Australian Government
Australian Transport Safety Bureau

Flight below minimum altitude involving Embraer ERJ135, VH-ZJG

near Essendon Airport, Victoria, 27 October 2017

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Addendum

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What happened

On 27 October 2017, at 1410 Eastern Daylight-savings Time (EDT),[1] a captain and first officer signed on for flight duty at Brisbane Airport, Queensland. The planned duty was to operate a JetGo Embraer ERJ135 aircraft, registered VH-ZJG, on four scheduled passenger transport sectors: from Brisbane to Dubbo, New South Wales, Dubbo to Essendon, Victoria, Essendon to Dubbo, and Dubbo to Brisbane.

The aircraft was scheduled to depart Brisbane at 1510. However, the flight crew were advised of an engineering delay of up to 45 minutes for unscheduled maintenance to change a main landing gear tyre. A replacement tyre was not immediately available, which resulted in an extended delay that eventually totalled 4 hours 15 minutes.

The aircraft departed Brisbane at 1925 and, after an uneventful flight, departed Dubbo for Essendon at 2116. The first officer was the pilot flying (PF) and the captain was the pilot monitoring (PM) for the sector from Dubbo to Essendon.[2]

Prior to commencing descent, the flight crew programmed the aircraft's flight management guidance system and briefed for an instrument landing system[3] (ILS) approach to runway 26. It was the first time either pilot had operated into Essendon at night, and therefore their preferred approach was a runway 26 ILS approach. The flight crew also discussed the possibility of receiving radar vectors[4] from air traffic control (ATC).

ATC informed the flight crew that due to aircraft traffic at neighbouring Melbourne Airport, runway 26 was unavailable. Therefore, ATC provided radar vectors for a visual approach to runway 35. As the aircraft passed abeam Melbourne Airport, the captain had Melbourne and Essendon runways in sight.

At 2220:18, ATC advised the flight crew that they would be positioned for a 5 NM (9.3 km) final approach at 2,100 ft above mean sea level (AMSL). This altitude was the radar lowest safe altitude for that sector of airspace. At 2221:48, ATC instructed the flight crew to descend to 2,100 ft.

The first officer recalled setting 2,100 ft on the aircraft's altitude preselector. This directed the automatic flight control system (AFCS) to continue descent to 2,100 ft. He also recalled confirming the 2,100 ft set altitude on his primary flight display, as well as the flight director modes of heading and vertical speed mode. The captain recalled verifying the assigned altitude being set and flight director modes. Both flight crew recalled the autopilot was engaged at this time.

At 2223:02, as the aircraft passed about 2,300 ft on descent, ATC requested the flight crew to report sighting runway 35. At this time, the captain had lost sight of the runway. Becoming concerned that the captain could not visually identify the runway, the first officer also focused his attention looking outside the aircraft to the left to help locate the airport.

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1 Eastern Daylight-saving Time (EDT): Coordinated Universal Time (UTC) + 11 hours. EDT was the time zone relevant where the occurrence took place and it has been used throughout the report to minimise confusion. The time in Brisbane was Eastern Standard Time, or UTC + 10 hours.

2 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.

3 Instrument Landing System: A landing aid which provides lateral and vertical guidance to flight crew during approach to land.

4 Radar vectoring: ATC provision of track bearings and altitudes used to guide and position an aircraft.

At about 2223:35, when 7.1 NM (13.1 km) from Essendon Airport and on a heading of 080°, the aircraft descended below the assigned altitude of 2,100 ft. Neither flight crew detected the aircraft was now below the radar minimum safe altitude and continuing to descend. When the captain next looked inside the aircraft at his primary flight display, he recalled seeing the altimeter indicating 1,600 ft, and he then called 'height'. The first officer also recalled seeing that they were below the assigned altitude at the same time.

At 2223:52, ATC instructed the flight crew to climb to 2,100 ft. However, that instruction was over transmitted by another aircraft and not heard by the flight crew. At 2223:58, ATC issued another instruction to climb immediately to 2,100 ft, which the flight crew acknowledged.

At 2224:05, a cleared level adherence monitoring (CLAM) alarm[5] activated (Figure 1), further alerting ATC of a difference between the aircraft's assigned altitude and its actual altitude. ATC immediately issued a terrain safety alert, advising the flight crew that the lowest safe altitude was 2,100 ft.

