Australian Government

Australian Transport Safety Bureau

Weather related operational event involving Boeing 737s VH-YIR and VH-VYK, Mildura Airport, Victoria on 18 June 2013

ATSB Transport Safety Report
Aviation Occurrence Investigation
AO-2013-100
Interim – 19 December 2013

Released in accordance with section 26 of the *Transport Safety Investigation Act 2003*

Publishing information

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Addendum

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The occurrence

The information contained in this Interim report is released in accordance with section 25 of the Transport Safety Investigation Act 2003 and is derived from the ongoing investigation of the occurrence. Readers are cautioned that new evidence will become available as the investigation progresses that will enhance the ATSB's understanding of the accident as outlined in this Interim report. As such, no analysis or findings are included in this report.

History of the flights

On the morning of 18 June 2013, a Boeing Company 737 (B737) aircraft, registered VH-YIR (YIR) and operated by Virgin Australia Airlines Pty Ltd, was conducting a scheduled passenger service from Brisbane, Queensland to Adelaide, South Australia. On board were 6 crew members and 85 passengers. The aircraft was being flown by the pilot in command (PIC) with the first officer (FO) performing the duties of pilot monitoring.

On the same morning, another B737 aircraft, registered VH-VYK (VYK) and operated by Qantas Airways Ltd, was conducting a scheduled passenger service from Sydney, New South Wales, to Adelaide. On board were 6 crew and 146 passengers. The aircraft was being flown by the PIC with the FO performing the duties of pilot monitoring.

Pre-flight planning

VH-YIR

As part of their pre-flight routine, and after accessing the relevant weather forecasts and reports via the National Aeronautical Information Processing System, both flight crew members assessed the weather conditions for the flight on the night prior to and again on the morning of the flight. Their assessment was that conditions were fine and no adverse weather was expected either en route or at Adelaide.

The crew was provided with a flight briefing package by their company that was generated at 1913 Coordinated Universal Time[1]. The package included the flight and fuel plan, weather forecasts for a number of airports, NOTAMs[2] and the expected loading of the aircraft. The ramp fuel indicated on the flight plan and reported as carried by the crew was sufficient to meet the minimum operating requirement[3] for the flight. On the basis of the forecasts available to the crew in this briefing, they determined that an alternate airport for Adelaide was not required. According to the fuel plan, on arrival at Adelaide the aircraft was planned to have approximately 2,500 kg of fuel remaining in the tanks, which equated to a planned fuel reserve of 50 minutes (variable and fixed reserve) and an additional 30 minutes of fuel.

The flight briefing package indicated that the aircraft was capable of conducting an autoland[4,5] and the crew reported that they were trained and current in low visibility operations and autoland

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1 Local time in Brisbane and Sydney was Coordinated Universal Time (UTC) + 10 hours, and in Adelaide UTC + 9:30. Due to Adelaide being in a different time zone to most of the two flights and the respective departure airports, the times in this report are expressed in UTC for consistency and ease of understanding.

2 A Notice To Airmen advises personnel concerned with flight operations of information concerning the establishment, condition or change in any aeronautical facility, service, procedure, or hazard, the timely knowledge of which is essential to safe flight.

3 Minimum operating fuel was defined as including flight fuel from departure to destination, a variable fuel reserve of 10 per cent of the flight fuel, a fixed fuel reserve equal to 30 minutes of flight time, any fuel required due to forecast weather en route, planned air traffic control routing or traffic holding at the destination, any fuel required for flight to an alternate aerodrome (if required), and any fuel required due weather or traffic at that alternate aerodrome. It also included an amount for taxi.

4 An autoland is a landing that is conducted in conditions where there are insufficient visual cues available during landing to assist the pilots. It uses a number of automatic flight control systems on board the aircraft, along with specific procedures, and is combined with a ground-based instrument landing system and runway environment that results in a precisely repeatable approach and landing on an approved runway.

procedures. At the time of the occurrence, Virgin Australia did not have Civil Aviation Safety Authority (CASA) approval for its crews to use autoland procedures for landings in weather conditions below Category 1 minima.

The aircraft departed Brisbane for Adelaide at 2038 and the flight planned arrival time was 2320.

VH-VYK

The crew of VYK were provided with a flight briefing package by their company at about 2010. The package included the flight and fuel plan, weather forecasts for a number of airports, NOTAMs and the expected loading of the aircraft. The fuel uplift indicated on the flight plan and the total fuel load reported as carried by the crew was sufficient to meet the minimum operating requirements for the flight. According to the flight plan, on arrival at Adelaide the aircraft was planned to have approximately 2,800 kg of fuel remaining in the tanks, which equated to a planned fuel reserve of 40 minutes (variable and fixed reserve) and an additional 45 minutes of fuel.

The flight crew assessed the weather information that was provided to them in the briefing and determined that no adverse weather was expected either en route or at Adelaide. On the basis of the available forecasts, the crew assessed that an alternate airport for Adelaide was not required. The PIC reported that, as part of his pre-flight preparation, on arrival at the aircraft he checked the actual weather conditions at Adelaide and confirmed that they had not changed from the forecast conditions.

There was no indication on the flight plan of the aircraft's autoland status; however, the flight crew reported that they were trained and current in low visibility operations and autoland procedures.

The aircraft departed Sydney for Adelaide at 2127 and the flight planned arrival time was 2317.

En route to Adelaide

VH-YIR

The crew of YIR were routinely transferred from one air traffic control (ATC) sector to another as they flew across New South Wales. At 2243 they were transferred to a new ATC sector as the aircraft approached the descent point, which was about 160 NM (300 km) from Adelaide. About 40 seconds later the air traffic controller broadcast the following information to the crews of YIR and VYK:

> Qantas seven-thirty-five and Velocity thirteen-eighty-four[6] you are probably both aware of the weather in Adelaide at the moment. Latest SPECI[7] from two-two-three-zero, wind zero four zero degrees at five knots, visibility one five zero metres in fog, cloud overcast at one hundred, temperature is six, dewpoint is zero five.

The crews acknowledged the broadcast and the crew of YIR reported that they immediately commenced obtaining additional weather information for a number of alternate airports, including Mildura, Victoria. The crew also reported that, prior to the advice at 2243:40, they had not heard any discussion between ATC and other aircraft about the weather conditions at Adelaide, nor had they received any transmissions relating to the weather at Adelaide.

At 2247, the latest weather report for Mildura was requested by the crew of YIR and provided by air traffic control. The report indicated that visibility was in excess of 10 km, with a broken[8] cloud layer at 3,400 ft. Based on this weather information, the crew decided that they were able to continue to a point approximately 48 NM (89 km) from Adelaide, from where they would divert to

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5 In Australia, the only airport at the time of this report with a runway that was approved for autoland procedures in low visibility weather conditions was runway 16 at Melbourne, Victoria.

6 'Qantas 735' was the callsign for VH-VYK and 'Velocity 1384' was the callsign for VH-YIR.

7 Special Aerodrome Weather Reports (SPECI) are issued whenever weather conditions fluctuate about or are below specified criteria.

8 Cloud cover is normally reported using expressions that denote the extent of the cover. Broken indicates that more than half to almost all the sky was covered, while Overcast means all the sky was covered.

Mildura if the weather had not improved at Adelaide. Their planning indicated that they would have about 2,000 kg of fuel, which included their reserve fuel overhead Mildura, if they diverted at their planned diversion point.

The crew were cleared by ATC to contact Adelaide Tower to obtain an appreciation of the actual weather conditions at Adelaide. The crew contacted the tower controllers at 2302 and, following the indication of the Adelaide weather during that radio call, the crew decided to divert to Mildura and at 2303 they obtained an ATC clearance to do so.

VH-VYK

At 2148, the crew of VYK were advised by their company via the aircraft communications addressing and reporting system (ACARS) that the forecast on which they had planned the flight had been amended and that Adelaide now required provision for an alternate airport, due to a period of probable fog between 2100 and 2400. There had been an approximate 45-minute delay in providing this information to the crew due to the operator's 'sterile flight deck' procedure,[9] during which ACARS messages were not normally transmitted to the aircraft.

Following receipt of the amended Adelaide forecast, the crew requested weather forecasts and reports for a number of other airports. On receipt of that information, they decided to continue towards Adelaide until approximately 80 NM (148 km) east of reporting point MAXEM, or about 280 NM (519 km) from Adelaide. Their expected time of arrival (ETA) at that position was 2220. The crew decided that if the weather indicated that they could not continue to Adelaide from that point, they would return to Sydney.

At approximately 2215, the crew of VYK obtained a weather report and a trend forecast via ACARS that was issued at 2205 regarding the conditions at Adelaide. The weather report indicated that the visibility had reduced to 2,000 m and to 500 m to the north in fog. The trend forecast indicated that from 2300 the visibility would improve to greater than 10 km. The crew also obtained an update on the conditions from ATC who advised that the current visibility at Adelaide was reported as 700 m. The crew elected to continue to Adelaide on the basis of the information received and taking into consideration the fuel on board, which allowed the aircraft to hold at Adelaide for 45 minutes after the estimated arrival time of 2320.

When the crew of VYK were transferred to Adelaide approach control they were advised that another B737 aircraft had conducted an approach to Adelaide and been unable to land because of low visibility due to fog and was diverting to Melbourne, Victoria. In response, the crew of VYK entered a holding pattern at a position 46 NM (85 km) from Adelaide and reviewed the weather information that they had received earlier. In addition, the crew requested an actual weather report for Royal Australian Air Force Base Edinburgh, 28 km north of Adelaide Airport. This report indicated that Edinburgh was not available as an alternate airport due to the presence of fog.

The crew also requested a report of the actual weather conditions at Mildura from ATC, which indicated a visibility in excess of 10 km, with a broken cloud layer at 3,900 ft. On the basis of that weather report the crew decided to divert to Mildura and at 2313 were cleared by ATC to track to Mildura. The crew reported planning to have approximately 2,900 kg of fuel on arrival at Mildura.

Weather forecasts and reports

The main weather-related events relevant to the en route phases of each flight are listed at appendix A. The published weather forecasts and weather reports at the time of each of those events are also highlighted.

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[9] The 'sterile flight deck' procedure was introduced to minimise unnecessary distractions during critical phases of flight. Qantas maintained a sterile flight deck from push back until the seatbelt sign was selected to the OFF position during the climb.

