



First Look, First Shot, First Kill!

F/A-22 

STATUS OF F/A-22

FULL SCALE FATIGUE TEST

30 Nov – 2 Dec

2004 USAF ASIP Conference

Memphis, Tennessee

Shery Welsh, Lead DADT Engineer

F/A-22 Structures

Acknowledgements:

Lockheed Martin Aeronautics Company

Dr. Thomas Brussat

Full-Scale Durability Test Team, Lockheed Martin Aeronautics Co.

Dr. Ji Eun Park

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Keith Keene

The Boeing Company

Michael McMaster





Outline



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- Test Article Configuration
- Non-Destructive Inspection Process
- Major Cracking Events
- Repairs & Downtime
- Test Anomaly Report Process
- Redesigns
- Test Completion
- Conclusion



F/A-22 Fatigue Test Article Configuration



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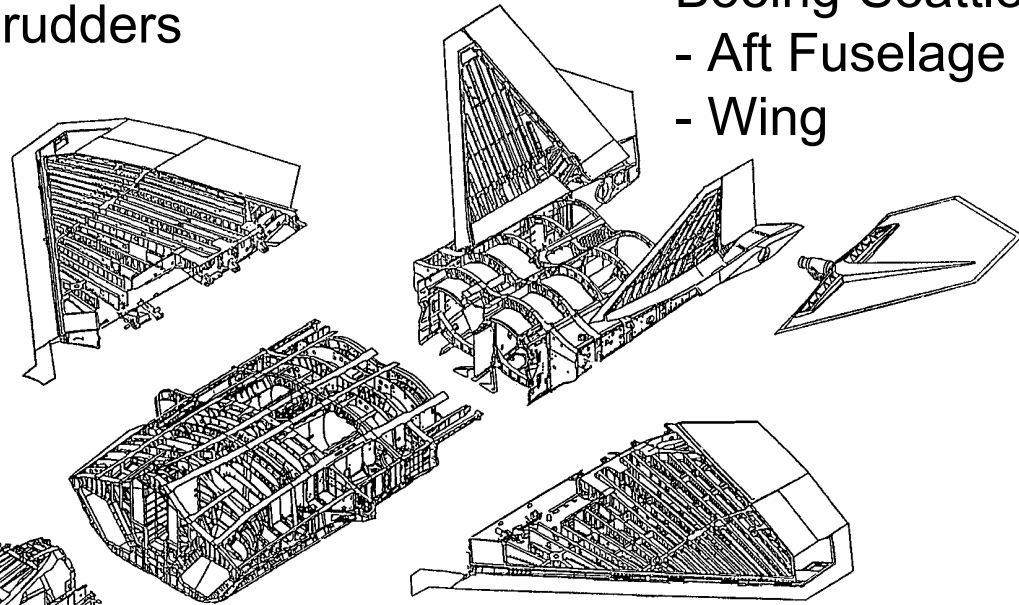
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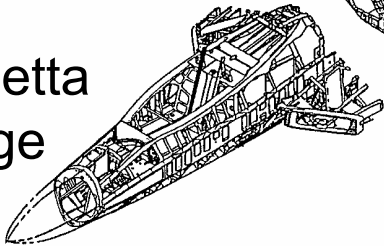
- **Structurally complete airframe**

- Forward, center & aft fuselage
- Wings, leading edge flaps, flaperons, & ailerons
- Vertical stabilizers & rudders

Boeing-Seattle
 - Aft Fuselage
 - Wing



LM Aero-Marietta
 - Fwd Fuselage
 - Empennage
 - Control Surfaces



LM Aero-Fort Worth
 - Mid Fuselage



NDI Inspection Process



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- Extensive test article inspections every 800-1000 flt hrs
 - Visual, eddie-current, ultrasonic, fluorescent-penetrant, borescope
 - Daily & weekly inspections as well
- Engineers trained as “screeners”
 - DaDT engineers intimately familiar with structure
 - Familiarity with analysis resulted in a more thorough inspection of the area and not just inspection location
 - Screeners immediately available; NDI personnel had to be scheduled
- On-site support from Lockheed Martin Fort Worth and The Boeing Company in Seattle
 - Decision making on-the-spot
 - Communicated larger/complicated issues to homeland site in real time
 - Rapid repairs



Strain Gage Data



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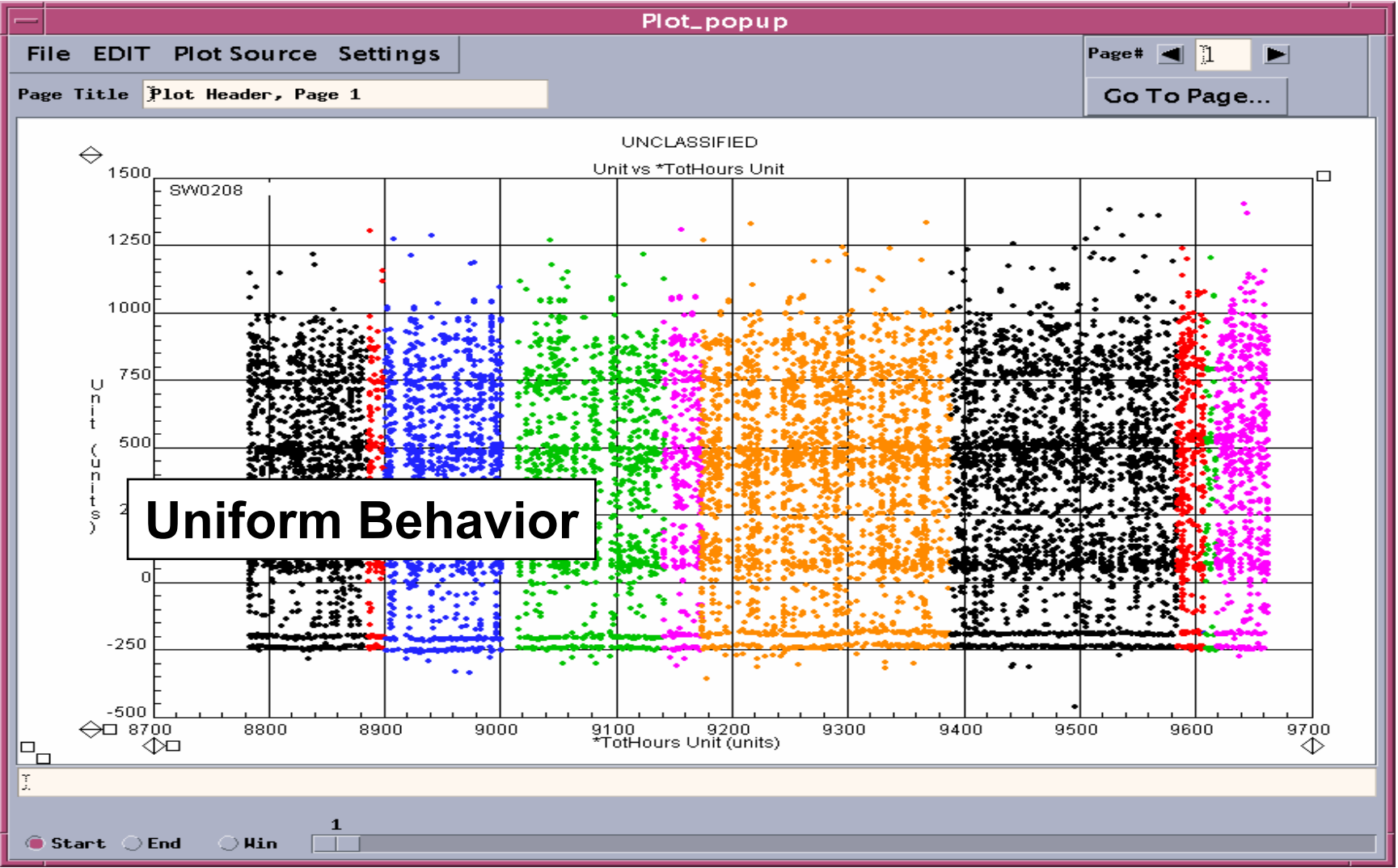
- **Approximately 1500 strain gages, 65 load bridges & 25 deflection gages installed on test article**
- **Throughout test, strain gage data reviewed “live” daily/weekly**
- **A couple of catastrophic failures & other general cracking events were avoided due to alerts from primary data reviewer**
 - **LHS Forward Boom Frame 2**
 - **RHS MWB Hinge Fitting at FS583**
 - **LHS MWB Actuator**
 - **RHS Forward Boom FS 681 Frame 3**
 - **LHS Forward Boom FS 708 Frame 4**
 - **LHS Forward Boom FS 681 Frame 3 Lower Web**
 - **Inboard Rear Spar**



