National Transportation Safety Board
Office of Research and Engineering
Washington, DC 20594

DCA22FA082

MATERIALS LABORATORY

Factual Report 23-056

January 09, 2024

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A. ACCIDENT INFORMATION

Location: Jolon, California
Date: 02/16/2022
Vehicle: JOBY AERO inc. JAS4-2 (N542AJ)
Investigator: Michael Hauf

B. COMPONENTS EXAMINED

The following parts were received at the NTSB Materials Laboratory on July 6, 2023.

1. Station 2 tilt actuator
2. Station 2 tilt slde anti sag roller bearing and mount
3. Station 3 tilt actuator
4. Station 3 portion of tilt slde anti sag roller bearing mount

C. EXAMINATION PARTICIPANTS

Specialist	Michael Budinski NTSB Washington, DC
SEM Microscopy	Edward Komarnicki NTSB Washington, DC

D. DETAILS OF THE EXAMINATION

The submitted items are shown in Figures 1, 2, and 6. No laboratory exam was conducted on the Station 2 and 3 tilt actuators shown in Figure 1.

Figure 2 shows multiple views of the Station 2 tilt slde anti sag roller bearing and mount. The tapered ring pressed onto the outer bearing race exhibited a dent as revealed in Figure 2b. The bearing assembly was removed from the mount using a plate-type bearing puller and an arbor press. A high force was required to remove the bearing indicating that the inner bearing race was assembled on the mount shaft with a tight interference fit. The Station 2 mount with the bearing assembly removed is shown in Figure 3.

Close digital microscope images of the transition from the bearing shaft to the mount body on the Station 2 mount are shown in Figures 4 and 5. The transition area was visually inspected with a 5x to 50 x stereozoom microscope for the presence of any cracks. As indicated in the figures, skived and raised material is present near the

shaft base consistent with deformation associated with press-fitting the bearing onto the shaft. No preexisting cracks were observed.

Images of the Station 3 mount are shown in Figure 6. The bearing shaft has been fractured from the mount (bearing and shaft portion were not recovered from the accident scene). Figures 7 and 8 show the overall fracture surface at the base of the bearing shaft using digital and scanning electron (SEM) microscopy, respectively. Approximately 90% of the fracture surface is mechanically damaged and precluded fractographic examination. The undamaged areas of the fracture surface exhibited fracture features consistent with monotonic overload (detail images are shown in Figures 9 and 10).

Submitted by:

