

On April 17 and 18, 2014, the fuel shut off valves (FSOV) from the Garrett TPE331-5-511K engines that were installed on the Gulfstream Commander 690C, N840V, that crashed at Bellevue, Tennessee, on February 3, 2014, were disassembled and examined at National Flight Services Component Repair and Overhaul facility, Holland, Ohio. National Flight Services is an FAA Part 145 Repair Station, No. DSCR311D. The National Flight Services Component Repair and Overhaul facility is a Honeywell authorized TPE331 component overhaul and repair center. Present for the disassembly and examination were representatives from the NTSB, Honeywell, and National Flight.

The two FSOVs were in boxes sealed in bags, although the boxes had been opened prior to the arrival of the NTSB and Honeywell representatives.

Left engine fuel shut off valve

The left engine's FSOV was part number (PN) 394230-4-1, serial number (SN) P7984. The lower body of the left engine's FSOV was marked with the left engine's SN and a capital L. (Photo No. 1)



Photo No. 1: Close up view of the lower body of the FSOV showing engine serial number and the letter L. (Honeywell)

The FSOV was complete from the top of the manual shutoff lever cover to the bottom at the fuel inlet port. The exterior of the FSOV was sooted. (Photo No. 2) The wire connector was in place on the side of the FSOV, although the wire harness to the connector had been cut about 6 inches from the connector. The manual shut off lever was in place on the spindle. The spindle was rotated so that the index mark on the spindle end was pointed to the left as viewed looking directly at the spindle end, which is 180° opposite from the normal closed position. (Photo No. 3) The front of the manual shutoff lever cover was dented on the left side.



Photo No. 2: View of front of left engine's FSOV showing sooted body.



Photo No. 3: Close up of manual lever arm spindle with indexing line pointing to left.

Before the cover was removed, the electrical connector and wire was removed from the FSOV. The inside of the connector was filled with soft black material. After the material was cleared from the connector, the continuity between pins A and C, B and C, and pins to case were checked and showed the circuits were open. After the cover was removed, it was noted that the fabric cover over the wires was in place and intact. When the fabric material was pulled back it was noted that the insulation on the wires to the switches was partially melted. The switches were in the closed position. The switches and the surrounding area were sooted. When electrical power was applied to the switches, there was no current draw and the switches did not actuate. When electrical power was applied to the solenoids using jumper wires past the switches, the

solenoids would open and close. Using a variable voltage power source, it was noted that the open and close solenoids would activate at around 11 Vdc. It was further noted that the resistance across the solenoids was about 8Ω . In comparison, the opening and closing voltage and resistance on an exemplar solenoid was about 11 Vdc and 8Ω , respectively.

The manual lever spindle frame was intact. The frame appeared to be sooted. There were clumps of fibrous material around the spindle frame and the switches. (Photo No. 4) The manual lever spindle was rotated so that the flat was facing downward, which is the closed position. The leaf springs were in place and when they were removed, they still had their spring resistance. The O-rings were dry and broken up. The ball was stuck in the opening of the Vespel bushing. (Photo No. 5)



Photo No. 4: Close up of top of fuel shut off valve with cover removed showing fibrous material.

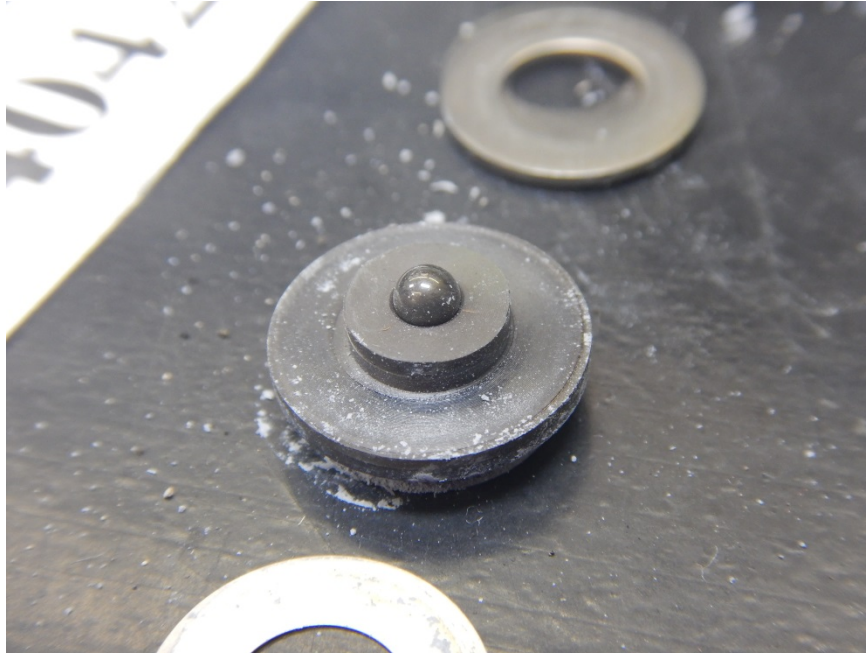


Photo No. 5: Close up of ball embedded in the Vespel seal seat. (Honeywell)

The Belleville washer was in the closed position. The Belleville washer was intact and there was no apparent damage to either side of the washer. (Photo No. 6) The Belleville washer could be moved between the open and closed position with finger pressure. The underside of the washer had a coating that was flaking off. (Photo No. 7) According to Honeywell, the engineering drawing shows the underside of the washer has a dry film lubricant applied. The FSOV poppet was the long stem configuration which is the -4 configuration and shows that the FSOV was pre-Service Bulletin (SB) TPE331-73-0208 that was issued on May 20, 1993. (Photo No. 8) According to Honeywell, SB TPE331-73-0208 was a category 2 bulletin meaning that it must be complied with when the component is accessible.