The diversion to Mildura

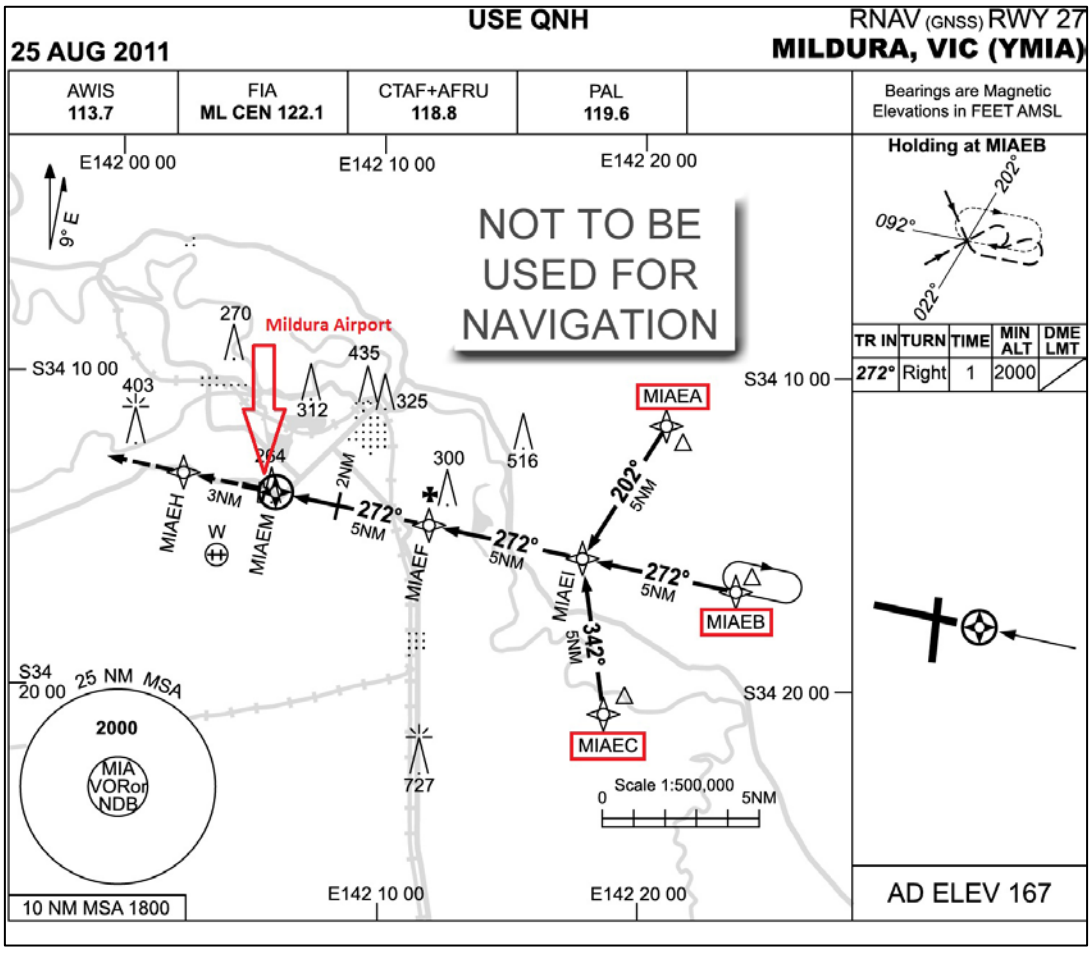
VH-YIR

During the diversion to Mildura, the crew briefed the cabin crew in relation to the fog at Adelaide and decision to divert to Mildura. The crew made preparations to carry out a Distance Measuring Equipment (DME)[10] arrival until below the reported cloud level, before making a visual approach to runway 27. They also entered the runway 27 area navigation global navigation satellite system (RNAV(GNSS))[11] instrument approach into the aircraft's flight management system to minimise workload later in the flight and to provide vertical profile guidance to the runway.

At 2317 the aircraft commenced descent for a DME arrival to Mildura and, on first contact with the sector controller with responsibility for that airspace, the crew were provided with the expected traffic at Mildura for their ETA of 2332. This included a SAAB 340 aircraft that was expected to arrive 2 minutes prior to YIR; a De Havilland DHC-8 aircraft, arriving 2 minutes after YIR's ETA; another SAAB 340 aircraft arriving 6 minutes later; and VYK with an ETA of 2342. Based on that information, the crew of YIR assessed that VYK was behind them.

As they approached the airport, the crew of YIR observed that the cloud was appreciably lower than the report provided to them at 2247. The crew decided to limit the descent to 2,000 ft and, if the conditions did not allow a visual approach, they would track direct to the MIAEC waypoint to conduct the RNAV(GNSS) instrument approach to runway 27 (Figure 1).

Figure 1 – Excerpt from Mildura RNAV(GNSS) approach showing waypoints (highlighted)



Source: Airservices Australia

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[10] Distance Measuring Equipment (DME) is a ground-based transponder station. A signal from an aircraft to the ground station is used to calculate its distance from the ground station.

[11] Formerly known as a global positioning system/non-precision approach (GPS/NPA), a RNAV(GNSS) approach provides pilots with lateral guidance only, based on a number of waypoints.

Information about the actual weather conditions at Mildura was not available to the crew from the automated weather information service (AWIS)[12] as the aircraft approached Mildura. This was due to the AWIS link from the automatic weather station to the very high frequency (VHF) omnidirectional radio range (VOR)[13], which was operated by Airservices Australia (Airservices), being unserviceable. The Bureau of Meteorology (BoM)-supplied automatic weather station was functioning correctly, as weather information was still available via telephone and the station was outputting a data stream to the BoM offices.

The unserviceability of the VHF output had been promulgated to flight crews via NOTAM.

As the aircraft descended through 2,500 ft, the crew of YIR assessed that the weather conditions would not permit a visual approach to runway 27 and they commenced tracking direct to the MIAEC waypoint. The crew were anticipating a low fuel warning at approximately 2,000 kg fuel remaining, and decided to action the relevant checklist. Shortly after, the crew of VYK broadcast on the Common Traffic Advisory Frequency (CTAF)[14] frequency that they were to the south-west of Mildura, passing 9,000 ft on descent and that they were tracking direct to the MIAEC waypoint.

As the crew of YIR tracked towards the MIAEC waypoint, they monitored the position of other traffic using traffic collision avoidance system (TCAS)[15] indications in the cockpit and observed, then heard, the crew of a SAAB 340 conduct a missed approach. The crew of the SAAB broadcast that they were tracking to the north of the airport and were planning to hold at the MIAEA waypoint. They also heard the crew of another SAAB 340 broadcast that they were at the MIAEC waypoint commencing the RNAV(GNSS) instrument approach. In response to this information the crew of YIR commenced an orbit to increase the distance between themselves and that aircraft. Following the orbit they planned to track via the MIAEI waypoint to commence the approach. At about this time the crew of the DHC-8 reported tracking to the MIAEB waypoint to commence the instrument approach.

The crew of VYK then broadcast that they had sighted YIR, and that VYK was starting the approach via MIAEC waypoint ‘due fuel’. The crew of YIR reviewed their own fuel status and, assessing the intent of the radio transmission from the crew of VYK as meaning that they had less fuel than YIR, decided to fly to the north of the MIAEI waypoint and allow the crew of VYK to conduct their approach. There was no further discussion regarding fuel status between the crews of the two aircraft. The crew of YIR reported that they were well clear of VYK at that time and continued to monitor that aircraft’s position, and the position of the other aircraft, on the TCAS.

The crew of YIR also decided that if VYK conducted the approach first, the crew of that aircraft would then be able to give them an appreciation of the weather and actual cloud base at Mildura. The crew of the DHC-8 aircraft then reported conducting a missed approach due to the fog as the crew of YIR monitored the progress of VYK on TCAS and discussed their own approach.

The crew of the second SAAB 340, which had conducted the approach via MIAEC, then broadcast that they were conducting a missed approach due fog and were diverting to Broken Hill, New South Wales. Shortly after the DHC-8 crew broadcast that they were in the missed approach and were tracking to the MIAEB waypoint to commence holding at 10,000 ft.

The crew of VYK then conducted the RNAV runway 27 approach and landed (see the section titled *The approach and landing at Mildura, VH-VYK* for further information).

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[12] The aerodrome weather information service (AWIS) provides actual weather conditions, via telephone or radio broadcast, from automatic weather stations.

[13] A ground-based navigation aid that emits a signal that can be received by appropriately-equipped aircraft and represented as the aircraft’s bearing (called a 'radial') to or from that aid.

[14] Common Traffic Advisory Frequency is the frequency on which pilots operating at a non-towered aerodrome should make positional radio broadcasts.

[15] Traffic collision avoidance system (TCAS) is an aircraft collision avoidance system. It monitors the airspace around an aircraft for other aircraft equipped with a corresponding active transponder and gives warning of possible collision risks.

VH-VYK

As they proceeded towards Mildura, the crew of VYK heard the crew of YIR broadcasting that they were discontinuing the visual approach and that they were tracking to the MIAEC waypoint to conduct the RNAV(GNSS) instrument approach to runway 27. The crew of VYK were already tracking to that waypoint and they broadcast their intentions to commence the approach via the MIAEC waypoint 'due fuel'. They asked the crew of YIR for their intentions. The reply from the crew of YIR indicated that they were prepared to let VYK conduct the approach first, so the crew of VYK proceeded on that basis. The crew of VYK were also aware of the other aircraft in the vicinity of Mildura Airport.

The approach and landing at Mildura

VH-VYK

The crew of VYK reported that as they approached the airport from the south-west, there was low stratus cloud in the area, and that fog was on the ground to the north of the airport. As they continued towards MIAEC waypoint, they heard the crew of an aircraft conduct a missed approach, which they considered to be an indication that the weather conditions at Mildura were rapidly deteriorating. They configured the aircraft early for the approach and planned to descend, if required, to 200 ft below the published minimum descent altitude of 660 ft.

The crew commenced the approach and they recalled that as they flew the approach, breaks started to appear in the cloud at about 100 ft above the published minimum descent altitude. However, they could not see the runway environment at this time. The crew then continued the descent below the minimum descent altitude.

Civil Aviation Regulation (CAR) 257(4) specifies that if an element of the meteorological minima for landing is less than that determined for the aircraft operation at the aerodrome, the aircraft must not to land at that aerodrome. However, CAR 257(5) specifies that 'if an emergency arises that, in the interests of safety, makes it necessary for an aircraft to land at an aerodrome where the meteorological minima is less than that determined for that aircraft operation at that aerodrome' then CAR 257(4) does not apply. The crew of VYK were in a situation where the aircraft's low fuel status did not permit a diversion to another airport.

The crew reported that they obtained visual reference with the runway between 100 and 150 ft below the published minimum descent altitude and landed the aircraft at 2346. They conducted the normal landing and rollout procedures and the PIC reported that, as the aircraft exited the runway, he noticed that the fuel remaining was 2,100 kg. Following the landing, the crew of VYK broadcast on the CTAF frequency to the crew of YIR that they had become visual at approximately 150 ft above ground level (AGL) and that visibility was around 3,000 m.

The crew taxied the aircraft to the parking area and shut down at 2350. The PIC reported that after shutdown, he looked towards the landing threshold for runway 27 but could not see it. The distance between the reported parking position of VYK and the threshold was approximately 700 m.

VH-YIR

The crew of YIR discussed the information provided by the crew of VYK and the implications for their planned approach. They also discussed the likelihood of the fog dissipating and, as it was approaching 0000 (1000 local time), assessed there was an increased likelihood of the visibility and conditions improving as the temperature increased. They revised their fuel endurance and determined that they had enough fuel to hold for 15 minutes before they had to start an approach. This took the form of a number of orbits between 20 to 30 NM (37 to 56 km) to the east of Mildura, which was well clear of the other aircraft.

As they were holding, the crew of YIR further discussed the approach and determined specific fuel quantities required at specific parts of the approach. The crew also sought updates on the weather conditions at Mildura from the crew of VYK. The crew of YIR decided to conduct the

runway 27 RNAV(GNSS) instrument approach and assess where the aircraft would be in relation to the runway environment during the final approach segment.

The crew reported contacting ATC to advise of the actual weather conditions encountered and their intentions, and to nominate an operations normal time.[16] ATC asked the crew for a revised fuel status and their alternate airport if they were unable to land at Mildura. The crew advised ATC that they would be landing at Mildura due insufficient fuel to divert. When asked by ATC if they wished to declare a fuel emergency, the crew replied that they would be doing so in the next 10 minutes. ATC asked if the crew wished to have a local standby[17] called for their arrival at Mildura. The crew replied that they required a local standby.

