

National Transportation Safety Board

Office of Research and Engineering

Washington, DC 20594



CEN25LA117

MATERIALS LABORATORY

Factual Report 25-089

April 6, 2026

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A. ACCIDENT INFORMATION

Location: Plainview, Texas
Date: March 10, 2025
Vehicle: Van's RV-7A, N923ZA
Investigator: Joshua Lindberg

B. COMPONENTS EXAMINED

AXSport Propeller Blades and Hub

C. EXAMINATION PARTICIPANTS

Specialist Daniel Crecco
National Transportation Safety Board
Washington, DC

D. DETAILS OF THE EXAMINATION

On March 25, 2025, a Van's RV-7A was taking off when it began to experience a violent shaking. When engine throttle was reduced, the shaking noticeably decreased. The aircraft was set down in a field near the runway and there were no fatalities. Upon inspection of the aircraft, it was found that one of the propeller blades had separated from the aircraft. This blade was recovered nearby. All three blades and the blade hub assembly were submitted to the NTSB Materials Laboratory in Washington, DC for examination into the cause of the blade separation.

The blades and hub assembly were photographed in the as-received condition (**Figure 1**). Dot peened impression marks representing 1, 2, and 3 were identified on propeller blades and the hub assembly, denoting their locations in the hub, and will be subsequently used to identify each blade. Additionally, the following part identification markings were observed on the forward hub shell surface:

AXSPORT
S/N 0138

The AXSport Aviation propeller system, designed and manufactured out of Cape Town, South Africa, is advertised as an experimental three-blade electric and hydraulic constant speed/variable pitch propeller designed for non-type certified aircraft. The subject unit appeared to be configured for electric operation. The propeller blades were made of a carbon fiber reinforced epoxy composite airfoil and

an aluminum alloy blade root section which were assembled into an aluminum alloy propeller hub.¹

The propeller hub assembly was a two-piece clamshell design that held the propeller blades in place via a set of bearings surrounding the blade root. Each blade root was fitted with three cartridge style bearings separated by spacer rings with a needle roller thrust bearing with washers located between the last cartridge bearing and the cam follower disk. The cam follower disk was attached to the base of the blade via 5 button head screws and a socket head screw, on which the blade cam follower was mounted and interfaced with the white plastic pitch control block.

The hub assembly was fastened directly to the motor fixing plate. When assembled with the intact blades, the blade radius measured approximately 35.7 inches, which meets the AXSport operator's manual propeller diameter requirements for the specified Lycoming O-360 design aircraft engine.

1.0 Blade 2 Root

Upon reviewing the components, the liberated blade was identified as Blade 2 (**Figure 2 and Figure 3**). Visual inspection of Blades 1 and 3 did not find any indications of cracking and were visually intact. The cracking in Blade 2 appeared to emanate from a fillet on the blade root. The primary fracture progressed transversely through the hollow blade root, intersecting the three radial mounting pins, and final fracture occurred on the opposite side at approximately a 120 degree angle to the origin (**Figure 4 and Figure 5**). Progressive growth was observed across the majority of the fracture surface, suggesting a high cycle, low nominal stress loading scenario. Adjacent to both the fracture initiation and final overstress regions, a portion of the machined fillet surface was found intact, exhibiting heavy wear marks indicating sliding contact against the hub housing (**Figure 6**). Surfaces adjacent to the wear path exhibited coarse machining marks, from which the crack appeared to originate. A single ratchet mark was observed towards one end of the region, while the rest of the origin appeared to emanate from a common plane.

Several secondary thumbnail cracks appeared to have initiated from the corners of radial retention pin holes, often progressing till terminating at the intersection with the primary fracture progression or region of final overstress. An additional crack was observed emanating from the retention pin hole adjacent to the final stress region but did not overstress during the final liberation of the propeller blade (**Figure 7**).

Black greasy witness marks indicating the position of the blade root were observed within the pin holes suggesting that the top cartridge bearing inner

¹ AXSport Aviation Website, <https://www.axsportaviation.com/>

diameter ring had slid at some point (**Figure 8**). It is unclear what drove this rotation to occur.

The hub-side portion of the blade root was disassembled from the cam follower disk and bearings and cleaned in an ultrasonic bath with lab-grade detergent to remove the dirt and black grease present on the component. The blade root was subsequently rinsed with ethanol and placed within an Apreo S field emission scanning electron microscope (FE-SEM) for fractography. The fracture surface exhibited a feathery appearance with tear ridges, consistent with a high-cycle fatigue (**Figure 9**). Numerous fine secondary cracks oriented perpendicular to the progression direction were observed going into the fracture surface. The origin sustained some fracture rub but appeared to largely emanate along a single machine mark spanning the region (**Figure 10**). Marks from other machine passes were observed parallel to origin. Using comparative machining finish standards, the external surface of the blade root was approximated to be between 90 and 125 microinches Ra².

Numerous ratchet marks were observed midway through the progression on the inner diameter of the root, indicative of multiple fracture origins that quickly coalesced with the primary fracture (**Figure 11**). Electron microscopy revealed these origins emanated from machining chatter marks observed on the adjacent threads³. It was unclear whether these thread features were permissible according to the design of the blade root.

Both sides of the fractured blade root were oriented to compare fracture profile (**Figure 12**). It was discovered that portions of the blade root were missing. Some secondary fracture propagation appeared to initiate from the fillet region and progress within the region of the first cartridge bearing interface, resulting in the separation of blade root fragments. The bearing interface surfaces that were still present appeared oxidized and had patches of galling, consistent with fretting corrosion and suggesting an amount of vibratory movement at the inner diameter (ID) bearing ring/blade root interface (**Figure 13**). It was unclear if an insecure bearing fitment at this interface was permissible by design. The second cartridge bearing additionally exhibited a small region of galling as well (**Figure 14**). No significant amounts galling or fretting corrosion was evident on the third cartridge bearing or thrust bearing interfaces.

² Surface roughness (Ra) is a standard measurement of the average of microscopic height deviations from an average surface height. The lower the average deviation the smoother the surface appears.

³ Chatter marking is a wave-like surface irregularity caused by high frequency vibration occurring between a cutting tool and material during machining.

2.0 Hub Assembly

The hub was separated into its forward and rear components (**Figure 15**). Damage consistent with the radial ejection of the propeller blade was observed on the Blade 2 hub slot. Witness marks were observed exhibiting a similar radius to the face of the retention pins and separated by similar spacing (**Figure 16** and **Figure 17**). Large cracks were observed on three of the four corners of the clamshell Blade 2 pocket. One of these cracks on the forward shell exhibited an outward deformation, revealing a thumbnail progressive fracture emanating from the ID corner of the shell (**Figure 18**). The orientation of the crack corresponded with aggressive contact wear observed on the inner lip of the blade opening. No further work was conducted on this fracture surface to preserve overall geometry of the hub slot.

Prior to disassembly and removal of the cartridge bearings and cam follower disk, the blade root was oriented in the hub slot using the witness marks from radial pins, as well as assembly part markings (**Figure 19**). Regions of the blade root fillet radius that exhibited aggressive contact wear corresponded to wear observed on the inner lip of the hub blade opening, indicating contact between the blade root and hub. No documentation was provided to indicate if this was an intended design of the assembly. Clearance was observed between the hub opening and the blade root of Blade 3, allowing the Blade 3 pitch to rotate freely without contact. However, this clearance was not present in the assembled Blade 2, permitting contact between the blade root and propeller hub opening (**Figure 20**).

Measurements between the bottom of the blade root and the fillet radius appeared consistent across all three blades and no significant dimensional deviation was observed. However, examinations of the Blade 2 hub slot indicated a discrepancy compared with the slots for Blades 1 and 3. In both Blades 1 and 3, a full-circumference seating surface is machined into the lip that interfaces with the outer ring of the cartridge bearings (**Figure 21**). However, in the Blade 2 slot, this surface blended into the machining of the slot opening lip, starting at the hub parting plane and disappearing altogether at the base of the slot. When properly configured with the fractured blade root, the initiation point of the primary fatigue crack correlated with missing region of the bearing seat. Similar bearing seat features were observed on the rear shell Blade 2 slot as well (**Figure 22**).

Chemical analysis was performed on the fractured blade root using X-ray fluorescence (XRF) spectroscopy. The alloy was consistent with a 6XXX series aluminum alloy with predominant additions of silicon, magnesium, and manganese. Hardness and electrical conductivity measurements were performed in accordance with Aerospace Material Specification (AMS) 2658 Hardness and Conductivity Inspection of Wrought Aluminum Alloy Parts. The average hardness was 57.4 Rockwell B Scale (HRB). Electrical conductivity was measured to be 44.5%

International Annealed Copper Standard (IACS) These results were consistent with a 6XXX series alloy in the heat treated condition.

3.0 Pitch Control Block

Both pieces of the white plastic pitch control block were recovered after the incident. The block was fractured into two pieces between the Blade 2 and 3 positions (**Figure 23**). The fracture surface exhibited radial marks, consistent with overstress, leading back to the cam follower slot for the Blade 2 position. Greasy witness marks were observed in the cam follower slot corresponding to the initiation point of the fracture. No other cracks were observed in the adjacent cam follower slots.

Submitted by:

Daniel Crecco
Materials Engineer



Figure 1. As-received photo of the AXSport propeller blades and hub assembly.



Figure 2. As-received photos of the three propeller blade assemblies. Blade 2 can be seen in the center with a fractured blade root at the point of the cartridge bearings.

