

NATIONAL TRANSPORTATION SAFETY BOARD

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



June 05, 2022

MATERIALS LABORATORY FACTUAL REPORT

Report No. 22-050

A. ACCIDENT INFORMATION

Place : North Myrtle Beach, South Carolina
Date : 05/26/2022
Vehicle : Robinson Helicopters R44
NTSB No. : ERA22LA256
Investigator : Brian Rayner

B. COMPONENTS EXAMINED

1. Forward clutch shaft yoke piece with separated lug piece
2. Main gearbox yoke
3. Clutch shaft/yoke attachment bolts
4. Forward flex plate piece and separated forward flex plate piece with bolt/washers/nut
5. Miscellaneous unidentified nut, washer, and portion of self-locking Palnut®

C. DETAILS OF THE EXAMINATION

The as-received evidence is shown in Figures 1 and 2, with key components annotated in Figure 2.

Details of the forward clutch shaft yoke pieces are shown in Figures 3-5. In the figures, a separated piece of the lug at the bolt hole is identified and has been placed in close proximity to its pre-separation location. The forward and aft faces of the lugs exhibit scratches and gouges whereas the separated piece is free from such damage. As identified in Figure 4, the main inside bore (the bore that fits over the clutch shaft) did not exhibit any fretting wear scars. No paint deposits or fretting wear scars were observed under the yoke mounting block pads, although a thin clear organic layer was present on the faying surfaces of the mounting block pads consistent with an adhesive. No fretting wear scars were observed on the bore walls of the mounting bolt holes.

Closer views of the separated forward clutch shaft yoke lug piece are shown in Figures 6 and 7 in the as-received and acetone-cleaned condition, respectively. The fracture faces on the separated piece and the lug were examined using a digital microscope under various lighting conditions to reveal the fracture features. The fracture surfaces from both halves of the fractured lug are shown in Figures 8-11 in the as-received and acetone-cleaned condition. The fracture faces exhibited contact damage and gross mechanical distortion; however, two fatigue cracks were observed. One fatigue crack nucleated at the bolt hole bore chamfer at the outer periphery on the flex plate side

and progressed towards the shaft side of the lug. Fatigue crack progression marks were observed over about 80% of the fracture surface. A second fatigue crack nucleated under the washer of the mounting bolt on the flex plate side of the lug. The crack progressed through the lug thickness towards the shaft side of the lug and outwards towards the free surface of the lug. Fatigue crack progression marks were present over about 90% of the fracture surface. The specific locations of the two fatigue crack nucleation sites are identified on the separated lug piece in Figures 12 and 13.

The hardness of the lug portion of the forward clutch shaft yoke was 39.7 HRC based on an average of three measurements. The composition of the lug on the forward clutch shaft yoke was consistent with type 4130 steel measured using an Olympus Vanta® C Series Handheld XRF Analyzer.

Details of the damage on the flex plate are annotated in Figure 14. Identified in the figure, one of the lugs was separated from the flex plate and additional unrecovered material was also separated. The fracture surfaces at the points of separation reveal features consistent with bending overstress fracture. The bolt, nut, and washers used at the fractured end of the lug on the forward clutch shaft yoke are identified in the figure. The washers and nut exhibited battering damage. The nut was tight on the bolt, consistent with being in the as-assembled (pre-incident) condition. Due to the damage to the bolt/washers/nut assembly, no indications of fretting wear were noted. Overall, the flex plate exhibited bending and twisting deformation at the lugs.

The main gearbox yoke, miscellaneous unidentified nut, washer, and portion of self-locking Palnut® were not examined in detail.

Michael Budinski
Chief, Materials Laboratory Division



Figure 1 Image of the as-received evidence.