Michael K. Budinski
Chief, Materials Laboratory

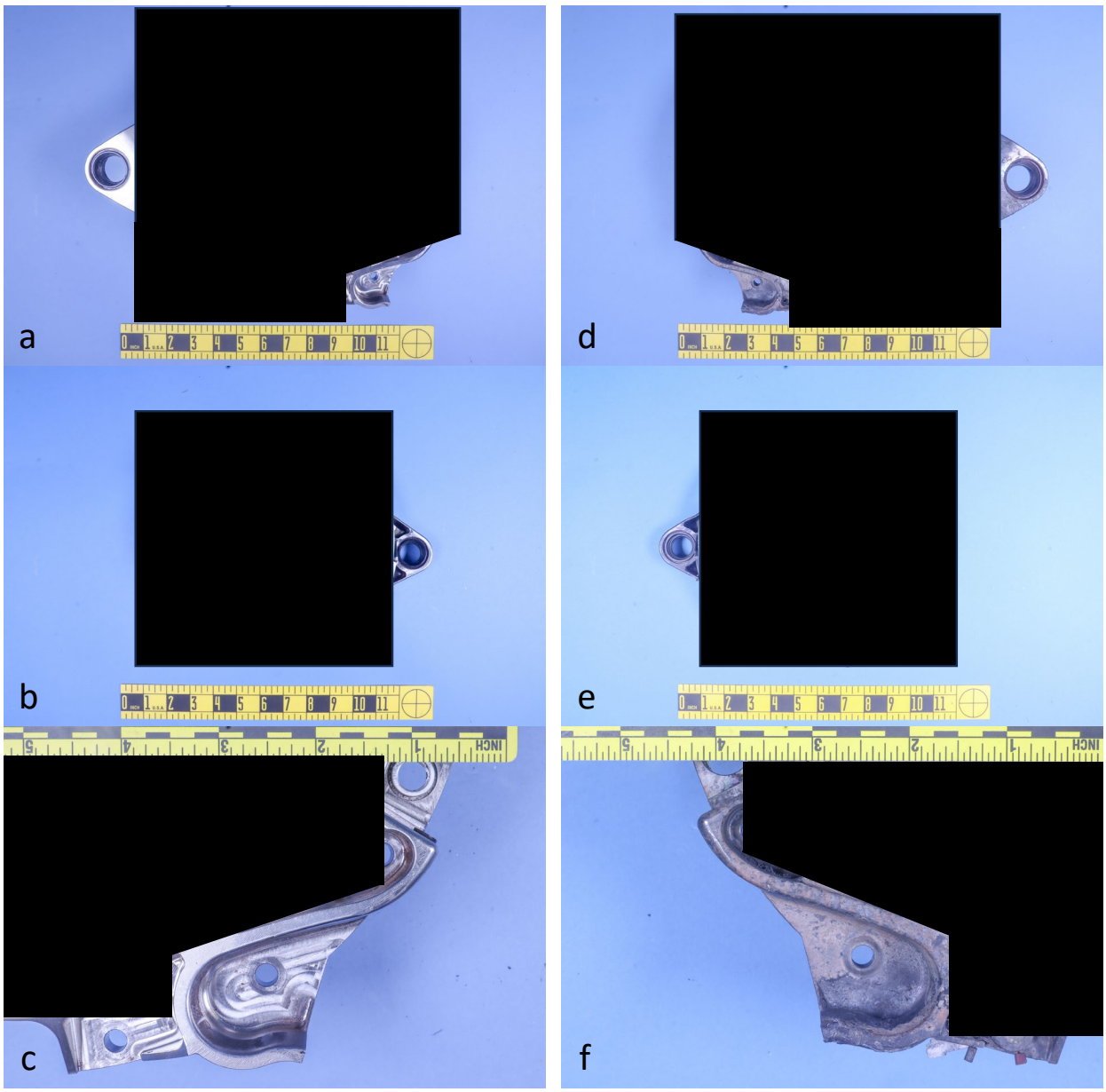

Figure 1. Images of the Station 2 (views a, b, and c) and Station 3 (views d, e, and f) tilt actuators, as-received.

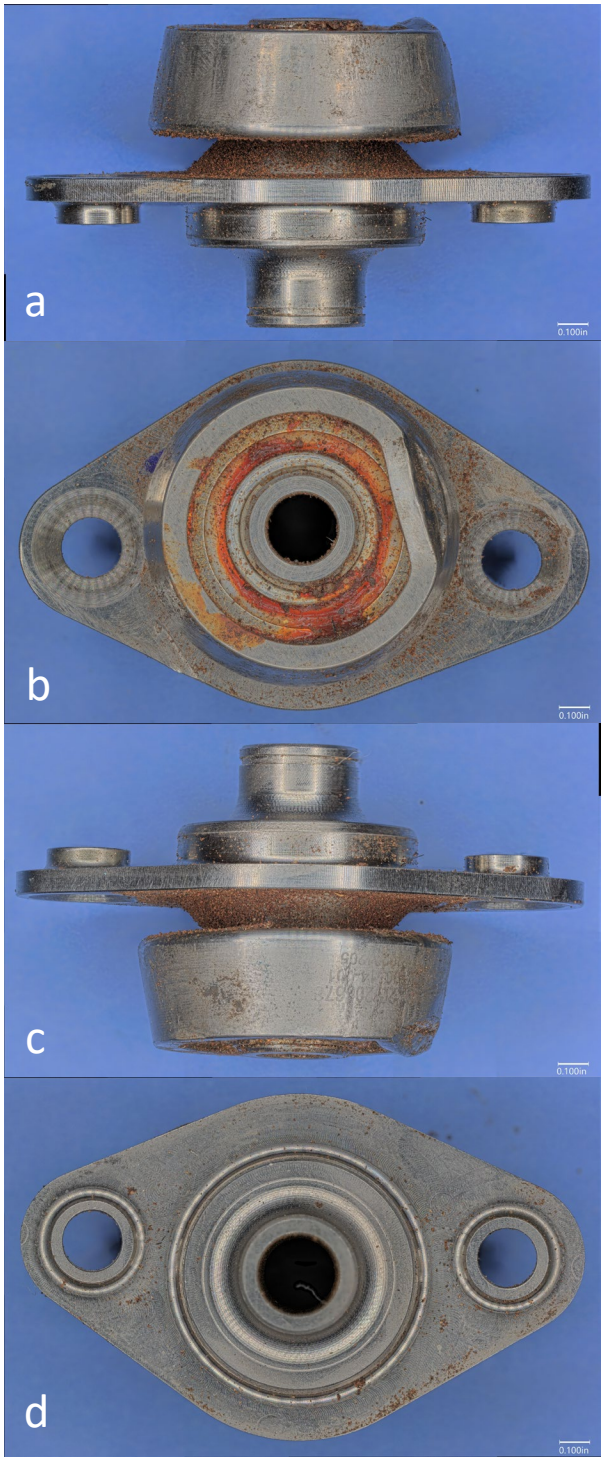

Figure 2. Digital microscope images of the Station 2 tilt slde anti sag roller bearing and mount, as-received.

