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Engine malfunction and in-flight shutdown involving Boeing 777, A6-EGA

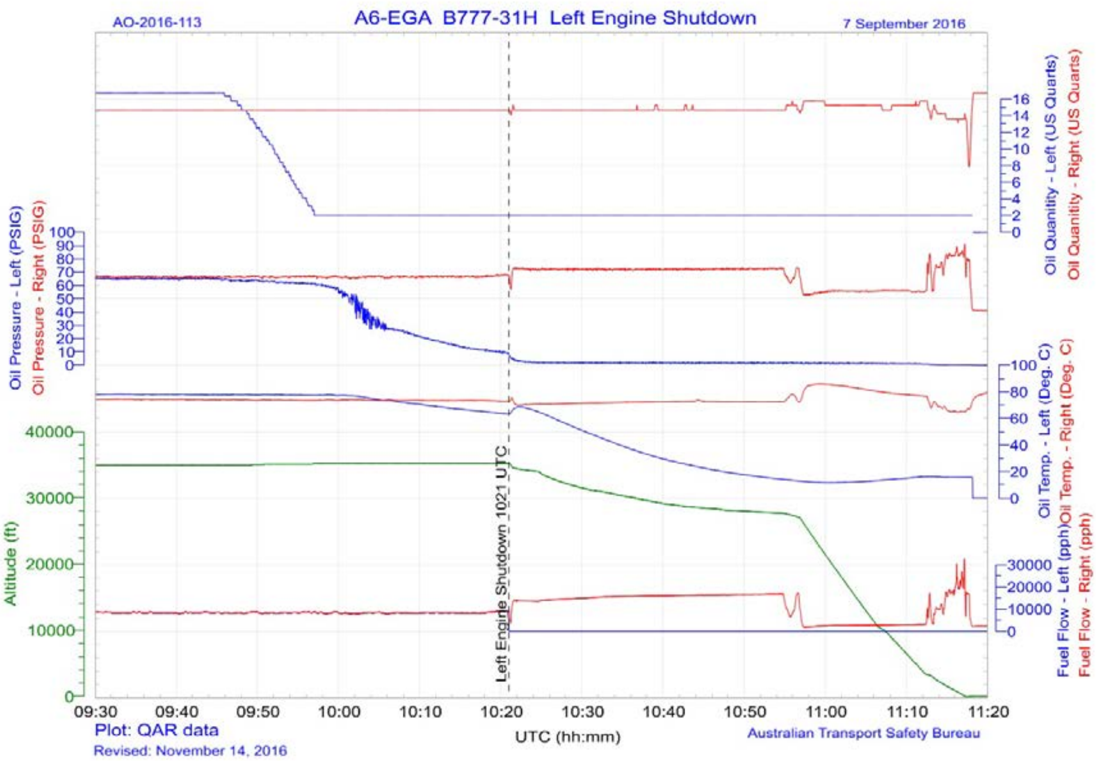
What happened

On 7 September 2016, an Emirates Boeing 777-31HER aircraft, registered A6-EGA, was operating a scheduled passenger flight from Dubai, United Arab Emirates, to Brisbane, Queensland. On board were 22 crewmembers and 308 passengers.

At about 1916 Central Standard Time (CST), the left engine oil quantity started to decrease from 16.4 quarts, stabilising at 2 quarts at 1927, when the aircraft was about 650 km north-west of Adelaide, South Australia, and at flight level (FL) 353.[1] The flight crew contacted company engineering and operations staff and advised them of the situation.

The flight crew received a left engine low oil engine-indicating and crew-alerting system (EICAS) message and conducted the associated non-normal checklist. At about 1951, the flight crew shut the left engine down (Figure 1).

Figure 1: Flight data plot including oil pressure and engine shutdown



Source: Aircraft operator analysed by ATSB

1 Flight level: at altitudes above 10,000 ft in Australia, an aircraft's height above mean sea level is referred to as a flight level (FL). FL 353 equates to 35,300 ft.

The flight crew contacted air traffic control, declared a PAN[2] and conducted a diversion to Adelaide Airport, which was the nearest suitable airport. The flight crew commenced a gradual descent to FL 270, and were subsequently cleared for the area navigation (RNAV) approach to runway 05 at Adelaide. The aircraft landed without incident, and arrived at the parking bay at 2056. There was no damage to the aircraft or injuries to crew or passengers.

A subsequent engineering inspection found the left oil supply line to bearings numbers 4 and 5 had fractured and the associated clamp was broken (Figure 2).

Captain comments

The captain commented that the flight crew managed the situation in accordance with their procedures. The weather in Adelaide was beautiful and the aircraft performed well and handled exactly as it did in the simulator in training.

Engine manufacturer investigation

The manufacturer is investigating the following aspects:

- Turbine centre frame (TCF) Supply Tube 2061M79G02:
  - evaluating high cycle fatigue (HCF) capability of the TCF tube when a clamp is separated/broken
  - studying tube dynamic behaviour, due to broken clamps and its interaction with external components.
- Numbers 4 and 5 Oil Supply Tube 2034M68G01:
  - evaluating effects of missing piston ring and clamp separation on the external hardware
  - correlating finite element analysis (FEA) (stress analysis) with event findings
  - running analysis to verify integrity of current system.
- Clamp Damage:
  - mapping broken clamp findings from operator data and shop inspections
  - reviewing installation procedures and design characteristics and their effect.

Figure 2: Fractured oil supply line

Source: Aircraft operator

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2 PAN PAN: an internationally recognised radio call announcing an urgency condition which concerns the safety of an aircraft or its occupants but where the flight crew does not require immediate assistance.

Safety analysis

The left oil supply line to bearings numbers 4 and 5 fractured, resulting in a loss of oil and oil pressure from the left engine. The flight crew received a left low oil pressure warning and followed the associated checklists, shut down the left engine and diverted the aircraft to Adelaide.

Findings

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

- The oil supply line to bearings 4 and 5 fractured at a welded joint and its support clamp was broken, resulting in an oil leak and therefore low oil pressure and quantity in the left engine.
- Following the receipt of a left low oil pressure warning, the flight crew completed the non-normal checklist, shut down the left engine and conducted a diversion to Adelaide.

Safety action

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

Aircraft operator

The operator performed a fleet-wide inspection and found no leaks or cracks on any other engine.

Safety message

This incident provides an excellent example of effective crew resource management techniques when faced with an abnormal situation. Additionally, regular proficiency checks in the simulator including scenarios of a single engine failure allow flight crew to respond appropriately in the event of such an occurrence in flight.

General details

Occurrence details

Date and time:	7 September 2016 – 1940 CST	
Occurrence category:	Incident	
Primary occurrence type:	Engine failure or malfunction	
Location:	650 km NW of Adelaide Airport, South Australia	
	Latitude: 30° 11.37' S	Longitude: 134° 28.90' E

Aircraft details

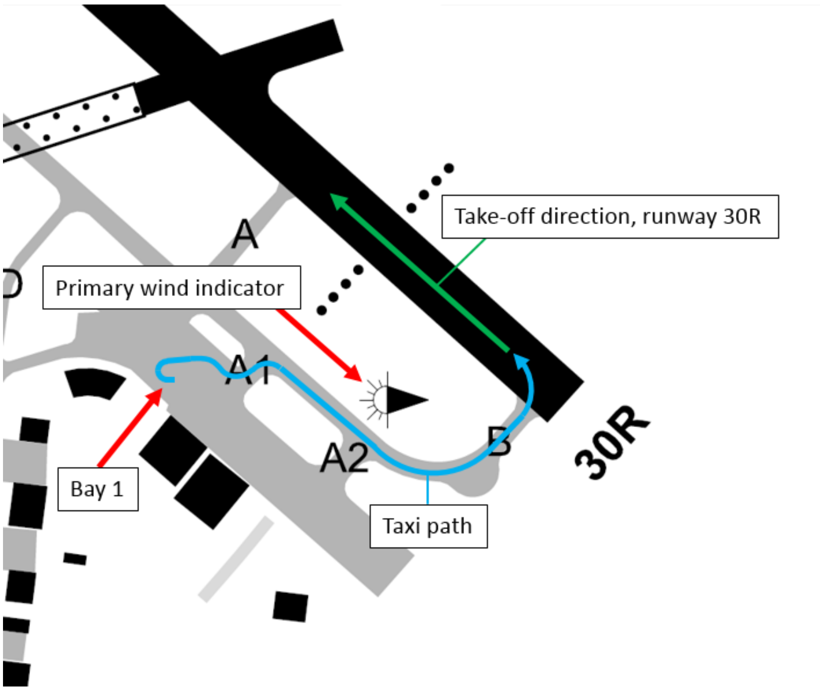
Manufacturer and model:	The Boeing Company 777	
Registration:	A6-EGA	
Operator:	Emirates	
Serial number:	38984	
Type of operation:	Air transport high capacity – passenger	
Persons on board:	Crew – 22	Passengers – 308
Injuries:	Crew – 0	Passengers – 0
Aircraft damage:	Minor damage to the left engine	

Take-offs without runway lighting involving Embraer ERJ-135, VH-JTG

What happened

On 19 August 2016, a JetGo Australia Embraer EMB-135LR, registered VH-JTG (JTG), operated scheduled passenger flight JG65 from Tamworth, New South Wales (NSW), to Brisbane, Queensland (Qld). At 2104 Eastern Standard Time (EST), the aircraft began to taxi from parking bay 1 to runway 30 right (30R) with the taxiway and runway lights not activated (Figure 1). At 2107, the captain taxied the aircraft onto the runway and immediately began the take-off run. During the take-off run, at a speed of about 70 knots, the first officer detected the runway lights were not illuminated and activated them using the pilot activated lighting (PAL) (Figure 2). The flight crew continued the take-off.

Figure 1: Taxi path overview (both incidents)



Source: Airservices Australia, modified by ATSB

Figure 2: Take-off run of JTG on 19 August showing runway lights not activated (left) and then activated (right)

Source: Airport Operator

On 28 August 2016, the same aircraft operated scheduled passenger flight JG65 from Tamworth to Brisbane. At 1937, the aircraft began to taxi from parking bay 1 to runway 30R. As the aircraft taxied, the runway and taxiway lights extinguished (Figure 3). The flight crew continued to taxi, lined up on runway 30R and selected the aircraft landing lights on. At 1940, 48 seconds after lining up, the aircraft began the take-off run and departed runway 30R with the runway lights not activated.

No persons were injured and the aircraft was not damaged in the incidents.

Figure 3: JTG taxiing on 28 August with runway lights illuminated (left) and then extinguished (right)

Source: Airport Operator

Runway and taxiway lighting

The taxiway and runway lighting at Tamworth Airport was controlled by a PAL system combined with an aerodrome frequency response unit (AFRU), known as AFRU + PAL. To activate the lights, pilots were required to transmit a sequence of three transmissions on the common traffic advisory frequency (CTAF). Each transmission was to have a maximum duration of 1 second with the break between transmissions being a maximum of 1 second. On receipt of the appropriate transmission sequence, the airport lights were activated and the AFRU broadcast the automatic message: 'Tamworth Airport CTAF, runway lighting on' on the Tamworth CTAF.

Once the AFRU + PAL system was activated, the airport lighting remained on for 30 minutes. If it was reactivated during this period, the lighting would remain on for 30 minutes from the time of reactivation. 10 minutes prior to the end of the 30-minute activation period, the primary wind indicator (windsock) lights commence flashing to warn users that the airport lighting is about to extinguish (Figure 4). In addition, an automated message 'Tamworth Airport CTAF, lights 10 minutes remaining' was broadcast on the CTAF to advise 10 minutes of runway lighting remaining.

Figure 4: Flashing primary wind indicator showing the windsock illuminated when the runway lights were active (left) and not illuminated (right)

Source: Airport Operator

On 19 August, at 2039, the AFRU broadcast ‘Tamworth Airport CTAF, lights 10 minutes remaining’, the lights then extinguished at 2049. At 2107, during the take-off run of JTG, the first officer broadcast an AFRU + PAL activation sequence on the Tamworth CTAF and the runway lights illuminated.

On 28 August, at 1928, the AFRU broadcast ‘Tamworth Airport CTAF, lights 10 minutes remaining’, the lights then extinguished at 1938. At 2007, an AFRU + PAL activation sequence was broadcast by another aircraft and the runway lights illuminated.

There was no indication that the AFRU + PAL system was malfunctioning on the nights of the incidents.

Captain comments

The same pilot was operating as captain of JTG during both incidents. The captain provided the following comments:

- The captain did not notice that the runway lights were extinguished during either incident and were not aware until notified after each incident.
- The taxiway lights at Tamworth are of the recessed centreline type. The taxi from bay 1 to runway 30R is over a rise. Therefore, only three to four taxiway lights are normally visible from the point at which you turn onto the taxiway. The captain remarked that the raised type taxiway side lights found at other airports are more easily visible.
- Wind information for pre-flight planning is obtained through the flight crew electronic flight bag or automatic weather information service (AWIS). Therefore, they will only observe the windsock as a back-up, if it is available and close.
- During turn-around between flights, the flight crew do not wear headsets and will not hear the 10 minutes remaining broadcast if it occurs during this time.
- The responsibility for ensuring the airport lighting would be active was not assigned to either flight crewmember. There was no procedure for ensuring the airport lighting would be illuminated for the departure.
- Both incidents occurred at the end of long duty days, so fatigue may have been a factor.

First officer comments – 19 August

The first officer of the 19 August incident provided the following comments:

- The tiller in the Embraer 135 is located on the captain’s side. Therefore the first officer always acts as pilot monitoring[1] (PM) during taxi. The taxi from bay 1 to runway 30R is short and a period of intense workload. During this time, the first officer did not look outside the cockpit.
- The first officer did not look outside of the cockpit until the aircraft began moving during the take-off run. Once they looked outside, they immediately felt that something was not right. About five seconds later, the first officer detected that the runway lights were not illuminated.
- The first officer was PM for this flight. As PM, they were able to quickly activate the PAL and resolve the issue, and did not consider aborting the take-off.
- The first officer used the take-off data card for wind information and did not look at the windsock prior to departure.

First officer comments – 28 August

The first officer of the 28 August incident provided the following comments:

- The first officer did not notice that the runway lights were extinguished and was not aware until notified after the incident.

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

- The primary wind indicator at Tamworth is situated so that it is illuminated by light from the adjacent apron lighting and a red obstacle light is located above the windsock. On subsequent flights to Tamworth, the first officer has observed that this gives the appearance of the windsock being illuminated when the runway lighting is extinguished (Figure 4).

Aircraft lighting

The Embraer 135 is fitted with three landing lights and two taxi lights. The combination of these lights provides a substantial amount of illumination in front of the aircraft.

The taxi lights are used from the beginning of taxi until after departure. Prior to commencing the take-off run, the landing lights are also selected on. The landing lights provide considerably more illumination than the taxi lights.

All flight crew described the aircraft lighting as extremely effective at illuminating the runway ahead of the aircraft and reported no controllability issues during the take-off runs.

Parking apron lighting

Prior to both incidents, the aircraft parked at bay 1 for the embarkation of passengers (Figure 5). This bay is substantially lit by apron floodlights. These lights are not part of the PAL system and remain illuminated when the PAL system extinguishes the runway and taxiway lights.

All three flight crew commented that the apron lighting degraded night-vision and the short taxi from bay 1 to runway 30R did not allow time for eyes to adjust to the dark surrounds of the runway.

Figure 5: JTG parked at bay 1

Source: Airport Operator

Environmental conditions

Last light[2] on 19 August 2016 occurred at 1757, three hours and ten minutes before the take-off. At 2017, the moon was 19 degrees above the horizon and about 99 per cent visible. There was a clear sky.

Last light on 28 August 2016 occurred at 1802, one hour and 38 minutes before the take-off. The moon was below the horizon and the sky was clear.

[2] Last light: the time when the centre of the sun is at an angle of 6° below the horizon following sunset. At this time, large objects are not definable but may be seen and the brightest stars are visible under clear atmospheric conditions. Last light can also be referred to as the end of evening civil twilight.

ATSB comment

Two different PAL systems exist at Australian airports, PAL and AFRU + PAL. The activation sequence for each system is different.

CTAF recordings for the period surrounding each incident showed multiple unsuccessful attempts by other aircraft to activate the AFRU + PAL using the sequence of transmissions for a PAL system.

AIP ERSA INTRO paragraphs 23.4 and 23.5 detail the differences between the two systems and the correct transmission sequence to activate each system.

While this did not contribute to the incidents, pilots are reminded to be familiar with the identification and use of the different systems.