Strain Gage Review



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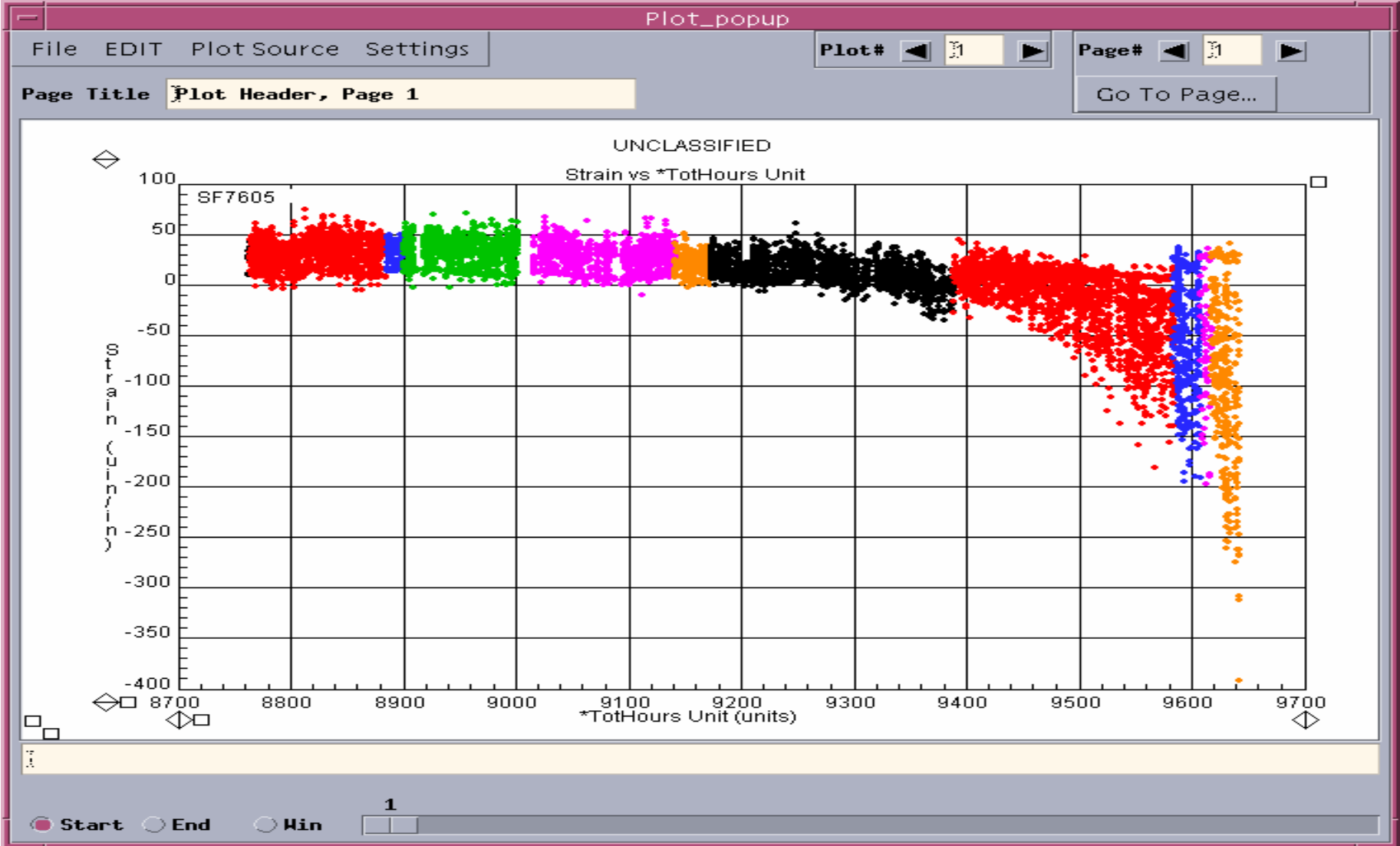
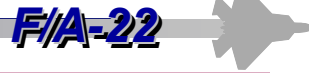




LHS Forward Boom Frame 2



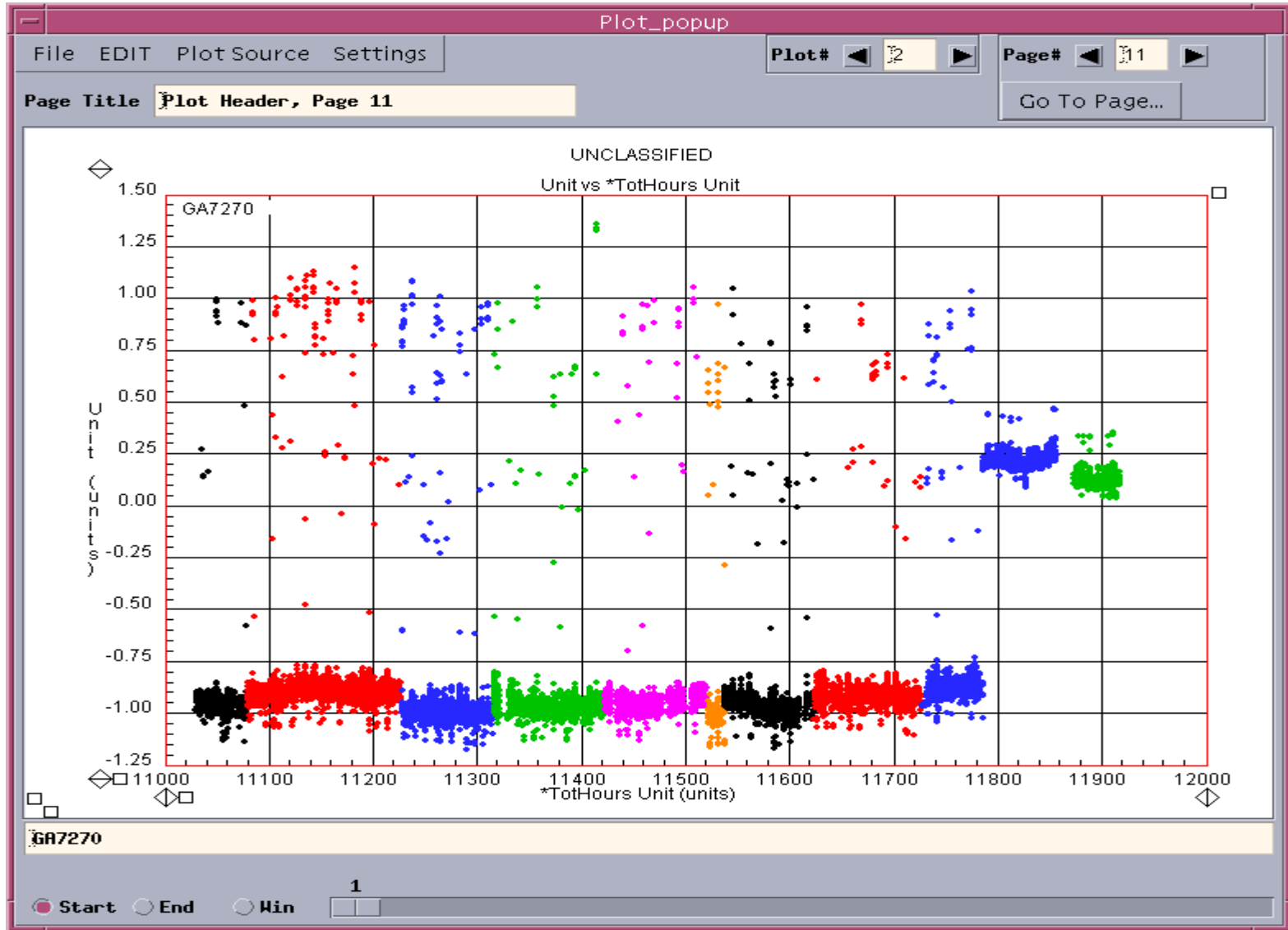
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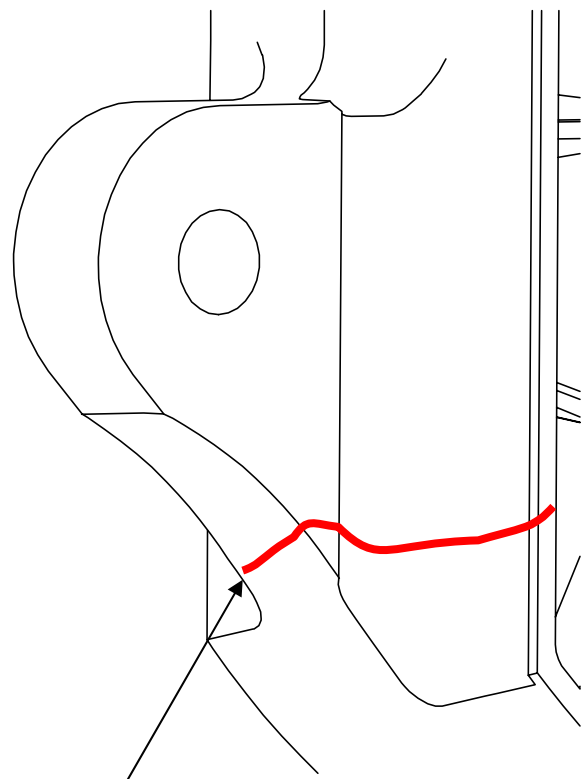
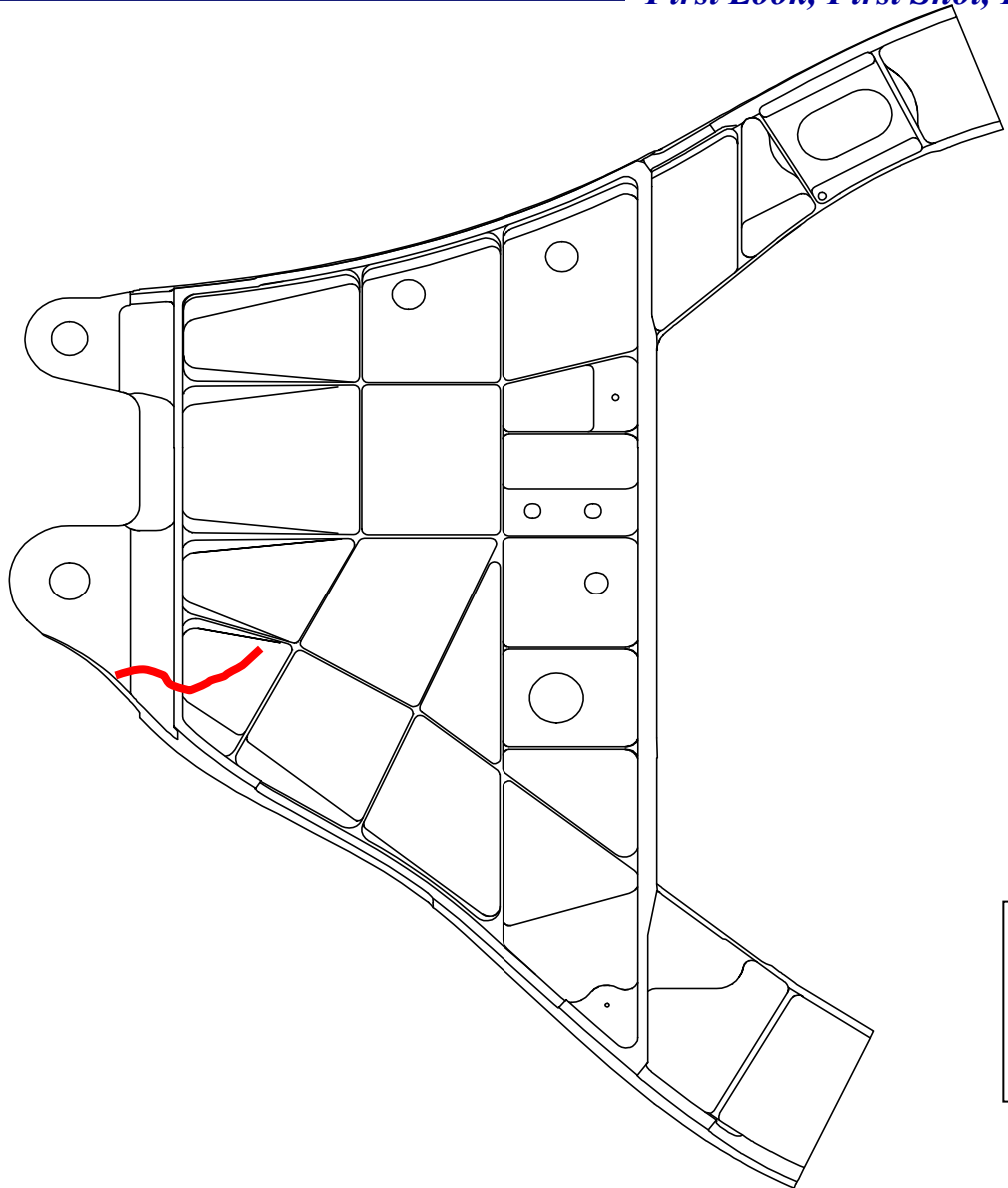
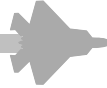


