Standard Practice for Fluorescent Liquid Penetrant Testing Using the Lipophilic Post-Emulsification Process[1]

This standard is issued under the fixed designation E1208; 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 covers procedures for fluorescent liquid penetrant examination utilizing the lipophilic post-emulsification process. It is a nondestructive testing method for detecting discontinuities that are open to the surface such as cracks, seams, laps, cold shuts, laminations, 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 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 fluorescent liquid penetrant examination, lipophilic post-emulsification 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 fluorescent penetrant examination of materials and parts using the lipophilic post-emulsification process. 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 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 regarded as standard. SI units given in parentheses are 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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

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 IR Detection
E165/E165M Practice for Liquid Penetrant Examination for General Industry
E433 Reference Photographs for Liquid Penetrant Inspection
E543 Specification for Agencies Performing Nondestructive Testing
E1316 Terminology for Nondestructive Examinations
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 *ASNT Documents:*[3]

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

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[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 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.

[3] Available from The American Society for Nondestructive Testing (ASNT), P.O. Box 28518, 1711 Arlingate Lane, Columbus, OH 43228-0518.

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

2.3 *AIA Standard:*[4]

NAS 410 Certification and Qualification of Nondestructive Test Personnel

2.4 *ISO Standards*[5]

ISO 9712 Nondestructive Testing—Qualification and Certification of NDT Personnel—General Principles

2.5 *Department of Defense (DoD) Contracts*—Unless otherwise specified, the issue 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*—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*—The definitions relating to liquid penetrant examination, which appear in Terminology E1316, shall apply to the terms used in this practice.

Throughout this practice, the term "black light" has been changed to "UV-A" to conform with the latest terminology in E1316. "Black light" can mean a broad range of ultraviolet radiation; fluorescent penetrant inspection only uses the UV-A range.

4. Summary of Practice

4.1 A post-emulsifiable, liquid, fluorescent 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 applying the lipophilic emulsifier and the part is water-rinsed and dried. If an aqueous developer is to be employed, the developer is applied prior to the drying step. A developer is applied to draw the entrapped penetrant out of the discontinuity and stain the developer. The test surface is then examined visually using a UV-A source in a darkened area to determine the presence or absence of indications. (**Warning—**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.)

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

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

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 practice is normally used for production examination of critical components or structures when (*a*) removal of excessive amounts of penetrant from discontinuities using a water-washable process can be a problem and (*b*) the use of a hydrophilic remover is impractical.

6. Reagents and Materials

6.1 *Liquid Penetrant Testing Materials,* for use in the lipophilic post-emulsification process (see Note 2) consist of a family of post-emulsifiable fluorescent penetrant, lipophilic emulsifier, and are classified as Type I Fluorescent, Method B—Post-Emulsifiable, Lipophilic. Each penetrant and emulsifier are approved together as a pair. Intermixing of materials from various manufacturers is not recommended. (**Warning—**While approved penetrant materials will not adversely affect common metallic materials, some plastics or rubbers may be swollen or stained by certain penetrants.)

NOTE 2—Refer to 8.1 for special requirements for sulfur, halogen, and alkali metal content.

6.2 *Post-Emulsifiable Penetrants* are designed to be insoluble in water and cannot be removed with water rinsing alone. They are designed to be selectively removed from the surface by the use of a separate emulsifier. The lipophilic emulsifier, properly applied and given a proper emulsification time, combines with the excess surface penetrant to form a water-washable mixture, which can then be rinsed from the surface, leaving the surface free of fluorescent background. Proper emulsification time must be experimentally established and maintained to assure that over emulsification does not occur, resulting in loss of indications.

6.3 *Lipophilic Emulsifiers* are oil-base liquids used to emulsify the oily penetrant on the surface of the part, rendering it water washable. The rate of diffusion establishes the emulsion time. They are either slow- or fast-acting, depending on both their viscosity and chemical composition, and the surface roughness of the area being examined (see 7.1.5.1).

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. Several types of developers are suitable for use with the lipophilic penetrant process. (**Warning—**Aqueous developers may cause stripping of indications if not properly applied and controlled. The procedure should be qualified in accordance with 9.2.)

