Australian Government
Australian Transport Safety Bureau

# Ditching – Israel Aircraft Industries Westwind 1124A, VH-NGA

5 km SW of Norfolk Island Airport | 18 November 2009


Investigation

**ATSB Transport Safety Report**
Aviation Occurrence Investigation
AO-2009-072
Final

Australian Government

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**ATSB TRANSPORT SAFETY REPORT**

Aviation Occurrence Investigation

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Final

# Ditching
# 5 km SW of Norfolk Island Airport
# 18 November 2009
# VH-NGA
# Israel Aircraft Industries Westwind 1124A

Released in accordance with section 25 of the *Transport Safety Investigation Act 2003*

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# SAFETY SUMMARY

## What happened

On 18 November 2009, the flight crew of an Israel Aircraft Industries Westwind 1124A aircraft, registered VH-NGA, was attempting a night approach and landing at Norfolk Island on an aeromedical flight from Apia, Samoa. On board were the pilot in command and copilot, and a doctor, nurse, patient and one passenger.

On arrival, weather conditions prevented the crew from seeing the runway or its visual aids and therefore from landing. The pilot in command elected to ditch the aircraft in the sea before the aircraft's fuel was exhausted. The aircraft broke in two after ditching. All the occupants escaped from the aircraft and were rescued by boat.

## What the ATSB found

The requirement to ditch resulted from incomplete pre-flight and en route planning and the flight crew not assessing before it was too late to divert that a safe landing could not be assured. The crew's assessment of their fuel situation, the worsening weather at Norfolk Island and the achievability of alternate destinations led to their decision to continue, rather than divert to a suitable alternate.

The operator's procedures and flight planning guidance managed risk consistent with regulatory provisions but did not minimise the risks associated with aeromedical operations to remote islands. In addition, clearer guidance on the in-flight management of previously unforecast, but deteriorating, destination weather might have assisted the crew to consider and plan their diversion options earlier.

The occupants' exit from the immersed aircraft was facilitated by their prior wet drill and helicopter underwater escape training. Their subsequent rescue was made difficult by lack of information about the ditching location and there was a substantial risk that it might not have had a positive outcome.

## What has been done to fix it

As a result of this accident, the aircraft operator changed its guidance in respect of the in-flight management of previously unforecast, deteriorating destination weather. Satellite communication has been provided to crews to allow more reliable remote communications, and its flight crew oversight systems and procedures have been enhanced. In addition, the Civil Aviation Safety Authority is developing a number of Civil Aviation Safety Regulations covering fuel planning and in-flight management, the selection of alternates and extended diversion time operations.

## Safety message

This accident reinforces the need for thorough pre- and en route flight planning, particularly in the case of flights to remote airfields. In addition, the investigation confirmed the benefit of clear in-flight weather decision making guidance and its timely application by pilots in command.

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# THE 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.

**Developing safety action**

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

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

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

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

# TERMINOLOGY USED IN THIS REPORT

**Occurrence:** accident or incident.

**Safety factor:** an event or condition that increases safety risk. In other words, it is something that, if it occurred in the future, would increase the likelihood of an occurrence, and/or the severity of the adverse consequences associated with an occurrence. Safety factors include the occurrence events (e.g. engine failure, signal passed at danger, grounding), individual actions (e.g. errors and violations), local conditions, current risk controls and organisational influences.

**Contributing safety factor:** a safety factor that, had it not occurred or existed at the time of an occurrence, then either: (a) the occurrence would probably not have occurred; or (b) the adverse consequences associated with the occurrence would probably not have occurred or have been as serious, or (c) another contributing safety factor would probably not have occurred or existed.

**Other safety factor:** a safety factor identified during an occurrence investigation which did not meet the definition of contributing safety factor but was still considered to be important to communicate in an investigation report in the interests of improved transport safety.

**Other key finding:** any finding, other than that associated with safety factors, considered important to include in an investigation report. Such findings may resolve ambiguity or controversy, describe possible scenarios or safety factors when firm safety factor findings were not able to be made, or note events or conditions which 'saved the day' or played an important role in reducing the risk associated with an occurrence.

**Safety issue:** a safety factor that (a) can reasonably be regarded as having the potential to adversely affect the safety of future operations, and (b) is a characteristic of an organisation or a system, rather than a characteristic of a specific individual, or characteristic of an operational environment at a specific point in time.

**Risk level:** the ATSB's assessment of the risk level associated with a safety issue is noted in the Findings section of the investigation report. It reflects the risk level as it existed at the time of the occurrence. That risk level may subsequently have been reduced as a result of safety actions taken by individuals or organisations during the course of an investigation.

Safety issues are broadly classified in terms of their level of risk as follows:

- **Critical** safety issue: associated with an intolerable level of risk and generally leading to the immediate issue of a safety recommendation unless corrective safety action has already been taken.
- **Significant** safety issue: associated with a risk level regarded as acceptable only if it is kept as low as reasonably practicable. The ATSB may issue a safety recommendation or a safety advisory notice if it assesses that further safety action may be practicable.
- **Minor** safety issue: associated with a broadly acceptable level of risk, although the ATSB may sometimes issue a safety advisory notice.

**Safety action:** the steps taken or proposed to be taken by a person, organisation or agency in response to a safety issue.

# FACTUAL INFORMATION

## History of the flight

At 1026:02 Coordinated Universal Time (UTC)[1] on 18 November 2009, an Israel Aircraft Industries Westwind 1124A (Westwind) aircraft (Figure 1), registered VH-NGA and operating under the instrument flight rules (IFR), was ditched 3 km south-west of Headstone Point, Norfolk Island after a flight from Faleolo Airport, Apia, Samoa. The two flight crew, doctor, flight nurse, patient and one passenger all escaped from the ditched aircraft and were rescued by boat crews from Norfolk Island.

**Figure 1: VH-NGA**


### Positioning flight to Samoa

At about 0900 on 17 November 2009, the pilot in command (PIC) and copilot were tasked to fly the aircraft from Sydney, New South Wales to Apia after a refuelling stop at Norfolk Island. The flight was an aeromedical retrieval operation with a doctor and flight nurse on board. The aircraft was equipped for the task and navigation documentation for South Pacific operations was carried on board.

The flight departed Sydney Airport at about 1130 and arrived at Norfolk Island Airport at 1459. The 1430 weather observation for Norfolk Island reported Broken[2]

1 The flight crossed several time zones and the International Date Line. As such, all times in the report are referenced to Coordinated Universal Time (UTC). Local time at Norfolk Island was UTC+11:30.

2 Cloud amount is reported in the international standard format to denote the total amount of cloud covering the sky at the described height in hundreds of feet above the aerodrome reporting point. The terms used are SKC (no cloud), Few (FEW) to indicate 1 to 2 oktas, Scattered (SCT) to indicate 3 to 4 oktas, Broken (BKN) to indicate 5 to 7 oktas and Overcast (OVC) to indicate 8 oktas An okta is one eighth of the celestial dome being obscured by cloud.

cloud at 400 ft above the aerodrome reference point (ARP)[3] and Overcast cloud 2,900 ft above the ARP. These reported conditions were less than the minimum conditions required to assure a safe landing at Norfolk Island, although the crew had sufficient fuel to make an instrument approach and land if visual reference was established.[4] Alternatively, the aircraft carried sufficient fuel to divert to Brisbane, Queensland in case the weather conditions at Norfolk Island prevented a landing.

At 1443, when the flight crew first contacted the Norfolk Island Unicom[5] operator, the operator advised that the airport's automatic weather station indicated Broken cloud at 500 ft above the ARP and Overcast cloud at 800 ft above the ARP. The flight crew acknowledged the report, and the operator replied that he had parked at the threshold of runway 29 and seen '... a fair few stars about...' on the approach for runway 29. The flight crew reported that they had no difficulty acquiring visual reference[6] with runway 29 during the approach and landing. The wind was reported as coming from 330 °(T).

The aircraft departed Norfolk Island at about 1525 and arrived in Samoa at 1810 (early in the morning local time). The flight crew reported having a 50 kts tailwind during the flight from Norfolk Island.

The flight crew indicated that after securing the aircraft, they proceeded to a hotel for their scheduled rest break and slept during the day. The aeromedical team departed to meet the patient and passenger, who were to be flown to Melbourne via Norfolk Island later that day.

## Return flight

### *Flight planning*

At 0433 on 18 November, the PIC telephoned the Airservices Australia briefing office and verbally submitted a flight plan for a flight from Samoa to Norfolk Island. The flight was planned to depart from Samoa at 0530, flying the reverse of the outbound flight from Norfolk Island that morning, with an estimated time of arrival (ETA) of 0900 at Norfolk Island.

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3 An aircraft's height above the ground is significant during an instrument approach and is measured from different reference points, depending on the need. In this report, altitude is a vertical distance measured from the mean sea level, elevation is the vertical distance of a point on the earth measured from mean sea level and height is the vertical distance from a point on the earth. During instrument approaches, heights can be expressed as the vertical distance above the ARP or above the elevation of a specified runway threshold.

4 For more details, see the section of this report titled *Weather considerations*.

5 Unicom is a non-Air Traffic Service communications service at a non-towered aerodrome that is provided to enhance the value of information normally available about that aerodrome. The duty reporting or work safety officer provided the Unicom service at Norfolk Island.

6 Visual reference requires visual contact with the runway's visual aids, or of the area that should have been in view for sufficient time for the crew to assess the aircraft's position and rate of change of position in relation to the desired flightpath. After the initial visual contact, pilots maintain the runway environment (the runway threshold, approach lights or other markings that are identifiable with the runway) in sight.

The PIC received the latest aerodrome forecast (TAF)[7] for Norfolk Island from the briefing officer during the submission of the flight plan. This TAF was issued at 0437 and was valid from 0600 to 2400. The TAF indicated that the forecast weather conditions at Norfolk Island were above the landing minima (that is, they were suitable for a landing) at the planned ETA, with Scattered cloud at a height of 2,000 ft above the ARP, and a light south-westerly wind. These forecast conditions were also above the alternate minima, meaning that the flight plan did not need to include options for diversion to an alternate airport.

The briefing officer also advised the PIC of a '...trend[8]...' in the forecast from 1500, after which the wind was forecast to become more southerly, and the cloud to increase to Scattered at 1,000 ft above the ARP and Broken at 2,000 ft above the ARP. When the briefing officer asked if the PIC would like the details of the trend, the PIC declined.

The copilot did not, and was not required, to participate in the flight planning process. She did report reading the Norfolk Island TAF as written down by the PIC and noting its content. The PIC did not obtain any other en route or terminal meteorological information, Notices to Airmen (NOTAM)[9] or additional briefing information from the briefing officer, such as the availability of facilities at any potential alternate aerodromes. Each was necessary should the need for a diversion to an alternate aerodrome develop.

No en route forecasts were requested by the PIC prior to or during the flight. Those forecasts would have advised of the forecast en route winds and other weather conditions. A subsequent examination of the forecast en route winds indicated broadly comparable winds to those experienced during the flight to Samoa that morning.

The PIC reported that he used the weather and NOTAM briefing information from the flight from Sydney to Samoa when planning the return flight to Norfolk Island, because of difficulty accessing internet-based briefing resources. That information included the upper wind experienced on that flight.[10] The copilot reported not being involved in planning the flight, but did receive a pre-flight briefing from the PIC before the flight. During this briefing, the Norfolk Island TAF was discussed.

During the pre-flight inspection of the aircraft, the PIC arranged for the aircraft's main fuel tanks to be refuelled to full. No fuel was added to the tip tanks. Based on the aircraft manufacturer's data, the aircraft had 7,330 lbs (3,324 kg) of usable fuel on board for the flight.[11]

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7 Aerodrome Forecasts are a statement of meteorological conditions expected for a specific period of time, in the airspace within a radius of 5 NM (9 km) of the aerodrome.

8 A forecasted change in weather conditions.

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

10 The section of this report titled *Additional information* includes an estimation of the fuel required for the flight based on these assumed conditions.

11 Details of the aircraft's fuel system are included in the section of this report titled *Aircraft information*. There is further discussion of the calculation of fuel quantities in the *Fuel requirements* and *Fuel planning* sections.

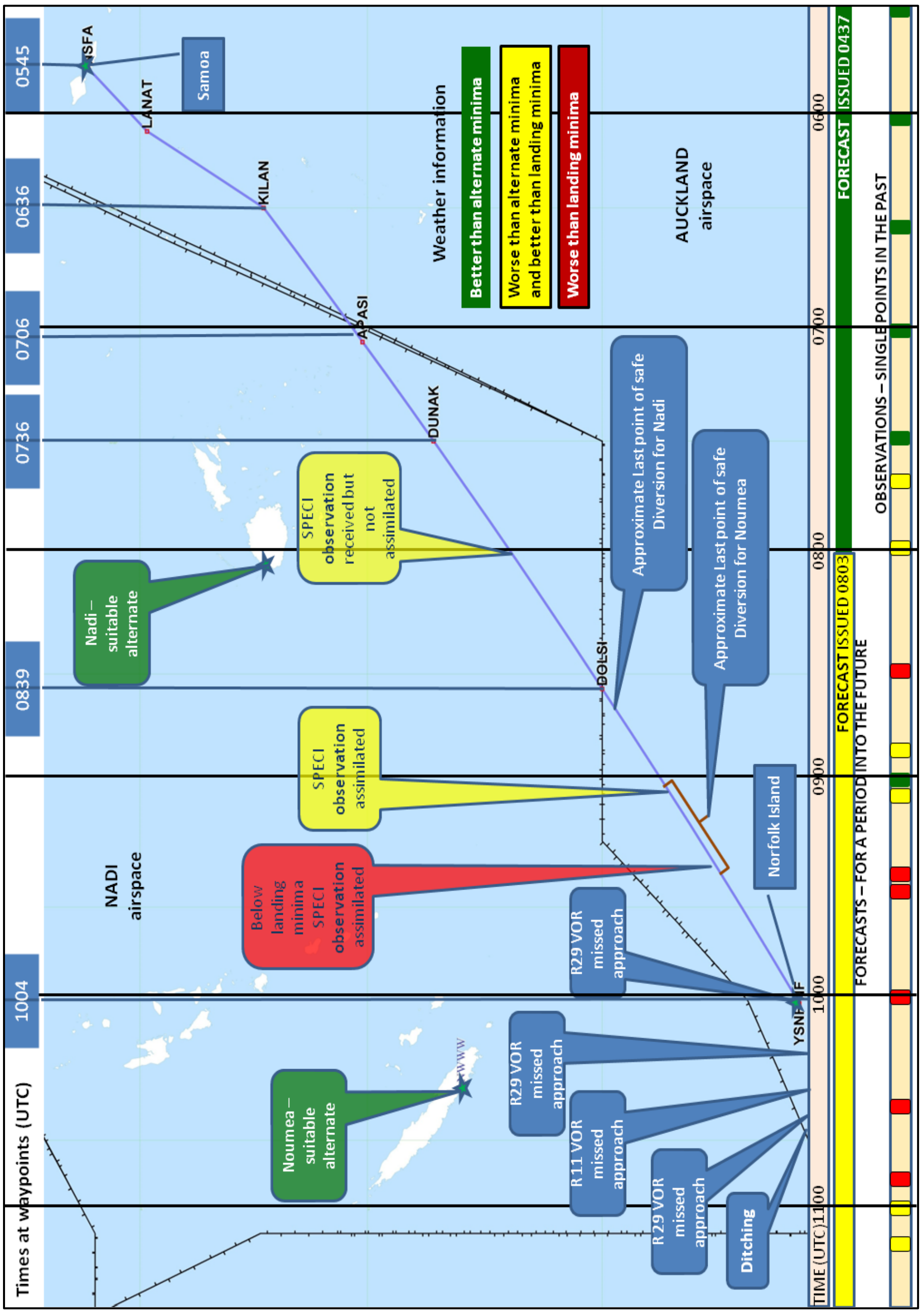
The two person flight crew normally flew 'leg for leg', alternating their roles as the flying pilot (PF) and the non-flying pilot (PNF). The copilot acted as PF for the leg from Norfolk Island to Samoa but had not flown the sector from Samoa to Norfolk Island that was to be flown that afternoon. The PIC reported asking if the copilot would like to be PF for the flight in order for the copilot to experience that leg. The copilot accepted the role.

The PIC reported that at mid-afternoon on the day of the flight, he unsuccessfully attempted to use the internet to submit a flight plan for the flight from Samoa via Norfolk Island to Melbourne. The PIC indicated that he attempted to contact a member of the operator's staff in Sydney to request the submission of a flight plan on his behalf, but this staff member did not answer the phone. Crews could normally contact the operator's staff if assistance was required; however, it was not normal practice to report to the operator if a flight was progressing normally.[12]

The departure was slightly delayed because of passenger medical requirements. Figure 2 is a pictorial representation of the return flight. The key events are expanded in the following sections.