Safety Analysis

The illumination provided by the aircraft taxi and landing lights made it difficult to detect that the PAL was not activated. Due to the rise on the taxiway, the crew would only have been able to see a few lights ahead of the aircraft, and these would have been illuminated by the aircraft lights. Adding to this, both crew did not have an expectation that the lights may have been extinguished as the cues available did not assist. The auditory 10-minute PAL extinguishing warning could not be heard without headphones, and the windsock flashing light warning was not noticed as the crew obtained wind information using the flight crew electronic flight bag or AWIS.

As the company standard operating procedures did not assign a task of ensuring the runway lights were selected on to a specific role prior to taxi, there was also no procedural prompt to the crew.

The short taxi with a high workload further reduced the chance of detection.

Findings

- The crew did not activate the airport lighting and did not detect that the lighting was off prior to the take-off run.
- Available lighting from the aircraft taxi and landing lights, a lack of crew expectation, a short taxi with high workload, and no assigned role or procedure to check for runway lighting resulted in the crew not detecting the lack of runway lights.

Safety action

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

Aircraft operator

As a result of these incidents, the aircraft operator has advised the ATSB that they are taking the following safety actions:

Changes to procedures

- When activating the aircraft taxi lights the pilots must ensure that they confirm the status of the PAL.
- When conducting night operations at an unmanned airport, the pilots must activate the PAL or AFRU + PAL by keying the microphone on the appropriate frequency unless the aircraft immediately ahead has already done so. For example, if the aircraft 10 minutes ahead has turned the lights on it will not be necessary to activate the lights again as the lights will normally remain on for a period of 30 to 60 minutes depending upon the installation.

- If no traffic is evident then the pilots must activate the PAL prior to taxi for departure and within 15 nm of the aerodrome and whilst above the lowest safe altitude for arrival.

Safety message

These incidents demonstrate the impact workload stress can have on operations. The short taxi created a high workload situation which impacted on the flight crews' ability to detect the extinguished runway lighting.

The incident on the 28 August also highlights the hazards associated with change blindness, inattention blindness and expectation bias.

Change blindness occurs when a person does not notice that something is different about the visual environment relative to before the change. Research has shown that in some cases, quite dramatic changes are not detected, particularly if changes occur when the observer is not looking at the relevant part of the visual environment at the time. In this incident the flight crew did not detect the runway lights extinguish during taxi prior to departure.

The Transport Canada article *Deadly Omissions* includes further information on change blindness, inattention blindness and expectation bias.

General details

Occurrence details – 19 August 2016

Date and time:	19 August 2016 – 2107 EST	
Occurrence category:	Incident	
Primary occurrence type:	Runway event	
Location:	Tamworth Airport, New South Wales	
	Latitude: 31° 05.030' S	Longitude: 150° 50.800' E

Aircraft details – 19 August 2016

Manufacturer and model:	Embraer - Empresa Brasileira De Aeronautica EMB-135LR	
Registration:	VH-JTG	
Operator:	JetGo Australia	
Serial number:	145687	
Type of operation:	Air transport low capacity - Passenger	
Persons on board:	Crew – 3	Passengers – 29
Injuries:	Crew – 0	Passengers – 0
Aircraft damage:	Nil	

Occurrence details – 28 August 2016

Date and time:	28 August 2016 – 1940 EST	
Occurrence category:	Incident	
Primary occurrence type:	Runway event	
Location:	Tamworth Airport, New South Wales	
	Latitude: 31° 05.030’ S	Longitude: 150° 50.800’ E

Aircraft details – 28 August 2016

Manufacturer and model:	Embraer - Empresa Brasileira De Aeronautica EMB-135LR	
Registration:	VH-JTG	
Operator:	JetGo Australia	
Serial number:	145687	
Type of operation:	Air transport low capacity - Passenger	
Persons on board:	Crew – 3	Passengers – 23
Injuries:	Crew – 0	Passengers – 0
Aircraft damage:	Nil	

Turboprop aircraft

Synthetic vision display error involving Pilatus PC-12, VH-OWA

What happened

On 18 June 2016, at about 0136 Western Standard Time (WST), the pilot flying and a check pilot (who was the pilot in command) of a Pilatus PC-12 47E aircraft, registered VH-OWA (OWA), prepared to conduct a medical retrieval flight from Meekatharra Airport to Paraburdoo, Western Australia, under the instrument flight rules.[1] Due to the remote area, the terrain surrounding the airport was dark, although the night was moonlit. The pilot flying was seated in the left seat, the check pilot in the right seat, and a flight nurse was also on board.

The pilot flying completed the pre-start, start and after-start checks. As the aircraft had been parked under a metal roof, the aircraft's two GPS units had not acquired enough satellites to complete their initialisation. The pilot flying therefore taxied the aircraft a short distance onto the taxiway before stopping. GPS 1 located all satellites as required, but GPS 2 failed to initialise and the crew received an UNABLE FMS-GPS MON caution message.[2] The pilot flying followed the quick reference handbook actions in response to that message, following which GPS 2 initialised and the caution cleared. The pilots then continued for a normal take-off from runway 09, at about 0145.

About 18 seconds after take-off, as the aircraft climbed through about 250 ft above ground level at an airspeed of about 110 kt, the pilots observed the radio altimeter (radalt) wind down to zero (see *Radio altitude*). The radalt low altitude awareness display rose to meet the altitude readout.

The synthetic vision image (see *Synthetic vision system*) on both pilots' primary flight displays (PFDs) then showed the runway move rapidly left and off the screen, and the ground representation on the PFD appeared to rise rapidly up to meet the zero pitch reference line (ZPRL).[3] As a result, the pilot flying pulled back on the control column and the flight data showed the flight path indicator (see *Aircraft reference symbols*) moved up to about 15°. No warnings or cautions were displayed, the stick shaker stall warning did not activate (as the aircraft angle of attack was not in the shaker range), and the crew did not receive any oral alerts from the terrain awareness and warning system (TAWS).

The pilot flying reported that the synthetic vision image created the impression that the aircraft was sinking rapidly towards the ground, and they responded by instinctively pulling back on the control column. There was no vestibular sensation[4] that the aircraft was descending, nor had there been any indication of a strong wind that may have caused the aircraft to drift off the runway centreline. The resulting sensory confusion caused the pilot flying to experience a level of motion sickness.

The check pilot immediately looked outside (there was no standby instrument on the right side of the cockpit), and was able to discern a visible horizon due to the moonlight. The check pilot cautioned the pilot flying that the aircraft had a nose-high attitude, which prompted the pilot flying to switch their focus to the electronic standby instrumentation system (ESIS) and closely monitor the attitude and the airspeed tape (see *Electronic standby instrumentation system*). The pilot flying

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1 Instrument flight rules (IFR): a set of regulations that permit the pilot to operate an aircraft to operate in instrument meteorological conditions (IMC), which have much lower weather minimums than visual flight rules (VFR). Procedures and training are significantly more complex as a pilot must demonstrate competency in IMC conditions while controlling the aircraft solely by reference to instruments. IFR-capable aircraft have greater equipment and maintenance requirements.

2 The monitor warning system continuously compares the positions between each FMS and each GPS and annunciates differences between any if the threshold is exceeded.

3 Zero pitch reference line is a true horizon tangential to the earth's surface but at the aircraft's altitude.

4 Sensation of body location, movement and balance controlled by the vestibular system of the inner ear.

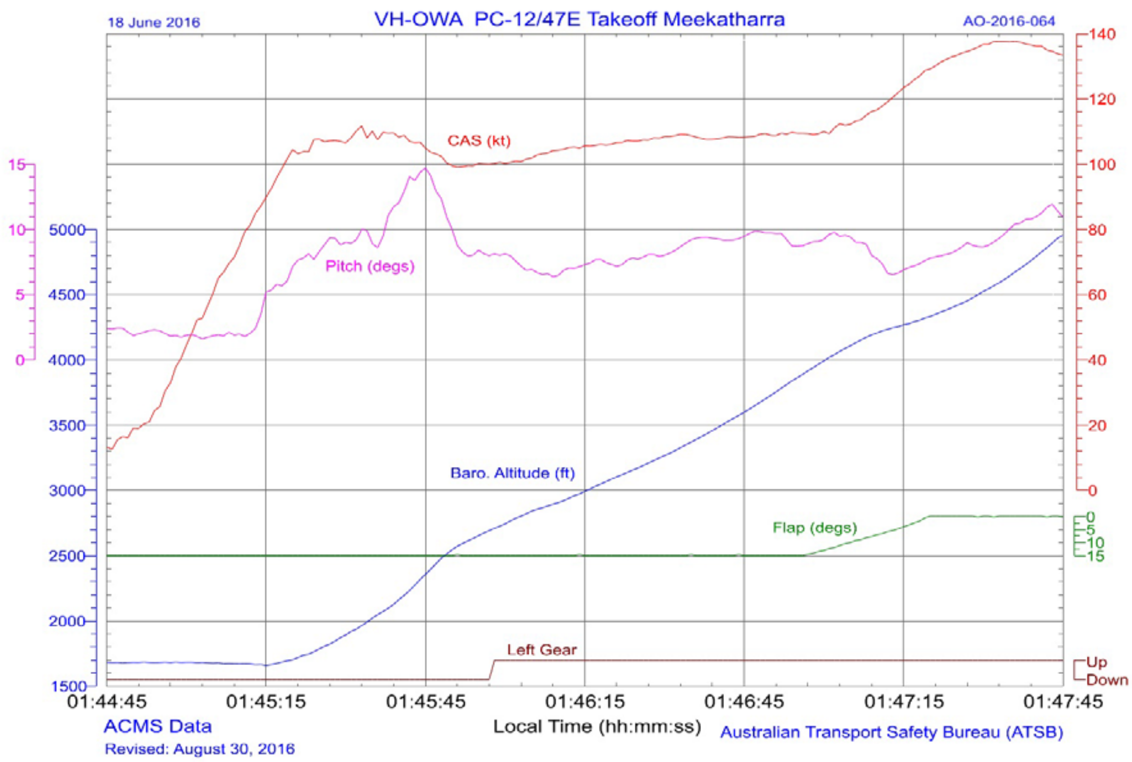
lowered the aircraft nose to regain an 8° pitch[5] attitude and the flight data showed that the airspeed, which had reduced to 101 kt, increased back to the target airspeed of 110 kt. The aircraft had continued to climb throughout the event.

Climbing through about 850 ft, the synthetic vision display corrected itself and all indications returned to normal. After retracting the landing gear and flap, the pilot flying deselected the synthetic vision mode on the left PFD. The check pilot continued to monitor the synthetic vision on the right PFD, and the issue did not recur during the flight. The aircraft subsequently landed at Paraburdoo Airport without further incident.

Flight data analysis

The flight data was downloaded from the aircraft condition monitoring system and analysed by the ATSB. Figure 1 depicts the calibrated airspeed and pitch angle from the start of the take-off roll. The change in pitch (pink line) from the pilot pulling back on the control column in reaction to the synthetic vision started at about 0145:30 in Figure 1.

Figure 1: Plot of selected data from the incident flight



Source: Aircraft flight data analysed by ATSB

Figure 2 shows the aircraft recorded GPS track, with the pink marker indicating the first significant increase in pitch attitude, and therefore the approximate point of radalt failure. The aircraft was then at about 250 ft above the runway.

5 The term used to describe the motion of an aircraft about its lateral (wingtip-to-wingtip) axis.

Figure 2: Deviation of OWA (travelling from left to right) from runway centreline showing the estimated point of the radalt failure (in pink)

Source: Google earth and aircraft flight data analysed by ATSB

Incorrect instrument indications

After the incident, an engineering assessment determined that both antennas associated with the radalt system (one for transmit and one for receive) had failed, and had been in service for over 9,000 hours. The antennas did not have a life limit, but were required to be replaced 'on condition', which essentially meant that the antennas remained in service until they failed. After consultation with the avionics manufacturer, engineers replaced both radalt antennas and also the radar transmitter/receiver. No subsequent similar event has occurred on the aircraft. The engineers also replaced the GPS 2 antenna due to slower than normal acquisition of satellite navigation after power up, and updated the GPS databases, although it was considered that these did not contribute to the incident.

The engineers reported that this failure of the radalt antennas was likely to have resulted in the radalt winding down to zero, and the radalt low altitude diagonal bars to appear on the altitude tape to show the aircraft was close to the ground (below 550 ft) (see Figure 4 in *Radio altitude* below). Additionally, the radalt information was used in conjunction with the runway (and obstacle) information in the database to provide the synthetic vision system display. This resulted in the runway appearing to rise up towards the aircraft reference symbol on the PFD.

The movement of the runway to the left of the screen was probably associated with a small displacement of the aircraft to the right of the runway centreline. The wind at the time was from 094° at 9–11 kt, therefore largely a headwind component and the lateral displacement of the aircraft was unlikely to be a result of the wind.

As the radalt senses that the aircraft is nearing the ground, smaller lateral deviations from the runway centreline generate significant movement of the synthetic vision runway image.

Radio altitude

The radalt display is shown in green numbers on the PFD when the radalt data is valid and less than 2,500 ft (Figure 6). If the radalt data becomes invalid, the radalt digital readout is replaced with a radar altitude data ('RAD') annunciator and an amber RA 1 FAIL crew alerting system ('CAS') message is displayed. The crew did not receive any annunciations during this incident to indicate that the radalt had failed.

When the altitude displayed on the radalt is below 550 ft above ground level, low altitude awareness is displayed using diagonal yellow lines (Figure 3). During this incident, the crew noticed that the low altitude awareness symbology was displayed.

Figure 3: Radalt low altitude awareness display

Source: Honeywell

Synthetic vision system

The synthetic vision system fitted to the aircraft is depicted in Figure 4. It supplies a three-dimensional view of surrounding terrain, obstacles and runways based on a terrain database. Normal attitude, altitude and airspeed information is overlayed on top of the terrain display. The TAWS terrain database provides geometric altitude (obtained from the GPS) in order to display synthetic vision terrain and terrain related items such as runways and obstacles. During this incident, the synthetic vision system provided no failure annunciations.

Figure 4: Synthetic vision system example display

Source: Honeywell

Figure 5 shows a sample image of the runway scale for an aircraft on final approach for reference.

Figure 5: Synthetic vision runway display on approach (at low altitude)

Source: Honeywell

The synthetic vision system was not to be used for primary input or navigation, with the following warning issued by Honeywell in the Pilot's Guide (used by the operator) to the avionics system:

> **WARNING**
>
> SYNTHETIC VISION SHOULD NOT BE USED FOR PRIMARY NAVIGATION, NOR SHOULD THE FLIGHT CREW RELY SOLELY ON SYNTHETIC VISION TO AVOID TERRAIN OR OBSTACLES.

A similar warning was contained in the Primus Apex Smart View supplement to the aircraft flight manual.

Both crew reported they were aware that the synthetic vision should not be used for primary navigation. When installed, the synthetic vision system is automatically activated at start-up but can be deselected by the pilot.

Aircraft reference symbols

The pilot flying was using the flight path indicator on the synthetic vision system. This consists of the flight director command bars (magenta symbol in Figure 6) and the flight path aircraft reference symbol (green symbol in Figure 6). The flight path indicator is a path-based mode and depicts the aircraft's predicted flight path (not just aircraft pitch) and is affected by pitch attitude and the aircraft's ground speed. It shows flight path angles[6] – up for increasing and down for decreasing flight path angles, whereas the traditional pitch-based mode depicts aircraft pitch angle. The flight path angle depicted in Figure 6 is -4°.

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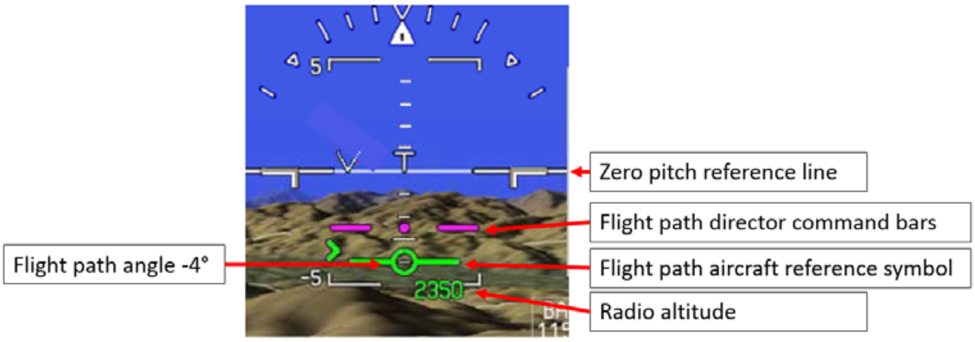
6 The flight path angle is the angle between horizontal and the flight path (or velocity) vector, which describes whether the aircraft is climbing or descending.

