Australian Government

Australian Transport Safety Bureau

Fuel starvation event involving a Beech BE58, VH-ECL

111 km E of Tindal Airport, Northern Territory, 14 August 2013

ATSB Transport Safety Report

Aviation Occurrence Investigation

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Addendum

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Fuel starvation event involving a Beech BE58, VH-ECL

What happened

On 14 August 2013, at about 0830 Central Standard Time,[1] the pilot of a Beech BE58 aircraft, registered VH-ECL (ECL) (Figure 1), was preparing for a charter flight from Tindal to the Borroloola aeroplane landing area (ALA), Northern Territory.

Figure 1: VH-ECL

Source: Operator

The previous night, the pilot received details of the flight. Using the operator's elected fuel flow rate for the aircraft of 125 L/hr, the pilot calculated that a minimum of 545 L of fuel was required. The pilot elected to carry 570 L.

On the following day, in preparation for the flight, the pilot referenced the flight data log (FDL),[2] which indicated that about 267 L of fuel was onboard the aircraft. Consequently, the pilot refuelled the aircraft by adding about 153 L into each of the main fuel tanks.[3] The pilot then conducted fuel drains and found no contaminants present. The pilot also reported that, when conducting engine run-ups, the fuel quantity gauges were indicating as expected.

The passengers boarded the aircraft and the flight departed Tindal.

During the cruise, the pilot observed the fuel quantity gauge for the right main fuel tank reading zero, but the fuel flow, and engine temperature and pressure indications were normal.

The aircraft landed at Borroloola and the passengers disembarked. The pilot re-checked the fuel calculations and determined that there was sufficient fuel on board for the return trip. The pilot noted that the right fuel quantity gauge was still reading zero and the fuel quantity gauge for the left main tank was indicating about ¾ full.

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1 Central Standard Time was Coordinated Universal Time (UTC) + 9.5 hours.

2 The amount of fuel uploaded and amount of fuel used during a flight is recorded on the FDL. From this, pilots can determine how much fuel is onboard the aircraft.

3 The aircraft was fitted with main and wing tip fuel tanks in each wing. On each side, the main and wing tip tank were interconnected and fuel used was drawn from the combined tanks. Filling the main tanks resulted in a 'known' fuel quantity of 628 L when both the left and right main tanks were full.

On the return flight, when about 50-60 NM from Tindal, the right fuel flow gauge dropped to zero. The pilot immediately placed the fuel mixture for the right engine in the full forward position and observed the right fuel flow gauge fluctuate, before returning to zero. The pilot completed the engine failure emergency checklist and determined that the most likely reason would have been insufficient fuel remaining in the right main tank. The pilot also reviewed the fuel calculations performed prior to the flight, which indicated that there should have been fuel remaining in the right main tank.

The pilot shut down the right engine and elected not to cross-feed fuel from the left main fuel tank into the right main fuel tank as the cause of the apparent excessive fuel burn on the right engine could not be determined.

The pilot notified air traffic control and conducted a single-engine landing at Tindal.

The useable fuel on board the aircraft after landing was later determined as 98 L in the left tanks and 0 L in the right tanks.

Aircraft information

The pilot reported that, due to the design of the aircraft's wings, it was not possible to determine the fuel quantity in each tank by visual inspection, unless the main tank and/or wing tip tank was full. Due to the wing dihedral,[4] the fuel filling points on each wing were positioned higher than the substantive volume of the fuel tanks. Consequently, when the fuel tanks were less than full, if a dipstick were used through the filling points, it would indicate low or nil fuel was onboard, but fuel would be remaining below the filling point.

The aircraft was fitted with internal fuel quantity gauges in the cockpit and external (direct reading) gauges on each wing.[5]

Fuel quantity and fuel flow determination

Fuel quantity

The exact quantity of fuel in the tanks could only be determined when the aircraft was fully fuelled. Fuel quantity was then estimated from when the tanks were last filled up to full and the calculated fuel remaining as recorded on the FDL. The internal fuel gauges provided a representation of the fuel onboard in quarterly increments. The direct reading gauges were calibrated between 182 L (40 US Gallons) and 227 L (60 US Gallons), but not precise outside of that range.

Fuel flow

The fuel flow rate for the aircraft was determined from the aircraft's operating handbook. This was then compared to 'actual' fuel flow rate figures recorded on the FDL. The operator also kept a spreadsheet of the fuel burn and provided monthly trend data to the company pilots. Based on this information, the operator had distributed a memorandum to pilots regarding ECL, stating that the right engine was using more fuel than the left engine.

The pilots had also been advised to use a fuel flow rate of 125 L/hr for ECL. The pilot on the incident flight reported that, prior to this; they had been using a rate of 130 L/hr.

