, and direction of indications considered acceptable, and those considered unacceptable.

1.4 The values stated in inch-pound units are to be regarded as the standard. SI units are provided for information only.

1.5 All areas of this document may be open to agreement between the cognizant engineering organization and the supplier, or specific direction from the cognizant engineering organization.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For specific hazard statements, see Notes 13 and 18.

2. Referenced Documents

2.1 ASTM Standards:

D 129 Test Method for Sulfur in Petroleum Products (General Bomb Method)³

D 516 Test Methods for Sulfate Ion in Water⁴

D 808 Test Method for Chlorine in New and Used Petroleum Products (Bomb Method)³

D 1552 Test Method for Sulfur in Petroleum Products (High-Temperature Method)³

E 165 Test Method for Liquid Penetrant Examination⁵

E 433 Reference Photographs for Liquid Penetrant Inspection⁵

E 543 Practice for Evaluating Agencies that Perform Nondestructive Testing⁵

E 1316 Terminology for Nondestructive Examinations⁵

2.2 ASNT Documents:

Recommended Practice SNT-TC-1A Personnel Qualification and Certification in Nondestructive Testing⁶

ANSI/ASNT-CP-189 Qualification and Certification of NDT Personnel⁶

2.3 Military Standard:⁷

MIL-STD-410 Nondestructive Testing Personnel Qualification and Certification

2.4 AIA Standard:

NAS 410 Certification and Qualification of Nondestructive Test Personnel⁸

2.5 *Department of Defense (DoD) Contracts*—Unless otherwise specified, the issue of the documents that are DoD

¹ This test method is under the jurisdiction of ASTM Committee E-7 on Nondestructive Testing and is the direct responsibility of Subcommittee E07.03 on Liquid Penetrant and Magnetic Particle Methods.

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² For ASME Boiler and Pressure Vessel Code applications see related Test Method SE-1209 in Section II of that Code.

³ Annual Book of ASTM Standards, Vol 05.01.

⁴ Annual Book of ASTM Standards, Vol 11.01.

⁵ Annual Book of ASTM Standards, Vol 03.03.

⁶ Available from the American Society for Nondestructive Testing, 1711 Arlington Plaza, Columbus, OH 43228-0518.

⁷ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

⁸ Available from the Aerospace Industries Association of America, Inc., 1250 Eye Street, N.W., Washington, DC 20005.

adopted are those listed in the issue of the DoDISS (Department of Defense Index of Specifications and Standards) cited in the solicitation.

2.6 *Order of Precedence*—In the event of conflict between the text of this test method and the references cited herein, the text of this test method takes precedence.

3. Terminology

3.1 *Definitions*—definitions relating to liquid penetrant examination, which appear in Terminology E 1316, shall apply to the terms used in this test method.

4. Summary of Test Method

4.1 A liquid penetrant is applied evenly over the surface being tested and allowed to enter open discontinuities. After a suitable dwell time, the excess surface penetrant is removed with water and the surface is dried prior to the application of a dry or nonaqueous developer. A developer is then applied, drawing the entrapped penetrant out of the discontinuity and staining the developer. If an aqueous developer is to be employed, the developer is applied prior to the drying step. The test surface is then examined visually under black light in a darkened area to determine the presence or absence of indications.

NOTE 1—The developer may be omitted by agreement between purchaser and supplier.

NOTE 2—**Caution:** Fluorescent penetrant examination shall not follow a visible penetrant examination unless the procedure has been qualified in accordance with 9.2, because visible dyes may cause deterioration or quenching of fluorescent dyes.

4.2 The selection of particular water-washable penetrant process parameters depends upon the nature of the application, condition under which the examination is to be performed, availability of processing equipment, and type of materials to perform the examination.

NOTE 3—**Caution:** A controlled method for applying water and disposing of the water is essential.

4.3 Processing parameters, such as precleaning, penetration time and wash times, are determined by the specific materials used, the nature of the part under examination, (that is, size, shape, surface condition, alloy) and type of discontinuities expected.

5. Significance and Use

5.1 Liquid penetrant examination methods indicate the presence, location, and, to a limited extent, the nature and magnitude of the detected discontinuities. This method is normally used for production inspection of large volumes of parts or structures, where emphasis is on productivity. The method enjoys a wide latitude in applicability when extensive and controlled conditions are available. Multiple levels of sensitivity can be achieved by proper selection of materials and variations in process.