6.4.1 *Dry Powder Developers* are used as supplied (that is, free-flowing, noncaking powder) in accordance with 7.1.8.1(*a*). Care should be taken not to contaminate the

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

[5] 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.

developer with fluorescent penetrant, as the penetrant specks can appear as indications.

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 7.1.8.1(*b*)).

6.4.3 *Nonaqueous, Wet Developers* are supplied as suspensions of developer particles in a nonaqueous solvent carrier 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 7.1.8.1(*c*)). (**Warning—**This type of developer is intended for application by spray only.)

6.4.4 *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 may be stripped from the part and retained for record purposes (see 7.1.8.1(*d*)).

7. Procedure

7.1 The following general procedure applies to the fluorescent liquid penetrant examination, lipophilic post-emulsification process 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 between 40 and 125°F (4 and 52°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 may be obtained on surfaces in the as-welded, as-rolled, as-cast, or as-forged conditions or for ceramics in the densified condition. These 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,

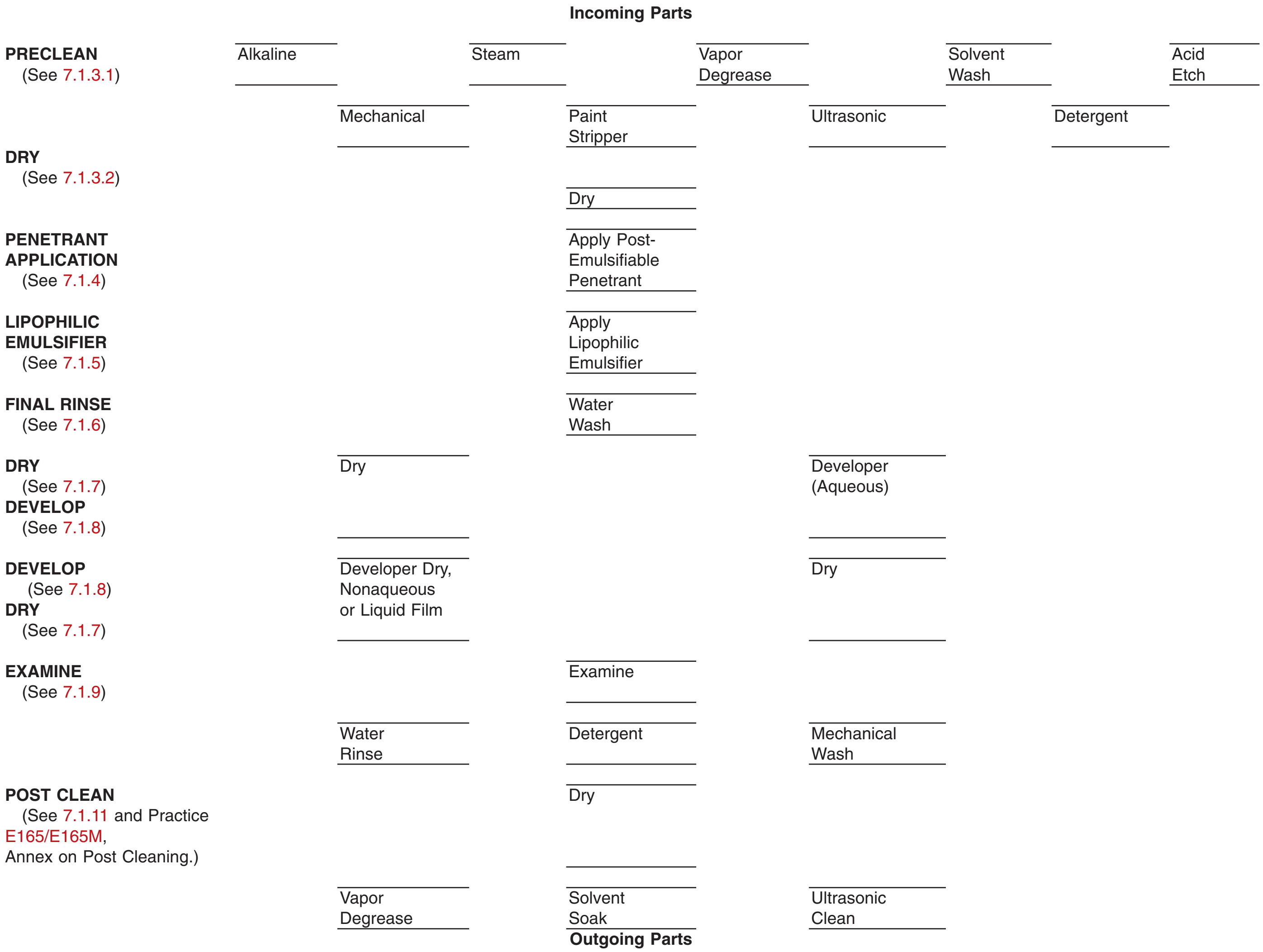

FIG. 1 General Procedure Flowsheet for Fluorescent Penetrant Examination Using the Lipophilic Post-Emulsification Process

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 Cleaning Parts and Materials in Practice E165/E165M for general precautions relative to surface preparation.) (**Warning—**Sand or shot blasting may possibly close indications. Extreme care should be used with grinding and machining operations.)

NOTE 3—When agreed between purchaser and supplier, grit blasting without subsequent etching may be an acceptable cleaning method.

NOTE 4—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) 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, 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 surface parts be thoroughly dry after cleaning, since any liquid residue will hinder the entrance of the penetrant. Drying may be accomplished by warming the parts in drying ovens, with infrared lamps, forced hot or cold air, or exposure to ambient temperature.

7.1.4 *Penetrant Application*—After the part has been cleaned, dried, and is within the specified temperature range, apply the penetrant to the surface to be inspected so that the entire part or area under examination is completely covered with penetrant.