LHS Forward Boom Frame 2



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The crack wraps around the lug to the thickened up area ending at a thin section

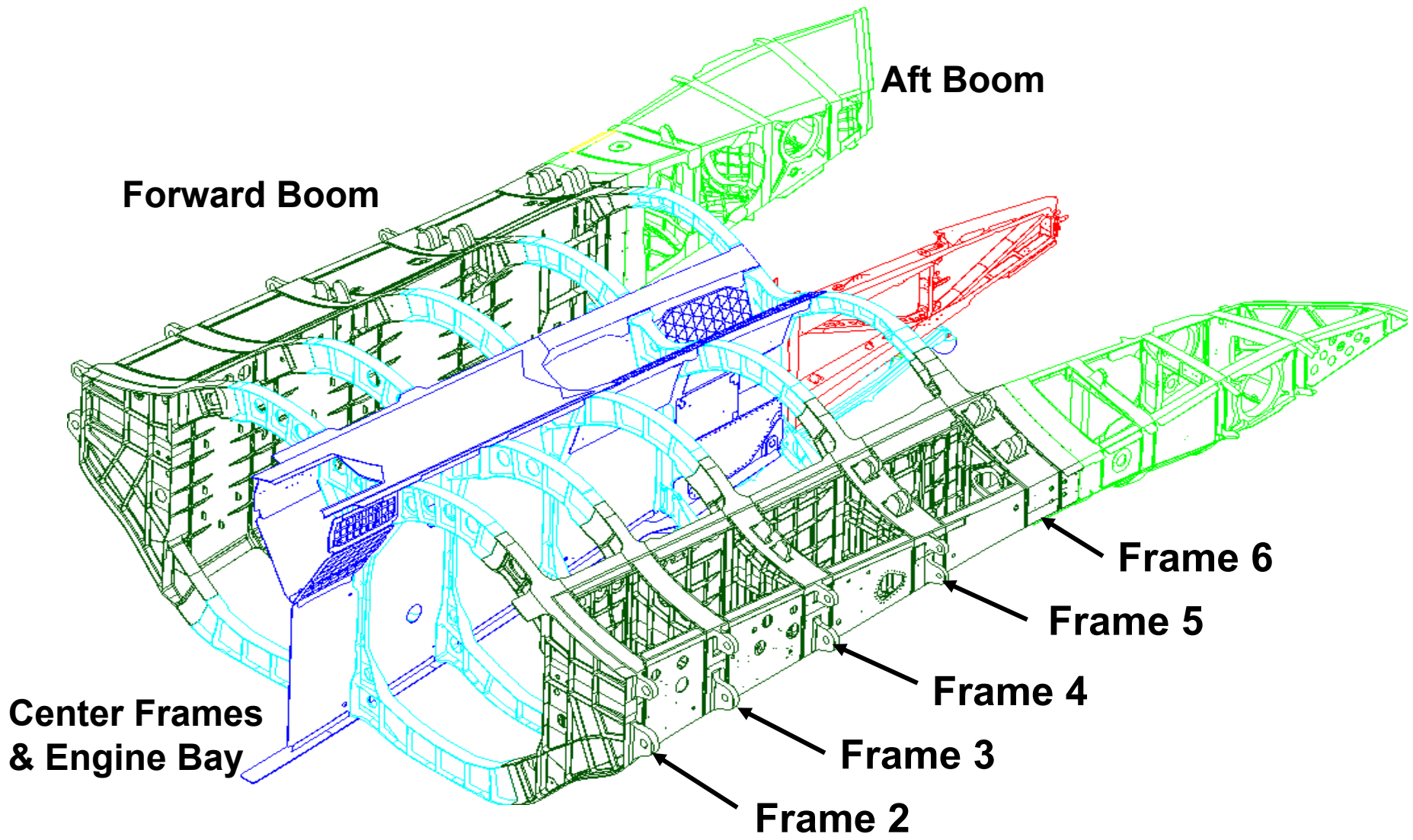


Fwd Boom & Engine Bay Structure



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Crack Locations Identified

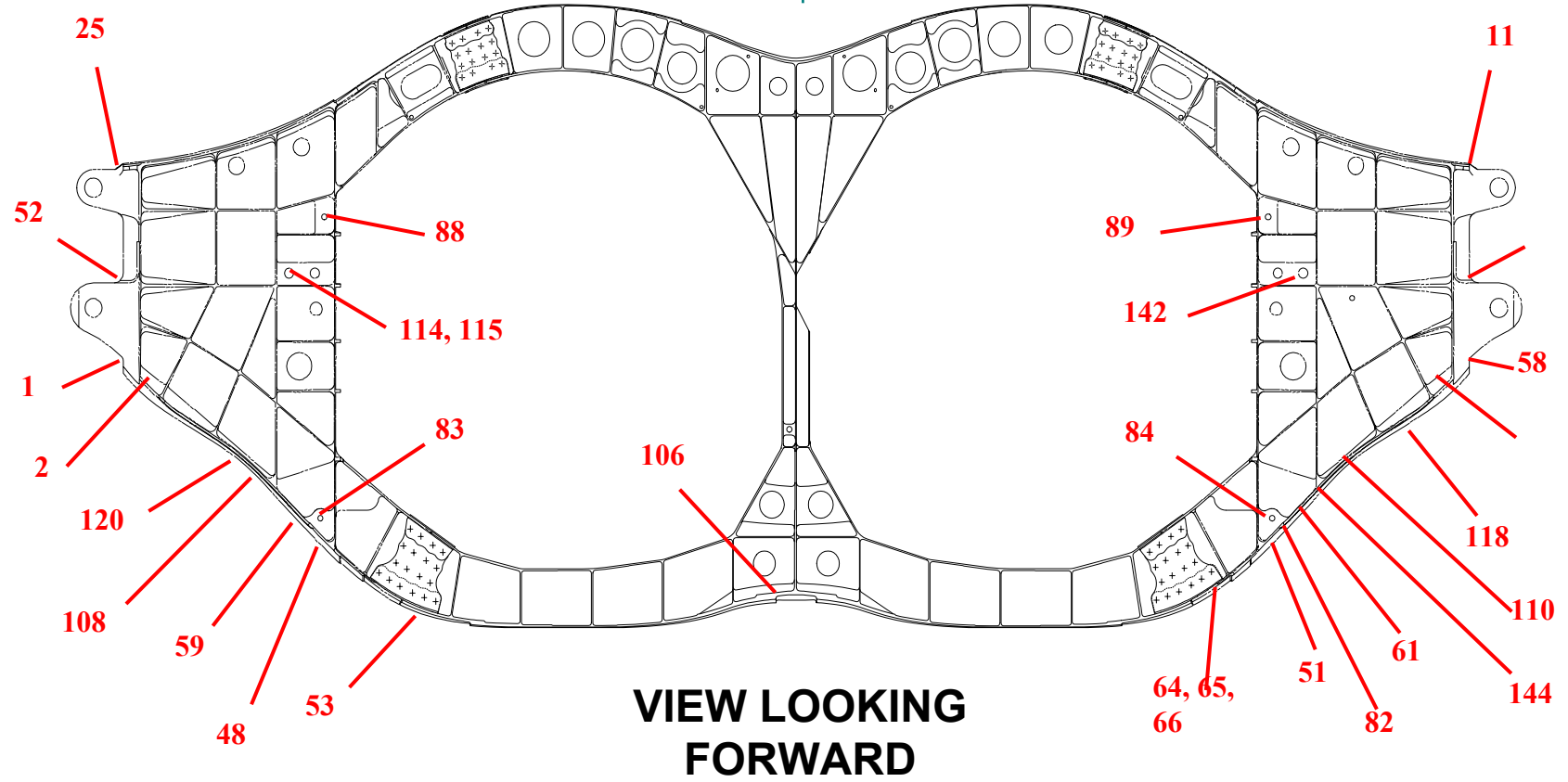


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FS 657 Frame 2

LHS ← | → RHS





Crack Locations Identified

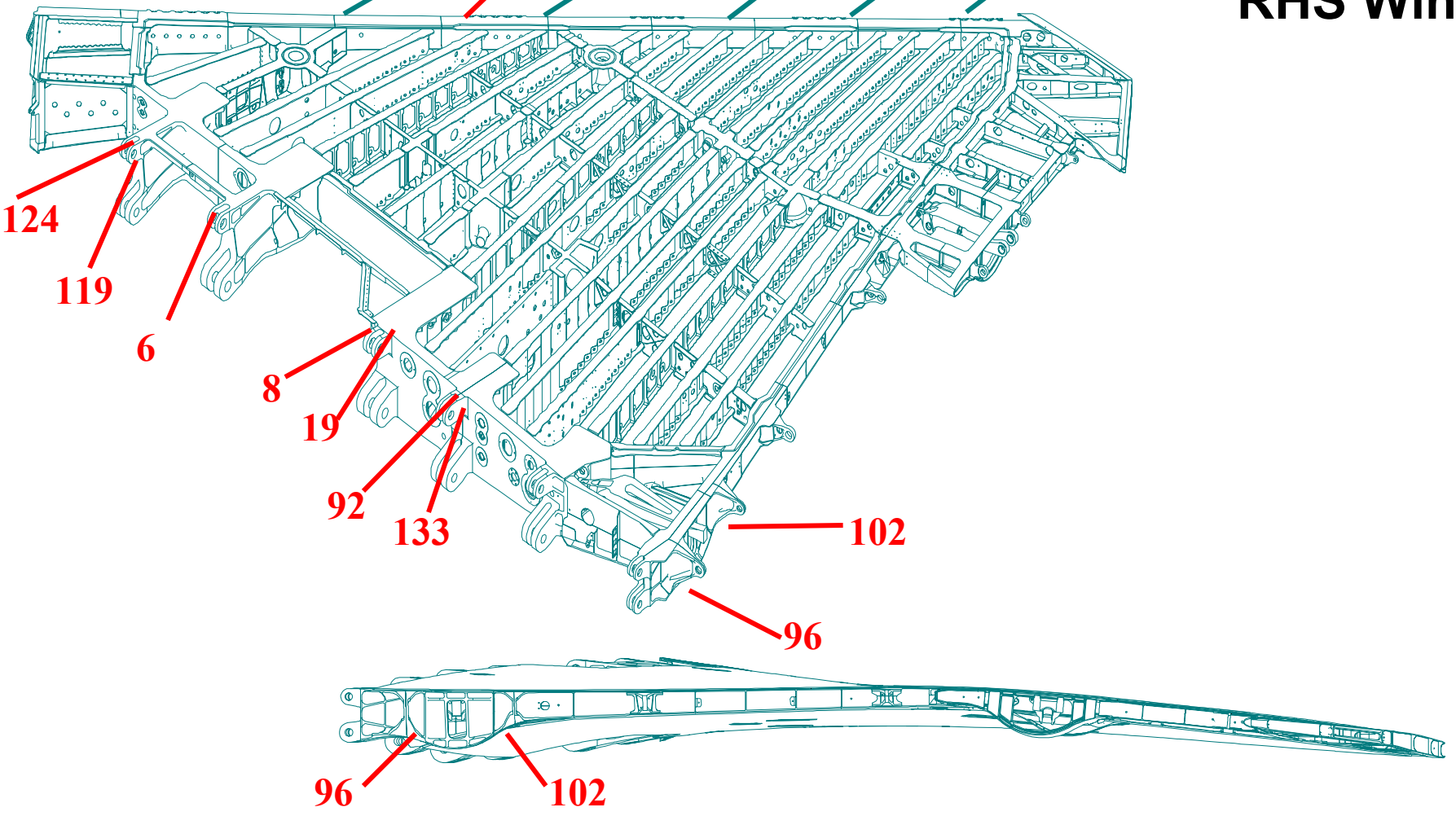


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FS 583 **90** FS 610 FS 657 FS 681 FS 708

RHS Wing