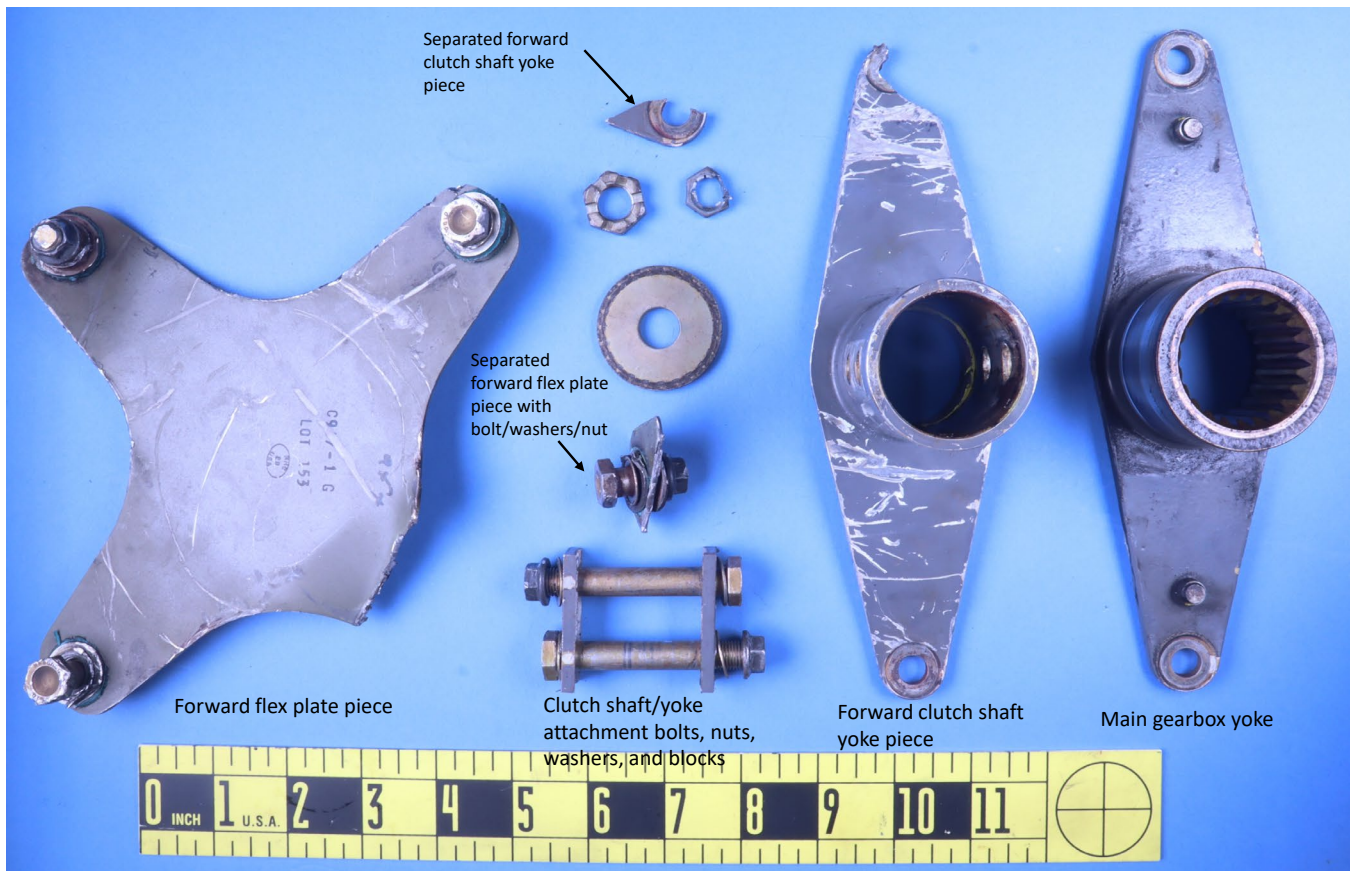


Figure 2 Image of the as-received evidence with key pieces identified.

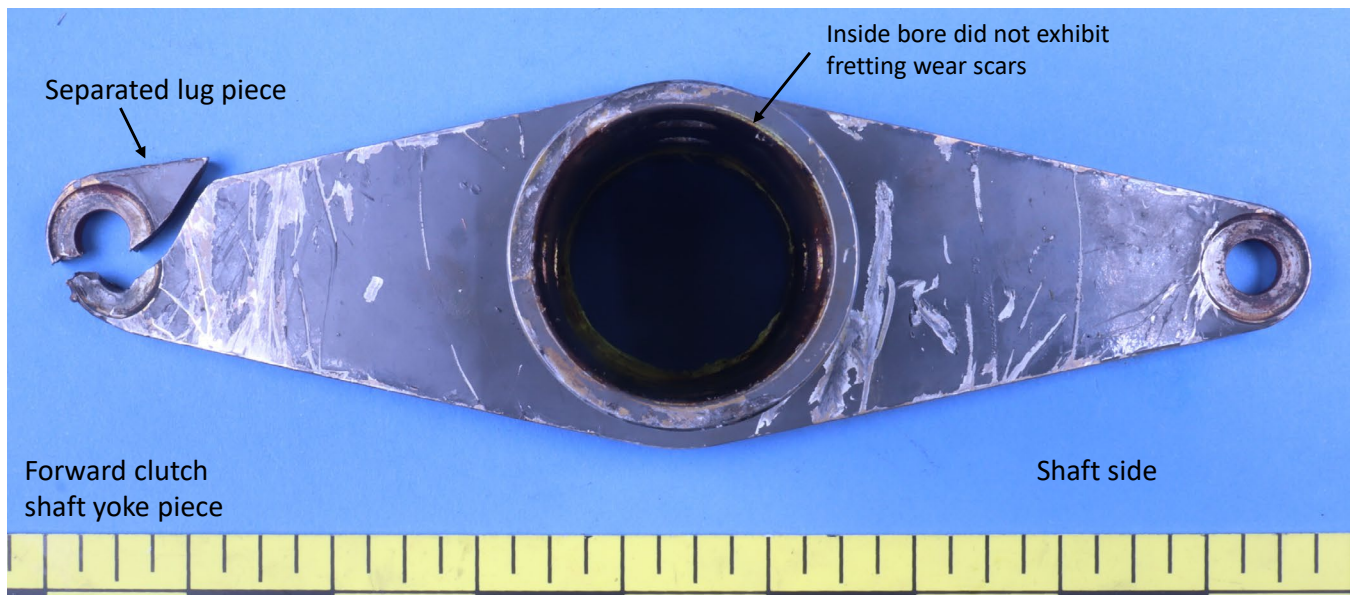


Figure 3 Macroscopic view of the of the clutch shaft side of the forward clutch shaft yoke piece with a separated lug piece positioned close to its pre-incident location. The shaft-side face of the lugs are scratched and gouged. The separated piece is free from scratches and gouges.

