



400 Commonwealth Drive, Warrendale, PA 15096-0001

# AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard



AMS 2647A

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Superseding AMS 2647

## (R) FLUORESCENT PENETRANT INSPECTION Aircraft and Engine Component Maintenance

### 1. SCOPE:

#### 1.1 Purpose:

This specification details requirements and procedures for the detection of defects in aircraft and engine components during maintenance and overhaul operations.

#### 1.2 Application:

This process has been used typically by maintenance and overhaul facilities to inspect aircraft and engine components and associated accessories when fluorescent penetrant inspection is specified, but usage is not limited to such applications

#### 1.3 Classification of Penetrant Systems:

Applicable fluorescent penetrant systems are classified into the following methods and sensitivity levels:

Method A: Water-Washable  
Method B: Post Emulsifiable, Lipophilic  
Method C: Solvent Removable  
Method D: Post Emulsifiable, Hydrophilic  
Sensitivity Level 2: Medium  
Sensitivity Level 3: High  
Sensitivity Level 4: Ultra-high

#### 1.4 Safety - Hazardous Materials:

While the materials, methods, applications, and processes described or referenced in this specification may involve the use of hazardous materials, this specification does not address the hazards which may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

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- 1.4.1 Safety Precautions: Protective clothing, including eye shields, suitable gloves, and aprons should be worn when filling tanks or when there is a possibility of splashing or overspray. Tanks should be covered when not in use and should be operated with adequate ventilation of fume extraction. Operating instructions from the manufacturer of the system employed together with local workshop regulations shall be followed.

## 2. APPLICABLE DOCUMENTS:

The following publications form a part of this specification to the extent specified herein. The applicable issue of referenced publications shall be the issue in effect on the date of the purchase order.

### 2.1 ASTM Publications:

Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187

ASTM D 95 Water in Petroleum Products and Bituminous Materials by Distillation

### 2.2 U.S. Government Publications:

Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-I-25135 Inspection Materials, Penetrant

MIL-STD-2073-1 DOD Materiel, Procedures for Development and Application of Packaging Requirements

QPL 25135 Inspection Materials, Penetrant

### 2.3 ATA Specifications:

Available from Air Transport Association of America, 1709 New York Avenue, N.W., Washington, DC 20006.

ATA Specification 105 Guidelines for Training and Qualifying Personnel in Nondestructive Testing Methods

## 3. TECHNICAL REQUIREMENTS:

### 3.1 Materials:

Materials used (i.e. penetrants, emulsifiers, and developers) shall conform to MIL-I-25135, and be listed in QPL 25135, and be approved by the original equipment manufacturer's (OEM's) part or material specifications.

- 3.1.1 Penetrant: Shall be a highly fluorescent liquid capable of penetrating discontinuities and with a sensitivity level as specified in the OEM's part or material specification.

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- 3.1.2 Lipophilic Emulsifier: Shall consist of a ready-to-use suitable oil-like liquid together with such additives as necessary to provide a stable, oil-miscible solution capable of being emulsified and rinsed away with water.
- 3.1.3 Hydrophilic Emulsifier: Shall be composed of surface-active agents together with additives. Emulsifiers shall be capable of dilution up to many times their volume in water to form stable aqueous solutions meeting the requirements of 3.5.5.4 and 3.5.5.5.
- 3.1.4 Developers: Applicable developers are classified into four types.
- |        |                                 |
|--------|---------------------------------|
| Type 1 | Dry Powder Developer            |
| Type 2 | Nonaqueous Wet Developer (NAWD) |
| Type 3 | Aqueous Soluble Developer       |
| Type 4 | Aqueous Suspendible Developer   |
- 3.1.5 Grouping of Materials: Penetrants and their emulsifiers shall be qualified and used as a "penetrant/emulsification" system, furnished by one manufacturer to perform a specific method or process of penetrant inspection.
- 3.2 Equipment:
- Shall be constructed and arranged to permit uniform, controlled operation. Quality control of equipment shall be as specified in Section 4.
- 3.3 System Performance Check:
- This check shall be performed using known defect standards. Recommended size of defects range from 0.38 to 6.35 mm (0.015 to 0.250 inch).
- 3.3.1 Process a known defect standard at the beginning of each operating shift and at initial reactivation of the system after it has been shut down.
- 3.3.1.1 Processing of a known defect standard may be performed concurrently with production parts.
- 3.3.2 Inspect known defect standard(s) under black light before processing production or reworked parts. Known defect standards shall not fluoresce prior to processing; after processing, defects shall produce a fluorescent indication.
- 3.3.3 Detection of the required number of known defect standards verifies acceptable process capability.
- 3.3.4 When the applicable number of flaws are not visible, clean and reprocess standards. If flaws are still not visible, the process line shall be shut down until the cause of the problem can be identified and corrective action taken.

