



Virtual Seminar Series – Tuesday 2, 9, 16 November



An Introduction to the Requirements for Safe-Life of Landing Gear for Aging Aircraft through Overhaul and Maintenance Processes

Presented by Mr. Andrew Clark
Landing Gear Systems, USAF

Tuesday, November 9, 2021

An Introduction to the Requirements for Safe-Life of Landing Gear for Aging Aircraft through Overhaul and Maintenance Processes

Abstract

This is a short presentation to introduce the following presentation. These are the USAF requirements and objectives for continued safe-life of landing gear for aging aircraft through overhaul and maintenance processes, for the development of fatigue tools and methods to incorporate surface treatment effects in USAF landing gear fatigue models.

About the presenter, Mr. Andrew Clark, Landing Gear Systems, United States Air Force

Air Force Sustainment Center (AFSC)

Integrity in USAF Landing Gear Systems

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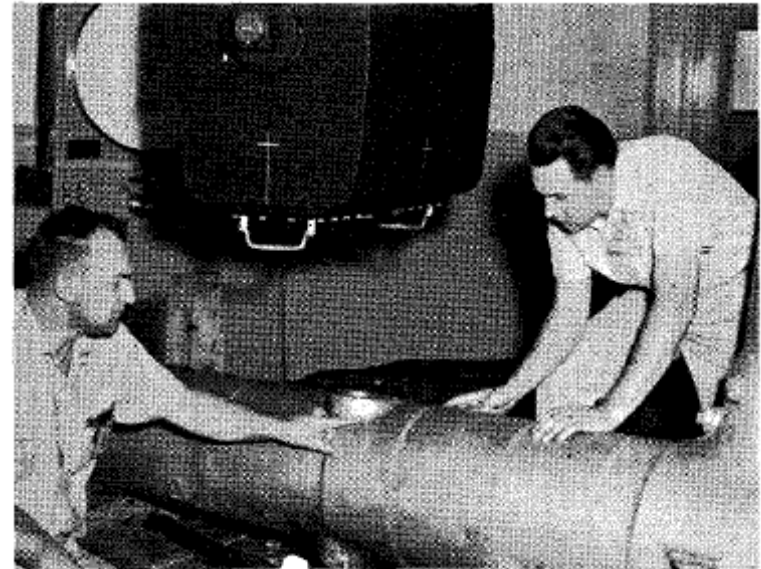
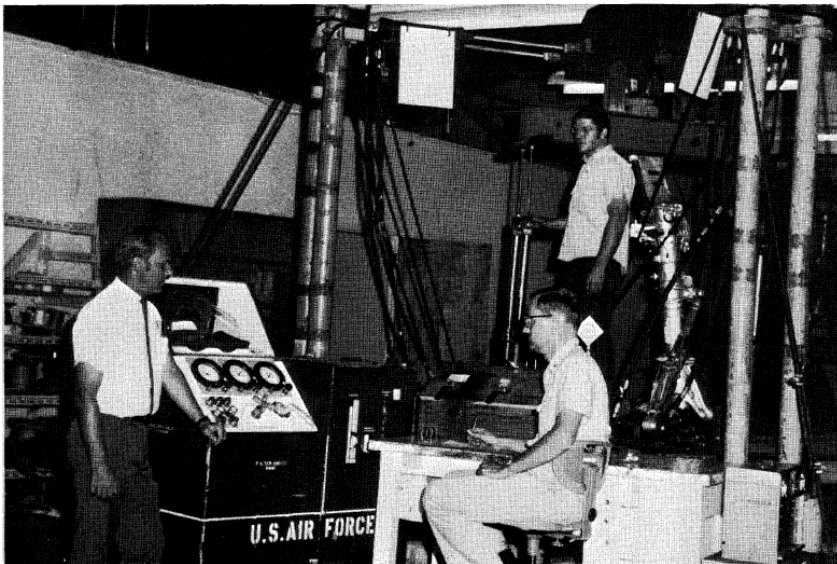
Parts on Target



Landing Gear – Who Are We?



