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Air Force Life Cycle Management Center



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Damage Tolerance vs. Durability: Analysis for Sustainment of T-38 Aircraft

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Outline



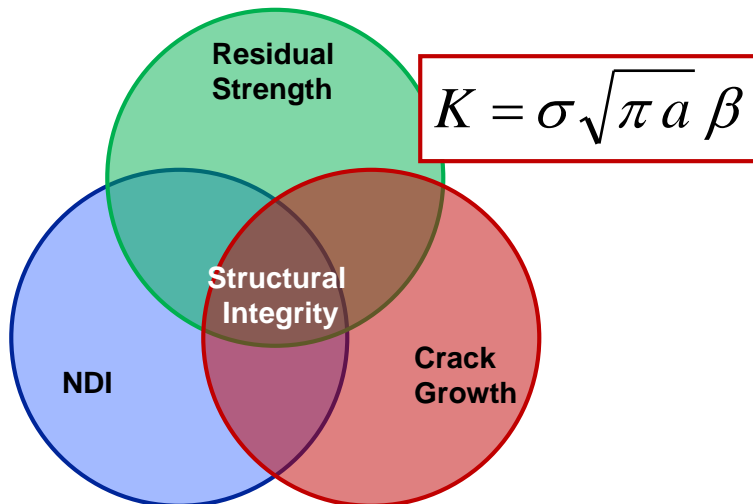
- **Analysis Methodology**
 - **Damage Tolerance**
 - **Durability**
- **Case Study**
 - **Background**
 - **Damage Tolerance and Durability Results**
 - 1) **Replacement (New)**
 - 2) **Inspect and Reuse (Old)**
- **Lessons Learned**
 - **Analysis Approach**



Analysis Methodology

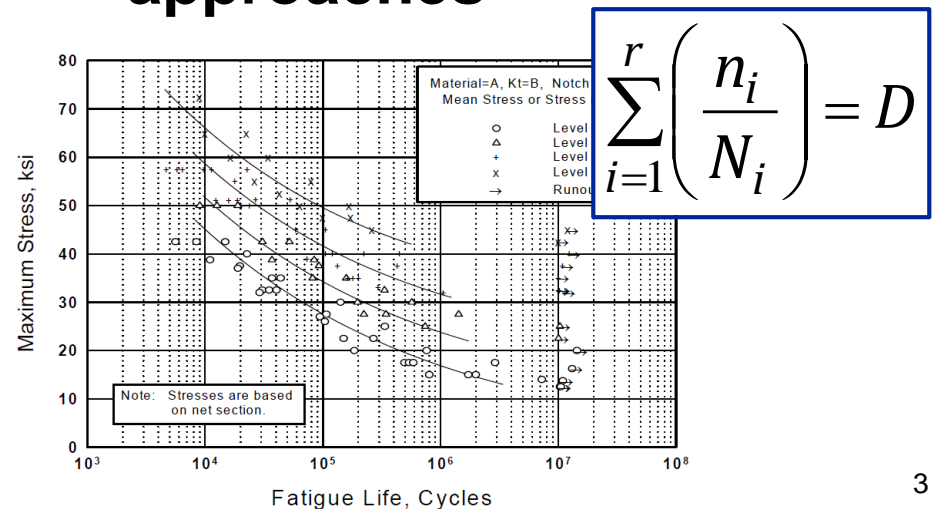
Damage Tolerance

- Rogue flaw
- Inspection
- Fracture mechanics approach



Durability

- No rogue flaw
- Remove and replace or retire (safe-life)
- Stress life, strain life, fracture mechanics approaches





