Australian Government
Australian Transport Safety Bureau

Unstable approach involving Embraer 190, VH-UZI

About 4 km north-east of Brisbane Airport, Queensland on 9 May 2024

ATSB Transport Safety Report
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Addendum

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Investigation summary

What happened

On 9 May 2024, an Embraer ERJ 190-100 IGW aircraft, registered VH-UZI and operated by Alliance Airlines, departed Cairns, Queensland (Qld) for Brisbane, Qld with 29 passengers and 2 flight crew on board.

As the aircraft approached Brisbane in darkness, and with the autopilot engaged, air traffic control cleared the aircraft for the instrument landing system (ILS) approach to runway 19 left. The captain (pilot flying) disconnected the autopilot and enabled the flight path reference (FPR) line on their primary flight display to assist with manually flying the approach. The captain asked the first officer (pilot monitoring) to adjust the FPR line to the ILS glideslope angle for the runway (3.0°). Shortly after, the aircraft's automated ILS flight mode unexpectedly disengaged.

Over the next 10 seconds, and with the aircraft becoming unstable below 500 ft above aerodrome level, the flight crew focused on troubleshooting the unexpected change and recapturing the ILS flight director mode, rather than conducting a go-around. During this time, the aircraft's glideslope deviation exceeded the stabilised approach criteria limit of 1.0 dot glideslope deviation. After recognising that the aircraft was low, the captain began to increase the aircraft pitch, and immediately after, the enhanced ground proximity warning system (EGPWS) generated a glideslope warning. The captain arrested the aircraft's descent and re-established the aircraft on the glidepath, before continuing the approach and landing.

What the ATSB found

The ATSB found that, in response to a request from the captain to adjust the FPR line on their primary flight display, the first officer inadvertently pushed the flight path angle (FPA) button which selected the FPA mode and disengaged the aircraft's ILS approach mode. The first officer's action constituted a 'slip' type error where an individual's understanding of the situation is correct, but the wrong action is performed.

Following the unexpected change to the aircraft's flight modes, the flight crew diverted their attention to recapturing the ILS approach mode and did not effectively monitor the aircraft's flight path. Consequently, the aircraft exceeded the glideslope limit requirement of the stabilised approach criteria undetected by the flight crew.

The aircraft continued to descend below the glideslope, resulting in the EGPWS glideslope alert activating. Subsequently, the flight crew did not perform the required terrain avoidance manoeuvre, and instead continued the approach.

What has been done as a result

In response to the occurrence, Alliance Airlines has:

- added a discussion in the pre-brief of the cyclic training program to include the EGPWS 'glideslope' activations and required procedures
- issued an Operational Notice to remind crew of the stabilised approach criteria and go-around requirements
- conducted a thematic review of unstable approaches and analysed data for further review.

Safety message

When flight crew are faced with the unexpected, effective crew resource management, with each crewmember performing their procedurally assigned roles of flying and monitoring, is essential to ensuring the continued safety of flight while the disruption is investigated and managed. Additionally, in the case of aircraft equipped with auto flight systems, immediate reference to the

flight mode annunciation display offers the best opportunity to promptly identify and resolve instances of inadvertent mode selection.

This incident highlights how quickly a disruption can result in an aircraft transitioning from a stable to unstable approach. If the disruption results in the exceedance of stabilised approach criteria, early recognition of the situation and prompt execution of a go-around, rather than continuing the approach, will significantly reduce the risk of approach and landing accidents. Furthermore, flight crew must execute the correct response to ground proximity warning systems glideslope alerts without hesitation to ensure obstacles or terrain are avoided.

The investigation

Decisions regarding the scope of an investigation are based on many factors, including the level of safety benefit likely to be obtained from an investigation and the associated resources required. For this occurrence, a limited-scope investigation was conducted in order to produce a short investigation report, and allow for greater industry awareness of findings that affect safety and potential learning opportunities.

The occurrence

On 9 May 2024 an Embraer ERJ 190-100 IGW aircraft, registered VH-UZI, was being operated by Alliance Airlines on flight[1] QF1887 from Cairns, Queensland (Qld) to Brisbane, Qld with 29 passengers and 2 flight crew on board. The captain was the pilot flying, and the first officer was the pilot monitoring.[2]

The aircraft departed Cairns at 2101 local time. By about 2243, the aircraft was stabilised on the Brisbane runway 19L instrument landing system (ILS) approach, descending below 1,000 ft above aerodrome level (AAL) – 1,015 ft above mean sea level (AMSL) – in darkness and in visual meteorological conditions.[3] At 2243:49, air traffic control provided a landing clearance, and shortly after, the captain disengaged the autopilot to manually fly the approach.

To assist with following the approach glidepath, the captain enabled the flight path reference (FPR) line on their primary flight display (PFD) (see the section titled *Flight guidance system and displays*). The FPR displayed the aircraft's flight path angle[4] reference line and digital readout on the PFD's attitude indicator. The reference line was initially presented at 3.2° down, and the captain asked the first officer to adjust the line to present 3.0° (the ILS glideslope angle for Brisbane runway 19L). To do so, the first officer first needed to press the FPR button on their display controller panel to display the reference line on their attitude indicator, and then turn the flight path angle select (FPA SEL) knob to the requested value of 3.0°. At 2244:12, with the aircraft at about 460 ft AAL (475 ft AMSL), the first officer inadvertently pressed the flight path angle (FPA) button, which selected the FPA mode and changed the lateral and vertical navigation guidance for the flight director from localiser (LOC) and glideslope (GS) to aircraft roll angle (ROLL) and flight path angle (FPA).

