

NATIONAL TRANSPORTATION SAFETY BOARD

Office of Research and Engineering
Materials Laboratory Division
Washington, D.C. 20594



July 18, 2016

MATERIALS LABORATORY FACTUAL REPORT

Report No. 16-060

A. ACCIDENT INFORMATION

Place : Newburg, Oregon
Date : July 1, 2015
Vehicle : Schweizer 269C
NTSB No. : WPR15FA205
Investigator : Thomas M. Little, AS-WPR

B. COMPONENTS EXAMINED

Impeller Schweizer P/N 269A8527 that was attached to the starter ring gear assembly Lycoming P/N 77579; drive adapter Schweizer P/N 269A5411; drive shaft assembly Schweizer P/N 269A5559; remains of the bump stop Lycoming P/N 77416; grease sample from engine cooling fan.

C. DETAILS OF THE EXAMINATION

Each as-received component was examined by binocular microscope. The sections below describe the results of the examination. The as-received pieces were examined at the Safety Board Materials Laboratory, Washington, D.C., with participation of Steve Gleason, a representative from Sikorsky. Sikorsky is the current holder of the type certificate for the Schweizer 269 helicopter.

Aluminum Impeller Schweizer P/N 269A8527 and Starter Ring Gear Assembly Lycoming P/N 77579

The impeller was attached by twelve bolts and nuts to the starter ring gear assembly (see Figure 1). The blades were specified to be made from an aluminum alloy and the starter ring gear specified to be made from steel. A magnet was brought near the two pieces. The magnet was not attracted to the impeller indicating it was non-magnetic, but was attracted to the starter ring gear indicating the starter ring gear was made from a ferrous alloy, such as steel. All the blades on the aluminum fan assembly were fractured at the root portion. The impeller fractured all around the circumference in the areas near the twelve attachment bolts. The two assemblies were cleaned with Alconox detergent and the two assemblies were disassembled from one another (by removal of the bolts). Bench binocular microscope examination of the fracture faces on both assemblies contained a rough texture on a slant fracture consistent with overstress separation, with no evidence of a pre-existing crack, such as a fatigue crack.

Drive Adapter Schweizer P/N 269A5411

The drive adapter is specified to be made from a steel alloy. The surface of the drive adapter contained a blue/gray tint and isolated areas of the adapter contained scale, both conditions are consistent with a steel part that had been exposed to heat, see figure 2. The outer surface contained a dent in the area indicated by an arrow in figure 2. The drive adapter contained an inner spline. Several spline teeth exhibited severe inward deformation and gaping cracks in the general area that corresponded to the dent. The exposed faces of the cracks in the spline exhibited blue/gray tint and was covered with scale. The spline teeth were intact and showed evidence of minor wear. Fragments of the mating spline teeth were found wedged in between the inner spline teeth.

Drive Shaft Assembly Schweizer P/N 269A5559

Figure 3 show photographs of the drive shaft assembly before and after cleaning. The drive shaft contained spline teeth on the forward and aft ends. The shaft portion between the forward and aft spline showed evidence of bending deformation. The as-received aft spline was covered with black lubricant (grease) and all the spline teeth were intact. The rubber boot for the aft spline was partially torn, attached to the drive shaft, and covered with black grease. A sample of the black grease was removed from the aft spline prior to cleaning and retained. No further work was performed on the grease sample. The lower portion of figure 3 shows the aft spline after cleaning. The aft spline teeth all around the assembly showed evidence of minor wear.

The forward spline was dry, exhibited a light brown oxide film consistent with iron oxide, with no evidence of grease. The rubber boot (a component that is used to retain grease) was not attached to the forward end. The forward spline exhibited severe wear and deformation damage that extended beyond the root of the spline teeth. The forward and aft ends of the forward spline all around the spline exhibited metal squeeze out (metal flow that extended forward and aft). The root radii between the spline teeth were not visible. The lower portion of figure 3 shows the aft spline after cleaning. A circumferential-radial section was made through the forward spline. The section was made partially through the spline and did not intersect the longitudinal axis. Examination of the section revealed the spline was worn beyond the root of the spline teeth.

