

National Transportation Safety Board

Office of Research and Engineering

Washington, DC 20594



CEN24LA079

MATERIALS LABORATORY

Factual Report 25-031

May 21, 2025

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A. ACCIDENT INFORMATION

Location: Davenport, Iowa
Date: December 31, 2023
Vehicle: Cirrus Design Corp SR22T, N773GB
Investigator: John Brannen, AS-CEN

B. COMPONENTS EXAMINED

Cylinder assembly with fractured exhaust rocker box ear from a Continental Aerospace Technologies TSIO550K2B engine; Cylinder P/N: 658595; Cylinder S/N: AC17AB774; Time since new: 1210.7 hours.

Two additional cylinder assemblies from other aircraft; P/N: 658595:
One cylinder assembly with fractured exhaust ear: S/N: AC16KA158
One cylinder assembly with cracked ear: S/N: AC17CB527

C. EXAMINATION PARTICIPANTS

Specialist Donald Kramer, Ph.D.
National Transportation Safety Board
Washington, DC

D. DETAILS OF THE EXAMINATION

A cylinder assembly with a fractured exhaust rocker box ear from the accident aircraft was submitted to the NTSB Materials Laboratory for examination (figures 1a, 1b, and 2). The ear had fractured from the corner at the lower side of the rocker footing where the ear projects from the cylinder head. The corner lies at the intersection of three edges as illustrated below in figures 3a and 3b. Those edges, for the purpose of this report, are the external edge on the rocker box footing (outer edge), the internal edge beneath the ear, and an external edge on the ear itself. The cylinder is covered by Continental Aerospace Technologies Mandatory Service Bulletin MSB18-08C. The service bulletin requires covered cylinders to be inspected and modified to remove casting flash build-up or a sharp radius edge condition. Two other cylinders from different aircraft were also submitted. Those cylinders were the same part number as the cylinder from the accident aircraft and their serial numbers indicated that they were also covered by the service bulletin.

1.0 Accident cylinder

According to engine maintenance records, the cylinder from the accident aircraft was installed at 366.1 h (engine total time). An entry indicating compliance with the service bulletin occurred at 920.8 h. The last inspection occurred at 1210.7 h.

The outer edge of the footing beneath the exhaust rocker box exhibited features consistent with material removal and blending of the edge at the location specified for inspection and modification as described in the service bulletin. The blended region extended approximately 0.15 inches underneath the ear and 0.12 inches deep into the cylinder head rocker box footing.

The fracture surface was cleaned with an alkaline detergent and soft-bristle brush, in accordance with standard laboratory protocols, and was examined using a scanning electron microscope (SEM). The fracture surface near the corner was comparatively flat and exhibited feathery features, consistent with high-cycle fatigue. The features were traced back to an origin area where the blended region transitioned to the internal edge beneath the ear (figures 4a and 4b).

2.0 Additional cylinder, S/N: AC16KA158

The exhaust rocker box ear had fractured from the cylinder head (figure 5a). The fracture features were similar to those seen on the accident cylinder, consistent with high-cycle fatigue fracture. The ear was stamped with an 'S', in accordance with the Continental service bulletin (figure 5b). Examination of the outer edge revealed material removal and blending along part of the edge. The blending did not extend up to the internal edge on the underside of the ear (figures 6a and 6b). Instead, a sharp outer edge was observed extending approximately 0.06 inches from the corner.

3.0 Additional cylinder, S/N: AC17CB527

The as received cracked cylinder is shown in figure 7a. The intake rocker box ear was stamped with an 'S', in accordance with the Continental service bulletin and the outer edge was rounded, consistent with filing of the edge (figure 7b). At its greatest extent, the blending extended approximately 0.24 inches underneath the ear (figure 8a) and 0.10 inches deep into the footing (figure 9a). The internal edge underneath the ear was blended approximately 0.08 inches from the corner. The external edge of the ear was beveled but not blended (figure 7b). The cylinder had previously undergone a fluorescent penetrant inspection, and fluorescent dye was still present inside the crack (figures 8b and 9b). The dye was used to mark the ends of the crack.

The portion of the cylinder with the crack was sectioned from the rest of the cylinder. Then, the crack was back-cut, and the piece was fractured, exposing the crack faces (figures 10a, 10b, and 11). The crack extended approximately 0.62 inches underneath the ear and 0.65 inches into the rocker box footing.