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3.3.5 To ensure independent, accurate results and to prevent clogging and contamination of the flaws, the known defect standards shall be cleaned in accordance with manufacturer's recommended practice after each run.

3.3.5.1 Following cleaning, the known defect standards shall be stored by immersing in a suitable solvent.

3.3.5.2 The known defect standards, if not properly maintained, may become unserviceable due to contamination of the flaws.

#### 3.4 Surface Preparation of Parts to be Inspected:

Cleaning procedures before penetrant application shall be as specified by the OEM's part or material specification.

3.4.1 General: Parts to be inspected shall be clean, dry, and free of dirt, oil, grease, paint, or other coatings, rust, scale, smeared metal, flux, chemical residue, and any other material which may interfere with entry of penetrant into and exit from discontinuities (capillary action).

3.4.2 Cleaning Methods: Cleaning methods chosen for a particular part shall be consistent with the type of contaminant to be removed, and shall not be chemically or physically detrimental to the part. Cleaners and etchants and methods shall be as specified by the OEM's part or material specifications.

3.4.2.1 Methods include solvent cleaning, steam cleaning, ultrasonic cleaning, paint and carbon stripping, alkaline cleaning, or other methods in common use.

3.4.3 Surface Coatings or Plating: Removal of surface coatings is generally considered to be necessary prior to fluorescent penetrant inspection. With certain types of coatings or plating, however, it may be possible to perform an adequate inspection with the coating or plating intact, but acceptability of this procedure depends upon the nature of the coating and recommendations or requirements by the OEM's part or material specification.

3.4.4 Mechanical Surface Treatment: Surface treatment, such as abrasive blasting, vapor blasting, peening, sanding, and burnishing operations, may produce a smeared surface that could block penetrant entry into a defect. The effect varies with material and the process used. Therefore, it may be necessary to chemically etch the surface to be inspected to remove a nominal 0.005 mm (0.0002 inch) of the material prior to penetrant application.

3.4.4.1 Etching can be detrimental and shall be performed only when specified or when required by 3.4.6.1.1, and shall be strictly controlled in accordance with the OEM's part or material specification.

3.4.5 Moisture: Unless otherwise specified by the OEM, parts cleaned with an aqueous wet process shall be either hot water flash dried for a sufficient time or at an elevated temperature to remove moisture from the surface and from possible defects.

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**3.4.6 Sequence of Operations: Shall be as follows:**

**3.4.6.1** Penetrant inspection shall be performed prior to any surface treatment operation that may close or smear openings or leave unremovable residue within a defect, such as plating, anodizing, peening, or surface cold work.

**3.4.6.1.1** Surface treatments, such as polishing, peening, sanding, or any machining operation that could smear material, shall be followed by approved etching procedures.

**3.4.6.2** Perform penetrant inspection subsequent to any operation that may introduce or expose defects, for example: heat treatment involving quenching, welding, cold forming, or grinding.

**3.5 Processing Procedures:**

Shall be as follows:

**3.5.1** The use of visible dye penetrant inspection process prior to fluorescent penetrant inspection is prohibited.

**3.5.1.1** Descriptions of the different processing procedures are presented in Figures 1, 2, 3, and 4.

**3.5.2 Penetrant Applications (Methods A, B, C, and D):**

**3.5.2.1** Cover all surfaces to be inspected for the specified dwell time.

**3.5.2.2** Unless otherwise specified, use not less than 20 minutes dwell time.

**3.5.2.3** Parts left to dwell longer than 2 hours shall have penetrant reapplied as required to prevent drying.

**3.5.2.4** Penetrants, prior to use, and part's surface temperature shall be within the range 5 to 50 °C ( 40 to 120 °F), unless otherwise specified.

**3.5.3 Water Washable Penetrant Removal (Method A):**

**3.5.3.1** Water washable (Method A) penetrant shall not be used on major engine rotating components unless otherwise approved by the OEM's part or material specification.

**3.5.3.2** Remove penetrant with a coarse spray rinse or an air agitated, immersion wash tank.

**3.5.3.3** Maximum water pressure shall be 275 kPa (40 psi). Hydro-air nozzles may be permitted with a maximum of 170 kPa (25 psi) added air pressure.

**3.5.3.4** For spray washing, use not less than 305 mm (12 inches) distance, when possible, between the part surface and spray nozzle.

