



AEROSPACE MATERIAL SPECIFICATION

AMS2647™**REV. G**Issued 1985-04
Revised 2021-09

Superseding AMS2647F

Fluorescent Penetrant Inspection Aircraft Structures and Engine Component Maintenance

RATIONALE

AMS2647F is a Five-Year Review and update of this specification. This revision proposes a title change, adds a reference and definition for Method A(W) penetrants and includes a new paragraph defining penetrant process restrictions for aerospace hardware. Terminology has been updated throughout to remain consistent with AMS2644. Process controls have been updated to include Method C penetrant materials. Editorial changes are also included throughout to include replacing "light meter" with the more accurate term "photometer." Terminology has been updated throughout to remain consistent with AMS2644. This revision also addresses technical negatives received from the first ballot 21 April 2021.

1. SCOPE

1.1 Purpose

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

1.1.1 This specification contains three appendices which provide additional guidance designed to supplement the information contained in the main body of the document. Because the guidance contained in the appendices is either subjective in nature or may have alternative acceptable approaches, it is not intended to be binding unless specifically invoked by the Cognizant Engineering Organization (CEO), an Original Equipment Manufacturer (OEM), or other contractual agreement. Personnel performing inspections to this specification should be familiar with the guidance and exercise good judgment if variance from this guidance is necessary. The following appendices are included:

1.1.1.1 Appendix A - Guidelines for Design, Procurement, and/or Fabrication of Penetrant Systems

1.1.1.2 Appendix B - Guidelines for Assessment of Background Fluorescence

1.1.1.3 Appendix C - Processing and Inspection of Drum Rotors/Deep Well Spools and Other Complex Parts w/Limited Accessibility

1.2 Processing of parts and interpretation and evaluation of indications revealed by this inspection process shall be accomplished by qualified personnel having experience with fluorescent penetrant inspection. Qualification of personnel shall be in accordance with ATA 105, NAS 410, EN 4179, or ASNT SNT-TC-1A.

1.3 Basis of 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.

SAE Executive Standards Committee Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be revised, reaffirmed, stabilized, or cancelled. SAE invites your written comments and suggestions.

Copyright © 2021 SAE International

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of SAE.

TO PLACE A DOCUMENT ORDER:
Tel: 877-606-7323 (inside USA and Canada)
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
<http://www.sae.org>

SAE WEB ADDRESS:

Full document details: [SAE AMS2647G](#)

For more information on this standard, visit
<https://www.sae.org/standards/content/AMS2647G/>

Documents

Document Sharing Hub

1.3.1 Restrictions

Method A(W) penetrants shall not be used for inspection of aerospace structural or engine components.

Method A and Method B penetrant processes shall not be used for inspection of critical major rotating engine components unless specifically authorized by the OEM or CEO.

1.3.2 There are areas in this document that may require specific direction from the OEM or CEO. This direction shall be provided in the part material specification for each part in the following areas:

1.3.2.1 Etching Requirements

Unless specifically authorized by the OEM or CEO, etching shall be performed before penetrant inspection if smearing operations precede the penetrant inspection (see 3.3.6).

1.3.2.2 Cleaning Requirements

If not specified, solvent cleaning using Alcohol, Acetone, or Methyl Ethyl Ketone (where locally approved) (see 3.3.4) or an approved QPL-AMS-2644 solvent cleaner/remover is acceptable.

1.3.2.3 Surface Coating Removal

Parts shall be inspected with surface coating removed unless specifically authorized by CEO or OEM instructions (see 3.3.5, 3.3.5.1, and 3.3.5.2).

1.3.2.4 Penetrant Sensitivity Level

If not specified, Level 4 penetrants shall be used on all Major Rotating components of engines and Auxiliary Power Units. If not specified, Level 3 penetrants shall be used on all airframe components and all other non-critical engine and non-critical auxiliary power unit components.

1.3.2.5 Penetrant Method

If not specified, Type I, Methods A, C, or D may be used for airframe and engine component inspections, except for critical major rotating engine components. Only Method D or C processes shall be used for critical major rotating engine components unless an alternate method is specifically authorized by the CEO or OEM.

1.3.2.6 Drying

If not specified, air-circulating oven drying shall be used. If other heat-assisted drying methods are used, they shall be approved by the CEO.

1.3.2.7 Developer

If not specified, dry developer (Form a) shall be used.

