

NATIONAL TRANSPORTATION SAFETY BOARD

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



November 19, 2021

MATERIALS LABORATORY FACTUAL REPORT

Report No. 21-047

A. ACCIDENT INFORMATION

Place : North Las Vegas, NV
Date : 10/23/2019
Vehicle : Robinson R44
NTSB No. : WPR20FA013
Investigator : Zöe Keliher

B. COMPONENTS EXAMINED

Tail rotor yoke with magnet holder remains (C908-1 E Lot 89), flex plate (C947-1 F Lot 60), Hall effect sensors and holder (D114-1 C Lot 32) as shown in Figure 1.

C. DETAILS OF THE EXAMINATION

The tail rotor yoke was designed with two cylinders attached that were used to contain and secure the magnets used to trip the hall effect sensors for the tachometer display. As received, the tail rotor yoke was missing one of the two cylindrical magnet holders and the one magnet holder present was damaged and without a magnet (Figure 2). The missing magnet holder had been removed during testing that preceded this Materials Laboratory exam. The missing magnet holder on the yoke had been found intact and containing the magnet after the accident.

Examination of the damaged magnet holder revealed that the deformation and fracture to the magnet holder was not caused by impact directly with the magnet holder body. The fractured side exhibited deformation consistent with an object pushing from the inside of the holder radially outwards through the cylindrical wall (Figure 3). The intact side of the magnet holder did not exhibit deformation or contain any witness marks consistent with a strike (Figure 4). Another view of the damaged magnet holder perpendicular to its direction of motion also exhibits deformation consistent with an internal force pushing through the magnet holder side wall without any visible damage to the opposing side (Figure 5). In this figure certain material deposits can also be seen. There is a circular outline in an orange residue on the exterior of the magnet holder's cylindrical wall. There are areas on the open end of the magnet holder's cylindrical wall where a brownish – amber colored residue is present. There is also an area of similar appearing brownish – amber colored residue on the yoke. This residue had a brittle response when scraped with a tool. The interior surface of the magnet holder contained some small grains of what appeared to be sand or rock mostly on the bottom of the cylinder (Figure 6). On the intact portion of the interior of the cylindrical wall some small

patches of residue similar in appearance to the brownish – amber residue previously discussed were observed. Some fine abrasions were noticed on the surface of the interior of the cylindrical wall near the bottom. These fine abrasions were approximately 0.037 inches from the bottom (figure 7). There were also areas of plastic deformation resembling a smearing like movement of material further up the interior of the cylindrical wall.

The Hall effect sensors exhibited some witness marks consistent with contact with a moving object (Figures 8, 9). These contact marks exhibited plastic deformation in a direction consistent with the intended movement between the magnets and the faces of the Hall effect sensors. The contact damage extended 0.025 down from the face of the sensor (Figure 10).

Joseph Panagiotou
Fire Protection Engineer



Figure 1: Tail rotor yoke with damaged magnet holder, flex plate, and hall effect sensors with holder.



Figure 2: Tail rotor yoke with damaged magnet holder.



Figure 3: Fractured side of damaged magnet holder.



Figure 4: Intact side of damaged magnet holder.

