

## Bearskin Airlines Uncommanded Engine Shut Down in Flight – Fuel Shut Off Valve Malfunction – In Flight Shut Down

- a. 2009-June-14 – [REDACTED]
- b. Engine Shut Down in Flight – by Fuel Shut Off Valve Malfunction.

Aircraft [REDACTED]

Right Hand Engine S/N: P44659C

Engine Model: TPE331-11U-612G

TSO: 3104.2 hours

Note: Engine last CAM inspected by Bearskin Airlines Turbine Shop per JC318P, 5 June 2007.

On June 14th on flight [REDACTED] from [REDACTED] to [REDACTED] the right engine of [REDACTED] lost power and was shut down during decent into [REDACTED]. Pilot, [REDACTED] was at the controls in the right seat and [REDACTED] was in the left seat. They were approximately 10 miles from [REDACTED], descending through about 3500ft (clear of cloud) at an indicated airspeed of about 200 knots torque was set to approximately 35 percent and the props were set at 97 percent. All engine indications were normal preceding the failure.

As the engine failed they felt a small deceleration of the aircraft and the pulsing of the NTSing prop. [REDACTED] looked at the gauges and noticed that torque was zero, and RPM and EGT were deteriorating, and fuel flow was at 50PPH.

[REDACTED] then asked [REDACTED] to confirm that the right engine had failed, [REDACTED] did so and they proceeded to shutdown and secure the right hand engine as per SOP. The flight crew had no problem landing the aircraft with one engine shut down.

Weather at the time of the shutdown was broken clouds based at about 3000 AGL, light winds, 16 degrees and no precipitation of icing during the flight. Turbulence on the decent was light.

Earlier during the day [REDACTED] noticed that the right engine was slower to shutdown than the left, although not in a manner that appeared to be abnormal. Maintenance was informed. Additionally, on departure from [REDACTED] on flight [REDACTED] there was an electrical anomaly where we had a battery fault indication and both batteries came off line, then came back on line by themselves and then the right generator came off line. [REDACTED] reset the right generator and turned it back on, then verified that all busses were being powered and the generators were sharing the electrical load. All was normal afterwards. The occurrence seemed odd but did not repeat itself and we don't know whether it had and bearing on the subsequent engine shutdown.

[REDACTED] Maintenance got the call from [REDACTED] from [REDACTED], explaining that they had the R/H Engine shutdown in flight going into [REDACTED]. [REDACTED] took the call. They had declared an emergency and landed without incident. [REDACTED] asked him if it tried to relight and he said he did not know if the ign. came on for sure but it did feather. [REDACTED] got them to try to start it again and it started with no problems. He pulled 50 % torque and all was okay. [REDACTED] got them to start it again and see if it would make target torque but it would not. The engine only went to about 20 % Torque and flamed out again. They tried another start and this time it flamed out when they put the speed levers to high. To go along with this, more than likely unrelated, about 10 min. prior to the in flight flameout both batteries kicked off line then they came back on their own. Then the R/H Gen. kicked off line, they reset it and had no further problems with the Batteries or Gen. On another note, [REDACTED] called earlier in the day and mentioned that he wanted to make sure we had parts in [REDACTED] for Sunday night for another issue he was having. He said that the R/H engine

did not seem to be shutting down the same as the L/H; Almost as if, the fuel shut off wasn't closing totally. [REDACTED] made sure they had one and sent them a purge solenoid.

[REDACTED] in the engine shop, got called in by [REDACTED]. On Sunday evening at 9:00 pm. [REDACTED] told us they had another flame out upon approach in [REDACTED], [REDACTED] was flying, He did not try to restart the engine and just landed the aircraft, When he got on the ground he called Maintenance and they told him to go and start it and give it a try, It started okay and appeared to have no problems, He called and talked to [REDACTED], [REDACTED] suggested he go outside and try several ground runs (per above). [REDACTED] was working when [REDACTED] got in to help them find a FCU / Fuel Pump Assembly. [REDACTED] removed a serviceable assembly off one of our engines in the shop, S/N P44205C. The FCU is zero time since overhaul and the Fuel pump has only 3371.6 Hrs TSO. The FCU being removed is POST A73-0254 and has approximately 150 hour remaining to overhaul. This FCU is the unit that [REDACTED] made a Job Card to remove and evaluate for spline wear from before. [REDACTED] is going to [REDACTED] on [REDACTED] and will be changing the FCU and Fuel Pump Assembly and doing additional engine troubleshooting. Also, [REDACTED] was going to send an Auto Ignition Switch and a Fuel Shut Off Valve with a few more odds and ends just to make sure everything works.