1.3.2.8 Inspection Coverage

If not specified, the areas described in 3.4.12.1 shall be inspected. If inspection of areas requiring special equipment or techniques (i.e., UV-A borescopes or light sources, special material application or removal devices, part handling fixtures, part masking, etc.) is necessary, detailed instructions shall be provided by the OEM part or material specification. When specific areas of parts require intensified inspection scrutiny, due to either their critical nature or past history of failure, this information shall be included in the repair or inspection manual or document.

1.3.2.9 Post-Inspection Cleaning

If not specified, parts shall be cleaned and dried after inspection to remove inspection residue which may be detrimental to subsequent operations or impair the structural or functional integrity of the part.

1.3.2.10 Processing Parameters

Shall be as specified within this document. If approved by the OEM, different processing parameters, other than those specified herein, may be used.

1.3.2.11 Acceptance Criteria

This specification does not provide accept/reject criteria for specific components. Where no accept/reject criteria are specified by the CEO, all relevant indications shall be regarded as suspect and shall not be accepted without review by the CEO.

1.4 Classification of Penetrant Systems

1.4.1 Applicable fluorescent penetrant systems are classified into the following Types, Methods, and Sensitivity Levels:

Type I - Fluorescent Dye

Type II - Visible Dye (not applicable to this specification)

Method A: Water Washable

Method A(W): Water Washable – Water Containing ($\geq 20\%$ water by volume)

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

1.4.2 Applicable developers are classified into four forms.

Form a Dry Powder Developer

Form b Water Soluble Developer

Form c Water Suspensible Developer

Form d Nonaqueous Wet Developer (NAWD)

1.5 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.

1.5.1 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 for fume extraction. Operating instructions from the manufacturer of the system employed together with local workshop regulations shall be followed.

2. APPLICABLE DOCUMENTS

The issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been cancelled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AMS2644 Inspection Material, Penetrant

ARP1917 Clarification of Terms Used in Aerospace Metals Specifications

2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM E1135 Comparing the Brightness of Fluorescent Penetrants

ASTM E1417 Liquid Penetrant Testing

ASTM E2297 Use of UV-A and Visible Light Sources and Meters used in the Liquid Penetrant and Magnetic Particle Methods

ASTM E3022 Measurement of Emission Characteristics and Requirements for LED UV-A Lamps Used for Fluorescent Penetrant and Magnetic Particle Testing

2.3 U.S. Government Publications

Copies of these documents are available online at <https://quicksearch.dla.mil>.

QPL-AMS2644 Inspection Material, Penetrant

2.4 Airlines for America (A4A) Publications

Available from Airlines for America (A4A), 1301 Pennsylvania Avenue, NW, Suite 1100, Washington, DC 20004, Tel: 202-626-4000, www.airlines.org.

ATA Specification 105 Guidelines for Training/Qualifying Personnel in Non-Destructive Testing Methods

2.5 AIA Publications

Available from Aerospace Industries Association, 1000 Wilson Boulevard, Suite 1700, Arlington, VA 22209-3928, Tel: 703-358-1000, www.aia-aerospace.org.

NAS 410 Certification and Qualification of Nondestructive Test Personnel

2.6 ASNT Documents

Available from American Society for Nondestructive Testing, P.O. Box 28518, 1711 Arlingate Lane, Columbus, OH 43228-0518, 800-222-2768 (inside U.S. and Canada), 614-274-6003 (outside USA), www.asnt.org.

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

2.7 EN Documents

Available from the British Standards Institute, 389 Chiswick High Road, London, W4 4AL, United Kingdom, +44 (0)20 8996 9001, www.bsi-global.com.

EN 4179 Qualification and approval of personnel for non-destructive testing

2.8 Terms used in AMS are clarified in ARP1917 and as follows:

- 2.8.1 **ANGSTROM:** A unit of length formerly used to express wavelength of electromagnetic radiation. One angstrom equals 0.1 nanometer.
- 2.8.2 **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.
- 2.8.3 **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.
- 2.8.4 **CAKED:** A semi-solid condition of dry developer caused by moisture or other liquid contaminants.
- 2.8.5 **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.
- 2.8.6 **COGNIZANT ENGINEERING ORGANIZATION (CEO):** The company, agency, or other authority responsible for the design or delivery, and the end use of the system or component for which liquid penetrant examination is required. This in addition to design personnel may include personnel from material and process engineering, stress analysis, NDT, or quality groups, as appropriate.
- 2.8.7 **CONTACT TIME:** The total time between application and removal of the penetrant or emulsifier or remover, or both.
- 2.8.8 **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.
- 2.8.9 **CRITICAL COMPONENTS:** Airframe or engine components where failure could result in unsafe operation or loss of an aircraft. Critical engine components typically include major rotating components where failure could result in uncontained damage and failure. The CEO or OEM establishes component criticality designations.
- 2.8.10 **DAILY:** Each day that the system is in use.
- 2.8.11 **DARK ADAPTATION:** The adjustment of the eyes, which commences when one passes from a bright to a darkened place.
- 2.8.12 **DEFECT:** Discontinuity, which exceeds specified acceptance criteria.
- 2.8.13 **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.
- 2.8.14 **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 absorbent film on the test part surface.
- 2.8.15 **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.
- 2.8.16 **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.
- 2.8.17 **DEVELOPER, SOLUBLE:** A material completely soluble in its carrier (usually water) which dries to an absorbent coating. It is applied to the part after removal of the excess penetrant and prior to drying.

