

September 16, 2015 Agenda

- **Session 3: High Energy, Wide Area, Blunt Impact (HEWABI)**

8:30-8:50	"HEWABI as Related to Safety and Certification" - Larry Ilcewicz (FAA)
8:50-9:20	"UCSD FAA Research" - Hyonny Kim (UCSD)
9:20-9:40	"EASA Research" - Simon Waite (EASA)
9:40-10:00	"Airline Experiences" - Eric Chesmar (United), Ray Kaiser (Delta)
10:00-10:30	HEWABI Recap Session



High Energy Wide Area Blunt Impact

HEWABI as Related to Safety and Certification

Presented at: 2015 FAA/Bombardier/TCCA/EASA/Industry
Composite Transport Damage Tolerance and
Maintenance Workshop (Montreal, Quebec)

By: Larry Ilcewicz

Date: September 15 to 17, 2015



Federal Aviation
Administration

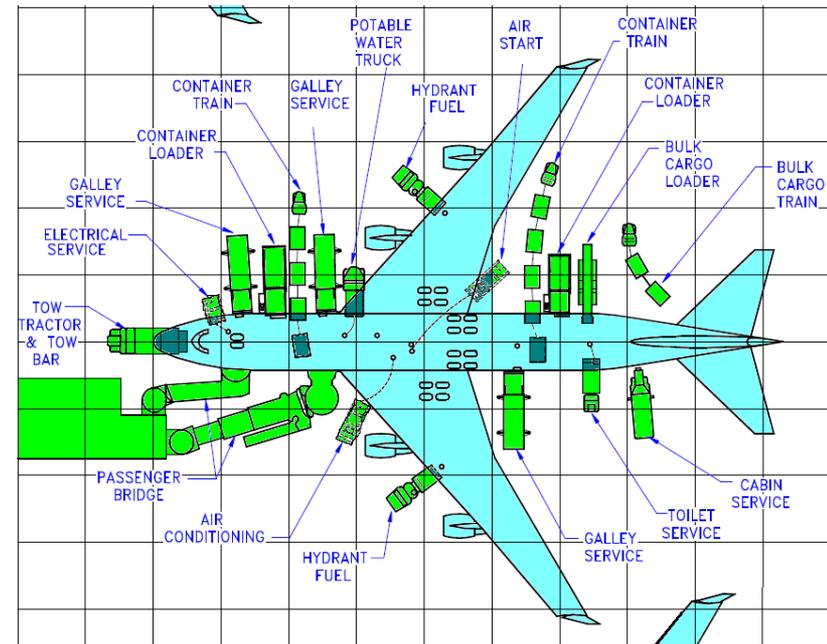


FAA AVS Plan: COS B, HEWABI

- **Background**

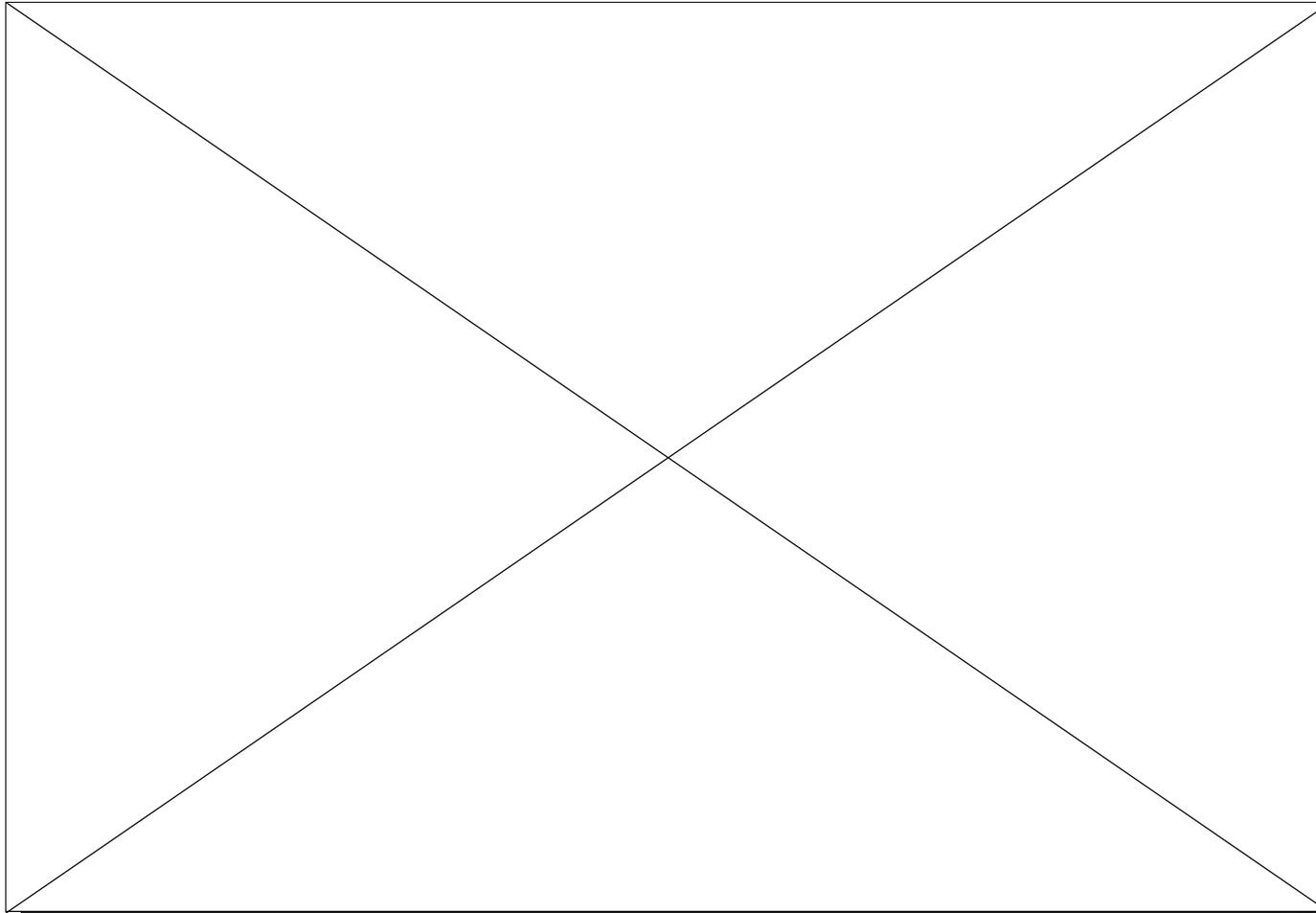
The FAA and industry is concerned with damage that occurs after part inspection when it is not visible to the naked eye. High-energy wide-area blunt impacts (HEWABI) are a type of this damage.

- Composite airframe structures may not show damage as readily as traditional metallic structures (less prone to plastic deformation / dents)
- In-service characteristic of transport airplanes where they are impacted by baggage carts and other service vehicles
- Also possible from damage in the factory or in production flight line
- In either case, reporting is essential for safety



Our Tenth Anniversary Year Studying a Key Area

HEWABI = High Energy Wide Area Blunt Impact



According to comments on Flightaware:
Occurred March 23 2014,
UPS Boeing 757-200
(N462UP) on Spot 90 at the
