

NATIONAL TRANSPORTATION SAFETY BOARD

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



March 9, 2021

MATERIALS LABORATORY FACTUAL REPORT

Report No. 21-018

A. ACCIDENT INFORMATION

Place : Celburne, TX
Date : June 4, 2020
Vehicle : Beech 23, N7941L
NTSB No. : CEN20LA211
Investigator : David Bowling (AS-CEN)

B. COMPONENTS EXAMINED

No. 1 cylinder from CMI engine

C. DETAILS OF THE EXAMINATION

The no. 1 cylinder was submitted separated into 2 pieces, as shown in Figure 1. The separation occurred between the 4th and 5th cooling fins, near the barrel to head junction. The part marking '536727 MPG' was observed cast into the external surface of the cylinder.

Figures 2 and 3 show the fracture surface on the barrel half of the cylinder, while Figures 4 and 5 show the mating fracture surface on the head portion of the cylinder. The fracture surface was flat and had features consistent with fatigue cracking around roughly 60 degrees on the exhaust side of the cylinder (red double-sided arrows, Figures 2 and 4). The fatigue cracking emanated from the inner diameter (ID) of the cylinder. Dark colored deposits coated the fracture surface in this area, likely resulting from combustion products exiting the cylinder during operation once the fatigue cracking had progressed through-wall.

Thumbnail-shaped patterns consistent with fatigue cracking were observed on the fracture surface at the intake side of the cylinder (red arrows, Figures 3 and 5). The patterns were located diametrically opposite the cracking on the exhaust side of cylinder. The cracking was not through-wall like on the exhaust side, but the patterns did emanate from the ID of the cylinder. The fatigue cracking on the intake side was likely secondary to the through-wall fatigue cracking on the exhaust side.

The fracture surface on the barrel half of the cylinder was cleaned using a solution of water and Alconox detergent (manufactured by Alconox, Inc., White Plains, NY), and rinsed with isopropanol. The red dots in Figure 6 outline the edges of the through-wall

fatigue crack. The white double-sided arrow indicates the fatigue initiation region. Multiple fatigue initiation sites were visible along the ID of the cylinder within the initiation region.

The remainder of the fracture surface of the separated cylinder was consistent with overstress.

The piston head from the no. 1 cylinder was submitted with the piston pin still assembled, as shown in Figure 7. Dark colored carbon deposits consistent with combustion byproduct were observed on the flat top of the piston head. Slight detonation damage was observed around the outer edge of the piston head. The piston skirting appeared in relatively good condition, but some dark colored staining consistent with blow-by was present near the piston pin bore hole.

Adrienne V. Lamm
Materials Engineer



Figure 1: Macro photo of the two halves of the separated no. 1 cylinder.

