



Australian Government

Australian Transport Safety Bureau

Pre-flight planning event involving a Boeing 737, VH-VUC

Darwin Airport, Northern Territory, 14 October 2013

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Addendum

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Pre-flight planning event involving a Boeing 737, VH-VUC

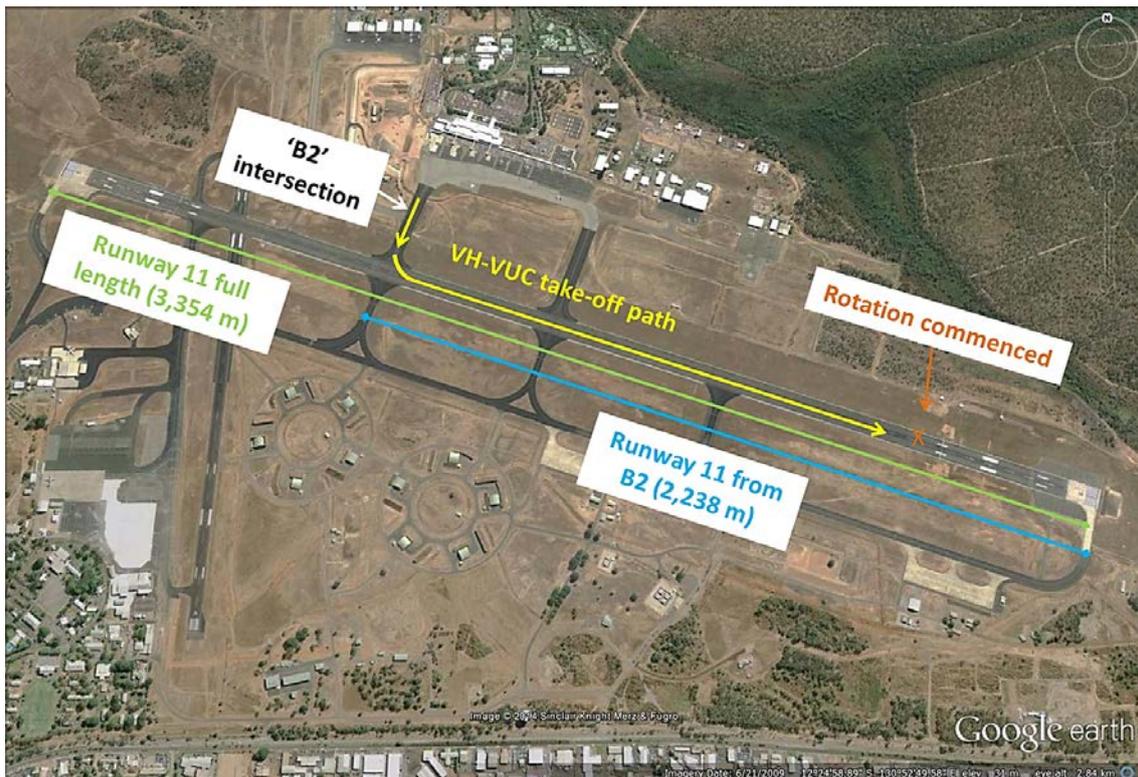
What happened

On 14 October 2013, the crew of a Virgin Australia Airlines Boeing 737 aircraft, registered VH-VUC, were preparing for a scheduled passenger service from Darwin, Northern Territory to Melbourne, Victoria.

The flight was scheduled to depart at about 1815 Central Standard Time; however, it was delayed due to thunderstorms passing through the area.

In preparation for the flight, the captain conducted an external inspection of the aircraft, while the first officer (FO) remained in the cockpit and prepared two take-off data cards (TODCs). This included referencing the Darwin Airport charts in the 'Airport Analysis Manuals' (AAMs) and extrapolating the take-off reference speeds (V speeds)¹ for a runway 11 full length departure and an intersection departure from taxiway 'Bravo 2' (B2) (Figure 1).² The take-off performance data for a full length and intersection departure were then transcribed onto the TODCs and the data for a full length departure entered into the flight management computer (FMC).

Figure 1: VH-VUC take-off



Source: Google earth; ATSB

¹ Take-off reference speeds, commonly referred to as V speeds, assist pilots in determining when a rejected take-off can be initiated and when the aircraft can rotate, lift-off and climb away safely given the existing flight conditions.

² The operator specified take-off run available (TORA) for the full length of runway 11 was 3,354 m, while the TORA for the intersection departure from B2 was 2,238 m.

