



Australian Government

Australian Transport Safety Bureau

Loss of control and collision with water involving Piper Aircraft Corp PA-28-235, VH-PXD

33 km SSE of Avalon Airport, Victoria on 29 January 2016

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Addendum

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Safety summary

What happened

On the morning of 29 January 2016, a Piper Aircraft Corp PA-28 aircraft, registered VH-PXD, was on a private flight from Moorabbin Airport, Victoria to King Island, Tasmania. After passing over Point Lonsdale, the aircraft entered an area of low visibility. The pilot conducted a 180° turn and initially tracked back towards Point Lonsdale, before heading south over the ocean. After about 2 minutes, the aircraft was again turned right before entering a rapid descent. The aircraft impacted the water at 1227 Eastern Daylight-saving time, 6.6 km south-west of Point Lonsdale. All four occupants of the aircraft were fatally injured.

What the ATSB found

The ATSB found that continuation of the flight beyond Point Lonsdale, and towards an area of low visibility conditions, was likely influenced by the inherent challenges of assessing those conditions.

The ATSB also found that due to the presence of low cloud and rain, the pilot probably experienced a loss of visual cues and became spatially disorientated, leading to a loss of control and impact with the water. The risk of a loss of control in the conditions was increased by the pilot's lack of instrument flying proficiency.

Safety message

Pre-flight planning needs to include consideration of not only the conditions on departure, but at all stages of the flight. This informs the decision of whether to depart and allows for prior consideration of alternative actions in the case of deteriorating weather, such as returning or diverting.

It is always possible that the actual weather conditions will be different to those forecast. Pilots conducting a flight under the visual flight rules make every effort to avoid areas of low visibility and plan for unforeseen eventualities. However, this is dependent on the pilot perceiving the risks of the situation, which is not inherently easy. Education and training in the practical application of meteorological principles has been shown to enhance pilots' ability to recognise and respond to deteriorating weather conditions.

The ATSB cautions that, on entering an area of reduced visual cues, the risk of experiencing spatial disorientation and a loss of control is high, measuring from between 60 to 178 seconds from the time of entering the area of low visibility. This risk is highest for those without proficiency or recent experience in instrument flying. Requesting assistance from air traffic control can increase the chances of re-establishing visual cues.

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The occurrence

On the morning of 29 January 2016, a Piper Aircraft Corp. PA-28 aircraft, registered VH-PXD (PXD), was on a private flight under the visual flight rules (VFR)¹ from Moorabbin Airport, Victoria to King Island, Tasmania with four occupants on board. The ATSB was unable, given the physical evidence and available flight documentation, to establish which occupant was the pilot in command of the flight.

Several members of the Royal Victorian Aero Club (RVAC) were planning to fly to King Island throughout the weekend, although there was no coordination between the members.

Two of the occupants of PXD arrived at Moorabbin Airport by about 0800 Eastern Daylight-saving Time² that day and ascertained that the weather in the vicinity of the airport was not yet suitable for departure. However, other pilots reported advising the occupants of PXD that the weather at King Island was good. It was also reported that one of the occupants formed the understanding that the weather was slowly moving east and that it was clearing to the west. At around 1000, the early arrivals contacted the other occupants of PXD. It was reported that the decision to go was made during that exchange. By 1100, all four occupants were at the airport and preparing for the flight.

At some stage during the morning, one of the occupants logged into their National Aeronautical Information Processing System account³ and accessed a number of weather and aerodrome forecasts, weather observations and notices to airmen (NOTAM)⁴ for the day. This same occupant also called the local Bureau of Meteorology phone number. Two of the occupants also made phone calls to the recorded Aerodrome Weather Information Services⁵ for King Island (the evening before) and Moorabbin (that morning). Those products and services were broadly consistent with the intended route.

Recorded radio calls indicated that, as PXD was being prepared to depart, a number of other aircraft requested clearance for their arrivals/departures at Moorabbin under special VFR (refer to the section titled *Additional information – Visual flight rules and visual meteorological conditions*). This was due to a reported cloud base of 800 ft. The requests for special VFR were made by a pilot departing at 1138 and a pilot arriving into Moorabbin at 1213.

At 1144:32, a transmission was made by the pilot of PXD on the Moorabbin Ground frequency that the aircraft was positioned in the engine run-up bay and that they were ready for departure for King Island. At 1157:55, the pilot of PXD advised the Moorabbin Tower controller that they were at the holding point for runway 13L and ready for take-off. This call did not include a request for special VFR and ATC did not prompt the request. Three minutes later they received clearance for take-off before departing Moorabbin at 1203. The aircraft's track to Point Lonsdale and a number of pilot actions and other observations are at Figure 1.

Around the same time, one of the RVAC aircraft flying to King Island was nearing Point Lonsdale. The pilot of that aircraft later reported having seen what appeared to be a storm cell over Point Lonsdale and the heads. The likelihood of reduced visibility in the area was reported to have

¹ VFR: a set of regulations that permit a pilot to operate an aircraft only in weather conditions generally clear enough to allow the pilot to see where the aircraft is going.

² Eastern Daylight-saving Time (EDT) was Coordinated Universal Time (UTC) + 11 hours.

³ NAIPS is a multi-function, computerised aeronautical information system. It processes and stores meteorological and NOTAM information and facilitates the provision of briefing products and services to pilots.

⁴ NOTAM: A notice distributed by means of telecommunication containing information concerning the establishment, condition or change in any aeronautical facility, service, procedure or hazard, the timely knowledge of which is essential to personnel concerned with flight operations.

⁵ Aerodrome weather information service (AWIS): actual weather conditions, provided via telephone or radio broadcast, from Bureau of Meteorology (BoM) automatic weather stations, or weather stations approved for that purpose by the BoM.

prompted the pilot to return to Moorabbin Airport. The pilot of the RVAC aircraft landed back in Moorabbin at 1220 with a special VFR clearance. This was after PXD's departure.