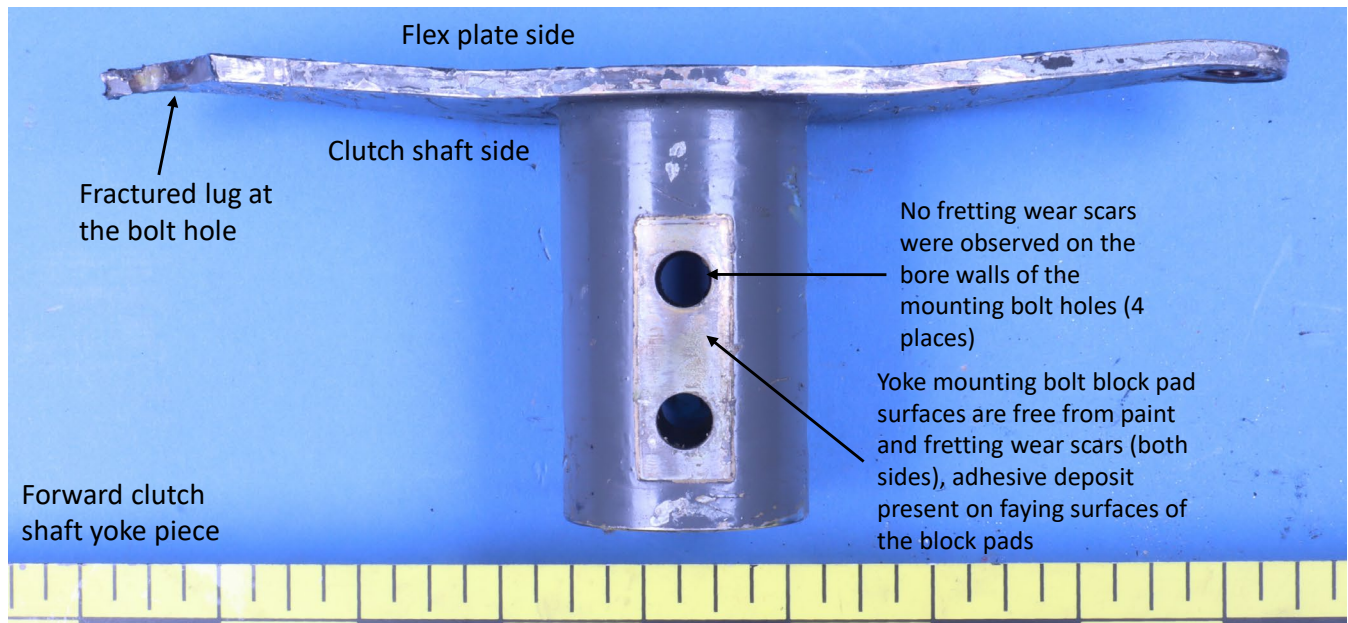


Figure 4 Macroscopic profile view of the forward clutch shaft yoke piece.

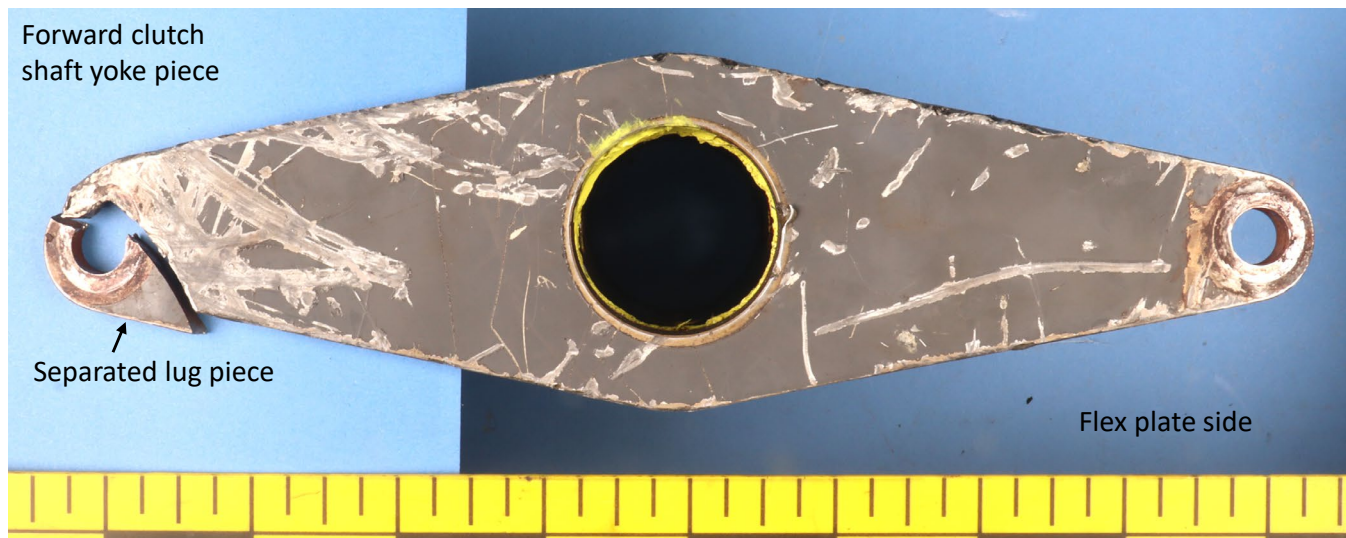


Figure 5 Macroscopic view of the of the flex plate side of the forward clutch shaft yoke piece with a separated lug piece positioned close to its pre-incident location. The shaft-side face of the lugs are scratched and gouged. The separated piece is free from scratches and gouges.

