

ACCIDENTS INVESTIGATION BRANCH
Department of Trade and Industry

**Brantly B-2B Helicopter G-ATJY
Report on the accident at Oxford Airport
(Kidlington) Oxfordshire on 9 November 1972**

List of Civil Aircraft Accident Reports issued by AIB in 1973

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1/73	Douglas DC3 PH-MOA at Southend Airport, June 1971	February 1973
2/73	Bolkow BO 208C Junior G-ATVB near Hambledon, Surrey, January 1972	February 1973
3/73	Beagle 206 Series 2 G-AVAL at Chouppes (Vienne) near Poitiers, France, March 1971	May 1973
4/73	Trident I G-ARPI near Staines, June 1972. Report of the Public Inquiry	May 1973
5/73	Jodel DR 1050 Ambassadeur G-AYEA in Bridgwater Bay, Somerset, March 1972	May 1973
6/73	Fournier RF 4D G-AXJS in the sea about ¼ mile northeast of Skateraw, Kincardine, October 1972	June 1973
7/73	Piper PA-28R Series 200, Cherokee Arrow G-AYPW at Six Ashes Road, Halfpenny Green, Staffordshire, August 1972	September 1973
8/73	Nipper T66 Mark 3 G-AVKT at Burton Constable Hall, Yorkshire, August 1972	August 1973
9/73	Piper PA 30-160 Twin Comanche G-AVFV at Crib-y-Ddysgl, Snowdonia, October 1972	August 1973
10/73	Helicopter Bell 47D1 G-ASJW 1 mile northwest of Saxilby, Lincolnshire, July 1971	September 1973
11/73	Piper PA 30 Twin Comanche G-ASRN at Newbury, Berkshire, June 1972	September 1973
12/73	Brantly B-2B Helicopter G-ATJY at Oxford Airport (Kidlington) Oxfordshire, November 1972	September 1973

Department of Trade and Industry
Accidents Investigation Branch
Shell Mex House
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19 June 1973

The Rt Honourable Peter Walker MBE MP
Secretary of State for Trade and Industry

Sir,

I have the honour to submit the report by Mr G M Kelly, an Inspector of Accidents, on the circumstances of the accident to Brantly B-2B Helicopter G-ATJY which occurred at Oxford Airport (Kidlington) Oxfordshire on 9 November 1972.

I have the honour to be
Sir
Your obedient Servant

V A M Hunt
Chief Inspector of Accidents

Accidents Investigation Branch
Civil Aircraft Accident Report No 12/73
(EW/C428)

Aircraft: Brantly B-2B Helicopter G-ATJY
Engine: Lycoming IVO – 360 AIA
*Registered Owner
and Operator:* Mr C E Rose
Crew: Captain G Meyrick – Instructor – Killed
Mr G S Rose – Student Pilot – Slightly injured
Place of Accident: Oxford Airport (Kidlington) Oxfordshire
Date and Time: 9 November 1972 at 1557 hrs
All times in this report are GMT

Summary

The helicopter was carrying out a local dual training flight. Whilst it was manoeuvring at a height of about 10 feet at the start of its detail a main rotor blade became detached. The subsequent out of balance forces caused the rotor head with the other two blades still attached to separate from its mountings. The helicopter rolled to the right and struck the ground in an inverted attitude before coming to rest on its left side. The instructor was killed and the student pilot received minor injuries. The report concludes that the accident was due to the failure in fatigue of the outboard bearing shaft of the green blade of the main rotor.

1. Investigation

1.1 History of the flight

The helicopter lifted off from outside the British Executive Air Services hangars at Oxford Airport for a dual circuit training flight and flew at slow speed for some 200 yards and then hovered about 10 feet above the ground while awaiting clearance from Air Traffic Control to cross the runway in use and proceed to the area of the aerodrome assigned to helicopters. The clearance having been obtained the helicopter was put into forward flight. Almost immediately there was a loud report. One of the main rotor blades flew off and the rotor head became detached from its mountings. The helicopter rolled sharply to the right, struck the ground inverted and came to rest on its left side.

The instructor, who was sitting in the left hand seat, was killed. The student pilot received minor injuries and was able to release himself from the wreckage. There was no fire.

1.2 Injuries to persons

<i>Injuries</i>	<i>Crew</i>	<i>Passengers</i>	<i>Others</i>
Fatal	1	—	—
Non-fatal	1	—	—
None	—	—	—

1.3 Damage to aircraft

Destroyed.

1.4 Other damage

None.

