Australian Government
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ATSB TRANSPORT SAFETY INVESTIGATION REPORT

SUPPLEMENTARY APPENDIX

Aviation Occurrence Report – 200503265

Collision with Terrain
Mount Hotham, Victoria
8 July 2005
VH-OAO
Piper Aircraft Corporation
PA31-350 Navajo Chieftain

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Released in accordance with section 25 of the *Transport Safety Investigation Act 2003*

Published by: Australian Transport Safety Bureau
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ISBN and formal report title: see 'Document retrieval information' on page iii.

DOCUMENT RETRIEVAL INFORMATION

Report No.	Publication date	No. of pages	ISBN
200503265	August 2006	13	1 921092 85 8

Publication title

Supplementary Appendix. Collision with Terrain, Mt Hotham, Victoria

Prepared by

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Acknowledgements

Figures 5A and 5B adapted from Figure 2-2 of Hartzell Propeller Owner's Manual 115N, Rev. 7 Oct/02

THE AUSTRALIAN TRANSPORT SAFETY BUREAU

The Australian Transport Safety Bureau (ATSB) is an operationally independent multi-modal Bureau within the Australian Government Department of Transport and Regional Services. ATSB investigations are independent of regulatory, operator or other external bodies.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within Commonwealth jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to fare-paying passenger operations. Accordingly, the ATSB also conducts investigations and studies of the transport system to identify underlying factors and trends that have the potential to adversely affect safety.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and, where applicable, relevant international agreements. The object of a safety investigation is to determine the circumstances in order to prevent other similar events. The results of these determinations form the basis for safety action, including recommendations where necessary. As with equivalent overseas organisations, the ATSB has no power to implement its recommendations.

It is not the object of an investigation to determine blame or liability. However, it should be recognised that an investigation report must include factual material of sufficient weight to support the analysis and findings. That material will at times contain information reflecting on the performance of individuals and organisations, and how their actions may have contributed to the outcomes of the matter under investigation. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner.

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. While the Bureau issues recommendations to regulatory authorities, industry, or other agencies in order to address safety issues, its preference is for organisations to make safety enhancements during the course of an investigation. The Bureau prefers to report positive safety action in its final reports rather than making formal recommendations. Recommendations may be issued in conjunction with ATSB reports or independently. A safety issue may lead to a number of similar recommendations, each issued to a different agency.

The ATSB does not have the resources to carry out a full cost-benefit analysis of each safety recommendation. The cost of a recommendation must be balanced against its benefits to safety, and transport safety involves the whole community. Such analysis is a matter for the body to which the recommendation is addressed (for example, the relevant regulatory authority in aviation, marine or rail in consultation with the industry).

INTRODUCTION

This Supplementary Appendix has been prepared to include additional factual information gathered during the ATSB investigation into the accident involving a Piper Aircraft Corporation model PA-31-350 *Navajo Chieftain* (VH-OAO), at Mt Hotham, Victoria on 8 July 2005.

The information is presented to substantiate the statements contained in section 1.12 of the final Aviation Safety Investigation report, in light of questions raised by some parties.

The appendix also contains additional radar data depicting the morning approach of VH-OAO to Mt Hotham for comparison against the accident flight approach.

The final report was publicly released on 11 May 2006. This appendix should be read in conjunction with that document.

FACTUAL INFORMATION

Impact sequence

The distribution of airframe components and sections along the wreckage field indicated that the aircraft had broken up progressively as a result of multiple large tree and ground impacts. On the basis of their position in the wreckage field, it was evident that the right wing, engine and propeller assembly had separated from the airframe early in the impact sequence, with the powerplant breaking away from the wing firewall mounts. The left engine and propeller had remained with the airframe and was located adjacent to the main fuselage and left wing at the end of the wreckage field.

Left engine

Inspection of the left engine found all primary and accessory components intact and in place, with no indications that the engine was operating abnormally. The crankcase and all cylinders showed no evidence of structural failure and the principal fuel, ignition, and forced aspiration (turbocharger) components showed no indication of abnormal operation or malfunction. The crankcase contained lubricating oil.

