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Technology Development, Validation, and Transfer Via the FAA Airworthiness Assurance Validation Center

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In 1991, the Federal Aviation Administration (FAA) established an Airworthiness Assurance NDI Validation Center (AANC) at Sandia National Laboratories. Its primary mission is to support technology development, validation, and transfer to industry in order to enhance the airworthiness and improve the aircraft maintenance practices of the U.S. commercial aviation industry. The Center conducts projects in a myriad of engineering disciplines. The results are placed in the public domain so that the industry at-large can reap the benefits of FAA-funded Research and Development efforts. To support the Center's goals, the FAA/AANC has set up a hangar facility at the Albuquerque International Airport which contains a collection of transport and commuter aircraft as well as other test specimens. The facility replicates a working maintenance environment by incorporating both the physical inspection difficulties as well as the environmental factors which influence maintenance reliability.

Sandia's charter with the FAA includes a wide array of airworthiness assurance disciplines such as nondestructive inspection, structural mechanics, engines, landing gear, crashworthiness, computer science, fire safety, and advanced materials. In its existing role with the FAA, Sandia's Airworthiness Assurance NDI Validation Center works with researchers, aircraft manufacturers, and airlines to foster new technologies associated with civil aircraft maintenance and structural repair. The basic goal is to support the development and evaluation of new technology.

A key aspect of Sandia's ability to carry out this work is the utilization of a formal validation process which matches specific test activities with a technology's state of maturity. This validation process has been reviewed and approved by the aviation industry. It has been used in numerous projects to optimize technology fusion and subsequent transfer to airline end users.

The AANC can support customers in numerous technical disciplines. AANC's main role in each technical discipline would be validation and the integration of new technology into FAA/Air Force/NASA laboratories, Department of Defense (DoD) maintenance and logistics centers, and commercial aircraft maintenance depots as appropriate. The sections below discuss AANC's background in aircraft industry technology that can support the goals of government and industry customer programs.

The evaluation expertise and test capabilities available at Sandia National Laboratories provide a balanced combination of technology development and performance assessment from parallel hardware tests. The test specimens may range from simple, idealized structures to complex, multi-element structures. These structures may also include additional variables such as material flaws or other off-design conditions. In addition to the NDI validation laboratory, Sandia's capabilities include a broad range of test facilities relevant to aircraft and other structural analysis. The physical parameters to be measured may include load, acceleration, stress/strain, displacement, flaw growth, energy dissipation, natural frequencies and mode shapes, and damping.

Validation and Technology Transfer

Key to carrying out the government or industry initiatives is a formal validation process developed by AANC which matches specific test activities with a technology's state of maturity. Technology validation involves the independent, quantitative and systematic evaluation of both the reliability and implementation costs of a design, analysis, or process. The objective is to provide quantifiable evidence that a particular technology is capable of achieving a satisfactory result. The validation process takes into account a number of specific issues ranging from human factors to the construction of suitable Validation Assemblies (test articles) to the need for comprehensive and uniform validation exercises. It has been used in numerous projects to optimize technology fusion and subsequent transfer to maintenance depot end users. Some examples of successful, multi-discipline projects with industry include:

1. Eddy Current Inspection Reliability Experiment - This experiment was the first in civil aviation history to assess the reliability of existing aircraft inspections. It determined the probability of detecting cracks around rivet holes using standard eddy current techniques.

2. DC-9 Wing Box Inspection - The AANC teamed with Northwestern University, Northwest Airlines, McDonnell Douglas, and SAIC to produce an improved method for inspecting DC-9 aircraft. An ultrasonic technique was validated and transferred into a cost-saving field application for the inspection of corrosion in the DC-9 wing tee caps.

3. Application of Composite Doublers on Commercial Aircraft - The AANC led a team including Delta Air Lines, Lockheed-Martin, and Textron to produce the first use of bonded composite doublers on U.S. commercial aircraft. Through the use of laboratory test structures and flight demonstrations on an in-service L-1011 airplane, this study investigated composite doubler design, fabrication, installation, and nondestructive inspection issues. The AANC consulted Air Force expertise to introduce this new repair technique to commercial aircraft and obtained FAA approval for its use.

4. Evaluation of RAPID Repair Design Software - The FAA is developing a PC software package (Repair Assessment Procedure and Integrated Design - RAPID) to assist in the design and analysis of structural repairs to commercial aircraft. The AANC has supported this effort by conducting a series of laboratory experiments that assessed RAPID damage tolerance analysis capabilities for complex repairs. Large-panel fatigue tests on engineered repair specimens were used to compare RAPID predicted residual strength, crack growth, and rivet load predictions with experimental measurements. The continued development of RAPID was guided by these validation benchmarks.

5. Visual Inspection Reliability Assessment - The AANC conducted experiments, using inspectors from industry, to assess various visual acuity aspects of aircraft inspections. The Air Transport Association Inspection Subcommittee feels that the experiment results will induce improvements in today's maintenance practices.

6. Full-Scale Aircraft Structure Testing - The AANC has conducted both in-situ and laboratory full-scale tests on aircraft structure. Fuselage pressurization tests were performed on the AANC Boeing 737 Transport Aircraft Testbed in order to study the phenomenon of Widespread Fatigue Damage (WFD).

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Also, to support the assessment of composite doubler repair technology, the AANC developed a biaxial test facility for testing aircraft fuselage sections. The facility is capable of providing computer-controlled pressure and axial loads to a curved, 14' X 14' aircraft panel.

7. Evaluation of Space Shuttle Attachment Fixtures - Sandia provided NASA/Boeing with a newly manufactured and tested airborne support equipment assembly. Three axis, design verification load tests were conducted on fracture critical flight hardware assemblies using computer controlled hydraulic actuators. The new assembly permits the launch of heavier payloads on future space shuttle missions.

8. Integration of Thermography Into Air Force Maintenance – The AANC conducted a comprehensive assessment of the application of thermography to detect flaws in composite and metallic honeycomb structure and bonded composite doublers. The program also included the integration of thermography (training, manuals, procedures) into the Air Logistic Centers.

9. Air Force Structural Repair of Aging Aircraft Program - The AANC has partnered with Boeing to develop, validate, and produce an enhanced ultrasonic scanning system to address a myriad of metallic and composite inspection problems. The project, currently underway, involves structural integrity issues and will match damage tolerance needs with inspection sensitivity and probability of flaw detection.

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy under contract DE-AC04-94AL85000.