- Dec 1958 – Hill AFB Assigned Landing Gear Mission
- Feb 1967 – Large Scale Cadmium Capability Installed at Hill AFB, USAF LG Consolidation Begins
- Feb 1977 – USAF LG Consolidation Mature – New Landing Gear Overhaul Facility (Bldg. 507)





Supported USAF Systems



A-10



B-1B



B-2



B-52



C-130



C-5



E-3A



F-4



F-15



F-16



KC-135



F-5/T-38



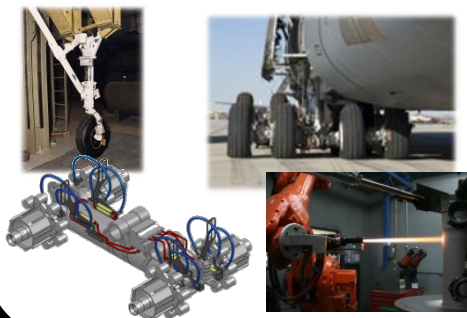
Functional Areas



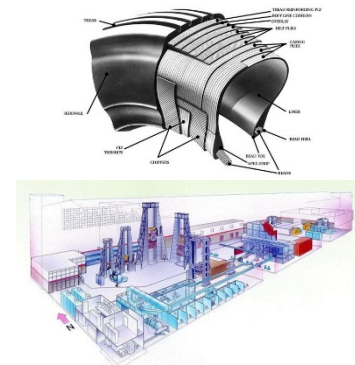
System Engineering



Struts Systems, Mat'l & Proc's



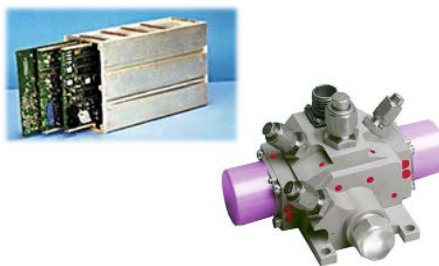
Tires, Landing Gear Test Facility



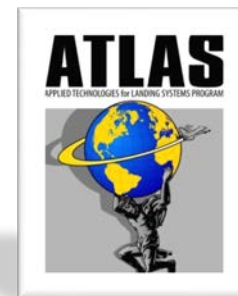
Rolling Stock Systems (Wheels, Brakes)



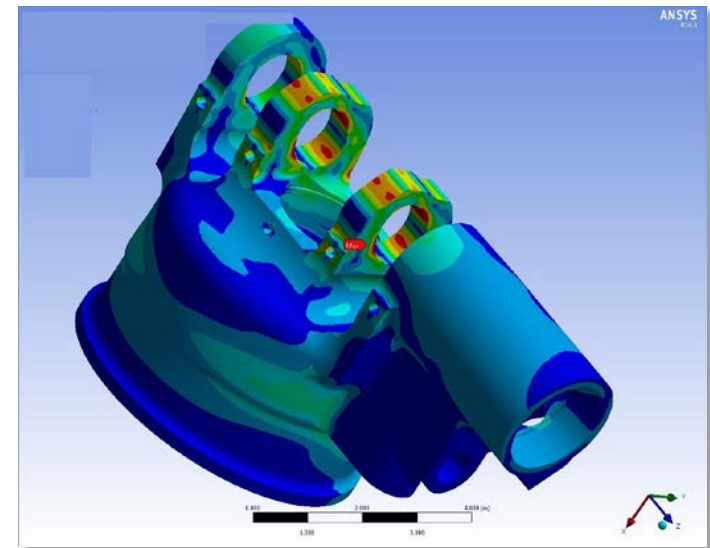
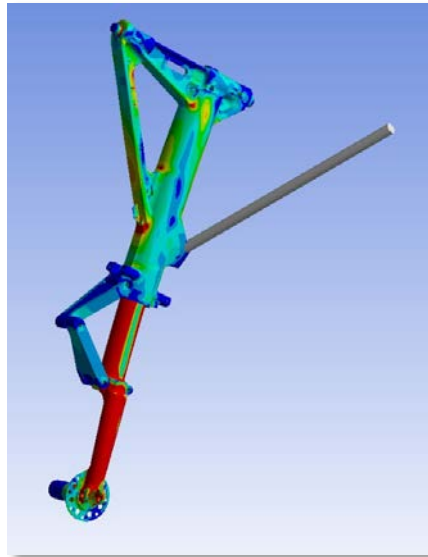
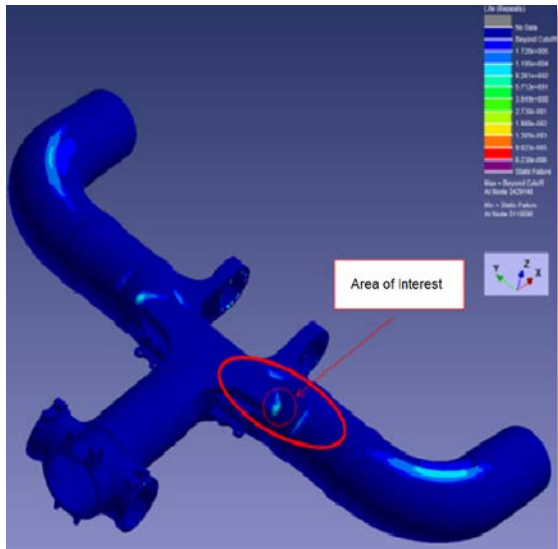
Anti-Skid, Nose Wheel Steering, Hydraulic & Software Systems