- 2.8.18 **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 aqueous developers (form b or form c).
- 2.8.19 **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.
- 2.8.20 **DRAIN TIME:** That portion of the contact or dwell time during which the excess penetrant, emulsifier, or remover drains off the test piece.
- 2.8.21 **DRYING OVEN:** A low temperature oven used for drying rinse water from the test part or to hasten drying of aqueous wet developer.
- 2.8.22 **DRYING TIME:** The time required for a rinsed or wet-developed part to dry.
- 2.8.23 **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.
- 2.8.24 **EMULSIFIER:** A liquid that interacts with an oily penetrant to make it water washable.
- 2.8.25 **EMULSIFICATION TIME:** The total time that an emulsifier is permitted to combine with the penetrant prior to removal by water.
- 2.8.26 **ENGINE COMPONENTS:** Disassembled turbine or reciprocating engine parts.
- 2.8.27 **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.
- 2.8.28 **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.
- 2.8.29 **FALSE INDICATION:** A penetrant indication that might be erroneously interpreted as a defect or discontinuity in the test part.
- 2.8.30 **FILTER:** Used in conjunction with a UV-A lamp to suppress visible and harmful short-wavelength ultraviolet radiation and to transmit near ultraviolet radiation.
- 2.8.31 **FLAW:** An imperfection in a part or material which may or may not be relevant to the function of the part.
- 2.8.32 **FLUORESCENCE:** The emission of light (usually yellow-green) by fluorescent penetrant as the result of, and only during, irradiation by UV-A.
- 2.8.33 **FLUORESCENT CONTAMINATION:** Contamination of parts or developer with fluorescent penetrant. Also, contamination of the inspection area.
- 2.8.34 **FOOT-CANDLE:** The illumination on a surface, 0.09 m² (1 square foot) in area, on which is uniformly distributed a flux of 2 lm (lumen). It equals 10.8 lm/m² or 0.09 lx (lux).
- 2.8.35 **HYDROPHILIC EMULSIFIER:** A water soluble detergent concentrate used with the post-emulsifiable penetrants.
- 2.8.36 **INDICATION (PENETRANT):** The visible evidence of penetrant fluorescence indicating to the inspector that some sort of surface anomaly may be present. Indications may be either false or valid, or may be relevant or nonrelevant.
- 2.8.37 **INSPECTION:** Visual examination of test parts, using UV-A irradiation, after completion of the penetrant processing steps.
- 2.8.38 **INTERPRETATION:** The determination of the significance of the indications from the standpoint of whether they are relevant or nonrelevant.

