

NATIONAL TRANSPORTATION SAFETY BOARD

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



May 2, 2019

MATERIALS LABORATORY FACTUAL REPORT

Report No. 19-020

A. ACCIDENT INFORMATION

Place : Bell Glade, Florida
Date : December 17, 2018
Vehicle : Cessna 152, N4886B
NTSB No. : ERA19LA069
Investigator : Lynn Spencer, AS-ERA

B. COMPONENTS EXAMINED

Number 1 cylinder assembly and piston assembly with intake and exhaust valves, valve springs, valve spring seats, and valve keys from a Lycoming O-235-L2C engine.

C. DETAILS OF THE EXAMINATION

An overall view of the submitted components is shown in figure 1. As found during the engine teardown, the intake valve upper seat had fractured, and the intake valve was stuck within the intake valve guide. The exhaust valve remained assembled within the cylinder assembly as received. Markings on the side of the cylinder head near the rocker cover read "16A23033" and "A193088" on the intake side and "094176" and "6102" on the exhaust side, indicating the cylinder assembly was Lycoming Engines part number 16A23033. Markings on the tip of the intake valve read "SL-17236 T-T N7", indicating that it was a part number SL17236 intake valve made by Superior Air Parts.

A closer view of the intake valve components is shown in the lower image in figure 1. The intake valve upper seat was fractured into 2 pieces, and the fracture surfaces had rough matte gray features consistent with overstress fracture.

The intake valve head was dark in color, and pitting was observed in areas around the circumference of the head. Radial cracks were observed emanating inward from the pits at the outer edges.

The tip of the intake valve stem is shown in figure 2. Contact damage was observed on the shoulder for the valve key groove and around the edge of the rocker contact face (see arrows in figure 2).

The interior face of one of the valve keys exhibited contact damage as shown in figure 3. A portion of the surface had smooth smeared features and the raised portion that normally fits into the groove in the valve tip was flattened. A dashed line in figure 3

outlines the deformed area with smooth features, and the overall shape of the region fit a cylinder with a circumference corresponding to the outer diameter of the intake valve tip oriented slightly off axis relative to the longitudinal axis of the key.

The tip of the intake valve is shown positioned on the valve key with the valve tip positioned on the smooth area outlined in figure 3. The rocker contact face on the valve tip had a machined surface that was mostly free of the normal rocker arm contact wear pattern characterized by a circular wear patch. A portion of the valve key extended past the rocker face, and sliding contact damage was observed on the valve key face adjacent to the valve tip as shown outlined in figure 4. The outer edge of the damaged area had an approximately 90-degree bend corresponding to contact with the edge of the square-shaped pad on the rocker arm for the Lycoming O-235 series engine.

A view of the piston crown is shown in figure 5. Dark brown combustion deposits covered most of the piston crown except a nearly circular area located near the outer edge of the crown. The nearly circular area was slightly dished, corresponding to contact with the slightly convex face of the intake valve head.

According to the Service Table of Limits for Lycoming engines presented in SSP-1776-4-PTI,¹ the maximum clearance between the intake valve stem and the valve guide should be 0.006 inch. The outer diameter of the intake valve stem measured 0.4015 inch, and the inner diameter of the intake valve guide measured 0.412 inch to 0.418 inch. The clearance is the difference in diameters divided by 2, which was 0.0053 inch to 0.0083 inch for the accident intake valve stem and guide.

The compression loads for the outer valve spring and the auxiliary valve spring at specified compressed lengths are also listed in the Service Table of Limits in SSP-1776-4-PTI. According to the table, the minimum load to compress the outer valve spring to a length of 1.30 inch should be 109 pounds, and the minimum load to compress the auxiliary valve spring to a length of 1.17 inch should be 58 pounds. To test the compression strength of the intake valve springs, each spring was placed on a scale. Then the spring was compressed to the respective length listed in SSP-1776-4-PTI, and the load on the scale was measured. For the outer valve spring, the measured load was 116 pounds, and for the auxiliary valve spring the measured load was 66 pounds. The measured load for each spring satisfied the respective minimum load requirement listed in the Service Table of Limits.