The captain reported that the mode change was unexpected for the flight crew, while the first officer reported experiencing 'startle'.[5] After the mode change, the flight crew focused on troubleshooting the unexpected change and recapturing the ILS flight director modes. With the captain still manually flying, the aircraft's pitch angle began to decrease, with an associated increase in the descent rate. A few seconds later, the captain selected the approach (APP) navigation mode which armed the ILS approach mode but did not capture the LOC or GS navigation modes. One second later, at 2244:16, the aircraft's glideslope deviation reached 0.5 dot below the ILS glidepath, and a second later, the vertical rate of descent exceeded the operator's stabilised approach criteria limit of 1,000 feet per minute, reaching a maximum of 1,139 feet per minute at about 300 ft AMSL. At 2244:19, 7 seconds after the FPA button was

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1 The flight was operated under Civil Aviation Safety Regulations Part 121 (Air transport operations – larger aeroplanes)

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 Visual meteorological conditions (VMC) are expressed in terms of inflight visibility and distance from cloud (horizontal and vertical) and are prescribed in the Civil Aviation Safety Regulations (CASR).

4 Flight path angle: the angle between the flight path vector (where the aircraft is going), and the horizon; the aircraft's climb/descent angle.

5 Startle is a stress response to a sudden intense event. It can cause involuntary reflex and cognitive impairment and can last from 0.3 seconds at the low end, to 1.5 seconds for a high intensity response (Rivera et al, 2014).

pressed, the glideslope deviation increased to about 1.0 dot below, which was the stabilised approach criteria limit, and the lateral guidance (LOC) for the ILS approach mode was captured.

Over the next few seconds, as the aircraft descended to about 295 ft AAL (310 ft AMSL), the glideslope deviation increased to 1.5 dots. During this time, the captain felt that the aircraft's nose was low and observed the low glideslope indications on their attitude indicator, as well as the precision approach path indicator (PAPI) system[6] showing 3 red lights, indicating the aircraft was below the glideslope. In response, the captain began to increase the aircraft pitch, and immediately after, with the aircraft still descending, the enhanced ground proximity warning system (EGPWS) generated a glideslope warning (see the section titled *Enhanced ground proximity warning system* (EGPWS)). The first officer reported calling out 'slope' at some point before the EGPWS activation (see the section titled *Flight crew task sharing and standard calls*). A maximum glideslope deviation of 1.8 dots was reached while the excessive descent rate was being arrested.

As the aircraft descended to about 235 ft AAL (250 ft AMSL), the vertical guidance (GS) for the ILS approach mode was captured. A few seconds later, when the aircraft was about 1 dot below the glideslope, the descent rate reduced to less than 100 feet per minute. The aircraft then levelled at 233 ft AAL (248 ft AMSL) and the glideslope warning deactivated. Over the next 5 seconds, the captain re-established the aircraft on the glidepath, and then continued the approach, with the aircraft subsequently landing within the touchdown zone[7] at an appropriate speed without further incident. The circumstances of this occurrence meant that there was no air traffic control alert issued to the flight crew for the glideslope deviation and excessive descent rate.

Context

Flight crew

The captain and first officer both held an air transport licence (aeroplane) and class 1 aviation medical certificates. The captain had over 12,100 hours of flying experience, of which 2,100 hours were on the E190 aircraft type, with 110 hours accrued in the previous 90 days. The first officer had almost 8,200 hours of flying experience, of which 975 hours were on the E190, with 154 hours accrued in the previous 90 days.

Fatigue

At interview, both pilots reported that they obtained poor quality sleep the night before the day of the incident flight. While the captain was uncertain about why they slept poorly, the first officer reported that they went to sleep about 2.5 hours past their usual bedtime and generally did not sleep well outside of their usual pattern. The captain reported obtaining 8–9 hours of sleep in the previous 24 hours and 17.5–19.5 hours in the previous 48 hours while the first officer reported 5.5–6 hours and 13.5–14 hours respectively.

The crew also reported feeling 'moderately' tired towards the later stage of the flight and that flight crew fatigue was identified in the approach briefing as a threat to be managed. While the incident occurred during the approach, both crew remarked that it was not a high workload situation at the time.

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[6] The PAPI is a system of lights on the side of an airport runway threshold that provides visual descent guidance information during final approach.

[7] Touchdown zone means the portion of a runway, beyond the threshold, where landing aeroplanes are to first contact the runway.

The ATSB conducted an assessment of the flight crew's sleep opportunity, actual sleep obtained, and quality of sleep leading up to the flight as well as other fatigue-related factors, identifying that:

- the flight crew had an adequate rest opportunity of about 14 hours before the incident flight
- the rest opportunity was overnight which coincided with the circadian rhythm cycle and was unlikely to increase the risk of fatigue
- although the flight crew reported poor sleep quality, the conditions at the hotel accommodation where they spent the night were suitable and therefore conducive to obtaining restful sleep
- biomathematical modelling[8] of the flight crew's roster data for the 2 weeks leading up to the flight indicated a low likelihood of fatigue.

In addition, research indicated that:

- the crew's reported hours of sleep in the previous 24 and 48 hours were within limits that were unlikely to increase the risk of fatigue
- the time the flight crew had been on duty at the time of the incident was unlikely to have increased the risk of fatigue
- the time the flight crew had been awake at the time of the incident was not associated with significant performance degradation
- the time the incident occurred (2245 local time) would not have increased the risk of fatigue as it was outside the window of circadian low.[9]

The assessment concluded it was unlikely the flight crew were experiencing a level of fatigue known to adversely affect performance.