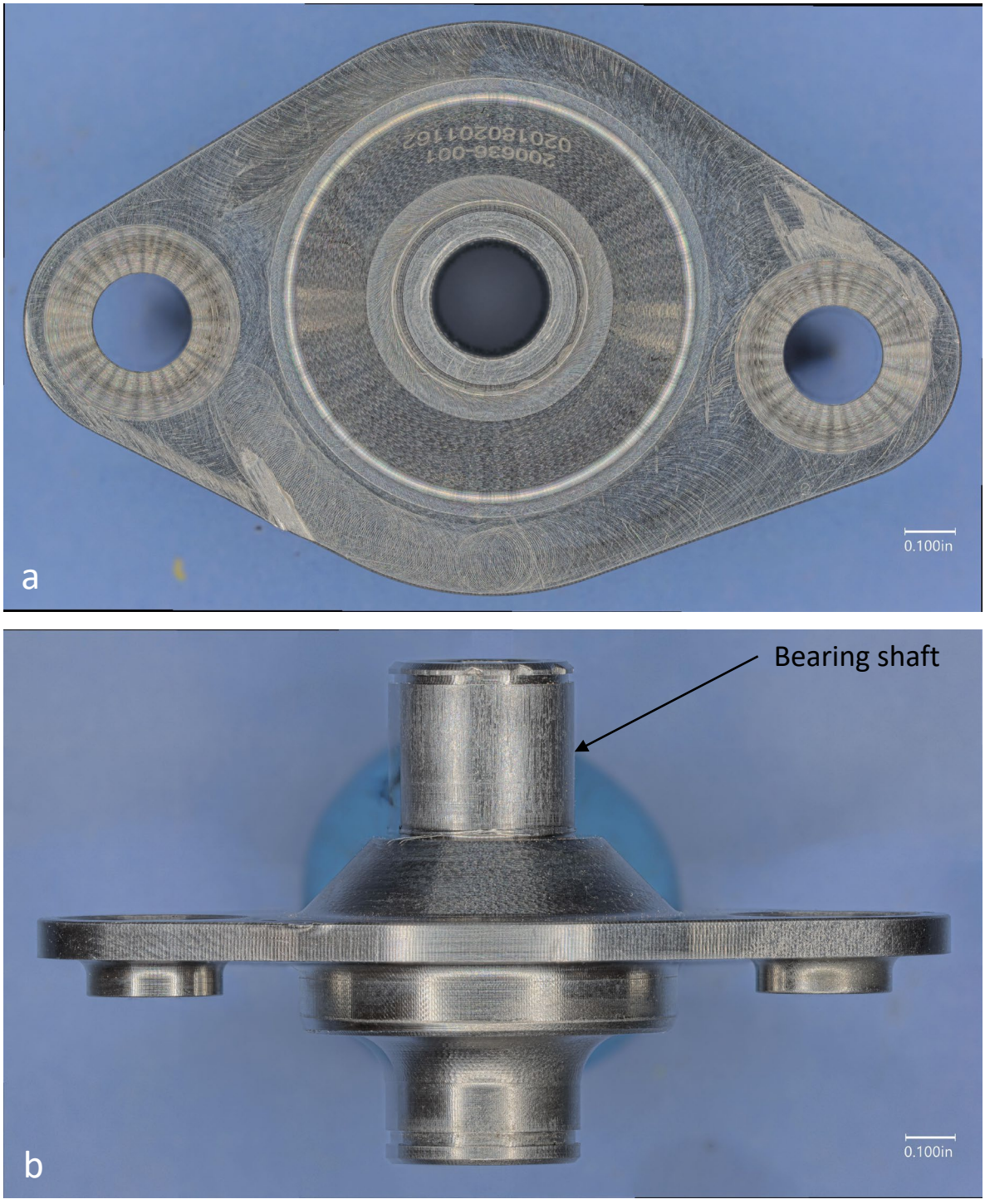

Figure 3. Digital microscope images of the Station 2 tilt slde anti sag roller bearing mount, with the bearing removed.