One of the crack faces was examined by SEM (figures 12a and 12b). The fracture surface exhibited feathery features consistent with high-cycle fatigue. Radial

lines and crack progression features were traced back to an origin near the end of the blended region along the internal edge beneath the ear.

E. ATTACHMENTS

Continental Aerospace Technologies Mandatory Service Bulletin MSB18-08C, issued 2018/12/10, revised 2020/09/21.

FAA Airworthiness Directive 2020-16-11.

Submitted by:

Donald Kramer, Ph.D.
Materials Engineer

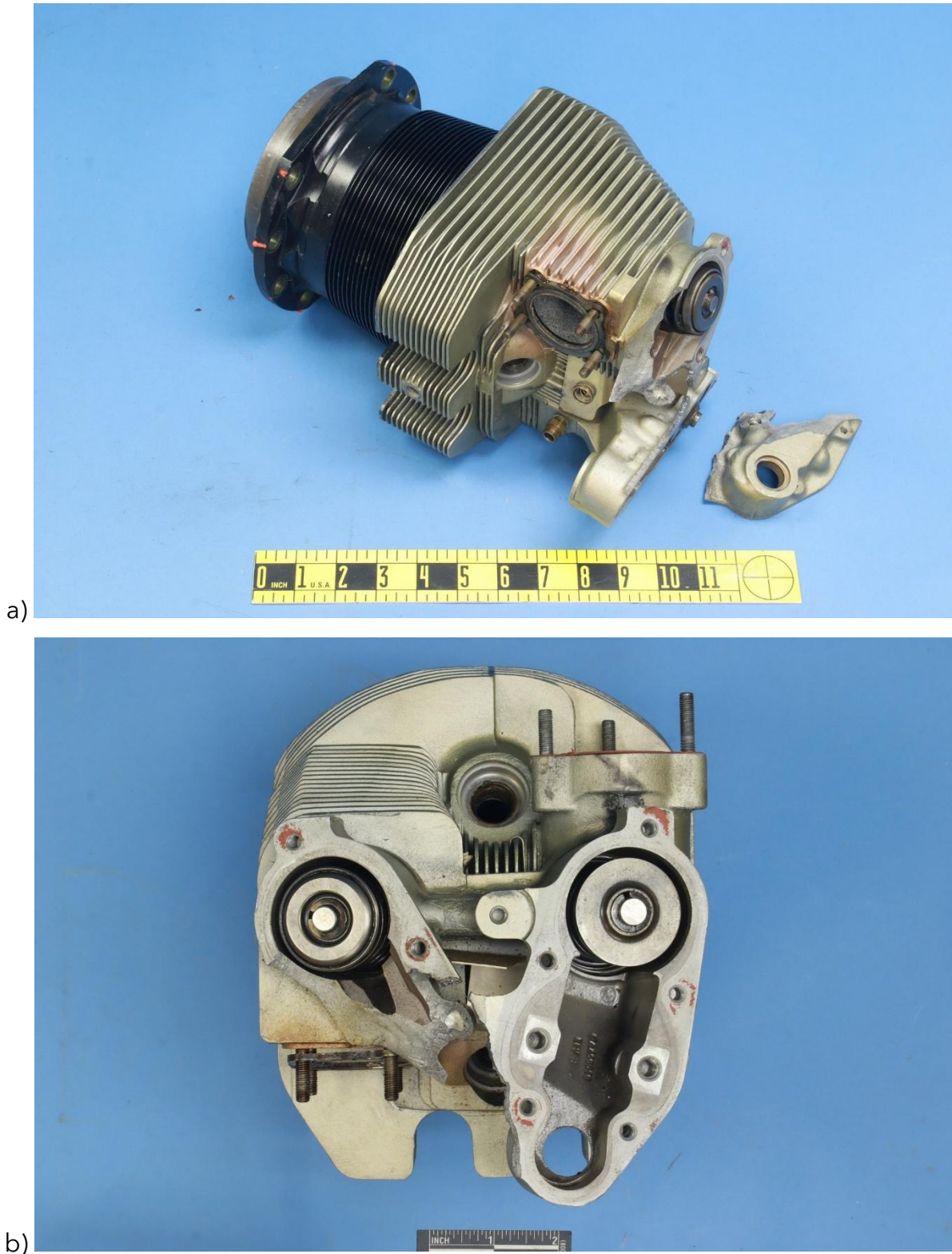


Figure 1. a) and b) Images of the as received cylinder from the accident aircraft, serial number AC17AB774.



Figure 2. Fatigue fracture starting at the outer edge of the lower corner of the exhaust rocker box footing.