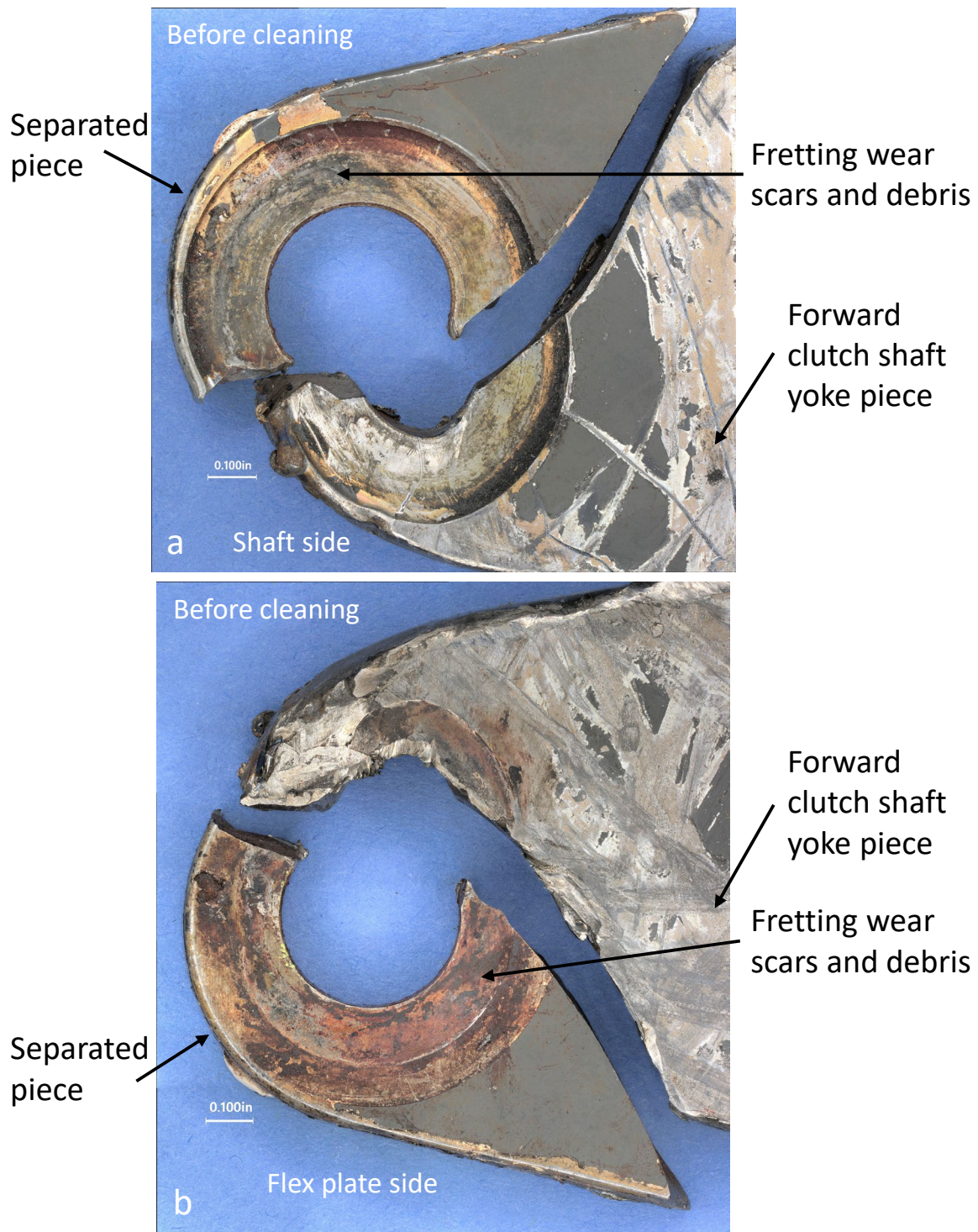


Figure 6 Close views of the fractured lug on the forward clutch shaft yoke piece with the separated lug piece positioned close to its pre-incident location (before cleaning). Indications of fretting wear are noted in the images.

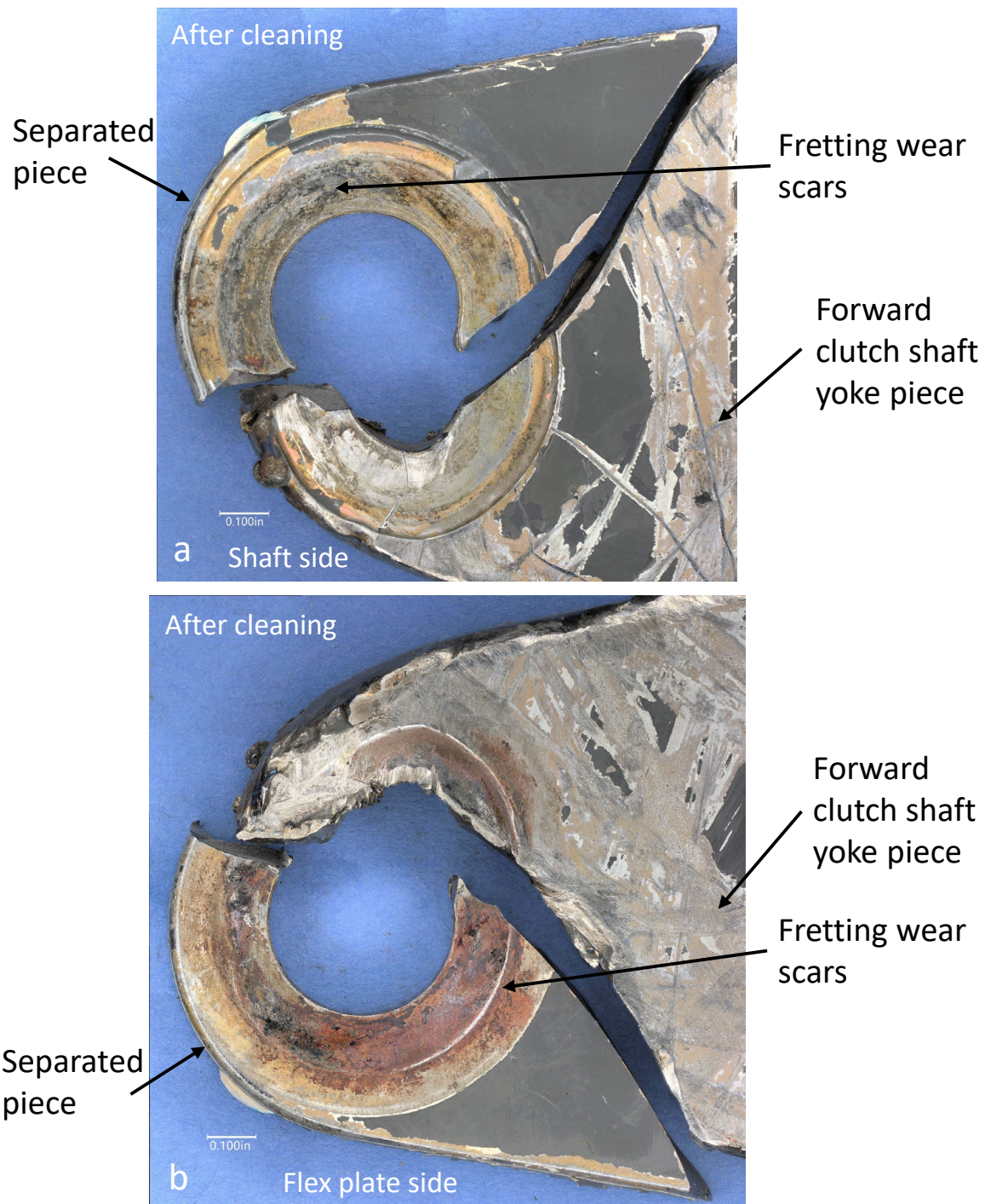


Figure 7 Close views of the fractured lug on the forward clutch shaft yoke piece with the separated lug piece positioned close to its pre-incident location (after acetone cleaning). Indications of fretting wear are noted in the images.