A transmission was made by the pilot of PXD on the Moorabbin Tower frequency at 1209. In this transmission, the pilot reported that the cloud base over Carrum was about 800–900 ft. No further radio contact with PXD was recorded. At 1212 the aircraft's transponder code was switched to '1200' per normal airspace procedures.⁶

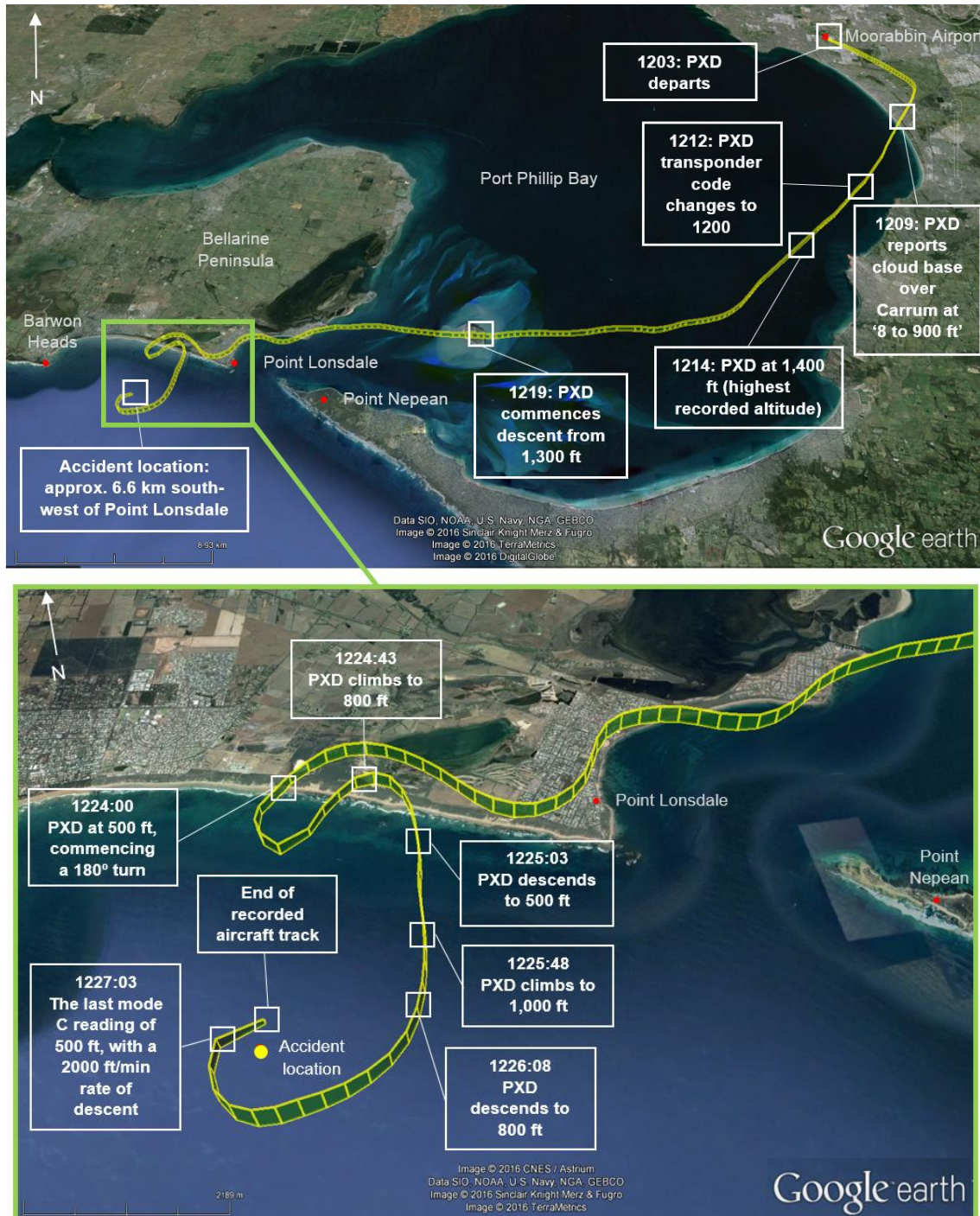
At about 1222, after passing over Point Lonsdale, the pilot conducted a series of left and right turns, followed by a 180° turn to initially track back towards Point Lonsdale. This was followed by a gentle right turn heading south over the ocean for about 2 minutes, before again turning right and entering a rapid descent. At about 1227, PXD impacted the water 6.6 km south-west of Point Lonsdale. All of the aircraft occupants were fatally injured.

Witnesses who were fishing in the vicinity of Point Lonsdale at the time reported hearing an aircraft pass nearby at what they interpreted to be a 'very low altitude'. Due to the low cloud and visibility in the area they could not initially see the aircraft. The witnesses recalled that, a few minutes later, they saw the aircraft just before it impacted the water. It appeared to be in a nose-down, right wing-low attitude and the engine sounded as though it was producing power.

Another two aircraft that were also from the RVAC departed Moorabbin for King Island at 1230 and 1250 respectively. Whilst communicating with each other on the RVAC frequency, they discussed the area of low visibility around Point Lonsdale. Both pilots reported descending in the vicinity of Point Lonsdale in an effort to maintain better visibility, particularly over Barwon Heads. One pilot took several photographs whilst flying over the area that show the weather conditions. Showers were reported passing through this area, reducing the cloud base. The two aircraft continued on to King Island.

⁶ For civil VFR flights operating in Class E or G airspace, a transponder code of '1200' is selected, unless otherwise directed by ATC. On departure from the Moorabbin control zone, PXD entered Class G airspace.

Figure 1: PXD's track from Moorabbin Airport until the collision with water near Point Lonsdale with the area between Point Lonsdale and the impact with the water at inset.
Noteworthy pilot actions and other observations are annotated.



Source: Google earth, modified by the ATSB

Context

Personnel information

Of the four occupants on board PXD, three were pilots. Of these, two held the necessary qualifications and a current medical to be able to conduct the flight. None of the pilots had ever held an instrument rating. However, there was insufficient evidence to definitively identify the pilot in command for this flight.

Fatigue

An assessment was undertaken of whether any of the aircraft occupants may have been experiencing a level of fatigue known to have an effect on performance. This included consideration of their possible time awake at the time of the occurrence, sleep history and potential workload associated with the task and environmental factors. However, the limited data available on the occupants' activities in the preceding days meant there was insufficient evidence to determine whether fatigue was contributory to this occurrence.

Aircraft information

General

VH-PXD (PXD) was a Piper Aircraft Corp. PA-28 four seat, low wing, all metal, unpressurised, fixed undercarriage aircraft with a single reciprocating engine (Figure 2). It had current certificates of airworthiness and registration and a current maintenance release, with no noted defects.

The last periodic maintenance inspection on PXD was conducted in Bacchus Marsh on the day before the occurrence. During that inspection, the right-upper wing skin was replaced, the artificial horizon was repaired and all of the aircraft's control cables were replaced. The maintenance was completed by an appropriately-qualified Licensed Aircraft Maintenance Engineer in an approved maintenance facility.

The 25-minute return flight to Moorabbin after the maintenance at Bacchus Marsh was completed with no reported issues.

Figure 2: VH-PXD, taken in April 2011 in Echuca, New South Wales



Source: Nick Dean (www.airport-data.com)

Weight and balance

The ATSB was unable to determine the actual weights and seating positions of the occupants and amount of baggage on board at the time of the occurrence. Therefore, the actual weight of the aircraft and its centre of gravity was unable to be calculated.

It was reported that the aircraft was refuelled to full tanks prior to departing Moorabbin Airport that day. The weight of the aircraft on departure from Moorabbin Airport was estimated based on:

- the recorded aircraft weight
- the weight of the fuel
- data from the Civil Aviation Safety Authority (CASA) medical examinations for three of the aircraft occupants⁷
- a statistical average for the fourth occupant.

