Australian Government
Australian Transport Safety Bureau

Runway excursion involving Boeing 737-8FE, VH-YFH

Brisbane Airport, Queensland on 30 November 2022

ATSB Transport Safety Report
Aviation Occurrence Investigation (Defined)
AO-2022-064
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Addendum

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Executive summary

What happened

On 30 November 2022, a Boeing 737, registered VH-YFH and operated by Virgin Australia, commenced its take-off roll from the A3 intersection of Brisbane Airport's runway 19L. During the take-off the aircraft briefly entered, and became airborne in, the section of the runway that was closed due to the runway works. The aircraft completed the departure and continued onto its destination where a maintenance inspection subsequently cleared the aircraft of any damage.

What the ATSB found

The ATSB found that the briefing package for the aircraft's previous sector from Melbourne to Brisbane included:

- a dispatcher's note which stated that Brisbane RWY 01R had a displaced threshold, but without any resultant landing weight performance limitation
- a notice to airmen (NOTAM) with the headline RWY 01R THR DISPLACED, which identified reduced runway distances for take-off and landing on Brisbane's runways (RWY) 01R/19L
- critical performance data appended to the displaced threshold NOTAM.

The captain misinterpreted the dispatcher's note to mean that there were no performance requirements for operations on RWY 19L. The captain reviewed the NOTAMs and, based on this misunderstanding, dismissed the NOTAM as not being relevant for their operation. There was uncertainty about whether the first officer reviewed the dispatcher's note and NOTAMs in Melbourne, but if they were, the relevance of the note and this NOTAM was probably missed. As such, neither crew member identified the critical performance data appended to this NOTAM.

The NOTAMs were not reviewed en route or as part of the approach briefing prior to descent into Brisbane, as required by the operations manual. Additionally, the automatic terminal information service (ATIS) advice of the reduced landing distance for RWY 19L was not identified and accounted for in the performance calculations for the landing (or subsequent departure) on that runway. Fortunately, this did not affect the landing as the landing's stopping solution was based on the aircraft exiting the runway well before the closed section. The flight crew's misunderstanding was reinforced by the absence of any visible runway works or other indications of restrictions on the runway during the landing.

Due to the now-established belief that there were no performance requirements for operations on RWY 19L, together with time pressures and distractions from prioritising training needs, the flight crew used the full runway length in the performance data calculation for departure, instead of the reduced length identified in the ATIS and NOTAM. This resulted in a departure with insufficient runway available due to the aircraft being overweight for that reduced runway length.

Finally, contrary to the requirements of Part 139 Manual of Standards, the A3/19L intersection departure point take-off run available Movement Area Guidance Sign presented a take-off distance that was more than that available, creating the potential to mislead flight crews about the status of the runway when conducting a departure from that point.

What has been done as a result

Virgin Australia implemented a number of safety management, procedural and information-based changes designed to improve flight crew awareness of changes to runway configuration and related aircraft performance criteria.

Brisbane Airport Corporation implemented several safety actions to reduce the risk associated with this type of occurrence. These included:

- changes to departure and arrival procedures associated with runway works
- redrafting of the NOTAM to clarify the operational changes to both runways 01R and 19L, and the procedures to ensure correct runway distance was displayed on movement area guidance signs
- publication of an aeronautical information circular supplement for the works.

Safety message

Flight crews must ensure they consider possible variations to take-off and/or landing dimensions when determining runway performance data. While this operator's procedures accounted for such changes through notification of performance requirements within their NOTAM system, due to a combination of distraction and incorrect assumption, they were not identified.

When presented with many NOTAMs, flight crews need to be aware that dismissing them based on the headline alone increases the risk that safety relevant data may be overlooked. As an additional defence, flight crews should ensure that the data input into that calculation is in conformance with other relevant information, such as the ATIS.

Contents

The occurrence

Overview

On 30 November 2022 a Boeing 737-8FE (B737), registered VH-YFH and operated by Virgin Australia as flight number VA324, commenced its take-off roll from the A3 intersection of Brisbane Airport's runway 19L. The take-off thrust and speeds set by the flight crew for the take-off from A3 were based on the full runway length from that intersection being available. However, unrecognised by the crew, the take-off distance available for runway 19L had been reduced at the upwind (01R threshold) end by 871 m due to runway works. As a result, the thrust set for the take-off was insufficient for the actual runway length available and the aircraft briefly entered, and became airborne in, the section of the runway that was closed due to the runway works. The aircraft completed the departure and continued on to its destination where a maintenance inspection subsequently cleared the aircraft of any damage.

The sequence of events that resulted in the runway excursion commenced earlier the same day, during flight planning for the previous sector from Melbourne to Brisbane.

Melbourne

Arrival

VH-YFH arrived in Melbourne as flight number VA254 from Canberra at 0846 EDT,[1] about 10 minutes behind schedule. The aircraft was scheduled to depart Melbourne for Brisbane as flight number VA319 at 0910 EDT. The flight crew consisted of a training captain (captain) and a first officer (FO). The captain had been assigned a number of 'line flying under supervision'[2] sectors with the FO over the previous 2 days as part of the FO's conversion onto the B737.

Pre-flight

Flight planning package

Shortly after arriving, the flight crew received the flight planning package[3] (see the section titled *Flight planning*) for the flight from Melbourne to Brisbane. This package included the operational flight plan (OFP),[4] NOTAMs[5] for the sector and flight operations engineering (FOE) data appended to the relevant NOTAMs. The captain recalled that the package was initially missing a part of the NOTAMs section, although a full reprint was subsequently received prior to departure.

The OFP commenced with a section titled 'Dispatcher Notes to Crew' (Figure 1), which included a note from the dispatcher that stated:

> YBBN RWY 01R DISPLACED BY 921M. NO LDW PERF LIMITATION.

The flight crew expected the approach and landing into Brisbane would be on runway (RWY) 19L. The captain incorrectly interpreted the dispatcher's note to mean that the displaced threshold of RWY 01R did not have associated performance requirements for runway 19L (see the section titled *Flight dispatch*). The captain then reviewed the Brisbane NOTAMs, which included a NOTAM (NOTAM YBBNC1174/22) with the headline 'RWY 01R THR DISPLACED'. This NOTAM

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1 Eastern Daylight-saving Time (EDT): Coordinated Universal Time (UTC) + 11 hours.

2 Following the completion of the flight training and checking part of the operator's conversion course, supervised line flying exposes flight crew to the operator's line operations, while also attaining the experience requirements required under the Civil Aviation Safety Regulations. A pilot is considered to be inexperienced until they have achieved a certain number of hours and/or sectors under the supervision of a flight crew member nominated by the operator.

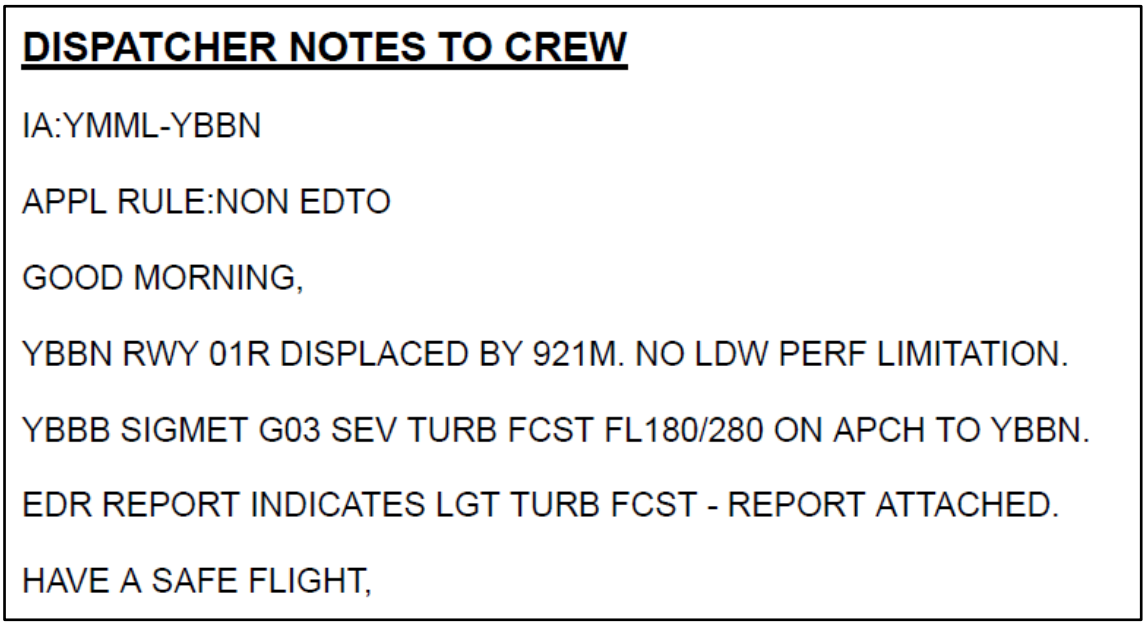
3 The flight planning package was a paper-based briefing document.

4 The Virgin OFP provided fuel, weight and route data necessary for pre-flight planning purposes.

5 Notice to Airmen (NOTAM): A notice distributed by means of telecommunication containing information concerning the establishment, condition or change in any aeronautical facility, service, procedure or hazard, the timely knowledge of which is essential to personnel concerned with flight operations.

was dismissed as it referred to the displaced runway threshold in the dispatcher note, and because the headline did not include any reference to RWY 19L (which was the expected landing runway).

Figure 1: Dispatcher notes for VA319 (Melbourne to Brisbane)



Source: Virgin Australia

FOE requirements for RWY 19L

The NOTAM section of the flight planning package also included a company notice, titled 'VOZ FOE COMPANY REMARK', appended to the displaced threshold NOTAM YBBNC1174/22 (see the section titled *VA319 (Melbourne to Brisbane) flight planning package*). This notice included specific data required to be used for both landing and take-off performance data calculations when using Brisbane RWY 01R and RWY 19L. The captain did not identify the company notice associated with NOTAM YBBNC1174/22. There was uncertainty about whether the FO read the dispatcher notes and NOTAMs prior to departure from Melbourne, but if they did, the relevance of the dispatcher's displaced threshold note and NOTAM was probably missed. As a result, both flight crew were unaware of the performance data calculation requirements for operations at Brisbane's RWY 01R and RWY 19L.

En route to Brisbane

The aircraft departed Melbourne at 0940 EDT with the flight to Brisbane expected to take about 2 hours. The FO conducted the pilot flying (PF)[6] duties for the sector, while the captain was the pilot monitoring (PM). The intention was to reverse these roles for the later return flight to Melbourne. Available spare time during the cruise portion of the flight was used to cover training-related matters.

As the aircraft approached Brisbane, the crew completed arrival preparations, which included recording the Brisbane automatic terminal information service (ATIS),[7] calculating the landing performance data, and briefing for the approach and landing. The ATIS stated that arrivals were

[6] Pilot flying (PF) and Pilot monitoring (PM): procedurally assigned roles with specifically assigned duties at specific stages of a flight. The PF does most of the flying, except in defined circumstances such as planning for descent, approach and landing. The PM carries out support duties and monitors the PF's actions and the aircraft's flight path.

[7] Automatic terminal information service: The provision of current, routine information to arriving and departing aircraft by means of continuous and repetitive broadcasts. ATIS information is prefixed with a unique letter identifier and is updated either routinely or when there is a significant change to weather and/or operations.

being conducted onto RWY 19L and RWY 19R, and that RWY 19L had a reduced length with the landing distance available being 2,689 m.[8]

The flight crew did not review the Brisbane NOTAMs inflight or as part of arrival preparations.

While the crew completed the landing performance data calculations based on the full length of RWY 19L being available, and not the reduced length as stated on the ATIS, the stopping solution (see the section titled *Enroute landing performance calculator*) was based on the aircraft exiting the runway at the A6 taxiway.

Brisbane

Arrival

VH-YFH landed on Brisbane's RWY 19L at 1050 EST[9] and exited the runway using the A6 rapid exit taxiway located about 850 m from the displaced threshold at the end of RWY 19L.[10] The flight crew stated that they did not observe any runway works activity or markers indicating works on the runway during the landing roll and exit from the runway.

Post-flight

VH-YFH was scheduled to arrive at the gate in Brisbane at 1020 and depart for Melbourne as VA324 at 1055. The aircraft arrived at the gate 34 minutes behind schedule, at 1054.

Following completion of post-flight duties, the flight crew did not immediately commence preparation for VA324. The captain's observations of the FO's performance as PF for the landing into Brisbane identified a need to alter the intended flight crew duties for the VA324 sector and assign the FO the PF role once again. To support this decision, the captain allocated time to debrief the FO on their performance during the completed sector and to provide training support for the return flight. During those training discussions the crew received the flight planning package for the return flight to Melbourne.

Pre-flight

The training discussions were put on hold while the flight crew reviewed the OFP and dispatcher notes and determined the fuel order for the VA324 sector. The OFP included a dispatcher's note that stated:

> YBBN RWY 01R THR DISPLACED 29/2100-30/0630Z

The flight crew understood that this note was in reference to the same runway matter identified by the dispatcher in the previous sector's OFP and was dismissed.

The captain then finalised the training discussion and, at its completion, the FO exited the flight deck to conduct an exterior inspection of the aircraft while the captain commenced pre-flight duties. The captain later estimated that around 5 minutes of the turnaround was spent in the training discussion.

As part of the pre-flight duties, the captain obtained a hard copy of the ATIS from the ACARS,[11] and used that data to fill out the relevant fields of the take-off data card (TODC). The captain made a handwritten entry '2689 TORA' in the remarks section at the bottom of the card (see the section titled *Pre-flight procedures and the performance data calculation*). The take-off

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8 See the section titled *Air traffic control information* for the full ATIS data.

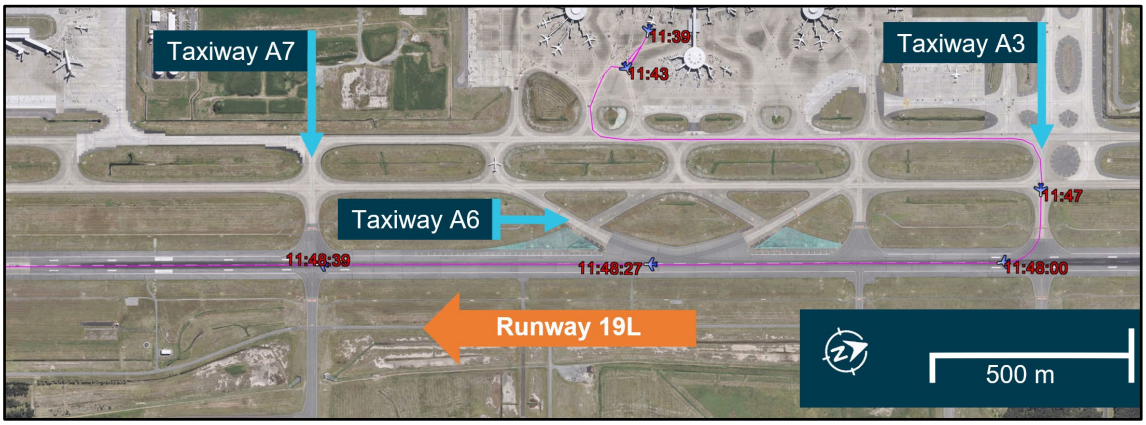
9 Eastern Standard Time (EST): Coordinated Universal Time (UTC) + 10 hours. Unless otherwise indicated, all times in this report are EST.