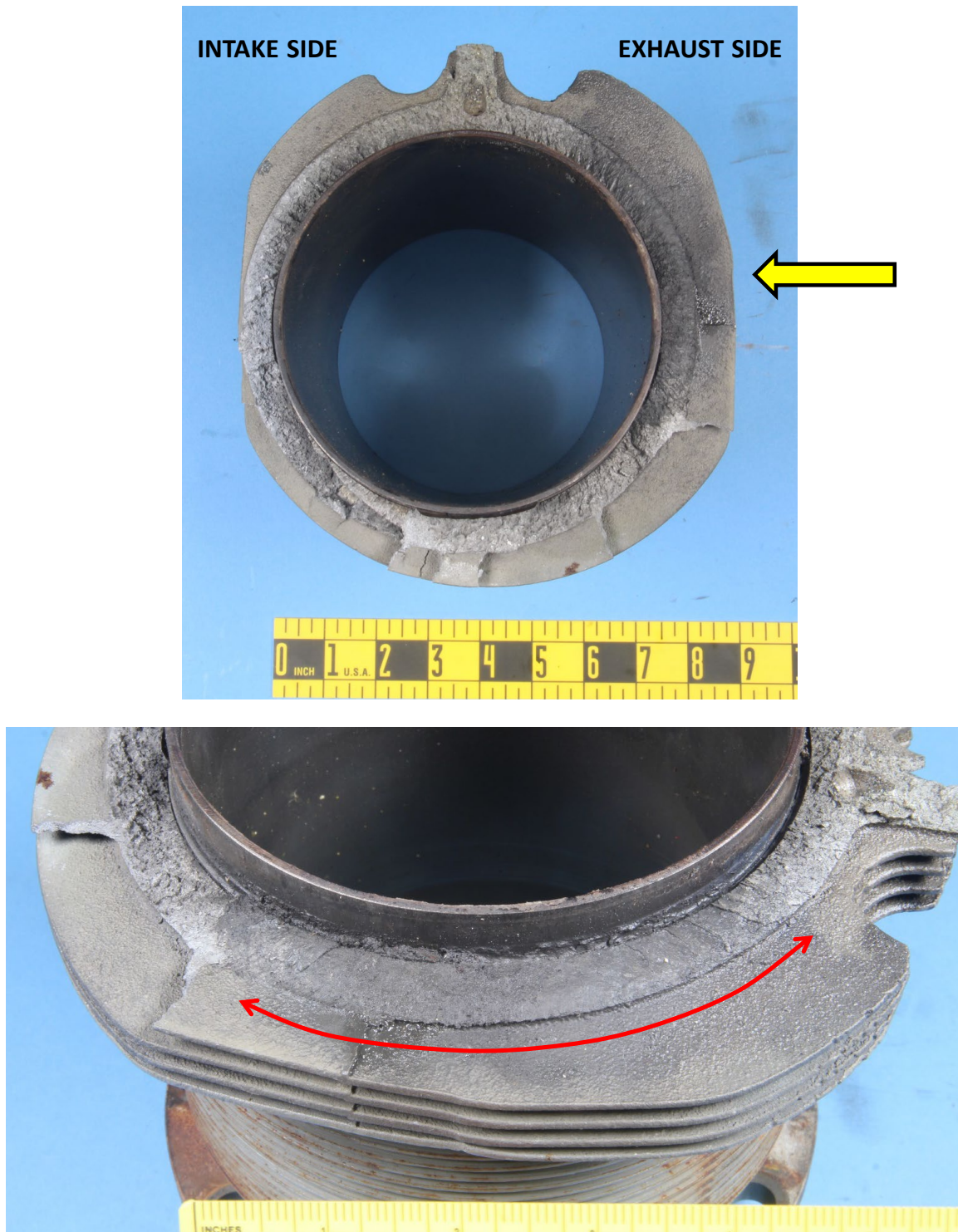


Figure 2: (Top) Macro photo of the fracture surface on the barrel half of the separated cylinder. (Bottom) Close-up photo of the fracture surface on the exhaust side in the location indicated by the yellow arrow in the top photo. The red double-sided arrow indicates a through-wall crack on the fracture surface.

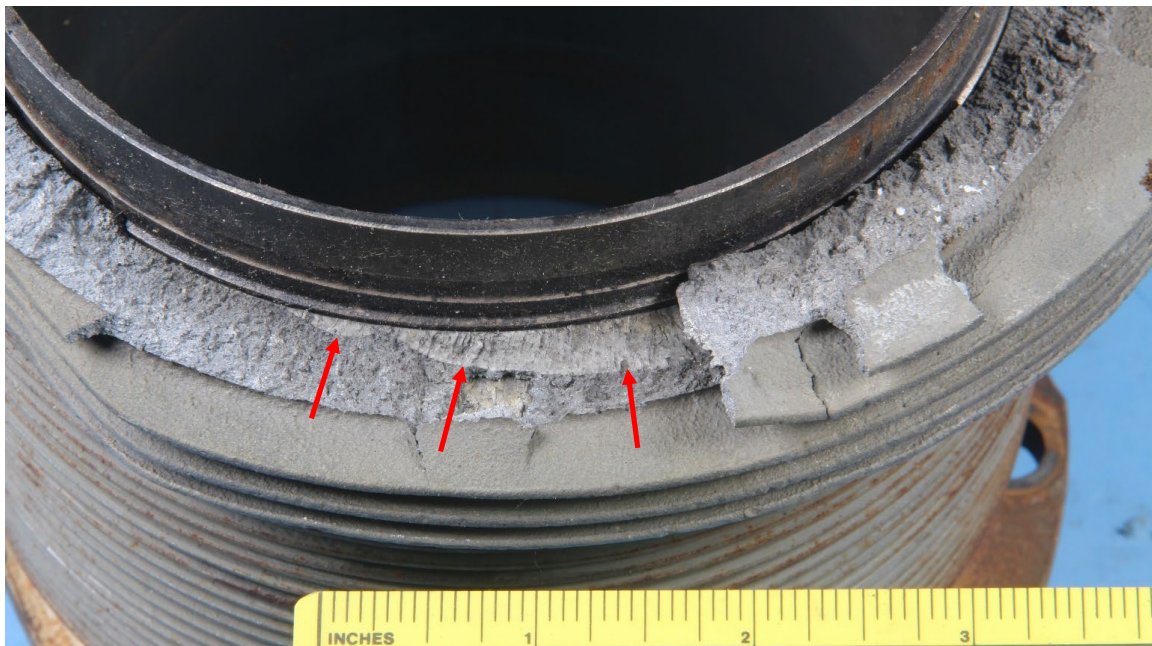
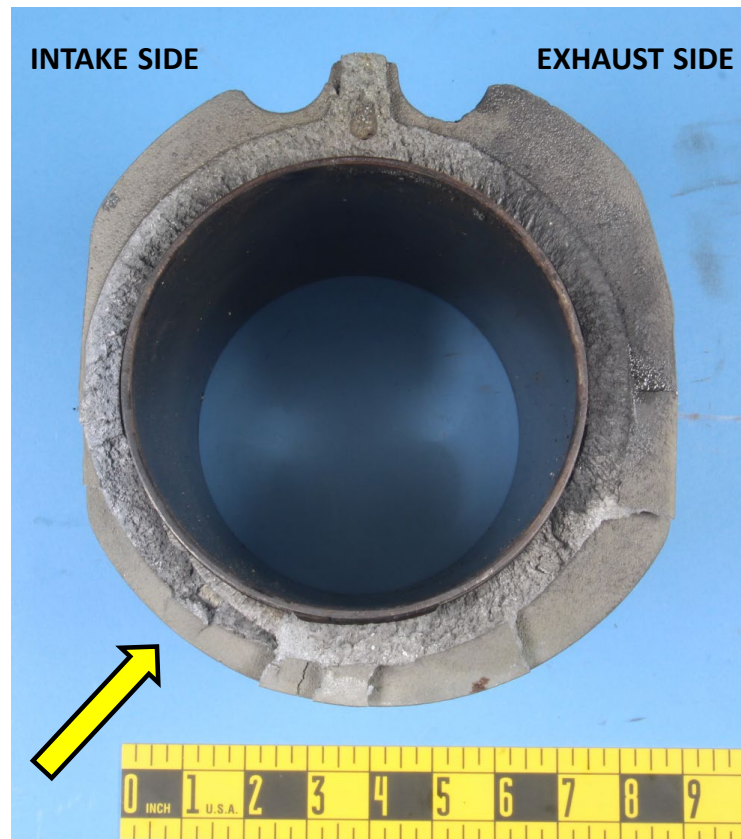


