

NATIONAL TRANSPORTATION SAFETY BOARD

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



January 18, 2017

MATERIALS LABORATORY FACTUAL REPORT

Report No. 16-091

A. ACCIDENT

Place : West Caldwell, New Jersey
Date : August 15, 2015
Vehicle : Cessna T206H; N63TV
NTSB No. : ERA15FA312
Investigator : Todd Gunther, AS-ERA

B. COMPONENTS EXAMINED

Components from a turbocharger
Oil pressure supply line check valve
Exemplar check valves

C. DETAILS OF THE EXAMINATION

On August 15, 2015, at 1002 eastern daylight time, a Cessna T206H was substantially damaged after a loss of engine power during initial climb at Essex County Airport (CDW), Caldwell, New Jersey. The commercial pilot was fatally injured. Shortly after becoming airborne, the pilot declared an emergency, reporting that he was unable to maintain engine power. The airplane then rolled to the left and impacted trees and terrain.

Examination of the propeller revealed that there was no evidence of propeller rotation during the impact sequence. The engine, a Lycoming TIO-540-AJ1A, showed no evidence of any type of blockage in the intake or exhaust systems.¹ The spark plug electrodes displayed evidence of black sooty deposits indicative of carbon fouling. Metal fragments were found present in the lubrication system. According to maintenance and FAA records, the airplane was manufactured in 2009. The most recent annual inspection was completed on April 17, 2015. At the time of the inspection, the airplane had accrued 1155.4 total hours of operation.

Portions of the engine, turbocharger system, and fuel injection system were sent to the NTSB Materials Laboratory for further examination. Figure 1 shows some of the components from the Hartzell turbocharger (P/N 466881-5), as received.² All of the

¹ Lycoming TIO-540 is a family of turbocharged, fuel-injected six-cylinder, horizontally opposed fixed-wing aircraft and helicopter engines made by Lycoming Engines, Williamsport, PA.

² The turbocharger system was manufactured by Hartzell Engine Technologies, Montgomery, AL.

turbocharger components exhibited surface oxidation (rusting) and evidence of coking with soot residue. These conditions were consistent with exposure to fire, as well as exposure to water. The center housing label plate, shown in Figure 2, stated the following: "FAA-PMA, Part No. 466881-0001, Serial No. H-PHL00, Hartzell Engine Technologies."

The center housing of the turbocharger is depicted from both the compressor and turbine sides in Figure 3. As previously stated, the part had rusted to a degree that the iron oxide was starting to spall. No other visible damage, such as distortion, wear, or cracking was present on the component exterior. The center housing was radiographed and inspected using computed tomography (CT) scanning. There were no discernable features noted on the center housing using these techniques.

The center housing was sectioned using a band saw with a water-based emulsion-coolant. The location of the sectioning was along the position of the turbine wheel, as illustrated in Figure 4. Figure 5 shows one of the sectioned halves of the center housing interior. Figure 6 shows the same section with the turbine wheel assembly, as it was present during the accident.

The housing bearing on the turbine side exhibited longitudinal and circumferential wear, with relatively less rust and other surface contamination compared to the bearing on the compressor side (see Figure 7). Some gouging was also present on the interior surface of the turbine side bearing (Figure 8). There was no evidence of damage to, or blockage of, the oil holes.

In contrast, the center housing bearing on the compressor side exhibited primarily circumferential wear (Figure 9). The longitudinal marks were consistent with machine marks or sliding wear. There was internal surface rusting on this bearing. There was no evidence of blockage or damage to the oil holes or channels in this section of the housing. No other indications of internal mechanical malfunctions were found inside the center housing.

The turbine wheel assembly is illustrated in Figure 10, as received. The turbine wheel blade fins did not exhibit any mechanical damage consistent with foreign object impacts, overheating, or distortion. There was no chipping or cracking observed.

The tapered stub shaft of the compressor side had fractured away from the threaded portions of the shaft. The features on the fracture surface had been entirely obliterated by smearing, consistent with post-fracture damage. However, the area adjacent to fracture exhibited a jog on one side, with a general flat surface. This pattern was consistent with overstress failure in shear of a ductile material.

