

No: 1/92 **Ref:** EW/C91/9/4 **Category:** 2c

Aircraft Type and Registration: Enstrom 280FX, G-BSIE

No & Type of Engines: 1 Lycoming HIO-360-F1AD piston engine

Year of Manufacture: 1990

Date & Time (UTC): 30 September 1991 at 1405 hrs

Location: Near Thruxton Aerodrome, Hampshire

Type of Flight: Private

Persons on Board: Crew - 1 Passengers - 1

Injuries: Crew - None Passengers - None

Nature of Damage: Tail rotor gearbox and spindle broken,
minor damage to tail rotor and guard

Commander's Licence: Private Pilot's Licence with
Assistant Flying Instructor's rating

Commander's Age: 52 years

Commander's Flying Experience: Approximately 2,000 hours
(about half on rotary wing aircraft and 500 on type)

Information Source: AAIB Field Investigation

The helicopter was on a short local flight from Thruxton Aerodrome. As it was returning to rejoin the Thruxton circuit the pilot felt a high-frequency vibration followed rapidly by a massive airframe vibration and a loud bang. The aircraft started to yaw to the right and the pilot found the yaw pedals had seized. He entered autorotation using engine power to control the yaw and performed a successful forced-landing in a field about one and a half miles north of Thruxton, incurring no further damage to the machine. Upon initial examination, he found that the tail rotor gearbox casing had separated into two pieces (see photo). The aft part had slid rearwards, disconnecting the output from the input gear, until it was restrained by the tail rotor control cables. It had then swung downwards, causing minor damage to the tail-rotor guard and nicking one of the tail rotor control cables. The commander, who held an Assistant Flying Instructor's rating, considered that the accident could have been much more serious had it occurred to a student or low-time pilot.

Subsequent examination also revealed that the tail rotor spindle, part number 28-150064-11, had fractured across one of the teeter bearing housings (see photo). This had not, surprisingly, led to liberation of the entire tail rotor assembly but meant that the blades were no longer co-axial and must

therefore have generated substantial out-of-balance forces. Visual inspection showed clear evidence of fatigue damage involved with the fracture and it is considered that this was the primary failure which led to a secondary failure of the gearbox. The broken items were removed and submitted for metallurgical examination.

The metallurgist's report confirmed the presence of long-term fatigue damage in the fractured spindle. Indeed, the failure was almost entirely in fatigue with very little static overload. One side of the bearing housing had failed in long-term fatigue occurring over millions of cycles whilst the other had failed over a shorter term involving hundreds, possibly thousands, of cycles. Thus the fatigue initiation had occurred early in the life of the part and progression was probably associated with tail rotor RPM frequency on one side of the housing before additional loads transferred to the other side of the housing and caused this to fail in fatigue at a higher rate more closely associated with flight cycles. This implies that a crack existed on both sides of the spindle fitting over a considerable number of flight cycles. The part was original-build on G-BSIE and had only accrued some 285 flying hours. The cause of the primary fatigue initiation was considered to be "stress-raisers" caused by surface discontinuities in the as-forged and descaled surface and/or flaking caused by a poor shot-peening process. The metallurgical report also confirmed that the gearbox case fracture was a secondary event following on from the spindle failure.

Enstrom Service Directive Bulletin No.0077

On 12 February 1988, the Enstrom Helicopter Corporation issued the above bulletin applicable to the 280FX model and several others including those which may have been converted to use this part number spindle. The bulletin called for as "mandatory", a visual inspection using a 10-power magnifying glass of the area of the spindle where the failure on G-BSIE occurred. This was called-for on a repeat daily basis and it was also required that some disassembly be carried out within 25 flying hours to allow a dye-penetrant crack check to be performed. The latter was then to be repeated at 100-hour intervals. The bulletin cited one known case of a crack occurring in the affected spindle type and implied that research work was being undertaken which could lead to modification or other action to relieve these requirements. There was, however, no further communication on this subject nor was it made the subject of any form of Airworthiness Directive action by either the FAA or the CAA and thus it had no official mandatory status. Discussion with the manufacturer revealed that the original discovery of a crack which led to the Service Directive Bulletin remained the only report until the last few months when two further reports were received before the failure occurred on G-BSIE.

The owner/pilot of G-BSIE stated that he was aware of the daily visual check as required by the Enstrom Service Directive Bulletin and that documentation existed to prove that the dye-penetrant

check had been performed by his maintenance organisation at about the time of the last 100-hour check, 81 hours previously. The metallurgical examination found no evidence of penetrant or developer either in the crack or around the area. In addition it was recognised that the initiation point of this particular fatigue failure was such that it would have been difficult to detect by visual examination and may have been obscured by excess grease from the pitch bearings. Developing cracks could also be hidden by the teeter bearing cap locking wires.