10 A rapid exit taxiway is a taxiway connected to a runway at an acute angle, designed to allow landing aircraft to turn off the runway at higher speeds than are achieved on exit taxiways, thereby minimising runway occupancy times.

11 Aircraft Communications, Addressing and Reporting System, a datalink system for message exchange connecting aircraft and ground services.

performance data was then determined using the onboard performance tool (OPT).[12] The captain decided to use the taxiway A3 intersection with RWY 19L as the take-off commencement point (Figure 2). The power setting, take-off speeds and other data relevant to this take-off commencement point were then calculated using the OPT's runway selection that related to the normal runway length from A3 rather than the reduced available length. The resultant calculated data was then transcribed onto the TODC.

Figure 2: VA324 departure



A Google Earth image of Brisbane Airport with the departure track of VA324 overlaid. The image shows location and timestamps for specific points of the departure.
Source: Google Earth, modified by ATSB

After completing the exterior inspection, the FO returned to the flight deck and commenced their pre-flight checks. This included a required independent calculation of the take-off performance data using the OPT. The FO conducted the calculation using data from the TODC (previously filled out by the captain). The FO stated that they did not see the captain's annotation of '2689 TORA' in the remarks section.

On completion of the performance calculation, both flight crew cross-checked and confirmed agreement on the calculated data using the OPT cross-check function. The subsequent pre-flight procedures and checklists then confirmed that the data entered into the flight management computer was in agreement with that on the TODC. The FO then conducted a departure briefing, which included stating that the take-off was planned to commence from the A3 intersection for RWY 19L. The aircraft was then prepared for push back from the gate.

It is likely that the NOTAMs were not reviewed by either pilot during the turnaround and that while the specific reasons could not be determined, it may have been due to a combination of distraction, time pressure and a previously-formed view of the NOTAM content.

Departure

The flight crew commenced push-back at 1139 and, at 1143, requested a taxi clearance from air traffic control (ATC), advising that ATIS information D had been copied, and that an A3 departure could be accepted. ATC cleared the aircraft to taxi to the A3 runway holding point. As the aircraft approached the holding point, ATC cleared the aircraft for take-off from RWY 19L. On passing the runway distance signs (see the section titled *Movement area guidance signs*) at the A3 holding point at about 1147, the flight crew completed the take-off performance check (see the section titled *Runway entry performance check*) and, with all checks completed, the aircraft entered the runway. Both flight crew later recalled that the runway looked clear with no markers or obstructions visible from their take-off commencement point.

The crew performed a rolling take-off, with take-off power being applied at 1148. The captain later recalled that, following the power application, their attention was mostly inside the aircraft

[12] See the section titled *OPT calculated runway performance data*.

performing PM duties and that they did not observe any obstructions or cones on the runway during the take-off.

The FO recalled that:

- at an airspeed of about 100 kt, they observed cones positioned in a line across the runway
- while they considered the cones an immediate threat, they estimated that the aircraft would become airborne before the cones and, as the aircraft's airspeed had exceeded 80 kt, they continued the take-off
- they did not verbally notify the captain of sighting the cones as it was assessed that the aircraft would clear them
- they commenced the take-off rotation before the cones and as the aircraft climbed through about 50 to 70 ft above the runway, the cones were observed to pass underneath.

Recorded audio[13] from the ATC tower identified that, during the aircraft's take-off run, when it was about midway between the runway intersections of taxiways A6 and A7, the tower controller commented on whether the aircraft was going to rotate. As the aircraft passed over the cones, the tower controller remarked that the aircraft had passed very close over the cones. ATC immediately called a ground vehicle on the tower frequency to inspect the cones. The aircraft's flight crew heard this exchange before transferring to the departure frequency. Shortly after, the ground vehicle reported that, while the cones did not appear to have been struck, 3 cones had been blown from their original position.

About midway through the climb out of Brisbane, ATC informed the flight crew of the cones being blown over during their departure. The flight crew discussed the departure, noted that the aircraft was handling normally and continued to monitor the aircraft's instruments for abnormal indications. Shortly after, the captain contacted Virgin maintenance to report that they may have struck cones during departure and organised an inspection on arrival. The aircraft proceeded on to Melbourne without further incident and landed safely at 1441 EDT. The aircraft was subsequently cleared of any damage by a maintenance inspection in Melbourne.

[13] In accordance with international standards, ATC units, including tower operations, are equipped with devices that record radio and background communications as well as the aural environment at ATC workstations.

Context

Pilot information

Both the captain and the first officer held Air Transport Pilot Licences (Aeroplane) with Class 1 aviation medical certificates and were appropriately qualified for the flight. The ATSB found no indicators that increased the risk of the flight crew experiencing a level of fatigue known to affect performance.

The captain had accumulated about 9,000 hours of flight experience, of which about 5,500 hours were on the Boeing 737 (B737). In the previous 90 days, the captain had flown 73 hours on B737 type aircraft. The first officer had accumulated about 13,000 hours of flight experience, of which about 9,200 hours were on the B737, with 77 hours flown in the previous 90 days.

Flight planning

Flight plan manager

Flight crews were provided with all required pre-flight briefing material in a single document – the flight planning package (FPP). The FPP was generated by flight dispatch using the Flight Plan Manager (FPM), a flight planning software package used by Virgin Australia to automate the collation of flight planning data and the production of briefing material for flight crews. The FPP comprised the operational flight plan (OFP),[14] weather data, route plots and NOTAMs for the sector.

NOTAMs were automatically received and imported into the FPM database. For a particular FPP, the FPM software would filter the NOTAMs, presenting only those relevant to that sector, format that NOTAM data into a form usable in a pre-flight information bulletin (see the section titled *Notice to Airmen*), and attach any company remarks applicable to that NOTAM.

Flight dispatch

Virgin flight dispatch was responsible for the maintenance of the FPM database and the production of the FPP, including the acquisition, collation and evaluation of NOTAM, meteorological and other operational information in support of flight planning activities. Flight dispatch was also responsible for the distribution of NOTAM data to relevant specialist functions within Virgin, such as flight operations engineering (FOE).

As part of the flight planning process, flight dispatchers were required to establish whether the runway, environmental and aircraft performance conditions required a reduction in the normal aircraft limit weights—that is, whether there was any performance limitation to the aircraft's weight, such as for take-off and/or landing. This was done through calculations using the onboard performance tool (OPT) (see the section titled *Performance calculators*).

In determining whether there was a limiting weight to be applied, dispatch used weather conditions sourced from TAF[15] data, and were required to ensure consistency of that weather data with other data sources such as METAR[16] and automatic terminal information service (ATIS). Flight dispatch was also required to apply any FOE-determined performance requirement in the limiting weight calculation. When the calculation determined that a weight restriction was to be applied, that limiting weight (or performance limitation) was to be input into the FPM and applied to the overall plan. Any performance limitation was to be noted in the FPP, and the parameters used

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[14] The Virgin OFP included the fuel and weight plan, wind data, alternate summary, critical fuel summaries and the navigation log.

[15] Aerodrome Forecast (TAF): a statement of meteorological conditions expected for a specific period of time in the airspace within a radius of 5 NM (9 km) of the aerodrome reference point.

[16] METAR: a routine aerodrome weather report issued at routine times, hourly or half-hourly.

for the calculation provided in the OFP. The dispatcher was also required to ensure that flight crew were aware of the performance restriction.

Flight operations engineering

On receipt of a NOTAM from flight dispatch, FOE were required to determine whether the NOTAM had a performance impact on operations. For NOTAMs impacting performance, FOE would input the required performance response into the FPM as a company remark, as well as amend the OPT database with the relevant input options applicable to that NOTAM. Where FOE determined that there was no performance impact associated with a received NOTAM, an FOE company remark with a statement such as 'NO PERFORMANCE IMPACT' would be input into the FPM.

The flight planning package

Operational flight plan

The FPP's operational flight plan (OFP) component contained a synopsis of data critical to the conduct of the planned flight. It included information such as the dispatch message, fuel and weight data,[17] the navigation log[18] and any applicable performance restrictions.[19] The dispatch message comprised dispatcher notes to the crew, aircraft discrepancy items and the filed air traffic services[20] flight plan.

Dispatcher notes were required for every flight, and were used by dispatchers to notify flight crew of all decisions pertaining to the preparation of the briefing package and any other information that could assist in the safe conduct of the flight. The notes could also be used to provide flight crew with an overview of the flight planning requirements or any special considerations.

NOTAMs

The FPP was the primary source of NOTAM information for flight crews, and the only source of information for FOE performance requirements. NOTAMs provided as part of the FPP by flight dispatch were stated to be the latest available for departure and arrival ports and, as a general rule, were valid for 30 minutes prior to the estimated time of departure and for 4 hours after the estimated time of arrival.

The National Aeronautical Information Processing System (NAIPS)[21] was an alternative source of NOTAM information available to flight crew and was accessible through the flight crew's electronic flight bag (EFB).[22] Unlike the FPP NOTAM data, NAIPS NOTAMs were unfiltered and did not have FOE company remarks data attached.

VA319 (Melbourne to Brisbane) flight planning package

The VA319 flight dispatcher determined that there was no landing weight performance limitation for the Melbourne to Brisbane sector resultant from the displaced threshold for Brisbane's RWY 01R. This was notified to the flight crew through a remark in the 'Dispatcher notes to crew' section of the FPP (see Figure 1) as follows:

> YBBN RWY 01R DISPLACED BY 921M. NO LDW PERF LIMITATION

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17 The fuel and weight plan was primarily used during pre-flight to determine various aircraft and payload weights and fuel uplift.

18 The navigation log was used during flight for route segment information and to monitor the flight's progress and fuel usage.

19 The post-flight copy of the OFP was retained as the formal record of the flight.

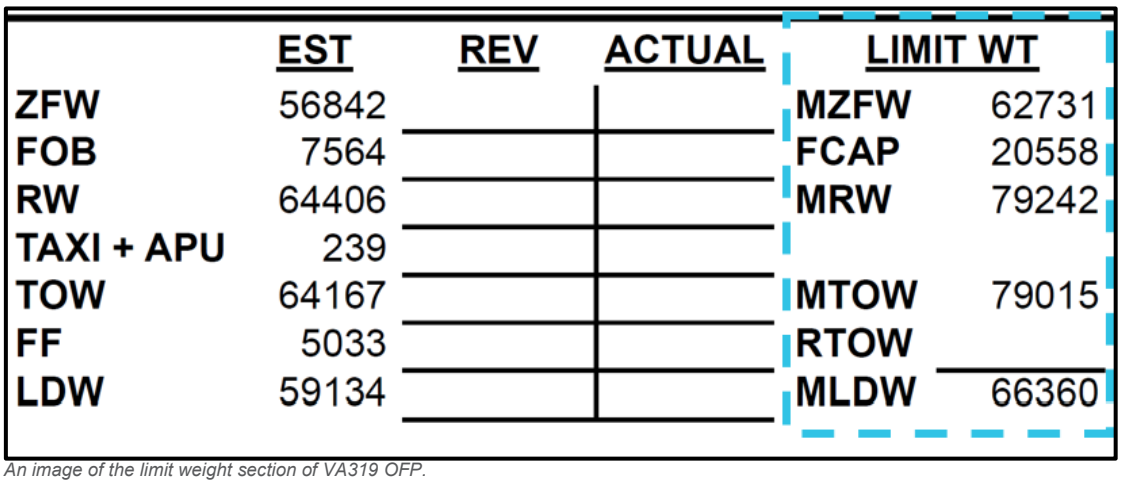
20 Air Traffic Service: a generic term meaning variously, flight information service, alerting service, air traffic advisory service, air traffic control service (area control service, approach control service or aerodrome control service).

21 NAIPS is a computerised, aeronautical information system. It processes and stores meteorological and NOTAM information as well as enables the provision of briefing products and services to pilots. It is accessed through the Airservices Australia website.

22 Electronic flight bag (EFB): an electronic device or set of devices containing applications used for flight planning, such as take-off performance calculations.

The absence of any performance weight limitation was also identifiable from the aircraft limit weights section of the OFP (Figure 3), where the limit weights listed were maximum weights for those conditions in the aircraft's flight manual. While the dispatcher's note identified that there were no performance weight limitations, the OFP did not present the specific parameters used in the limit weight calculations (see the section titled *Flight dispatch*). However, flight crew could ascertain the parameters from various parts of the FPP.

Figure 3: VA319 limit weights



	EST	REV	ACTUAL	LIMIT WT	
ZFW	56842			MZFW	62731
FOB	7564			FCAP	20558
RW	64406			MRW	79242
TAXI + APU	239				
TOW	64167			MTOW	79015
FF	5033			RTOW	
LDW	59134			MLDW	66360

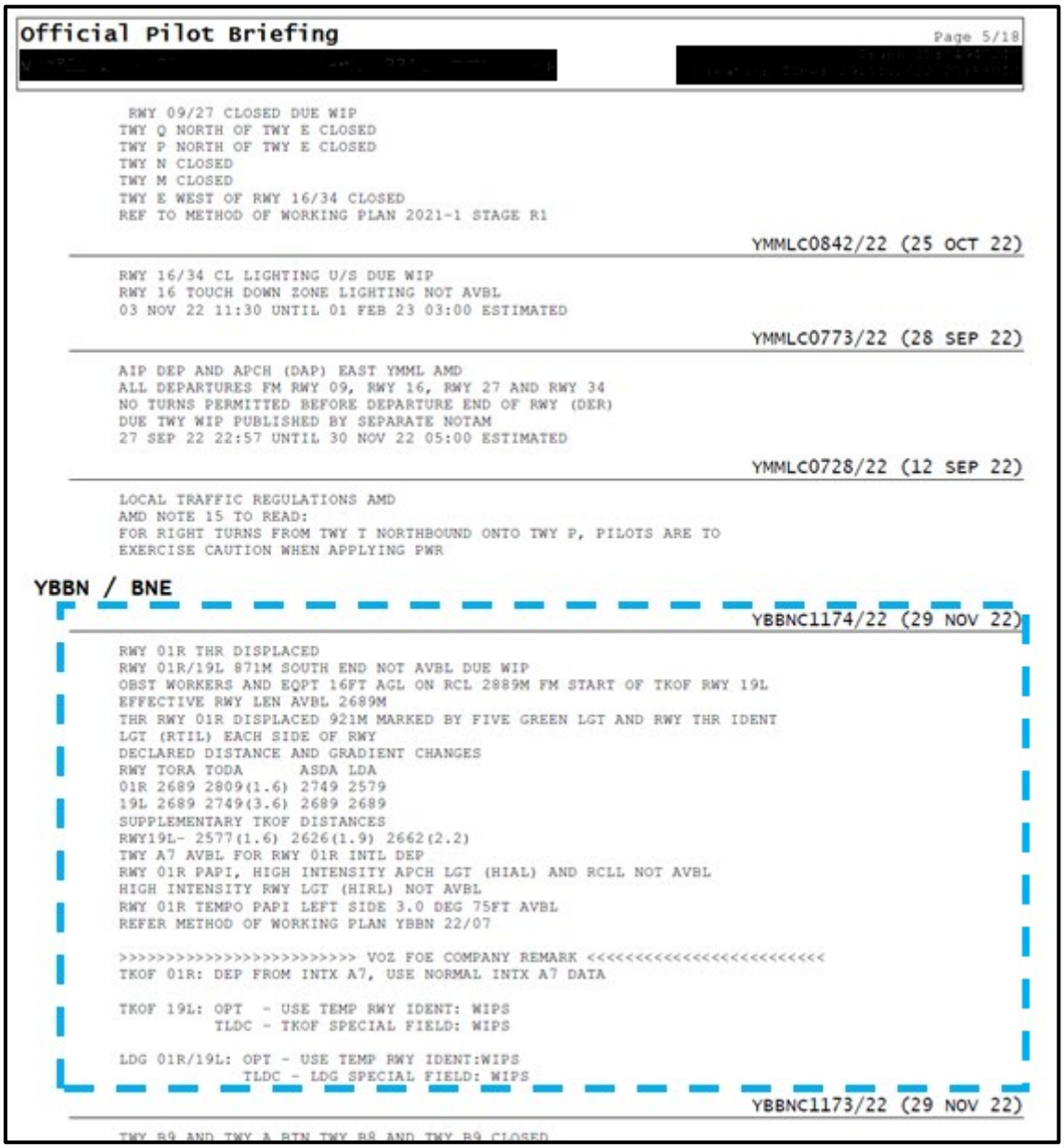
An image of the limit weight section of VA319 OFP.
Source: Virgin Australia, annotated by ATSB

VA319 NOTAMs

The VA319 FPP consisted of 33 pages, of which 18 contained the sector's NOTAMs. There were about 120 individual NOTAMs within the package.