Gouge marks were present on the hexagonal cap on the turbine side of the wheel (Figure 11). These marks were consistent with a sudden impact with an adjacent component or tool, in a clockwise rotation. The turbine side bearing surface of the turbine wheel is illustrated in Figure 12. The surface exhibited longitudinal gouging marks, in addition to the circumferential wear marks. These gouge marks matched those of the

bearing surface of the sectioned center housing. These marks were consistent with the wheel assembly shifting forward while positioned in the housing.

The check valve submitted is shown in Figure 13, along with an exemplar check valve. This check valve had been positioned in the oil pressure supply line. The accident check valve and an exemplar check valve were inspected by radiography and CT scanning. As shown in Figure 14, the accident check valve exhibited a small gap (yellow dashed circle in Figure 14) between the ball and the internal channel along the neck. The spring that held the ball was angled. In contrast, neither the ball nor the spring in the exemplar check valve exhibited these features noted in the accident valve.

Both the accident and the exemplar check valves were sectioned along the channel direction. One of the sections of the accident check valve is shown in Figures 15 and 16. The internal components showed a darker color, consistent with long-term exposure to oil. However, the channel in front of the spring-loaded ball contained contamination and solid material. Inspection of this material with Fourier transform infrared spectroscopy (FTIR) found some of the constituents to be consistent with lubricating oil (Figure 17). This oil and debris residue was positioned between the ball and the channel wall. The mating side of the sectioned check valve (absent the ball and spring) is shown in Figure 18.

The sectioned exemplar check valve is shown in Figures 19 through 21. The exemplar did not contain any loose or foreign material in the channel. The channel exhibited circumferential marks, which were consistent with machine marks from manufacture. These marks were also visible in the sectioned accident valve (compare with Figure 18). The ball and spring in the exemplar valve were damaged during sectioning. However, the ball was still in contact with the channel walls after sectioning.

All other parts examined exhibited mechanical damage consistent with accident the accident ground impact, or heat damage from exposure to the post-crash fire.

Erik Mueller
Materials Research Engineer



Figure 1 – Some of the components submitted from the Hartzell turbocharger.



Figure 2 – The label plate on the upper side of the center turbocharger housing.