Matthew R. Fox, Ph.D.
Senior Materials Engineer

¹ Special Service Publication SSP-1776-4-PTI, *Service Table of Limits and Torque Value Recommendations*, Lycoming Engines (April 2018).

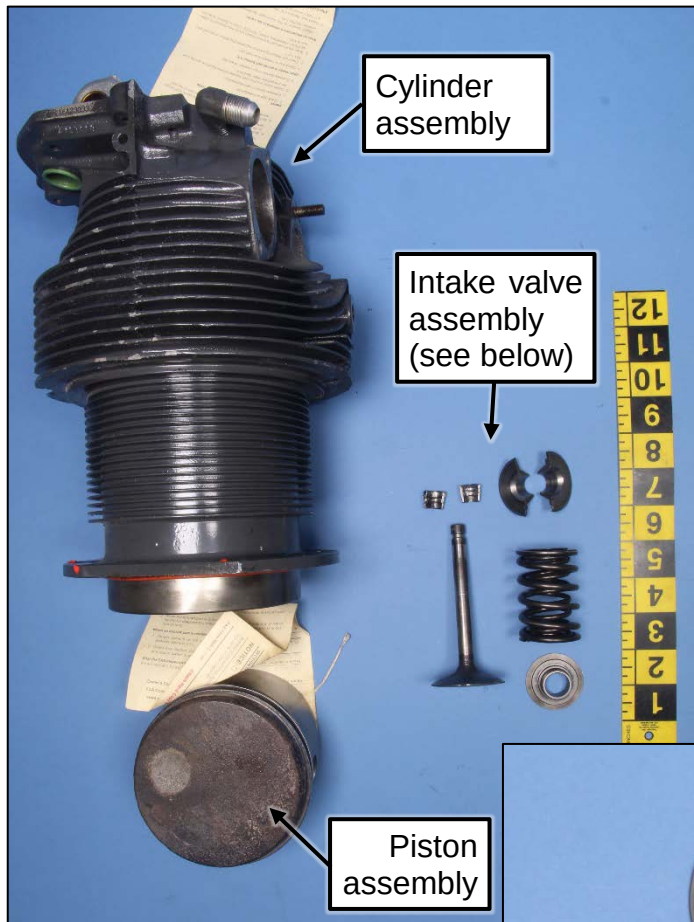


Figure 1. Overall view of the submitted components (image to the left) and a closer view of the intake valve assembly components (image below).