That estimate would have meant PXD was about 35 kg under the maximum permissible take-off weight for the flight. However, that weight did not account for the unknown amount of baggage on board. It was therefore concluded likely that the aircraft was close to its maximum take-off weight when it departed from Moorabbin Airport.

Meteorological information

Forecast weather

On the day of the occurrence, there was a complex weather pattern over south-eastern Australia. That weather pattern included a number of low pressure systems, along with upper atmosphere and surface troughs. This was forecast to result in significant areas of low cloud, showers and areas of rain.

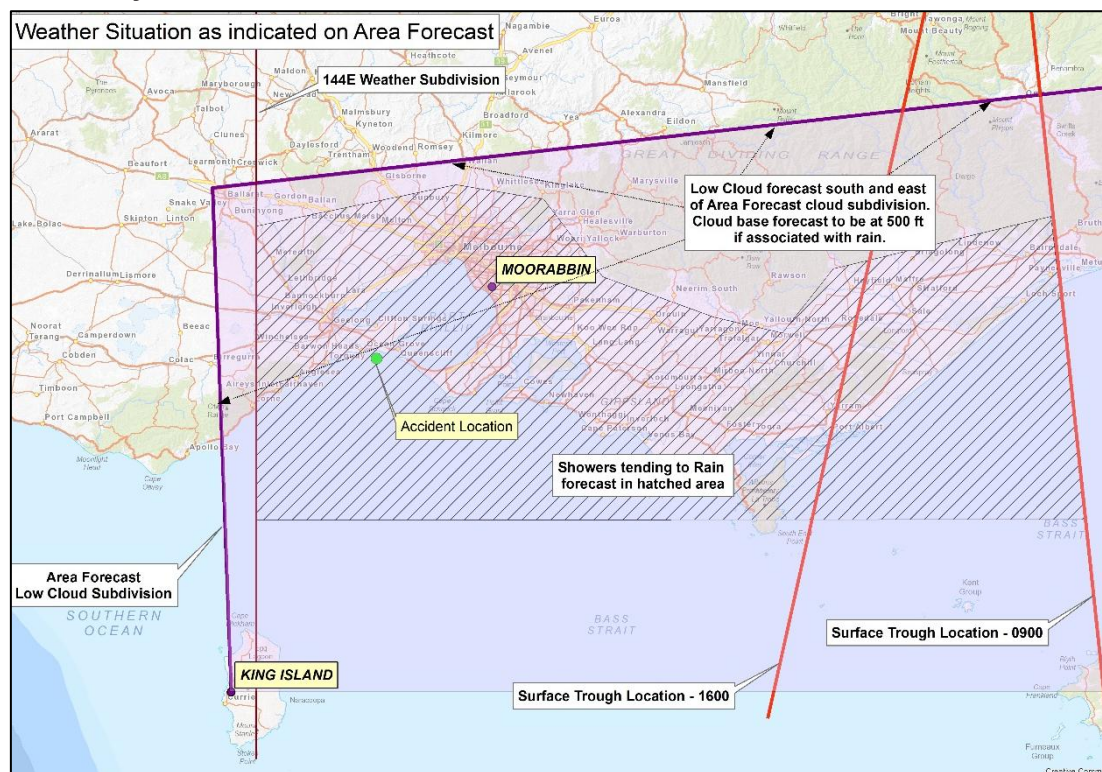
An area forecast (ARFOR)⁸ covering the proposed route indicated a surface trough to the east of Melbourne that was forecast to slowly move to the west during the day. There were isolated thunderstorms forecast over the sea, coast and adjacent ranges to the east of Melbourne. Showers of rain, with associated broken⁹ low cloud with a minimum base of 500 ft were forecast in an area starting west of Melbourne and extending to the east. Additionally, there was forecast low cloud south-east of a line extending from King Island, north to Ballarat and then east to Bombala. A pictorial representation of these areas is shown at Figure 3.

⁷ The medical records were up to 6 years old. As a result, the actual weights of the three occupants affected would likely have varied since that time.

⁸ ARFOR: routine forecasts for designated areas and amendments when prescribed criteria are satisfied. Australia is subdivided into a number of forecast areas.

⁹ Cloud cover: in aviation, cloud cover is reported using words that denote the extent of the cover – ‘scattered’ indicates that cloud is covering between a quarter and a half of the sky, ‘broken’ indicates that more than half to almost all the sky is covered, and ‘overcast’ indicates that all the sky is covered.

Figure 3: Pictorial representation of the Area 30/32 forecast valid from 0900 on 29 January 2016



Source: ATSB

The aerodrome forecast (TAF)¹⁰ for Moorabbin Airport that was issued at 1003 indicated that the wind would be from the south-east at 8 kt and that the visibility would generally be greater than 10 km. Light rain was forecast with a scattered cloud base at 1,200 ft above the aerodrome and a broken layer at 3,500 ft. The forecast noted that there would also be periods of up to 60 minutes duration, starting from 1100, where the visibility would decrease to 4,000 m in rain and the cloud base would lower to 1,000 ft and the amount of cloud increase to broken.

A TAF for Avalon Airport indicated that the wind would be variable in direction at 5 kt and that the visibility would generally be greater than 10 km. Light showers of rain were forecast and the cloud was forecast to be scattered with a base 1,000 ft above the aerodrome and a broken layer at 3,500 ft. The forecast indicated that, from 0800, there would be periods of 30 minutes duration where the visibility would decrease to 5,000 m in showers of rain, and the cloud base would be scattered at 1,500 ft.

Actual weather conditions

Weather reports (captured by automatic sensors) for Moorabbin between 1100 and 1200 indicated a scattered layer of cloud with a base between 800 and 1,200 ft above the aerodrome elevation and a visibility of 10 km or more. A special report (SPECI)¹¹ issued at 1209 indicated that the cloud base was broken at 1,200 ft. None of the weather reports suggested that decreased visibility might have affected PXD's departure.

A weather report issued at 1130 for Avalon indicated the visibility had reduced to 9,000 m in drizzle with cloud overcast at 2,700 ft. A SPECI at 1133 reported a further decrease in visibility to

¹⁰ TAF: a statement of meteorological conditions expected for a specific period of time in the airspace within a radius of 5 NM (9 km) of the aerodrome reference point.

¹¹ SPECI: an aerodrome weather report that is issued whenever weather conditions fluctuate about, or are below specified criteria.

6,000 m with cloud unchanged. The 1200 SPECI for Avalon indicated scattered cloud but with a lower base of 1,100 ft, and that the visibility had increased to in excess of 10 km.

