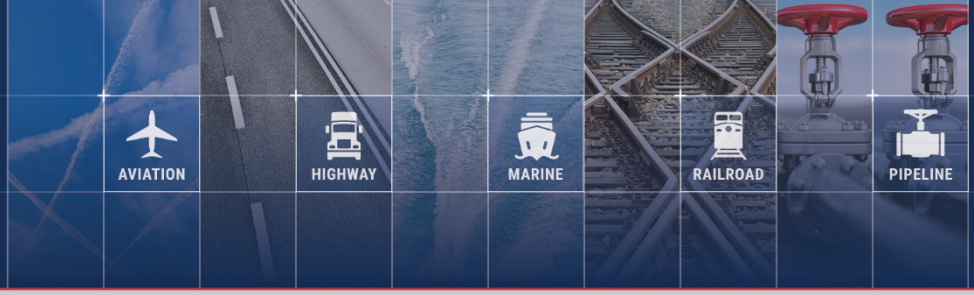

Aviation Investigation Factual Report

Location:	Otter Lake, New York	**Accident Number:**	ERA12TA542
Date & Time:	August 16, 2012, 08:39 Local	**Registration:**	N365R
Aircraft:	RIDGE LOWELL H Jabiru J230	**Aircraft Damage:**	Substantial
Defining Event:	Loss of engine power (total)	**Injuries:**	2 None
Flight Conducted Under:	Public aircraft		

On August 16, 2012, about 0839 eastern daylight time, an experimental, amateur built Jabiru J230, N365R, received substantial damage during a ditching in Gull Lake, near Otter Lake, New York, following a total loss of engine power and separation of the propeller. The public use flight was operated by Patriot Technologies LLC under contract with the Department of Defense, U.S. Air Force. The airline transport pilot and one additional crew member were not injured. Visual meteorological conditions prevailed, and no flight plan was filed for the flight which departed Burlington International Airport (BTV), Burlington Vermont about 0800, destined for Griffiss International Airport (RME), Rome, New York.

According to the operator, the purpose of the flight was to provide aerial support for a U.S. Air Force training exercise. At the time of the accident, the flight was receiving VFR flight following from the New York Air Route Traffic Control Center (ARTCC).

According to the pilot, after departing BVT, he headed westbound and climbed to 6,500 feet above mean sea level. Approximately 45 minutes into the flight, the engine began to run roughly "like it was developing carburetor ice" so the pilot applied carburetor heat. The engine however, continued to run rough and began to "cough" like it was being starved for fuel, so the pilot made sure that both fuel valves were open, and turned on the electric fuel boost pump.

The pilot then assessed that the engine might stop running, so he called for the high altitude engine failure checklist. However, before he and his crewmember began the checklist, the propeller came off the engine, struck the right side of the cowling, struck the right lift strut, and fell away.

The pilot then declared an emergency with the ARTCC, began evaluating landing sites, and elected to ditch in a nearby lake. After ditching, the airplane came to rest on the surface of the lake with the cabin halfway submerged. Both crewmembers then egressed from the cabin, swam to the lake shore, and were later picked up by helicopter. The airplane later sank to the bottom of the lake.

Pilot Information

Certificate:	Commercial; Flight instructor	**Age:**	34
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	4-point
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	Airplane multi-engine; Instrument airplane	**Toxicology Performed:**	No
Medical Certification:	Class 2 Without waivers/limitations	**Last FAA Medical Exam:**	June 4, 2012
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	June 21, 2012
Flight Time:	3147 hours (Total, all aircraft), 42 hours (Total, this make and model), 1717 hours (Pilot In Command, all aircraft), 47 hours (Last 90 days, all aircraft), 38 hours (Last 30 days, all aircraft)		

Other flight crew Information

Certificate:	Commercial	**Age:**	44
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Right
Other Aircraft Rating(s):	None	**Restraint Used:**	4-point
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	None	**Toxicology Performed:**	No
Medical Certification:	Class 3 Without waivers/limitations	**Last FAA Medical Exam:**	January 1, 1990
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	
Flight Time:	(Estimated) 2350 hours (Total, all aircraft), 42 hours (Total, this make and model)		

According to Federal Aviation Administration (FAA) and pilot records, the airline transport pilot, held an airline transport pilot certificate with a rating for airplane multi engine-engine land, commercial privileges for airplane single-engine land, and type ratings in the BE-300, and C-295. He also held a flight instructor certificate with ratings for airplane multi-engine, and instrument airplane. His most recent FAA second-class medical certificate was issued on June 4, 2012. He reported 3,147 hours of total flight experience, 42 of which were in the airplane make and model.

