

NATIONAL TRANSPORTATION SAFETY BOARD

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



January 05, 2022

MATERIALS LABORATORY FACTUAL REPORT

Report No. 21-104

A. ACCIDENT INFORMATION

Place : Lumberton, Mississippi
Date : 03/14/2020
Vehicle : Cessna 182 (N20847)
NTSB No. : CEN20LA123
Investigator : Josh Lindberg

B. COMPONENTS EXAMINED

1. Portion of fractured number 1 cylinder intake valve. The number 1 cylinder was installed on 05/09/2014 as a repaired P/N 655469, S/N 17829-2 Eagle Engines FAA CRS NO3R717L for a Continental Motors O-470 series engine. The number 1 cylinder operated for 598 hours at the time of valve fracture.

C. DETAILS OF THE EXAMINATION

The as-received intake valve is shown in Figures 1 and 2. The images are annotated to identify key features of the valve. As indicated in the figures, a portion of the valve head is missing, consistent with the inward propagation of a radial rim fracture and the initiation and propagation of a chordal fracture in the fillet area perpendicular to the axis of the stem (see Figures 2b and 3). As documented in Figures 4-6, crack progression marks are indicative of fatigue crack propagation. The initial crack developed at the valve margin or rim (biased to the combustion face side) and propagated inward toward the center of the valve head as a radial rim crack and when the crack front reached the fillet region of the head, a second crack initiated and propagated in fatigue as a chordal fracture. As indicated in Figure 3, a final overstress fracture occurred near the valve's rim or margin.

The combustion face of the valve exhibited impact marks uniformly across the face. The edge of the fracture as it intersects the combustion face was damaged by impact along its entire length. Such impact damage is indicated in Figures 5 and 6 and precluded the documentation of the origin region for the radial rim fracture as indicated in Figure 6.

Adjacent to the keeper/collet groove, there are fretting wear scars (also known as chafe marks) around the circumference of the valve stem (See Figure 1 and 7). These scars or marks can be indicative of valve floating.

The tip of the valve (Figure 1) exhibited parallel grinding lines across the face and a faint radial wear pattern consistent with rotational contact with the rocker pad as documented in Figure 8.

The valve stem exhibited fine circumferential grind lines along the ground length (see Figure 1 and 9). A faint but defined polishing wear scar was observed as indicated in Figures 1 and 9. The length of the wear scar was approximately 0.42 inch (consistent with valve lift).

Images of the valve seal face or seat are shown in Figures 10 and 11. Impact marks and rim damage documented in Figure 10 are consistent with foreign object damage. A closer view of the seal face in Figure 11 reveals impact wear scars and deformed machining marks. No indications of seal face erosion were noted.

