National Transportation Safety Board

Office of Aviation Safety

Washington, D.C. 20594-2000

May 27, 2014

SPLINE WEAR MEASURMENTS REPORT

ERA14LA130

4 imbedded photographs

A. Accident

Location: Apopka, Florida
Date: February 23, 2014
Time: 1335 EST
Vehicle: Victor M Cordero, RV-9A, S/N 90319, N19VC, Experimental Amateur Built
Engine: Eggenfellner Subaru EJ25 Automobile Engine Conversion

B. Investigators

Stephen Stein
Air Safety Investigator (IIC)
National Transportation Safety Board
45065 Riverside Parkway
Ashburn, VA 20147

John Clark
Senior Technical Advisor
National Transportation Safety Board
45065 Riverside Parkway
Ashburn, VA 20147

C. Summary

On February 23, 2014, about 1335 Eastern Standard Time, an experimental amateur built RV-9A airplane, N19VC, operated by a private individual, was substantially damaged during an emergency landing in Apopka, Florida. The instrument rated private pilot received minor injuries and the passenger sustained serious injuries. Visual meteorological conditions prevailed for the personal flight conducted under Title 14 Code of Federal Regulations Part 91. The pilot cancelled his instrument flight rules (IFR) flight plan and was operating under visual flight rules. The flight originated from Marsh Harbour International Airport (MYAM), Marsh Harbour,

Bahamas at 1130 and was maneuvering to land at Orlando Sanford International Airport (SFB), Orlando, Florida.

According to the pilot's written statement he cancelled his IFR clearance at 3,000 feet and was cleared to maintain his "present heading" for runway 9L at SFB. Two minutes later, about 1330, the propeller suddenly stopped rotating, but the engine appeared to function normally. There were no annunciations or warnings on the engine monitoring unit. The pilot executed an emergency landing near Apopka Airport (X04). During the landing roll the airplane nosed over and came to rest in an inverted attitude.

D. Details of Investigation

1.0 Hardware

Power is transferred from the engine to the propeller speed reduction unit (PSRU) through a spline shaft. One end of the spline shaft is inserted into a drive disk adapter at the engine. The other end is inserted into the PSRU input spline. The pilot provided records that showed that the PSRU had been in service about 340 hours. The spline shaft and PSRU input spline were hardened. The drive disk adapter that mates to the solid flywheel is not hardened while the drive disk adapter that mates to the dual mass flywheel is hardened.

PSRU – Propeller Speed Reduction Unit – The unit was manufactured by Eggenfellner Aircraft, LLC[1]. The unit was a GEN 3, Ver 4 model. The PSRU is a geared reduction drive that provides for a propeller RPM that is about ½ that of the engine RPM. The PSRU was installed on the engine before the first flight. The engine instrument system (EIS) indicated that the PSRU had been in service for 325 hours. The pilot provided records that showed that the PSRU and been in service about 340 hours.

Eggenfellner Aircraft recommended replacing the solid flywheel with the dual-mass flywheel in an effort to minimize in-service wear of the PSRU and spline drive. According to the builder/pilot, he decided to replace the solid mass flywheel around 500 hours of operation. A kit consisting of a new spline shaft and drive disk adapter was to be used with a new dual-mass flywheel.

Spline shaft – The spline shaft inserts into both the drive disk adapter at the engine and the input spline of the PSRU. The spline shaft transfers power from the drive disk adapter to the PSRU. The thicknesses of the spline teeth decrease as the teeth wear in service.

Drive disk adapter – The adapter bolts directly to the engine crankshaft with a solid flywheel between the two. The adapter has grooves that align with the teeth of the spline shaft. The grooves are separated by walls. The thicknesses of the walls will decrease as the walls wear in service.

[1] Eggenfellner Aircraft, LLC; Edgewater, FL; Eggenfellner Aircraft is no longer in business.

PSRU input spline – The PSRU input spline is integral with the gear shaft and input gear. The input spline has grooves that align with the teeth of the spline shaft. The grooves are separated by walls. The thicknesses of the walls will decrease as the walls wear in service.