Miami International Airport
Repaired by AAR Aircraft
Services Miami, and returned
to flight status on April 13.

The truck belongs to a
catering company. It was
being driven by a female who
was not supposed to be
driving, hence the reason they
jumped out and switched
really quick.

The passenger told security
he was the driver, but once
they reviewed this footage
they saw he clearly wasn't.
They were both fired.



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INDEPENDENT AND LOCALLY OWNED SINCE 1896 | seattletimes.com

“Absolutely terrifying” flight after ground-crew mistake

PLANE MAKES EMERGENCY RETURN TO SEA-TAC
Baggage handlers blamed for gash in jet’s side

BY JENNIFER SULLIVAN
AND MELISSA ALLISON
Seattle Times staff reporters

Alaska Airlines Flight 536 was 20 minutes out of Seattle and

heading for Burbank, Calif., Monday afternoon when a thunderous blast rocked the plane.

Passengers gasped for air and grabbed their oxygen masks as

the plane dropped from about 26,000 feet, passenger Jeremy Hermanns said by phone Tuesday.

“This was absolutely terrifying for a few moments,” said Hermanns, 28, of Los Angeles. “Basically your ears popped, there’s a really loud bang and there was a lot of white noise. It was like

somebody turner in your ear.”

Though the quickly stabilizing passengers spent minutes tearful and in a “rid” odor of overwhelmed Hermanns said.

“A lot of p

She said Alaska conducted safety briefings with employees at Sea-Tac on Tuesday “to discuss the importance of rapid and thorough reporting of any ground incidents, whether there is apparent aircraft damage or not.”