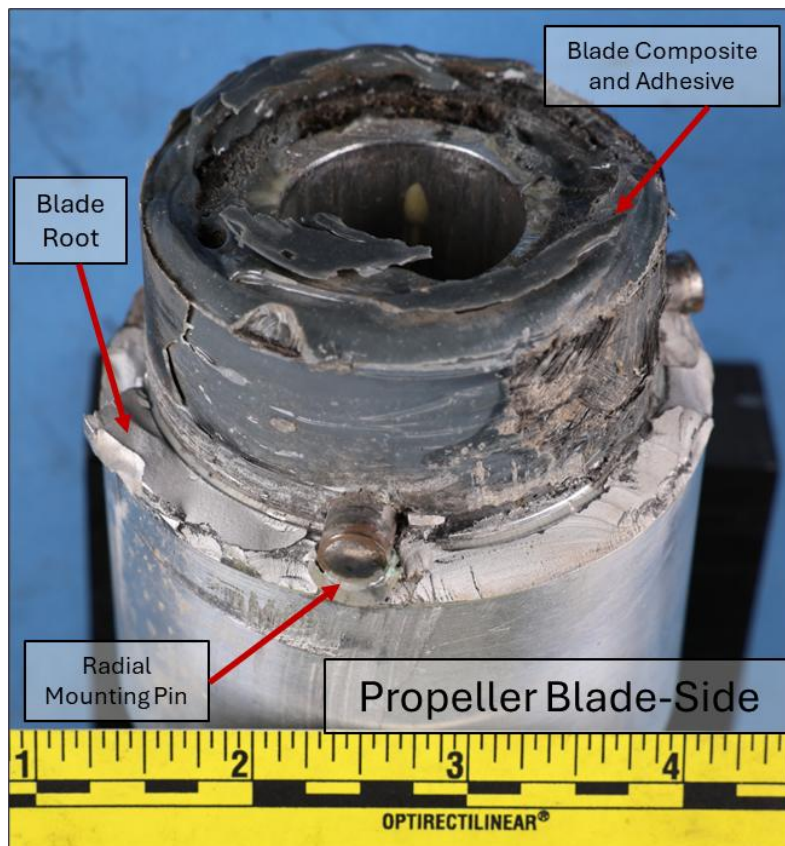
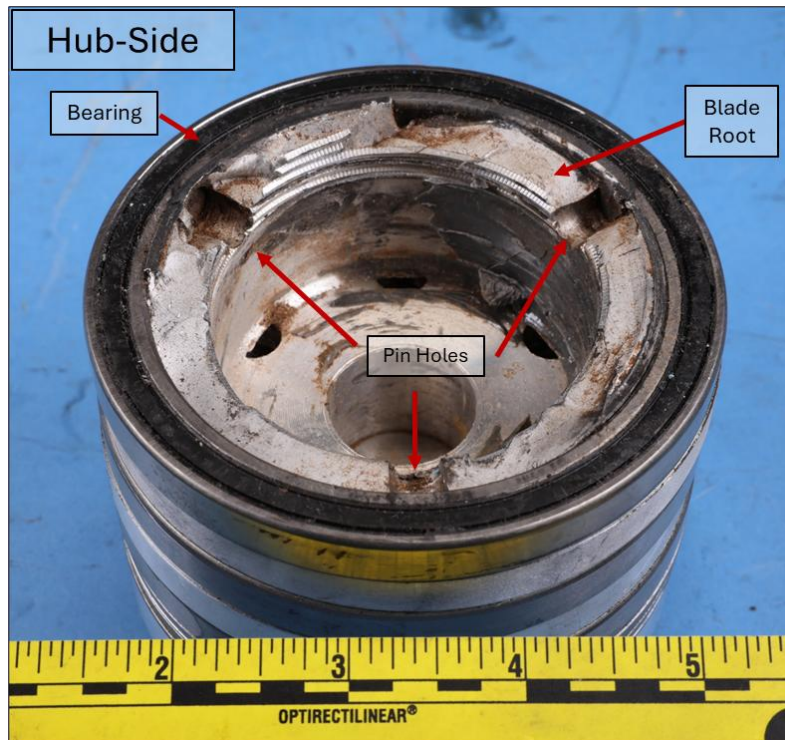


Figure 3. As-received photos of the Blade 2 blade root fracture sections.

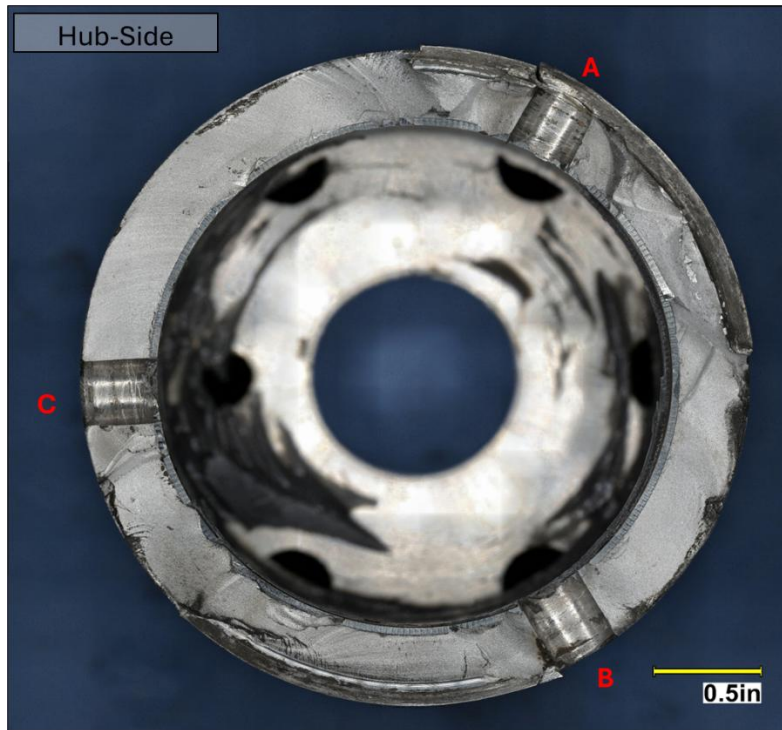


Figure 4. Digital Microscopic image (top) and photograph of the Blade 2 blade root fracture surfaces.

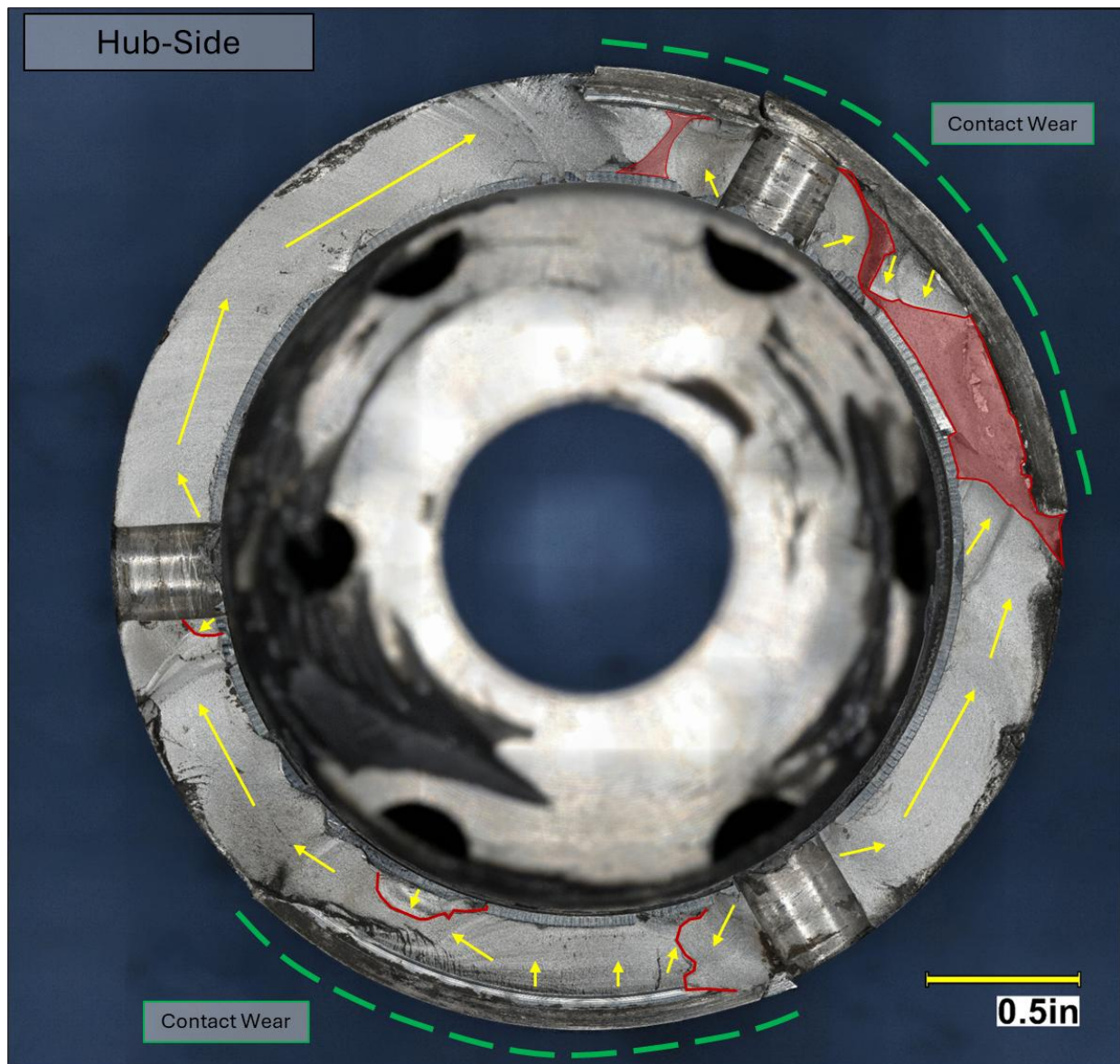


Figure 5. Annotated digital microscope image of the Blade 2 blade root fracture surface. Yellow arrows designate the fracture propagation direction and various additional fracture initiations. Red denotes fracture boundaries and regions of overstress. Green highlights regions where the fillet radius was still present and exhibiting aggressive contact wear.