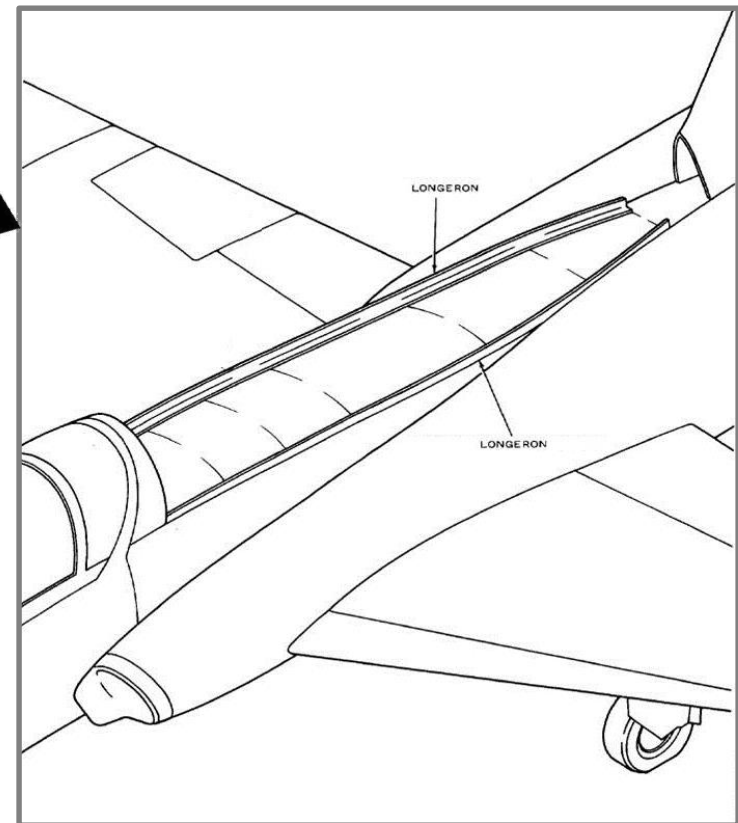
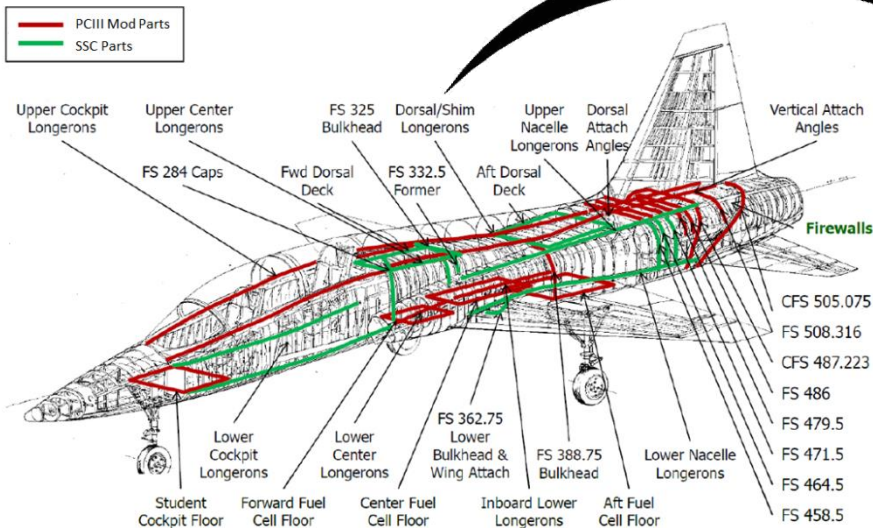
Background

Case Study



■ Pacer Classic III

- Structural modification
- Longerons, floors, frames, etc





Background (cont.)

Case Study

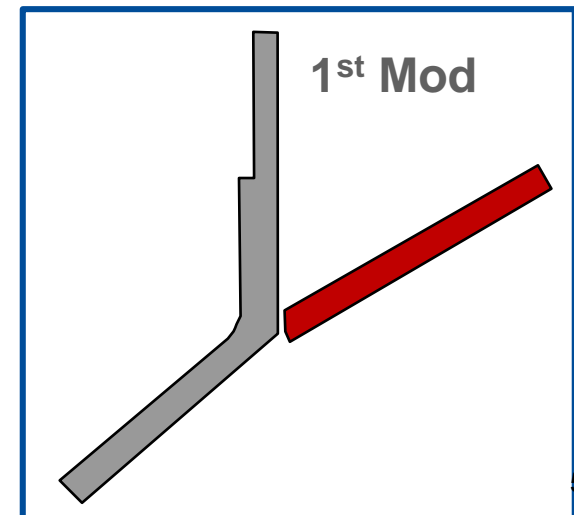
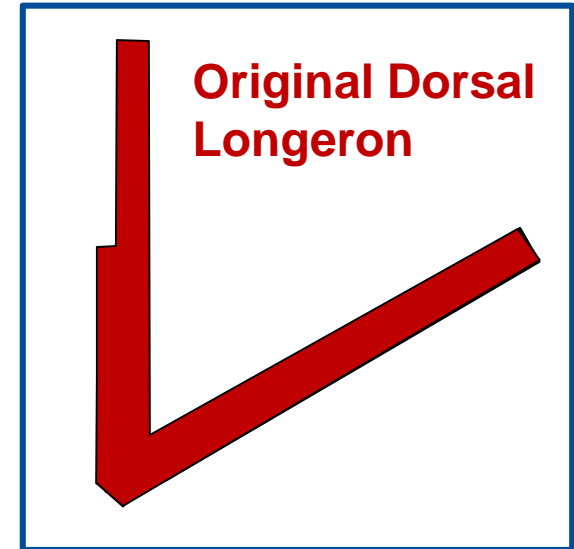