The airline also is reviewing details from Monday’s incident with the NTSB and working with the agency to ensure aircraft safety, she said.



JEREMY HERMANNS

In a photo taken aboard the plane, Jeremy Hermanns uses an oxygen mask.

An Excellent Safety Message



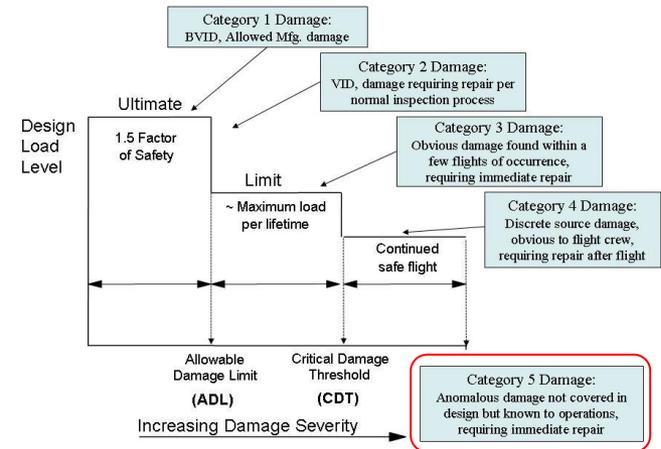
Key HEWABI Issues

- **Significant Impact Events can cause major damage to airframe structures**
 - impacts with service vehicles
 - Impacts with ground structures
- **Composite airframe structures may not show damage as readily as traditional metallic structures**
 - less prone to plastic deformation (dents)
- **Awareness & reporting of significant impact events will close potential safety gaps**
 - Safety Management Approach is needed to protect safety
 - Partners: OEM, line maintenance, operations, other people involved

FAA/Industry Awareness: Engineering

• Category 5 Damage

- Severe damage
- Rare event
- Capability *potentially* below limit load
- Beyond design considerations
- Unbounded
- “Examples: severe collisions with service vehicles or other aircraft, flight overload conditions, very large bird strike



• Composite Initiatives Covering Category 5 Damage

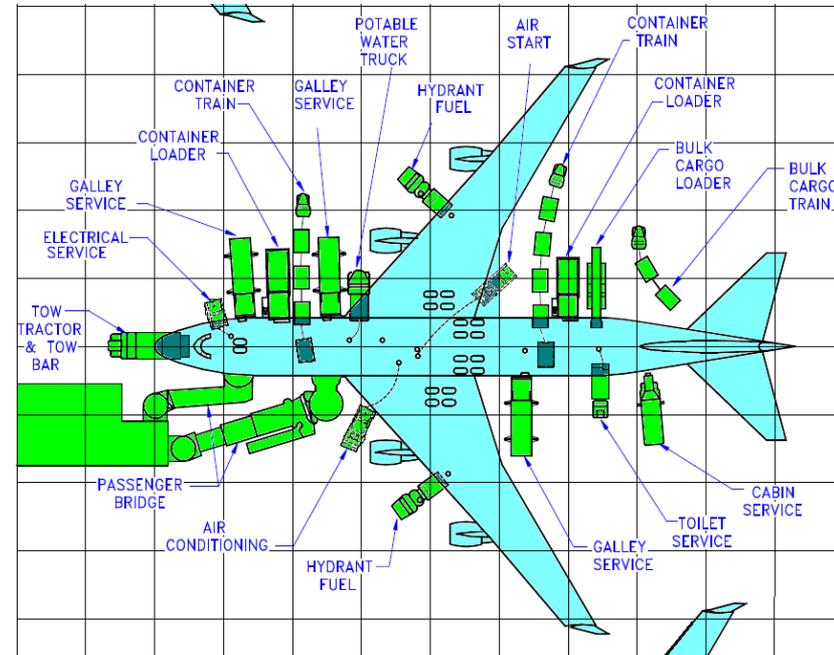
- FAA/EASA/Airbus/Boeing Working Group (*starting in 2005 & 2011*)
- Chicago, IL (2006) FAA/CMH-17 Workshop
- Amsterdam, Netherlands (2007) FAA /CACRC Workshop
- Tokyo, Japan (June 2009) FAA /CACRC Workshop
- AC 20-107B (Sept. 2009)
- FAA White Paper (2008) and FAA/EASA research (ongoing: 2014+)