Technical Engineering Programs Safe-Life, Integrity Programs, Safety, Strategic Initiatives, Analysis



■ Structural Integrity Complexities

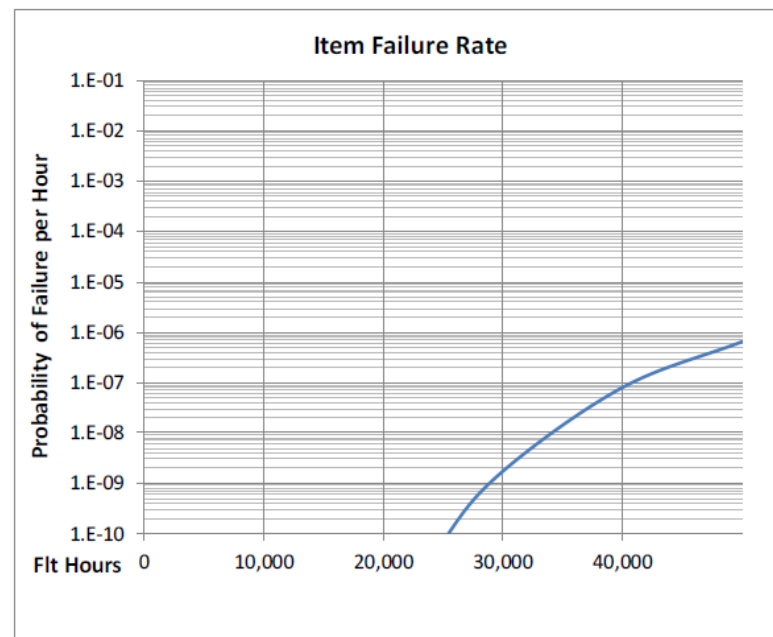
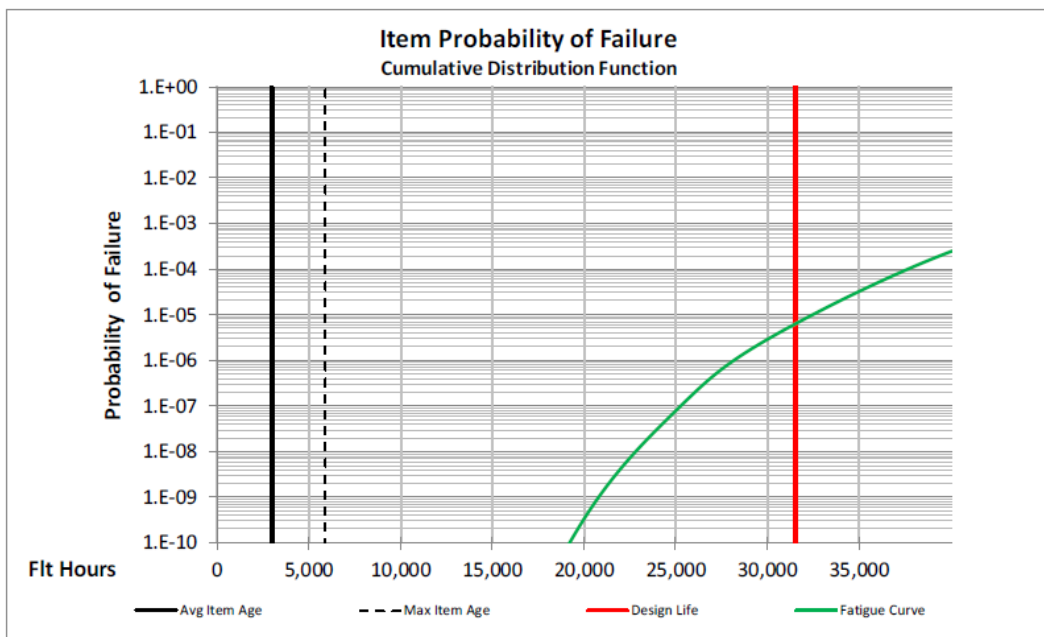