■ Original Dorsal Longeron

- Length is ~13 ft
- 300+ fasteners
- 20+ years

■ 1st Modification

- Recommended from first T-38 DTA
- Sized to take all longeron load
- Remnant remained (secondary)
- 20+ years



(Sketches not to scale)

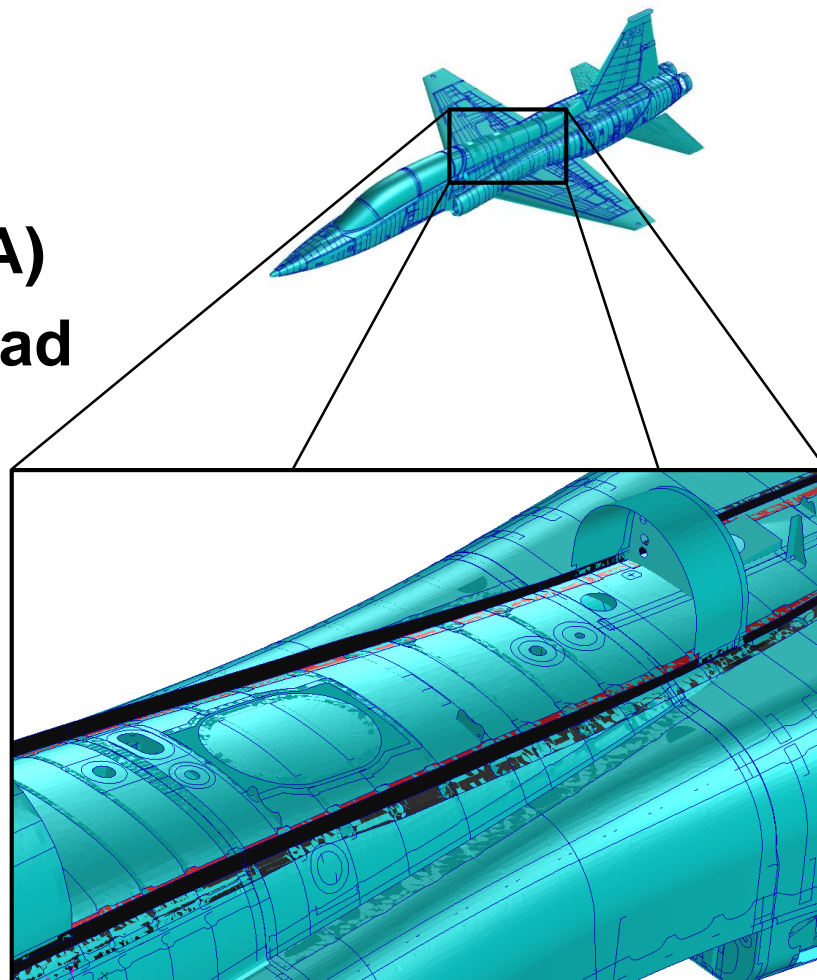


Background (cont.)

Case Study



- **Remnant Included in:**
 - Fuselage fatigue test
 - Current models (FEA, DTA)
 - 1st mod doesn't take all load
 - Inspection intervals
- **2nd Dorsal Mod**
 - Part Removal Required
- **Loading**
 - 20+ years as primary
 - 20+ years as secondary



Inspect and Reuse or Remove and Replace?