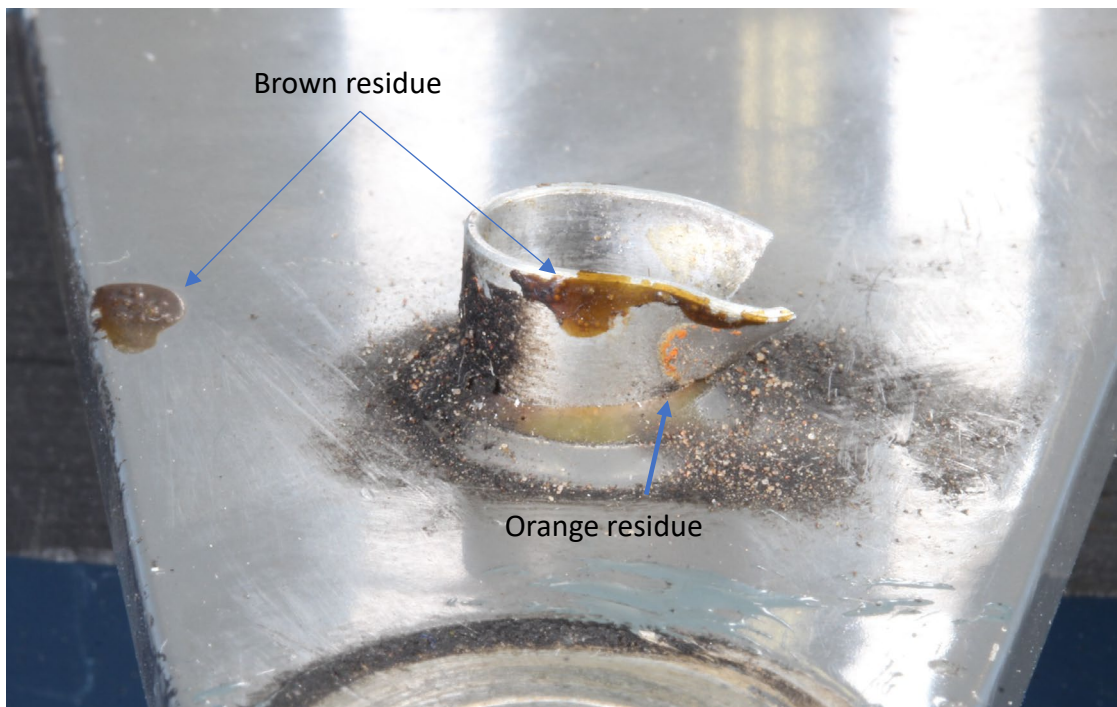


Figure 5: Residue deposits on damaged magnet holder.



Figure 6: Interior surface of magnet holder.

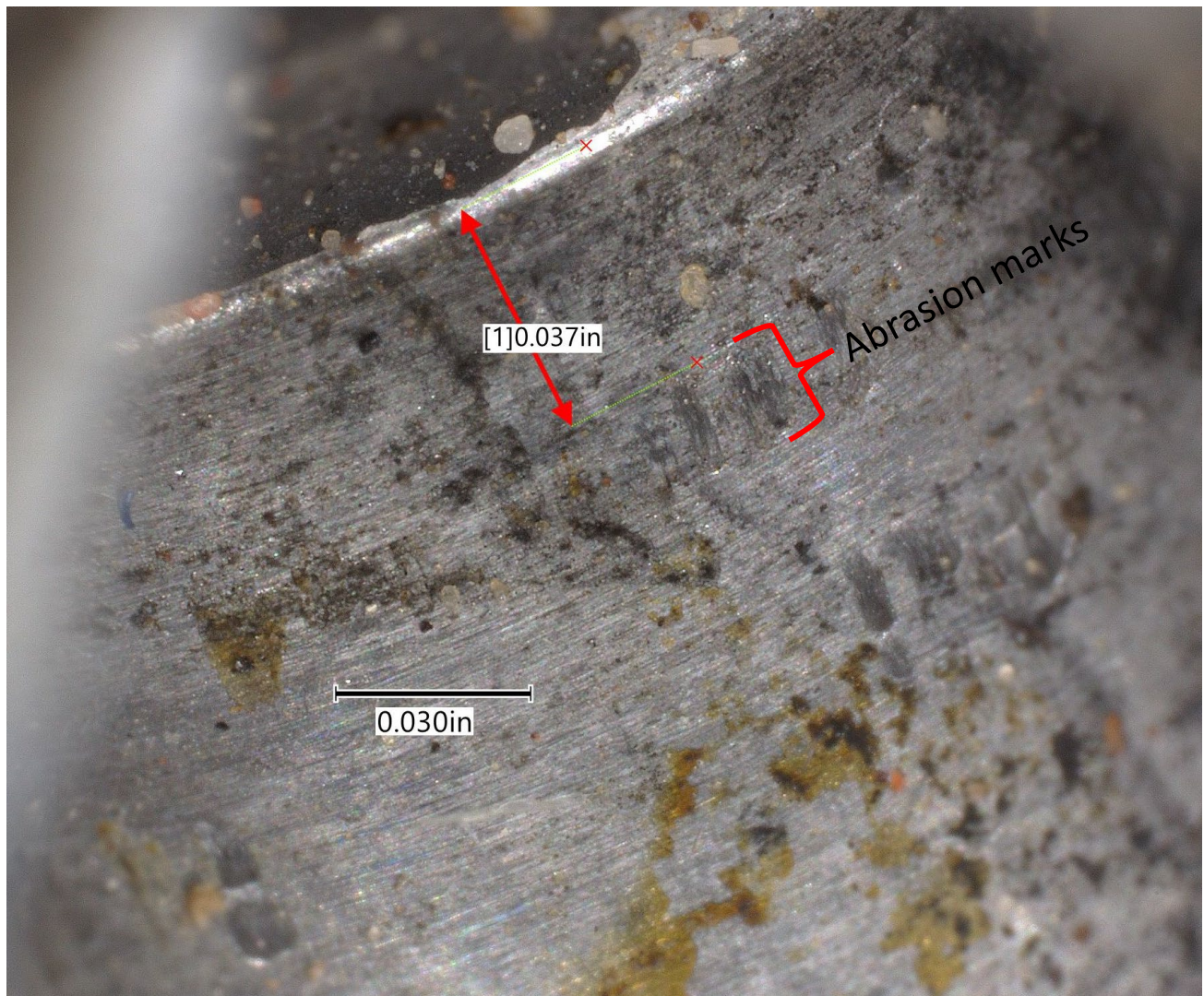


Figure 7: Close up of abrasion marks.