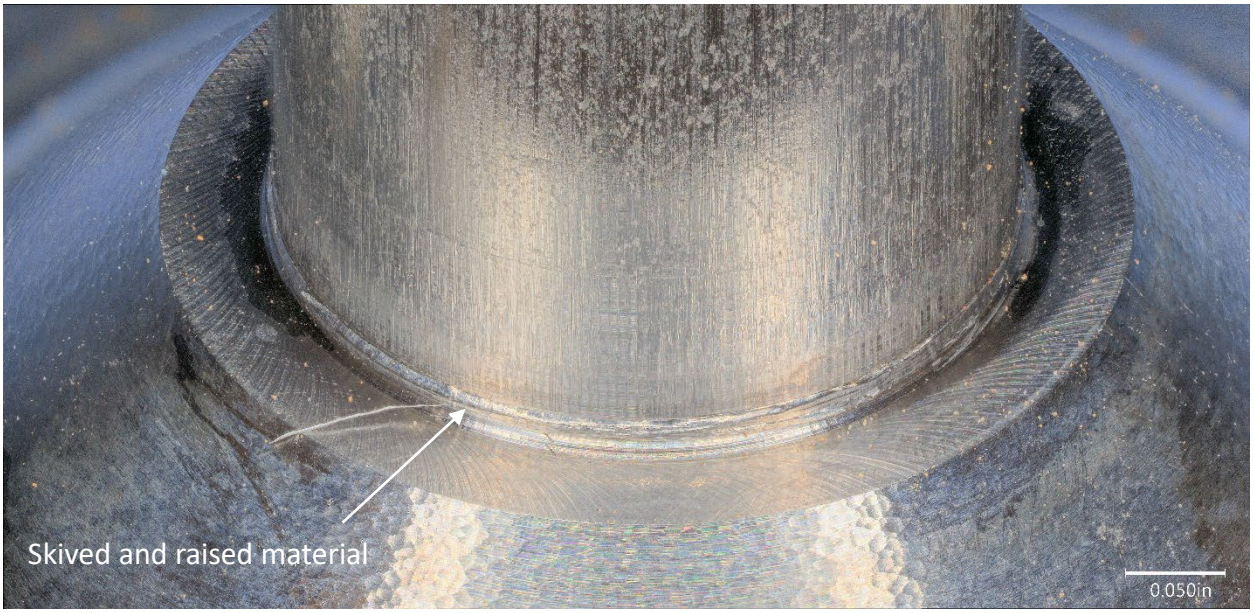

Figure 4. Close view digital microscope image of the base of the bearing shaft where it meets the mount body for the Station 2 tilt slde anti sag roller bearing mount. Note the raised material and skived filament associated with the pressing of the bearing onto the shaft.