The first of the Brisbane NOTAMs listed was NOTAM YBBNC1174/22 with the headline 'RWY 01R THR DISPLACED' (Figure 4 – broken blue box highlighting added by the ATSB). This NOTAM appeared on page 5 of the NOTAMs section and detailed the reduction in length for runways 01R (RWY 01R) and 19L (RWY 19L) due to aerodrome works being conducted around the RWY 01R threshold. Appended to the end of this NOTAM was a company remark titled '…>>> VOZ FOE COMPANY REMARK <<<…'. This remark was to notify the flight crew of FOE-required modifications to the take-off and landing performance data calculations for Brisbane RWY 01R and RWY 19L as a consequence of NOTAM YBBNC1174/22.

Figure 4: Page 5 of the NOTAM package, highlighting NOTAM YBBNC1174/22 and its associated FOE performance requirement



Official Pilot Briefing

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[redacted]

RWY 09/27 CLOSED DUE WIP
TWY Q NORTH OF TWY E CLOSED
TWY P NORTH OF TWY E CLOSED
TWY N CLOSED
TWY M CLOSED
TWY E WEST OF RWY 16/34 CLOSED
REF TO METHOD OF WORKING PLAN 2021-1 STAGE R1

YMMLC0842/22 (25 OCT 22)

RWY 16/34 CL LIGHTING U/S DUE WIP
RWY 16 TOUCH DOWN ZONE LIGHTING NOT AVBL
03 NOV 22 11:30 UNTIL 01 FEB 23 03:00 ESTIMATED

YMMLC0773/22 (28 SEP 22)

AIP DEP AND APCH (DAP) EAST YMML AMD
ALL DEPARTURES FM RWY 09, RWY 16, RWY 27 AND RWY 34
NO TURNS PERMITTED BEFORE DEPARTURE END OF RWY (DER)
DUE TWY WIP PUBLISHED BY SEPARATE NOTAM
27 SEP 22 22:57 UNTIL 30 NOV 22 05:00 ESTIMATED

YMMLC0728/22 (12 SEP 22)

LOCAL TRAFFIC REGULATIONS AMD
AMD NOTE 15 TO READ:
FOR RIGHT TURNS FROM TWY T NORTHBOUND ONTO TWY P, PILOTS ARE TO
EXERCISE CAUTION WHEN APPLYING PWR

YBBN / BNE

YBBNC1174/22 (29 NOV 22)

RWY 01R THR DISPLACED
RWY 01R/19L 871M SOUTH END NOT AVBL DUE WIP
OBST WORKERS AND EQPT 16FT AGL ON RCL 2889M FM START OF TKOF RWY 19L
EFFECTIVE RWY LEN AVBL 2689M
THR RWY 01R DISPLACED 921M MARKED BY FIVE GREEN LGT AND RWY THR IDENT
LGT (RTIL) EACH SIDE OF RWY
DECLARED DISTANCE AND GRADIENT CHANGES
RWY TORA TODA ASDA LDA
01R 2689 2809(1.6) 2749 2579
19L 2689 2749(3.6) 2689 2689
SUPPLEMENTARY TKOF DISTANCES
RWY19L- 2577(1.6) 2626(1.9) 2662(2.2)
TWY A7 AVBL FOR RWY 01R INTL DEP
RWY 01R PAPI, HIGH INTENSITY APCH LGT (HIAL) AND RCLL NOT AVBL
HIGH INTENSITY RWY LGT (HIRL) NOT AVBL
RWY 01R TEMPO PAPI LEFT SIDE 3.0 DEG 75FT AVBL
REFER METHOD OF WORKING PLAN YBBN 22/07

>>>>>>>>>>>>>>>>>>>>>>>>>> VOZ FOE COMPANY REMARK <<<<<<<<<<<<<<<<<<<<<<<<<<
TKOF 01R: DEP FROM INTX A7, USE NORMAL INTX A7 DATA

TKOF 19L: OPT - USE TEMP RWY IDENT: WIPS
TLDC - TKOF SPECIAL FIELD: WIPS

LDG 01R/19L: OPT - USE TEMP RWY IDENT:WIPS
TLDC - LDG SPECIAL FIELD: WIPS

YBBNC1173/22 (29 NOV 22)

TWY B9 AND TWY A BTN TWY B8 AND TWY B9 CLOSED

An image of page 5 of the VA319 NOTAMs, with YBBN NOTAM 1174/22 highlighted.
Source: Virgin Australia, annotated by ATSB

VA324 (Brisbane to Melbourne) flight planning package

Similar to VA319, the VA324 flight dispatcher determined that there were no performance weight limitations for the return sector to Melbourne as a result of the displaced threshold, and while the OFP did not include a direct statement of the parameters used in that determination, those parameters could be ascertained from data within the FPP.

The VA324 flight dispatcher stated that one of the roles of the Dispatcher Notes was to highlight to flight crew any information considered critical by the dispatcher, such as NOTAM YBBNC1174/22. Further, given the short turnarounds often associated with multi-sector flights, the dispatcher intended to direct the flight crew's attention to this NOTAM through inclusion of the following statement in the dispatcher notes:

> YBBN RWY 01R THR DISPLACED 29/2100-30/0630Z.

VA324 NOTAMs

The VA324 FPP consisted of 30 pages, 13 of which contained the sector's NOTAMs. There were about 80 individual NOTAMs within the package.

The YBBNC1174/22 NOTAM was the first of the NOTAMs included within the VA324 NOTAM package and included an attached FOE company remark. The presentation of the NOTAM and its FOE remark directly reflected the VA319 presentation (Figure 4), but was split over 2 pages, with the FOE remarks appearing on the second page.

FOE conspicuity

The operator's internal investigation into the event noted that performance critical NOTAMs with associated FOE data were presented in the FPP in the same typeface as less critical NOTAMs, and that there was 'little to draw the reader's attention' to something that was critical to safety of flight. The investigation noted that, in a high workload environment with many distractions, it was '…not difficult to miss text that looks the same'.

The VA319 FPP contained 8 NOTAMs with FOE remarks attached, while the VA324 FPP contained 5 NOTAMs with FOE remarks attached. For both FPPs, only 2 of the FOE notices contained performance requirements, while the rest were notifications that the NOTAM had no performance effect. The ATSB also noted that FOE remarks were highlighted via a unique banner (Figure 4) intended to increase their conspicuity to flight crew.

Notice to Airmen

Notification of aerodrome facilities

Airport operators were required to report detailed information about their various aerodrome facilities to Airservices. This information was then published in the Aeronautical Information Publication (AIP). Short-term changes to these facilities were also required to be notified to Airservices. Users of those facilities were then advised of these short-term changes through the NOTAM system.

NOTAM standards

CASR Part 175 prescribed standards covering when NOTAMs were to be issued and how they were to be structured and formatted. A detailed examination of those standards, and the documents in which they are found, is at *Appendix – NOTAM standards and related guidance materials*.

A NOTAM issued by Airservices was required to meet a prescribed format and contain specific information about the matter being reported. That format comprised multiple fields that not only provided a description of the matter(s) being reported—referred to as the free text section—but also contained coding that enabled both the automatic classification and filtering of that NOTAM, The NOTAM content presented to the flight crew in the FPP was limited to the free text section.

As well as meeting the format and content requirements, a NOTAM was also to adhere to various rules. These are covered in detail at *Appendix – NOTAM standards and related guidance materials*, but can be summarised under the following 4 basic principles:

- A NOTAM shall deal with only one subject and one condition of that subject. It shall be as brief as possible and compiled such that the meaning is clear, and without the need to refer to another document.
- The subject matter and related condition shall be determined in accordance with specific coding procedures and tables found in the International Civil Aviation Organization (ICAO) Document 8400.[23]

[23] Procedures for Air Navigation Services – ICAO Abbreviations and Codes (PANS-ABC).

- The code identifying the subject or denoting its status of operation is, whenever possible, self-evident. Where more than one subject could be identified by the same self-evident code, the most important subject is chosen.
- The content of the free-text section of the NOTAM shall be based on the selected code, be clear and concise and if possible limited to 300 characters—to facilitate use in a Pre-flight Information Bulletin (PIB).[24]

Of the various standards-defining documents identified in CASR Part 175, only ICAO Document 8126[25] included material on circumstances where multiple NOTAMs could be combined and reported in a single NOTAM. The document stated:

> The NOTAM Code selected describes the most important status or condition to be promulgated.

Although not included in CASR Part 175 as a standards document, EUROCONTORL[26] guidance material on NOTAMs included the following caution on combining NOTAMs:

> The negative impact on end-users caused by NOTAM proliferation is not to be solved by including more information in a single NOTAM, but that this fact further increases the difficulty for end-users. More information in one NOTAM makes the message less readable and essential information more difficult to detect.

Assessment of NOTAM YBBNC1174/22

The ATSB sought advice from both ICAO and the Civil Aviation Safety Authority (CASA) regarding NOTAM YBBNC1174/22 and its adherence to the applicable standards. ICAO and CASA acknowledged the guidance with regard to NOTAM content being limited to one subject matter and one condition of that subject matter, but differed in the application of this limitation with respect to related content.

CASA advised that the most important status or condition being reported in this NOTAM was the displaced threshold, and that the matters being reported within the free text section were the result of the changed condition of that subject matter. Further, the additional matters being reported were information necessary for the safe conduct of flight. As an overall assessment, CASA stated that the NOTAM met the standards as required under CASR Part 175. On whether the NOTAM's headline should have contained reference to 'RWY 19L', CASA stated that this could not be the case as there was no displacement of that runway's threshold.

ICAO stated that, as per PANS-AIM, matters not directly related to the subject matter and related conditions should not be included within the free text section, but that there also needed to be a balance between usability and convenience while adhering to the guidance principles. ICAO nevertheless advised that the free text section of the NOTAM held critical information interspersed with less critical information, and that the critical information should have preceded the less critical information. While ICAO indicated that the NOTAM complied with ICAO guidance principles, the information concerning the runway lighting, and probably the taxiway information, should have been published as separate NOTAMs.

Brisbane Airport

Runway works

The Brisbane NOTAM YBBNC1174/22 was published as notification of scheduled works around the threshold of RWY 01R. Those scheduled works were part of a larger programme of works documented in a Method of Working Plan (MOWP) YBBN 22/07,[27] published by Brisbane Airport

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[24] The PIB is a cutdown version of the original NOTAM, where the content is limited to the free text section of the NOTAM.

[25] Titled the Aeronautical Information Services Manual, 7th Edition, 2022.

[26] EUROCONTROL is a pan-European, civil-military organisation, governed by an international convention that supports European aviation and is mostly comprised of ATS providers.

[27] Method of Working Plan YBBN 22/07, Brisbane Airport: AGL Cable Upgrade Phase 2 – Pillars 1, 2, 3C, 4, 5, and 7.

Corporation (BAC) in August 2022. The works were to be staged over about a year to minimise disruption to operations at the airport. In accordance with the Civil Aviation Safety Regulations (CASR) Part 139, the MOWP detailed the timing, scope of the works and specific aerodrome facilities that would be affected. The MOWP also identified how the individual work stages affected aircraft operations, and listed any NOTAM to be issued, where required, for each stage.

The works around the threshold of RWY 01R were scheduled to commence on 30 November 2022. After being notified of these works by BAC, on 23 November Airservices issued the predecessor of YBBNC1174/22. As a result of some minor changes, that original NOTAM was modified, and on 30 November YBBNC1174/22 was published by Airservices.

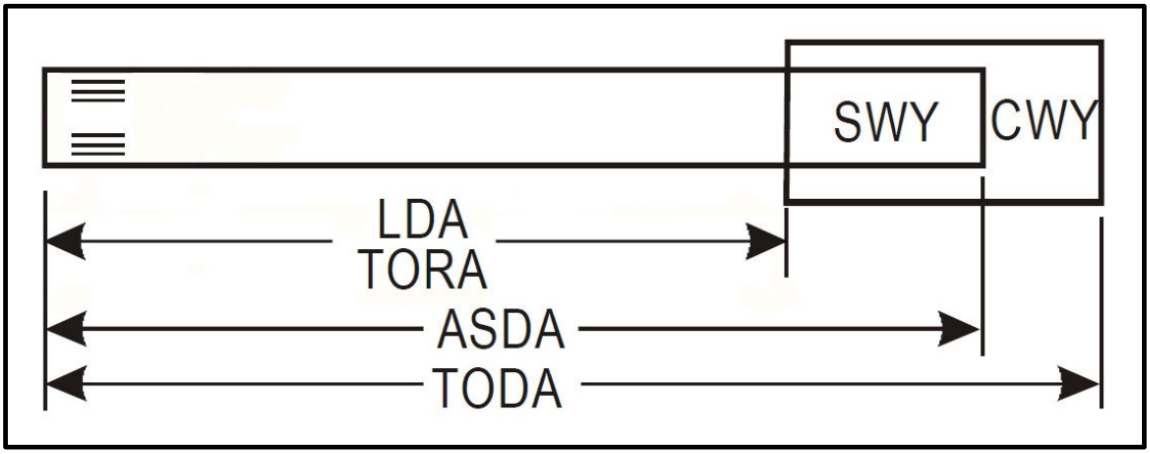
Runway distance information

NOTAM C1174/22 included runway distance data under the title DECLARED DISTANCE AND GRADIENT CHANGES. The information immediately below this line provided runway distance measurements used in the calculation of aircraft runway performance data.