FAA Technical Paper on Awareness & Reporting of Significant Impact Events Involving Composite Airframe Structures

(effort initiated by FAA/EASA/Airbus/Boeing WG)

Not all damaging events (e.g., severe vehicle collisions) can be covered in design & scheduled maintenance

- Safety must be protected for severe accidental damage outside the scope of design (defined as Category 5 damage) by operations reporting
- Awareness and a “No-Blame” reporting mentality is needed
- Category 5 damage requirements:
 - a) damage is **obvious** (e.g., clearly visual) and **reported** &/or
 - b) damage is **readily detectable** by required pre-flight checks &/or
 - c) the **event** causing the damage is otherwise **self-evident** and **reported** e.g., obvious, severe impact force felt in a vehicle collision



Solution Path for Vehicle Collisions Classified as Category 5 Damage

- **Layers of Safety management needed**
 - Damage resistant structure (to ensure Cat. 5 criteria is met!)
 - Damage tolerance for legitimate Cat. 2 & 3
 - No blame reporting encouraged or mandated
 - Conditional inspection documented
 - Practical NDE to avoid internal access when not practical
- **Provide supporting data on events justified to yield Category 5 damage and the resulting disposition**

1) Impact Event is Reported	Awareness by ground crews, service crews, air crews, and/or ramp personnel
2) Line Maintenance Ensures Proper Evaluation	Line and Dispatch personnel trained to seek skilled disposition assistance
3) Engineering Evaluation & Repair (if necessary)	<ul style="list-style-type: none"> a. Engineers, OEM, technicians, inspectors with proper training b. Allowable Surface Damage Limits do <u>NOT</u> apply c. Initial inspection is to detect <u>MAJOR</u> internal damage

OEM Side

- Well-defined rules and boundaries for airframe damage tolerance (Categories 1 to 4)



Maintenance and Operations Side

- Defend everything else (Category 5, e.g., HEWABI)

FAA High Energy Wide Area Blunt Impact Policy

- **Currently completing internal FAA reviews/updates for the associated FAA Transport Directorate Policy (Focal: Mark Freisthler)**
- **2015 release schedule**
 - Public commenting Late September, 2015
 - Disposition public comments: Late October, 2015
 - Final policy updates: Mid November, 2015
 - Final issuance: November 30, 2015
- **Other HEWABI efforts in work**
 - FAA and EASA HEWABI research remains active
 - OEM HEWABI efforts continue for composite fuselage in new transport aircraft products
 - Future HEWABI initiatives includes new CMH-17 content and further interface with airports/operations

HEWABI Recap Session

- **Layers of safety management**
 - Roles of the OEM, line maintenance and operations
 - Assurance for operations reporting
 - Technology advances versus practical solutions
- **Boeing Video as applied for line maintenance safety awareness**
 - Effective, entertaining, complete safety message
 - Additional work needed to reach operations personnel
- **Future FAA, EASA and industry research focus?**
 - Calibrated analyses to address “unbounded scenarios”
 - Practical NDT that doesn’t stop revenue flights for damage covered by scheduled maintenance
 - Design guidelines for balanced damage resistance

September 16, 2015 Agenda

- **Session 4A: Composite Fatigue and Damage Tolerance**

10:45-11:00	"Introduction for Sessions 4 through 6" - Larry Ilcewicz (FAA) and D.M. Hoyt (NSE)
11:00-11:15	"Perspectives on Fatigue and Damage Tolerance Standardization" - Mark Nienhaus (Textron Aviation)
11:15-11:45	"Boeing Composite Fatigue & Damage Tolerance Certification Experiences" - Allen Fawcett (Boeing)
11:45-12:15	"Airbus Composite Fatigue and Damage Tolerance Certification Experiences" - L. Ratier and C. Fualdes (Airbus)
12:15-1:00	Lunch

Workshop Sessions versus CMH-17 Content

- **Sessions 1 - 3**

- Sandwich Disbond Assessments
- Bonded Repair
- High Energy, Wide Area, Blunt Impact (HEWABI)

Some coverage of HEWABI, others topics not covered.

