Research Program Overview

Maintenance & Inspection (M&I)
Part of Continued Airworthiness

William J Hughes Technical Center
Structures and Materials Section

Presented to: 58th Annual A4A NDT Forum
By: David Westlund
Date: 09/22/2015
The FAA William J. Hughes Technical Center (Technical Center) is one of the nation's premier aviation research, development, test and evaluation facilities. Its world-class laboratories and top-notch engineering place the Technical Center at the forefront of the FAA's challenge to modernize the U.S. air transportation system. The Technical Center serves as the FAA national scientific test base for research and development, test and evaluation, and verification and validation in air traffic control, communications, navigation, airports, aircraft safety, and security. The Technical Center is the primary facility supporting the nation's Next Generation Air Transportation System, called NextGen.

Located 10 miles northwest of Atlantic City, and covering over 5,000 acres, the Technical Center consists of state-of-the art laboratories, test facilities, support facilities, the Atlantic City International Airport (ACY), and a non-commercial aircraft hangar. The Technical Center is also home to the Department of Homeland Security, Transportation Security Lab, and the United States Coast Guard Group Air Station Atlantic City, as well as the New Jersey Air National Guard 177th Fighter Wing. While the Technical Center serves to advance aviation, it is a key focal point for Homeland Security as well.
Aviation Research Division

Mission Statement
• Develop scientific solutions to current and future air transportation challenges by conducting applied research and development in collaboration with industry, academia, and government.

Vision
• Extend the Wright brother’s legacy of research and development to ensure maximal safety, efficiency, and environmental stewardship for the air transportation system.

Branches
• Fire Safety Branch
• Human Factors Branch
• Airport Technology R&D Branch
• Software and Systems Branch
• Structures and Propulsions Branch
Aviation Safety Research Act

Aloha Airlines Incident…

(Measure indefinitely postponed in Senate, H.R. 4686 passed in lieu) Aviation Safety Research Act of 1988 - Amends the Federal Aviation Act of 1958 to direct the Administrator of the Federal Aviation Administration (FAA) to initiate aviation maintenance and safety research on:

(1) fire and smoke resistance technologies;

(2) specified aspects of aircraft maintenance and structural technologies;

(3) the relationship between human factors and aviation accidents; and

(4) air traffic control (including dynamic simulation models).

Requires the Administrator to submit a national aviation research plan to the Congress. Cites plan contents.

Requires the Administrator to report annually to certain congressional committees concerning the previous year's research accomplishments.
GAO Report on FAA Actions to Oversee Safety of Composite Airplanes

• **Safety Related Concerns**
  – Limited information on the behavior of airplane composite structures
  – Technical issues related to the unique properties of composite materials
  – Standardization of repair materials and techniques
  – Training and Awareness

• **Technical Concerns**
  – Challenges in detecting and characterizing damage in composite structures and making adequate repairs
  – Impact damage
  – Applying correct NDI techniques
  – No NDI exists that can measure the strength of a bonded composite repair after it is completed
  – Making repairs, human factors

• **Limited Standardization**
  – Repair materials, processes

• **Training and Awareness**
  – Inspectors
Aviation Safety (AVS)

Aviation Safety is the organization within the FAA that is responsible for the certification, production approval, and continued airworthiness of aircraft; and certification of pilots, mechanics, and others in safety-related positions.

Aviation Safety is also responsible for:
• Certification of all operational and maintenance enterprises in domestic civil aviation
• Certification and safety oversight of approximately 7,300 U.S. commercial airlines and air operators
• Civil flight operations
• Developing regulations
AVS is our customer…

- Research supports AVS general mission areas:
  - **Continued Operational Safety (COS)** - Assess and ensure the long-term airworthiness of existing aircraft structure.
  - **Standards and Policy** – Create and amend as necessary the rules and regulations that provide the airframe structural safety standards.
  - **Certification** - Issue initial and renewed certificates that allow manufacturers to build aircraft and organizations to provide maintenance services.
Composite Inspector Training

Dennis Roach and Stephen Neidigk

Sandia National Laboratories
Research Challenge:
The objective of this work is to enhance inspector’s ability to inspect composite laminate structures by developing training curriculum and proficiency specimens.

Description of Work:
The FAA initiated the “Quantitative Assessment of Conventional NDI Techniques for Detecting Flaws in Composite Laminate Aircraft Structures” study, which provided POD values for inspecting composite laminate structures, and a series of recommendations for improvements. A primary recommendation from this study and from the CACRC Inspection Task Group is to enhance inspector’s preparation and training by focusing on the unique challenges and signal differences associated with composite inspections. The Composite Inspector Training Task will produce the following deliverables;

a. A comprehensive report on training needs as a result of an industry input meeting
b. A syllabus and draft curriculum (with recommended hours) specifically to address the unique characteristics of composite inspection. This will be based on the premise that the students possess a basic knowledge of NDI and will include at a minimum the following topics:
   i. Familiarization with composite structure and construction
   ii. Refresher on the principles of ultrasonics
   iii. Signal differences related to ply tapers, secondary bonds and composite repairs
   iv. Repair inspection (pre and post)
   v. Proficiency training on representative composite structure
c. The lack of routine exposure to composite inspections makes it difficult to achieve and/or maintain the desired level of efficiency. The second deliverable from this tasking is:
   i. Develop a specification for the fabrication of representative NDI proficiency training aides both solid laminate and honeycomb
   ii. Produce a proof of concept set of proficiency training aides to be used in developing the training syllabus and curriculum
d. Develop a specific curriculum and syllabus for training in the use of go-no-go devices such as the ramp damage checker.
e. Conduct a workshop with industry experts to review the proposed curriculums and the use of proficiency standards.
Composite Impact Damage and Characterization

