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ATSB TRANSPORT SAFETY REPORT
Aviation Occurrence Investigation AO-2008-060
Final

Fuel system event
50 NM north-east Brisbane Airport, Qld
2 September 2008

INFRA-08449

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Abstract

On 2 September 2008, at about 0845 Eastern Standard Time (EST), while climbing through flight level 250, en route from Brisbane, Qld to Honiara, Solomon Islands, fuel started venting/leaking from both main wing tanks of the Embraer RJ 190-100 LR, registered VH-SXK. The aircraft, with five crew and 40 passengers on board, returned to Brisbane. The fuel venting/leakage was later determined to be the result of a design issue related to maintaining positive air pressure in the fuel surge tanks in the aircraft's wings. The aircraft manufacturer had previously identified the fuel system design issue and has developed a new float vent valve design to eliminate the problem. The design change has been introduced into newly manufactured aircraft and a service bulletin with recommendations to replace the current float vent valve with a redesigned valve will be issued in 2009.

FACTUAL INFORMATION

The information presented below, including any analysis of that information, was prepared principally from information supplied to the Australian Transport Safety Bureau.

On 2 September 2008, at about 0845 Eastern Standard Time[1], while climbing through flight level (FL) 250, en route from Brisbane, Qld to Honiara, Solomon Islands, a regular fare paying passenger-carrying Embraer RJ 190-100 LR aircraft, registered VH-SXK, sustained a fuel leak from both main wing tanks.

The flight crew later reported that, as they flew through moderate turbulence, they were notified by the cabin crew (the aircraft had two flight crew, three cabin crew and 40 passengers) that 'vapour' was streaming from both wing tanks. The pilot in command walked back to check and confirmed fuel streaming at a high rate from both wings (Figure 1).

Figure 1: Photograph taken by cabin crew of vapours from right wing during descent

The flight crew notified air traffic control that they had a problem and requested and received a clearance to return to Brisbane Airport. During the return to the airport, the aircraft reached a maximum level of FL370, with fuel still leaking. Cabin crew reported that the fuel venting/leakage momentarily stopped about 8 minutes later, but then resumed when the aircraft flaps were extended at about 4,000 ft above mean sea level on descent into Brisbane.

1 The 24-hour clock is used in this report to describe the local time of day, Eastern Standard Time (EST), as particular events occurred. Eastern Standard Time was Coordinated Universal Time (UTC) +10 hours.

After landing at Brisbane Airport, aerodrome rescue and fire fighting crews inspected the aircraft and reported no fuel leakage.

Aircraft data

The operator downloaded the data from the aircraft's flight data recorders and provided it to the Australian Transport Safety Bureau (ATSB) for analysis. The aircraft, serial number 190-0154, had accumulated 853.18 hrs total time in service when the recorders were downloaded.

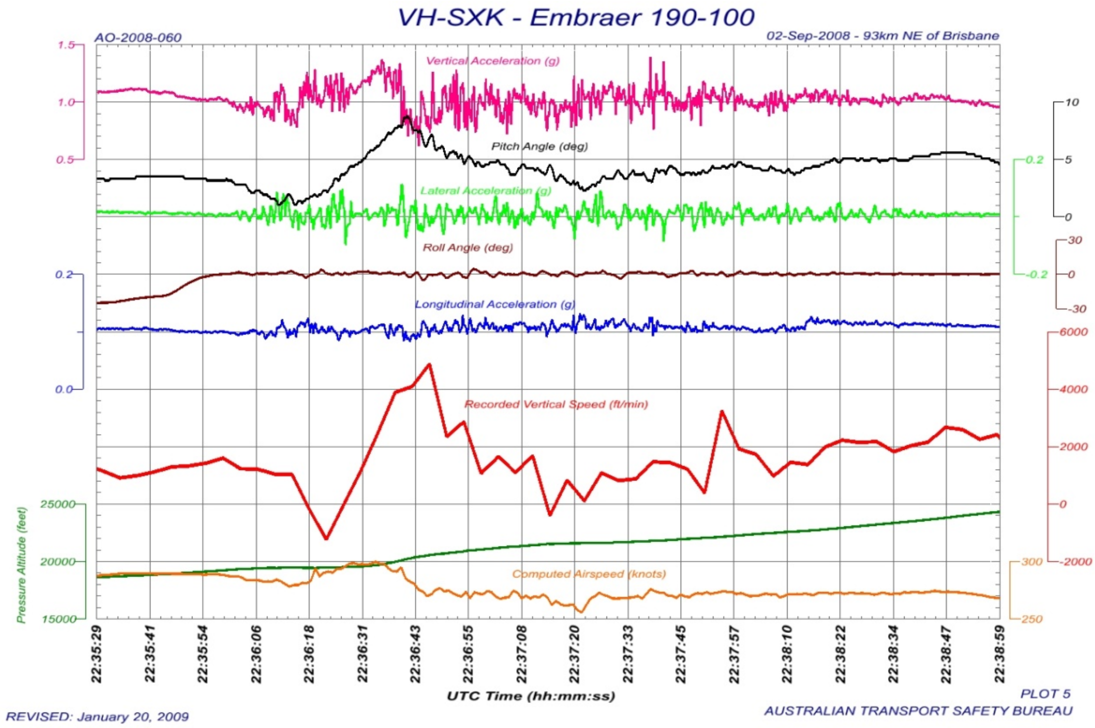
The data recovered documented that just prior to the occurrence, the aircraft was passing through FL250 at 290 KIAS[2] when it encountered turbulence (Figure 2). The turbulence recorded values ranged from 0.6 to 1.4 positive absolute g[3], a range of about 0.8 g, which lasted from about 0836:00 (22:36:00 UTC) until about 0838:30 (22:38:30 UTC).