Part 139 Manual of Standards (Part 139 MOS) required aerodrome operators to report various runway distances for publication in the AIP. The following 'declared distances', as defined in Part 139 MOS, were to be notified by aerodrome operators (Figure 5):

- Take-off run available (TORA). The length of runway declared available and suitable for the ground run of an aeroplane taking off. The take-off run available may include additional length available from a starter extension if provided, but neither stopway (SWY)[28] nor clearway (CWY)[29] were included in the take-off run available.
- Take-off distance available (TODA). The length of the take-off run available plus the length of the clearway, if provided.
- Accelerate-stop distance available (ASDA). The length of the take-off run available plus the length of the stopway, if provided.
- Landing distance available (LDA). The length of runway which is declared available and suitable for the ground run of an aeroplane landing.

Figure 5: Runway declared distances



A diagram identifying the various components of a runway's declared distances, and their relationships to the physical dimensions of the runway.
Source: ICAO Annex 14, modified by ATSB

[28] A defined rectangular area on the ground at the end of the take-off run available prepared as a suitable area in which an aircraft can be stopped in the case of an abandoned take-off.

[29] A defined area at the end of the take-off run available, under the control of the aerodrome operator, that is selected or prepared as a suitable area over which an aeroplane may make a portion of its initial climb to a specified height.

The various take-off and landing distances applicable to RWY 19L[30] and the A3 intersection with RWY 19L, while in unrestricted use and when the displaced threshold was in effect (as notified by NOTAM C1174/22), are stated in Table 1.

Table 1: Runway 19L distances

Departure designation	TORA	TODA	ASDA	LDA
19L	3560	3620	3560	3560
19L/A3	2781	2841	2781	-
19L-WIPS	2689	2749	2689	2689
19L/A3-WIPS	1910	1970	1910	-

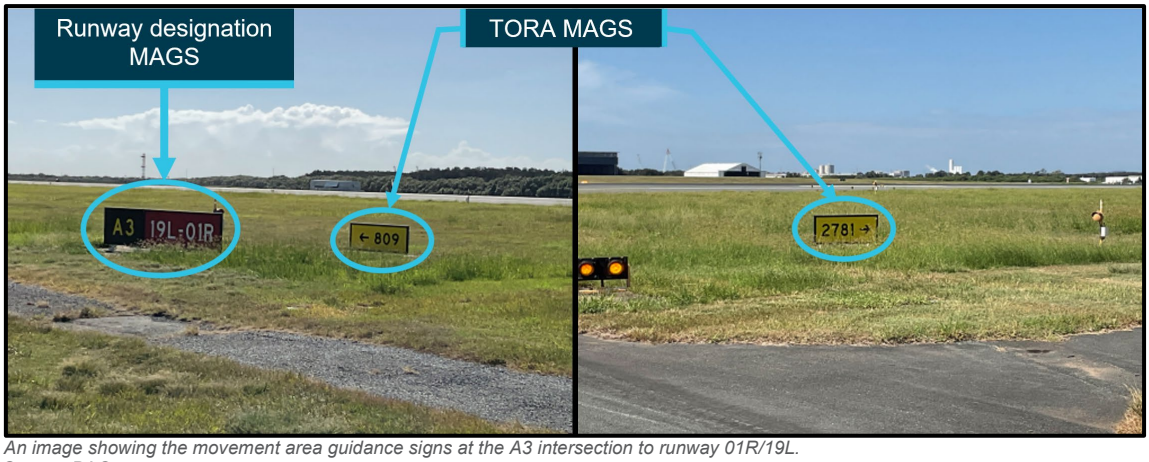
Movement area guidance signs

Movement area guidance signs (MAGS) were installed at the taxiway A3 holding point for entry to RWY 01R/19L. MAGS may be either mandatory instruction signs or information signs. Instruction signs used white lettering on a red background, while information signs used black lettering on yellow background. There were 2 types of MAGS installed abeam that runway holding point (Figure 6):

- a runway designation sign that identified the taxiway and runway, located to the left of the taxiway and adjacent to the holding point
- 2 take-off run available (TORA) signs located either side of the taxiway that stated the TORA distances available in the identified direction from that runway entry point.

The flight crew stated that these signs were not obscured at the time of VA324's departure. Brisbane Airport personnel advised that the TORA MAGS would not normally be covered or obscured when there was variation in the runway length due to works.

Figure 6: MAGS situated at the A3 holding point for 01R/19L



An image showing the movement area guidance signs at the A3 intersection to runway 01R/19L.
Source: BAC

Part 139 MOS paragraph 8.27(4) stated:

> If:
>
> (a) a movement area guidance sign (MAGS) displays declared distance information; and

[30] The *Departure designation* column uses the OPT nomenclature to identify the various RWY 19L conditions and departure points. 19L identifies the full length of RWY 19L, while 19L-WIPS identifies the reduced runway length due to NOTAM C1174/22. 19L/A3 is the A3 intersection of RWY 19L take-off commencement point.

(b) because of a period of temporary threshold displacement the MAGS information is incorrect for the period;

the MAGS must be obscured until the permanent threshold is reinstated.

The MOWP did not include any instruction for obscuring the TORA MAGS located at the A3 holding point.

OPT calculated runway performance data

Introduction

The Onboard Performance Tool (OPT) was developed by Boeing as the application to be used by flight crew for calculating take-off and landing performance. While the primary source of B737 aircraft performance data was the Airplane Flight Manual (AFM),[31] the OPT provided data equivalent to the AFM and met all take-off and landing regulatory requirements. It was accessed through the Electronic Flight Bag (EFB).

OPT database

The OPT used a database of airports and runways available for use by the operator's flight crew. That database was maintained by flight operations engineering (FOE). Changes to an airport's runway data, such as a reduction in runway length notified through NOTAM, required FOE to determine how aircraft performance was affected and what additional runway data was to be included within the OPT database. As part of their response, FOE would amend the database to include a temporary runway identifier with the modified runway data relevant to this change. The requirement to use this temporary identifier would be notified to flight crews through the VOZ FOE COMPANY REMARK notice attached to the relevant NOTAM in the FPP. Updates to the OPT database were automatically sent to the EFB. Prior to the first use of the day, the user was required to ensure that the OPT database version was the latest, as listed within the company NOTAMs. Virgin stated that quality control procedures established within FOE ensured that flight crew were not required to independently verify runway data used by the OPT.

Performance calculators

Introduction

In setting up the OPT for performance calculation, the user was required to select the relevant airframe registration and airport from the database. There were 3 types of performance calculators available:

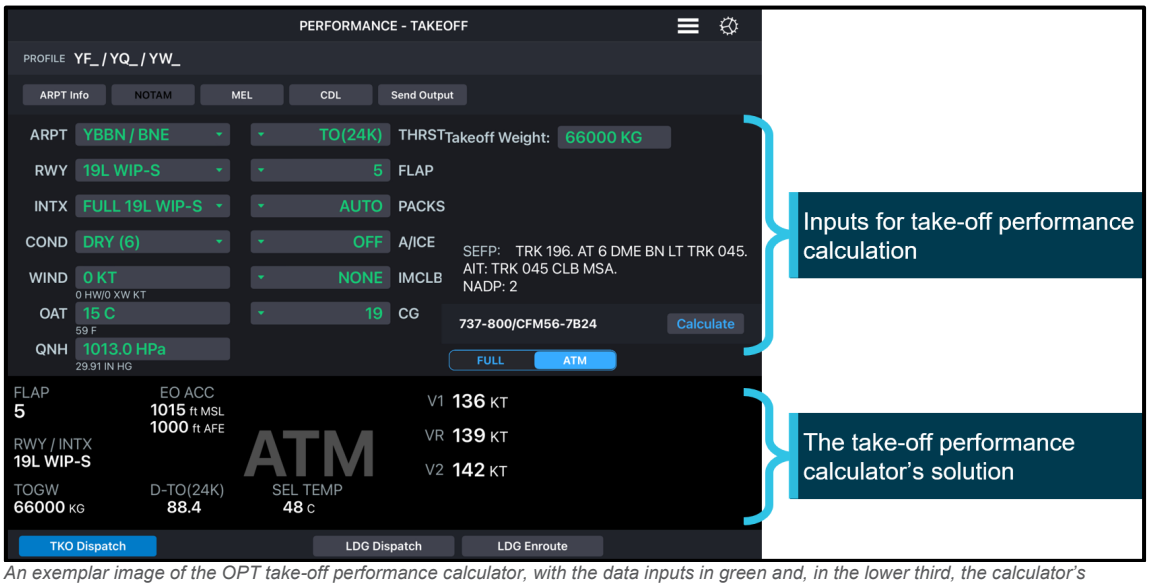
- take-off performance
- landing performance
- en route landing performance.

Take-off and landing performance calculators

The take-off and landing performance calculators enabled determination of take-off and landing performance data as well as the performance limited weights for take-off and landing. The performance limited weight feature of both the take-off and landing performance calculators were primarily used by flight dispatch during flight planning to determine whether the sector had limiting weight considerations. The take-off performance calculator was used by flight crew for calculating take-off performance data as part of the preliminary pre-flight procedure (Figure 7).

[31] The AFM is part of the certification documentation for the aircraft type. It contains the operating data, limitations and procedures necessary for safe flight and operation of the aircraft.

Figure 7: OPT take-off performance calculation screen



An exemplar image of the OPT take-off performance calculator, with the data inputs in green and, in the lower third, the calculator's take-off performance data.
Source: Virgin Australia

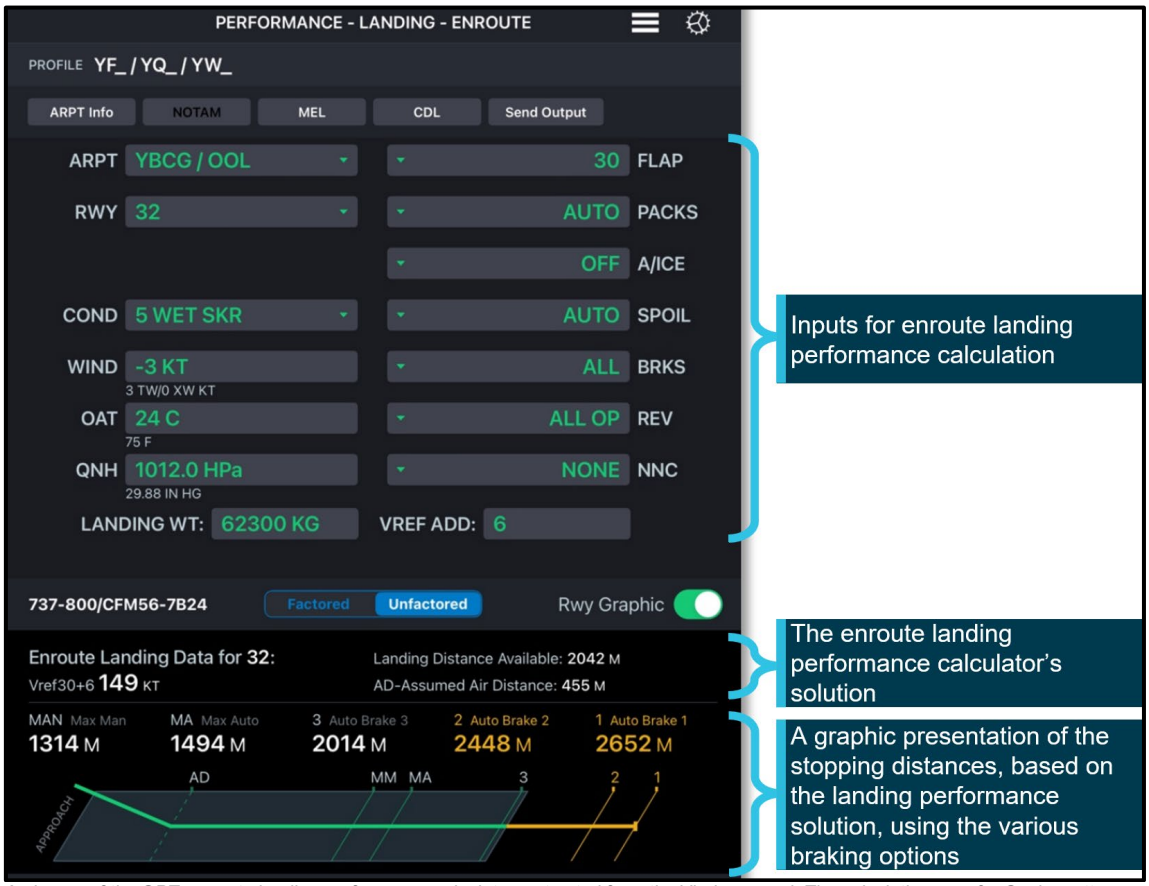
When used by flight crew for take-off or landing performance data calculation, the user was required to input data into the various fields, and if a valid performance solution was possible, the application would provide performance data for those parameters. For a take-off calculation, a valid performance solution would provide data that included the relevant take-off speeds and any available thrust derate.[32] An invalid performance solution would clearly advise the flight crew that a take-off using those parameters was not permitted. With respect to the landing calculator, the performance results included the landing limit weight and relevant landing speed for the selected flap setting at that weight.

En route landing performance calculator

The en route landing performance calculator was the primary landing data calculator used by flight crew (Figure 8). It provided data based on an input landing weight and selected environmental and aircraft configuration inputs. If a valid landing performance solution was possible, the calculator would provide landing performance data that included the landing speed and stopping distances for the various braking selections available. That stopping data could be displayed in both tabular and graphic form. The selected runway's landing distance available (LDA) was displayed as a product of the landing data solution.

[32] A derated thrust, or reduced thrust, take-off is a take-off that is accomplished utilising less thrust than the engines can produce under the existing conditions of temperature and pressure altitude. Designed to reduce engine wear and maintenance costs, the amount of thrust reduction is dependent on regulatory requirements and variables such as the runway length and weather conditions.