Examination of the aft spline revealed all the teeth were intact. The surfaces of the aft spline teeth exhibited minor wear. A circumferential-radial section was made through the intact aft spline. The section was made partially through the spline and did not intersect the longitudinal axis. The prepared section was etched with Nital reagent. Examination of the etched section revealed the core of the shaft contained a microstructure of tempered martensite, typical for a quench and tempered steel, and the surfaces adjacent to the spline teeth contained a darker band consistent with a carburized surface treatment. According to the representative from Sikorsky, the spline teeth are specified to be carburized to a depth between 0.02 inch and 0.04 inch. The

hardness of the carburized layer is specified to be between 57 HRC and 61 HRC. The carburized layer was to have a minimum hardness of 56 HRC at a depth of 0.002 inch below the surface. Traverse microhardness testing was conducted on the metallurgical mount using a 500 gram load and a Knoop indenter. Results of the hardness test are shown in table 1. The measured hardness values were converted by the testing instrument to HRC values. The measured hardness values adjacent to the spline surface were consistent with the hardness values specified for a carburized surface.

Table 1. Traverse Microhardness Test Results for Spline teeth on the Aft Spline

Distance From the Surface (Inch)	Measured Hardness (DPH)	Converted Hardness (HRC)
0.0052	719	61
0.0102	719	61
0.0152	692	59.8
0.0202	663	58.5
0.0252	638	57.3
0.0302	611	55.9
0.0352	581	54.2
0.0402	558	52.9
0.0452	549	52.3
0.0502	534	51.4

The drive shaft is specified to be made from steel per the composition indicated in SAE-AMS 6425. The specified composition is indicated in table 2. The polished section from the drive shaft was analyzed with a Thermo Scientific Niton XL3t-980 X-ray fluorescence (XRF) portable alloy analyzer. The alloy analyzer indicated the drive shaft contained 1.31% manganese, 0.383% chromium, 1.85% nickel, 0.449% molybdenum and 0.242% copper, consistent with the elements specified for the drive shaft.

Table 2. Specified Composition for SAE-AMS 6425 Steel (Weight %)

Element	min	max
Carbon	0.23	0.28
Manganese	1.20	1.50
Silicon	1.30	1.70
Phosphorus	--	0.01
Sulfur	--	0.01
Chromium	0.20	0.40
Nickel	1.65	2.00
Molybdenum	0.35	0.45
Copper	--	0.35

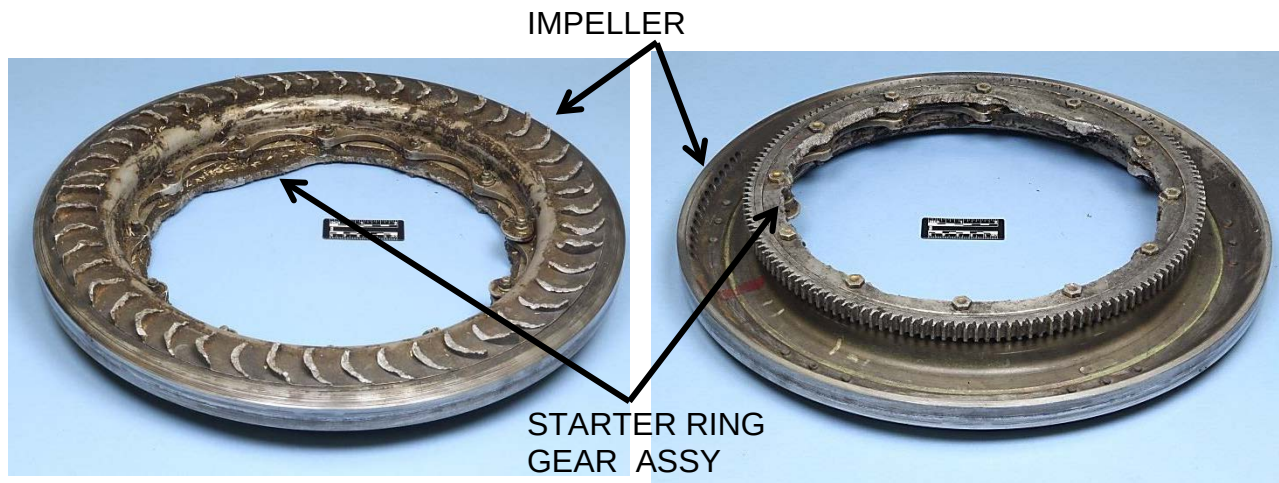
Remains of the Plug (Bump Stop) Lycoming P/N 77416

