No: 9/91 **Ref: EW/C1195** **Category: 2a**

Aircraft Type and Registration:	Bell 214ST, G-BKFN
No & Type of Engines:	2 General Electric CT7-2A turboshaft engines
Year of Manufacture:	1982
Date & Time (UTC):	24 December 1990 at 1856 hrs
Location:	Near the Cormorant A platform in the North Sea
Type of Flight:	Public Transport
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Serious failure of fin structure
Commander's Licence:	Airline Transport Pilot's Licence (Helicopters)
Commander's Age:	43 years
Commander's Flying Experience:	9,692 hours (of which 916 hours were on type)
Information Source:	AAIB Field Investigation

The crew were to fly G-BKFN from Unst, at the north of Shetland, to the Cormorant A platform from where they were to carry out a series of inter-rig shuttle flights to the Safe Supporter accommodation vessel which was located close to the Dunlin A platform, some 20 nm to the north-east. The forecast weather for the period was broken cumulus/cumulonimbus cloud, base 2,600 feet, visibility over 10 km and a wind of 210°/30 kt. Later in the period wind gusts of 80 kt were forecast.

Both crew were well rested and took-off from Unst at 1716 hrs with the commander handling the aircraft. There were no passengers or freight and the take-off weight was 14,367 lb (Maximum Take-off Weight 17,500 lb). The transit was flown at a speed of 135 kt using the standard power setting of 70% torque. The flight was uneventful apart from some turbulence encountered near cumulonimbus cloud. On arrival at the Cormorant A, the commander handed control to the co-pilot because, given the wind conditions, the left hand seat afforded the best view of the landing area. Some turbulence from the rig structure was encountered on this and all subsequent landings and take-offs. G-BKFN then completed two return trips to the Safe Supporter with between 16 and 18 passengers, but with no significant freight. Transits were flown at 118 kts using 70% torque, however significantly higher torques were used during take-off and landing. Having completed their first inter-rig shuttle task, the crew intended flying to the Dunlin A platform to refuel prior to a further shuttle task. There were no passengers or freight onboard and the aircraft weight was now 13,227 lbs. Given the aircraft's light weight and the prevailing wind, the co-pilot needed to use only 70% torque for the take-off. On becoming airborne, G-BKFN was accelerated to 80 kts and turned from 210° left onto 070° while climbing to 500 feet. At 500 feet, the co-pilot levelled the aircraft and allowed it to accelerate. On reaching 110 kts, the crew became aware of a low amplitude vibration with a frequency somewhere between a 'buzz' and 'once per rotor-revolution'. There was no associated noise, no handling problem and no indication on the flight deck instruments to indicate a malfunction of any of the aircraft systems. The commander took control of the aircraft and lowered the collective lever slightly to reduce speed, while maintaining height. As the speed reduced, an additional vibration with a frequency of about one to two per rotor-revolution was noted. On passing 100 kt the crew observed a pronounced lateral cyclical movement which persisted until the speed had fallen below 90 kts. By 80 kts, all vibration had reduced to negligible amplitude and this speed was maintained. The commander decided to abandon his planned flight to the Dunlin A and divert to the Safe Gothia accommodation vessel, which was alongside Brent B platform some 20 miles to the east. The decision to divert to the 'Safe Gothia' rather than other, closer, helipads was conditioned by the forecast of winds gusting to 80 kts and the availability of a hangar on the Safe Gothia. The diversion was uneventful and G-BKFN landed at 1918 hrs, at a weight of 12,800 lb, with 900 lb of fuel remaining following the 29 minute flight.

An initial inspection by the maintenance staff on board Safe Gothia revealed cracks in the fin root structure, in the zone around the 42° gearbox, in both the left hand side skin and the inclined fin front spar web fitting (known as the 'Banjo' fitting). This cracking was deemed sufficiently serious to preclude further flight before the tailboom/fin had been replaced. Although replacement of the tailboom and detailed examination of the failure was severely delayed by bad weather, on 15 January 1991 the manufacturer issued an Alert Service Bulletin calling for inspection of the affected area before the next flight and at 25 hour intervals subsequently.

After recovery the fin and tailboom assembly was examined by AAIB, together with the manufacturer and the operator, at one of the operator's maintenance bases. It was found that the crack in the fin front spar web had progressed across about 80% of the spar width and the crack in the left side skin had progressed about halfway towards the fin rear spar. (The left side skin is predominantly subjected to tensile stress arising from tail rotor loads.) This had resulted in a major degradation of the strength and stiffness of the fin attachment. The position of the crack in the spar web was in such a location that, in normal service, the presence of the 42° gearbox at the fin root and the natural oiliness and dirtiness of the zone would have made the crack difficult to see during routine inspections.