Crack Locations Identified



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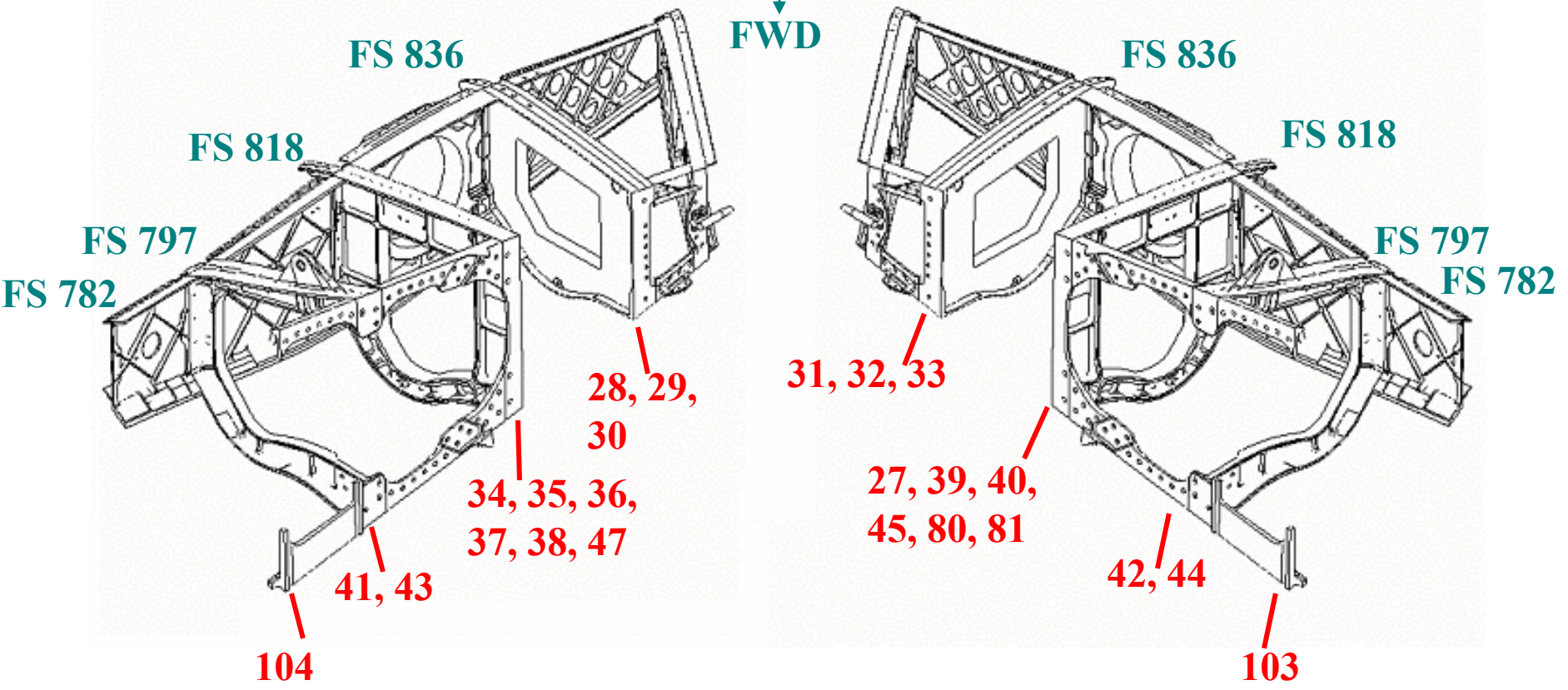
Aft Booms

ISO View

RHS

LHS

FWD





Major Cracking Events



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- **Aft boom frames**
- **Forward boom frame lugs**
- **Forward boom flange/web fastener holes**
- **Inboard wing rear spar**
- **Main Weapon Bay Door hinge**



Repairs



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- **Aft boom frame doublers**
- **Aft boom patch**
- **Forward boom lug weld (non-fleet representative)**
- **Main Weapon Bay door hinge replacement with redesigned part**



