Australian Government
Australian Transport Safety Bureau

Stall warning event involving a Raytheon B200, VH-ZCO

Darwin Airport, Northern Territory, 17 May 2015

ATSB Transport Safety Report
Aviation Occurrence Investigation
AO-2015-049
Final –7 October 2015

Released in accordance with section 25 of the *Transport Safety Investigation Act 2003*

Publishing information

Published by: Australian Transport Safety Bureau
Postal address: PO Box 967, Civic Square ACT 2608
Office: 62 Northbourne Avenue Canberra, Australian Capital Territory 2601
Telephone: 1800 020 616, from overseas +61 2 6257 4150 (24 hours)
Accident and incident notification: 1800 011 034 (24 hours)
Facsimile: 02 6247 3117, from overseas +61 2 6247 3117
Email: atsbinfo@atsb.gov.au
Internet: www.atsb.gov.au

Addendum

Page	Change	Date

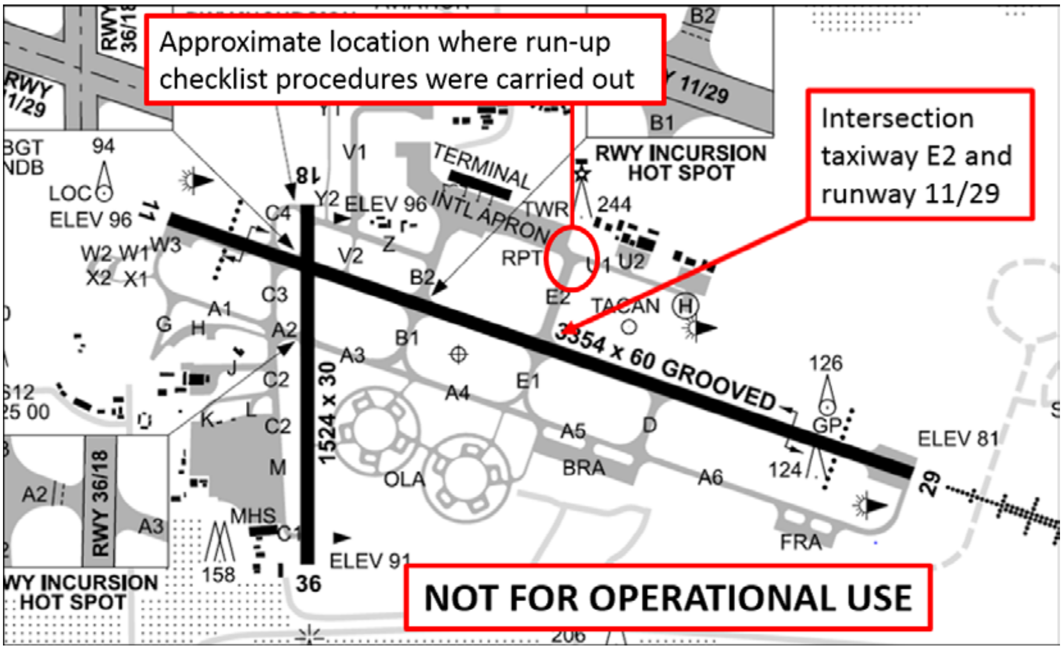
Stall warning event involving a Raytheon B200, VH-ZCO

What happened

At about 1300 Central Standard Time on 17 May 2015, the pilot of a Raytheon B200, registered VH-ZCO, taxied at Darwin Airport for a flight to Jabiru, in the Northern Territory. The flight was an aeromedical retrieval flight, with a doctor and flight nurse on board. The weight of the aircraft was just under the maximum permitted take-off weight. The weather conditions were fine and clear, with a light breeze from the north-east.

The pilot positioned the aircraft at the intersection of taxiways U1 and E2 to complete pre-flight run-up checklist procedures. During the first flight of the day, the operator's run-up checklist procedures included a check to confirm that the wing and horizontal stabiliser de-ice system was serviceable. The wing and horizontal stabiliser de-ice system includes pneumatically inflatable boots fitted to the leading edges of those surfaces (see later description for more detail). The pilot recalled that all run-up checks were normal, including the wing and horizontal stabiliser de-ice system check. Following completion of the run-up checklist procedures, the pilot taxied to the holding point on taxiway E2 before departing from that intersection on runway 11 (Figure 1).

Figure 1: Excerpt from Darwin Airport aerodrome chart showing the approximate location where run-up checklist procedures were carried out and the intersection from which the aircraft commenced take-off



Source: Airservices Australia, additions by the ATSB

The take-off was initiated with the flaps retracted, consistent with the operator's normal procedures for a take-off under the prevailing conditions. The take-off proceeded normally up to the point that the aircraft reached decision speed[1] and the pilot rotated the aircraft to the take-off pitch attitude. At that point, the pilot noticed that the aircraft did not 'unstick'[2] as readily as normally

1 Decision speed is the maximum speed at which a decision to reject the take-off can be made. Rejecting a take-off after having accelerated through the decision speed may result in over-running the runway.