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- 3.5.3.5 Spray or immersion washing time shall be held to a minimum. Wash time shall be held to not more than 90 seconds on any one area of a part, unless otherwise specified by the OEM's part or material specification. Washing, unless otherwise specified by the OEM's specification, shall be conducted under appropriate illumination.
- 3.5.3.6 Control water temperature within the range 10 to 38 °C (50 to 100 °F).
- 3.5.3.7 After washing, drain water from parts, utilizing repositioning, suction, blotting with clean absorbent material, or filtered shop air at less than 170 kPa (25 psi) to prevent pooling.
- 3.5.4 Pre-Rinse for Hydrophilic Emulsifier (Method D):
- 3.5.4.1 Spray rinse parts in the least possible time to remove excess penetrant from the part. Maximum wash time for engine parts shall be held to 90 seconds on any one area of a part unless otherwise specified by the OEM's part or material specification.
- 3.5.4.2 Allow water to drain from the part. Reposition parts as necessary to aid in draining.
- 3.5.4.3 If necessary, use filtered shop air at a pressure less than 170 kPa (25 psi) or use a suction device to remove excess water from cavities.
- 3.5.4.4 Control water temperature within a range of 10 to 38 °C (50 to 100 °F) and a maximum pressure of 275 kPa (40 psi).
- 3.5.5 Application of Hydrophilic Emulsifier (Method D):
- 3.5.5.1 All surfaces to be inspected shall be completely covered in hydrophilic emulsifier solution during contact time.
- 3.5.5.2 Contact with the emulsifier shall be kept to the least possible time consistent with an acceptable background and shall not exceed two minutes or as otherwise specified by the OEM's part material specifications.
- 3.5.5.3 In immersion systems, emulsifier and/or part shall be mildly agitated.
- 3.5.5.4 For immersion application, the concentration of emulsifier shall be no higher than the manufacturer's qualified (approved) concentration, and shall be within  $\pm 3\%$  of the nominal for which the penetrant system was qualified.
- 3.5.5.5 For spray application, the concentration of emulsifier shall not exceed 5%.
- 3.5.6 Post-Rinse of Hydrophilic Emulsifier (Method D):
- 3.5.6.1 Emulsifier shall be removed by immersing the part in a water-filled, air-agitated tank followed by a spray touch-up rinse, or by spray rinsing. Hydro-air nozzles are acceptable.

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- 3.5.6.2 Water temperature shall be controlled within a range of 10 to 38 °C (50 to 100 °F) and a maximum pressure of 275 kPa (40 psi). Hydro-air nozzles may be permitted with a maximum of 170 kPa (25 psi) added air pressure.
- 3.5.6.3 For spray washing, the distance between part surface and spray nozzle shall be not less than 305 mm (12 inches), when possible.
- 3.5.6.4 Washing time shall be held to the minimum required to remove excess penetrant from the part. Wash time shall be held to not more than 90 seconds on any one area of a part unless otherwise specified by the OEM's part or material specification.
- 3.5.6.5 After rinsing, drain water from parts utilizing repositioning, suction, blotting with a clean absorbent material, or filtered air at less than 170 kPa (25 psi) pressure to prevent pooling.
- 3.5.7 Application of Lipophilic Emulsifier (Method B):
- 3.5.7.1 Lipophilic emulsifiers are not acceptable for engine parts.
- 3.5.7.2 Apply by flowing emulsifier on the part or by dipping the part in emulsifier and letting it dwell for the required time. Lipophilic emulsifiers shall not be applied by spray or brush and shall not be agitated while in contact with the surface of the part.
- 3.5.7.3 Contact with emulsifier shall be kept to the least possible time consistent with an acceptable background and shall not exceed three minutes.
- 3.5.8 Post-Rinse of Lipophilic Emulsifier (Method B):
- 3.5.8.1 Water spray or dip rinse parts to remove emulsified penetrant. Maximum spray or dip time shall be held to 90 seconds on any one area of a part unless otherwise specified by the OEM's part or material specification.
- 3.5.8.2 During washing, observe parts under black light to confirm removal of fluorescent background.
- 3.5.8.3 After rinsing, drain water from parts utilizing repositioning, suction, blotting with a clean absorbent material, or filtered air at less than 170 kPa (25 psi) pressure to prevent pooling.
- 3.5.8.4 Water temperature shall be controlled within the range 10 to 38 °C (50 to 100 °F) and a maximum pressure of 275 kPa (40 psi).
- 3.5.8.5 For spray washing, the distance between part surface and spray nozzle shall be not less than 305 mm (12 inches), when possible.

