AIRCRAFT ACCIDENT REPORT

CAA OCCURRENCE 20/4164

SONEX

ZK-NAF

DEPARTURE FROM CONTROLLED FLIGHT DURING EMERGENCY LANDING

ŌTAKI AERODROME

17 AUGUST 2020

Photo: NZ Civil Aircraft http://4.bp.blogspot.com/-wYKuy1BHkO8/URW7qNo1j3I/AAAAAAAAXXk/l0UqSGNH1KU/s1600/DU8A0009.jpg

Foreword

New Zealand's legislative mandate to investigate an accident or incident is prescribed in the Transport Accident Investigation Commission Act 1990 (the TAIC Act) and Civil Aviation Act 1990 (the CA Act).

Following notification of an accident or incident, TAIC may open an inquiry. CAA may also investigate subject to Section 72B(2)(d) of the CA Act which prescribes the following:

72B Functions of Authority

(2) The Authority has the following functions:

(d) To investigate and review civil aviation accidents and incidents in its capacity as the responsible safety and security authority, subject to the limitations set out in section 14(3) of the Transport Accident Investigation Commission Act 1990

The purpose of a CAA safety investigation is to determine the circumstances and identify contributory factors of an accident or incident with the purpose of minimising or reducing the risk to an acceptable level of a similar occurrence arising in the future. The safety investigation does not seek to ascribe responsibility to any person but to establish the contributory factors of the accident or incident based on the balance of probability.

A CAA safety investigation seeks to provide the Director of Civil Aviation with the information required to assess which, if any, risk-based regulatory intervention tools may be required to attain CAA safety objectives.

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Glossary of abbreviations:

AIP	Aeronautical Information Publication
agl	above ground level
amsl	above mean sea level
ARA	Annual Review of Airworthiness
ATSB	Australian Transport Safety Bureau
BFR	Biennial flight review
CAA	Civil Aviation Authority of New Zealand
CAN	Continuing Airworthiness Notice
CAR	Civil Aviation Rules
EFB	Electronic Flight Bag
ELT	Emergency Locater Transmitter
fpm	feet per minute
kts	knot(s)
lbs	pounds
M	magnetic
MHz	megahertz
NSC	nil significant cloud
NSW	nil significant weather
NZOT	Ōtaki Aerodrome
NZST	New Zealand Standard Time
PPL (A)	Private Pilot Licence (Aeroplane)
RPL (A)	Recreational Pilot Licence (Aeroplane)
RPM	revolutions per minute
UTC	Coordinated Universal Time
TTIS	total time in service
WGS 84	World Geodetic System 1984

Data summary

Aircraft type, serial number and registration:	Sonex, s/n 1049, ZK-NAF
Number and type of engines:	One, Jabiru Engine Div. 2200A
Year of manufacture:	2009
Date and time of accident:	17 August 2020, 1307 hours[1] (approximately)
Location:	Ōtaki Aerodrome Latitude[2]: S 40° 47' 01" Longitude: E 175° 09'.04"
Type of flight:	Private
Persons on board:	Crew: 1
Injuries:	Crew: 1 (fatal)
Nature of damage:	Aircraft destroyed
Pilot-in-command's licence:	Recreational Pilot Licence (Aeroplane)
Pilot's age:	74 years
Pilot-in-command's total flying experience:	596 hours, (approximately) 340 hours on type (approximately)
Investigator-in-charge:	Alan Moselen

[1] All times in this report are NZST (UTC + 12 hours) unless otherwise specified.

[2] NZ Geodetic Datum 1949 (or WGS-84).

Synopsis

The Civil Aviation Authority (CAA) was notified at 1410 hours NZST on Monday 17 August 2020 of an aircraft accident involving ZK-NAF. The Transport Accident Investigation Commission was notified shortly thereafter and chose not to investigate. A CAA field investigation was commenced the following day.

At approximately 1248 hours on 17 August 2020, ZK-NAF departed Ōtaki Aerodrome on a test flight after a new propeller was fitted to the aircraft. Approximately 17 minutes after take-off and while returning to the aerodrome, the propeller detached from the aircraft. During the approach, and shortly after crossing the runway threshold, the aircraft developed a steep descent from which it did not recover. The aircraft struck the grassed surface adjacent to the aerodrome runway and the impact forces fatally injured the pilot.