Figure 8: Exemplar OPT en route landing performance calculator

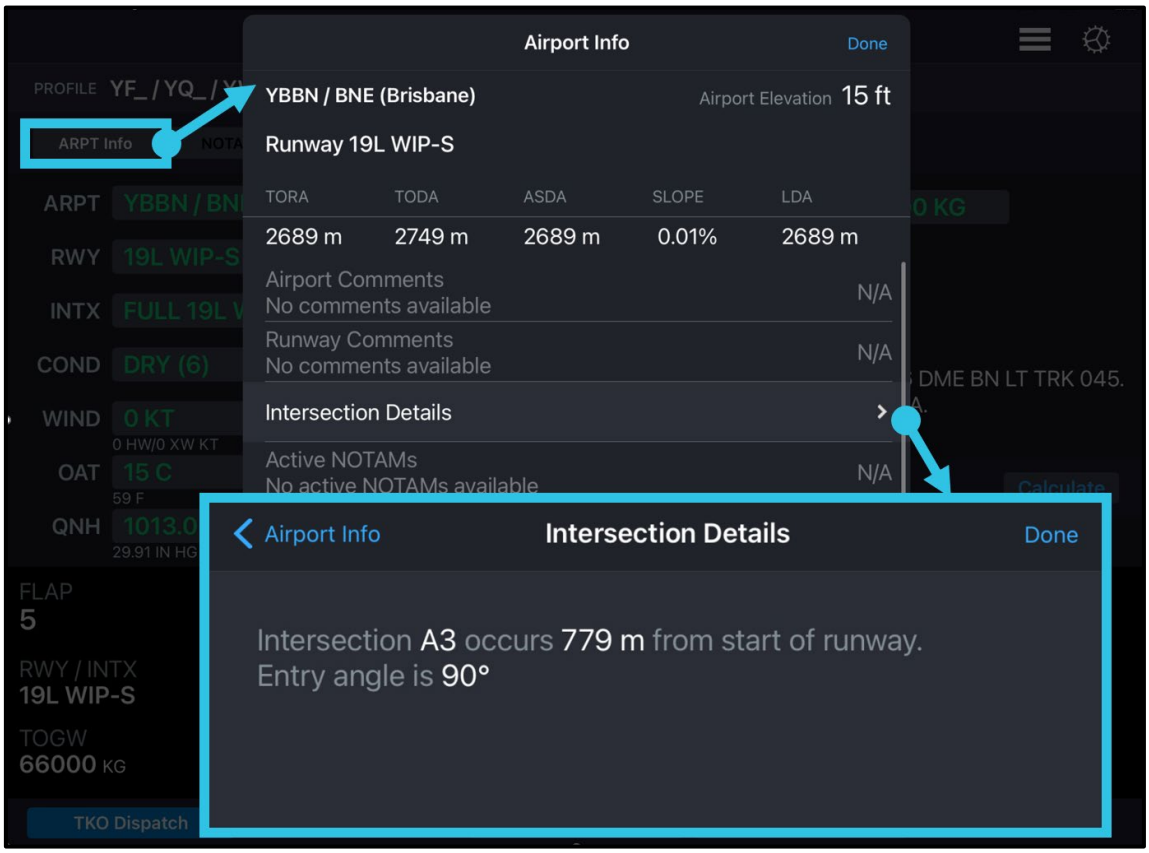


An image of the OPT en route landing performance calculator, extracted from the Virgin manual. The calculations are for Coolangatta, with the data inputs in green and, in the lower third, the calculated landing performance data. The image also shows the calculated stopping solution in graphic form.
Source: Virgin Australia

Runway distance data

While runway distance data was displayed in the calculation results for the en route landing performance calculator (displayed as the Landing Distance Available), it was not displayed as part of the calculated take-off performance data. However, runway data was available in all OPT calculators through the *ARPT Info* tab (see Figure 7 and Figure 8). Selecting the *ARPT Info* tab (Figure 9) provided database details for the airport and runway that were selected as inputs. Intersection details relevant to that runway data was then available through a further selectable option. However, to determine the TORA for an intersection departure, the flight crew needed to manually calculate it using the displayed information.

Figure 9: OPT airport information



An image showing access to runway data through the Airport Info tab in the various OPT calculators.
Source: Virgin Australia modified by ATSB

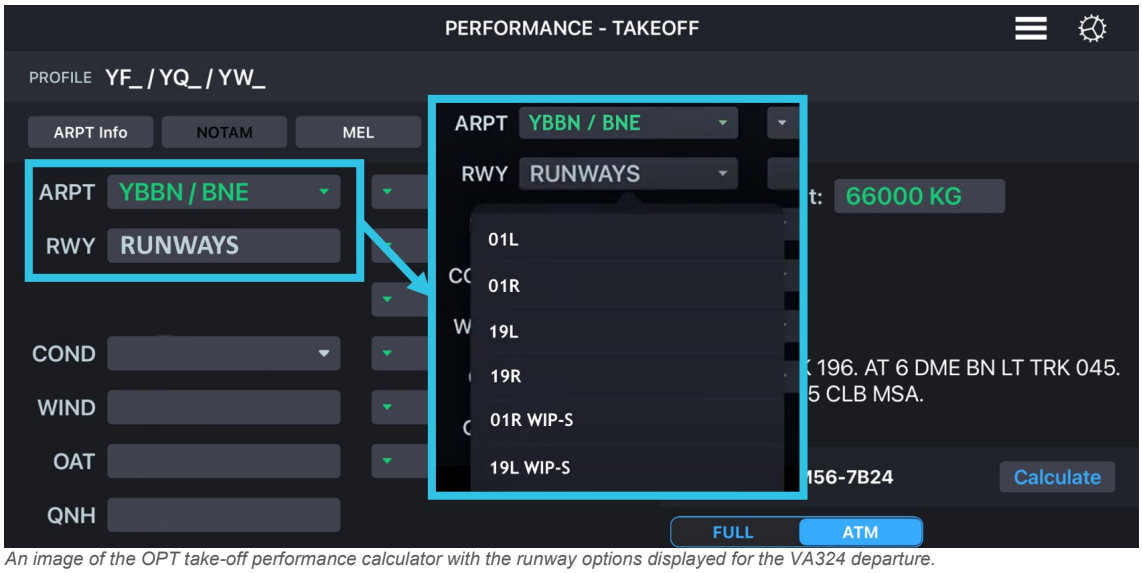
VA319 landing performance data

For the VA319 landing, the runway (RWY) input for Brisbane Airport (YBBN/BNE) had several selectable options available through a drop-down box. These were, in order, 01L, 01R, 19L, 19R, 01R WIP-S and 19L WIP-S (Figure 10). The 2 WIP-S runway options were the required selections for those runways based on the FOE remark in the VA319 FPP while NOTAM 1174/22 and the RWY 01R threshold displacement was in effect.

As part of their landing performance calculations for arrival into Brisbane, the flight crew selected the 19L option. The calculator provided a stopping solution based on the full runway length, and the other selectable variables input by the flight crew. The displayed landing solution included the LDA for RWY 19L, which was 3,560 m, while the available stopping solutions were based on this full runway length.

While the stopping solution for the landing in Brisbane was based on an incorrect runway length, the landing was not affected by this error. The aircraft was able to exit the runway using the using the A6 rapid exit taxiway, which was about 850 m short of the displaced threshold.

Figure 10: Runway input selection



An image of the OPT take-off performance calculator with the runway options displayed for the VA324 departure.
Source: Virgin Australia modified by ATSB

VA324 take-off performance data

For the VA324 departure, the selectable YBBN/BNE runway inputs were those as stated for the VA319 arrival. However, on selecting the runway, the user was then also able to select various intersection (INTX) departure points available for that runway. While the normal RWY 19L configuration had the FULL and A3 INTX (intersection) options available, FOE had removed the A3 INTX option for RWY 19L WIP-S, and therefore the A3 intersection departure was not an available input.

For the VA324 take-off performance calculation, the flight crew selected the 19L option as the departure runway and A3 as the intersection departure. The OPT provided take-off performance and thrust derate based on the TORA of 2,781 m.

As part of its internal investigation, Virgin calculated the VA324 take-off performance data using the same inputs as the flight crew, but with the 19L WIP-S runway option and an A3 INTX selection (an A3 intersection departure). The OPT displayed an invalid take-off performance solution, with the following message being displayed:

> No takeoff allowed. Planned weight exceeds max allowable weight of 67350 KG.

This result indicated that, even with maximum take-off thrust, the aircraft was overweight for a departure from A3 on runway 19L with the reduced runway length due to the displaced RWY 01R threshold.

Operator's policies and flight procedures

Operations manual requirements

The operations manual detailed the operator's general policies and specific procedures that governed the conduct of safe flying operations. With respect to the approach and pre-flight phases of operations, it contained both common and specific requirements relevant to both. While the aircraft captain was accountable for the aircraft's safety, and to obtain and check all available relevant information, the first officer was also required to be able to assume pilot in command duties should the aircraft captain become incapacitated. To meet this requirement, the first officer was to actively participate in the preparation and conduct of the flight, and in particular regarding flight preparation, to be familiar with all relevant operational information, including NOTAMs.

The operations manual also required both flight crew to independently review the weather information to be used in the departure and arrival preparations, such as that sourced from the

ATIS. This independent review required each pilot to listen to the source information, or, if the source was a printed readout, independently read that data. That review was required to include verification of the information recorded on the take-off data card (TODC).

Flight crews were also required to be alert for NOTAMs that may have performance effect, but which did not have an FOE remark attached. The absence of the FOE remark identified that the NOTAM had not been assessed by FOE, and in such cases flight crews were required to contact flight dispatch and initiate an assessment of the NOTAM.

The manual also included a requirement for departure and arrival briefings. These briefings, which were normally conducted by the PF, had explicit content requirements, but both specifically included applicable NOTAMs. There was also a general threat and error management component to be addressed in these briefings.

Departure specific requirements

The pilot-in-command was responsible for ensuring that the aircraft's gross weight was such that the flight could be conducted in compliance with the AFM, and similarly that the aircraft did not exceed take-off performance limitations. For take-off performance calculations, the operations manual required compliance with procedures that ensured an adequate independent cross-check be conducted with respect to several factors, including the input data used for the calculation. These independent cross-check procedures were detailed in the FCOM and the Performance and Loading Manual. Finally, the operations manual required specific items to be included within the departure briefing, when applicable. These items included any NOTAMs that were relevant to the departure.

Approach specific requirements

Before landing, the pilot in command was required to determine that the landing distance available (LDA) was sufficient and with an adequate safety margin. The operations manual provided 3 methods through which this determination could be made.

The first 2 methods were based on the dispatcher's pre-flight calculation of the landing weight limit for the sector. This limit was stated as the maximum landing weight (MLDW) in the limit weight (LIMIT WT) section of the OFP (Figure 3). If the aircraft's landing weight was less than this MLDW:

- and there had been no adverse changes to the environmental conditions, aircraft configuration or runway of intended use, or
- having considered any changes to the environmental conditions, aircraft configuration and/or runway of intended use and found them to have no adverse effect,

then the landing distance requirement was met. Both MLDW methods were reliant on the flight crew knowing the variable parameters of environmental conditions, aircraft configuration and runway of intended use, that the dispatcher used in the MLDW calculation. Generally, dispatchers did not declare the parameters used in the MLDW determination within the OFP (see the section titled *Flight planning*). However, the dispatcher's manual stated how these variable parameters were to be determined and flight crew could ascertain them from various parts of the FPP.

The third method required the flight crew to calculate an operational landing distance using maximum manual braking and factored by 1.15, and then ensuring that this landing distance was less than or equal to the LDA. The operations manual also required a stopping solution be determined when the LDA was sufficient. An operational landing distance calculation was made as part of the OPT's en route landing performance solution (see the section titled *En route landing performance calculator*). Therefore, the sufficient LDA determination was met as part of the stopping solution calculation.

Training manual requirements

As the occurrence flight was also being used to support a training function (line flying under supervision), it was necessary to examine relevant training policy and guidance to determine any likely effect on the conduct of normal operations. The operator's training manual stated that safety remained the primary objective of all training events, and that:

> The safe conduct of our flying operations and all supporting activities relies on our systems, our operating procedures, and most importantly in the way we think and act.

The manual further stated that:

> All flight crew and Training and Checking personnel engaged in … training and assessment activities are required to ensure that safety remains at the forefront of all actions and decisions. This is especially important for training conducted in the aircraft, where Trainers … must always ensure that the safety of the aircraft and its occupants is never compromised.

The training manual also stressed that training pilots should conclude all training events with some degree of debrief.

Flight procedures

Introduction

The procedures required of the flight crew for the various phases of flight were contained in the operator's Flight Crew Operating Manual (FCOM). These procedures were to be performed by memory and ensured that operational systems were correctly configured for the relevant phase of flight, and data for the flight management systems was entered and correct. Pre and post-flight duties were divided between the captain and first officer, while phase of flight duties were divided between the PF and PM.

The procedures required of the flight crew as part of the approach preparation for VA319, and those required as part of the departure preparation for VA324, are addressed separately. The FCOM procedures for both the approach and departure preparation required calculation of performance data. Those calculations, which were made using the OPT, were to be completed using procedures and guidance found in the aircraft Performance and Loading Manual.

Pre-flight procedures and the performance data calculation

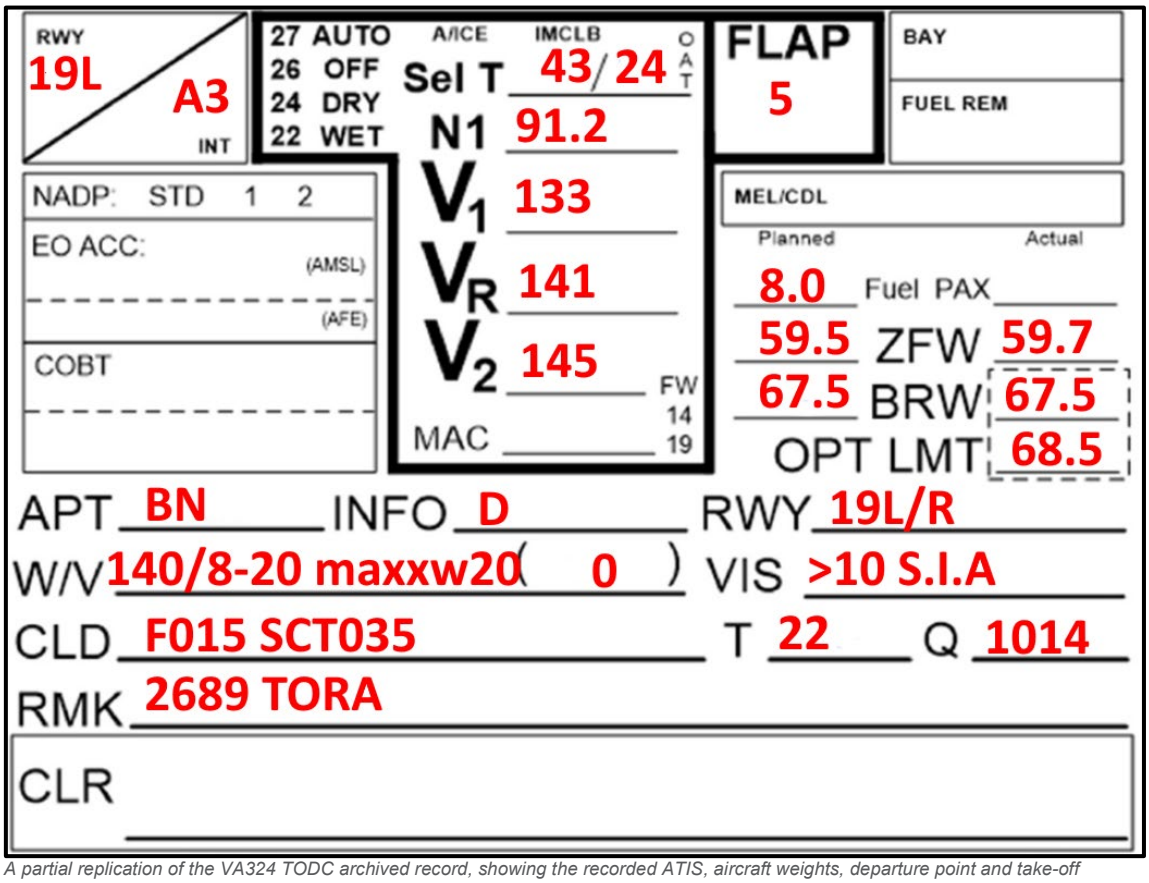
Take-off performance data calculations were part of the FCOM flight management computer's (FMC) data entry procedure that was conducted in parallel with the captain and FO pre-flight procedure. This procedure required the determination of input data for the performance calculation, recording of that data on the TODC, and entry of that data into the OPT. These procedures and method of calculation using the OPT were prescribed by the Performance and Loading Manual.