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**3.5.9 Local Application (Method C):**

**3.5.9.1** Remove penetrant by wiping the excess penetrant with a clean, lint-free, dry cloth or absorbent toweling.

**3.5.9.2** Remove the remainder of the surface penetrant with a solvent dampened, lint-free cloth or towel. Ensure that the surface of the part and/or the cloth or towel is not saturated with solvent. During the wiping, the part and cloth or towel shall be observed under appropriate black light illumination to ensure adequate removal of surface penetrant. Excessive removal of the surface penetrant or flooding of the solvent on the surface of the part shall require the part to be cleaned, dried, and reprocessed.

**3.5.9.3** The surface of the part shall be dried by blotting with a lint-free, dry cloth or towel or by evaporation.

**3.5.10 Drying (Method A, B, and D):**

**3.5.10.1** Drying oven temperature shall not exceed 70 °C (160 °F).

**3.5.10.2** Use minimum drying time to completely dry parts.

**3.5.11** Developing: Use dry developer except where aqueous soluble/suspendible or nonaqueous wet developer (NAWD) is specifically required by the OEM's part or material specification.

**3.5.11.1** Parts shall not be exposed to blacklight radiation while developing.

**3.5.11.2** Dry Developers (Methods A, B, C, and D): Ensure parts are dry before applying developer.

**3.5.11.2.1** Apply dry developer to a dry part so that all areas to be inspected are completely covered with a light coating of developer.

**3.5.11.2.2** Allow part to develop for not less than 10 minutes before inspection.

**3.5.11.2.3** Excessive powder may be removed after 10 minutes by blowing with dry air at pressure not greater than 35 kPa (5 psi).

**3.5.11.2.4** Parts shall be cleaned and reprocessed if time after development exceeds four hours.

**3.5.11.3** Nonaqueous Wet Developers (NAWD) (Methods A, B, C, and D): Ensure parts are dry before applying developer to part.

**3.5.11.3.1** When NAWD is specified, apply the developer, by spray only, to a dry part at touch temperature and with frequent agitation of the suspension.

**3.5.11.3.2** When using NAWD, surface coverage is very important and should be carefully controlled. Too light a coating will not provide sufficient development while too heavy a coating may mask defect indications.

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- 3.5.11.3.3 An adequate coating has a whitish appearance, yet the metallic surface background is visible. If too heavy a coating is applied such that no metallic background is visible, parts shall be recleaned, dried, and reprocessed.
- 3.5.11.3.4 Allow parts to develop for not less than 10 minutes before inspection.
- 3.5.11.3.5 Parts shall be inspected within one hour of developing. Parts shall be recleaned, dried, and reprocessed if time after developing exceeds one hour.
- 3.5.11.4 Aqueous Wet Developers (Soluble/Suspendible) (Methods A, B, and D):
- 3.5.11.4.1 Soluble aqueous wet developers are not acceptable for use in conjunction with water washable penetrants (Method A).
- 3.5.11.4.2 Soluble aqueous wet developer shall be completely dissolved. Concentrations shall be in accordance with manufacturer's instructions.
- 3.5.11.4.3 Apply wet developer by dipping or spraying immediately after removal of excess penetrant. Do not brush. Apply a uniform solution of developer only as necessary to wet all inspection surfaces. Avoid accumulations of developer in fillets, recesses, or crevices. Avoid prolonged contact with developer solution in order to minimize removal of penetrant from discontinuities. Dry as in 3.5.10.
- 3.5.11.4.4 Allow part to develop for 10 minutes after drying and before inspection.
- 3.5.11.4.5 Parts shall be inspected within two hours of developing. Parts shall be cleaned and reprocessed if time after developing exceeds two hours.
- 3.5.12 Inspection:
- 3.5.12.1 Inspect parts in a booth or darkened area where ambient and incident white light does not exceed  $20 \text{ lx/m}^2$  (2 foot-candles). Use light meter for measurement of white light.
- 3.5.12.2 Blacklight should be turned on for at least 15 minutes before beginning inspection.
- 3.5.12.3 Before beginning inspection, the individual shall wait at least one minute to adapt to darkness vision. Photochromic lenses shall not be worn during inspection.
- 3.5.12.4 During inspection, place blacklight within 150 to 300 mm (6 to 12 inches) of part surface, when possible.
- 3.5.12.5 Fluorescent contamination in the immediate area of interest should be considered an indication until evaluated and cleared.
- 3.5.12.6 White light may be used with visual aids (mirrors, borescopes, or other suitable equipment) in conjunction with blacklight to assist in interpretation of indications.