The data also confirmed that the maximum computed airspeed was 299.75 KIAS at 0836:34 (22:36:34 UTC), momentarily decreasing to 270 KIAS before returning to 290 KIAS[4], and that the vertical speed varied from -1,232 to 4,880 ft/min, with associated variations in pitch angle.

At 0839:30 hrs (22:39:30 UTC), the data confirmed the fuel disparity between fuel burn[5] and fuel removed from the fuel tanks. According to the data, the difference was around 680 kg (1,500 lbs).

The operator reported that the aircraft departed with 12,800 kg of fuel (6,400 kg per wing tank) and that after landing and taxiing, 9,600 kg remained, with a total of 600 kg lost due to the venting/leakage.

Figure 2: Plot of recorded data



2 This was the computed airspeed expressed as knots indicated airspeed (KIAS).

3 Acceleration due to Earth's gravity, international standard value being 9.80665 m/s. Absolute g meant that 1.0 g was constantly recorded by the accelerometers as the earth's gravitational force.

4 Aircraft Turbulent Air Penetration procedures advise a maximum recommended air penetration speed of 270 KIAS at FL250.

5 Fuel actually used by the aircraft's engines.

AIRCRAFT MANUFACTURER'S BULLETINS

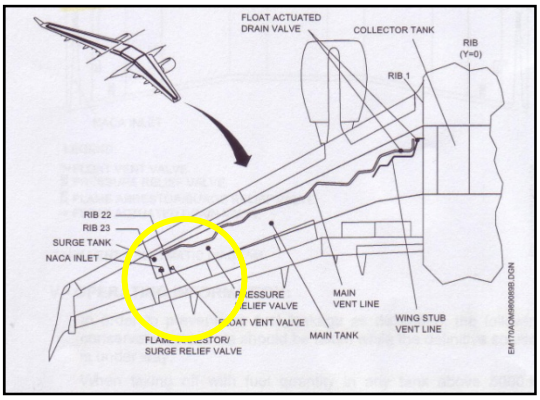
On 15 February 2007, the aircraft manufacturer released Operation Bulletin number 170-001/07 titled, *FUEL LEAKAGE THROUGH NACA INLETS*[6]. The effectivity of the bulletin was "ALL EMBRAER 190/195 AIRPLANES" and was issued to provide operators with guidance regarding possible in-flight fuel leakage. The bulletin noted an occurrence where an aircraft climbing from FL220 to FL320 with a speed above 300 KIAS, sustained a fuel leakage from the left wing NACA inlet underneath the wing.

The bulleting explained the leakage as follows:

- At high speeds, the NACA inlet air flow pattern may alter its performance in keeping positive pressure;
- The pressure inside the Surge Tank is suddenly reduced. This forces a high air flow from Wing Tank to the Surge Tank through the Float Vent Valve that jams it closed;
- Once the line between the Wing Tank and the Surge Tank is closed, the pressure inside the Wing Tank remains constant. As the airplane climbs, the outside pressure decreases generating a delta pressure between the Wing Tank and the atmosphere;
- In this condition, if the fuel level inside the Wing Tank is above the Main Vent Line end, located at the wing root, the fuel is boosted out of the wing tank to the surge tank and leaks to the atmosphere through the NACA inlet;
- The leak stops automatically after the Main Vent Line becomes uncovered.

The bulletin included a schematic of the fuel system with the area of the NACA inlet circled in yellow (Figure 3).

Figure 3: Operation bulletin fuel system[7]



The bulletin recommended the following operating information to prevent fuel leakage:

> In order to prevent the fuel leakage as described, the following conservative measure should be taken while the definitive solution is underway.
>
> When taking off with fuel quantity in any tank above 5000 kg (11000 lb), adopt the pre-set FMS [flight management system] climb schedule or maintain 290 KIAS maximum during climb until reaching cruise altitude (the recommendation also applies to step climb).
>
> If other kinds of fuel leakage are suspected, accomplish the FUEL LEAK non-annunciated procedure presented in the QRH [quick reference handbook].
>
> This Operational Bulletin is valid until the release of the definitive solution.