Aft Boom Frame 4 Repair

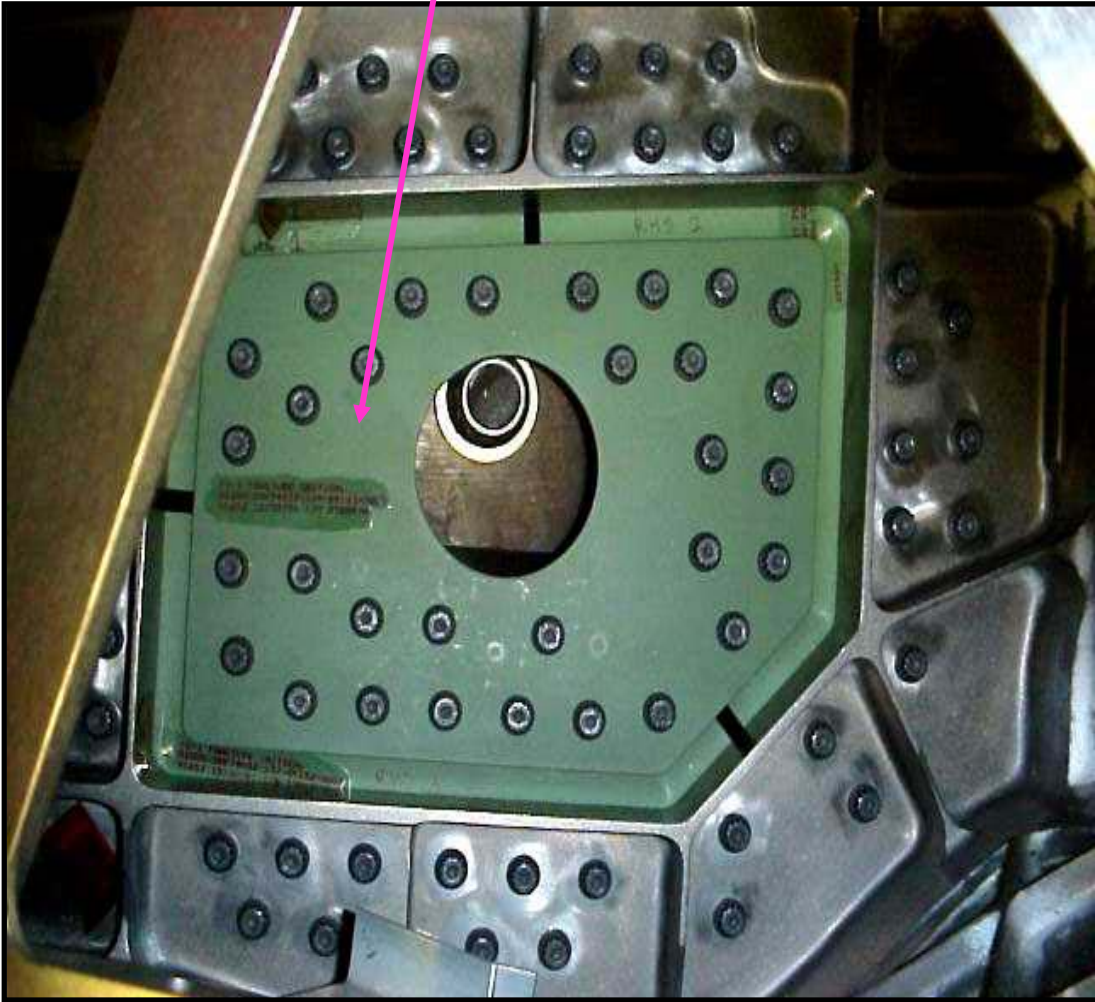
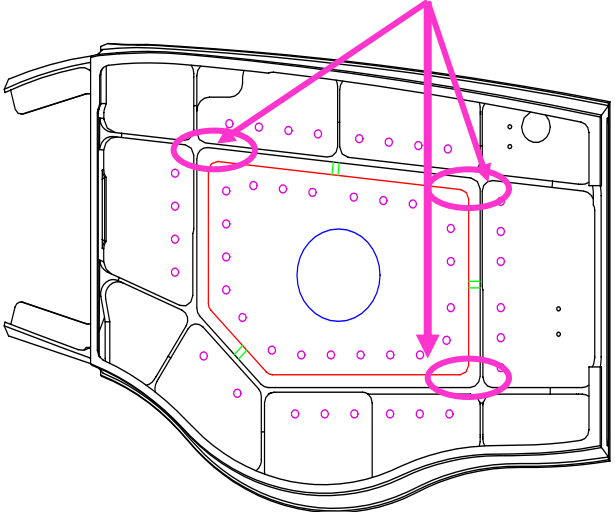


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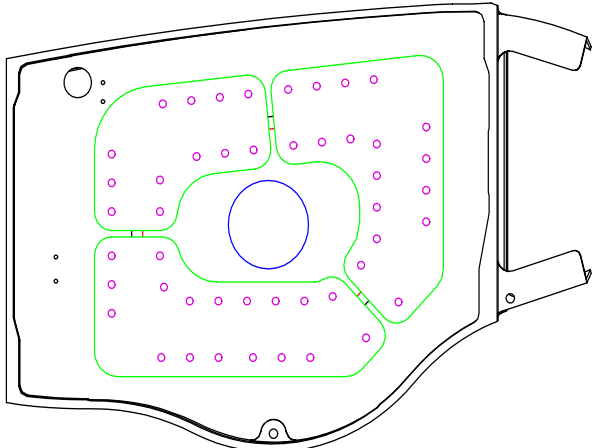
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Crack locations

Secondary shear plate



Looking Forward



Looking Aft

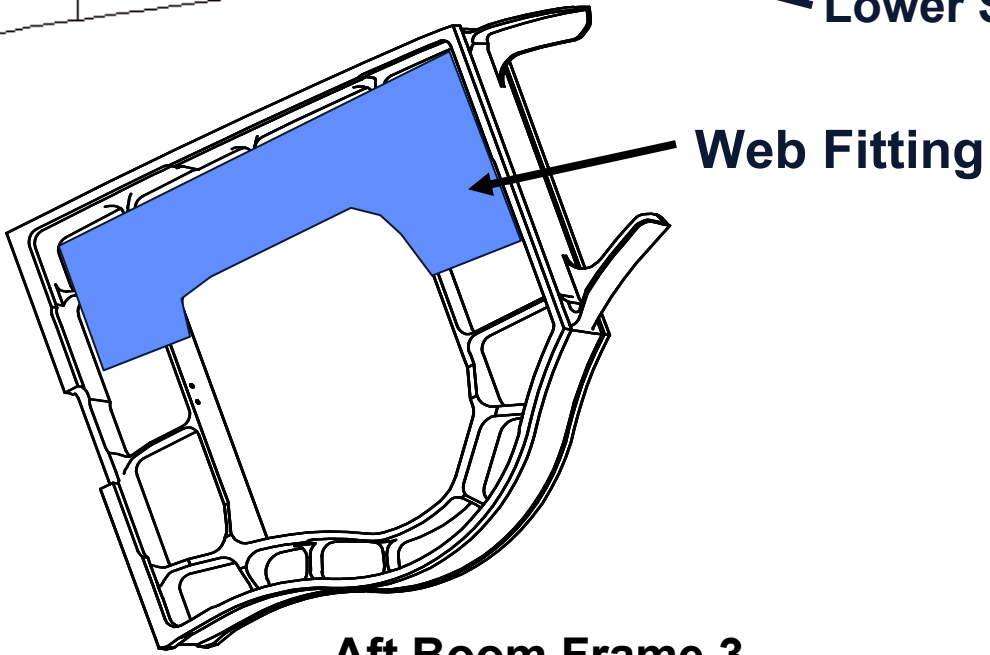
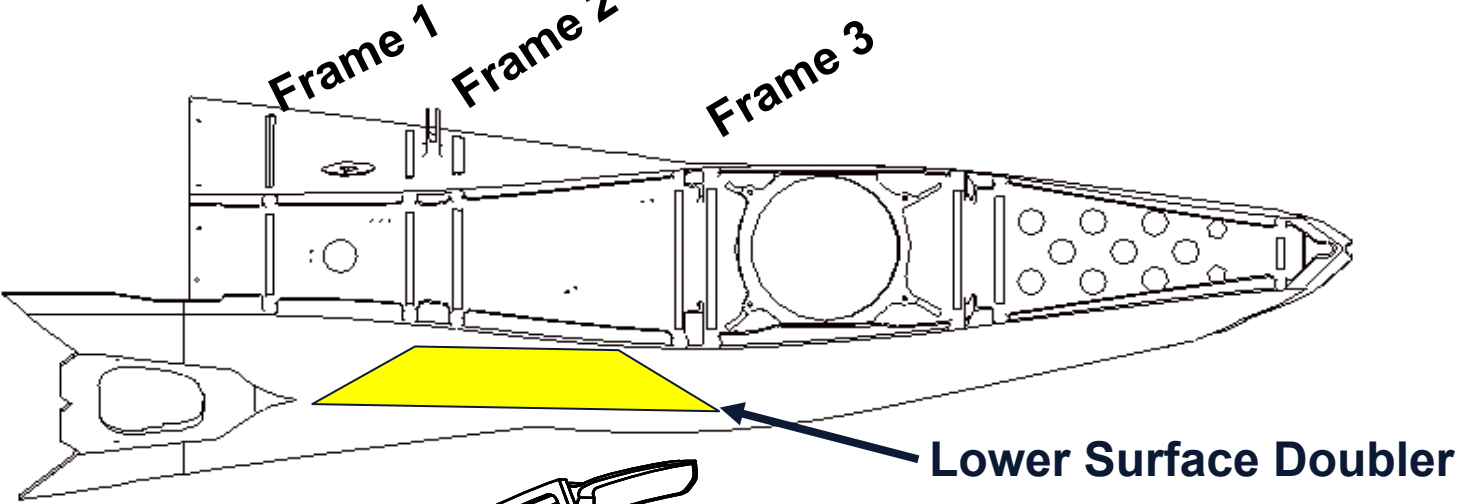