Landing Gear Safe Life



■ Failure Probabilities



Probability of one or more failures in the fleet

0.000E+00

Effective item probability of failure

0.000E+00

Average age of on aircraft items

2,978

 Flight hours
Mean time of failure

126,067

 Flight hours

Items delivered with new aircraft

20

Active items on aircraft

20

Quantity per aircraft

2



Basic LG Design Issues



- **Aircraft Design LG Considerations**
 - System Requirement Developed – Need & Usage
 - A/C Configuration & Structural Loads Developed
 - Landing Gear – Usually Designed as Secondary Priority
 - Limited Space & Weight for Design
 - Utilizes High Strength Steels & Aluminums
- **High Strength Material Properties**
 - LG Steels – 280 – 300 ksi UTS





Basic LG Design Issues



- **Safe Life Design**

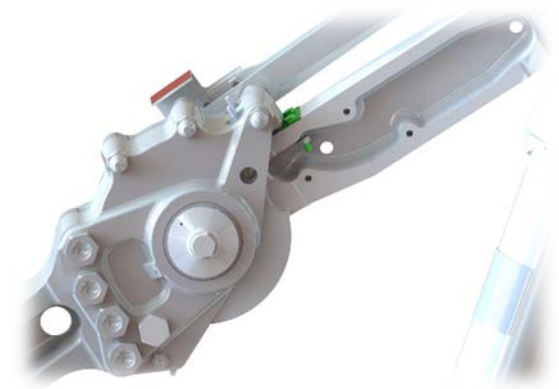
- Design - 4 Lives / Test - 2 Lives / Fly - 1 Life

- **Common Failure Modes of LG Materials**

- General Corrosion
 - Grinding Burns
 - Stress Corrosion Cracking (SCC)
 - Hydrogen Embrittlement (HE)

- **Protective Coatings & Processes**

- Coatings – Protect Against Corrosion
 - Process – Controlled: Reduce Risk HE & Grinding Burns





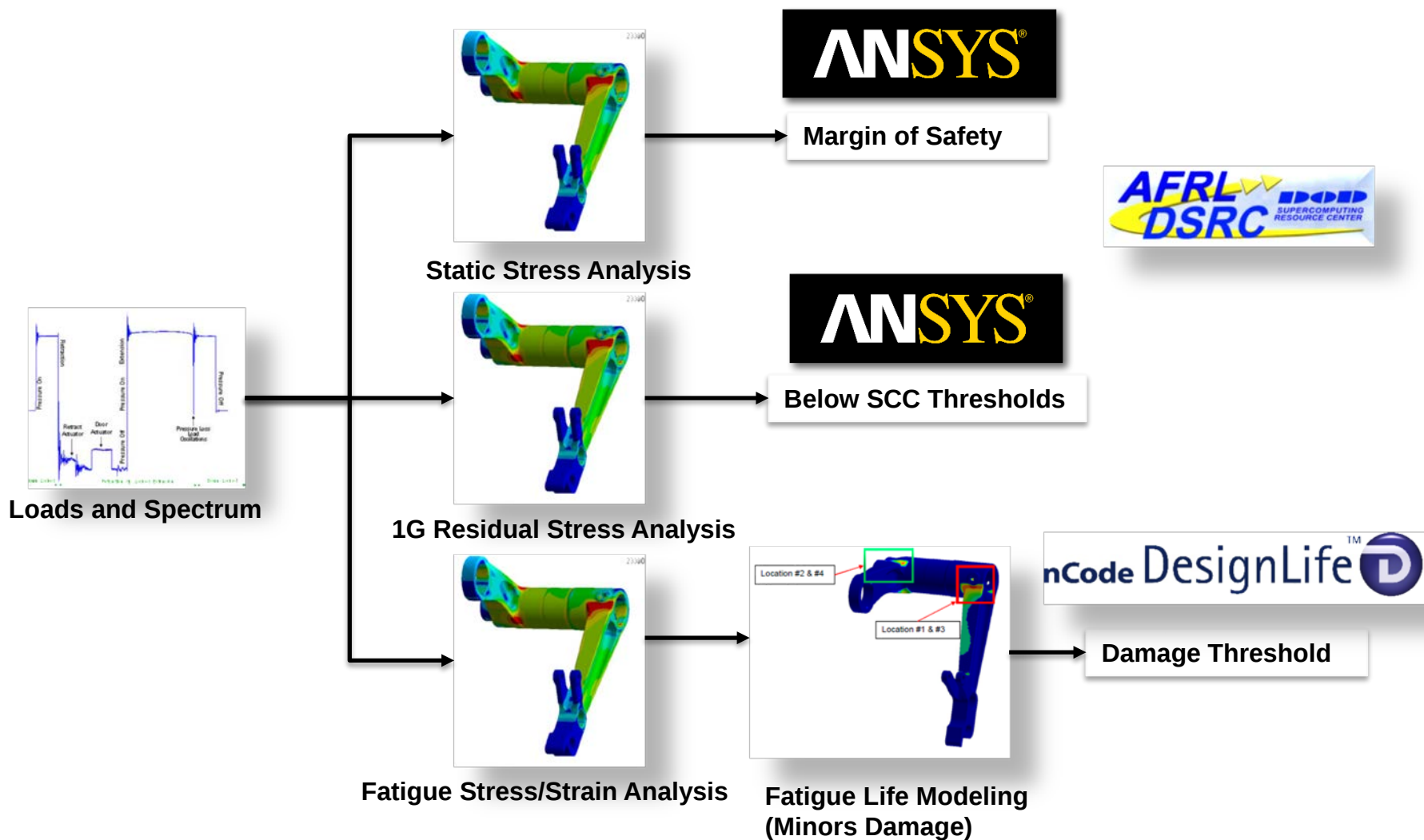
What is Considered in Landing Gear Repair and Design?



