

National Transportation Safety Board

Office of Aviation Safety

Washington, DC 20594



WPR22LA263

INVESTIGATIVE SUPPLEMENTAL MATERIAL

ACCIDENT

Location: Bothell, Washington
Date: July 19, 2022
Time: 2200 Pacific daylight time
Airplane: Zenith 701

INVESTIGATIVE SUPPLEMENTAL MATERIAL

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HISTORY OF FLIGHT

On July 19, 2022, about 2200 Pacific daylight time, a Zenith CH-701, N8787G, sustained substantial damage when it was involved in an accident near Bothell, Washington. The pilot and passenger sustained serious injuries. The airplane was operated as a Title 14 Code of Federal Regulations (CFR) Part 91 personal flight.

The pilot stated that before takeoff, he topped off the fuel tanks to full. After departure, he maneuvered clear of the surrounding Class B airspace and proceeded to the destination airport. As he approached the proximity of the airport, he turned the airplane east, on a path to adjoin the right downwind-leg of the traffic pattern for Runway 34L. When the airplane was about 6 nautical miles (nm) from the airport, he began the descent to the traffic pattern altitude of 1,600 ft mean sea level (msl). Immediately thereafter, the engine experienced a total loss of power and the propeller stopped.

The pilot further stated that he attempted to restart the engine by turning on the auxiliary fuel pump and the carburetor heat. The engine did not respond, and the pilot maneuvered the airplane toward a vacant road to make an off-airport landing. The airplane collided with high-tension powerlines and descended onto the road below.

AIRPLANE INFORMATION

The experimental, amateur-built airplane was certificated in 2011. It was powered by a Jabiru 3300 engine, rated to produce 120 horsepower, and equipped with a 3-blade Warp Drive composite propeller. The Jabiru 3300 is a direct drive, six-cylinder, horizontally opposed, air-cooled engine. A flywheel is mounted to the crankshaft to provide rotational energy to drive the ignition system and cylinder valve train. The flywheel is mounted to the aft end of the crankshaft using six 5/18" cap screws.

WRECKAGE AND IMPACT

The engine cowlings appeared intact and remained installed over the engine. The engine remained attached to the airframe, though some impact deformation was noted to the engine mount. The engine accessories remained mounted securely to the engine. The engine controls remained attached to the carburetor. Movement of the engine control knobs resulted in the corresponding engine controls to move freely and smoothly. Removal of the spark plugs revealed that the electrodes were light gray in appearance, consistent with normal operation; the exception was the No. 6 cylinder spark plug which contained carbon deposits.

Manual rotation of the propeller did not produce corresponding valve train movement. Disassembly of the engine accessory system revealed the six screws securing the flywheel to the crankshaft were separated, resulting in the separation of the flywheel from the aft end of the crankshaft.