The fin together with the rear section of the tailboom was separated from the main tailboom at a manufacturing joint and taken to RAE Farnborough for detailed metallurgical examination. This revealed that the mechanism of crack initiation and progression in both the spar web and the skin had been by fatigue which had nucleated, in the spar, from a poorly finished rivet hole (No.7 in Fig.1e: associated photographs show the appearance of crack face and hole finish) and in the two rivet holes (No 10 and the adjacent hole above in Fig.1e) just aft of a doubler patch on the left side skin. The fatigue cracks appeared to have propagated steadily at first but the rate had accelerated during the later stages. Evidence of fatigue and shear failures in the two rivets Nos.8 & 9 suggested that they failed completely at the same time and, by joining the two fatigue cracks, lead to the apparently sudden change in the stiffness characteristics. Although the fatigue striations were clearly visible it has not, as yet, been possible to identify any particular load cycle and thereby make an assessment of the period of fatigue growth.

This aircraft had been involved in a previous incident which had necessitated an inspection requiring the removal and deskinning of the tailboom in September 1986. This was done under contract by an approved repair organization who, in consultation with a manufacturer's representative, had fitted the side skin doubler patch at the fin base on the left side of the aircraft whilst rebuilding the assembly. This modification was incorporated before the standard strengthening modification of this area (Technical Bulletin 214ST-88-90) had been designed and approved. (Removal of the doubler fitted to this aircraft revealed that there had been no pre-modification cracking of this tailboom side-skin.)

Alignment of the new holes in the doubler with the existing holes in the spar flange was apparently difficult since the spar side flange twists and curves at this location, making the direction of the rivet holes difficult to judge. The photographs show the resultant damage to the original rivet hole surfaces caused by the drill-bit whilst hole alignment was being attempted. This damage is typical of that expected when rivets are removed and replaced without drilling-out to an oversize diameter and fitting appropriate oversize rivets. However, such an increase in rivet and hole size should not be undertaken without the approval and consent of the design authority and manufacturer.

This tailboom had accumulated a total of 8610 hrs, of which 3884 hrs/2162 cycles had been flown since the side skin doubler had been fitted.

