Improving Structural Durability and Aircraft Availability through Innovative Tracking, Analysis and Repair Technology

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Overview

• Importance of F-16 ASIP Data Collection
• Examples of how data collection has supported repair/modification implementation
  – TukLoc – under WAF
  – FS 479 vertical tail attach pads
  – Lower FS 341 bulkhead bonded repair
  – Wing pylon rib repair
• Conclusions
Introduction

• Data collection is important in the process of identifying drivers for:
  – maintenance
  – modification
  – overall aircraft problem areas

• Analysis of the collected data may lead to action for repair and/or aircraft modification
F-16 ASIP Data Collection

- Fatigue Crack Database (FCD) captures current fleet cracking information
- Common Inspection Reporting Engine (CIRE) stores inspection data for various special inspection requests (TCTO, inspections requiring elevated visibility, etc.)
- Individual Aircraft Tracking provides inspection results for a block-specific set of control points
F-16 ASIP Data Collection

- Review current fleet state
- Project future cracking trends
- Assess risk
- Discover underlying causes of fatigue cracking
- Predict potential aircraft modification needs
- Presentation on Thursday ("USAF F-16 ASIP Data Collection") will discuss this in more detail
TukLoc under Wing Attach Fittings

- In 2003 the USAF had 78 aircraft in depot for SLIP modifications
- For these aircraft, 862 extra days of unplanned downtime due to fuel leaks from wing fasteners
  - (ten days per aircraft)
- Aircraft not in depot report fuel leaking as the top driver for maintenance effort and reduced mission capability rates.
Wing Attach Fittings
Wing Attach Fitting
Repair / Modification

• Replaced NAS1734 blind nuts with TukLoc blind nuts
  – Fixed the leaking problem
    • No leaks on correctly installed fasteners since implementation
  – Enhanced torque resistance
  – Improved fatigue life of the holes
    • Some testing ongoing
    • Fatigue life improvement will be quantified
TukLoc™ Benefits
Sealing

• Prevents leaking from all potential leak paths
  - High interference fit reduces / eliminates primary leak path
  - Cap eliminates a second leak path (threads)

• Accepts multiple bolt installations without leaking

• No sealant required
FS 479 Bonded Doubler Mod

- 479 bulkhead replacement performed during Falcon STAR
  - 479 is the driving mod for blocks 40-52 FS
  - Expensive, intrusive, and time consuming

- 479 bonded doubler will be approved for all blocks
  - Extensive successful testing
  - Repair has flown on 2 jets for years with no problems
  - Can preclude the need for FS 479 bulkhead replacement during FS
  - On-board sensors; health monitoring system being planned
  - Could save $6-25 million depending on implementation approach
479 Bonded Doubler Modification

- The upper 479 bulkhead cracks at the base of the attach pad
- Sudden change in beam stiffness
- Small radius
479 Bonded Doubler Modification

- Consists of layers of aluminum bonded together with a high strength adhesive
- Provides a smooth stiffness transition
- Eliminates stress concentration

Courtesy of CSC
479 Bonded Doubler Modification
Lower FS 341 Bulkhead Bonded Repair

Background / Problem

- Background: OO-ALC in conjunction with AFRL and Southwest Research Institute (SWRI) have developed a Bonded Repair for the FS 341 Bulkhead
  
- Problem: Cracking on lower 341 Blkhd
- Cracking caused by:
  - Stress Concentration
  - Maintenance Induced Damage
  - Rework exceeding limitations
- Cracks extending to vertical web require bulkhead replacement

Finite element model shows stress concentration at FS 341 Bulkhead Keel Beam Radius
FS 341 Bulkhead Bonded Repair

- 6 day repair time vs. 90 day replacement time
- Work accomplished on site
- Repair cost is $45K
- Replacement costs $200K+
- Doublers reduce local stress over 60%
- Bumpers prevent future maintenance damage
- Repaired bulkhead coupons survived 6X as long as un-repaired coupons
FS 341 Bulkhead Bonded Repair Installations

- Installed on Block 42 aircraft in Feb 2004. Aircraft has flown more than 800 hours with no problems noted
- Installed on Block 50 aircraft in March 07, at Shaw AFB - no problems have been noted
- Installed on 2 Block 40 aircraft in June 07, at Osan AB Korea - no problems have been noted
16W112 Wing Rib Pylon Attach Point Repair
Problem Areas
16W112 Wing Rib Pylon Attach

30+ reports in one year of corrosion and/or gouging
Problem Areas
16W112 Wing Rib Pylon Attach

- Has been problematic for several years
  - Pitting/galvanic corrosion
  - Upward facing “cup” retains water—doesn’t evaporate
  - Bare metal requirements per engineering drawings
  - Impacting aircraft Fully Mission Capable rates

- Solutions (1st iteration long-term)
  - Slip fit Al sleeve-type repair (16RW148)
    - Corrosion re-occurring after sleeve repair
    - Sleeve migration observed
Problem Areas
16RW148 “Hone and Sleeve” Repair

• Solutions (short-term) – Engineering Disposition
  – 12 month waivers

• Solutions (2nd iteration long-term)
  – FTI ForceMate bushing-type repair
    • Coated to prevent galvanic issues
    • Reduce recurring maintenance
    • Prevent wing changes and minimize A/C downtime
    • Wing overhaul costs ~$100k, this repair is ~$20k on aircraft at location; about 10 hours per wing
    • Implementation expected January 2008
Conclusions

- Data collection, visibility, and analysis capability allows for early problem identification and time for repair development
- Repairs can be substituted for expensive and time consuming part replacement
- Savings from these efforts alone are $M’s
- Maintenance burden reduced
- Aircraft availability greatly improved