Figure 1: Left engine and propeller assembly as located at the accident site



Left propeller

The left propeller had remained affixed to the engine during the aircraft impact and break-up sequence (figure 1). All three propeller blades had bent rearwards from the one-third span position and all presented chordwise surface abrasion across the forward faces. Superimposed on the rearward blade bending was a degree of axial twisting, producing a blade curvature that opposed the normal clockwise direction of rotation. At the point of hub entry, all blades sat at a pitch angle typical of the normal propeller operating range. The propeller spinner remained in place and showed diagonal creasing in several locations around the external diameter.

Right engine

The right engine presented no evidence of anomalous operation or malfunction. All six cylinders and the crankcase were intact, with no evidence of movement, separation or gross structural failure. All major external accessories were located and all damage sustained was consistent with the accident impact forces. The turbocharger compressor / turbine rotated without restriction and was clear of oil ingestion. A quantity of lubricating oil was evident on the ground beneath and surrounding the engine.

Figure 2: Right propeller as first located at the accident site



Right propeller

The right propeller had fractured through the base of the hub where it adjoined the crankshaft mounting boss and was found immediately in front of the right engine when the assembly was first located by on-site investigators (figure 2). At that time, two of the propeller blades were visible above the terrain; both presenting blade angles typical of the propeller normal operating pitch range. After removal from the ground, the remaining blade also presented at an angle typical of the propeller normal operating pitch range.

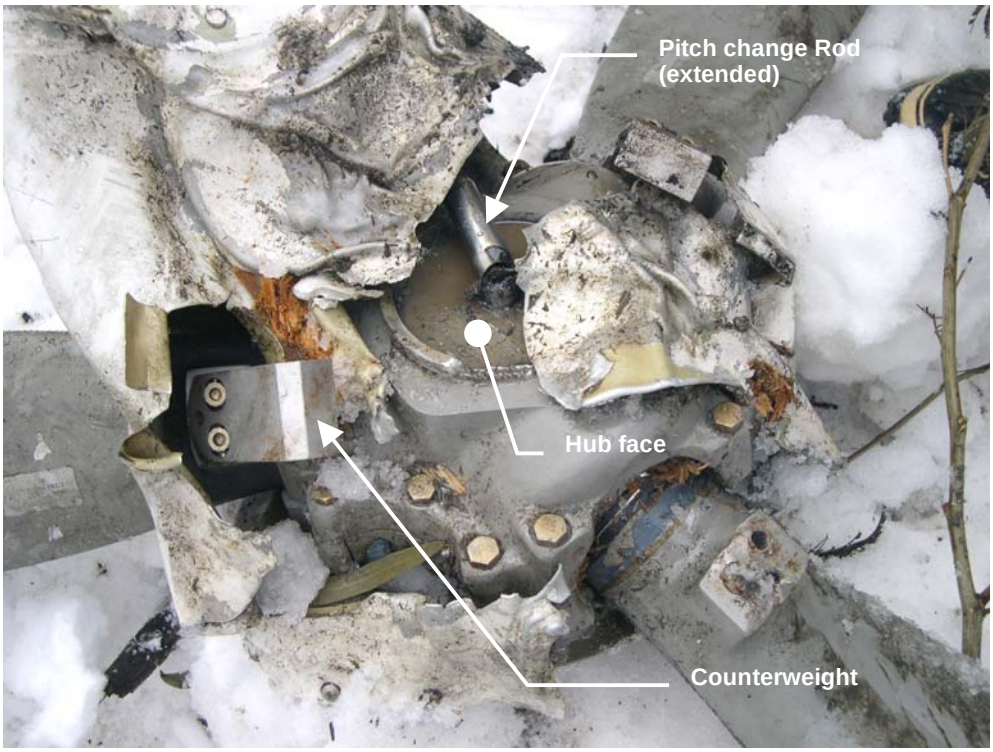
All three blades exhibited chordwise scoring of the aerofoil surfaces. Pronounced variability of blade bending was evident (figure 3), with one blade showing strong forward bending and twisting along the outer span. The two adjacent blades had remained comparatively straight throughout the impact, with one showing shallow forward bending evident along the outer span.