Recorded radar data showed the aircraft's lowest altitude was about 1,500 ft during 2224:05 to 2224:10 (Figure 1).

Figure 1: Image of air traffic controller's monitoring screen showing CLAM alarm activation following the aircraft's descent below 2,100 ft

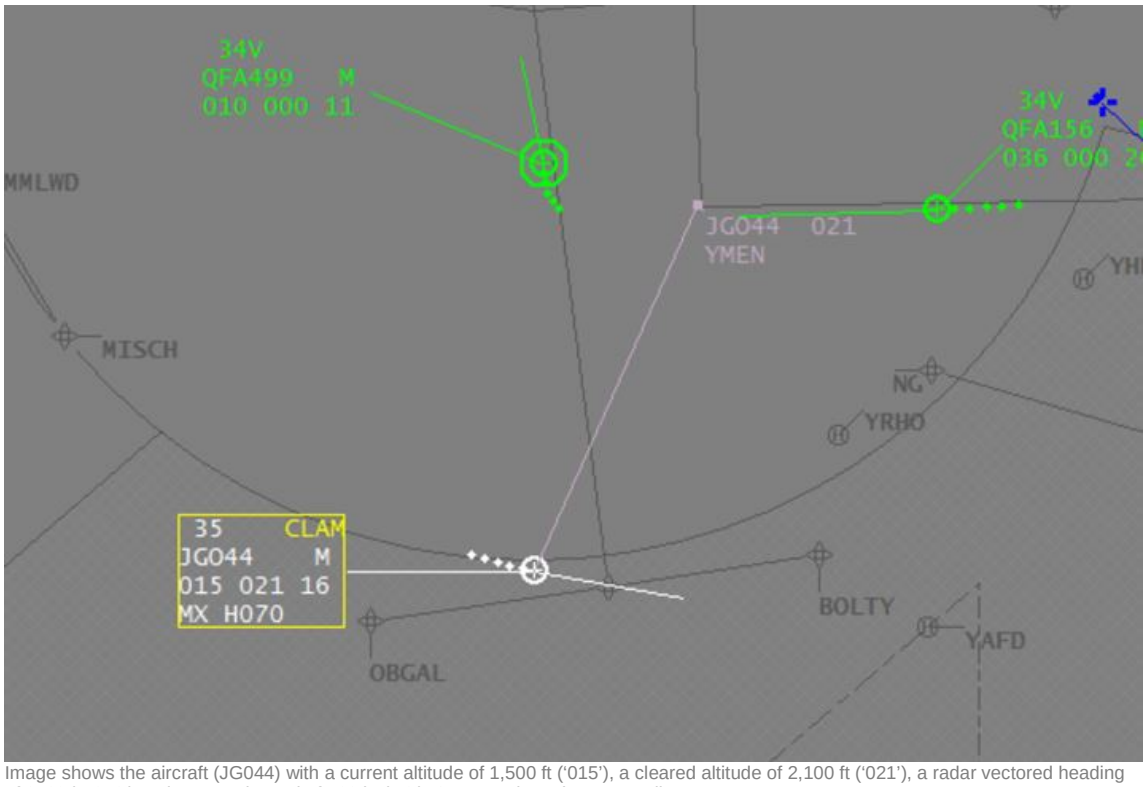

Image shows the aircraft (JG044) with a current altitude of 1,500 ft ('015'), a cleared altitude of 2,100 ft ('021'), a radar vectored heading of 070° ('H070') and a groundspeed of 160 kt ('16'). Source: Airservices Australia

As the aircraft climbed above 2,100 ft, ATC advised the flight crew of their position relative to runway 35 and asked if they had the runway in sight. When they confirmed that they did, ATC asked if they wanted to continue the approach. The flight crew elected to discontinue the approach and ATC subsequently vectored the aircraft for another approach. The aircraft landed without further incident at 2236.

At 2259, the aircraft taxied for departure from Essendon and then completed the service to Dubbo and Brisbane. The flight crew finished duty in Brisbane at 0245.

[5] System-detected non-conformance alert that checks the conformance of the actual flight level of a surveillance track with respect to the cleared flight level inputted by the controller.