Figure 6: Synthetic vision and flight path indicator symbols



Source: Honeywell

Electronic standby instrumentation system

An electronic standby instrumentation system (ESIS) (or electronic standby indicator (ESI)), was fitted to the left of the pilot flying's PFD. Figure 7 shows the pilot's side PFD with the ESIS to the left of the main screen in another Pilatus PC-12 aircraft (not OWA). Note in this photo, the synthetic vision is on and the aircraft is over water.

Figure 7: Electronic standby indicator and main PFD in flight (not OWA)

Source: ATSB

Pilot comments

The two pilots were highly experienced; the pilot flying had over 11,000 hours total aeronautical experience and over 2,600 on the aircraft type, and the check pilot had over 15,000 hours total experience and 3,000 hours on type.

Both pilots commented that they had previously experienced failure of primary flight instruments at low level and at night in different aircraft (without synthetic vision systems). They had been able to disregard the erroneous or failed instruments and reference the standby instruments to maintain control of the aircraft and situational awareness. However, the prominence of the synthetic vision display is such that it is difficult to ignore erroneous information and locate valid information. Additionally, the pilot flying reported feeling a level motion sickness, probably associated with the combined effects of the prominent synthetic vision display and conflicting vestibular sensory information.

The combination of the runway and the radalt speed tape moving up gave the very strong illusion that the aircraft was going to hit the ground. The pilot flying reported that they realised something was wrong but could not initially figure out what it was. The image of the ground rising up and the runway disappearing rapidly sideways took the focus of the pilot flying away from anything else.

The pilot flying commented that the check pilot's caution 'attitude' helped to redirect the pilot flying's attention to the standby indicator. The check pilot could not easily see the standby indicator. Both pilots commented that the situation may have been more serious if operating single pilot or if they had already flown more sectors that night and been more tired.

The pilots commented that it was impossible to discern the valid attitude information on the PFD (overlaid on top of the synthetic vision) and revert to flying 'power and attitude' given the prominence of the erroneous synthetic vision information. While it is possible to deselect the synthetic vision, it requires two button presses or the use of the cursor control device to do so. That is very difficult to do at low level while maintaining control of the aircraft – keeping the right hand on the thrust lever and the left hand on the control column.

The Pilot Advisory Letter issued in response to this incident (see *Safety action*) reminded pilots to look at the primary flight indications presented on the PFD at all times. The pilot flying commented that it should refer pilots to the standby attitude indicator instead. The screen at the time of failure was simply too confusing to start looking for two small, white attitude bars. Similarly, to break the fixation on the erroneous information, it is important to look somewhere else at a different instrument – the standby indicator.

Most of the pilots' training is done on board the aircraft, as they do not have access to a Pilatus PC-12 simulator. Although some system failures can be simulated, it is not possible to generate a false display as occurred in this incident.

Spatial disorientation

Spatial disorientation can occur when visual cues provide sensory inputs that are not matched by the motion sensed by the pilot through the vestibular senses. The discrepancy between the visual display showing the aircraft apparently descending towards the ground, and the lack of any consistent physical sensation, led to disorientation. The flight was conducted at night, and the pilot flying did not look outside for a visual reference. The check pilot did look outside and found that there was enough moonlight to provide some visual reference, sufficient to show the aircraft pitch and roll attitudes relative to the horizon.

ATSB research report *'An overview of spatial disorientation as a factor in aviation accidents and incidents'* describes this type of spatial disorientation as 'recognised'. That is, the pilot identified that they were sensing erroneous information. The conflict between their own perceptions and that given by the instruments alerted them to a problem, which they were then able to address. However, the crew reported feeling some level of disorientation stress, or motion sickness, which is indicative of a disagreement between the senses.

The visual system provides around 80 per cent of orientation information, hence the overriding presence of incorrect visual information deprived the pilots of the majority of orientation information.

Other factors such as tiredness or fatigue, and high workload, can contribute to a pilot's ability to assess and effectively deal with spatial disorientation. Both pilots commented that they wanted to share their experience because if they had been operating single pilot or near the end of a long shift, recovery from the instrumentation failure may have been much more difficult.

In addition, if the outside light conditions had been completely dark due to a lack of any moonlight in an area without terrain lighting, or the aircraft was in cloud, recognition of the spatial disorientation would have been reliant on the pilots being able to either extract the basic attitude, altitude and airspeed information from the primary display ignoring the background image, or revert to the accurate information depicted on the smaller standby indicator.

Pilots operating under instrument flight rules are trained to focus their attention on the visual information presented by the aircraft instruments and to 'believe' that information rather than the sensory information from the vestibular system, which can provide misleading cues.

The ATSB research report further states that:

> *…instrumentation should present a clear and intuitive sense of position, which the pilot under conditions of high stress and workload can instantly achieve an idea of what the aircraft is doing.*
>
> *Failure of the aircraft instruments should hopefully never occur. However, in the event that it does, the pilot needs to receive clear and non-ambiguous indications of instrument failure. If a key instrument fails, such as the attitude indicator, the pilot needs to know that it has failed so they no longer depend on its information.*

Manufacturer investigation

An investigation by the synthetic vision system manufacturer, Honeywell, found that the radio altimeter sent incorrect radio altitude data to the synthetic vision system while still indicating that the data was valid. Therefore, the synthetic vision display system continued to display the terrain information using incorrect data.

Safety action

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

Aircraft operator

The aircraft operator has advised the ATSB that they have taken safety actions including the following:

- Engineering replaced the RADALT aerials across the fleet.
- The minimum equipment list has been amended to include synthetic vision.
- Flight crew were alerted to the potential hazard of a synthetic vision failure during flight through a safety communication on 1 July 2016. The potential for confusion or spatial disorientation during an event, particularly at night or in low visibility environmental conditions was highlighted.
- The event has been discussed by the Training and Check Department. They are reviewing the possibilities of incorporating scenarios related to ambiguous/incorrect information from the primary flight display into check flights and have commenced trialling a scenario.

Honeywell – avionics manufacturer

As a result of this occurrence, the avionics system manufacturer has advised the ATSB that they are taking the following safety actions:

Pilot advisory letter

Honeywell issued a Pilot Advisory Letter (PAL-APEX-01) to all pilots, chief pilots and flight operations managers on 11 August 2016. The letter included a description of the event. The letter also advised pilots that the use of synthetic vision is for situational awareness and should not be utilised for the indication of attitude or altitude in lieu of the primary flight display indications for pitch, roll, yaw, or altitude. The letter advises pilots to follow the primary flight indications presented on the PFD at all times.

The letter was also made available on the Pilatus ‘mypilatus’ website and all subscribers to that website were notified by email.

System solution

Honeywell is investigating ways to make the synthetic vision system more robust against a similar failure. The focus of their investigation is to prevent the synthetic vision display from continuing to display the image when the data is incorrect but assessed as valid by the Radalt.

Safety message

Incorrect instrument indications that are not associated with a failure mode present pilots with a complex and challenging situation. This situation may be exacerbated during single-pilot (rather than multi-crew) operations, where there is a lack of external visual references (such as at night or in instrument meteorological conditions), under high pilot workload conditions, or where a pilot is experiencing an elevated level of fatigue.

The image of terrain on the primary flight display is powerful and compelling. This incident highlights the manner in which an inaccurate synthetic vision image can rapidly lead to a degree of spatial disorientation. Pilots need to ensure that they are familiar with the limitations of the synthetic vision system and how to effectively deal with erroneous information as well as system failure modes. Organisations that operate aircraft fitted with similar technology should ensure that appropriate information and training is available to pilots, including when and how it should be used when it is not approved for primary navigation.

General details

Occurrence details

Date and time:	18 June 2016 – 0147 WST	
Occurrence category:	Serious incident	
Primary occurrence type:	Technical systems – Avionics/Flight Instruments	
Location:	Meekatharra, Western Australia	
	Latitude: 26° 36.70’ S	Longitude: 118° 32.87’ E

Aircraft details

Manufacturer and model:	Pilatus Aircraft PC-12	
Registration:	VH-OWA	
Serial number:	1115	
Type of operation:	Aerial Work - EMS	
Persons on board:	Crew – 2 (flight crew) 1 (flight nurse)	Passengers – 0
Injuries:	Crew – 0	Passengers – 0
Aircraft damage:	Nil	

Severe turbulence involving Bombardier DHC-8, VH-LQM

What happened

On 10 October 2016, a QantasLink Bombardier DHC-8-402, registered VH-LQM, conducted a scheduled passenger flight from Melbourne, Victoria, to Canberra, Australian Capital Territory. On board the aircraft were two flight crew, two cabin crew and 70 passengers. The captain was the pilot flying (PF) and the first officer was the pilot monitoring (PM).[1]

During the pre-flight briefing at Melbourne Airport, the flight crew noted there was severe turbulence and severe mountain wave turbulence in the area forecast[2] and SIGMET[3] for their descent and approach to Canberra. They briefed the cabin crew to be prepared for a quick cabin service and that the seat belt sign would be activated early on the approach due to the forecast turbulence.

The aircraft departed from Melbourne at about 1158 Eastern Daylight-saving Time (EDT) and climbed to a cruising level of FL 210.[4] The flying conditions were smooth at FL 210 and the flight was issued with the POLLI FOUR ALPHA standard arrival route into Canberra, which started at waypoint POLLI, to the south west of Canberra (Figure 1). The flight crew instructed the cabin crew to prepare the cabin for landing several minutes before the top of descent. However, the flying conditions continued to be smooth during the descent, so the flight crew waited until about FL 130 before activating the seatbelt sign. This was shortly after passing waypoint POLLI.

Between waypoints GOMAN and HONEY, the aircraft descended below FL 110 and the PF reduced the aircraft speed to 210 kt, which is the best speed for turbulence penetration. The PM estimated that the tailwind component reduced from about 70 kt to about 40 kt after the descent below FL 110. At this point, the aircraft was tracking about 060° and passing in and out of cloud over the Brindabella Ranges, which has ridgelines orientated north-south to the south-west of Canberra.

During the descent, the flight crew did not observe any weather radar indications of potential turbulence or visible indications from the shape or movement of the clouds. Between waypoints HONEY and DALEY at about 7,000 ft AMSL, while passing through a small cloud, the aircraft dropped abruptly. The flight crew reported that everything in the flight deck became airborne, the autopilot disengaged and the PF struck the left side of their head on the overhead air-vent and light, which dislodged their headset. The captain handed control over to the first officer while they refitted their headset and re-established communications, then resumed their flying pilot role and reset the auto-pilot.

The flight crew continued the approach to land at Canberra without further incident and notified Canberra air traffic control of their severe turbulence encounter on the approach. After the aircraft landed, the PM contacted the cabin crew to check if there were any cabin injures to report. The cabin crew indicated they were uninjured and made a public address to the passengers to check

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

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

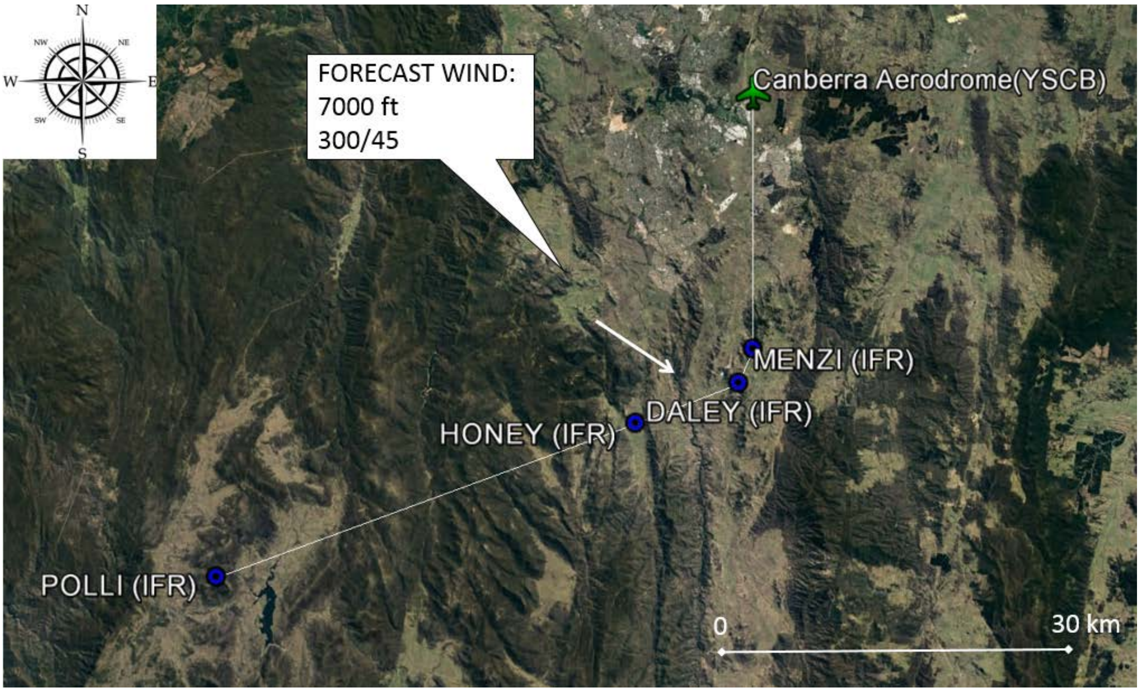
3 Significant meteorological information (SIGMET): a weather advisory service that provides the location, extent, expected movement and change in intensity of potentially hazardous (significant) or extreme meteorological conditions that are dangerous to most aircraft, such as thunderstorms or severe turbulence.

4 Flight level: at altitudes above 10,000 ft in Australia, an aircraft's height above mean sea level is referred to as a flight level (FL). FL 210 equates to 21,000 ft.

for injuries. The PM then called their company to inform them the aircraft was unserviceable after a severe turbulence incident, and also noticed the captain's minor injuries.

During the disembarkation of the passengers, the cabin crew informed the first officer that one passenger had hit their head on the overhead baggage locker. The first officer then asked a company ground agent to contact the emergency services so the passenger could be checked. However, the passenger declined treatment. The emergency services arrived and checked the captain. The captain was then advised by the company to visit a doctor where they were diagnosed with minor injuries.

Figure 1: POLLI FOUR ALPHA arrival track of VH-LQM



Source: Google earth, annotated by ATSB

Flight data recorder

The flight data recorder showed that as the aircraft descended through about 7,800 ft the aircraft was in a stable descent maintaining 210 kt and heading 042°. As the aircraft descended through about 7,300 ft the airspeed peaked at about 240 kt and the vertical acceleration oscillated rapidly between a maximum of +1.6G,[5] minimum of -1G, then maximum of +1.6G before returning to +1G.

Maintenance inspection

After landing, the captain raised a defect report in the maintenance technical log for the severe turbulence encounter. Inspections were then conducted for the severe turbulence assessment. No defects were found and the aircraft returned to service on 12 October 2016.

Weather forecast

The weather forecast for the Canberra area, issued for the period from 0840 to 2200 EDT on 10 October 2016 included severe turbulence below 12,000 ft and severe mountain wave turbulence above 5,000 ft. The wind was forecast as follows:

- 10,000 ft, from 300° at 60 kt

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5 G load: the nominal value for acceleration due to Earth gravity. In flight, g load represent the combined effects of flight manoeuvring loads and turbulence and can have a positive or negative value.

- 7,000 ft, from 300° at 45 kt
- 5,000 ft, from 290° at 30 kt.

Mountain waves

Mountain waves may be experienced on the lee-side of mountain ranges as smooth undulating airflow or may contain turbulence in the form of breaking waves and rotors (Figure 2). They typically form when the wind direction is close to perpendicular to a ridge line (+/-30°), the wind speed is at least 15 kt[6] and increases with height, and there is stable air above the crest of the ridge with less stable air above that and a stable layer below the ridge. The formation of clouds on the lee-side may indicate turbulent flying conditions. Further information can be found in the ATSB website safety publications: *Mountain wave turbulence*.