[12] The flight crew stated that the operator did not normally monitor a flight as it progressed.

**Figure 2: Timeline for the flight**




### *Departure and cruise*

The flight departed Samoa at 0545, and initially climbed to flight level[13] 350 (FL350) in airspace that was controlled from New Zealand. High frequency (HF) radio was used for long distance radio communication between the aircraft and air traffic control (ATC) and very high frequency (VHF) radio for line of sight radio communications with airport service providers.

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13 Altitude related to a datum of 1013.25 hectopascals, expressed in hundreds of ft. FL350 equates to 35,000 ft.

At 0628, when the aircraft was approaching the intended cruising level of FL350, ATC instructed the flight crew to descend to FL270 by time 0650 in order to maintain separation with crossing traffic. The flight crew later reported to ATC that a descent to that altitude would have increased the aircraft's fuel consumption and requested a climb to a higher flight level. At 0633, ATC issued an amended clearance for the flight crew to climb to FL390 and the aircraft was established at this level at 0644.The flight continued at FL390 until the descent into Norfolk Island.

The PIC reported that, once established at FL390, he reviewed the fuel required for the remainder of the flight against the fuel remaining in the aircraft. He recalled that the 80 kts headwind experienced thus far was greater than expected (the pilot had planned on the basis of the upper winds that affected the flight the previous night), resulting in a revised ETA of 0930, 30 minutes later than planned. The flight crew reported calculating that, due to the increased headwind, the flight could not be completed with the required fuel reserves intact and that they adjusted the engine thrust setting to achieve a more efficient, but slower cruise speed. The flight crew recalled satisfying themselves that the revised engine thrust setting would allow the aircraft to complete the flight with the required fuel reserves intact.[14]

The aircraft entered Fijian controlled airspace and the flight crew contacted Fijian ATC at 0716. At 0756, the PIC requested a METAR[15] for Norfolk Island. At 0801, the controller provided the 0630 METAR for Norfolk Island, incorrectly reporting the cloud as being Few at 6,000 ft and correctly reporting Broken cloud at 2,400 ft above the ARP (see Appendix A for the controller transcript and Appendix B for the 0630 METAR). The PIC queried the time that the METAR was issued, which the controller confirmed and stated that it was the latest available observation. Routine reports can be used by flight crew to monitor the weather at a reporting station and any trends in that weather. The observations contained in those reports do not predict the weather into the future.

Less than 1 minute later, the controller contacted the PIC again and advised the availability of the latest weather observation for Norfolk Island. In response to the pilot's request for that information, the controller advised '... SPECI [special weather report[16]] I say again special weather Norfolk for 0800 Zulu[17]...'.[18] The SPECI reported an observed visibility of greater than 10 km and Overcast cloud at 1,100 ft above the ARP. These conditions were less than the alternate minima for Norfolk Island Airport, but above the landing minima.[19] The PIC acknowledged

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14 For more details, see the section of this report titled *Company fuel management policy.*

15 Routine aerodrome weather report issued at fixed times, hourly or half-hourly.

16 Aerodrome weather report that is issued whenever the weather conditions at that location fluctuate about or are below specified criteria. At weather stations like Norfolk Island, SPECI reports are issued either when there is Broken or Overcast cloud covering the celestial dome below an aerodrome's highest alternate minimum cloud base or 1,500 ft (whichever is higher) or when the visibility is below an aerodrome's greatest alternate minimum visibility or 5,000 m (whichever is greater).

17 'Zulu' is used in radio transmissions to indicate that a time is reported in UTC.

18 A partial transcript of this radio communication can be found at Appendix A.

19 For more details, see the section titled *Weather considerations*

receipt of that weather report but did not enquire as to the availability of an amended TAF for the island.

The Australian Bureau of Meteorology (BoM) issued an amended TAF at 0803. It forecast Broken cloud at 1,100 ft above the ARP at the aircraft's ETA at Norfolk Island. Like the conditions reported in the 0800 SPECI, the conditions that were forecast in the TAF were below the alternate minima for Norfolk Island, but above the landing minima at the aircraft's ETA.[20] Nadi ATC did not, and was not required by any international agreement to, proactively provide the 0803 amended Norfolk Island TAF to the flight crew.

The copilot reported that she could have been taking a scheduled 'short sleep' at the time of the radio communication with ATC. Short sleeps were an authorised component of the aircraft operator's fatigue management regime. The copilot did not recall receipt of the 0800 SPECI.

The observed weather at Norfolk Island in the 0800 SPECI differed from that forecast in the 0437 TAF that was received by the crew prior to the flight. The flight crew reported that, at the time, they were either not aware of or did not recognise the significance of the changed weather that was reported in this SPECI. They advised that if either had realised that significance, they would have initiated planning in case of the need for an en route diversion.

### *Approach planning and descent*

At 0839, the aircraft re-entered New Zealand-controlled airspace, with an ETA for Norfolk Island of 0956 (4 hours 11 minutes after departing Samoa). At 0904, the flight crew requested the latest Norfolk Island METAR from New Zealand ATC. The controller provided the 0902 SPECI that was sourced from the automatic weather station (AWS)[21] located near the centre of the airport. This included a report of the local QNH[22], which remained the same for the rest of the flight. The visibility was reported as 7,000 m, with Scattered cloud at 500 ft, Broken cloud at 1,100 ft and Overcast at 1,500 ft above the ARP. The observed weather was again less than the alternate minima but greater than the landing minima. The flight crew later reported that this was the first time they became aware that the destination weather conditions had deteriorated since they departed Samoa.

The flight crew later reported that at that time, they were not confident that the aircraft had sufficient fuel to reach the nearest suitable alternate airport at Tontouta, Noumea. The crew indicated that the higher-than-expected en route winds, and not knowing the winds for an off-track diversion, reinforced their doubt. The crew stated that they decided to continue to Norfolk Island because, on the basis of the observed weather conditions at the island being above the landing minima, they expected to be able to land safely. They believed that action was safer than a longer

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20 For more details, see the section titled *Weather considerations.*

21 A basic AWS provides an indication of the wind direction and speed, temperature, humidity, pressure setting and rainfall at the station's location. Advanced AWSs also provide an automated observation of the cloud and visibility. Norfolk Island Airport's AWS provided information on cloud and visibility.

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

off-track diversion to Noumea, with at that stage unknown destination weather and marginal fuel remaining.

At 0928, when about 160 NM (296 km) from Norfolk Island, the flight crew contacted the airport's Unicom operator to request an update of the airport's weather conditions. In response, the operator reported the presence of Broken cloud at 300 ft, 800 ft and 1,100 ft above the ARP and visibility 6,000 m. That was, the observed weather was below the landing minima.[23] The flight crew then asked the Unicom operator if he could visually assess the weather conditions at the runway thresholds when he drove out to inspect the runway prior to their arrival.

At 0932, ATC contacted the flight crew and requested the time at which they planned to commence descent into Norfolk Island. The flight crew advised that descent would commence at 0940 and received a descent clearance from ATC on that basis. ATC then relayed the latest weather observations for Norfolk Island that had been issued at 0930 and indicated Broken cloud at 200 ft and 600 ft and Overcast at 1,100 ft above the ARP and visibility 4,500 m.

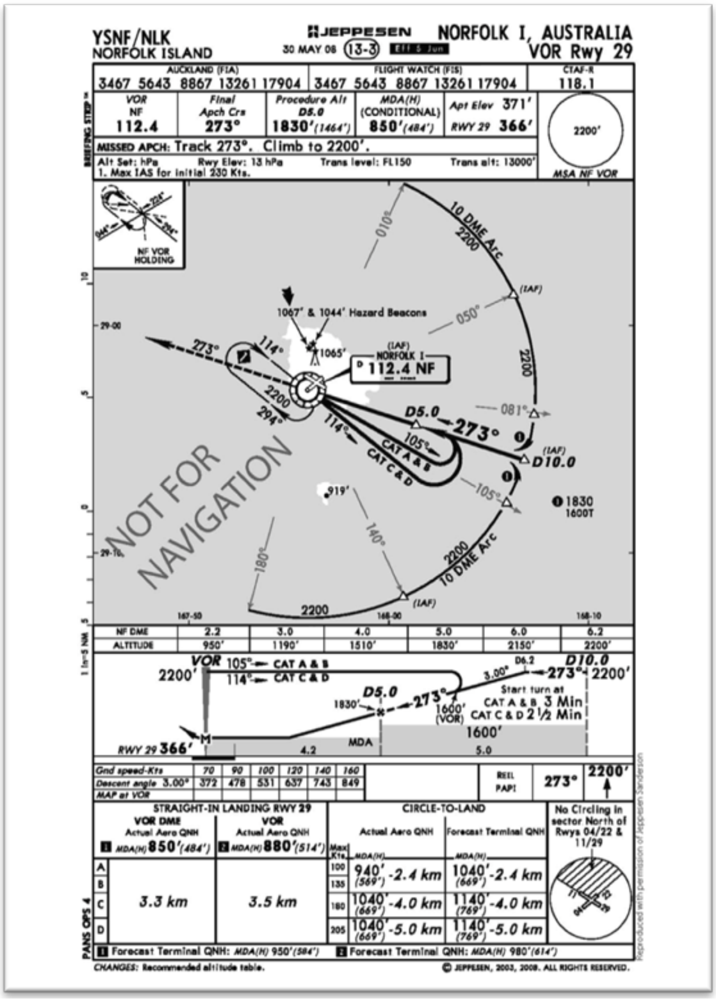
The flight crew reported conducting a pre-descent brief. The copilot planned to conduct a runway 29 VHF omnidirectional radio range/distance measuring equipment (VOR/DME)[24,25] instrument approach (Figure 3), which enabled the aircraft to descend safely to a height of 484 ft above the runway 29 threshold. The instrument approach would align the aircraft to land if visual reference was obtained with the runway threshold, approach lighting or other markings identifiable with the runway and the visibility was 3,300 m or greater.

[23] For more details, see the section titled *Weather considerations*.

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

[25] DME is a ground-based transponder station. A signal from an aircraft to the ground station is used to calculate its distance from the ground station.

**Figure 3: Runway 29 VOR instrument approach**




The crew reported agreeing that the expected weather would mean that visual reference with the runway may be difficult to obtain, and that the PIC would closely monitor the approach by the copilot. During the briefing for the first approach, the crew agreed that, if visual reference with the runway was not obtained, the PIC would take over control of the aircraft for any subsequent approaches.

The Unicom operator contacted the crew again at 0938 and stated that the weather conditions had deteriorated because a rainstorm was 'going through', with 'four oktas'[26] of cloud at 200 ft above the ARP and that the visibility had deteriorated. The operator also reported that the AWS indicated Broken cloud 600 ft above the ARP.

One minute later, the Unicom operator contacted the flight crew to advise that the automatic cloud base measurement remained the same, the visibility had increased to 4,300 m, and that '... the showers have sort of abated a bit here...'. The flight crew requested regular weather updates, which the operator provided three more times before the aircraft's first approach. Those updates indicated that the cloud base was generally Broken at 200 ft to 300 ft and 1,400 ft above the ARP, and that the visibility was around 4,500 m.

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26 Indicating that half of the sky was covered by cloud (at that height).

### *Conduct of four instrument approaches*

Recorded radio transmissions between the aircraft and the Unicom operator indicated that the flight crew initiated a missed approach procedure from the first approach at 1004:30. The flight crew reported that the PIC then assumed control of the aircraft as agreed during the pre-descent briefing. Shortly after, the operator advised the flight crew that '...the rain seems to be coming in waves...we've had two [waves] in the past 10 minutes... so it's not a heavy shower...it seems to be just coming in waves'. The PIC recalled there was about 1,300 lb (590 kg) of usable fuel remaining in the aircraft at that time.

At 1012:30, the Unicom operator reported that there was '... another weather cell rolling through'. At 1013, the flight crew initiated a second missed approach for runway 29 as they did not obtain the required visual references before the missed approach point.

The flight crew then elected to conduct a VOR approach to runway 11 (in the opposite direction) to take advantage of the lower landing minima for that approach. The runway 11 VOR permitted the aircraft to be flown to 429 ft above the runway threshold and to continue for a landing with a visibility of 3,000 m (Figure 4); however, there was a tailwind of up to 10 kts for operations to runway 11. The crew did not obtain the required visual references from the approach and initiated a missed approach procedure at 1019.

At this time, the flight crew decided that they would ditch the aircraft in the sea before the fuel was exhausted. The copilot briefed the doctor and the passenger who was sitting in the front left cabin seat to prepare for a ditching.[27] At 1019:30, the crew reported to the Unicom operator that 'we're going to have to ditch we have no fuel'.

Subsequently, the flight crew decided not to ditch the aircraft after the runway 11 VOR approach because the intended flight path would take them toward a nearby island that they could not see to avoid. The flight crew decided to conduct one more instrument approach for runway 29 as, if they did not become visual off that approach, the missed approach procedure track of 273 °(M) would take the aircraft to the west of Norfolk Island, over open sea and clear of any obstacles for the planned ditching.

The PIC reported descending the aircraft to a lower height than the normal minimum descent altitude for the runway 29 VOR approach procedure in a last attempt to become visual. The crew did not become visual and at 1025 the PIC made a fourth missed approach. At 1025:03, the crew notified the Unicom operator that they were '...going to proceed with the ditching'. The operator recalled being unable to determine where the flight crew were planning to ditch on the basis of the previous radio conversations.

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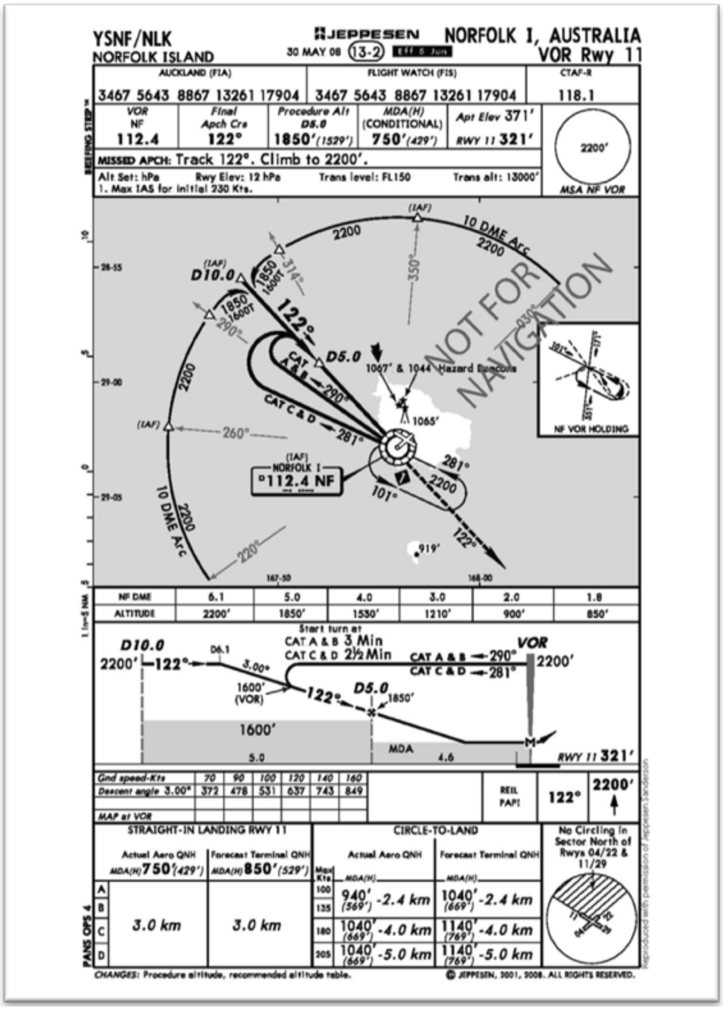
[27] The actions that were taken to prepare for ditching are described in detail in the section titled *Survival aspects*.