The removed POST A73-0254 FCU / Fuel Pump Assembly was forwarded to the Engine Shop where it was split and the FCU Input Drive between the FCU and the Fuel Pump was visually checked for spline wear on the external Vespel Splines. The Splines were measured using 0.050 inch pins in three different locations around the diameter. They measured 0.418, 0.412, and 0.416 inch. This seemed okay as these numbers are in the range for PRE A73-0254 FCU Splines; Unfortunately, no dimensions or procedure is published in the Honeywell Maintenance Manual for POST A73-0254 Spline inspection. However, NO appreciable wear was seen during a close visual examination of the Vespel Splines. This FCU seemed hard to turn over when turning the input drive over by hand. It appeared to have a lot of drag when compared to other POST style FCU's we have checked. This FCU P/N 897801-4, S/N 1992152, was sent down to [REDACTED] for an as received run, external and internal Spline inspection, evaluation and overhaul.

[REDACTED] Maintenance determined that the cause of the in flight shut down was due to a malfunctioning right hand Fuel Shut Off Valve and replaced this unit. Fuel Shut Off Valve, S/N P6160 was removed. Engine ground runs were completed for over an hour and all systems checked good. Ref: Log Sheet A174137. A Test Flight was completed and all engine parameters checked serviceable.

The removed Fuel Shut Off Valve has 4,206.3 hours TSO. The same FSOV was involved in an engine flame-out situation in December of 2002. However, it is not known if this is a related problem as that engine, which flamed out during preflight take off checks, happened seven years ago and since then this FSOV has been tested, overhauled, and has run for approximately 11,206 hours. At that time, after the flame-out situation the FSOV was tested, no fault was recorded, and no repair was made to the unit. This FSOV was last overhauled by [REDACTED] on 16 June 2006.

On 18 June 2009, the removed, suspect FSOV was installed on the left hand side of [REDACTED] for testing purposes. The engine was run at various power settings with no faults found; but, when they went to shut down the engine with the stop button, the engine would hang at 30%, with about 50 to 70 lbs Fuel Flow, then had to be shut down manually. This was tried several times with the same results.

The suspect FSOV, P/N 394230-9-1, S/N P-6160C, will be sent to [REDACTED] for evaluation and the results will be forwarded to [REDACTED]. This report will be updated following the individual component investigations.

Here are the findings from the investigation of the Fuel Shut Off Valve with [REDACTED] in [REDACTED] conducted by [REDACTED] and [REDACTED] of [REDACTED]:

### **F.S.O.V. Serial # P-6160C - involved in an in flight shutdown on engine P44659C:**

#### **Functional bench test observations**

- unacceptable leakage in the closed position (cause of hanging shutdown)
- opening action functioning properly with voltage and flows in limits
- manual closing action functioning properly
- electric closing action functioning within limits but with an unusually low voltage of 5.8V required to close the valve. Limit is "must close under 17.0 Volts", normally observed is 12-14 volts.
- rigging adjustments on the manual lever proved to prevent the valve from opening at all, ruling out any possibility of a missed rigged valve closing in flight. An out of rig valve would not allow the engine to start at all.

#### **Disassembly and Inspection observations**

- ball and seat (similar to a small carburetor) showed wear and determined to be the cause of the leak at shutdown. The steel ball had a ridge worn into it from the Vespel (plastic) seat.
- the latch assembly houses the spring washer which was found **cracked**. This spring is a large thin coned washer that snaps "coming up" and snaps "coming down", driving the ball into its seat. The crack in the spring washer caused it to partially snap with very little force, practically on its own. We believe this would have been enough movement to drive the ball towards the seat limiting or cutting off fuel flow to the engine and ultimately flaming out the engine.