7.1.4.1 *Modes of Application*—There are various modes of effective application of penetrant such as dipping, brushing, flooding, or spraying. Small parts are quite often placed in suitable baskets and dipped into a tank of penetrant. On larger parts, and those with complex geometries, penetrant can be applied effectively by brushing or spraying. Both conventional and electrostatic spray guns are effective means of applying liquid penetrants to the part surfaces. Electrostatic spray application can eliminate excess liquid buildup of penetrant on the part, minimize overspray, and minimize the amount of penetrant entering hollow-cored passages which might serve as penetrant reservoirs, causing severe bleedout problems during examination. Aerosol sprays are conveniently portable and suitable for local application. (**Warning—**Not all penetrant materials are suitable for electrostatic spray applications.) (**Warning—**With spray applications, it is important that there be proper ventilation. This is generally accomplished through the use of a properly designed spray booth and exhaust system.)

7.1.4.2 *Penetrant Dwell Time*—After application, allow excess penetrant to drain from the part (care should be taken to prevent pools of penetrant on the part), while allowing for proper penetrant dwell time (see Table 1). The length of time the penetrant must remain on the part to allow proper penetration should be as recommended by the penetrant manufacturer. Table 1, however, provides a guide for selection of penetrant dwell times for a variety of materials, forms, and types of discontinuity. Unless otherwise specified, the dwell time shall not exceed the maximum recommended by the manufacturer.

NOTE 5—For some specific applications in structural ceramics (for example, detecting parting lines in slip-cast material), the required penetrant dwell time should be determined experimentally and may be longer than that shown in Table 1 and its notes.

TABLE 1 Recommended Minimum Dwell Times

Material	Form	Type of Discontinuity	Dwell Times, minutes[A]	
			Penetrant[B]	Developer[C]
Aluminum, magnesium, steel, brass and bronze, titanium and high-temperature alloys	castings and welds	cold shuts, porosity, lack of fusion, cracks (all forms)	5	10
	wrought materials—extrusions, forgings, plate	laps, cracks (all forms)	10	10
Carbide-tipped tools		lack of fusion, porosity, cracks	5	10
Plastic	all forms	cracks	5	10
Glass	all forms	cracks	5	10
Ceramic	all forms	cracks, porosity	5	10

[A] For temperature range from 40 to 120°F (4 to 49°C).

[B] Maximum penetrant dwell time 60 min in accordance with 7.1.4.2.

[C] Development time begins as soon as wet developer coating has dried on surface of parts (recommended minimum). Maximum development time in accordance with 7.1.8.2.