The forward faces of the propeller hub and spinner had sustained a heavy, glancing impact, sufficient to break away a blade counterweight and fracture the propeller dome. Forced and bent sideways by the fractured dome, the internal pitch change rod had buckled and fractured at the point of emergence from the forward hub, approximately 50 mm beneath the dome piston connection (figure 4). Hard wood fragments were found trapped and embedded amongst the spinner, hub and blades.

Figure 3: Right propeller after removal from its partly embedded location in front of the right engine



Figure 4: **Frontal view of the right propeller hub showing the extended pitch change rod (arrowed). Compare against the rod positions in the operating and feathered conditions shown in figures 5A and 5B**



Propeller operating mechanism

The Hartzell HC-E3YF-2 propellers fitted to the accident aircraft were contra-rotating, fully-feathering, constant-speed (pitch controllable) units with compact aluminium hubs and an internal, hydraulically actuated blade pitch-change mechanism. Controlled by an engine speed-sensing device (governor), the propeller pitch is varied to maintain a constant engine/propeller RPM. Propeller blade angle change is accomplished via a hydraulic piston/cylinder combination mounted on the forward end of the propeller hub (the 'dome'). The linear motion of the piston is translated to each blade through a pitch change rod and fork, acting on offset journals (knobs) at the base of each blade. When rotating at speed, propeller blade centrifugal twisting moments act to move the blades to a lower pitch, however those forces are balanced by the effects of the blade counterweights and an air-charge and spring combination in the upper chamber of the dome. Governed oil pressure acting against the hydraulic piston opposes the spring and air pressure above the piston, to move and control the blade pitch in response to changes in the engine load, airspeed, throttle or commanded RPM settings (figure 5A).

If oil pressure is lost during operation as a result of engine failure, oil will drain from the cylinder and the opposing spring and air-charge will move the piston to the bottom of the cylinder, moving the blades to the feathered position (maximum blade angle, figure 5B). Normal in-flight feathering is accomplished in a similar way, by the pilot moving the propeller pitch (RPM) control past the feather detent.

Figure 5A: **Diagrammatical representation of a Hartzell series -2 propeller hub with the blades and internal mechanisms in the operating pitch range**

