Inspection of Tail Boom/Fenestron Junction Frame on EC130 B4 Eurocopter Aircraft Using Phased Array

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Abstract

Following the issue of an information notice reporting cracks in the tail boom/fenestron junction frame, Eurocopter has released an Emergency Alert Service Bulletin (EASB) providing the corrective action to be taken.

The bulletin requires paint stripping and a visual check every 100 flight hours. Stripping and repainting incurs significant cost, and would most likely result in just primer paint being applied, which detracts from the appearance of the aircraft. An ultrasonic phased array inspection technique through paint in lieu of visual crack detection (which requires paint removal) has been developed and proposed as an alternative means of compliance to Transport Canada, and is now effective.

This paper presents the current problem, how phased array has been used to reduce inspection cost and time as well as providing a higher level of confidence.

Keywords: Phased array inspection, helicopter, ultrasound inspection through paint, alternate means of compliance.

1. Introduction

To ensure the highest level of safety and get the most of their helicopters, operators are subject to a strict maintenance and overhauls program through the whole life cycle of their aircraft. As part of this program, periodic inspections are required based on the manufacturer recommendations. When reports indicating possible issues with the aircraft are received by the manufacturer, an Airworthiness Directive (AD) can be published by the appropriate Agency. In the latest case, the aircraft cannot be flown except in accordance with the requirements of that AD. On the Eurocopter EC 130 B4 helicopters', such an AD has been issued following findings of cracks in the tail boom / fenestron junction frame. The AD has been followed by an Emergency Alert Service Bulleting (EASB) requiring the aircraft operator to check for cracks in the tail boom / fenestron junction frame. As part of the procedure to be followed for compliance with the AD, the critical area had to be paint stripped for a visual inspection.

The development of an ultrasonic phased array technique has permitted omission of that step and has led to an Alternate Means Of Compliance (AMOC) resulting in significant cost saving for the aircraft owners. Below is presented the problem leading to the EASB, the inspection technique developed and the AMOC approval process along with the resulting benefits.

2. Problem

The Eurocopter Group is the helicopter manufacturer of the EC 130 B4 model. This helicopter model is used by rescue team as well as by private owners. Following reports indicating findings of cracks in the tail boom / fenestron junction frame Eurocopter issued the EASB on June 14th 2011. According to the EASB, "the cracks start in the plane of the rivet head countersinks on the right-hand side of the Fenestron and spread to the web of the frame"[1]. If not detected, the cracks could lead to a structural failure, meaning that the tail boom / fenestron could be separated resulting in a loss of control of the helicopter.

Helicopter's owner have the option of applying the structural modification (EC modification 073880) solving this issue or comply with the repetitive inspections made mandatory by the AD.

The compliance to the AD requires stripping the paint from the area on the outside of the frame as shown below at position a. The paint stripping ensures that all rivet heads are made visible to the naked eye.

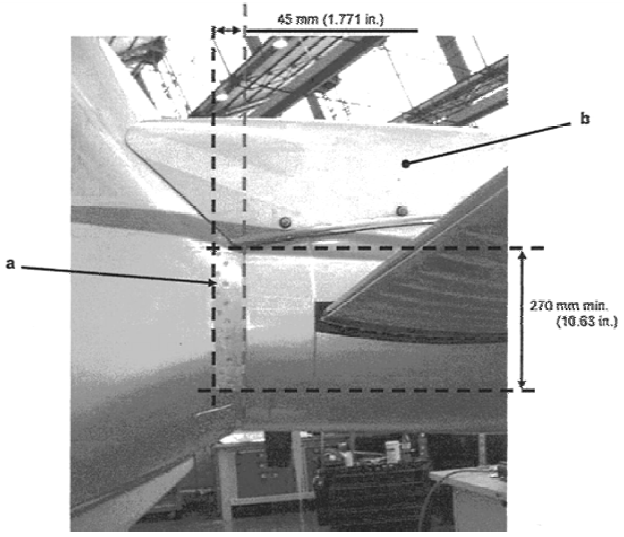

Figure 1: Paint strip area at the tail boom / fenestron junction frame

For many aircraft owner's stripping was the preferred choice as performing the EC modification 073880 was required grounding the helicopter for a significant period of time with a high cost of repair. Stripping and repainting the frame every hundred flight hours was

[1]Eurocopter, "Emergencey Alert Service Bulleting 53A019", pp 3, June 2011

obviously not feasible. However, permanent stripping of the frame, which detracts from the appearance of the aircraft, wasn't a fully satisfactory. For several helicopters operators, leaving the aircraft unpainted was not an acceptable situation. Approached by some helicopters owners, TORNGATS Technical Services undertook the challenge of proposing an improved solution using the Sonatest veo phased array flaw detector.