Solid flywheel –Eggenfellner Aircraft subsequently recommended replacing the solid flywheel with a dual-mass flywheel in an effort to minimize in-service wear of the PSRU and spline drive. According to the builder/pilot, he planned on replacing the solid mass flywheel when the engine had about 500 hours of operation. A kit consisting of a new spline shaft and drive disk adapter was to be used with a new dual-mass flywheel.

Dual mass flywheel – The modified Subaru dual mass flywheel has two separate masses that are isolated by springs and energy absorbers. The second mass is to be removed and replaced with a splined adapter plate. The intent is to lessen wear within the PSRU, splines teeth and adapter grooves.

At the examination, the Eggenfellner Aircraft LLC representative stated that all of the splines would fail if the dual-mass flywheel was not incorporated into the installation.

2.0 Examination

Examination showed that, at the engine end, the spline shaft teeth and the walls of the drive disk adapter grooves were worn to the point that the spline shaft would rotate freely within the adapter. The remaining material rolled over at the tips of the thinned spline teeth and thinned walls.

Further examination showed similar, but less severe wear at the PSRU end. The PSRU input spline grooves were worn such that the walls between grooves were 40% less than the original width. The spline teeth on the PSRU-end of the spline shaft were worn such that the thicknesses were more than 25% less than the original thickness. The spline shaft would wobble when inserted into the PSRU input spline. There was free play when the spline shaft was rotated while inserted into the input spline.

Photo 1 – Drive Disk Adapter - The thicknesses of the walls between the spline grooves on the drive disk adapter were reduced by more than 75% due to wear. The remaining thinned-edges of the groove walls were bent over due to rotation of the spline shaft within the drive disk adapter.

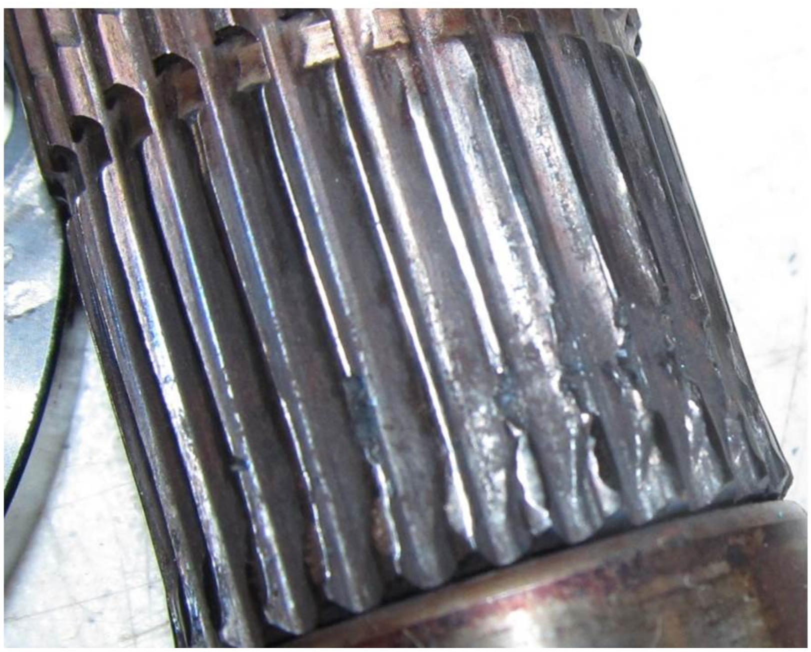

Photo 2 – Engine end of the spline shaft - The thicknesses of the spline teeth on the engine end of the spline shaft were reduced by more than 75% due to wear. The remaining thinned-edges of the spline teeth were bent over due to rotation of the spline shaft within the drive disk adapter.

