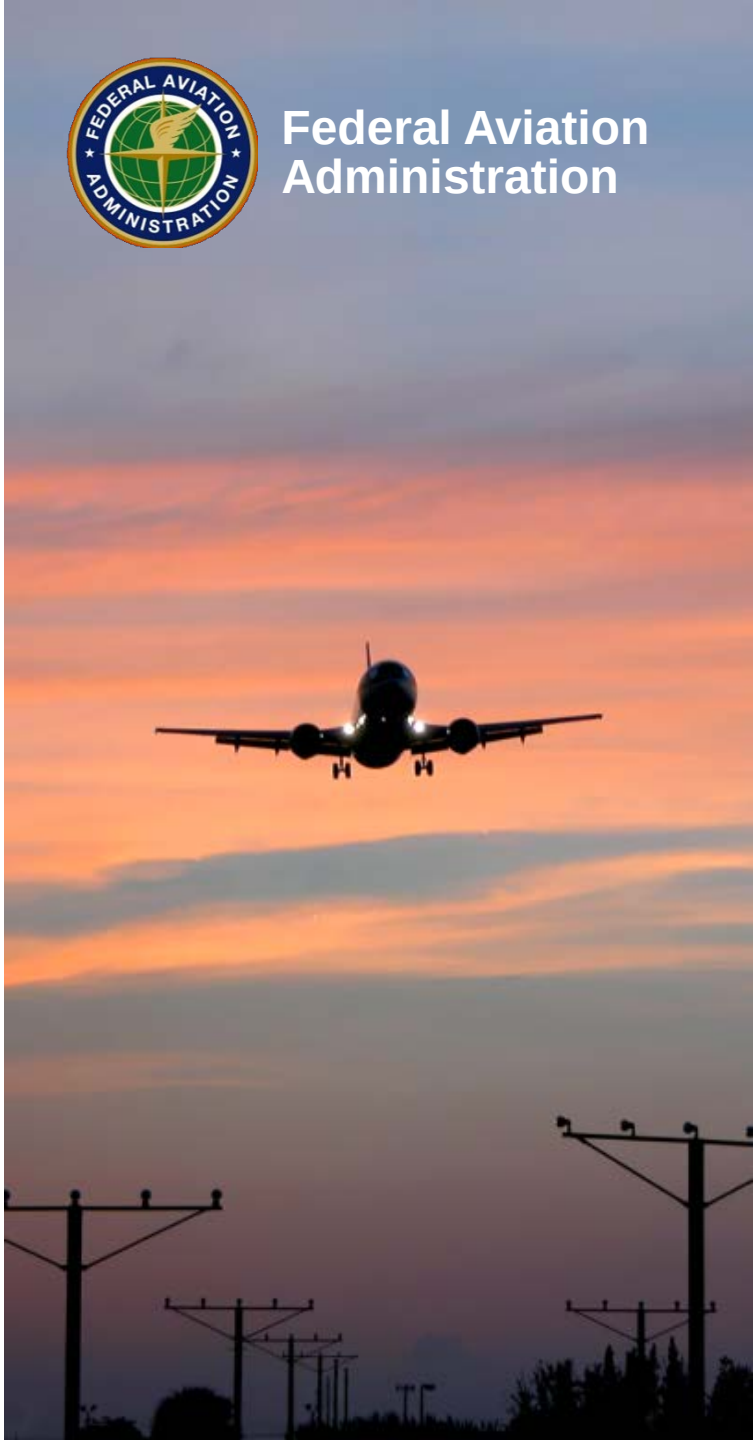
Research Program Overview

Maintenance & Inspection (M&I) – Technical Community Representative Group (TCRG)

Part of

BLI A11e – Continued Airworthiness

Federal Aviation Administration



Presented to: 57th Annual A4A NDT Forum

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William J. Hughes Technical Center

- 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 (AVS)

Aviation Safety is an organization 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

M&I – TCRG Portfolio Overview

- **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.