Instrument landing system

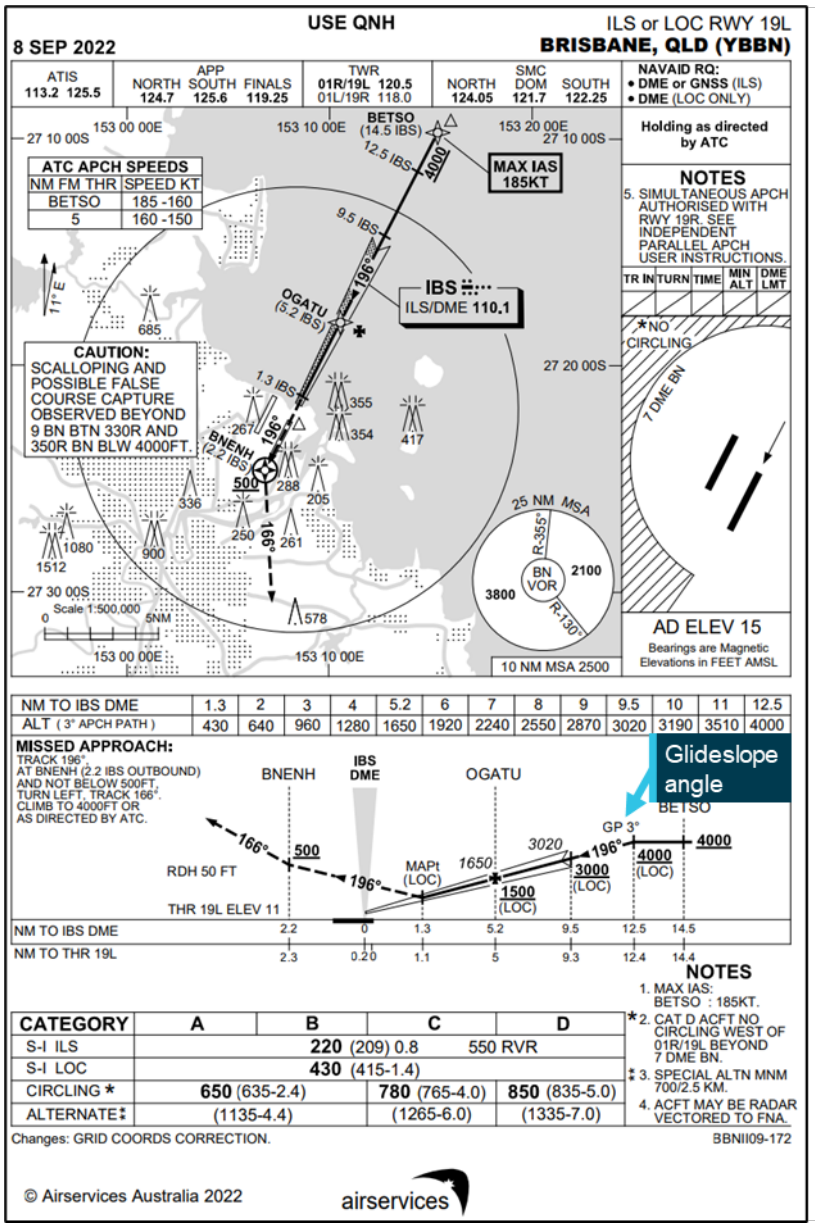
An instrument landing system (ILS) is an instrument approach procedure that provides lateral (localiser) and vertical (glideslope) position information using angular deviation signals from the localiser antennas (located past the upwind end of the runway) and the glideslope antennas (located approximately 1,000 ft from the runway threshold). Aircraft systems detect these radio signals and provide instrument indications which, when utilised in conjunction with the flight instruments, enable an aircraft to be manoeuvred along a precise final approach path.

The Brisbane runway 19L ILS approach provided the typical 3° glideslope to the runway (Figure 1).

[8] A biomathematical model of fatigue predicts the effect of different patterns of work on measures such as subjective fatigue, sleep, or the effectiveness of performing work, using mathematical algorithms. Each model uses different types of inputs and assumptions and produces different types of outputs, each having limitations. The ATSB used the biomathematical modelling software SAFTE-FAST and FAID Quantum for the analysis.

[9] Window of circadian low (WOCL): Time in the circadian body clock cycle when fatigue and sleepiness are greatest and people are least able to do mental or physical work. The WOCL occurs around the time of the daily low point in core body temperature – usually around 0200–0600 when a person is fully adapted to the local time zone. However, there is individual variability in the exact timing of the WOCL.

Figure 1: Brisbane runway 19L ILS approach chart



Source: Airservices Australia, annotated by the ATSB

Flight guidance system and displays

The E190 featured an integrated automatic flight control system (AFCS) that processed inputs from several aircraft systems and sensors. The AFCS supplied this processed data to the flight guidance control system (FGCS), which provided visual and aural information to the flight crew.

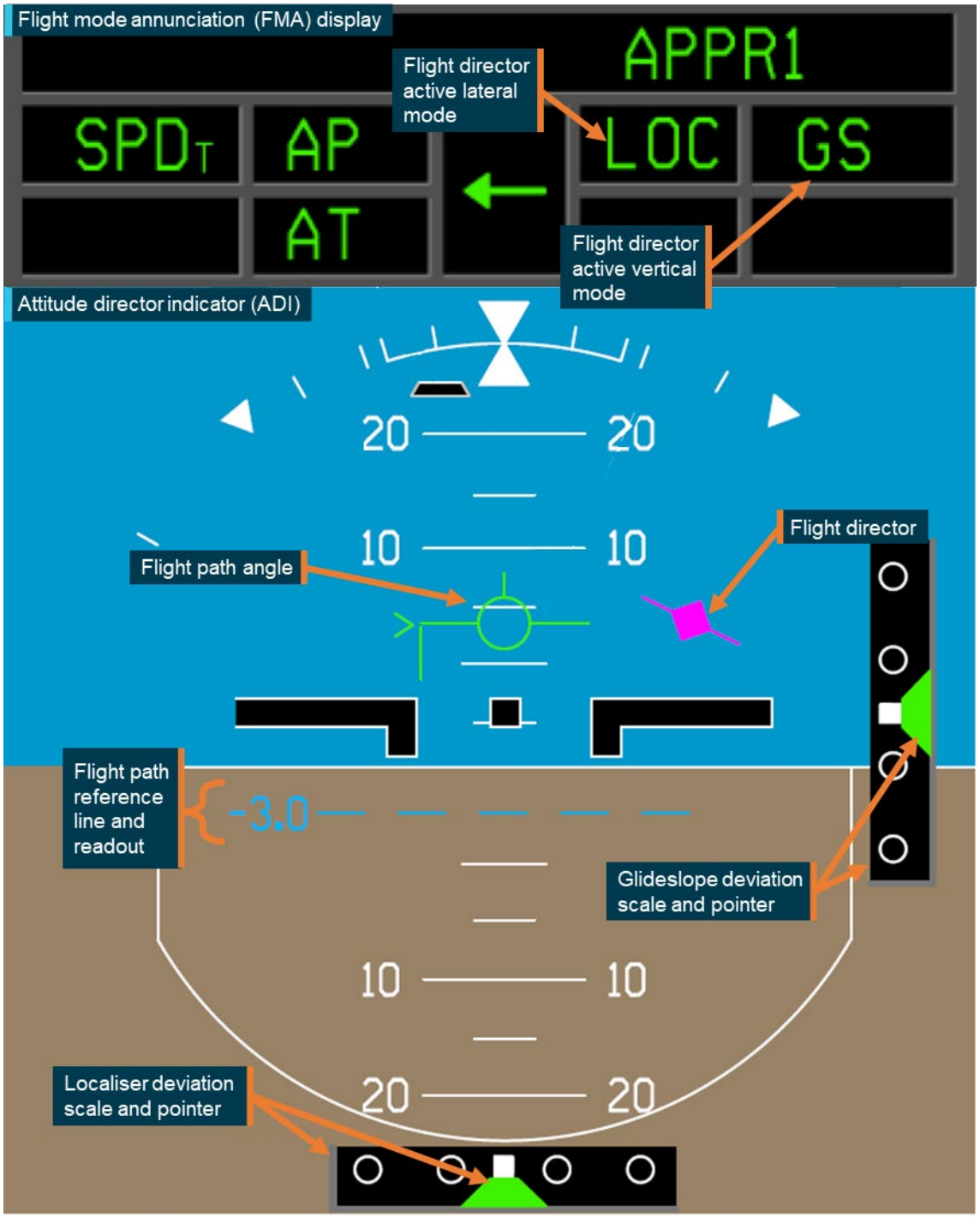
The E190 FGCS also provided flight guidance information to the primary flight display (PFD) flight director (Figure 2) and the autopilot. The flight mode annunciation (FMA) display was located at the top of the PFD and displayed autothrottle, autopilot, approach status, and flight director lateral and vertical mode indications.

