ACCIDENT

Aircraft Type and Registration:	Socata TB10, G-BNRA
No & Type of Engines:	1 Lycoming O-360-A1AD piston engine
Year of Manufacture:	1987
Date & Time (UTC):	16 February 2006 at 1120 hrs
Location:	Nottingham Airport (Tollerton), Nottinghamshire
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Propeller blade shed, propeller and drive flange separated from engine, crankcase damaged and engine partly separated from mounting structure
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	41 years
Commander's Flying Experience:	2,198 hours (of which 10 were on type) Last 90 days - 90 hours Last 28 days - 30 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot; debris plot made by the maintenance company; photographs of damaged aircraft; examination of failed propeller components and of maintenance documentation by the AAIB

Synopsis

This accident was the subject of AAIB Special Bulletin S2/2006. A propeller blade detached during a touch-and-go landing, leading to loss of the propeller and partial separation of the engine from the aircraft. An existing Manufacturer's Service Bulletin was identified as being relevant to the failure. Three Safety Recommendations were made, to the Civil Aviation Authority (CAA), the Federal Aviation Administration (FAA) and the European Air Safety Agency (EASA). Subsequent metallurgical analysis confirmed the cause as a fatigue failure.

Since publication of the Special Bulletin, the CAA has issued a Letter to Operators on the subject and the FAA and the EASA have produced appropriate Airworthiness Directives. This final report expands on the Special Bulletin.

History of the flight

The pilot reported that during a touch-and-go landing, as he applied full power smoothly for takeoff, a loud bang was heard, the propeller detached and the engine shook from its mountings. He brought the aircraft to a halt maintaining it level despite asymmetric effects.

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Engineering investigation

Analysis of the photographs provided to the AAIB confirmed that the engine had partly separated from the aircraft structure and had become re-orientated both in plan and in side elevation at angles between 30 and 40 degrees to the normal location (Figure 1). The two-bladed, constant speed propeller had detached and was found, with one blade missing, alongside the runway close to the point at which the aircraft came to a halt. The missing blade was on the other side of the runway closer to the touch-down point. Two depressions in the paved surface indicated where propeller debris had impacted with considerable force.

Figure 1

This model of propeller, a Hartzell HCC2YK-1BF, is of the variable pitch type in which the blades are located by thrust bearings within a two-piece hub (see Figure 2). The hub components consist of an aft casing bolted to the drive flange of the crankshaft and a forward casing upon which is mounted the cylinder and piston of the pitch change mechanism. The two casings are secured together by a series of bolts whose axes are parallel to that of the crankshaft. The plane of the joint between forward and aft casings coincides with the axes of the blade pitch change bearings.

Examination of the separated components indicated that the engine crankshaft had fractured close to its forward end, as had part of the crankcase casting in which it was located. The isolated blade appeared to have been released as a result of the fracture of part of the hub which carried a blade pitch change bearing and hence the centrifugal blade force.

Examination of the crankshaft fracture face revealed that its condition was consistent with the effects of bending load and exhibited no evidence of fatigue or corrosion. The fracture of the crankcase casting also appeared to have occurred as a result of overload. The hub was dismantled to enable its fracture faces to be examined under laboratory conditions (Figure 3). It was noted that the pitch change bearing of the blade which remained attached was fully charged with grease, whilst those components of the bearing securing the separated blade, recovered from the proximity of the accident site, indicated a marked lack of lubrication.

Initial metallurgical examination of the fracture faces of the hub indicated that although the fracture of the aft section of the casing appeared to be in simple overload, the forward section had a more complex failure mechanism which included some fatigue.

More detailed examination confirmed that a crack, circumferential to the blade root, had propagated from several closely spaced locations on the inside surface of the hub forward casing. An axial fatigue fracture had also propagated from the outer corner of the blade