The crew assessed their fuel status and sought another update on the weather conditions from the crew of VYK, before deciding to commence the first approach. Prior to commencing the approach, the crew of YIR again contacted the crew of VYK and asked them to provide the QNH[18], a further update of the actual weather conditions and to confirm whether the runway lights were illuminated. The crew of VYK provided the information as requested. The crew of YIR revised their fuel status once more, and reviewed the minimum descent altitude and what actions they would take during the approach.

At about this time, ATC attempted to contact the crew of YIR; however, there was no reply as the crew were concentrating on flying the approach. After a second attempt by ATC, the crew of the DHC-8 responded to ATC and indicated that YIR was conducting the approach and that 'the crew were probably a bit busy'.

At 2355, the crew of YIR commenced their first approach. They configured the aircraft early for the final approach and planned to descend to 300 ft, which is approximately 150 ft AGL. They reported entering the fog layer at about 800 ft. The PIC concentrated on flying the aircraft, while the FO provided support and assessed the aircraft's position visually over the ground. The FO indicated that visibility to the front of the aircraft was minimal, so he decided to look down from the right cockpit side-window to assess the aircraft's position. He recalled sighting the threshold and runway as the PIC called going around. The FO provided support to the PIC and during the go around sighted runway 18/36, which crosses runway 27 about 380 m upwind from the runway 27 threshold.

As the aircraft climbed out, the crew became visual above the fog at approximately 800 ft and conducted a right circuit. They discussed the first approach and assessed that the RNAV(GNSS) approach would locate the aircraft over the physical runway environment. During the climb out the crew of VYK broadcast their assessment of the approach of YIR and indicated that it appeared they were in the correct position along the runway to land and that they had gone around from about 50 ft AGL.

The crew reported that due to the aircraft's low fuel state, they had no other option than to land from the next approach, regardless of conditions. The crew briefed the cabin crew of their plan and advised that an emergency landing announcement would be made over the cabin public address (PA) system during the approach. The cabin crew were also advised to review their emergency procedures and prepare the cabin for what might be a firm touchdown in about 4 minutes' time.

As the crew reconfigured the aircraft for the second approach, they decided to raise the height of their seats to increase the downward visible segment ahead of the aircraft. The PIC also reported noting the wind velocity from the navigation display during the base leg and assessed where the runway was likely to be appear in relation to the cockpit windows during the final part of the approach. The FO decided that he would make the PA broadcast to the cabin to allow the PIC to

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16 A time nominated by either ATS or flight crew by which two-way radio contact will be made, indicating that operations are normal. This procedure allows for the continuation of a search and rescue watch on the aircraft.

17 A local standby is the deployment of emergency services to an airfield to await the arrival of an aircraft.

18 Altimeter barometric pressure subscale setting to provide altimeter indication of height above mean seal level in that area.

concentrate on flying the aircraft. He recalled making the appropriate radio calls and hearing another aircraft holding overhead Mildura at 10,000 ft.

The flight crew commenced the second approach at 0010 and the FO made the emergency landing announcement over the PA as the aircraft descended through 600 ft. The cabin crew immediately called for passengers to assume the brace position and to keep their heads down.

The crew continued the descent below the minimum descent altitude as they were committed to a landing from the approach due to the low fuel status. The FO reported that he acquired visual reference with the ground and saw the same terrain features as he had on the first approach. He assessed the aircraft was over the runway and reported hearing the PIC disconnect the autopilot. The PIC reported that he started to get some visual cues above the runway and disconnected the autopilot before landing the aircraft at 0014. The crew obtained slightly better visual cues as the aircraft rolled out on the runway and conducted the normal after-touchdown and rollout procedures. As the aircraft was turned off the runway, the FO made a PA to the cabin advising that they had landed and that the emergency procedures were no longer applicable.

The crew taxied to the parking area and shut down the aircraft at 0018. The recorded total fuel remaining in the fuel tanks on shut down was 535 kg.

Communications

Both aircraft were operating scheduled regular public transport services and were required to be in contact with ATC at all stages of the flights. Both crews reported being transferred between numerous ATC sectors with no problems with radio communications between the aircraft and ATC.

Recorded ATC communications

A review of the recorded ATC communications for VH-YIR from the time that the crew first contacted Brisbane departures control until ATC advised the crew of the weather conditions at Adelaide revealed that the aircraft was identified on first contact with each sector and transferred between sectors uneventfully. There were no directed transmissions to the flight crew from ATC in relation to the weather at any time before the crew were advised about the weather conditions shortly before their descent point into Adelaide at 2243:40.

A review of the recorded ATC communications for VH-VYK from the time that the crew first contacted Sydney departures control until they were advised of the weather conditions at Adelaide revealed that the aircraft was identified on first contact with each sector and transferred between sectors uneventfully. There were no directed transmissions to the crew from ATC in relation to weather prior to 2216, when the crew asked for a clarification of the weather at Adelaide.

Operational documentation and weather information

Aeronautical Information Publication Australia

The Aeronautical Information Publication Australia (AIP) is published by the Aeronautical Information Services (AIS) section of Airservices Australia (Airservices). The AIP is prepared in accordance with the standards and recommended practices outlined in a number of International Civil Aviation Organization (ICAO) documents. The technical content is obtained via a number of different providers. The opening section of the AIP stated:

> The originating authority of material to be issued as part of the AIP must ensure that it is thoroughly checked and coordinated with other services or organisations before it is submitted to AIS. This ensures that all necessary information has been included and is correct in detail before distribution.

The AIP is primarily an operational document used by flight crews to ascertain certain requirements and understand specific procedures. It is updated regularly in accordance with a specified schedule.

Provision of flight information service

AIP GEN 3.3, Section 2 *FLIGHT INFORMATION SERVICE*, contained information about the provision of a flight information service (FIS), which was 'structured to support the responsibility of pilots to obtain information in-flight on which to base operational decisions relating to the continuation or diversion of a flight.'

During the period prior to the occurrence involving VH-YIR and VH-VYK there were several amendments to the AIP regarding the provision of FIS, including an amendment in June 2007 and another in March 2009, which are discussed below.

AIP of 15 March 2007

The version of the AIP that was current as at 15 March 2007 stated that, in relation to the FIS, pilots were responsible for requesting information necessary to make operational decisions. However, there was also scope for the provision of ATC-initiated FIS.

The AIP also indicated that the FIS comprised three elements:

a. Automatic Broadcast Services;

b. On Request Service; and

c. Hazard Alert Service

The automatic broadcast services consisted of:

- Automatic Terminal Information Service (ATIS),
- Automatic En Route Information Service (AERIS),
- Automatic Weather Information Service (AWIS), and
- Meteorological Information for Aircraft in Flight (VOLMET).

An automatic terminal information service (ATIS) is an automated pre-recorded transmission indicating the prevailing weather conditions at an airport and other relevant operational information for arriving and departing aircraft. An AERIS is a continuous broadcast of routine aerodrome weather reports (METAR[19]) from selected airports around Australia. It operates from specific VHF transmitters and the contents of the broadcast from each transmitter cater for the needs of aircraft operating in control areas within the broadcast range of each transmitter.

[19] Routine aerodrome weather report issued at fixed times, hourly or half-hourly.

An AWIS is a transmission of actual weather conditions, as measured by automatic weather stations (AWS),[20] via either telephone or radio broadcast from selected sites. AWIS is also used to describe the component that provides the information from the AWS. The broadcast is usually continuous with updates available on a minute by minute basis.

VOLMET broadcasts provide meteorological information for Australian major international airports and contain METAR/SPECI or trend forecast (TTF) information and the availability of SIGMET[21]. Broadcasts are of 5 minutes' duration and occur at times 00-05 and 30-35 (commencing on the hour and one-half hour).

The on-request service is provided by FLIGHTWATCH, the generic call sign of the service, which responds to in-flight requests for operational information from pilots operating in all classes of airspace on air traffic control VHF frequencies or high frequencies (HF).

The Hazard Alerting service is provided by ATC and provides pilots with information that is assessed by ATC to be of an unexpected and critical nature, and could assist pilots to avoid hazardous situations. The AIP indicated that a hazard alert would be broadcast on appropriate ATC frequencies during the 60-minute period following the onset of the hazardous conditions or would be directed to those aircraft in continuous communications with ATC within 60 minute's flight time of the hazardous condition.

The AIP defined hazard alerts to include:

a. SIGMET,

b. AIRMET,

c. Observations, pilot reports, or amended forecasts indicating that weather conditions at the destination have unexpectedly deteriorated below the IFR or VFR alternate minima, and

d. Any additional information that could assist the pilot in the avoidance of hazardous situations.

Amendment 51 of 7 June 2007

On 7 June 2007, amendment 51 of the AIP redefined the elements of an FIS by adding an ATC-initiated FIS and removing the Hazard Alert Service. The automatic broadcast services and the on-request service remained as described in the previous version of the AIP.

The AIP stated that ATC-initiated FIS provided pertinent operational information including meteorological conditions and the existence of non-routine meteorological products. It also indicated that the provision of ATC-initiated FIS would be generally limited to aircraft within 60 minutes flight time of the condition or destination at the time of the receipt of the information by ATC. It cautioned that pilots must consider that time period when complying with the requirement to obtain information on which to base their operational decisions.

Hazard alerting was removed from the list of FIS elements and the definitions of what constituted a hazard alert were removed from the AIP. The only section in the AIP that defined hazard alerting procedures stated:

> A sudden (not forecast NOTAMed) change to a component of FIS having an immediate and detrimental effect on the safety of an aircraft will be communicated by ATC using the prefix "Hazard Alert".

Amendment 58 of 12 March 2009

On 12 March 2009, amendment 58 of the AIP changed the pilot responsibility in relation to FIS from 'requesting' the operational information to 'obtaining' the information. The amendment also introduced the following change regarding the availability of aerodrome weather reports (METAR/SPECI):

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[20] These conditions can be determined by BoM or other AWSs.

[21] A weather advisory service issued to warn of potentially hazardous (significant) or extreme meteorological conditions that are dangerous to most aircraft, such as thunderstorms or extreme turbulence.

> When providing FIS, ATC will not alert pilots to the availability of aerodrome weather reports that are available from an automatic broadcast service.

In addition, when there was a sudden change in pertinent operational information that was not described in a current meteorological product or NOTAM and had an immediate and detrimental effect on the safety of an aircraft, ATC would communicate this change to pilots with the prefix 'Hazard Alert'. The AIP did not contain a list of information that would constitute a Hazard Alert, or what constituted non-routine meteorological products.

The information in amendment 58 was current at the time of the occurrence involving VH-YIR and VH-VYK.

Industry education on the changes to AIP in March 2009

The March 2009 changes to the AIP were communicated to the aviation industry by three methods. The first was the change to the AIP itself, which included standard amendment bar marking against each changed, introduced or deleted paragraph or text. The second was the issue of an Aeronautical Information Circular, effective 12 March 2009 that was intended 'to provide education on changes to the delivery of the SPECI and ARFOR elements of the ATC initiated Flight Information Service (FIS)'. The third method was an article in the *Flight Safety Australia* magazine, March-April 2009 edition. This magazine was produced by CASA and distributed to pilots and other aviation personnel. The article stated:

> 'Aviation special weather' - SPECI, which can be obtained from an automatic broadcast service (ABS), no longer needs to be 'directed' or 'broadcast' to aircraft by ATS [air traffic services]. The availability of SPECI from an ABS meets the requirement for in-flight information service. If an ABS is not available, pilots may request weather information from ATS as part of the on-request flight information service.