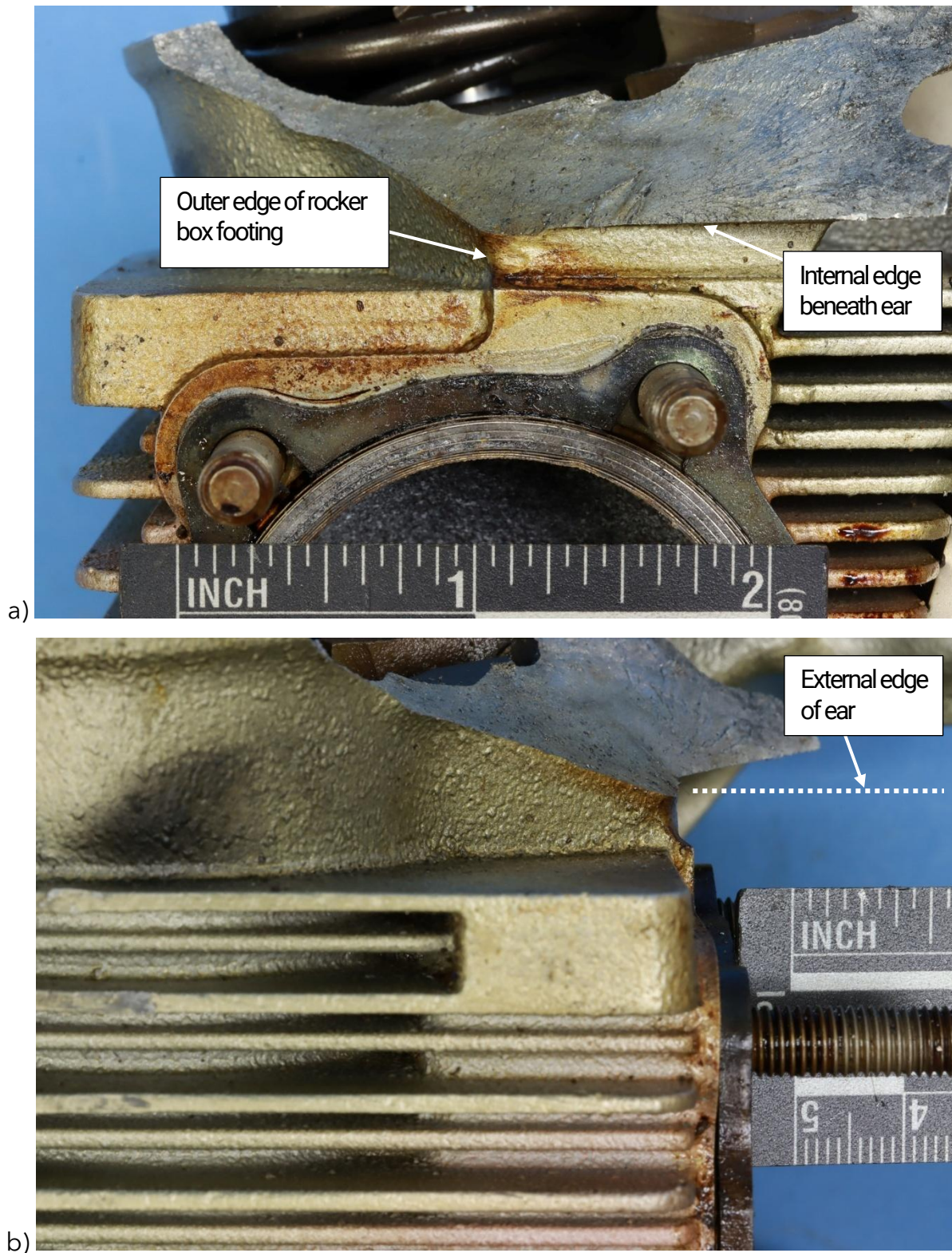


Figure 3. Images showing blending of the outer edge: a) blending along the underside of the ear and b) blending into the footing.

