

NATIONAL TRANSPORTATION SAFETY BOARD

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



April 28, 2017

MATERIALS LABORATORY FACTUAL REPORT

Report No. 17-042

A. ACCIDENT INFORMATION

Place : Bayonne, New Jersey
Date : February 19, 2017
Vehicle : Piper PA-28R-200
NTSB No. : ERA17LA110
Investigator : Leah Read, AS-ERA

B. COMPONENTS EXAMINED

Number 3 cylinder assembly including fractured intake valve from a Lycoming IO-360-C1C engine.

C. DETAILS OF THE EXAMINATION

An overall view of the submitted number 3 cylinder assembly is shown in figure 1. The intake valve was fractured in the stem in two places and through the head in one place. The interior of the cylinder and the piston dome were battered consistent with impacts from the fractured intake valve. The connecting rod was intact, but the bearings were worn through both the Babbitt and copper layers.

The valve stem cap and tip piece of the intake valve remained in place in the valve spring seat under the intake rocker arm. To facilitate examination of the intake valve stem fractures, the intake rocker arm and valve stem piece were disassembled from the cylinder assembly. The exhaust rocker arm and valve were also disassembled from the assembly for examination.

An overall view of the outboard faces of the intake valve key and upper spring seat are shown in figure 2. As installed, the underside of the intake valve tip contacted the intake valve key on the outboard surface near the inner diameter as indicated in figure 2. The valve tip contact area on the valve key was worn into a concave shape consistent with wear from contact with the intake valve tip.

An overall view of the fractured intake valve is shown in figure 3. The head was fractured from the stem, and the head end of the stem was bent. The fracture features associated with the fracture at the head end of the stem were rough and matte gray, consistent with overstress fracture. The head was also fractured across a chord adjacent to the stem. The fracture surface of the head was rough matte gray appearance, and the adjacent areas showed deformation, features consistent with overstress fracture.

A closer view of the tip end of the intake valve stem is shown in figure 4. The stem showed rub marks consistent with sliding contact between the stem and the key in the area indicated in figure 4. The area of sliding contact was larger than the normal contact area also indicated in figure 4.

Views of the fracture surface on the intake valve stem tip are shown in figure 5. The fracture initiated at the fillet radius between the valve stem tip and the key area of the valve stem shaft. Fracture features were rubbed consistent with fracture surface recontact. However, radial features consistent with ratchet marks¹ were observed at one side of the fracture as indicated in the upper image in figure 5, features consistent with fatigue fracture with multiple origins. Brackets in the upper image in figure 5 indicate approximate fatigue origin areas. The fracture surface had a concave shape consistent with fatigue fracture from the fillet area associated with a change in diameter of a shaft.

Part number markings were identified on the valves, valve stem caps, valve upper spring seats, rocker arms, and push rods. All part numbers were listed in the Lycoming Illustrated Parts Catalog for the accident engine or were alternate part numbers for listed part numbers.

The investigator in charge provided notes from the engine teardown examination conducted after the accident. According to the notes, the hydraulic lifters were installed in the tappet body in an orientation that was 180 degrees from the proper orientation shown in the engine maintenance manual.

Matthew R. Fox
Senior Materials Engineer

¹ A ratchet mark is a small step in the fracture surface formed when two adjacent fatigue cracks originate on slightly offset planes.



Figure 1. Overall view of the submitted number 3 cylinder assembly components.



Figure 2. View of the outboard faces of the intake valve key and upper spring seat.



Figure 3. Overall view of the intake valve.

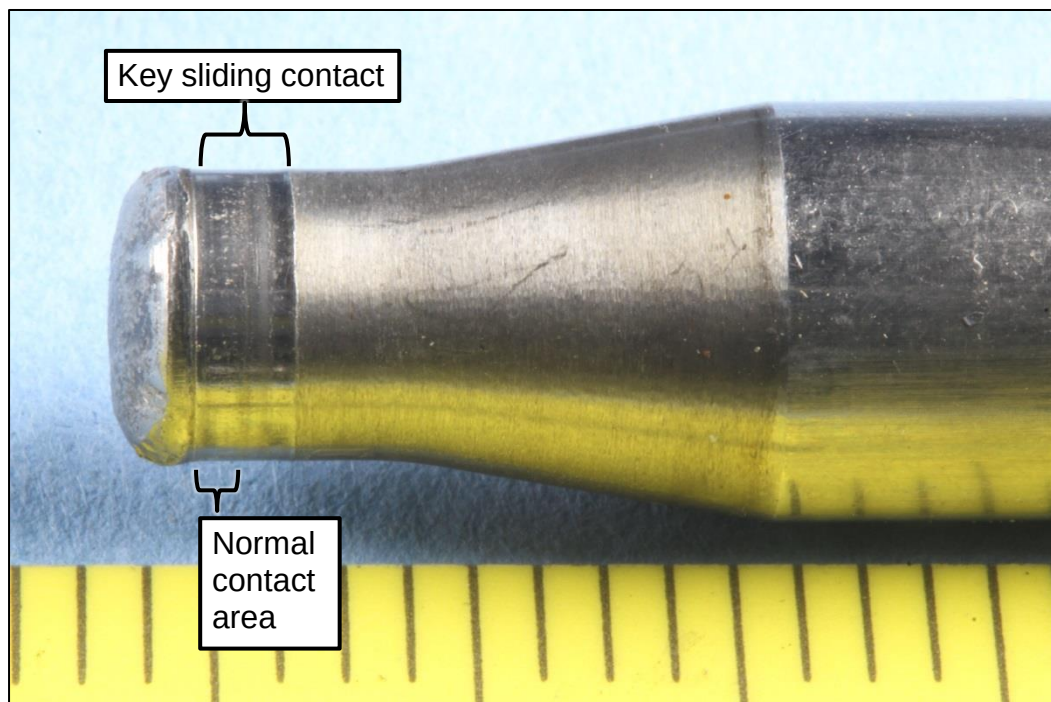


Figure 4. View of the tip end of the intake valve stem showing the area corresponding to sliding contact with the valve stem key.