7.1.5 *Application of Emulsifier*—After the required penetration time, emulsify the excess penetrant on the part by immersing, flooding, or spraying the parts with the required emulsifier (the emulsifier combines with the excess surface penetrant and makes the mixture removable with water rinsing). After application with the emulsifier, drain the parts in a manner that prevents the emulsifier from pooling on the part.

7.1.5.1 *Emulsification Dwell Time* begins as soon as the emulsifier has been applied. The length of time that the emulsifier is allowed to remain on the part and in contact with the penetrant is dependent on the type of emulsifier employed and the surface condition (smooth or rough). Nominal emulsification time should be as recommended by the manufacturer. Determine experimentally the actual emulsification time for each specific application. The surface finish (roughness) of the part is a significant factor in the selection of and in the emulsification time of an emulsifier. *Contact time* should be kept to the least possible time consistent with an acceptable background and should not exceed the maximum time specified for the part or material.

7.1.6 *Post Rinsing of Emulsified Parts*—Effective post rinsing of the emulsified penetrant from the surface can be accomplished using either manual, semiautomatic, or automatic water spray or immersion equipment or combinations thereof.

7.1.6.1 *Immersion*—For immersion post rinsing, parts are completely immersed in the water bath with air or mechanical agitation. The time and temperature should be kept constant.

(a) The maximum dip rinse time should not exceed 120 s unless otherwise specified by part or material specification.

(b) The temperature of the water should be relatively constant and should be maintained within the range of 50 to 100°F (10 to 38°C).

7.1.6.2 *Spray Post Rinsing*—Effective post rinsing following emulsification can also be accomplished by either manual or automatic water spray rinsing of the parts as follows:

(a) The maximum spray rinse time should not exceed 180 s unless otherwise specified by part or materials specification.

(b) Control rinse water temperature within the range from 50 to 100°F (10 to 38°C).

(c) Spray rinse water pressure should be 40 psi max (275 kPa max) or in accordance with the manufacturer's instructions.

7.1.6.3 *Rinse Effectiveness*—If the emulsification and final rinse steps are not effective as evidenced by excessive residual surface penetrant after emulsification and rinsing, dry (see 7.1.7) and reclean the part and reapply the penetrant for the prescribed dwell time.

7.1.7 *Drying:*

7.1.7.1 During the preparation of parts for examination, drying is necessary either following the application of the aqueous, wet developer or prior to applying dry or nonaqueous developers. Drying time will vary with the size, nature, and number of parts under examination.

7.1.7.2 *Drying Modes*—Parts can be dried by using a hot-air recirculating oven, a hot- or cold-air blast, or by exposure to ambient temperature. Drying is best done in a thermostatically controlled recirculating hot-air dryer. (**Warning—**Drying oven temperature should not exceed 160°F (71°C).)

7.1.7.3 Do not allow parts to remain in the drying oven any longer than is necessary to dry the part. Excessive time in the dryer may impair the sensitivity of the examination.

7.1.8 *Developer Application:*

7.1.8.1 *Modes of Application*—There are various modes of effective application of the various types of developers such as dusting, immersing, flooding, or spraying. The size, configuration, surface condition, number of parts to be processed, etc., will influence the choice of developer application.

(a) Dry Powder Developers—Apply immediately after drying in such a manner as to assure complete part coverage. Parts can be immersed into a container of dry developer or into a fluid bed of dry developer; they can also be dusted with the powder developer through a hand powder bulb or a powder gun. It is quite common and most effective to apply dry powder in an enclosed dust chamber, which creates an effective and controlled dust cloud. Other means suited to the size and geometry of the specimen may be used, provided the powder is dusted evenly over the entire surface being examined. Excess powder may be removed by shaking or rapping the part gently, or by blowing with low-pressure (5 to 10 psi (34 to 70 kPa)) dry, clean, compressed air.