Figure 4 shows a photograph of the remains from the plug (bump stop). The plug is specified to be made from aluminum. A magnet was brought near the plug. The magnet was not attracted to the plug indicating it was non-magnetic. The core portion of the plug was missing but the outer circumferential portion remained intact all around. The circumferential portion of the plug was covered with black deposits; showed no evidence of a fracture feature; and exhibited a smooth surface consistent with an aluminum alloy that had fused and re-solidified.

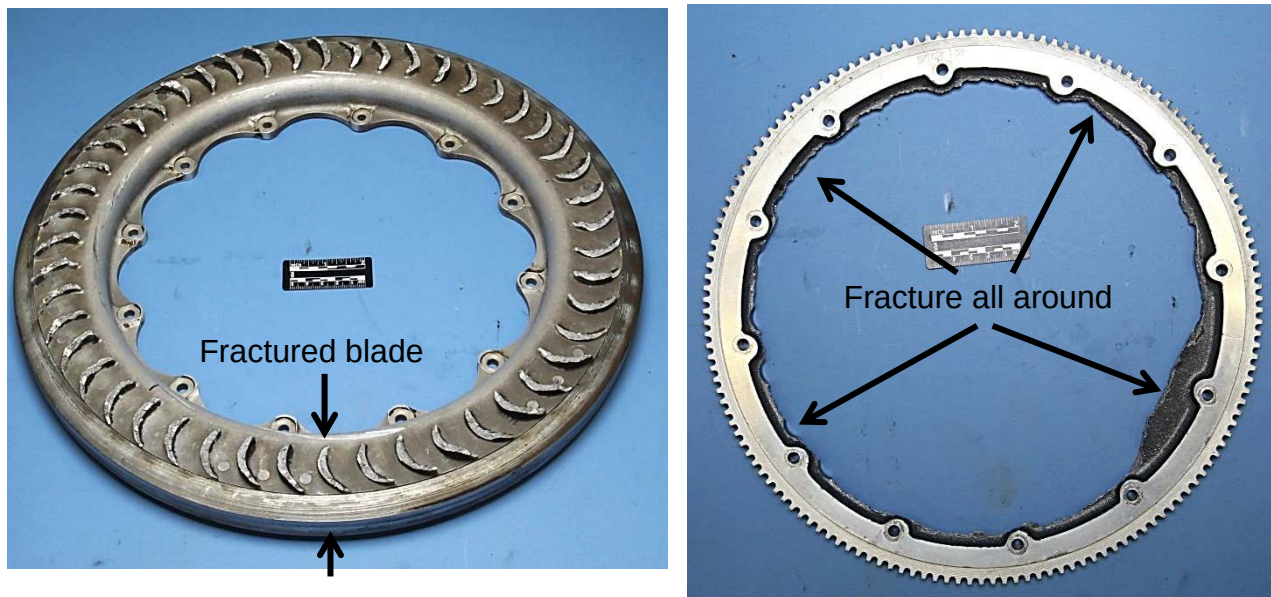
Grease Sample from Engine Cooling Fan

Figure 5 shows a photograph of the as-received grease sample, after it was removed from a plastic bag. Bench binocular microscope examination of the grease sample revealed the grease contained evidence of solid particles (fragments).