A further article in the *Flight Safety Australia*, March - April 2012 edition, outlined the provision of ATC-initiated flight information services. That article highlighted the 60-minute flight time restriction on the provision of information. It also indicated that the FIS was for the provision of operational information, which included meteorological products and the existence of non-routine MET products. The article did not contain a definition of non-routine MET products but did contain the following practical example of what ATC-initiated FIS would not include:

> …you will **not** automatically receive **routine** TAF information showing deteriorating weather conditions if you are en route to a location [bolding in original]

The article directed readers to the applicable section of the AIP for more information. In May 2012, Airservices published on its website an information paper for pilots about the provision of inflight information services. That paper indicated that the ATC-initiated FIS service was 'mainly designed to inform you of unexpected or non-routine information'. Other sections of the information paper repeated the information that was contained in the AIP.

Manual of Air Traffic Services

The Manual of Air Traffic Services (MATS) is an Airservices and Department of Defence internal document that contains the procedures regarding the provision of air traffic services in Australia. It is not routinely made available outside these organisations and is not made available to pilots or operators. The content of MATS is intended to be consistent with the content of the AIP so that procedures and practices used by pilots and air traffic controllers are standardised.

Provision of flight information service

During the period prior to the occurrence involving VH-YIR and VH-VYK there were several amendments to the MATS regarding the provision of FIS, including three amendments as discussed below.

MATS of 15 March 2007

The MATS, current as at 15 March 2007, indicated that FIS was to be provided to all aircraft that were being provided with an air traffic control service, or were otherwise known to the relevant ATC unit. It stated that the FIS was to include operational information about meteorological conditions and hazard alerts.

The MATS also contained a section dealing with the provision of a hazard alerts service. It defined a hazard alert as information assessed by ATC to be of an unexpected and critical nature. It stated that controllers were to consult a number of sources of information to assess if a hazard alert was necessary. This included weather forecasts, amended forecasts and observations and reports indicating weather conditions at the destination have deteriorated below the IFR or VFR alternate minima.

The MATS also indicated that responsibility for issuing a hazard alert rested with 'the responsible ATS unit'. Further information in the MATS stated:

> Unless the destination is within a control zone, it is the responsibility of the ATS unit within whose area the destination aerodrome is situated to distribute Hazard Alert information relating to the destination. It is the responsibility of the Tower to identify and coordinate Hazard Alert information relating to destination aerodrome(s) within activated civil or military control zones.

The MATS also stated that:

> Officers may, at times, experience situations not specifically covered whereby the safety of an aircraft may be considered to be in doubt. Nothing in these instructions shall preclude officers from exercising their best judgement and initiative to assist pilots.

Amendment 12 of 7 June 2007

In this amendment the section on the provision of FIS was changed in several areas. In particular, the sections on hazard alerts were amended, with other sections relating to the provision of significant information and a hazard alert service, and the associated responsibilities, being deleted from the manual.

The operational information required to be provided by ATC to pilots was amended to require the provision of information about meteorological conditions and the existence of non-routine meteorological products such as SPECI reports and amended TAFs.

A timing requirement on the provision of this operational information was also introduced so that pilots were alerted 'within one hour of the conditions' with controllers being able to use various means to communicate the information including:

> a. by directed transmissions to those aircraft maintaining continuous communications with ATS at the time the information is identified and that are within one hour's flight time of the conditions;[22]

Information on the provision of hazard alerts was amended to require controllers to:

> Communicate a sudden (not forecast or NOTAMed) change to a component of FIS having an immediate and detrimental effect on the safety of aircraft by using the prefix "Hazard Alert". Use the prefix only until an updated MET product or NOTAM is available for dissemination as per 5.1.1.9.

Section 5.1.1.9 of the MATS indicated that components of the FIS would be notified to relevant aircraft as soon as practicable after receipt by ATC.

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22 The time period for the provision of SIGMETs (messages about en route weather phenomena that are potentially hazardous to aircraft) was increased to 2 hours in MATS version 6 effective on 19 November 2008.

MATS version 1 of 7 September 2007

In September 2007, the MATS was entirely reformatted and the reference to amendments changed to 'versions', with version 1 being effective on 7 September 2007. The section of this version on the provision of FIS to pilots in flight indicated that the controller was to provide FIS to all aircraft that were being provided with an air traffic control service. The definition of FIS remained substantially the same as the 7 June 2007 release of MATS but the section on hazard alerts was reduced to:

> Use the prefix HAZARD ALERT when communicating a sudden change to a component of FIS which has an immediate and detrimental effect on the safety of aircraft.

The amendment further indicated that the use of the prefix 'hazard alert' was only to be used until such time as the updated meteorological product, such as a report or forecast, or NOTAM on which the alert was based, became available to pilots by other means.

In addition, the section relating to the responsibilities of officers 'exercising their best judgement and initiative to assist pilots' was removed from the section relating to the provision of flight information services.

The order of precedence in the provision of FIS by controllers was indicated as:

> Where air traffic service units provide both flight information and air traffic control services, give precedence to the provision of air traffic control over flight information, unless doing so would compromise safety.

The MATS also outlined the responsibility of air traffic service officers in relation to how information was to be communicated to relevant aircraft. It indicated that, if they became aware of information that was outside their area of responsibility, they may have to address the information to a pilot of an aircraft though another ATC unit. Furthermore, controllers were to notify the pilots of aircraft affected by non-routine meteorological products at the time that the products were identified in the form of a directed transmission to the pilots and within 60 minutes' flight time of the conditions notified.

MATS version 7 of 11 March 2009

MATS version 7, effective on 11 March 2009, amended the examples of non-routine meteorological products to 'selected' SPECI reports under the 'Scope of FIS' section. In respect of the provision of SPECI information to pilots, MATS was amended to include the requirement that:

> Do not alert pilots to the availability of a SPECI that can be obtained from an Automatic Broadcast Service.

In addition, an amendment was made so that pilots were responsible for 'obtaining' information necessary to make operational decisions, rather than being responsible for 'requesting' the information, as had been contained within MATS since 2001. That change was to reflect the availability of automatic broadcast services and amendments to ATC directed FIS.

MATS version 23 was current at the time of occurrence involving VH-YIR and VH-VYK. The section relating to the provision of FIS was substantially the same as version 7 of the MATS.

International procedures regarding the provision of flight information services

ICAO Document 7030, *Regional Supplementary Procedures*, Fifth Edition 2008, outlines the procedural parts of the air navigation plans that have been developed to meet the needs of specific regions that are not covered in the worldwide provisions. The document describes specific flight information regions in which the procedures are to apply, each having a section that is further divided into chapters dealing with specific topics.

The Brisbane and Melbourne flight information regions are listed in the section *Middle East/Asia (MID/ASIA) Regional Supplementary Procedures*. Chapter 6 – Air Traffic Services, states:

> Amended aerodrome forecasts shall be passed to aircraft within 60 minutes from the aerodrome of destination, unless the information has been made available through other means.

Reason for the change to AIP and MATS in March 2009

Prior to the changes to AIP and MATS in March 2009, ATC notified pilots receiving an air traffic control service about all SPECI reports and amendments to forecasts. However, an increase in the number of SPECI reports due to an increase in the number of AWS being commissioned, and the introduction of required change parameters being programmed into the software of the AWS led to a large increase in the number of SPECI reports being received by controllers. This reportedly increased controller workload and Airservices reviewed their position on the provision of in-flight information to flight crews. At the same time, Airservices were also conducting a review of the provision of hazard alerting services to aircraft. The result of these reviews was reflected in changes to the AIP and to MATS in March 2009.

The reviews, and subsequent procedural amendments, resulted in a number of changes in the way in which SPECI reports were handled by the air traffic control system and the way in which this information was relayed to pilots in flight. In particular, if a SPECI report was available from the AERIS or VOLMET, or if the weather conditions were available on an AWIS, then it would not be made available to the pilot by ATC. The pilot would be responsible for seeking this information from the automatic broadcast service.

The changes also resulted in any SPECI report that was available from an automatic broadcast service not being sent automatically to a controller's workstation. The controller could request specific SPECI reports available from an automatic broadcast service if required; however, only those SPECI reports that covered airports without an automatic broadcast service would be automatically sent to the controller's workstation.

The changes were specifically introduced to reduce controller workload. In addition, changes regarding the 60-minute time period in which amended aerodrome forecast information would be broadcast to aircraft that are being provided with an air traffic control service, aligned the MATS to the ICAO *Regional Supplementary Procedures*.

Bureau of Meteorology

The Bureau of Meteorology (BoM) is the designated meteorological authority in Australia for the provision of a meteorological service for international air navigation in accordance with ICAO Annex 3 – *Meteorological Service for International Air Navigation.* The objective of the meteorological service is to contribute towards the safety, regularity and efficiency of air navigation. To achieve that objective, the BoM produced and supplied relevant operational meteorological information to operators, flight crew, air traffic services units, search and rescue services, airport management and others concerned with the conduct of air navigation. In accordance with the core standards and recommended practices outlined in Annex 3, the BoM had implemented a quality management system that is certified in accordance with the standards contained in AS/NZ ISO 9001:2008.

International standards and practices

The ICAO Document 8896*, Manual of Aeronautical Meteorological Practice*, Ninth Edition 2011, is intended as a guide for use by pilots and other aviation personnel on meteorological procedures, codes, symbols and abbreviations. The manual contained the procedures and requirements to ensure that aerodrome forecasts (TAF)[23], along with other aviation meteorological products, were

[23] Aerodrome Forecasts (TAF) are 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. A TAF is used by the flight crew to determine the need to plan for an alternate aerodrome, based on weather conditions forecast.

kept under continuous review. This included the following requirements in relation to issuing an amended TAF:

> An amended TAF is identified as "TAF AMD" in place of "TAF"; it covers the whole of the remaining period of the original forecast. A TAF is amended as a result of changes to the forecast or current meteorological conditions leading to the original TAF no longer accurately reflecting the expected meteorological situation.

ICAO Annex 3, Chapter 6.3, required that landing forecasts to be prepared by the meteorological service and stated that they had to be in the form of a trend forecast, appended to a METAR or SPECI. The trend forecast consisted of a concise statement of the expected significant changes in the meteorological conditions at that airport for a period of 2 hours from the time of the report to which the trend was appended. In Australia, a landing forecast is referred to as a trend forecast (TTF) which is valid for 3 hours from the time of the aerodrome weather report to which the TTF is appended. The TTF supersedes the current TAF for the validity period of the TTF. Use of the term PROB is not permitted in TTFs but is, when appropriate, contained in TAFs.

Fog forecasting and the 'code grey' forecast

The ICAO *Manual of Aeronautical Meteorological Practice* does not permit the inclusion in a TAF of a probability of less than 30 per cent that a weather phenomenon, such as fog, may occur during the forecast period. In order to provide some airline operators of an advance notice about such low probability of weather conditions that may interrupt flight operations, the BoM issues an aerodrome weather briefing (AWB) product and a 'code grey' forecast. These products are unique to Australia, and highlight the possibility of weather conditions that the airline operators may wish to consider in terms of flight planning. There is no regulatory requirement to carry alternate aerodrome fuel if a 'code grey' forecast has been issued.