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- 3.5.12.7 All indications shall be investigated to verify their nature whether relevant, nonrelevant, or false.
- 3.5.12.8 All parts free of relevant penetrant indications shall be accepted.
- 3.5.12.9 Parts exhibiting indications caused by faulty processing, improper cleaning, or excessive background fluorescence shall be cleaned, dried, and reprocessed.
- 3.5.12.10 Parts with relevant indications shall be withheld pending evaluation in accordance with the OEM's part or material specification or other engineering requirements. Where no defect limits are specified by the equipment component manufacturer or are not given in the maintenance manual, all relevant indications shall be regarded as suspect and shall not be accepted without review.
- 3.5.12.11 Interpretation and evaluation of indications revealed by this inspection procedure shall be the responsibility of only qualified personnel having experience with fluorescent penetrant inspection. Qualification of personnel shall be in accordance with ATA 105 or as specified by the OEM's procedure.
- 3.5.13 Post-Inspection Cleaning: Parts shall be cleaned and dried after inspection to remove developer and any other inspection residue if they are detrimental to subsequent operations or where it would impair the structural or functional integrity of the part.
- 3.6 Responsibility for Inspection:
- The inspection source shall be responsible for performing all required tests and identifying the parts inspected and accepted.
- 3.7 Reports:
- As required by regulatory agency or customer.
4. QUALITY ASSURANCE PROVISIONS:
- 4.1 General:
- This section contains specific checks to ensure that penetrants, emulsifiers, removers, developers, and equipment meet an acceptable level of quality. Since the frequency of checks is dependent upon the level of usage and local conditions, frequency shall be varied as necessary to ensure process control.
- 4.1.1 Operators should be alert to any changes in performance, color, odor, consistency, or appearance of powders and fluids and to conduct appropriate checks and tests if they have reason to believe the quality may have deteriorated.

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## 4.2 Blacklight:

4.2.1 Unless otherwise specified by OEM procedure, check blacklights daily or as necessary to ensure that they provide not less than  $1000 \mu\text{W}/\text{cm}^2$  at 380 mm (15 inches), measured by a blacklight meter. Turn on blacklights not less than 15 minutes prior to verifying the intensity of the blacklight.

4.2.1.1 CAUTION: Unfiltered ultraviolet radiation is hazardous. Blacklight bulbs shall have suitable filters to eliminate short and medium wavelength ultraviolet radiation.

4.2.1.2 CAUTION: Self filtered blacklight bulbs shall not be used unless specified by OEM's procedures.

4.2.2 If the filter glass is scratched, damaged, or poor fitting so that white light escapes, the condition shall be corrected or the unit replaced.

4.2.3 Examine blacklight reflectors and filters daily and clean as necessary.

4.2.4 Calibrate blacklight meter every 6 months.

## 4.3 White Light Intensity:

White lights used in the fluorescent penetrant inspection booths should provide not less than 100 foot-candles (1000 lx) (See 8.2.36) on the inspection surface, measured with a light meter. Check monthly unless another frequency is established by cognizant engineering authority.

## 4.4 Fluorescent Penetrant Materials (Methods A, B, C, and D):

## 4.4.1 Penetrant:

4.4.1.1 Water washable penetrants (Method A) in immersion or recirculating tanks shall be checked for water content monthly.

4.4.1.1.1 Penetrants shall be discarded if the water content of the in-use penetrant is in excess of 5% by volume of the original penetrant when tested in accordance with ASTM D 95.

4.4.1.2 Fluorescent brightness of all in-use penetrants in immersion or recirculating tanks shall be checked quarterly. Tests shall be made by performing a visual comparison between in-use material from the same penetrant manufacturer and product designations as that of the in-use material. The comparison shall be made by wetting one Whatman #4 filter paper, or equivalent, with the unused material and another Whatman #4 filter paper, or equivalent, with the in-use material and comparing the two papers side by side under blacklight.