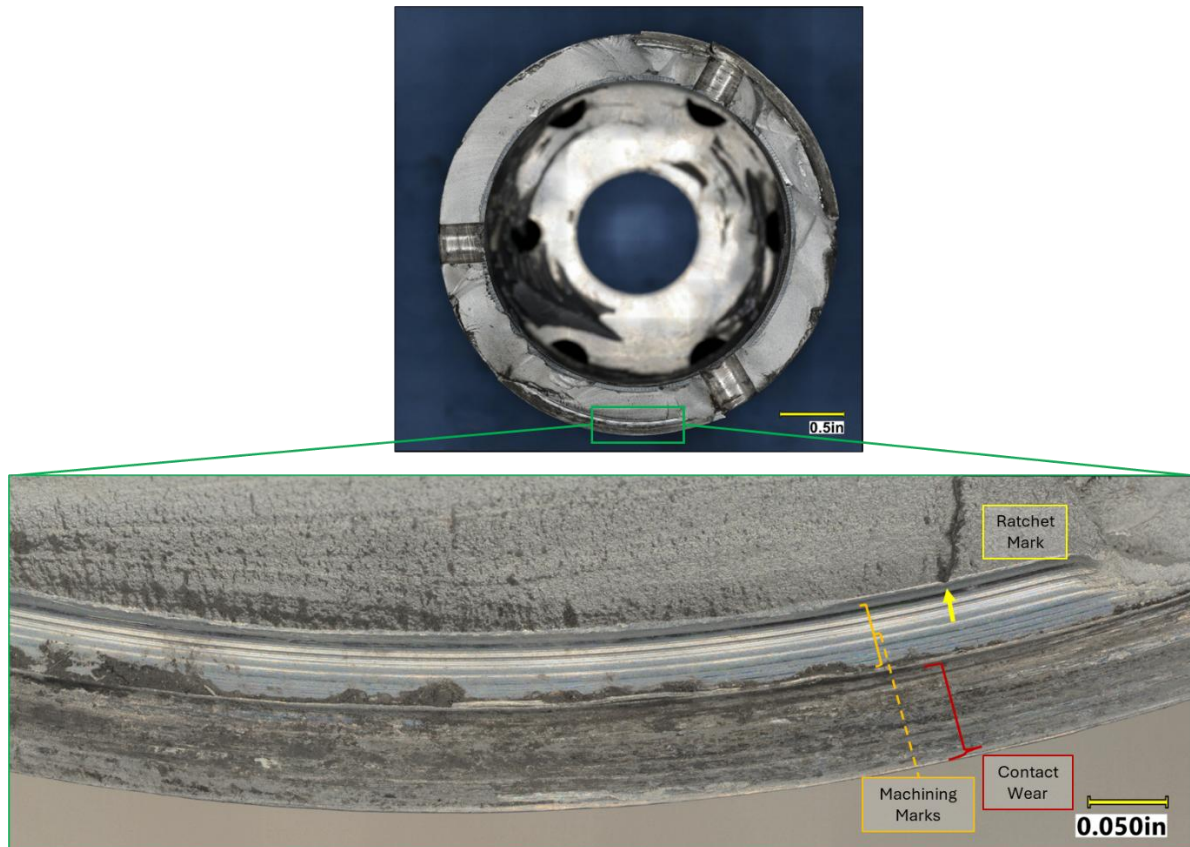


Figure 6. Digital microscopic images highlighting the contact wear adjacent to the fracture initiation point. Red denotes the contact wear exhibiting loss of material. Coarse machine marks were observed circumferentially around the blade root.

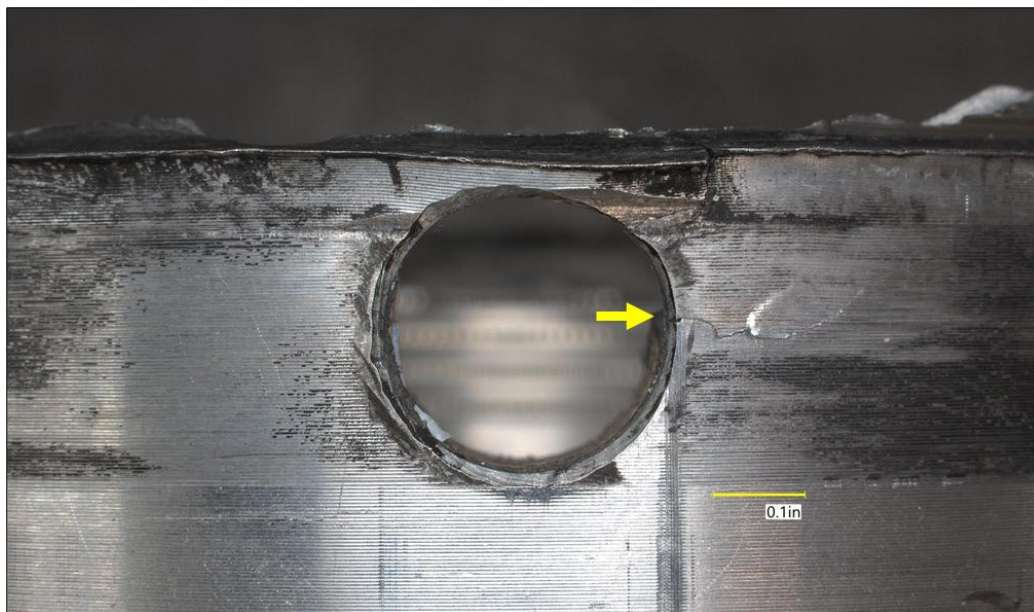


Figure 7. Digital microscopic image of a radial pin hole with bearing removed, exhibiting a crack emanating from the corner.



Figure 8. Witness marks indicating the cartridge bearing inner ring migrated during operation or failure.

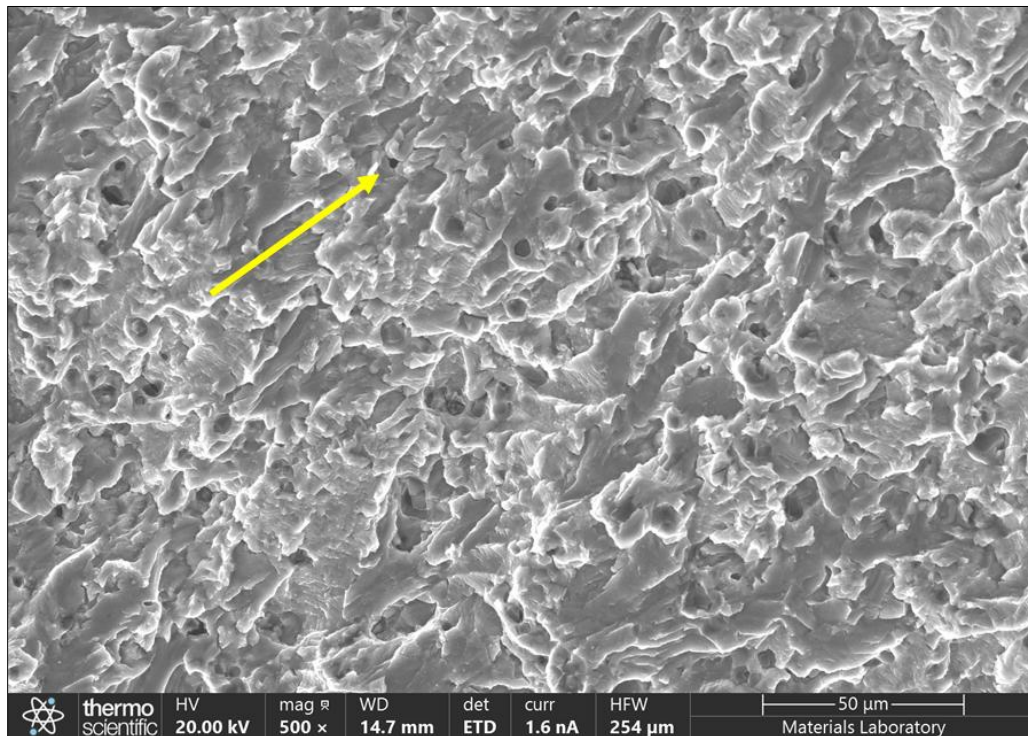
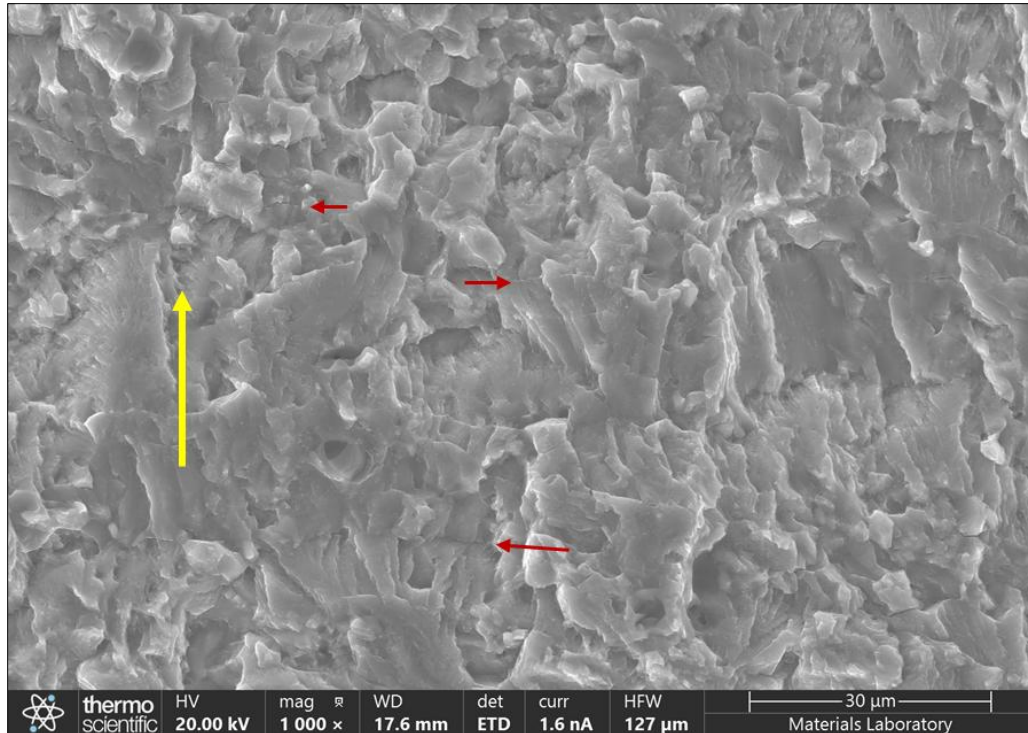


Figure 9. Scanning electron microscopic images of the blade root fracture surface exhibiting a feathery fracture progression and numerous tear ridges, consistent with high cycle fatigue in aluminum. Red arrows identify fine secondary cracking perpendicular to the propagation direction (yellow arrows).