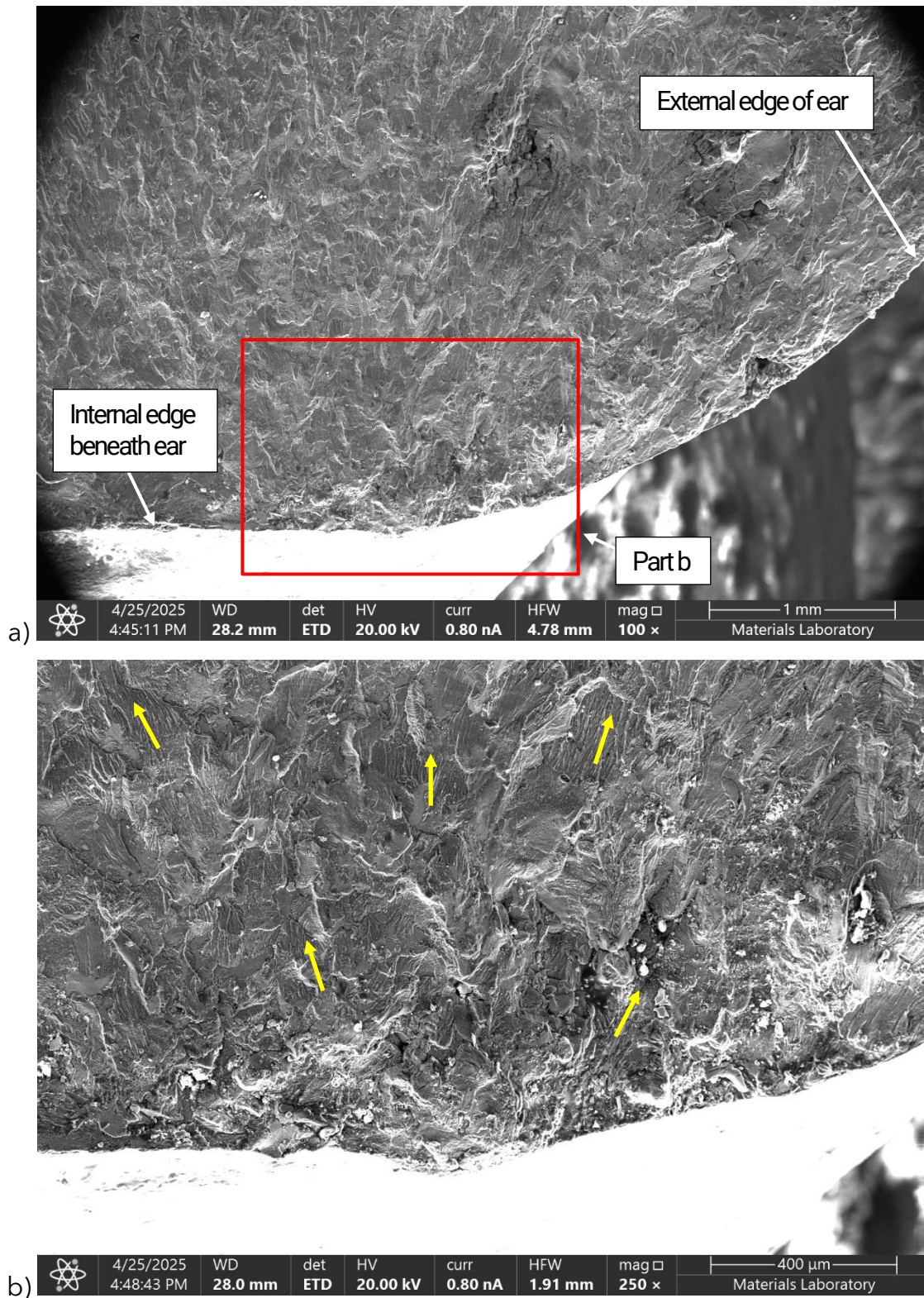


Figure 4. Scanning electron microscope images of the fracture initiation area: a) overview image and b) higher magnification image showing crack initiation at the edge of the blended region.



Figure 5. a) Overview image of cylinder, serial number AC16KA158, with fractured exhaust rocker box ear and b) image of fractured ear showing stamp mark.