The attitude director indicator (ADI) was located below the FMA display on the PFD, and presented the following:

- flight director represented by a magenta diamond providing lateral and vertical guidance
- glideslope and localiser deviation pointers with scales (1 dot spacing), independent of flight director guidance

- flight path angle symbol that showed the current flight path angle in reference to the horizon line
- flight path reference line (FPR) and readout which indicated a manually selected flight path angle for reference.

Figure 2: E190 flight mode annunciation and attitude director indicator displays

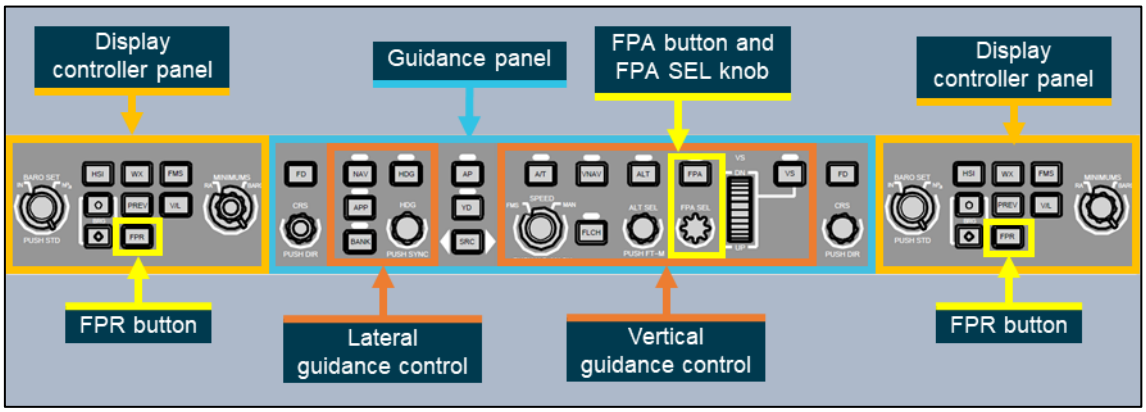


Source: Alliance Airlines, annotated by the ATSB

The flight director provided guidance based on pilot selections on the guidance panel (Figure 3). When a mode change was selected by the flight crew, the selected mode was armed and, when certain conditions were met, became active. This active mode was displayed on the FMA display which temporarily flashed in reverse video (black text on green background) to highlight the change.

Pressing the ‘APP’ button armed approach navigation modes, and when on an ILS approach, activated the ILS approach mode, providing vertical (glideslope) and lateral (localiser) flight director guidance. This navigation mode was displayed on the FMA as ‘LOC’ and ‘GS’.

Figure 3: Guidance panel and display controller panel



Source: Alliance Airlines, annotated by the ATSB

Pressing the FPA button selected the flight path angle vertical mode and the aircraft roll hold (ROLL) lateral mode. When the FPA mode was active, it commanded the flight director to a flight path angle reference and the flight path reference (FPR) line was displayed as a solid line. The FPA SEL control knob was then used to manually select the desired flight path angle, represented by the FPR line.

The FPR line feature could also be used by pilots to assist with flight path management when manually flying an ILS approach and was activated by pressing the FPR button located on the display controller panel. The FPR line was then presented as a dashed line when activated and adjusted using the same FPA SEL control knob on the guidance panel (Figure 3). When the FPR button was pressed, the line and numerical flight path angle value presented was that of the aircraft’s flight path angle at that time.

The first officer reported that they had previous experience using the FPR function, but it was not a feature commonly used by the operator’s flight crew.