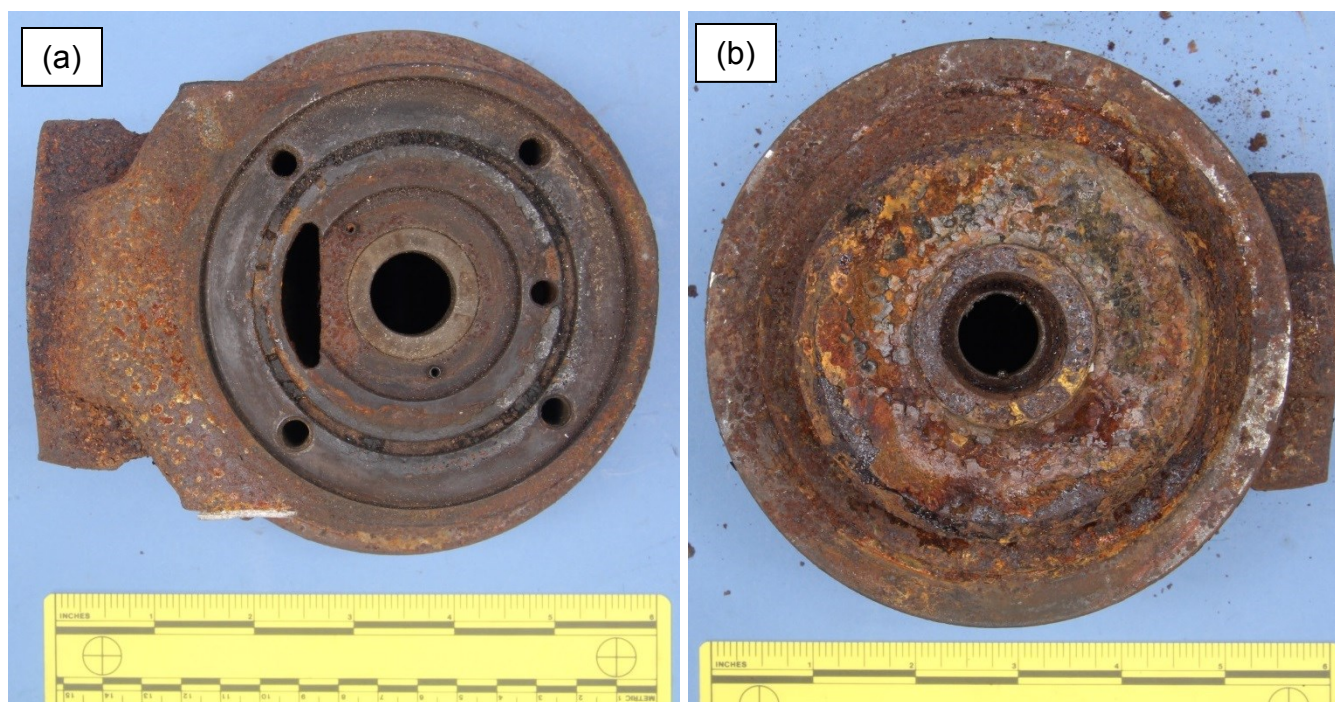


Figure 3 – The center housing of the turbocharger, viewed from (a) the compressor side and (b) the turbine side.

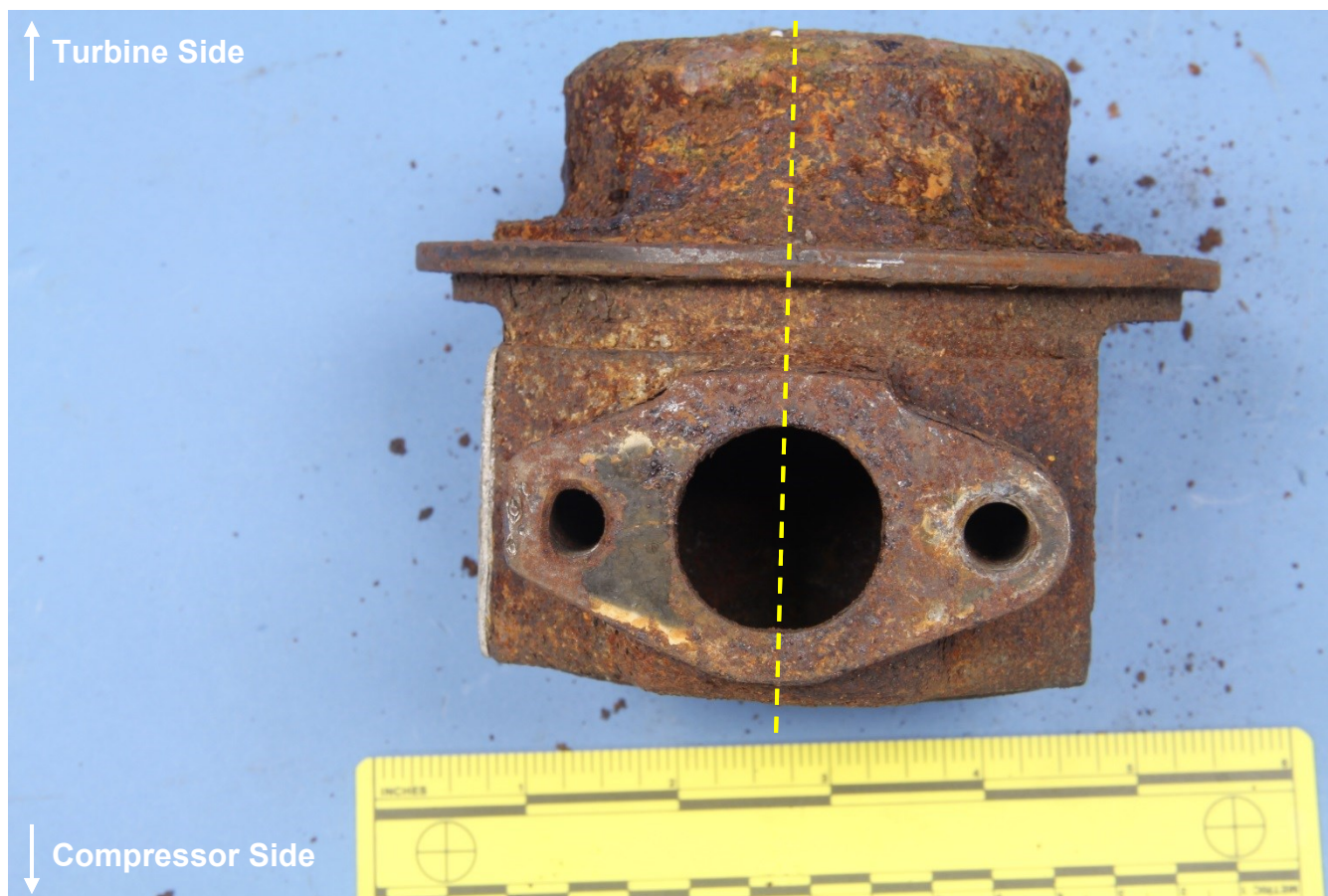


Figure 4 – The center housing of the turbocharger, viewed from the upper side. The yellow line shows the location of the sectioning.