Figure 3: (Top) Macro photo of the fracture surface on the barrel half of the separated cylinder. (Bottom) Close-up photo of the fracture surface on the intake side in the location indicated by the yellow arrow in the top photo. The red arrows point to thumb-nail-shaped fatigue cracking emanating from the cylinder ID.

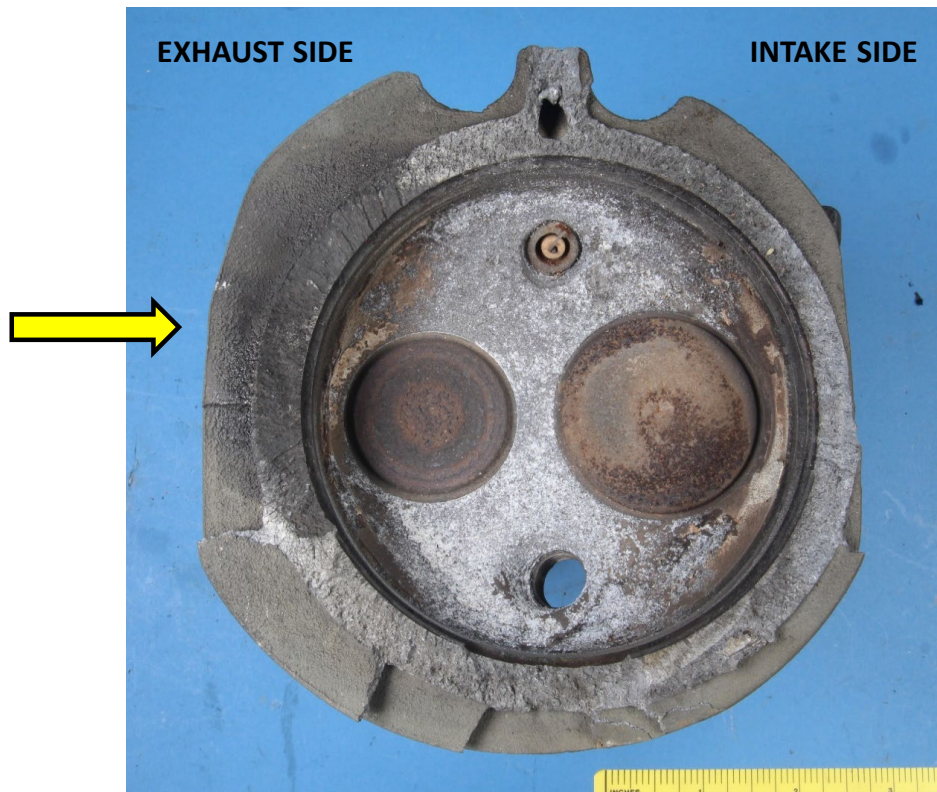


Figure 4: (Top) Macro photo of the fracture surface on the head half of the separated cylinder. (Bottom) Close-up photo of the fracture surface on the exhaust side in the location indicated by the yellow arrow in the top photo. The red double-sided arrow indicates a through-wall crack on the fracture surface.