Figure 2: Mountain wave turbulence

Source: US Federal Aviation Administration

Flight crew harnesses

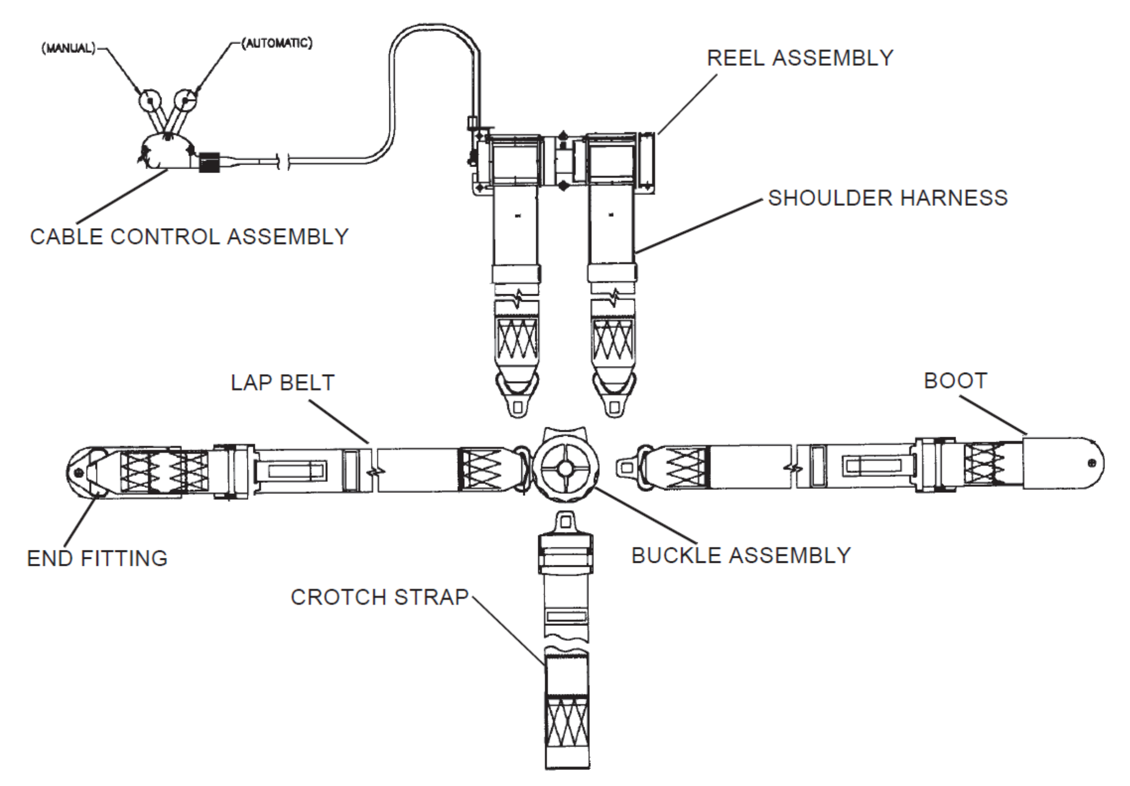
The aircraft's flight crew seats are fitted with five point harnesses. The harness consists of a lap belt, a rotary buckle, a crotch strap, two shoulder straps and inertia-reel assembly with emergency locking retractors and cable control assembly (Figure 3). At the time of the turbulence, both flight crewmembers had the five points of their harnesses fitted, but with their shoulder harnesses in the AUTOMATIC position. In the AUTOMATIC position, the shoulder harness inertia-reel permits the occupant to move forward slowly, but locks when the straps are pulled at 1.5G and remains locked until the force is removed. In the MANUAL position, the shoulder straps are locked. The shoulder harness is primarily intended to mitigate forward movement of the torso and head.

The lap belt combined with the crotch strap are the primary means of restraint for turbulence encounters and exposure to negative-G forces. The crotch strap is also referred to as the 'negative-G strap' and its purpose is to reduce upward movement of the lap belt during negative-G aircraft motion. The length of the crotch strap should be adjusted such that no slack exists in the strap when the lap belt is properly positioned in the pelvic region. In this position, the crotch strap will resist the upward pull from the shoulder harness in negative-G.

When the aircraft encountered the negative-G turbulence, the captain felt the aircraft drop from underneath them and struck their head on the overhead air-vent and light. The captain and first officer reported that they had their lap belts tightened to 'firm but comfortable'. The first officer reported that they may have hit their head on the ceiling of the flight deck, but received no injuries. The captain reported that some crotch straps do loosen during flight. The captain also advised that they had set their seat height so their eyes were lined up with height bar markers on the screen. They estimated that provided them with about 20-25 cm head clearance.

[6] This number varies between references with a lower limit of 15 kt and upper limit of 25 kt cited.

Figure 3: Aircraft flight crew harness



Source: Operator

Safety analysis

The flight crew had briefed and prepared the aircraft for flight in forecast severe turbulence.

As the aircraft tracked from waypoint HONEY to DALEY, it entered the lee-side of the Brindabella Ranges, tracking towards the north-east with a strong tailwind component. The wind was forecast to be 30 kt at 5,000 ft, increasing to 45 kt at 7,000 ft and within 30° of perpendicular to the ridgeline, at this location. Therefore, the abrupt encounter with turbulence was probably the result of mountain wave activity.

During the encounter, the flight crew described their movement relative to the aircraft as vertical when the aircraft dropped from underneath them. The primary method of restraint for negative-G is the lap belt supported by the crotch strap. If there is slack in the lap belt, this will permit the body to move up relative to the lap belt, and if there is slack in the crotch strap, this will permit the lap belt to move up if it is pulled upwards by the shoulder harness. The captain reported that the crotch strap can loosen with occupant movement and the aircraft was subject to minor fluctuations in G before the turbulence incident. Therefore, the captain's injury was probably the result of some measure of slackness in their crotch strap.

Findings

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

- The severe turbulence incident was probably an encounter with mountain wave activity in the lee-side of the Brindabella Ranges.
- The captain was probably insufficiently restrained by their crotch strap to prevent them striking their head during the encounter with turbulence.

- The flight crew were prepared for the risk of an encounter with severe turbulence during the descent and approach to Canberra.

Safety message

This incident highlights the importance of flight crew preparation for entry into an area of forecast turbulence and the importance of ensuring the correct adjustment of all harness straps. The captain planned to activate the seat belt sign early on the descent into Canberra and briefed the cabin crew accordingly. On descent into Canberra, all personnel were seated, the seat belt sign was activated and the aircraft speed reduced to turbulence penetration speed before the encounter with severe turbulence, which minimised the risk of injury to personnel and damage to the aircraft. However, despite the precautions taken by the crew, the captain received minor injuries.

Further information on flight crew harnesses can be found in United States Federal Aviation Administration Advisory Circular 21-34: *Shoulder harness – safety belt installations*.

General details

Occurrence details

Date and time:	10 October 2016 – 1240 EDT	
Occurrence category:	Serious incident	
Primary occurrence type:	Weather – turbulence / windshear / microburst	
Location:	30 km south of Canberra Airport, Australian Capital Territory	
	Latitude: 35° 34.27’ S	Longitude: 149° 7.43’ E

Aircraft details

Manufacturer and model:	Bombardier Incorporated DHC-8-402	
Registration:	VH-LQM	
Operator:	Sunstate Airlines (QLD) PTY LTD (Operating as QantasLink)	
Serial number:	4450	
Type of operation:	Air transport high capacity - Passenger	
Persons on board:	Crew – 4	Passengers – 74
Injuries:	Crew – 1 (minor)	Passengers – 0
Aircraft damage:	Nil	

Piston aircraft

Wheels up landing involving Cessna 210, VH-UPN

What happened

At 1433 Western Standard Time (WST), on 10 October 2016, a Cessna 210N aircraft, registered VH-UPN (UPN), departed Fitzroy Crossing, Western Australia (WA), for a passenger charter flight to Broome Airport, WA. On board were a pilot and three passengers.

At about 80 NM from Broome, the pilot began a descent from the cruising altitude of 8,500 ft. At 1540, as the aircraft approached 15 NM from Broome, Broome air traffic control (ATC) cleared UPN to conduct a straight-in approach to runway 28. The pilot manoeuvred the aircraft to join a 10 NM final approach to runway 28.

At 1545, passing 5 NM from Broome Airport, the pilot reported they levelled the aircraft at 1,000 ft and conducted the pre-landing checklist in accordance with operator procedures. The pre-landing checklist included selecting the landing gear down and confirming that the landing gear was extended. At about 1547, an individual located under the approach path to runway 28, about 800 m from the runway 28 threshold, observed a Cessna 210 on approach with the landing gear retracted. The individual contacted a member of Broome Airport operations to notify them of the sighting, however, the notification was not received until after the incident.

At 1548, the aircraft touched down on runway 28 with the undercarriage retracted (Figure 1). The aircraft slid along the runway on the underside of the fuselage before stopping. After the aircraft stopped, the pilot contacted ATC to request assistance. The pilot then raised the flaps to provide a clear evacuation path for the passengers. After raising the flaps, the pilot shut the aircraft down, selected fuel off and assisted the passengers with exiting the aircraft.

No persons were injured in the incident and the aircraft sustained minor damage.

Figure 1: UPN after the wheels-up landing

Source: Aircraft operator

Pilot comments

The pilot of UPN provided the following comments:

- The pilot's roster required them to operate both the fixed landing gear Cessna 206 and the retractable landing gear Cessna 210. They found this difficult and felt that this may have contributed to the landing gear not being selected down prior to landing.
- Prior to departure, the pilot operated a flight from Broome to Fitzroy Crossing. The pilot initially planned to spend 30 minutes at Fitzroy Crossing, however late passengers delayed departure by about 50 minutes. The temperature at Fitzroy Crossing during this time was 41 degrees. The pilot was able to spend about 10 minutes of this time in an air-conditioned caravan, but the rest of the time was spent outside in the heat. A full bottle of water was consumed during this time, however, at the time of departure the pilot reported feeling agitated and slightly dehydrated.
- Prior to landing, as the aircraft passed over the runway threshold, at a height of about 50-100 ft, the pilot reduced engine power to idle. The pilot reported that they did not hear the landing gear unsafe warning horn prior to the landing.
- The pilot may have only completed the pre-landing checklist mentally without actually performing the required actions.
- The pilot felt that ATC personnel should have checked to confirm that the aircraft's landing gear was extended prior to the aircraft landing.
- While shutting down and securing the aircraft after the incident, the pilot may have selected the landing gear down.
- After exiting the aircraft, the pilot observed the landing gear to be slightly extended and resting on the runway surface.

Operator report

The operator provided a report with the following comments:

- An engineering inspection conducted after the incident found no fault with the landing gear system or landing gear unsafe warning system.
- The damage to the underside of the fuselage and absence of damage to the landing gear indicated the landing gear was fully retracted during the landing.
- After the landing, the propeller pitch control was found approximately 5 cm from the high-RPM position, the fuel selected off, the flaps retracted and the landing gear selector in the down position.
- During straight in approaches, pilots are trained to select landing gear down at 5 NM from the destination airport and to complete the pre-landing checks at 3 NM if not already complete. Once established on final approach, pilots are trained to conduct a final check. This final check includes selecting the propeller pitch control to high-RPM, confirming the undercarriage is selected down and selecting full flaps. The final check is not included in the company operating procedures or aircraft checklists.
- The pilot was wearing a noise cancelling type headset, which may have prevented them from hearing the landing gear unsafe warning horn.
- Broome Airport ATC personnel did not detect that the landing gear had not been extended.

Landing gear warning system

The Cessna 210 is fitted with a landing gear warning system. This system is designed to help prevent a pilot landing with the landing gear retracted. The system will activate when engine power is reduced below about 12 inches of manifold pressure and the landing gear is not down and locked. When activated, the system emits an intermittent tone through the cabin speaker.

Air traffic control procedures

The provider of air traffic services within Australia, Airservices Australia, procedures require a controller to confirm the undercarriage is extended for a civil aircraft when:

- Doubt exists as to whether the aircraft's landing gear is fully extended.
- Issuing a landing clearance to a general aviation aircraft with retractable undercarriage that has experienced abnormal operation.

The controller on duty at the time of the incident acted in accordance with ATC procedures. The controller also reported that they checked the aircraft while it was on final approach and did not detect anything unusual.

Airservices Australia advised that if anything unusual is detected by a controller, the pilot in command will be notified.

Safety analysis

The aircraft was observed on final approach with the landing gear retracted. The pilot commented that after exiting the aircraft the landing gear was found sagging against the runway surface. However, the absence of damage to the nose landing gear doors and the main landing gear legs and tyres indicated that the landing gear was fully retracted when the aircraft landed.

The propeller control was found positioned about 5 cm from the high RPM position required by the final approach check. This was a position consistent with a cruise and approach setting. Therefore, the pre-landing checklist and final approach check were likely not completed resulting in the aircraft landing with the landing gear selected up.

The operator did not have a documented distance from the airport by which the pre-landing checklist should be completed and the final approach check had also not been documented. Such measures increase the chance a pilot will detect incomplete pre-landing checks.

The pilot reported that they did not hear the landing gear warning system prior to the landing. The pilot reduced engine power to idle at a height of about 50-100 ft and glided to the landing. The system should have activated to alert the pilot to the retracted landing gear. The pilot's noise-cancelling headset may have prevented the landing gear warning tone from being heard.

Findings

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

- The pilot did not complete the pre-landing checklist and the final approach checks resulting in the aircraft landing with the landing gear retracted.
- The operator's procedures did not define a distance where the pre-landing checks should be completed and the final approach checklist was not documented.
- The landing gear warning system did not alert the pilot to the retracted landing gear, probably as the pilot was wearing a noise-cancelling headset.

Safety action

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

Aircraft Operator

As a result of this occurrence, the aircraft operator has advised the ATSB that they are taking the following safety actions:

Change to operating procedures

The final approach check has been added to the company operating procedures and aircraft checklists and a distance has been added to the pre-landing checklist to specify when the pre-landing checks should be completed.

Pilot training

Company pilots have been reminded to confirm the position of the landing gear during the pre-landing and final approach checks on all company aircraft, regardless landing gear type. This assists in building well established routines for operating aircraft with retractable landing gear.

Safety message

This incident provides a good example of the importance of checklist vigilance. Checklists are designed to ensure that flight crew properly configure the aircraft for any given phase of flight. Regular routine flying can lead to checklists, which are regularly completed, being conducted mentally without the required actions being completed. Vigilance is required to ensure that each checklist is completed correctly and in full.

Pilots should also familiarise themselves with the expected performance of an aircraft for a given power setting, configuration and loading. Extending the landing gear creates an increase in drag which must be balanced by an increase in engine power to maintain a given flight path. When aircraft performance deviates from expectations this may be an indication that aircraft configuration is not correct, such as landing gear remaining retracted when the phase of flight requires it to be extended. This should act as a trigger for the pilot to confirm the configuration of the aircraft.

The Flight Safety Australia article *Those who won't: avoiding gear-up landings* includes the following information to assist pilots in avoiding gear up landings:

> Most retractable landing gear aeroplanes have landing gear warning systems, but there are normal flight situations where warning systems won't help.
>
> For instance, most gear warning horns are rigged to sound when the throttle is brought to idle if the gear is not down. But if you use power to touchdown, which many pilots do in windy conditions, or to cushion even a normal landing, the gear warning horn will not sound. In some aeroplanes the gear warning also sounds if the flaps are fully down when the gear is not. This warning only works, however, if you select full flaps. Some pilots don't use full flaps for every landing, especially in windy conditions, and in these cases the warning will not sound.
>
> In some aeroplanes the gear warning also flashes an annunciator on the instrument panel. Pilots generally focus their attention outside the aeroplane on final approach, however, and may not see a cockpit warning. Conditions that prevent the gear warning horn from sounding will also inhibit the annunciator light.
>
> If you make full-stall landings you get used to hearing the stall warning horn on touchdown. You may not notice the difference between a steady stall warning and the intermittent gear advisory.
>
> Lastly, modern noise-cancelling headsets often prevent the pilot from hearing a warning horn, unless the aeroplane has been modified to pipe the warning through the intercom.

General details

Occurrence details

Date and time:	10 October 2016 – 1548 WST	
Occurrence category:	Serious incident	
Primary occurrence type:	Wheels up landing	
Location:	Broome Airport, Western Australia	
	Latitude: 17° 56.98’ S	Longitude: 122° 13.67’ E

Aircraft details

Manufacturer and model:	Cessna Aircraft Company 210	
Registration:	VH-UPN	
Serial number:	21064125	
Type of operation:	Charter - Passenger	
Persons on board:	Crew – 1	Passengers – 3
Injuries:	Crew – 0	Passengers – 0
Aircraft damage:	Minor	

Engine failure and collision with terrain involving Ryan Aeronautical Company STA-SPL, VH-SQD

What happened

On 15 November 2016, at about 1150 Eastern Daylight-saving Time (EDT), a Ryan STA-SPL aircraft, registered VH-SQD, departed from Tyabb aircraft landing area (ALA), Victoria, for a private local pleasure flight. The pilot was the sole occupant of the aircraft.

