Designation: ~~E1220 – 16~~ E1220 – 21

Standard Practice for Visible Penetrant Testing Using Solvent-Removable Process[1]

This standard is issued under the fixed designation E1220; 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 practice[2] covers procedures for visible penetrant examination utilizing the solvent-removable process. 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 fusion 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 practice also provides a reference:

1.2.1 By which a visible penetrant examination method using the solvent-removable 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 visible, solvent-removable liquid 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 practice does not indicate or suggest standards for evaluation of the indications obtained. It should be noted, however, that after indications have been produced, they must be interpreted or classified and then evaluated. For this purpose there must be a separate code, specification, or a specific agreement to define the type, size, location, and direction of indications considered acceptable, and those considered unacceptable.

1.3.1 The user is encouraged to use materials and processing parameters necessary to detect conditions of a type or severity which could affect the evaluation of the product.

1.4 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.

1.5 *Units*—The values stated in inch-pound units are to be regarded as standard. ~~SI units~~The values given in parentheses are ~~for information only.~~mathematical conversions to SI units that are provided for information only and are not considered standard.

[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 Test Method SE-1220 in Section II of that Code.

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

1.7 *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)
D516 Test Method for Sulfate Ion in Water
D808 Test Method for Chlorine in New and Used Petroleum Products (High Pressure Decomposition Device Method)
D1552 Test Method for Sulfur in Petroleum Products by High Temperature Combustion and Infrared (IR) Detection or Thermal Conductivity Detection (TCD)
E165/E165M Practice for Liquid Penetrant Testing for General Industry
E433 Reference Photographs for Liquid Penetrant Inspection
E543 Specification for Agencies Performing Nondestructive Testing
E1316 Terminology for Nondestructive Examinations

2.2 *ASNT Documents:*[4]

SNT-TC-1A Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing
ANSI/ASNT-CP-189 Standard for Qualification and Certification of NDT Personnel

2.3 *Other Standards:*

AMS 2644 Inspection Material, Penetrant[5]
ISO 9712 Nondestructive Testing—Qualification and Certification of NDT Personnel—General Principles[6]

2.4 *AIA Standard:*[7]

~~NAS 410~~NAS410 Certification and Qualification of Nondestructive Test Personnel

2.5 *DoD ~~Contracts~~-Contracts*—Unless otherwise specified, the issues of the documents that are DoD 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~~-Precedence*—In the event of conflict between the text of this practice and the references cited herein, the text of this practice takes precedence.

3. Terminology

3.1 *Definitions*—~~definitions~~—Definitions relating to liquid penetrant examination, which appear in Terminology E1316, shall apply to the terms used in this practice.

4. Summary of Practice

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 by wiping and the surface is dried. If an aqueous developer is to be employed, the developer is applied prior to the drying step. A developer is then applied, drawing the entrapped penetrant out of the discontinuity, staining the developer. The test surface is then examined visually to determine the presence or absence of indications.

4.2 Processing parameters, such as precleaning, penetration time, etc., 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

[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.
[4] Available from The American Society for Nondestructive Testing (ASNT), P.O. Box 28518, 1711 Arlingate Lane, Columbus, OH 43228-0518.
[5] Available from SAE International (SAE), 400 Commonwealth Dr., Warrendale, PA 15096, http://www.sae.org.
[6] Available from International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, http://www.iso.org.
[7] Available from the Aerospace Industries Association of America, Inc., 1250 Eye Street, N.W., Washington, DC 20005.

the detected discontinuities. This practice is intended primarily for portability and for localized areas of examination, utilizing minimal equipment. Surface roughness may be a limiting factor. If so, an alternate process, such as water-wash visible or post-emulsified penetrant should be considered when grinding or machining is not practical.