The BoM *Aeronautical Services Handbook*, dated 30 May 2013, was a manual used by BoM staff that specified policy and standards, and described the practices and procedures to be followed in providing meteorological services to the aviation industry. The handbook stated that when a TAF is issued that is valid for the period 1800 to 2400, any current 'code grey' forecast is superseded by the TAF.

Fog forecasting and reporting at Adelaide

At 1726 on 16 June the BoM indicated in an airport weather briefing (AWB) [24] that there was a slight chance (10 per cent) of fog developing on Tuesday morning between 1800 and 2300 at Adelaide Airport. Table 1 provides a chronology of the changes to the aviation meteorological observations and forecasts for Adelaide Airport on 17 June during the 15-hour period prior to the departure of VH-YIR and VH-VYK and while both aircraft were en route to Adelaide.

Table 1: Meteorological observations and forecasts for Adelaide

Time (UTC)	Information available
0533	An update to the AWB indicated that if the winds remained from the south-west overnight and the cloud cleared, there would still be a slight chance of fog developing during the following morning at Adelaide. To indicate this low chance of fog, the BoM issued a 'code grey' forecast with a probability of 5% of fog reducing visibility to 500 m between 1600 and 2400.
1127	The AWB was reissued and increased the probability of fog and associated reduction in visibility in the 'code grey' forecast from 5% to 20%.
1712	The AWB was reissued and included the 1703 TAF for Adelaide. This TAF was valid from 1800 and was used in the development of the flight plans for VH-YIR and VH-VYK. Fog was not forecast in that TAF, however in the section of the AWB titled 'other

[24] The airport weather briefing is available via the National Aeronautical Information Processing Service (NAIPS).

Time (UTC)	Information available
	possibilities' the BoM commented: > There remains a slight chance of fog this morning (as per the 20% Code Grey issued last night), but most likely that we will just get more shallow fog patches (MIFG).
About 2030	The BoM received notice that fog was affecting visibility at Parafield Airport and Edinburgh Airport (Royal Australian Air Force Base Edinburgh) to the north of Adelaide. The decision was made to amend the TAF for Adelaide to include a 30% probability of fog reducing visibility to 500 m between 2100 and 2400. That amendment resulted in a new TAF for Adelaide being issued at 2100, which was outside the normal 6-hour issue period and was appropriately annotated with the 'AMD' (amend) notification. The amended forecast was disseminated to users via the Aeronautical Fixed Telecommunications Network. Fog was not initially contained on the trend forecasts (TTF) for Adelaide that were issued from 2030 onwards. The BoM indicated that the surface winds were reported as being from the east to north-east at between 4 kt and 6 kt and that this wind velocity did not support the development of advection fog at Adelaide Airport. This did not appear to be consistent with other information that indicated the nocturnal surface airflow over the Adelaide area during the winter months is predominantly from the north-east and is associated with the rapid onset of low cloud, drizzle and fog.[25] As the TTF product is not permitted to include probabilities, the TTFs for Adelaide did not include any probability of fog while the TAF for Adelaide covering the same period, as mentioned above, did contain a 30% probability of fog occurring.
2111	A SPECI report was issued, which indicated that one or more elements met specified criteria and there was an impact on aviation operations. These related to the presence of shallow fog patches (code MIFG) and the associated reduction in visibility within the reporting area. The SPECI had a TTF appended that indicated that no significant changes (NOSIG) were expected during the 3-hour forecast period.
2200	Another SPECI was issued, which indicated that visibility was now reduced to 1,000 m to the north-west and contained the previously reported shallow fog patches. The report also contained the code PRFG which indicated that the airport was partially covered by fog[26]. The appended TTF removed the earlier NOSIG code and indicated that from 2200 the wind was expected to be from 010° at 5 kt and that the visibility would reduce to 500 m in fog. It also indicated that from 2300 the weather would improve to visibility greater than 10 km and FEW clouds at a base of 2,500 ft.
2205	A SPECI was issued that indicated visibility had decreased to 500 m to the north due to fog and 2,000 m overall. The appended TTF was the same as the 2200 TTF above.
2215	A further SPECI issued that indicated visibility had reduced to 250 m to the north and 500 m overall. The appended TTF remained the same as the 2200 TTF.
2230	A SPECI was issued that indicated visibility was now 150 m. This visibility was repeated in the subsequent 30-minute reports between 2300 and 0030. The

[25] Tepper, G. & Watson, A., 1990, 'The wintertime nocturnal northeasterly wind of Adelaide, South Australia: an example of topographic blocking in a stably-stratified air mass', *Australian Meteorology Magazine*, no. 38, pp. 281-291.

[26] The World Meteorological Organizational Document No. 782 *Aerodrome Reports and Forecasts – A User's Handbook to the Codes*, provided a more precise definition of PRFG which stated that the code indicated 'a **substantial part** of the aerodrome is covered by fog, while the remainder is clear [emphasis added]'.

Time (UTC)	Information available
	appended TTF continued to indicate that from 2300 the visibility would improve to greater than 10 km. The 2300 'from' time was amended to 2330 at the issue of the 2300 TTF and it was then progressively amended to 0215 in subsequent TTFs.

Fog forecasting and reporting at Mildura

Table 2 provides a chronology of the changes to the aviation meteorological observations and forecasts for Mildura Airport during the 10-hour period prior to the departure of VH-YIR and VH-VYK, while both aircraft were en route to Adelaide, during their diversions to Mildura and then while operating in the Mildura area.

Table 2: Meteorological observations and forecasts for Mildura

Time (UTC)	Information available
1024	A TAF was issued that was valid between 1200 and 2400 and indicated a 30% probability of fog at Mildura between 1900 and 2400.
1558	An amended TAF was issued, valid from 1800, which indicated that the fog was no longer forecast but that temporary (TEMPO)[27] periods of cloud with a base of 600 ft were forecast between 1900 and 2400.
About 2230	The staff at BoM were preparing a TAF that was to be valid from 0000. The available information indicated that there were significant amounts of stratocumulus cloud in the area with the surface wind trending to a southerly flow. The BoM reported that the forecasting models and local climatology information indicated that fog at Mildura was rare in a southerly flow, so the decision was made to leave the TEMPO for low cloud in place in the developing TAF until 2400 and then forecast good conditions.
2302	A TAF was issued, valid from 0000, that had no operational requirements due to low cloud or visibility. Additional information from satellite imagery became available and indicated that there was a bank of low cloud near Mildura. The current forecast was considered to still be appropriate but an amendment to the TAF could be needed if the cloud persisted for a long period. The BoM staff were then diverted to the preparation of a SIGMET for icing conditions, which had a higher work priority and to the preparation of other forecast products.
2327	The visibility data from the Mildura automated weather station (AWS) recorded a reduction in visibility from approximately 12 km, to less than 1,500 m in a 1-minute period.
2341	The staff at BoM were contacted by Melbourne ATC and questioned about the conditions at Mildura as they had an aircraft en route to that airport. The staff explained the current conditions, and indicated that after assessing the latest observations, the TAF would be amended if necessary. The meteorological observer at Mildura indicated to the BoM staff that fog had advected into the area from the south and that there was a rapid deterioration in visibility. The available data indicated that this fog was likely to be short-lived over a period of 1-2 hours. This resulted in an amendment to the TAF that forecast a visibility of 3,000 m in mist and a 30% probability of fog with low cloud for 2 hours from 0000.
2347	AWS data indicated that the visibility had reduced to 800 m. The BoM staff continued with the preparation of the icing SIGMET and other forecast products in

[27] A temporary deterioration in the forecast weather conditions, during which significant variation in prevailing conditions are expected to last for periods of between 30 and 60 minutes.

Time (UTC)	Information available
	accordance with their stipulated priorities.
2352	An amended TAF was issued, valid from 0000, which forecast a visibility of 3,000 m in mist, a 30% probability of fog from 0000 to 0200, visibility of 500 m in fog, and broken cloud at 200 ft.

Airservices Australia weather reporting

Air traffic controllers are approved weather observers for creating an automatic terminal information service (ATIS) broadcast for use by arriving and departing aircraft. The 2107 ATIS for Adelaide recorded the wind from 050° at 5 kt, with a visibility of greater than 10 km. The 2130 ATIS indicated the same wind direction and speed but that the visibility had reduced to 4,000 m to the north in fog.[28]

A further reduction in visibility was recorded at 2156, when the amended ATIS reported a visibility of 1,500 m in fog. There was no specific direction specified in that broadcast, indicating that the observation was considered to cover all of the airport and reporting area.

Another ATIS was recorded at 2158. The only changes to the previous ATIS were that flight crews could now expect an instrument approach to runway 23, and that the high-intensity approach lighting was turned on.

At 2155, due to the reduced visibility, Adelaide tower controllers introduced low visibility operations[29] at the airport. An amended ATIS was recorded at 2204, to report a visibility of 700 m in fog. This visibility was less than the 800 m minimum visibility required to conduct an instrument landing system approach to runway 23. The visibility reduced further at 2230, with the ATIS reporting visibility as being 500 m in fog. Visibility of 500 m in fog remained on the ATIS broadcasts until 0042, when the visibility increased to 800 m.

Awareness of the amended aerodrome forecast for Adelaide

The operator of VH-YIR

The operator of YIR had a flight watch service that operated from facilities within its organisational base at Brisbane. The staff included a dispatch manager, a flight watch dispatcher and a contracted meteorological briefing officer.

These staff members reported that they were aware of an amended 2100 TAF for Adelaide that contained a 30 per cent probability of fog with the potential to affect the arrival of YIR. The staff compared the TAF to the then available weather report and TTF. As the weather report indicated that the visibility was greater than 10 km and there were FEW clouds at 2,200 ft, and the appended TTF indicated no significant change from that observation, the staff decided that there was no need to forward the amended TAF to the crew of YIR.

The preferred methods of contacting aircraft in flight were listed as ACARS, followed by SATCOM[30], then high frequency (HF) radio. YIR was equipped with ACARS, SATCOM and HF radio. At the time of the occurrence, approximately half of the operator's fleet of B737 aircraft were equipped with ACARS and its use in operations had only recently been formally introduced.

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[28] Fog is associated with a horizontal ground-level visibility of less than 1,000 m. For the reported visibility in the 2130 ATIS, the correct aviation meteorological term was 'mist'.

[29] Low visibility operations only allow one aircraft to be taxiing on the movement area at any time. As there is no ground surveillance radar at Adelaide, to ensure aircraft and occupant safety, the aircraft's position is monitored by air traffic controllers using procedural separation based on the flight crew reporting at specific locations, such as holding points or parking bays.

[30] Satellite communications system that enables voice telegraphy between an aircraft crew and a ground station.

The staff reported that they considered their workload during the morning of the occurrence to be high as they were involved in handling a number of aircraft diversions resulting from the weather conditions in south-east Australia that day.

The operator's flight watch staff became aware of the SPECI reports for Adelaide at about 2220, but their assessment of these reports was that there was no need to forward them to the crew, as the aircraft would be approaching the descent point for Adelaide and there was a company procedure to not distract the crew once they had started descent. The staff indicated that the TTF appended to the 2200 SPECI also included the FM 2300 code, indicating that the conditions would clear from that time and, as the aircraft was planned to land at Adelaide after 2300, the information did not affect the flight. They also reported that the crew would be within range of the VHF services at Adelaide and would have already obtained the necessary information. The descent point time of YIR was 2249.

The operator of VH-VYK

The operator of VYK also maintained a flight watch service for its aircraft, from facilities within its operational base at Sydney. The staff included a dispatch manager, a flight watch dispatcher and a staff meteorological briefing officer.