- 2.8.39 **KNOWN DEFECT TEST STANDARD:** A test standard containing known defects used to perform system performance checks.
- 2.8.40 **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.
- 2.8.41 **LUMEN (lm):** A measure of the total quantity of visible light emitted by a source.
- 2.8.42 **LUX (lx):** A unit of illuminance and luminous emittance, measuring luminous flux per unit area.
- 2.8.43 **MAJOR ROTATING COMPONENTS:** A rotating part whose life is governed by low cycle fatigue limits or other mechanical property limits. (Examples: disks, shafts, spools, hubs, spacers, seals.)
- 2.8.44 **MICRO (μ):** A prefix that indicates one millionth (10^{-6}).
- 2.8.45 **μW/cm²:** Microwatts per square centimeter. Units used in measurement of short wavelength energy.
- 2.8.46 **NONRELEVANT INDICATION:** A penetrant indication that is not or cannot be associated with a discontinuity.
- 2.8.47 **PART OR MATERIAL SPECIFICATIONS:** A specification provided by the OEM in the form of manuals, drawings or other documents that instruct the user in the maintenance and handling of specific parts or components.
- 2.8.48 **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.
- 2.8.49 **PENETRANT, FLUORESCENT:** An inspection penetrant that is characterized by its ability to fluoresce when excited by UV-A radiation.
- 2.8.50 **PENETRANT, POST-EMULSIFIABLE:** A penetrant that requires the application of a separate emulsifier to render the surface penetrant water washable.
- 2.8.51 **PENETRANT, WATER WASHABLE:** A penetrant with built-in emulsifier which makes it directly water washable.
- 2.8.52 **PENETRANT, WATER WASHABLE, WATER CONTAINING:** A water washable penetrant that contains greater than or equal to 20% water in its formulation.
- 2.8.53 **PHOTOMETER:** A meter that measures white light in foot-candles or lux.
- 2.8.54 **POST-INSPECTION CLEANING:** The removal of penetrant material residues and developer from the test part after the penetrant inspection process is completed.
- 2.8.55 **PRECLEANING:** The removal of surface contaminant from the test part so that it cannot interfere with the penetrant inspection process.
- 2.8.56 **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.
- 2.8.57 **RELEVANT INDICATION:** An indication caused by a discontinuity.
- 2.8.58 **RINSE:** The process of removing liquid penetrant inspection materials from the surface of the test part by either immersion in an agitated water tank or vigorous spraying with water. Also termed “wash.”
- 2.8.59 **SENSITIVITY:** The ability of a penetrant system to indicate the presence of a surface-connected discontinuity. The three categories of penetrant materials, i.e., medium, high, ultra high, as determined by known defect standards.
- 2.8.60 **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).

- 2.8.61 **ULTRAVIOLET LIGHT (UV):** 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, UV-A 2.8.61.
- 2.8.62 **UV-A:** Electromagnetic radiation in the near ultraviolet range (UV-A) of wavelength 3200 to 4000 Angstrom units (320 to 400 nm). See also, Ultraviolet Light 2.8.60. The term “black light” has been used in the past.
- 2.8.63 **UV-A PASS FILTER:** See Filter 2.8.31.
- 2.8.64 **UV-A RADIOMETER:** A meter containing photo sensitive cells for reading of UV-A irradiance in microwatts per square centimeter ($\mu\text{W}/\text{cm}^2$).
- 2.8.65 **VISCOSITY:** The state or degree of being viscous, i.e., the resistance of a fluid to flow, for example, through a restricted orifice.
- 2.8.66 **WATER CONTENT:** The percentage of water contamination of a sample of water washable penetrant or lipophilic emulsifier taken from the process tanks.

3. TECHNICAL REQUIREMENTS

3.1 Materials

Materials used (i.e., penetrants, emulsifiers, and developers) shall conform to AMS2644 and be listed in QPL-AMS-2644, and be approved by the original equipment manufacturers (OEMs) part or material specifications.

3.1.1 Grouping of Materials

Penetrants and their emulsifiers shall be qualified and used as a “penetrant/emulsifier” system, furnished by one manufacturer to perform a specific method or process of penetrant inspection. Method A penetrants are not qualified with an emulsifier. Developers may be from a different manufacturer.

3.2 Equipment

Equipment shall be constructed and arranged to permit uniform, controlled operation. Quality control of equipment shall be as specified in Section 4.

NOTE: Guidelines available for use in design, procurement and/or fabrication of penetrant inspection equipment are contained in Appendix A.

3.3 Surface Preparation of Parts to be Inspected

Proper surface preparation of parts for penetrant inspection is extremely critical. The primary objectives of part preparation are to ensure the flaw is clean, dry, and open to the surface and that minimal fluorescent background is obtained after processing. Surface preparation, including cleaning, stripping, masking, blasting, peening, etching, and drying, shall be accomplished using methods and materials specified in the OEM's part or material specifications. If OEM guidance is not provided, the information in the following paragraphs shall be considered by the CEO in establishing requirements to prepare parts for inspection.

CAUTION: Visible or contrast dye penetrant shall not be used on a part prior to fluorescent penetrant inspection (FPI). Contamination from the visible dye can severely degrade the brightness of the fluorescent dyes.

3.3.1 General

Reliable penetrant inspections are highly dependent on proper pre-inspection processing. Because this is difficult or impossible for inspection personnel to determine or control, it is the responsibility of the CEO to include proper pre-inspection processing requirements in all work documents specifying the use of penetrant inspection. As a rule, any operation, which may prevent penetrant from entering defects, shall be avoided.

- 3.3.1.1 Personnel accomplishing surface preparation such as cleaning shall be properly trained so that they are fully knowledgeable with the operations they are performing, including both company and OEM specifications. They should also be aware of the impact that improper performance of their duties can have on both hardware and on subsequent operations such as FPI.

