

National Transportation Safety Board

Office of Research and Engineering

Washington, DC 20594



DCA21FA174

MATERIALS LABORATORY

Factual Report 22-010

March 22, 2022

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A. ACCIDENT INFORMATION

Location: Honolulu, Hawaii
Date: July 2, 2022
Time: 0145 Hawaii standard time (HST)
1145 coordinated universal time (UTC)
Vehicle: Boeing 737-200, N810TA, Rhoades Aviation Inc,
dba TransAir Flight 810
Investigator: Amanda Taylor, AS-60

B. COMPONENTS EXAMINED

Flight deck chair, first officer's.
Flight deck chair, captain's.

C. EXAMINATION PARTICIPANTS

Specialist	Donald Kramer NTSB Washington, DC
Group Chair	Amanda Taylor, AS-60 NTSB Washington, DC

D. DETAILS OF THE EXAMINATION

A flight deck chair (first officer's) that experienced a forward collapse of the seat back was submitted to the NTSB Materials Laboratory for examination, as shown in figures 1a - 1d. On March 1 and 2, 2022, the seat was torn down to examine and document the condition of the components that control the seat back position.

1.0 Seat back position - design and operation

By design, the seat back position is controlled by a screw jack mechanism that is mounted to the underside of the seat, as shown for the captain's chair in figure 2a. An exploded view of the screw jack assembly from the first officer's chair, after it was disassembled, is shown in figure 2b. The occupant adjusts seat back position by pulling an adjustment lever on the right side of the chair, indicated in figure 1b. The lever is connected to a shaft that passes through the seat base into the space underneath the seat. A Bowden cable, attached to the lever assembly, runs forward along the underside of the seat, loops through a 180° bend, and attaches to an anchor point near the seat's forward end and at its mid-plane, with the cable now running in the aft direction. The cable is connected, via a clevis, to a spring-loaded latch (see figures 2a and 2b). The latch is mounted to a jack nut housing via a hinge

pin. The latch tip passes through a slot in the housing and engages longitudinal slots on the outer diameter surface of a jack nut that is contained within the housing (figure 2b). When the lever is pulled, the latch pivots about its hinge, pulling the tip out of the slot. The nut is then free to rotate inside the housing. The nut is manufactured out of a polymer and is composed of the previously mentioned large-diameter section that is approximately 0.35 inch in length and, immediately aft, a smaller-diameter section with a smooth outer diameter surface that is approximately 0.68 inch in length. The large-diameter portion of the nut is supported at its forward and aft ends by needle-roller thrust bearings (figure 2b). An additional washer, shims, and a retention clip at the forward end adjust axial play and secure the nut assembly.

The base of the jack screw is connected to the seat back with a hinge pin (figure 2a). A compression spring and a sleeve are installed over the screw. The screw passes through the nut housing and the nut rotates about the screw as it translates longitudinally. A washer is attached to the end of the jack screw (not shown), which prevents the screw from backing out of the nut assembly. The spring, under residual compression, acts to push the screw hinge pivot aft, which causes the seat back to pivot forward. The seat occupant uses body weight to push against the seat back, which results in forward movement of the screw.

2.0 Disassembly and examination

The jack screw, screw spring, and spring sleeve were previously removed in the field, as seen in figures 1c and 1d, so disassembly focused on removal of the jack nut assembly. The Bowden cable was examined and determined to be intact and rotating the nut assembly back into its typical orientation placed the cable under tension. The cable was then cut. The surrounding seat material was cut with a reciprocating saw and rivets were through-drilled until the nut assembly could be removed.

Visual examination of the nut assembly revealed that the jack nut was fractured in the transverse plane, as shown in figure 3. The latch was found in the locked position and the latch tip was rotated out of the slot to examine it. There was no apparent deformation to the tip and the nut slot appeared to be aligned with the slot in the housing (see figures 4a and 4b and the discussion below).

Further teardown of the nut assembly required cutting the housing approximately 180° from the latch slot. While the retention clip could be removed, corrosion and salt residues had mechanically locked the backing washer and thrust bearing within the housing. After the housing was cut (see figure 4a), a chisel and hammer were used to open the housing inner diameter. The washer and bearing assembly were then removed revealing the forward face of the nut, shown in figure 4a. During the disassembly, the nut rotated slightly so that the slot in the nut was slightly misaligned with the slot in the housing. The slot alignment was documented prior to disassembly using a digital optical microscope, as shown in

figure 4b, and the two slots appeared to be aligned. The 6 o'clock position was marked on the nut and the nut was then pressed out of the housing, as shown in figure 5.