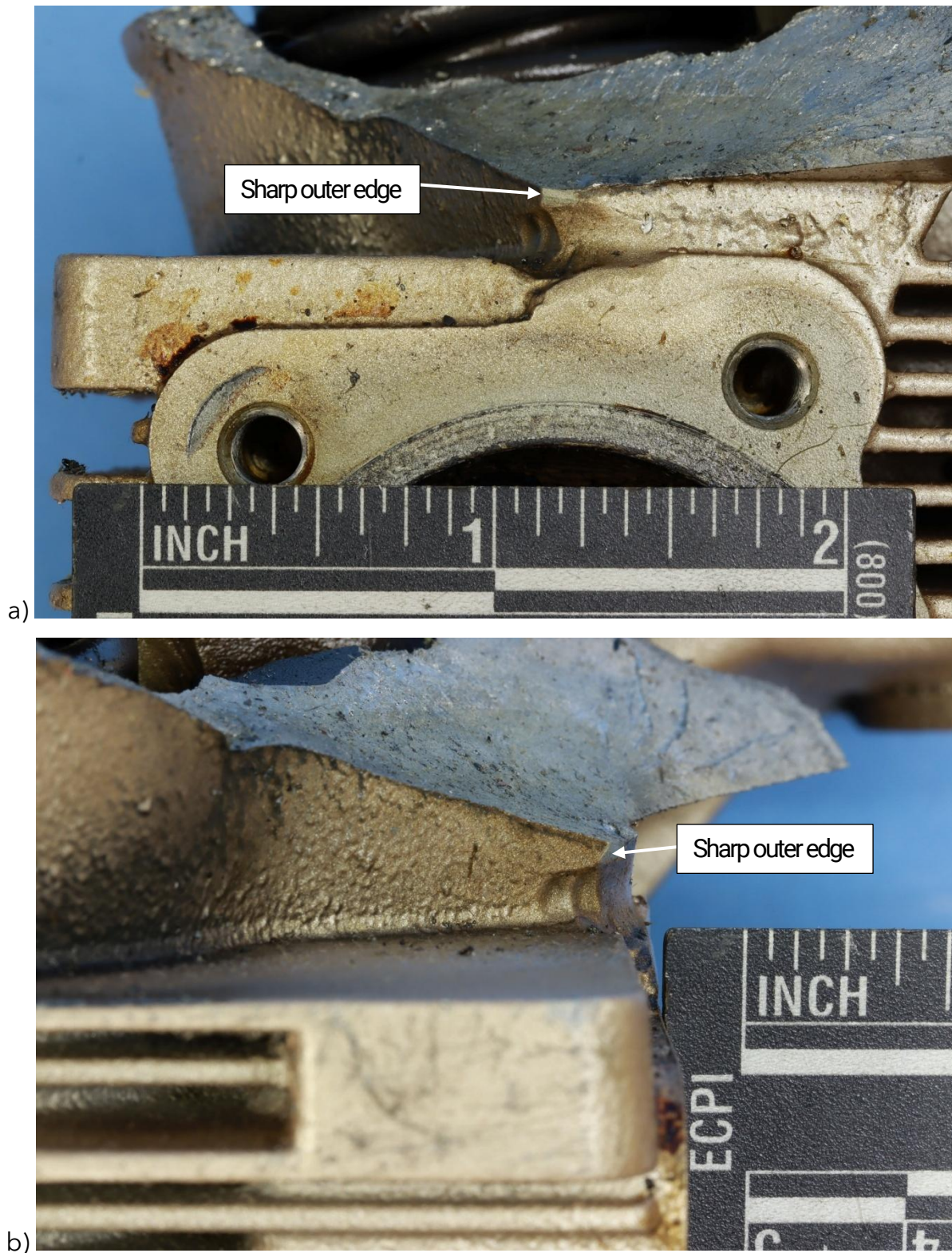


Figure 6. Images showing blending of the outer edge: a) blending along the underside of the ear and b) blending into the footing.



Figure 7. a) Overview image of the as received cylinder with the cracked exhaust rocker box and b) image of the blended outer edge.