Weather radar images from the Melbourne (Laverton) radar recorded the following:

- At 1218, significant rainfall returns, from light to moderately heavy rain to the east of Melbourne, extending from the ranges to Bass Strait. There were also rainfall returns to the south-west of the radar location over land, the coastline and extending out to sea in the area of Barwon Heads. These indicated light rainfall, with the heaviest returns over the sea to the east of Anglesea.
- At 1224, that the rainfall returns to the south-west had increased in area and intensity. The returns were generally orientated along a line in a north-westerly to south-easterly direction. That line covered an area estimated from 5 km inland to a point estimated to be 20 km out to sea. A portion of this image is shown in Figure 4, with the aircraft's track superimposed.
- At 1307, that the area of rain enlarged, extending from Torquay to Anglesea and out to sea.

The weather radar information from 1224, when overlayed with the aircraft track, indicated that the aircraft likely entered an area of low visibility associated with light-to-moderate rain at about 1223.

Moorabbin Automatic Terminal Information Service

Relevant aspects of the Moorabbin Automatic Terminal Information Service (ATIS) reports of the actual conditions and requirements at around the time of the flight by PXD are listed in Table 1.¹² When operating at a controlled aerodrome where an ATIS is in operation, pilots are required to listen to the facility prior to taxi and advise air traffic control of receipt of that information. This advice is part of the pilot's taxi call.

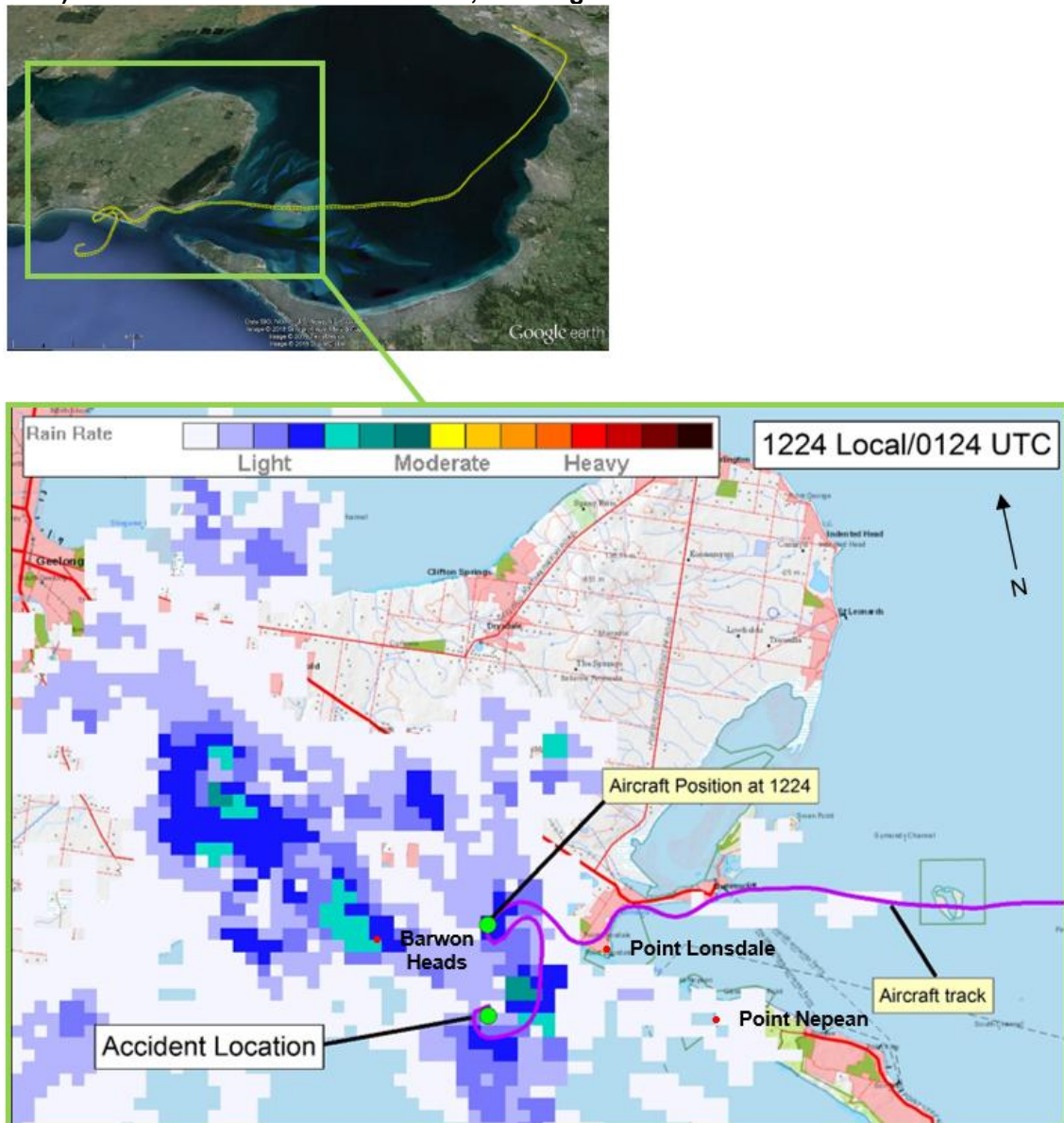
Table 1: Actual weather conditions and requirements as reported in successive ATIS reports at around the time of the flight by PXD

Condition/requirement	ATIS and time issued		
	'Papa' of 1137	'Quebec' of 1152	'Romeo' of 1215
Approach type	Expect instrument approach	Expect instrument approach	Expect instrument approach
Visibility	Reduced to 6 km	Reduced to 6 km	Greater than 10 km
Weather	Showers in the area	Showers in the area	Nil reported
Cloud	Broken at 600 ft	Scattered at 800 ft and broken at 1,500 ft	Scattered at 800 ft and broken at 1,500 ft

The pilot of PXD made their taxi call at 1144:32. Although ATIS is a passive facility, there was no indication in the recorded radio calls that the pilot of PXD accessed ATIS information 'Papa'.

¹² ATIS: The provision of current, routine information to arriving and departing aircraft by means of continuous and repetitive broadcasts during the hours when the unit responsible for the service is in operation.

Figure 4: Weather radar recording (orientated with reference to a Google earth map at inset) and associated 'Rain rate' at 1224, showing the aircraft's track



Source: At inset, Google earth, modified by the ATSB and larger image Geoscience Australia (base map) and the Bureau of Meteorology (weather radar), both modified by the ATSB

Closed-circuit television images from Port of Melbourne cameras facing east across the water from Point Lonsdale, and north from Point Nepean both showed drizzle, light rain and reduced visibility including little natural horizon as PXD tracked south along the eastern shore of Port Phillip Bay (Figure 5).

Witnesses that saw the aircraft recalled that the visibility at that time was very low, such that it prevented them seeing the land. The witnesses estimated that the land was between 1 and 4 km away and indicated that it was raining at the time.