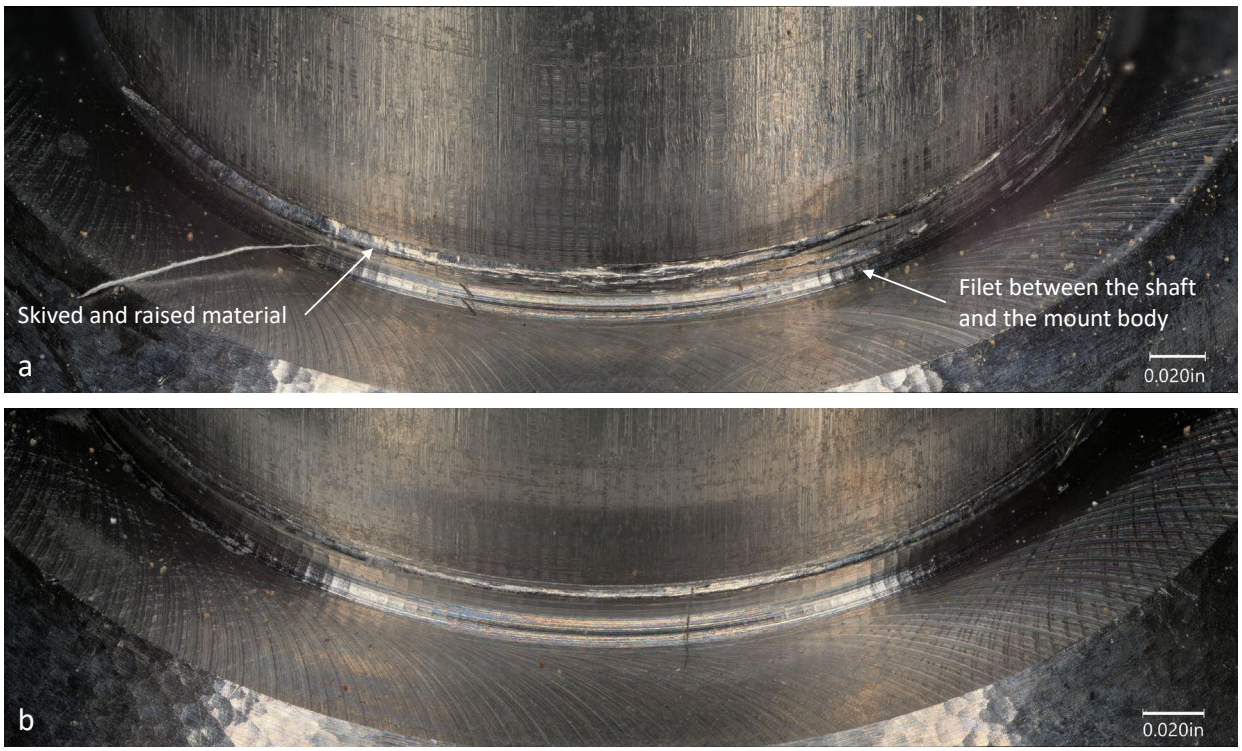

Figure 5. Higher magnification digital microscope images of the base of the bearing shaft where it meets the mount body for the Station 2 tilt slde anti sag roller bearing mount. Note the raised material and skived filament associated with the pressing of the bearing onto the shaft. Views a and b are 180° apart. No preexisting cracks were observed.