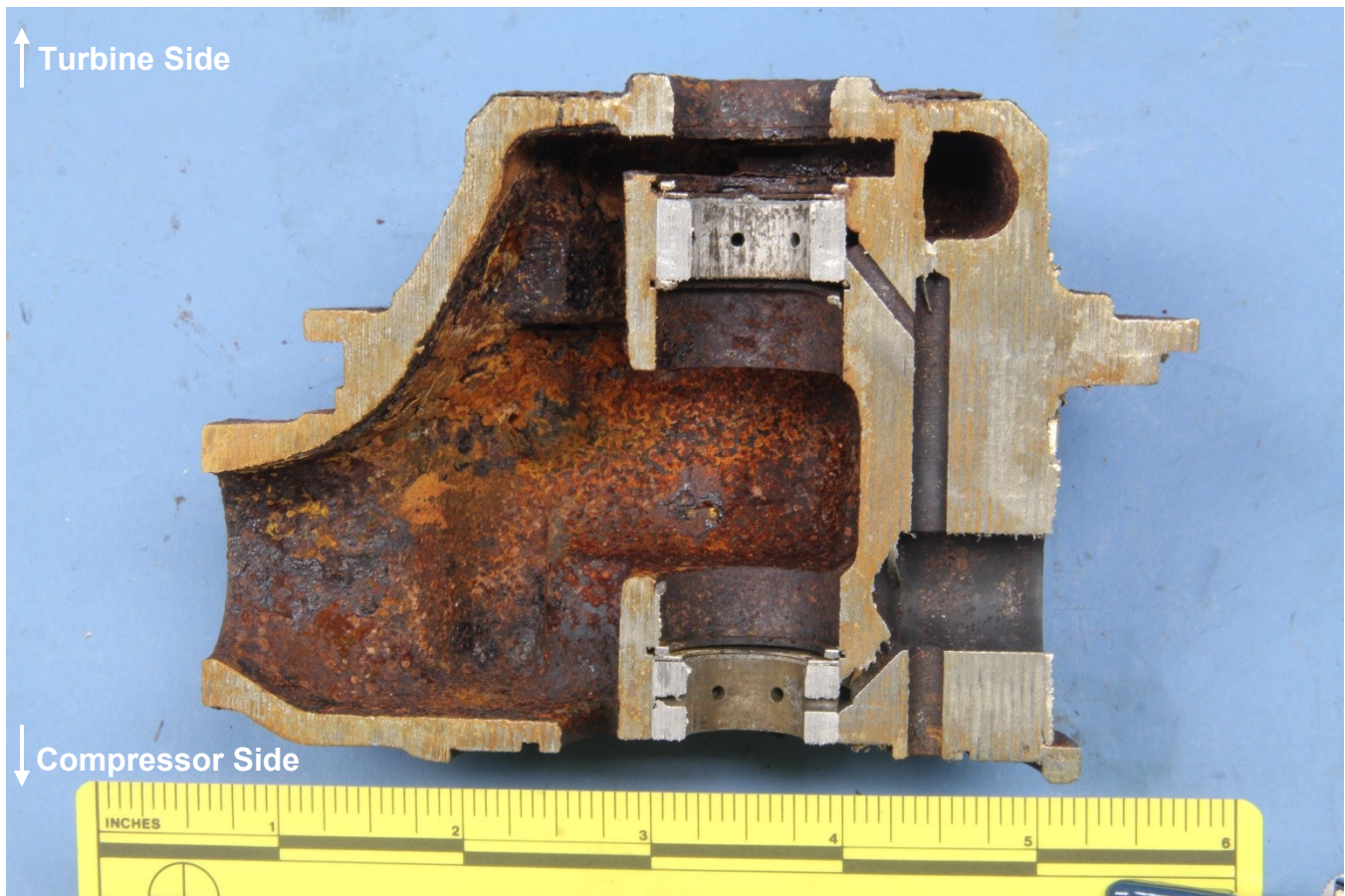


Figure 5 – The center housing, after sectioning along the center axis identified in Figure 4.