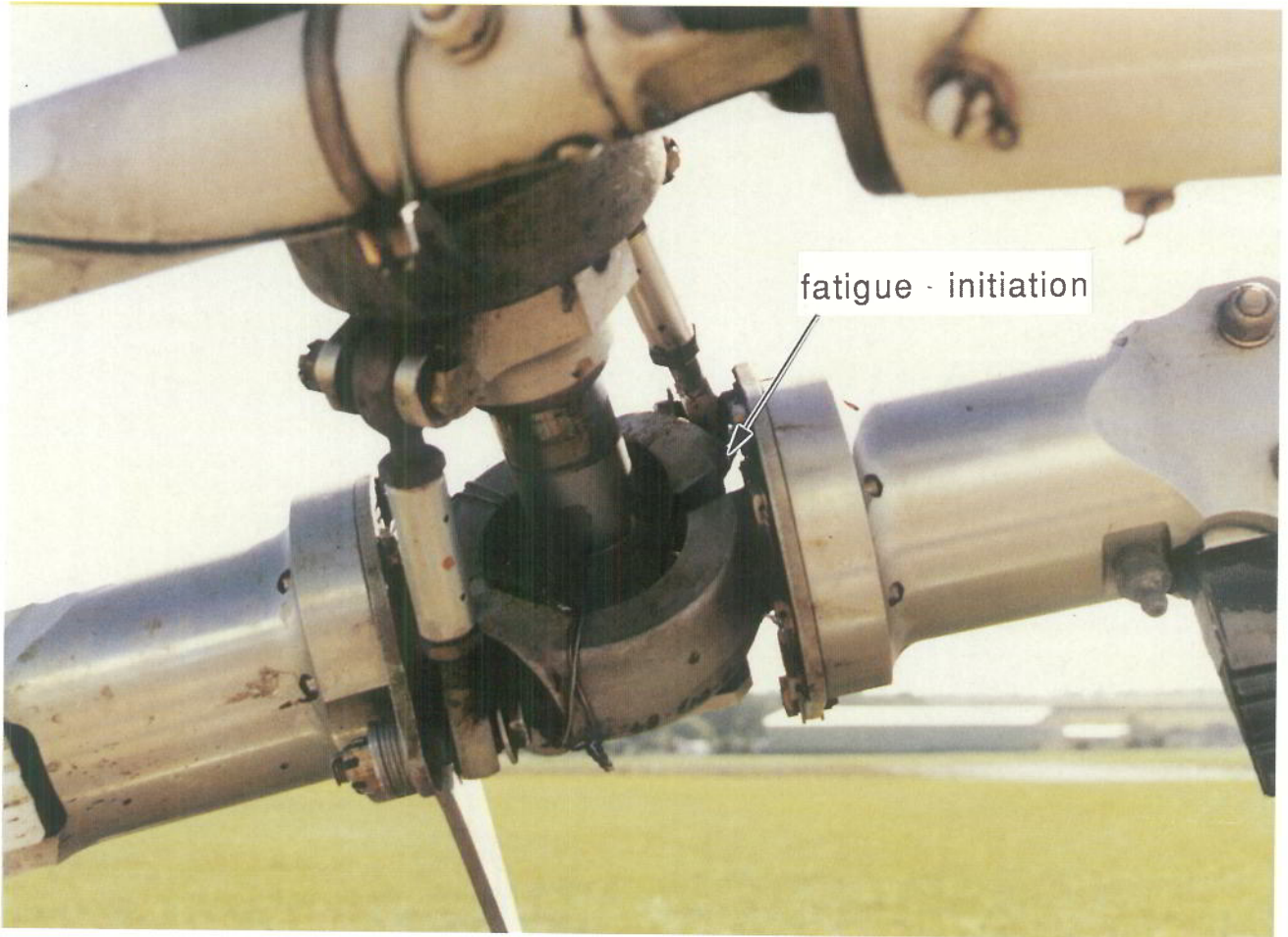
Subsequent Actions

On 4 October AAIB made the following recommendation to the CAA:-

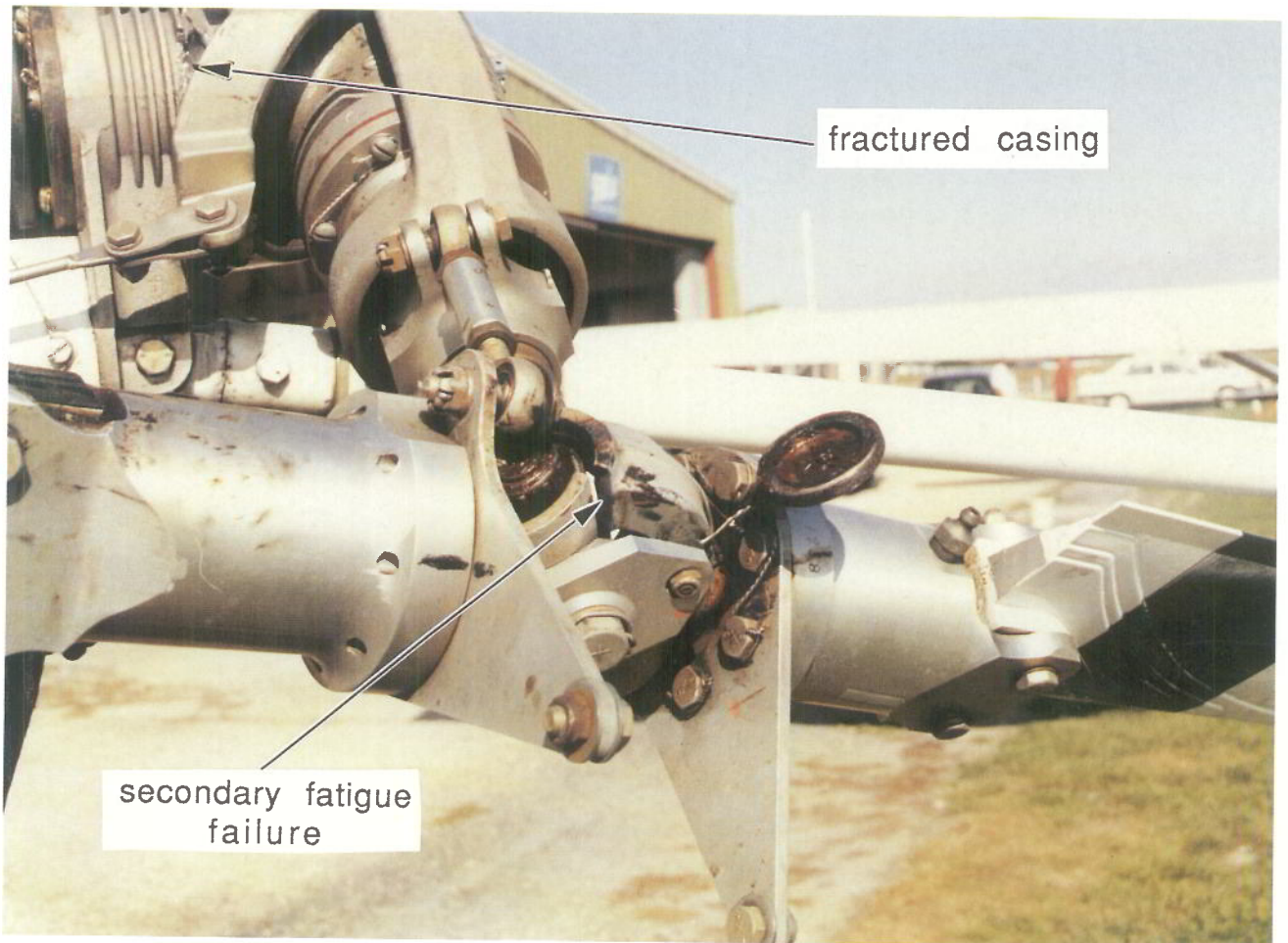
"The Civil Aviation Authority should urgently consider making Enstrom Service Bulletin 0077 mandatory as an interim measure. Compliance requires a visual inspection (described in the SB) before further flight and on a repeat daily basis. The authority should also emphasise the necessity to inspect under the bearing cap locking wires which could obscure indications of a crack."

The AAIB also requested the CAA to review the situation which exists when a Service Bulletin is considered mandatory by the manufacturer but is not given official endorsement by Airworthiness Directive action and also where long-term airworthiness can be reliant on detailed daily inspection by pilots.

On 8 October, the CAA issued Emergency Airworthiness Directive 001-10-91. This called for an immediate, once-off, visual inspection of the affected tail rotor spindles by qualified personnel and advised that a further Directive was likely to be issued following discussions with the manufacturer and the FAA.



G-BSIE - view showing inboard face of fractured tail-rotor spindle



G-BSIE - view showing fractured tail-rotor gearbox casing