Airport information

Essendon Airport is located about 8 km south-east of Melbourne Airport. The proximity of the two airports adds complexity to operations at Essendon.

The airport has two runways aligned 17/35 and 08/26, and it is bounded on two sides by freeways with substantial amber lighting and well-lit residential areas. At night, the lights around the airport present a complex picture. The published aerodrome chart had a caution note describing that amber freeway lighting may confuse flight crews when attempting to identify runway 08/26 lighting.

Runway 35 did not have an instrument approach procedure. Instead, pilots were required to conduct visual approaches to this runway. It was equipped with a precision approach path indicator light (PAPI) array to provide pilots with vertical profile guidance during visual approaches.

At the time of the occurrence, visibility was greater than 10 km, and the wind was a northerly at 14 kt.

Essendon Airport had a curfew prohibiting aircraft movements from 2300 until 0600 for all operations other than emergency services. Operators would incur financial penalties for flights arriving or departing during the curfew period.

To continue the service from Essendon to Dubbo (and then Brisbane), the aircraft had to commence taxiing for departure before the curfew. Missing curfew would result in the aircraft being grounded until 0600 the next morning, disrupting the current service and that of the following day.

The aircraft taxied for the return flight from Essendon at 2259, 1 minute before the commencement of the curfew period. Both flight crew reported feeling significant pressure to complete the service and return the aircraft to Brisbane. Both pilots reported being aware of the potential problem with the curfew prior to departing Brisbane, and the first officer reported considering the potential problem with the curfew during the visual approach into Essendon.

Air traffic control information

Airservices Australia provided an ATC service to the aircraft for the entire flight, including the descent to Essendon. The approach controller who provided radar vectors to the flight crew was also responsible for sequencing a large number of aircraft arrivals into Melbourne at the same time.

In an effort to manage the risk that neither pilot had operated at night into Essendon, the captain's preferred arrival was to runway 26 as it was equipped with an ILS and was the longer runway. However, due to the congestion of arriving and departing aircraft at Melbourne, ATC advised this request was not available. Although the captain maintained the ability to instruct ATC that he required the ILS approach, he was likely aware that doing so would possibly result in ATC needing the aircraft to enter a holding pattern until the controller could sequence the flow of aircraft traffic at both airports.

When conducting a visual approach to a runway, ATC can provide radar vectors to the pilot until the aircraft is aligned with the runway centreline. A pilot is required to report that they have sight of, and can maintain sight of, the landing runway in order for ATC to clear a pilot to conduct the approach.

The flight crew reported that during the radar vectoring towards Essendon, they felt pressure from ATC to sight runway 35. The ATSB reviewed audio recordings between the approach controller and the flight crew. The flight crew first contacted Melbourne Approach at 2213:58. At 2223:02, the approach controller asked them to report Essendon runway 35 in sight. This was the only recorded request made by the approach controller to the flight crew to sight runway 35.

Automatic flight control system

Flight crews normally manage flight of an ERJ135 using the aircraft's AFCS. This system consists of dual autopilots, a flight guidance controller (FGC) and flight instrument displays.

To manage the aircraft in all flight phases, pilots select various modes on the FGC. Selected descent modes included flight level change, speed hold and vertical speed.

The pilot can engage the autopilot by pressing a button on the FGC. Intentional disengagement of the autopilot by a pilot generates an audible voice AUTOPILOT alert. Failure and disconnection of an autopilot results in the same audible voice alert and generates a warning message illuminated on a separate indicating system.

In the 'vertical speed' (VS) selected descent mode, the AFCS will maintain a selected vertical speed. The rate of vertical speed can be changed as needed by the pilot. With the autopilot engaged, the VS mode would automatically change to altitude capture mode as the aircraft approached a preselected altitude.

An 'altitude preselect' (ASEL) mode armed automatically if the aircraft climbed or descended towards a preselected altitude. Altitude preselect mode would then automatically capture and cancel any existing mode at an appropriate point based on preselected altitude error and vertical speed. The system would then automatically switch to altitude hold mode after the aircraft had levelled off at the preselected altitude.

