

National Transportation Safety Board

Office of Research and Engineering

Washington, DC 20594



WPR22LA334

MATERIALS LABORATORY

Factual Report 23-106

December 29, 2023

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A. ACCIDENT INFORMATION

Location: Medicine Bow, Wyoming
Date: September 5, 2022
Vehicle: Long EZ
Investigator: Eleazar Nepomuceno (WPR)

B. COMPONENTS EXAMINED

Exhaust valve that fractured at the stem, rocker arm, inner and outer valve springs from the #4 cylinder of a Lycoming O-235 series engine.

C. EXAMINATION PARTICIPANTS

Senior Metallurgist Frank Zakar
 NTSB
 Washington, DC

D. DETAILS OF THE EXAMINATION

Figure 1 shows an overall view of the as-received exhaust valve that fractured at the stem, rocker arm, two particles that were not labeled, and inner and outer valve springs. The fractured stem segment at the rocker arm end was not submitted. The as-received parts were covered with oil and at the NTSB Materials Laboratory were ultrasonic cleaned with a solution of Alconox, a commercial detergent. The rocker arm contained evidence of contact wear at the pad and the valve springs showed no evidence of mechanical damage or a crack.

Bench binocular microscope examination of the exhaust valve revealed the outer surface of the stem in the area that extended between the fracture and an area located approximately 0.3 inch from the fracture contained corrosion damage (see figure 2). The corrosion extended round the circumference of the stem. Detailed examination of the fracture face revealed evidence of severe oxidation damage that obliterated the fine fracture features. However, the fracture face in several isolated areas showed evidence of fatigue striations that emanated from severe corrosion pits at the outer surface of the stem in the area indicated by a bracket "O" in figures 3 through 5. The arrows in figures 3 through 5 indicate the general direction of fracture propagation. The terminus of the fatigue crack was not determined because of the severe oxidation damage on the fracture face.

The two unlabeled particles were examined with bench binocular microscope. The length of the largest particle measured as long as 0.3 inch. Both particles were covered with black soot. The fracture face of the largest particle at the core area exhibited a luster-green (jade) like color. The particles were not attracted to a magnet (consistent with nonferrous metal). The fracture face of the largest particle was

analyzed with a handheld Olympus Vanta, Series C, handheld XRF alloy analyzer. The alloy analyzer indicated the material contained 30.5% lead, 24.7% aluminum, 12.8% copper, 11.9% cadmium, 10.3% magnesium, 3.33% silicon, 3.09% bismuth, 1.52% phosphorus, 1.44% iron, 0.26% chromium, and 0.205% zinc.

Submitted by:

Frank Zakar
Sr. Metallurgist

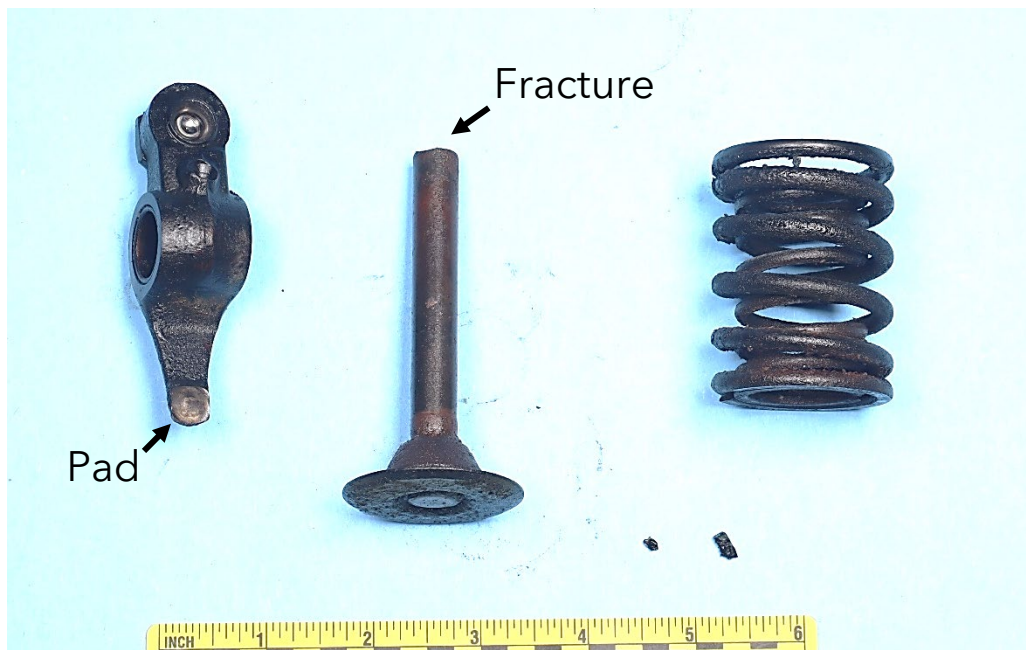


Figure 1. As-received rocker arm, exhaust valve that fractured at the stem, two particles that were not labeled, inner and outer valve springs (left to right).



Figure 2. Side view of the fractured valve stem, after cleaning.

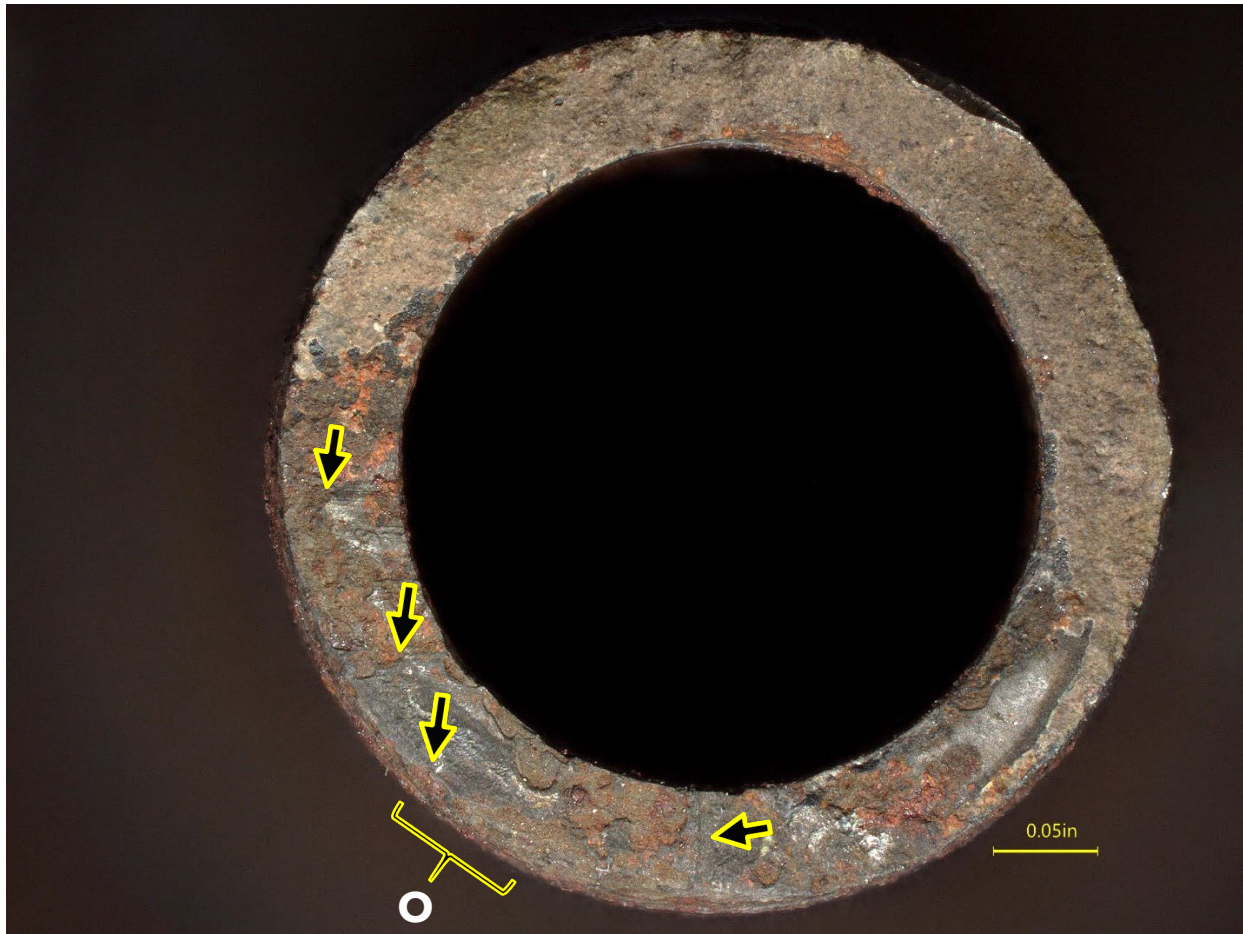


Figure 3. Optical image of the fracture face from the fractured valve stem, showing the origin of the fatigue crack, indicated by bracket "O", after cleaning.