The crew member held a commercial pilot certificate with ratings for airplane multi-engine land limited to center thrust, instrument airplane, and private privileges for airplane single-engine land. At the time of the accident he did not possess a valid FAA medical Certificate. He reported 2,350 hours of total flight experience.

Aircraft and Owner/Operator Information

Aircraft Make:	RIDGE LOWELL H	**Registration:**	N365R
Model/Series:	Jabiru J230	**Aircraft Category:**	Airplane
Year of Manufacture:	2005	**Amateur Built:**	Yes
Airworthiness Certificate:	Experimental (Special)	**Serial Number:**	201
Landing Gear Type:	Tricycle	**Seats:**	2
Date/Type of Last Inspection:	February 27, 2012 Condition	**Certified Max Gross Wt.:**	1675 lbs
Time Since Last Inspection:		**Engines:**	1 Reciprocating
Airframe Total Time:	915 Hrs at time of accident	**Engine Manufacturer:**	Jabiru
ELT:	C91A installed, not activated	**Engine Model/Series:**	3300
Registered Owner:	Multi-Mission, LLC	**Rated Power:**	120 Horsepower
Operator:	Patriot Technologies Group, LLC	**Operating Certificate(s) Held:**	None

According to FAA and airplane maintenance records, the airplane was manufactured in 2005. The airplane's most recent conditional inspection was completed on February 27, 2012. At the time of the accident, the airplane had accrued 915.2 total hours of operation. The engine had accrued 531.2 total hours of operation.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	KRME,504 ft msl	**Distance from Accident Site:**	24 Nautical Miles
Observation Time:	08:45 Local	**Direction from Accident Site:**	225°
Lowest Cloud Condition:		**Visibility**	10 miles
Lowest Ceiling:	Overcast / 1200 ft AGL	**Visibility (RVR):**	
Wind Speed/Gusts:	0 knots / None	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	0°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	29.97 inches Hg	**Temperature/Dew Point:**	19°C / 16°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Burlington, VT (BTV)	**Type of Flight Plan Filed:**	None
Destination:	Rome, NY (RME)	**Type of Clearance:**	None
Departure Time:	08:00 Local	**Type of Airspace:**	Military operation area

The recorded weather at RME, approximately 25 nautical miles southwest of the accident site, at 0853, included: calm winds, visibility 10 miles, overcast sky at 1,200 feet, temperature 19

degrees C, dew point 16 degrees C, and an altimeter setting of 29.98 inches of mercury.

Wreckage and Impact Information

Crew Injuries:	2 None	**Aircraft Damage:**	Substantial
Passenger Injuries:		**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	2 None	**Latitude, Longitude:**	43.552776,-75.0625(est)

Four days after the ditching occurred, the airplane was recovered from the lake. Examination revealed that the airplane was substantially damaged due to water immersion.

Further examination revealed that the entire propeller assembly, including the propeller spinner, and propeller flange extension, had separated from the forward portion of the engine crankshaft.

Despite a search of the surrounding area, the separated components of the propeller assembly were not found.

Tests and Research

Maintenance Records Review

According to aircraft maintenance records, the valves and valve seats had been reground / recut at 204 hours total engine operating time. The sparkplugs had been replaced at 451.6 hours. On August 5, 2012, approximately 11 days prior to the accident, at 510.8 hours total engine operating time, the exhaust gas temperature (EGT) probes were inspected.

Engine Examination

Examination of the engine by Jabiru Pacific LLC revealed that the capscrews which held the propeller flange extension on to the engine crankshaft appeared to have sheared off. Further examination revealed that the top of the engine case under the starter near the No. 6 cylinder was disfigured. Attempts to rotate the drive train in both a clockwise direction and counterclockwise direction were unsuccessful, indicating that the engine was seized internally.

Examination of the No. 1, No.2, No.3, No. 4, and No. 5 cylinder heads, pushrods, barrels, pistons, and connecting rods revealed no evidence of any preimpact anomalies or failures which would have

precluded normal operation of the engine. However, examination of the No. 6 cylinder head revealed that significant damage was present, and it was discovered that the exhaust valve and valve seat were missing. Examination of the No. 6 cylinder also revealed that the piston was lying in the bottom of the cylinder, along with the wrist pin which was broken into two pieces. Both pieces displayed evidence of impact damage and fracturing. The No. 6 connecting rod was visibly connected to the crankshaft but, it was bent almost in half and wedged between the crankshaft and the top of the engine case indicating that it was the source of the internal seizure as it prevented rotation of the crankshaft.