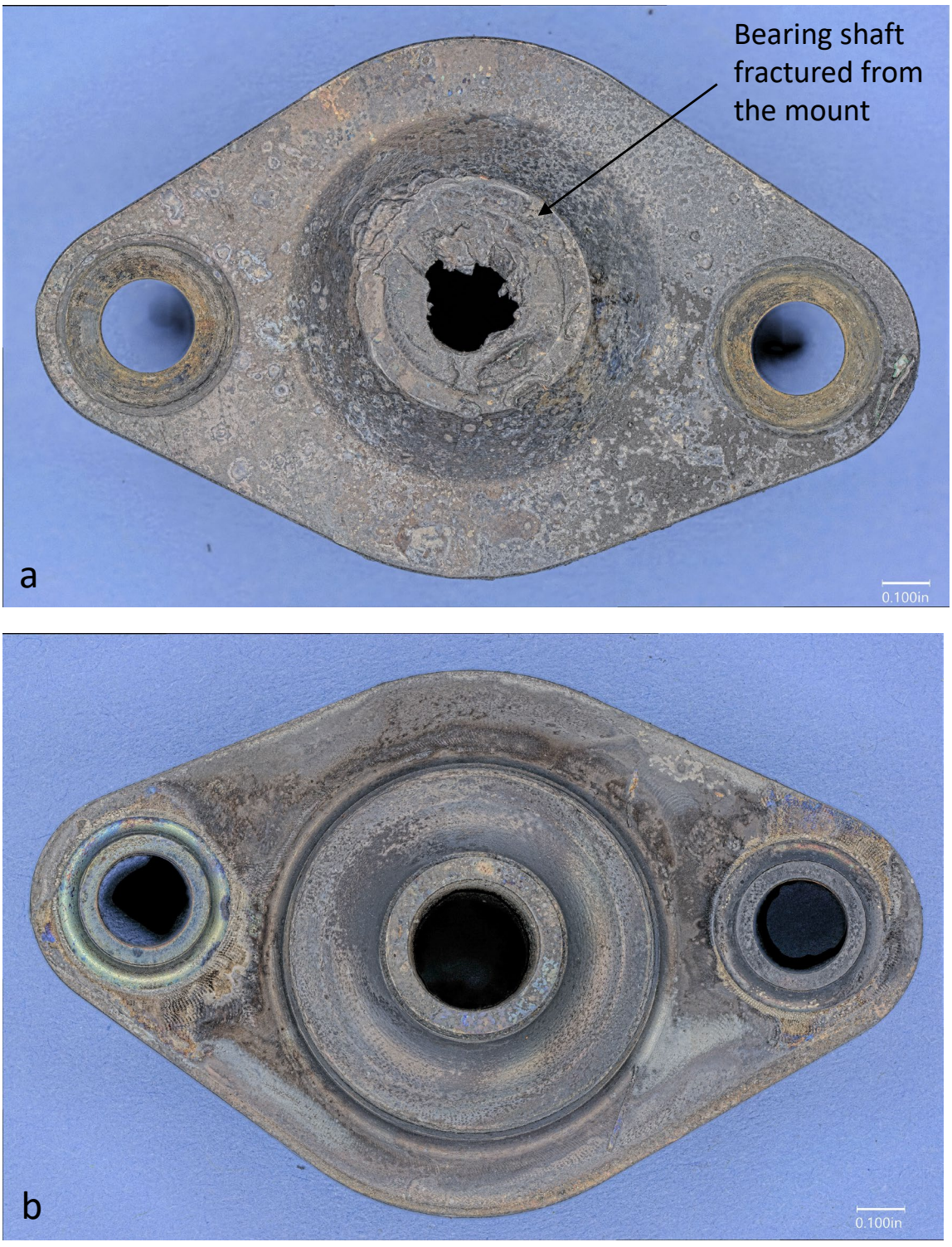

Figure 6. Digital microscope images of the Station 3 portion of tilt slde anti sag roller bearing mount, the separated shaft and bearing were not submitted.

Figure 7. Digital microscope image of the bearing shaft fracture surface from the Station 3 portion of tilt slde anti sag roller bearing mount.