Figure 6 – The sectioned center housing of the turbocharger, showing the location of the turbine wheel along the internal bearings.



Figure 7 – A closer view of the sectioned turbine side bearing inside the center turbo housing.



Figure 8 – A closer view of the sectioned turbine side bearing inside the center turbo housing.

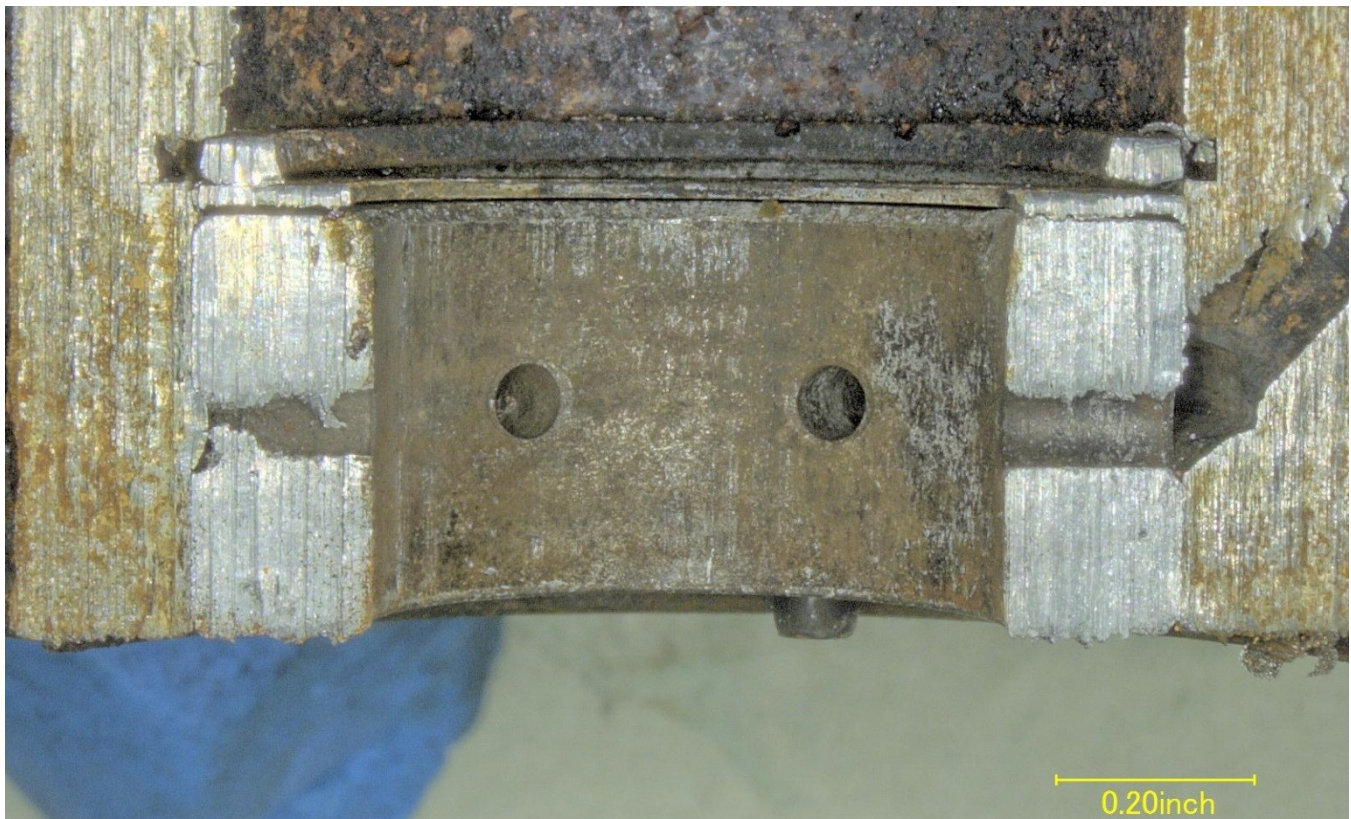


Figure 9 – A closer view of the sectioned compressor side bearing inside the center turbo housing.