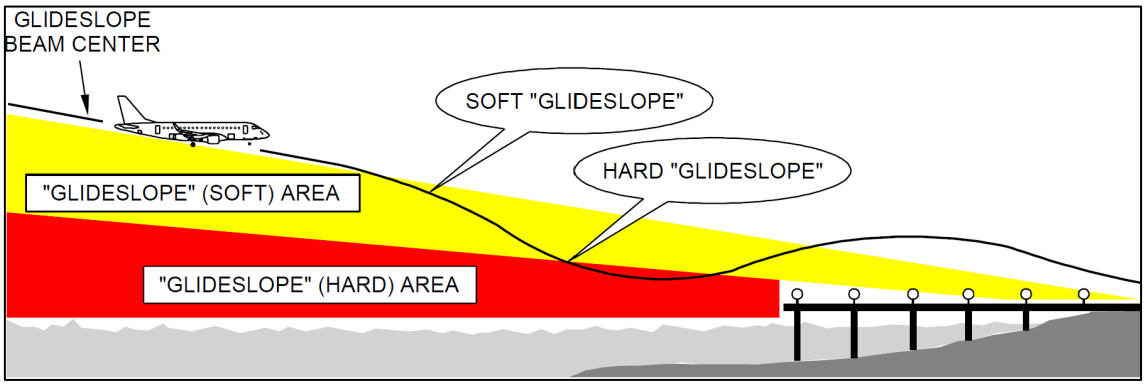
The aircraft manufacturer advised the ATSB that it had not received any previous flight crew reports of a similar inadvertent selection of FPA instead of FPR as occurred during this incident.

Enhanced ground proximity warning system (EGPWS)

The aircraft was fitted with a Honeywell EGPWS, which used aircraft position and configuration information, along with a radio altimeter and a terrain database, to provide flight crew with increased awareness of the terrain along the projected flight path via aural and visual alerts and warnings. These included a mode that alerted pilots to excessive glideslope deviation during an ILS approach (Figure 4), and excessive descent rate (Figure 5).

When the aircraft descended more than 1.3 dots below the glideslope while at a radio altitude less than 1,000 ft, an aural ‘GLIDESLOPE’ would be generated and an amber ‘GND PROX’ alert displayed on each PFD (‘soft’ glideslope alert). If the descent continued to less than 300 ft and the glideslope deviation was 2 dots below, the ‘GLIDESLOPE’ aural alert would be louder and faster (‘hard’ glideslope alert). The aural and visual alerts continued until the aircraft exited the alert envelope.

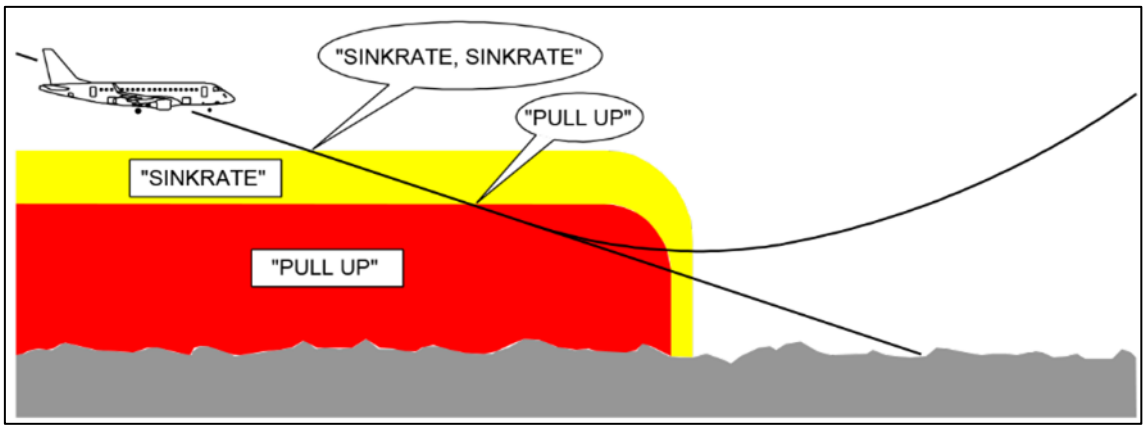
Figure 4: EGPWS descent below glideslope alert



Source: Alliance Airlines

When the aircraft altitude was lower than 2,450 ft above ground level, aural and visual alerts were generated when the EGPWS calculated that the aircraft had an excessive descent rate towards terrain (Figure 5). When the outer limit of the descent rate envelope was breached, an aural 'SINKRATE' would be generated with an amber 'GND PROX' alert displayed on each PFD. If the inner limit was breached, a 'PULL UP' aural and visual alert was generated.