The pilot not performing the exterior inspection was required to complete the TODC. The weather conditions for the departure, such as that reported by the ATIS, and the input variables for the OPT calculation were to be determined and recorded onto the TODC. These included items such as:

- the relative wind (headwind or tailwind component)
- adjusted ambient temperature
- runway data to be used
- aircraft configuration data, such as the relevant weights, fuel on board, engine thrust rating, and the intended take-off flap setting.

These variables were then entered into the OPT and if a valid take-off performance solution was calculated, the various take-off speeds, any take-off thrust derate (if applicable), and other performance data provided by the OPT calculation were to be recorded on the TODC (Figure 11).

Figure 11: A partial replication of the VA324 TODC



A partial replication of the VA324 TODC archived record, showing the recorded ATIS, aircraft weights, departure point and take-off performance data.
Source: Virgin Australia modified by ATSB

The take-off performance data was entered into the FMC as part of the data entry component of the pre-flight procedure. The other pilot was then required to independently calculate the take-off performance data as part of their pre-flight procedures.

Validating performance data calculations

The OPT had a '*compare calculation'* function to compare the performance calculations made by 2 EFB devices connected through wi-fi. This '*compare calculation'* function operated as the independent cross-check of input data required by the operations manual for all take-off performance calculations. The '*compare calculation'* function displayed a comparison of the performance results and checked for any differences in the user inputs. Any discrepancies were notified to the user. Where no differences existed, both devices displayed a '*check complete'* and '*no mismatches found'* message.

Runway entry performance check

The FCOM's before take-off procedures required the flight crew to verify that the runway about to be used for the take-off and the runway take-off position were correct. This was triggered when the aircraft was approaching the take-off position. It required, among other things, that the flight crew confirm that the runway location used for the performance calculation was coincident with the aircraft's actual location.

Landing performance calculations

The OPT's Landing En route Performance calculation, using the actual landing weight and the relevant weather components drawn from the ATIS, provided the operational landing distance for the various braking options (see the section titled *En route landing performance* calculator).

The landing distance available was also displayed, however, flight crews were not required to confirm that a changed landing distance available notified on the ATIS matched the landing distance available displayed on the OPT. This assurance was met through flight crew awareness and selection of the appropriate runway selection from the runway drop-down options in the OPT, which in turn was dependent on timely FOE updates to both the OPT database and notification to flight crew through the FPP.

Pre-flight tasks and turnaround schedules

The operator provided a synopsis of the normal turnaround tasks and timings for a B737 flight crew. A turnaround was allocated 40 minutes from arrival to departure from the gate. The tasks required to be performed during the turnaround were estimated to take about 30 minutes, of which 4 minutes was assigned to planning the next sector. The operator noted that sector patterns were arranged such that ports were revisited, thereby enabling a significant part of the briefing process to be covered during an earlier cycle.

Air traffic control information

VA324 departure

Airservices Australia stated that several aircraft departed via the A3 intersection prior to the VA324 departure, and that there were no restrictions on doing so. The airport operator had installed several cones across the runway about 200 m south of the A7 taxiway intersection with the runway (Figure 12). VA324's nose wheel was observed by the tower controller to lift at about taxiway A7 and the main wheels were observed to have passed extremely close to the displaced threshold cones. Several of the cones were blown over, and the airport operator advised that one cone was damaged.

In its internal investigation report, Virgin identified that some tower controllers were heard on the day, advising other flights that the runway was operating with a reduced length. Further, while acknowledging this was a non-standard radio call, the internal report also stated that consideration should be given to enhancing this radio call.

The ATSB determined that absence of such an alert for the VA324 departure was not contributory to the overrun occurrence. The shortened runway was included within the ATIS, which the flight crew acknowledged receipt of. Nevertheless, the inclusion of limiting runway conditions such as a shortened runway within the take-off clearance would enhance flight crew awareness of those conditions.

ATIS information

The ATIS information for both the arrival of VA319 and the departure of VA324 was 'D', which stated:

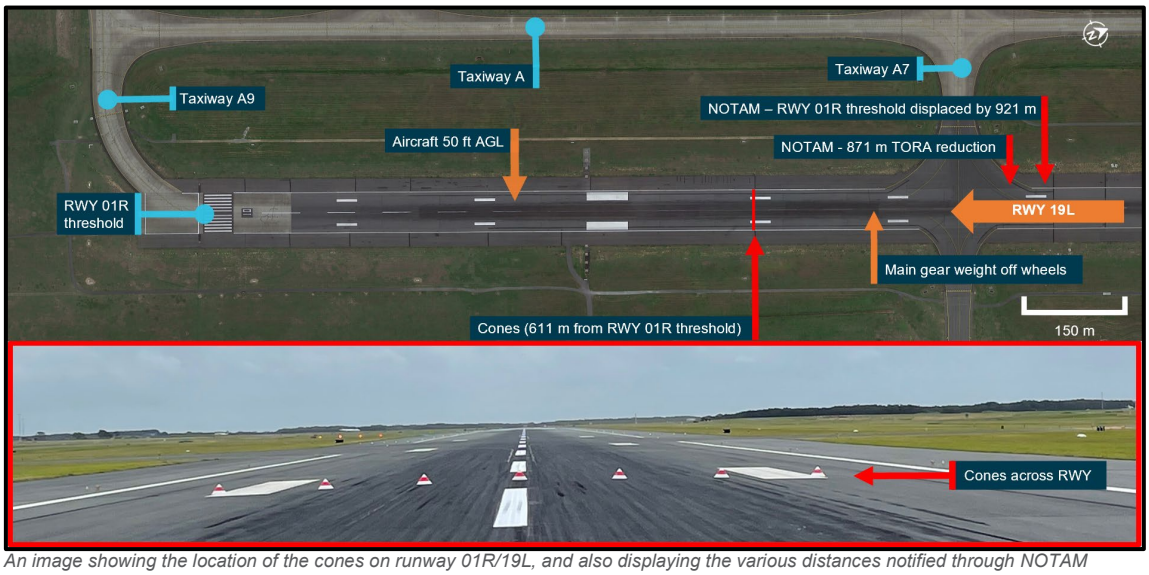
> EXPECT INSTRUMENT APPROACH
> RWY 19L AND R FOR ARRIVAL AND DEPARTURES
> INDEPENDENT PARALLEL DEPARTURES IN PROGRESS
> REDUCED RUNWAY LENGTH IN OPERATION RWY 19L, LANDING DISTANCE AVAILABLE 2689 M, TAKE OFF RUN AVAILABLE 2689 M
> WIND 140 DEG, MIN 8 KT MAX 20 KT, CROSSWIND MAX 20 KT
> VISIBILITY GREATER THAN 10 KM
> SHOWERS IN AREA
> CLOUD FEW 1500 SCT 3500
> TEMPERATURE 22
> QNH 1014

Recorded data

Recorded data from the aircraft's flight data recorder, Automatic Dependent Surveillance Broadcast (ADS-B) data from Airservices Australia, and video from various aircraft gates around

the airport, enabled the ATSB to determine where VA324 became airborne. The relationship between the point where the aircraft's main wheels left the runway and the cones, as well as the declared distances stated in NOTAM YBBNC1174/22 are identified in Figure 12.

Figure 12: Runway 19L configuration for VA324 take-off



An image showing the location of the cones on runway 01R/19L, and also displaying the various distances notified through NOTAM YBBN 1174/22. Specific locations of VA324's take-off are also displayed.
Source: ATSB

The Global Action Plan for the Prevention of Runway Excursions

In May 2021, EUROCONTROL, with the support of the Flight Safety Foundation, published the Global Action Plan for the Prevention of Runway Excursions (GAPPRE). This publication was the result of contributions from multiple international public and private organisations with the goal of enhancing the safety of runway operations. The GAPPRE recommendations represent industry best practice which extend beyond regulatory compliance.

As part of its examination of take-off performance data calculations, the GAPPRE made the following observations:

- Many runway safety events stem from erroneous or inadequate take-off performance calculations.
- While the independent take-off performance calculations by all active crew members, which are subsequently cross-checked, can be time consuming, it is highly recommended.
- EFB solutions incorporating navigational charts and applications for flight planning such as take-off and landing performance calculation programs not only save costs but also can simplify processes for flight crews. However, if threats such as runway shortening are not incorporated in time into the database used for performance calculations, the probability of the flight crew failing to detect such errors is high, especially as current NOTAM format and presentation in aviation in combination with fatigue, time pressure or complacency may lead to flight crews sometimes not reading or checking NOTAM information properly.
- Visualisation in particular is a great tool to enable flight crews to easily build a correct risk picture for their take-off in terms of runway excursion prevention. Being aware of the additional stop margin resulting from their calculation and being able to easily cross-check that the take-off position and line-up procedure used for the calculation matches the one expected or used is key for flight crews' safety-relevant decision-making (e.g. deciding on a re-calculation or accepting or rejecting line-up clearances). If technically feasible, visualisation of this information should therefore combine results of performance calculations and airport layouts.

These, and other observations with respect to the calculation of performance data, led to several recommendations, including that aircraft operators develop policies or standard operating

procedures that require flight crews to perform independent performance calculations. This should include an independent cross-check of actual TORA/TODA from the AIS with the TORA/TODA used to calculate the take-off performance.

The implementation of this recommendation included a strategy that the actual TORA/TODA, especially if being altered by NOTAM, should be checked against the value used in the take-off performance program individually and independently by each flight crew member. If it is not technically feasible to combine the results of take-off performance calculations and airport/runway layout in one visualisation, at least the EFB solution should make it possible to visualise the available stop margin in relation to the TORA.

Operator processes

Virgin's procedures did not require flight crew to confirm that the runway distance used in the performance calculation matched that stated on the aerodrome ATIS. The operator advised that the OPT and gross error checking systems currently used were satisfactory for runway performance calculations.

While the operator's dispatch NOTAM update service and FOE review provided the latest information available for flight crew for use in runway performance calculations, it did not mitigate inadvertent flight crew error where FOE performance requirements were not identified as part of the briefing process. Further, while extremely remote, there is also the likelihood of late changes in runway configuration being reported on ATIS but being outside of any update to the NOTAM package being provided to flight crew. Both could lead to miscalculation of runway performance data, which could be mitigated through procedure requiring confirmation of an ATIS reported change in runway data being confirmed and matched to the data used in the performance calculation.

Similarly, tools that enable the visualisation of the relevant performance distances, and in particular the stopping margins available for the take-off, are of great value in enabling flight crews to easily build a correct risk picture for their take-off in terms of runway excursion prevention. While these visual tools were available for the OPT's en route landing calculator, there was not an equivalent visual tool available for use in the take-off calculator.

Related occurrences

ATSB research and analysis report AR-2008-018

The first part of this 2-part ATSB research and analysis report presented a worldwide perspective of accidents and incidents involving take-off performance parameter errors. The report noted that, despite advanced aircraft systems and robust operating procedures, accidents continued to occur during the take-off phase of flight. The report documented accidents and incidents that resulted from take-off performance parameter data being incorrectly calculated or entered into aircraft systems.

It was found that calculation and entry of erroneous take-off performance parameters had many different origins, and that many factors were identified at all levels of influence. Due to the immense variation in the mechanisms involved in making take-off parameter calculation and entry errors, the report stated that there was no single solution to ensure that such errors were always prevented or captured. The report did, however, discuss several error capture systems that airlines and aircraft manufacturers can explore.

ATSB Investigation AO-2013-195

On 14 October 2013, a B737 aircraft departed from runway 11 intersection B2 at Darwin Airport using take-off performance data for the full runway length. The flight crew had prepared performance data for both a B2 intersection departure and a full-length departure and entered data for the full-length departure into the flight management computer. As the aircraft taxied for a

full-length departure, ATC advised of delays for a full-length departure due to arriving aircraft, but that an immediate departure was available from B2. The flight crew elected to use the B2 departure and reprogrammed the flight management computer. After a normal take-off, the flight crew identified that they had used the full-length data to reprogram the flight management computer, and that the aircraft had taken off with incorrect performance data.

ATSB Investigation AO-2021-037

During the month of September 2021, a NOTAM advised flight crew that Darwin Airport runway 29 had a displaced threshold due to runway works. Two flight crews, the first on 3 September and the second on 19 September, misinterpreted the NOTAM to mean that runway 11 threshold was displaced. Both flight crews planned for a displaced threshold landing on runway 11, and both crews subsequently landed long with reduced runway available for the landing roll. Further, both flight crews misinterpreted the aerodrome ATIS, which stated the active runway as being 11 and that the runway had reduced length.

NTSB Investigation NTSB/AIR-18/01

On 7 July 2017, an Airbus A320 was cleared to land at San Francisco airport runway 28R. The aircraft, which was conducting a visual approach to the runway, was lined up with the parallel taxiway C and not the runway. There were 4 air carrier aircraft waiting clearance to take off that were occupying taxiway C. The A320 descended to an altitude of 100 ft AGL before initiating a go-around, during which the aircraft descended to 60 ft and overflew a number of the waiting aircraft, narrowly missing one of the waiting aircraft.

The flight crew aligned the aircraft with the taxiway on an incorrect understanding that the lights to their left were for the parallel runway 28L. That runway, however, was closed and not lit. A NOTAM stating the closure of runway 28L was included within the flight crew's briefing package. The NTSB found several contributing factors to the runway misalignment, including that the flight operations information provided to the flight crew needed more effective presentation of information to optimise pilot review and retention of relevant information, particularly given the large volume of data presented to flight crew.

Safety analysis

Introduction

At 1148 on 30 November 2022, a Boeing 737-800 flight from Brisbane to Melbourne, operating as VA324, commenced its take-off run from the A3 intersection of runway 19L (RWY 19L) at Brisbane Airport (BNE). While the aircraft's flight crew were aware of the upwind threshold being displaced, they were not aware that the take-off distance available for runway 19L had also been significantly reduced due to that displacement and that there were cones across the runway to mark the closed end of the runway.

Consequently, the performance data used for the take-off was incorrectly based on a normal length runway being available. This resulted in insufficient power being applied at the commencement of the take-off for the aircraft to complete the take-off in the declared distance available. This analysis will examine the factors that led to this serious incident and the opportunities to have corrected the misunderstanding of the runway status.