**Figure 4: Runway 11 VOR instrument approach**



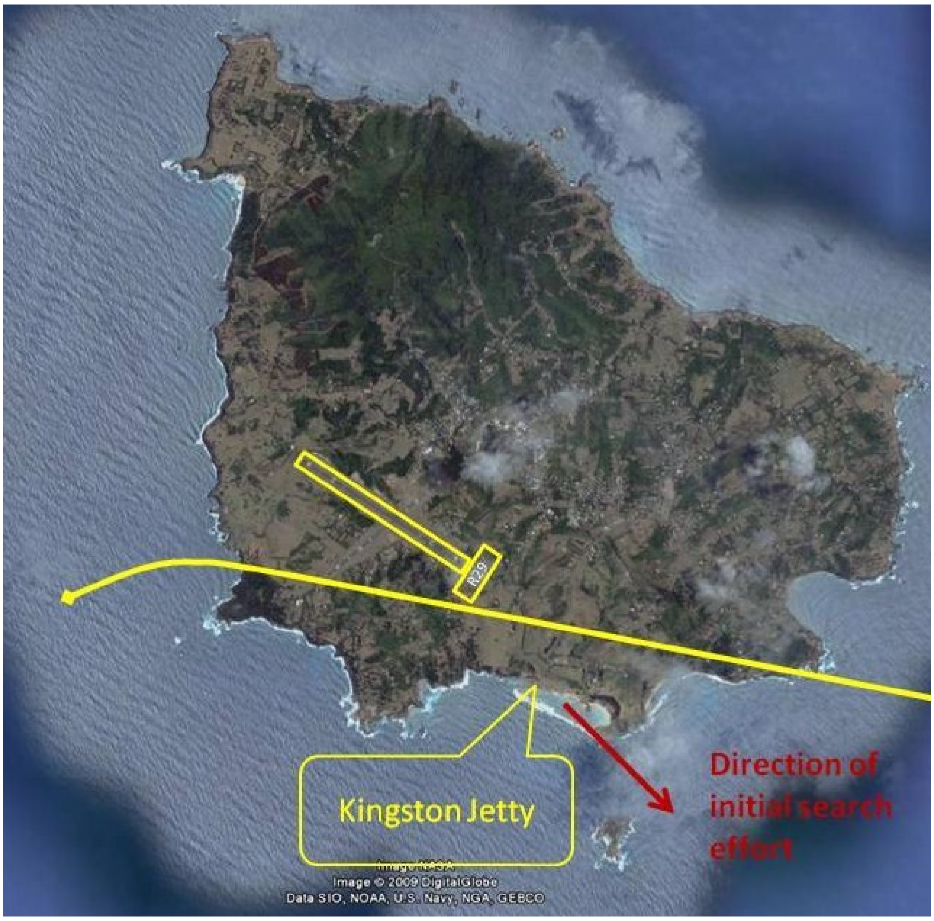

The crew indicated that they climbed the aircraft to 1,200 ft above mean sea level (AMSL), turned left in a south-westerly direction (Figure 5), and configured the aircraft to land without extending the landing gear. The flight crew descended towards the water while monitoring the digital height readout from the aircraft's radar altimeter (RADALT)[28], which was mounted near the attitude indicator in the cockpit instrumentation.

The crew reported initiating a landing flare at about 40 ft RADALT and that the aircraft first contacted the water at an airspeed of about 100 kts. The flight crew recalled that, although they had selected the landing lights ON, they did not see the sea before impacting the water. Although there was no recorded MAYDAY or other radio call coincident with the ditching, a short unintelligible radio transmission was recorded on the Unicom frequency at 1026:02.

There was no fire.

[28] Also known as a radio altimeter, a radar altimeter uses reflected radio waves to determine the height of the aircraft above the ground or water.

**Figure 5: Approximate aircraft track before the ditching**




## Injuries to persons

| Injuries | Crew | Passengers | Others |
|---|---|---|---|
| Fatal | 0 | 0 | 0 |
| Serious | 1 | 1 | 0 |
| Minor/None | 1 | 3 | 0 |

## Damage to the aircraft

The aircraft was seriously damaged.[29] The fuselage broke in two and sank in 48 m of water. The aircraft was not recovered.

29 The *Transport Safety Regulations 2003* define serious damage as including the destruction of the transport vehicle.

## Personnel information

### Pilot in command

| | |
|---|---|
| Flight Crew Licence | Air Transport Pilot (Aeroplane) Licence, issued 11 October 2002 |
| Instrument rating | Command instrument rating, valid to 28 February 2010 |
| Aviation Medical Certificate | Class 1, valid to 23 January 2010; vision corrections stipulated |
| Wet drill emergency training | Conducted 27 April 2008 |
| Aircraft endorsement | Issued 27 July 2007[30] |
| Check to line, Westwind captain | 10 November 2008 |
| 72-hour history | Not on duty 13 to 15 November 2009, on standby[31] 16 November 2009 |
| Total aeronautical experience | 3,596 hours |
| Aeronautical experience in the previous 365 days | 309 hours |
| Aeronautical experience in the previous 90 days | 38 hours |
| Total hours on type | 923 |
| Total hours on type in the previous 90 days | 39 |

The operator's operations manual Part D titled *Check and training*, section 3.4 included the requirement for post-endorsement training to be completed by captains and copilots before being permitted to undertake aerial work. Included in that additional training was:

- In-flight planning, including the examination of fuel, weather and operational requirements, suitable alternates, and the application of critical points (CP) and points of no return (PNR) during normal operations and with one engine inoperative (OEI) and in consideration of aircraft depressurisation.
- Navigation, including the calculation and adjustment of CPs and PNRs.

30 An aircraft endorsement is required to act as copilot. The PIC flew as copilot between August 2007 and November 2008.

31 A pilot on standby is not on duty, but is available to be called on duty by the operator.

There was no requirement in the operations manual for the content of such training to be recorded. The Australian Transport Safety Bureau (ATSB) was unable to independently confirm the extent of the PIC's post-endorsement training.

## Copilot

| | |
|---|---|
| Flight Crew Licence | Commercial Pilot (Aeroplane) Licence, issued 7 September 2004 |
| Instrument rating | Command instrument rating, valid to 31 October 2010 |
| Aviation Medical Certificate | Class 1, valid to 8 April 2010; vision correction stipulated |
| Wet drill emergency training | Conducted 19 April 2008 |
| Aircraft endorsement | Command endorsement, issued 29 January 2008 |
| 72-hour history | On standby 13 November 2009, not on duty from 14 to 16 November 2009 inclusive |
| Total aeronautical experience | 1,954 hours |
| Aeronautical experience in the previous 365 days | 418 hours |
| Aeronautical experience in the previous 90 days | 78 hours |
| Total hours on type | 649 |
| Total hours on type in the previous 90 days | 78 |

## General

Both flight crew members underwent a crew resource management education program that was conducted by the operator in March 2009. They had not received any threat and error management (TEM)[32] training as part of that program, nor was there any regulatory requirement for them to have done so.

The flight crew had been awake for over 12 hours before being called on duty at 0900 for the departure from Sydney on the previous day, and they had been awake for over 22 hours when they landed at Samoa. After having breakfast they had about 8 hours opportunity at a hotel for rest prior to returning to the airport. The captain initially reported to the ATSB that he slept for most of this period and was well rested, but later reported to the Civil Aviation Safety Authority (CASA) that he had only about 4 hours sleep but did not feel fatigued. The first officer advised of having 5 to 6 hours sleep and feeling well rested.

Based on this information, it is likely that the flight crew were experiencing a significant level of fatigue on the flight to Samoa, and if the captain only had

[32] The concept of TEM is discussed in the section titled *Additional information*.

4 hours sleep then it is likely he was experiencing fatigue on the return flight at a level likely to have had at least some effect on performance. However, there was insufficient evidence available to determine the level of fatigue, or the extent to which it may have contributed to him not comprehending the significance of the 0800 SPECI.

## Aircraft information

| | |
|---|---|
| Manufacturer | Israel Aircraft Industries Ltd |
| Model | 1124A |
| Serial Number | 387 |
| Registration | VH-NGA |
| Year of manufacture | 1983 |
| Certificate of airworthiness | Issue date 6 March 1989 |
| Certificate of registration | Issue date 25 January 1989 |
| Maximum take-off weight (kg) | 10,659 |
| Maintenance Release | Continuous subject to system of maintenance |
| Airframe hours | 21,528 |
| Landings | 11,867 |
| Engine type | Honeywell Garrett turbofan |
| Engine model | TFE731-3-1G |
| Approach performance category | Category C |

The aircraft was maintained as a Class A aircraft in accordance with a CASA-approved system of maintenance. No deficiency in the aircraft's system of maintenance was identified with the potential to have contributed to the occurrence.

The aircraft's maintenance records provided a complete record of maintenance, inspection and defect rectification. There were no deferred maintenance entries in the aircraft's logbook or technical loose leaf log.

### Fuel system

The aircraft's fuel system was comprised of:

- three fuselage tanks
- one wing tank in each wing
- two wingtip tanks.

The fuselage and wing tanks were interconnected, were commonly known as the ‘main tanks’ and carried about 7,330 lbs (3,324 kg) of usable fuel. The wingtip tanks, if filled, provided for a total usable fuel capacity of 8,870 lbs (4,023 kg).

## Meteorological information

### Norfolk Island weather products

An aerodrome weather report (METAR) was provided for Norfolk Island Airport every 30 minutes and a TAF every 6 hours. The frequency of those observations and forecasts could be increased by issuing another report or an amended TAF if there was a change in the observed or forecast weather conditions beyond specified criteria.

While planning and conducting the flight, the flight crew received the following weather information for Norfolk Island Airport:

- TAF issued and obtained at 0437, and valid between 0600 and 2400, indicating no operational requirements, such as the need to nominate an alternate or to carry additional fuel for the planned ETA.
- METAR 0630, obtained at 0801 indicating the observation of no conditions at 0630 that might suggest an operational requirement.
- SPECI 0800, obtained at 0802 and suggesting the need to consider the options of an alternate aerodrome.
- SPECI 0902, obtained at 0904 indicating the observation of conditions that continued to suggest the need to consider the options of an alternate aerodrome.
- SPECI 0930, obtained at 0932 and indicating that the observed weather at Norfolk Island was below the required landing minima.
- From 0928, frequent real-time updates from the Unicom operator. Although the operator was not an ‘Approved Observer’ in accordance with Aeronautical Information Publication (AIP) General (GEN) 4 Meteorological Reports paragraph 4.5.1., most of the operator’s updates and AWS-based reports suggested that the weather was below the required landing minima.

The relevance of each of the received forecasts and observations in relation to the alternate and landing minima are indicated in Figure 2 and Appendix B. Other forecasts and reports were available on request.

An amended Norfolk Island TAF that was valid for the aircraft’s ETA was issued by the Australian BoM at 0803. In that TAF, the visibility was forecast to be 10 km or more, with Broken cloud at 1,000 ft above the ARP. Those conditions indicated that the weather would be below the alternate minima for Norfolk Island at the aircraft’s ETA, but above the landing minima. The flight crew were not advised, and were not required by any international agreement to be advised, of the amended forecast and they did not request an updated forecast for Norfolk Island during the flight.

End of daylight at Norfolk Island that day was at 0750.

## Aids to navigation

The flight crew navigated the aircraft during the en route phase of the flight using approved global navigation satellite system (GNSS) equipment. The flight crew was qualified and approved to use that equipment as an en route oceanic navigation aid.

During the approach phase of the flight, the flight crew navigated the aircraft by reference to the ground-based Norfolk Island VOR transmitter and the co-located DME. The aircraft's barometric and radar altimeters were used to ascertain the aircraft's altitude and height above ground level respectively.

There was also a non-directional beacon (NDB)[33] that was situated 2 NM (4 km) to the north-west of Norfolk Island Airport. There were two NDB instrument approaches that could have been used to approach the airport to land but neither would have enabled an aircraft that was in cloud to descend as low as the VOR approaches for runways 11 and 29.

Instrument approach procedures were also promulgated for runways 04, 11 and 29 based on an augmented GNSS landing system (GLS) that was known as a radio navigation (RNAV) special category-1 (SCAT-1) approach system. The use by operators of the RNAV SCAT-1 required prior approval from CASA. Once approved for SCAT-1 approaches, and their aircraft were equipped with the necessary specialised equipment, pilots were able to descend 130 ft lower than the published minimum for the runway 11 VOR instrument approach procedure.

The Westwind was not approved for RNAV SCAT-1 approaches.

## Communications

Communications with Samoa ATC and the Norfolk Island Unicom operator were via VHF radio. The use of VHF provided for high quality, line-of-sight communications up to about 150 NM (278 km) from Norfolk Island.

Communications with New Zealand and Fiji ATC were via HF radio, which gives a longer range but provides a lower quality output. Differing HF frequencies may be required depending on the ambient conditions and the time of day.

No difficulties were identified by the flight crew with their radio communications during the flight.

## Aerodrome information

Norfolk Island Airport was located in the southern part of the island at an elevation of 371 ft. The main east-south-east/west-north-west runway (runway 11/29) was intersected by a smaller north-east/south-west runway (runway 04/22) (Figure 6).

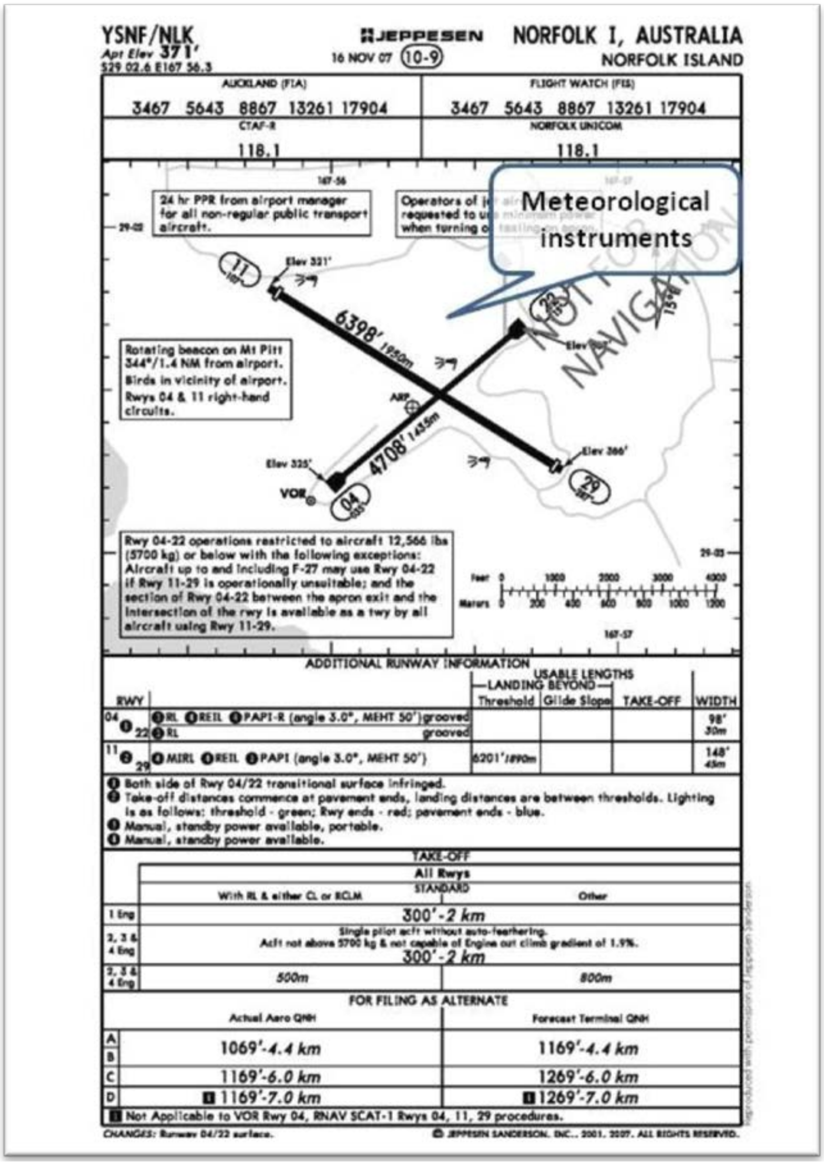
Both runways were available for use by the Westwind if required.

The normal airport staff was in place for the Westwind's arrival and the medium intensity runway lighting, runway end identifier lighting (threshold strobe lighting) and precision approach path indicator were illuminated to their maximum intensity

[33] An NDB is a ground-based radio transmitter at a known location that can be used as a navigational aid. The signal transmitted does not include inherent directional information.

on runway 11/29 at the time. The Unicom operator had access to a repeater that showed the readouts from the airport's meteorological instruments and was able to relay those readings to pilots on request.

**Figure 6: Aerodrome chart**




## Flight recorders

The aircraft was equipped with a model FA2100 solid-state cockpit voice recorder (CVR) and a flight data recorder (FDR). Both units were installed in the aircraft's tailcone.

The CVR recorded the previous 120 minutes of in-cockpit audio information based on an endless-loop principle. The recorded information included audio inputs from the pilots' headsets and from the 'cockpit area microphone' that was installed in the centre of the glare shield. Each input was stored on separate channels in the CVR's solid-state storage device.

The recovery of the recorders from the wreckage was considered in the context of the other available sources of information on the conduct of the flight. Those sources included: the flight crew, medical staff and passengers; the Unicom operator; Fiji and New Zealand radio recordings; operator documentation and recollections; the relevant meteorological forecasts and observations; and so on.

The wreckage was in 48 m of water in open sea, which required specialist divers and major support equipment from mainland Australia to carry out any attempt to recover the FDR and CVR. In comparison with the recovery risk, the availability and quality of the information provided by the flight crew, medical staff and passengers, Unicom operator and the operator was very good.

While some benefit could have been derived from any information able to have been recovered from the CVR and the FDR, the anticipated benefit was not considered sufficient to justify the recovery risk, because most of the information was available from other sources. In addition, the flight crew did not report any aircraft anomalies during the flight. On that basis, the decision was taken not to recover the FDR and CVR.