CAUTION: Failure to properly clean parts prior to FPI can prevent the detection of flaws which could ultimately result in property damage, loss of aircraft, and/or loss of life.

- 3.3.2 Sequence of operations shall be as follows:

- 3.3.2.1 Penetrant inspection shall be performed prior to any operation (such as plating, anodizing or cold working) which may close or smear openings or leave unremovable residue within a defect.

- 3.3.3 Penetrant inspection shall be performed subsequent to any operation (such as heat treatment involving quenching, welding, cold forming, or grinding) that may introduce or expose defects.

3.3.4 Cleaning

Areas of parts to be examined shall be free of moisture, grease, oil, grinding compounds, rust, scale, acids or alkalis, fluxes, burrs, feather edges, paint (primer, enamel), and other foreign materials which could hide defects or produce irrelevant indications that may interfere with the examination process. It is the responsibility of both cleaning and inspection personnel to visually assess cleanliness for suitability of inspection. Guidance on assessing the level of background fluorescence is provided in Appendix B.

- 3.3.4.1 Surface cleaning and penetrant processing should be considered a continuous operation to prevent inadvertent contamination of the part. When not conducted as a continuous operation, the CEO should consider the need for special precautions to ensure parts are protected from environmental or other inadvertent contamination between cleaning and FPI processing.

3.3.4.2 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 mechanically detrimental to the part. Potential methods include solvent cleaning, steam cleaning, ultrasonic cleaning, vapor blasting, paint and carbon stripping, and alkaline or acid cleaning. Wet glass bead blasting has been shown to be detrimental to FPI performance and its use on parts prior to FPI is not recommended¹. Adherence to OEM recommended media blast pressures and grit sizes is critical to avoid closing of indications.

- 3.3.4.3 Cleaning methods shall not leave a residue, which could interfere with the FPI process or potential subsequent operations. Aqueous cleaning shall be followed by a thorough fresh water rinse to ensure cleaning residues do not remain on the part surface.

NOTE: Halogenated/chlorinated solvents shall not be used on titanium alloys.

- 3.3.4.4 For spot cleaning prior to FPI, surface contamination should be removed using Isopropyl Alcohol, Acetone or Methyl Ethyl Ketone (where locally approved) or an approved QPL-AMS-2644 solvent cleaner/remover. Aqueous cleaners should not be used in a field inspection or for spot cleaning because of concerns with drying the part sufficiently for effective FPI. If aqueous cleaners are used, parts must be dried with an approved drying method.

3.3.5 Plating or Surface Coatings

Coatings or surface treatments can prevent penetrant from entering defects as well as cause varying levels of fluorescent background on the part. High background fluorescence reduces the contrast between indications and background (signal to noise ratio) with a corresponding decrease in inspection sensitivity. With certain types of plating or coating, it may be possible to perform an adequate inspection providing the plating or coating is in good condition and the defect is open to the surface.

¹ "Engineering studies of cleaning and drying processes in preparation for fluorescent penetrant inspections," L. Brasche, L. Clements, A. D'Ovillio, H. Griffiths, W. Griffiths, P. Khandelwal, T. Kessler, A. Kinney, B. Larson, J. Lively, R. Lopez, B. Meeker, J. Stevens, K. Smith, and S. Vandiver, FAA Report No. DOT/FAA/AR/03/73, January 2004, available through the National Technical Information Service (NTIS).

- 3.3.5.1 Conversion coatings, impregnations, flame spray, plating, or paint should be removed prior to penetrant inspection if an inspection with a high level of sensitivity is desired. Removal of these coatings shall be specified in the work document. If not specified, it will be assumed that inspections are to be conducted with the coating intact. Removal of these coatings should not be done in a manner which may cause metal smearing, or which leaves chemical residue on the part that may contaminate defects.

3.3.6 Mechanical Surface Treatment

Surface treatment such as abrasive blasting, sanding or burnishing operations can smear the surface metal and clog discontinuities with debris preventing penetrant from entering discontinuities. Data demonstrating the detrimental effects of surface treatments on penetrant inspection exist¹. If it is necessary to perform these operations prior to penetrant inspection etch shall be performed prior to inspection. The use of surface treatments without etch must be approved by the CEO and responsible Level 3 and the surface treatment shall be demonstrated to not be detrimental to the inspection performance and detection of the flaws of concern. Demonstration that the surface treatment does not smear surface material is not sufficient. Media blasting operations shall be followed by an approved process to remove remaining media. Data exists to support the use of a rinse to remove remaining media¹.