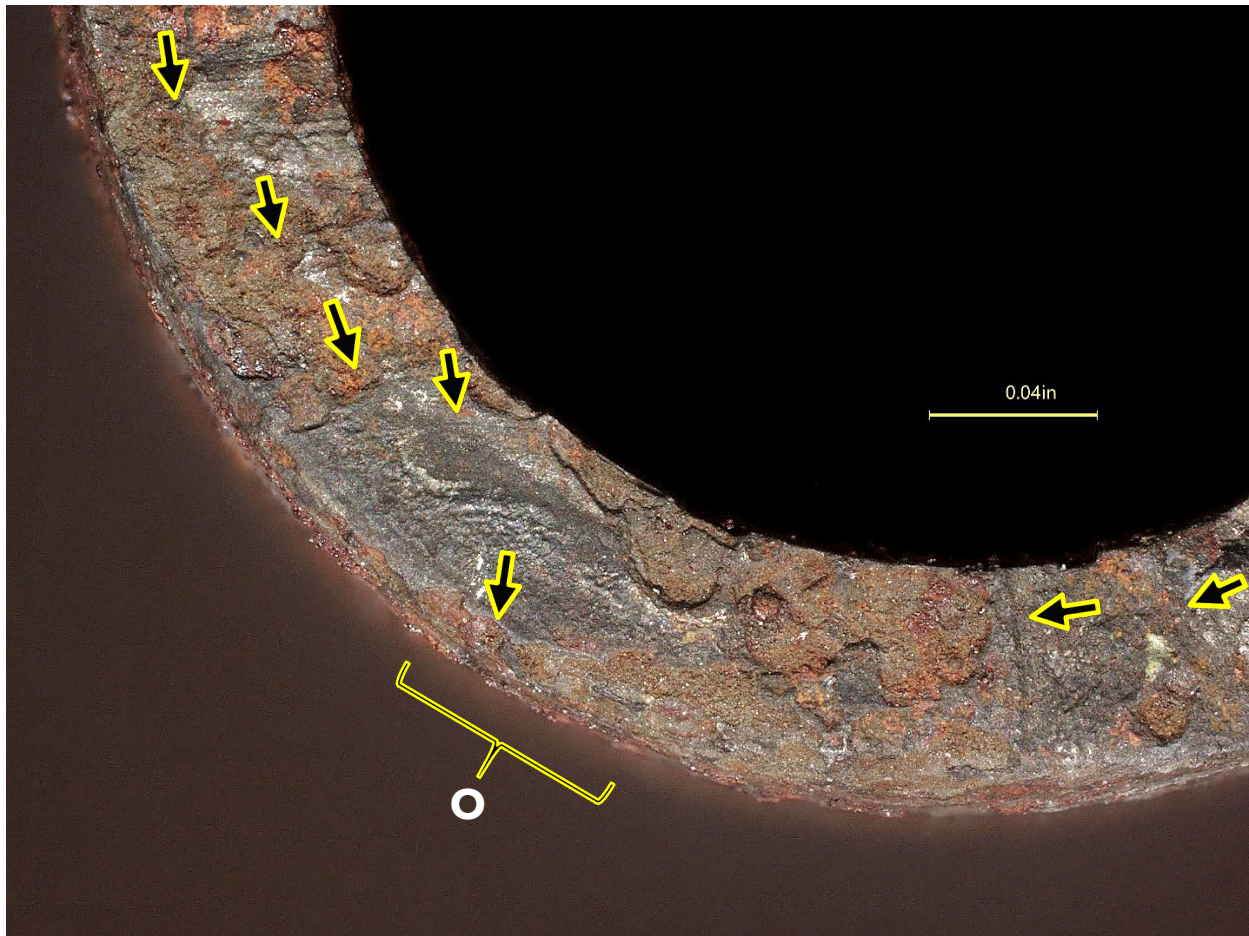


Figure 4. Higher magnification view of the fracture face from the fractured valve stem showing the origin of the fatigue crack, indicated by bracket "O", after cleaning.