The safety investigation concluded that the accident occurred as a result of the aircraft departing controlled flight, likely during a sideslip[3] manoeuvre close to the ground during an emergency landing.

Based on several contributing factors leading to the accident the investigation promulgated two safety actions, and also several examples of CAA's ongoing education and guidance for owners of aircraft.

1. Factual information

1.1 History of the flight

1.1.1 Prior to the accident and during the morning at Ōtaki Aerodrome, the pilot and owner of ZK-NAF fitted a new propeller to the aircraft. The reason for replacing the propeller was to improve climb performance. On completion of the task, the pilot prepared the aircraft for a test flight.

1.1.2 Flight data recovered from the pilot's AvPlan electronic flight bag (EFB) and overlaid on Google Earth indicated that the aircraft departed from the aerodrome off Runway 34 at approximately 1248 hours.

[3] A sideslip is an intentional cross control manoeuvre in which the pilot has made an aileron input in one direction with a simultaneous rudder input in the opposite direction. This manoeuvre is used to increase the rate of descent without increasing airspeed, or to maintain the runway centreline during a crosswind landing. (SKYbrary definition)

1.1.3 The aircraft initially completed two circuits at the aerodrome then tracked on a north-easterly heading in a climb. During the climb, and over a brief period of ten seconds, the rate of climb reached 1000 feet per minute (fpm) before reducing to an average of 400 fpm, until reaching an approximate height of 3000 feet agl. The aircraft continued on a north-easterly track, maintaining the same height, until six nautical miles north of the aerodrome. At that point the aircraft turned left and commenced a shallow descent, tracking in a south-westerly direction back toward the aerodrome.

1.1.4 At 1304:30 hours, the aircraft was overhead the Ōtaki township, at approximately 1800 feet agl, and appeared to be on a track to join for a left-hand downwind landing on Runway 34.

1.1.5 Prior to crossing the Ōtaki River the aircraft turned left in an easterly direction. A series of S-turn[4] manoeuvres then occurred, prior to the aircraft making another left turn directly toward Runway 16 of the aerodrome.

1.1.6 At 1306:47, the aircraft crossed overhead a public road bordering the aerodrome, 40 metres east of the grass runway, at an approximate height of 300 feet agl.

1.1.7 For the next six seconds, the aircraft descended at approximately 1000 fpm, and at an approximate flight path angle of ten degrees. The aircraft track was in a south-westerly direction toward the centreline of Runway 16.

1.1.8 At 1306:53, the rate of descent reduced during another heading change to the left. The aircraft rate of descent then increased to approximately 800 fpm as it tracked south-east and across the runway centreline for the second time.

1.1.9 At 1306:57, and three seconds from impact, the aircraft had flown over approximately a quarter of the available landing distance of the runway and had travelled a total distance of approximately two nautical miles after first turning east.

[4] S-turns: Kermode, A. C. (1972). Mechanics of Flight. p.218, p. 261. Used for prolonging a glide during a forced landing without power and to reduce height.

1.1.10 For the next two seconds the aircraft rate of descent increased to 2000 fpm and continued to increase until the aircraft struck the ground adjacent to the narrow-mown surface of the runway. The recorded data plot of the aircraft position aligned to the identified initial point of impact timed at 1307 hours.

1.1.11 The accident occurred in daylight, at 1307 hours NZST, at Ōtaki Aerodrome, adjacent to Runway 16/34, at an elevation of 100 feet above mean sea level (amsl), latitude S 40° 47.133', longitude E 175° 09.066'.

1.2 Injuries to persons

Injuries	*Crew*	*Passengers*	*Other*
Fatal	1	0	0
Serious	0	0	0
Minor/None	0	0	

Table 1: Injuries to persons

1.3 Damage to aircraft

1.3.1 The aircraft was destroyed.

1.4 Other damage

1.4.1 Minor damage to the aerodrome grassed surface adjacent to the runway.

1.5 Personnel information

Flying hours	Other types	Relevant Type
Last 24 hours	Nil	Not known
Last 7 days	Nil	Not known
Last 30 days	Nil	3
Last 90 days	Nil	7
Total hours 596	Approximately 256	Approximately 340

Table 2. Pilot flight hours

1.5.1 The pilot held a Recreational Pilot Licence RPL (A), a current medical certificate and a current biennial flight review (BFR).

1.5.2 The pilot converted his Private Pilot Licence PPL (A) to an RPL (A) in October 2012, having previously held the PPL from September 1998.