Figure 5: Still images taken at 1215 from two different closed-circuit television cameras owned by the Port of Melbourne. One camera (left image) was positioned on the Point Lonsdale lighthouse facing east. The other camera (right image) was positioned at Point Nepean, facing north. The image quality is affected by contaminants on the camera lens, but the extent of the low visibility conditions in the area is evident



Source: Port of Melbourne, modified by the ATSB

Recorded data

Recorded flight data was obtained from an ‘electronic flight bag’ iPad™ application that the occupants were using on the flight. This data was used to assist in the wreckage recovery and in the analysis of the aircraft track.

Flight track information was also obtained from air traffic control (ATC) radar information. This included recorded radar returns from the aircraft from its departure from Moorabbin Airport to the time of the occurrence.

Witnesses that saw the occurrence also provided the ATSB with their ‘fish finder’ Global Positioning System device. Data was downloaded from this device and assisted with locating the wreckage.

Wreckage and impact information

The aircraft impacted the water after a rapid descent, with parts of the wreckage descending to the sea floor. Evidence from the wreckage was consistent with the aircraft impacting the water in a nose-down attitude, with the engine delivering power.

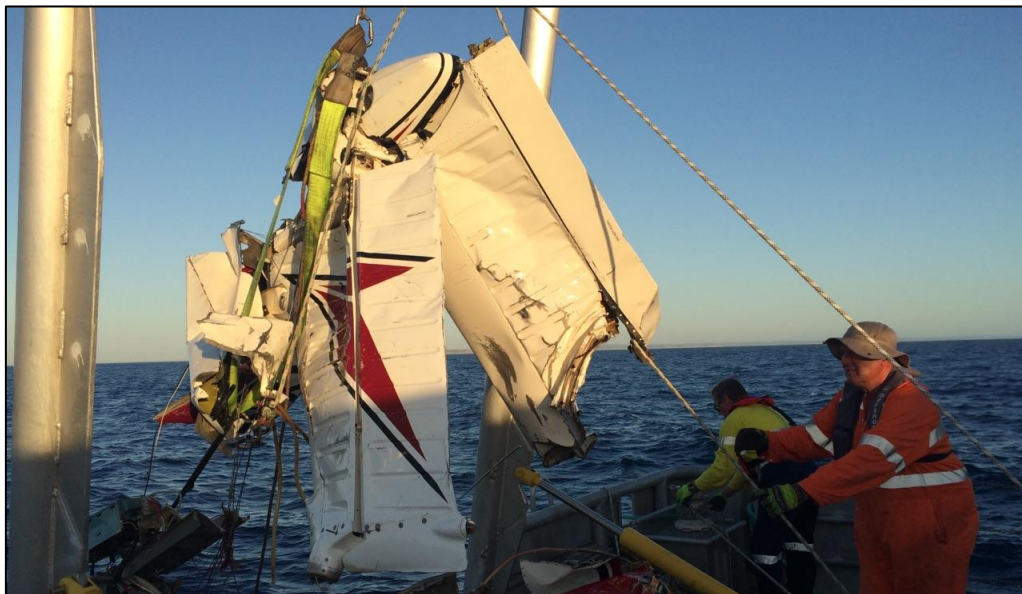
Recovery of the wreckage

A search for the wreckage was commenced by the Victoria Water Police and Air Wing within an hour of the accident. Small items of wreckage had surfaced, or remained on the surface and were recovered by the water police and nearby witnesses. These included items such as a number of the occupants’ personal effects and the three pilots’ CASA flight crew licences and aviation medical certificates.

After several day’s search using surface sonar and underwater robotic equipment, on 2 February 2016 Victoria Police located a large portion of the aircraft wreckage on the ocean floor at a depth of 34 m. The wreckage was about 1 km from shore, off the Point Lonsdale lighthouse.

On the evening of 6 February 2016, the wreckage was recovered to the surface by police divers, supported by a barge and lifting equipment (Figure 6). On 7 February, the ATSB assisted with the removal and transportation of the wreckage to a secure site for inspection.

Figure 6: Recovery by Victoria Police of the aircraft's fin and left horizontal stabiliser



Source: Victoria Police

Wreckage inspection

The majority of the aircraft's fuselage, fin, horizontal stabiliser, engine and propeller, flight control cables, main landing gear assembly, instrument panel and some items from the cabin interior were recovered. Figures 7 and 8 show some of the airframe and other items and components that were recovered.

All identified fracture surfaces throughout the recovered wreckage were consistent with overload failure as a result of the impact with water. There was no evidence of pre-existing damage to the airframe, or failure of the primary control systems that may have contributed to the accident. However, the aircraft wreckage exhibited severe disruption.

Some components, such as the engine carburettor, right horizontal stabiliser assembly and left and right wing structures were not recovered.

Figure 7: Some of the recovered aircraft wreckage. Note the extent of the disruption of the airframe



Source: ATSB

A detailed inspection of the engine and propeller was conducted in a CASA-approved maintenance facility. Nothing was identified during that inspection that may have contributed to the accident, or would have prevented the engine and propeller from normal operation.

Figure 8: Recovered aircraft engine, propeller and propeller spinner, looking at the lower surface of the engine



Source: ATSB

Medical and pathological information

Post-mortem and toxicological examination of all of the aircraft occupants found no underlying medical disorder likely to lead to incapacitation. All occupants on board PXD sustained multiple fatal injuries consistent with the aircraft impacting water.

Survival aspects

Due to the extent of the impact forces and aircraft break-up, the occurrence was not survivable. While the occupants of PXD were seen by witnesses to acquire life jackets prior to their departure from Moorabbin Airport, these were not found in the recovered wreckage.

Additional information

Visual Flight Rules and Visual Meteorological Conditions

The CASA *Visual Flight Rules Guide* outlined that flight under the visual flight rules (VFR) can only be conducted in Visual Meteorological Conditions (VMC).¹³ This was provided that, when operating at or below 2,000 ft above the ground or water, the pilot is able to navigate by visual reference to the ground or water.

¹³ VMC: a series of minimum meteorological conditions in which flight is permitted under the visual flight rules – that is, conditions in which pilots have sufficient visibility to fly the aircraft while maintaining visual separation from terrain and other aircraft.

Moorabbin Airport was surrounded by Class D (controlled) airspace out to 3 NM (6 km) and below 2,500 ft above mean sea level. The visual meteorological conditions for class D airspace included:

- a flight visibility of 5,000 m
- a minimum horizontal distance from cloud of 600 m and height vertically above cloud of 1,000 ft or vertically below cloud of 500 ft.

When requested by a pilot, ATC could permit operations by day in Class D airspace under special VFR when the weather conditions did not meet the above VMC criteria. Operations under special VFR required pilots to:

- remain clear of cloud
- in the case of aeroplanes, ensure an in-flight visibility of 1,600 m
- operate within the requirements of Civil Aviation Regulation 157 *Low flying*.

After departing class D airspace, the aircraft entered (uncontrolled) Class G airspace. The following conditions were stipulated for flight under the VFR in this airspace when below 10,000 ft:

- a flight visibility of 5,000 m
- a minimum vertical distance of 1,000 ft and horizontal distance of 1,500 m from cloud.

