



Designation: E165/E165M – 23

Standard Practice for Liquid Penetrant Testing for General Industry¹

This standard is issued under the fixed designation E165/E165M; 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 practice² covers procedures for penetrant examination of materials. Penetrant testing is a nondestructive testing method for detecting discontinuities that are open to the surface such as cracks, seams, laps, cold shuts, shrinkage, laminations, through leaks, or lack of fusion and is applicable to in-process, final, and maintenance examinations. It can be effectively used in the examination of nonporous, metallic materials, ferrous and nonferrous metals, and of nonmetallic materials such as nonporous glazed or fully densified ceramics, as well as certain nonporous plastics, and glass.

1.2 This practice also provides a reference:

1.2.1 By which a liquid penetrant examination 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 and procedures dealing with the liquid penetrant testing of parts and materials. Agreement by the customer requesting penetrant testing is strongly recommended. All areas of this practice may be open to agreement between the cognizant engineering organization and the supplier, or specific direction from the cognizant engineering organization.

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

1.3 This practice does not indicate or suggest criteria for evaluation of the indications obtained by penetrant testing. It should be pointed out, however, that after indications have been found, they must be interpreted or classified and then evaluated. For this purpose there must be a separate code, standard, or a specific agreement to define the type, size, location, and direction of indications considered acceptable, and those considered unacceptable.

1.4 *Units*—The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents;

therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.5 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards*:³

D129 Test Method for Sulfur in Petroleum Products (General High Pressure Decomposition Device Method)

D329 Specification for Acetone

D770 Specification for Isopropyl Alcohol

D1193 Specification for Reagent Water

D1552 Test Method for Sulfur in Petroleum Products by High Temperature Combustion and Infrared (IR) Detection or Thermal Conductivity Detection (TCD)

D4327 Test Method for Anions in Water by Suppressed Ion Chromatography

D6919 Test Method for Determination of Dissolved Alkali and Alkaline Earth Cations and Ammonium in Water and Wastewater by Ion Chromatography

E433 Reference Photographs for Liquid Penetrant Inspection

E516 Practice for Testing Thermal Conductivity Detectors Used in Gas Chromatography

E543 Specification for Agencies Performing Nondestructive Testing

E1208 Practice for Fluorescent Liquid Penetrant Testing Using the Lipophilic Post-Emulsification Process

¹ This practice is under the jurisdiction of ASTM Committee E07 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 Recommended Test Method SE-165 in the Code.

³ For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

*A Summary of Changes section appears at the end of this standard



- E1209 Practice for Fluorescent Liquid Penetrant Testing Using the Water-Washable Process
- E1210 Practice for Fluorescent Liquid Penetrant Testing Using the Hydrophilic Post-Emulsification Process
- E1219 Practice for Fluorescent Liquid Penetrant Testing Using the Solvent-Removable Process
- E1220 Practice for Visible Penetrant Testing Using Solvent-Removable Process
- E1316 Terminology for Nondestructive Examinations
- E1418 Practice for Visible Penetrant Testing Using the Water-Washable Process
- E2297 Guide for Use of UV-A and Visible Light Sources and Meters used in the Liquid Penetrant and Magnetic Particle Methods
- E3022 Practice for Measurement of Emission Characteristics and Requirements for LED UV-A Lamps Used in Fluorescent Penetrant and Magnetic Particle Testing
- 2.2 APHA Standard:⁴
- 429 Method for the Examination of Water and Wastewater
- 2.3 SAE Standards:⁵
- AMS 2644 Inspection Material, Penetrant
- QPL-AMS-2644 Qualified Products of Inspection Materials, Penetrant

3. Terminology

3.1 The definitions relating to liquid penetrant testing, which appear in Terminology E1316, shall apply to the terms used in this practice.

NOTE 1—Throughout this practice, the term *blacklight* has been changed to *UV-A* to conform with the latest terminology in Terminology E1316. *Blacklight* can mean a broad range of ultraviolet radiation – fluorescent penetrant testing uses only UV-A light.

4. Summary of Practice

4.1 Liquid penetrant may consist of visible or fluorescent material. The liquid penetrant is applied evenly over the surface being examined and allowed to enter open discontinuities. After a suitable dwell time, the excess surface penetrant is removed. A developer is applied to draw the entrapped penetrant out of the discontinuity and stain the developer. The test surface is then examined to determine the presence or absence of indications.

NOTE 2—The developer may be omitted by agreement between the contracting parties.

NOTE 3—Fluorescent penetrant examination shall not follow a visible penetrant examination unless the procedure has been qualified in accordance with 10.2, because visible dyes may cause deterioration or quenching of fluorescent dyes.

4.2 Processing parameters, such as surface precleaning, penetrant dwell time, and excess penetrant removal methods, are dependent on the specific materials used, the nature of the part under examination (that is, size, shape, surface condition, alloy), and type of discontinuities expected.

⁴ Available from American Public Health Association, Publication Office, 1015 Fifteenth Street, NW, Washington, DC 20005.

⁵ Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, <http://www.sae.org>.

5. Significance and Use

5.1 Liquid penetrant testing methods indicate the presence, location, and to a limited extent, the nature and magnitude of the detected discontinuities. Each of the various penetrant methods has been designed for specific uses such as critical service items, volume of parts, portability, or localized areas of examination. The method selected will depend accordingly on the design and service requirements of the parts or materials being tested.

6. Classification of Penetrant Materials and Methods

6.1 Liquid penetrant testing methods and materials are classified in accordance with AMS 2644 as listed in Table 1.

6.2 *Fluorescent Penetrant Testing (Type I)*—Fluorescent penetrant testing utilizes penetrants that fluoresce brilliantly when excited by UV-A radiation. The sensitivity of fluorescent penetrants depends on their ability to be retained in the various size discontinuities during processing, and then to bleed out into the developer coating and produce indications that will fluoresce. Fluorescent indications are many times brighter than their surroundings when viewed under appropriate UV-A illumination.

6.3 *Visible Penetrant Testing (Type II)*—Visible penetrant testing uses a penetrant that can be seen in visible light. The penetrant is usually red, so that resultant indications produce a definite contrast with the white background of the developer. Visible penetrant indications must be viewed under adequate visible light.

7. Materials

7.1 *Liquid Penetrant Testing Materials* consist of fluorescent or visible penetrants, emulsifiers (oil-base and water-base), removers (water and solvent), and developers (dry powder, aqueous, and nonaqueous). A family of liquid penetrant testing materials consists of the applicable penetrant and emulsifier, as recommended by the manufacturer. Any liquid penetrant, remover, and developer listed in QPL-AMS-2644 can be used, regardless of the manufacturer. Penetrants and emulsifiers shall be from the same family; use of a penetrant and emulsifier from different manufacturers or family groups is prohibited.

NOTE 4—Refer to 9.1 for special requirements for sulfur, halogen, and alkali metal content.

TABLE 1 Classification of Penetrant Testing Types and Methods

Type I—Fluorescent Penetrant Testing
Method A—Water-washable (see Practice E1209)
Method A(W)—Water Washable Penetrant (penetrant containing >20 % water) (see Practice E1209)
Method B—Post-emulsifiable, lipophilic (see Practice E1208)
Method C—Solvent removable (see Practice E1219)
Method D—Post-emulsifiable, hydrophilic (see Practice E1210)
Type II—Visible Penetrant Testing
Method A—Water-washable (see Practice E1418)
Method A(W)—Water Washable Penetrant (penetrant containing >20 % water) (see Practice E1418)
Method C—Solvent removable (see Practice E1220)