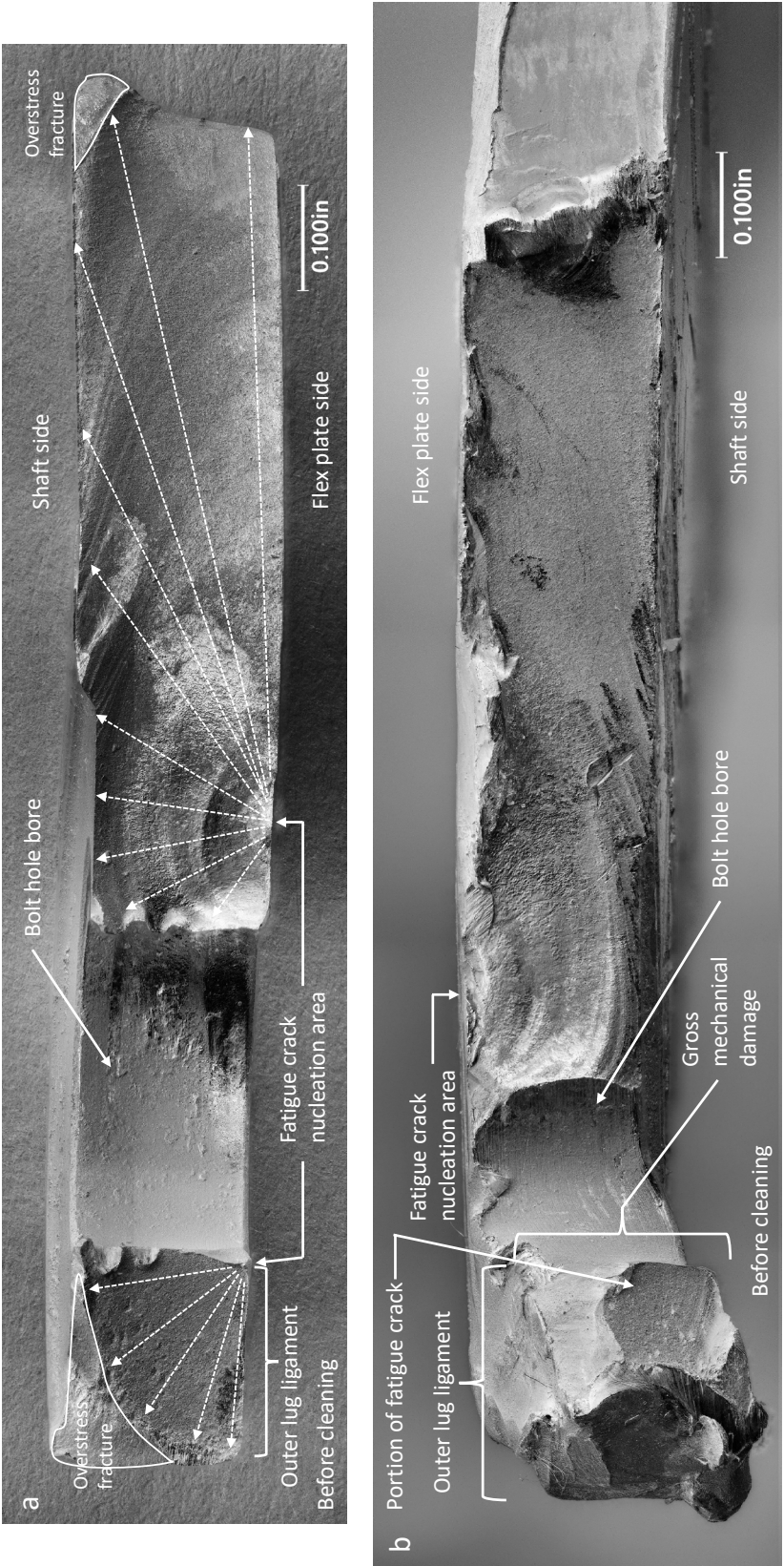


Figure 8 As-received monochromatic digital microscope images of the fracture surfaces on the fractured lug of the forward clutch shaft yoke with key features annotated. View a shows the fracture surfaces on the separated lug piece with origin areas and direction a crack propagation (dashed arrows) annotated. View b shows the fracture surfaces on the main lug with origin area annotated.



Figure 9 As-received high-dynamic range digital microscope images of the fracture surfaces on the fractured lug of the forward clutch shaft yoke with key features annotated. View a shows the fracture surfaces on the separated lug piece with origin areas annotated. View b shows the fracture surfaces on the main lug with origin area annotated.