2 Unstick is a term used to describe the point at which the aircraft lifts off the surface of the runway.

expected. At about the same time, the pilot recalled that the stall warning horn sounded.[3] The pilot continued with the take-off and the aircraft lifted off, but it was not climbing or accelerating as efficiently as normal. Despite the relatively poor performance, the pilot was able to build speed slowly by holding the aircraft in ground effect.[4]

After achieving a positive rate of climb, the pilot retracted the landing gear. As the aircraft continued a shallow climb, the pilot carefully balanced airspeed and rate of climb as the stall warning horn continued to sound intermittently. After passing about 200 ft above ground level, the pilot was able to reduce the pitch attitude to allow the aircraft to accelerate further. Beyond that point, the stall warning horn no longer sounded.

Satisfied that the aircraft had reached a safe altitude, the pilot inspected the wings in an attempt to ascertain the reason for the poor take-off performance and stall warning. At that point, the pilot noticed that the right wing de-ice boots appeared to be inflated. Due to the position of the sun, the pilot was unable to immediately ascertain if the boots on the left wing were also inflated. Nonetheless, the pilot was confident that the inflated condition of the wing de-ice boot (or boots) explained the poor performance and stall warning. The pilot immediately cycled the wing and horizontal stabiliser de-ice system control switch in an attempt to deflate the boots, but cycling the switch appeared to have no effect.

As the aircraft continued to accelerate, the pilot noticed that aileron control forces were abnormally light. The pilot surmised that light aileron control forces were the result of a disturbance in the airflow over the wing associated with the inflated leading edge de-ice boot (or boots). As the aircraft turned and its orientation changed with respect to the position of the sun, the pilot was able to clearly see that the boots on the left wing were also inflated.

The pilot advised air traffic control that a return to Darwin was necessary. Air traffic control initially asked the pilot if runway 36 was acceptable, but uncertain about aircraft performance and noting a crosswind on runway 36, the pilot indicated a preference for runway 11 (runway 11 is substantially longer than runway 36). The pilot was subsequently cleared by air traffic control to make a circuit for runway 11.

Given concerns regarding aircraft performance and control, the pilot elected to land with approach flap[5] selected, and added 20 kt to the approach reference speed. Making the approach at this speed allowed the pilot to comply with the operator’s stabilised approach criteria, while providing increased confidence with respect to aircraft performance and controllability.

The pilot had no difficulty handling the aircraft during the circuit and landing, but noted that substantially more power than normal was required to hold the desired speed. The stall warning horn remained silent throughout the approach and landing. The pilot landed without further incident and taxied to the aircraft parking position. The wing de-ice boots remained inflated until the engines were shut down.

Subsequent inspection by engineering staff found that the wing de-ice boots inflated again during an engine ground run, without having been selected. The boots returned to normal operation when the wing and horizontal stabiliser de-ice system control switch was cycled.[6] Numerous subsequent system tests (in accordance with the relevant maintenance manual) found that the wing and horizontal stabiliser de-ice system functioned normally, and the aircraft was returned to service. The operator also advised CASA of the occurrence.

---

3 The stall warning horn sounds to warn the pilot of an impending stall. The horn is triggered by a transducer vane fitted to the leading edge of the left wing. Angle of attack information from the transducer vane and flap position signals are processed by a computer that sounds the warning horn.

4 Ground effect is the term used to describe the improved performance of a wing experienced when an aircraft flies close to the ground, associated with the modification in airflow caused by the ground.

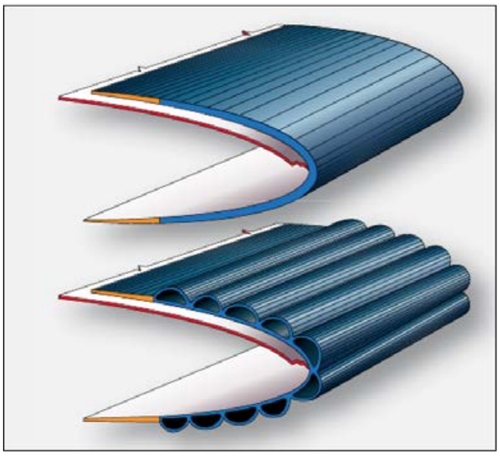
5 Approach flap is an intermediate flap setting often used for landing where runway length permits.

6 Engineering inspection also confirmed that only the wing de-ice boots had remained inflated, not the boots fitted to the leading edge of the horizontal stabiliser.

Raytheon B200 wing and horizontal stabiliser de-ice system

On the Raytheon B200, the leading edge of the wings and the horizontal stabiliser can be protected from an accumulation of ice by inflatable boots. The wing has an inner boot between the fuselage and engine nacelle, and an outer boot that extends from outboard of the engine nacelle. The boots are normally held down by a vacuum, and only inflated when an appropriate selection is made by the pilot. The boots are inflated by pneumatic pressure, and expand in a manner intended to shed any accumulated ice (Figures 2 and 3). Regulated high-pressure engine bleed air supplies pressure and a vacuum source for the wing and horizontal stabiliser de-ice system.