Frank Zakar
Senior Metallurgist

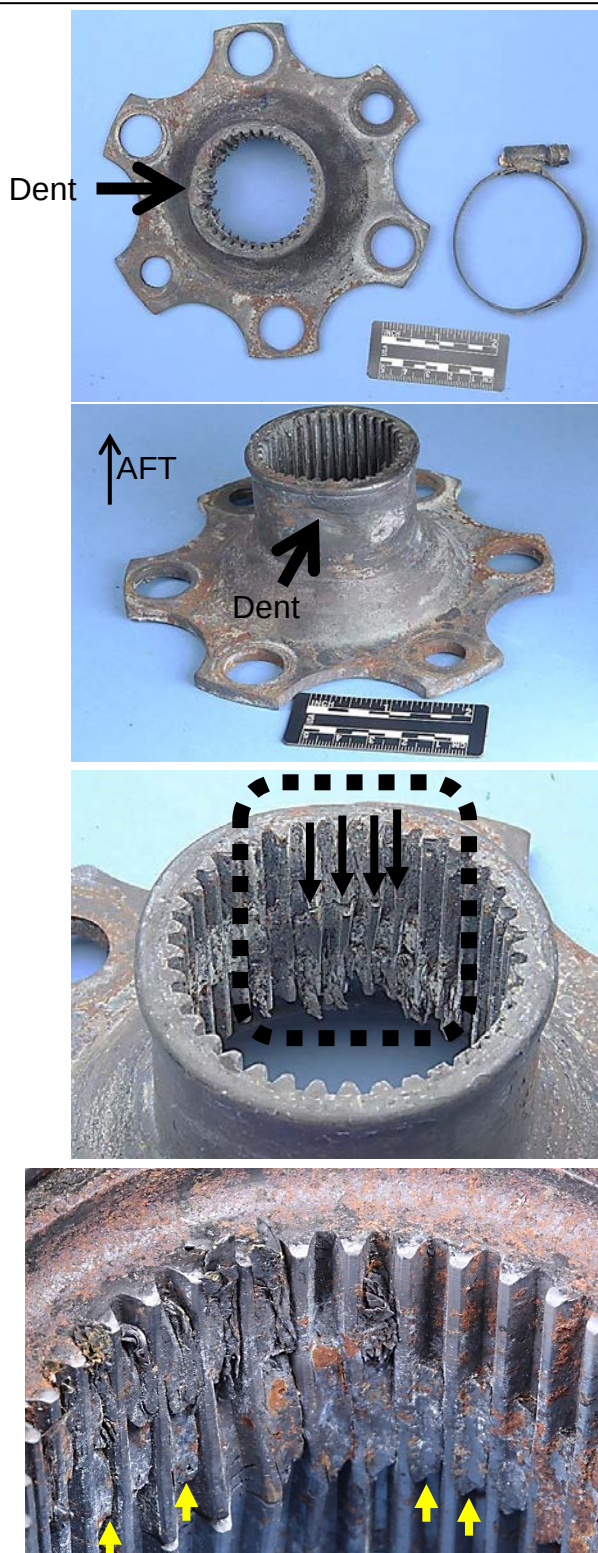


As-received impeller (left side of page) that was attached by bolts to the starter ring gear assembly (right side of page).



Disassembled impeller (left) and starter gear assembly (right) after cleaning.

Figure 1. Impeller Schweizer P/N 269A8527 and starter ring gear assembly Lycoming P/N 77579.



Drive adapter (left side) and clamp (right side) that was secured to the forward rubber grease bolt. The drive adapter contained a dent in the area indicated by an arrow,

Oblique view of the drive adapter showing a dent on the outside surface in the area indicated by an arrow.

Oblique view of the drive adapter showing the inner spline. Several spline teeth exhibited severe inward deformation (within dashed box) and gaping cracks (indicated by arrows) in the general area that corresponded to the dent.

Close-up view of the inner spline showing fragments from the mating spline teeth (several are indicated by arrows).

Figure 2. As-received drive adapter Schweizer P/N 269A5411.