6. Reagents and Materials

6.1 *Visible, Solvent-Removable Liquid Penetrant Testing Materials,* (see Note 1) consist of a family of applicable visible penetrant, solvent remover, as recommended by the manufacturer, and are classified as Type II Visible, Method C—Solvent-Removable. Penetrant materials shall conform to AMS 2644 unless approved by the contract or Level III. Intermixing of materials from various manufacturers is not recommended. (**Warning—**While approved penetrant materials will not adversely affect common metallic materials, some plastics or rubber may be swollen or stained by certain penetrants.)

NOTE 1—Refer to 8.1 for special requirements for sulfur, halogen, and alkali metal content.

6.2 *Visible, Solvent-Removable Penetrants* are designed so that excess surface penetrant can be removed by wiping with dry, clean, lint-free material, and repeating the operation until most of the penetrant has been removed. The remaining traces shall be removed by wiping the surface with clean, lint-free material lightly moistened with the solvent remover. To minimize removal of penetrant from discontinuities, care should be taken to avoid the use of excess solvent. Flushing the surface with solvent to remove the excess penetrant is prohibited. Visible penetrant examination makes use of a penetrant that is visible under normal lighting conditions. The penetrant is usually red in color so that the indications produce a definite contrast with the visible background of the developer. Visible penetrant indications must be viewed under adequate visible light (see 7.1.8.1).

6.3 *Solvent Removers* function by dissolving the penetrant, making it possible to wipe the surface clean and free of residual penetrant as described in 7.1.5.

6.4 *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. The developer used shall provide a contrasting white background. Nonaqueous, wet developers and aqueous developers are the most commonly used developers in the visible, solvent-removable penetrant process. Liquid film developers also are used for special applications.

6.4.1 *Nonaqueous, Wet Developers* are normally supplied as suspensions of developer particles in a volatile solvent carrier and are ready for use as supplied. They are applied to the surface by spraying after the excess penetrant has been removed and the surface has dried. Nonaqueous, wet developers form a white coating on the surface of the part when dried and serve as a contrasting background for visible penetrants (see 7.1.7.1(*a*)). (**Warning—**This type of developer is intended for application by spray only.)

6.4.2 *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 manufacturer's recommendations (see 7.1.7.1(*b*)). (**Warning—**Aqueous developers may cause stripping of indications, if not properly applied and controlled. The procedure should be qualified in accordance with 9.2.)

~~6.4.3 *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 surface and retained for record purposes (see 7.1.7.1(*c*)).~~

7. Procedure

7.1 The following general procedure applies to the solvent-removable, visible penetrant examination 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 from 40 to ~~125°F~~125 °F (4 to ~~52°C).~~52 °C). Where it is not practical to comply with these temperature limitations, the procedure must be qualified 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 ceramic in the densified condition. 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