CAUTION: When employing one of the above surface treatments, it is important to follow the approved parameters, consumable materials and procedures as specified by the OEM's specification for the particular part.

- 3.3.6.1 Peening operations shall not be performed prior to penetrant application because the smearing and compressive stresses imparted by peening can completely eliminate the possibility of penetrant from entering a discontinuity.

3.3.7 Chemical Surface Treatment

Chemical surface treatments such as etching can be detrimental to part function or serviceability. It is the responsibility of the CEO to make this determination and act accordingly. If the repair or overhaul document does not specify acid etch prior to inspection, it will not be accomplished. In all cases, only approved etching and cleaning procedures and consumable materials specified by the OEM's engine manuals for a specific part shall be permitted.

3.3.8 Drying

Parts shall be fully dry before application of penetrant. Failure to sufficiently dry a part after cleaning can affect the capillary action and prevent the penetrant from entering a flaw. Parts cleaned with an aqueous or slow drying solvent cleaner shall be dried in accordance with OEM requirements. If not specified, parts may be "flushed dried" and/or dried at an elevated temperature to remove moisture from the part surface and possible discontinuities.

CAUTION: Drying times will depend upon the number of parts and the size and mass of the part being heated. Pooled or trapped water will prevent proper drying. If moisture remains on a part surface, the drying process shall be repeated.

- 3.3.8.1 Flash dry parts by submerging the part in a tank of hot water or by hot water spraying. With either method, the water shall be heated to 66 to 93 °C (150 to 200 °F) and the part shall dwell (i.e., remain submerged or sprayed) until the temperature of the part reaches the water temperature. Remove the part from the tank and remove excess water by draining, repositioning, suction, blotting with a clean absorbent material, or by blowing off with an oil filtered and water filtered shop air gun. Proper flash drying is indicated by seeing the water on the surface of a part start to "flash" or "whisk" off as the part is being removed from the hot water tank.
- 3.3.8.2 Air dry parts by placing the part in an oven or hot air dryer. There shall be no significant pooling of water prior to placing the part in the oven or hot air dryer. If necessary, utilize repositioning, suction, blotting with clean absorbent material, or air blowing with filtered (oil and water) shop air to remove excess water. Unless otherwise specified, the oven temperature shall be between 71 to 121 °C (160 to 250 °F), to remove moisture. Parts shall remain in the oven for a minimum of 1 hour or for 10 minutes after the surface of the part reaches a minimum of 66 °C (150 °F).

- 3.3.8.2.1 Where single parts and/or batches of parts having approximately the same mass/surface area are processed through the oven or hot air dryer, drying times may be established by sampling surface temperatures of representative parts. Sampling must be repeated for different oven/hot air dryer configurations or if nominal oven drying temperatures are changed. If sampling is used, a log of drying times for each part or group of parts must be maintained.

3.3.9 Masking

Parts inspected using the penetrant method shall be inspected over all visibly accessible surfaces except that parts having riveted doublers, data plates, air seals, rubberized coatings, or other areas which may entrap penetrant and which are not removed as part of the normal process will not receive inspection in the areas where excessive bleed out of the penetrant prohibits it. If inspections of these areas are required, removal and/or masking shall be specified in the applicable repair or inspection document.

- 3.3.9.1 Removal of anti-friction bearings prior to penetrant inspection is recommended. If bearings are not removed, they should be completely masked prior to routing to FPI in order to prevent contamination by penetrant fluid.

3.4 Processing Procedures

Descriptions of the different processing procedures are presented in Figures 1, 2, 3, and 4. When invoked, Appendix C contains requirements for processing parts with complex geometry and/or limited access.