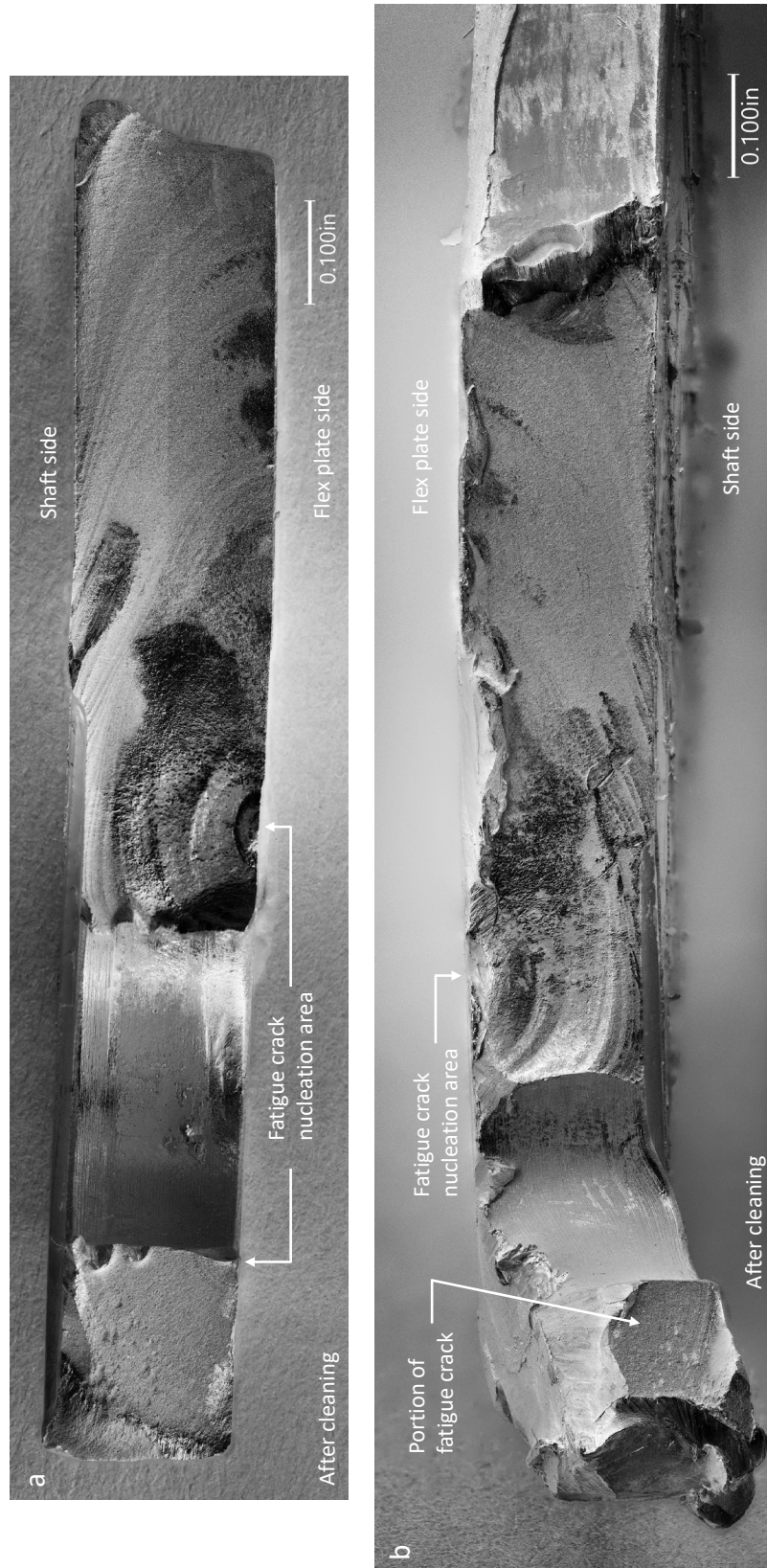


Figure 10 Acetone-cleaned monochromatic digital microscope images of the fracture surfaces on the fractured lug of the forward clutch shaft yoke with key features annotated. View a shows the fracture surfaces on the separated lug piece with origin areas annotated. View b shows the fracture surfaces on the main lug with origin area annotated.

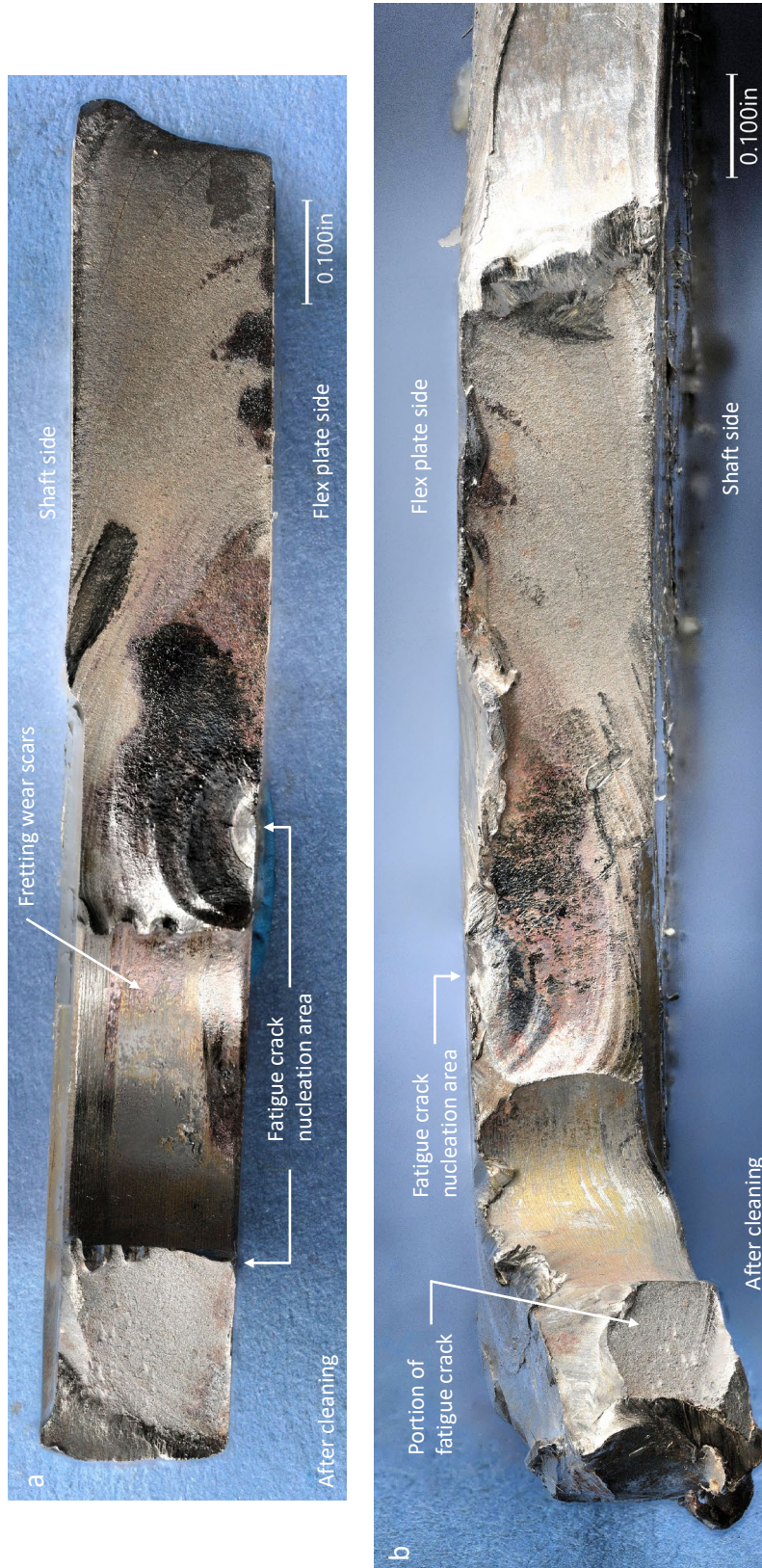


Figure 11 Acetone-cleaned high-dynamic range digital microscope images of the fracture surfaces on the fractured lug of the forward clutch shaft yoke with key features annotated. View a shows the fracture surfaces on the separated lug piece with origin areas annotated. View b shows the fracture surfaces on the main lug with origin area annotated.