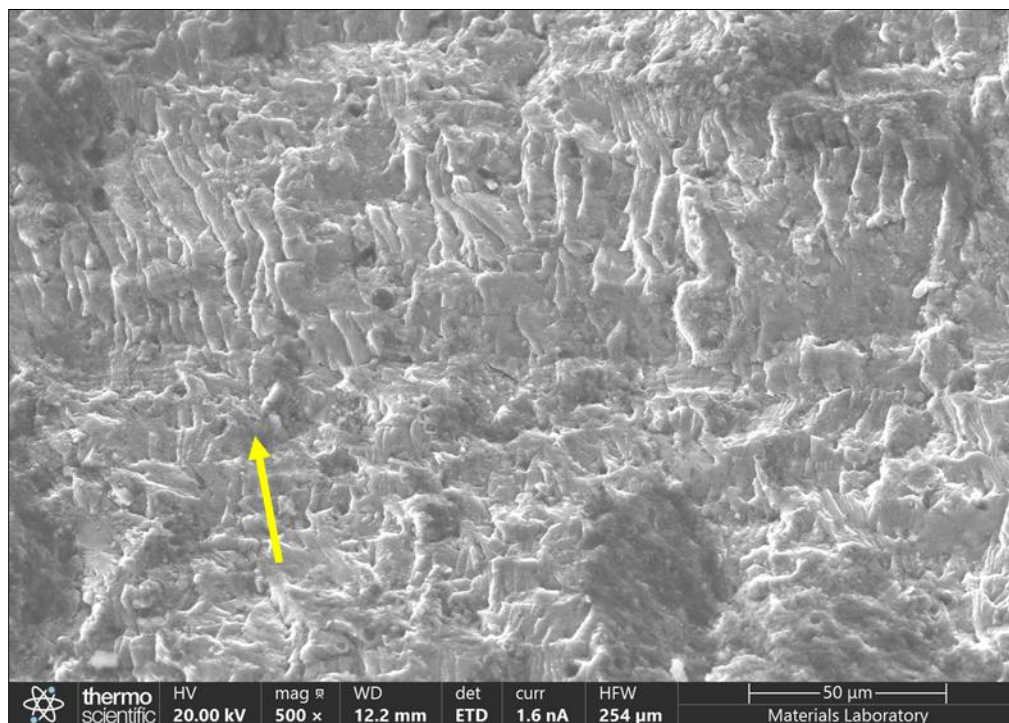
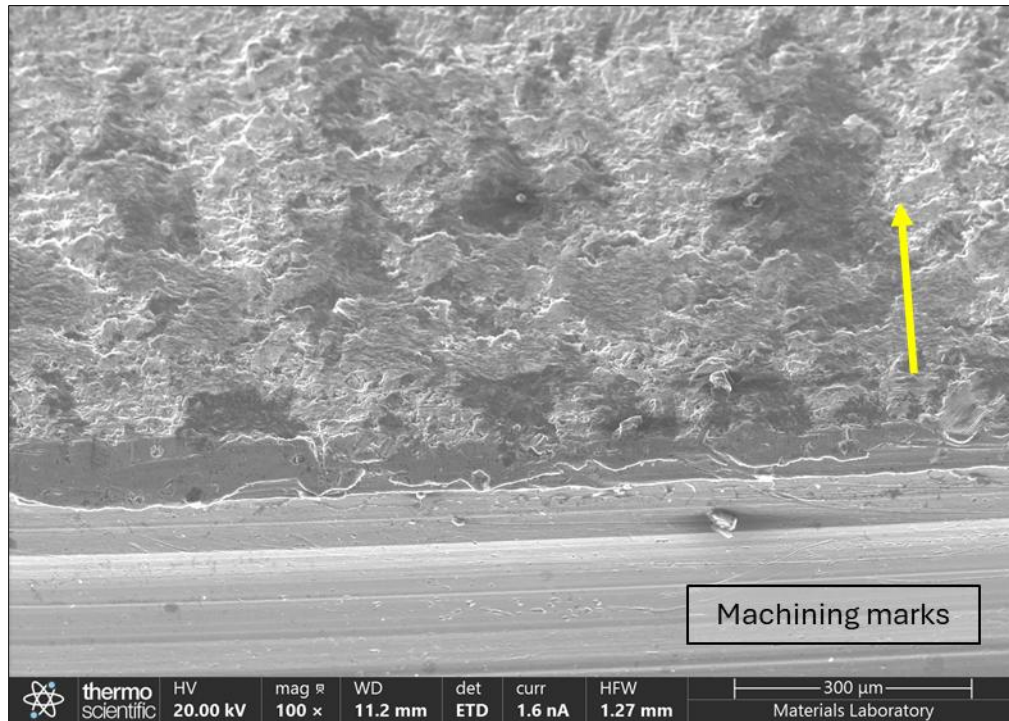


Figure 10. SEM images at the origin of the primary fracture. The crack appears to emanate from a single machining mark spanning the width of the region. Some of the origin sustained fracture rub. The direction of crack growth is indicated by yellow arrows.

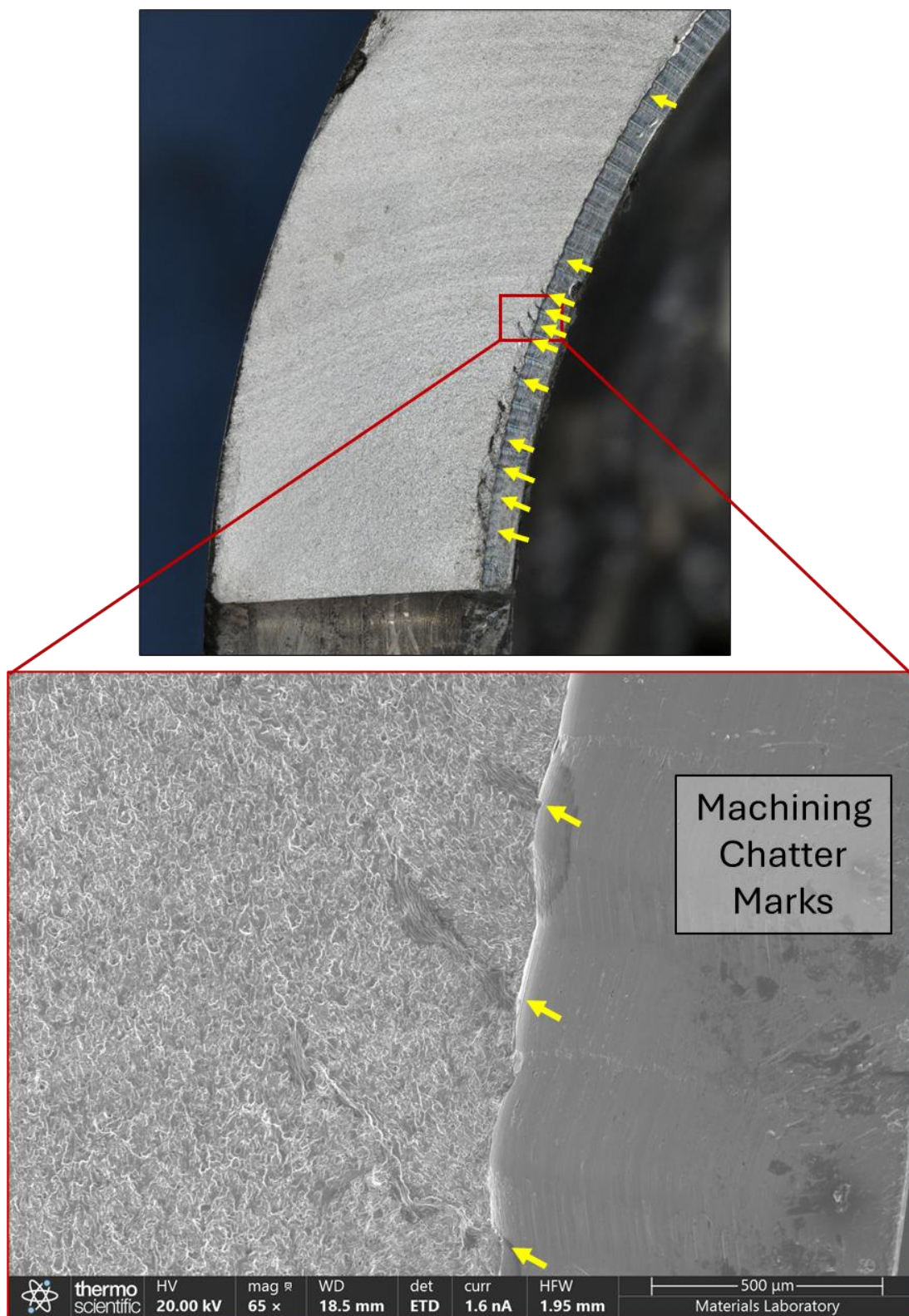


Figure 11. Ratchet marks observed mid-progression of the fracture. Scanning electron microscope images show they appear to emanate from chatter marks observed on the internal threads of the blade root. Yellow arrows indicate observed ratchet marks.