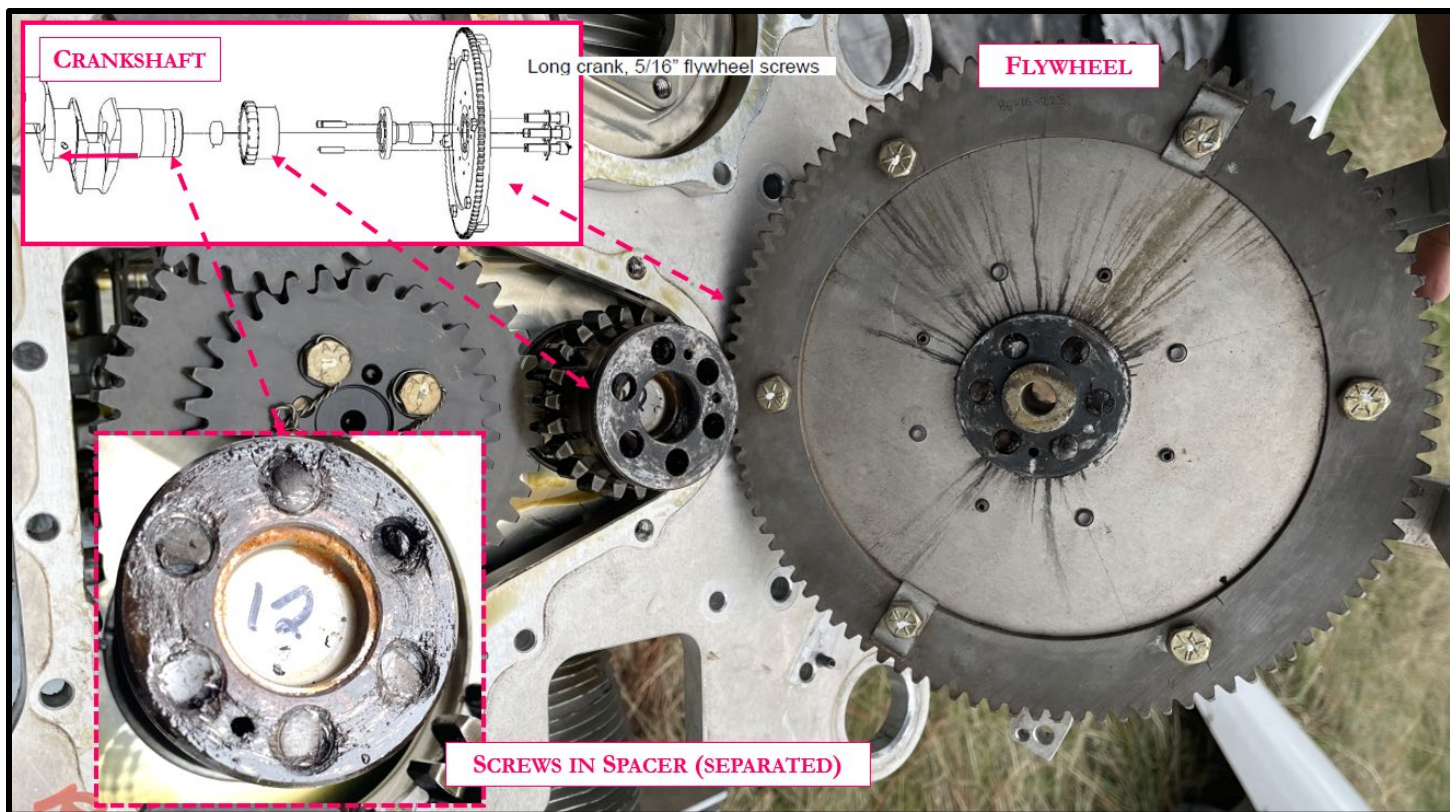


Figure 1: Flywheel and Spacer

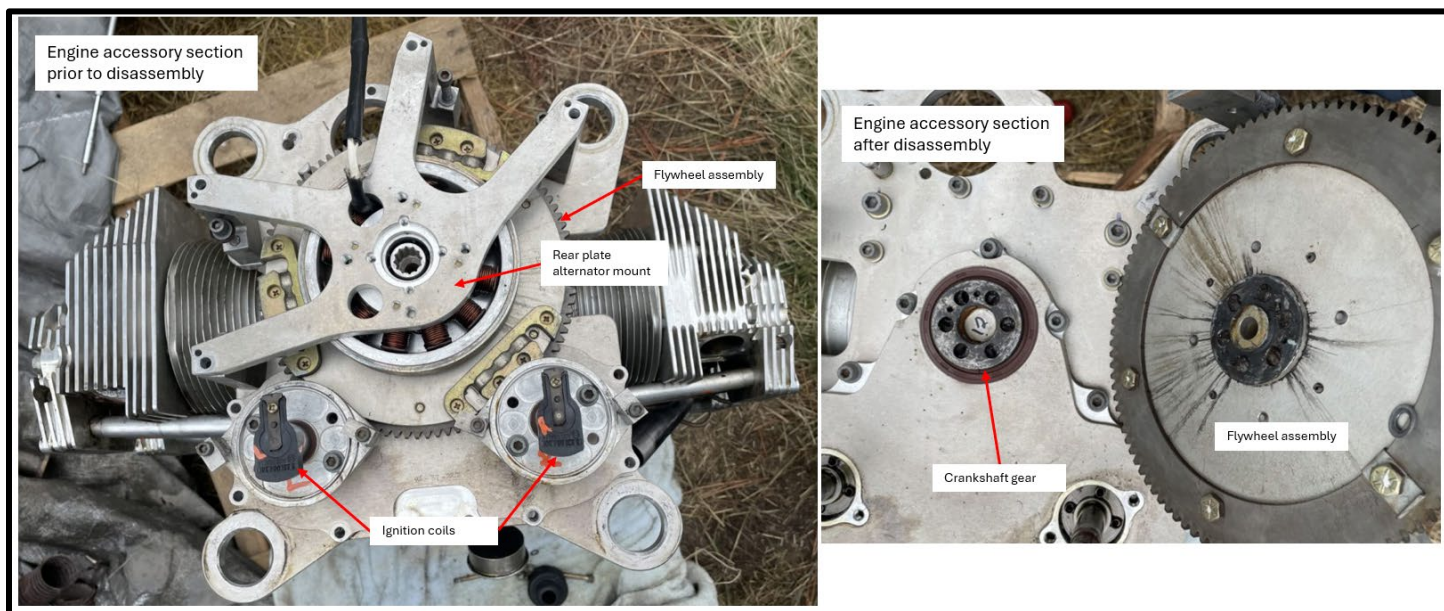


Figure 2: The Accessory Section Including the Separated Flywheel

TESTS AND RESEARCH

The Safety Board Material Laboratory performed an examination of the flywheel, flywheel mounting screws, alternator assembly, and crankshaft timing gear.

The timing gear appeared undamaged. Removal of the stator ring and bracket revealed galling wear in a circular pattern near the location of the alternator ring when the two pieces were attached. The wear was consistent with repeated contact and rubbing between the spinning flywheel assembly and bracket during engine operation.