Visual examination revealed that the nut had fractured at the transition between the large- and small-diameter sections. Salt and corrosion products were removed by putting the nut pieces in a beaker filled with an alkaline detergent solution and placing the beaker in a sonicating bath. The fracture face on the large-diameter portion of the nut (the forward fracture face) is shown in figures 6 and 7, with and without fracture mapping annotations, respectively. Crack propagation marks were observed radiating from the outer diameter surface of the nut at the transition radius between the small-diameter section and the aft face of the large-diameter section. Two primary origins were observed, one on the left side and one on the right side, approximately in line with the attachment pins that connect the jack nut assembly housing to the seat frame. Each crack progressed radially inward and circumferentially around the top and bottom of the nut from their respective origins until the two cracks met at two lines of final separation. The crack originating from the left side had progressed approximately 135° around the top and bottom, subtending an approximately 270° arc angle. The crack originating from the right side accounted for the remaining 90° . Four smaller cracks, distributed about the inner diameter, had originated at thread roots and progressed radially outward, terminating at the primary fracture, as indicated in figure 6. Examination with a stereomicroscope did not reveal any apparent progressive cracking features. Considered as a whole, the observations were consistent with a tensile overstress fracture.

The threads on the large-diameter portion of the nut exhibited a stripped appearance, as shown in figure 8a. By contrast, the threads on the small-diameter portion of the nut did not, as shown in figure 8b. The attachment screw that secured the retaining washer to the end of the jack screw had fractured, as shown in figure 9. The fracture exhibited a rough appearance with a slanted fracture surface, consistent with a tensile overstress fracture.

Submitted by:

Donald Kramer, Ph.D.
Sr. Materials Engineer

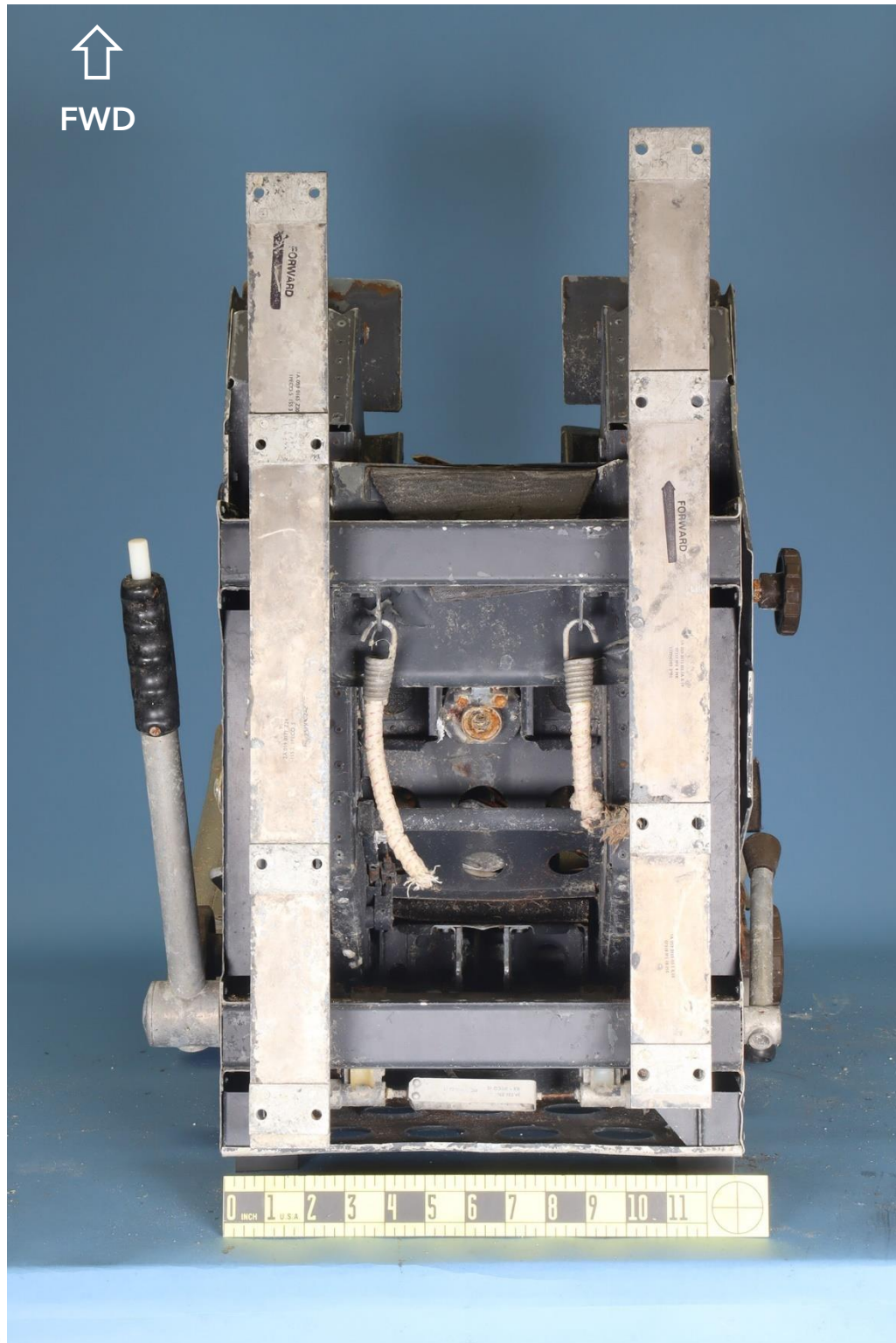


a)



b)

Figure 1. Images of the first officer's flight deck chair, as received; a) viewed forward looking aft; b) right-side view;



c)

Figure 1 (cont.). c) viewed below looking up. The jack screw assembly is not present as it was previously removed in the field; and

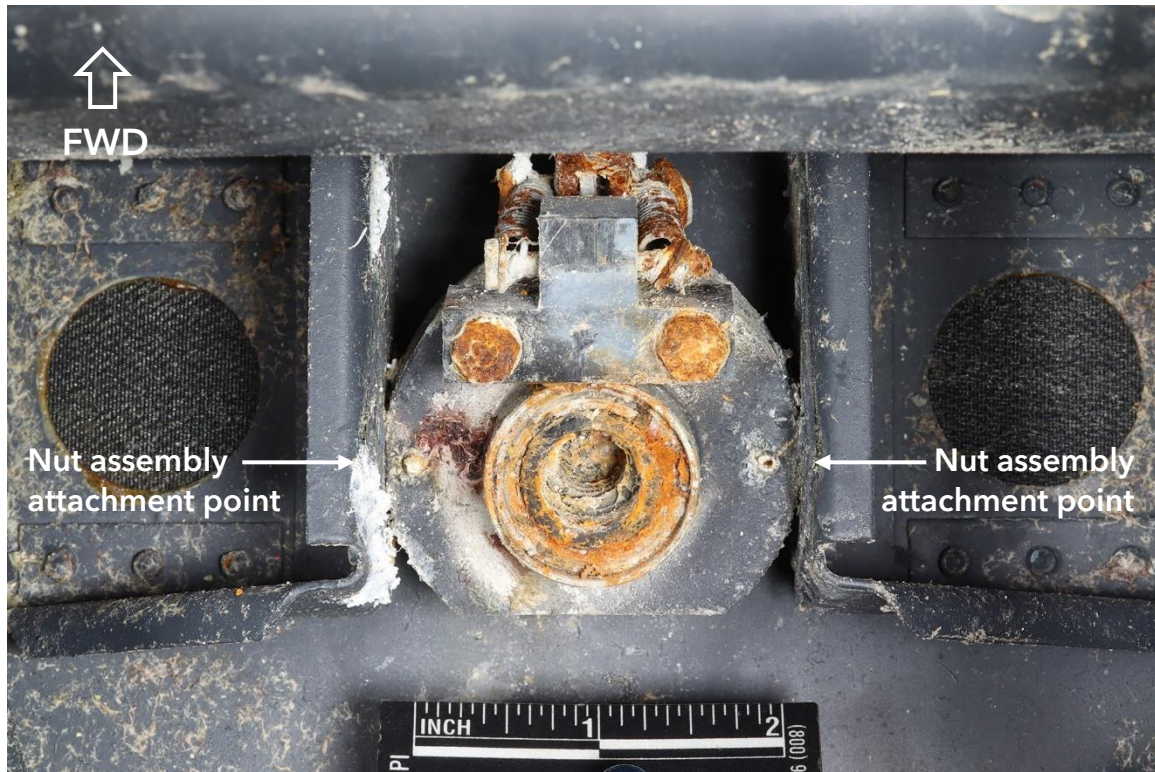


Figure 1 (cont.). d) higher magnification image of the jack nut assembly. The assembly rotated about its attachment points after the jack screw pulled out of the nut.