1.5.3 Owing to there being no local instructors rated on the Special Category Amateur Built Sonex to conduct a BFR flight test, the pilot used another single-engine aircraft type for that purpose.

1.5.4 In addition to the pilot's numerous single-engine type ratings, the pilot held the following approvals issued by the CAA:

- A valid New Zealand Certificate of Maintenance Approval for the purpose of maintaining his own aircraft in accordance with a CAA-approved maintenance programme for the aircraft. The maintenance approval was not valid for overhaul of components, compass swings, or weight and balance changes. More importantly, the maintenance programme for the pilot's aircraft makes no provision for design changes.

- A CAA test flight approval expired on completion of the initial test flying programme for ZK-NAF in June 2010.

1.6 Aircraft information

1.6.1 ZK-NAF, Sonex, serial number 1049, was built from kit plans by the pilot from May 2007 to April 2009. Of all metal construction, it was fitted with conventional type, fixed landing gear (tail-wheel) and provided seating for two persons in a side-by-side arrangement. When first registered, the aircraft was powered by a Jabiru 2200A (serial number 22A-664) engine, driving a Sensenich fixed pitch, two-bladed wooden propeller.

1.6.2 Test flying of the aircraft commenced in September 2009 and was completed by the pilot in June 2010.

1.6.3 The test flight programme, set out by the Sport Aircraft Association NZ Inc, required certain flight manoeuvres to be completed, including sideslips. On completion of the flight test programme the pilot certified that the aircraft did not have any undesirable characteristics under normal flight conditions.

1.6.4 The aircraft kit manufacturer was approached on the use of sideslip manoeuvres, with the wing flaps fully extended. The kit manufacturer responded that the aircraft responded to sideslip manoeuvres very well and had full control authority throughout recovery.

1.6.5 The aircraft was issued a non-terminating airworthiness certificate, amateur-built in 2009. The airworthiness certificate was later reissued owing to a flight manual amendment reflecting a change of propeller to a Brent Thompson type.

1.6.6 During the investigation it was identified that the aircraft had two propeller strikes.

1.6.7 The first incident, early in the flight test programme, was the result of an emergency landing causing damage to the left wing from contact with a fence post, and minor propeller damage, a small nick, from contact with an electric fence wire. While repairs were recorded for the damage to the left wing, no evidence was found to indicate the propeller was inspected.

1.6.8 The second incident, on 30 January 2012, resulted in damage to the propeller blade tips after taxiing over rough ground. Aircraft logbook records found that on 29 February 2012 the propeller blade tips were repaired, and a propeller strike inspection carried out in accordance with the Engine Maintenance Manual.

1.6.9 The aircraft was not flown again until 30 April 2012. On that day, the pilot carried out a test flight after replacing the original Sensenich propeller with a newly manufactured Brent Thompson Aeronautical propeller.

1.6.10 The new propeller assembly had larger diameter propeller attachment bolts than the Sensenich and this aspect would have required modifying the propeller attachment flange from their smaller diameter holes to accommodate the new propeller. There were no specific details in any logbook as to how and where this work was done.

1.6.11 On 27 July 2012 the propeller was removed by the pilot to enable re-pitching of the blades. The re-pitching work was carried out by the propeller manufacturer. On 23 August 2012 the pilot signed the logbooks for refitting the re-pitched propeller and later retorquing the propeller attachment bolts.

1.6.12 Information obtained from Jabiru Aircraft Pty Ltd, found that the Brent Thompson Aeronautical propeller and later, the Aero Performance propeller fitted on the morning prior to the accident were not approved for use with a Jabiru engine.

1.6.13 Jabiru added that to approve a propeller for use with an engine and airframe was a large undertaking. Rarely were propeller manufacturers prepared to perform or fund the tests that are required to be done in conjunction with Jabiru testing engineers. Both the Engine Maintenance Manual and Engine Overhaul Manual caution operators on the use of a non-approved propeller fitment to a Jabiru engine, and that they do so at their own risk.

1.6.14 In addition, Jabiru re-issued Service Bulletin JSB 014 issue 3 on 12 February 2019[5], highlighting that propeller selection is critical and must meet limits given in the Engine Installation Manual, adding that over-pitched, over-weight or otherwise non-compliant propellers can cause propeller or engine damage.