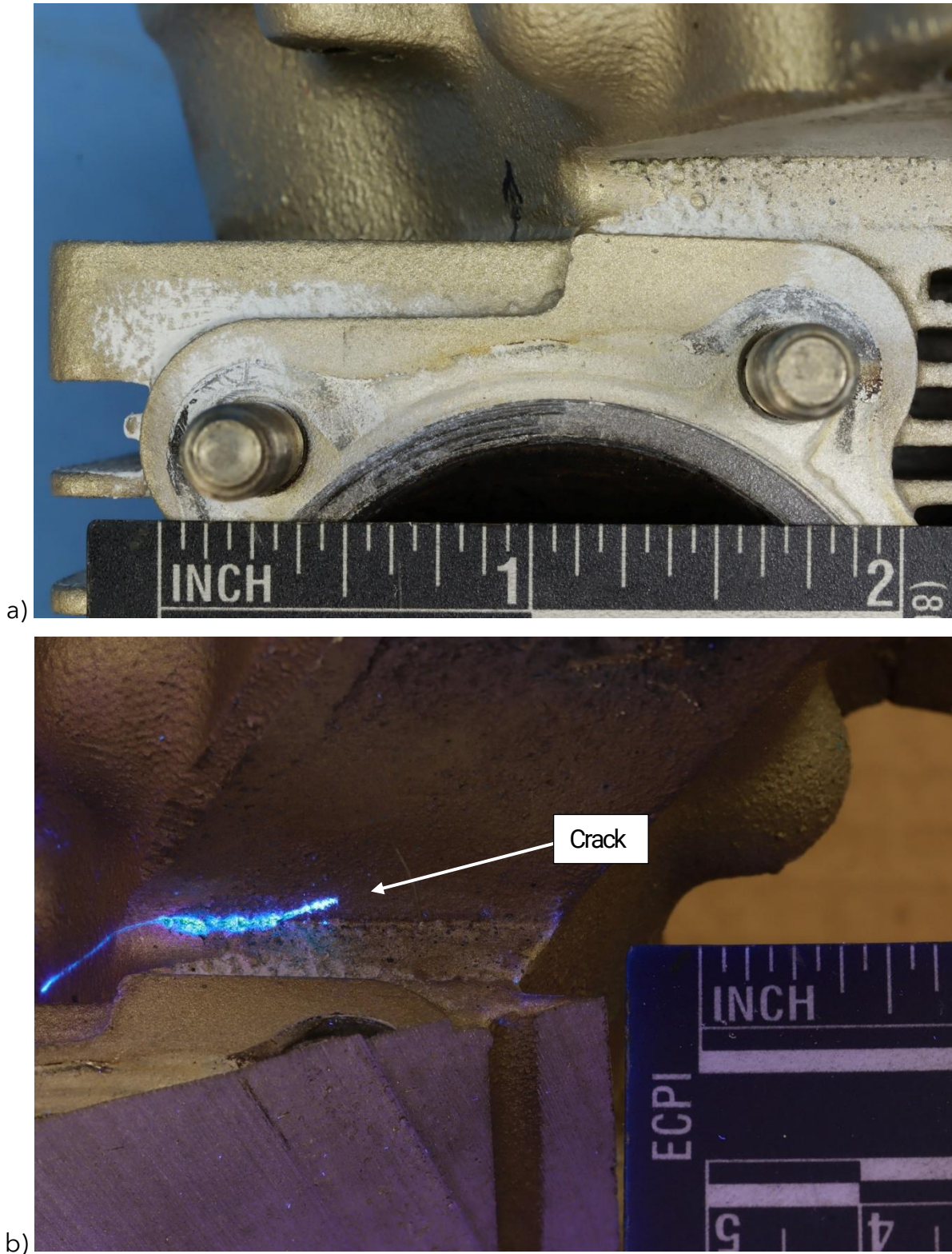


Figure 8. a) Image showing blending of the outer edge along the underside of the ear and b) black light image showing fluorescence of crack, initially running along the internal edge and the progressing into the ear.