1.5 Crew information

Captain G Meyrick, aged 58, held a valid Airline Transport Pilot's Licence for helicopters and gyroplanes and was a fully qualified helicopter instructor. He was last medically examined for the renewal of his licence on 12 May 1972. At the time of the accident he had accumulated 7,018 hours flying experience mostly in helicopters.

Mr G S Rose, aged 21, held a Student Pilot's Licence. At the time of the accident he had received about 18 hours flying instruction on helicopters and had flown with Captain Meyrick on several occasions.

1.6 Aircraft information

G-ATJY was a dual control, two-seater, three-bladed helicopter. It was manufactured by the Brantly Helicopter Corporation, United States of America in November 1965. After being test flown it was dismantled and imported into the United Kingdom where it was re-assembled and issued with a certificate of airworthiness in the Special Category valid until 23 March 1973. It had been regularly maintained to a standard beyond that normally required for aircraft in the private and special categories. At the time of the accident it had flown 770 hours. Its weight and centre of gravity were within the specified limits.

The rotor hub of the Brantly B.2 helicopter is conventional but the blades are distinctive in having flapping hinges near the hub and flapping and drag hinges at about 40 per cent of the blade length. The inner portion of each blade consists of a 'pylon' of circular section, with a covering to produce a symmetrical aerofoil section, into the outer end of which the bearing shaft for the outer portion of the blade is screwed during assembly. After being tightened to 2,500 inch/pounds, the union is drilled and pinned.

Once the bearing shaft has been assembled the male threaded portion cannot be inspected without unpinning and removing the shaft. No requirement for such an inspection has ever been included in the maintenance procedures in this aircraft.

The pylon and bearing shaft of the 'green'* blade on G-ATJY had not been removed or replaced since the helicopter's assembly and had therefore completed the same number of flying hours as the helicopter. Although no unusual inflight vibrations had been reported by the pilots who flew the aircraft, the records show that nine satisfactory dynamic balance checks of the main rotor blades were carried out between January 1966 and June 1970. The green outer main rotor blade was replaced in February 1971 in an effort to reduce a small amount of vibration which had been noted during routine maintenance checks. Since that time two further satisfactory balance checks had been carried out.

1.7 Meteorological information

The weather at the time of the accident was partly cloudy with good visibility. The wind was from 220° at 22 knots and the ground temperature was 10°C.

1.8 Aids to navigation

Not applicable.

1.9 Communications

Normal radio communications were established between the helicopter and Oxford tower at the commencement of the flight. No indication of mechanical malfunction was given by the pilot.

* Colours are commonly used to distinguish the blades of a helicopter rotor.

1.10 Aerodrome and ground facilities

Oxford (Kidlington) Airport is a grass aerodrome on which three runway directions are marked, and there is a hard surface runway on the northern side of the airfield. The aerodrome is used mainly as a flying training school for both fixed and rotary wing aircraft. At the time of the accident Runway 21 with a left hand circuit was in use for the fixed wing aircraft, and an area on the northwest side of the field, clear of fixed wing traffic, was assigned for use by helicopters.

1.11 Flight recorders

None required and none fitted.

1.12 Wreckage

The helicopter came to rest on its left side on a heading of 230^o (magnetic). The main gear box and rotor head with the red and blue blades still attached was about 80 feet from the main wreckage. The inner and outer aerofoil sections of the green blade were found about 450 feet to the rear.

Examination of the wreckage showed that the green blade had become detached in flight causing massive vibration and the main rotor and its gear box to become detached from the aircraft structure. Impact marks on the ground indicated that the helicopter had rolled to the right and had struck the ground in an inverted position breaking the perspex canopy before coming to rest.

Examination of the green pylon indicated that the detachment of its blade had been caused by a fatigue failure. The relevant parts of all three blades were therefore sent to the Royal Aircraft Establishment at Farnborough for a detailed metallurgical examination.

1.13 Fire

There was no fire.

1.14 Survival aspects

The pilot's death from head injury was the inevitable result of the aircraft's inverted impact with the ground and it would not have been prevented by a protective helmet. The incorporation of an anti-roll bar within the canopy might have so modified the crash environment as to have enabled him to survive.

1.15 Tests and research

The pylon assemblies of the three blades and their associated bearing shafts were examined at the Royal Aircraft Establishment, Farnborough. The fracture of the bearing shaft of the green blade showed evidence of fatigue crack growth through about 85 per cent of the section. The cracking had

been initiated from the forward face of the male thread inboard of the hexagonal flange and in particular from several origins in the root of the first thread nearest the flange. Evidence of other cracking was found in the root of the fourth thread. It was not possible to determine the rate of growth of the fracture or its relation to blade rotations and flight cycles.