ECL had last been filled to full on 16 May 2013 and 9,750 L of fuel had been added since that time.

4 Dihedral is the acute angle between the wing and the lateral axis.

5 The internal gauges were electric free floating within the bladder tanks in the wings and interlinked to the gauge in the cockpit. The direct gauges were mechanical, floating on a screw that adjusts the gauge.

Engineering inspection

After the incident, an engineering inspection of the internal and direct reading fuel gauges was conducted. The internal gauges were consistent through the range of testing, but the direct reading gauge for the right tanks was unserviceable. The day after the incident, the direct reading gauge was reading correctly, indicating that it may have become stuck and then resolved again. It was determined that the right internal fuel quantity gauge was intermittently faulty.

Guidelines for aircraft fuel requirements

The Civil Aviation Safety Authority Civil Aviation Publication (CAAP) 234-1(1): Guidelines for Aircraft Fuel Requirements[6] states that:

> Unless assured that the aircraft tanks are completely full, or a totally reliable and accurately graduated dipstick, sight gauge, drip gauge or tank tab reading can be done, the pilot should endeavour to use the best available fuel quantity cross-check prior to starting. The cross-check should consist of establishing fuel on board by at least two different methods…

Safety action

Whether or not the ATSB identifies safety issues in the course of an investigation, relevant organisations may proactively initiate safety action in order to reduce their safety risk. The ATSB has been advised of the following proactive safety action in response to this occurrence.

Operator

As a result of this occurrence, the aircraft operator has advised the ATSB that they are taking the following safety actions:

- ***Operations manual:*** The operations manual and electronic flight planning system have been amended to indicate that the fuel flow rate for the aircraft is 130 L/hr.
- ***Flight data log (FDL) option:*** The operations manual will be amended so that the letter ‘G’ can be placed on the FDL indicating that the fuel figure was obtained with reference to the fuel gauge. The manual already included options for ‘C’ (calculated), ‘K’ (known) and ‘D’ (dipped) to be entered on the FDL. This will assist as a reminder to pilots that the fuel gauge is a viable means to attain fuel data for comparison and cross checking.
- ***Fuel:*** Fuel tanks are to be filled to full once per month to assist in fuel quantity calculations.

Safety message

On average, the ATSB receives 21 reports of fuel exhaustion or starvation occurrences each year. Research[7] conducted by the ATSB indicated that fuel mismanagement was three time more likely to involve fuel starvation than exhaustion, and was more likely to occur in private and charter operations. Furthermore, for reported fuel starvation occurrences, 46 per cent led to a forced or precautionary landing or ditching, 22 per cent led to a diversion or return to the aerodrome and 7 per cent resulted in a collision with terrain.

This incident highlights the importance of establishing a known fuel status regularly and the need to use multiple sources to determine fuel quantity. This is particularly important for determining accurate fuel flow rate calculations and when the fuel quantity onboard can only be accurately determined when the fuel tanks are full.

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6 www.casa.gov.au/download/caaps/ops/234_1.pdf

7 *Avoidable Accidents No. 5 – Starved and exhausted: Fuel management aviation accidents* is available at www.atsb.gov.au/publications/2012/avoidable-5-ar-2011-112.aspx

General details

Occurrence details

Date and time:	14 August 2013 – 1130 CST	
Occurrence category:	Incident	
Primary occurrence type:	Fuel starvation event	
Location:	111 km east of Tindal Airport, Northern Territory	
	Latitude: 14° 35.02' S	Longitude: 133° 24.42' E

Aircraft details

Manufacturer and model:	Beech Aircraft Corporation BE58	
Registration:	VH-ECL	
Serial number:	TH-1078	
Type of operation:	Charter	
Persons on board:	Crew – 1	Passengers – Nil
Injuries:	Crew – Nil	Passengers – Nil
Damage:	None	

About the ATSB

The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory agency. The Bureau is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers. The ATSB's function is to improve safety and public confidence in the aviation, marine and rail modes of transport through excellence in: independent investigation of transport accidents and other safety occurrences; safety data recording, analysis and research; and fostering safety awareness, knowledge and action.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within Commonwealth jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to fare-paying passenger operations.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and Regulations and, where applicable, relevant international agreements.

The object of a safety investigation is to identify and reduce safety-related risk. ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated.

It is not a function of the ATSB to apportion blame or determine liability. At the same time, an investigation report must include factual material of sufficient weight to support the analysis and findings. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner.

About this report

Decisions regarding whether to conduct an investigation, and the scope of an investigation, are based on many factors, including the level of safety benefit likely to be obtained from an investigation. For this occurrence, a limited-scope, fact-gathering investigation was conducted in order to produce a short summary report, and allow for greater industry awareness of potential safety issues and possible safety actions.