About 10 minutes after take-off, when at about 1,000 ft above mean sea level, the aircraft's engine suddenly stopped, then briefly restarted and then stopped again. The pilot conducted a forced landing into a field. The aircraft landed heavily and with a tailwind, and the pilot assessed that the aircraft may not slow down sufficiently before a fence up ahead. The pilot therefore used the available airspeed to take-off again and fly the aircraft about 15 ft over the fence. The pilot aimed the aircraft's wing at a tree to reduce the remaining speed and ensure it stopped prior to a major freeway. The aircraft collided with the tree, then the ground and was substantially damaged (Figure 1). The pilot sustained a minor injury.

Figure 1: Accident site showing damage to VH-SQD

Source: Victoria Police

Engineering report

A post-accident inspection found no evidence indicating the cause of the engine failure.

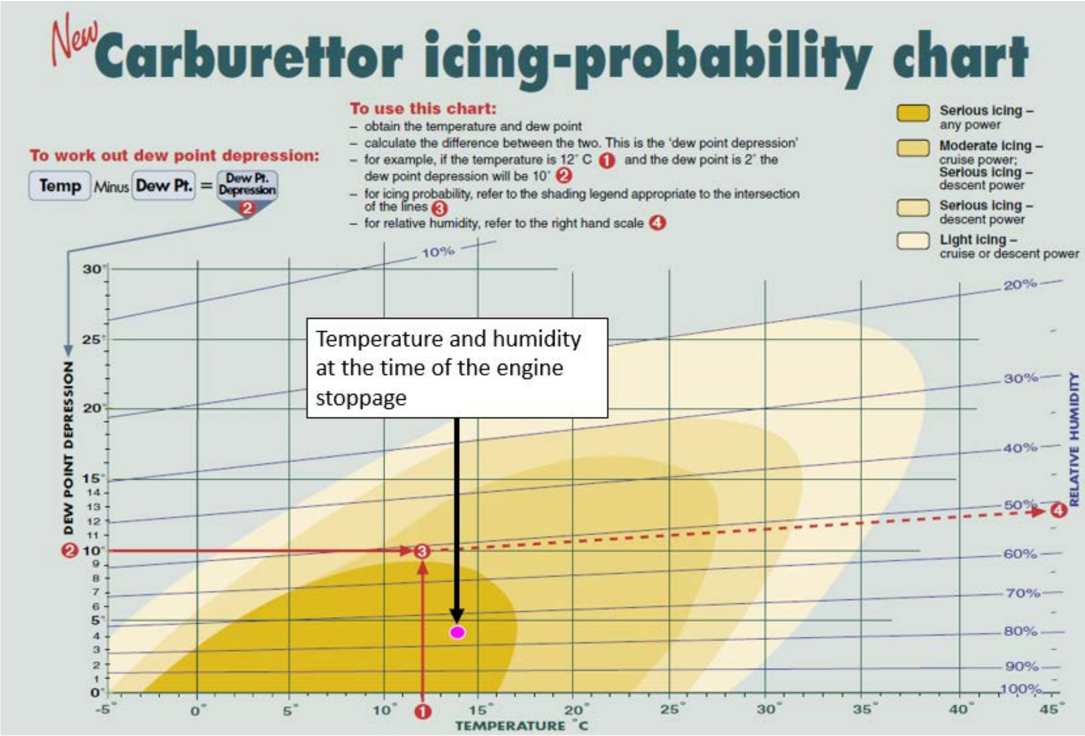
Pilot comments

The pilot reported that their priorities in the event of engine failure were to control the aircraft, land as soon as possible, and get rid of any excess energy (speed). The conditions may have been conducive to carburettor icing, but the aircraft was not fitted with carburettor heat.

Weather conditions and carburettor icing

The temperature at the time of the accident was 14 °C, the relative humidity 76 per cent, and the dew point depression 4 °C. According to the carburettor icing probability chart (Figure 2), there was a serious risk of carburettor icing at any power setting.

Figure 2: Carburettor icing probability chart



Source: CASA – annotated by ATSB

Safety analysis

The engine probably stopped due to carburettor icing, and the aircraft was not (and was not required to be) fitted with carburettor heat.

The aircraft was below 1,000 ft above ground level when the engine failed and the pilot had limited options for landing sites. The pilot landed the aircraft with a tailwind component, and directed the aircraft towards a tree to reduce the ground roll and prevent the aircraft continuing onto a freeway.

Findings

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

- The engine probably failed due to carburettor icing, at relatively low level and with few options for the pilot to safely conduct a forced landing.

Safety message

It is essential to have a plan and practise simulated forced landings to assist in reducing the consequences of conducting one in the event of engine failure. The height above ground at which an engine failure occurs affects the time available to complete failure management checks and select an appropriate landing site.

General details

Occurrence details

Date and time:	15 November 2009 – 1200 EDT	
Occurrence category:	Accident	
Primary occurrence type:	Engine failure or malfunction	
Location:	14 km NNW of Tyabb ALA, Victoria	
	Latitude: 38° 08.57' S	Longitude: 145° 08.72' E

Aircraft details

Manufacturer and model:	Ryan Aeronautical Company STA-SPL	
Registration:	VH-SQD	
Serial number:	193	
Type of operation:	Private – Pleasure/Travel	
Persons on board:	Crew – 1	Passengers – 0
Injuries:	Crew – 1 Minor	Passengers – 0
Aircraft damage:	Substantial	

Separation issues

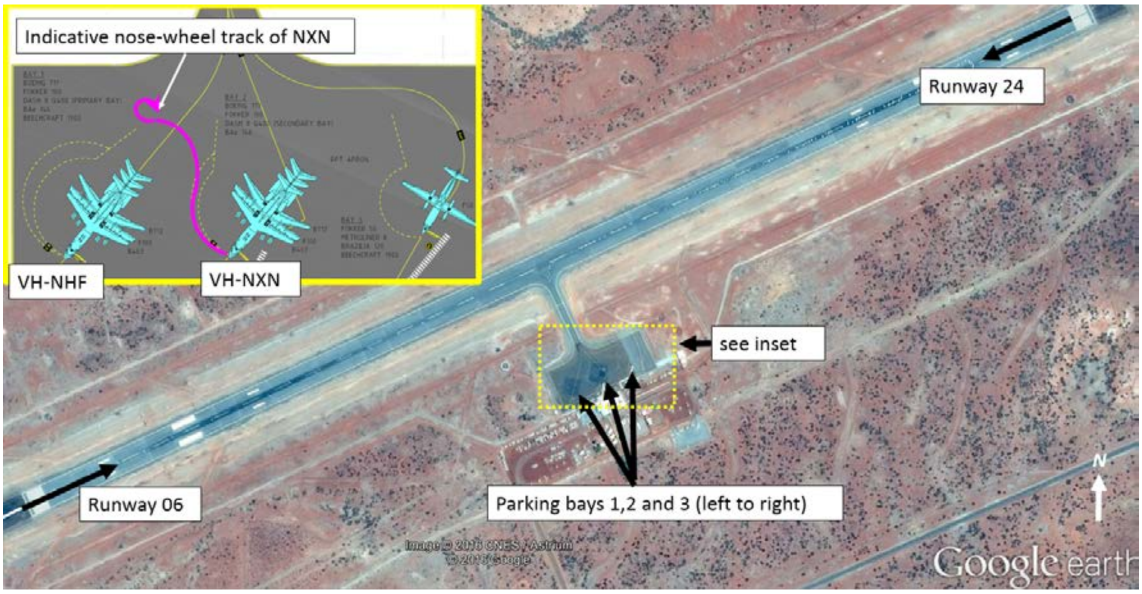
Taxiing collision involving Boeing 717, VH-NXN, and Fokker 100, VH-NHF

What happened

On 5 October 2016, at about 1600 Western Standard Time (WST), a Boeing 717 (B717) aircraft, registered VH-NXN (NXN), was being operated by Cobham Aviation Services as QantasLink, on a scheduled passenger flight from Paraburdoo Airport to Perth, Western Australia. On board were the captain, first officer, three cabin crewmembers and 115 passengers.

The aircraft had been parked on Bay 2 facing south-west towards the terminal building, and the flight crew planned to depart from runway 24 (Figure 1). The captain commenced taxiing, turning the aircraft around to the right in accordance with the normal taxi procedure. As the aircraft turned, the captain sighted a company B717 aircraft about to land on runway 06. The captain quickly assessed that due to limited apron space at Paraburdoo, they needed to taxi behind a Network Aviation Fokker F28 MK 0100 (F100) aircraft, registered VH-NHF (NHF), which was parked on Bay 1, also facing the terminal, to allow the inbound B717 room to pass and taxi to Bay 2, which they had just vacated.

Figure 1: Paraburdoo Airport showing runways and parking bays



Source: Google earth and aircraft operator – annotated by ATSB

After starting a left turn to taxi behind the F100, the captain was not confident there was sufficient clearance between the two aircraft, and asked the first officer to request a member of ground staff to come out as a 'wing walker'.

An engineer for Network Aviation, who had been working on the F100, observed NXN taxiing. As NXN deviated from the painted taxi line, the engineer became concerned about the proximity of its left wingtip to the tail of the parked F100. As a result, as NXN taxied forward, the engineer checked the clearance between its wingtip and tail of the F100, and gave the captain the 'thumbs up' signal to indicate the aircraft was clear.[1] The captain assumed therefore that the aircraft was

[1] The NXN company operations manual stated that the thumbs up signal means you are clear to proceed.

clear and continued taxiing around the back of the F100, then turned the aircraft sharply around to the right (Figure 1 insert). The aim was to leave enough room for the inbound B717 to taxi past, and then continue onto the taxiway once they were clear.

The engineer had expected NXN to taxi towards the runway rather than turning around the back of the F100. The engineer immediately assessed that the horizontal stabilisers of the two aircraft may collide, and tried to signal the captain to stop, but was near the wing of the aircraft and no longer in the captain's sight. The engineer ran towards the front of the aircraft and waved to the captain to stop. The captain braked heavily. The crew did not feel a collision. Some hours later, it was determined that the horizontal stabiliser of NXN had slid under that of NHF, scraping the surface, and both aircraft sustained minor damage (Figure 2). The passengers and crew of NXN were not injured and no one was on board NHF.

Figure 2: Horizontal stabiliser of NXN under that of NHF

Source: Cobham Aviation Services

Airport facilities

Paraburdoo Airport had one taxiway from the runway to the apron area. There were three parking bays, but only two were suitable for F100 and B717 aircraft. Bay 1 was occupied by the F100, NHF, and NXN had been parked on Bay 2. It was also not possible for a B717 to turn around on the runway except at the thresholds due to pavement restrictions.

Captain comments

Awareness of inbound aircraft

NXN was a few minutes late for their scheduled departure and the inbound B717 arrived several minutes earlier than scheduled. There was no procedure for the aircraft operator to notify pilots of the potential for multiple aircraft (from that company) to be at Paraburdoo at the same time.

The captain (and first officer) of NXN reported that they did not hear the inbound or final calls from the crew of the inbound B717. This may have been because at about the time of the inbound calls, the crew of NXN were resolving loadsheet issues with ground staff.

The captain commented that the ground staff were busy due to the arriving B717, and did not alert the crew of NXN to its imminent arrival. Furthermore, a wing walker was not at the parking bay when NXN started taxiing, which was the normal procedure.

The crew of NXN reported that they were not aware of the arriving B717 until they commenced taxiing. While the inbound aircraft had landed on runway 06, the conditions necessitated a departure from runway 24 for NXN.

Non-normal taxi manoeuvre

The captain reported that they would normally conduct a right turn out of the parking bay and taxi the aircraft directly onto the taxiway leading to the runway. This was what the crew were expecting to do until they sighted the inbound B717, landing in the opposite direction to their planned take-off direction.

When the captain of NXN saw the other B717 about to land on runway 06, they thought they were going to be 'boxed in' and formulated a plan in 'about 10 seconds' for the two B717s to pass on the apron area. The captain needed to formulate a plan with limited time available due to parking space constraints and noting that B717-size aircraft could only conduct 180° turns at the runway thresholds. The captain assessed that the only way they could pass the incoming B717 was to taxi behind the parked F100.

The captain later realised that they could have taxied to the runway 06 threshold, turned there, and taxied back to the runway 24 threshold, but that would have added about 2 km to their taxi and therefore increased fuel required.

Engineer comments

The engineer gave the 'thumbs up' having assessed that the wingtip of NXN would not collide with the (tail of the) F100, but did not expect the captain to continue taxiing around the parked aircraft. The engineer was only trying to ensure the aircraft did not collide having assessed the potential for a collision. They had not intended to act as a 'wing walker', did not know what the captain's intentions were, and had no means of communicating with the captain other than by hand signals.

By the time the engineer assessed that there was insufficient clearance between the horizontal stabilisers of the two aircraft, they were no longer in sight of the captain. The horizontal stabiliser of NXN slid under that of the F100 before the engineer was able to signal the captain to stop.

Ground crew resources

The flight crew could not visually confirm the relative position of the two aircraft due to the limited view from the flight deck. Ground handling agent staff would normally have been available to assist the crew, but their attention had shifted to management of the inbound company aircraft. The first officer was about to request a wing walker from the ground staff, when the engineer appeared and signalled the captain.

The crew would have considered the use of ground vehicles if they had been available, but there was no infrastructure such as a tug or tow bar available at Paraburdoo.

Safety analysis

Due to the inbound aircraft and tarmac constraints, the flight crew assessed that a non-standard taxi manoeuvre was necessary to allow the two B717 aircraft to pass.

There was no wing walker in position on the tarmac to provide the crew with a more timely warning of the proximity of the tail to the tail of the F100, and with whom the crew could communicate to discuss their intentions. The crew were about to request a wing walker because the captain was not certain they would be clear of the F100, when the engineer from another company appeared.

Although the engineer used a standard hand signal, the crew interpreted the 'thumbs up' to mean that both the wing tip and tail were clear. The crew had not communicated with the engineer until the engineer gave the signal.

The engineer did not anticipate the sharp right turn of the aircraft after it had apparently passed the F100. The engineer was not in a position to warn the crew about the position of the tail once the sharp right turn had commenced.

Findings

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

- The crew was unaware of the inbound company B717 until after taxi had commenced, then taxied on a non-standard path to accommodate entry of that aircraft onto the tarmac.
- A ground handling agent wing walker was not in place to assist the crew as they taxied.
- The inability to communicate verbally with the non-company engineer resulted in the crew interpreting the engineer's thumbs up signal as meaning the entire aircraft was clear of the parked aircraft.

General details

Occurrence details

Date and time:	5 October 2016 – 1630 WST	
Occurrence category:	Incident	
Primary occurrence type:	Taxiing collision	
Location:	Paraburdoo Airport, Western Australia	
	Latitude: 23° 10.27' S	Longitude: 117° 44.72' E

Aircraft details: VH-NXN

Manufacturer and model:	The Boeing Company 717	
Registration:	VH-NXN	
Operator:	National Jet Systems (Cobham Aviation Services) as QantasLink	
Serial number:	55095	
Type of operation:	Air transport high capacity – Passenger	
Persons on board:	Crew – 5	Passengers – 115
Injuries:	Crew – 0	Passengers – 0
Aircraft damage:	Minor	

Aircraft details: VH-NHF

Manufacturer and model:	Fokker Aircraft BV F28	
Registration:	VH-NHF	
Operator:	Network Aviation	
Serial number:	11458	
Type of operation:	Air transport high capacity – Passenger	
Persons on board:	Crew – 0	Passengers – 0
Injuries:	Crew – 0	Passengers – 0
Aircraft damage:	Minor	

Aircraft separation issues involving Embraer ERJ 190, VH-ZPJ, and GippsAero GA-8, VH-XGA

What happened

On 31 May 2016 at 1018 Eastern Standard Time (EST), Virgin Australia Airlines flight VA1615, an Embraer ERJ 190 aircraft, registered VH-ZPJ (ZPJ), departed Melbourne Airport on a scheduled passenger service to Mildura Airport, Victoria. On board the aircraft were 2 flight crew, three cabin crew and 81 passengers. The aircraft captain was the pilot flying (PF) and the first officer was the pilot monitoring (PM).[1]

About 40 NM from Mildura and just prior to ZPJ leaving controlled airspace, air traffic control (ATC) passed the flight crew traffic information about two aircraft operating above 10,000 ft to the west of Mildura Airport. In addition, there was also a public transport flight inbound to Mildura from Broken Hill and a light twin-engine aircraft inbound to Mildura on a converging track to ZPJ. The PM on board ZPJ contacted the light twin-engine aircraft and confirmed they would arrive at Mildura after ZPJ. The estimated arrival time for the public transport flight at Mildura was also later than the estimate for ZPJ, and consequently the flight crew on board ZPJ did not consider any of the traffic passed to them by ATC would conflict with their own arrival.