In addition, in the case of aeroplane operations in Class G at or below 3,000 ft above mean sea level or 1,000 ft above ground level (whichever is higher), the following minimum conditions were stipulated:

- a flight visibility of 5,000 m
- that the aeroplane shall be maintained clear of cloud and in sight of the ground or water
- that a radio must be carried and used by the pilot on the correct frequency.

In this case, the area and aerodrome forecasts for Avalon and the surrounding area indicated that visibility was reduced to 5,000 m and a scattered cloud base of 1,500 ft around Avalon. In addition, there was an overall reduced visibility in the region.

Visual flight into Instrument Meteorological Conditions

The safety risks of VFR pilots flying from VMC conditions into instrument meteorological conditions (IMC)¹⁴ are well documented. This has been the focus of numerous ATSB reports and publications, as VFR pilots flying into IMC represents a significant cause of aircraft accidents and fatalities. In 2013 the ATSB Avoidable Accidents series was re-published. Of these publications, the booklet titled *Accidents involving pilots in Instrument Meteorological Conditions* outlined that:

In the 5 years 2006–2010, there were 72 occurrences of visual flight rules (VFR) pilots flying in instrument meteorological conditions (IMC) reported to the ATSB...About one in ten VFR into IMC events result in a fatal outcome.

Additionally, a study conducted by the United States National Transportation Safety Board (2005) found that 'about two-thirds of all general aviation accidents that occur in instrument meteorological conditions (IMC) are fatal'.

Wiggins and O'Hare (1995) explained that when pilots are not trained or qualified to fly in IMC and find themselves in these conditions, 'the result will almost inevitably involve loss of control of the aircraft resulting in a fatal crash'.

¹⁴ IMC: weather conditions that require pilots to fly primarily by reference to instruments, and therefore under Instrument Flight Rules (IFR), rather than by outside visual reference. Typically, this means flying in cloud or limited visibility.

Loss of visual cues and spatial disorientation in low visibility conditions

Gibb and others (2010) explain that seeing the horizon is ‘crucial for orientation of the pilot’s sense of pitch and bank of the aircraft.’ In conditions of low visibility, the horizon may not be visible to the pilot, during which time they can become rapidly disorientated. Newman (2007) found that ‘the major environmental factors [that contribute to spatial disorientation] are related to time of day and the ambient weather conditions. Poor visual cues are a function of most disorientation illusions, so flight at night or in conditions of bad weather can set a pilot up for a disorientation experience’.

In a discussion of spatial disorientation, Benson (1999) defined the experience as follows:

Spatial disorientation is...[where] the pilot fails to sense correctly the position, motion or attitude of the aircraft or of him/herself [resulting in] errors in perception by the pilot of their position, motion or attitude with respect to their aircraft...

Newman (2007) summarised the primary reason for spatial disorientation as follows:

The visual system is by far the most important of the three systems, providing some 80 per cent of the raw orientation information. In conditions where visual cues are poor or absent, such as in poor weather or at night, up to 80 per cent of the normal orientation information is missing. The remaining 20 per cent is split equally between the vestibular system and the proprioceptive system, both of which are prone to illusions and misinterpretation. In poor or absent visual cue situations, humans are forced to rely on the remaining 20 per cent of orientation information, which is less accurate...In the aviation setting, such a situation can then result in any number of well-described SD [spatial disorientation] illusions being experienced by the pilot...The majority of disorientation events are associated with poor visual cues (as in IMC or night flight).

Extensive research on spatial disorientation indicates that loss of control will likely occur between 60 seconds (Benson, 1983 in Gibb and others, 2010) and 178 seconds (Newman, 2007) after the loss of visual reference. This is the case even when the aircraft is in straight and level flight at the time vision is lost, and is shorter still if the aircraft is in a turn. Gibb and others (2010) state that ‘spatial disorientation accidents have fatality rates of 90–91 percent, which indicates how compelling the misperceptions can be’.

Pilot instrument flying proficiency

When there are no external visual cues, the ability to fly on instruments is essential. Research from the United States has shown that pilots without instrument ratings are five times more likely to have accidents in degraded visual conditions than pilots with instrument ratings (Groff and Price, 2006). The National Transportation Safety Board also noted that ‘Tests and experience have shown that non-instrument-trained pilots or non-proficient pilots are rarely successful in overcoming spatial disorientation’ (NTSB, 1988).

Gibb and others (2010) add that ‘a visual-only general aviation pilot encountering weather or night conditions is severely at risk because of [their] total inexperience, education, and training in using instruments.’ Simulator experiments at the University of Illinois determined that on average, a pilot with no instrument training can expect to retain control of their aircraft for 178 seconds after entering bad weather and losing visual contact (ATSB, 2011).

Although instrument flying proficiency is a very important defence against spatial disorientation, many studies have shown overall flying experience has little, if any, influence on spatial disorientation accident rates (Gawron, 2004). Newman (2007) noted that spatial disorientation can affect ‘any pilot, any time, any where, in any aircraft, on any flight, depending on the prevailing circumstances’.

Related occurrences

The previously-discussed ATSB research reports and educational material were based on occurrences up until 2013 (see the section titled *Visual flight into Instrument Meteorological Conditions*). In the period 2014 through to October 2016 there were 28 reported occurrences (not

including this accident). Six of these included a decision by the pilot to divert or return to the departure airport, and another eight pilots sought assistance from ATC.

In addition, a number of recent ATSB investigations examined VFR into IMC occurrences. Of these, three are summarised below and are available at www.atsb.gov.au.

ATSB investigation AO-2011-100

On 15 August 2011, the pilot of a Piper PA-28-180 Cherokee aircraft, registered VH-POJ, was conducting a private flight transporting two passengers from Essendon to Nhill, Victoria under the VFR. The flight was arranged to return the passengers to their home location after medical treatment in Melbourne.

Global Positioning System data recovered from the aircraft indicated that when about 52 km from Nhill, the aircraft conducted a series of manoeuvres followed by a descending right turn. The aircraft subsequently impacted the ground at 1820 Eastern Standard Time¹⁵, fatally injuring the pilot and one of the passengers. The second passenger later died in hospital as a result of complications from injuries sustained in the accident.

The ATSB found that the pilot landed at Bendigo and accessed a weather forecast before continuing towards Nhill. After recommencing the flight, the pilot probably encountered reduced visibility conditions approaching Nhill due to low cloud, rain and diminishing daylight, leading to disorientation, loss of control and impact with terrain.

ATSB investigation AO-2014-029

On 21 February 2014, the pilot of a Piper PA-28R aircraft, registered VH-TBB, departed Scone, New South Wales on a private flight to Warwick, Queensland. The flight was planned under the VFR.