1.6.15 A review of the aircraft airworthiness certificate issued for ZK-NAF showed that the conditions and limitations required that the owner must inform the CAA after a major modification, and receive its response in writing, prior to flying the aircraft. Additionally, no change may be made to the basic design of the aircraft except in accordance with an acceptable modification. The change in the propeller type to improve climb performance resulted in a change to the aircraft's operational characteristics and was therefore considered a design change and a major modification. Without CAA acceptance, fitment of the new type of propeller invalidated the airworthiness certificate.

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[5] Jabiru Service Bulletin JSB 014 Issue 3 12 February 2019 https://jabiru.net.au/wp-content/uploads/2019/02/JSB014-3_Propeller_Installation_Maintenance.pdf

1.6.16 With respect to weight and balance, and given the aircraft's empty weight, the pilot, fuel and baggage weights, it was estimated that the operating weight at take-off was within the specified maximum limit. Therefore, it was considered that the aircraft remained within the approved fore and aft centre of gravity limits.

1.6.17 As at 29 July 2019 the aircraft total time-in-service was approximately 354 hours. The last maintenance recorded in the aircraft logbook was a 100-hour inspection dated 19 November 2019. A Review of Airworthiness (RA) was performed on 29 January 2019, where all maintenance and known defect rectification had been carried out satisfactorily.

1.7 Meteorological information

1.7.1 On 17 August 2020 a ridge of high pressure covered most of New Zealand. The Graphical Aviation Forecast for the central and lower north island indicated nil significant weather and nil significant cloud. Observations for the Ōtaki area recorded clear skies with a light west to north-westerly wind.

1.7.2 It was determined that weather was not a factor in the accident.

1.8 Aids to navigation

1.8.1 The pilot used a tablet with an AvPlan EFB installed for navigation purposes.

1.8.2 Flight information data of the flight was retrieved from the tablet, which included date, time, latitude, longitude, altitude, and track and ground speed, were used to assist the investigation.

1.9 Communications

1.9.1 The aircraft was equipped with a VHF radio, transponder and an emergency locator transmitter (ELT).

1.9.2 Paraparaumu Flight Service 118.3 MHz communication recordings on the day of the accident found there were no radio calls made from the aircraft during the flight.

1.10 Aerodrome information

1.10.1 Ōtaki Aerodrome, located 1.5nm south of Ōtaki, is non-certificated and unattended.

1.10.2 The Aeronautical Information Publication chart for the aerodrome advises that all departure and arrival communications use Paraparaumu Flight Service frequency of 118.3 MHz.

1.10.3 The aerodrome elevation is depicted as 100 feet amsl and the grassed surface Runway 16/34 has an available take-off and landing distance of 730 metres. Both circuit directions are left-hand.

1.11 Flight recorders

1.11.1 Not applicable

1.12 Wreckage and impact information

1.12.1 The aircraft struck the ground on a heading of 175°M while nose down, in a right yaw, and a right-wing low attitude.

1.12.2 The impact forces were absorbed initially in three areas:

- The right main landing gear wheel and spat
- the right-hand wing tip and leading edge
- the aircraft nose section.

1.12.3 After initial impact, ground scars indicated the aircraft had slid 30 metres forward while rotating to the right onto a heading of 254°M, before coming to rest.

1.12.4 Inspection of the wreckage found the wing flaps in the fully extended position. Aft of the cockpit, the rear fuselage and tail section had remained relatively intact and it was observed that the rudder was canted to the right along with the tail wheel. Continuity checks of the flight controls found that, except for the rudder, they moved through their full range. Rudder movement was restricted owing to damage to the left rudder pedal. The damage was consistent with the pilot being on the 'controls'.

1.12.5 General debris in the wreckage trail consisted of engine parts, shattered windscreen Perspex® and other small items. Examination of the nose section of the aircraft found that the propeller, spinner and propeller attachment flange were not present at the accident site. An extensive search for the propeller was carried out, without success.

1.12.6 Inspection of the engine found it could be turned by hand, and there were no signs of internal damage. Inspection of the engine crankshaft to propeller flange found the six crankshaft to propeller flange attachment cap screws had failed. There were also no positive location dowel pins in the three holes of the crankshaft flange face.

1.12.7 It was later found that positive location dowel pins were not fitted, owing to the engine being an earlier model manufactured prior to 2011[6]. However, the fitment of the positive location dowel pins was not mandatory but strongly recommended by the Jabiru Aircraft Pty Ltd Propeller Flange Attachment Service Bulletin JSB 022-2, Issue 2, published on 20 June 2014[7].