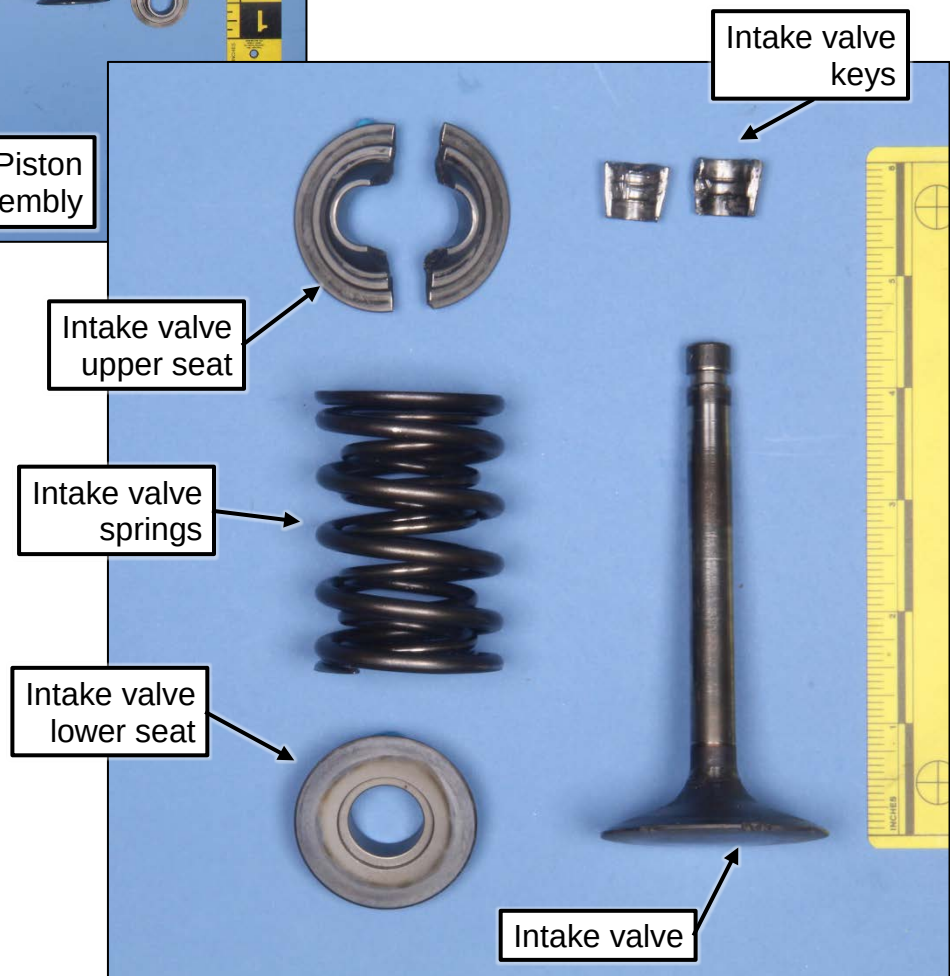




Figure 2. Intake valve tip. Unlabeled arrows indicate damage to the shoulder and the edge of the rocker contact face.



Figure 3. Interior face of one intake valve key. A dashed line indicates an area of smeared features with an off-axis cylindrical curvature matching the outer circumference of the intake valve tip.

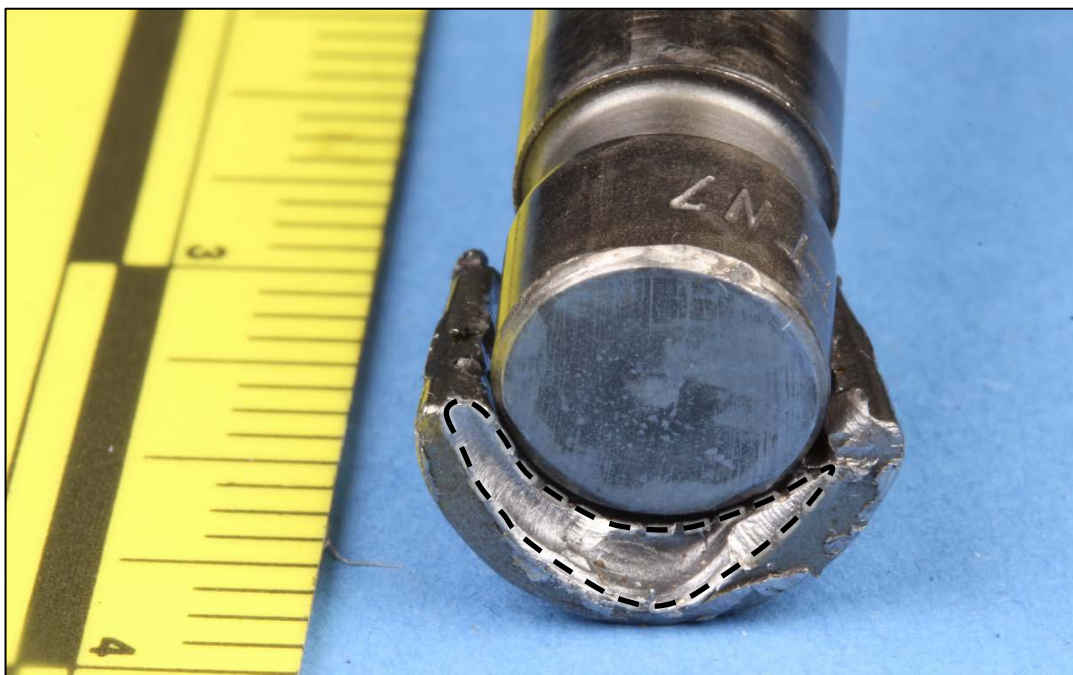


Figure 4. View of the intake valve tip positioned on the valve key in the area of smooth features outlined in figure 3. An area of damage on the end of the key as outlined in this figure had a shape corresponding to contact with the square face of the rocker arm.



Figure 5. Piston crown showing a contact area that was generally free from combustion deposits.