The captain completed his inspection and returned to the cockpit where he conducted an independent check of the take-off performance data and the data entered into the FMC. The TODCs were then placed on the centre pedestal.

As the crew had elected to conduct a runway 11 full length departure, they noted that a Notice to Airmen (NOTAM) required them to backtrack along the runway to the beginning of the runway due to taxiway closures.

Shortly after, at dusk, the aircraft was taxied to the B2 intersection holding point where the crew were advised by air traffic control of two inbound aircraft, which would delay a full runway length departure. Consequently, the crew elected to depart from the B2 intersection. The FO re-programmed the FMC with the take-off performance data previously transcribed on the TODC for that departure and subsequently cross-checked by the captain.

At about 1847, the aircraft departed, with the crew reporting a normal take-off occurred. After take-off, the crew noted that the TODC for the full runway length departure was visible on the centre pedestal, on top of the intersection departure TODC. The crew discussed whether the take-off from the B2 intersection was conducted based on the take-off performance data for a full runway length departure. While the crew were unable to determine what data was used, in the interests of safety, the event was reported to the operator and the Australian Transport Safety Bureau (ATSB).

Take-off performance data preparation

Prior to take-off, the FO had prepared one TODC for a runway 11 full length departure, referencing the AAM for a 24,000 lbs (24K) engine thrust rating,³ with an 'assumed' temperature.⁴ A second TODC was also prepared for a runway 11 B2 intersection departure, referencing the 26,000 lbs (26K) engine thrust rating AAM. The V speeds obtained from each AAM and subsequently entered onto the TODCs were based on a range of variables including, a wet runway, flap 5 setting, air conditioning 'auto' and a 5 kt tailwind component.

After preparing the TODCs, the FO closed the AAMs. In accordance with the operator's standard operating procedures (SOPs), the captain independently cross-checked the take-off performance data by completing a full recalculation.

Recording information

The aircraft was fitted with a quick access recorder (QAR) and following the incident, the data was downloaded and provided to the ATSB. The recorded data showed that the V speeds were initially entered into the FMC as 145 kt (V_1),⁵ 149 kt (V_R)⁶ and 153 kt (V_2),⁷ but changed to 145 kt (V_1), 148 kt (V_R) and 152 kt (V_2) when at the B2 holding point. The FMC selected temperature (assumed temperature) was initially 36 °C and changed to 48 °C.

³ Take-off operations conducted at engine thrust settings less than the maximum take-off thrust available (reduced thrust) may provide substantial benefits in terms of engine reliability, maintenance, and operating costs (United States Federal Aviation Administration Advisory Circular 25-13).

⁴ As ambient air temperature increases, the thrust produced by an engine will decrease. By using a temperature higher than the actual ambient temperature, a lower thrust setting for take-off will result. To do this, an 'assumed' temperature is used to calculate the thrust setting.

⁵ V_1 is the critical engine failure speed or decision speed. Engine failure below this speed shall result in a rejected takeoff; above this speed the take-off run should be continued.

⁶ V_R is the speed at which the rotation of the aircraft is initiated to takeoff attitude. This speed cannot be less than V_1 or less than 1.05 times V_{MC} . With an engine failure, it must also allow for the accelerations to V_2 at the 35-foot height at the end of the runway.

⁷ V_2 is the minimum speed at which a transport category aircraft complies with those handling criteria associated with climb, following an engine failure. It is the take-off safety speed and is normally obtained by factoring the stalling speed or minimum control (airborne) speed, whichever is the greater, to provide a safe margin.

Take-off performance data comparison

The initial V speeds entered into the FMC corresponded to the V speeds contained in the 24K AAM for a runway 11 full length departure, which provided an assumed temperature of 36 °C and a take-off weight of 73,000 kg.⁸ The revised V speeds (for the intersection departure) entered into the FMC when positioned at the B2 holding point, corresponded to the V speeds contained in the 26K AAM for a runway 11 full length departure; which provided an assumed temperature of 48 °C and take-off weight of 72,100 kg. Table 1 provides a comparison of the V speeds used by the crew and that required for the B2 intersection departure (26K B2 intersection).

