

NATIONAL TRANSPORTATION SAFETY BOARD

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

October 25, 2021



MATERIALS LABORATORY FACTUAL REPORT

Report No. 21-071

A. ACCIDENT INFORMATION

Place : Los Angeles, California
Date : November 6, 2020
Vehicle : Agusta A109S, N109EX
NTSB No. : WPR21LA039
Investigator : Fabian Salazar (AS-WPR)

B. COMPONENTS EXAMINED

Tail rotor gearbox assembly

C. DETAILS OF THE EXAMINATION

The tail rotor gearbox (TRGB) was submitted to the NTSB Materials Laboratory still assembled, but with the sleeve disengaged from the mating locking nut. Overall photos of the TRGB from opposite sides of the assembly are shown in Figures 1 and 8.

The visible portions of the components were examined for evidence of engagement and any damage noted was documented. No safety wire was observed attached to the holes in the locking nut or sleeve, as indicated by the yellow dotted circles in Figures 2 and 9. Yellow arrows in Figure 3 point to a snap ring installed outboard of the locking nut. The threads on the outer diameter (OD) of the locking nut (outlined by yellow dotted line in Figure 4) appeared intact. The threads on the inner diameter (ID) of the mating sleeve were caked with grease and not visible. A light wipe was performed in one area, circled by a yellow dotted line in Figure 5, and the revealed threads appeared intact.

The inboard slots on the locking nut were examined and appeared to be undamaged. Several of the slots are circled by a yellow dotted lines in Figure 6.

All the balls from the inboard bearing (outlined by yellow dotted line in Figure 7) and 1 ball from the outboard bearing (circled by a yellow dotted line in Figure 10) were missing. Yellow arrows in Figure 11 point to the outer ring from the inboard bearing was still assembled inside the sleeve.

The TRGB assembly was transported to a Leonardo Helicopter Company facility outside Philadelphia, Pennsylvania for disassembly. The disassembled components were individually bagged and subsequently returned to the NTSB Materials Laboratory. The

sleeve and the locking nut are shown in the as-disassembled condition in Figure 12 and Figure 13, respectively.

The sleeve and locking nut were cleaned using a two-step process of light brushing with liquid detergent and a subsequent ultrasonic bath in methanol. The cleaned sleeve is shown in Figures 14–16 and the cleaned locking nut is shown in Figures 17–19.

Primer paint was visible on the ID thread surfaces of the sleeve (red arrows, Figures 14 and 15). Primer paint was allowable on the threads per manufacturer specifications. Damage was observed on the crests of the ID threads on the sleeve, as indicated by the black arrows in Figures 14 and 15. The spacing of the damage was compared to the spacing of the balls in the adjacent ball bearing but did not match. Deformation was observed around both lock wire holes of the sleeve (black arrows, Figure 16). Damage was visible along the edge of the sleeve adjacent to the holes (red arrows, Figure 16).

There was a step in the bottom surface of the locking nut at the OD edge, as indicated by the black arrows in Figure 17. The step appeared similar to a wear footprint observed by the manufacturer on other locking nuts from Augusta TRGB assemblies. Wear marks inside the step were consistent with circumferential movement. Primer paint was visible on the OD thread surfaces of the locking nut (red arrows, Figures 18 and 19). The crests of the OD threads were intact and undamaged. Black arrows in Figure 18 and Figure 19 point to deformation around both lock wire holes of the locking nut.

Scrapings from the following locations on the accident hardware taken prior to disassembly and cleaning were submitted for spectroscopic examination: sleeve threads, locking nut threads, housing ID threads, nut OD threads, sleeve ID, and nut ID.

A small amount of material from each sample was examined using a Fourier Transform Infrared (FTIR) spectrometer with a diamond attenuated total reflectance (ATR) accessory in accordance to ASTM E1252-98 (American Society for Testing Materials E1252-98: Standard Practice for General Techniques for Obtaining Infrared Spectra for Qualitative Analysis). The spectrometer was used to collect and process infrared wavelength absorbance spectra of the unknown material(s). The resultant spectra were compared to known library spectra for lubricating greases and thread locking materials. The manufacturer allows for either AeroShell 22 (Shell Corporation, The Hague, The Netherlands) or Mobilgrease 28 (Exxon Mobil, Spring, Texas) as a lubricating grease, and specifies Loctite 222 (Henkel Corporation, Westlake, Ohio) for a thread locking material. While the grease and the thread locker material shared several major spectral peaks, the thread locking material did have a few strong spectral peaks that were unique. The unique peaks occurred at $\sim 1770\text{ cm}^{-1}$ (consistent with C=O stretching) and $\sim 1630\text{ cm}^{-1}$ (consistent with C=C stretching). In the accident sample spectra, all the spectra were consistent with lubricating grease and no spectral peaks unique to the thread locking material were found.

To determine if any thread locking material was present in the accident samples, a small amount of material removed from the sleeve threads and locking nut threads were repeatedly rinsed with toluene to remove the lubricating grease from the sample. The spectra of the washed samples were matches to the original accident materials spectra indicating that the oil base and thickener found in the grease was still present.

To understand the amount of thread locking material that would have to be present for its unique spectral peaks to start to appear in the IR spectrum, a small amount of known lubricating grease was mixed with increasing amounts of known thread locking material. The thread locking material spectral peaks did not start to appear until several additions had been made to the grease, resulting in an amount above that used in a proper application. In a proper installation, the amount of lubricating grease present would be larger than the amount of correctly applied thread locker material. Therefore, the thread locker material's unique spectral signatures possibly lack the intensity to be visualized in spectra containing both materials. Consequently, the FTIR spectroscopic determination of the presence of thread locking material in the accident samples was inconclusive.

Adrienne V. Lamm
Materials Engineer





