3.4.1 Visual Examination

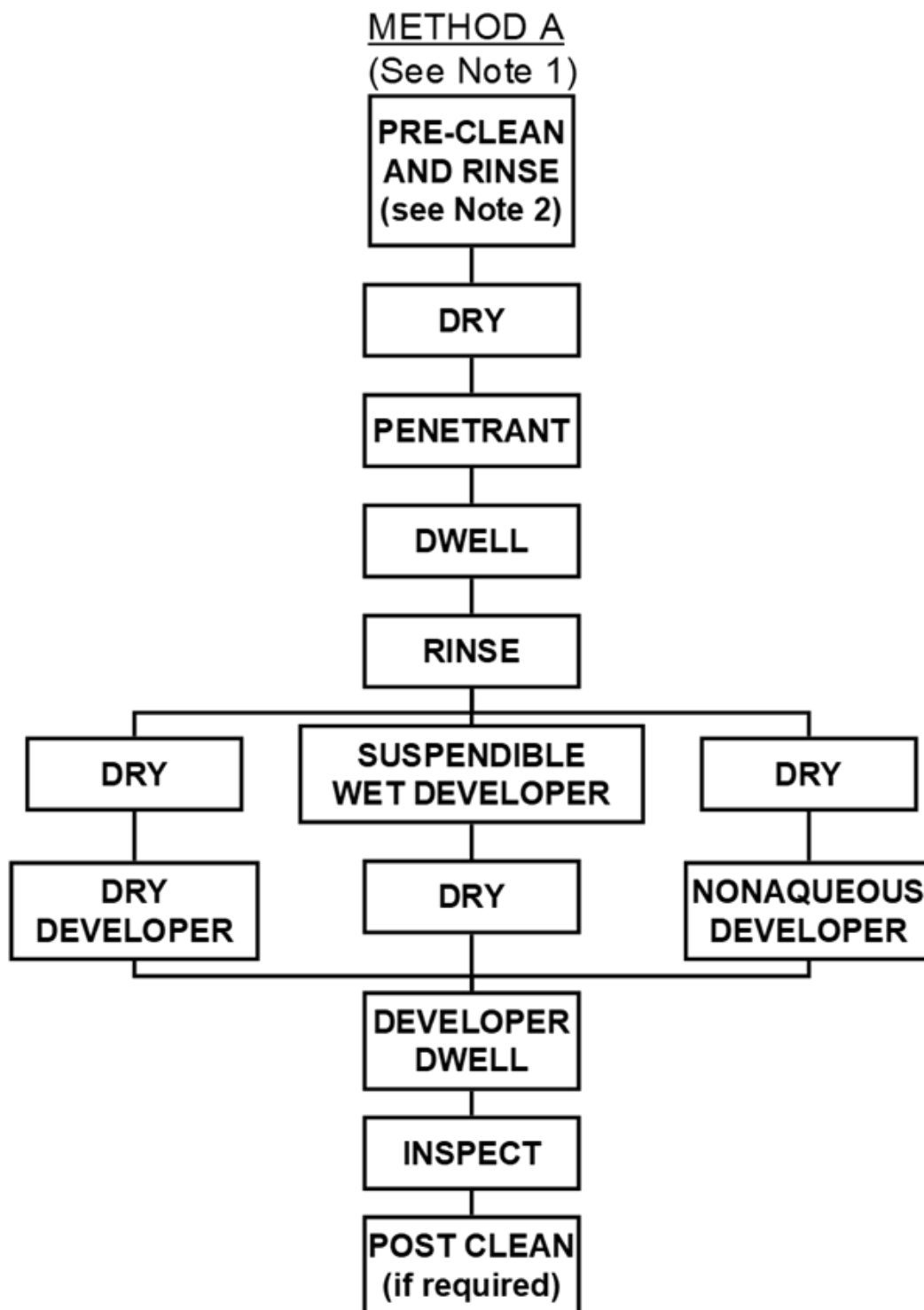
Visually examine parts. Parts to be processed/inspected shall be clean, dry, and free of surface contaminants. Surface contamination can interfere with the capillary action of the penetrant and prevent the penetrant fluid from being drawn into a surface discontinuity, thus compromising the FPI results. The goal is to get parts clean enough to perform a reliable inspection. Parts shall not be processed if they are considered insufficiently clean for FPI.

- 3.4.1.1 If contaminants (grease, oil, loose soils, etc.) can be removed with your finger or if the part has scale (hardened deposits), then the part is not sufficiently clean. Reclean the part until acceptable (see 3.3).

NOTE: If necessary, localized surface contamination may be removed using Isopropyl Alcohol, Acetone or Methyl Ethyl Ketone (where locally approved) or an approved QPL-AMS-2644 solvent cleaner/remover if the contaminant is amenable to this type of cleaning method.

- 3.4.1.2 Parts which show visible evidence or are suspected of having been contaminated with visible (contrast) dye penetrant shall be thoroughly cleaned to remove all traces of contamination as these dyes can severely degrade the brightness of the fluorescent penetrant. Visible dye penetrant shall not be used for inspection of aerospace components unless approved by the CEO.
- 3.4.1.3 Use of a UV-A lamp during initial examination may help to identify the presence of contaminants. Many organic contaminants fluoresce blue under UV-A radiation.
- 3.4.1.4 The use of one higher penetrant sensitivity level from that sensitivity level specified for a given part is permissible.