Michael Budinski
Chief, Materials Laboratory Division

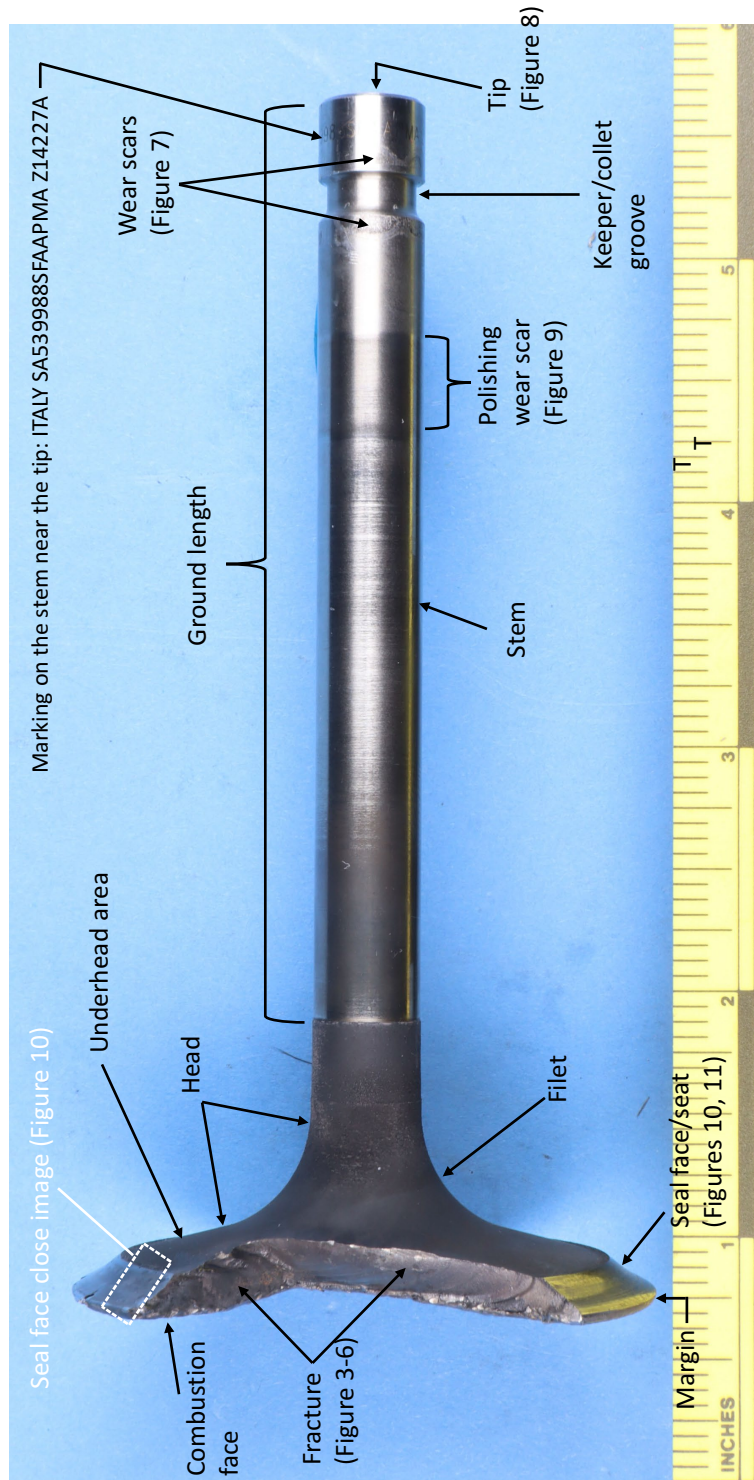


Figure 1 Side view of the fractured number 1 intake valve with key details annotated.