Flight planning in Melbourne

Incorrect mental model for runway 19L

Before the departure from BNE RWY 19L, the flight crew operated a sector from Melbourne (MEL) to BNE as VA319. The VA319 operational flight plan (OFP) component of the flight planning package (FPP) included a dispatcher's note that identified that the threshold for BNE RWY 01R was displaced, but also contained the statement 'NO LDW PERF LIMITATION'. This was intended to inform the flight crew that the displaced threshold had not led to any change to the aircraft's maximum landing weight limitation for the landing into BNE.

The captain, however, misinterpreted this to mean that the displaced threshold had no performance effect for operations on runway 19L, that is, that flight operations engineering (FOE) had determined that there were no specific requirements with respect to the onboard performance tool (OPT) data input due to the threshold displacement. This misunderstanding led to a mental model that the displaced threshold for RWY 01R had no effect on performance requirements for RWY 19L.

Dismissing NOTAM YBBNC1174/22

The operator's turnaround time between flights was generally scheduled at 40 minutes, of which about 5 was allocated to planning for the next sector. During this short period, there was typically a large volume of NOTAM data to be reviewed and flight critical data identified and actioned. While the grouping of sectors, revisiting of ports, and the use of a dispatcher to provide support, enabled efficiencies related to briefing, the aircraft captain retained overall responsibility for being aware of all relevant data.

To achieve this in the limited time available, the occurrence captain used NOTAM headlines as a guide to the content when assessing the relevance of a NOTAM. The scanning of NOTAMs using their heading is a practice often used by flight crew to enable large volumes of NOTAMs to be reviewed quickly. While the one subject matter and one condition standard for NOTAM construction generally supports this practice, there may be instances where a NOTAM's headline does not fully reflect data contained within the free text section. NOTAM YBBNC1174/22 was one such NOTAM.

The 33-page VA319 FPP, which was presented to the flight crew in Melbourne, contained 120 NOTAMs over 18 pages. The NOTAMs for BNE included NOTAM YBBNC1174/22 with the headline RWY 01R THR DISPLACED. That NOTAM detailed the reduction in the runway length for operations on 01R/19L, data that was critical for the arrival into Brisbane. During review of the sector's NOTAMs, the captain sighted the NOTAM headline and identified the NOTAM as being

the matter to which the dispatcher had referred to in the note. However, the captain incorrectly dismissed this NOTAM as not being relevant to the flight because they:

- had previously incorrectly interpreted the dispatcher note on the performance effect of the displaced threshold, and therefore this NOTAM, as having no impact on their operations
- expected a landing on RWY 19L in Brisbane and the NOTAM headline made no reference to RWY 19L.

The ATSB was unable to conclusively determine whether the first officer reviewed the dispatcher's notes and sector NOTAMs prior to departure from Melbourne, however, if they did, they missed the relevance of the note, the NOTAM and its attached FOE data.

FOE data not identified

The FPP was the only source available to the flight crew for notification of FOE data changes. Any performance calculation made without the use of the applicable FOE data had an elevated potential to be incorrectly applied. The FOE remark attached to YBBNC1174/22 contained the data necessary to select the correct OPT inputs and correctly calculate aircraft performance data when using the reduced length of runway 01R and 19L in Brisbane.

During the VA319 pre-flight at MEL, the flight crew did not identify the FOE data applicable to operations on Brisbane's RWY 19L during the review of the NOTAMs. The FOE data appended to NOTAM YBBNC1174/22 was either missed or dismissed due to an expectation that there was no performance effect.

The operator found that performance critical NOTAMs were presented in the same typeface as less critical NOTAMs and that this was contributory to the flight crew not identifying the FOE remark. While this is possible, it was also noted that the remarks were distinguished by a unique heading banner. The ATSB assessed that the incorrect mental model established by the captain was probably the overriding factor which influenced the dismissal of the NOTAM and its associated FOE remark.

Finally, the ATSB considered the possibility that the delayed issue of the complete FPP to the flight crew in Melbourne impacted the crew's ability to effectively review NOTAMs and associated FOE. However, a full reprint of the FPP's NOTAMs was available to the crew before departure and the preparations for arrival into Brisbane including the arrival briefing offered another opportunity to review the NOTAMs and identify applicable FOE data.

The Brisbane arrival

Readdressing the NOTAM

The operations manual requirements for an arrival briefing specified runway conditions and applicable NOTAMs for the arrival as items to be addressed in the briefing. It also included a general threat and error assessment for the arrival and landing. NOTAM YBBNC1174/22 contained critical information that merited review under both the briefing and the threat and error assessment.

However, contrary to these requirements, NOTAMs were not reviewed before arrival, nor were they reviewed when the time and opportunity was present during the en route phase of flight between MEL and BNE. While this time was likely allocated to training, the flight crew's primary responsibility for safety of flight necessitated that, at a minimum, this NOTAM be reviewed. As a result, another opportunity to correct the captain's (crew's) mental model of BNE RWY 19 was missed.

ATIS and incorrect landing performance

While the BNE ATIS stated that the runway length of RWY 19L was reduced and specified the reduced landing distance available (LDA), the flight crew did not consider this notification to be

relevant to the approach preparations. This was probably a result of the continuation of the misunderstanding of the dispatcher's note regarding the performance requirements for RWY 19L. This resulted in the flight crew selection in the OPT of the full runway length for the runway input criteria, instead of the reduced length option. While the OPT landing performance data was based on an incorrect runway landing distance available, the calculated stopping solution was based on exiting the runway well before the closed section. Therefore, the landing was not affected by the incorrect runway data input. Further, the aircraft performed in accordance with the calculated data, exiting the runway normally using the planned rapid exit taxiway. The flight crew also did not see any visible restrictions or obstructions either on or around the runway which further supported their incorrect mental model.

While the LDA used in the landing performance calculation was displayed as part of the OPT en route landing performance calculation, the operator's procedures did not require flight crews to crosscheck the LDA presented by the OPT with any notification of LDA change, such as that stated on the ATIS. Such a check, as recommended by the GAPPRE, could have provided an additional defence to capture the flight crew's incorrect mental model and landing performance error.

The Brisbane departure

The pre-flight

The flight crew commenced the pre-flight preparations for VA324 with an understanding that YBBNC1174/22 did not impose any limitation on RWY 19L operations. Due to a combination of time pressures and distractions, particularly the delayed arrival into Brisbane and the initial prioritisation of training requirements during departure preparations, the flight crew had reduced time for their review of the VA324 FPP. As a result, the captain dismissed the dispatcher's note alerting the flight crew to the displaced threshold and, while the flight crew reviewed the OFP component of the briefing package prior to departure, they likely did not review the NOTAM package.

Take-off data error

Despite reviewing the ATIS content, due to an enduring belief there were no runway restrictions, the captain used an incorrect normal runway length input to determine the take-off performance figures for the BNE departure. This error was not identified as the first officer used the captain's input data from the take-off data card (TODC), contrary to the independent take-off performance calculation procedures, resulting in the same incorrect figures.

Due to the use of the full runway length option as the basic runway configuration, the OPT calculator enabled a departure from the A3 intersection with a power derate. However, had the actual reduced runway length option (19L-WIPS) been used, the OPT would have excluded an A3 departure as the aircraft was overweight for such a departure, even with full take-off power. Further, had the A3 intersection departure selection been available for the 19L-WIPS option, the OPT would have notified the flight crew that a take-off from that point on the runway was not permitted.

Due to the incorrect take-off performance calculation, the aircraft did not meet the required performance for its departure from the A3 intersection of RWY 19L. The effect of this meant that the aircraft may have been unable to stop within the declared TORA if the take-off had to be rejected at high speed, and a runway excursion would have occurred. In addition, in the event of engine failure at high speed, the aircraft would probably have been unable to achieve its required performance.

Misleading MAGS

The Part 139 Manual of Standards required that movement area guidance signs (MAGS) located at runway intersection holding points be obscured when a temporarily displaced runway threshold

altered the distance displayed by the MAGS. This did not occur while NOTAM YBBNC1174/22 was in effect. The signs presented a take-off distance that was in excess of that available, creating the potential to mislead flight crews about the status of the runway and the distance available when conducting a departure from that point.

While the operator's procedures required the conduct of a performance data check at the holding point, they did not require consideration of the MAGS data in relation to that check. However, as MAGS were not required by Part 139 at all departure holding points, the mandating of a MAGS check as standard procedure would not have been possible. Nevertheless, obscuring the signs or including an indication of works in progress on the signs, had the potential to alert flight crews to changed conditions and trigger crews to confirm that correct runway data was being used for the take-off performance calculation.

Findings

ATSB investigation report findings focus on safety factors (that is, events and conditions that increase risk). Safety factors include 'contributing factors' and 'other factors that increased risk' (that is, factors that did not meet the definition of a contributing factor for this occurrence but were still considered important to include in the report for the purpose of increasing awareness and enhancing safety). In addition 'other findings' may be included to provide important information about topics other than safety factors.

Safety issues are highlighted in bold to emphasise their importance. A safety issue is a safety factor that (a) can reasonably be regarded as having the potential to adversely affect the safety of future operations, and (b) is a characteristic of an organisation or a system, rather than a characteristic of a specific individual, or characteristic of an operating environment at a specific point in time.

These findings should not be read as apportioning blame or liability to any particular organisation or individual.

From the evidence available, the following findings are made with respect to the incorrect calculation of take-off performance data by the flight crew of VH-YFH on 30 November 2022 that led to a runway excursion on Brisbane Airport runway 19L.

Contributing factors

- For the Melbourne to Brisbane sector, the dispatcher notes in the operational flight plan stated that Brisbane runway 01R displaced threshold had no landing weight performance limitation. The captain misinterpreted that note to mean that there were no performance requirements limits for operations on runway 19L.
- While the Brisbane NOTAM with the headline RWY 01R THR DISPLACED contained data concerning a significant reduction in the length of runways 01R/19L, the previously established misunderstanding of this NOTAM and the absence of any reference to 19L in the heading resulted in the captain incorrectly dismissing this NOTAM, which was also probably missed by the first officer.
- The flight crew did not identify the critical performance data that was appended to the Brisbane NOTAM that stated the runway length reduction for 01R/19L prior to the departure from Melbourne.
- The ATIS notification of the reduced length of runway 19L was not recognised or accounted for in the performance calculations for operations on that runway, likely due to the captain's established belief that there were no performance requirements for runway 19L and the absence of the required independent check by the first officer.
- Due to time pressures and distractions from prioritising training requirements during the preparation for departure from Brisbane's runway 19L, and a previous assessment that it was not relevant, the flight crew dismissed a dispatcher's note alerting the crew to the RWY 01R THR DISPLACED NOTAM. Also, while the crew reviewed the operational flight plan component of the briefing package prior to departure, they probably did not review the NOTAM package.
- Unaware of the reduced available length of the departure runway, which was reinforced by the absence of any visible runway works or restrictions during the previous landing on 19L, the flight crew miscalculated the aircraft's take-off performance data. That resulted in a departure with insufficient available runway due to the aircraft being overweight for that reduced runway length.

Other factors that increased risk

- Having not reviewed the NOTAMs as part of the approach briefing prior to descent into Brisbane, contrary to the requirements of the operations manual, or on an opportunity basis en route, the flight crew missed an opportunity to correct the incorrect mental model developed for Brisbane's RWY 19L during the turnaround in Melbourne.
- Contrary to the requirements of Part 139 Manual of Standards, the A3/19L intersection departure point take-off run available Movement Area Guidance Sign (MAGS) presented a take-off distance that was more than that available, creating the potential to mislead flight crews about the status of the runway when conducting a departure from that point.

Safety actions

All of the directly involved parties were provided with a draft report and invited to provide submissions. As part of that process, each organisation was asked to communicate what safety actions, if any, they had carried out or were planning to carry out in relation to each safety issue relevant to their organisation.

The initial public version of these safety issues and actions are provided separately on the ATSB website, to facilitate monitoring by interested parties. Where relevant, the safety issues and actions will be updated on the ATSB website as further information about safety action comes to hand.

Safety action not associated with an identified safety issue

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.

Additional safety action by Virgin Australia

Virgin Australia (VA) advised the ATSB of several changes and improvements made as a result of learnings from an examination of the occurrence. These included:

- The introduction of threat-based standard dispatcher notes, with enhanced engagement between VA fight dispatch and flight operations in identifying impactful NOTAMs, while also constructing standard dispatcher notes that focus on the threat presented to flight crew.
- An operational performance tool (OPT) update to bring runway options with a WIP designator ahead of the normal runway selection options.
- A focus on standard operating procedure changes to limit pilot distraction at the runway entry point and to remove scan items requiring action below the glareshield.
- Enhanced engagement between Brisbane Airport and VA on safety initiatives.
- The risk assessment methodology for runway displacements has been adapted from a general risk model to an airport-specific risk analysis, as well as a monthly runway works risks review meeting being established by Flight Operations Quality Assurance.
- A flight operations STOP PRESS Safety Update relating to the occurrence event was issued by the chief pilot on 5 December 2022.
- Flight operations now provide enhanced guidance for flight crew for runways with displacements through easy to read and digest marked-up runway diagrams.
- In response to a holistic review of communication to flight crew regarding significant events, flight operations introduced a monthly Safety Town Hall to better communicate current issues, trends, and events. These have been in place and running every calendar month since February 2023.
- In response to a number of events that had contributing factors of distraction/situational awareness, VA conducted an independent human factors review through a specialist third party. A number of findings and actions were issued as a result and are now being tracked through safety governance.

Additional safety action by Brisbane Airport Corporation

Brisbane Airport Corporation implemented several changes to reduce the risk associated with this type of occurrence. The changes included:

- adjustments to departure and arrival procedures associated with runway works
- redrafting of the NOTAM to clarify the operational changes to both runways 01R and 19L, and procedures to ensure correct runway distance was displayed on take-off run available movement area guidance signs
- publication of an aeronautical information circular supplement for the works.