The first officer recalled selecting the descent mode to vertical speed at the time ATC commenced issuing radar vectors. The flight crew reported that the autopilot was engaged during the descent and that the AFCS failed to capture the preselected altitude (2,100 ft) as expected. Further, the flight crew recalled that no alert was heard, either for autopilot disconnect or altitude exceedance, which should have sounded when the aircraft was 200 ft below the preselected altitude.

After descending below 2,100 ft, the flight crew reported that the flight director pitch bars, which indicate the direction of the preselected altitude, were providing guidance that the aircraft should climb.

The ATSB requested the aircraft's flight data recorder. However, at the time of the request, the data for the occurrence flight had been overwritten.

Following the flight, no technical log entry was made regarding a problem with the autopilot capturing the selected altitude. Nevertheless, an engineering inspection of the AFCS was conducted following the aircraft's arrival back in Brisbane, and no fault was found.

The flight crew advised that they were aware of other recent AFCS problems associated with the aircraft and the operator's other ERJ135 aircraft. A review of maintenance records for the operator's ERJ135 fleet identified that several AFCS-related problems had been reported during the period from 3 August. However, none of those problems were similar to what occurred during the occurrence flight. In addition, no subsequent problems that were similar in nature were reported on the occurrence aircraft.

Flight crew information

The captain held an Air Transport (Aeroplane) Pilot Licence (ATPL) and had 10,100 hours total flight experience, including 155 hours on the aircraft type. The first officer held a Commercial (Aeroplane) Pilot Licence and had 2,100 hours total flight experience, including 473 hours on type.

Both flight crew had operated into Essendon on many previous occasions, but neither had operated to that airport at night.

Flight and duty times

The captain had the two previous days (25−26 October) rostered off duty, and had conducted administrative work from 1000−1600 on the 24 October. The first officer had the four previous days rostered off duty.

On the day of the occurrence, both flight crew signed on to commence duty at 1410 EDT. Due to the delay before the first flight, they ultimately signed off duty at 0245, a duty period of 12.6 hours. However, the captain advised that he commenced administrative duties, unrelated to the subsequent flights, at about 1200 EDT. Therefore, his actual duty time was 14.8 hours.

The captain recalled waking up at about 0700 EDT on the day of the occurrence after a 'normal' sleep. He therefore had been awake for 15.4 hours at the time of the occurrence, and 18.8 hours at the end of the extended duty period. The first officer recalled waking up at 0630 EDT on the day of the occurrence after a 'reasonable' sleep, and was therefore awake for 15.9 hours at the time of the occurrence and 19.3 hours at the end of the extended duty period.

The operator managed its flight crews' flight and duty times to comply with a standard industry exemption to Civil Aviation Order (CAO) 48.0, which was issued to the operator by the Civil Aviation Safety Authority (CASA). The exemption stated that duty included any task associated with the business of an operator.

The operator's rostering personnel managed flight crew flight and duty times in order to comply with the exemption. The operator's procedures required that all work-related activities for the operator be reported and considered as duty time.

The rostered flight duty limit for a pilot signing on after 1300 local time for a four-sector duty was 12 hours. However, a pilot could elect to extend a duty already started for up to 2 hours as long as they felt mentally and physically fit to continue (and they submitted a report upon completing the duty). Although the captain's recorded duty time did not exceed 14 hours by the end of the trip, the actual duty time did exceed the limit.

During the delay on the ground in Brisbane, the crew were offered an option to stand down as they were now facing a long duty period. The captain reported that he was told his standing down would mean his four scheduled flights that day would be cancelled as there were no replacement captains available. Both pilots reported feeling fit to continue and elected to continue the flights. However, the captain later reported that he felt some pressure to operate the flights. The cabin crewmember stood herself down and was replaced.

Safety analysis

During radar vectoring to runway 35 at Essendon Airport, the aircraft descended below the radar minimum safe altitude of 2,100 ft. The flight crew reported that the autopilot was engaged and the altitude of 2,100 ft was preselected at the time of the occurrence. A subsequent engineering inspection found no fault with the AFCS. Because no flight data was able to be obtained, the ATSB was unable to confirm what the AFCS mode(s) and settings were at the time of the occurrence, or the reason why the aircraft descended below the preselected altitude.