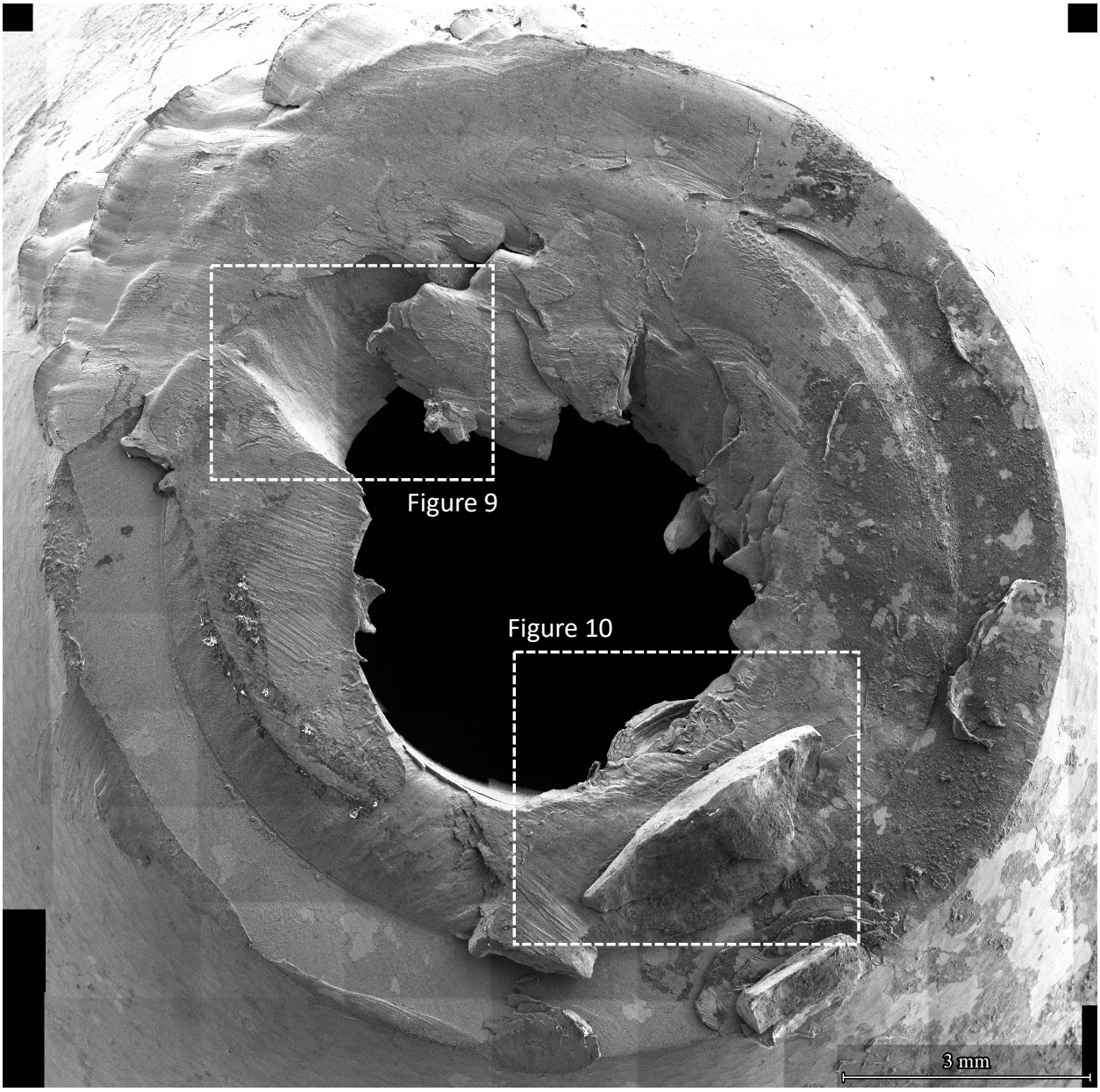

Figure 8. Scanning electron microscope image of the bearing shaft fracture surface from the Station 3 portion of tilt slde anti sag roller bearing mount.

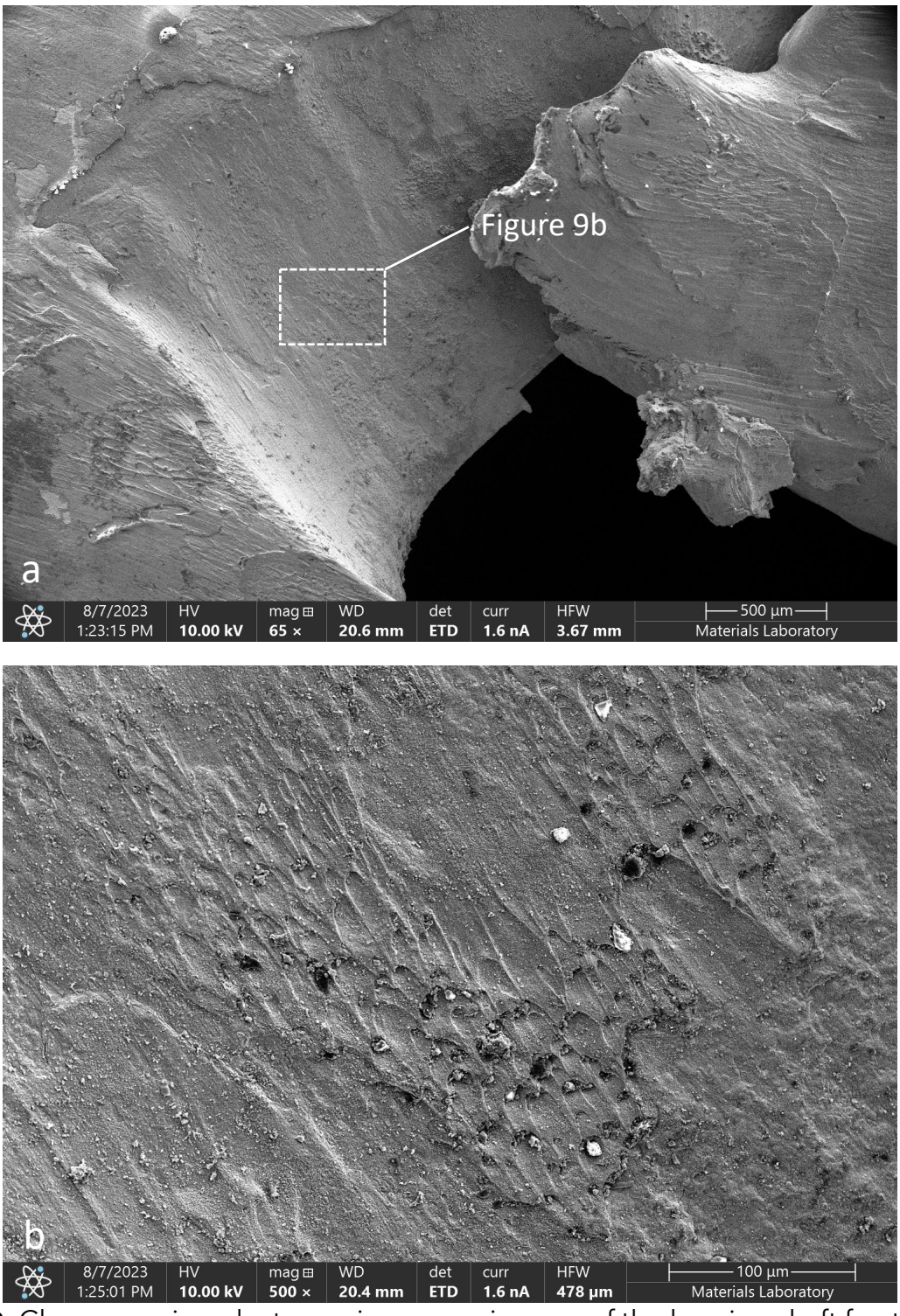

Figure 9. Close scanning electron microscope images of the bearing shaft fracture surface from the Station 3 portion of tilt slde anti sag roller bearing mount (see figure 9 for the specific location). The fracture features are consistent with monotonic overload.