The staff reported that they were aware of the issuing of the amended 2100 TAF for Adelaide and, as the aircraft was within the operator's 'sterile flight deck' period during the departure, they intended transmitting the information to the crew of VYK once that period had ended. The information was transmitted to the crew at 2148. The staff reported that they waited to support any decision of the crew of VYK in relation to a possible diversion. Following transmission of the amended TAF by the flight watch staff, the crew obtained current weather reports for various airports via ACARS to determine their suitability as alternates.

The flight watch staff did not consider the workload on the day to be excessive, as they had planned on the weather conditions and had not dispatched aircraft to airports in the south-east of Australia that were affected by adverse weather.

Airservices controllers and line managers

Airservices staff in the Melbourne air traffic control centre reported that they were aware of the amended 2100 TAF for Adelaide. The staff reported that following the issue the amended TAF there was no need to advise regular public transport aircraft as they assumed that airline flight watch personnel would advise the crews about the amendment.

The Airservices staff also reported being aware of the series of SPECI reports being issued for Adelaide. However, the staff considered that as these were available via an automated broadcast service, such as AERIS, AWIS and VOLMET, they considered that there was no need for the controllers to broadcast these reports to aircraft crews, and the MATS did not require them to do so.

Airservices National Operations Centre

Staff in the Airservices National Operations Centre reported that they were aware of the amended 2100 TAF for Adelaide and that it contained an operational requirement due to fog. They assessed the operational requirement as being significant and indicated that they contacted all the applicable airlines to ensure they were aware of the amended TAF.

Continuing investigation

The investigation is continuing and will:

- examine the accuracy of aviation meteorological products in Australia
- examine the procedures used to provide information to flight crews from air traffic services and management of changes to those procedures
- examine the provision by the operators of information to the respective flight crews
- examine the relevant recorded data
- review the distribution, dissemination and sharing of operational information to the aviation industry as stipulated by the Civil Aviation Safety Authority, and enacted by Airservices Australia and the Bureau of Meteorology.

The final report is anticipated for release to the public by June 2014. Should any significant safety issues emerge during the intervening period, the ATSB will immediately bring those issues to the attention of the relevant authorities or organisations and publish them as required.

Safety Action

As a result of its developing understanding of the occurrence, the Australian Transport Safety Bureau (ATSB) has commenced the following safety action.

Safety forum regarding the provision of operational information

The ATSB is planning to convene a safety forum in respect of the provision of operational information to the flight crews in this occurrence, and more generally. This forum is planned to include representatives from the Civil Aviation Safety Authority (CASA), Airservices Australia (Airservices), the Bureau of Meteorology (BoM), the operators of VH-YIR and VH-VYK, and other relevant parties.

The aim of the safety forum is to:

- apprise the participants of the circumstances of this occurrence as understood to date
- identify and analyse any gaps in understanding of the responsibilities and processes for the dissemination of operational information to flight crew, when on the ground and in flight
- discuss/examine options for improving the reliability of the dissemination of operational information to flight crew.

It is anticipated that this forum will take place early in calendar year 2014. The results of the forum will be included in the ATSB's ongoing scoping of its investigation and, where relevant, included in the final investigation report.

Reliability of aviation weather forecasts

As a result of this and other occurrences involving observed but not forecast weather, the ATSB has commenced research investigation AR-2013-200 *Reliability of aviation weather forecasts*. This investigation will analyse BoM data across Australian airports, with a focus on those supporting regular public transport operations, and is subject to the availability of long-term data holdings of aviation forecasts and observations.

Analyses will be performed across time, comparing forecast and observed conditions as they affected aircraft arrivals at particular airports. The focus of this examination is limited to observed conditions below specified aviation minima, or other conditions that may result in aircraft exceeding safe limits of operation.

This research investigation is expected to be completed by mid-2014. When complete, the investigation report will be available on the ATSB's website at www.atsb.gov.au.

General details

Occurrence details

Date and time:	18 June 2013 – 1014 EST	
Occurrence category:	Serious incident	
Primary occurrence type:	Weather related operational event	
Location:	Mildura Airport, Victoria	
	Latitude: S 34° 51.08'	Longitude: E 139° 26.12'

Aircraft details

Manufacturer and model:	Boeing Company B737-8FE	
Registration:	VH-YIR	
Operator:	Virgin Australia Airlines Pty Ltd	
Serial number:	39925	
Type of operation:	High Capacity Scheduled Regular Public Transport	
Persons on board:	Crew – 6	Passengers – 85
Injuries:	Crew – 0	Passengers - 0
Damage:	None	

Manufacturer and model:	Boeing Company B737-838	
Registration:	VH-VYK	
Operator:	Qantas Airways Limited	
Serial number:	34183	
Type of operation:	High Capacity Scheduled Regular Public Transport	
Persons on board:	Crew – 6	Passengers – 146
Injuries:	Crew – 0	Passengers – 0
Damage:	None	

Appendix A

Weather forecasts and reports

The weather-related events and published weather forecasts and reports tabulated below do not indicate whether the applicable weather information was passed to the aircraft. More particularly, they indicate specific times when weather information was issued by the Bureau of Meteorology or Airservices Australia.

A diagram is provided to show the approximate position of each aircraft in relation to the departure airports of Brisbane and Sydney, and destination airports of Adelaide and then Mildura at appropriate times. All times are in coordinated Universal Time (UTC). Local time at Brisbane, Sydney and Mildura was UTC + 10 hours and at Adelaide UTC + 9:30 hours.

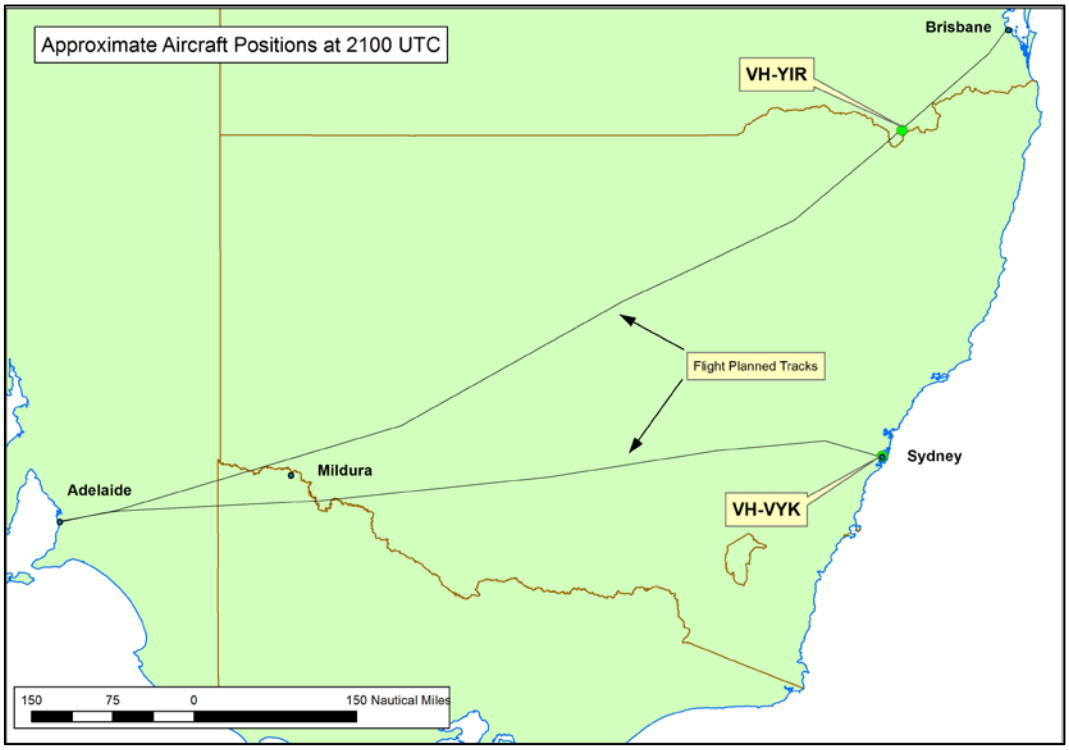
Time: 1925 – YIR crew at flight briefing	
Adelaide TAF	TAF YPAD 171703Z 1718/1824 VRB05KT 9999 FEW030 SCT045 FM181000 VRB05KT CAVOK RMK T 06 06 11 14 Q 1018 1018 1020 1020
Adelaide METAR	METAR YPAD 171900Z 07004KT 9999 FEW022 05/04 Q1018 RMK RF00.0/000.0 TTF: NOSIG
Mildura TAF	TAF AMD YMIA 171758Z 1718/1812 24005KT 9999 SCT030 BKN060 BECMG 1718/1720 21006KT 9999 SCT006 SCT030 BECMG 1800/1802 18010KT 9999 SCT030 SCT050 BECMG 1807/1809 16008KT 9999 SCT040 TEMPO 1719/1724 BKN006 RMK T 06 05 07 13 Q 1016 1018 1020 1019
Mildura METAR	METAR YMIA 171900Z AUTO 29005KT 9999 SCT048 06/05 Q1017 RMK RF00.0/000.0

Time: 2000 – VYK crew at flight briefing	
Adelaide TAF	TAF YPAD 171703Z 1718/1824 VRB05KT 9999 FEW030 SCT045 FM181000 VRB05KT CAVOK RMK T 06 06 11 14 Q 1018 1018 1020 1020
Adelaide METAR	METAR YPAD 172000Z 06004KT 9999 FEW022 05/04 Q1019 RMK RF00.0/000.0 TTF: NOSIG
Mildura TAF	TAF AMD YMIA 171758Z 1718/1812 24005KT 9999 SCT030 BKN060 BECMG 1718/1720 21006KT 9999 SCT006 SCT030 BECMG 1800/1802 18010KT 9999 SCT030 SCT050 BECMG 1807/1809 16008KT 9999 SCT040 TEMPO 1719/1724 BKN006 RMK T 06 05 07 13 Q 1016 1018 1020 1019
Mildura METAR	METAR YMIA 172000Z 26003KT 9999 FEW042 06/05 Q1017 RMK RF00.0/000.2

Time: 2038 – YIR departs Brisbane	
Adelaide TAF	No change from previous
Adelaide METAR	METAR YPAD 172030Z 08005KT 9999 FEW022 05/05 Q1019 RMK RF00.0/000.0 TTF: NOSIG
Mildura TAF	No change from previous
Mildura METAR	METAR YMIA 172030Z 27003KT 9999 FEW038 05/05 Q1017 RMK RF00.0/000.2

Time: 2100 – YIR approaching top of climb, VYK at gate loading last passengers at Sydney (Figure A1)	
Adelaide TAF	TAF AMD YPAD 172100Z 1721/1824 05005KT 9999 FEW025 FM180000 VRB05KT 9999 FEW030 SCT045 FM181000 VRB05KT CAVOK PROB30 1721/1724 0500 FG RMK T 05 10 14 15 Q 1019 1020 1020 1020
Adelaide METAR	METAR YPAD 172100Z 05004KT 9999 FEW022 05/05 Q1019 RMK RF00.0/000.0 TTF: NOSIG
Mildura TAF	No change from previous
Mildura METAR	METAR YMIA 172100Z 28005KT 9999 FEW042 05/05 Q1018 RMK RF00.0/000.2