(b) Aqueous Developers—Apply to the surface immediately after the excess penetrant has been removed and prior to drying. The dried developer coating appears as a translucent or white coating on the part. Prepare and maintain aqueous developers in accordance with the manufacturer's instructions and apply them in such a manner as to assure complete, even coverage. Aqueous developers may be applied by spraying, flowing or immersing the part. It is most common to immerse the parts in a prepared developer bath. Immerse parts only long enough to coat all of the surfaces with the developer. Then remove parts from the developer bath and allow to drain. Drain all excess developer from recesses and trapped sections to eliminate pooling of developer, which can obscure discontinuities. Dry the parts in accordance with 7.1.7. (**Warning—**Atomized spraying is not recommended since a spotting film may result.) (**Warning—** If parts are left in the bath too long, indications may leach out.)

(c) Nonaqueous, Wet Developers—After the excess penetrant has been removed and the surface has been dried, apply developer by spraying in such a manner as to assure complete coverage with a thin, even film of developer. These types of developer carrier evaporate very rapidly at normal room temperature and do not, therefore, require the use of a dryer. Dipping or flooding parts with nonaqueous developers is prohibited, since it will flush (dissolve) the penetrant from within the discontinuities because of the solvent action of these types of developers. (**Warning—**The vapors from the evaporating, volatile, solvent developer carrier may be hazardous. Proper ventilation should be provided in all cases, but especially when the surface to be examined is inside a closed volume, such as a process drum or a small storage tank.)

(d) Liquid Film Developers—Apply by spraying as recommended by the manufacturer. Spray parts in such a manner as to ensure complete coverage of the area being examined with a thin, even film of developer.

7.1.8.2 *Developer Time*—The minimum and maximum penetrant bleedout time with no developer shall be 10 min and 2 h respectively. Developing time for dry developer begins immediately after the application of the dry developer and begins when the developer coating has dried for wet developers (aqueous and nonaqueous). The minimum developer dwell time shall be 10 min for all types of developer. The maximum developer dwell time shall be 1 h for nonaqueous developer, 2 h for aqueous developer and 4 h for dry developers.

7.1.9 *Examination*—Perform examination of parts after the applicable development time as specified in 7.1.8.2 to allow for bleedout of penetrant from discontinuities onto the developer coating. It is good practice to observe the surface while applying the developer as an aid in evaluating indications.

7.1.9.1 *UV-A Irradiation*—Examine fluorescent penetrant indications under UV-A radiation in a darkened area. UV-A irradiance shall be measured with a UV-A radiometer on the surface being examined. A minimum of 1000 $\mu W/cm^2$ is recommended. The UV-A source shall have a peak wavelength in the range of 360 to 370 nm. The UV-A irradiance shall be checked daily to assure the required output. Since a drop in line voltage can cause decreased UV-A irradiation with consequent inconsistent performance, a constant voltage transformer shall be used when there is evidence of voltage fluctuation. (**Warning—**Certain high-intensity UV-A sources may emit unacceptable amounts of visible light, which may cause fluorescent indications to disappear. Care should be taken to use only bulbs certified by the supplier to be suitable for such examination purposes.)

NOTE 6—The recommended minimum in 7.1.9.1 is intended for general usage. For critical examinations, higher UV-A irradiance may be required.

7.1.9.1.1 *LED UV-A Sources*—LED UV-A sources shall meet the requirements of E3022.

7.1.9.2 *UV-A Source Warm-Up*—For all UV-A sources except LED UV-A sources, allow the UV-A source to warm up for a minimum of 10 min prior to its use or the measurement of UV-A irradiation.

(1) LED UV-A sources are at full intensity at power-on, and the intensity may decrease as the lamp warms up. If UV-A measurement is made at power-on, then a minimum of 1500 $\mu W/cm^2$ is recommended.

7.1.9.3 *Visible Ambient Light*—Visible ambient light shall not exceed 2 fc (21.5 lux). The measurement should be made with a visible light meter on the surface being examined.

NOTE 7—More information on UV-A and visible lamps, UV-A radiometers, and visible light meters can be found in E2297.

7.1.9.4 *Visual Adaptation*—The examiner should be in the darkened area for at least 1 min before examining parts. Longer times may be necessary for more complete adaptation under some circumstances. (**Warning—**Photochromic or darkened lenses shall not be worn during examination.)

7.1.9.5 *Housekeeping*—Keep the examination area free of interfering debris or fluorescent objects. Practice good housekeeping at all times.

