

National Transportation Safety Board

Office of Research and Engineering

Washington, DC 20594



ERA23FA070

MATERIALS LABORATORY

Factual Addendum 22-006B

April 13, 2023

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A. ACCIDENT INFORMATION

Location: Charlotte, North Carolina
Date: November 22, 2022
Vehicle: Robinson R44, N7094J
Investigator: Ralph Hicks, AS-ERA and Van McKenny, AS-40

B. COMPONENTS EXAMINED

Swashplate assembly with attached pitch change link and yoke assemblies, main rotor blade pitch horn piece, and two forward upper flight control tube assemblies.

C. EXAMINATION PARTICIPANTS

Specialist Matthew R. Fox, Ph.D.
NTSB
Washington, DC

D. DETAILS OF THE EXAMINATION

This report is an addendum to the examination of the above submitted components as documented in Materials Laboratory Factual Report 23-006. This addendum provides additional documentation of features observed on the upper end fitting for the forward left upper flight control tube assembly.

Macro photographs of each face of the end fitting are shown in figure 1. Contact damage and light gray deposits consistent with contact with adjacent aluminum structure and/or components was observed on the end fitting. The jam nut was loose, and orientation of the fitting relative to the aircraft was not noted on the assembly. For reference in this report, the faces of the end fitting were arbitrarily labeled A and B as shown in figure 1.

The spacer contact faces on the inner race of the end fitting bearing appeared rubbed and had pitting damage, features consistent with fretting damage, on both spacer contact faces as indicated in figure 1. Additional images of the damaged spacer contact faces on the inner race are shown in figure 2 as acquired using a Keyence VHX-7000 optical microscope in depth mode with optical shadow effect. On face A, the spacer contact face for the bearing inner race was worn, leaving a lip around the outside diameter of the contact face. In contrast, the wear on face B was relatively flat across the spacer contact face and did not show a lip at the outside diameter. As shown in the upper image in figure 2, the diameter of the recessed portion of the wear damage on face A measured 0.392 inch, which corresponded to the outside diameter of the central thicker portion of the hat-shaped spacer (measured on an exemplar spacer).

The inside diameter of the outer race on each face had localized deformation corresponding to contact with the attachment bolt shank. On face A, the damage had a smooth curving deformation consistent with contact with the attachment bolt grip (smooth portion of the bolt shank) at the location indicated in the upper image in figure 1. On the opposite face, the local deformation to the outer race had a different appearance with similar curvature, but with damage more localized to near the surface. The local damage to the outer race on face B corresponded to contact with the threaded portion of the attachment bolt shank at the location indicated in the lower image in figure 1.

The bolt shank contact marks on the outer race shown in figure 1 were on diametrically opposite sides of the end fitting, and the presence of witness marks from the threaded end of the bolt on face B with a corresponding grip contact mark on face A indicate that face A was closest to the head end of the attachment bolt, and face B faced toward the swashplate lug as installed with the threaded end of the bolt facing to the right through the swashplate lug. The orientation of the aircraft forward direction shown in figures 1 and 2 is based on this bolt orientation as determined by the corresponding witness marks on the bearing outer race.

Submitted by:

Matthew R. Fox, Ph.D.
Chief Technical Advisor - Materials

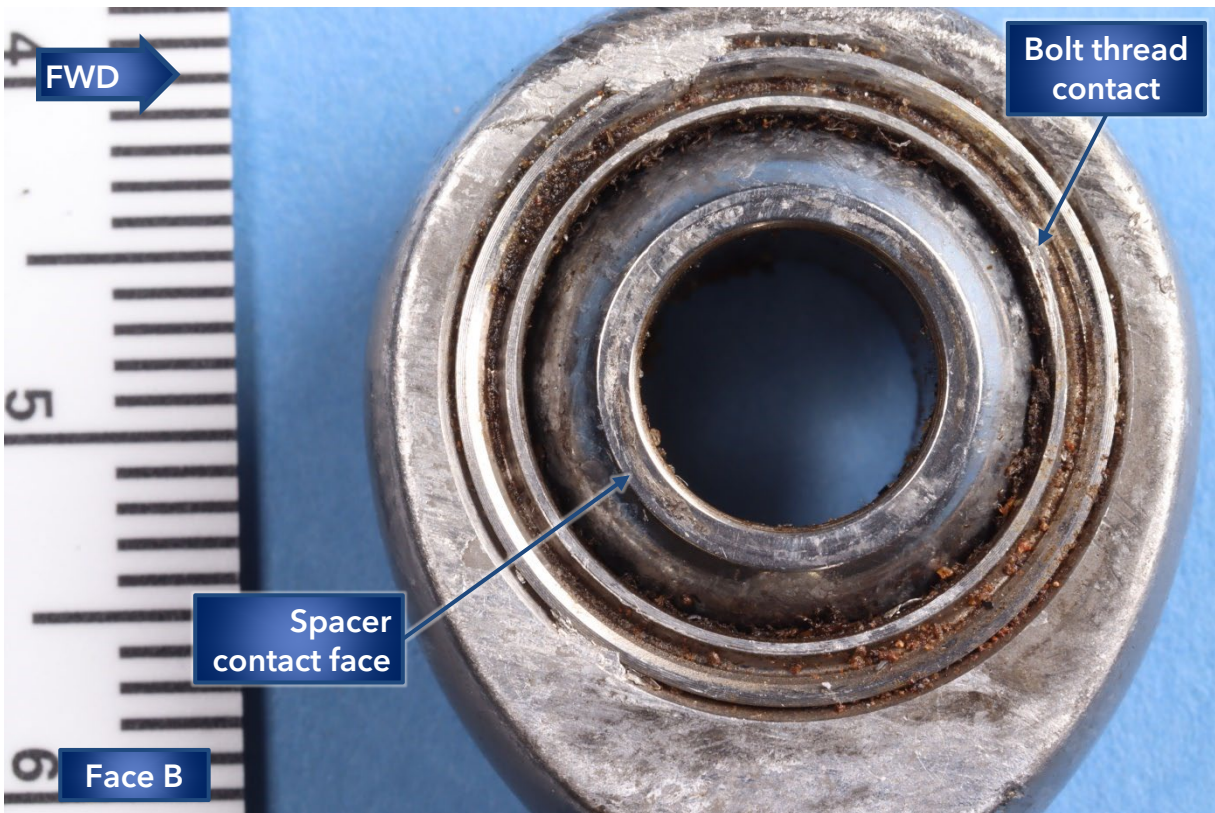
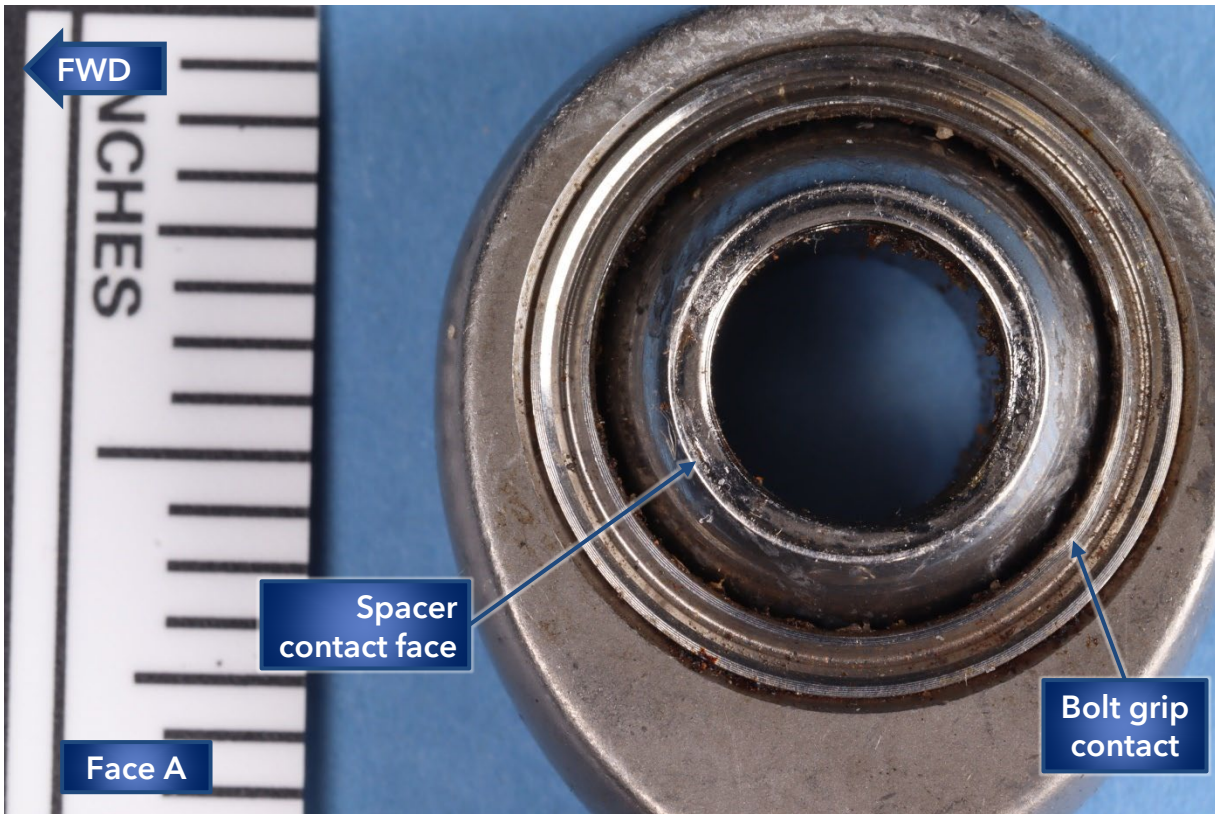


Figure 1. Macro photographs showing opposite faces of the upper end fitting for the forward left upper flight control tube assembly.