The operator advised the ATSB that they did not have access to the bulletin at the time of the occurrence. They reported that they utilised the aircraft manufacturer's electronic on-line document access system and that the bulletin was listed as not applicable to their fleet and was not accessible.

The aircraft manufacturer confirmed that at the time of the event, the bulletin was not available online to the operator.

6 NACA inlets (ducts) are a common form of low-drag intake design, originally developed by the National Advisory Committee for Aeronautics (the precursor to NASA) in 1945. When properly implemented, it allows air to be drawn into an internal duct, often for cooling purposes, with a minimal disturbance to the flow.

7 Figure courtesy of Embraer - Empresa Brasileria de Aeronautica SA.

The aircraft manufacturer was contacted by the ATSB to inquire as to any proposed actions to further mitigate the design issue of the fuel system. The manufacturer provided the following comment:

> The solution encountered was to develop a new float vent valve to avoid its closure during the passage of high air flow through the valve.
>
> The new valve has been implemented in our production line. Aircraft SN [serial number] 190-0243 (190/195 models) and Aircraft SN 170-0264 (170/175 models) were the first SNs delivered with the new valve.
>
> For airplanes older than SN 190-0243 and SN 170-0264, a Service Bulletin with recommendations to replace the current float vent valve by the redesigned valve will be issued this year.

ANALYSIS

The fuel vapours noted by the cabin crew during the climb were the result of fuel venting/leaking from the wing fuel surge tanks and eventually from the NACA inlet as outlined in the operational bulletin issued on the subject. The fuel leakage noted by the cabin crew during the approach to land at Brisbane Airport was likely to be the result of residual fuel released during the flap extension.

In 2007, the aircraft manufacturer identified the problem (following a similar occurrence on a similarly designed model aircraft) and issued an operational bulletin recommending aircraft operating procedures to mitigate the likelihood of a fuel leak. However, the operator did not have access to the bulletin using the aircraft manufacturer's electronic on-line document system.

Although the operator was unaware of the problem, on this occasion the aircraft was being operated generally within the recommended operating parameters when the fuel leakage occurred. However, the turbulence sustained by the aircraft during climb out, along with a momentary airspeed increase and the large variations in vertical speed, probably contributed to the fuel leakage.

FINDINGS

From the evidence available, the following findings are made with respect to the fuel systems event involving VH-SXK and should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing Safety Factors

- Under certain flight conditions, if the aircraft is equipped with a part number 2930015-102 float vent valve, the Embraer RJ 190-100 aircraft fuel system is susceptible to fuel venting/leakage through the wing NACA inlets. [*Safety issue]*
- The aircraft manufacturer did not make Operation Bulletin number 170-001/07 available to the operator on their electronic on-line document access system. *[Safety issue]*
- During climb out while passing through FL250 at 290 KIAS, the aircraft encountered turbulence and large variations in vertical speed, which probably permitted positive pressure in the main wing fuel surge tanks to decrease, allowing fuel to leak from the NACA inlets.

Other Safety Factor

- The aircraft computed airspeed values momentarily exceeded the climb schedule and airspeed recommended by the aircraft manufacturer's Operation Bulletin number 170-001/07.

SAFETY ACTION

Susceptibility to fuel venting

Safety Issue

Under certain flight conditions, if the aircraft is equipped with a part number 2930015-102 float vent valve, the Embraer RJ 190-100 aircraft fuel system is susceptible to fuel venting/leakage through the wing NACA inlets.

Action taken by the aircraft manufacturer

The aircraft manufacturer had identified the fuel system design issue and developed a new float vent valve design to eliminate the problem. The design change was introduced into newly manufactured aircraft and a service bulletin with recommendations to replace the current part number 2930015-102 float vent valve with the redesigned part number 2060091-101 valve will be issued in 2009.

No operator access to bulletin

Safety Issue

The aircraft manufacturer did not make Operation Bulletin number 170-001/07 available to the operator on their electronic on-line document access system. *[Safety issue]*

Action taken by the aircraft manufacturer

On 2 September 2008, the aircraft manufacturer issued a revised applicability list, modifying the referred bulletin as applicable and making it downloadable by the operator.

SOURCES AND SUBMISSIONS

Under Part 4, Division 2 (Investigation Reports), Section 26 of the Transport Safety Investigation Act 2003, the Executive Director may provide a draft report, on a confidential basis, to any person whom the Executive Director considers appropriate. Section 26 (1) (a) of the Act allows a person receiving a draft report to make submissions to the Executive Director about the draft report.

A draft of this report was provided to the Civil Aviation Safety Authority, the operator and aircraft manufacturer for comment.

Submissions were received from the Civil Aviation Safety Authority, the operator and the aircraft manufacturer. The submissions were reviewed and where considered appropriate, the text of the report was amended accordingly.