Damage Tolerance Method

Case Study

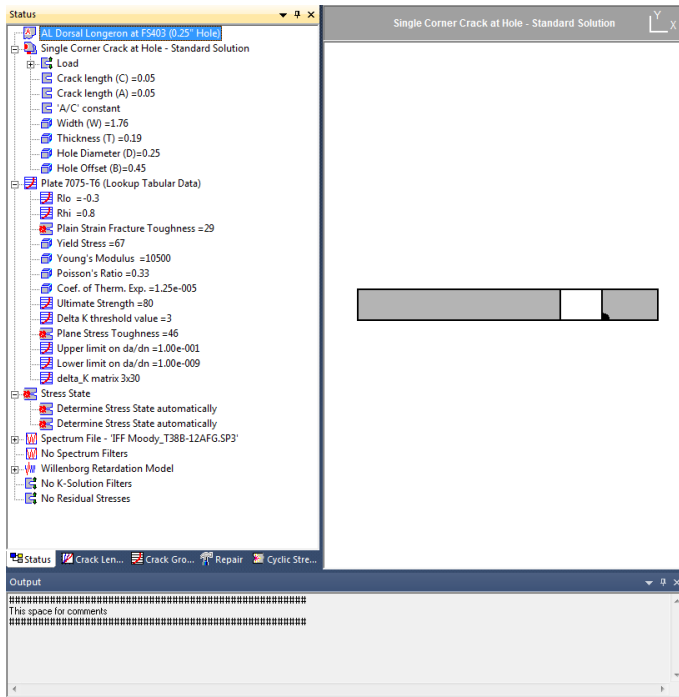


■ Material, Loading, Geometry – Same

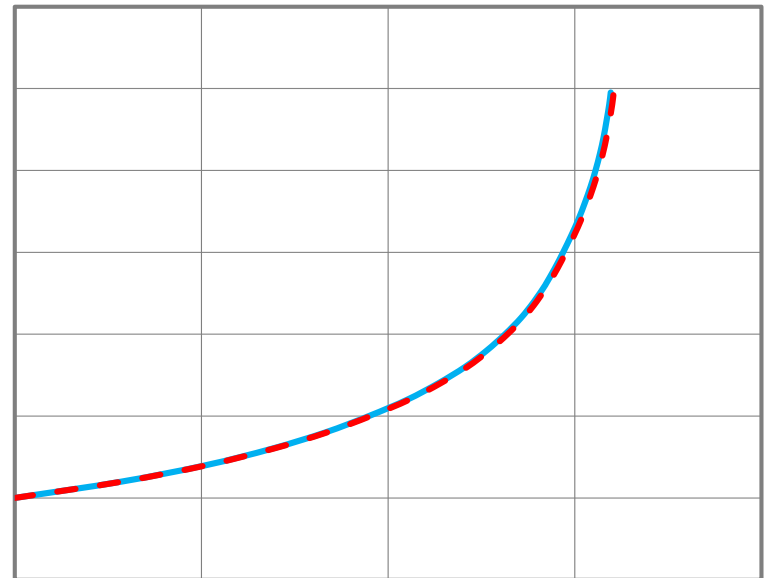
■ Flaw Sizes

- New IFS = 0.05”

- Bolt hole inspection for old → DFS = IFS = 0.05”



Crack Length



Life



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Damage Tolerance (cont.)

Case Study



- **BHEC is Feasible on Old During Mod**
- **Old vs New**
 - **Life and inspection intervals the same**
- **DTA Life < Design Service Life**
- **Recurring Inspection not Practical**



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Durability Method

Case Study



- **Fracture Mechanics Approach**
- **Same as DTA but IFS = 0.005” (New)**
- **Stress Spectra, Prior 40+ years Unavailable**