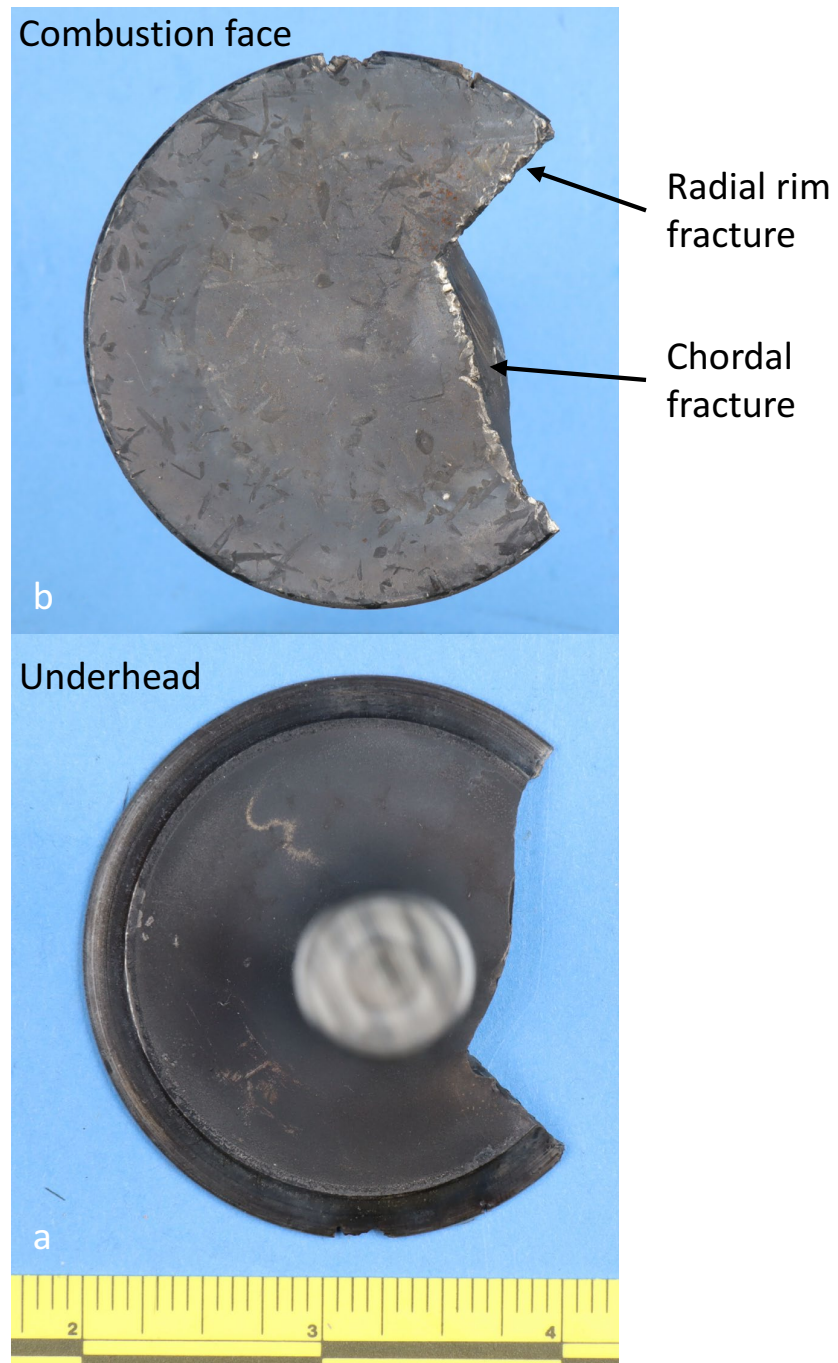


Figure 2 Views of the number 1 valve combustion face and underhead.

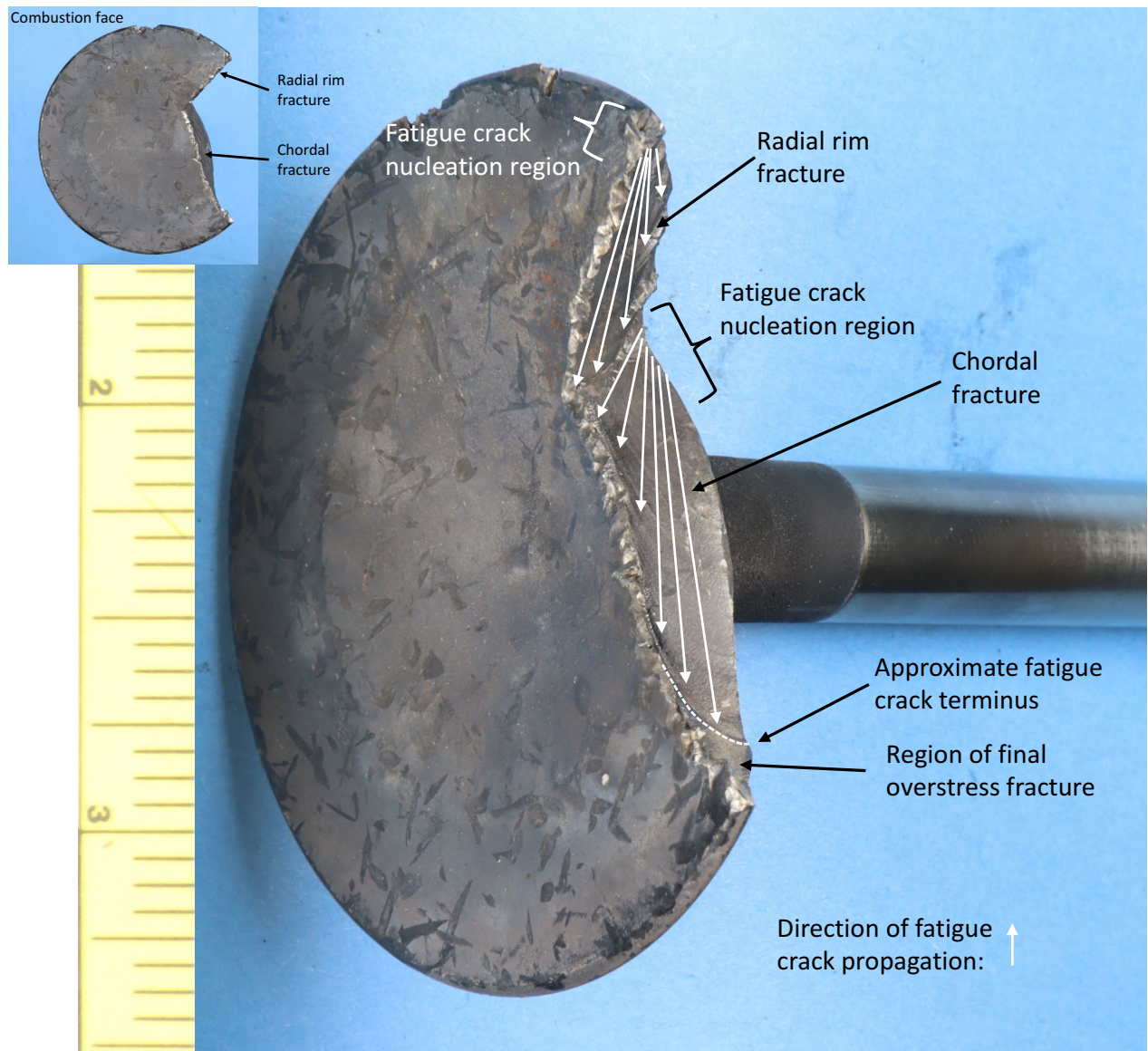


Figure 3 Oblique image of the number 1 intake valve head. The fracture initiation (nucleation) and crack propagation directions are annotated.