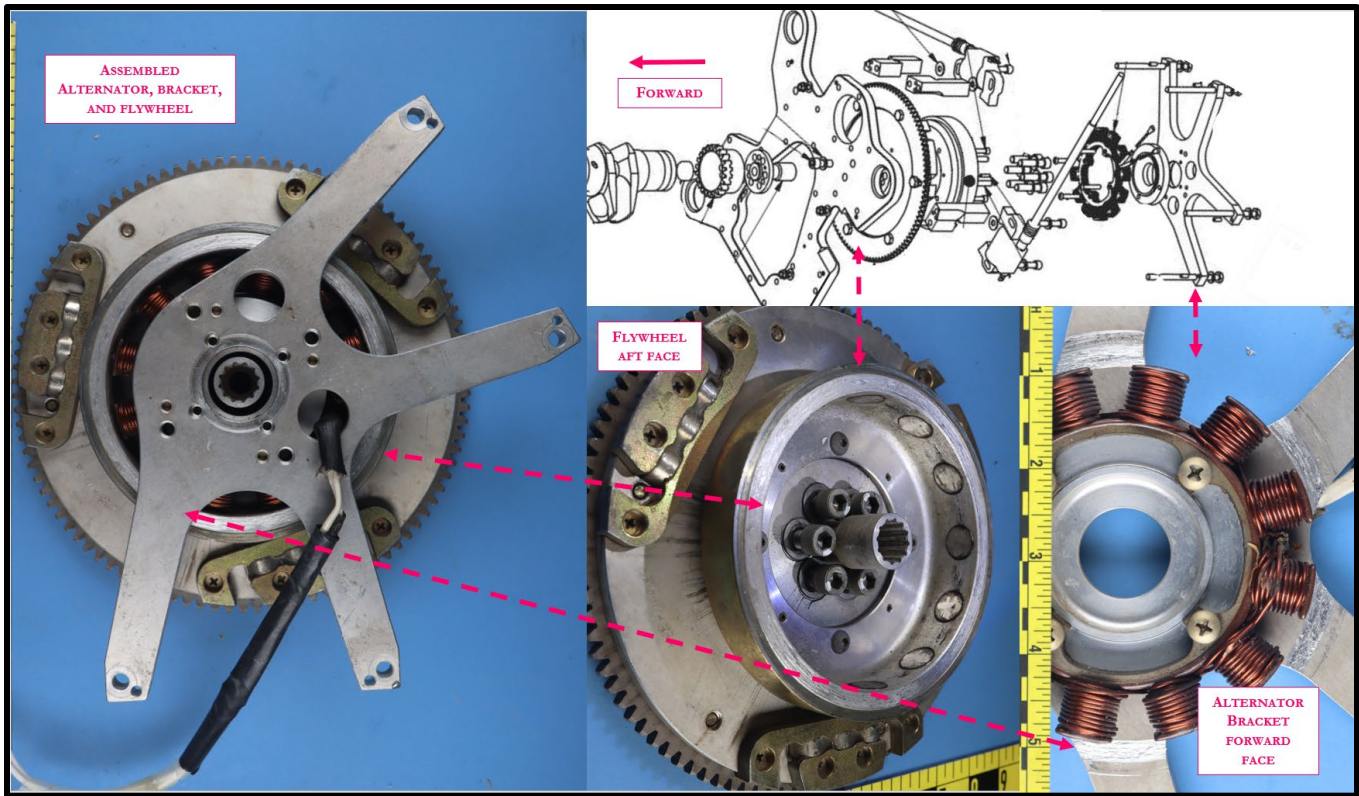


Figure 3: Galling wear found between aft face of flywheel and forward face of alternator bracket.

The six fractured flywheel hex-head screws were backed out of their fully seated positions by approximately 0.25 inch. The screws were loosely threaded into the holes; According to the Jabiru parts manual, the holes were manufactured with a smooth bore. It could not be determined if the screw positions represent their position after the failure or if they shifted during the subsequent crash or retrieval. The washers under the screw heads were deformed in a manner consistent with bending forces and a crack was discovered in one washer.

Examination of the screw threads showed contact damage consistent with impingement on the walls of the through-holes, and complimentary wear resembling screw threading was visible in the through-holes. Examination of the screw fracture surfaces revealed that several had ratchet marks (indicative of multiple fatigue initiation points) near the base of the threads. Fatigue crack progression marks were present across most of the face until final failure as indicated by a shear lip, consistent with low stress bending-fatigue. Additionally, three of the screws displayed secondary fatigue cracks originating from the threads. One screw displayed multiple fracture planes with contact damage on the highest plane; it additionally had fatigue progression marks radiating from several points at the roots of the threads.