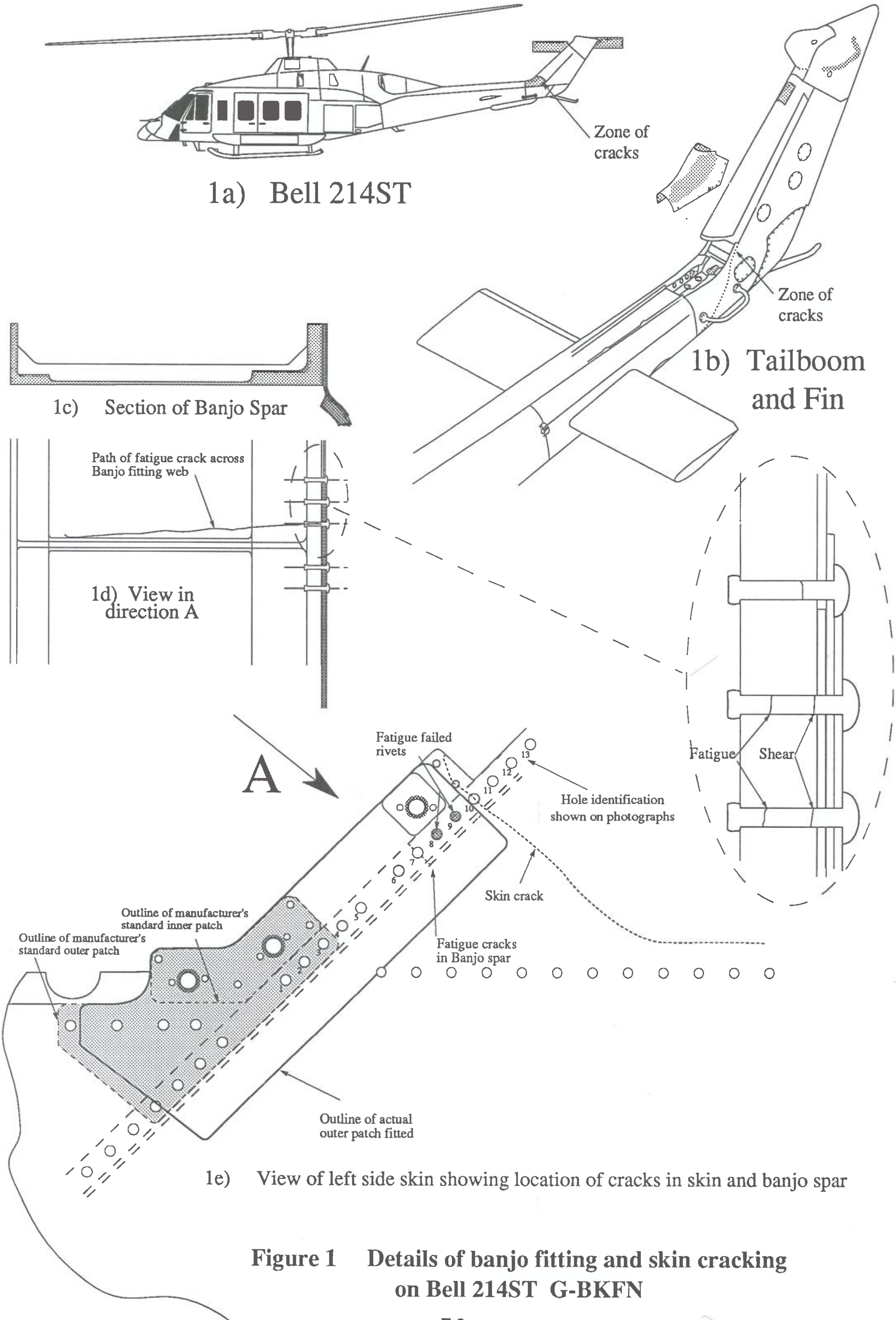
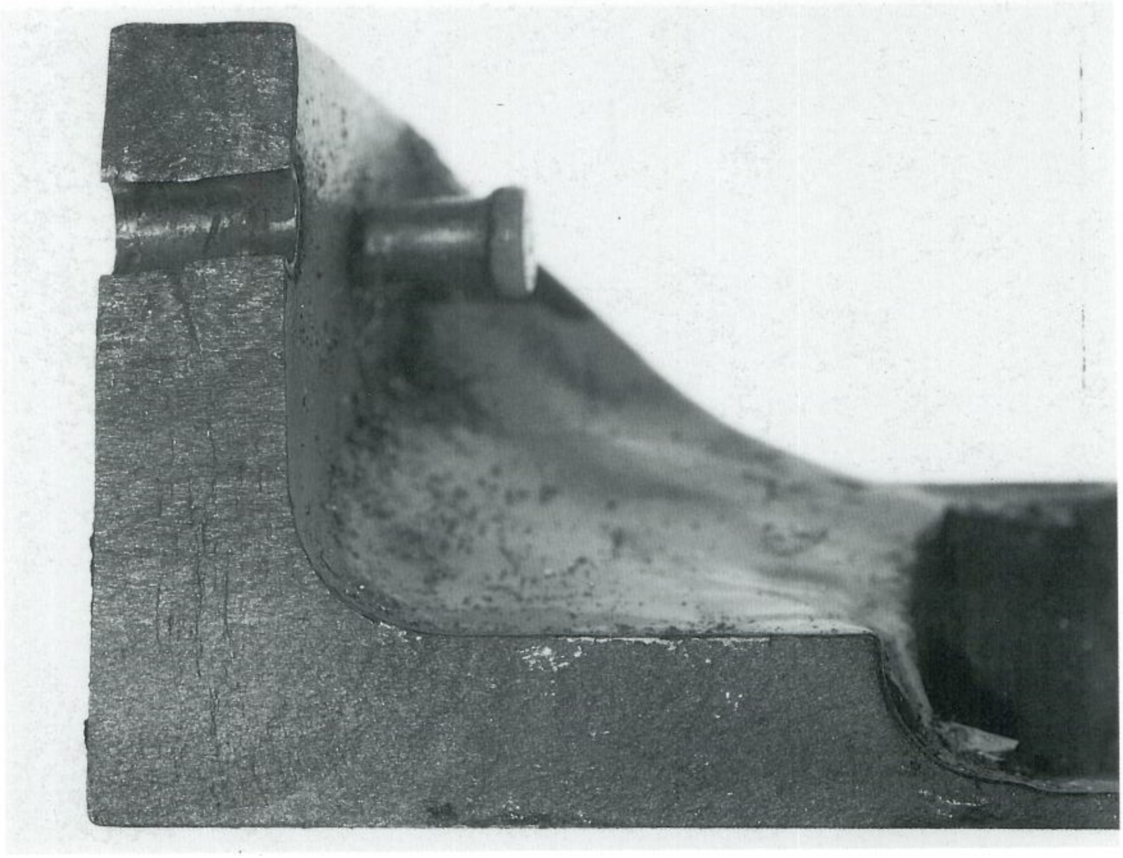


Figure 1 Details of banjo fitting and skin cracking on Bell 214ST G-BKFN



Photograph 1 Fatigue failure zone emanating from rivet hole

Photograph 2 Close up of damaged rivet hole
(note scoring of hole surface and uneven shape)