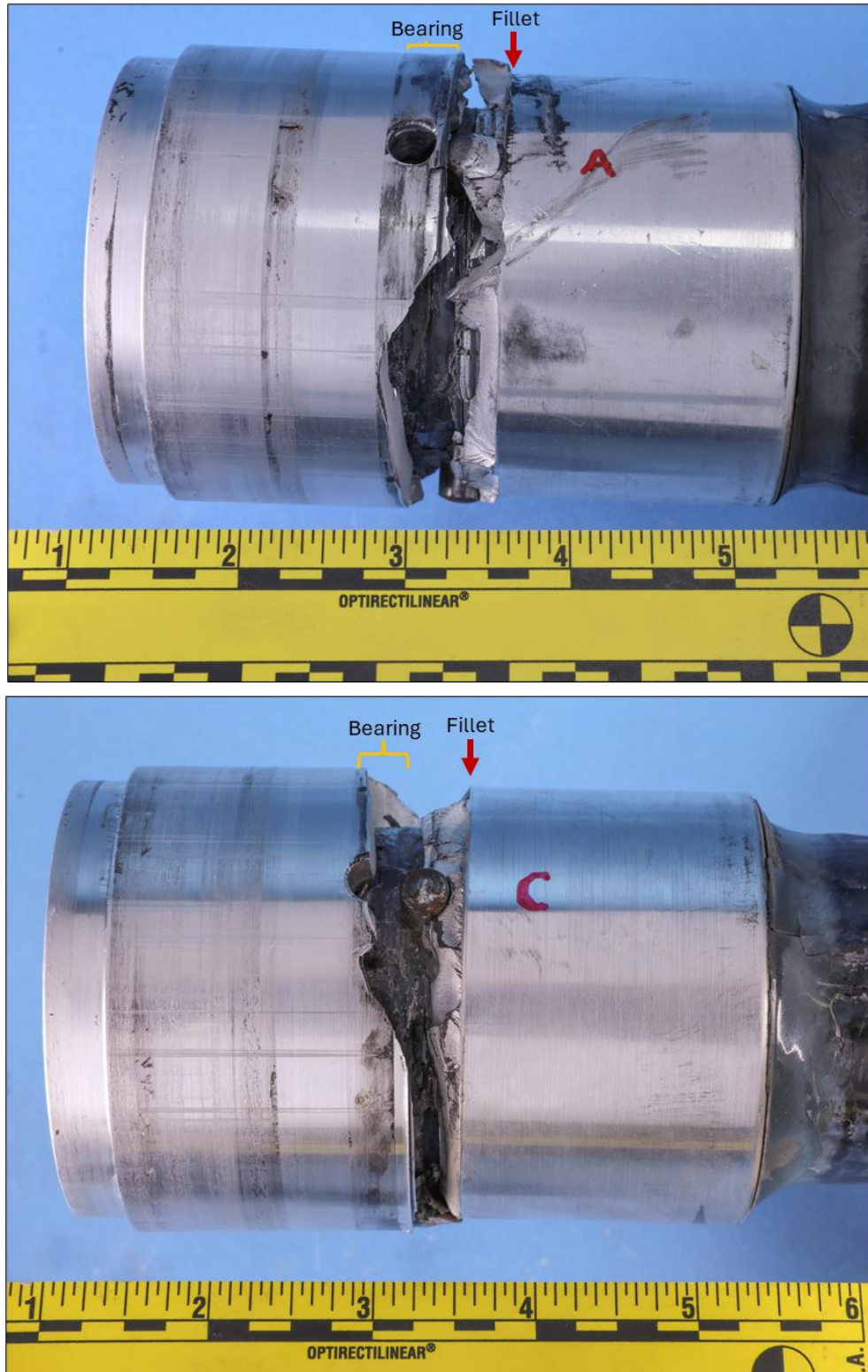


Figure 12. Assembled images of the Blade 2 blade root comparing fracture surface profiles, exhibiting missing sections along the cartridge bearing interface. A gap is present between the fitment to prevent the opposing fracture surfaces from contact and damage.



Figure 13. Digital microscopic image of the fretting corrosion and galling observed on the blade root underneath the top cartridge bearing. Vertical scratches observed are associated with lab disassembly and removal of the bearings.

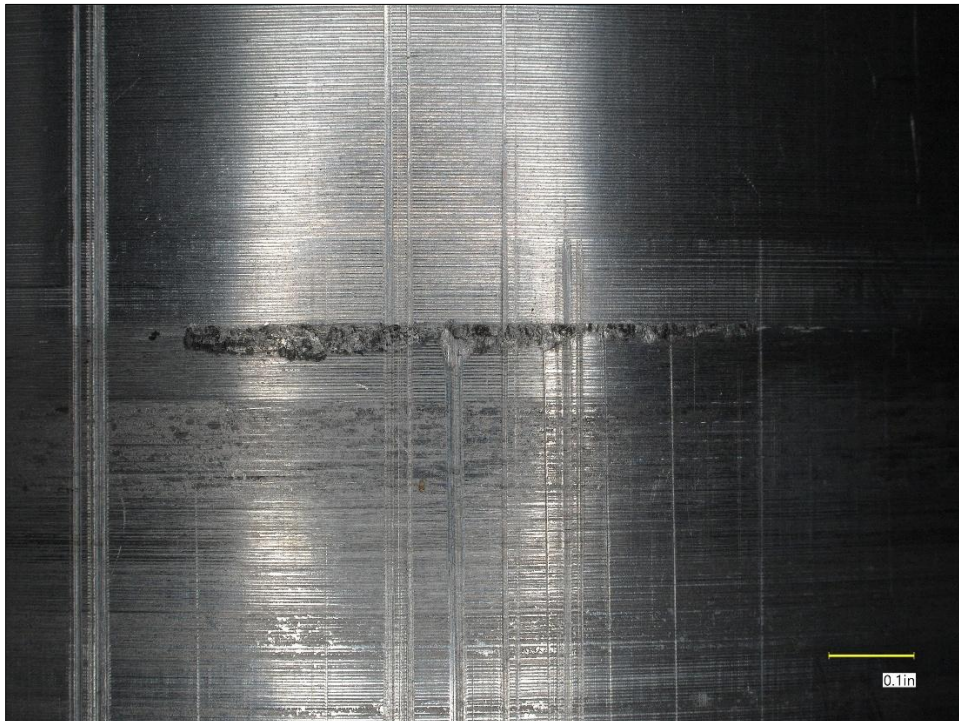


Figure 14. Digital microscopic image of the fretting corrosion and galling observed on the blade root underneath the middle cartridge bearing. Vertical scratches observed are associated with lab disassembly and removal of the bearings.

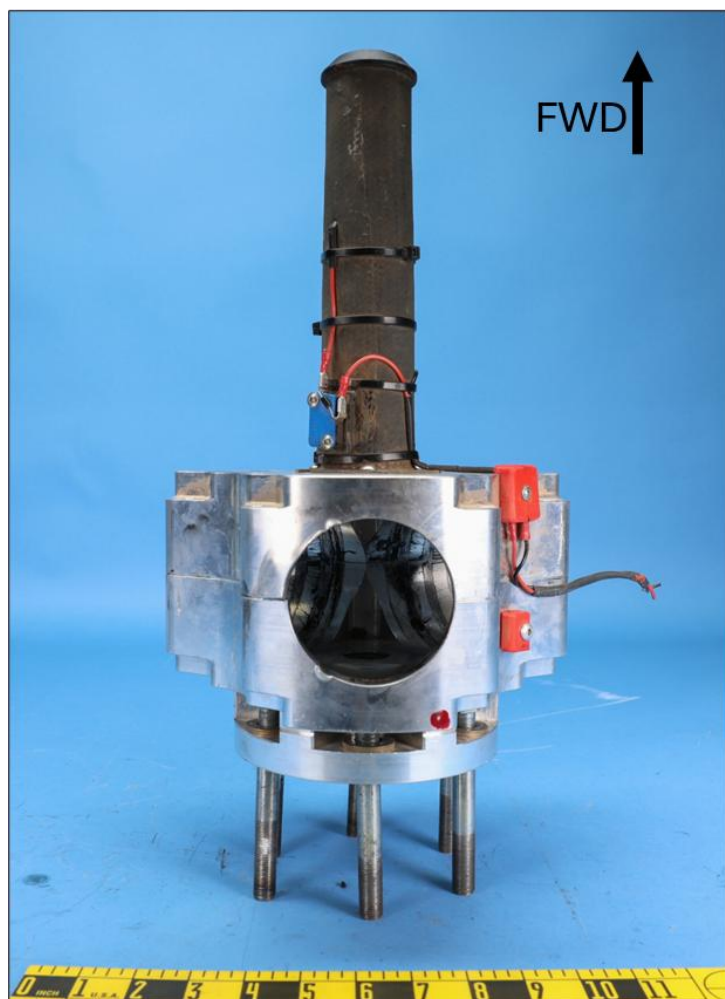


Figure 15. As-received photos of the hub assembly, both assembled (left) and separated into both half components (right).

