Gulfstream

A GENERAL DYNAMICS COMPANY

Large Damage Capability

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Large Damage Capability

Design and Analysis Criteria For Large Damage (Metallic)

- Intended To Cover Non-Critical Acreage Structure
  - Not Meant To Be A Fatigue Management Plan For Known Issues
  - Fuselage Shell Requirements For High Altitude Flight
- Used To Support Determination of Threshold Criteria Under 25.571(a)(3)
  - Criteria For Residual Strength Is 25.571(b)
- Focus On Growth Rates Of Initially Detectable Damage
  - Acceptable Rates Are Based on MSG-3 Inspection Intervals
- Primarily Achieved Thru Control of Design Stress Levels
  - Ultimate Design Stresses Limited To Meet Acceptable Crack Growth Rates And Residual Strength
  - Fracture Toughness of Cracked Element
  - Consideration Of Relevant Design Features To Reduce SIF

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Guidance Material

- **AC 25.571-1D**

j. Threshold for Inspections.

(1) Where it can be shown by observation, analysis, and/or test that a load path failure in multiple load path "fail-safe" structure or partial failure in crack-arrest "fail-safe" structure will be detected and repaired during normal maintenance, inspection, or operation of an airplane prior to failure of the remaining structure, the thresholds can be established using either:

(a) Fatigue analysis and tests with an appropriate scatter factor; or

(b) Slow-crack-growth analyses and tests, based on appropriate initial manufacturing damage.

- **ATA MSG3, 2007.1, "Rating Accidental Damage"**

c. Timely detection of damage, based on the relative rate of growth after damage is sustained and visibility of the SSI for inspection. Assessments should take into account damage growth associated with non-chemical interaction with an environment, such as disbond or delamination growth associated with a freeze/thaw cycle.

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Typical Applications

- **Wing Lower Covers & Spar Chords**
  - Designed To Leak Fuel From A Crack For A Reasonable Period
  - Safe Use With Failed Wing Stringer Longer Than MSG-3 Internal Interval
- **Fuselage Skins**
  - Safe Use For 4 Inspections
- **Pressurized Doors**
  - Safe Use With Failed Stop Fitting Longer Than MSG-3 Internal Interval
- **Flap Rollers**
  - Safe Use With Failed Roller Longer Than MSG-3 Internal Interval

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Fuselage Damage Tolerance Criteria

- Gulfstream Aircraft Are Certified To Operate Up To 51,000 ft.
- Design Criteria To Ensure Pressure Vessel Integrity
  - Criteria Defined In AC 25-20
  - Establish Residual Strength And Crack Growth Requirements
  - Design For Stable Crack Growth; No Flapping Open Of Skin Allowed
- Perform Crack Growth & Residual Strength Analysis
- Test Correlation
- Evaluate Fuselage Leakage Rates
- Establish Periodic Fuselage External Inspection

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Design and Evaluation Criteria

AC 25-20, "Pressurization, Ventilation And Oxygen Systems Assessment For Subsonic Flight Including High Altitude Operation", 9/10/96.

8. FUSELAGE STRUCTURE.

a. Higher operational altitudes could make the loss of cabin pressure due to fuselage skin cracks catastrophic even though the structure remains capable of supporting flight loads. Therefore, pressure-loaded structures for high altitude operation should be designed to be more reliable than those of present airplanes. Additional damage-tolerance requirements are necessary to prevent fatigue and corrosion damage which could result in a rapid depressurization.

b. The cabin altitude/time history should not exceed the limitations of § 25.841(a) after the maximum pressure vessel opening resulting from an initially detectable crack propagating for a period encompassing four normal inspection intervals. Cracks through skin-stringer and skin-frame combinations should be considered. A higher level of structural integrity in the pressure vessel is necessary for high altitude operations.

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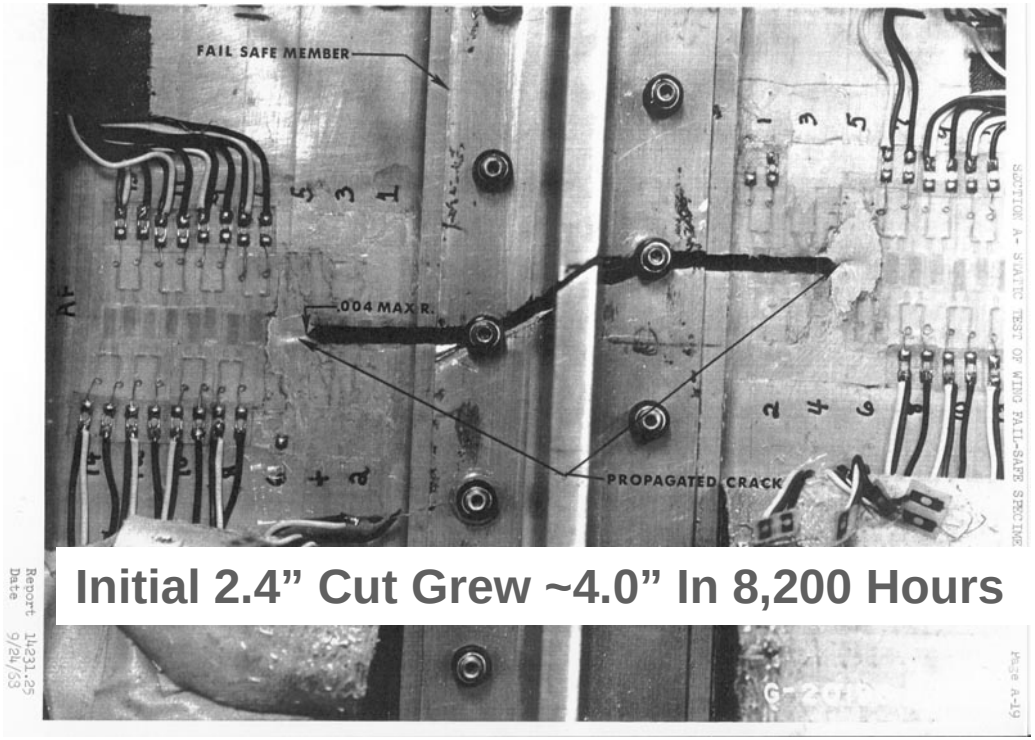
History of Design and Evaluation Criteria

- **GII Wing (Certified in 1967) Was Deemed 'Safe Life' Despite Slow Crack Growth Demonstration And Added Design Features**
  - **3 Integrally Stiffened Panels; Not 'Fail Safe' For Complete Loss of A Single Panel**



Initial 2.4" Cut Grew ~4.0" In 8,200 Hours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