1.12.8 The engine was removed from the site and the crankshaft sent for analysis by a facility specialising in forensic metallurgy (refer to the tests and research section in this report).

1.12.9 The safety investigation found the cockpit instruments revealed little to no useful information.

1.12.10 All aircraft fuel and oil contents had leaked away during the accident sequence. However, there was ample evidence at the site to confirm there had been sufficient fuel and oil contents available for the flight prior to impact.

1.13 Medical and pathological information

1.13.1 Post-mortem examination showed the cause of the fatality were multiple injuries consistent with a high-energy impact.

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[6] Engines manufactured after 2011 had positive location dowel pins fitted as standard from the factory. Engines already in service were recommended to have positive location dowel pins fitted at the next full overhaul or at bulk strip.

[7] Jabiru Propeller Flange Attachment Service Bulletin JSB 022-2 Issue 2 published on 20 June 2014 https://jabiru.net.au/wp-content/uploads/2018/05/JBS022-2.pdf

1.13.2 No evidence of a pre-existing medical condition was found that could have resulted in incapacitation or affected the pilot's ability to fly the aircraft. Supporting the medical finding, was the presence of clear evidence that the pilot was manoeuvring the aircraft normally during the flight and attempting to recover the aircraft moments before impact.

1.13.3 Results from toxicology testing, showed traces of Citalopram was confirmed in the blood at a level in keeping with normal use. The pilot's medical records indicate the Citalopram had been prescribed over many years for the treatment of anxiety.

1.14 Fire

1.14.1 Fire did not occur.

1.15 Survival aspects

1.15.1 Whilst the pilot had been adequately restrained, the impact forces were not survivable.

1.15.2 The aircraft was fitted with a Kannard 406 ELT which activated on impact and continued until deactivated by rescue services.

1.16 Tests and research

1.16.1 The crankshaft from the Jabiru engine fitted to ZK-NAF was submitted for the forensic examination of the following:

- the failure mode of the propeller flange cap screws
- whether or not positive location dowels had been fitted
- examination for the presence of Loctite (thread locking compound).

1.16.2 The examination found that four of the six crankshaft to propeller flange attachment cap screws exhibited beach marks, consistent with fatigue crack propagation. The remaining two screws were consistent with overload failure. Ageing of the fracture surfaces suggested the fatigue cracking had been occurring for some time prior to the accident.

1.16.3 There was no evidence of positive location dowel pins being fitted.

1.16.4 Green thread compound was found in four of the screw holes. Further disassembly would have been required to examine the remaining two. However, it was likely the compound would have been present.

1.16.5 The examination also found fretting damage on the crankshaft to propeller flange mount face. It was determined that some of the clamping force imparted to the six securing cap screws had been lost prior to the accident. The loss of clamping force allowed slippage between the crankshaft and propeller flange, resulting in fretting of the crankshaft mounting surface (refer Figure 1).

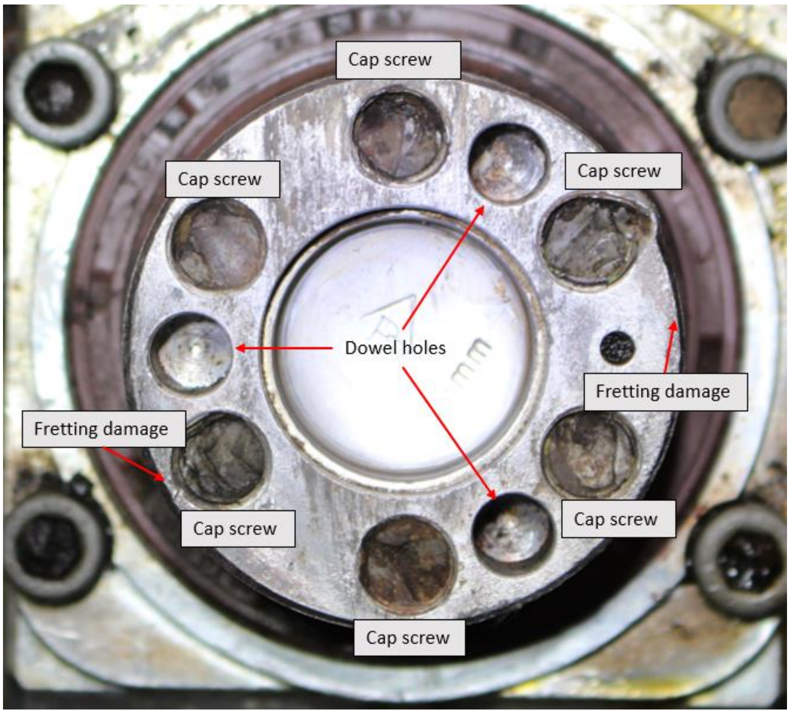

Figure 1: Crankshaft to propeller flange face detail (CAA photo)