## Wreckage and impact information

The ATSB located the aircraft by using a sonar receiver to localise the ultrasonic signal emitted from the underwater locator beacon that was attached to the aircraft's cockpit and flight data recorders. With the assistance of the Victoria Water Police, a remotely-operated vehicle with an underwater video camera was used to assess the wreckage.

The wreckage came to rest on a sandy seabed. Video footage showed that the two parts of the fuselage remained connected by the strong underfloor cables that normally controlled the aircraft's control surfaces. The landing gear was extended, likely in consequence of the impact forces and the weight of the landing gear. The flaps appeared to have been forced upwards from the pre-impact fully extended selection reported by the PIC.

The underwater video showed a lack of visible damage to the turbine compressor blades at the front of the engines. That was consistent with low engine thrust at the time of the first contact with the sea.

Consistent with the aircraft occupants' recollections, the video footage indicated that aircraft's configuration resulted in the bottom of the fuselage below the wing making the first contact with the water.

On contact with the water, the fuselage fractured at a point immediately forward of the main wing spar. The flight nurse was seated nearest to that location and reported the smell of sea water and feeling water passing her feet immediately after the impact. All of the aircraft occupants recalled that the fuselage parts remained aligned for a few seconds after the aircraft stopped moving, before the aircraft's nose and tail partially sank, leaving the centre section above the surface of the sea. The passenger cabin/cockpit section adopted a nose-down attitude, leaving the wings partially afloat and the engines below the surface.

An edited version of the underwater video will be released as part of the final Australian Transport Safety Bureau (ATSB) investigation report and be made available at http://www.atsb.gov.au/media/782199/vh-nga_underwater.mp4. As such, the video will be subject to the same restrictions of use as the final investigation report itself.[34]

## Medical and pathological information

There was no evidence that physiological factors or incapacitation affected the performance of the flight crew.

## Survival aspects

### Ditching

In the case of multiengine aircraft, Civil Aviation Order (CAO) 20.11 *Emergency & life saving equipment & passenger control in emergencies* required sufficient life jackets to be carried for all occupants during flights that were greater than 50 NM (93 km) from land. Jackets were required to be stowed at, or immediately adjacent to each seat. The aircraft was equipped with life jackets for all on board and two life rafts.

The operator's operations manual contained procedures for ditching that included advice on the control and orientation of the aircraft with respect to the sea surface, the deployment of any life rafts and jackets, and on water survival. As the flight crew initiated the third missed approach, the copilot instructed the passengers to prepare for the ditching. To the extent possible, the company's ditching procedures were followed by the crew.

The flight crew had previously taken part in practice ditching procedures (wet-drill training). That included a simulated escape from a 'ditched aircraft'. Similarly, the medical staff normally flew in aeromedical helicopters, and had previously conducted helicopter underwater escape training (HUET). HUET training exposes trainees to simulated helicopter ditching and controlled underwater escape exercises. That includes in simulated dark conditions and with simulated failed or obstructed exits.

The PIC and medical staff stated that their ditching training assisted in their escape from the aircraft.

#### *Preparation for the ditching*

The copilot reported turning the cabin lights ON and briefing the passengers and the medical staff from the control seat to prepare the cabin for ditching. The flight crew recalled having insufficient time to put on their life jackets between deciding to ditch and the ditching, and that they were unable to ensure their approach path was aligned with the sea swell because they could not see the sea.

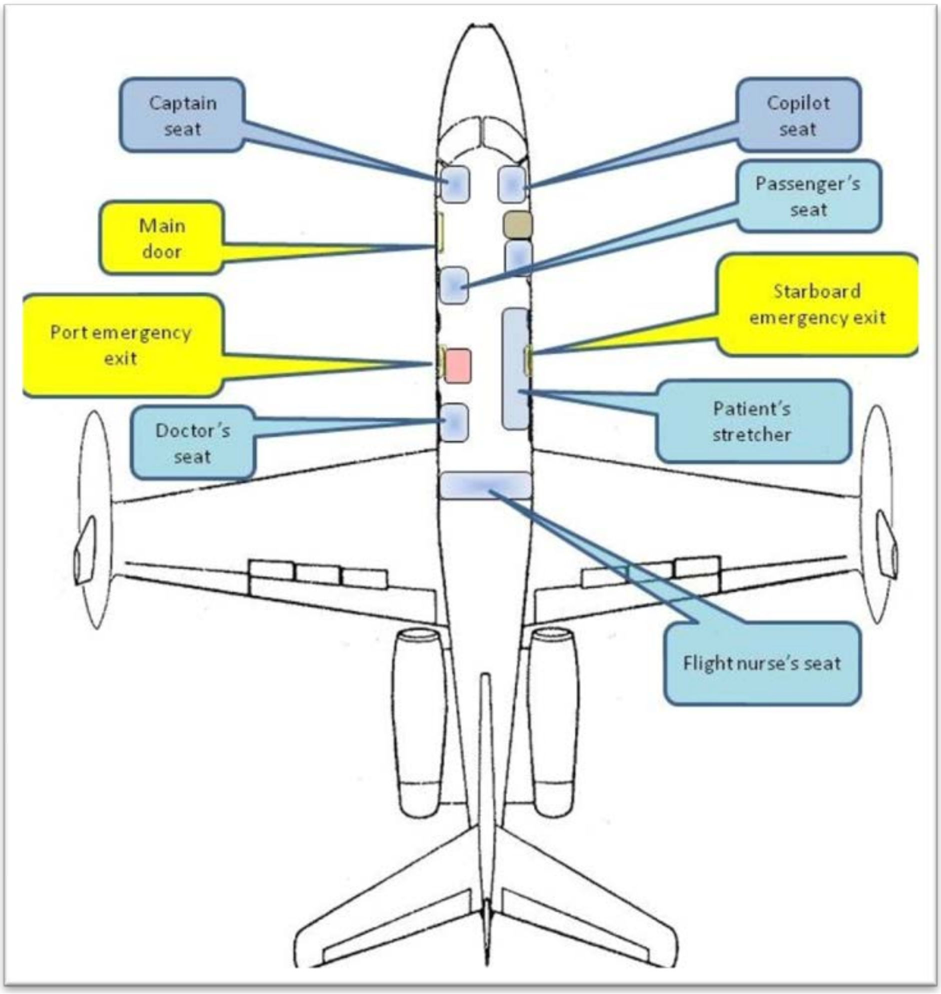
The passenger, doctor and nurse put their life jackets on in preparation for the ditching. The patient was lying on a stretcher on the right side of the cabin and was restrained by a number of harness straps (Figure 7). The doctor decided not to put a life jacket on the patient due to concerns about the life jacket hindering the release

[34] See section 27 of the *Transport Safety Investigation Act 2003*.

of the patient's restraints after the ditching.[35] The doctor ensured that the patient's harness straps were secure and instructed the patient to cross her arms in front of her body for the ditching.

The life rafts were reported removed from their normal stowed position and placed in the aircraft's central aisle ready for deployment after the ditching.

**Figure 7: Seating positions at the time of the ditching**




### *Impact with the water*

The aircraft occupants recalled two or three large impacts when the aircraft contacted the water. Those in the front of the aircraft described the impact forces acting in a horizontal, decelerating direction. The flight nurse, who was seated in the rearmost seat in the aircraft (Figure 7), reported far stronger vertical accelerations during the deceleration sequence compared with the other aircraft occupants. That was consistent with the nature of the injuries sustained by the nurse.

35 Part C section 3.1.6 of the operations manual titled *Conduct of Medivac Flights* stated that 'Where stretcher patients are carried on over-water flights, they must have a life jacket in place and the pilot in command shall ensure that special arrangements have been made to evacuate the patient as well as the attendants in case of ditching.' The term 'in place' was not defined.

The copilot was shorter in stature than the PIC and had adjusted the seat and rudder positions appropriately to enable full and free access to the flight controls. The nature of the injuries sustained by the copilot was consistent with an impact with the control yoke during the deceleration sequence. The copilot stated that she may have been unconscious for a short but unknown time as a result of the impact forces.

### *Exit from the aircraft*

The inwards force of the water entering the cabin reportedly prevented the main plug-type aircraft fuselage door[36] from being fully opened. Water was reported to have flowed into the cabin through the bottom of the partially-open door.

It was not possible to determine exactly when the cabin lighting failed. Most occupants reported that the cabin remained illuminated immediately after the aircraft stopped moving. The last occupants to exit the aircraft reported that the fuselage was dark at that time.

Similarly, it was not possible to determine the exit sequence for the last two occupants – the copilot and the doctor. Neither clearly recalled the presence of the other in the fuselage; however, one of the occupants, who was already clear of the aircraft, reported that they believed the copilot was the last to surface.

<u>Pilot in command</u>

The PIC reported checking that the copilot was responding before moving rearwards into the cabin and ascertaining that the main door was not usable (Figure 7). Continuing rearwards to the two emergency exits in the fuselage centre section, the PIC opened the port (left, looking forward) emergency exit, and exited as water flowed in through the door opening.

<u>Flight nurse, doctor and patient</u>

The patient’s stretcher was positioned in the area of the starboard (right) emergency exit. That area was reported to have become very crowded and busy as the medical staff released the patient from the stretcher.

The doctor released the patient’s harnesses and opened the starboard emergency exit. Water flowed through the emergency exit and the doctor believed that the door opening was completely underwater. The nurse, doctor and patient exited the aircraft through the starboard emergency exit. All three reported holding onto each other as they departed ‘in a train’ but could not provide a consistent recollection of the sequence in which they exited the aircraft.

<u>Copilot</u>

The copilot recalled being alone in the cockpit before moving to the main door and attempting unsuccessfully to open it. The copilot reported that the fuselage then tilted nose downward and that a quantity of equipment and baggage descended or rolled down the fuselage as it filled with water. The copilot abandoned the main door, swam up towards the rear of the fuselage, located an emergency exit door by touch, and exited the aircraft.

---

[36] An aircraft door that is larger than the doorway and has tapered edges to increase the security of a pressurised fuselage. In-flight pressurisation loads force the plug door more tightly against the doorframe.

Passenger

When the passenger, who was seated immediately behind the main door on the left of the aircraft, released his seat belt, there was little breathing room between the surface of the incoming water and the top of the fuselage. The passenger stated that there was no light and that the nose of the aircraft had tipped down. The passenger recalled swimming rearwards along the fuselage until he felt an emergency exit door and then exiting the aircraft, probably through the port emergency exit.

The passenger believed that he swam upwards some distance after exiting the aircraft before reaching the surface of the water.

### *Post exit*

All of the aircraft occupants stated that they exited the aircraft very quickly, and that there had been no time to take the life rafts. The PIC stated that he returned to the aircraft in an attempt to retrieve a life raft but the 1.5 m to 2 m swell and the jagged edges surrounding the broken fuselage made it hazardous to be near the aircraft, so he abandoned any attempt to retrieve a raft.

## Search and rescue

At about 1010, when the weather first deteriorated to the extent that the Unicom operator thought it might be difficult for an aircraft to land, he alerted the island's emergency response agencies to a local standby condition. The operator subsequently deployed the emergency services following the aircraft's second missed approach. In addition, two local boat owners prepared to launch their fishing vessels at Kingston Jetty to search for the potentially ditched aircraft and its occupants (Figure 5).

When the Unicom operator lost radio contact with the flight crew, the airport firefighters drove from the airport to Kingston Jetty to help with the recovery efforts. One of the firefighters reported using a different route to Kingston Jetty, believing that it was possible the aircraft had ditched to the west of the island. That route took the firefighter along the cliff overlooking the sea to the west of the airport.

The first rescue vessel departed Kingston Jetty to the south-east at 1125, toward the flightpath for the missed approach segment of the runway 11 VOR instrument approach (Figure 4).

At about that time, the PIC remembered that he had a bright, light-emitting diode torch in his pocket. He shone the torch beam upwards into the drizzle and towards the shoreline. The firefighter who had used the different route to Kingston Jetty reported stopping on the cliffs to the west of the airport to visually search for the aircraft. From that vantage point, the firefighter saw what he believed was an intermittent, faint glow in the distance to the west of the island. After watching for a few minutes to satisfy himself that he could actually see the light, the firefighter reported the sighting to the Emergency Operations Centre (EOC) at the airport. The EOC forwarded the information to the departing rescue vessel.

In response, the rescue vessel turned and travelled toward the reported position of the light. The crew of the rescue vessel stated that they identified a radar return when they were 1.4 NM (3 km) from the aircraft occupants. The rescue vessel crew reported sighting the lights on the survivors' life jackets when they were 1 NM (2 km) from the survivors. The survivors reported that most of the life jacket lights had stopped working by the time they were recovered by the rescue vessel.

### Locator beacons

The aircraft was fitted with a 406 MHz emergency locator transmitter (ELT), which was designed to transmit a distress signal that could be received by a satellite. The ELT could be manually activated by a switch in the cockpit, and it would also activate automatically if the aircraft was subjected to g-forces[37] consistent with an aircraft accident.

The aircraft was also equipped with four personal locator beacons (PLBs) that could be carried separately and manually activated. Two of these beacons were installed in the life rafts, and one of the remaining beacons was equipped with Global Positioning System (GPS) equipment, which would enable it to transmit its position when it was activated. The aircraft occupants were unable to retrieve any of the PLBs before they exited the aircraft after the ditching.

The aircraft-mounted ELT was not GPS-equipped. A geostationary satellite received one transmission from that ELT and the information associated with that transmission was received by Australian Search and Rescue (AusSAR)[38] 8 minutes after the aircraft ditched. AusSAR was able to identify the owner of the ELT, but was not able to assess its location from the one transmission.

## Organisational and management information

### Regulatory context for the flight

The regulatory requirements affecting the flight were administered by CASA and established a number of risk controls for the operation that were promulgated in the Civil Aviation Regulations (CAR) and CAOs. Those controls related to the operator, the pilot in command (PIC) and the conduct of the flight. Surveillance was carried out by CASA of operators' procedures and operations to ensure that such flights were conducted in accordance with those approvals and the relevant regulations and orders.

In addition, guidance on how operators and pilots might satisfy the requirements of the regulations and orders was available in Civil Aviation Advisory Publications (CAAP).

#### *The operator*

CAR 215 required the operator to maintain an operations manual that provided guidance to its pilots and other operations personnel. Operations manuals were to include information, procedures and instructions in respect of the safe operation of

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37 The force needed to accelerate a mass. G-force is normally expressed in multiples of gravitational acceleration.

38 Australian Search and Rescue operates a 24-hour rescue coordination centre and is responsible for the national coordination of search and rescue.

all of an operator's aircraft types. That did not include the need for a repeat of information that was already included in other documents that were required to be carried in the aircraft.

The operator maintained an operations manual in accordance with CAR 215. The contents of that manual as they affected the flight are discussed in the subsequent section titled *Operator requirements*.

### *Pilot in command*

Flights were to be planned in accordance with CAR 239, which required PICs to carefully study all available information that was relevant to an operation. In the case of flights under the IFR, or those away from the vicinity of an aerodrome, this included the study of current weather reports and forecasts for the route and aerodromes intended for use, the en route facilities and their condition, the condition and suitability of any aerodromes to be used or contemplated as alternates and any relevant air traffic procedures.[39]

Norfolk Island Airport had suitable runways, runway lighting, navigation aids and other facilities for the operation.

### *Conduct of the flight*

General

The aeromedical retrieval flight was conducted in a transport category aircraft but was an aerial work operation under CAR 206. Aerial work operations are a separate flight category from passenger-carrying charter and scheduled air transport operations.

A number of the conditions affecting aerial work, charter and scheduled air transport operations were set out in CAO 82.0. In that CAO, Norfolk Island was defined as a 'remote island' that, depending on the category of operation, invoked a number of specific operational requirements.

Fuel requirements

In accordance with CAR 234, a pilot was not to commence a flight unless all reasonable steps had been taken to ensure that sufficient fuel and oil was carried for the planned flight. An operator also shared that responsibility, and was required by CAR 220 to include specific guidance for the computation of the fuel carried on each route in their operations manuals.

Matters to be considered in determining an appropriate amount of fuel and oil included the meteorological conditions affecting the flight and the possibility of a diversion to an alternate aerodrome, an engine failure in a multiengine aircraft, and a loss of pressurisation. CAAP 234-1 *Guidelines for Aircraft Fuel Requirements* [40]

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[39] Although not assessed as part of the study, the importance of the PIC as a risk mitigator in the case of unforecast deteriorated weather at the destination was discussed in the conclusion to ATSB Research Report B2004/0246 titled *Destination Weather Assurance – Risks associated with the Australian operational rules for weather alternate weather* (available at www.atsb.gov.au).