3. AMOC Approval Process and Inspection Technique

Ultrasonic inspection through paint is a common practice in the industry with equipment such as thickness gaged. Phased array ultrasonic inspection has also been successfully used through paint for different applications. The development of a new inspection technique has been undertaken on this basis and with the confidence that an Alternative Means of Compliance could be approved for "alternative inspection procedures"[2].

The Canadian authorities states that "under no circumstances shall a request for an exemption to a foreign AD be made directly to a foreign issuing authority"[3]. This means that all AMOC application have to be made directly to a local Transport Canada Center. This approach has been strictly followed, leading to the issue of detailed inspection procedure submitted to Transport Canada, as an AMOC request. The key requirements for the approval of an AMOC is the demonstration that the alternative mean of inspection is "offering a degree of safety at least equivalent to that offered by compliance with the AD[4]". This has been achieved by submitting the procedure and results from manufactured samples which have been presented to Transport Canada NDT experts and accepted.

Prior submitting the exact details of the proposed changed, preliminary tests have been conducted on a first aircraft to evaluate the feasibility of using ultrasonic phased array for the detection of cracks at the tail boom/fenestron junction frame. It has been clearly validated that indications from fastener holes could be properly detected. Each fastener returned a loud echo with a distinctive ultrasonic signature. It was then confirmed that the complete area of interest could be inspected using a small foot print and high frequency transducer. As it can be seen on Figure 1, a small foot print was required due to the curved shape of this critical region. The next step consisted in preparing samples of the same material and thickness with identical fastener holes. Notches have been added with their initiating point at the edge of the fasteners holes. Different paint thicknesses have been applied to monitor the effect of the paint on crack-like indications. The material being tested had a nominal thickness of 70 mil (1,78mm) and the maximum paint layer was 25 mil (0,63mm). An attenuation of up to 6dB has been measured on the calibration sample for the thickest layer of paint. Figure 2 shows a typical echo from a fastener with no cracks.

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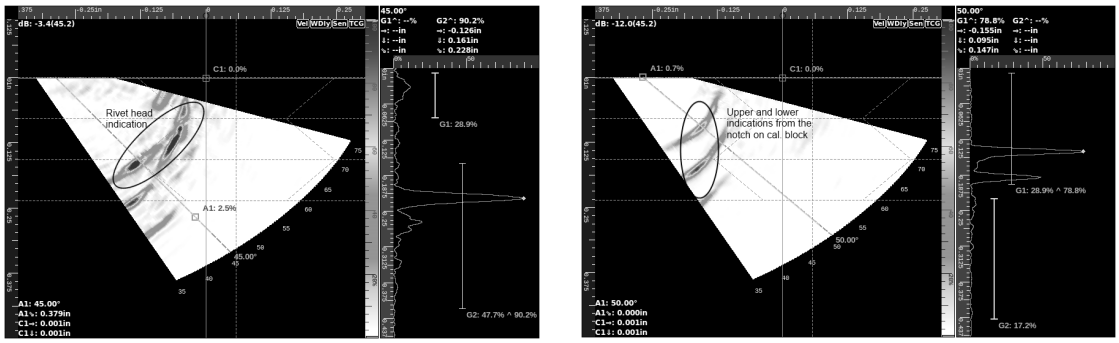
[2] http://www.tc.gc.ca/eng/civilaviation/regserv/cars/part6-standards-a625h-2464.htm, (3) Exemptions and Alternatives Means of Compliance.
[3] http://www.tc.gc.ca/eng/civilaviation/regserv/cars/part6-standards-a625h-2464.htm
[4] http://www.tc.gc.ca/eng/civilaviation/regserv/cars/part6-standards-a625h-2464.htm, (3) Exemptions and Alternatives Means of Compliance.

The inspection is carried using a sectorial scan with a high gain sensitivity. The first goal is to ensure crack detection. If there is presence of a crack, then the location and length of the crack will dictate the action to be taken.



a b

Figure 2: Example of a rivet head indication with no crack (a) and indication from a notch (crack-like indication) (b)

Since approval, the inspection has been performed on a number of aircraft. It typically takes less than 1 hour to perform the inspection. As a reference, a crack grown outside the rivet head from 1/16" (1, 6mm) would most likely be detected, and from 1/8" (3,2mm), it would have a high probability of detection. It ends up to have a similar efficiency than a visual inspection after paint stripping but with a higher level of confidence. It has actually been asked by some clients to perform the phased-array inspection even on stripped surface to add confidence to their visual inspection.

4. Conclusion

This alternative phased array inspection has been approved by Transport Canada and meet the requirements of the AD. The technique is mostly directed to aircraft operators with great aircraft esthetical concerns, but has proved itself to be beneficial for any aircraft owners affected by the AD. It proved that phased array ultrasonic inspection is a very versatile NDT method even on thin material through paint.