Figure 5: EGPWS excessive descent rate alert



Source: Alliance Airlines

Recorded data

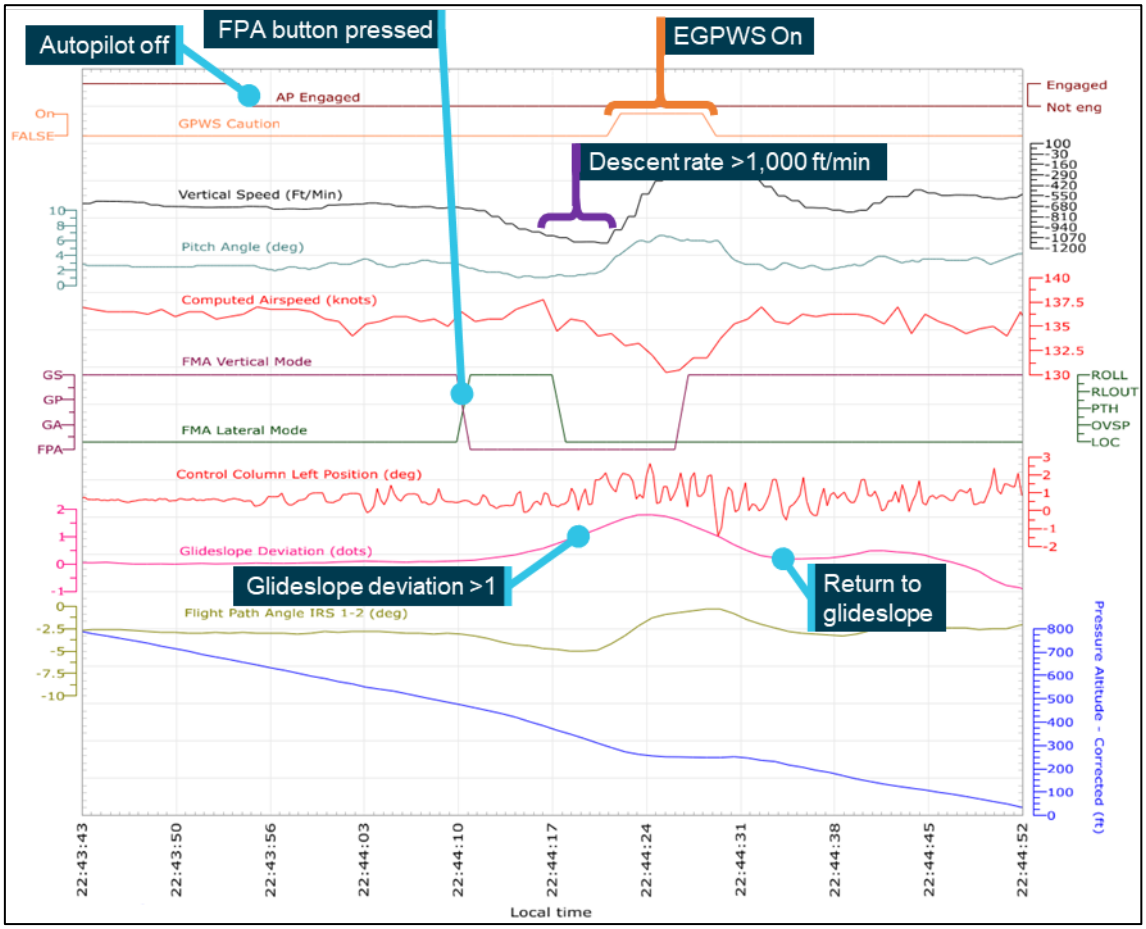
The ATSB was notified of the incident 4 days after it had occurred. By this time, the cockpit voice recorder audio covering the time of the incident had been overwritten and was unavailable to the investigation.

The flight data from the aircraft's quick access recorder was analysed by the ATSB and the aircraft manufacturer, Embraer (Figure 6). The data showed that at 2243:57, the autopilot was disconnected, and the aircraft closely followed the glideslope until 2244:12, when the first officer inadvertently selected the FPA mode. At that time, the aircraft's flight path angle was 3.3° down with a pitch angle of about 2.5° up. Over the next 10 seconds, the control column pitch up input reduced, with a subsequent reduction in aircraft pitch up angle, and the descent rate and deviation from the glideslope both increased.

Between 2244:18 and 2244:23, the descent rate exceeded 1,000 feet per minute, reaching a maximum of 1,139 feet per minute at about 300 ft above ground level. This was outside of the EGPWS excessive descent rate activation envelope and, therefore, no 'SINKRATE' alert was generated. At 2244:21, the glideslope deviation reached 1.0 dot, and 2 seconds later, the captain pitched the aircraft up, with the EGPWS 'GLIDESLOPE' alert activating immediately after. Three seconds later, a maximum glideslope deviation of 1.8 dot was recorded and the EGPWS alert

deactivated after a further 5 seconds. The glideslope deviation reduced below 1.0 dot at 2244:31, and about 5 seconds later, the aircraft recaptured the glideslope at around the approach minima (220 ft AMSL). The maximum deviation below the glideslope was approximately 60–70 ft during the EGPWS activation.

Figure 6: VH-UZI recorded flight data during the approach



Source: ATSB

Operator procedures

Approach briefing

The objective of an approach briefing is to ensure all flight crew understand and share a common mental model for the proposed plan of action. The approach briefing was normally performed by the pilot flying with the pilot monitoring reviewing and checking the information.

The operator's procedures required that the flight crew cover several topics during the briefing such as the expected manoeuvring to the initial approach fix, nomination of navigation aids required for the approach (for example, ILS), terrain, weather, obstacles, and any threats.

The captain stated that the approach briefing for the occurrence flight was 'normal' other than fatigue being identified as a threat (see the section titled *Fatigue*). The captain stated that they did not brief the use of the FPR line feature during the approach briefing as they only decided to use it after the approach had already commenced and following the autopilot disconnection.

Stabilised approach criteria

An approach is stable when all of the stabilisation criteria specified by the operator are met and an unstable approach is any approach which does not meet these criteria. According to an International Air Transport Association (IATA) report published in 2017, historical commercial

aviation accident data indicated that many accidents occur during the approach and landing phase of flight, with frequent contributing factors being an unstable approach together with a subsequent failure to initiate a go-around. Failure to maintain a stable approach could result in a landing that is too fast or too far down the runway, leading to a hard landing, runway excursion, loss of control, or collision with terrain.

The operator's standard operating procedures required all flights conducting instrument approaches to be stabilised by 1,000 ft above aerodrome level, and an immediate go-around was required for any approach that did not meet the following stabilised approach criteria:

> a) the correct flight path;
>
> b) only small changes in heading/pitch are required to maintain the correct flight path;
>
> c) the aircraft speed is not more than VAPP + 10 knots indicated airspeed and not less than VREF;
>
> d) the aircraft is in the correct landing configuration;
>
> e) sink rate is no greater than 1,000 feet per minute
>
> f) thrust or power setting is appropriate for the aircraft configuration;
>
> g) all briefings and checklists have been completed;
>
> h) specific types of approached are stabilized if they also fulfil the following
>
> i. instrument landing system (ILS) approaches must be flown within one dot of the glideslope and localizer
>
> ii. a Category II or Category III ILS approach must be flown within the expanded localizer band
>
> i) unique approach procedures or abnormal conditions requiring a deviation from the above elements of a stabilized approach require a special briefing to have been completed prior to beginning the approach.
>
> • **Note 1:** A momentary excursion is permitted for points (c) & (e). A momentary excursion is defined as a deviation lasting only a few seconds and where every indication is that it will return to the stabilised criteria as listed in points (c) & (e).
>
> • **Note 2:** Where the nominal descent path for a particular approach requires a descent rate greater than 1000 fpm. This is only permitted when expected rates of descent have been briefed prior to the approach being commenced.