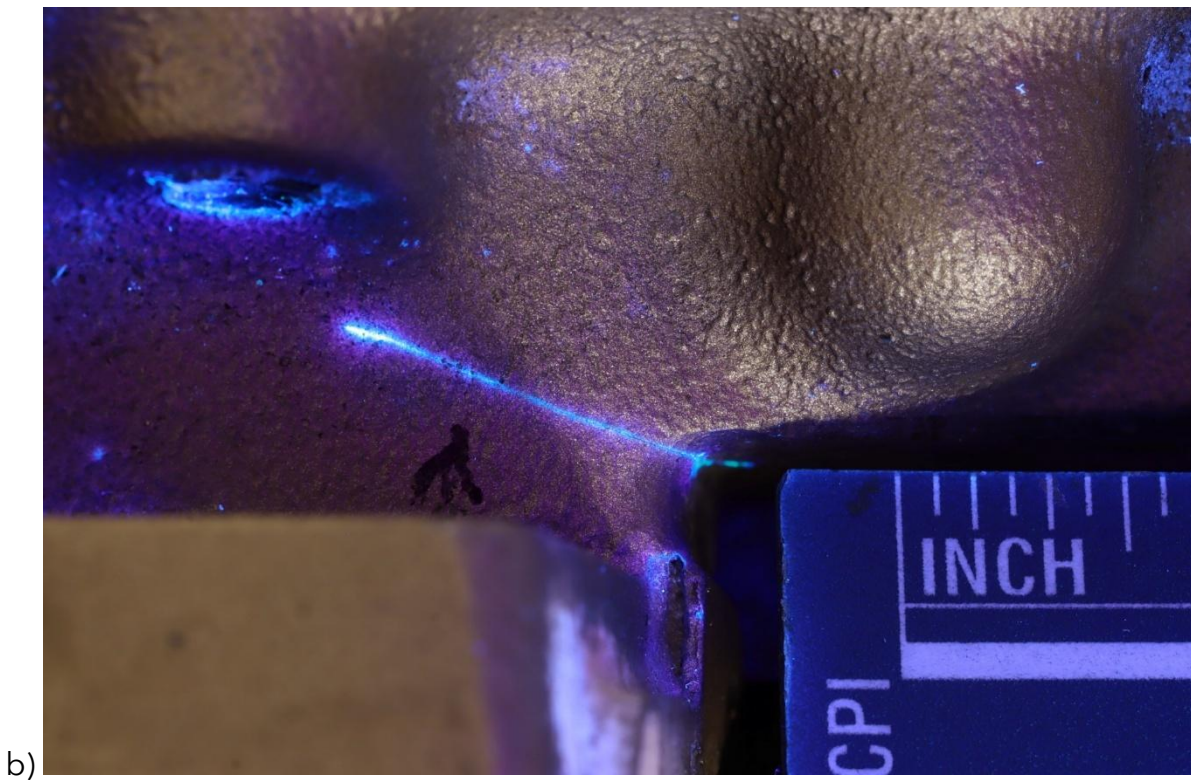
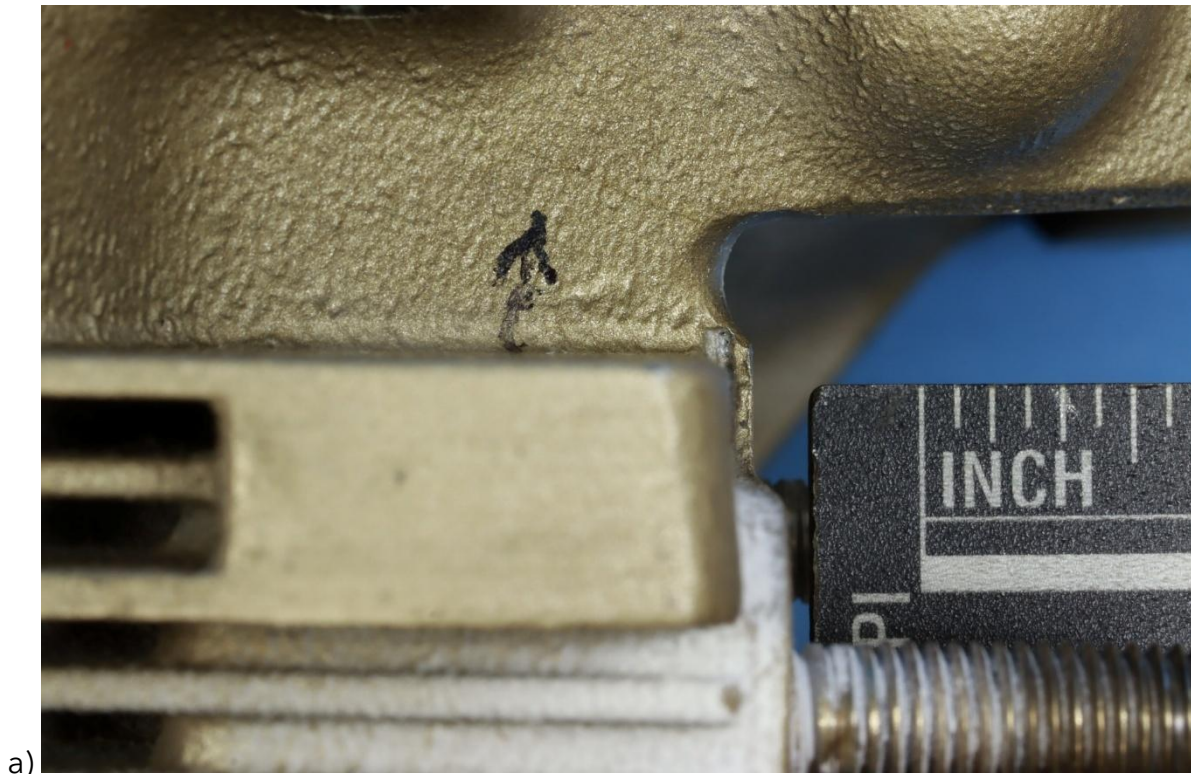


Figure 9. a) Image showing blending of the outer edge into the rocker box footing and b) black light image showing fluorescence of crack, progressing into the rocker box footing.



a)



b)

Figure 10. a) Exhaust valve rocker box region sectioned from the rest of the cylinder and b) further sectioning and exposure of the crack.