Tensile and hardness tests carried out on the failed bearing shaft showed that its tensile strength was 7 per cent below the Drawing Specifications. Because of the position of the fracture it was not possible to check the load to which the shaft had been tightened into its pylon. However, markings on the end of the pylon and on the inboard face of the hexagonal flange on the bearing shaft suggested that the faces had remained in even contact after being tightened.

The examination of the bearing shaft showed that the thread, (American National type) had been formed by a cutting or grinding process. The American National thread is non-radiused. The poor fatigue-resistance of a non-radiused form of thread, especially when it is produced other than by a rolling process, is well known.

Tests carried out on the pylon assemblies of the red and blue blades showed that the materials conformed to the required specification and that the respective bearing shafts had been tightened to the correct torque.

Checks carried out for tightness and condition during the dismantling of the main rotor assembly revealed no evidence of abnormality.

The investigation into an accident involving a Brantly B-2B helicopter in the United States of America in August 1972 revealed that a fatigue type fracture in the threaded area of a pylon outboard bearing shaft had resulted in the detachment in flight of its associated main rotor blade. On 3 October 1972 the United States Federal Aviation Authority issued an airworthiness directive reducing the life of the bearing shaft from 2,500 hours to 835 hours. The United Kingdom Civil Aviation Authority classified this directive as mandatory and issued it to all owners of Brantly B.2 helicopters in the United Kingdom on 11 October 1972. Since the accident to G-ATJY the life of the pylon bearing shafts has been further reduced to 500 hours.

Instances have been discovered since the accident where the inboard face of the hexagonal flange on the bearing shaft has not made complete circumferential contact with the end of its pylon, as a result of its having been under- or over-torqued. There have also been instances where the female thread of the pylon was slightly oversize. Either of these circumstances allow movement of the threaded area of the bearing shaft in the pylon, and such movement is conducive to fatigue.

The nature and the mode of failure in the bearing shaft of G-ATJY was such that no test could be made for the presence of either of these defects. There was no evidence, however, that the shaft had been incorrectly torqued, and it may be inferred from the fact that the red and blue blades were correctly torqued that the green blade was properly tightened.

2. Analysis and Conclusions

2.1 Analysis

The evidence is clear that the accident was caused by the loss of the green main rotor blade as the result of the fracture in fatigue of its bearing shaft. There would have been no warning to the crew that the failure was imminent and there was nothing that they could have done to prevent it or even to retain control of the helicopter and effect a satisfactory emergency landing.

It was established that the failed shaft was 7 per cent below its specified tensile strength whereas those of the blue and red blades were within the required range. It is significant that the tensile strength of the only other shaft known to have failed, (the American accident in August 1972), was also below the required specification. It was not possible to establish why either of these shafts were below strength. The thread on all the bearing shafts were American National, formed by a cutting or grinding process. This type of thread formed by this method does not have inherently good fatigue resistance, and if the fit of the components is such as to allow even small stress reversals eventual cracking in fatigue is to be expected.

Implicit in the fatigue discovered in the accident is at least some movement of the failed component during its working life. Two sources of appropriate movement came to light in other assemblies after the accident. The first was that the hexagonal flange of the bearing shaft may not make complete circumferential contact with the end of the pylon through having been under- or over-torqued, and the second was the possibility of an oversize female thread in the pylon. Whether or not these deficiencies were present in the green blade assembly of G-ATJY is impossible to say, since crash damage precluded appropriate examination and testing. From the balance of such evidence as there is it may be inferred that the failed shaft had been correctly assembled.

In sum the evidence was insufficient to determine the precise cause and progress of the fatigue cracking to the point of failure. The reduction in tensile strength of the material and the type and method of forming the thread of the failed shaft and some movement involving stress reversals must all have contributed to the failure, but it was not possible to establish to what extent.

2.2 Conclusions

(a) *Findings*

- (i) Both pilots were properly licensed.
- (ii) The aircraft had been properly maintained and its documentation was in order.
- (iii) The inner and outer sections of the green blade became detached in flight following a fatigue failure in the outboard bearing shaft. Subsequent out of balance forces tore the main rotor head and its gear box from the aircraft.
- (iv) The tensile strength of the material in the failed bearing shaft was 7 per cent below specifications.
- (v) The thread used in the bearing shaft was of a type with poor fatigue resistance.
- (vi) The evidence was insufficient to determine the precise cause and progress of the failure, or the extent to which the reduction in tensile strength and type of thread contributed.

(b) *Cause*

The accident was caused by the failure in fatigue of the outboard bearing shaft of the green blade of the main rotor.

G M Kelly
Inspector of Accidents

Accidents Investigation Branch
Department of Trade and Industry
June 1973