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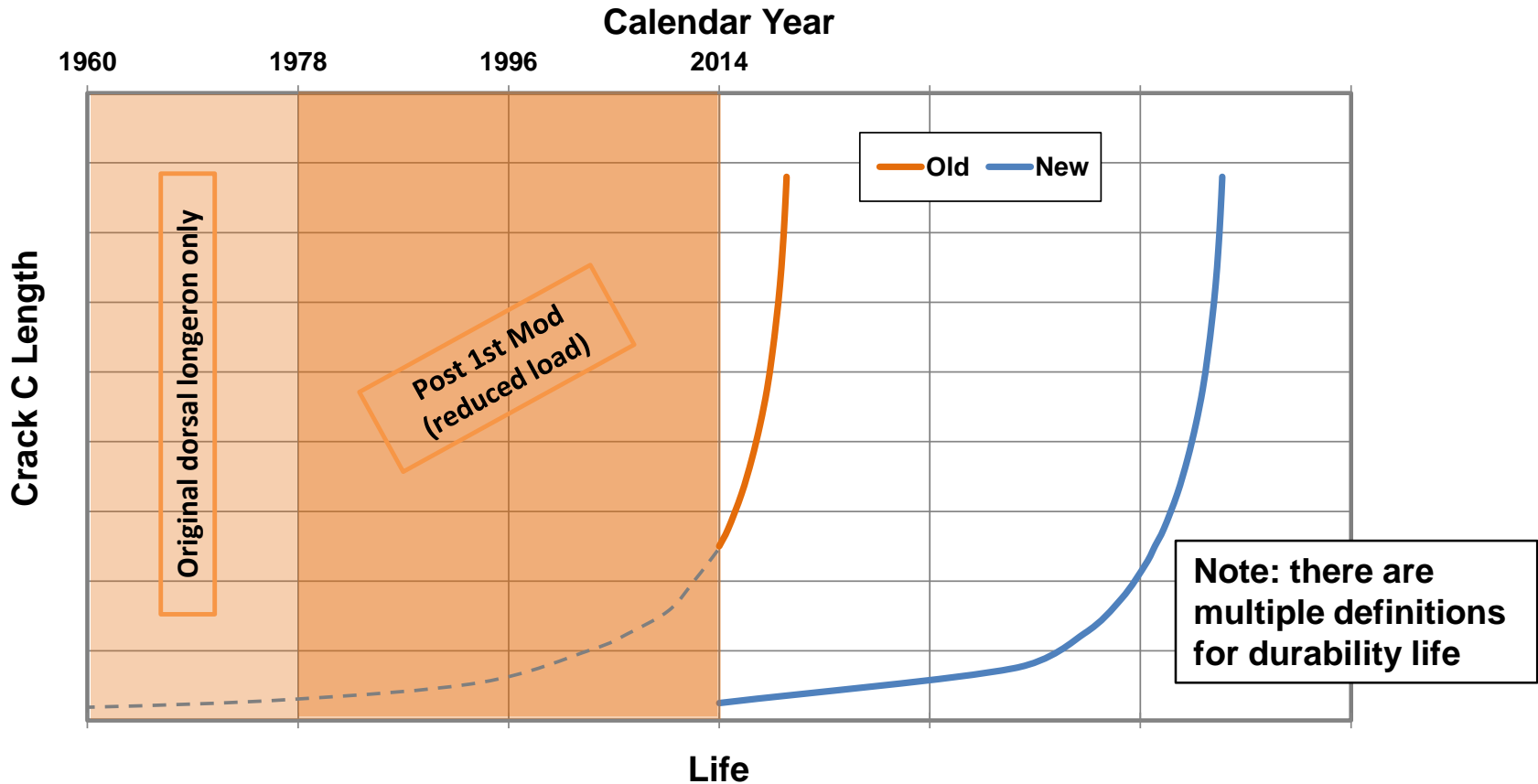


Durability (cont.)

Case Study



- Durability Life (New = 7×Old) > Service Life



Recommendation: Remove and Replace



Analysis Approach

Lessons Learned



■ Manage using Durability

- Component is not a single load path (fail-safe)
- Future inspection not practical
 - Cost and a_{NDI} vs c_{cr}
 - Sealant removal
 - Limited access