Figure 4 Overall digital microscope image of the number 1 intake valve fracture surfaces with the initiation or nucleation regions identified.

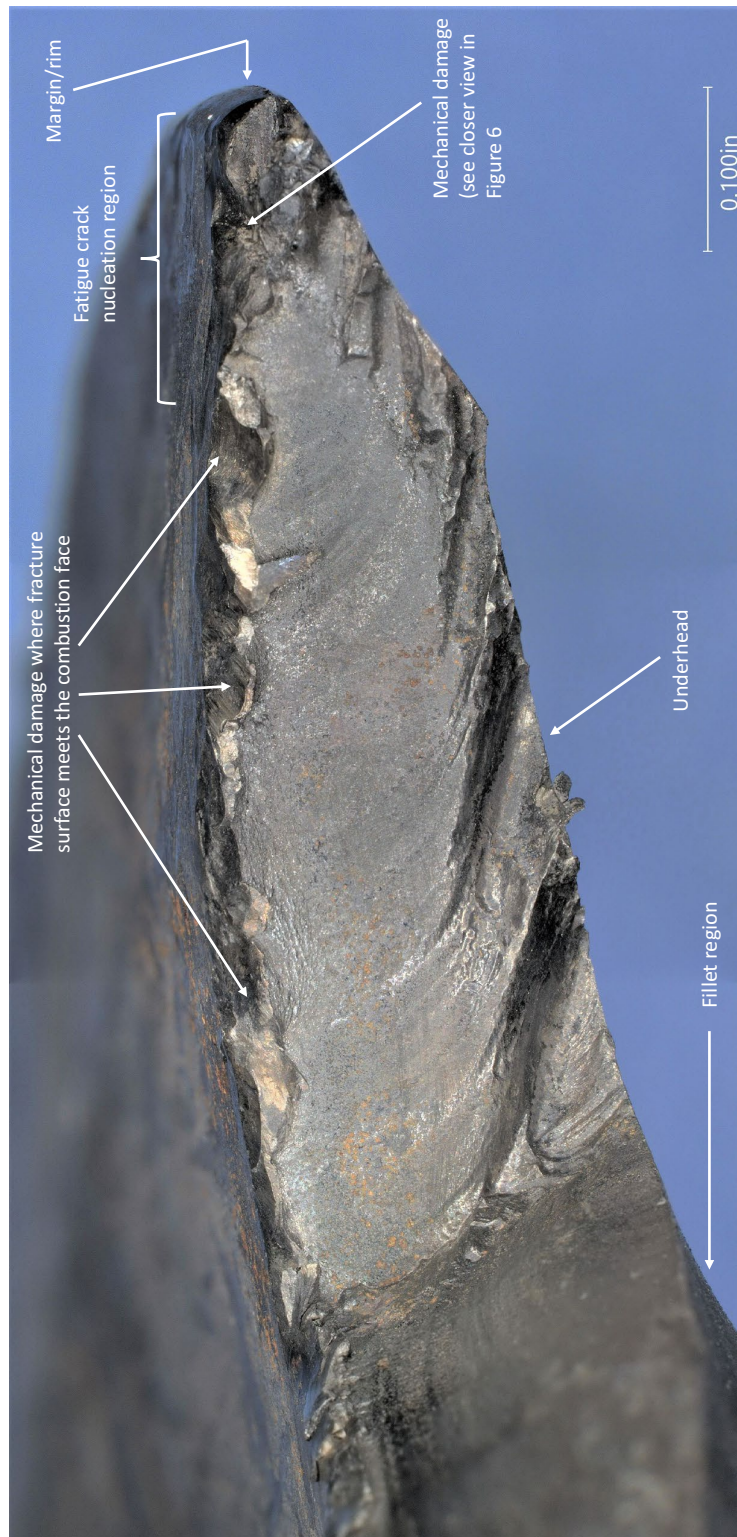


Figure 5 Digital microscope image of the fracture surface of the radial rim crack with key features annotated. Mechanical damage at the origin or nucleation region is noted.