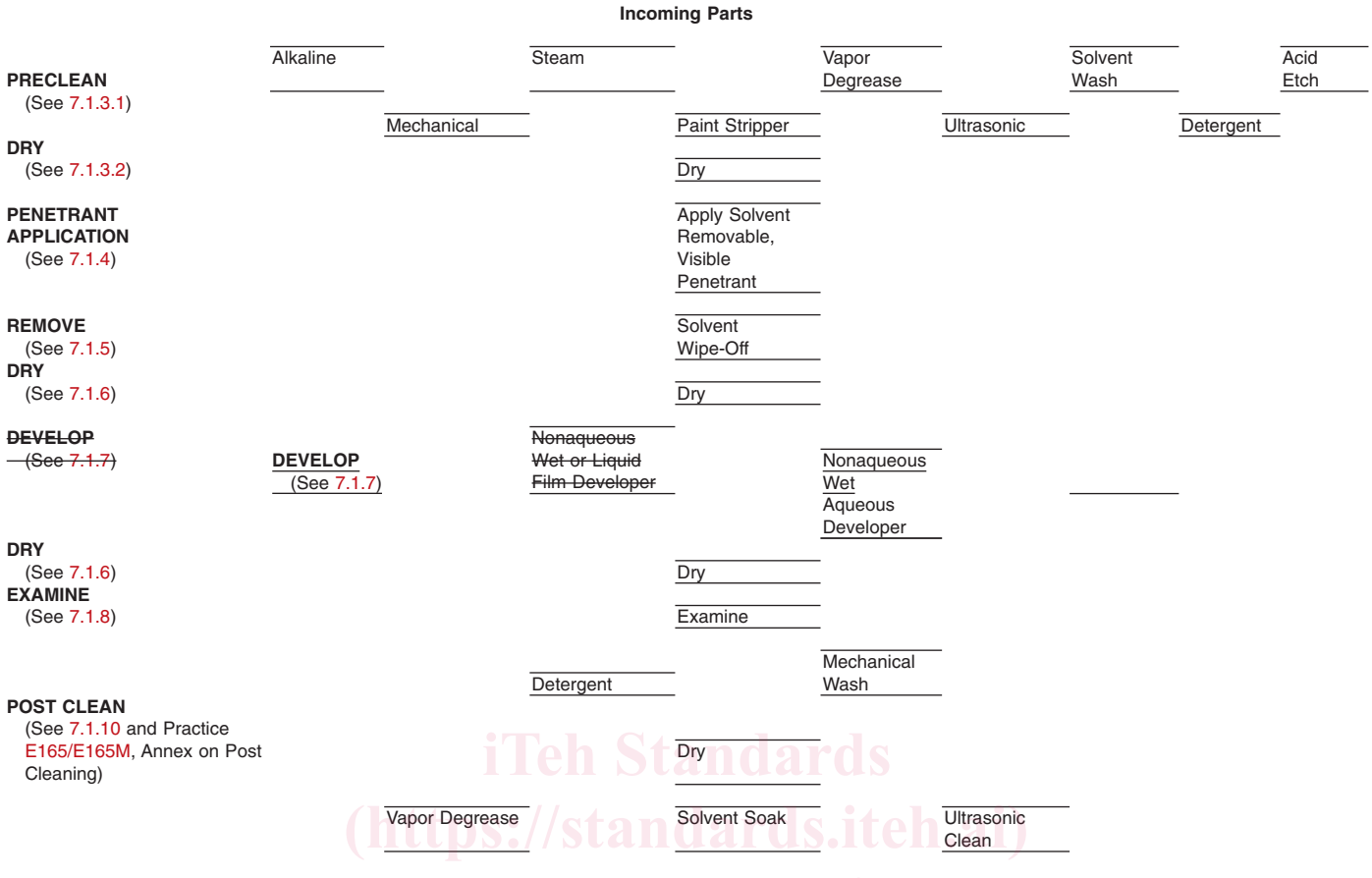

FIG. 1 Solvent-Removable Visible Penetrant Examination General Procedure Flowsheet

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 Cleaning Parts and Materials in Practice E165/E165M for general precautions relative to surface preparation.)

NOTE 2—When agreed between purchaser and supplier, grit blasting without subsequent etching may be an acceptable cleaning method. (**Warning—**Sand or shot blasting may possibly close indications and extreme care should be used with grinding and machining operations.)

NOTE 3—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 that might interfere with the penetrant process. All parts or areas of parts to be inspected must be clean and dry before the penetrant is applied. If only a section of a part, such as a weld, including the heat-affected zone is to be examined, all contaminants shall be removed from the area being examined as defined by the contracting parties. "Clean" is intended to mean that the surface must be free of any rust, scale, welding flux, spatter, grease, paint, oily films, dirt, etc., that might interfere with penetration. All of these contaminants can prevent the penetrant from entering discontinuities (see Annex on Cleaning of Parts and Materials in Practice E165/E165M for more detailed cleaning methods). (**Warning—**Residues from cleaning processes, such as strong ~~alkalies~~alkalis, pickling solutions, and chromates in particular, may adversely react with the penetrant and reduce its sensitivity and performance.)

7.1.3.2 *Drying After Cleaning*—It is essential that the area to be examined be thoroughly dry after cleaning, since any liquid