Regardless of the reason for the aircraft descending through the prescribed altitude, flight crew have a vital role in monitoring the aircraft's flight path, particularly during descent. In this case, the first officer (pilot flying) relied upon automation to capture the assigned altitude and diverted his attention outside of the aircraft to assist the captain (pilot monitoring) in sighting the runway. As a result, neither pilot was monitoring the aircraft's flight instruments or descent path as it approached and subsequently descended through the assigned level, which was also the minimum safe altitude.

The flight had been significantly delayed from its scheduled time of operation. The flight crew were aware of the reduced time margin for their scheduled return flight to depart Essendon prior to the 2300 curfew. In addition, neither pilot had operated at night into Essendon Airport, and the captain's requested option of conducting an ILS approach to runway 26 had been declined by ATC due to traffic. The captain's subsequent difficulty in identifying runway 35 at night, the delayed arrival of the aircraft at Essendon and the proximity of the curfew time probably contributed to the first officer (pilot flying) focussing his attention outside the aircraft at a critical time of flight.

Both flight crew had the previous days off duty and had a reasonable amount of sleep the night before. Although both flight crew had been awake for 15–16 hours at the time of the occurrence, there was insufficient evidence to conclude that they were operating at a level of fatigue known to influence performance at the time of the occurrence. Nevertheless, they would probably have been operating at an elevated risk of fatigue during the subsequent two flights.

Findings

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

- During radar vectoring to runway 35 at Essendon, the aircraft descended through the radar lowest safe altitude (2,100 ft). The extent to which there was a problem with the functioning of the aircraft's automatic flight control system could not be determined.
- Due to the captain (pilot monitoring) having difficulty sighting the runway, as well as perceived pressure to complete the flight, the first officer (pilot flying) focussed his attention outside the aircraft at a critical time during the descent.
- The flight crew did not detect that the aircraft had descended through the assigned level (2,100 ft) until the aircraft reached 1,600 ft.

Safety action

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

Aircraft operator

As a result of this occurrence, JetGo advised the ATSB that they had taken the following safety actions:

- The flight crew involved in the incident were subsequently provided with ground and simulator training for operations into Essendon at night.

Safety message

Flight crew should be mindful that during higher workload phases of flight, such as during approach and landing at an unfamiliar airport, introducing tasks that divert both flight crew members' attention from monitoring the aircraft's flight profile and altitude should be minimised. Further, during a visual approach, pilots must ensure that at least one pilot monitors the aircraft's flight path profile and energy state.

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

An increasing trend has been identified where pilots do not effectively manage their aircraft's flightpath when unexpected events arise during the approach to land.

When compared to other phases of flight, the approach and landing has a substantially increased workload and is traditionally the phase of flight associated with the highest accident rate. Flight crews must continuously monitor aircraft and approach parameters, and the external environment, to ensure they maintain a stable approach profile and make appropriate decisions for a safe landing.

The selection of inappropriate autoflight modes, unexpected developments, or any confusion about roles or procedures can contribute to decisions and actions that increase the safety risk to the aircraft and its passengers.

The ATSB SafetyWatch information on Descending too low on approach provides more resources and information.

General details

Occurrence details

Date and time:	27 October 2017 – 2223 EST	
Occurrence category:	Incident	
Primary occurrence type:	Flight below minimum altitude	
Location:	12.8 km SW of Essendon Airport, Victoria	
	Latitude: 37° 49.58' S	Longitude: 144° 49.57' E

Aircraft details

Manufacturer and model:	Embraer-Empresa Brasileira De Aeronautica ERJ135KL	
Registration:	VH-ZJG	
Operator:	JetGo	
Serial number:	145522	
Type of operation:	Air Transport High Capacity - Passenger	
Persons on board:	Crew – 3	Passengers – 25
Injuries:	Crew – 0	Passengers – 0
Aircraft damage:	Nil	

About the ATSB

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

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

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

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

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

About this report

Decisions regarding whether to conduct an investigation, and the scope of an investigation, are based on many factors, including the level of safety benefit likely to be obtained from an

investigation. For this occurrence, a limited-scope, fact-gathering investigation was conducted in order to produce a short summary report, and allow for greater industry awareness of potential safety issues and possible safety actions.