1.17 Organisational and management information

1.17.1 Not applicable.

1.18 Additional information

1.18.1 Research carried out revealed there have been several incidents[8] around the world involving propeller loss that may have had relevance to events involving ZK-NAF.

1.19 Useful or effective investigation techniques

1.19.1 Flight data information retrieved from the aircraft and presented in a report, and also overlaid on Google Earth provided valuable information to the investigation. When analysed, the information helped piece together and determine events likely to have occurred during the flight and during the short period prior to impact.

2. Analysis

The accident

2.1 Evidence gathered by the safety investigation indicated the aircraft departed from controlled flight. The departure from controlled flight occurred after the pilot either mishandled or misjudged the low-level sideslip manoeuvre during an emergency landing. Evidence for the finding was from analysis of retrieved flight track data and the aircraft's impact observations.

2.2 At the approximate time of the manoeuvre, excessive height remained, following the decision by the pilot to take the shortest route to the aerodrome and land with a light tailwind on Runway 16.

2.3 The pilot's decision to land on Runway 16 was likely influenced by several factors:

- the pilot would have likely become anxious, realising there was a problem with the aircraft. This was likely to have been from vibration felt through the airframe which also would likely have increased in amplitude prior to the departure of the propeller
- startle effect[9] and a heightened state of anxiety after the propeller loss

[8] ATSB Investigation AO-2013-046 https://www.atsb.gov.au/publications/investigation_reports/2013/aair/ao-2013-046/, South African CAA CA/18/2/3/9604 9604.pdf (caa.co.za) and Dutch Safety Board Quarterly Aviation Report quarterly_aviation_report_q4_2019.pdf (onderzoeksraad.nl)

- the proximity of Runway 16 threshold was less than two nautical miles away
- given the nature of the situation, the pilot likely became fixated and determined to get the aircraft back on the ground as soon as possible.

2.4 Having made the decision, the pilot made a series of S-turns to lose height. However, the power-off glide path would have been flatter without a propeller providing wind milling drag. With only a short distance to the runway and aggravated by a tailwind, excessive height remained when the aircraft arrived overhead the threshold of the runway.

2.5 The pilot, faced with some urgency, likely placed the aircraft into a sideslip in an attempt to land within the confines of the runway. However, the flight data indicated that during the manoeuvre, the aircraft adopted an increasingly high rate of descent. The field investigation determined the aircraft slid for approximately 30 metres after the initial impact. Given the response from the aircraft kit manufacturer on conducting sideslip manoeuvres, the investigation could not determine whether the pilot, in his attempt to land, mishandled, or misjudged, the low-level sideslip manoeuvre.

2.6 While startle effect and anxiety were likely to be prevalent as events evolved, there were other factors contributing to the situation. The pilot had no prior knowledge of how his aircraft would perform without a propeller. The loss of a propeller would, in any circumstance, be an unthinkable and frightening event, and the situation cannot be trained for. More importantly, the pilot could only do the best he could to salvage a situation he had not experienced before. His simulated engine failure practice conducted in different aircraft types is also noted.

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[9] **The effects of startle on pilots during critical events: A case study** (W Martin, P.S. Murray,& P.Bates)
Research has shown adverse effects in a proportion of volunteers during startle experiments. Tests by Vlasek (1969), Woodhead (1959, 1969) and others have shown cognitive impairment for up to 30 seconds following startle and this has been shown in some accidents to be a period where underperformance has been critical to recovery.

The aircraft

2.7 The aircraft had various propeller assemblies fitted to it over several years. The fitment of these propeller assemblies likely contributed to the in-flight emergency.

2.8 Based on aircraft maintenance records examined during the safety investigation, it's evident that, after the second propeller strike, the pilot completed the required inspections, in accordance with the Engine Maintenance Manual. The Engine Maintenance Manual did not require the replacement of the crankshaft to propeller flange cap screws.

