Safety Management

Damage Tolerance and Maintenance Workshop
Chicago, IL
July 19, 2006
Bjorn Backman – Structured Research
Why is Safety the Challenge for Composites?

• A Steady Stream of New Materials, New Processes and New Structure;

• Slow Accumulation of Production Experience;

• Scant Service Experience;

• Many Damage Threats;

• Metal Design Rules are Obsolete;
Structural Safety – A Joint Responsibility

- Regulate / Enforce
- Design-In
- Design
- Manufacturing
- Operations
- Maintenance
- Protect / Restore
- Preserve / Report Breaches
Safety Management

New Airplane Roll-out

Airplane Updates & New Derivatives
Safety Improvements
Risk Reduction
Uncertainty Reduction

New Airplanes

SERVICE

Feedback

New Insights

Safety Data, Service Data

Education
Probability of a Structurally Safe State

The probability of a structurally safe state is the joint probability of safe design, safe manufacturing, safe maintenance and inspection, safe operation, and safe requirements.

\[
P(S_T) = P(S_D S_M S_I S_O S_R)
\]

where

\(S_T = \text{Safe Structural State}\)

\(S_D = \text{Safe Design}\)

\(S_M = \text{Safe Manufacturing}\)

\(S_I = \text{Safe Maintenance and Inspection}\)

\(S_O = \text{Safe Operation}\)

\(S_R = \text{Safe Requirements}\)
Purpose

• A process that deals with Structural Safety as a function of time and manage the contributions of all the participants
  • Design
  • Manufacturing
  • Maintenance and Inspection
  • Operation
  • Requirements

• The process establishes, maintains and improves safety from Roll-out to continuous improvements for the fleet
Safety and Time

Continuous Improvement via changes in inspection plan (method, locations, timing) based on in-service feedback

Roll-out

Safety

Time

T_1 T_2 T_3 T_4 T_5 T_6

Inspections

Upper bound

Lower bound

Minimum safety level

Preserve LIMIT Integrity
Unsafe Scenario

Integrity

Time

Roll-out

T_n

T_{n+1}

Detection & Repair

Damage

Large Damage

Growth

Ultimate

Limit

Inspection Interval

← Preserve LIMIT Integrity →
Walk-Around Detection

Example: 30 inspections @ 50% POD ≈ 99% POD
What Would Be Nice!!

- “Cherry-pickers” for the walk-around inspections

- “Hand-held” detection devices for internal / hidden, large damage
No Walk-Around … Fail-Safe

- Damage to PSE Load path
- PSE Integrity
- Load path Failure!
- Load Redistribution
- Detection & Repair
- Ultimate Limit
- Inspection Interval
Safety Considerations

- Ultimate Integrity
- Limit Integrity
- Damage Tolerance
- Damage Resistance
- Testing
- Damage Growth
- Inspection
- Detection
- Repair
- Damage Reporting

- Quality Assurance
- Quality Control
- Preventive Maintenance
- Service Monitoring
- Degradation
- Process Control
- “Operations Reporting”
- Risk Management
- Safety Requirements
- Violation Reporting
Safety Management Assures …

- Limit Integrity
- Fail-Safety
- Damage Tolerance
- Damage Resistance
- Controlled Damage Growth
- Timely Detection
- Monitoring
- Risk Management