The aircraft operating to the west of Mildura were a GippsAero GA10 aircraft, registered VH-XGY (XGY), conducting spin testing supported by a Gippsland Aeronautics GA-8 ‘chase plane’, registered VH-XGA (XGA), from the same company.

ZPJ joined the Mildura Airport circuit on the crosswind leg for a left visual circuit to land on runway 09.

On the base leg of the circuit, the flight crew on board ZPJ heard their traffic collision alert system (TCAS) announce a traffic advisory (TA) aural alert (see *TCAS limitations on approach*). They glanced at their TCAS display to check the relative position of the traffic, which indicated it was to their right (position 1 in Figure 1). The flight crew looked out the right window of the flight deck and identified the traffic to their right and high against the skyline. The traffic appeared to them to be stationary in the windscreen relative to their own aircraft and with a high closure rate (from TCAS data the aircraft were 1.25 NM apart at the time of the TA alert).[2]

The PM on board ZPJ contacted the other traffic on the radio and requested their intentions. The other traffic was XGA, which was leading XGY back to Mildura Airport for a straight-in approach to runway 09. When the pilot of XGA responded that they were tracking for a straight-in approach to runway 09, the PM assessed they were on a collision course on their present track. They also recognised that there would be a potential risk of collision if both aircraft performed a go-around to the south of the main runway. Therefore the PM responded to the pilot of XGA to immediately turn and remain south of the airport. The pilot of XGA identified ZPJ ahead of them on approach to runway 09 and responded that they would discontinue their approach and manoeuvre to the south of the airport.[3]

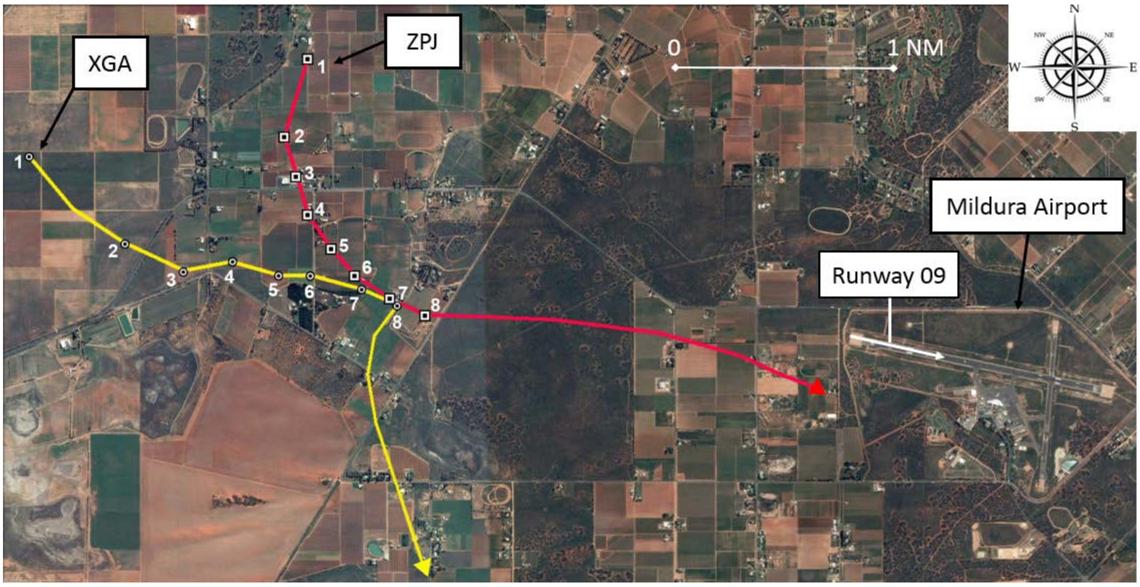
1 Pilot Flying (PF) and Pilot Monitoring (PM): procedurally assigned roles with specifically assigned duties at specific stages of a flight. The PF does most of the flying, except in defined circumstances; such as planning for descent, approach and landing. The PM carries out support duties and monitors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

2 Traffic that is closing, but appears stationary in the windscreen, is indicative of a collision course. In this case, the ERJ 190 will also appear stationary in the windscreen of XGA.

3 Traffic in the circuit have ‘right-of-way’ over traffic tracking for a straight-in approach.

The PF on board ZPJ decided to discontinue their approach to land on runway 09, as they were too late for their turn onto final and therefore not in a stabilised condition.[4] However, the PM indicated to the PF that they could not execute a go-around manoeuvre because there was another aircraft joining the circuit on crosswind (the light twin-engine aircraft). The PF decided that continuing the approach to land was not an option and therefore executed the go-around to the south of runway 09, maintained separation from the other traffic on crosswind and then landed from the subsequent circuit. During the go-around manoeuvre, the aircraft's TCAS detected XGA pass about 200 ft above and 0.125 NM behind ZPJ (position 7 & 8 in Figure 1).

Figure 1: Traffic conflict between ERJ 190 (VH-ZPJ) and GA-8 (VH-XGA)



Source: Google earth, annotated by ATSB based on Virgin Australia Airlines TCAS data (numbers indicate the relative positions of the conflict aircraft at the same time)

Airspace

Class E airspace

A Class E controlled airspace corridor extends from Melbourne to overhead Mildura Airport with a lower limit of FL 125.[5] In Class E airspace, instrument flight rules (IFR) traffic, such as ZPJ, require a clearance. Visual flight rules (VFR) traffic, such as XGA and XGY, do not require a clearance, but should monitor the Class E airspace air traffic service frequency. In Class E airspace, IFR flights are separated from other IFR flights and receive traffic information on VFR flights as far as practicable. ZPJ left Class E airspace on descent to Mildura about 37 NM from Mildura Airport, at which point ZPJ entered Class G airspace for the remainder of the flight.

Class G airspace

Class G airspace is non-controlled airspace. IFR and VFR traffic are permitted without a clearance and there is no separation service provided by ATC. Mildura Airport is a non-controlled aerodrome with a discrete common traffic advisory frequency (CTAF), which is a different frequency from the surrounding Class G airspace area frequency. About 10 NM to the north-west of Mildura Airport is Wentworth Aerodrome. Wentworth uses the same CTAF as Mildura.

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4 Stabilised approach criteria is used for identifying the need for a go-around or missed approach. For the ERJ 190 this included being established on runway centreline with wings level by 500 ft above ground level.

5 Flight level: at altitudes above 10,000 ft in Australia, an aircraft's height above mean sea level is referred to as a flight level (FL). FL 125 equates to 12,500 ft.

Radio broadcasts at non-controlled aerodromes

The following Table 1 indicates the non-controlled aerodrome radio broadcast requirements for inbound aircraft in accordance with the aeronautical information publication (AIP).

Table 1: Summary of broadcasts required for inbound aircraft at non-controlled aerodromes

Situation	Remark
Inbound to the aerodrome	Broadcast 10 NM from the aerodrome, or earlier, commensurate with aeroplane performance and pilot workload, with an estimated time of arrival (ETA) for the aerodrome.
Ready to join the circuit	Broadcast immediately before joining the circuit.
Intention to make a straight-in approach	Broadcast on final approach at not less than 3 NM from the threshold.

Incident flight radio broadcasts

During the spin testing of XGY, XGY was classified as ‘lead’ aircraft and XGA as ‘in-trail’. The pilot of XGA set one of their two radio frequencies to their company frequency, for communication with XGY, and the other to area frequency, for communication with other traffic if required. While operating on the area frequency, the pilot of XGA heard a broadcast from ZPJ that they were inbound to Mildura from Melbourne, and a broadcast from another public transport aircraft inbound to Mildura from Broken Hill. On completion of the spin testing, XGA assumed the lead from XGY at about 10,000 ft and 11–12 NM from Mildura Airport. Shortly after the lead change, the pilot of XGA changed from area frequency to the Mildura CTAF.

The pilot of XGA made a 10 NM broadcast on CTAF, which included their position, altitude and intentions for a 5 NM straight in approach for final approach to runway 09. They received an immediate response from the public transport aircraft tracking from Broken Hill, who provided an estimated time of arrival for their 5 NM final approach position for runway 09. The pilot of XGA responded with a revised estimate for their arrival on the ground at Mildura Airport, which was the same time as the other aircraft’s estimate for their 5 NM final position. At the end of this exchange, XGA, with XGY in-trail, was about 7 NM from Mildura Airport tracking to the north-east to intercept a 5 NM final position, at 140–150 kt airspeed, descending at about 2,000 ft per minute. The pilot of XGA heard no radio broadcasts from ZPJ on CTAF and assumed they had already landed.

XGA made a right turn onto final approach for runway 09 at about 3,200 ft, 4.5 NM[6] from the runway threshold. Shortly after the turn, the pilot of XGA heard a broadcast requesting their intentions from ZPJ. Following the initial exchange of broadcasts with ZPJ, the pilot of XGA visually identified ZPJ about 2 NM ahead on approach to runway 09. They recognised that ZPJ had right-of-way and made a broadcast that they were ‘breaking off’ their approach to runway 09 and turning south.

The PM duties on board ZPJ included managing the radio communications with other traffic. During the approach to join the circuit, and subsequently while flying the circuit, the captain was preoccupied with PF duties and did not comprehend all the radio broadcasts. However, the PM made several CTAF broadcasts, which started at 42 NM from Mildura at 01:06:35. The last broadcast before entering the Mildura circuit was just prior to ZPJ crossing overhead runway 09 to join crosswind at 01:15:27. The next CTAF broadcast made by ZPJ was at 01:18:16, after they turned base. The flight crew received a TA at 01:18:31 and subsequently made a broadcast to challenge the intentions of XGA at 01:18:43.

6 This position is based upon TCAS data from VH-ZPJ and is indicative only.

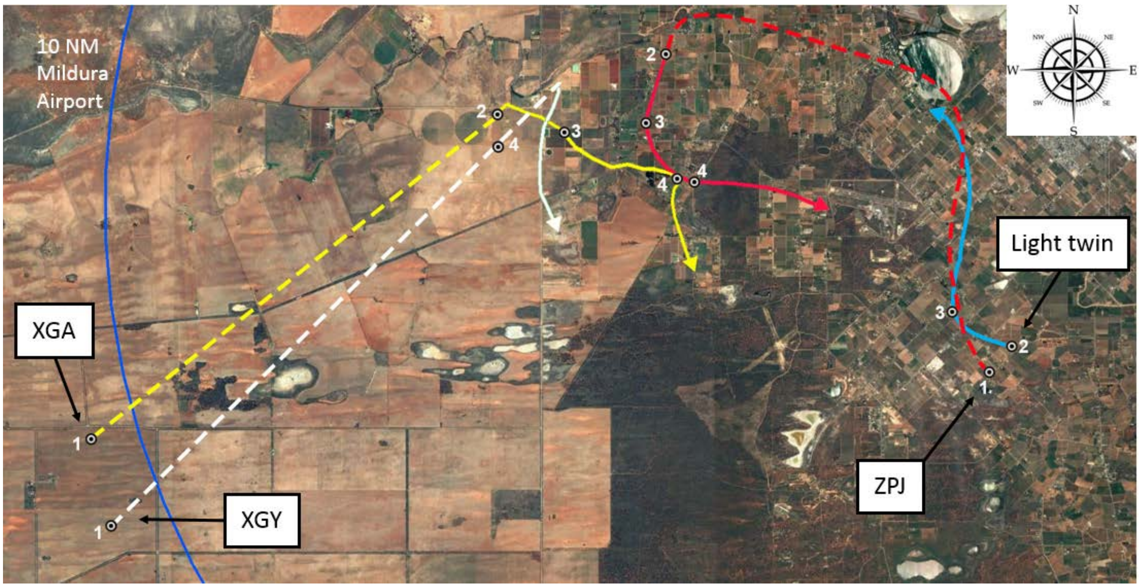
Incident aircraft geometry

The following Table 2 indicates the positions of ZPJ and the conflict aircraft XGA. Figure 2 depicts the geometry of traffic in the vicinity with numbering in accordance with Table 2. The positions of the aircraft are based upon TCAS data from ZPJ.

Table 2: Aircraft geometry

Time	Event	VH-ZPJ	VH-XGA
1:15:27 (1)	ZPJ CTAF broadcast – joining circuit	2,237 ft, 2.5 NM SE Mildura Airport	11,130 ft, 10.5 NM WSW Mildura Airport
1:18:16 (2)	CTAF broadcast ZPJ – after turning base	1,009 ft, Base runway 09	3,209 ft, 4.5 NM final runway 09
1:18:31 (3)	Aural TA annunciation	733 ft, Base runway 09	1,300 ft, 3.5 NM final runway 09
1:18:59 (4)	Closest point of approach	442 ft, 2.0 NM W runway 09	642 ft, 2.1 NM W runway 09

Figure 2: Aircraft geometry from Table 2



Source: Google earth, annotated by ATSB based on Virgin Australia Airlines TCAS data.

TCAS limitations on approach

The traffic alert and collision avoidance system (TCAS) II, will display traffic to the flight crew as: *other traffic*, *proximate traffic*, *traffic advisory*,[7] or *resolution advisory*.[8] However, only traffic advisories and resolution advisories trigger an aural alert to the flight crew.

The collision avoidance system logic is based on the concepts of sensitivity level (SL), threshold time (tau) for issuing a traffic alert or resolution advisory, and protected volume of airspace around the TCAS equipped aircraft. The higher the SL, the greater the volume of protected airspace. As SL reduces, the volume of protected airspace reduces and TCAS functions may become inhibited.

Tau is an approximation of the time, in seconds, to the closest point of approach of another aircraft. This forms the basis for the alerting functions and therefore the volume of protected

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[7] An indication given by TCAS to a flight crew when an aircraft has entered, or is projected to enter, the protected volume of airspace around their own aircraft.

[8] An indication given by TCAS II to a flight crew that a vertical manoeuvre should, or in some cases should not, be performed to attain or maintain safe separation from another aircraft.

airspace. Therefore, a reduction in the TCAS SL reduces the volume of protected airspace by reducing the value of tau.

Below 1,000 +/-100 ft above ground level, the TCAS SL reduces from SL3 to SL2. For the ERJ 190 this equates to 900 ft when on descent and 1,100 ft when on climb. From SL3 to SL2 the tau reduces from 25 seconds to 20 seconds and resolution advisories are inhibited. Below 500 +/-100 ft above ground level, TCAS aural alerts are inhibited. For the ERJ 190 this equates to 400 ft when on descent and 600 ft when on climb. Close to the ground, the windshear and ground proximity warning system alerts have a higher alert priority.

The PM on board ZPJ commented that during the visual circuit they changed the focus of their scan from inside the cockpit to outside the cockpit. They suspect that XGA was probably displayed as other traffic on their TCAS before they received the TA alert. However, there are no company procedures specific to the use of TCAS at non-controlled aerodromes. Company procedures emphasise the importance of flight crew maintaining a 'constant lookout when operating within a CTAF', and use positive altitude separation or alternatively coordinate a track deviation with conflict aircraft.[9]

Limitations with visual sighting

Three limitations to sighting other traffic, of interest to this incident, are:

- alerted search versus unalerted search
- lack of relative motion on collision course
- effects of complex backgrounds

Alerted search versus unalerted search

Traffic alerts may come from radio calls or TCAS at a non-controlled aerodrome. Knowing where to look has been shown to improve visual detection of other traffic. The PF on board ZPJ was alerted to the potential conflict by TCAS, and then visually identified XGA. The pilot of XGA was alerted to the potential conflict following ZPJ's radio broadcast on the base circuit leg, and then visually identified ZPJ.

Lack of relative motion on collision course

The PF on board ZPJ commented that when they visually sighted XGA, the aircraft appeared to be stationary in the windscreen, which indicated a potential collision course. In this case ZPJ would also appear stationary to the pilot of XGA. Lack of relative motion against a background reduces the probability of visual detection.

Effects of complex backgrounds

When the PF on board ZPJ visually identified XGA, XGA was above the horizon (higher altitude relative to ZPJ) and against a background of sky. For the pilot of XGA, ZPJ was lower and against a background of terrain. The pilot of XGA was therefore required to detect the contrast between the aircraft and terrain to detect ZPJ. A terrain background may create a complex background and reduce the probability of visual detection.