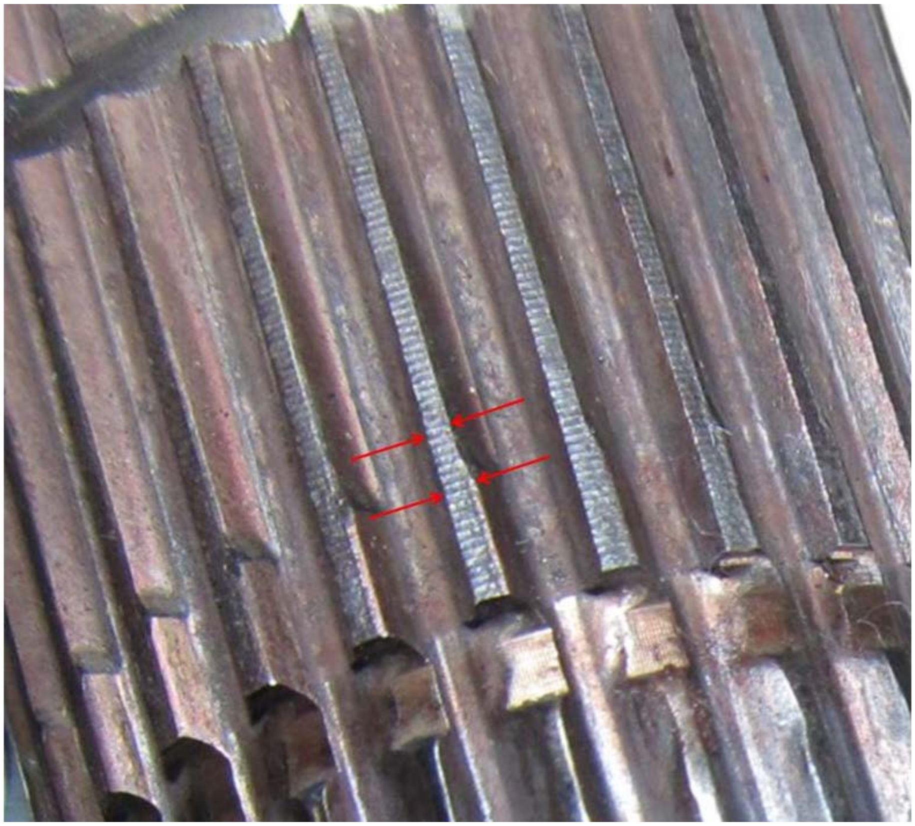

Photo 3 – PSRU end of the spline shaft. The thicknesses of the spline teeth were reduced by more than 25% due to wear (arrows). The shape of the wear can be seen in the three teeth to the left.

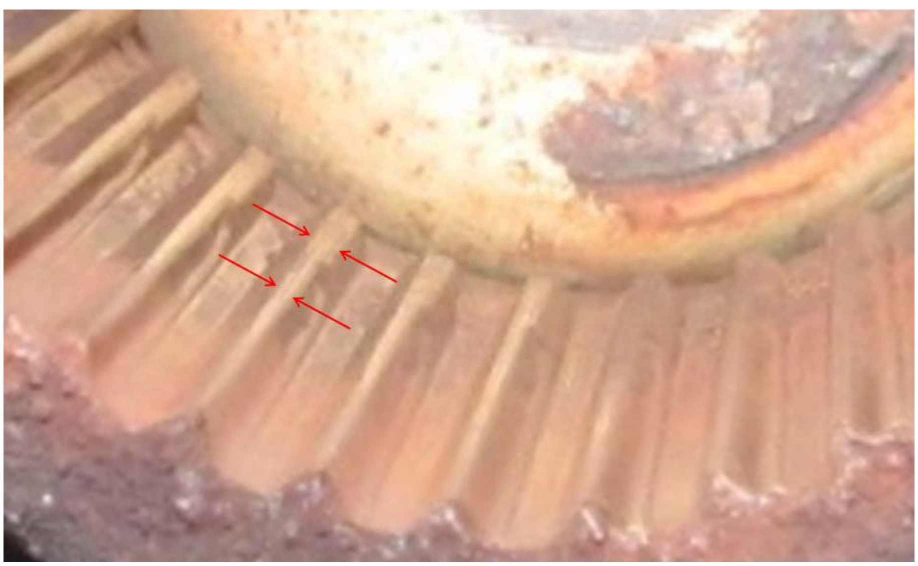

Photo 4 – PSRU Input Spline – The thickness of the walls between the spline grooves on the input spline were reduced by more than 40% due to wear (arrows). The shape of the wear can be seen in the five walls to the left.

Stephen Stein
John Clark