The flight proceeded normally until the pilot encountered an increasing amount of cloud and light rain showers while en route between Inverell and Warwick. The pilot initially attempted to pass beneath the cloud, but had difficulty maintaining VMC. Although the pilot reported the cloud appeared to be relatively light with ill-defined edges, they found that forward visibility was restricted. The pilot advised ATC of occasionally encountering IMC, and with the aircraft intermittently identified on radar, ATC was able to assist the pilot with relevant advice.

The pilot had undertaken some instrument flight training about 2 years prior to the incident, which they reported had provided some confidence with respect to aircraft control in marginal conditions.

ATSB investigation AO-2014-139

On 9 July 2014, at about 1340 Eastern Standard Time, a Cessna 206, registered VH-NCR, departed Dubbo, New South Wales on a private flight to the Gold Coast and Archerfield, Queensland, under the VFR, with three passengers on board.

When about 15 NM (28 km) south of Inverell, the pilot observed the weather deteriorating with low cloud about the ranges, and elected to climb and operate VFR on top of the cloud. As the aircraft climbed above 5,000 ft, the pilot observed a widespread frontal mass of cloud with tops around 12,000 ft. As a result, they contacted Brisbane Centre ATC and requested navigation assistance and ATC provided updated weather information.

The pilot initially considered a diversion to Moree, however, they were able to descend through a break in the cloud and elected to divert to Inverell. A turn was commenced, but passing about 3,800 ft during the turn, the aircraft entered cloud. The pilot immediately applied full power and commenced climbing until the aircraft cleared cloud at about 5,000 ft. The pilot diverted to Gunnedah.

¹⁵ Eastern Standard Time (EST) was Coordinated Universal Time (UTC) + 11 hours.

One of the safety messages included in the report was to encourage pilots to make conservative decisions when considering how forecast weather may affect their flight. If poor weather is encountered en route, timely and conservative decision making may be critical to a safe outcome.

Safety analysis

While en route from Moorabbin, Victoria to King Island, Tasmania, Piper Aircraft Corp. PA-28 aircraft, registered VH-PXD (PXD), entered an area of low visibility around Point Lonsdale. The aircraft's track became increasingly erratic until its impact with the water. There were no significant defects or anomalies found with the recovered components of the aircraft that might have contributed to the accident.

Of the three aircraft occupants that held a pilot licence, the ATSB was not able to establish the pilot in command for the flight. None of these occupants held an instrument rating and the flight was being carried out under the Visual Flight Rules (VFR).

The following analysis examines the decision to depart on the flight and the various human performance factors that likely influenced a VFR pilot, who did not hold an instrument rating, to continue the VFR flight with reduced visual cues. The effect on human performance of spatial disorientation is also examined.

Decision to depart Moorabbin Airport

Prior to departing Moorabbin, the occupants on board PXD had retrieved a number of aerodrome and area forecasts, weather observations and notices to airmen for the day. During their pre-flight preparations, the two early arrival occupants formed a view that the weather conditions at Moorabbin Airport would improve and suggested the last two occupants make their way to the airport.

The weather observations either side of PXD's departure suggested scattered to broken cloud with a base of between 1,000 and 1,200 ft and a visibility of 10 km or more. The lower of those cloud bases, and content of the earlier Automatic Terminal Information Service 'Papa', would explain the use by a number of pilots of previous arrivals/departures to/from Moorabbin of special VFR.

The lack of evidence of the pilot of PXD accessing information 'Papa', or later information, could suggest that the pilot did not have that information on taxi. There was also no evidence of the pilot being on Moorabbin Tower frequency until about 1144, after the time the last of the preceding aircraft movements sought clearance under the special VFR. In this case, the pilot of PXD would not have developed an understanding of the implications of the content of information 'Papa' or the subsequent information, or of the earlier pilots' clearance requests for departure from/entry to the Moorabbin control zone under special VFR. In the absence of that understanding, the successful arrival/departure of those aircraft could have contributed the decision by the pilot of PXD to depart Moorabbin.

ATSB analysis of the area forecasts relevant to the flight identified a complex weather system with showers tending to rain, low cloud with a minimum base of 500 ft and isolated thunderstorms over the sea, coast and adjacent areas. These conditions could be expected on the planned route to King Island. Although several sources of weather forecast information were accessed, the ATSB could not determine the extent to which the occupants of PXD considered these forecasts and the associated risk to their flight once they departed Moorabbin. In addition, the recorded weather conditions around the time of PXD's departure from Moorabbin indicated minimal cloud cover en route to the Point Lonsdale area.

In the event, other pilots also departed Moorabbin for King Island. Of these, a preceding pilot returned to Moorabbin in response to the reduced visibility in the area of Point Lonsdale. The pilot of the returning aircraft indicated that the reduced visibility was due to what appeared to be storms. Two following pilots continued to King Island, although also reported reduced visibility conditions in the Point Lonsdale area.

The importance of careful study of all relevant weather and other operational information affecting a flight was highlighted in the ATSB Avoidable Accident Series booklet *Accidents involving pilots in Instrument Meteorological Conditions*. The benefits of thorough pre-flight planning in minimising in-flight decision errors were highlighted as follows:

Prior to a flight, a pilot must study all available information appropriate to the intended operation, including the current weather forecasts. This is a requirement in the Civil Aviation Regulations (CAR 174) and [is] repeated in the Aeronautical Information Publication...Pre-flight planning minimises in-flight decision errors because it removes the unforeseen element from situations that arise during the flight. Failure to carry out this prior planning can result in decisions being made under a situation of considerable stress and increases the likelihood of poor or incorrect decision making.

The following section examines the decision by the pilot of PXD to apparently continue the flight to King Island in the deteriorating weather conditions.

Flying into areas of low visibility

The United States National Transportation Safety Board (2005) found that ‘reduced-visibility weather represents a particularly high risk to [general aviation] operations’ and that ‘weather may...test the limits of pilot knowledge, training, and skill to the point that underlying issues are identified.’

After ascertaining that it was suitable to depart Moorabbin, the occupants of PXD encountered conditions over eastern Port Phillip Bay that allowed for flight to a recorded altitude of 1,400 ft. This may have strengthened a perception that continuing on their planned track past Point Lonsdale towards King Island was possible.

In contrast, closed-circuit television footage, witness statements and photographs taken by other pilots indicated localised precipitation and low cloud and low visibility conditions in the Point Lonsdale area. These conditions were consistent with the area forecast and would have affected PXD. Although audible, PXD was not visible to witnesses in the reported low cloud and visibility until it descended through, or appeared from behind the cloud and impacted the water.

Wiegmann and Goh (2000) explained that:

One reason why pilots may decide to continue a VFR flight into adverse weather is that they make errors when assessing the situation. That is, pilots are seen to engage in VFR flight into IMC [instrument meteorological conditions] because they do not accurately assess the hazard (i.e., the deteriorating weather conditions)...