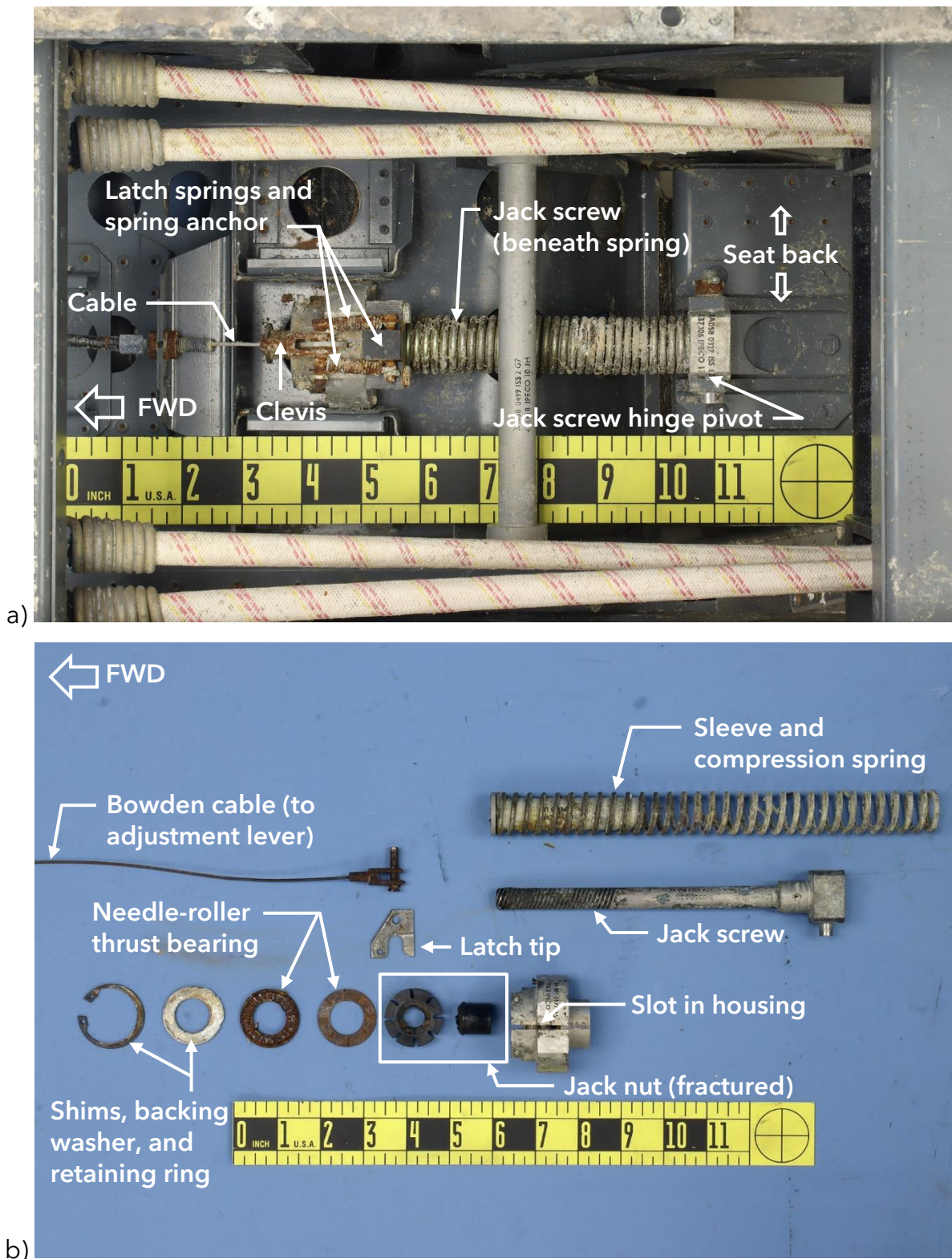
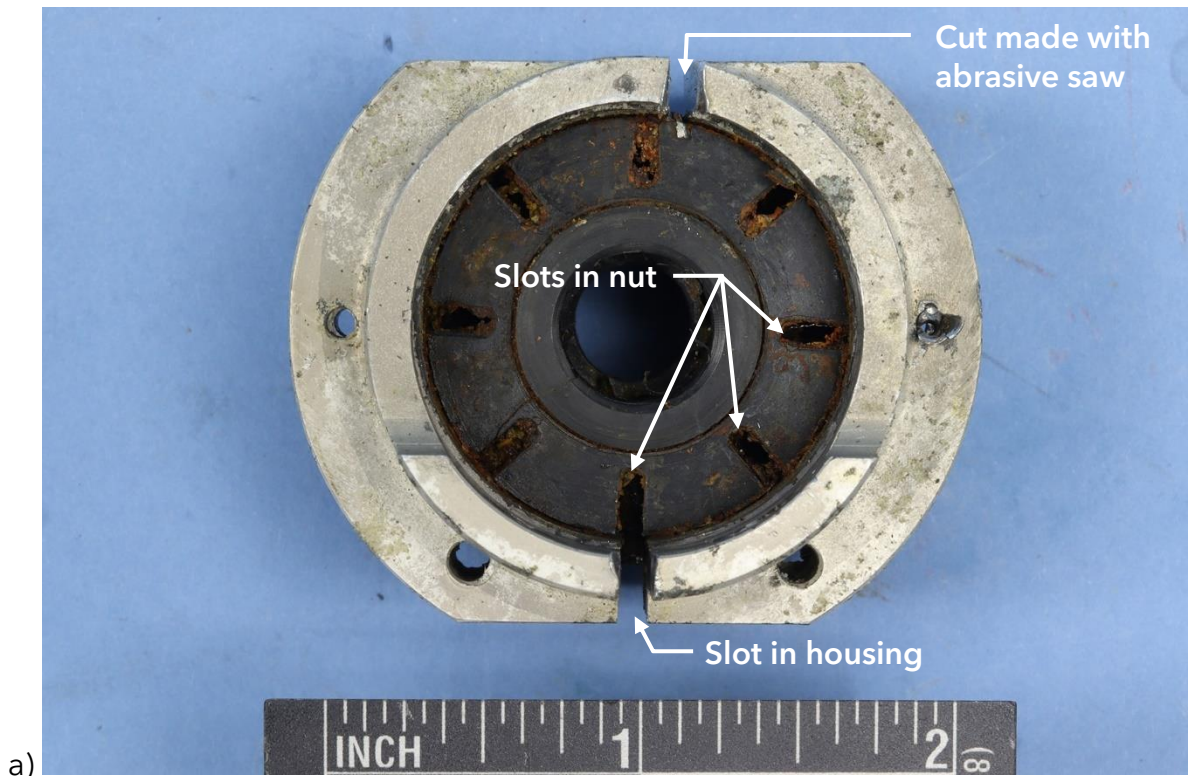