Examination of the contents of the oil pan revealed more shattered portions of the No. 6 piston, as well as parts of the piston rings, and the exhaust valve head.

Examination of the exhaust system also revealed that parts of the exhaust valve seat had been captured in the muffler. Examination of the valve seat revealed that it had fragmented into two main pieces along with numerous smaller fragmented ones.

Materials Laboratory Component Examination

Examination of the engine components by the NTSB Materials Laboratory Division confirmed that the No.6 cylinder exhaust valve seat had dislodged from its seat and had fractured into multiple fragments. Examination of the fragments under a stereomicroscope revealed that they had a rough appearance which was consistent with overstress fractures. The compression face of the No. 6 cylinder head also exhibited multiple impact marks.

Evidence of lead like deposits was discovered during visual examination of the No.6 cylinder exhaust. These deposits were later confirmed to be lead using energy dispersive spectroscopy (EDS). Examination of the other cylinders and pistons also revealed the presence of lead deposits on those components as well.

The cylinder valve and rocker arm assemblies were designed to incrementally rotate the valves with each cycle of the rocker arms. Examination of the No. 6 rocker arm shaft and exhaust valve rocker arm bushing exhibited features consistent with abrasive wear. Circumferential wear marks were observed on the shaft and a step could be felt by hand where the bearing had been articulating against the shaft. On the bushing, the wear had progressed through the bearing material into the steel backing material. Lesser wear marks were observed on the intake rocker arm bushing and the corresponding location on the shaft. When the valve stems were removed from the valve guides, metal particulates could be seen on the stems.

Measurements taken using a caliper of the No. 6 exhaust valve spring indicated that the exhaust valve spring free height was within the limits specified in the Jabiru Overhaul Manual (JEM0001-4). Examination of the valve assembly recess of the cylinder head displayed features consistent with deformation and wear of the sidewall around the exhaust and intake valve stems, consistent with impingement by the valve spring. Similar impingement features were observed on the No. 2 and No. 4 cylinder heads, but not the No. 1, No. 3, or No. 5 cylinder heads.

The No.6 cylinder exhaust valve head had also fractured from the stem near the transition from the head radius to the cylindrical stem. There were lead deposits on the stem next to the fracture over an

approximately 0.4 inch in length. The fracture surface was flat, and was perpendicular to the longitudinal axis of the stem. Multiple rachet marks were present around the perimeter of the stem. The presence of the ratchet marks and the morphology of the fracture surface were consistent with fatigue crack initiation and propagation from multiple initiation sites around the perimeter of the stem.

The fracture initiation sites were examined at higher magnification using a scanning electron microscope (SEM). Along the perimeter of the stem, dark thumbnail shaped regions were observed at the crack initiation sites. The surface was covered with lead deposits except near the thumbnails, where material had spalled off the stem surface. The composition of the fracture surface was examined using EDS within and outside of the thumbnail shaped regions. Within the thumbnail regions, the EDS spectrum revealed the presence of a greater amount of oxygen relative to the EDS spectrum taken outside of the thumbnail region. The EDS spectrum outside of the thumbnail regions indicated that the stem material was comprised primarily of iron, chromium, manganese, and nickel.

Examination of the valve stem surface using the SEM revealed the presence of spalled material on the stem surface near the fracture. An EDS spectrum taken near the center of the spalled region revealed that it had a comparatively high level of oxygen, similar to the EDS spectrum of the thumbnails. Near the edge of the spalled region, a dark grey coating was also observed. An EDS spectrum of the coating revealed that compared to the base material, the spectrum exhibited a high concentration of oxygen, and chromium. An EDS spectrum outside of the spalled area exhibited a high concentration of lead.

Materials Laboratory Crankshaft Examination

Examination of the propeller flange by the NTSB Materials Laboratory Division revealed that the propeller flange had six evenly spaced threaded bolt holes and three smooth bored holes. Each threaded hole contained the shank of a capscrew that had fractured flush with the face of the flange. The three smoothed-bored holes showed no evidence of them containing anything that had been inserted or installed in the bore.

The fracture faces on the capscrews had a smooth appearance with smear marks orientated in the direction of rotation. Some of the capscrews were deformed in the direction of engine rotation, as evidenced by threads that were deformed over the threaded hole chamfers. The features were consistent with an overstress fracture in shear.