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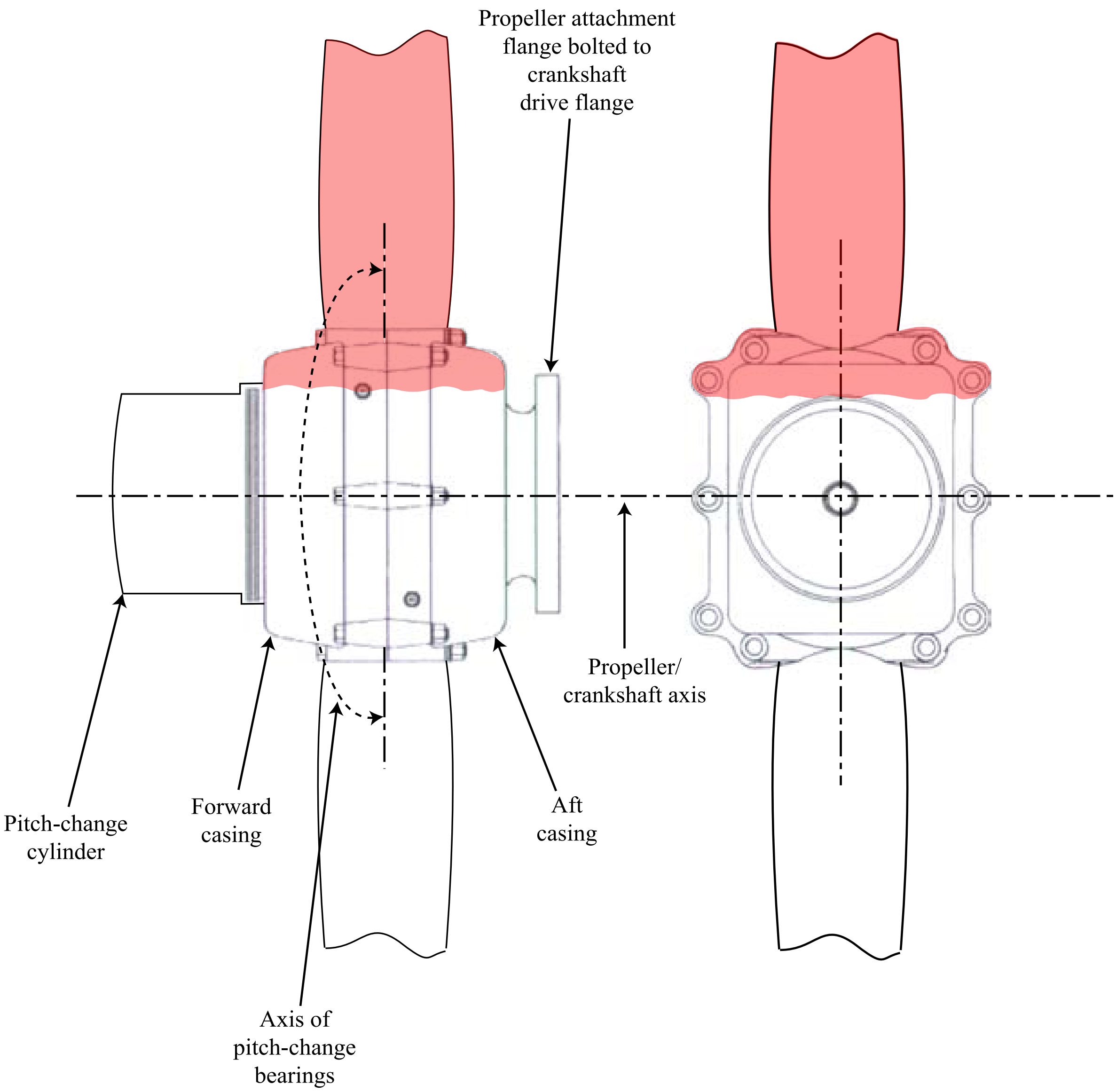

Figure 2

Schematic view of propeller hub with separated portion shown in orange

seal face. It was not clear which initiation occurred first, although the axial failure formed the single 'leg' of a three-way fracture junction showing that it joined the circumferential failure after the latter was well developed. No evidence was present to suggest that abnormal service conditions had been present.

Service Bulletin information

The manufacturer's Service Bulletin HC-SB-61-269 drew attention to:

> *'numerous occurrences of hub fillet cracks, including incidents of in-flight blade separation in Hartzell two blade "compact" series aluminium hub propellers'.*

The failed propeller on G-BNRA was of the type to which this problem applied. The Service Bulletin noted that cracks were typically discovered during inspection following reports of abnormal vibration or grease leakage. The Service Bulletin required visual and eddy current inspection of fillet radii in the general area where unusual fracture surface conditions were observed on G-BNRA. Inspection was to be carried out within 50 flying hours of the receipt of the bulletin and repeated at 100 hour intervals.