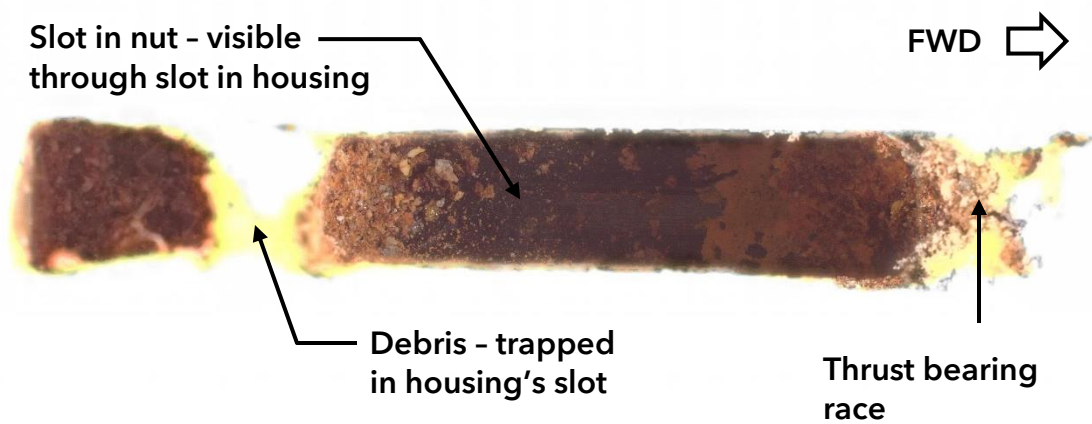
Figure 2. a) Seat back adjustment mechanism on captain's chair and b) exploded view of screw jack assembly from the first officer's chair after disassembly. The latch springs and spring anchor assembly are not shown.



Figure 3. Image of the nut prior to disassembly. The nut was fractured in the transverse plane.



a)



b)

Figure 4. a) Image of the nut inside its housing. The latch locking slot is located at the bottom (6 o'clock position) and a cut made with an abrasive saw is located at the top and b) image taken through the locking slot showing the slot in the nut, centered with the slot in the housing.



Figure 5. Image of the fractured nut after disassembly.