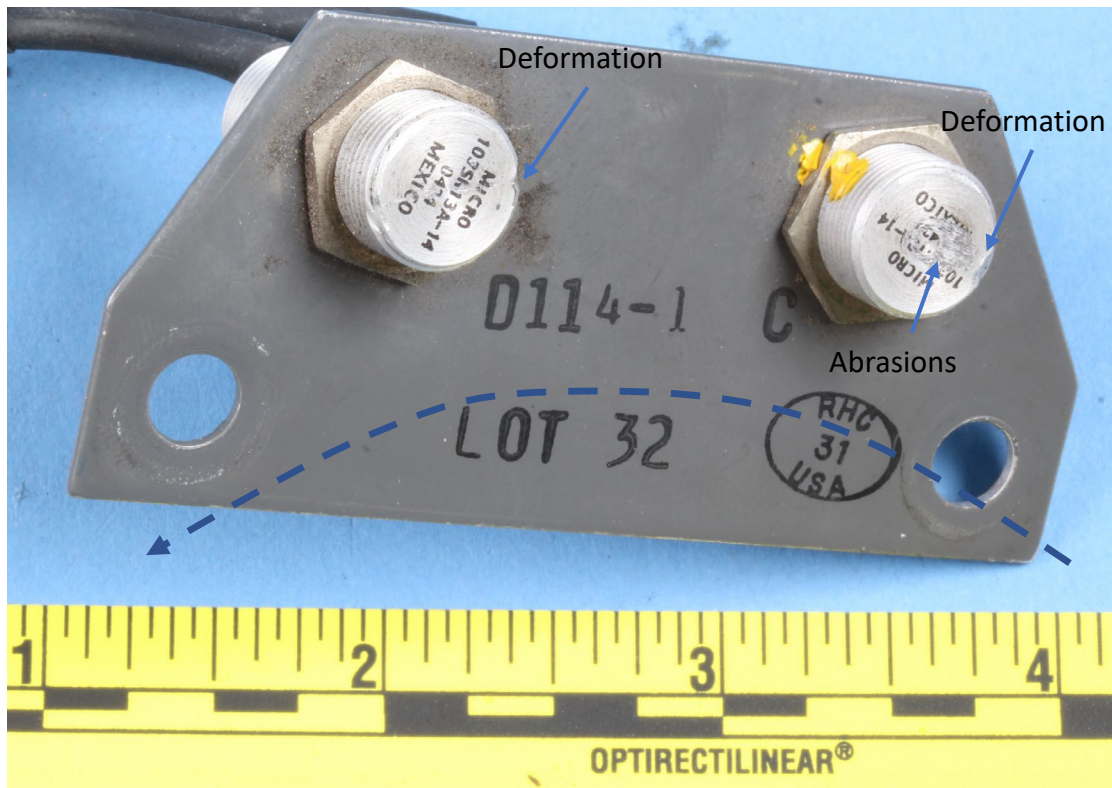


Figure 8: Hall effect sensors with contact damage. The dashed blue line with arrow indicates the direction of the motion of the magnets past the sensor faces.