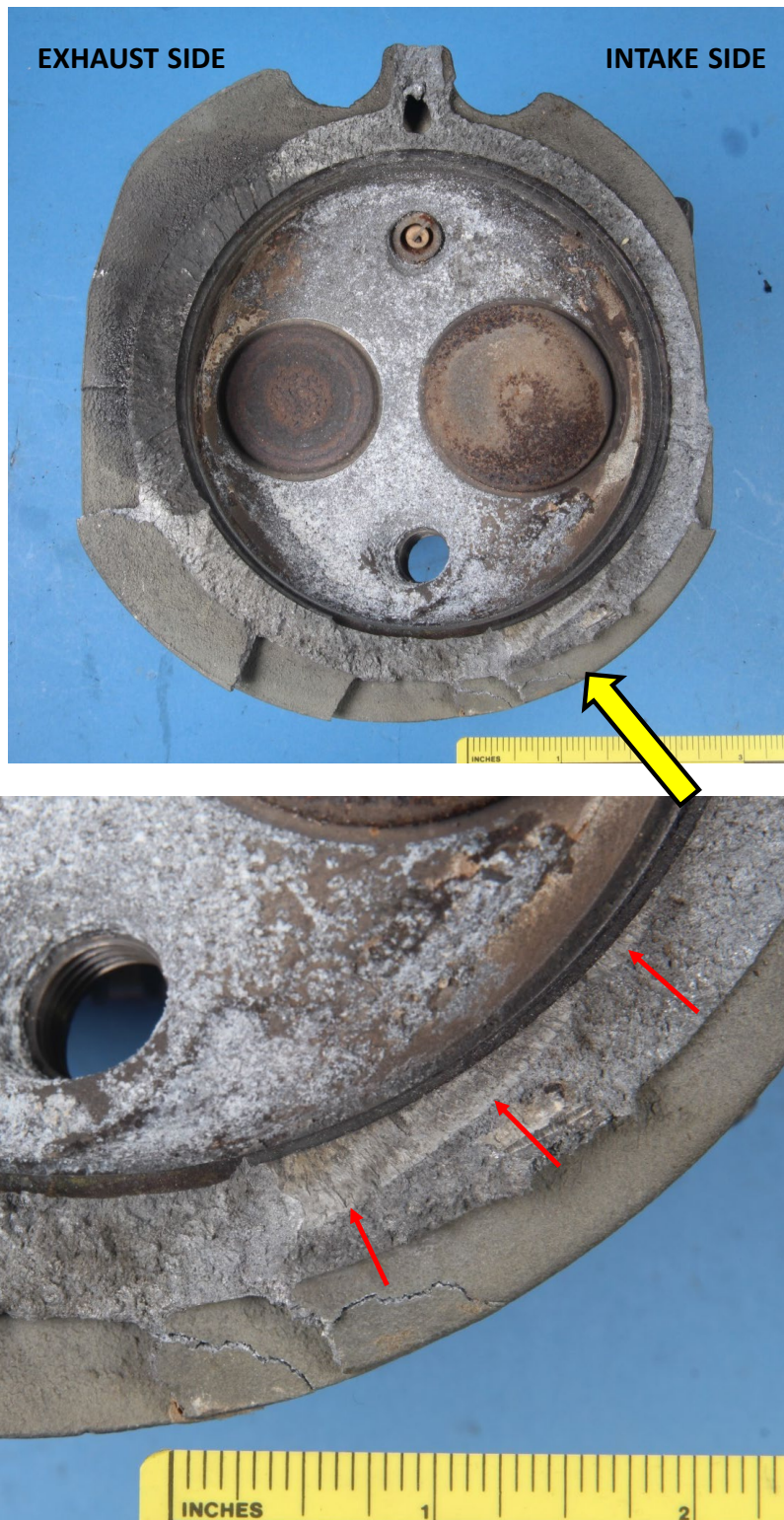


Figure 5: (Top) Macro photo of the fracture surface on the head half of the separated cylinder. (Bottom) Close-up photo of the fracture surface on the intake side in the location indicated by the yellow arrow in the top photo. The red arrows point to thumb-nail-shaped fatigue cracking emanating from the cylinder ID.