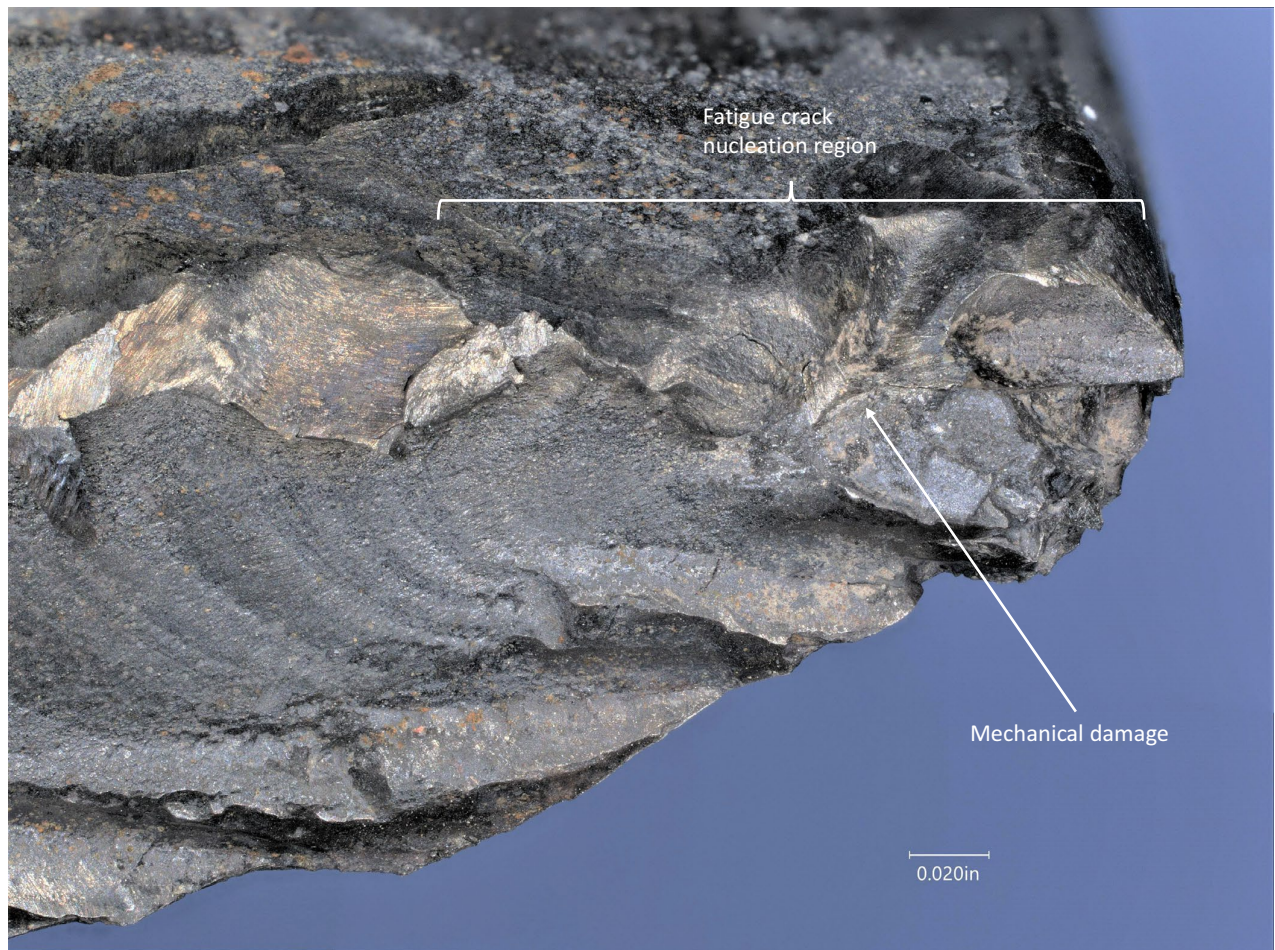


Figure 6 Close digital microscope image of the fracture origin or nucleation region of the radial rim crack. Mechanical damage obscures the fatigue crack origin area.