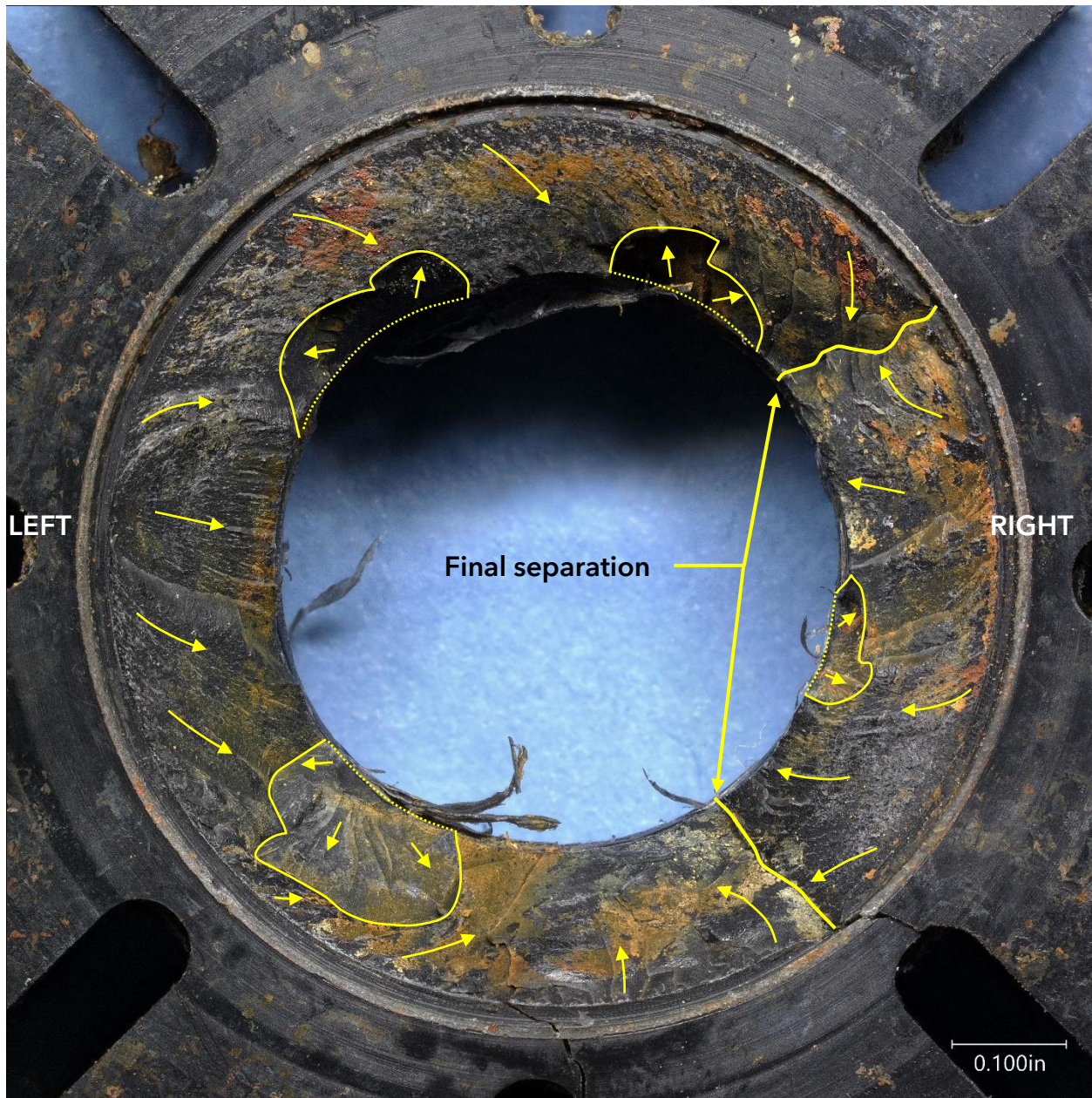


Figure 6. Jack nut fracture surface annotated with a fracture map. Arrows indicate the direction of crack propagation. Solid lines indicated fracture boundaries where two cracks meet.



Figure 7. Jack nut fracture surface without annotations.



Figure 8. Images of the jack nut threads; a) stripped threads in the large-diameter portion with the locking slots and b) intact threads on the smooth-barrel small-diameter portion.



Figure 9. Image of the fractured attachment screw used to secure the stop washer to the end of the jack screw. The fracture had a rough appearance and a conical profile, consistent with an overstress fracture.