Dr. Hyonny Kim and Dr. Francesco Di Scalea
University of California San Diego
**Composite Impact Damage and Characterization**

**Research Challenge:**
The objective of this research is to evaluate NDE methods’ capability to detect major sub-surface damage to internal composite structural components.

**Description of Work:**
In conjunction with SIC TCRG studies at University of California San Diego, establish NDE methods for finding major sub-surface damage to internal composite structural components such as frames and shear ties, and correlate NDE-measurements with damage location, damage level, and reduction in structural performance. This work will leverage current FAA-funded research on High Energy Wide Area Blunt Impact (HEWABI).

**Tasks:**
a. Identify significant frequencies giving best sensitivity to detecting frame cracks.
b. Determine suitable “ramp-friendly” equipment to be used for exciting and sensing acoustic signals.
c. Establish algorithms for damage location determination based on shear tie station pair readings.
d. Correlate NDE measurements to damage state and differentiating between damage in frame vs. in shear tie vs. at frame-floor joints,
e. Relate NDE measurements to reduction in component’s residual strength. A key component of these tasks will include using modeling to define how to select sensor locations and dominant frequency information, as well as residual strength assessment.
f. Provide final technical report to the FAA that quantifies the above items with recommendations for the use of field deployable NDI for the detection of HEWABI.
Commercial Aircraft Composite Repair Committee (CACRC)
Structural Repair Manual (SRM) Repair Round Robin Exercise

Dr. John Tomblin and Dr. Lamia Salah
National Institute for Aviation Research at
Wichita State University
Commercial Aircraft Composite Repair Committee (CACRC) Structural Repair Manual (SRM) Repair Round Robin Exercise

Research Challenge:
The fundamental objective of this research work is to assess the potential variability associated with damage inspection, detection and repair following SRM (Structural Repair Manual) instructions.

Description of Work:
The fundamental objective of this research work is to assess the potential variability associated with damage inspection, detection and repair following SRM (Structural Repair Manual) instructions. The ultimate goal is to identify areas of improvement in the existing inspection and repair standards yielding robust inspection and repair procedures and standardized techniques that can be used across OEMs, airlines and repair stations. Results from the investigation can also be used to promote awareness of the challenges associated with composite repair, provide guidelines and recommendations in composite repair awareness courses, training curriculum, safety initiatives and policies.
14 CFR Part 147 Composite Technician Training

Dr John Tomblin
National Institute for Aviation Safety (NIAR)
Research Challenge:
The objective of this work is to update composite curriculum required by CFR part 147 for composite.

Description of Work:
CFR Part 147 which regulates curriculums for Aviation Maintenance Technician School requires that students be taught basic information about the uses of composites in aviation. This can be a very basic composite awareness course or an extensive curriculum preparing students to be composite repair technicians. This research project will provide necessary teaching points for both levels of training.

While AIR 5719, Teaching Points for a Class on “Critical Issues in Composite Maintenance, Repair and Overhaul” contains an extensive list of teaching points this should be reviewed and condensed for the level 1 training syllabus. Critical items need to be determined and listed in a format that can be easily adopted and understood by instructors with limited knowledge of composites.

A. Level I training
   i. Composite awareness, i.e. terminology, uses, basic principles
   ii. Advantages/disadvantages
   iii. Regulatory aspects
B. Level II Technician Skills
   i. Composite awareness
   ii. Regulatory aspects
   iii. Tools and equipment
   iv. Skill building exercises
Inspection and Teardown of Aged In-Service Bonded Repairs

Jonathan Doyle and David Westlund
William J. Hughes Technical Center
Inspection and Teardown of Aged In-Service Bonded Repairs

Research Challenge:
The objective of this work is to assess the effects of service history and environmental aging effects on the strength and durability of adhesively bonded repairs and to document best industry practices in adhesive bonding.

Description of Work:
Composite materials are primarily damaged by mechanical loads and/or environmental conditions. With an increased usage of advanced composites in primary and secondary aerospace structural components, it is thus essential to have robust, reliable and repeatable structural bonded repair procedures to restore damaged composite components. But structural bonded repairs, especially with primary structures, pose several scientific challenges with the current existing repair technologies. Therefore, it is imperative that we study the effects of environment and age on bonded repairs.

NDI will be performed on repaired specimens obtained from aircraft with known service-life history. Repairs that have any discernible damage will undergo full scale component testing for static strength, while intact repairs will be surrogated into groups for either component or coupon scale testing of fatigue and run-out. Correlations between test performance and the repair specifications will be made through statistical analysis.
Questions?

David Westlund
Federal Aviation Administration
Structures and Materials Section
David.westlund@faa.gov
609.485.4923