4.4.1.2.1 Penetrants shall be discarded if a visual difference is detected between the two filter papers.

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- 4.4.2 Hydrophilic Emulsifier: Check emulsifier in immersion tanks weekly for penetrant contamination. If emulsifier bath has penetrant floating on the surface or adhering to the sides of the tank, the bath shall be discarded. After discarding the contaminated emulsifier, clean the tank before adding fresh emulsifier.
- 4.4.2.1 Check concentration of emulsifier (dip tank and spray) weekly and after replenishing using a refractometer, and correct as necessary. Refractometer value shall be in accordance with the material manufacturer's specification. If there is an unexplained increase in background fluorescence, recheck emulsifier concentration.
- 4.4.2.2 Corrections to the concentration shall be made if the concentration is not within  $\pm 3$  percentage points from the initial unused concentration.
- 4.4.3 Lipophilic Emulsifier: Check for penetrant contamination of emulsifier monthly and after replenishing. Compare a sample from the tank with a sample of unused emulsifier for emulsifying ability. Discard emulsifier in tank when its emulsifying ability is less than that of the unused material.
- 4.4.3.1 Check for water contamination of emulsifier monthly in accordance with ASTM D 95. Water content in excess of 5% is unsatisfactory.
- 4.4.3.2 After discarding contaminated emulsifier, clean tank before adding fresh emulsifier.
- 4.4.4 Replenishment: Add fresh penetrant and emulsifiers when necessary. The contents of fresh containers shall be near shop (room) temperature and thoroughly mixed with in-use materials.
- 4.5 Operating Pressures and Temperatures:
- Verify indicators and controls daily as to setting and calibrate every six months.
- 4.6 Dry Developing Powders:
- 4.6.1 Check dry developer daily to ensure it is fluffy and not caked. Discard if it is caked.
- 4.6.2 Check recycled dry developer monthly for contamination by forming a thin layer approximately 100 mm (4 inches) in diameter on a paper towel and examine under blacklight. Discard developer if ten or more fluorescent specks appear.
- 4.6.3 Check automated developing system daily to ensure it is working properly and guns are not clogged.
- 4.7 Water Soluble/Suspendible Developers:
- 4.7.1 Check concentration in dip tanks initially and at least weekly with a hydrometer. Specific gravity shall be in accordance with manufacturer's specification.

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- 4.7.2 Scan the surface of developer weekly with a blacklight for indications of fluorescence or immerse a clean aluminum panel approximately 75 x 250 mm ( 3 x 10 inches) in the developer and remove for drying and inspection under blacklight for indications of fluorescence. Replace developer when fluorescence is detected.
- 4.7.3 Check developer daily for scum on the surface or inability to completely wet the surface of parts being inspected. Replace the developer if any of these conditions is evident.
- 4.7.3.1 If contaminated developer is discarded, ensure tank is cleaned before adding fresh developer.
- 4.8 Inspection Booth:
- With curtains drawn, check residual white light in booth at least monthly using a white light meter (See 3.5.12.1). Confirm daily cleanliness of the work area and absence of fluorescent contamination which may contaminate parts or degrade the inspection.
- 4.9 Material Storage:
- Properly store and legibly identify all materials.
- 4.10 Material Check:
- The designation and frequency of required material checks are specified in Table 1 (See 4.1).
5. PREPARATION FOR DELIVERY:
- 5.1 Identification:
- Shall be in accordance with OEM requirements.
- 5.2 Packaging:
- 5.2.1 All parts susceptible to corrosion shall be coated with a corrosion inhibiting oil or other protective treatment when required by part or material specification.
- 5.2.2 The product shall be prepared for shipment in accordance with commercial practice and in (R) compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the product to ensure carrier acceptance and safe delivery.
- 5.2.3 For direct U.S. Military procurement, packaging shall be in accordance with MIL-STD-2073-1, Level C, unless Level A is specified in the request for procurement.

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TABLE 1 - Material Check Frequency

| Description                                                           | Frequency                                                                       | Applicable Paragraph |
|-----------------------------------------------------------------------|---------------------------------------------------------------------------------|----------------------|
| System performance check                                              | Daily, or before start-up                                                       | 3.3                  |
| Blacklight                                                            | Daily                                                                           | 4.2                  |
| Blacklight meter calibration                                          | 6-month intervals                                                               | 4.2.4                |
| White light intensity                                                 | Monthly                                                                         | 4.3                  |
| Water content (water washable penetrant)                              | Monthly                                                                         | 4.4.1.1              |
| Penetrant brightness                                                  | Quarterly                                                                       | 4.4.1.2              |
| Hydrophilic remover concentration and contamination                   | Weekly                                                                          | 4.4.2                |
| Lipophilic emulsifier contamination                                   | Monthly and after replenishment                                                 | 4.4.3                |
| Pressure and temperature controls                                     | Verified daily and 6-month calibration                                          | 4.5                  |
| Dry developer                                                         | Daily for caking and monthly for contamination of recycled developer            | 4.6                  |
| Water soluble/suspendible developer                                   | Concentration initially and weekly<br>Weekly for fluorescence<br>Daily for scum | 4.7                  |
| Inspection booth, residual white light, and fluorescent contamination | Monthly for residual white light and daily for contamination                    | 3.5.12.1 and 4.8     |

## 6. ACKNOWLEDGMENT:

A vendor shall mention this specification number and its revision letter in all quotations and when acknowledging purchase orders.

## 7. REJECTIONS:

Parts not conforming to this specification, or to modifications authorized by purchaser, will be subject to rejection.

## 8. NOTES:

- 8.1 The (R) symbol is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this specification. If the symbol is next to the specification title, it indicates a complete revision of the specification.