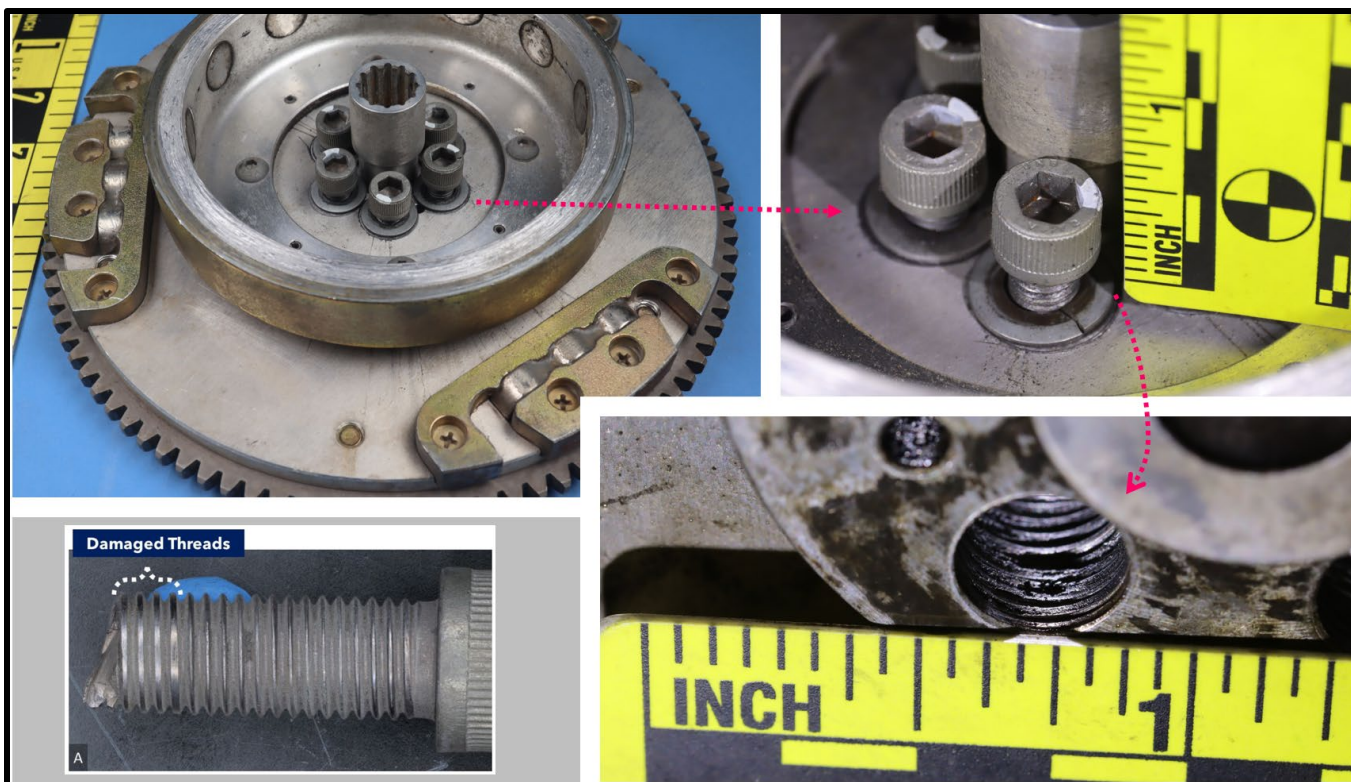


Figure 4: The flywheel with screws installed, and hardware through the hole after removal of the screw.

Galling wear was found between the forward face of the rear plate alternator mount and the aft face of the flywheel. The flywheel attachment screws remained installed in the flywheel, with contact damage noted on the inside of the flywheel hardware holes. Communication with Jabiru revealed that the flywheel hardware hole was manufactured with a smooth bore.



Figure 5: A Flywheel Screw with Damaged Threads, And Thread Imprints In The Corresponding Flywheel Hardware Hole)

The six flywheel attachment screws were removed from the flywheel, cleaned, and examined using a digital microscope. Four of the screws displayed fatigue crack progression marks across the fracture faces, consistent with low-stress bending fatigue. Additionally, three of the screws displayed secondary fatigue cracks originating from the threads.