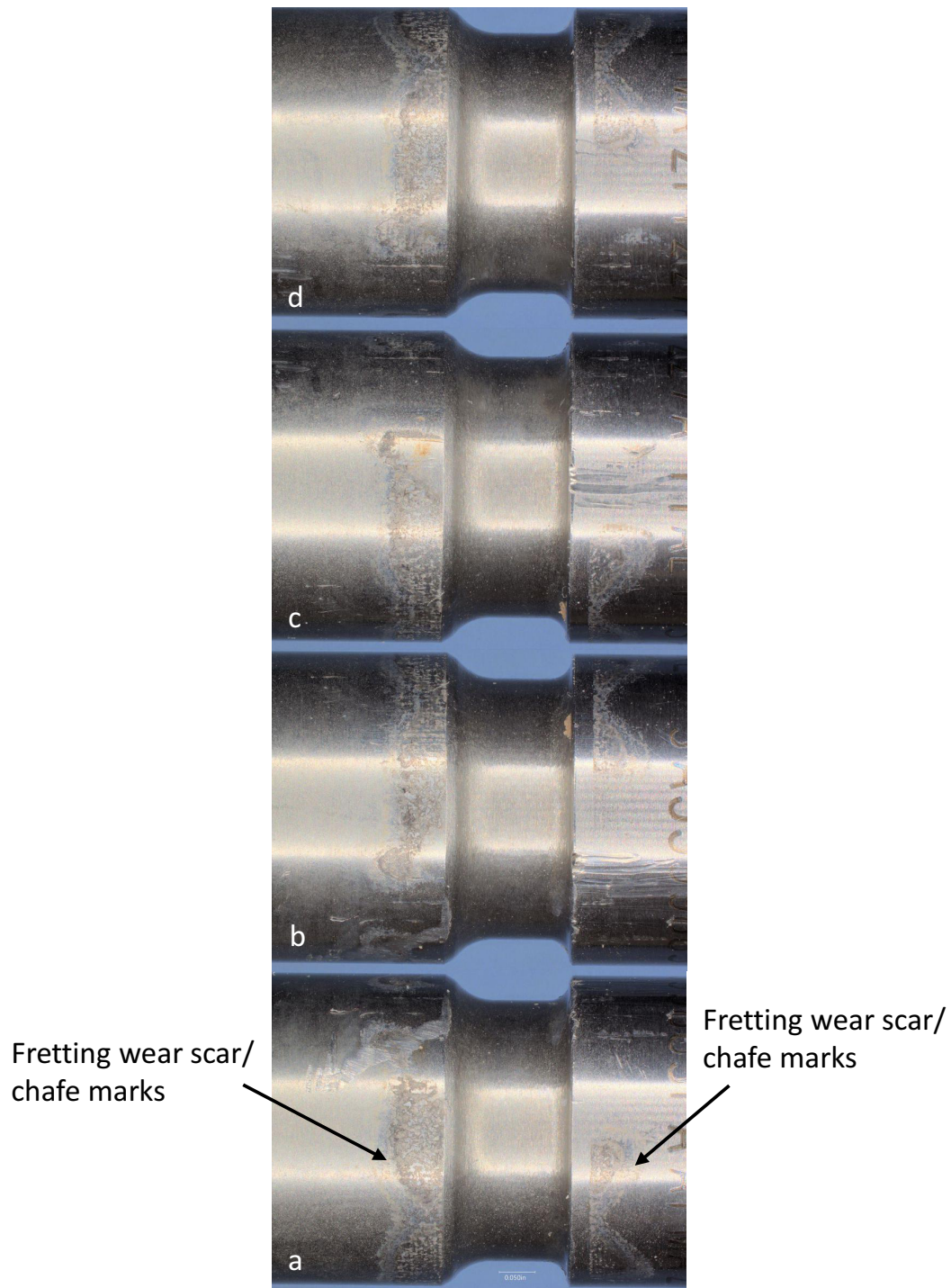


Figure 7 Images of the stem surface near the keeper groove showing fretting wear scars (or chafe marks). Views a-d were taken by digital microscope every 90°.