6. Reagents and Materials

6.1 *Liquid Fluorescent Penetrant Examination Materials* (see Note 4) for use in the water-washable process consist of

a family of fluorescent water-washable penetrants and appropriate developers and are classified as Type I Fluorescent, Method A—Water-Washable. Intermixing of materials from various manufacturers is not recommended.

NOTE 4—Refer to 8.1 for special requirements for sulfur, halogen, and alkali metal content.

NOTE 5—**Caution:** While approved penetrant materials will not adversely affect common metallic materials, some plastics or rubbers may be swollen or stained by certain penetrants.

6.2 *Water-Washable Penetrants* are designed to be directly water-washable from the surface of the test part after a suitable penetrant dwell time. Because the emulsifier is “built-in” to the water-washable penetrant, it is extremely important to exercise proper process control in removal of excess surface penetrant to assure against overwashing. Water-washable penetrants can be washed out of discontinuities if the rinsing step is too long or too vigorous. Some penetrants are less resistant to overwashing than others.

6.3 *Developers*—Development of penetrant indications is the process of bringing the penetrant out of open discontinuities through blotting action of the applied developer, thus increasing the visibility of the penetrant indications. Several types of developers are suitable for use and the fluorescent penetrant water-washable process.

NOTE 6—**Caution:** Aqueous developers may cause stripping of indications if not properly applied and controlled. The procedure shall be qualified in accordance with 9.2.

6.3.1 *Dry Powder Developers* are used as supplied (that is, free-flowing, noncaking powder) in accordance with 7.1.7.1(a). Care should be taken not to contaminate the developer with fluorescent penetrant, as the specks can appear as indications.

6.3.2 *Aqueous Developers* are normally supplied as dry powder particles to be either suspended or dissolved (soluble) in water. The concentration, use, and maintenance shall be in accordance with the manufacturer’s recommendations (see 7.1.7.1(b)).

6.3.3 *Nonaqueous, Wet Developers* are supplied as suspensions of developer particles in nonaqueous, solvent carriers ready for use as supplied. Nonaqueous, wet developers form a coating on the surface of the part when dried, which serves as the developing medium for fluorescent penetrants (see 7.1.7.1(c)).

NOTE 7—**Caution:** This type of developer is intended for application by spray only.

6.3.4 *Liquid Film Developers* are solutions or colloidal suspensions of resins/polymer in a suitable carrier. These developers will form a transparent or translucent coating on the surface of the part. Certain types of film developer will fix indications and may be stripped from the part and retained for record purposes (see 7.1.7.1(d)).

7. Procedure

7.1 The following general procedure applies to the fluorescent penetrant examination water-washable method (see Fig. 1).

7.1.1 *Temperature Limits*—The temperature of the penetrant materials and the surface of the part to be processed should be