[40] CAAP 234-1 provided information and guidance on the aircraft fuel requirements in CARs 220 and 234. This information and guidance may be used by operators and pilots when complying with these regulations.

termed those kinds of operations ‘abnormal’, in that they resulted in lower performance configurations but did not compromise the safety of flight. The CAAP stated that the fuel requirements for abnormal operations from the least favourable position in a flight, which could be expected to be greater than for normal operations, should be accounted for when fuel planning.

CAO 82.0 expanded on a number of the CAR 234 requirements for application in specified circumstances, including passenger-carrying charter operations to defined remote islands, such as Norfolk Island. As an aerial work flight, the aeromedical flight to Norfolk Island was not subject to these CAO 82.0 requirements, but they nevertheless provide useful context.

Paragraph 2.3 of the CAO defined the minimum safe fuel for such flights as the minimum amount set out in the operations manual of the aeroplane’s operator. In the absence of such a provision in the manual, paragraph 2.4 provided that the minimum safe fuel should be:

> (a) the minimum amount of fuel that will, whatever the weather conditions, enable the aeroplane to fly, with all its engines operating, to the remote island and then from the remote island to the aerodrome that is, for that flight, the alternate aerodrome for the aircraft, together with any reserve fuel requirements for the aircraft; and
>
> (b) The minimum of fuel that would, if the failure of an engine or a loss of pressurisation were to occur during the flight, enable the aeroplane:
>
> (i) to fly to its destination aerodrome or to its alternate aerodrome for the flight; and
>
> (ii) to fly for 15 minutes at holding speed at 1,500 feet above that aerodrome under standard temperature conditions, and
>
> (iii) to land at that aerodrome.

<u>Weather considerations</u>

The CAR 239 requirement for PICs to make a careful study of current weather reports and forecasts for the route to be flown, and the aerodromes used (see the earlier section titled *Pilot in command*) necessitated the study of either a flight forecast or an area forecast and aerodrome forecast for the destination (AIP En route (ENR) 1.10 *Flight planning*). When promulgated, as in the case of Norfolk Island Airport, aerodrome instrument approach charts showed landing and alternate ceiling and visibility minima for that aerodrome. AIP ENR *Alternate weather minima* stated that those minima should:

> ...be compared with the meteorological forecasts and reports [for the destination and any alternates] to determine both the need to provide for an alternate aerodrome and the suitability of an aerodrome as an alternate

That was, to determine whether an alternate aerodrome was required for Norfolk Island, the pilot was required to study the TAFs and meteorological reports (observations) for the island and for any potential alternate aerodrome. There was no associated guidance within the AIP about the in-flight study of amended forecasts, or how and when to apply new aerodrome observations to the initial forecast-based decision on the need or otherwise for an alternate or to a later decision about a possible diversion (see the discussion immediately following).

In terms of pilot responsibility, AIP GEN 2 *Flight information service (FIS)* stated that pilots were responsible for ensuring they obtained the necessary information to support operational decisions. The need to allow sufficient time for FIS to provide that information and for a PIC to act on it appropriately was stipulated. Operational information that was available from FIS included the relevant meteorological conditions, information on the navigation aids, communications facilities and aerodromes, and hazard alerts. Paragraph 2.4 titled *In-flight information* stated that:

> The in-flight information services are structured to support the responsibility of pilots to obtain information in-flight on which to base operational decisions relating to the continuation of diversion of a flight. The service consists of three elements:
>
> a. ATC Initiated FIS;
>
> b. Automated Broadcast Services; and
>
> c. an On-request Service.

AIP ENR 73 – *Alternate Aerodromes* section 73.2.12 required the pilot of an IFR aircraft to provide for a suitable alternate aerodrome when arrival at the intended destination would be during the currency of, or up to 30 minutes prior to the forecast commencement of any of the following weather conditions:

> a. cloud - more than SCT [4 OKTAS] below the alternate minimum[41]...; or
>
> b. visibility - less than the alternate minimum[39]; or
>
> c. visibility – greater than the alternate minimum, but the forecast is endorsed with a percentage probability of fog, mist, dust or any other phenomenon restricting visibility below the alternate minimum[39]; or
>
> d. wind - a crosswind or downwind component more than the maximum for the aircraft.

The alternate minima for a Westwind at the time of the attempted landing at Norfolk Island are listed at Table 1.

**Table 1: Instrument approach alternate minima[42]**

| Approach | Cloud Minimum[43] | Minimum visibility |
|---|---|---|
| VOR Rwy 29 | 1,169 ft | 6,000 m |
| VOR Rwy 11 | 1,169 ft | 6,000 m |

The crosswind and downwind components did not create an operational restriction for Westwind operations at the time of the occurrence.

Minimum weather conditions for landing from an instrument approach are also promulgated. Those conditions, known as the landing minima, include the lowest cloud base of any significant cloud, which was defined as the cumulative forecast of

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41 For IFR flights to aerodromes with an instrument approach procedure, such as Norfolk Island, the minima as published on the relevant approach chart for that aerodrome.

42 The Westwind is an approach Category C aircraft, based on its normal approach speeds.

43 Above the ARP.

more than Scattered[2] cloud below the stipulated cloud minimum; and the required minimum visibility.

A pilot is not permitted to descend below the Minimum Descent Altitude (MDA) for a non-precision instrument approach, including during a VOR or a VOR/DME, unless the weather is above the landing minima. Should the pilot become 'visual' and elect to continue the approach, visual contact must be maintained with the landing runway environment. That environment was defined as the runway threshold or approach lighting, or other markings identifiable with the runway.

The landing minima affecting the flight crew's attempted landing at Norfolk Island are listed at Table 2.

**Table 2: Instrument approach landing minima[42]**

| Approach | MDA[44] | Minimum visibility |
|---|---|---|
| VOR/DME Rwy 29 | 850 ft (484 ft above the runway threshold) | 3,300 m |
| VOR Rwy 11 | 750 ft (429 ft above the runway threshold[45]) | 3,000 m |

## Operator requirements

The operator's operational requirements were promulgated in its operations manual. That manual controlled the operator's flights and other procedures and ensured compliance with the current regulatory requirements under the operator's Air Operator's Certificate. All of the operator's flight crew were required to acknowledge that they had read, understood and agreed to comply with the requirements of the manual.

### *Operations manual*

Fuel planning

Part A *Policy and Organisation* section 8.1 of the operations manual required that, prior to departure on each stage of a flight, PICs were to ensure sufficient fuel was carried for the intended flight and that a careful study was made of the weather pertaining to the flight, any alternate routes and all aerodromes intended for use. Those weather forecasts were required to be valid and current for the period of operation.

Section 9.11.1 of the operations manual titled *Company Fuel Policy* required pilots to:

> b) ...calculate the amount of fuel to be carried by using the consumption rate for the type of aircraft as specified in Part B.[46] Sufficient fuel shall be carried for:
>
> - Flight fuel from the departure aerodrome to the destination aerodrome; and

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44 Expressed in ft above mean sea level.

45 The two runway thresholds were at different elevations.

46 Part B of the operations manual contained type-specific aircraft planning and other data.

- Alternate fuel to an alternate aerodrome, if required; and
- The provision of variable reserve fuel[47]; and
- The provision of fixed reserve fuel[48]; and
- Additional fuel[49] for weather, traffic, OEI[50] or loss of pressurisation or other specified reasons; and
- Taxi fuel.

In the case of flight with OEI, flight fuel from the critical point (CP, see subsequent discussion)[51] to the intended suitable aerodrome was to be calculated at the appropriate OEI consumption rate for the aircraft type as specified in the relevant aircraft flight manual (AFM). Pilots were to base that fuel consumption on the mid-zone aircraft weight for the sector. The OEI cruise speed for the Westwind was 300 kts true airspeed.

Part A Section 9.11.2 of the operations manual titled *Critical Point* required pilots to calculate a CP on 'appropriate' flights over water that were greater than 200 NM (371 km) from land and on all other flights for which the availability of an 'adequate aerodrome'[52] was critical. There was some disparity between that section and Part B section 6.1.2 of the operations manual titled *Calculation of Critical Point*, which omitted the need for an available adequate aerodrome, instead stating that a CP was to be calculated for flights where no 'intermediate aerodromes' were available.

PICs were required to determine the most critical case between normal operations, OEI operations and those operations with all engines operating but where the aircraft was depressurised. Aerodrome criticality and adequacy were not specifically defined.

If relevant to a flight, CPs were to be calculated before flight and updated at the top of climb after departure. Section 6.1.2.4 of the operations manual stated that the in-flight calculation or revision of a CP should make use of observed, actual data.

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47 Defined for the operator's aircraft types as10% of the trip fuel including trip fuel to an alternate if required. In the event of in-flight re-planning, contingency fuel was 10% of the trip fuel for the remainder of the flight.

48 Six hundred pounds (272 kg) in the Westwind.

49 Defined as fuel for flight to the critical point and then to a suitable aerodrome either with OEI or with both engines operating but the aircraft depressurised. In each case, a contingency fuel of 10% and 30 minutes final reserve was stipulated (section 9.11.1.7 of the OM refers).

50 'OEI' is a standard abbreviation for one engine inoperative. It refers to the ability to continue flying when one engine is not operating. OEI operations are considered as abnormal.

51 Defined by the operator as that point between two suitable aerodromes from which it takes the same time to fly to either aerodrome.

52 An 'adequate aerodrome' was defined in CAO 82.0 as an aerodrome that met the relevant physical requirements and provided facilities and services for the aircraft type. That included the provision of meteorological forecasts and at least one suitable and authorised instrument approach procedure.

In addition, Part A Section 9.11.3 of the operations manual titled *Point of No Return* (PNR)[53] required PICs to calculate a PNR before flight in similar conditions as for the calculation of a CP (see discussion above). As with CPs, PNRs were to be based on the most critical case between normal, OEI and all engines available but depressurised operations. PNRs were to be updated at the top of climb after departure and prior to reaching any PNR position.

The most fuel critical PNR in a Westwind was normal flight to the PNR, before continuing to a suitable aerodrome in a depressurised configuration. The operations manual-described method for calculating a PNR was suitable for calculating a PNR for a return leg in the same configuration as the outbound leg. It was not suitable for calculating a PNR where the return leg had a higher fuel use than for the outbound leg.

The most effective time to consider the need to divert is shortly before an aircraft passes its PNR, when the most current destination aerodrome forecast is available and there is time for a pilot to decide whether to continue or to divert. In this case, a safe diversion option still exists. In contrast, once an aircraft has passed its PNR, the flight crew is unable to divert to an alternate aerodrome with fuel reserves intact. In such cases, if there was a subsequent deterioration in the weather conditions at the intended destination, a crew would be compelled to either continue to its destination in the hope of becoming visual and being able to land, or to divert and arrive at an alternate aerodrome with less than the stipulated fuel reserves.

The Westwind fuel planning data was promulgated at Part B section 16.5.2 *Fuel Consumption and Block Speeds* of the operations manual and included:

**Fuel Consumption and Block Speeds**

The following table is a guide only to planning. Refer to A/C OPS Planning Manual for precise information.

| | |
|---|---|
| Block Speed (over 400 miles) | 380 Kts |
| Block Speed (200 – 400 miles) | 360 Kts |
| Range (full fuel – Nil wind) | 2250 nm |
| Climb to cruise FL350 | 28 min/162 nm/1050 lbs [476 kg] |
| Initial cruise altitude (at gross) | FL350 @ ISA |
| Cruise speed (10 000 Kg) | M.72/400 – 420 Kts |
| Long range cruise (10 000 Kg) | M.70/400 Kts |

**Fuel Usage**

| | |
|---|---|
| 1st hour | 1700 lb [771 kg] |
| 2nd hour | 1400 lb [635 kg] |
| 3rd hour | 1300 lb [590 kg] |
| 4th hour | 1200 lb [544 kg] |

53 Defined by the operator as '...the point farthest removed from a suitable aerodrome, to which an aircraft can fly to, with statutory reserves of fuel remaining.'

| | |
|---|---|
| 5th hour | 1100 lb [499 kg] |

For temperatures above ISA[54], add 100 lbs [45 kg] fuel on to first hour for every 5° temp is above ISA.

Through Company experience in Westwind operations, it has been found that an alternative method for fuel calculations is:

a) Pre-flight Planning

Allow 23 lbs [10 kg]/minute plus 400 lbs [181 kg] for the climb;

eg. Planned flight time = 100 mins, so 100 x 23 + 400 = 2700 lbs [1,225 kg] of fuel can be expected to be burned on this sector.

b) In-flight Re-planning

Allow 23 lbs [10 kg]/minute in stable cruise.

In the case of international operations, PICs were also required to conduct in-flight fuel quantity checks at regular intervals, meaning at the end of each leg or 30-minute period, whichever came first. A record was to be made in the Flight Navigation Log that compared the actual fuel consumption with the planned rate, confirmed the remaining fuel was sufficient for the flight, and determined the expected fuel remaining on arrival at the destination.

If a successful approach and landing at the destination aerodrome appeared marginal due to weather or any other reason, Part A section 9.11.5 *Latest Divert Time/Point* required the determination by a PIC of the latest divert time or position from which to proceed to a suitable alternate. No definition was provided in respect of the marginality of an aerodrome. The operations manual stated that if at that point the expected fuel remaining was:

...less than the sum of:

a) Fuel to divert to an enroute alternate aerodrome; and

b) Variable reserve fuel; and

c) Fixed reserve fuel.

The PIC shall either:

a) Divert; or

b) Proceed to the destination, provided that two separate runways are available and the expected weather conditions at the destination enable a successful approach and landing.

A PIC was to ensure that the usable fuel remaining on board was sufficient for flight to an aerodrome where a safe landing could be carried out with the fixed reserve intact. An emergency was to be declared where the usable fuel was less than the fixed reserve. The operations manual did not indicate whether that remaining fuel related to normal or abnormal operations from the least favourable position in the flight.

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54 ISA refers to meteorological conditions in an 'International Standard Atmosphere'. ISA conditions provide standard temperatures and pressures at specified altitudes. ISA conditions are used as a datum for providing aircraft performance data.

Flight planning

The operator required the submission of a flight plan to air traffic services by PICs of all IFR flights. That included the estimated time between checkpoints and waypoints and fuel calculations, which were each dependent on a knowledge of the forecast winds anticipated to affect a flight. Flight plans were able to be submitted via the internet, by facsimile, by telephone or, with provisos once airborne.

Flight crews were expected to use their own methods, systems and tools for pre-flight planning in compliance with the provisions of the operations manual. It was reported that copilots modified their techniques to reflect the preferred methods for each PIC with whom they flew. There was no independent evidence to indicate that the operator routinely assured itself of the accuracy of pilot's international flight planning and forms or their in-flight navigation logs and crews' compliance with the operator's procedures.

In accordance with Part D section 3.9 *Proficiency Line Check* of the operations manual, a proficiency line check formed the second part of the operator's 6-monthly pilot proficiency check. Pilot's flight planning in support of that check was required to show a satisfactory knowledge of the:

> ...
>
> h) Calculation of fuel requirements, CP and PNR;
>
> i) Conditions requiring an alternate and selection of an alternate;
>
> ...

There was no independent evidence to confirm that the operator routinely assessed pilots' processes for calculating/updating PNRs en route and their application of that revised data to their alternate decision making. This was consistent with the requirements of the operations manual, which did not require all elements of a proficiency check to be recorded as having been carried out.

# Additional information

## Application of the pilot's assumed weather conditions to the flight

The investigation used a BoM wind/temperature chart to derive the temperature at the cruising altitude as approximating ISA + 10°C. The application of that temperature to the available aircraft performance figures and the PIC-anticipated 50 kts headwind to the relevant cruise speed from the AFM to the distance from Apia to Norfolk Island of 1,450 NM (2,688 km) resulted in an estimated planned fuel consumption of 5,550 lb (2,517 kg). Allowing for the stipulated reserves, a minimum 6,705 lb (3,041 kg) of fuel was required for the flight in the case of normal operations. The PIC stated that he planned his fuel requirements based on the method in the operations manual, which was found to give a similar result to that using the AFM fuel consumption figures.

The actual fuel in the aircraft on departure from Apia of 7,330 lbs (3,324 kg) exceeded the requirements for the flight for normal operations. However, this did not provide sufficient fuel to allow for abnormal operations (typically depressurised or OEI operation) from the least favourable position in the flight.

For a flight in a Westwind from Apia to Norfolk Island, the most critical fuel requirement was in the case of depressurised operations from the least favourable position in the flight. The carriage of full fuel would have meant that if the aircraft experienced a depressurisation near this position, there would have been sufficient fuel remaining to fly to either of at least two suitable destinations in the depressurised configuration.

In contrast, the carriage of main tank fuel only, such as in the case of the aeromedical retrieval flight, meant that if the aircraft had experienced a depressurisation near the least favourable position in the flight, it would not have had sufficient fuel remaining to fly to a suitable destination in the depressurised configuration.