Flight crew task sharing and standard calls

During a manually flown approach, the pilot flying was responsible for controlling the aircraft flight path. The pilot monitoring was responsible for performing actions requested by the captain and monitoring the aircraft status (for example, configuration, altitude, speed, and flight path). For precision approaches, such as an instrument approach, the pilot monitoring was required to call out flight path deviations, such as glideslope deviations, below the stabilisation height:

> Any time the [pilot monitoring] calls deviations from 'on slope' the PF should make corrections to avoid flight path excursions towards full scale.
>
> The [pilot monitoring] should continue slope deviation calls until the glideslope indicator stops moving toward full scale and whenever the indicator is at full scale.

Defined phraseology was used to standardise communication of critical items in high workload situations. Deviation calls were to be made if a deviation limit was exceeded, and no corrective action had been observed (Table 1).

Table 1: Relevant standard calls

Situation / Deviation	Pilot monitoring	Pilot flying
Glideslope 0.5 dot	"SLOPE"	"CHECKED"
Glideslope 1.0 dot	"SLOPE LIMIT"	"GO AROUND…"
Unstable approach	"UNSTABLE"	"GO AROUND…"

EGPWS

The operator's E190 EGPWS policies and procedures required the crew to take the following action in response to an EGPWS alert:

> If an EGPWS alert is associated with a PFD AMBER visual message of 'GND PROX', the EGPWS WARNING CORRECTIVE MANEUVER must be performed unless on daylight operations with clear visual conditions (not IMC), and a positive visual verification ensures that no obstacle or terrain hazards exist.
>
> …During daylight in VMC, with terrain and obstacles clearly in sight, the alert may be considered cautionary. Take positive corrective action until the alert ceases or a safe trajectory is ensured.
>
> Perform the appropriate GPWS warning or alert procedure at all other times and climb the aircraft to the [lowest safe altitude] when enroute or to the [minimum safe altitude] when in the terminal area.

The 'EGPWS WARNING CORRECTIVE MANEUVER' required the pilot flying and pilot monitoring to perform various actions and callouts (Figure 7).

Figure 7: EGPWS warning corrective manoeuvre

EGPWS WARNING – ACTIONS AND CALLOUTS		
	PF	**PM**
Upon receiving EGPWS Warning	• Disengages the Autopilot. • Advances thrust levers to MAX detent. • Set pitch 20° or PLI, whichever is lower. [1] • Maintain the present aircraft configuration (gear/flaps) until terrain separation is achieved.	• Communicates with ATC. • Turns FSTN BELTS Switches to ON • Scans for visual reference. • Calls out the Radio Altimeter indication. • Reads MFD Terrain indications to check the obstacle height, guides for the best course of action and indicates when obstacle is cleared.
With terrain clearance assured	• Reduces thrust levers to TO/GA or below (as required). • Adjust FPA as required. • Select or request appropriate modes • AP as required	• Select modes as requested
Acceleration	• Confirm configuration. • Retract flap and gear as required	• Select flap and gear as requested

[1] After stabilising, pitch may be increased above 20°, limited to pitch limit indicator.
Source: Alliance Airlines

The operator advised that flight crew received training on the EGPWS during initial type training and through recurrent cyclic simulator training sessions. The training involved different scenarios involving an EGPWS alert that required the corrective manoeuvre to be performed, with the training focus being on ensuring that the procedure was executed correctly. The operator advised that while EGPWS glideslope alerts were probably not simulated as frequently as other EGPWS alerts, the response to almost all EGPWS alerts, as specified in the operator's procedures, was to perform the corrective manoeuvre.

The captain reported being surprised when the EGPWS glideslope alert activated as they could see they were 'very near the place they needed to be' and assessed that the safest course of action was to continue the approach.

Safety analysis

Incorrect mode selection

While manually flying the Brisbane runway 19L instrument landing system (ILS) approach, the captain enabled the flight path reference (FPR) line function and requested the first officer adjust the FPR value to the runway ILS glideslope angle of 3.0°. This required the first officer to press the FPR button and then turn the FPA SEL knob to the requested value. Instead, the first officer inadvertently pressed the FPA button.

The first officer's action constituted a 'slip' type error that is a failure of an execution of an action (Reason, 1990). Specifically, slips occur when an individual's understanding of the situation is correct, but the wrong action is performed (Wickens et al, 2022). Characteristics of this error also occur when people accept a match for the proper object, something that looks like it, is in the expected location or does a similar job. Specifically, it can occur when some characteristics of either the stimulus environment or the action sequence itself are closely related to the wrong action. It occurs during well practiced tasks where the operator may not be carefully monitoring their own action selections (Salvendy and Karwowski, 2021).

The first officer's prior intention was to press the FPR button, which was a routine action, but this did not go as planned. In addition, the FPA and FPR buttons were both used in conjunction with FPA SEL control knob, which the first officer would have needed to turn after pressing either button. The aircraft manufacturer reported they were unaware of any similar occurrences that would indicate that this was a significant ergonomic issue.

The captain had not briefed the use of the FPR line function during the approach briefing and therefore the flight crew did not have a shared mental model regarding the use of this function during the approach. However, it was unlikely that this influenced the first officer's 'slip' type error as the first officer knew, and intended to press, the correct button.

Pressing the FPA button disengaged the ILS approach mode and changed the active flight director modes from glideslope and localiser to flight path angle and roll mode on the flight mode annunciator display. As a result, the flight director moved to the aircraft's flight path angle at the time of the button press (3.3° nose down), and the flight path reference line turned solid with the readout indicating 3.3°. Although the ILS approach can be flown without the flight director guidance, the change to the flight director mode was unexpected and resulted in the crew diverting their attention to correct the mode change.

Diversion of attention

Although the first officer reported being 'startled' when the flight director mode change occurred, they were more likely experiencing 'surprise', which is when a mismatch is detected between what is observed and what is expected (Rankin et al, 2013). Surprise can be described as a '… combination of physiological, cognitive, and behavioural responses, including increased heart rate, increased blood pressure, an inability to comprehend/analyse, not remembering appropriate operating standards, "freezing," and loss of situation awareness' (Rivera et al, 2014).