Figure 10 – The turbine wheel assembly, showing both fractured portions of the shaft segment from the compressor side.



Figure 11 – Witness marks on the turbine side of the wheel.



Figure 12 – The turbine side of the turbine wheel shaft, which mated against the turbine side bearing in the center turbine housing. The shaft shows rotational and longitudinal wear marks.



Figure 13 – The accident oil check valve (above) and an exemplar (below).

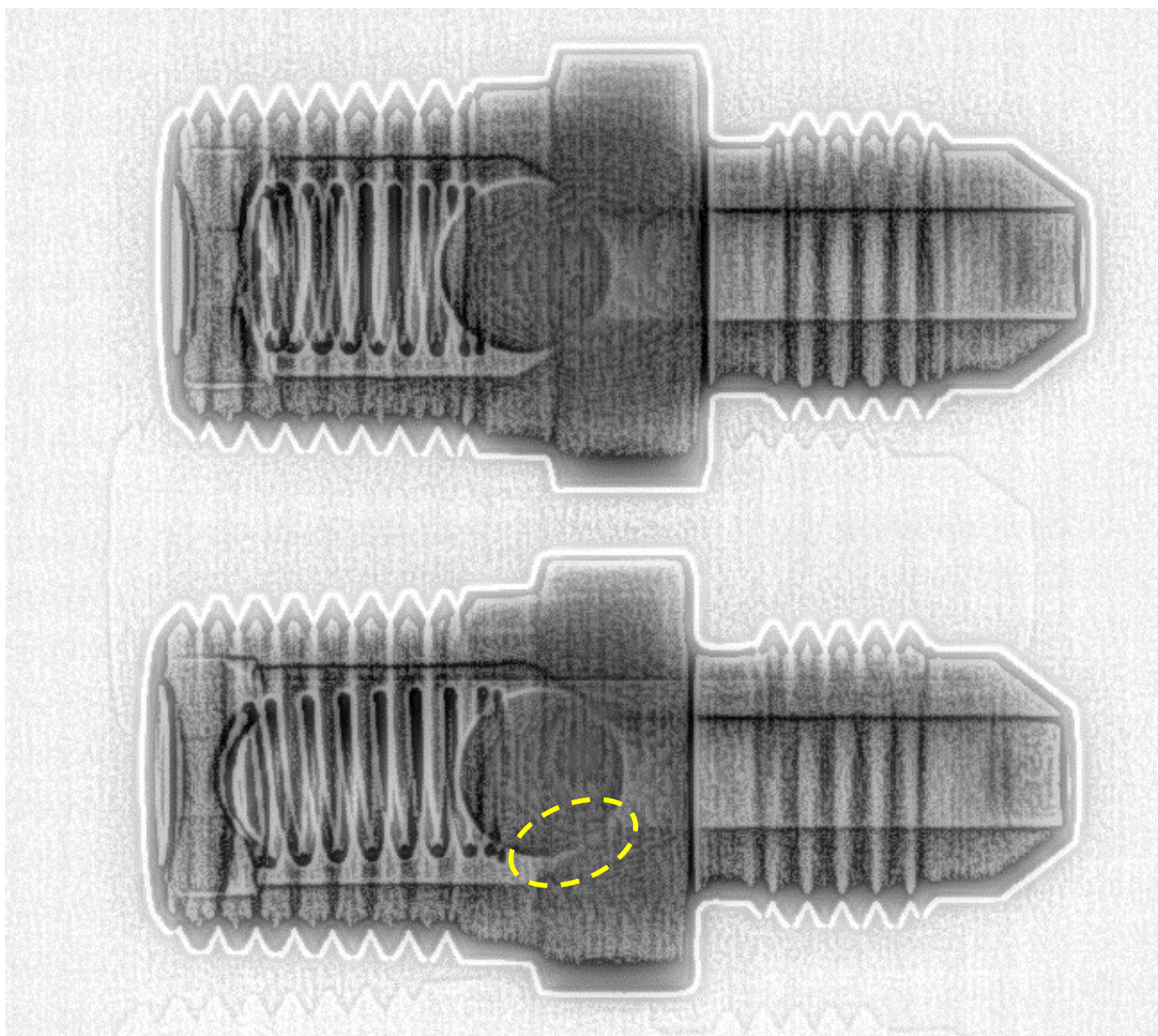


Figure 14 – Radiograph of the exemplar (top) and accident (bottom) check valves. The circled area shows a gap between the ball valve and the shoulder wall. Radiograph was taken at 140 kV and 210 μ A.