The PIC indicated that for operations in the Westwind, there were effectively two refuelling options; either the aircraft carried full fuel, or the wing tanks only were filled. With full fuel, when the aircraft was required by ATC to descend to FL270 at 0628, the pilot would probably not have had the option of climbing to FL390 because of the extra fuel weight and relatively high outside air temperature. The pilot therefore would have been compelled to descend to FL270 and then maintain that altitude for some time. A higher fuel flow would have resulted, albeit from a larger load of fuel.

## The decision to continue to Norfolk Island

Under conditions of increased stress or workload, working memory can be constrained and may limit the development of alternative choices and the evaluation of options. Depending on whether the available options are framed in a positive (lives saved) or negative way (injuries and damage), a decision maker can be influenced by how they perceive the risks associated with each option when making a decision.[55]

When decision-makers are confronted with options that are considered as a choice between two different benefits, decision makers tend to be more risk averse. They tend to prefer a guaranteed small benefit, compared with just the chance of a larger benefit. On the other hand, when decision makers are faced with a choice between two options that are considered as two separate losses, they tend to be more likely to accept risk.

In this instance, the flight crew described the choice when they first comprehended the deteriorating weather conditions at Norfolk Island as being between diverting to Noumea and continuing to the island in terms of assessing competing risks. Given the weather and other information held by the crew at that time, including their not having information on any possible alternates, their perception that the higher risk lay in a diversion was consistent with the greater number of unknown variables had they diverted.

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[55] Kahneman, D., & Tversky, A. (1984). *Choices, values and frames*. American Psychologist, 39, 341-350.

## Support information available to flight crew

### *Regulatory requirements and advisory or operational guidance*

As previously discussed, the regulatory, advisory and operational guidance for application during a flight should an amended aerodrome forecast indicate an in-flight deterioration in a destination's weather conditions was of a general nature.

However, pilots were exposed to the concepts of CPs and PNRs under item 5.4 of the ATPL(A) Aeronautical Knowledge Syllabus[56] titled *Practical flight planning and flight monitoring.* This included a practical exercise that was intended to test candidates' knowledge and ability to apply flight planning, performance and navigation principles at that licence standard. Candidates were exposed to the calculation of CPs (also known as equi-time points (ETP)) and PNRs during normal flight, with an inoperative engine and when their aircraft sustained a depressurisation. The associated Examination Information Book[57] explained the examination conditions as they would affect the calculation by candidates of CPs/ETPs and PNRs during the ATPL(A) exam. These conditions included advice that the calculation of CPs and PNRs may involve any flight condition, and normal and abnormal operations.

The ATPL(A) theory syllabus also examined the calculation of the fuel required for a flight during normal and abnormal operations and changes to operational circumstances. It did not provide any rules or specific guidance on what:

- operational information to seek, or when it should be sought
- to do with updated operational information that may become available
- information could be sought en route that might influence the decision to continue to a destination.

During the investigation, so as to get a better understanding of the level of crew knowledge of en route management, a group of 50 ATPL students were asked what they would do on receiving an amended destination aerodrome forecast indicating conditions that were less than the alternate minima but more than the landing minima for their ETA as they approached their PNR. All of the students stated that they would divert to an alternate aerodrome.

The students were then asked whether they could legally continue to the destination if they had not received that forecast, or not actively checked whether the forecast had been amended before they reached the PNR. The responses were inconsistent, and it was established that the subject had not been covered during the training course because the subject was not assessed in the ATPL(A) theory exam.

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56 Issue 1.1 – June 2000.

57 Version 2.2 – July 2000.

### *Examination of a number of operator's operations manuals*

In light of the flight crew's actions and decisions on this flight, the ATSB examined a number of operations manuals from similar operators that also flew long overwater flights on an ad hoc basis. The aim was to understand how those operators managed such flights in the following circumstances:

- The flight was of several hours duration, with few alternate aerodromes available.
- There was a valid destination aerodrome forecast at the time of flight planning that did not provide any requirement to plan for an alternate.
- An amended destination weather forecast was issued during the flight and forecast weather conditions below the alternate minima but above the landing minima at the time of arrival.

Five different operators were interviewed and provided relevant sections of their operations manuals for review. Those manuals generally reflected the requirements of CAAP 234-1 but also had individual operational requirements appended. However, they either had no guidance, or did not provide consistent guidance on the process to be used when deciding whether to continue to a destination in circumstances similar to those affecting the flight to Norfolk Island.

When questioned on how they expected their flight crews would act in this situation, the operators generally answered that they expected flight crews to base their decisions on past experience and a conservative approach to flight planning to ensure their flight remained safe at all times. The concept of 'good airmanship' was frequently used, but consistent methods for implementing good airmanship to address this situation were not provided.

### *Pilot methods to assure continued safe flight with deteriorating destination weather*

Although a small sample, eight pilots were interviewed to assess whether a common level of knowledge existed for application in the case of an amended destination forecast that predicted a deterioration in the destination weather for the pilot's ETA at that destination. All of the pilots flew turboprop or turbojet aircraft on charter operations and held an ATPL(A) with varying levels of experience.

Each pilot was presented with a scenario involving their present aircraft type on a route that would take 3 to 4 hours with only one or two suitable alternate aerodromes. The scenario included a destination aerodrome forecast at the time of flight planning that indicated no weather-based alternate requirements. The scenario was then developed to consider the possibility of deteriorating destination weather conditions. The interview was developed to assess:

- the time during the flight when a decision would be made to continue to the destination or to divert
- what source(s) of weather information would be used when making a decision to continue to a destination or to divert
- what rules or weather criteria would be used when making a decision to continue to a destination or to divert.

Two of the eight pilots described a process in which, if the changed forecast destination weather conditions were less than the alternate minima at their ETA, they would divert just before the last PNR. The other pilots did not have a consistent process to address the scenario.

## Threat and error management

On 14 March 2006, International Civil Aviation Organization (ICAO) Annex 6 - *Operation of Aircraft, amendment 30,* adopted a change to its standards that required training in threat and error management (TEM) for air transport operations. There was no requirement in that Annex for TEM training in aerial work operations. However, effective 17 November 2011, ICAO Annex 1 – *Personnel Licensing, amendment 170*,[58] sought to harmonise the TEM training requirements for flight crew licences. Those requirements were not applicable at the time of the accident.

TEM provides a means to objectively observe and measure a pilot's response to in-flight risks. The three basic components of TEM include:

- **Threats.** Threats are 'events or errors that occur beyond the influence of the flight crew, increase operational complexity, and which must be managed to maintain the margins of safety'. Examples of threats include high terrain, adverse weather conditions, aircraft malfunctions and dispatch errors. When undetected, unmanaged or mismanaged, threats may lead to errors or an undesired aircraft state.
- **Errors.** Errors are 'actions or inactions by the pilot that lead to deviations from organisational or pilot intentions or expectations', and can include handling, procedural and communications errors. When undetected, unmanaged or mismanaged, errors may lead to undesired aircraft states.
- **Undesired aircraft states.** Such states are defined as 'an aircraft deviation or incorrect configuration associated with a clear reduction in safety margins'. Undesired aircraft states can include unstable approaches, altitude deviations, and hard landings and are considered the last stage before an incident or accident. Thus, the management of undesired aircraft states represents the last opportunity for flight crews to avoid an unsafe outcome, and hence maintain safety margins in flight operations.

Despite not being stipulated for aerial work operations either in ICAO Annex 6 or in national legislation, operators may find that the application of TEM to their operations is worthy of consideration.

## Aeromedical organisation consideration of operator risk

The aeromedical retrieval company that was involved in this accident last undertook its own safety audit of the operator in 2002. There was no standing requirement for the company to undertake such audits.

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58 Eleventh edition of July 2011.

# ANALYSIS

## Introduction

The ditching on 18 November 2009 was a consequence of deteriorating weather at Norfolk Island that was not forecast at the time of flight planning but was subsequently forecast and developed during the long flight. However, more effective flight planning, and application of a number of the existing regulatory and operator's requirements before and during the flight would have better informed and prepared the flight crew for such contingencies. As it was, by the time that the crew comprehended the deteriorating weather at Norfolk Island they perceived that, given the available fuel and apparent lack of options, the safest avenue was to continue to Norfolk Island in the hope that they would be able to land safely.

In the event, and after a number of unsuccessful attempts at becoming visual and landing, the aircraft was ditched due to low fuel and all of the aircraft occupants were able to exit the aircraft. Similarly, it was largely fortuitous that, although the crew did not advise of the intended location of the ditching, rescue personnel were able to locate the aircraft and recover the survivors. The outcome might not have been so positive.

This analysis will examine the factors affecting the flight to Norfolk Island and discuss the missed opportunities that, if taken up, would have prevented the need to ditch and resulted in the aircraft's probable diversion to a suitable alternate aerodrome for landing. In addition, enhancements to existing guidance are discussed that have the potential to address similar risks to other long flights with few alternate aerodromes available and with weather forecast to be adequate that subsequently deteriorates.

## Operational guidance and oversight

The accident flight demonstrated that variable weather conditions, if not managed effectively, were a risk factor in aeromedical operations to remote island destinations. For passenger-carrying charter operations, that risk was addressed by a regulatory requirement in Civil Aviation Order 82.0 that sufficient fuel shall be carried to reach the destination and then divert to an alternate aerodrome. The accident flight was, however, classified as aerial work and so those provisions did not apply. Instead, the requirement was that, in specific forecast or current weather conditions, sufficient fuel should be carried to reach an alternate aerodrome. Otherwise, including in the case of the accident flight, fuel planning did not need to consider alternate destinations.

The operator's procedures complied with the relevant regulatory guidance. Part A of those procedures set out requirements for fuel planning. Methods for calculating fuel consumption to support that planning were set out in Part B. It was possible to understand the fuel calculations in Part B as being a method of fuel planning. No detailed and consistent methodology for carrying out flight planning was available, which would explain flight crews applying their own individual methodologies and reports of copilots varying their techniques to suit respective pilots in command (PIC).

Although the PIC complied with a Westwind-specific fuel planning method in Part B of the operations manual, his flight planning method did not ensure compliance with all of the fuel policy requirements in Part A of that manual. Part A required pilots to account in their fuel planning for the possibility of abnormal operations.

Operational oversight relies *inter alia* on procedures that ensure compliance with an operator's procedures. In this instance, there was significant variation in pre-flight planning procedures by flight crews that would have made it more difficult for the operator to oversee the consistent conduct of flights. Although not required by the operator's procedures, closer review of flight documentation and how it was being applied would have increased the likelihood that inconsistent interpretation and application Parts A and B of the operations manual concerning fuel management would have been identified.

## Pre-flight planning

### Flight plan preparation and submission

The extensive regulatory and operator flight planning requirements were intended to address the risks associated with the flight. Those requirements were predicated on flight crews accessing the relevant information, such as weather observations, en route and aerodrome weather forecasts, notices to airmen (NOTAM), and aerodrome and other facilities information.

Although the PIC was ultimately able to submit a flight plan for the flight, the Australian Transport Safety Bureau (ATSB) considered the extent to which the difficulty experienced by the pilot in accessing the internet and then contacting the operator for support during flight planning may have impacted on the thoroughness of that planning. Despite the likely increased workload and stress as a result the difficulties experienced in preparing and submitting the flight plan, a number of alternate flight plan submission options were available. It was concluded that the potential for the difficulty accessing the internet and contacting the operator to have explained any incomplete or inaccurate flight planning, or problems with its submission, was minimal.

The development of the flight plan by the PIC without input from the copilot was in accordance with standard operating procedures. This meant that the flight plan was developed by one person and not reviewed by the copilot for accuracy and compliance with requirements, which reduced the likelihood that any flight planning omissions or errors would be identified.

### Implications for the flight

As indicated in this instance, weather in the maritime environment can be quite changeable, increasing the likelihood of variations in aerodrome and other forecasts. Based on the aerodrome forecast (TAF) for Norfolk Island that was accessed by the PIC during flight planning, there was no requirement to nominate an alternate aerodrome and sufficient fuel was carried to allow for normal operations. However, the weather situation at Norfolk Island progressively deteriorated during the flight until at 0803, the amended TAF indicated that, based on the cloud base being below the island's alternate minima, an alternate was now required for Norfolk Island.

A number of regulatory and operator risk controls were in place to address the risk of previously unforecast but deteriorating weather at Norfolk Island. In the first instance, more complete fuel planning would have been possible had an en route forecast been sought that predicted the wind at the intended cruising level. Knowledge of these winds was also necessary for the PIC to comply with the operator's requirement for the calculation during flight planning of the CP and PNR, and to take account of the risk of the aircraft sustaining an engine failure or in-flight depressurisation. It might also be expected that acting to obtain the upper winds might also have influenced the PIC to seek other perhaps relevant en route and aerodrome forecasts, NOTAMs and other information.

Not accessing the additional weather and other information before the flight was a missed opportunity to fully understand the potential hazards affecting the flight and did not allow for the pre-flight, or efficient in-flight management of those risks. In consequence, and in the absence of suitably updated CP and PNRs, NOTAMs and other information, the workload associated with any need for in-flight diversion would have been increased, elevating the risk of mistaken in-flight decision making.

In the event, given the forecast in-flight weather, aircraft performance and regulatory requirements, the flight crew departed Apia with less fuel than required to safely complete the flight in case of one engine inoperative or depressurised operations from the least favourable position during the flight. If the flight had been a passenger-carrying charter flight, the regulations would have required the PIC to carry sufficient fuel to allow for a diversion from the destination to an alternate aerodrome.

## En route management of the flight

The series of weather observations for Norfolk Island indicated that the weather there was worsening from that predicted in the aerodrome forecast used by the crew for flight planning. This weather trend would, if comprehended, have alerted the crew of the need to request an update from air traffic control (ATC) on the forecast weather at Norfolk Island and any potential alternate destinations, and presumably on any NOTAMs at those locations. Although ATC could have obtained an amended TAF for Norfolk Island, responsibility for operational decisions, such as seeking any amended TAFs, rests with a PIC.

The identification by the crew of the need to access those forecasts before passing the PNR, and their application to Norfolk Island Airport's alternate minima as soon as they became known, would have allowed time to consider the diversion options. Of equal importance, an earlier understanding of the deteriorating forecast weather at Norfolk Island would have helped ensure that any decision to divert was made before passing the relevant PNR. However, there were no regulated requirements or operator procedures to inform the crew of when to obtain the most recent weather information in order to manage an unforecast deterioration in the weather. This increased the risk of crews inadvertently continuing to an unsafe destination.

In contrast, by the time the crew understood the implications of the worsening weather conditions at Norfolk Island, they were faced with little time to decide whether to continue to the destination or to divert. The lack of immediate operational knowledge to support a possible diversion and the reduced time available to consider their options influenced the crew's decision to continue to Norfolk Island, rather than to divert.

Application of threat and error management principles by the flight crew may have increased the likelihood that they would have identified the need to divert with sufficient time to do so safely.

## Seeking and applying appropriate en route weather updates

The PIC would have been aware of his responsibility for the safety of the flight, for which both crew members were qualified. This included the need for in-flight weather-related decisions that were based on the most recent weather and other relevant information.

The PIC's Airline Transport Pilot (Aeroplane) Licence (ATPL(A)) qualification assessed his ability to calculate and apply the regulatory and operator requirements in terms of CPs and PNRs. However, in the absence of any independent record of post-endorsement training or proficiency checks of that knowledge, the ATSB was unable to independently determine the PIC's ongoing exposure to, and application of those requirements in the Westwind. Clear and readily available guidance for seeking and applying amended en route weather and other information to in-flight operational decisions would assist pilots maintain proficiency in such in-flight decisions.

The inconsistent interpretation and application of the regulatory and other guidance by a number of pilots, ATPL trainees and operators that were involved in similar long range operations was consistent with the general nature of that guidance. Any inconsistent interpretation and application of the intent of that guidance by pilots increases the risk of incorrect methods being used when deciding to divert or to continue to an unsuitable destination. In order for pilots to more consistently interpret and apply the intent of the existing regulatory and other guidance, particularly in the case of flight to a remote island, such operations would benefit from more specific guidance.

## Exit from the aircraft and subsequent rescue

Given the decision to ditch, a number of factors, some fortuitous, combined to allow a successful exit from the aircraft and subsequent rescue. In the first instance, and in the absence of any visual reference with the water in the dark and overcast conditions, the use by the flight crew of the aircraft's radar altimeter informed their flare height. A satisfactory flare reduces an aircraft's landing speed and rate of descent and, in this case probably minimised the impact forces and contributed to a survivable first contact with the sea.

The failed/obstructed exit simulations inherent in the medical personnel's helicopter underwater escape training (HUET), and the flight crew's wet drills went some way to preparing them for the ditching. While the effect of the difficulties and setbacks experienced that night would not necessarily have been able to have been simulated in the training, the cabin occupants' early preparation of that area and prior exposure to HUET, and the flight crew's wet drill training, facilitated their and the passengers' successful, if difficult exit from the immersed/submerged aircraft.