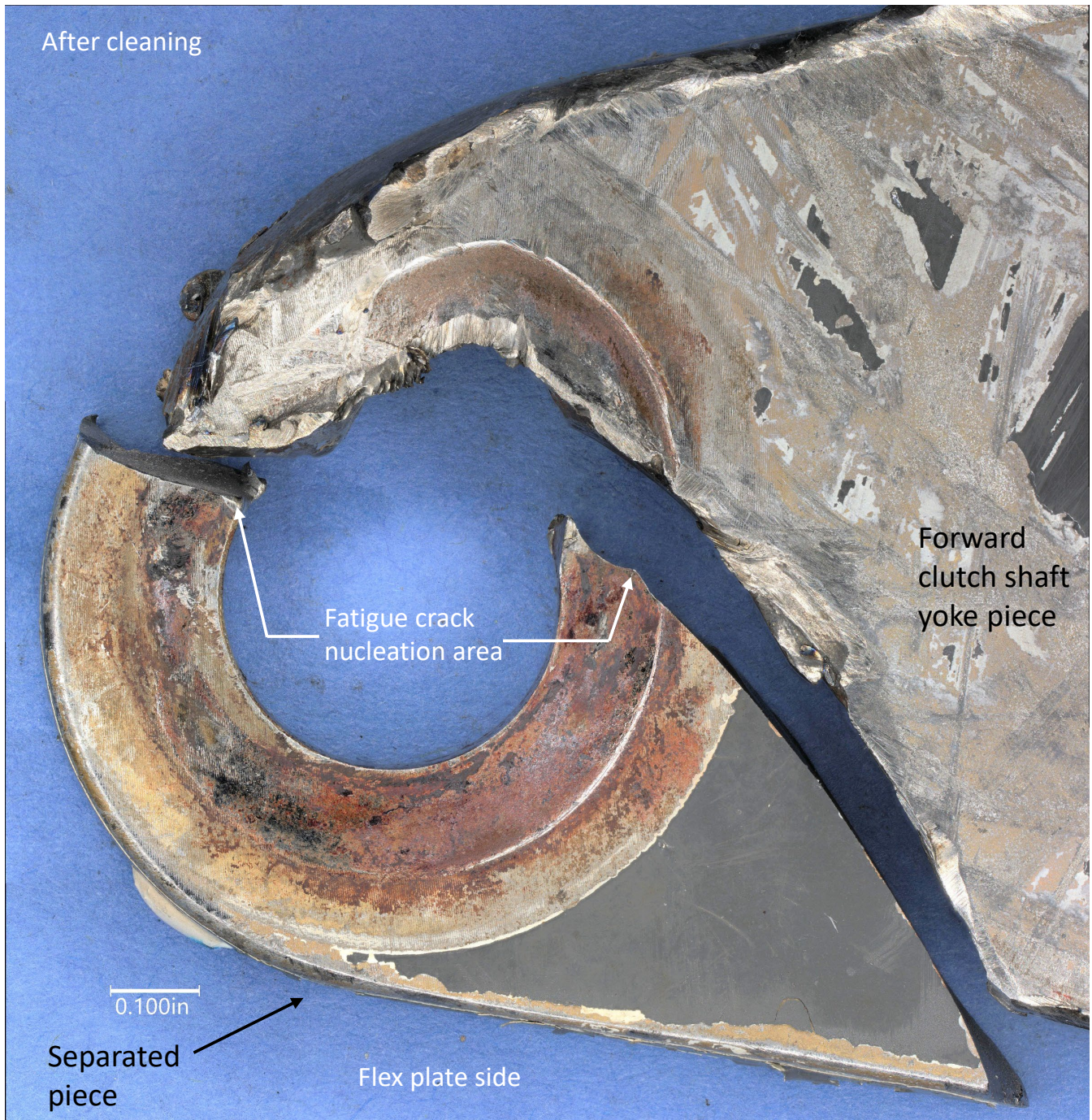


Figure 12 Close view of the fractured lug on the forward clutch shaft yoke with the fatigue crack nucleation areas annotated.