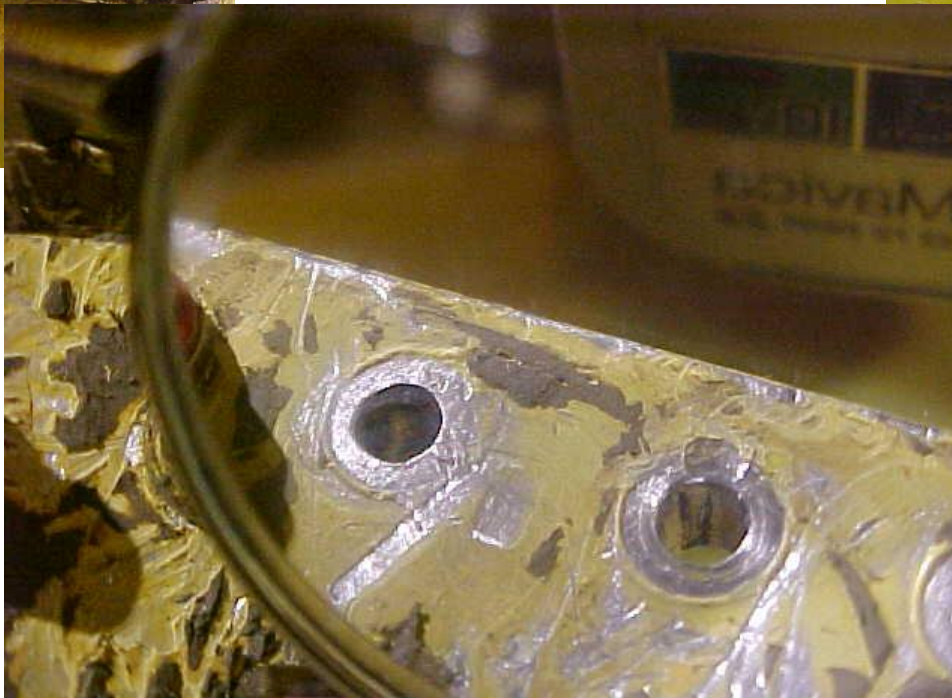
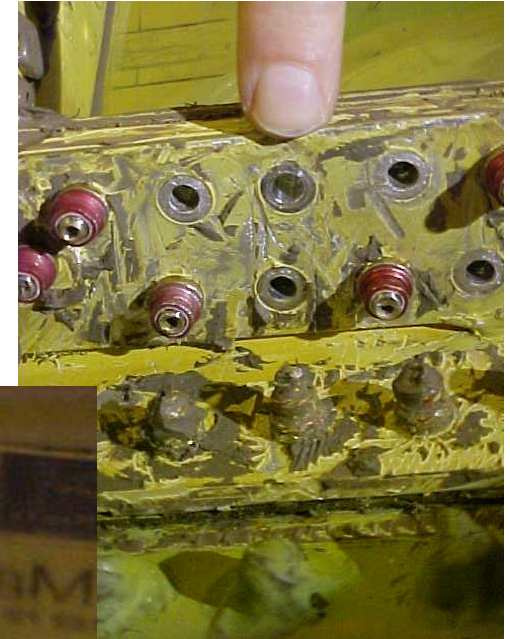
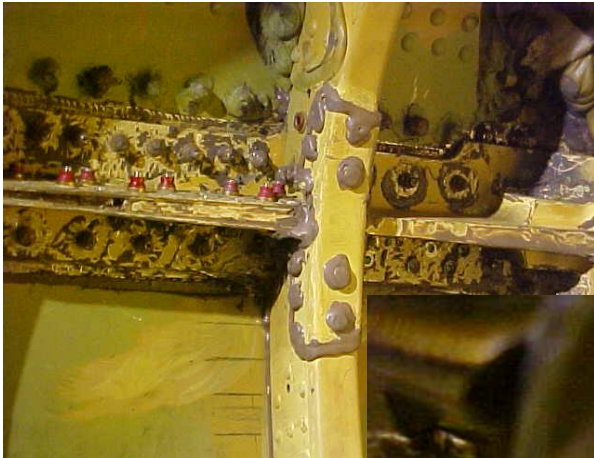
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Analysis Approach (cont.)

Lessons Learned



■ Sealant Removal Gone Bad





Analysis Approach (cont.)

Lessons Learned



■ Durability Analysis

- Fracture mechanics approach with IFS = 0.005”
 - JSSG-2006, para. A.3.12.1
- Durability life / 2 > service life

■ Divide by 2

- JSSG-2006, para. A.4.11.1.1
- Fail safe structure
- Loads are well known
- Appropriate for fracture mechanics approach



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Questions

