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Crack Detection on HU-25 Guardian Aircraft

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Abstract

An ultrasonic inspection method was developed at the Federal Aviation Administration's Airworthiness Assurance NDI Validation Center (AANC) to easily and rapidly detect hidden fatigue cracks in the copilot vertical windshield post on United States Coast Guard (USCG) HU-25 'Guardian' aircraft. The inspection procedure locates hidden cracks as small as 3.2 millimeters emanating from internal fastener holes and determines their length. A test procedure was developed and a baseline assessment of the USCG fleet conducted. Inspection results on forty-one aircraft revealed a good correlation with results made during subsequent structural disassembly and visual inspection of selected aircraft.

Background

The USCG deploys HU-25 'Guardian' aircraft for medium range surveillance to satisfy the needs of the maritime community. The USCG monitors radio coverage on distress frequency bands for recreational boats and commercial craft. When emergencies occur, the HU-25 is deployed to aid the search and rescue mission. Other HU-25s are specifically outfitted to perform other unique functions such as drug interdiction and environmental compliance monitoring. The Aircraft Repair & Supply Center (ARSC) is the engineering center for the fixed wing aircraft. One role of ARSC is to examine existing or impending problems for the HU-25 fleet, then seek solutions based upon scientific advancements in science and technology. ARSC has created an aggressive program of research and development in the area of nondestructive inspection to support appropriate advancements to the HU-25 maintenance program. ARSC concentrates on areas of interest where there is potential for high payoff to increase quality and productivity. ARSC then conducts tests and evaluations in conjunction with its support activities, to improve its mission effectiveness and efficiency. To this end, ARSC completed a Work-for-Others (WFO) agreement with Sandia National Laboratories - AANC. The mutually agreed upon Scope of Work specified that AANC would study and recommend nondestructive inspection techniques that could help the ARSC better use their assets to extend the service life of their HU-25 fleet.

The first task in the WFO agreement was to receive, prepare, and store a HU-25 aircraft in the AANC hangar (Figure 1). This task was completed in June 1994. The second task was to develop a detailed understanding of the HU-25 maintenance procedures and determine if NDI could augment the current maintenance program. ARSC directed the AANC to concentrate its efforts on the fixed copilot

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DISCLAIMER

Figure 1. Deployment of Coast Guard Aircraft at the AANC.

windshield post. During heavy maintenance checks, ARSC discovered fatigue cracks developing in the vicinity of internal fastener holes of the copilot vertical windshield post. To visually inspect this area, windshields must be removed from the aircraft. This inspection requires 35 man-hours to perform (30 hours for disassembly, window removal and reassembly; 15 minutes to inspect; and 4.75 hours for functional pressure check of the aircraft after reassembly). ARSC requested the AANC to develop a portable inspection technique which could detect and characterize the fatigue cracks without performing the disassembly and visual inspection.

Inspection Development

A 3 mm diameter, 20 Mhz transducer was selected to evaluate a known flawed windshield frame removed from an aircraft during a heavy maintenance check. The transducer was placed on the top surface of the windshield post. The inspection of the flawed sample revealed the location of: the web thickness (backwall echo), shallow and deep rivet fastener holes in the windshield post structure and fatigue cracks emanating from fastener holes (Figure 2). The technique was deployed on the HU-25 at the AANC hangar. After a successful hangar implementation, a field demonstration was conducted on additional aircraft at ARSC. Six HU-25 aircraft were inspected. Three aircraft were clear of fatigue cracks and three possessed single (3 mm in length) to multiple cracks (54 mm in length) in the window post. Subsequent to this field demonstration, ARSC requested that an initial baseline inspection be performed on all its operational aircraft.

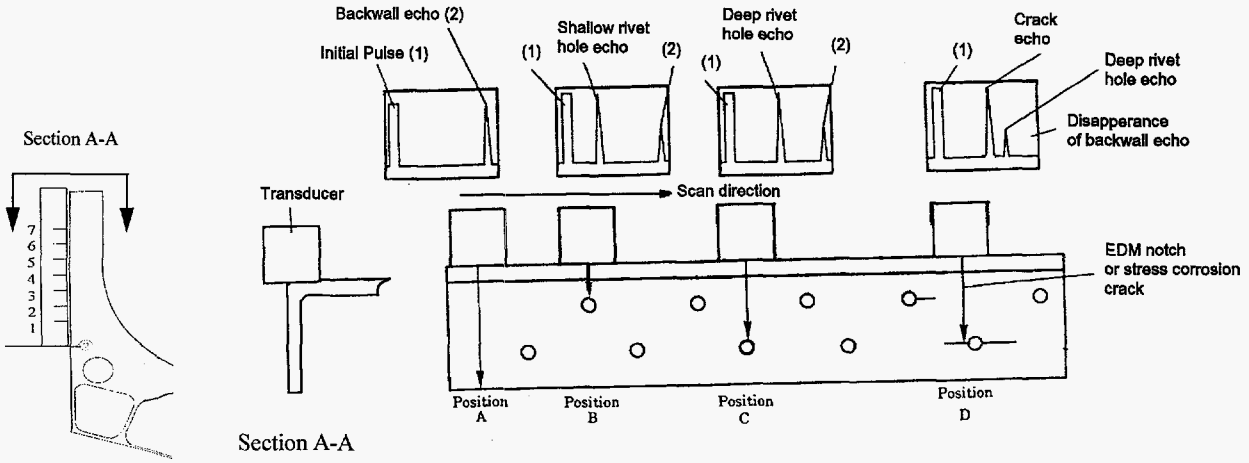

Figure 2. Window post frame, inspection region (Section A-A) and representative signals produced by an ultrasonic flaw instrument.

Baseline Inspection Results

The baseline inspection of the USCG HU-25 operational fleet was conducted in three weeks at the following Coast Guard Air Stations: 5 at Mobile, AL, 3 at Corpus Christi, TX, 3 at San Diego, CA, 2 at Cape Cod, MA, 6 at Miami, FL, 1 at Fort Worth, TX and 7 at Elizabeth City, NC. Of the 27 aircraft inspected, 20 were found to be free clear of detectable cracks in the co-pilot window post. Of the seven that possessed cracks four were considered small, i.e. less than 25.4 mm. Two of the seven had window posts with larger cracks, i.e. greater than 25.4 mm but less than 102 mm and one aircraft failed the upper length requirement of 102 mm.

Conclusions

As part of a Work-for Others agreement between the USCG and Sandia, one area which received significant attention resulted in the development, demonstration of capability, and drafting of an inspection procedure to identify and document cracks which have been known to occur in HU-25 copilot vertical fixed windshield posts.

Application of this ultrasonic inspection requires less than an hour. Additional advantage of using NDI is that it does not require any mechanical disassembly, reassembly or pressurization verification testing. This represented a fleet-wide savings in excess of $80,000 and 90 operational days. In addition, 6 operational aircraft were able to be kept in service and placed in an NDI monitoring program.

Acknowledgments

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