Aft Boom



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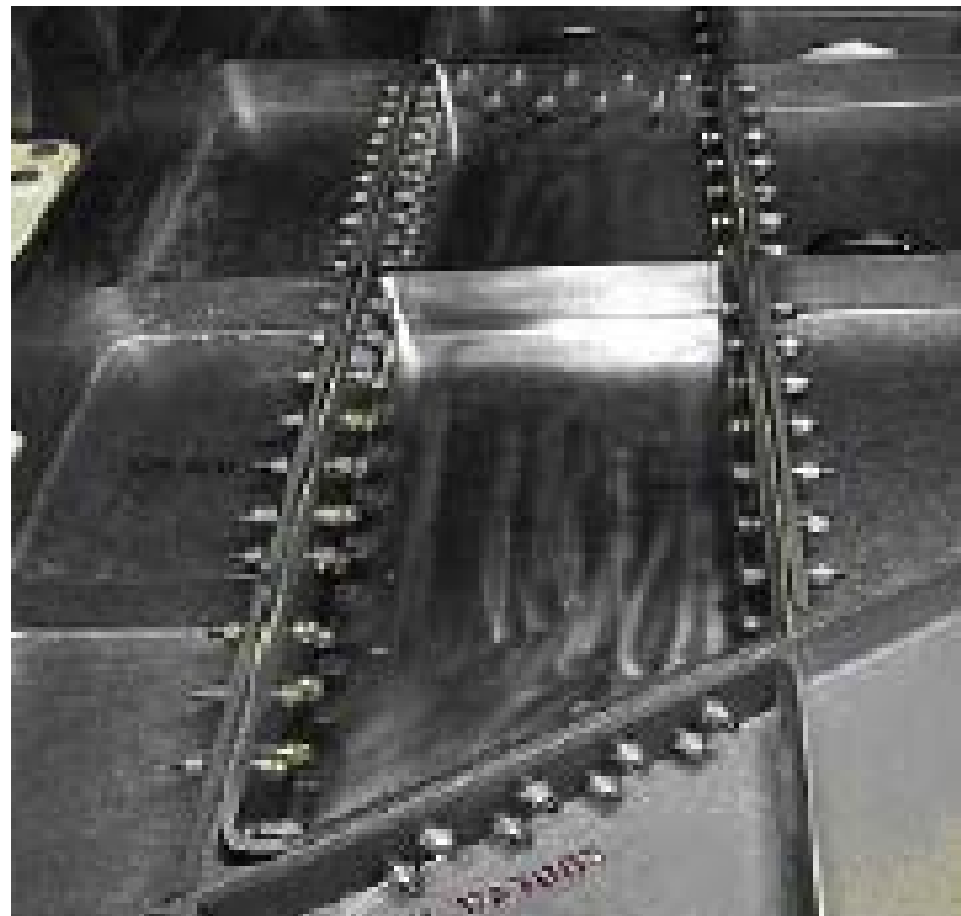
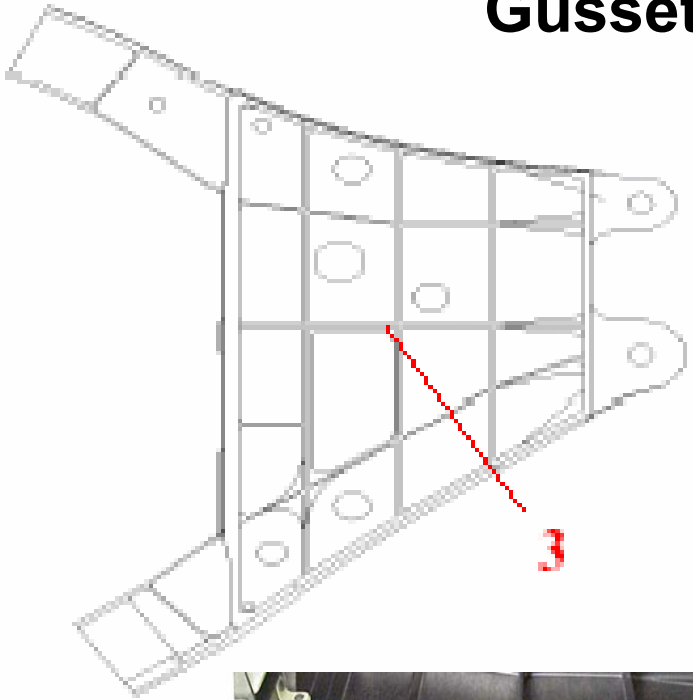
FS 681 LHS Fwd Boom, A1 Tank, Web



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Gusset (fleet representative)





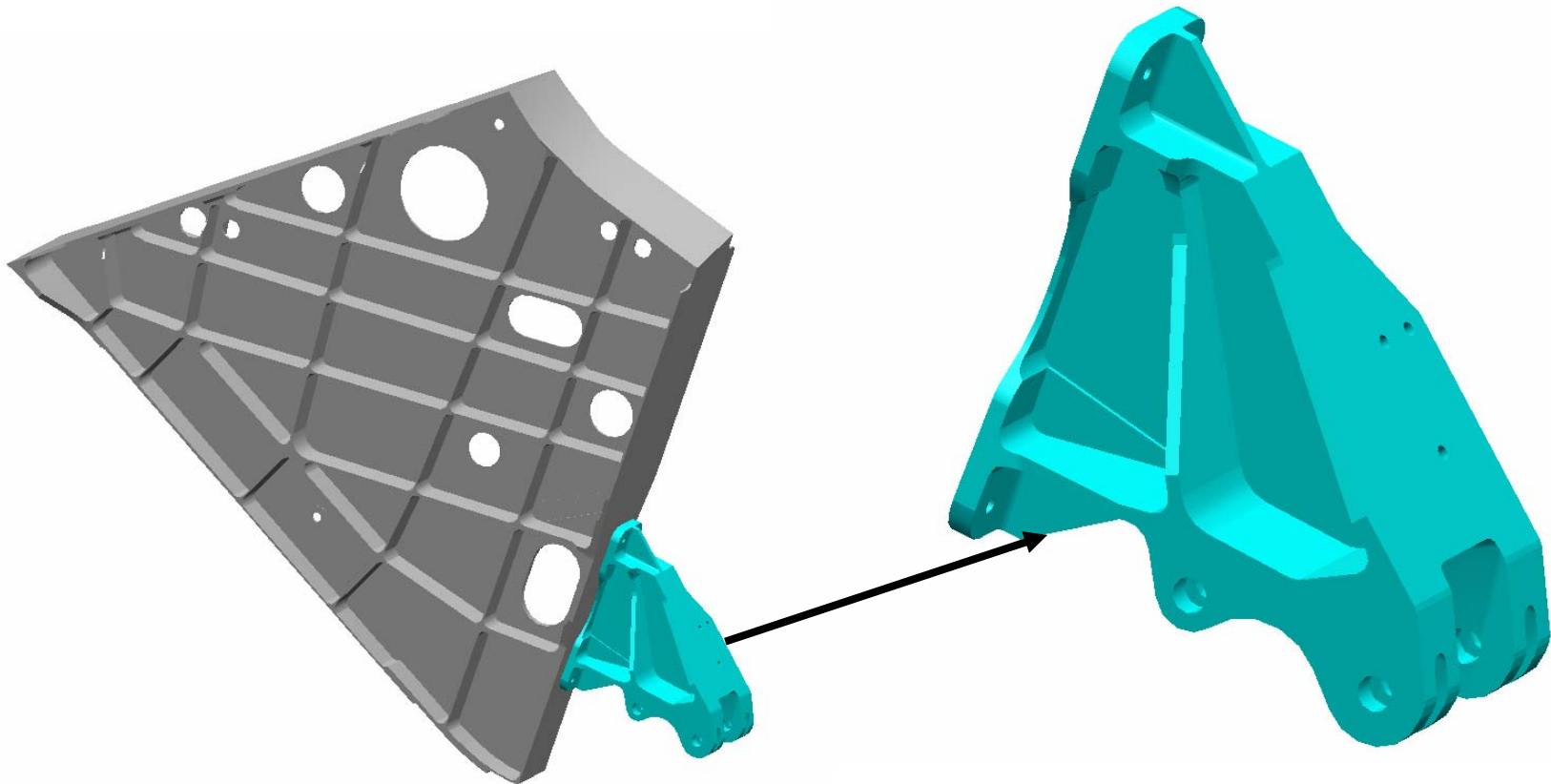
Mid Fuselage Structure



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- **Main Weapon Bay Door Hinge Fitting @ FS 583**
 - Replaced Aluminum configuration with redesigned Titanium hinge fitting