The Service Bulletin was issued in April 2005 and the records showed that the aircraft had completed approximately 105 hours operation between the end of that month and the date of the accident. There was no indication that the Service Bulletin had been implemented on this propeller.

The aircraft was maintained by an M3 maintenance organisation in accordance with the CAA/LAMS/A schedule which uses a 50 hour/150 hour/annual cycle of inspections. They confirmed that Service Bulletin HC-SB-61-269 had not been implemented on the propeller. During normal aircraft scheduled inspections specific work on the propeller is limited to a general examination and implementation of any applicable Airworthiness Directives. This is the normal procedure for M3 organisations. Eddy current inspection equipment and appropriate expertise is not required and not normally possessed by such organisations.

The Service Bulletin noted that 'Regulatory action is expected'. At the time of the accident this Service Bulletin had not been the subject of such action and was not, therefore, mandatory.

The similarity of the position of the unusual fracture face on the hub to the area highlighted in the Manufacturer's Service Bulletin, as well as the absence of grease from the pitch-change bearing of the separated blade, strongly suggested that the failure was of the type which the Service Bulletin was intended to address. The absence of an Airworthiness Directive on the subject had inhibited the ability of maintenance companies and operators to identify the propellers at risk of blade loss and to take steps to prevent such hazardous situations from occurring.

Figure 3

Hub fracture faces

The manufacturer had replaced this type of hub with one of a different design on propellers in production some time before the accident occurred. The later design of hub is interchangeable with the type involved in this event. However the different hub designs do not have identification marks on them; they can only be differentiated by comparing details of their profiles with the manufacturer's descriptions. It is not known how many of the type of hub involved in the accident remain in service either in the UK or elsewhere.

AAIB Special Bulletin S2/2006 contained three Safety Recommendations which are reproduced here:

Safety Recommendation 2006-046

It is recommended that the CAA take immediate action to alert M3 organisations and other relevant maintainers in the UK to the existence and importance of Hartzell Service Bulletin HC-SB-61-269.

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Safety Recommendation 2006-047

It is recommended that the FAA take urgent steps to issue an Airworthiness Directive making the inspection requirements of Hartzell Service Bulletin HC-SB-61-269 mandatory.

Safety Recommendation 2006-048

It is recommended that the EASA take urgent steps to issue an Airworthiness Directive making the inspection requirements of Hartzell Service Bulletin HC-SB-61-269 mandatory.

Regulatory responses to Safety Recommendations

The CAA has since responded to Safety Recommendation 2006-046 as follows:

The CAA accepts this recommendation insofar as it relates to the need to alert relevant persons to the existence and importance of Hartzell Service Bulletin HC-SB-61-269. To that end CAA issued, on 30 March 2006, a letter to relevant UK operators strongly recommending that owners of aircraft affected by Hartzell Service Bulletin HC-SB-61-269 arrange for an eddy current inspection to be performed in accordance with the Service Bulletin instructions as soon as possible.

Since that letter, the Federal Aviation Agency has responded to Safety Recommendation 2006-047 and has introduced an Airworthiness Directive 2006-18-15 which is subject to a consultation process but which must, nonetheless, be implemented by 25 September 2006. It requires adoption of an inspection procedure in accordance with the existing Hartzell Service Bulletin.

On 3 May 2006 the EASA responded to Safety Recommendation 2006-048 by issuing Airworthiness Directive No 2006-0092, which mandated the inspection procedure or optional terminating action (replacement of the hub) described in the Hartzell Service Bulletin.

Conclusions

The engine partly separated from the airframe as a result of propeller imbalance following the release of one blade due to fatigue failure in its hub. The fatigue cracking appears to have been partly a consequence of non-optimum temperature conditions in the hub material during the forging process. Recommendations within an existing Service Bulletin addressed the problem although the absence, at the time, of an Airworthiness Directive rendering such checks mandatory contributed to its non-implementation on this aircraft before the accident. The UK CAA, the EASA and the FAA have all responded positively to contain the hazard by introducing inspections and/or replacement of the hub parts.

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