Figure A1: Approximate aircraft positions at 2100



Time: 2107 – YIR in cruise, VYK preparing to pushback from Sydney

Adelaide ATIS	ATIS YPAD S 172107 RWY: 23 WND: 050/5, MAX DW 5 KTS. VIS: GREATER THAN 10 KM CLD: FEW022 TMP: 5. QNH: 1020

Time: 2111 – YIR in cruise, VYK on taxi at Sydney

Adelaide SPECI	SPECI YPAD 172111Z 06005KT 9999 MIFG FEW022 SCT058 05/05 Q1020 RMK RF00.0/000.0 TTF: NOSIG

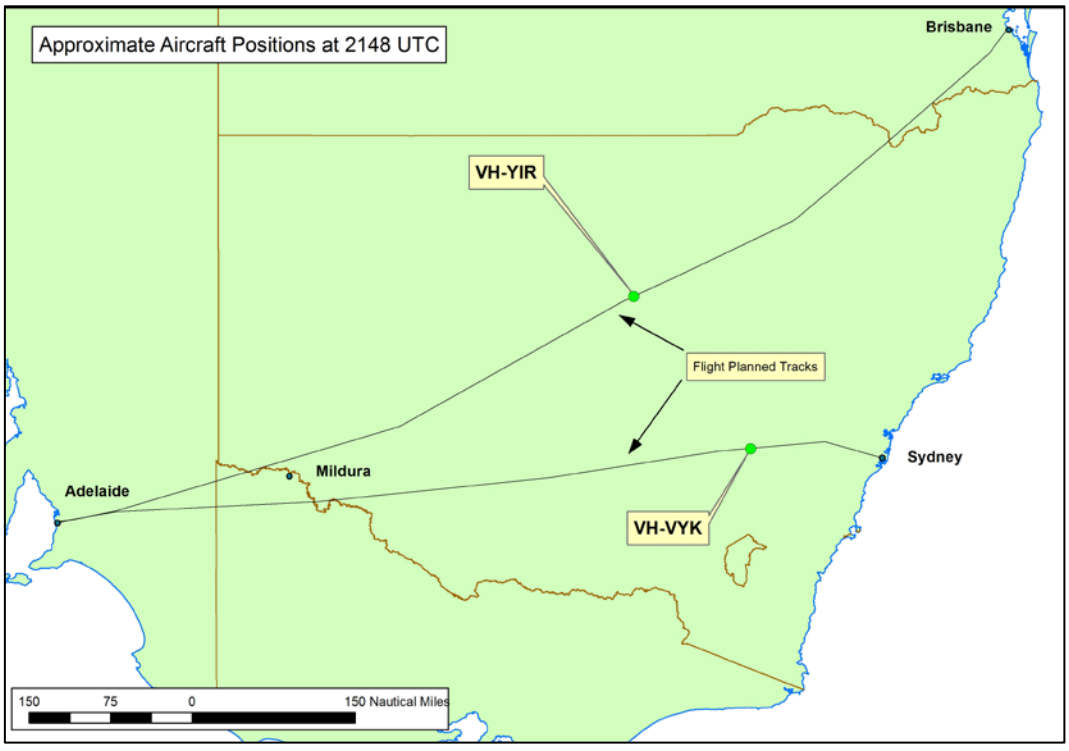
Time: 2130 – YIR in cruise, VYK on initial climb from Sydney

Adelaide SPECI	SPECI YPAD 172130Z 06004KT 9999 MIFG FEW022 05/04 Q1020 RMK RF00.0/000.0 TTF: NOSIG
Adelaide ATIS	ATIS YPAD T 172130 RWY: 23 WND: 050/5, MAX DW 5 KTS. VIS: GREATER THAN 10 KM, REDUCED TO 4000 M TO THE NORTH IN FOG. CLD: FEW020 TMP: 5. QNH: 1020
Mildura METAR	METAR YMIA 172130Z 27004KT 9999 FEW040 05/05 Q1018 RMK RF00.0/000.2

Time: 2148 – YIR in cruise, VYK in cruise (Figure A2)

Amended TAF for Adelaide issued at 2100 passed to the crew of VYK via ACARS.

Figure A2: Approximate aircraft positions at 2148



Time: 2156 – YIR in cruise, VYK in cruise

Adelaide ATIS	ATIS YPAD U 172156 RWY: 23 WND: 360/5, MAX DW 5 KTS. VIS: GREATER THAN 10 KM, REDUCED TO 1500 M IN FOG. CLD: FEW015 TMP: 5. QNH: 1020

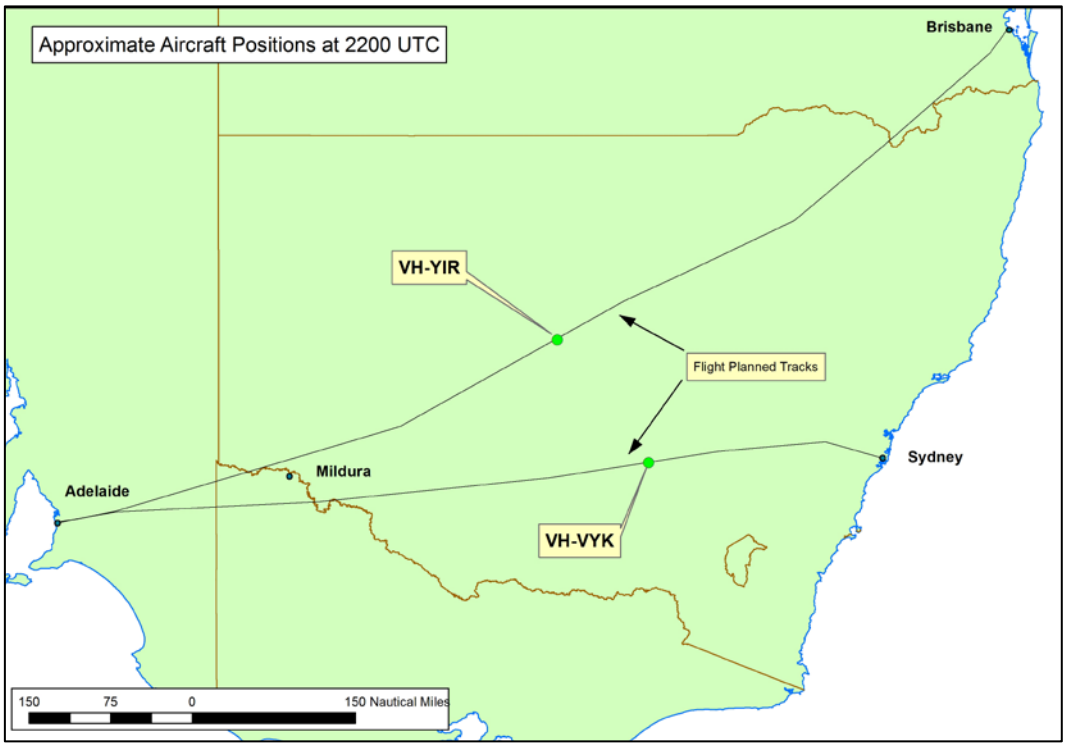
Time: 2158 – YIR in cruise, VYK in cruise

Adelaide ATIS	APCH: EXP INST APCH RWY: 23 OPR INFO: HIAL ON WND: 360/5, MAX DW 5 KTS. VIS: GREATER THAN 10 KM, REDUCED TO 1500 M IN FOG. CLD: FEW015 TMP: 5. QNH: 1020

Time: 2200 – YIR in cruise, VYK in cruise (Figure A3)

Adelaide SPECI	SPECI YPAD 172200Z 01006KT 1000NW 9999 PRFG MIFG FEW022 05/05 Q1020 RMK RF00.0/000.0 TTF: FM2200 01005KT 0500 FG FM2300 05005KT 9999 FEW025
Mildura METAR	METAR YMIA 172200Z 28005KT 9999 SCT034 05/04 Q1019 RMK RF00.0/000.2

Figure A3: Approximate aircraft positions at 2200



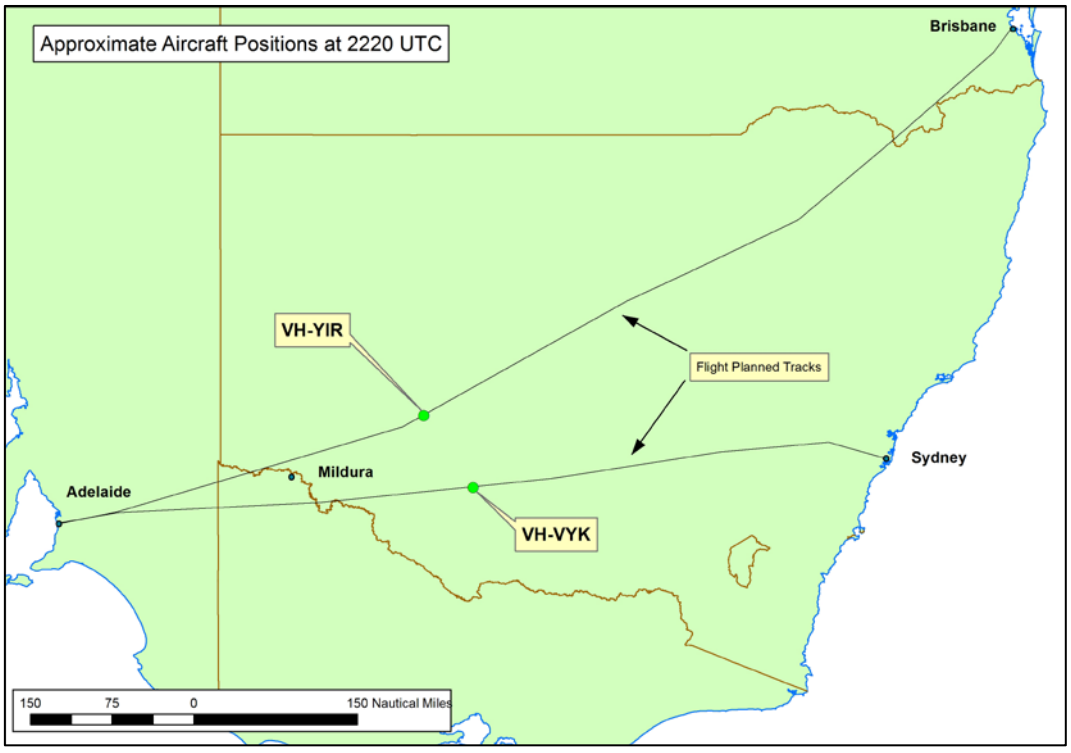
Time: 2204 – YIR in cruise, VYK in cruise	
Adelaide ATIS	ATIS YPAD W 172204 APCH EXP INST APCH RWY 23 OPR INFO HIAL ON. LOW VIS PROCS WND 360/5, MAX DW 5 KTS. VIS 700M IN FOG CLD FEW015 TMP 5. QNH 1020

Time: 2205 – YIR in cruise, VYK in cruise	
Adelaide SPECI	SPECI YPAD 172205Z 01006KT 0500N 2000 FG FEW022 04/04 Q1020 RMK RF00.0/000.0 TTF: FM2205 01005KT 0500 FG FM2300 05005KT 9999 FEW025
Mildura METAR	No change from previous

Time: 2215 – YIR in cruise, VYK approaching diversion point	
Adelaide SPECI	SPECI YPAD 172215Z 02006KT 0250N 0500 FG BKN001 04/04 Q1020 RMK RF00.0/000.0 TTF: FM2300 05005KT 9999 FEW025
Mildura METAR	No change from previous

The aircraft's position at 2220 is shown in Figure A4.