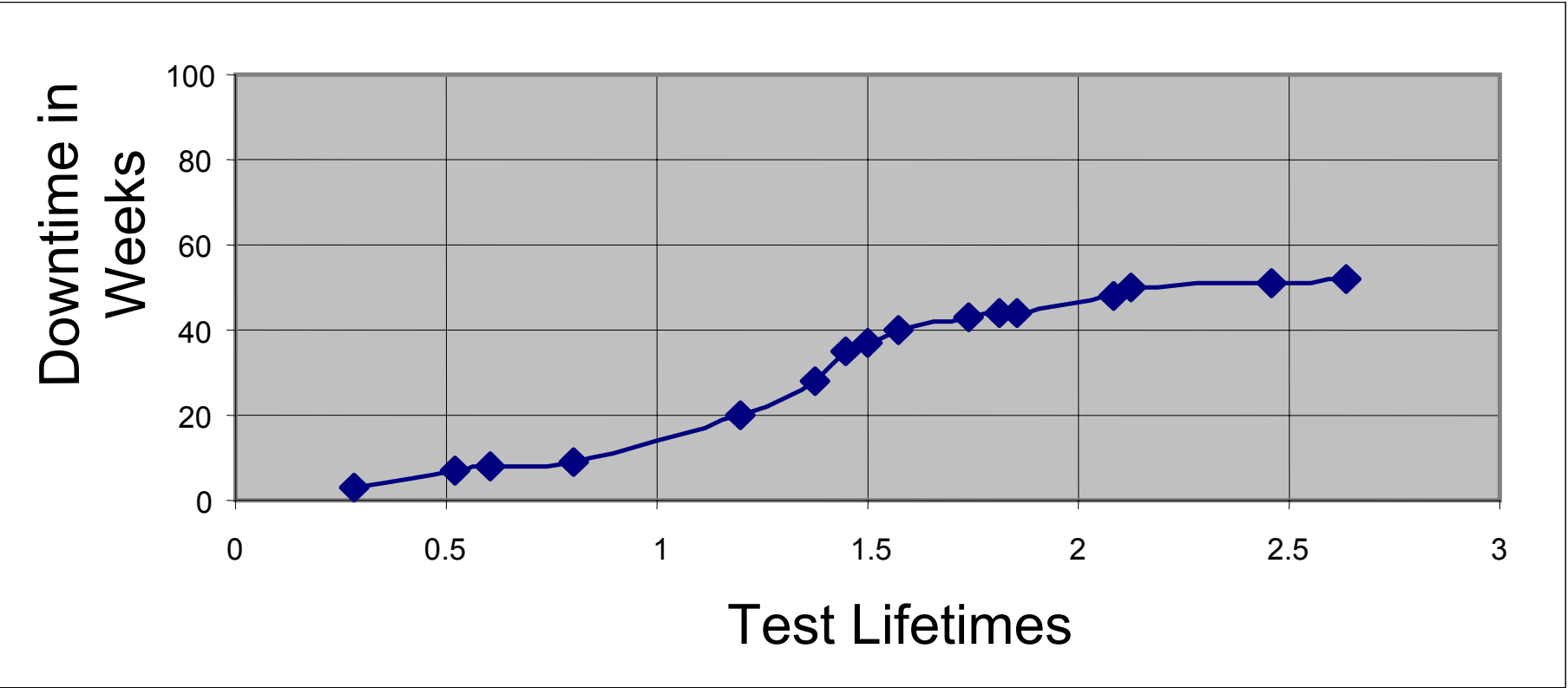
A/C 4000 Repair Downtime



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Downtime for fleet representative structural repair only

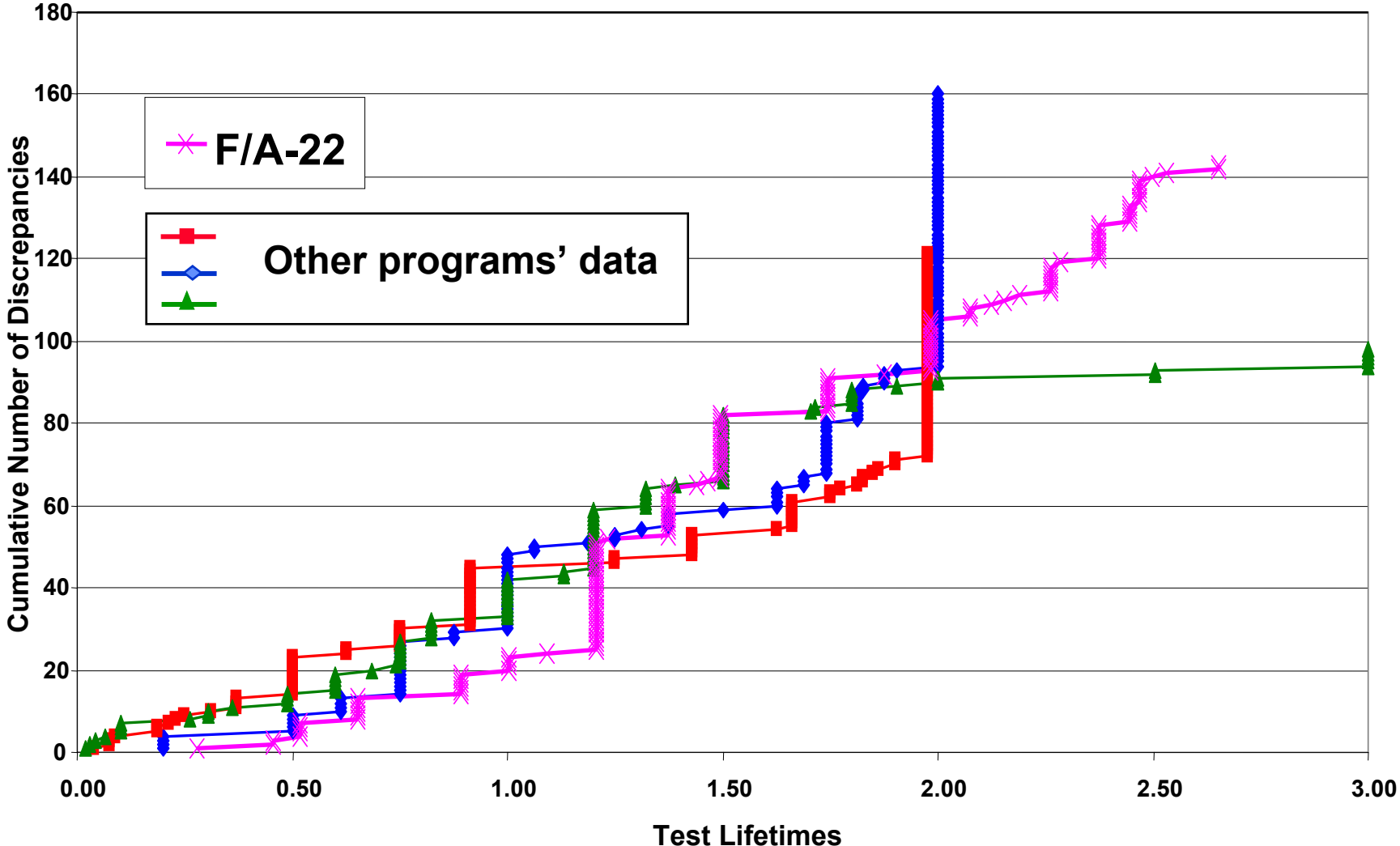




Historical Experience



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Test Anomaly Process



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- Every anomaly initiates a Test Anomaly Report (TAR)

| | |
|---------------------|---|
| Section 1.0: | Description & history of anomaly |
| Section 2.1: | Investigation (includes initial correlation summary) |
| Section 2.2: | Conclusions |
| Section 2.3: | Recommended resolution |
| Section 3.0: | Resolution (retrofit/redesign/inspection update) |

- TAR also includes embedded or attached files
 - Fleet inspection requirement authorizations
 - Redesign or Retrofit memos
 - EMD aircraft inspection results if appropriate
 - Test article inspection/lab results
 - Fractography results