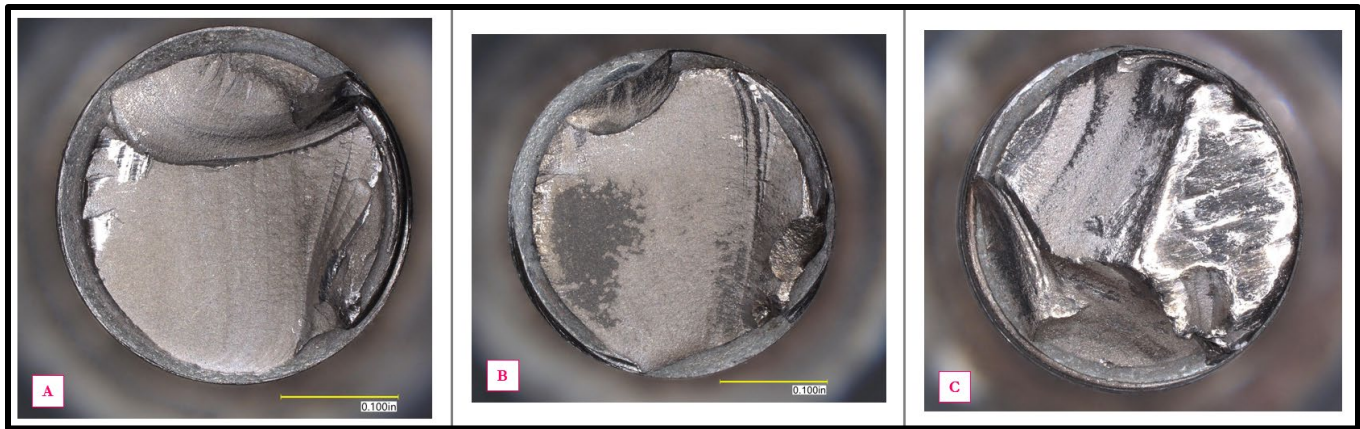


Figure 6: Microscope images of flywheel screws; Images A and B show fracture faces with multiple fatigue initiation points, and Image C shows a screw with multiple fatigue planes and contact damage.

One screw displayed multiple fracture planes with contact damage on the highest plane. This screw showed fatigue progression marks radiating from several points at the roots of the threads.

RECORDS

A review of the maintenance records revealed that the airframe had accrued 70.5 total flight hours, and the engine had accrued 252.1 total flight hours. The most recent maintenance performed on the airplane was an Annual Inspection recorded as being performed on June 20th, 2022, at an airframe total time of 46.6 hours. The records indicate that the Jabiru 3300A engine (serial number 33A453) was installed at the time the airplane was built and had a total time of 133.4 hours.

Date	Recording Tach/ Hour Meter Time	Total Time in Service	Description of work performed
8-17-2011	0	0	built this Aircraft Zenith 701 in accordance with the Zenith Kit Plans + CD's. I installed a used Jabiru engine 3300A, S/N 33A453 with tach time 133.4 Hours. I installed propeller model W642K42 Sensenich S/N AH 7385

Figure 7: Record of Engine Installed on Accident Airplane

ENGINE LOG DATA			
(THIS PAGE MUST BE FILLED OUT COMPLETELY)			
MANUFACTURER	Jabiru		SERIAL NO. 33A 453
MODEL	3300 A		
DISPLACEMENT	3300cc / 200 CI	OIL PRESSURE MAX. 76 ^{psi} MIN. 31 ^{psi}	OIL TEMP MAX. 244 ^F MIN. 104 ^F
WEIGHT	178 lbs	RATED H.P. 120 AT 3300	R.P.M.
OIL GRADE: SUMMER	Aero shell 15-50	WINTER 15-50	OIL CAPACITY 3.69 qts
FUEL MINIMUM OCTANE	100 LL or 91 Auto gas octane	FIRING ORDER 1-4-5-2-3-6	
MAGNETO TIMING	25° BTDC	MAGNETO POINT SETTING	
SPARK PLUG GAP	NGK D9EA .022" - .024" (.55 - .6 mm)		

Figure 8: Engine Logbook Excerpt

ENGINE LOG		
YEAR		DESCRIPTION OF INSPECTIONS, REPAIRS AND ALTERATIONS Certified mechanics or repair facilities must endorse all inspections and repairs on type certified aircraft with name, rating & Cert. No.
MO.	DAY	
5-17-2010		Installed new Float, Rebuild kit, Diaphragm, Piston Assembly, needle carrier, in carb, needle jet tach time 133.4. A+P
5-2-2011		I certify that this ^{Engine} Aircraft has been Inspected in Accordance with the scope and detail of appendix O to part 43 and has been found to be in a condition for safe operation. Removed oil filter & cut open no debris found. Installed new (spark plugs) Per Jabiru instructions. Compression - 1-72, 2-74, (NGK D9EA) 3-73, 4-71, 5-73, 6-70, Installed Air Filter A+P Total tach time 134.2

Figure 9: Engine Logbook Excerpt Prior to Installation on Accident Airplane

PAST ACCIDENT

A review of maintenance records revealed the engine had been installed on a different airplane prior to the accident airplane. This airplane was also an experimental, amateur-built airplane that had been involved in an

accident in May 2004 (NTSB accident number IAD04LA019). The pilot involved in that accident reported the airplane had suffered damage to the propeller during the accident sequence.