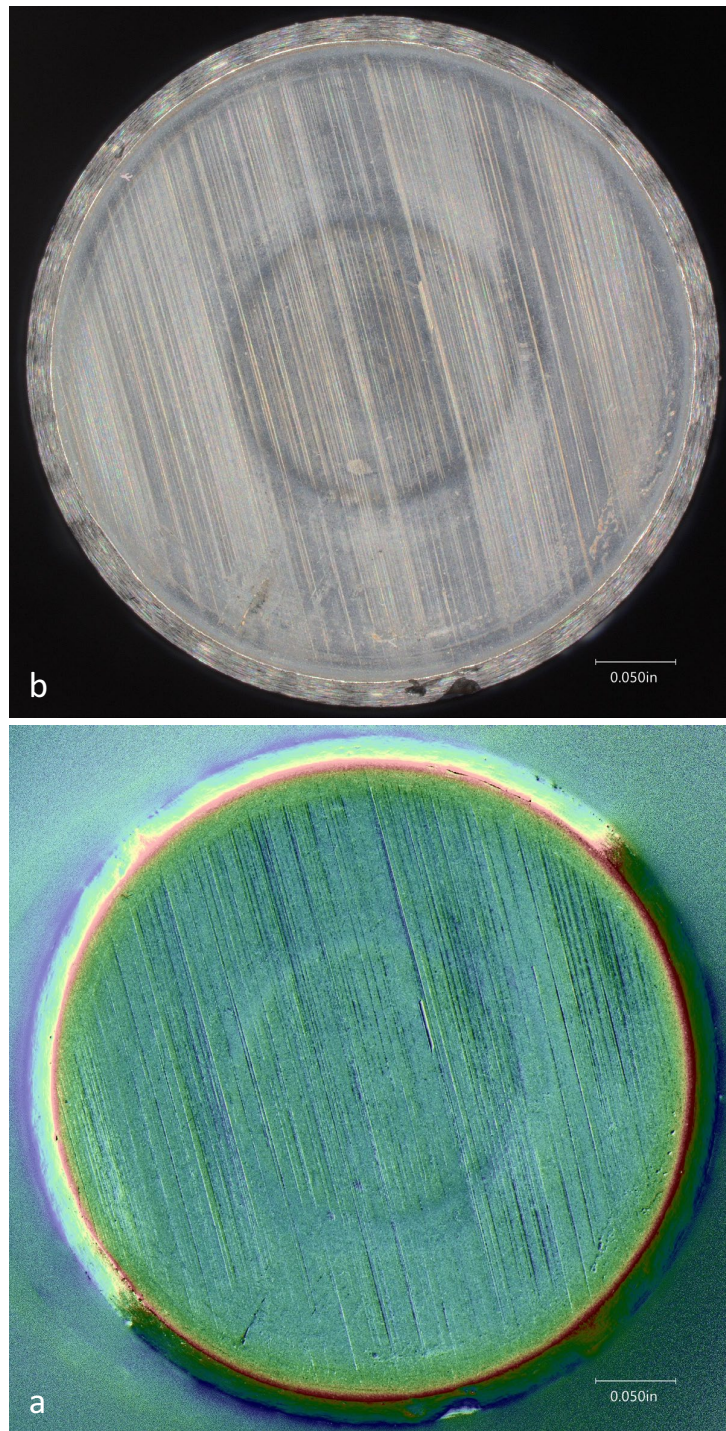


Figure 8 Digital microscope images of the valve stem tip. Parallel grinding lines and a faint circular impression are present.

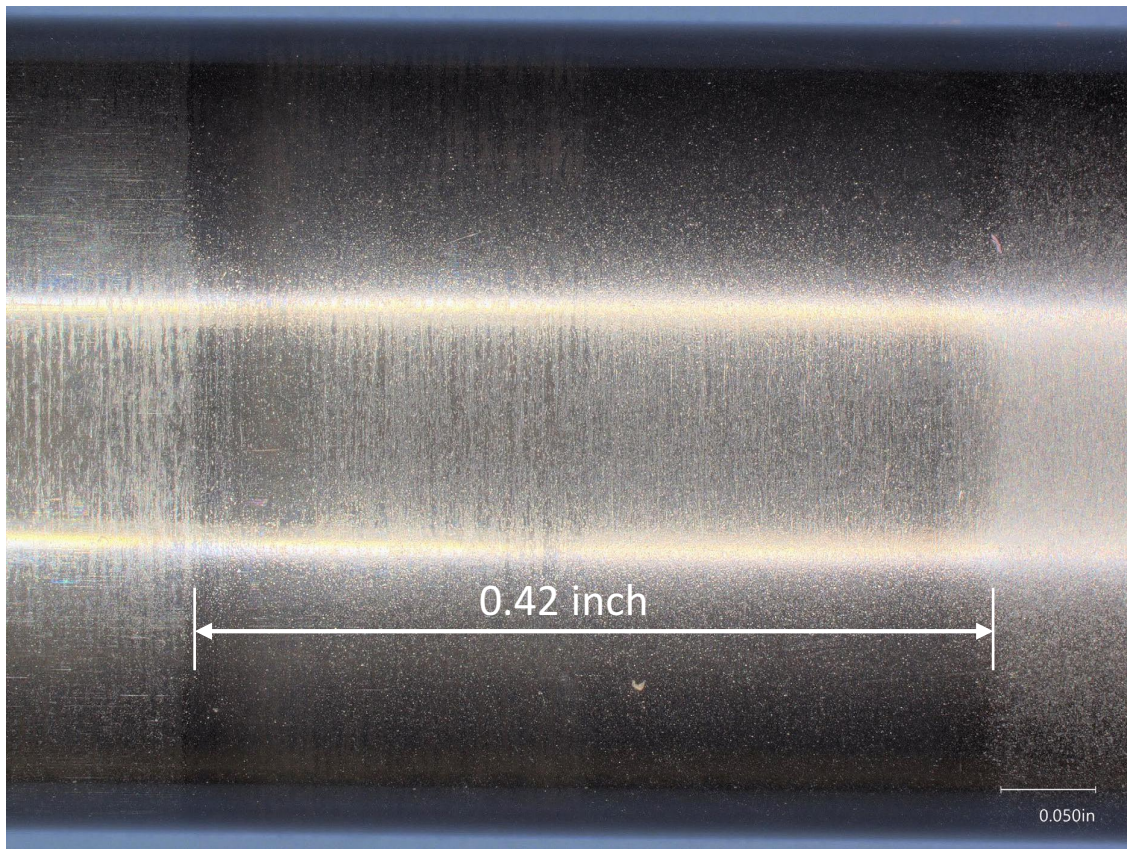


Figure 9 Digital microscope image of the outside surface of the stem in the vicinity of a 0.42 inch polishing wear scar (see Figure 1 for the location).