At the time, the flight crew did not expect a mode change and were surprised when it occurred. After the mode change, the flight crew diverted their attention from monitoring the flight path and became preoccupied with resolving the mode change and recapturing the ILS flight director modes. As a result, the aircraft descended below the glideslope and the approach became unstable with respect to glideslope deviation, which was not recognised by either flight crewmember. The descent rate also exceeded the stabilised approach criteria limit of 1,000 feet

per minute for about 6 seconds, although the criteria allowed for ‘momentary excursions’ of this parameter.

The first officer reported calling out ‘slope’, however they did not make the ‘slope limit’ or ‘unstable’ call to indicate that a go-around was required. Furthermore, the time of the ‘slope’ call in relation to the glideslope deviation could not be determined. However, if these calls were made, they were unlikely to have affected the outcome given that the captain began to recover the aircraft’s descent shortly after the 1.0 dot glideslope criteria was exceeded.

Research has highlighted the difficulties in understanding the aircraft’s present state following a surprising event, which includes an inadvertent mode change (Rankin et al, 2016). As a result, there are also challenges in identifying which response is appropriate. In such circumstances, immediate reference to the flight mode annunciation display offers the best opportunity to promptly identify and resolve the situation. When focus is diverted to a primary task such as manual flying or emergency actions, attention narrows to that task, and so monitoring of other sources degrades (CAA, 2023). This degradation of monitoring often occurs without the flight crew realising it.

Response to ground proximity warning system alert

Shortly after the aircraft exceeded 1.0 dot glideslope deviation, the captain recognised that the aircraft was too low and initiated a pitch up manoeuvre to correct the deviation. Immediately after, the enhanced ground proximity warning system (EGPWS) glideslope alert activated, which was heard by the flight crew. As the alert occurred at night, procedures required that the EGPWS corrective manoeuvre be performed. The EGPWS glideslope alert also indirectly indicated to the flight crew that the aircraft had exceeded the stabilised approach criteria for glideslope deviation. However, the flight crew did not perform the required EGPWS corrective manoeuvre and continued the unstable approach until the aircraft landed. The decision not to perform the corrective manoeuvre and to continue the approach increased the risk of landing too fast or too far down the runway, which in turn increased the risk of a hard landing, runway excursion, loss of control, or collision with terrain.

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.

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 unstable approach involving Embraer 190, VH-UZI, about 4 km north-east of Brisbane Airport, Queensland on 9 May 2024.

Contributing factors

- In response to a request from the pilot flying to adjust the flight path reference line on their primary flight display, the pilot monitoring inadvertently disengaged the aircraft’s instrument landing system approach mode by mis-selecting the flight path angle mode.
- Following the unexpected change to the aircraft’s flight modes, the flight crew diverted their attention to recapturing the instrument landing system approach mode and did not effectively monitor the aircraft's flight path. Consequently, the aircraft exceeded the glideslope limit requirement of the stabilised approach criteria undetected by the flight crew.

- The aircraft continued to descend below the glideslope, resulting in the Enhanced Ground Proximity Warning System 'GLIDESLOPE' alert. Subsequently, the flight crew did not perform the required terrain avoidance manoeuvre, and instead continued the approach.

Safety actions

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. All of the directly involved parties are invited to provide submissions to this draft report. As part of that process, each organisation is asked to communicate what safety actions, if any, they have carried out to reduce the risk associated with this type of occurrences in the future. The ATSB has so far been advised of the following proactive safety action in response to this occurrence.

Safety action by Alliance Airlines

Following the occurrence, the operator conducted an internal review of the incident, including interviews with the flight crew and analysis of flight data to assess procedural adherence and identify contributing factors.

In response to the occurrence, Alliance Airlines implemented the following to enhance safety and learning:

- a discussion was added in the pre-brief of the cyclic training program to include the EGPWS 'glideslope' activations (hard and soft) and required procedures
- issued an Operational Notice to remind crew of the stabilised approach criteria and go-around requirements
- conducted a thematic review of unstable approaches and analysed data for further review.

General details

Occurrence details

Date and time:	9 May 2024 – 2245 Eastern Standard Time	
Occurrence class:	Incident	
Occurrence categories:	Incorrect configuration, Unstable approach, Ground proximity alerts / warnings, Inter-crew communications	
Location:	4 km north-east of Brisbane Airport, Queensland	
	Latitude: 27.3560° S	Longitude: 153.1450° E

Aircraft details

Manufacturer and model:	Embraer ERJ 190-100 IGW	
Registration:	VH-UZI	
Operator:	Alliance Airlines	
Serial number:	19000191	
Type of operation:	Part 121 Australian air transport operations - Larger aeroplanes-Standard Part 121	
Activity:	Commercial air transport-Scheduled-Domestic	
Departure:	Cairns Airport, Queensland	
Destination:	Brisbane Airport, Queensland	
Persons on board:	Crew – 2	Passengers – 29
Injuries:	Crew – 0	Passengers – 0
Aircraft damage:	None	

Sources and submissions

Sources of information

The sources of information during the investigation included:

- the flight crew
- quick access recorder data
- Alliance Airlines
- the aircraft manufacturer (Embraer)
- Airservices Australia.

References

Civil Aviation Authority (CAA) (2023) *Flight-crew human factors handbook,* Civil Aviation Authority, United Kingdom Government.

IATA (2017). *Unstable Approaches – Risk, Mitigation Policies, Procedures and Best Practices* (3rd ed.). Retrieved from https://www.iata.org/contentassets/7a5cd514de9c4c63ba0a7ac21547477a/iata-guidance-unstable-approaches.pdf.

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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
- Alliance Airlines
- Qantas Airways
- Embraer
- United States National Transportation Safety Board
- Brazilian Aeronautical Accidents Investigation and Prevention Center

- Civil Aviation Safety Authority
- Airservices Australia.

Submissions were received from:

- Alliance Airlines
- Civil Aviation Safety Authority.

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

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.