The Teamwork Of Jet Engine Cleaning & Fluorescent Penetrant Inspection (FPI)

By Jeff Stevens

Editor’s Note: At the 1998 Aerospace/ Airline Plating and Metal Finishing Forum in San Antonio, TX, Jeff Stevens received the Garland Award for best paper presented at the conference. Reprinted here is an outline of his presentation, in bulleted format, with accompanying graphics.

This presentation provides a “hands-on” maintenance engineer’s perspective on the basic steps to success in jet engine cleaning, part stripping and inspection. Subjects covered include:

- The purpose of chemical and abrasive blasting (precautions and key points to remember).
- How clean is “clean”?
- What are the causes for dirty parts at inspection time?
- The use of silicated cleaners.
- “Flash” drying.
- Common fluorescent penetrant inspection (FPI) problems.
- Solutions to cleaning and FPI problems.

Cleaning procedures and test results will be presented for the effects of water and plastic blast on cracks, oven-dried parts, wet and dry parts, “flash” drying and crack detection results.

It’s About Crack Detection!
The basic steps to success are:

- Clean
- Strip
- Inspect

Purpose of Chemical & Abrasive Blasting
- Prepares parts for inspection

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<table>
<thead>
<tr>
<th>Test Piece</th>
<th>Length</th>
<th>Crack Size</th>
<th>Material</th>
<th>Nomenclature</th>
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<td>A &amp; B</td>
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<td>0-50 micron Crack Panels</td>
<td>Cr Plate on Brass Panel</td>
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Why Do I Have Dirty Parts At Inspection?
- Inadequate cleaning equipment/solution agitation
- Incorrect process/SPOPs
- Improper solution temperature, concentration or dwell time
- Ineffective rinsing
- Lack of solution maintenance
- Inadequate training of personnel and loss of experience

How Clean Is Clean?
- Parts are rejected at FPI when:
  - They are considered insufficiently clean and the reason is obvious, or when it becomes a matter of opinion
  - Inspectors unnecessarily want parts to look like new
- Parts not fully clean as a result of improper cleaning method(s)
- Parts are not clean enough when:
  - Soil, grease or oil rubs off on your finger
- Penetrant beads up or separates on part surface
- Water beads up or “breaks” on part in FPI wash cycle
- Light smut or dust causes excessive background fluorescence
- Background from soil or coating interferes with FPI
  - Light surface dust is permissible
  - It’s normal to see some background fluorescence on:
    - Castings
    - Mating surface contact areas, such as splines, bolt head/spacer contact area
    - Manufactured or refurbished areas, including plasma, diffused coatings, chromium plate, edges of nickel plate
    - Oxidation and stained areas
  - What about discoloration in galled areas on fan blades and disk/hub slots?
  - Area is sufficiently clean for FPI if background fluorescence is not excessive
  - Pressure face surface galling should not be removed by abrasive blasting prior to FPI
  - Crack indications on titanium can be masked by unapproved dry glass bead or other blasting

What About Silicated Cleaners?
  - Highly silicated cleaners and improper processing parameters can mask cracks prior to FPI
  - Processing parameters can mask cracks prior to FPI
  - SPOP 209 aqueous degreasing provides low and non-silicated solutions and parameters that do not mask FPI indications

Precautions on Abrasive Blast Cleaning
  - Improper parameters can cause part surface smearing
    - Media
    - Pressure
    - Angle
    - Dwell
  - Abrasive blasting should only be used to supplement chemical cleaning or stripping
  - Do not mix media

What Is “Flash” Drying?
  - Immerse part fully or spray-wash part in hot water (150–200 °F)
  - Allow part temperature to equalize with water temperature before removing
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• Immediately remove residual water by part rotation, air blast or suction

Common FPI Problems
• Incorrect processing parameters
• Incorrect penetrant sensitivity
• Improperly cleaned parts
• Inspectors inadequately trained

Solutions to Cleaning/FPI Problems
• Proper training does reduce turn time/rejection rates
• Departmental cooperation builds understanding of reasons for parts recycling
• Training needs include addressing:
  – Engine part variations in configuration and complexity
  – Variations in materials, coatings and engine run conditions
• Maintaining an experienced work force to minimize problems

What’s the Bottom Line?
• Teamwork
• Common sense
• Proper and continuous training
• Experienced work force

PW Test Results on the Effects Of Water & Plastic Blast on Cracks
• Oven, air or “flash”-dried parts
• Wet parts and penetrants
• “Flash” drying and penetrants
• Wet vs. dry parts and penetrants
• Wet parts and very tight cracks
• Plastic blasting

About the Author
Jeff Stevens is a senior development engineer with Pratt & Whitney, 400 Main St., M/S 169-11, East Hartford, CT 06108, and is responsible for overhaul processes in the company’s Commercial Standard Practices Manual. He specializes in chemical cleaning/stripping, abrasive blasting, fluorescent penetrant inspection, fluorescent magnetic particle inspection and plating processes. Working in this capacity for the past 15 years, he has responded to thousands of inquiries about these processes from commercial overhaul shops around the world, and often visits the facilities to review and troubleshoot problems.