The omission of the anticipated location of the ditching in the last transmission to the Unicom operator, while perhaps understandable in terms of the priority of flying the aircraft, deprived the Unicom operator and therefore search and rescue agencies and services of an accurate search datum. In this instance, it resulted in the rescue boats initially proceeding to an incorrect location that reflected the understanding that the aircraft was tracking to the south-east at the time of the ditching.

The observation of the survivors to the west of the island by the airport firefighter facilitated the re-direction and timely arrival of the rescue craft at the scene of the ditching.

## Conclusion

The requirement to ditch the aircraft was a consequence of a number of pre- and in-flight actions and decisions that resulted in the flight continuing to Norfolk Island where a safe landing could ultimately not be assured. The delayed in-flight identification and management by the flight crew of the worsening and previously unforecast weather at Norfolk Island adversely influenced their decision to continue to the island, rather than divert to a suitable alternate.

The investigation could not discount the potential for clearer regulatory or operator guidance in respect of the application of amended en route weather information to have influenced the outcome. If that clearer guidance had been available, the flight crew may have comprehended the need to react to the unforecast weather deterioration at Norfolk Island earlier and increased the time available to consider their options and undertake the necessary diversion planning.

The occupants' successful exit from the immersed/submerged aircraft was facilitated by the flight and medical crews' prior exposure to wet drill and HUET training. Their location after exiting the aircraft was somewhat fortuitous and the outcome may not have been so positive.

# FINDINGS

From the evidence available, the following findings are made with respect to the ditching 5 km south-west of Norfolk Island Airport on 18 November 2009 involving Israel Aircraft Industries Westwind 1124A aircraft, registered VH-NGA. They should not be read as apportioning blame or liability to any particular organisation or individual.

## Contributing safety factors

- The pilot in command did not plan the flight in accordance with the existing regulatory and operator requirements, precluding a full understanding and management of the potential hazards affecting the flight.
- The flight crew did not source the most recent Norfolk Island Airport forecast, or seek and apply other relevant weather and other information at the most relevant stage of the flight to fully inform their decision of whether to continue the flight to the island, or to divert to another destination.
- The flight crew's delayed awareness of the deteriorating weather at Norfolk Island combined with incomplete flight planning to influence the decision to continue to the island, rather than divert to a suitable alternate.

## Other safety factors

- The available guidance on fuel planning and on seeking and applying en route weather updates was too general and increased the risk of inconsistent in-flight fuel management and decisions to divert. *[Minor safety issue]*
- Given the forecast in-flight weather, aircraft performance and regulatory requirements, the flight crew departed Apia with less fuel than required for the flight in case of one engine inoperative or depressurised operations.
- The flight crew's advice to Norfolk Island Unicom of the intention to ditch did not include the intended location, resulting in the rescue services initially proceeding to an incorrect search datum and potentially delaying the recovery of any survivors.
- The operator's procedures and flight planning guidance managed risk consistent with regulatory provisions but did not effectively minimise the risks associated with aeromedical operations to remote islands. *[Minor safety issue]*

### Other key findings

- At the time of flight planning, there were no weather or other requirements that required the nomination of an alternate aerodrome, or the carriage of additional fuel to reach an alternate.
- The aircraft carried sufficient fuel for the flight in the case of normal operations.
- A number of the flight crew and medical personnel reported that their underwater escape training facilitated their exit from the aircraft following the ditching.

- The use by the flight crew of the aircraft’s radar altimeter to flare at an appropriate height probably contributed to a survivable first contact with the sea.
- The observation of the pilot in command’s torch re-directed the search to the correct area and facilitated the timely arrival of the rescue craft.

# SAFETY ACTION

The safety issues identified during this investigation are listed in the Findings and Safety Actions sections of this report. The Australian Transport Safety Bureau (ATSB) expects that all safety issues identified by the investigation should be addressed by the relevant organisations. In addressing those issues, the ATSB prefers to encourage relevant organisations to proactively initiate safety action, rather than to issue formal safety recommendations or safety advisory notices.

All of the responsible organisations for the safety issues identified during this investigation were given a draft report and invited to provide submissions. As part of that process, each organisation was asked to communicate what safety actions, if any, they had carried out or were planning to carry out in relation to each safety issue relevant to their organisation.

## Civil Aviation Safety Authority

### Fuel planning and en route decision-making

#### *Minor safety issue*

The available guidance on fuel planning and on seeking and applying en route weather updates was too general and increased the risk of inconsistent in-flight fuel management and decisions to divert.

#### *Action taken by the Civil Aviation Safety Authority*

During this investigation, the ATSB and Civil Aviation Safety Authority (CASA) have had a number of meetings in respect of the general nature of the available guidance and its possible influence on the development of this accident. In response, in July 2010 CASA issued Notice of Proposed Rule Making (NPRM) 1003OS, section 3.3.4 of which stated:

> CASA also intends to review Civil Aviation Advisory Publication (CAAP) 234-1 relating to fuel requirements. This review is being undertaken in two phases: the first to enhance the guidance for fuel planning and in-flight fuel-related decision making on flights to remote destinations (including remote islands); and secondly a holistic review of guidelines for fuel and alternate planning.

In addition, NPRM 1003OS proposed changes to the requirements for the carriage of fuel on flights to remote islands. The proposed changes affected Civil Aviation Order (CAO) 82.0 and included:

- Designating Cocos (Keeling) Island as a ‘remote island’.
- Removing the provision that allowed an operator not to carry fuel for diversion to an alternate aerodrome if the operator’s operations manual allowed such a procedure.
- Amending the definition of ‘minimum safe fuel’ to require the calculation of fuel for diversion to an alternate aerodrome in the event of a loss of

pressurisation coupled with the failure of an engine, in addition to either of the individual failures.

- A requirement that a pilot in command who is subject to a condition to carry fuel for diversion to an alternate aerodrome on a flight to a remote island must nominate an alternate aerodrome.
- Extending the condition to carry fuel for diversion to an alternate aerodrome on a flight to a remote island to passenger-carrying aerial work and regular public transport flights.
- Providing for CASA to be able to approve an operator not to comply with a condition to carry fuel for diversion to an alternate aerodrome on a flight to a remote island, subject to conditions that would not adversely affect safety.

On 25 June 2012, CASA advised that amendment 36 to International Civil Aviation Organization (ICAO) Annex 6, State Letter AN 11/1.32-12/10 detailed a number of new Standards and Recommended Practices (SARP) in regard to fuel planning, in-flight fuel management, the selection of alternates and extended diversion time operations (EDTO). In this respect, CASA provided the following update:

- CASA intends to review Civil Aviation Advisory Publication (CAAP) 234-1 relating to fuel requirements. The ICAO fuel and alternate Standards and Recommended Practices (SARPs) are the basis of these changes and will be coordinated by CASA project OS09/13. While this project will focus specifically on passenger-carrying commercial flights the project will also be reviewing fuel requirements generally. The project will now be conducted in four phases. The first three phases will involve amendments to the relevant Civil Aviation Order (CAO) applicable Civil Aviation Advisory Publication (CAAP) 234-1 and Civil Aviation Regulation (CAR) 234. The project objectives are as follows:
  - Phase 1 will involve amendments to the relevant CAOs and a review of CAAP 234-1 for flights to isolated aerodromes in light of the ICAO amendments. This phase will encompass fuel and operational requirements for flights to isolated aerodromes and will also consider the provision for flight to an alternate aerodrome from a destination that is a designated isolated aerodrome. The CAAP 234-1 will also be expanded to provide guidance and considerations necessary for flights to any isolated aerodrome, in particular when, and under what circumstances, a pilot should consider a diversion.
  - Phase 2 will involve amendments to the relevant CAOs and further review of CAAP 234 in light of the ICAO amendments. This phase will encompass regulatory changes related to the implementation of general fuel planning, in-flight fuel management and the selection of alternate aerodromes. This review will include the methods by which pilots and operators calculate fuel required and fuel on-board.
  - Phase 3 will involve amendment to CAR 234 to specify that the pilot in command, or the operator, must take reasonable steps to ensure sufficient fuel and oil shall be carried to undertake and continue the flight in safety. In addition, for flights conducted in accordance with Extended Diversion Time Operations (EDTO), CAO 82 and CAR 234 shall be amended to require consideration of a "critical fuel scenario" taking into account an aeroplane system failure or malfunction which could adversely affect safety of flight. It is anticipated that the methods chosen by the pilot-in-command and

operator will therefore be sufficient to meet the requirements of CAR 234 to enable a flight to be undertaken and continue in safety.

– Phase 4 will involve the publication of internal and external educational material along with conducting briefings where necessary.

and that:

> The amendment to the ICAO Annex 6 standards will be considered, and where appropriate, incorporated into the relevant legislation/advisory publication. In addition it is anticipated that there will be guidance material for operators who can demonstrate a particular level of performance-based compliance. The intent is to provide a bridge from the conventional approach to safety to the contemporary approach that uses process- based methods and Safety Risk Management (SRM) principles.
>
> The ICAO Fuel and Flight Planning Manual are reflected in the SARP to Annex 6. Inclusion of the provisions of the Amendment 36 SARPs will be captured throughout this project. The ICAO SARP becomes effective from November 2012.
>
> CASA will endeavour to make the changes as soon as possible - subject to third party arrangements such as drafting and resource availability. However the timing of the CAR changes will be subject to a timetable that is not necessarily able to be controlled by CASA.

Finally, CASA also advised of their intent to regulate Air Ambulance/Patient transfer operations as follows:

- Air Ambulance/Patient transfer operations in the proposed operational Civil Aviation Safety Regulations (CASRs) will be regulated to safety standards that are similar to those for passenger operations.
- While CASR Parts 138/136 will be limited to domestic operations and, if CASA decides to retain Air Ambulance/Patient transfer operations in these rule suites, any such operation wishing to operate internationally will also be required to comply with CASR Part 119. If, however, CASA decides to move these operations into CASR Parts 121/135/133 they will already be required to comply with CASR Part 119. Either way, Air Ambulance/Patient transfer operations will be regulated to the same standard as Air Transport Operations (ATO). In relation to Norfolk and Lord Howe Islands, all ATO which include Air Ambulance/Patient transfer, will be required to carry mainland alternate fuel.
- CASR Parts 119/121/135/133 are expected to be finalised by the end of 2012 and are currently proposed to commence in June 2014. CASR Parts 138/136 are expected to be made by June 2013 and are proposed to commence in June 2014. Given that the drafting of these CASR Parts are subject to third party arrangements (Attorney-General's Department) and CASA and the industry's ability to effectively implement the new rule suite, these timelines are subject to change.

# Aircraft operator

## Oversight of the flight and its planning

### *Minor safety issue*

The operator's procedures and flight planning guidance managed risk consistent with regulatory provisions but did not effectively minimise the risks associated with aeromedical operations to remote islands.

### *Action taken by aircraft operator*

Following the accident, CASA carried out a special audit[59] of the operator's operations in Sydney, Adelaide and Nowra between 26 November and 15 December 2009. The audit included an extensive assessment of the operator's Westwind operations and a number of the operator's organisational aspects.

The operator voluntarily ceased its Westwind operations and collaborated with CASA during the special audit. A management action plan was developed in response to the audit findings and was designed to address a wide range of measures to provide the operator with confidence in the safety of its operations.

The plan required the implementation of a range of standards and processes, supported by suitable training and included a number of stages to be completed before recommencing Westwind domestic operations. Following the commencement of those actions domestically, the plan addressed the operator's international operations.

In addition, a formal process of reviewing the operator's systems of control and oversight of flight crew and operational procedures was implemented. The plan also enacted the following substantive changes:

- All flights to Norfolk, Lord Howe and Christmas Islands were required to carry fuel to continue from the destination to a suitable alternate.
- Enhanced fatigue risk management procedures were developed.
- An approved system for flight and fuel planning was implemented, and unapproved systems disallowed.
- A controlled flight planning application system was introduced.
- Portable satellite telephones were supplied for international flights to enable crew to communicate with the company.
- The Westwind fuel policy was reviewed and amended.
- Both pilots are now required to check flight and fuel plans before departure.
- Regular in-flight weather updates were mandated and contingency planning is enforced.
- An internal Quality Assurance plan with specific reference to the management action plan was developed and implemented.

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[59] EF09/25167 report dated 8 January 2010.

- A decision-making process to ensure that aviation safety aspects are not influenced by the medical needs of the patient was established.
- A refresher training course for Westwind pilots was implemented that covered required knowledge for Westwind operations.

## Aeromedical organisation

### Consideration of operator risk

The investigation did not identify any organisational or systemic issues in respect of the aeromedical service provider's consideration of aviation operator risk that might adversely affect the future safety of their aeromedical retrieval service.

However, the aeromedical organisation advised that in response to this accident, it has implemented a policy of requiring a contracted safety audit of all of its aeromedical retrieval service providers. Safety audits were arranged for the aeromedical organisation's contracted aeromedical retrieval service providers in July and August 2010. These audits are planned to take place annually.

# APPENDIX A: PARTIAL TRANSCRIPT OF THE HF RADIO COMMUNICATIONS BETWEEN NADI AND THE AIRCRAFT (VH-NGA)

| Time UTC | From | To | Transmission |
|---|---|---|---|
| 0756:34 | VH-NGA | Nadi | Nadi radio victor hotel november golf alpha request |
| 0756:46 | Nadi | VH-NGA | Victor november golf alpha nadi |
| 0756:48 | VH-NGA | Nadi | Is it possible to obtain a METAR for yankee sierra november foxtrot please |
| 0757:01 | Nadi | VH-NGA | Victor november golf alpha nadi standby |
| 0801:15 | Nadi | VH-NGA | Victor hotel november golf alpha nadi |
| 0801:20 | VH-NGA | Nadi | Nadi go ahead victor golf alpha |
| 0801:24 | Nadi | VH-NGA | Roger ready to copy METAR Norfolk? |
| 0801:27 | | | Go ahead victor golf alpha |
| 0801:31 | Nadi | VH-NGA | METAR Norfolk at 0630 Zulu wind 300 09 knots 9999, few 6,000 broken 2400 temperature 21 dewpoint 19 QNH norfolk 1011 remarks closed till 1930 UTC go ahead |
| 0802:08 | VH-NGA | Nadi | Ahhh ...copy... just say again the issue time for the METAR |
| 0802:14 | Nadi | VH-NGA | Issue time for the METAR this is the latest 0630 Zulu |
| 0802:22 | VH-NGA | Nadi | Victor golf alpha thank you |
| 0802:26 | Nadi | VH-NGA | Victor november golf alpha nadi |
| 0802:29 | VH-NGA | Nadi | Go ahead nadi victor golf alpha |
| 0802:32 | Nadi | VH-NGA | Roger this the latest weather for Norfolk...SPECI... I say again special weather Norfolk at 0800 Zulu... auto I say again auto, alpha uniform tango oscar, wind 290 08 knots, 999 november delta victor, overcast one thousand one hundred , temperature 21, dew point 19, QNH Norfolk 1012...remarks... romeo foxtrot zero zero decimal zero oblique zero zero zero decimal zero go ahead |
| 0803:21 | VH-NGA | Nadi | Thank you nadi... much appreciated november golf alpha |
| 0803:24 | Nadi | VH-NGA | November golf alpha...DOLSI, DOLSI contact Auckland thank you |
| 0803:24 | VH-NGA | Nadi | Auckland at DOLSI victor golf alpha |
| *(End of Transcript)* | | | |

# APPENDIX B: WEATHER INFORMATION AT NORFOLK ISLAND

A number of meteorological products were available to the flight crew. That included their ability to access weather reports and weather forecasts.

The following discussion explains those products and relates them to the conditions at Norfolk Island in the days prior to, and during the flight from Apia, Samoa to Norfolk Island that day. An explanation of the meteorological events affecting the flight is given and a number of supporting satellite images provides.

## Meteorological report

An aerodrome weather report was a report of actual conditions at a particular aerodrome at a specified time, usually provided at half-hourly intervals unless changes in the weather conditions exceeded specified criteria which would initiate an extra report. Aerodrome weather reports were the primary observation code used in aviation for reporting surface meteorological data.

A routine aerodrome weather report was called a METAR.

A SPECI was a special report of meteorological conditions, issued when one or more elements met specified criteria significant to aviation. SPECI was also used to identify reports of observations recorded 10 minutes following an improvement (in visibility, weather or cloud) to above SPECI conditions.

The weather reports for Norfolk Island changed from a METAR to a SPECI when the observed weather conditions deteriorated to less than the highest alternate minima for Norfolk Island Airport.

The Aeronautical Information Publication GEN stated that:

> Aerodrome weather reports are reports of observations of meteorological conditions at an aerodrome. The reports are generated by electronic recording devices called automatic weather stations (AWS) and may have manual input by an approved observer. Manual input of visibility, weather and cloud is for an area within a radius of approximately 8 km (5nm) of the aerodrome reference point.
>
> Owing to the variability of meteorological elements in space and time, to limitations of observing techniques and to limitations caused by the definitions of some of the elements, the specific value of any of the elements given in a report shall be understood by the recipient to be the best approximation to the actual conditions at the time of the observation.