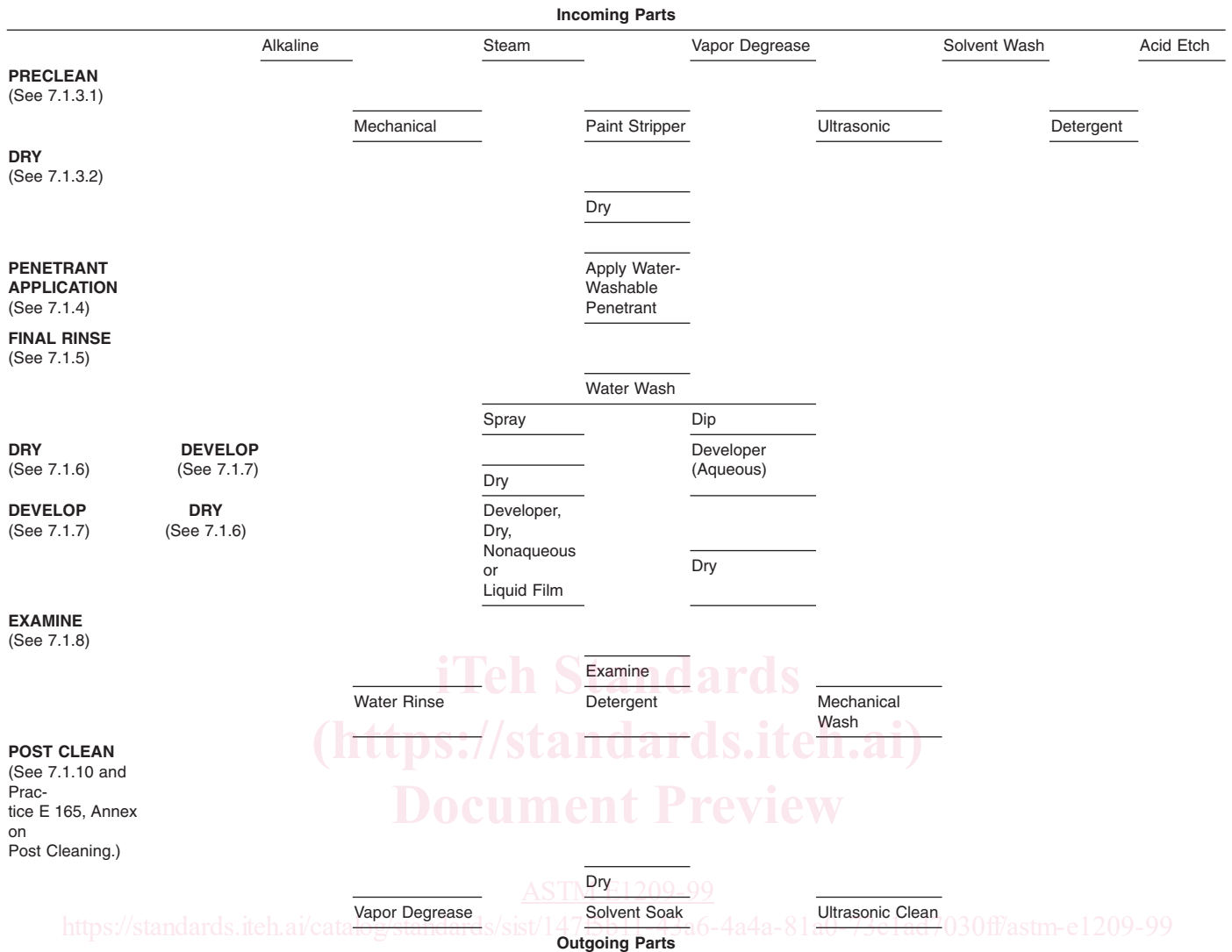


FIG. 1 General Procedure Flowsheet for Fluorescent Penetrant Examination Using the Water-Washable Process

between 40° and 120°F (4° and 49°C). Where it is not practical to comply with these temperature limitations, qualify the procedure at the temperature of intended use as described in 9.2.

7.1.2 Surface Conditioning Prior to Penetrant Inspection—Satisfactory results can usually be obtained on surfaces in the as-welded, as-rolled, as-cast, or as-forged conditions or for ceramics in the densified condition. The more sensitive penetrants are generally less easily rinsed away and are therefore less suitable for rougher surfaces. When only loose surface residuals are present, these may be removed by wiping the surface with clean lint-free cloths. However, precleaning of metals to remove processing residuals such as oil, graphite, scale, insulating materials, coatings, and so forth, should be done using cleaning solvents, vapor degreasing or chemical removing processes. Surface conditioning by grinding, machining, polishing or etching shall follow shot, sand, grit and vapor blasting to remove the peened skin and when penetrant entrapment in surface irregularities might mask the indications of unacceptable discontinuities or otherwise interfere with the

effectiveness of the examination. For metals, unless otherwise specified, etching shall be performed when evidence exists that previous cleaning, surface treatments or service usage have produced a surface condition that degrades the effectiveness of the examination. (See Annex on Mechanical Cleaning and Surface Conditioning and Annex on Acid Etching in Test Method E 165 for general precautions relative to surface preparation.)

NOTE 8—When agreed between purchaser and supplier, grit blasting without subsequent etching may be an acceptable cleaning method.

NOTE 9—Caution: Sand or shot blasting may possibly close indications and extreme care should be used with grinding and machining operations.

NOTE 10—For structural or electronic ceramics, surface preparation by grinding, sand blasting and etching for penetrant examination is not recommended because of the potential for damage.

7.1.3 Removal of Surface Contaminants:

7.1.3.1 Precleaning—The success of any penetrant examination procedure is greatly dependent upon the surface and discontinuity being free of any contaminant (solid or liquid)