Figure 2: Pneumatic leading edge de-ice boot (representation) in the normal (deflated) condition and the inflated condition



Upper illustration shows leading edge boot held against the leading edge contour (normal in-flight condition). Lower illustration shows leading edge boot in an inflated condition, typically held in that position for a short time only, to remove an accumulation of ice.

Source: FAA, description added by the ATSB

Figure 3: Inflated Raytheon B200 wing leading edge de-ice boot

Source: Aircraft operator

The wing and horizontal stabiliser de-ice boots are operated by a three-position switch, spring-loaded to the centre OFF position (Figure 4). When the switch is selected to the DEICE CYCLE SINGLE (up) position, the wing boots are inflated for 6 seconds, followed by the horizontal stabiliser boots, which are inflated for 4 seconds to complete the cycle. The switch must be selected up again to commence another cycle. When the switch is selected to the MANUAL (down) position, the wing and horizontal stabiliser boots inflate simultaneously, and remain inflated while the switch is held in the MANUAL position. When the switch is released back to the centre OFF position, the boots deflate.

Figure 4: Raytheon B200 ice protection panel (typical) – wing and horizontal stabilizer de-ice control switch highlighted

Source: FAA

Apart from a visual inspection of the de-ice boots, there are no direct indications of the status of the boots available to the pilot. Aircraft pneumatic system gauges provide an indirect indication of boot function by indicating a momentary reduction in pneumatic pressure (and momentary needle movement on the gyro suction gauge) as pressure is redirected, but there is nothing that directly alerts the pilot to an inflated boot condition.

Where required by the operator's checklist procedures, the wing and horizontal stabiliser de-ice system is checked by selecting the switch to the up position, and monitoring pneumatic pressure (momentary decrease) and boot inflation for a single cycle. The switch is then held in the down position to check system operation in the manual mode, again expecting the boots to inflate with a corresponding momentary decrease in pneumatic pressure.

The aircraft flight manual includes a warning to pilots not to cycle the de-ice boots during take-off. The manual does not expand on the reasons for the warning, but it probably relates substantially to degradation in the aerodynamic qualities of the wing and horizontal stabiliser associated with inflated leading edge boots, and the associated impact on aircraft performance and control.

Pilot comments

The pilot believed that the wing de-ice boots probably remained inflated following the wing and horizontal stabiliser de-ice system check, and that the inflated condition of the boots went unnoticed following the check. The pilot could recall completing the checklist procedures as normal, by monitoring the pneumatic pressure gauges and the status of the wing boots during the check, but not specifically confirming that the wing boots had deflated following the check. The pilot also noted that even though the checklist procedure did not specifically call for confirmation that the wing de-ice boots had deflated following the check, it was normal practise to check them.

The pilot also commented that if the wing de-ice boots did remain inflated following the wing and horizontal stabiliser de-ice system check, a number of circumstantial factors may have increased the likelihood that their inflated condition went unnoticed. These factors included:

- The orientation of the aircraft with respect to the position of the sun (at the time the checks were completed) was such that the status of the wing de-ice boots may not have been readily apparent without a concentrated inspection.

- The taxi from the point where the pilot completed the run-up checklist procedures to the holding point of the runway was relatively short (see Figure 1). A short taxi following the run-up checks reduced the likelihood that inflated wing de-ice boots would have been noticed during a normal lookout while taxiing.
- Flying conditions were such that it was unlikely that the wing and horizontal stabiliser de-ice system would be required during the flight. This may have reduced the intensity of the pilot's focus on the wing and horizontal stabiliser de-ice system check, and reduced the likelihood that the inflated condition of the wing de-ice boots would be noticed at the completion of the check.

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 that following this incident, the operator issued a safety bulletin to company B200 pilots, drawing their attention to the incident and highlighting the importance of checking that the wing de-ice boots deflate following a cycle of the de-ice system.

Safety message

Pilots operating Raytheon B200 or similar aircraft, fitted with pneumatic wing and horizontal stabiliser de-ice boots, are encouraged to take particular care when inspecting the boots during the system function check. Pilots are cautioned that the status of the boots may not be immediately obvious under some conditions, and that a concentrated inspection may be necessary. This may require the assistance of an external observer to assist with monitoring the status of the de-ice boots, particularly the boots fitted to the leading edge of the horizontal stabiliser which may not be visible from the cockpit.

Any aerofoil leading edge contamination, damage or distortion has the potential to significantly adversely affect aircraft performance and handling qualities, and aerodynamic stall characteristics. This incident highlights the significance of the manufacturer's warning not to cycle the de-ice boots during take-off.

General details

Occurrence details

Date and time:	17 May 2015 – 1315 CST	
Occurrence category:	Serious incident	
Primary occurrence type:	Stall warning event	
Location:	Darwin Airport, Northern Territory	
	Latitude: 12° 24.9' S	Longitude: 130° 52.6' E

Aircraft details

Manufacturer and model:	Raytheon Aircraft Company	
Registration:	VH-ZCO	
Serial number:	BB-1955	
Type of operation:	Aerial work	
Persons on board:	Crew – 3	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 ATSB 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.