- **Sessions 4 - 6**

- Composite Fatigue & Damage Tolerance
- Damage Tolerance (Special Subjects)

Focus of CMH-17 “roadmap”

- **Sessions 7a - 7c**

- Smarter DT Testing
- Use of Probabilistic Methods
- Modifications, Alterations & Repairs

Some coverage of probabilistic methods, other topics not covered

Categories of Damage & Defects for Primary Composite Aircraft Structures

Category	Examples (not inclusive of all damage types)
<u>Category 1</u> : Allowable damage that may go undetected by scheduled or directed field inspection (or allowable mfg defects)	Barely visible impact damage (BVID), scratches, gouges, minor environmental damage, and allowable mfg. defects that retain ultimate load for life
<u>Category 2</u> : Damage detected by scheduled or directed field inspection @ specified intervals (repair scenario)	VID (ranging small to large), deep gouges, mfg. defects/mistakes, major <i>local</i> heat or environmental degradation that retain limit load until found
<u>Category 3</u> : Obvious damage detected within a few flights by operations focal (repair scenario)	Damage obvious to operations in a “walk-around” inspection or due to loss of form/fit/function that must retain limit load until found by operations
<u>Category 4</u> : Discrete source damage known by pilot to limit flight maneuvers (repair scenario)	Damage in flight from events that are obvious to pilot (rotor burst, bird-strike, lightning, exploding gear tires, severe in-flight hail)
<u>Category 5</u> : Severe damage created by anomalous ground or flight events (repair scenario)	Damage occurring due to rare service events or to an extent beyond that considered in design, which must be reported by operations for immediate action

Relationships Between Categories of Damage

(using accidental impact damage as an example)

- **Category 1:** More common “small damage”, which could be covered by standards (e.g., impactor size/shape, energy cutoffs) if the same limits are **not** maintained in moving to Categories 2 and 5.
- **Category 2:** Less common, “more significant damage” that can range in size from the Cat. 1 threshold to larger (bounded by the threats, structural capability and scheduled inspection details, method & interval). Impact standards generally don’t exist for this damage and it is likely that a larger, softer impactor can generate damage within visual detection limits (without maintaining Ult. Load); however, taking damage to clearly detectable levels and showing large damage capability (Cat. 3) suggests it’s acceptable.
- **Category 3:** Uncommon, large damage that ensures the damage tolerance of the structure without getting into a significant experimental effort on the effects of impactor variables & accidental damage detection.
- **Category 4:** Defined by regulatory event and area of the damage threat
- **Category 5:** Everything else.

Key Components of Composite Fatigue and Damage Tolerance and Related Maintenance Practice that are Typically Addressed During Type Certification

- 1. Damage threat assessment, including considerations as a function of structural locations**
 - Accidental damage types
 - Environmental damage types
 - Manufacturing defect types
 - Other defect and damage types
 - **Discrete source damage threats**
 - **Large damage capability (relationships with selected inspection procedures, design criteria and categories of damage)**
 - **Identification of damage threats beyond Damage Tolerance Assessments**

Key Components of Composite Fatigue and Damage Tolerance and Related Maintenance Practice that are Typically Addressed During Type Certification, *continued*

2. Repeated load tolerance (fatigue and DT)

- Load and life enhancement factors (e.g., LEF) to address statistical scatter
- *Will you allow combined load and life enhancement approaches? To what degree?*
- Truncation and clipping (supporting data)
- Experimental data to establish the fatigue spectrum and LEF
- What is the composite equivalent of the LOV?
- **What is the *minimum number of Lifetimes* that need to be demonstrated?**
- LEF has been allowed to support the above question in the past (i.e., repeated load cycles have been reduced below 2 lifetimes with a higher LEF for the composite part of demonstrations)

Key Components of Composite Fatigue and Damage Tolerance and Related Maintenance Practice that are Typically Addressed During Type Certification, *continued*

3. Categories of Damage

- Category 1 Damage (within allowable damage limits for the airplane life)**
- Category 2 Damage (ties to the scheduled maintenance program)**
- Category 3 Damage (minimum damage sizes for large damage capability)**
- Category 4 Damage (acceptable simulations for discrete source events)**
- Category 5 Damage (set by the criteria applied for Category 2 through 3)**

4. How to address Composite Weak Bonds (as produced in the base design and bonded repairs – BRSL PS)

Key Components of Composite Fatigue and Damage Tolerance and Related Maintenance Practice that are Typically Addressed During Type Certification, *continued*