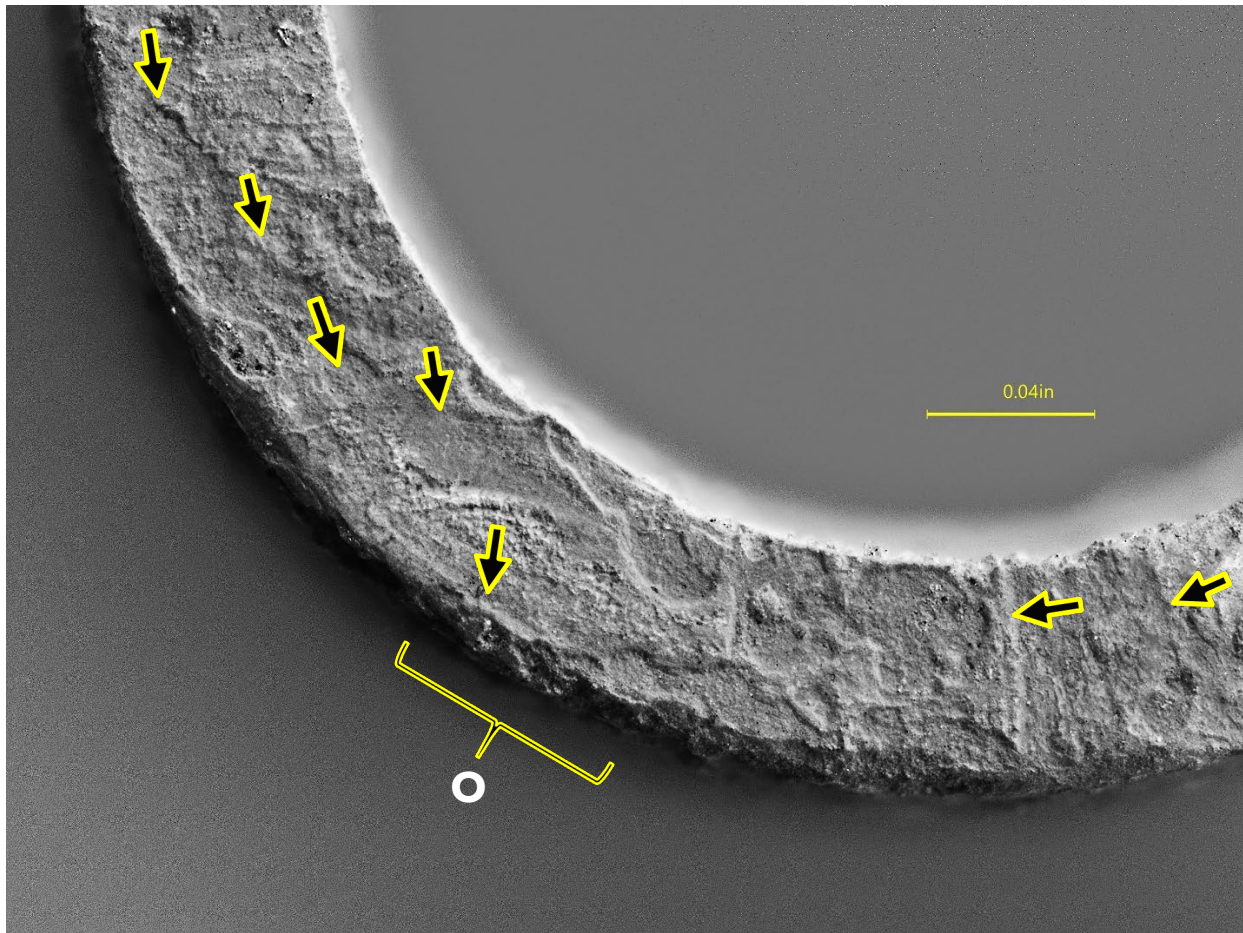


Figure 5. Same location as in figure 4 except using side lighting to make uneven contours stand out (increases elevational contrasts). The image is presented in grey scale.