Description Of Damage To Aircraft And Other Property	
1-Set of VASI lights AT EOI.	
Prop, nose wheel, Right Gear, Right wing, Left wing. Front fuselage, Cocle wheel. FARNINGS, ENGINE SUBMERGED IN WATER IN CHECK	

Figure 10: Excerpt of Prior Engine Owner's NTSB Accident Form (6120.1/2) with Damage Information

II. AIRCRAFT INFORMATION	
Model <u>UM-1 Esau</u>	Engine(s) Make <u>Jabiru 3300</u>
Assigned Serial No. <u>E180032</u>	Engine(s) Serial No.(s) <u>334453</u>
Registration No. <u>N626EA</u>	Prop./Rotor(s) Make <u>Sensenich</u>
Aircraft Fabricated: Plan ☐ Kit ☒	Prop./Rotor(s) Serial No.(s) <u>AD 9542</u>

Figure 11: Excerpt of Prior Airplane's Airworthiness Records

Engine Manufacturer <u>JABIRU</u>		Engine Model/Series <u>3300</u>		Engine Rated Power 1. <u>120</u> Horsepower 2. _____ Lbs Thrust		Type Of Fire Extinguishing System Used 1. None 2. Specify <u>1</u>	
Engine(s)	Date of Mfg.	Mfg. Serial No.	Total Time	Time Since Inspection	Time Since Overhaul		
Engine No. 1	<u>2003</u>		<u>138.4</u> Hours	<u>14.6</u> Hours	<u>N/A</u> Hours		
Engine No. 2			Hours	Hours	Hours		
Engine No. 3			Hours	Hours	Hours		
Engine No. 4			Hours	Hours	Hours		
Type Of Maintenance Program 1. ☒ Annual 2. ☐ Manufacturer's Inspection Program 3. ☐ Other Approved Inspection Program(AAIP) 4. ☐ Continuous Airworthiness 5. ☐ Specify _____		Type Of Last Inspection 1. ☒ Annual 2. ☐ 100 Hours 3. ☐ AAIP 4. ☐ Continuous Airworthiness		Date Last Inspection Performed <u>03-13-2004</u> (M/D/Y) Time Since Last Inspection <u>14.6</u> Hours Airframe Total Time <u>138.4</u> Hours			

Figure 12: Excerpt of Prior Engine Owner's NTSB Accident Form (6120.1/2) with Engine Information

ADDITIONAL INFORMATION

According to Jabiru Engine Maintenance Manual JEM0002-11, a detailed inspection of the flywheel screws must be performed at every annual inspection. This inspection includes checking each screw for proper torque, and replacement of any screws found not to be properly torqued.

Jabiru Service Bulletin JSB 012 also states, “[i]f the flywheel screws fail the flywheel will partially or completely separate from the crankshaft. This results in a loss of ignition timing and/or valve timing, damage to the alternator and ignition coils and a stoppage of the engine.”

JSB 012 also lists the potential causes of flywheel screw failure, which include:

- Excess lubrication- the presence of oil between the crankshaft, crankshaft gear, and flywheel can reduce the friction between the parts, reducing the strength of their connection.
- Propeller strike and abrupt engine stoppage- can produce a spike of torque along the crankshaft, which can overload the flywheel screws.

- Improper propeller screw tension, propeller imbalance, loose propeller drive bushes, incorrect propeller type, incorrect propeller flange, or damaged propeller- May allow the propeller to move and fret against the mounting flange, causing vibration to be reflected down the crankshaft to the screws.
- Damaged flywheel- any engine operation with loose screws or the conditions listed above can result in elongation of the flywheel hardware holes, resulting in breakage of the screws.