#### **Recommendation**

There is only a visual inspection on this part and is not typically found damaged and is returned to service. These latch assemblies may be original to the valve which could have been manufactured as far back as 1960's. [REDACTED] will be FPI inspecting these parts at overhaul for Bearskin from now on. I recommend that we should start changing out FSOV's and have them Overhauled or disassembled, to accomplish F.P.I. on the spring washer and have the FSOV functionally tested until all our FSOV's have had the FPI inspection.

We should start with any valves that show signs of any leakage at shutdown because leakage may also be caused by a weak or possibly cracked spring washer not driving the ball into the seat hard enough.

This valve is currently quarantined at [REDACTED] and they are replacing it with a freshly overhauled one at no charge.

[REDACTED] has quoted me \$250/valve for the FPI inspection and bench test, and \$950/valve for a flat rate overhaul exchange with FPI inspection. [REDACTED] is prepared to supply us with overhauled exchanges if we would like to change out ours as quickly as possible.

**F.S.O.V. Serial # P-3537C - hanging at normal engine shutdown**

██████████ right hand engine P44659.

This was the FSOV that we installed after the In flight shut down (to replace s/n P-6160C) but latter also caused problems:

**Functional bench test observations**

- unacceptable leakage in the closed position (cause of hanging shutdown)
- opening action functioning properly with voltage and flows in limits
- manual closing action functioning properly
- electric closing action functioning properly, voltage of 14V required to close the valve.

**Disassembly and Inspection observations**

- ball and seat showed wear and determined to be the cause of the leak at shutdown. the steel ball had a ridge worn into it from the vespel (plastic) seat.
- the spring washer in the latch assembly was visually inspected and appeared OK. FPI to be completed.

**Recommendation**

Bearskin should perform a part reliability report to determine if a snag trend exists. If so, ██████████ should be notified that there FSOV design should be improved to increase reliability between overhaul periods (make a better ball and seat to last 7000hrs). This snag is easy to trouble shoot and the FSOV can be changed easily.

This valve is currently being overhauled at ██████████ at no charge. The spring washer will be FPI inspected. See archived pictures of the cracked spring washer, grooved valve ball, and ball and seat arrangement.

At OH no FPI inspection is required on the spring washer. We recommend that it should be an FPI inspection and needs to be accomplished at every overhaul. We also recommend that really old Fuel Shut Valves have the latch Assy upgraded. We will add these requirements to the PO, when sending them out, and will have this as a custom build spec. item with the fuel shut off valve overhaul agencies.

**Conclusions and Closing Remarks**

Additional NDT (eddy current) inspection of the Latch Assembly has been added to our custom build specification to be accomplished at each FSOV overhaul. This problem was illustrated to ██████████ and the ██████████ by ██████████ at the ██████████ meeting in order to make the manufacturer, other operators and overhaul companies aware that no crack detection is currently called out per the overhaul manual/ component maintenance manual requirements. This item is important and it was stressed in great detail, that this situation needs to be reviewed and corrected by ██████████. In addition, ██████████ explained this problem to ██████████ for review and it was recorded as an action item at the ██████████.

Update from [REDACTED] Meeting, Jan. 2010

This matter was again discussed during our visit to [REDACTED] at the [REDACTED] [REDACTED]. Reference Bearskin Engineering report [REDACTED].

This was reviewed in depth with the [REDACTED]  
[REDACTED]  
[REDACTED]

We reviewed Fuel Shut off Valve, p/n 394230-9-1, reliability problems, a failed unit caused interrupted fuel flow to one of our engines and this caused an un-commanded shut-down of the engine. The latch assembly (integral to the FSOV) houses a spring washer which was found cracked. The spring washer is a large thin coned washer that snaps "coming up" and snaps "coming down", driving the ball into its seat. The crack in the spring washer caused it to partially snap shut with very little force, practically on its own. Cutting off fuel to the engine. No crack detection is currently called out per the overhaul manual/ component maintenance manual requirements. Additional NDT inspection of the Latch Assembly is required. [REDACTED] agrees and needs a copy of our report from [REDACTED]. This report was sent in.