One-stop Shopping For All Test Anomaly Information



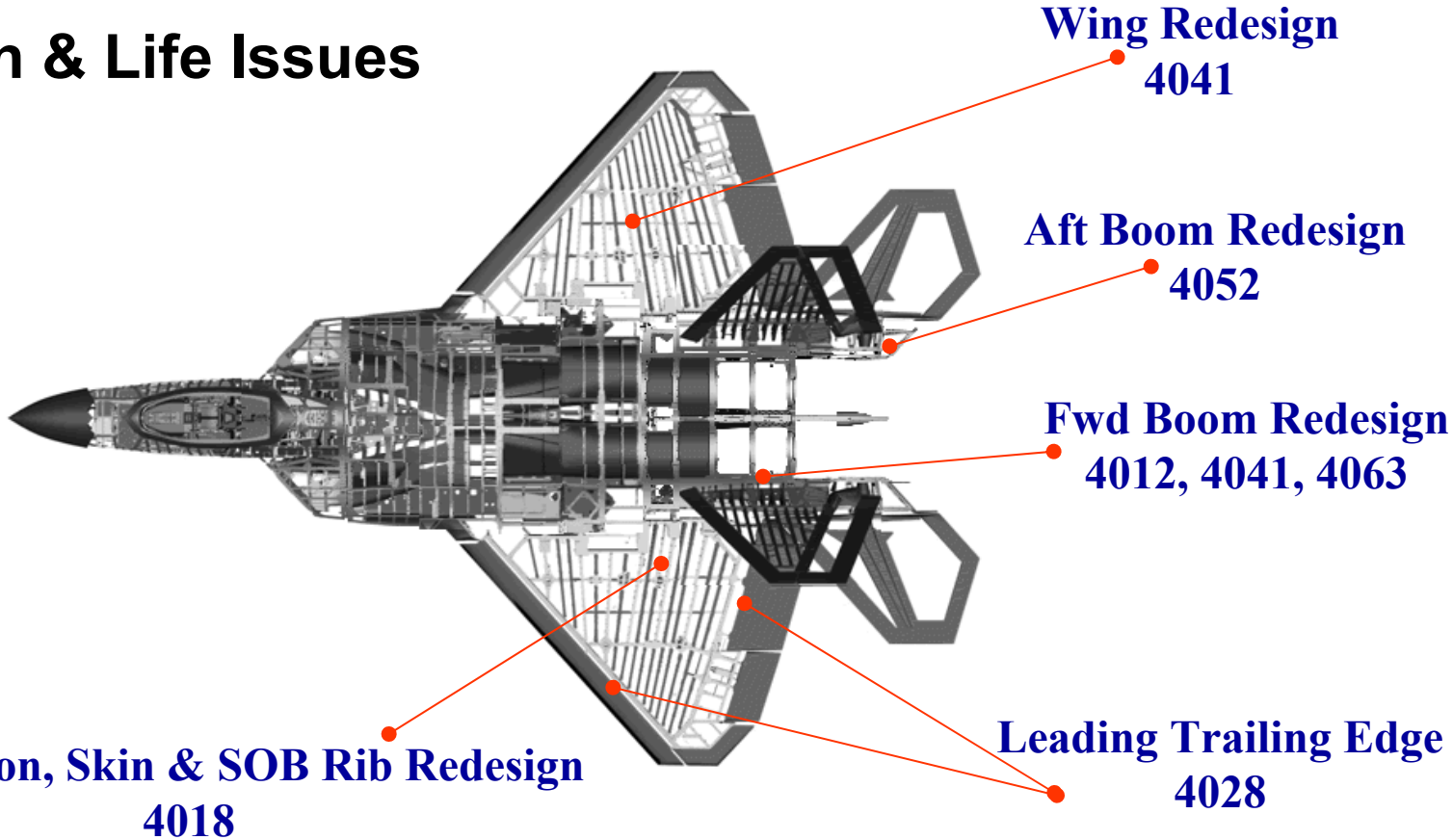
F/A-22 Structural Redesigns



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Strength & Life Issues

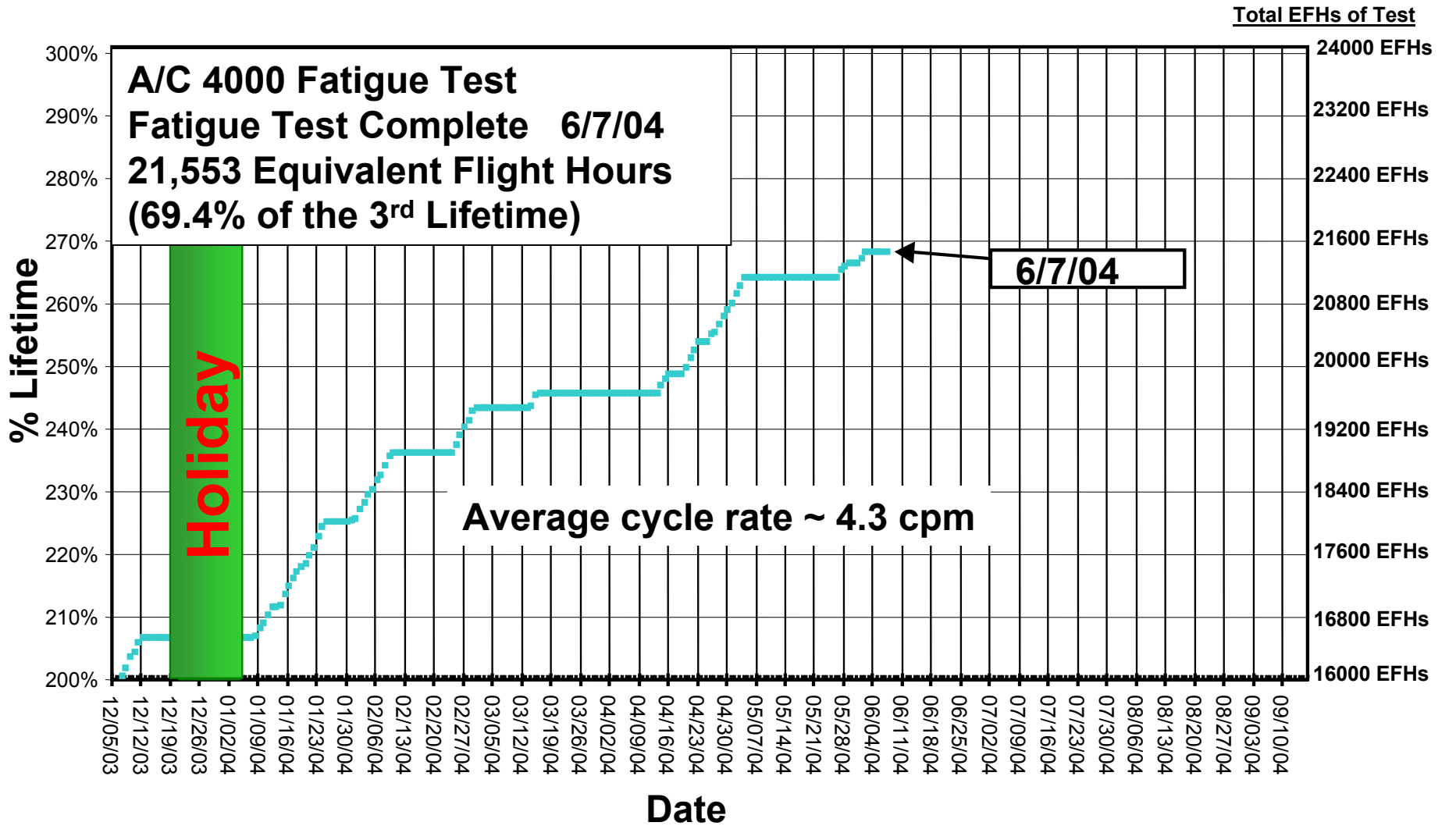




Test Completion



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Conclusion



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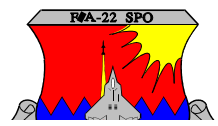


- F/A-22 fatigue test was designed, planned and instrumented to verify the durability of the airframe
- Through the Test Anomaly Report process, test results have influenced several actions
 - Redesigns
 - Inspection requirement updates
 - Full-Scale component tests
 - › Horizontal Tail
 - › Aft Boom
 - Structures Retrofit Plan for a/c 4010-62
- With scheduled NDI inspections, daily diagnostic monitoring of gage data, and repairs as needed, the test article achieved 2.68 lifetimes without catastrophic failure

Teardown is in progress

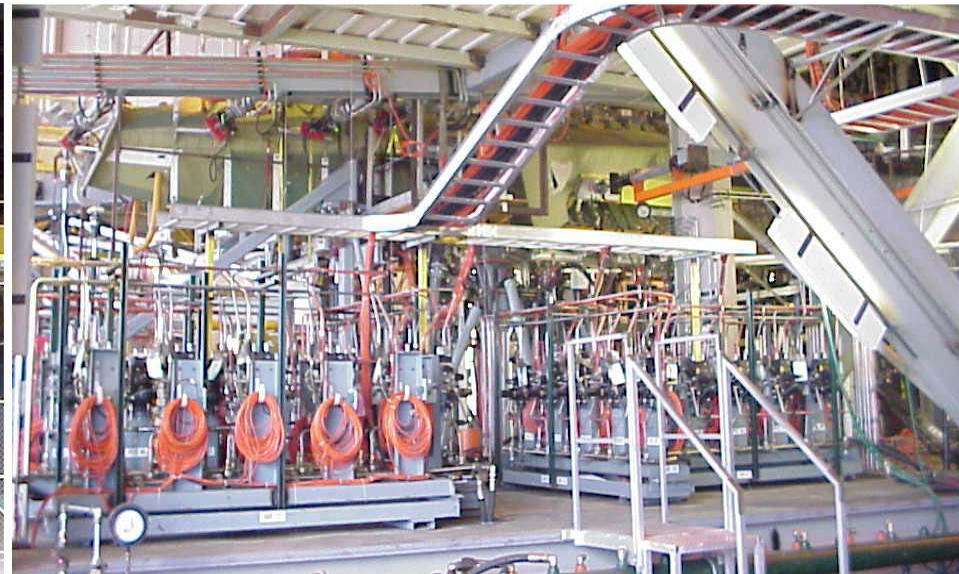
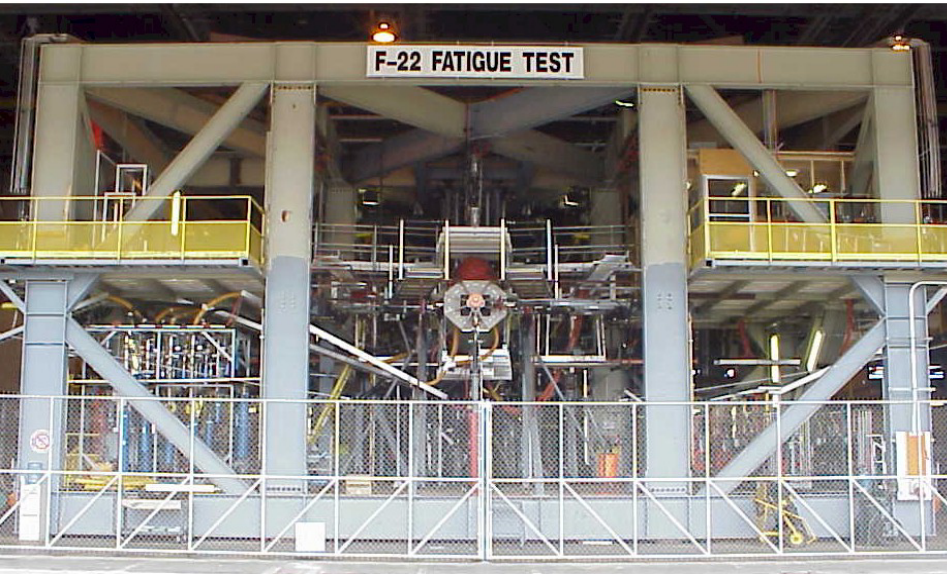


Questions?



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F/A-22 Team Members Supporting Full Scale Fatigue Test:
Boeing DADT Engineering
LM Aero-Fort Worth DADT Engineering
LM Aero-Marietta DADT & Ground Test Engineering
LM Aero-Marietta Structural Test Engineering