Figure A4: Approximate aircraft positions at 2220



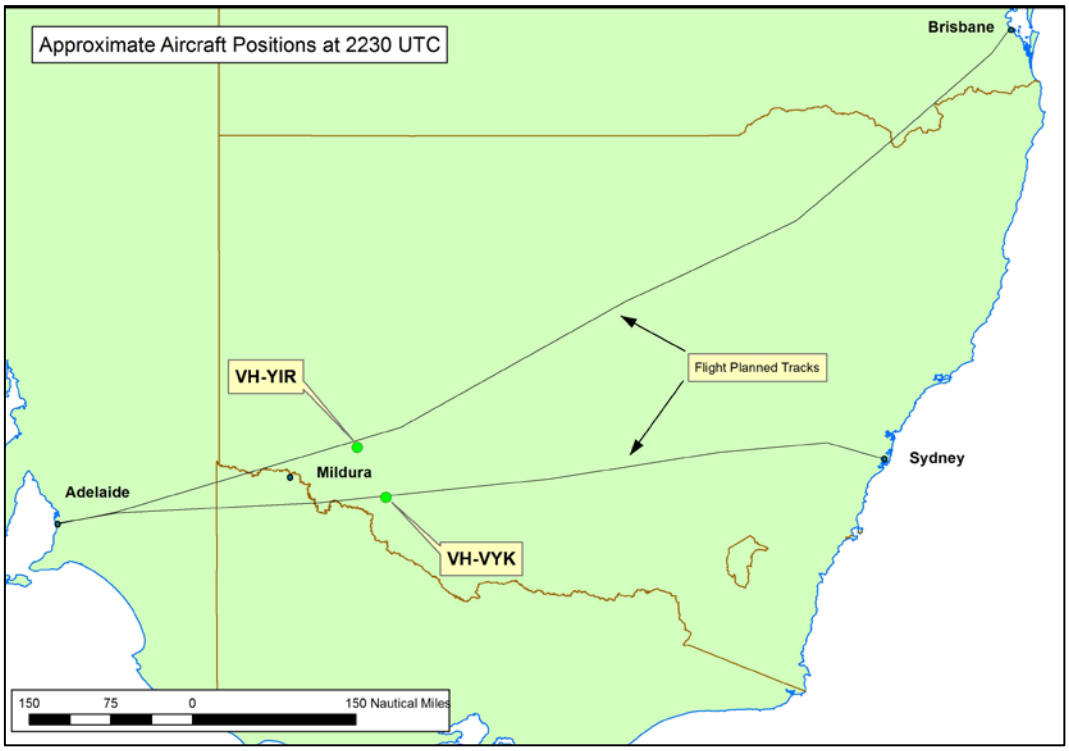
Time: 2230 – YIR in cruise, VYK in cruise

Adelaide SPECI	SPECI YPAD 172230Z 04005KT 0150 FG BKN001 06/05 Q1020 RMK RF00.0/000.0 TTF: FM2300 05005KT 9999 FEW025
Mildura METAR	METAR YMIA 172230Z 27004KT 9999 BKN034 06/05 Q1019 RMK RF00.0/000.2

Time: 2230 – YIR in cruise, VYK in cruise (Figure A5)

Adelaide ATIS	ATIS YPAD X 172230 APCH EXP INST APCH RWY 23 OPR INFO HIAL ON. LOW VIS PROCS WND 360/5, MAX DW 5 KTS. VIS 500M IN FOG CLD FEW015 TMP 6. QNH 1020

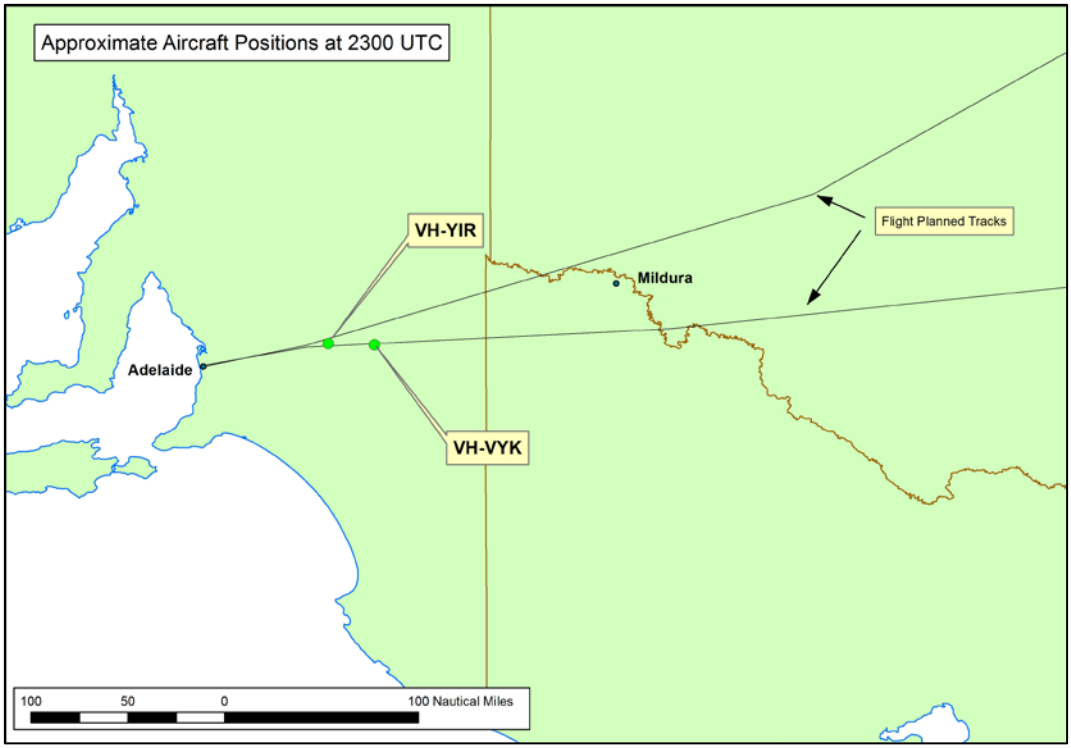
Figure A5: Approximate aircraft positions at 2230



Time: 2300 – YIR on descent to Adelaide, VYK on descent to Adelaide (Figure A6)

Adelaide SPECI	SPECI YPAD 172300Z 04006KT 0150 FG BKN000 06/06 Q1021 RMK RF00.0/000.0 TTF: FM2330 05005KT 9999 FEW025
Mildura METAR	METAR YMIA 172300Z 23004KT 9999 BKN039 07/06 Q1019 RMK RF00.0/000.2

Figure A6: Approximate aircraft positions at 2300



Time: 2302 – YIR on descent, VYK on descent	
Adelaide TAF	TAF YPAD 172302Z 1800/1906 VRB05KT 9999 FEW030 SCT045 FM181000 VRB05KT CAVOK FM190000 04008KT CAVOK RMK T 11 14 15 11 Q 1020 1020 1020 1021
Mildura TAF	TAF YMIA 172302Z 1800/1812 20008KT 9999 SCT030 SCT050 RMK T 08 12 13 10 Q 1020 1019 1019 1020

Time: 2311 – YIR diverting to Mildura, VYK holding to east of Adelaide	
Adelaide ATIS	ATIS YPAD Y 172311 APCH: EXP INST APCH RWY: 23 OPR INFO: HIAL ON. LOW VIS PROCS WND: 360/5, MAX DW 5 KTS. VIS: 500M IN FOG CLD: FEW015 TMP: 7. QNH: 1021

Time: 2318 – YIR en route to Mildura, VYK en route to Mildura	
Mildura SPECI	SPECI YMIA 172318Z 22004KT 9999 BKN002 SCT041 08/06 Q1019 RMK RF00.0/000.0

Time: 2328 – YIR on descent to Mildura, VYK on descent to Mildura

Mildura SPECI	SPECI YMIA 172328Z 21006KT 5000 BR BKN002 07/07 Q1019 RMK RF00.0/000.0

Time: 2330 – YIR approaching Mildura, VYK approaching Mildura

Adelaide SPECI	SPECI YPAD 172330Z 04005KT 0150 FG BKN000 07/07 Q1021 RMK RF00.0/000.0 TTF: FM2400 05005KT 9999 FEW025
Mildura SPECI	SPECI YMIA 172330Z 21006KT 3300 BR BKN002 07/07 Q1019 RMK RF00.0/000.0

Time: 2332 – YIR overhead Mildura, VYK approaching Mildura

Mildura SPECI	SPECI YMIA 172332Z 20007KT 2100 BR BKN002 07/07 Q1019 RMK RF00.0/000.0

Time: 2348 – YIR overhead Mildura, VYK landed at Mildura

Mildura SPECI	SPECI YMIA 172348Z 19007KT 0900 FG OVC001 07/07 Q1019 RMK RF00.0/000.0

Time: 2352 – YIR overhead Mildura, VYK shutdown at Mildura

Mildura TAF	TAF AMD YMIA 172352Z 1800/1812 20007KT 3000 BR SCT003 BKN040 BECMG 1800/1801 19006KT 9999 SCT030 SCT050 PROB30 1800/1802 0500 FG BKN002 RMK T 07 11 13 10 Q 1019 1019 1019 1020

Time: 2353 – YIR overhead Mildura

Adelaide TAF	TAF AMD YPAD 172353Z 1800/1906 02004KT 0500 FG FM180100 VRB05KT 9999 FEW030 SCT045 FM181000 VRB05KT CAVOK FM190000 04008KT CAVOK RMK T 11 14 15 11 Q 1020 1020 1020 1021

Time: 2356 – YIR overhead Mildura

Mildura SPECI	SPECI YMIA 172356Z 21007KT 0400 FG OVC001 07/07 Q1020 RMK RF00.0/000.0

Time: 0000 – YIR overhead Mildura

Adelaide SPECI	SPECI YPAD 180000Z 01005KT 0150 FG BKN000 08/07 Q1021 RMK RF00.0/000.0 TTF: FM0100 05005KT 9999 FEW025
Mildura SPECI	SPECI YMIA 180000Z 20006KT 0300 FG OVC001 07/07 Q1020 RMK RF00.0/000.0

Time: 0011 – YIR on final approach to runway 27 Mildura	
Mildura SPECI	SPECI YMIA 180011Z 20006KT 0200 FG OVC001 07/07 Q1020 RMK RF00.0/000.0

Time: 0014 – YIR lands Mildura

Australian Transport Safety Bureau

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; fostering safety awareness, knowledge and action.

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

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

Purpose of safety investigations

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

Developing safety action

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. The ATSB prefers to encourage the relevant organisation(s) to initiate proactive safety action that addresses safety issues. Nevertheless, the ATSB may use its power to make a formal safety recommendation either during or at the end of an investigation, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation.

When safety recommendations are issued, they focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on a preferred method of corrective action. As with equivalent overseas organisations, the ATSB has no power to enforce the implementation of its recommendations. It is a matter for the body to which an ATSB recommendation is directed to assess the costs and benefits of any particular means of addressing a safety issue.

When the ATSB issues a safety recommendation to a person, organisation or agency, they must provide a written response within 90 days. That response must indicate whether they accept the recommendation, any reasons for not accepting part or all of the recommendation, and details of any proposed safety action to give effect to the recommendation.

The ATSB can also issue safety advisory notices suggesting that an organisation or an industry sector consider a safety issue and take action where it believes it appropriate. There is no requirement for a formal response to an advisory notice, although the ATSB will publish any response it receives.