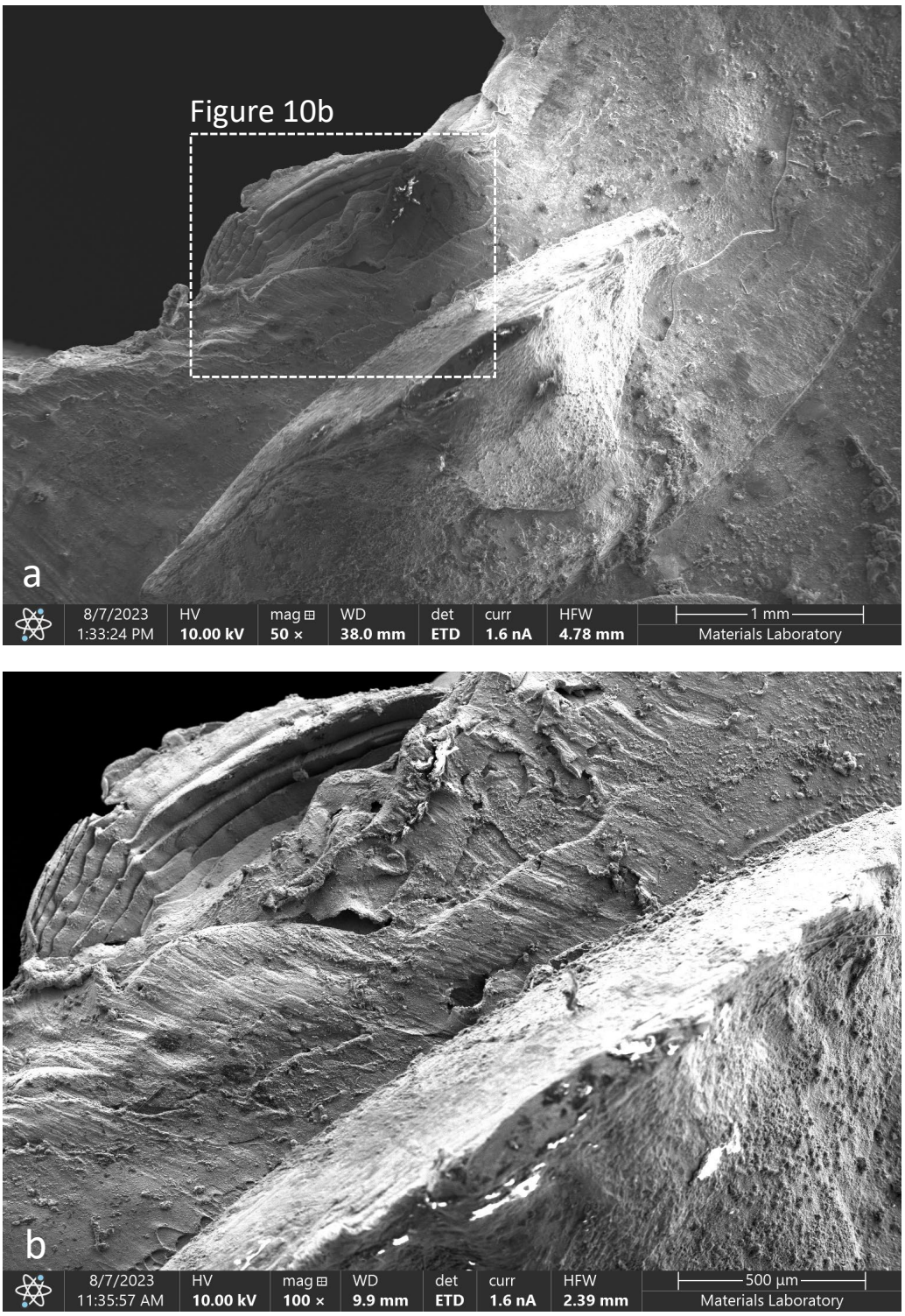

Figure 10. Close scanning electron microscope images of the bearing shaft fracture surface from the Station 3 portion of tilt slde anti sag roller bearing mount (see figure 9 for the specific location). The fracture features are consistent with monotonic overload.