## FAA William J. Hughes Technical Center

## Aging Aircraft Inspection Systems Research

The Aviation Safety Research Act of 1988 directed the FAA to develop technologies and conduct data analysis for predicting the effects of aircraft design, testing, wear, and fatigue on the life of aircraft and on air safety.

It also expanded the research mission of the FAA to include research to improve maintenance technology and the detection of cracking, delamination, and corrosion of aircraft structures. Pursuant to this Act, the FAA developed the National Aging Aircraft Research Program of which the Inspection Systems Research is a major program area.

The inspection systems research program is divided into two parts: Inspection Systems Development and Inspection Systems Validation. Within the Inspection Systems Development program area, tasks have been grouped into five categories.

Crack Detection. This research is directed at improving the sensitivity and reliability of techniques to detect and characterize small, inter-layer, and obscured cracks characteristic of widespread fatigue damage and improving the sensitivity of techniques to detect small cracks in engine Technologies of current components. general interest include: laser ultrasonics, pulsed eddy current (shown in the photograph), superconducting quantum interference devices (SQUID), ultrasonic pulse compression, energy sensitive x ray for engine case inspection, dual probe ultrasonics, electromagnetic acoustic transducers, advanced electromagnetic sensors for widespread fatigue damage assessment, and an advanced penetrant



inspection technology. Tasks focused on engine rotating components include: a portable eddy-current instrument and scanner, specifications for a shop eddycurrent scanner, a data acquisition and analysis system, a low-pressure rotor rotator, a study of the applicability of eddy-current arrays to engine disk inspection, 2D and 3D image display and signal and image processing algorithms, and an optimal eddycurrent probe for typical engine disk inspections.

Bond Integrity Verification. This research is developing noninvasive techniques to detect and characterize disbonding and understrength bonds in skin splices and developing noninvasive techniques to detect and characterize flaws in composite structures. Technologies of current interest include: thermography (thermal wave imaging), low-frequency ultrasonic scanning, air-coupled ultrasonics, and capacitive array sensors (for inspection of composites).

**Corrosion Detection.** This research is focused on developing noninvasive techniques to detect and characterize corrosion in skin splices and other airframe structures. Technologies of current interest include: magneto-optic eddy-current imaging (MOI); pulsed eddy current; optical enhancement of surface contour (D-Sight); and portable, lowradiation hazard, real-time x ray.



Robotics and Automation. The capability and reliability of inspection systems will be enhanced by developing faster more accurate means of deploying the probes and interpreting probe signals. Technologies of current interest include: signal processing for sliding and rotating eddy-current probes, self-focusing ultrasonics, and signal processing for ultrasonic billet inspection.

Process Control and Quality Assurance. Inspection methodologies are being developed for engine and airframe components which, when applied in the manufacturing environment, can reduce the occurrence of latent defects capable of causing severe in-service failure. This task area is presently focused on multizone and focused array ultrasonics for billet inspection.

Accurate assessments of the reliability of inspection techniques are critical to the effectiveness of any continued airworthiness program. The Inspection Reliability and Validation initiative encompasses several approaches including experimental analysis, maintenance data analysis, and simulation to assess the reliability of inspection techniques. The six specific tasks under this task area are:

Reliability Assessment Tool. Methods, algorithms, and hardware are being developed to assess the reliability of conventional and emerging inspection equipment, materials, and systems.

Visual Inspection. This task area will quantify the reliability associated with the visual inspection of aircraft, identify areas where visual processes can be improved, and identify methods for enhancing the reliability of the visual inspection process.

Task Structured Experiments. Experiments are designed to provide FAA Certification and Flight Standards Offices with independent, quantitative evaluations of current practices and to assess and compare emerging nondestructive inspection technologies and procedures for application to specific aircraft structures.



Liquid Penetrant Evaluation. A capability will be established at the FAA Aging Aircraft Nondestructive Validation Center (AANC) to maintain a working penetrant qualification process following USAF guidelines to assist industry in the evaluation of penetrant inspection materials, products, systems, and technology.

Composite Reference Standards. A set of composite calibration standards will be developed to be used for nondestructive testing equipment calibration during damage assessment and postrepair inspection of commercial aircraft composites.

Technology Transfer. To expedite industry's acceptance of the new and emerging inspection technologies developed by the FAA's Inspection Research Program, technologies selected for transfer are those which will improve safety and, where possible, reduce inspection costs.

To find out more about the Aging Aircraft Inspection Systems Program, contact:

- Airport and Aircraft Safety Research and Development Division
- Airworthiness Assurance Research and Development Branch
- Maintenance, Inspection, and Repair Section, AAR-433

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