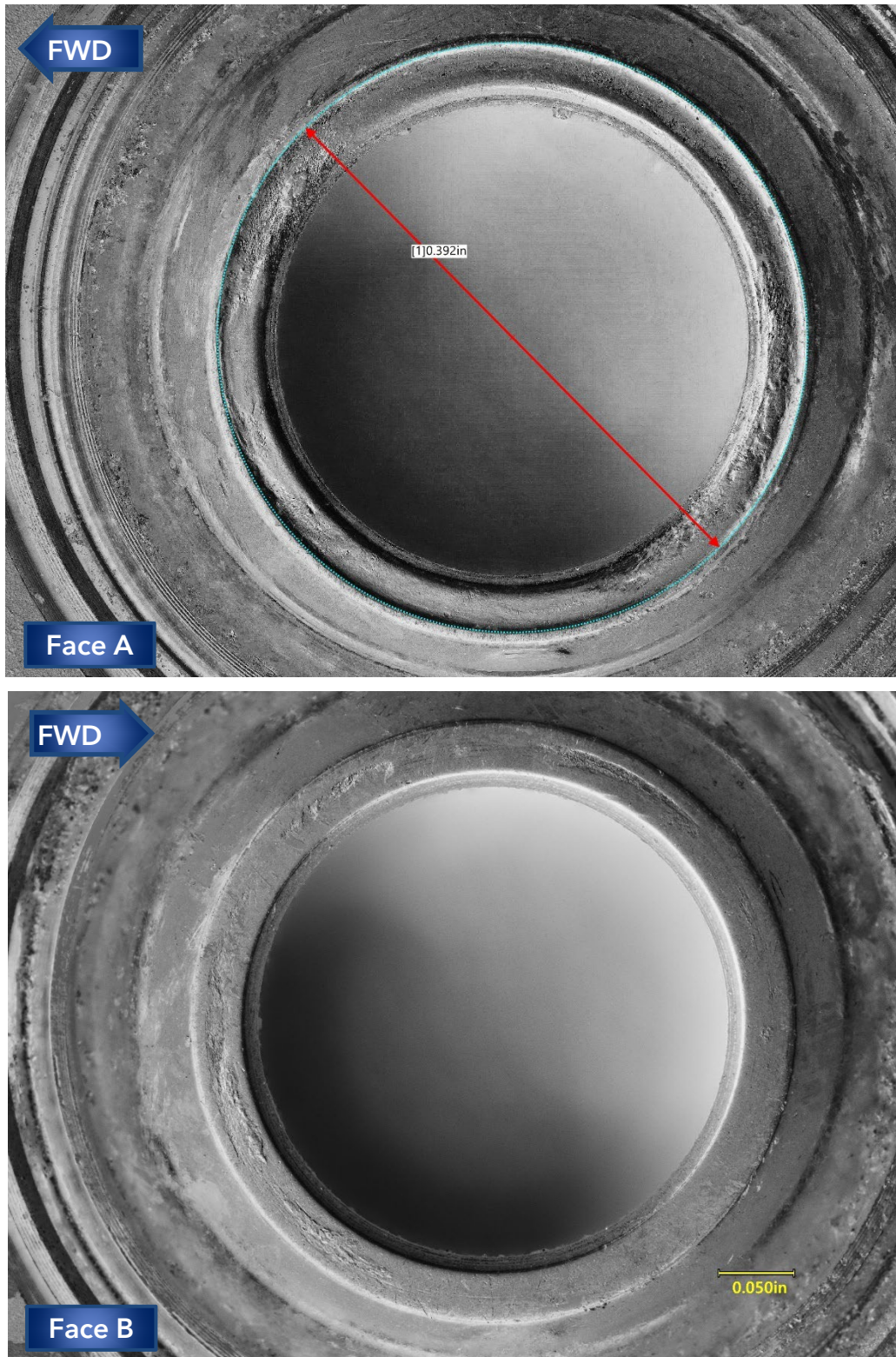


Figure 2. Images of the end fitting faces shown in figure 1 obtained using a Keyence VHX-7000 optical microscope in depth mode with optical shadow effect. The diameter of the recessed area on the spacer contact face of the inner race is indicated in the upper image.