Figure 15 – The accident check valve, after sectioning the inner channel, with the spring and ball still present.



Figure 16 – Closer view of the ball valve of the accident check valve, showing a gap (arrow) with foreign material.

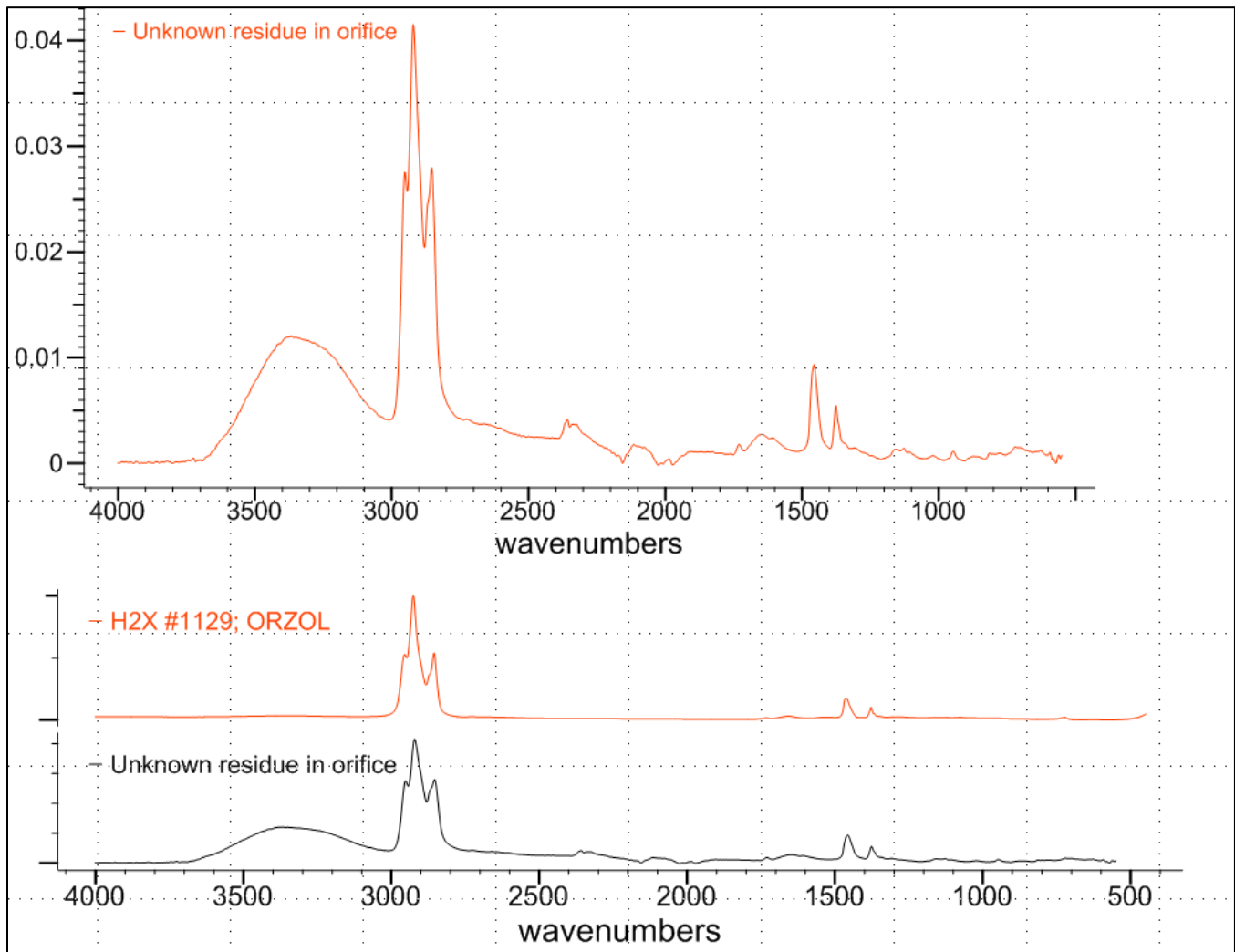


Figure 17 – FTIR spectra of the debris found in the accident oil pressure supply line check valve, compared to lubricating oil.