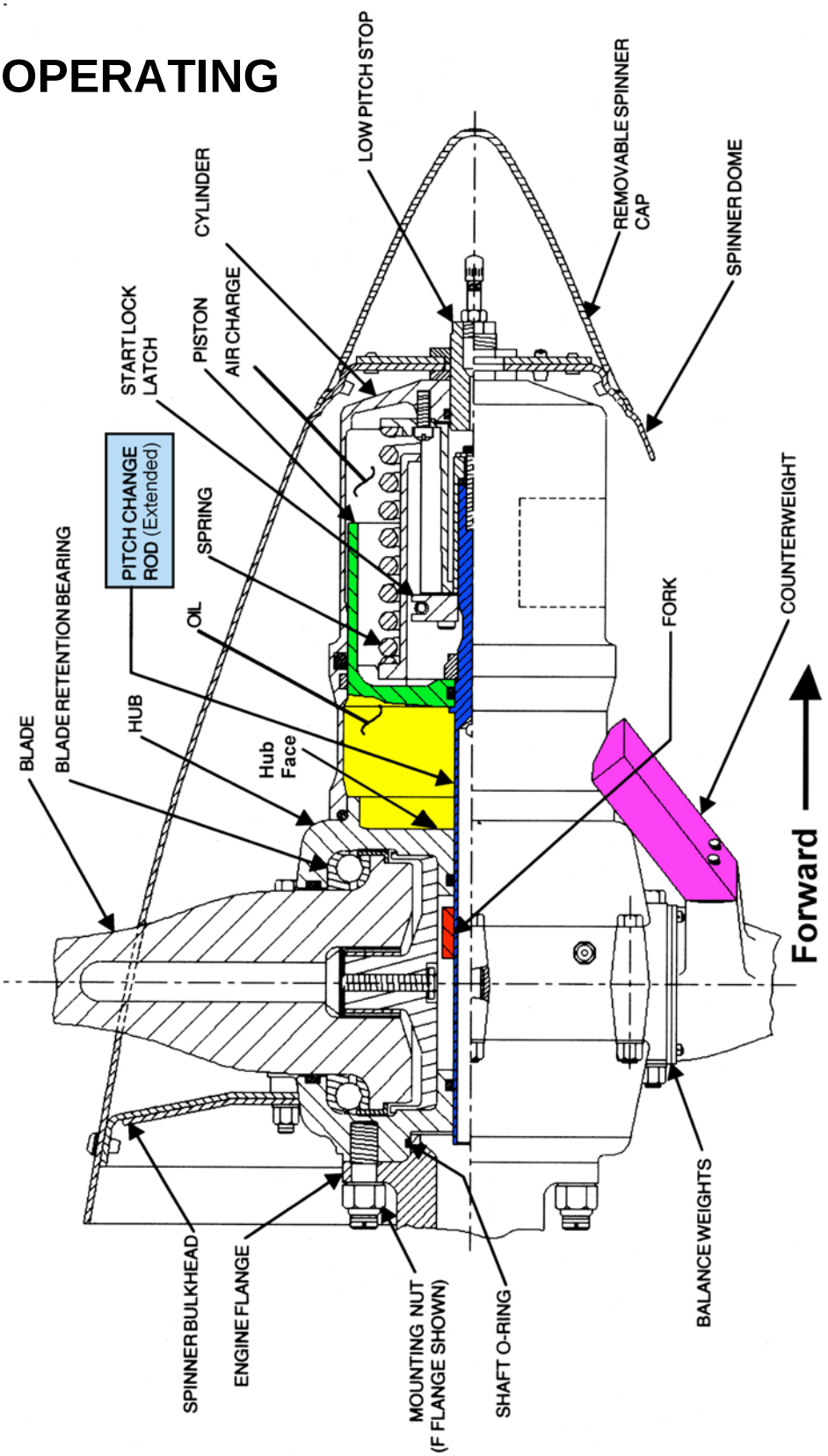
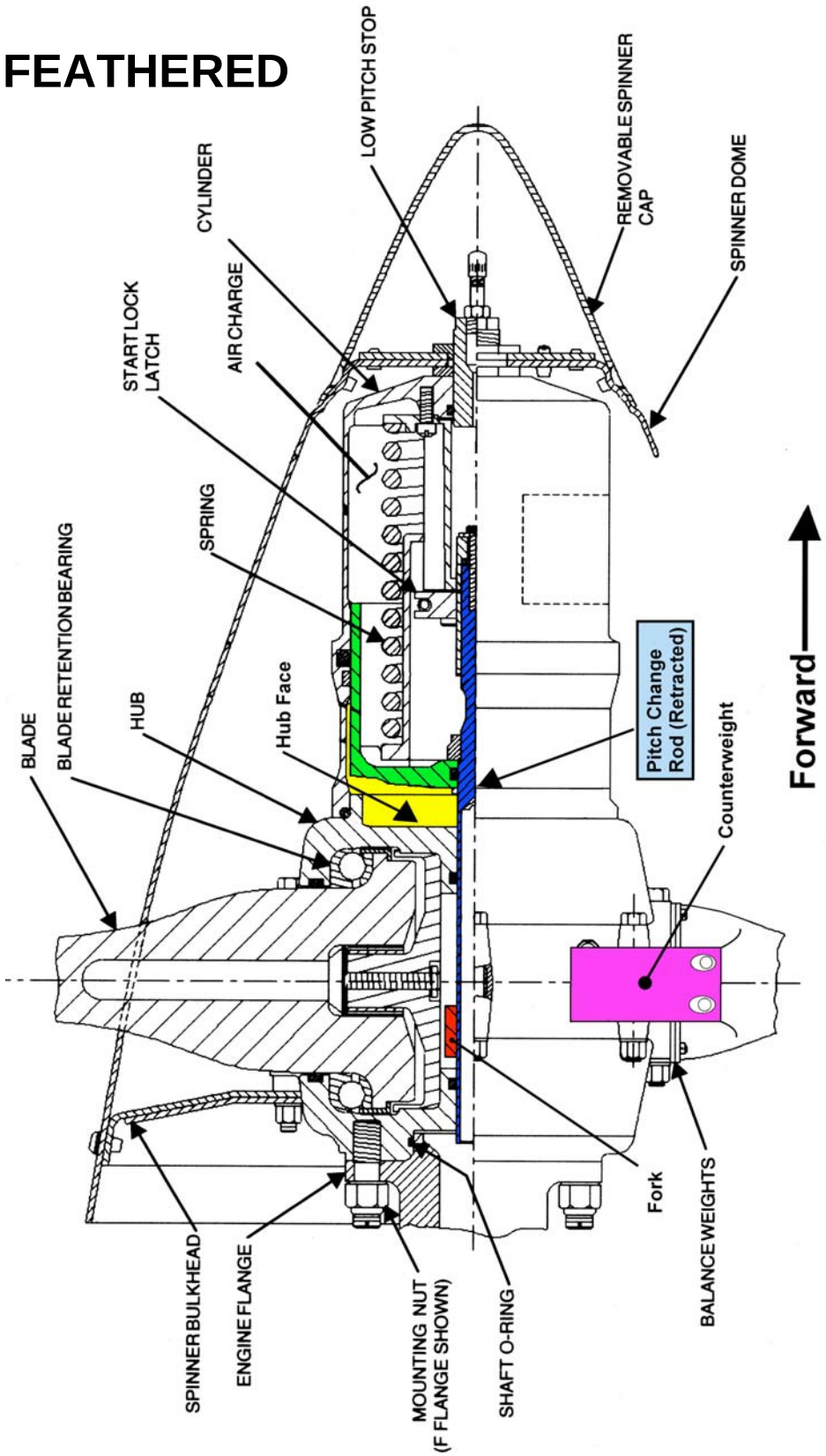