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8.2 Definitions of terms used in AMS are presented in ARP1917 and as follows:

- 8.2.1 **Angstrom:** A unit of length formerly used to express wavelength of electromagnetic radiation. One angstrom equals 0.1 nanometer.
- 8.2.2 **Background:** The surface of the part upon which the indication is viewed. It may be either the natural surface of the test part or the developer coating on the surface..
- 8.2.3 **Background Fluorescence:** Fluorescent residues observed over the general surface of the test part. Local areas of background fluorescence are generally caused by improper penetrant removal or surface contamination. Such contamination, if present, can interfere with the visibility of defect indications.
- 8.2.4 **Blacklight:** Electromagnetic radiation in the near ultraviolet range of wavelength 3200 to 4000 Angstrom units (320 to 400 nm)
- 8.2.5 **Blacklight Filter:** See Filter 8.2.32.
- 8.2.6 **Blacklight Meter:** A meter containing photo sensitive cells for reading of blacklight intensity in microwatts per square centimeter ( $\mu\text{W}/\text{cm}^2$ ).
- 8.2.7 **Caked:** A semi-solid condition of dry developer caused by moisture or other liquid contaminants.
- 8.2.8 **Capillary Action:** The tendency of certain liquids to travel, climb, or draw into tight crack-like interface areas due to such properties as surface tension, wetting, cohesion, and adhesion.
- 8.2.9 **Contact Time:** The total time between application and removal of the penetrant or emulsifier or remover, or both.
- 8.2.10 **Contaminants:** Any material or material residue which interferes with entry of the penetrant into surface discontinuities. Also pertains to material left on the surface of the part because of improper cleaning and retained residual penetrant. Can also mean undesired materials in the penetrant, emulsifier, and remover which affect their performance.
- 8.2.11 **Dark Adaptation:** The adjustment of the eyes which commences when one passes from a bright to a darkened place.
- 8.2.12 **Defect:** Discontinuity which exceeds specified acceptance criteria.
- 8.2.13 **Degreasing:** A cleaning method using solvents or cleaners employed to remove oil and grease from the surface of the part before the penetrant is applied.
- 8.2.14 **Developer:** A material that is applied to the test part surface after the excess penetrant has been removed and that is designed to enhance the penetrant bleedout to form indications. The developer may be a fine dry powder, or a suspension (in solvent or water) that dries leaving an adsorptive film on the test part surface.

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- 8.2.15 **Developer, Dry:** A dry, fine powder that is applied as a dust to the test part after the excess penetrant is removed and the surface dried.
- 8.2.16 **Developer, Nonaqueous Wet (NAWD):** A developer consisting of fine particles suspended in a volatile solvent which is applied by spraying onto the test part surface after the excess penetrant is removed and the surface dried.
- 8.2.17 **Developer, Soluble:** A material completely soluble in its carrier (usually water) which dries to an adsorptive coating. It is applied to the part after removal of the excess penetrant and prior to drying.
- 8.2.18 **Developing Time:** The elapsed time between the application of dry developer or NAWD and the examination of the part for indications. Also the elapsed time between removal of the part from the dryer and the examination when using water soluble developer.
- 8.2.19 **Discontinuity:** Any interruption in the normal physical structure or configuration of a part, such as cracks, laps, seams, inclusions, or porosity. A discontinuity may or may not be a relevant defect.
- 8.2.20 **Drain Time:** That portion of the contact or dwell time during which the excess penetrant, emulsifier, or remover drains off the test piece.
- 8.2.21 **Drying Oven:** A low temperature oven used for drying rinse water from the test part or to hasten drying of aqueous wet developer.
- 8.2.22 **Drying Time:** The time required for a rinsed or wet-developed part to dry.
- 8.2.23 **Dwell Time:** The total time that a penetrant, emulsifier, remover, or developer spends in contact with the component. For aqueous and nonaqueous developers, the dwell time starts after the developer is dry on the component.
- 8.2.24 **Emulsifier:** A liquid that interacts with an oily penetrant to make it water washable.
- 8.2.25 **Emulsification Time:** The total time that an emulsifier is permitted to combine with the penetrant prior to removal by water.
- 8.2.26 **Engine Parts:** Disassembled turbine or reciprocating engine parts or components.
- 8.2.27 **Major Engine Rotor Component:** A rotating part whose life is governed by low cycle fatigue limits or other mechanical property limits. (Examples: disks, shafts, spools, hubs, spacers, seals.)
- 8.2.28 **Etching:** A process for the controlled removal of surface material by chemical agents. May be used to remove smeared metal caused by intentional or adventitious cold working.
- 8.2.29 **Evaluation:** A process of determining the severity of the condition after a penetrant indication has been interpreted. Evaluation leads to determining whether the part is acceptable, salvageable, or rejectable.