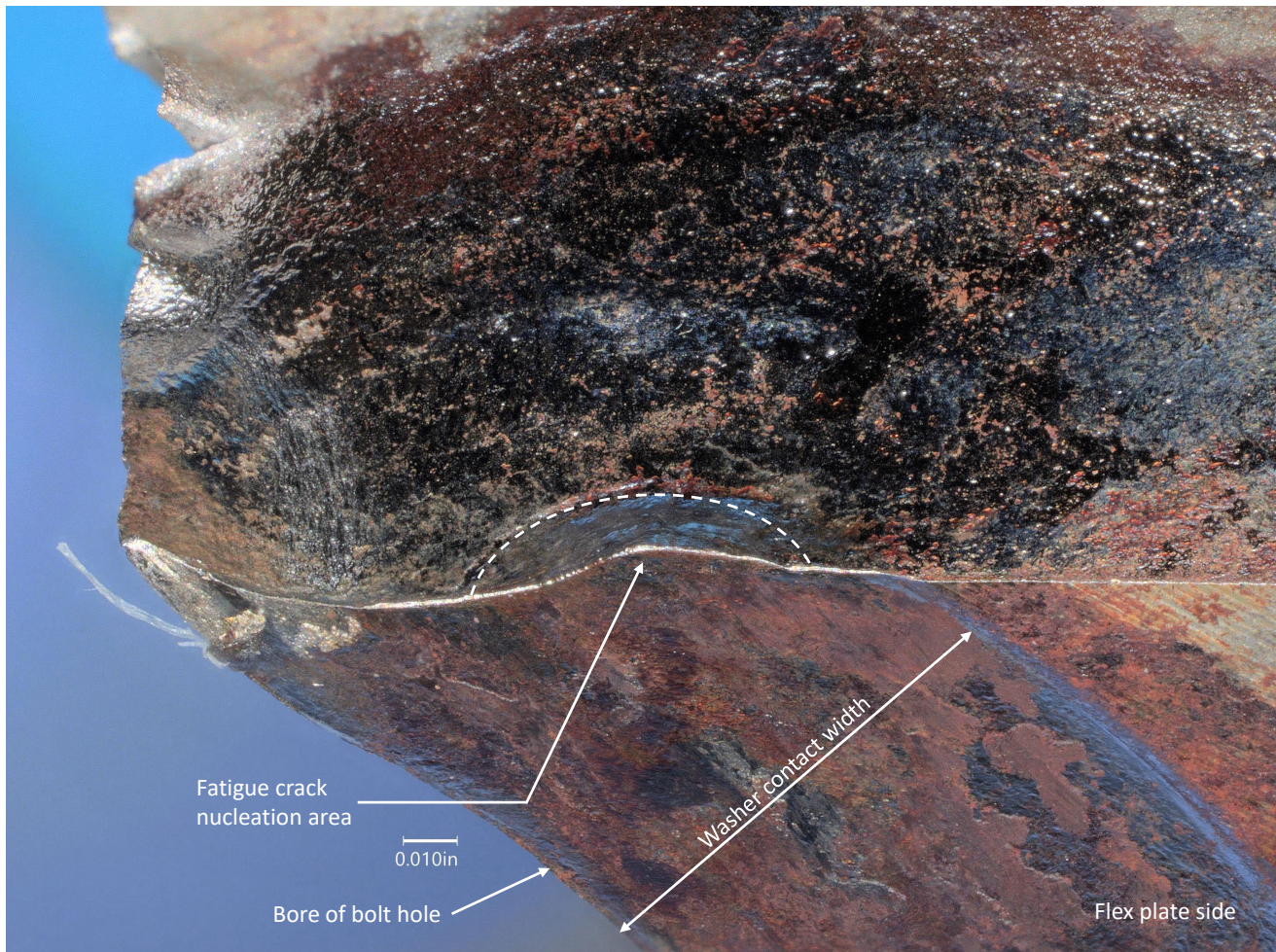


Figure 13 Oblique close view of the fracture surface on the separated piece of lug on the forward clutch shaft yoke with the fatigue crack nucleation area annotated.

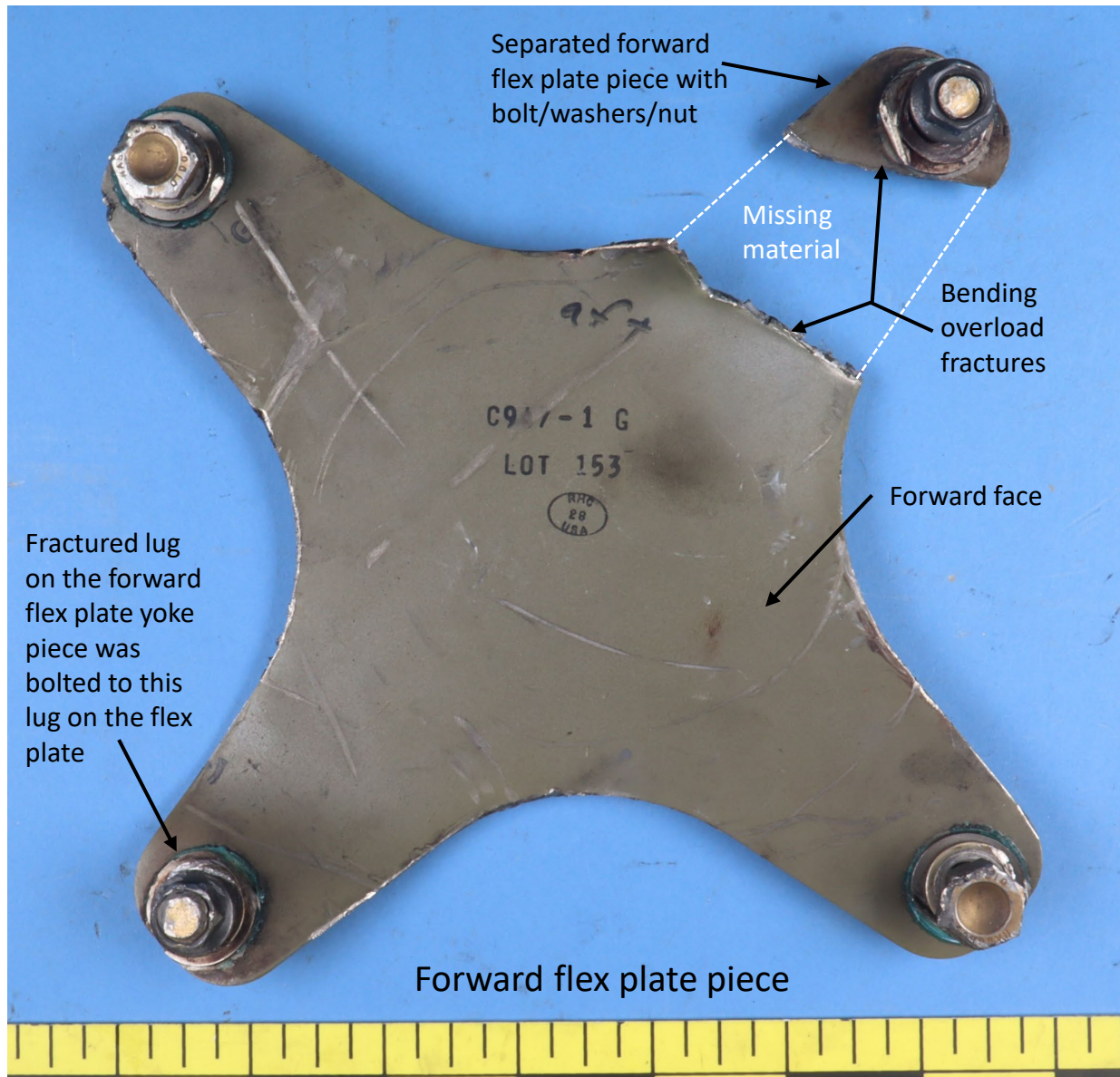


Figure 14 Image of the forward flex plate pieces with key observations annotated.