Safety analysis

The AIP directs pilots to the minimum required radio broadcasts when operating at non-controlled aerodromes and the pilots of ZPJ and XGA complied with these requirements. However, it is likely that the pilot of XGA was not on the Mildura CTAF when the PM on board ZPJ made a broadcast that they were joining the Mildura circuit. When the pilot of XGA switched to the Mildura CTAF they were initially occupied with communicating with another public transport aircraft inbound from

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[9] Aircraft not equipped with transponders may be operated in non-controlled airspace, in which case they will not be detected by TCAS.

the north and considered this aircraft to be their only potential conflict. It could not be determined why the flight crew on board ZPJ did not comprehend the presence of a potential conflict from this radio traffic. However, the flight crew of ZPJ had previously dismissed these two aircraft (XGA and XGY) as a potential conflict for their arrival.

After ZPJ turned onto the base leg for runway 09, the PM made a base radio broadcast. It could not be determined why the pilot of XGA did not comprehend the presence of a potential conflict from this broadcast. However, the investigation could not rule out the possibility that other aircraft operating at Mildura or Wentworth made broadcasts which interfered with one or several of the broadcasts made by ZPJ or XGA.

Shortly after the base leg radio broadcast from the PM in ZPJ, the flight crew were alerted to the presence of XGA by a TCAS TA aural alert. At this time ZPJ was below 900 ft and therefore TCAS resolution advisory was inhibited. However, the TCAS visual display of the relative position of XGA cued their visual search and facilitated a quick identification. XGA appeared to the flight crew on board ZPJ as stationary against a background of sky. Therefore, to the pilot of XGA, ZPJ was probably against a more complex background with no relative motion, contributing to the difficulty for the pilot of XGA to detect ZPJ before they were alerted by the radio call by ZPJ.

The radio broadcast from the PM on board ZPJ directed to the 'traffic inbound to Mildura from the west' alerted the pilot of XGA to the presence of other traffic and cued them to search for the conflict. The PM on board ZPJ then directed the pilot of XGA to 'turn immediately away to the south' to avoid a potential collision either during their turn onto final approach or in the event that both aircraft attempted a simultaneous go-around manoeuvre on the south side of runway 09.

After receiving an acknowledgement from the pilot of XGA, the flight crew on board ZPJ turned their attention to the execution of their go-around manoeuvre as their turn onto the final leg of the circuit was late due to their preoccupation with monitoring XGA. However, during their turn to join the upwind circuit leg for runway 09 on the south side of the runway, XGA continued to converge to a closest point of 0.125 NM behind and about 200 ft above ZPJ before making an abrupt turn to the south. This was the result of the intention of the pilot flying XGA to join the upwind leg of the circuit to the south of runway 09, before they realised that ZPJ was also conducting a go-around from their approach.

Findings

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

- The pilot of XGA was probably not monitoring Mildura CTAF when the PM on board ZPJ broadcast joining the Mildura circuit.
- The flight crew of ZPJ did not detect the broadcast from XGA that they were intending to join a straight in approach to runway 09.
- After a separation strategy was agreed, XGA continued to close on ZPJ to a closest point of approach of 0.125 NM behind and 200 ft above ZPJ when ZPJ started their go-around.
- Both aircraft made the required broadcasts on the CTAF.
- The flight crew on board ZPJ were cued to the conflict by their TCAS traffic advisory alert.
- The pilot on board XGA was cued to the conflict by the radio broadcast from ZPJ.

Safety message

Despite compliance with the radio broadcast requirements, a traffic conflict occurred in an environment with limited manoeuvring options for a high capacity public transport aircraft. This incident highlights the importance of an alerted search to the successful identification of potential conflict traffic. Further information is available from ATSB Research report: *Limitations of the See-and-Avoid Principle.*

The ATSB SafetyWatch highlights the broad safety concerns that come out of our investigation findings and from the occurrence data reported to us by industry. One of the safety concerns relates to *safety around non-controlled aerodromes*.

General details

Occurrence details

Date and time:	31 May 2016 – 1130 EST	
Occurrence category:	Incident	
Primary occurrence type:	Aircraft separation - issues	
Location:	Near Mildura Airport, Victoria	
	Latitude: 34° 13.75’ S	Longitude: 142° 5.13’ E

Aircraft details – VH-ZPJ

Manufacturer and model:	Embraer-Empresa Brasileira De Aeronautica – ERJ 190	
Registration:	VH-ZPJ	
Operator:	Virgin Australia Airlines PTY LTD	
Serial number:	19000209	
Type of operation:	Air Transport High Capacity - passenger	
Persons on board:	Crew – 5	Passengers – 78
Injuries:	Crew – 0	Passengers – 0
Aircraft damage:	Nil	

Aircraft details – VH-XGA

Manufacturer and model:	Gippsland Aeronautics – GA-8	
Registration:	VH-XGA	
Serial number:	GA8-96-03	
Type of operation:	Private – test and ferry	
Persons on board:	Crew – 2	Passengers – 0
Injuries:	Crew – 0	Passengers – 0
Aircraft damage:	Nil	

Near collision involving Cessna 172S, VH-USL, and parachutists

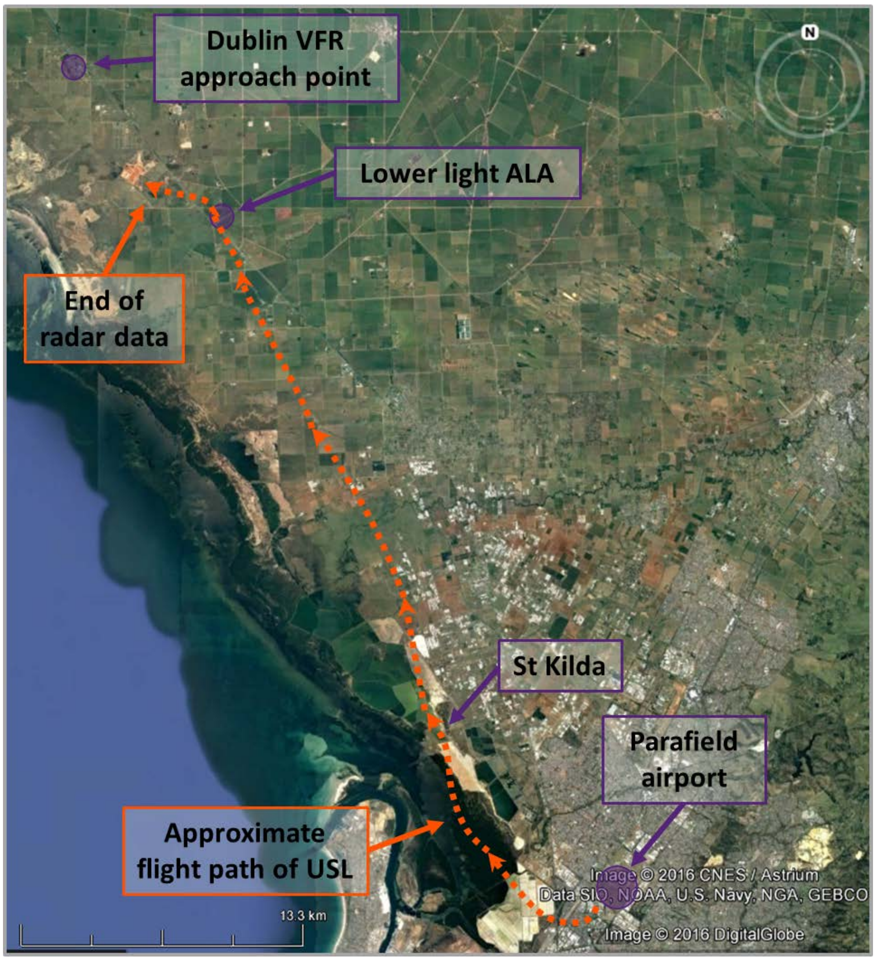
What happened

At about 1113, Central Daylight-saving Time (CDT) on the 6 November 2016, a Cessna 172S aircraft, registered VH-USL (USL), departed Parafield Airport, South Australia for a local flight in the western training area. The pilot was the only person on board the private flight.

The pilot reported that the aircraft has a 'glass cockpit'[1] and they had only flown it once before with an instructor. The purpose of this flight was to become more familiar with the 'glass cockpit' and specifically the autopilot. Prior to taxi with the engine running, the pilot reviewed the operation of the autopilot. In addition, as preparation the pilot had read the auto pilot manual and watched some videos on the operation of the autopilot.

During the initial climb, the pilot engaged the autopilot. As the aircraft started to climb at a faster rate than expected, the pilot disconnected the autopilot and continued on to St Kilda (Figure 1).

Figure 1: Approximate flight path of USL from Parafield to just past the Lower Light ALA

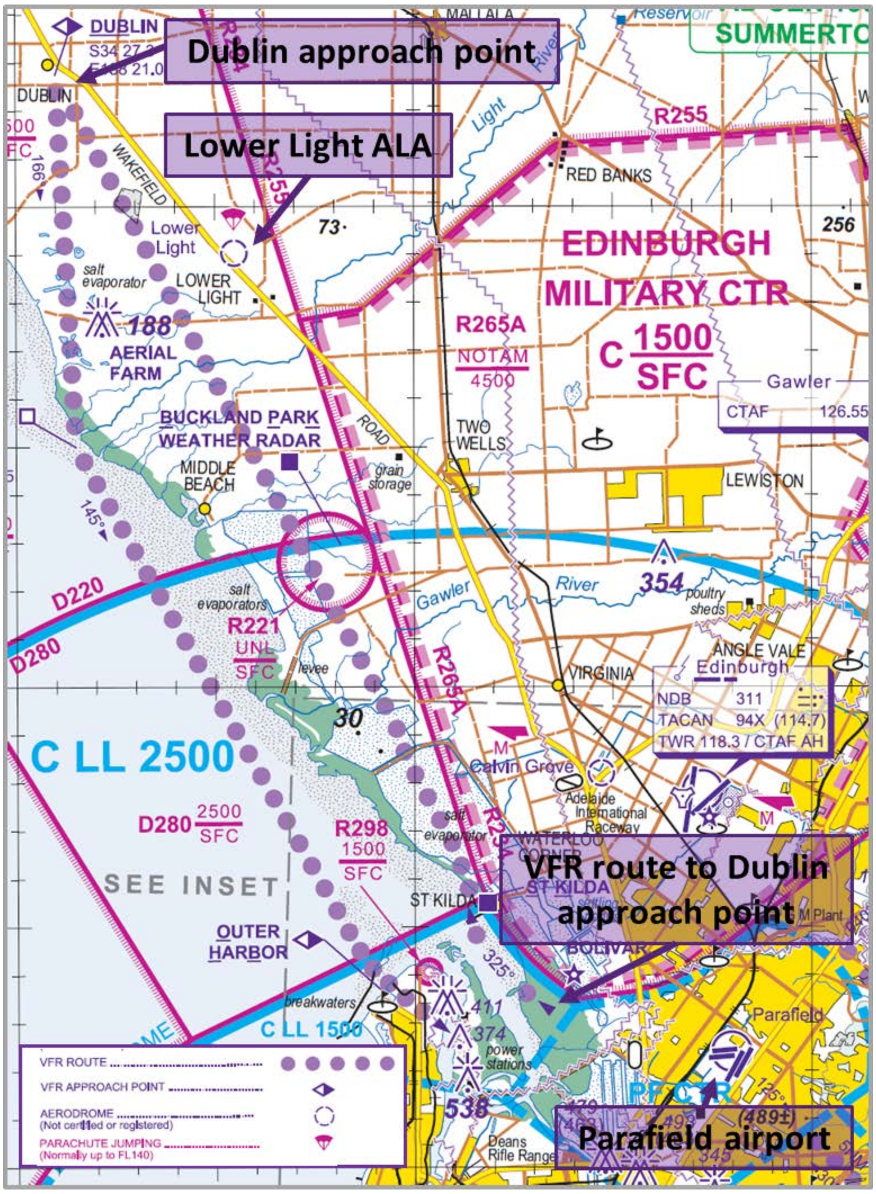


Source: Google earth, modified by the ATSB

[1] A glass cockpit is an aircraft cockpit that features electronic (digital) flight instrument displays, typically large liquid-crystal display (LCD) screens, rather than the traditional style of analog dials and gauges. A glass cockpit uses several displays driven by flight management systems, that can be adjusted (multi-function display) to display flight information as needed.

When the aircraft reached 1,000 ft, the pilot again engaged the autopilot and the autopilot again started to change the attitude of the aircraft, not as expected, and the pilot disconnected the autopilot. After passing St. Kilda, the pilot initiated a climb to 2,500 ft and navigated along the VFR route towards Dublin (Figure 2). In the cruise, the pilot continued to attempt to get the autopilot to engage but it did not respond as they expected. The pilot reported that they made regular checks and would look from inside the cockpit to outside to check the aircraft was maintaining a direction to Dublin and that no other aircraft were in the vicinity.

Figure 2: Visual Terminal Chart showing Dublin, Lower Light ALA, VFR route



Source: Airservices Australia: Visual Terminal Chart, modified by the ATSB

During this time, a Cessna 206 (C206) aircraft departed Lower Light aircraft landing area (ALA) for parachute operations. They were on climb to flight level (FL) 120 where four parachutists planned to exit the aircraft overhead the Lower Light ALA. The aircraft planned to then continue to climb to FL 140 where two other parachutists in tandem were to exit the aircraft.

The pilot contacted the Adelaide Approach controller and received a clearance to climb initially to FL 120. Approaching FL 120, the pilot received a clearance to drop the first parachutists and then climb to FL 140. The controller also advised them that there was an unverified aircraft (USL) about 3 NM to the south of Lower Light ALA at 2,500 ft. At about 1123, the pilot broadcast on the area frequency advising traffic in the Lower Light area that in about three minutes they would be at FL 120 and would conduct a parachute drop. The pilot of USL reported that they heard this broadcast but no subsequent broadcasts from the aircraft.

The parachute operator's safety officer was listening on the radio frequencies (parachute operation frequency, area frequency and Adelaide Approach frequency) and was standing in front of the operator's hangar. The safety officer reported that they heard the broadcast made that the four parachutists had exited the aircraft (this was not recorded on the area or Adelaide approach frequencies). At about the same time, the safety officer saw a Cessna 172 (C172) aircraft (USL) fly directly over the hangar from the south, heading towards where the safety officer expected to see the four parachutes open. The safety officer contacted the C206 pilot on the radio to let the pilot know that there was an aircraft flying directly towards the parachutists. The safety officer observed the parachutes open near the C172 and observed the C172 aircraft turn to the right slightly and then make a left turn away from Lower Light ALA.

At about the same time, the pilot looked out and observed parachutes just below and to the left of the aircraft at a distance of about 200 m. After checking that it was all clear, the pilot turned the aircraft to the left to manoeuvre away from Lower Light ALA.

At about 1126, the C206 pilot broadcast that the traffic adjacent to Lower Light ALA to depart the area immediately, as there were parachutists in the air. However, the pilot heard no response from the pilot of USL. The C206 pilot contacted Adelaide Approach and advised that an aircraft had interfered with the parachutists. The controller replied that the traffic was outside controlled airspace and they did not have any details on the aircraft. As the C172 was heading away from the area, the controller approved the C206 to drop the remaining parachutes and then descend from FL140.

The pilot of USL disconnected the autopilot, navigated to Dublin, returned to Parafield via the inbound VFR route, and landed without further incident. The six parachutists landed without further incident.

Pilot comment

The pilot reported that they were distracted while trying to operate the autopilot and were not aware that they had flown close to the Lower Light ALA. They heard the broadcast from the C206 pilot but they did not realise that they were that close to the ALA and did not take any action. When the parachutes were sighted, the pilot checked the area before turning, to ensure they were not about to turn into another parachute which was taking action to avoid his aircraft.

After the incident, the pilot reported they informed the flying school where the pilot hired the aircraft about the incident and that they believed the autopilot had a problem.

The pilot reported that the weather was clear and the wind was about 8 knots from the west.

Aircraft owner

The maintenance release for USL contained an endorsement that the autopilot roll servo was unserviceable in August 2016 and another roll servo was installed. On 26 October 2016, the autopilot roll servo was replaced with an exchange servo. There were no other endorsements on the maintenance release about the autopilot.

The aircraft owner reported that apart from the replacement of the autopilot servo there had been no defects recorded about the serviceability of the autopilot. Subsequent to the incident, the operator conducted a full test in flight of the autopilot on USL and no fault was found with the autopilot or with any of its functions.

Parachute operator

The parachute operator reported that in the past they have contacted flying schools in the area notifying them of the frequencies that their pilot will use to notify that there are parachute operations. The parachute operator indicated that there have been other 'close calls' reported but this was the closest that an aircraft has come to a collision with a parachutist.

A search of the ATSB database confirmed three other notifications from 2006 to 2016 where an aircraft was near parachutists at the Lower Light ALA.

Findings

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

- The pilot of the Cessna 172 was distracted by the operation of the aircraft autopilot and as a result, had reduced awareness of the aircraft's position and flew in close proximity to four parachutists.