General details

Occurrence details

Date and time:	30 November 2022 – 1139 Eastern Standard Time	
Occurrence class:	Serious incident	
Occurrence categories:	Runway excursion	
Location:	Brisbane Airport	
	Latitude: 27.3842° S	Longitude: 153.1175° E

Aircraft details

Manufacturer and model:	The Boeing Company 737-8FE	
Registration:	VH-YFH	
Operator:	Virgin Australia Airlines Pty Ltd	
Serial number:	40996	
Type of operation:	Part 121 Australian air transport operations – Larger aeroplanes – Standard Part 121	
Activity:	Commercial air transport—Scheduled—Domestic	
Departure:	Brisbane Airport, Queensland	
Destination:	Melbourne Airport, Victoria	
Persons on board:	Crew – 8	Passengers – 169
Injuries:	Crew – None	Passengers – None
Aircraft damage:	None	

Glossary

ACARS	Aircraft Communications, Addressing and Reporting System
ADS-B	Automatic dependent surveillance - broadcast
AFM	Airplane Flight Manual
AIC	Aeronautical information circular
AIP	Aeronautical information publication
AIS	Aeronautical information service
ASDA	Accelerate stop distance available
ATC	Air traffic control
ATS	Air traffic services
ATIS	Automatic terminal information service
B737	Boeing 737
BAC	Brisbane Airport Corporation
BNE	Brisbane
CASA	Civil Aviation Safety Authority
CASR	Civil Aviation Safety Regulations
EDT	Eastern daylight-saving time.
EFB	Electronic flight bag
EST	Eastern Standard Time
FCOM	Flight crew operations manual
FMC	Flight management computer
FO	First officer
FOE	Flight Operations Engineering
FPP	Flight planning package
FPM	Flight plan manager
GAPPRE	Global Action Plan for the Prevention of Runway Excursions
GM-AIS	Guidance Manual for Aeronautical Information Services
ICAO	International Civil Aviation Organization
LDA	Landing distance available
MAGS	Movement area guidance signs
METAR	Aviation routine weather report
MOS	Manual of standards
MLDW	Maximum landing weight
MOWP	Method of working plan
NAIPS	National aeronautical information processing system
NOTAM	Notice to airman
OFP	Operational flight plan
OPADD	Operating Procedures AIS Dynamic Data
OPT	Onboard performance tool
PANS-ABC	Procedures for Air Navigation Services – Abbreviations and Codes
PANS-AIM	Procedures for Air Navigation Services – Aeronautical Information Management
PIB	Pre-flight information bulletin
PF	Pilot flying
PM	Pilot monitoring
SARP	Standard and Recommended Practice
TAF	Aerodrome forecast

TODA	Take-off distance available
TODC	Take-off data card
TORA	Take-off run available
UTC	Coordinated Universal Time
YBBN	Brisbane Airport
YMML	Melbourne Airport

Sources and submissions

Sources of information

The sources of information during the investigation included:

- the flight crew and dispatchers
- Virgin Australia Airlines
- Civil Aviation Safety Authority
- International Civil Aviation Organization
- Airservices Australia
- Boeing
- Brisbane Airport Corporation
- recorded data from the aircraft and Airservices Australia.

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Submissions

Under section 26 of the *Transport Safety Investigation Act 2003*, the ATSB may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. That section allows a person receiving a draft report to make submissions to the ATSB about the draft report.

A draft of this report was provided to the following directly involved parties:

- the flight crew
- Virgin Australia
- Brisbane Airport Corporation
- Airservices Australia

- United States National Transportation Safety Board, and Boeing
- Civil Aviation Safety Authority
- International Civil Aviation Organization.

Submissions were received from:

- Civil Aviation Safety Authority
- Virgin Australia
- Brisbane Airport Corporation
- the flight crew.

The submissions were reviewed and, where considered appropriate, the text of the report was amended accordingly.

Appendices

Appendix – NOTAM standards and related guidance materials

Introduction

The following sections discuss the various types of aeronautical information and the role of NOTAM within this scheme. The sources of NOTAM standards are identified, and each of these examined for their contribution. Other authoritative source material that provided guidance on NOTAM structure and content is also examined. In examining these standards and guidance materials, NOTAM C1174/22 will be used as an example of their application. To provide some background into the reasons for issuing C1174/22, the origins of that NOTAM will also be examined.

Types of aeronautical information

CASR Part 139 required airport operators to provide detailed information about various aerodrome facilities, such as movement areas, lighting systems and other facilities that were available for use by aircraft at that airport. That aeronautical information was to be sent to relevant aeronautical information service (AIS) providers for publication. Airport operators were also required to notify users of any changes or limitations to that published information, such as that caused by aerodrome works.

The AIS provider, Airservices Australia, collated aeronautical data concerning airspace, navigation aids and other facilities provided by airport operators and other sources. That information was published in:

- the aeronautical information publication (AIP) and supplements
- notices to airmen (NOTAM)
- aeronautical information circulars (AIC).

The AIP was the primary aeronautical information document, containing current information of a lasting character that was essential for air navigation. AIP supplements provided a means to publish information of a temporary nature but of a long duration. The NOTAM system was designed to provide immediate distribution of information of direct operational significance that was of short duration. Information that did not qualify for publication within the AIP or as a NOTAM, but which related to flight safety or other aviation activities, was published as an AIC.

The RWY 01R displaced threshold NOTAM

The Brisbane Airport MOWP YBBN 22/07 included scheduled work segments for the replacement of various runway and approach lighting power cables. This required working near the RWY01R threshold and the consequent need to displace that runway's threshold. The works also resulted in the temporary disabling of various runway lighting systems.

After submission to Airservices of data detailing facilities that would be affected by these works, NOTAM C1139/22 was issued. Due to minor changes in the taxiway availability and the relocation of the displaced threshold markers, C1139/22 was amended and reissued as C1174/22. The full published version of NOTAM C1174/22 stated:

> C1174/22 NOTAMR C1139/22
> Q) YBBB/QMTCM/IV/NBO/A/000/999/2723S15307E005
> A) YBBN
> B) 2211292100 C) 2211300630
> E) RWY 01R THR DISPLACED
> RWY 01R/19L 871M SOUTH END NOT AVBL DUE WIP
> OBST WORKERS AND EQPT 16FT AGL ON RCL 2889M FM START OF TKOF RWY 19L
> EFFECTIVE RWY LEN AVBL 2689M

THR RWY 01R DISPLACED 921M MARKED BY FIVE GREEN LGT AND RWY THR IDENT LGT (RTIL) EACH SIDE OF RWY
DECLARED DISTANCE AND GRADIENT CHANGES
RWY TORA TODA ASDA LDA
01R 2689 2809(1.6) 2749 2579
19L 2689 2749(3.6) 2689 2689
SUPPLEMENTARY TKOF DISTANCES
RWY19L- 2577(1.6) 2626(1.9) 2662(2.2)
TWY A7 AVBL FOR RWY 01R INTL DEP
RWY 01R PAPI, HIGH INTENSITY APCH LGT (HIAL) AND RCLL NOT AVBL
HIGH INTENSITY RWY LGT (HIRL) NOT AVBL
RWY 01R TEMPO PAPI LEFT SIDE 3.0 DEG 75FT AVBL
REFER METHOD OF WORKING PLAN YBBN 22/07

Aeronautical information standards

CASR Part 175 (Regulation.175.105) required aeronautical information published through the AIP, NOTAM and AIC to meet standards established under specific publications as follows:

- Part 175 Manual of Standards (MOS)
- Annex 15 to the Chicago Convention – *Aeronautical Information Services*
- International Civil Aviation Organization (ICAO) Document 10066 *Procedures for Air Navigation Services – Aeronautical Information Management* (PANS-AIM)
- ICAO Document 8126 *Aeronautical Information Services Manual* (Doc 8126)
- other AIS-applicable ICAO documents.

The CASR dictionary included a definition for 'other AIS applicable ICAO documents'. That definition identified those documents, which included ICAO Doc 8400 ICAO Procedures for Air Navigation Services – Abbreviations and Codes (PANS-ABC).

Regulation 175.105 also stated that, when standards established under one document contradicted those stated in another, then the standards in the first listed document were to apply.

At the time of the occurrence, Part 175 MOS had not been published. Annex 15 did not contain any standards relevant to the structure and required content of NOTAM. The principal document for those standards was PANS-AIM, which also made direct reference to PANS-ABC on matters relating to a specific but critical component of the NOTAM. Doc 8126 provided guidance material on the requisite components of the *NOTAM Format*.

PANS-AIM

PANS-AIM contained the following basic principles governing NOTAMs:

- A NOTAM shall contain information in the order stated in the *NOTAM Format*, a template that set out communications handling instructions and the required content for a NOTAM. That required content was structured around various fields labelled as Item 'Q)' and Items 'A)' through 'G)'. Each field had a specific structure and required content, as designated by the NOTAM Format.

ATSB Observation

These fields can be identified in the following extract from C1174/22:

Q) YBBB/QMTCM/IV/NBO/A/000/999/2723S15307E005
A) YBBN
B) 2211292100 C) 2211300630
E) RWY 01R THR DISPLACED

Each field had a specific structure and required content, as designated by the *NOTAM Format*.

- A NOTAM shall deal with one subject and one condition of that subject only. It should be as brief as possible and compiled such that the meaning is clear.

ATSB Observation

NOTAMs advise flight crews of information that has direct operational significance. In the case of C1174/22, this was the displacement of RWY 01R threshold. For this NOTAM, the runway threshold was the subject matter, while its displacement the condition.

- The subject matter and related condition shall be reported through coding contained within Item Q). The components of that coding are to be selected from NOTAM Code tables published in PANS-ABC.

ATSB Observation

For C1174/22, the Q-Code was stated in the 5 letters QMTCM, the second field in the Q) line. The first letter, Q, identified that the field is the Q-Code field, the second and third letters MT stated the subject matter, which was decoded as *Threshold (specify runway)*. The fourth and fifth letters CM stated the condition of that subject matter, which was decoded as *Displaced*.

- The content of the free-text section of the NOTAM, Item E), shall be based on the decoded NOTAM code, also called the code's signification, supplemented where necessary by ICAO abbreviations and other identifiers and designators. The content of Item E) is to be sufficiently clear and concise so as to facilitate its use in a Pre-flight Information Bulletin (PIB).

ATSB Observation

The NOTAM content for C1174/22 printed in the VA319 FPP (Figure 4) was an example of a PIB version of a NOTAM. Similarly, NOTAMs published by NAIPS use the PIB version of the NOTAM. Essentially, for a PIB, the NOTAM is stripped of all detail except the free text Item E) content.

PANS-ABC

PANS-ABC is the principal document for the NOTAM code, which is reported in the Item Q) line as the NOTAM's Q-code. The NOTAM's Q-code is a comprehensive description of the information contained in the NOTAM. In combination with the other information presented in the Item Q) line, it provides a means of determining the operational significance of the information and a method for

storage and retrieval of information. Further, the Q-Code is a method for standardisation of information presented in item E).

PANS-ABC details procedures used to select the code reported in item Q). The code's subject matter and status/condition components are derived from separate tables within PANS-ABC. With respect to selection of the code letters, PANS-ABC stated:

> The code identifying the subject or denoting its status of operation is, whenever possible, self-evident. Where more than one subject could be identified by the same self-evident code, the most important subject is chosen.

The code components listed in these tables have an associated standardised plain language text, referred to as the code's signification, or decode, which forms the basis for the NOTAM's free text section, Item E.

With respect to C1174/22, and the PIB content of that NOTAM found in the VA319 and VA324 FPPs, the free text section contained items of information that were reportable under various subject matter codes listed in the PANS-ABC tables. These subject matter codes were:

- Movement and landing area subject matters
  - MD, Declared distances for RWY 01R and RWY 19L
  - MT, Threshold for RWY 01R
  - MX, Taxiway A9 and A7
- Lighting facilities subject matters
  - LC, Runway centre line lights
  - LH, Runway high intensity lights
  - LI, Runway end identifier lights
  - LP, Precision approach path indicator lights.

ICAO Doc 8126

While this document re-affirmed that a NOTAM was to be limited to one subject matter and one condition related to that subject matter, it also included the statement that:

> The NOTAM Code selected describes the most important status or condition to be promulgated.

This indicated that more than one status or condition of a specific subject matter could be reported in a NOTAM. There was nothing further in Doc 8126 to support how, or under what circumstances, such combinations of status or conditions were to be made.

With respect to Item E), the free text section of the NOTAM, Doc 8126 stated that the information was to be kept as short as possible, preferably not exceeding 300 characters, containing all the essential information and ready for inclusion in PIB.

ICAO APAC GM-AIS

The Asia and Pacific office of ICAO had produced a guidance material document that provided States with a single source manual, the Guidance Manual for Aeronautical Information Services (AIS) in the Asia/Pacific Region (GM AIS).[33] The GM-AIS repeated much of what was provided in the above source documents. It also contained a significant amount of data extracted from the EUROCONTROL *Operating Procedures AIS Dynamic Data* (OPADD), which was stated to contain best practice material for AIS support.

The GM-AIS contained more specific guidance on how and when to combine multiple NOTAMs into a single NOTAM. It stated that combining NOTAMs may be appropriate when they are directly related to each other; however, the choice of subject matter was critical, in that the selected

[33] The GM-AIS was designed to assist states in the development and implementation of AIS systems.

subject matter must enable all elements to be reported to be included within Item E) of the NOTAM. Further, the GM-AIS stated:

> While selecting the most precise code enables quick information identification, in some cases a more general approach provides the end-user with sufficient relevant information in a single NOTAM with no negative impact on briefing. For example, if a displaced threshold results in a change in declared distances, it may be more appropriate to use the code QMDCH (rather than QMTCM) and include in Item E) the information on the displaced threshold and declared distances.

This guidance had direct relevance to the codes chosen for C1174/22 as it indicated a preference for coding using QMDCH (decoded to Declared distances (specify runway) and Changed) over QMTCM for a displaced threshold.

The GM-AIS also cited other situations that enabled the combining of NOTAMs into a single NOTAM, including when:

- there was more than one occurrence of one subject matter
- a facility consisting of several elements had all elements unserviceable then a single NOTAM covering the combined facility could be used.

EUROCONTROL OPADD

The OPADD was specifically designed to document and harmonise operating procedures for *AIS dynamic data* (primarily NOTAMs). It was designed as supporting guidance for NOTAM operations, but also contained enhanced explanations to take into account identified deficiencies reported by users of PIB content.

The following statement from the OPADD was relevant to combining NOTAMs:

> To avoid excessive publication of NOTAM, the listed events in ICAO SARPs for which a NOTAM shall be issued must be strictly adhered to. Issuance of unnecessary or irrelevant NOTAM contributes to a greater pressure on the end-user and NOTAM providers during the filtering stage, generating a growing risk of missing vital information that could have a flight safety impact.
>
> Note: The negative impact on end-users caused by NOTAM proliferation is not to be solved by including more information in a single NOTAM, but that this fact further increases the difficulty for end-users. More information in one NOTAM makes the message less readable and essential information more difficult to detect.

Automated NOTAM systems

PANS-ABC described the code in the NOTAM's item Q) field as a means of enabling storage and retrieval of information and being designed for easy adaptation to automated systems to enable filtering of NOTAMs. The Virgin Australia operations manual identified the adoption of automated NOTAM filtering, through the use of the Flight Plan Manager (FPM) software which automatically imported the NOTAMS and displayed or supressed them based on their code—that is the coding presented in Item Q).

Australian Transport Safety Bureau

About the ATSB

The ATSB is an independent Commonwealth Government statutory agency. It is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers.

The ATSB's purpose is to improve the safety of, and public confidence in, aviation, rail and marine transport through:

- independent investigation of transport accidents and other safety occurrences
- safety data recording, analysis and research
- 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, as well as participating in overseas investigations involving Australian-registered aircraft and ships. It prioritises investigations that have the potential to deliver the greatest public benefit through improvements to transport safety.

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

Purpose of safety investigations

The objective of a safety investigation is to enhance transport safety. This is done through:

- identifying safety issues and facilitating safety action to address those issues
- providing information about occurrences and their associated safety factors to facilitate learning within the transport industry.

It is not a function of the ATSB to apportion blame or provide a means for determining 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. The ATSB does not investigate for the purpose of taking administrative, regulatory or criminal action.

Terminology

An explanation of terminology used in ATSB investigation reports is available on the ATSB website. This includes terms such as occurrence, contributing factor, other factor that increased risk, and safety issue.