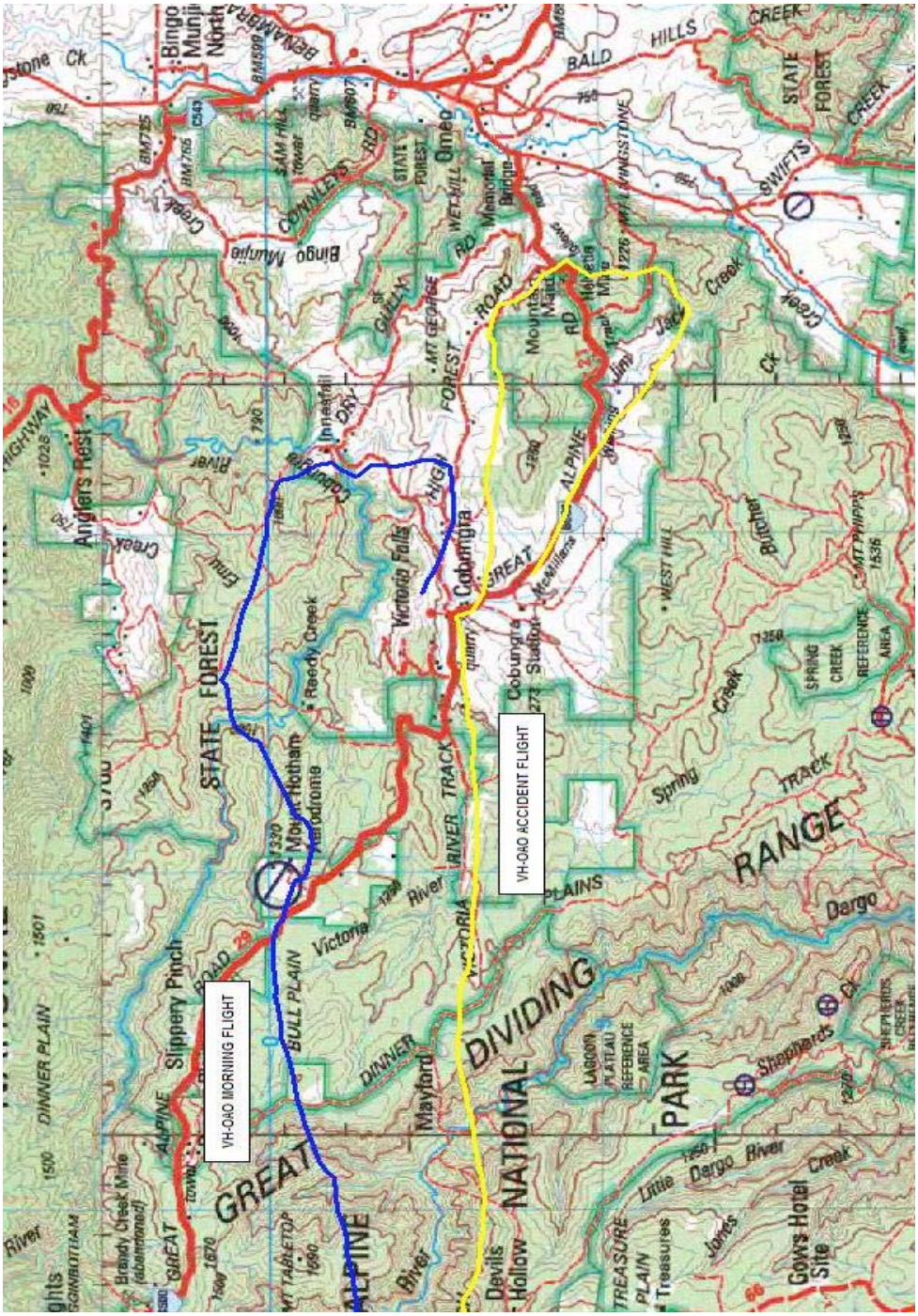
Figure 5B: **Diagrammatical representation of a Hartzell series -2 propeller hub with the blades and pitch change mechanisms in the feathered position**