5. **Acceptance of building block details, including full-scale test evidence for composite fatigue and damage tolerance**
 - **What constitutes large-scale test evidence to support “certification by analysis supported by test approaches”**
 - Protocol for analysis and test correlation/structural substantiation
 - Introduction of damages (simulation, locations, magnitude, spacing, etc.)
 - Repair test and analysis substantiation
 - *Statistical design values for impact-damaged structure*
 - *Combined load analysis and test demonstration of structural capability*
 - *How to deal with environmental effects and possible time-related issues for unique design details (e.g., co-cured splices)?*

Key Components of Composite Fatigue and Damage Tolerance and Related Maintenance Practice that are Typically Addressed During Type Certification, *continued*

6. Hybrid issues for composite and metal assemblies

- What is achieved in the full-scale “airplane” test (typically used for metal fatigue test substantiation) versus subcomponent and demonstrator/pre-production test articles (typically used for repeated load parts of composite substantiation)**
- Airplane temperature distributions and thermal load validation of analyses in large scale tests**
- Is it necessary to address thermal loads in large scale fatigue tests? (e.g., added cycles)**
- Differences in composite and metal repeated load/fatigue spectrums**
- How to deal with other load types that can’t be simulated in large scale tests**

Key Components of Composite Fatigue and Damage Tolerance and Related Maintenance Practice that are Typically Addressed During Type Certification, *continued*

7. **Flight with known composite damage and defects (within allowable limits)**
8. **Demonstration of related maintenance inspection technology details**
 - Validation of inspection methods used for detection (Category 1 - 3 damages), including the minimum number of inspection cycles
 - Validation of full extent/characterization of damage as related to allowable damage limits and repair size limits (e.g., the 2 BRSL criteria)
 - **Protocol for ICA as applied to scheduled composite maintenance**
 - **Conditional inspection details for HEWABI and other Category 5 damage types**
 - Guidelines for MSG-3 (accidental and environmental damage threats)

Key Components of Composite Fatigue and Damage Tolerance and Related Maintenance Practice that are Typically Addressed During Type Certification, *continued*

9. Application of probabilistic methods to different aspects of composite fatigue & DT

- Damage threat assessments
- Setting inspection intervals
- Use of metallic damage data for composite applications
- Justification of conservative design criteria

September 16, 2015 Agenda

- **Session 4B: Composite Fatigue and Damage Tolérance**

1:00-1:30	"Rear Pressure Bulkhead Large Damage Capability Demonstration" Jean-Philippe Marouze (Bombardier)
1:30-2:00	"Aviation Rulemaking Advisory Committee (ARAC) Tasking on § 25.571" - Walt Sippel (FAA) and Mike Gruber (Boeing)
2:00-2:30	"NIAR Research on Certification of Composite-Metal Hybrid Structures" - Dr. Waruna Seneviratne and Dr. John Tomblin (WSU)
2:30-3:00	"CMH-17 Durability & Damage Toleranc Roadmap" - D.M. Hoyt, Patrick Enjuto, and Tom Walker (NSE)

- **Session 5: Damage Tolerance (Special Subjects)**

3:15-3:45	"The Aging Composite Airframe" - John Halpin (Consutant)
3:45-4:15	"Some Thoughts on Strategies for Building Block Approach Development" - Eric Pomerleau and Dr. Isabelle Paris (Bombardier)
4:15-5:15	"Composite Fatigue and Damage Tolerance Recap" - Led by Larry Ilcewicz (FAA), D.M. Hoyt (NSE) and Waruna Seneviratne (WSU)

Composite Fatigue and DT Recap Session

- **Certification experiences**
 - Data and experience sharing
 - Documented knowledge of industry practice (CMH-17)
 - Support to ongoing ARAC Tasking on §25.571
- **Composite damage threats**
 - Categories of damage (small to large damage capability)
 - Relationships with inspection procedures
 - Discrete source damage threats
 - Damage threats beyond damage tolerance assessments
- **Repeated load tolerance and composite “aging”**
 - Efficient test & analysis protocol for repeated loads
 - Aging in composites: wide spread damage, WSD (LOV)
(cumulative environmental/accidental damage over time?)

Composite Fatigue and DT Recap Session, *continued*

- **Hybrid issues for composite & metal assemblies**
 - Differences in composite & metal *repeated load* spectrum
 - Full-scale tests versus subcomponent and demonstration/pre-production test articles
 - * *Note that thermal loads will be covered in the recap for Session 6 on the morning of September 17*
- **Building block test and analysis protocol**
 - Certification by analysis supported by tests
- **Current CMH-17 Rev. H efforts**
 - Additional needs
 - Support to ARAC (basis in industry practice)