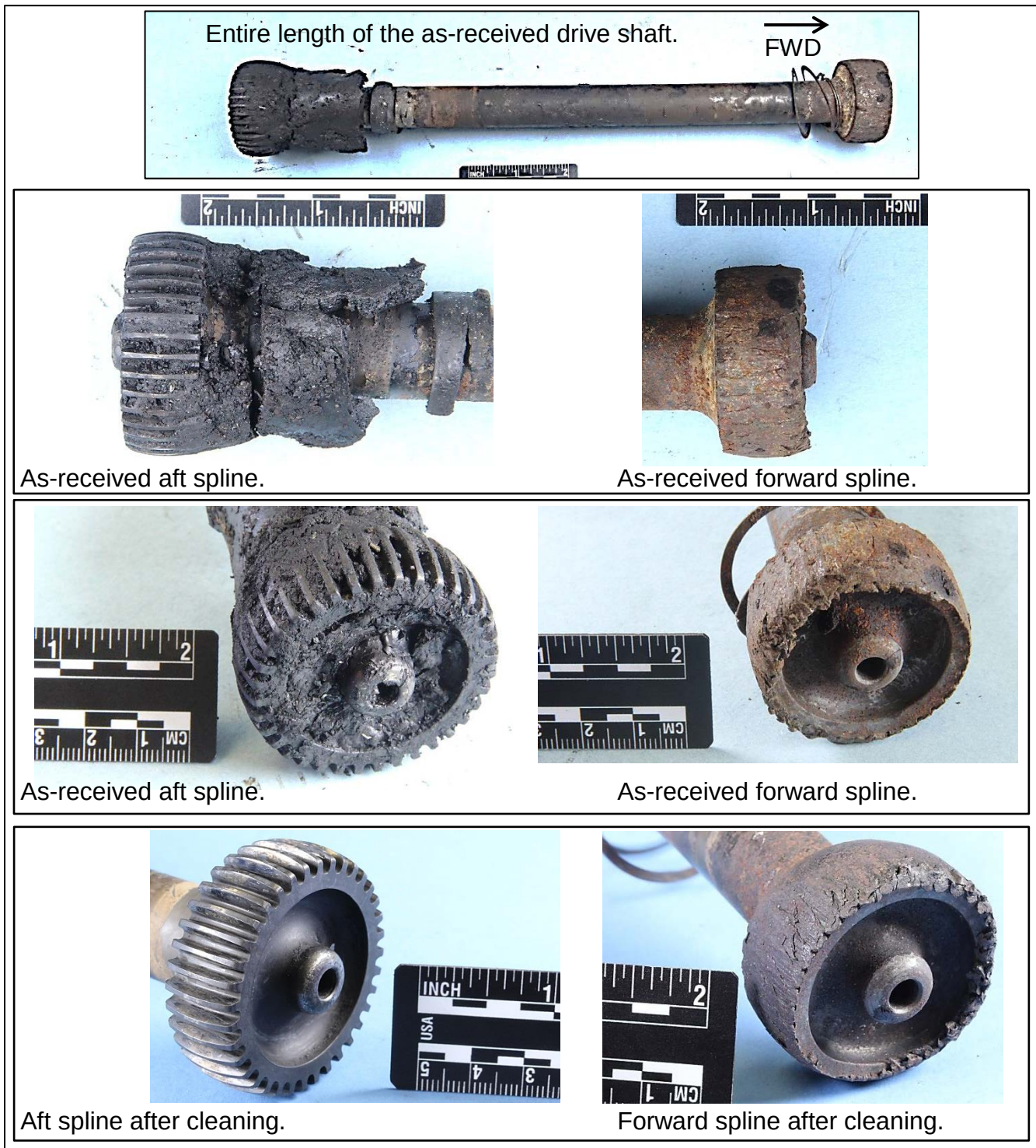


Figure 3. Drive shaft assembly Schweizer P/N 269A5559.



Figure 4. Remains of the plug (bump stop) Lycoming P/N 77416, which fits between the drive adapter and the engine crankshaft flange.



Figure 5. As-received grease sample from the engine cooling fan.