The previously-mentioned United States National Transportation Safety Board report (2005) added that in these cases, pilots who might appear to intentionally engage in risky behaviour may actually be making choices that they mistakenly believe to be safe:

Even if pilots are able to correctly assess current weather conditions, they may still underestimate the risk associated with continued flight under those conditions, or they may overestimate their ability to handle that risk.

This would explain the pilot’s assessment of the risk associated with the low visibility conditions in the Point Lonsdale area and subsequent decision to continue towards these conditions, rather than to divert. Wiggins and O’Hare (1995) further explained how errors in assessment can take place, acknowledging that weather-related decision making can be highly complex and therefore more prone to errors:

Because of the variable nature of operations in the aviation environment, weather-related decision making is often considered a skill that cannot be prescribed during training. Rather it is expected to develop gradually through practical experience. However, in developing this type of experience, relatively inexperienced pilots may be exposed to hazardous situations with which they are ill-equipped to cope.

ATSB Aviation Research and Analysis Report B2007/0063 stated that pilots should not attempt to fly into instrument meteorological conditions under the VFR. Pilots should develop a plan prior to take-off on what to do if the weather en route is different from that expected, or deteriorates. This plan should consider a requirement to divert or turn back prior to entering instrument meteorological conditions. However, this depends on a pilot correctly assessing the weather conditions. The United States National Transportation Safety Board (2005) noted that targeted weather-related training programs have had some success in teaching pilots to recognise and respond to deteriorating weather conditions.

Additionally, Wiggins and O'Hare (2003) evaluated the effectiveness of a cue-based training system called *Weatherwise*, which was designed to equip VFR pilots with the skills to recognise and respond to the cues associated with deteriorating weather conditions during flight. VFR pilots were more likely to use the cues following the training, with subsequent improvements in their weather-related decision-making. The *Weatherwise* program was made available to pilots by the Civil Aviation Safety Authority (CASA). Additionally, CASA produced a *Weather to Fly* education program which focuses on topics such as the importance of pre-flight preparation, making decisions early and talking to ATC.

It was not known how the occupants understood the weather conditions ahead of them prior to entering an area of low visibility conditions. The occupants of PXD may have misperceived the severity of the conditions, resulting in them tracking into the area. In this case, the inherent challenges of assessing low visibility conditions in-flight likely influenced the pilot's continuing towards an area of reduced visual cues, particularly when the pilots had limited instrument flying proficiency. This reinforces the benefits of comprehensive pre-flight planning to minimise the risk of in-flight decision errors.

Spatial disorientation resulting from a loss of visual cues

PXD entered an area that was reported by witnesses to include low visibility at about 1223, just after passing Point Lonsdale. The pilot had already executed a number of left and right turns approaching this area, conceivably as they sought to avoid cloud or move towards areas of improved visibility. The decision to then undertake a 180° turn was likely an effort to track back over Point Lonsdale and avoid or exit the low visibility conditions.

On entry into the low visibility conditions, the pilot of PXD would have lost visual cues, in particular the horizon. It is well established that a loss of visual cues significantly increases the risk of spatial disorientation.

Along with the loss of visual cues, there was the potential that the 180° turn contributed to the development, or exacerbated the effects of spatial disorientation. Subsequently the aircraft tracked south over the water, initially in a right turn, with a series of climbs and descents varying in height between 500 ft and 1,200 ft. The final right turn was accompanied by a high rate of descent from 1,200 ft, followed by impact with the water.

The time from PXD entering the area of low visibility to impacting the water was about 180 seconds. This is broadly consistent with the time indicated by research between experiencing spatial disorientation and a subsequent loss of control. Reinforcing the high likelihood that, in the conditions, the pilot of PXD experienced spatial disorientation the:

- pilot did not hold an instrument rating
- aircraft's track and height was erratic once it entered the area of low visibility
- aircraft was seen to exit or appear from behind cloud in conditions of low visibility, reducing the available visual cues and likelihood of a reliable horizon.

The conditions that confronted the pilot of PXD are not alone in contributing to the development of spatial disorientation. All pilots are at risk given certain conditions. The ATSB publication *Avoidable Accidents No. 4 – Accidents involving Visual Flight Rules pilots in Instrument*

Meteorological Conditions outlined that ‘disorientation can affect any pilot, no matter what their level of experience.’

As indicated previously (see the section titled *Related occurrences*), a pilot’s chances of avoiding and/or exiting disorienting conditions increase if they request the assistance of air traffic control. However, in reality the difficulties of identifying the risk faced in conditions of decreased visual cues, combined with what will likely be increased workload and stress, can often preclude a pilot considering this as an option. It is well-established that the likelihood of a loss of control when experiencing spatial disorientation remains very high.

The ATSB found that due to the presence of low cloud, rain and reduced visibility, the pilot of PXD likely experienced a loss of visual cues and became spatially disorientated, leading to a loss of control and impact with the water.

Findings

From the evidence available, the following findings are made with respect to the collision with water involving a Piper Aircraft Corp PA-28-235, registered VH-PXD, 33 km south-south-east of Avalon Airport, Victoria on 29 January 2016. These findings should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing factors

- Continuation of the flight towards an area of low cloud and rain was likely influenced by the inherent challenges of assessing low visibility conditions, particularly without instrument flying proficiency.
- Upon entering an area of low cloud, rain and reduced visibility, the pilot likely experienced a loss of visual cues and became spatially disorientated, leading to a loss of control and impact with the water.

Other findings

- During their pre-flight preparations, the occupants' understanding of improving weather conditions at Moorabbin Airport, potentially reinforced by with the successful departure/arrival of other aircraft at the airport, contributed to their decision to depart.

General details

Occurrence details

Date and time:	29 January 2016 – 1227 EDT	
Occurrence category:	Accident	
Primary occurrence type:	Collision with water	
Location:	33 km south-south-east of Avalon Airport, Victoria	
	Latitude: 38° 18.64' S	Longitude: 144° 33.83' E

Aircraft details

Manufacturer and model:	Piper Aircraft Corp PA-28	
Year of manufacture:	1967	
Registration:	VH-PXD	
Operator:	Private	
Serial number:	PA-28-235	
Total Time In Service	5,790 flight hours	
Type of operation:	Private	
Persons on board:	Crew – 1	Passengers – 3
Injuries:	Crew – 1	Passengers – 3 fatal
Damage:	Destroyed	

Sources and submissions

Sources of information

The sources of information during the investigation included:

- a number of witnesses
- Airservices Australia
- the Bureau of Meteorology
- the Civil Aviation Safety Authority
- Victoria Police and Coroner's office.

References

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Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003* (the Act), the ATSB may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. Section 26 (1) (a) of the Act 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 Civil Aviation Safety Authority.

Submissions were received from the Civil Aviation Safety Authority. The submissions were received and where considered appropriate, the text of report was amended accordingly.

Australian Transport Safety Bureau

The 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 operations involving the travelling public.

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

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.