Research Drivers: New Materials

- **Composite**
  - Honeycomb/skin
  - Solid Laminate
- **Metallic**
  - Aluminum Lithium
  - Advanced Metallic Alloys
- **Hybrid**
  - GLARE

Research Drivers: New Processes

- Additive Manufacturing
- Advanced Welding Techniques
- Fiber Tape Placement
- Vacuum Assisted Resin Transfer Molding (VARTM)
- Bonded Repairs
- Castings, Forgings

Research Drivers: New Technologies

- **Advances in NDI Technology**
  - Sonic Infrared (SIR)
  - Non-Linear Ultrasonic Inspection
  - Resonance Imaging
  - Ultrasonic Spectroscopy
  - Laser Bond Inspection

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

M&I TCRG Portfolio Overview – Past Projects

- Magnetic Particle Inspection – Iowa State University
- Sonic Infrared – Wayne State University
- Image Based Inspection for Rotorcraft – Bell Helicopter
- Instrumented Tap Testing – Iowa State University
- NDT of Weak Bonds and Quantification of Bond Strength – SANDIA National Laboratories

M&I TCRG Portfolio Overview – Current Projects

- **NDI of Composites**
  - **NDI of Composite Impact Damage**
    - Hail
    - Hardened (Tool Drop)
    - High Energy Wide Area Blunt Impact (HEWABI)
  - **NDI of Composite Repairs**
    - Honeycomb Repairs
    - Laminate Repairs
  - **Composite Damage Detection using FTIR**
    - Heat Damage, Environmental Damage
    - Over-Sanding Repair Surfaces
  - **Composite Inspector Training**
    - Composite NDI Training Class
    - Composite NDI Proficiency Standards
  - **Teardown and Inspection of In-Service Bonded Repairs**

Teardown and Inspection of Bonded Repairs

Research Question:

What are the long term effects of age/environment on bonded structures?

Research Outcomes:

Draft revision to AC 65-33: Development of Training/Qualification Programs for Composite Maintenance Technicians

Draft revision to AC43-214: Repairs and Alterations to Composite and Bonded Aircraft Structure

Performer:

TBD

Background

- **Continued Trend Towards using Bonding Processes**
- **Good Bonds are Good Bonds:**
  - Good designs, qualified materials, proven processes, well-trained and experienced personnel, and existence of a structural substantiation database reduce the risks of disbonds or weak bonds.
- **Bad Bonds are Bad Bonds:**
  - The risk of inadequate bond integrity is not fully mitigated, even if these aspects of good bonded repair practices are adopted; thus, the need to evaluate older bonded repairs that have been exposed to environmental aging and flight loads.

Research Objectives

- **Retired Aircraft with Documented Repairs**
  - Composite Parts in Particular, Control Surfaces, Metal and Composite Bonded Sandwich Structure
- **Study the Long-Term Aging and Environmental Effects on Bonded Repairs**
  - Residual Strength, Fatigue and Damage Tolerance, Moisture Content
- **Evaluate the Ability of Conventional and Advanced NDI to Detect Damage/Degradation of Bonded Repairs**
- **Document Best Practices in Bonding**

Research Approach

- **Obtain structural components (composite and metal) that have had documented field repairs (time in service, repair specification used)**
- **Conduct initial inspection (visual and multiple NDI)**
- **Conduct teardown of repairs and document findings as related to repair integrity and viability on NDI methods used for pre and post inspections**
- **Document all findings and provide recommendations for best repair practices**

Research Output

- **Final report containing results of all inspections of repairs and surrounding structure within 34 months of the beginning of the project.**
- **Final report will contain an appendix with best practice recommendations for inspecting and accomplishing bonded repairs.**
- **Inspector Training**

Research Outcome

- Draft revision to AC 65-33, Development of Training/Qualification Programs for Composite Maintenance Technicians
- Draft revision to AC 43-214 Repairs and Alterations to Composite and Bonded Aircraft Structure

Phases & Exit Criteria, Milestones, and Metrics

- **Phase 1. In coordination with the sponsor and the Structural Integrity of Composites TCRG obtain a representative sample of documented field repairs within 9 months of the beginning of the project.**
- **Phase 2. Conduct initial visual and NDI inspections of repairs and surrounding structure.**
- **Phase 3. Perform tear down inspection of repairs and surrounding structure. Phase 2 and 3 should be accomplished within 24 months of project award.**
- **Document all pertinent data and provide a draft report to the FAA within 34 months of the start of the project with a final report due three years from the start of the project.**