Figure 10 Digital microscope image of the seal face or seat of the valve near the origin of the radial rim crack.

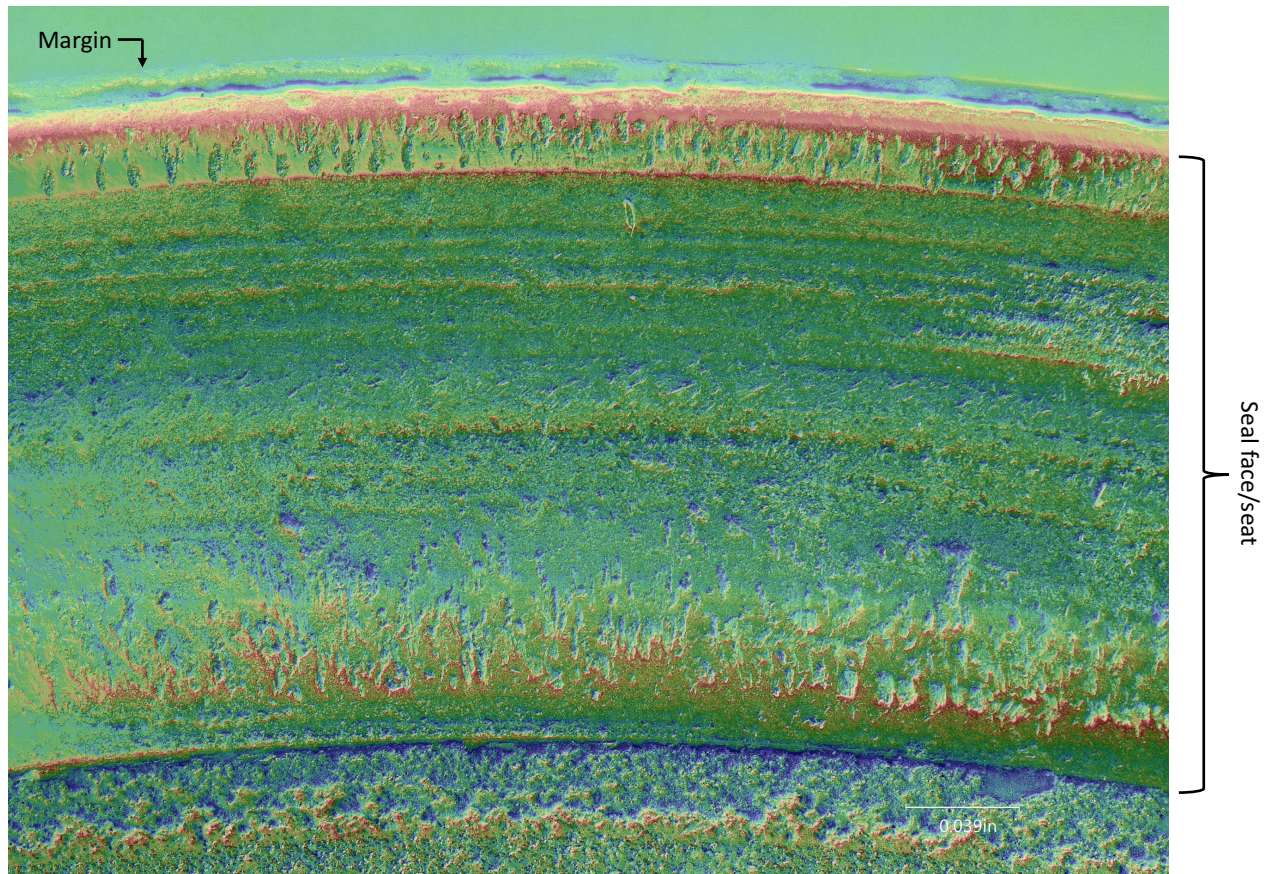


Figure 11 Digital microscope image of the valve seal face or seat approximately 90° from the radial rim crack. Shading and colorizing have been used to highlight the surface texture. This surface texture is representative of the remaining seal face present on the valve. No indications of erosion were observed.