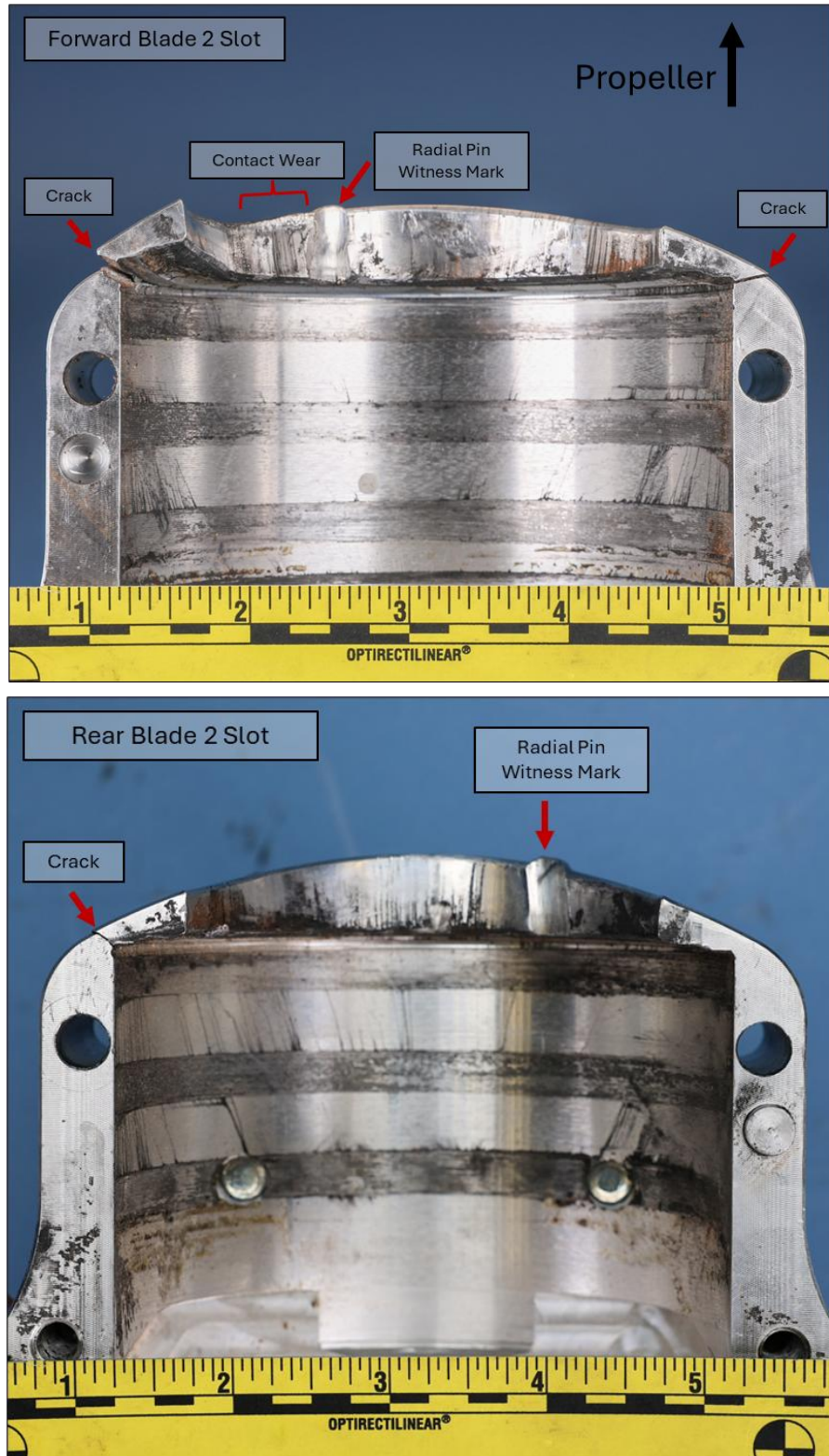


Figure 16. Annotated images of both shell halves of the Blade 2 slot., identifying cracks, contact wear, and radial pin witness marks that assisted in locating the final blade orientation.

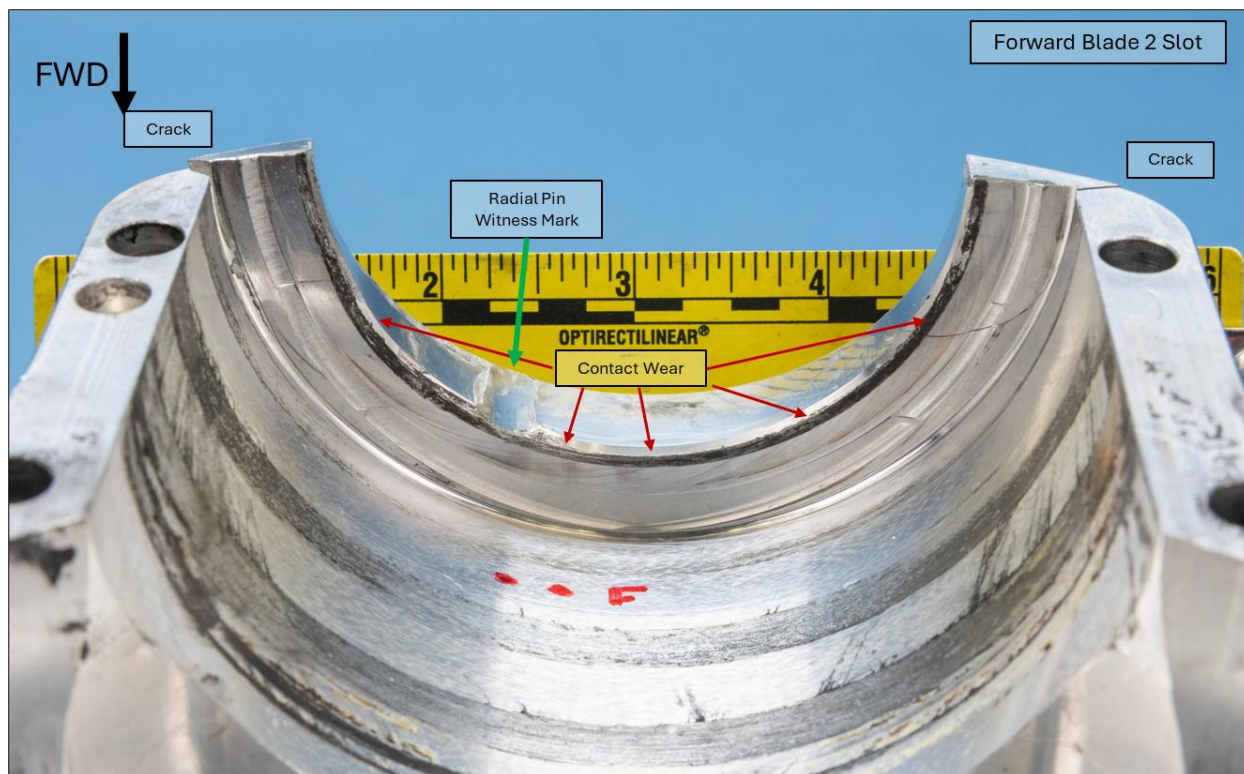


Figure 17. Radial view of the forward shell Blade 2 slot exhibiting the contact wear observed on the inner lip of the hub opening.

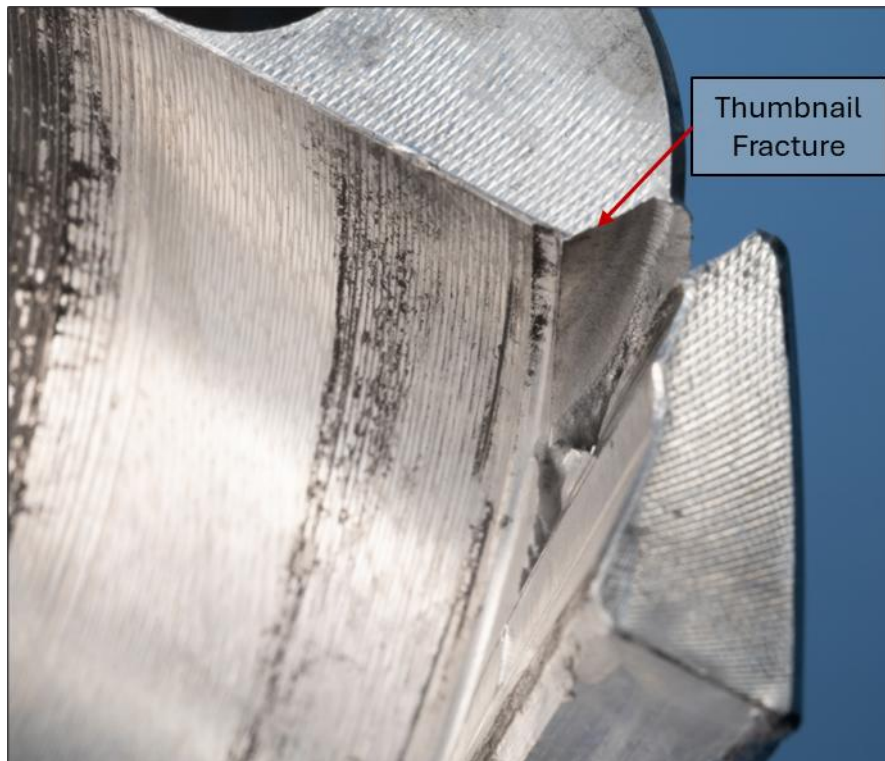


Figure 18. Detail images of a crack observed on the forward hub blade slot corners. While the bulk of the gross deformation likely occurred at the point of blade release, dark contact wear and the presence of a thumbnail crack emanating from the corner of the slot suggests a prolonged period of loading.