2.9 However, the Engine Overhaul Manual included a section titled 'Propeller Strike Procedures'. The inspection procedure required the crankshaft to propeller flange cap screws be replaced after any propeller strike.

2.10 The information provided within the Engine Maintenance Manual and Engine Overhaul Manual was inconsistent regarding propeller strike inspection requirements. The safety investigation informed Jabiru of the inconsistency and they have since amended the Engine Maintenance Manual to include the requirement to replace the crankshaft to propeller flange cap screws.

2.11 Based on the inconsistent information provided, and the evidence that the pilot referred to the Engine Maintenance Manual procedure, it's likely the crankshaft to propeller flange cap screws had never been replaced.

2.12 The forensic examination of the failed cap screws identified beach marks, consistent with fatigue crack propagation. It was determined the aging of the fracture surfaces suggest the fatigue cracking had been occurring for some time prior to the in-flight departure of the propeller.

2.13 Finally, investigations of other instances of propeller separations found that the lack of crankshaft positive location dowel pins fitted to the crankshaft was significant, in that they weakened the crankshaft to propeller flange joint. Without them, all the stresses were on the crankshaft to flange cap screws. This lack of strength and the fitting of unapproved propeller types to ZK-NAF, likely contributed to the failure of the cap screws and detachment of the propeller on the day of the accident.

2.14 As a result of this accident, the CAA issued Continuing Airworthiness Notice (CAN) 61-001 on 27 August 2020. Jabiru engines manufactured before July 2011 have reduced strength and reliability of the crankshaft/propeller flange joint, compared with the later design that incorporated positive location dowel pins. The CAN, in line with the Jabiru 2200/3300 Engine Overhaul Manual, strongly recommends that engines manufactured prior to July 2011 are updated during the next full overhaul or bulk strip, to include propeller flange positive location dowel pins between the crankshaft and the propeller flange.

Design change and major modifications

2.15 The replacement propeller types changed the operational characteristics of the aircraft and were considered to be a design change, and in addition, would be classified as a major modification.

2.16 As per the conditions and limitations on the certificate of airworthiness, the CAA must be notified, and its response received in writing prior to flying the aircraft, after incorporating a major modification or repair.

2.17 It was identified that the propeller types fitted were not on the engine manufacturer's approved list to be used with the Jabiru engine. Jabiru state that operators who use a non-approved propeller do so at their own risk.

2.18 Based on evidence gathered during the safety investigation, it's unclear if the pilot understood what constituted a design change or major modification. The CAA, however, has, over the years, provided education and guidance material on airworthiness matters for special category aircraft, and continues to do so.

3. Conclusions

3.1 The pilot was appropriately qualified, and his medical certificate was current for the flight.

3.2 The pilot fitted two different types of propellers to his aircraft that were not listed as approved by the engine manufacturer.

3.3 The fitment of a new type of propeller would be considered a major modification.

3.4 Forensic examination found the majority of the cap screws securing the propeller flange to engine crankshaft showed evidence of fatigue cracking.

3.5 The lack of positive location dowel pins led to additional loads being transferred onto the crankshaft to propeller flange attachment cap screws.

3.6 The remaining crankshaft to propeller flange attachment cap screws then failed from bending overload, resulting in the propeller detaching from the aircraft.

3.7 The aircraft crossed the runway threshold with excessive height remaining.

3.8 It was determined the accident occurred owing to a loss of control during the pilot's mishandling or misjudgement during a sideslip manoeuvre to reduce height during an emergency landing.

4. Safety actions

4.1 On 27 August 2021, the CAA issued Continuing Airworthiness Notice (CAN) 61-001, Jabiru 2200 and 3300 Engine Propeller Installations, advising Jabiru engine operators of the safety recommendations made by the ATSB after a propeller loss on a Jabiru J430 aircraft in Australia (refer Appendix 1).

4.2 On 20 October 2021, Jabiru Aircraft Pty Ltd. amended their Engine Maintenance Manual, JEM0002-11 to reflect a requirement to replace the six propeller flange to engine crankshaft caps crews after any propeller strike.

4.3 The CAA has and continues to provide education and guidance material to owner operators involving airworthiness matters involving special aircraft. For example:

- A *Vector* article *Is that a design change?* (Summer 2020/21), provides some clarification on what constitutes a design change or major modification.