Further examination of the bolt shanks after removal from the propeller flange revealed that each shank had approximately 0.4 inch (10 mm) of thread engagement and the threads were coated with thread locking compound in accordance with Jabiru Service Bulletin JSB 022-1.

The hardness of each bolt was also tested using a Rockwell hardness tester. According to JSB 022-1, the bolts must be "Unbrako 1960 type or equivalent." According to the Unbrako Engineering Guide, Unbrako 1960 types are alloy steel screw that conform to ASTM A574 and have a hardness between 38 HRC and 43 HRC. The hardness values for all of the capscrews were within the specified limits.

Valve Failure History

According to Jabiru Aircraft, they were aware of approximately eight previous in-service failures of

exhaust valves. They advised that the exhaust valves appeared to be intolerant of temperatures over approximately 750 degrees Celsius, and that heat stress was the most common issue that they had identified. They further advised that around that temperature, the exhaust valve would start showing indications of stress corrosion/cracking at the base of the stem.

Propeller Flange Loss History

The propeller flange on all Jabiru engines was of a removable type. This allowed for easier maintenance on the engine and made the power plant easier to customize for different cowl designs.

Historically, all Jabiru engines were shipped with the "standard"-length propeller flange – which added about 20 millimetres (mm) to the effective length of the crankshaft. Since the early 1990s, most Jabiru aircraft used an extended version of the flange which was about 51mm longer than the standard flange. Over time, this configuration became more and more popular with other aircraft models so that, in August 2010, Jabiru changed all new production engines to ship with the extended flange fitted as standard.

According to Jabiru Aircraft, at the time of the accident, they had identified approximately 8 instances where the propeller flange attachment had separated from airplanes due to varying circumstances including:

- Installation of incorrect length capscrews resulting in insufficient thread engagement.

- Fitting of non-approved propeller types.

- High time-in-service without replacement or checking of propeller attachment screws.
- Improper torque.

- Lack of thread-retaining compound.

- Fracture of the crankshaft extension attachment capscrews from fatigue due to insufficient clamping force from thread locking compound being trapped under the concave side of the washers.

To alleviate some of the problems areas that they observed, Jabiru took several steps to improve the chances of a flange being properly installed. These steps included issuing two service bulletins (JSB 014 "Propeller Installation Maintenance" and JSB 022 "Propeller Flange Attachment"). They also changed the configuration of new engines to have the longer flange as standard and altered the maintenance requirements of the engine for more detailed monitoring of the propeller flange area.

They also altered the design of the engine to incorporate three 8mm dowels between the crankshaft and the propeller flange, and in July of 2011, starting with engine serial number 33A2446, began inclusion of these propeller flange dowels. All 2,445 engines manufactured prior to serial number 33A2446, had no dowels.

Additional Information

In order to improve safety the participants in this investigation took the following actions:

Patriot Technologies Group LLC

- On September 18, 2012, Patriot Technologies Group advised the NTSB that they would be installing new propeller flange hubs (Jabiru Part Number: 466218N) and Dowel Pins (Jabiru Part Number: PH4A068N) to the airplanes in their fleet which were not equipped with propeller dowel pins.

Jabiru Aircraft Pty. LLC

- On October 1, 2013, Jabiru Aircraft advised the NTSB that they would be expanding guidance regarding extended running at low rpm / high altitude, in their "Alcohol, Lead, Compression Ratio: Fuel Guidance" (Service Letter JSL 007-4) to help preclude lead build up in Jabiru engines. This guidance will also extend to airplanes operating in the Light Sport Aircraft (LSA) categories through Safety Directive JSDL 007-4 which was prepared to allow application of JSL007-4 to aircraft operating within the LSA categories.

- On October 11, 2013, Jabiru Aircraft advised the NTSB, that in the next revision of the Jabiru Engine Overhaul Manual (JEM0001) the guidance would include:

1. Directions specifying that when installing the propeller flange, application of the retaining compound should be limited to within the bore of the female thread in the crankshaft.

2. A requirement that care be taken to ensure there is no excess retaining compound between the capscrew's washer and the propeller flange during installation.

3. A recommendation for owners that if not so equipped, to upgrade their engines to include propeller flange dowels during the overhaul.

Administrative Information

Investigator In Charge (IIC):	Gunther, Todd
Additional Participating Persons:	Steven McShea; Patriot Technologies Group, LLC; Alexandria, VA Peta Nesbit; ATSB; Australia Douglas Smith; Jabiru Pty Ltd; Australia
Report Date:	May 14, 2014
Last Revision Date:	
Investigation Class:	Class
Note:	
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=84884