Figure 18 – The mating side of the sectioned accident check valve, showing contamination in the channel.



Figure 19 – One of the exemplar check valves, after sectioning.

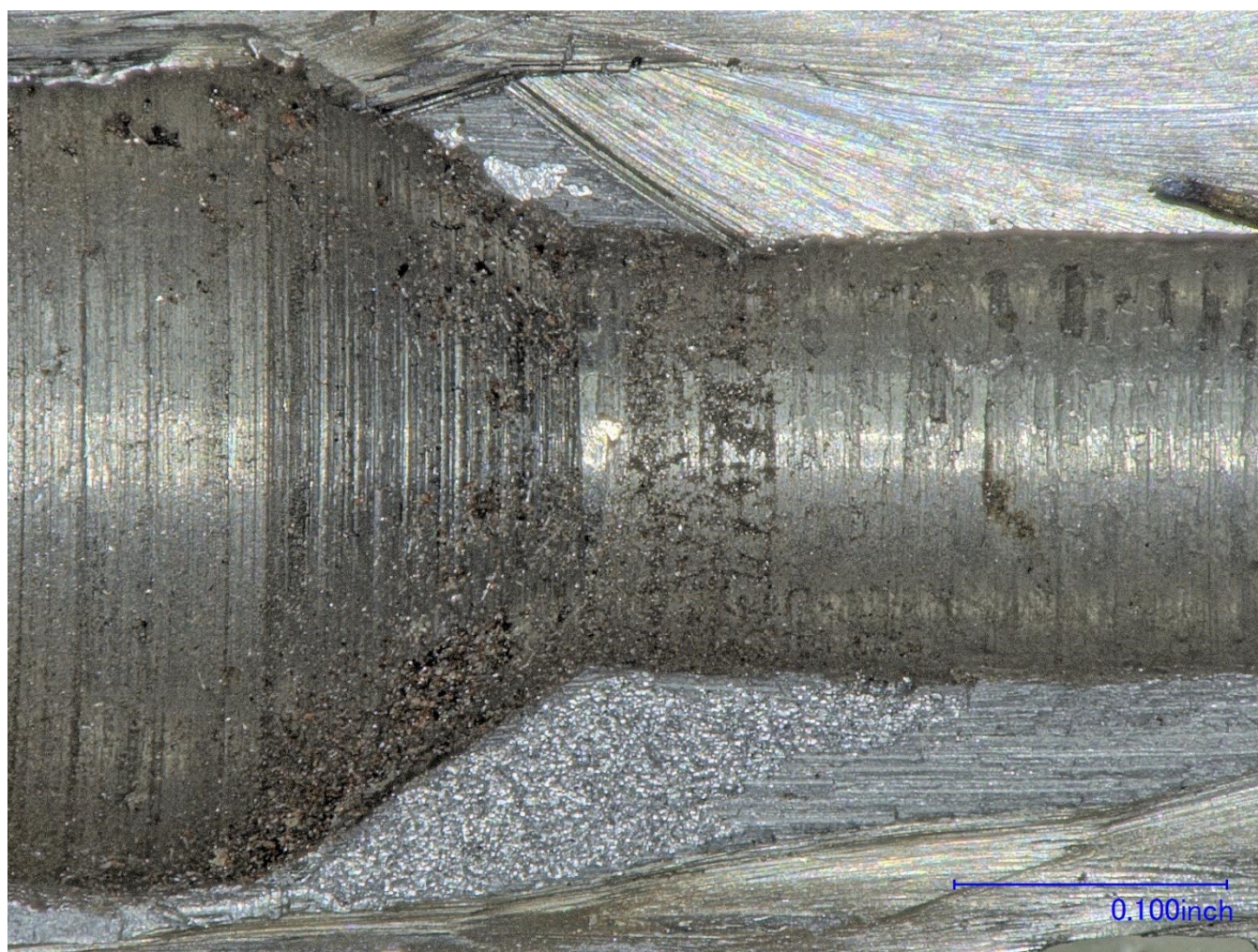


Figure 20 – Closer view of the channel in the exemplar check valve, after sectioning.



Figure 21 – The mating side of the sectioned check valve from Figure 19, showing the position of the ball and spring.