7.1.10 *Evaluation*—Unless otherwise agreed upon, it is normal practice to interpret and evaluate the discontinuity indication based on the size of the penetrant indication created by the developer's absorption of the penetrant (see Reference Photographs E433).

7.1.11 *Post Cleaning*—Post cleaning is necessary in those cases where residual penetrant or developer could interfere with subsequent processing or with service requirements. It is particularly important where residual penetrant examination materials might combine with other factors in service to produce corrosion. A suitable technique, such as a simple water rinse, water spray, machine wash, vapor degreasing, solvent soak, or ultrasonic cleaning may be employed (see Test Method E165/E165M, Annex on Post Cleaning). It is recommended that if developer removal is necessary, it shall be carried out as promptly as possible after examination so that it does not fix on the part. Water-spray rinsing is generally adequate. (**Warning—**Developers should be removed prior to vapor degreasing. Vapor degreasing can bake developer on parts.)

8. Special Requirements

8.1 *Impurities:*

8.1.1 When using penetrant materials on austenitic stainless steels, titanium, nickel-base, or other high-temperature alloys, the need to restrict impurities such as sulfur, halogens, and alkali metals must be considered. These impurities may cause embrittlement or corrosion, particularly at elevated temperatures. Any such evaluation should also include consideration of the form in which the impurities are present. Some penetrant materials contain significant amounts of these impurities in the form of volatile organic solvents. These normally evaporate quickly and usually do not cause problems. Other materials may contain impurities that are not volatile and may react with the part, particularly in the presence of moisture or elevated temperatures.

8.1.2 Because volatile solvents leave the tested surface quickly without reaction under normal inspection procedures, penetrant materials are normally subjected to an evaporation procedure to remove the solvents before the materials are analyzed for impurities. The residue from this procedure is then analyzed in accordance with Test Method D129, Test Method D1552, or Test Method D129 decomposition followed by Test Methods D516, Method B (Turbidimetric Method) for sulfur. The residue may also be analyzed by Test Methods D808 and Practice E165/E165M, Annex on Method for Measuring Total Fluorine Content in Combustible Liquid Penetrant Materials (for fluorine). The Annex on Determination of Anions and Cations by Ion Chromatography in Practice E165/E165M can be used as an alternate procedure. Alkali metals in the residue are determined by flame photometry or atomic absorption spectrophotometry.

NOTE 8—Some current standards indicate that impurity levels of sulfur and halogens exceeding 1 % of any one suspect element may be considered excessive. However, this high a level may be unacceptable in some cases, so the actual maximum acceptable impurity level must be decided between supplier and user on a case by case basis.

8.2 *Elevated Temperature Examination*—Where penetrant examination is performed on parts that must be maintained at elevated temperature during examination, special materials and processing techniques may be required. Such examination requires qualification in accordance with 9.2. Manufacturer's recommendations should be observed.

8.3 *Reduced Temperature Examination*—Where penetrant examination is performed on parts that shall be maintained at a reduced temperature during examination, special materials and processing techniques may be required. Such examination requires qualification in accordance with 9.2. Manufacturer's recommendations should be observed.

9. Qualification and Requalification

9.1 *Personnel Qualification*—Personnel performing examinations to this standard shall be qualified in accordance with a nationally or internationally recognized NDT personnel qualification practice or standard such as ANSI/ASNT-CP-189, SNT-TC-1A, NAS-410, ISO 9712, or a similar document and certified by the employer or certifying agency, as applicable. The practice or standard used and its applicable revision shall be identified in the contractual agreement between the using parties.

9.2 *Procedure Qualification*—Qualification of procedure using conditions or times differing from those specified or for new materials may be performed by any of several methods and should be agreed upon by the contracting parties. A test piece containing one or more discontinuities of the smallest relevant size is used. The test piece may contain real or simulated discontinuities, providing it displays the characteristics of the discontinuities encountered in product examination.

9.3 *Nondestructive Testing Agency Qualification*—If a nondestructive testing agency as described in Practice E543 is used to perform the examination, the agency shall meet the requirements of Practice E543.

9.4 *Requalification* may be required when a change or substitution is made in the type of penetrant materials or in the procedure (see 9.2).

10. Keywords

10.1 fluorescent liquid penetrant testing; lipophilic post-emulsification method; nondestructive testing