- **Static Strength**
 - Ultimate and Limit Stresses
 - Standard monotonic material properties
- **1G Residual Stresses**
 - Stress Corrosion Cracking Material Thresholds
- **Miners Fatigue Damage Accumulation**
 - Historically used stress life fatigue
 - Now strain life based fatigue
 - Can be problematic if sequencing is not considered



Contemporary Landing Gear Analysis





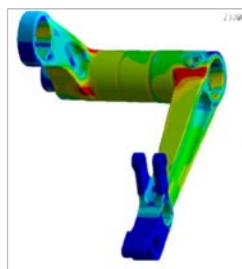
Advances in Safe Life Analysis



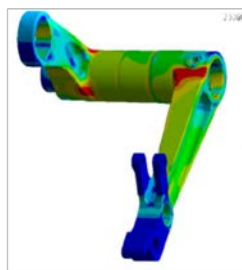
nCode DesignLife™



Vertical Load

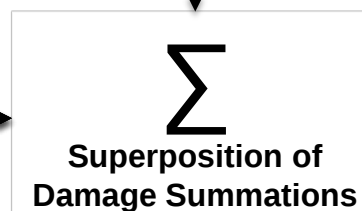
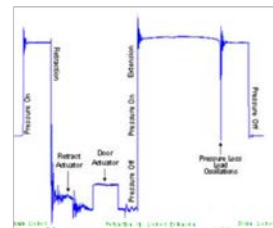


Side Load

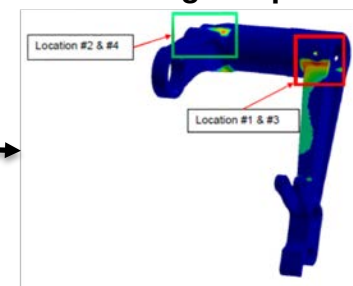


Drag Load

Loads and Usage Spectra



Damage Map

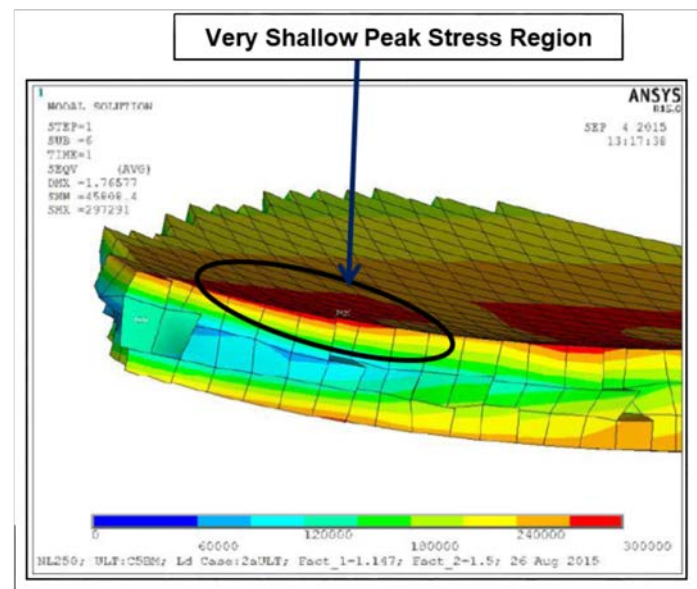




Owning the Technical Baseline



- **Landing Gear Technical Baseline Focus**
 - Maintain current library of design and engineering documentation for all supported systems
 - Ensure engineering is not fenced by intellectual property claims
 - No “Black Box” Solutions





Questions / Discussion





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