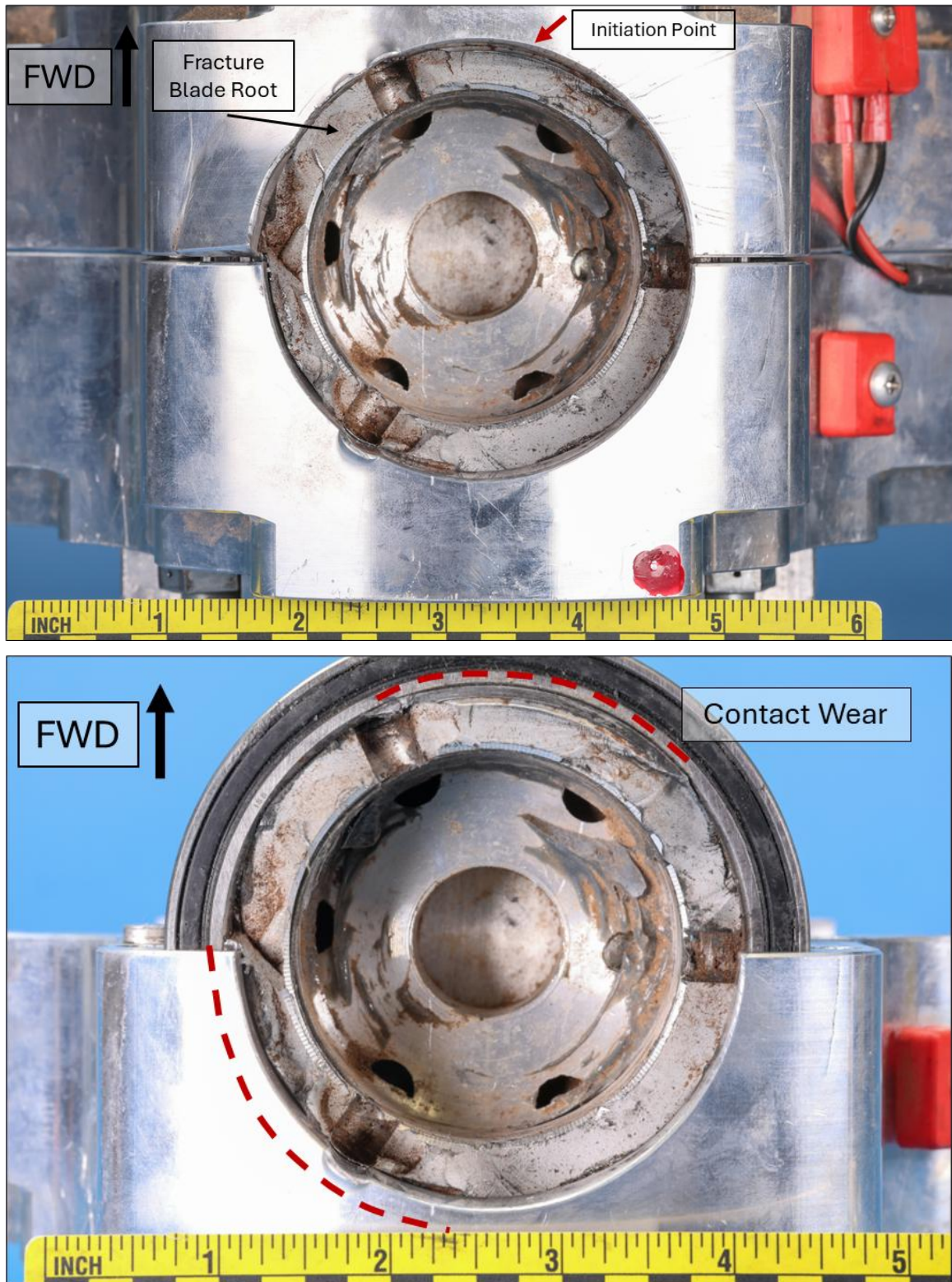


Figure 19. Annotated photographs of the propeller hub Blade 2 slot assembled with the bearing and fractured blade root. The fracture surface is oriented in the blade position at propeller liberation.

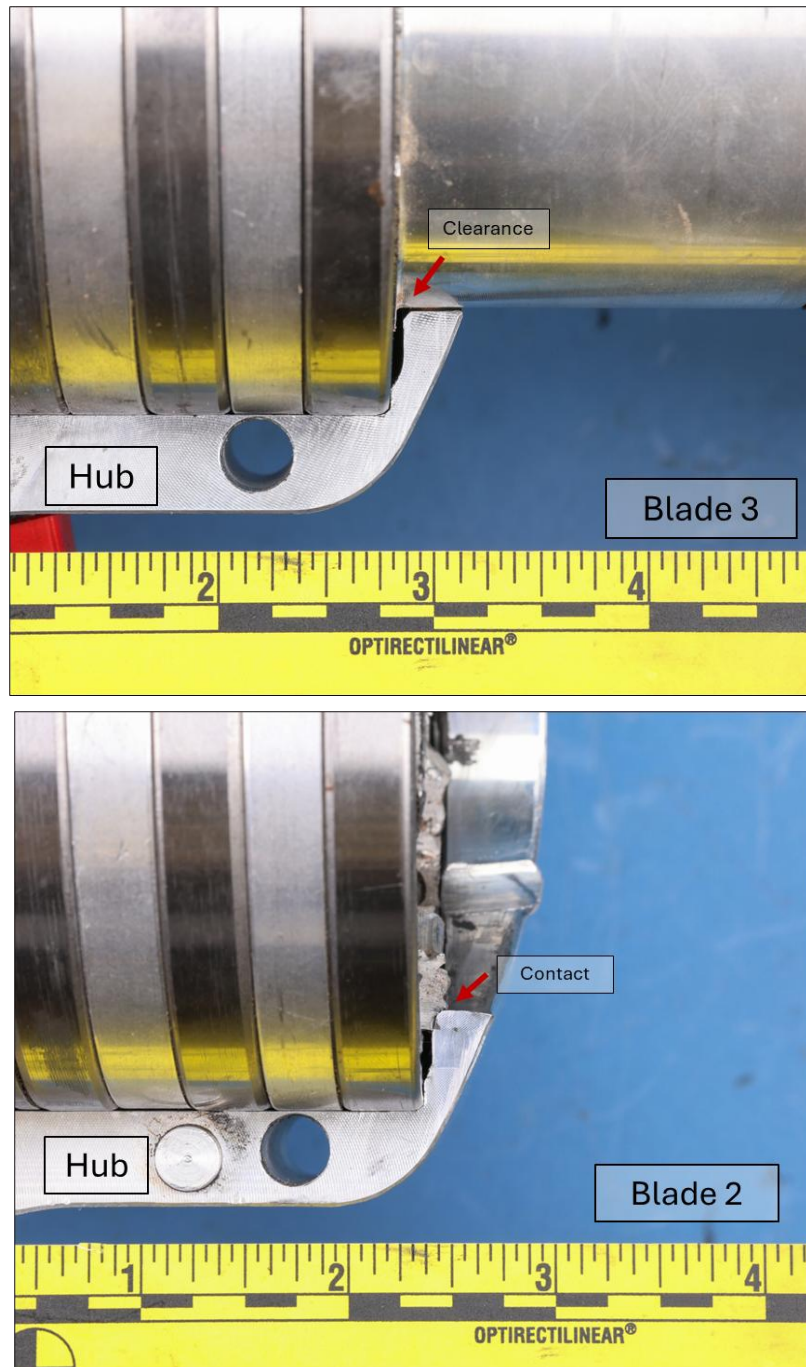


Figure 20. Comparison images of the Blade 3 (top) and Blade 2 (bottom) blade root bearing assemblies affixed within their respective slots. Clearance was observed between the hub opening and the blade root of Blade 3, allowing the Blade 3 pitch to rotate freely without contact. However, this clearance was not observed in the assembled Blade 2, allowing contact between the blade root and propeller hub opening. The contact surfaces corresponded with the aggressive wear observed on the remnants of the fillet surface observed on the fracture surface, as well as the wear observed on the inner lip of the hub opening.

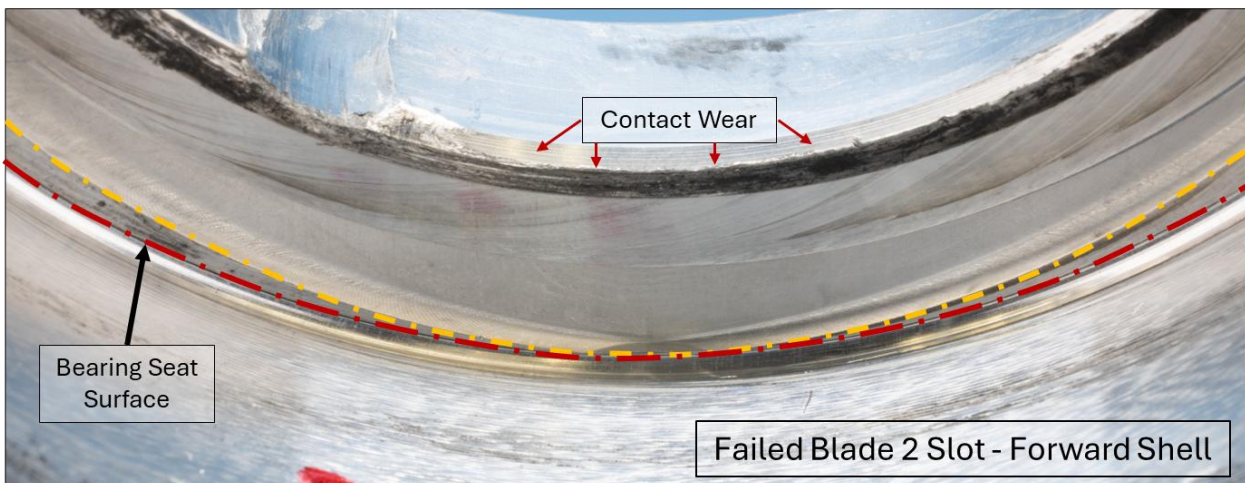
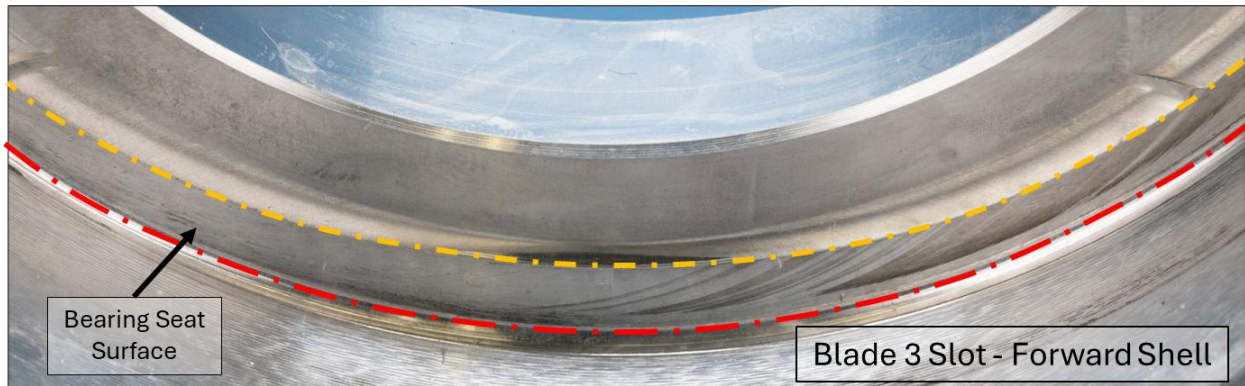


Figure 21. Annotated images of the inner lip surfaces of the forward shell Blade 2 and 3 slots. The bearing seat surface (contacting the top cartridge bearing) radial boundaries are identified via dashed lines, with the inner boundary denoted with orange and the outer with red. While both the Blade 3 and 1 forward slots exhibited a continuous flat seat surface, the Blade 2 seating surface disappears along the middle portion of the lip.