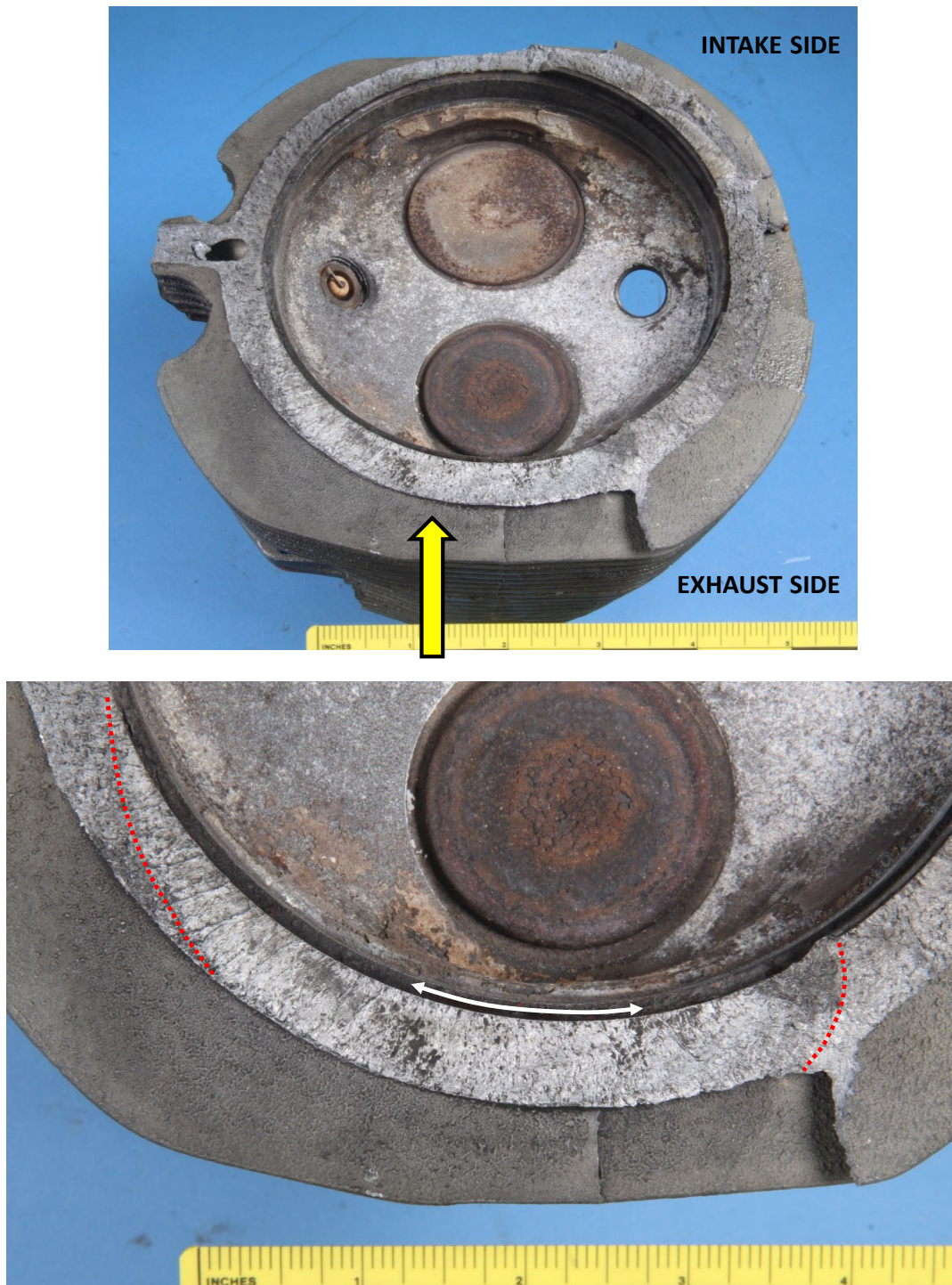


Figure 6: (Top) Macro photo of the fracture surface after cleaning on the barrel half of the separated cylinder. (Bottom) Close-up photo of the fracture surface on the exhaust side in the location indicated by the yellow arrow in the top photo. The red dots outline the edges of the through-wall fatigue crack. The white double-sided arrow indicates the fatigue initiation region along the ID of the cylinder.



Figure 7: Macro photos of the no. 1 piston head and mating piston pin as viewed from the top and side (top and bottom images, respectively).