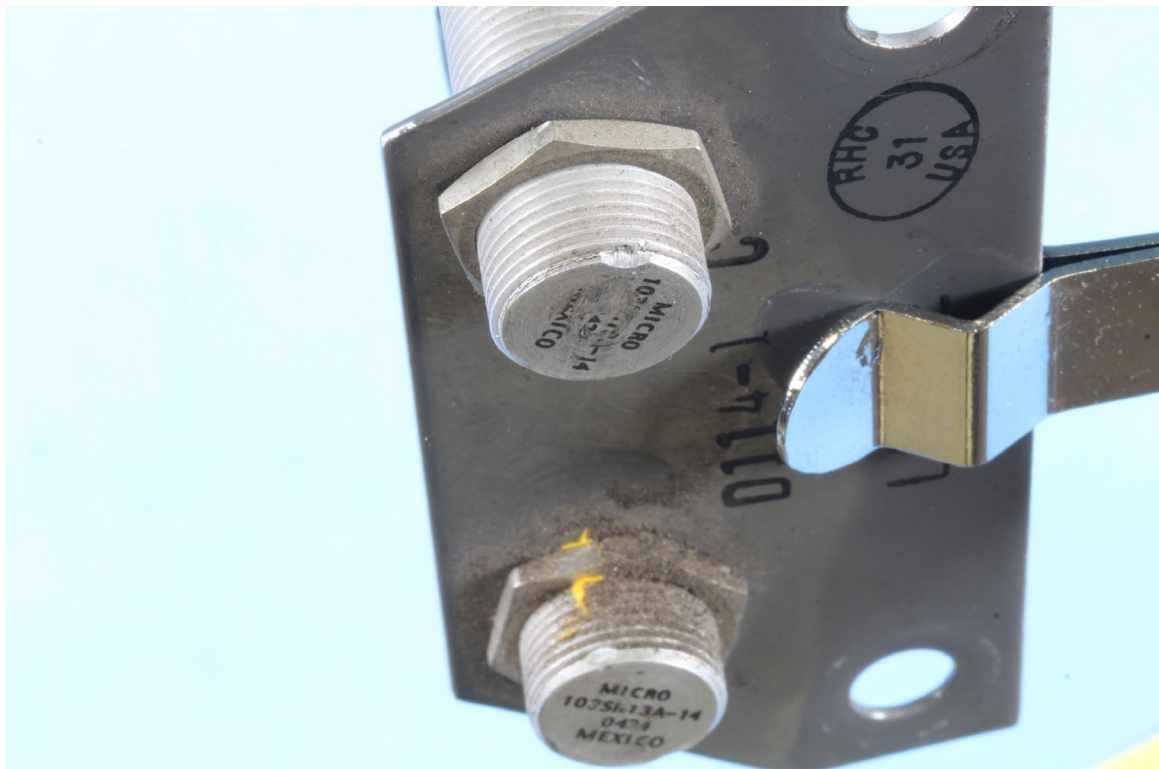


Figure 9: Hall effect sensors with contact damage.

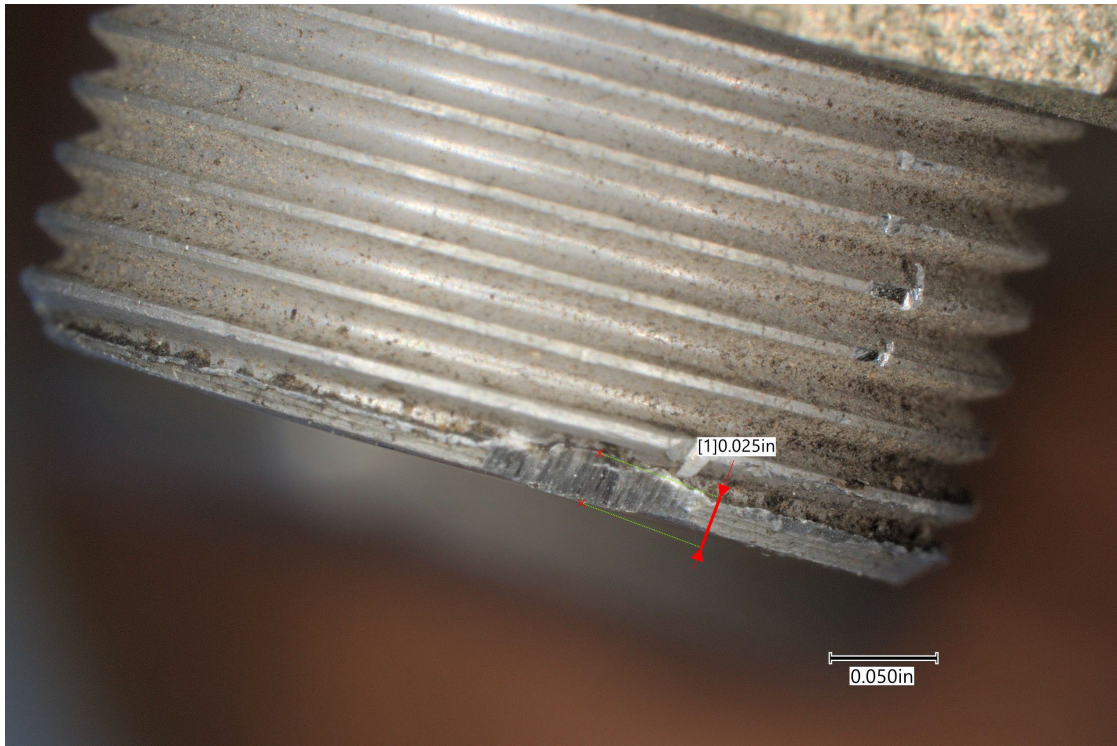


Figure 10: Depth of contact from face of Hall effect sensor.