Table 1: Take-off performance data comparison

Parameter	FMC (for take-off)	AAM		
		24K full runway length (initial)	26K B2 intersection (required)	26K full runway length (used)
Outside air temperature			24 °C	
Assumed temperature		36 °C		48 °C
V ₁ (kt)	145	145	136	145
V _R (kt)	148	149	145	148
V ₂ (kt)	152	153	153	152
Take-off weight	71,196	73,000 kg	71,600 kg	72,100 kg

Virgin Australia Airlines investigation

Virgin Australia Airlines conducted an internal investigation into the incident and identified the following:

- The aircraft departed from the runway 11 B2 intersection using the take-off performance data for a full length runway departure.
- It was possible that the FO had inadvertently referenced the runway 11 full length page in the 26K AAM instead of the B2 intersection page, which was subsequently not detected by the captain during the cross-check process.
- The TODCs for the flight were not required to be retained, which made it difficult to determine if the correct information was obtained from the AAM and if the correct data was entered into the FMC.
- The AAM full length and intersection pages were the same colour and therefore, not readily discernible.
- The 26K and 24K AAM's on the operator's Boeing 737 aircraft were similar in appearance.
- On the day of the incident, the FO prepared two TODCs. No documentation could be found on the use of two completed TODCs as a procedure or recommendation, however, recent feedback indicated that this may be a possible outcome on the line when a departure on different runways was possible.
- When there was a possibility of conducting either a full length or intersection departure, it was common practice to calculate one set of conservative take-off performance figures (for the intersection) as this data could be used for either departure. However, this process could be perceived by crews to conflict with engine wear management.
- At the time of the incident, a possible situational factor was the reduced lighting conditions between sunset and last light.
- While the flight was delayed due to thunderstorm activity and taxiway closures, the crew's preparation for the flight was not rushed and was very methodical.

⁸ The flight planned take-off weight for the aircraft was 71,589 kg.

- The captain and FO had completed the company's non-technical skills training course, which included a module on take-off data input errors.

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.

Virgin Australia Airlines

Virgin Australia Airlines has advised the ATSB that, in addition to the pre-take-off brief requirement, they are introducing a procedure to verify the intersection on line-up. This procedure could provide a latent defence as reminder for the take-off data used.

Safety message

The ATSB SafetyWatch highlights the broad safety concerns that come out of our investigation findings and from the occurrence data reported to us by industry. One of the safety concerns is data input errors



www.atsb.gov.au/safetywatch/data-input-errors.aspx.

Research conducted by the ATSB, *Take-off performance calculation and entry errors: A global perspective*, documented 20 international and 11 Australian occurrences identified between 1 January 1989 and 30 June 2009 where the calculation and entry of erroneous take-off performance data were involved. It also provided an analysis of the safety factors that contributed to the international occurrences and suggested ways to prevent and detect such errors.

Errors involving take-off performance data calculations and data entry probably occur frequently, but in most cases, there are sufficient defences in place to detect these errors prior to the aircraft leaving the gate. However, as there is varying take-off performance data calculation methods used by airlines, different aircraft involved, and different aircraft systems used to calculate and enter take-off performance data, there is no single solution to ensure that such errors are always prevented or captured.

The results of this study, and that from other related research, have recognised that these types of events occur irrespective of the airline or aircraft type, and that they can happen to anyone; no-one is immune. The following publications and ATSB investigations provide additional information on these types of occurrences:

- Tailstrike and runway overrun involving an Airbus A340 (ATSB investigation AO-2009-012) www.atsb.gov.au/publications/investigation_reports/2009/aair/ao-2009-012.aspx
- Performance calculation event involving an Airbus A321 (ATSB investigation AO-2011-073) www.atsb.gov.au/publications/investigation_reports/2011/aair/ao-2011-073.aspx
- Pre-flight planning event involving a Boeing 737 (ATSB investigation AO-2012-020) www.atsb.gov.au/publications/investigation_reports/2012/aair/ao-2012-020.aspx
- Take-off performance calculation and entry errors: A global perspective: www.atsb.gov.au/publications/2009/ar2009052.aspx
- Use of erroneous parameters at takeoff: www.skybrary.aero/bookshelf/books/668.pdf
- Performance Data Errors in Air Carrier Operations: Causes and Countermeasures www.human-factors.arc.nasa.gov/publications/NASA_TM2012-216007.pdf

Occurrence details

Date and time:	14 October 2013 – 1847 CST	
Occurrence category:	Incident	
Primary occurrence type:	Flight preparation/navigation	
Location:	Darwin Airport, Northern Territory	
	Latitude: 12° 24.88' S	Longitude: 130° 52.60' E

Aircraft details

Manufacturer and model:	The Boeing Company 737-800	
Registration:	VH-VUC	
Operator:	Virgin Australia Airlines	
Serial number:	34014	
Type of operation:	High capacity – air transport	
Persons on board:	Crew – 6	Passengers – 147
Injuries:	Crew – Nil	Passengers – Nil
Damage:	Nil	

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.