Damage and Repair Techniques for Bonded Nacelle Structures

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Agenda

♦ Introduction

♦ Nacelle Component Repair Considerations
  • Inlet
    – Drainage
    – Acoustic
  • Inlet and Fan Cowl
    – Lighting Strike Protection
  • Inlet, Fan Cowl, and Thrust Reverser
    – Corrosion Issues
    – Heat Damage

♦ Summary
Introduction

- Goodrich has over 65 years of experience in aviation industry.
- We operate Maintenance Repair facilities world wide.
- The Alabama Service Center is a Part 145 FAA repair station. (EASA and TCCA approved)
From Alabama - - to Scotland - - to Singapore, our service network spans the globe.

Our network of service centers enables us to provide maintenance, repair and overhaul services where – and when – our customers need them.
Alabama Service Center

✧ Current Staff - 17 Engineers
  - 5 Master of Science Degree
  - 6 Bachelor of Science Degree
  - 2 Associate Degree
  - 3 Airframe & Powerplant

✧ Years experience
  - 2 Engineers 30+
  - 5 Engineers 20+
  - 3 Engineers 10+
  - 5 Engineers MRB Board Member (former)
    - Boeing, McDonnell Douglas, Lockheed, Northrop, LTV, Learjet, Rolls Royce, Pratt Whitney, DCMC
  - 1 Engineer 6+ Structures DER

✧ 200,000 Square Feet MRO Facility
Inlet Cowl

Inlet Cowl (aka Nose Cowl)
Typical Damage

- Inner Barrel (Metal bond)
  - Punctures
  - F.O.D.

- Inner Barrel (Metal bond)
  - Corrosion
- Slotted core on 6 O’clock panel
- Conventional, sectional replacement of this core would destroy the panel's ability to drain
Drainage

- Local potted repair
  - blocking drainage path

Drain holes
Drainage

- Full Core Replacement
  - Slotted Core
- Partial Core Replacement
  - Slotted Core
  - Additional Consideration
- Drainage Check
Acoustic

- Acoustic Requirements must be maintained
  - Noise Emission
  - FAA Regulation- Part 36 and part 21.93
Key elements in acoustic panel

- Honeycomb core
  - Cell Size/Depth
  - Conventional or septum

- Perforated skin
  - Perforated hole size
  - Reticulation
  - Wire
Acoustic

♦ Septum Damage
**Acoustic**

- **Inner Panel (Composite)**
  - Missing Wire
  - Acoustic Blockage

- **Results**
  - Significant Acoustic Loss
  - Not Airworthy
Acoustic

Wire bonded with paste adhesive

Significant blockage in perforated skin
Acoustic

- Acoustic Wire
  - Rayl Value
  - Weave
  - Clean (Free of oil)

- Spray-on Adhesive
  - Application Angle
  - Thickness/Weight

- Inspection
  - Raylometer

- Perf Skin
  - POA
  - Reticulation

Perform verifilm inspection when working with formed parts.
Acoustic

- Raylometer
  - Test and verify
Acoustic

♦ Maintain Original Reticulation Method

Reticulating perf skin

Reticulating core

ℹ️ Do not brush-on paste adhesive.
**Acoustic**

- Completed Repair
  - Full Acoustics Restored

Inlet Cowl Inner Barrel Panel (composite construction)
Fan Cowl
Lightening Strike Protection

Increasing use of advanced composite structures.
Structure is TC with Lightening strike protection.
FAA Regulation - Part 25.1316.
Lightening Strike Protection

♦ Indication of lightening strike damage
  • Local vaporization of the structure
  • Burn marks
  • Electro-mechanical deformation (metallic structure)

♦ Effects
  • EBU Systems
  • Degradation of structural material properties
  • Split open skin/structure
  • Explosive ignition of flammable vapors
Lightening Strike Protection

- Outer Laminate
  - Continuous Copper Mesh
Lightening Strike Protection

♦ Core

- Conductive Grid over core splices

Discontinuities in the lightening current flow path such as adhesive joints must be bridged by a conductive path.
Thrust Reverser (TR)
Corrosion

- Injection - not a solution

Multiple disbonds

Large areas of corrosion under skin.
Corrosion
Heat Damage

- Indication of heat damage on composite structures
  - Change in coloration
  - Paint flaking
  - No local stiffness
  - Disbonds/Delamination

More severe

Resin Vaporized

Minor burn mark on opposite side
Heat Damage

- Fixed Duct, Thrust Reverser
Heat Damage

- Technicians repairing damaged area in the *clean room*. 
Summary

♦ Nacelle Repair Considerations
  • Drainage
  • Acoustics
  • Lightening Strike Protection
  • Corrosion
  • Heat Damage

♦ Questions?