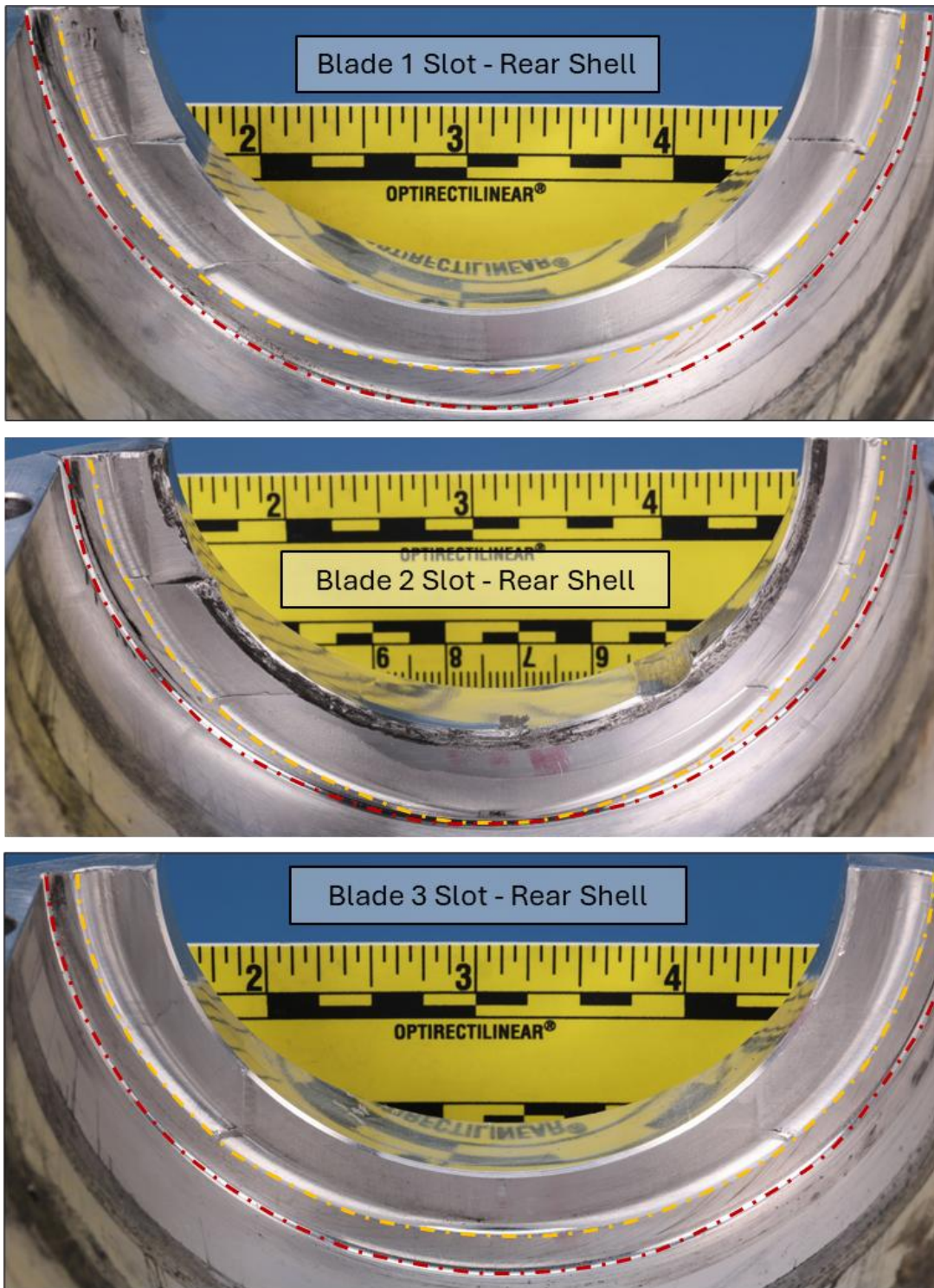


Figure 22. Annotated images of the inner lip surfaces of the rear shell for all three blades. Similar incongruities were observed between Blade 2, and Blades 1 & 3. Additionally, horizontally machined features were present on Blades 1 and 2 slots. Due to the rough and inconsistent appearance of these marks, it is unclear if these were intended features in the design.

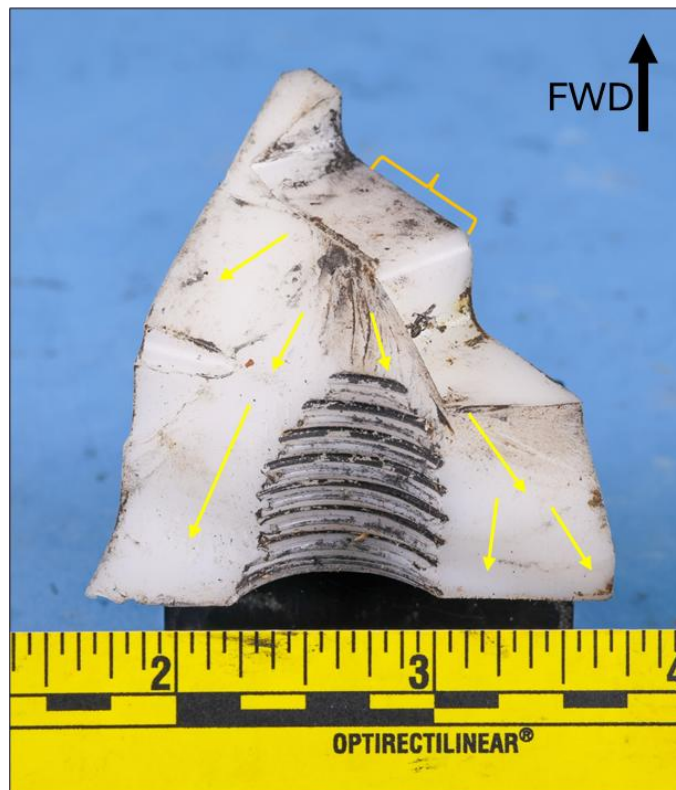
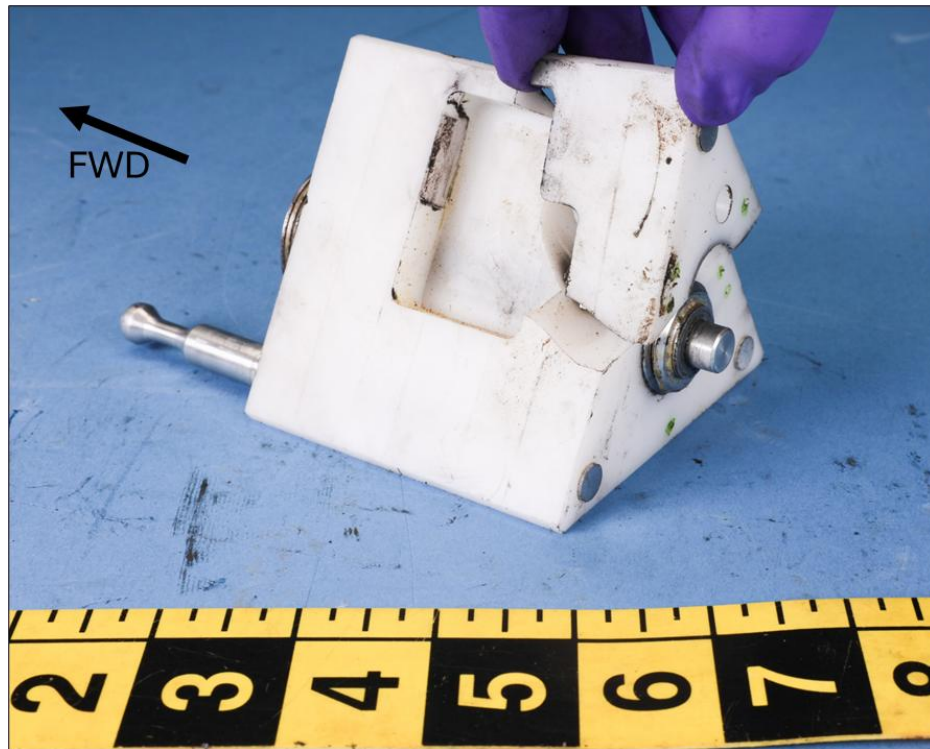


Figure 23. Photographic images of the fractured pitch change control block, with both pieces oriented (top) and the fracture surface annotated (bottom).