3.4.2 Penetrant Application for Methods A, B, C, and D



Note 1. Refer to paragraph 1.3.1 for restrictions on the use of Method A processes.

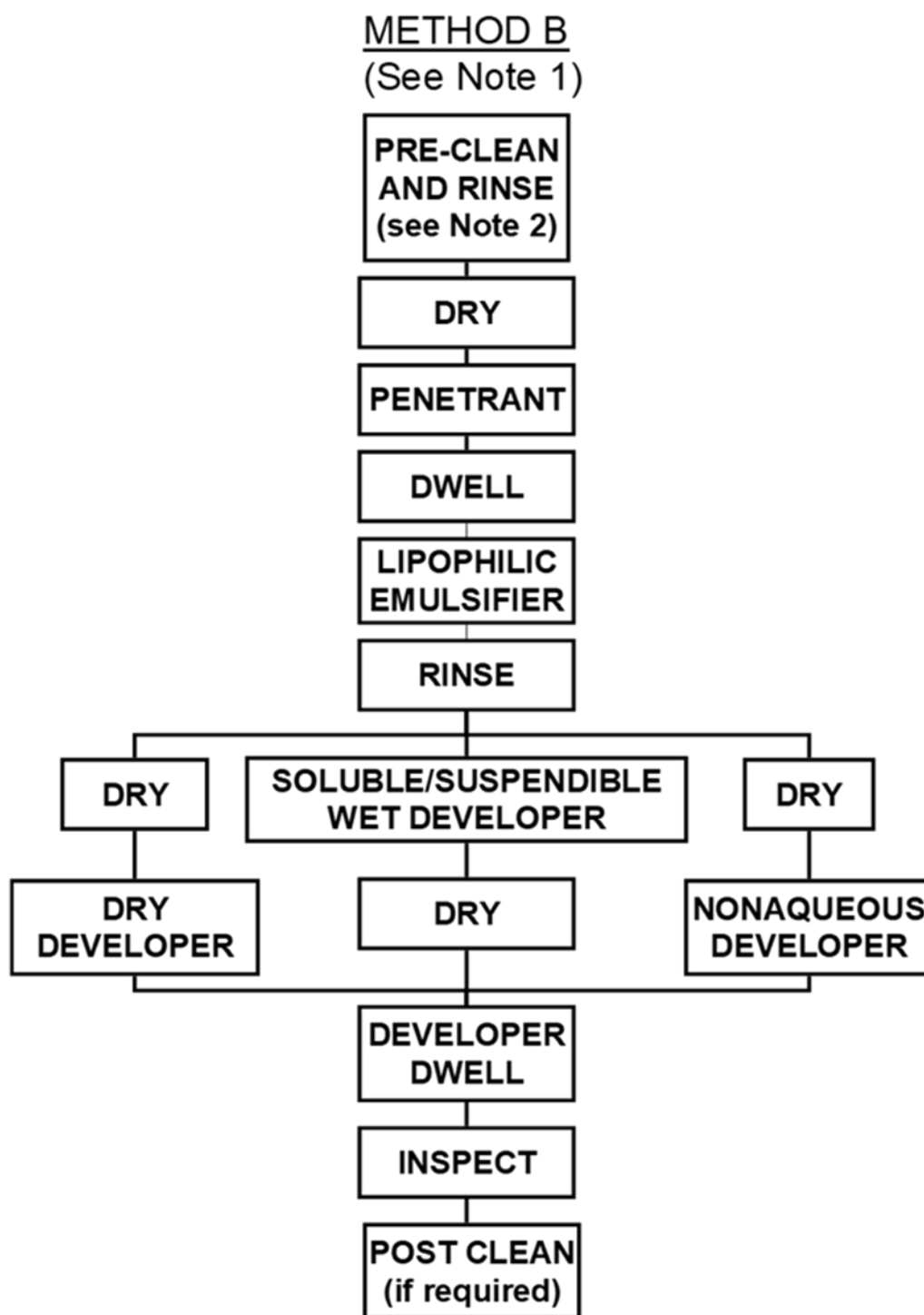
Note 2. Etch may be required to remove smeared metal. Consult part or material specification.

Figure 1 - Water washable penetrant inspection process



Documents

Document Sharing Hub



Note 1. Refer to paragraph 1.3.1 for restrictions on the use of Method B processes.

Note 2. Etch may be required to remove smeared metal. Consult part or material specification.

Figure 2 - Post-emulsifiable (lipophilic) penetrant inspection process



Documents

Document Sharing Hub