Photo No. 6: Close up of Belleville washer showing that it is intact.



Photo No. 7: Close up of back side of Belleville washer showing coating peeling off.



Photo No. 8: View of poppet stem showing it is a long stem and does not have the ball end.

Right engine fuel shut off valve

The right engine's FSOV was missing the data plate, so the PN and SN could not be determined. The FSOV's lower body was marked with the right engine's SN and a capital R. (Photo No. 9)



Photo No. 9: Right engine's FSOV lower body showing it marked with the engine serial number and the letter R.

The FSOV was complete from the top of the manual shutoff lever cover to the bottom at the fuel inlet port. The exterior of the FSOV was sooted. (Photo No. 10) The wire connector was in place on the side of the FSOV, although the wire harness to the connector had been cut about 6 inches from the connector. The manual shut off lever was in place on the spindle. The spindle was rotated so that the index mark on the spindle end was pointed 90° to the right as viewed looking directly at the spindle end, which is the normal direction of rotation. (Photo No. 11) The manual shutoff lever cover was buckled and partially melted.



Photo No. 10: Left engine's FSOV showing body sooted and cover partially melted.



Photo No. 11: Close up view of manual lever arm spindle

showing indicator line pointing to the right. (Honeywell)

Before the cover was removed, the electrical connector and wire was removed from the FSOV. The inside of the connector was filled with soft black material. After the material was cleared from the connector, the continuity between pins A and C, B and C, and pins to case were checked and showed the circuits were open. After the cover was removed, it was noted that the fabric cover over the wires was in place and intact. When the fabric material was pulled back it was noted that the insulation on the wires to the switches was melted. The switches were in the closed position. The switches and the surrounding area were sooted. When electrical power was applied to the switches, there was no current draw and the switches did not actuate. When electrical power was applied to the solenoids using jumper wires past the switches, the solenoids would not actuate even when the voltage was increased to 24 Vdc.

The manual lever spindle frame was broken on the right side as viewed looking at the front of the valve. The fracture surfaces were coarse and grainy and the edges appeared to have shear lips. (Photo No. 12) The frame appeared to be sooted. The manual lever spindle was rotated so that the flat was facing downward, which is the closed position. The leaf springs were in place and when they were removed, they still had their spring resistance. The O-rings were dry and broken up. The ball was loose, which is normal. (Photo No. 13)



Photo No. 12: Close up view of base of manual lever arm spindle support broken on right side.

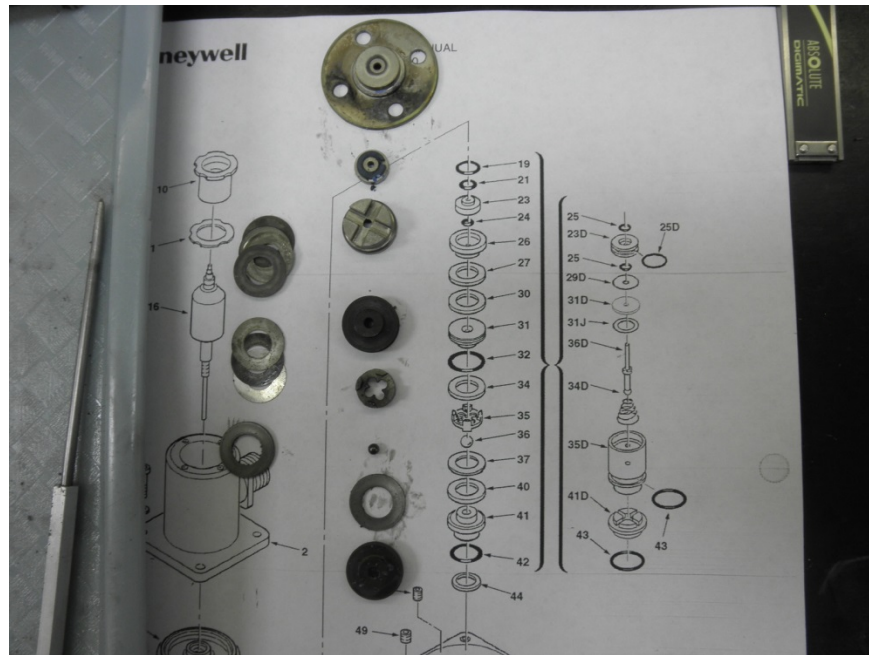


Photo No. 13: View of pieces including the ball, Vespel seal seat, and shims over the respective page of the Illustrated Parts Catalog.

The Belleville washer was in the closed position. The Belleville washer was intact and there was no apparent damage to either side of the washer. (Photo No. 13) The Belleville washer could be moved between the open and closed position with finger pressure. The FSOV poppet was the long stem configuration which is the -4 configuration and shows that the FSOV was pre-Service Bulletin (SB) TPE331-73-0208. (Photo No. 14)



Photo No. 14:



Photo No. 15: View of poppet stem showing it is a long stem and does not have the ball end.