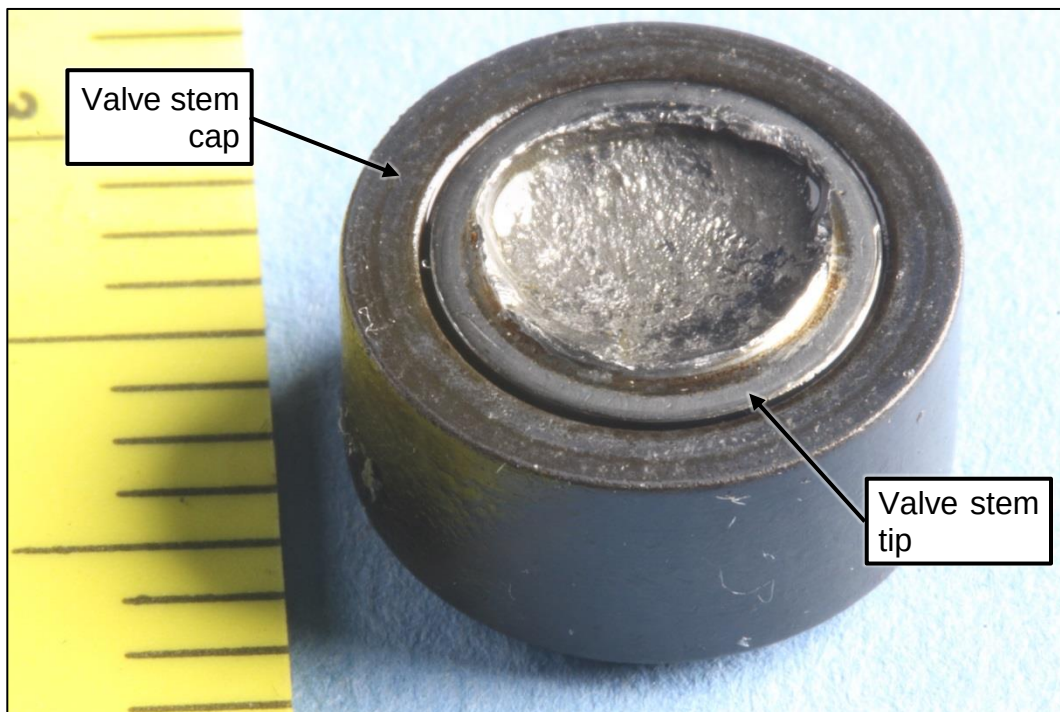
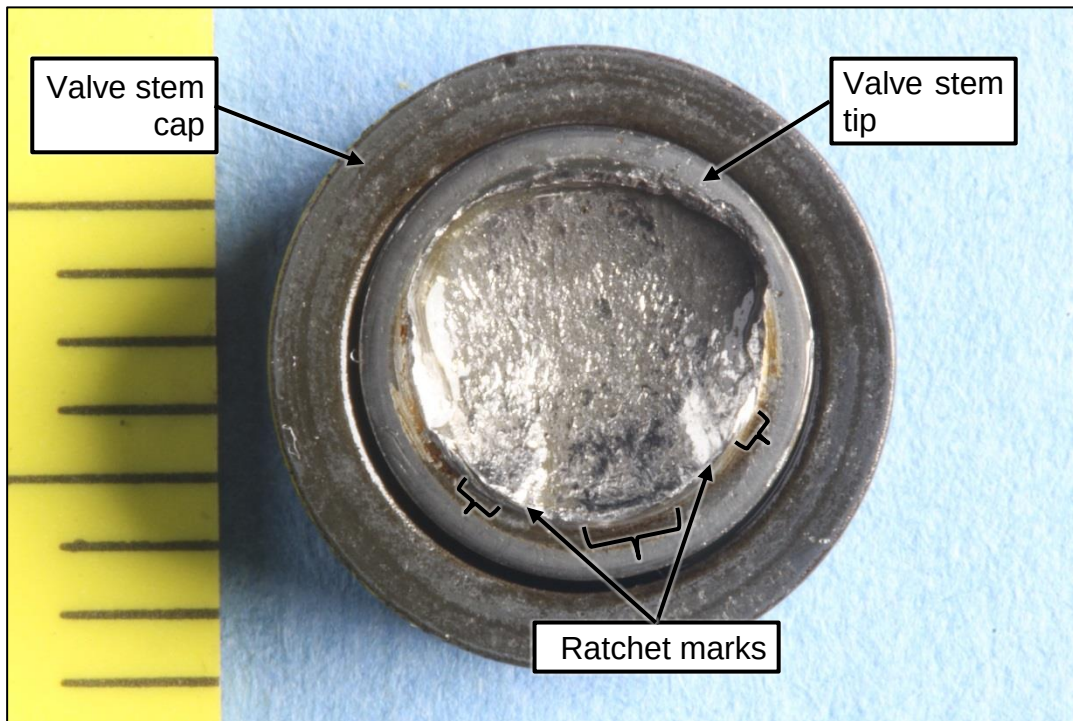


Figure 5. Views of the fracture surface on the tip end of the intake valve stem.