Figure 11. One of the crack surfaces after cleaning. The features were consistent with high-cycle fatigue.

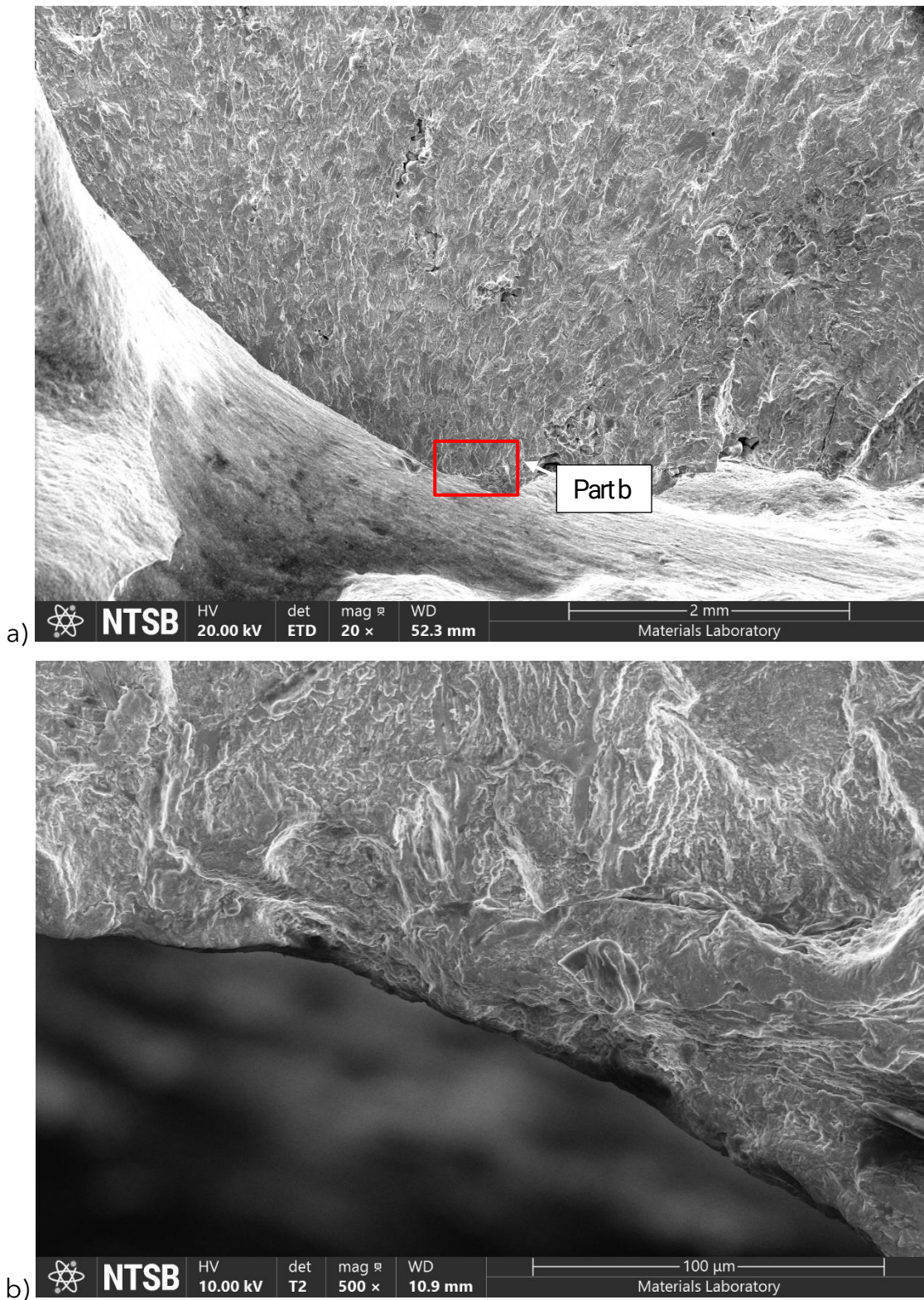


Figure 12. Scanning electron microscope images of the crack surface: a) Overview image showing the transition from the blended region to the internal edge underneath the ear and b) higher magnification image showing the fracture origin at the edge of blended internal edge.