Safety message

This incident highlights the importance to maintain situational awareness through active navigation and active listening to radio communications. Ensuring you are listening to the correct frequencies and communicating on the correct frequencies helps to maintain your situational awareness but also that of other pilots flying in your area.

The Civil Aviation Safety Authority (CASA) has developed the *Look out! Situational awareness* DVD and video for pilots to learn more about the safety-critical skills that makes up situational awareness. There is a strong emphasis on the need to prepare and plan for every flight. The DVD gives a definition of situational awareness as "what's happened, what's happening and what might happen".

The CASA Safety Video - *Situational awareness* is available from the CASA website and the CASA *Look out! Situational awareness* DVD is available from the CASA online store.

General details

Occurrence details

Date and time:	6 November 2016– 1126 CDT	
Occurrence category:	Serious incident	
Primary occurrence type:	Near collision	
Location:	Lower Light (ALA), South Australia	
	Latitude: 34° 30.97' S	Longitude: 138° 25.48' E

Aircraft details – VH-USL

Manufacturer and model:	Cessna Aircraft Company 172S	
Registration:	VH-USL	
Serial number:	172S10254	
Type of operation:	Private	
Persons on board:	Crew – 1	Passengers – 0
Injuries:	Crew – 0	Passengers – 0
Aircraft damage:	Nil	

Remotely piloted aircraft

Loss of control involving remotely piloted aircraft Pulse Aerospace Vapor 55

What happened

On 27 September 2016, a Pulse Aerospace Vapor 55[1] remotely piloted aircraft (RPA), was operating a test flight at Lighthouse Beach, Ballina, New South Wales (Figure 1).

Figure 1: Photo of a (different) Vapor 55 RPA

Source: www.skylineuav.com.au

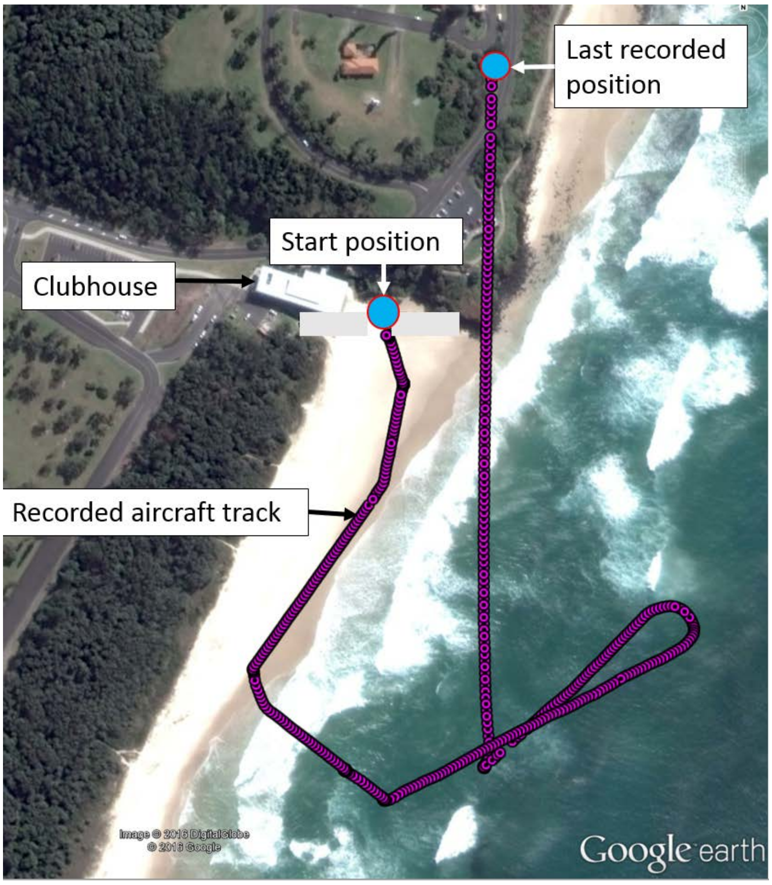
According to telemetry data[2] recorded on the remotely piloted aircraft system's ground control station (GCS), at about 0910 Eastern Standard Time (EST), the RPA lifted off from its start position in front of the surf clubhouse (Figure 2). About 30 seconds later, when the RPA was at an altitude of about 36 ft, it entered 'manual' flight mode. The RPA then tracked according to manual inputs from the pilot for about 7 minutes, at which time (when at 124 ft altitude) the data-link signal was lost. Thirty seconds later, the RPA entered the 'home' flight mode, and commenced tracking to the programmed home position at an altitude of 154 ft. The last position of the RPA recorded by the GCS was about 165 m NNE of the start position, and about 4 km SE of Ballina/Byron Gateway Airport.

In the home flight mode, the RPA did not respond to the flight control inputs made by the pilot and the pilot subsequently lost sight of the RPA. The RPA was not found despite an extensive search.

1 The Pulse Aerospace Vapor 55 is a helicopter, gross weight 25 kg, with a maximum cruise endurance of 60 minutes, controlled via a laptop computer operating the ground control station and flight controls (joystick).

2 The telemetry data is sent from the RPA to the ground station and stored.

Figure 2: Recorded RPA track



Source: Google earth and remotely piloted aircraft system operator, annotated by ATSB

Mission planning

Prior to the flight, the pilot's preparation for the planned mission involved using Google earth on a computer (not the GCS), and selecting a north-western and a south-eastern reference point. These markers defined an outer rectangle, within which the flight was to take place (Figure 3).

Figure 3: Planned operating area defined using NW and SE markers

Source: Google earth, annotated by ATSB

The pilot then transferred an image of the google earth map for the area onto the GCS using a USB stick, and uploaded it to create the 'Lighthouse Beach' mission. To georeference[3] the image, the pilot then overlaid the markers in the image with a point icon on the controller, and entered the latitude and longitude of two positions into the dialogue box on the GCS. The north-western GCS marker is visible in the top left corner of Figure 4, but the latitude and longitude values visible are image text only.

Once the image had been georeferenced, the pilot then used the graphical interface to place the start and home icons and any intervening waypoints for the planned mission (Figure 4).

Figure 4: Image uploaded onto GCS with planned mission overlaid

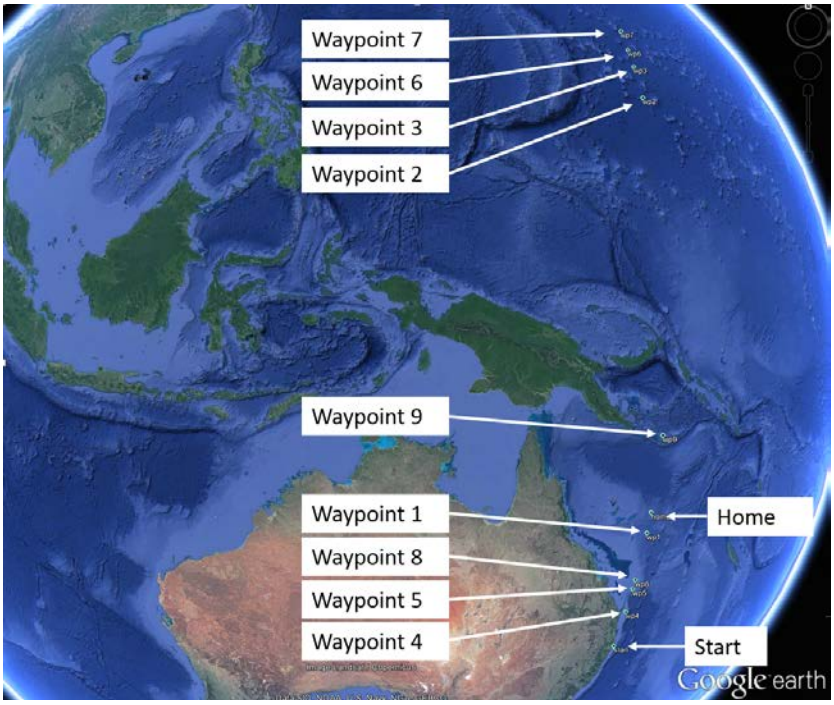
Source: Remotely piloted aircraft system operator, annotated by ATSB

Incorrect georeference

The remote pilot reported that both they and an observer checked each waypoint before the flight, verifying latitude, longitude, altitude and height. However, the GCS data shows that during the planning phase, while the north-western marker was correctly assigned, the south-eastern marker was incorrectly assigned to a georeference point with a latitude in the northern hemisphere. This resulted in all of the waypoints and home location being incorrect, as they were created by dragging icons on the georeferenced image. Waypoints 2, 3, 6 and 7 had latitudes in the northern hemisphere, and the home position was assigned to 17.222395° S and 153.591582° E. That location was in the Coral Sea Islands about 1,200 km north of the start position (Figure 5).

[3] Georeferencing means to assign a physical location (coordinates) with a position in an image.

Figure 5: Actual location of home position and waypoints from the GCS



Source: Google earth annotated by ATSB

The RPA's start position was correct as it was obtained using the RPA's GPS. As the aircraft entered manual mode after take-off and the pilot did not initiate the automatic mode to fly the programmed mission, it was only when the RPA lost the datalink, stopped responding to the pilot's manual control inputs and commenced tracking for the programmed home position, that it left the planned operating area. The pilot can also manually give the 'home' command. In all home and automatic modes, the handheld controller is ignored unless the pilot gives the 'manual' command via the GCS application and manually takes control of the RPA.

The GCS has a 'flight plan' tab, which shows the planned distance and time (among other items) for the mission, which could have alerted the pilot to the incorrect latitude references. However, a check of the flight plan tab had not been included in the operator's pre-flight procedures. In addition, the flight plan tab includes a measure tool that can be used to check that the map size is correct.

The manufacturer advised that the following steps are included in their pre-flight procedure specified in the aircraft flight manual:

- verify flight plans
- verify lost communication home waypoint.

The operator stated that there was no further detail of the verification process in the manual.

The default hemisphere was north (N) in the GCS for entering positions. The manufacturer stated that there was no feature that would change the default (to south (S)). The manufacturer assessed that changing the default could lead to issues with the conduct of appropriate pre-flight checks.

The operator reported that information about the default setting to north was not provided in the Aircraft Flight Manual.

Loss of data-link signal

The RPA system commands homing after 10 seconds of data link loss when in automatic mode and 2 seconds if in manual mode. In this incident, as the RPA was in manual mode, it initiated homing after 2 seconds.

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The cause of the lost signal could not be determined. The operator thought that there may have been interference from a media outside broadcast unit located about 30 m from the GCS. However, the media personnel advised the operator that they were using a satellite communications link and therefore should not cause interference.

Appropriate action

The manufacturer advised that once the aircraft commenced tracking to an incorrect home location, the appropriate action would have been to use the ‘hold’ or ‘manual’ command so that the joystick flight control could be used.

The remote pilot advised that they had attempted to use the ‘hold’ command, as they were shown in their training, but the RPA did not respond. No evidence of this was recorded in the GCS data.

Safety analysis

Although the pilot reported having completed the pre-flight preparations and associated checks, the data stored on the GCS showed that the incorrect (northern) hemisphere was assigned to the south-eastern georeference marker at the time the map image was created. This led to the home position being assigned a location in the Coral Sea Islands, so when the RPA lost signal and tracked for home, it headed north and was not recovered. The same outcome would have occurred if the pilot had selected the RPA to fly home, even with a continuous data-link signal. While all of the intermediate waypoints were also incorrect, as the GCS remained in manual mode, the RPA did not attempt to track to any of those waypoints.

Findings

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

- The south-eastern point used to georeference the image on the ground control station map was selected to a northern hemisphere latitude, which resulted in incorrect waypoints and home position for the mission.
- The RPA data-link signal to the ground control station was lost, so it commenced tracking to the programmed home position, which was in the Coral Sea Islands at a latitude 17.22° S, about 1,200 km north of the start position.

Safety action

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

Manufacturer

As a result of this occurrence, the RPAS manufacturer has advised the ATSB that they are taking the following safety actions:

- Audit of training curriculum to ensure that pilots understand how to verify GPS coordinates, interpret their values and signs. The training course will continue to train pilots on the tools available to them within, and outside of the GCS software.
- Share this incident with operator trainers so that new operators can learn from the events of this incident.

- Continued education and outreach discussions with RPAS operators pertaining to decreased mishap rates through training and currency policies.

Remotely piloted aircraft system operator

As a result of this occurrence, the remotely piloted aircraft system operator has advised the ATSB that they are taking the following safety actions:

- The pre-launch checklists have been modified to include additional and enhanced procedures to verify data input and flight plans.
- Investigate the fitting of either GPS or cellular tracking devices to remotely piloted aircraft.
- Update the risk assessment form to include location of external broadcast stations such as television outside broadcast units.
- Brief all company pilots on the event for safety and education purposes.
- Continue liaison with the manufacturer.

Safety message

Incorrect reference data can have potentially serious consequences in remotely piloted and manned aircraft. It is imperative that remotely piloted aircraft systems incorporate means of minimising the opportunity for errors to occur and also for detecting and correcting errors that do occur.

The careful application of operational controls and procedures, underpinned by robust risk assessment, will become increasingly important as relevant technologies develop further and new RPA applications continue to emerge. RPA operators should expect data loss events and prepare for these appropriately.

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

SafetyWatch

General details

Occurrence details

Date and time:	27 September 2016 – 0910 EST	
Occurrence category:	Accident	
Primary occurrence type:	Loss of control	
Location:	4 km NE of Ballina/Byron Gateway Airport, New South Wales	
	Latitude: 28° 48.93' S	Longitude: 153° 35.65' E

Aircraft details

Manufacturer and model:	Pulse Aerospace Vapor 55	
Registration:	Not required	
Serial number:	DPISSLHB270916	
Type of operation:	Aerial work	
Persons on board:	Not applicable	Not applicable
Injuries:	Ground – 0	
Aircraft damage:	Unknown (Missing)	

Australian Transport Safety Bureau

The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory agency. The Bureau 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 safety factors related to the transport safety matter being investigated. The terms the ATSB uses to refer to key safety and risk concepts are set out in the next section: Terminology Used in this Report.

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

About this Bulletin

The ATSB receives around 15,000 notifications of Aviation occurrences each year, 8,000 of which are accidents, serious incidents and incidents. It also receives a lesser number of similar occurrences in the Rail and Marine transport sectors. It is from the information provided in these notifications that the ATSB makes a decision on whether or not to investigate. While some further information is sought in some cases to assist in making those decisions, resource constraints dictate that a significant amount of professional judgement is needed to be exercised.

There are times when more detailed information about the circumstances of the occurrence allows the ATSB to make a more informed decision both about whether to investigate at all and, if so, what necessary resources are required (investigation level). In addition, further publically available information on accidents and serious incidents increases safety awareness in the industry and enables improved research activities and analysis of safety trends, leading to more targeted safety education.

The Short Investigation Team gathers additional factual information on aviation accidents and serious incidents (with the exception of 'high risk operations), and similar Rail and Marine occurrences, where the initial decision has been not to commence a 'full' (level 1 to 4) investigation.

The primary objective of the team is to undertake limited-scope, fact gathering investigations, which result in a short summary report. The summary report is a compilation of the information the ATSB has gathered, sourced from individuals or organisations involved in the occurrences, on the circumstances surrounding the occurrence and what safety action may have been taken or identified as a result of the occurrence.

These reports are released publically. In the aviation transport context, the reports are released periodically in a Bulletin format.

Conducting these Short investigations has a number of benefits:

- Publication of the circumstances surrounding a larger number of occurrences enables greater industry awareness of potential safety issues and possible safety action.
- The additional information gathered results in a richer source of information for research and statistical analysis purposes that can be used both by ATSB research staff as well as other stakeholders, including the portfolio agencies and research institutions.
- Reviewing the additional information serves as a screening process to allow decisions to be made about whether a full investigation is warranted. This addresses the issue of 'not knowing what we don't know' and ensures that the ATSB does not miss opportunities to identify safety issues and facilitate safety action.
- In cases where the initial decision was to conduct a full investigation, but which, after the preliminary evidence collection and review phase, later suggested that further resources are not warranted, the investigation may be finalised with a short factual report.
- It assists Australia to more fully comply with its obligations under ICAO Annex 13 to investigate all aviation accidents and serious incidents.
- Publicises ***Safety Messages*** aimed at improving awareness of issues and good safety practices to both the transport industries and the travelling public.

Australian Transport Safety Bureau

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Investigation

ATSB Transport Safety Report
Aviation Short Investigations
Aviation Short Investigations Bulletin Issue 56
AB-2016-176
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