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- 8.2.30 **False Indication:** A penetrant indication that might be erroneously interpreted as a defect or discontinuity in the test part.
- 8.2.31 **Family:** The complete series of compatible materials from one manufacturer designed to perform a specific process of penetrant inspection.
- 8.2.32 **Filter:** Used in conjunction with a mercury vapor lamp to suppress visible and harmful short-wavelength ultraviolet radiations and to transmit near ultraviolet radiation.
- 8.2.33 **Flaw:** An imperfection in a part or material which may or may not be relevant to the function of the part.
- 8.2.34 **Fluorescence:** The emission of light (usually yellow-green) by fluorescent penetrant as the result of, and only during, irradiation by ultraviolet light.
- 8.2.35 **Fluorescent Contamination:** Contamination of parts or developer with fluorescent penetrant. Also, contamination of the inspection area.
- 8.2.36 **Foot-candle:** The illumination on a surface,  $0.09 \text{ m}^2$  (1 square foot) in area, on which is uniformly distributed a flux of 2 lm (lumen). It equals  $10.8 \text{ lm/m}^2$  or  $0.09 \text{ lx}$ .
- 8.2.37 **Hydrophilic Emulsifier:** A water soluble detergent concentrate used with the post emulsifiable penetrants.
- 8.2.38 **Indication (Penetrant):** The visible evidence of penetrant fluorescence indicating to the inspector that some sort of surface anomaly is present. Indications may be either false or valid, or may be relevant or nonrelevant.
- 8.2.39 **Inspection:** Visual examination of test parts, using blacklight, after completion of the penetrant processing steps.
- 8.2.40 **Interpretation:** The determination of the significance of the indications from the standpoint of whether they are relevant or nonrelevant.
- 8.2.41 **Known Defect Test Standard:** A test standard containing known defects used to perform system performance checks and classify penetrants.
- 8.2.42 **Lipophilic Emulsifier:** A ready to use oil base emulsifier which is miscible with penetrant. The resulting mixture of the two oils is easily emulsified under a water spray.
- 8.2.43 **Micro ( $\mu$ ):** A prefix that indicates one millionth ( $10^{-6}$ ).
- 8.2.44  **$\mu\text{W/cm}^2$ :** Microwatts per square centimeter. Units used in measurement of short wavelength energy.
- 8.2.45 **Nonrelevant Indication:** A penetrant indication that is not or cannot be associated with a discontinuity.

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- 8.2.46 **Part or Material Specifications:** The original equipment manufacturer's (OEM's) specification provided in manuals and other documents that instruct the user in the care and handling of their products. These documents may also include inspection requirements.
- 8.2.47 **Penetrant:** A liquid capable of entering discontinuities or defects open to the surface and which is adapted to the inspection process by being highly visible in small traces.
- 8.2.48 **Penetrant, Fluorescent:** An inspection penetrant that is characterized by its ability to fluoresce when excited by blacklight.
- 8.2.49 **Penetrant, Post Emulsifiable:** A penetrant that requires the application of a separate emulsifier to render the surface penetrant water-washable.
- 8.2.50 **Penetrant, Water-Washable:** A penetrant with built-in emulsifier which makes it directly water-washable.
- 8.2.51 **Post Inspection Cleaning:** The removal of penetrant material residues and developer from the test part after the penetrant inspection process is completed.
- 8.2.52 **Precleaning:** The removal of surface contaminant from the test part so that it cannot interfere with the penetrant inspection process.
- 8.2.53 **Refractometer:** A device that measures the refractive index of a liquid. This value increases in proportion to the dissolved solids in the liquid, and hence has been used to measure hydrophilic remover concentration.
- 8.2.54 **Relevant Indication.** An indication caused by a discontinuity.
- 8.2.55 **Rinse:** The process of removing liquid penetrant inspection materials from the surface of the test part by means of washing with water. Also termed "wash".
- 8.2.56 **Sensitivity:** The ability to produce various size discontinuities. The three categories of penetrant materials, i.e., medium, high, ultra high, as determined by known defect standards.
- 8.2.57 **Specific Gravity:** The ratio of the density of a substance (usually aqueous developer) to the density of water usually measured at 15.6 °C (60 °F).
- 8.2.58 **Ultraviolet Light:** The term applied for radiation below the visible range. As used in fluorescent penetrant inspection between 3200 and 4000 Angstrom units (320 and 400 nm). See also, blacklight 8.2.4.
- 8.2.59 **Viscosity:** The state or degree of being viscous, i.e., the resistance of a fluid to flow, for example, through a restricted orifice.
- 8.2.60 **Water Content:** The percentage of water contamination of a sample of water washable penetrant or lipophilic emulsifier taken from the process tanks.