Radar plots of both Chieftain flights into Mount Hotham

Figure 6 illustrates the flight paths flown by the aircraft on both the morning flight and the accident flight. Although similar in appearance, the aircraft flight paths were markedly displaced from each other. On the morning flight, it is evident that the Chieftain had commenced its turn onto the final leg of the approach to land when much closer to the aerodrome.

Figure 6: **Radar plot of morning flight (blue track) and afternoon flight (yellow track).**



ANALYSIS AND COMMENT

Left powerplant

The left engine and propeller remained connected as a unit throughout the impact sequence. The proximity of the engine and propeller to the left wing and fuselage at the end of the wreckage trail was consistent with the unit remaining with those parts of the airframe for most of the break-up sequence. The uniform, backward bending of the propeller blades and the chordwise blade surface scoring was typical of the damage sustained by propellers that encounter terrain or other high-density media at an acute angle while rotating under power.

Right powerplant

In contrast with the left assembly, it was evident that the right engine and propeller separated from the aircraft early in the impact sequence, as a result of the severe forces that compromised the right wing and engine mounting structures. Unconstrained in its subsequent motion, the trajectory, orientation and motion of the powerplant would have been governed by the reactive forces of subsequent impacts with objects and terrain in its path. As a result, therefore, an assessment of blade bending could not be reliably used to provide an indication of powerplant functionality. Indirect evidence that the engine was operational was provided by the propeller mechanism, with the extension of the pitch change rod from the front of the hub being an indication that the propeller blades were in the operational pitch range and had not been feathered. Chordwise scoring of the blade surfaces was evidence of propeller rotation during the impact sequence.

Conclusion

Considering the impact sequence and the nature of the airframe break-up as the aircraft descended into the terrain, the damage sustained by the aircraft powerplants was consistent with both engines operating and both propellers rotating with blades in the operating pitch range. There was no evidence to indicate that one or both engines had malfunctioned or sustained a power loss prior to first contact with trees/terrain at the accident site.