- A *Vector* article, *Two sides to an airworthiness certificate* (Autumn 2021) advises owners there are important conditions concerning operating limitations and requirements listed on the back of the certificate.

- A safety education poster titled *Aircraft operator requirements (revised May 2022).*

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Appendix One   Continuing Airworthiness Notice 61-001

Jabiru 2200 and 3300 Engine Propeller Installations

27 August 2020

Issued by the Civil Aviation Authority of New Zealand in the interests of aviation safety. A Continuing Airworthiness Notice (CAN) is intended to alert, educate, and make recommendations to the aviation community. A CAN contains non-regulatory information and guidance that does not meet the criteria for an Airworthiness Directive (AD). The inspections and practices described in this CAN must still be carried out in accordance with the applicable NZCAR Parts 21, 43 and 91. CAN numbering is by ATA Chapter followed by a sequential number for the next CAN in that ATA Chapter.

Applicability:

All Jabiru 2200 and 3300 series aircraft engines.

Purpose:

This Continuing Airworthiness Notice (CAN) is issued to advise Jabiru engine operators of the safety recommendations identified by the Australian Transport Safety Bureau (ATSB) with an investigation of a propeller loss on a Jabiru J430 aircraft in Australia.

Background:

This CAN is prompted by a recent propeller loss on a Jabiru 2200A engine and a propeller loss in 2003 on Jabiru J430, VH-TJP in Australia, which resulted in a forced landing upon tidal flats at the western edge of Westernport Bay in Victoria. The pilot of VH-TJP was uninjured and able to disembark the aircraft safely.

The Australian Transport Safety Bureau (ATSB) investigation found that most of the cap screws connecting the propeller mounting flange to the engine crankshaft had failed by bending fatigue fracture – principally due to repeated relative movement between the mounted components. This movement was traced to a combination of an ineffective, multi-step torqueing method and the relaxation of tension within the crank–flange joint due to the compression of multiple layers of paint within the joint. It was also found that there were some anomalies within the maintenance documentation that related to these areas.

In July 2011, the engine manufacturer improved the strength and reliability of the crank–flange joint by adding positive-location dowels in all new production engines. However, that modification was not extended to earlier design assemblies, which included this specific Jabiru J430 aircraft engine.

Jabiru engines manufactured before July 2011 (pre-engine S/N 2446) have reduced strength and reliability of the crankshaft/propeller flange joint, compared with the later design that incorporated positive location dowel pins.

The current (revised) issue of the Engine Overhaul Manual has a strong recommendation that these dowels should be installed at the next full overhaul or at bulk strip of engines manufactured prior to July 2011. Furthermore, in addition to the earlier requirement for no paint on mating faces or where screw heads bear, a broad requirement was introduced to ensure that no paint, thread-locking compound, or contaminants remain in the propeller flange joint. The fastener torqueing method has been amended to a single-step process in which the required torque is to be obtained dynamically, while the fastener is being turned.

Finally, *Jabiru Propeller Flange Attachment Service Bulletin JSB 022-2* now refers maintainers directly to the engine overhaul manual for installation procedures – removing the variability that previously existed between documents.

For further information refer to ATSB Transport Safety Report AO-2013-046 dated 19 August 2014 available on the ATSB website at https://www.atsb.gov.au/publications/safety-investigation-reports/?mode=All&q=AO-2013-046

Recommendation:

Jabiru 2200 / 3300 Engine Overhaul Manual (document JEM0001) now includes a strong recommendation that operators update their engines during the next full overhaul or bulk strip to include propeller flange dowels between the crankshaft and the propeller flange.

Engine Overhaul Manual JEM0001 is available on the Jabiru website at https://jabiru.net.au/service/manuals/

Jabiru Propeller Flange Attachment Service Bulletin JSB 022-2 issue 2, dated 20 June 2014 has been revised to no longer specify the multi-step torqueing procedure, instead referring to the correct torque procedure in the Engine Overhaul Manual i.e. a single-step torqueing procedure.

Propeller Flange Attachment SB JSB 022-2 is available on the Jabiru website at https://jabiru.net.au/service/service-bulletins/

An additional requirement has been introduced into the overhaul manual for mounting surfaces to be free from paint, thread-locking compound, or other contaminants before assembly. The relevant painting process specification now requires that all three faying surfaces of the flange be masked plus an illustrative diagram accompanies the text.