## Meteorological forecast

A forecast is a statement of expected meteorological conditions for a specified period, and for a specified area or portion of airspace.

The Bureau of Meteorology (BoM) stated that:

> When a forecaster makes a prediction, the most probable conditions on the basis of the available information are described. The confidence the forecaster has in the prediction will depend on a number of factors, such as the location, season, complexity of the particular situation, the elements being forecast, and the period of the forecast.
>
> A forecast may be deficient because basic information is inadequate. Usually errors are due to a combination of factors. Elements, such as fog or low cloud, are usually more difficult to predict with precision than others, such as upper wind and temperature.
>
> Pilots who make the most effective use of weather services are usually those who understand the limitations. These pilots look upon forecasts as professional advice rather than categorical statements and take every opportunity to secure amendments and update their forecasts. Complete faith is almost as bad as no faith at all.
>
> Recognising that errors can occur, forecasters review their predictions in the light of later information and, if changes of significance are likely, they amend the forecasts.
>
> Amendments are usually not made unless expected changes from the original forecast are operationally significant, since there is a need to stress important amendments and eliminate unnecessary communication loads.[60]

Aviation forecasts used for flight planning include either flight or area forecasts, or destination and, where required, alternate aerodrome forecasts[61]. Area forecasts are used by pilots to understand the meteorological conditions during the en-route phase of a flight. Area forecasts are provided for lower level operations below 20,000ft.

A different set of forecast products are available for operations at altitudes above 10,000ft that are more relevant for higher altitude operations. En-route upper level winds and temperatures may be obtained from grid point forecasts, route sector wind and temperature (RSWT) forecast messages obtained in text form, and from wind and temperature charts that normally carry a 12-hour prognosis. A separate meteorological product, called a significant weather prognosis (SIGWX), provides a forecast of significant weather including strong winds, turbulence, thunderstorms and icing at upper levels.

An aerodrome forecast (TAF) covers an area within 5 NM (8 km) of an aerodrome and is useful to pilots when taking off or landing. This type of forecast provides the detail that is relevant to operations near the ground, with more emphasis on visibility near the ground. TAFs could be amended if the forecast conditions were expected to vary during the period of validity of the forecast.

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60 The Bureau of Meteorology (BoM) Manual of Aviation Meteorology (2nd Edition)

61 Aeronautical Information Publication ENR 1.10.1.2.1

## Norfolk Island aerodrome weather reports and forecasts

Decisions of whether to divert are based on aerodrome forecasts and their significance in terms of the alternate minima at those aerodromes. Observations or reports indicate the actual weather being experienced at a particular location at a particular time. While weather observations or reports are not specifically relevant in decisions to divert to an alternate aerodrome, they have the potential to inform a pilot as to the actual weather trend at a particular location and therefore the need to confirm the availability of an updated aerodrome or other forecast.

### Weather observations/reports

The following weather reports for Norfolk Island are provided in their original format and colour coded for ease of understanding as follows:

- The green reports indicate observed weather above the alternate minima.
- The yellow weather reports indicate observed weather less than the alternate minima but greater than the landing minima.
- The red weather reports indicate observed weather below the minima.

An explanation of how to interpret aerodrome weather reports can be found at http://www.bom.gov.au/aviation/data/education/awp-metarspeci.pdf

| | |
|---|---|
| | SPECI YSNF 171030Z AUTO 33009KT 9999 OVC006 20/19 Q1012 RMK RF00.0/000.0 |
| | SPECI YSNF 171100Z AUTO 33011KT 9999 OVC006 20/19 Q1012 RMK RF00.0/000.0 |
| Takeoff from Sydney | SPECI YSNF 171130Z AUTO 33009KT 9999 BKN005 OVC036 20/19 Q1012 RMK RF00.0/000.0 |
| | SPECI YSNF 171200Z AUTO 33009KT 9999 BKN005 20/19 Q1012 RMK RF00.0/000.0 |
| | SPECI YSNF 171230Z AUTO 33011KT 9999 BKN005 OVC009 20/19 Q1011 RMK RF00.0/000.0 |
| | SPECI YSNF 171300Z AUTO 33008KT 9999 OVC005 20/19 Q1011 RMK RF00.0/000.0 |
| | SPECI YSNF 171330Z AUTO 32009KT 9999 BKN004 OVC007 20/19 Q1011 RMK RF00.0/000.0 |
| | SPECI YSNF 171400Z AUTO 33011KT 9999 BKN005 OVC008 20/19 Q1011 RMK RF00.0/000.0 |
| | SPECI YSNF 171430Z AUTO 33011KT 9999 BKN004 OVC029 20/19 Q1010 RMK RF00.0/000.0 |
| Landing at Norfolk Island | SPECI YSNF 171500Z AUTO 34012KT 9999 BKN006 OVC010 20/19 Q1010 RMK RF00.0/000.0 |
| Takeoff from Norfolk Island | SPECI YSNF 171530Z AUTO 33009KT 9999 OVC004 20/19 Q1009 RMK RF00.0/000.0 |
| | SPECI YSNF 171600Z AUTO 33011KT 9999 OVC005 20/19 Q1009 RMK RF00.0/000.0 |
| | SPECI YSNF 171630Z AUTO 32011KT 9999 OVC005 20/19 Q1009 |

| | |
|---|---|
| | RMK RF00.0/000.0 |
| | SPECI YSNF 171700Z AUTO 32012KT 9999 OVC004 20/19 Q1009 RMK RF00.0/000.0 |
| | SPECI YSNF 171730Z AUTO 31012KT 9999 BKN006 OVC011 20/19 Q1010 RMK RF00.0/000.0 |
| Landing at Apia, Samoa | SPECI YSNF 171800Z AUTO 31012KT 9999 BKN005 OVC011 20/19 Q1010 RMK RF00.0/000.0 |
| | SPECI YSNF 171830Z AUTO 31011KT 9999 BKN003 BKN006 OVC017 20/19 Q1011 RMK RF00.0/000.0 |
| | SPECI YSNF 171900Z AUTO 30013KT 9999 BKN005 BKN014 20/19 Q1011 RMK RF00.0/000.0 |
| | METAR YSNF 171930Z 31012KT 9999 FEW005 21/19 Q1011 RMK RF00.0/000.0 |
| | SPECI YSNF 172000Z 31013KT 9999 BKN005 21/19 Q1011 RMK RF00.0/000.0 HZ |
| | SPECI YSNF 172030Z 31013KT 9999 SCT004 SCT007 21/19 Q1011 RMK RF00.0/000.0 |
| | SPECI YSNF 172030Z 31013KT 9999 SCT004 SCT007 21/19 Q1011 RMK RF00.0/000.0 HZ |
| | SPECI YSNF 172100Z 31016KT 9999 BKN005 22/19 Q1012 RMK RF00.0/000.0 HZ |
| | SPECI YSNF 172130Z 31014KT 9999 BKN006 22/19 Q1012 RMK RF00.0/000.0 HZ |
| | SPECI YSNF 172200Z 31013KT 9999 BKN006 22/19 Q1012 RMK RF00.0/000.0 HZ |
| | METAR YSNF 172230Z 30015KT 9999 SCT006 23/20 Q1012 RMK RF00.0/000.0 |
| | SPECI YSNF 172230Z 30015KT 9999 SCT006 23/20 Q1012 RMK RF00.0/000.0 IMPROVE E |
| | METAR YSNF 172300Z 30013KT 9999 SCT006 23/20 Q1012 RMK RF00.0/000.0 |
| | SPECI YSNF 172330Z 30014KT 9999 BKN006 23/20 Q1012 RMK RF00.0/000.0 HZ |
| | SPECI YSNF 180000Z 30014KT 9999 BKN005 23/20 Q1012 RMK RF00.0/000.0 HZ |
| | SPECI YSNF 180030Z 30016KT 9999 BKN005 23/20 Q1012 RMK RF00.0/000.0 |
| | SPECI YSNF 180100Z 30015KT 9999 SCT005 SCT130 23/20 Q1012 RMK RF00.0/000.0 HZ |
| | METAR YSNF 180130Z 30014KT 9999 SCT005 23/20 Q1011 RMK RF00.0/000.0 |
| | METAR YSNF 180200Z AUTO 30013KT 9999 SCT004 23/19 Q1011 RMK RF00.0/000.0 |
| | METAR YSNF 180230Z 31012KT 9999 FEW006 23/19 Q1011 RMK RF00.0/000.0 |
| | METAR YSNF 180300Z 31014KT 9999 FEW007 23/19 Q1011 RMK RF00.0/000.0 |
| | METAR YSNF 180330Z 31012KT 9999 FEW007 22/18 Q1011 RMK |

| | |
|---|---|
| | RF00.0/000.0 HZ |
| | METAR YSNF 180400Z 30011KT 9999 FEW007 23/19 Q1010 RMK RF00.0/000.0 |
| Flight plan submitted at Apia | METAR YSNF 180430Z 29014KT 9999 FEW008 22/18 Q1010 RMK RF00.0/000.0 HZ |
| | METAR YSNF 180500Z 29014KT 9999 FEW015 22/18 Q1010 RMK RF00.0/000.0 HZ |
| Takeoff from Apia, Samoa at 0545 UTC | METAR YSNF 180530Z 29013KT 9999 FEW010 22/18 Q1011 RMK RF00.0/000.0 HZ |
| | METAR YSNF 180600Z 31011KT 9999 FEW008 BKN025 21/19 Q1011 RMK RF00.0/000.0 HZ |
| First reported weather observation at 0800 UTC | METAR YSNF 180630Z 30009KT 9999 FEW006 BKN024 21/19 Q1011 RMK RF00.0/000.0 CLOSE TILL 1930UTC |
| | METAR YSNF 180700Z AUTO 29011KT 9999 BKN017 BKN024 21/19 Q1011 RMK RF00.0/000.0 |
| | METAR YSNF 180730Z AUTO 29010KT 9999 OVC013 21/19 Q1012 RMK RF00.0/000.0 |
| | SPECI YSNF 180739Z AUTO 29010KT 9999 OVC011 21/19 Q1012 RMK RF00.0/000.0 |
| Second reported weather observation at 0800 UTC and Norfolk Island TAF amended at 1803 | SPECI YSNF 180800Z AUTO 29008KT 9999 OVC011 21/19 Q1012 RMK RF00.0/000.0 |
| | SPECI YSNF 180830Z AUTO 22007KT 9999 BKN003 OVC009 20/19 Q1013 RMK RF00.0/000.0 |
| | SPECI YSNF 180856Z AUTO 21007KT 9999 SCT005 SCT012 OVC015 20/19 Q1013 RMK RF00.0/000.0 |
| | METAR YSNF 180900Z AUTO 20007KT 8000 SCT005 OVC015 20/19 Q1013 RMK RF00.0/000.0 |
| | SPECI YSNF 180902Z AUTO 20007KT 7000 SCT005 BKN011 OVC015 20/19 Q1013 RMK RF00.0/000.0 |
| | SPECI YSNF 180925Z AUTO 20008KT 6000 BKN003 BKN008 OVC011 20/19 Q1013 RMK RF00.0/000.0 |
| | SPECI YSNF 180930Z AUTO 20007KT 4500 BKN002 BKN006 OVC011 20/19 Q1013 RMK RF00.2/000.2 |
| Arrival at Norfolk Island at 1005. TAF amended at 0958 | SPECI YSNF 181000Z AUTO 18009KT 4500 OVC002 19/19 Q1013 RMK RF00.2/001.0 |
| Ditching at Norfolk Island at 1026 | SPECI YSNF 181030Z AUTO 16009KT 3000 OVC002 19/18 Q1013 RMK RF00.4/002.4 |

| | |
|---|---|
| | SPECI YSNF 181053Z AUTO 16009KT 5000 BKN002 BKN009 OVC014 18/18 Q1014 RMK RF00.0/002.4 |
| | SPECI YSNF 181100Z 14008KT 5000 -SHRA BR BKN005 BKN014 18/18 Q1014 RMK RF00.4/002.8 |
| | SPECI YSNF 181111Z AUTO 15006KT 3200 SCT003 BKN008 OVC014 19/18 Q1014 RMK RF00.2/003.0 |
| | SPECI YSNF 181128Z AUTO 15008KT 7000 SCT005 BKN012 OVC017 19/18 Q1014 RMK RF00.0/003.0 |
| | SPECI YSNF 181134Z 15008KT 8000 FEW006 BKN015 19/17 Q1014 RMK RF00.0/003.0 BR |
| | SPECI YSNF 181200Z 15009KT 9999 FEW008 BKN013 19/17 Q1014 RMK RF00.0/003.0 |

## Aerodrome forecasts (TAFs)

The following aerodrome forecasts are provided in their original format and are colour coded for ease of understanding as follows:

- The green parts of the forecasts predict weather greater than the alternate weather minima for the specified time periods.
- The yellow parts of the forecasts predict weather less than the alternate weather minima but more than the landing weather minima for the specified time periods.

An explanation of how to interpret Terminal Aerodrome Forecasts can be found at http://www.bom.gov.au/aviation/data/education/awp-taf.pdf

| **TAF issued for flight planning out of Sydney on 17 November 2009** | **TAF issued at 1017 UTC on 17 November 2009** |
|---|---|
| | TAF YSNF 171017Z 1712/1806 |
| | 34010KT 8000 HZ BKN005 |
| | FM172200 30015KT 9999 HZ SCT015 |
| | RMK |
| | T 19 18 18 21 Q 1012 1010 1010 1012 |
| | **TAF issued at 1637 UTC on 17 November 2009** |
| | TAF YSNF 171637Z 1718/1812 |
| | 34010KT 8000 HZ BKN005 |
| | FM172200 30015KT 9999 SCT015 |
| | FM180600 26008KT 9999 SCT020 |
| | RMK |
| | T 19 21 22 22 Q 1009 1011 1011 1010 |
| | **TAF issued at 2204 UTC on 17 November 2009** |
| | TAF AMD YSNF 172204Z 1722/1818 |
| | 30015KT 9999 BKN006 |
| | FM180600 26008KT 9999 SCT020 |

| | |
|---|---|
| | RMK |
| | T 22 22 22 20 Q 1012 1011 1010 1011 |
| | **TAF issued at 0429 UTC on 18 November 2009** |
| | TAF AMD YSNF 180429Z 1804/1818 |
| | 30012KT 9999 SCT020 |
| | FM180600 26008KT 9999 SCT020 |
| | RMK |
| | T 23 20 19 18 Q 1010 1011 1013 1013 |
| **TAF issued for flight planning out of Apia, Samoa on 18 November 2009** | **TAF issued at 0437 UTC on 18 November 2009** |
| | TAF YSNF 180437Z 1806/1824 |
| | 26008KT 9999 SCT020 |
| | FM181500 16012KT 9999 -SHRA SCT010 BKN020 |
| | RMK |
| | T 21 19 18 18 Q 1010 1013 1013 1012 |
| **Amended TAF issued halfway through the flight from Apia, Samoa to Norfolk Island** | **TAF issued at 0803 UTC on 18 November 2009** |
| | TAF AMD YSNF 180803Z 1808/1824 |
| | 26008KT 9999 BKN010 |
| | FM181500 16012KT 9999 -SHRA BKN010 |
| | RMK |
| | T 21 18 18 17 Q 1012 1013 1013 1013 |
| **Amended TAF issued at the aircraft's time of arrival at Norfolk Island** | **TAF issued at 0958 UTC on 18 November 2009** |
| | TAF AMD YSNF 180958Z 1810/1824 |
| | 26008KT 9999 -SHRA BKN010 |
| | FM181500 16012KT 9999 -SHRA BKN010 |
| | TEMPO 1810/1824 4000 SHRA BKN005 |
| | RMK |
| | T 19 18 17 18 Q 1013 1013 1012 1014 |

## Sequence of meteorological events at Norfolk Island Airport

During the night before the occurrence, the weather at Norfolk Island Airport was influenced by a moist north-west airstream that was lifted from the surface of the sea as it passed over Norfolk Island. This lifting mechanism was enough to create at least broken low level cloud at the centre of the airport throughout the night, with a cloud base between 400 ft and 600 ft above the aerodrome reference point (ARP). The terrain descends to the south-east of the airport, which would allow cloud formed by orographic uplift in the north-westerly airflow to dissipate to the south-east of the airport as the airflow descended. The approach to runway 29 is to the south-east of the airport.

During the day of the occurrence, the cloud amount decreased to Few, and the cloud base lifted to between 700 ft and 1,000 ft above the ARP by late morning. This change occurred as the air mass was warmed by daytime heating, allowing water droplets from the cloud to be absorbed into the atmosphere.

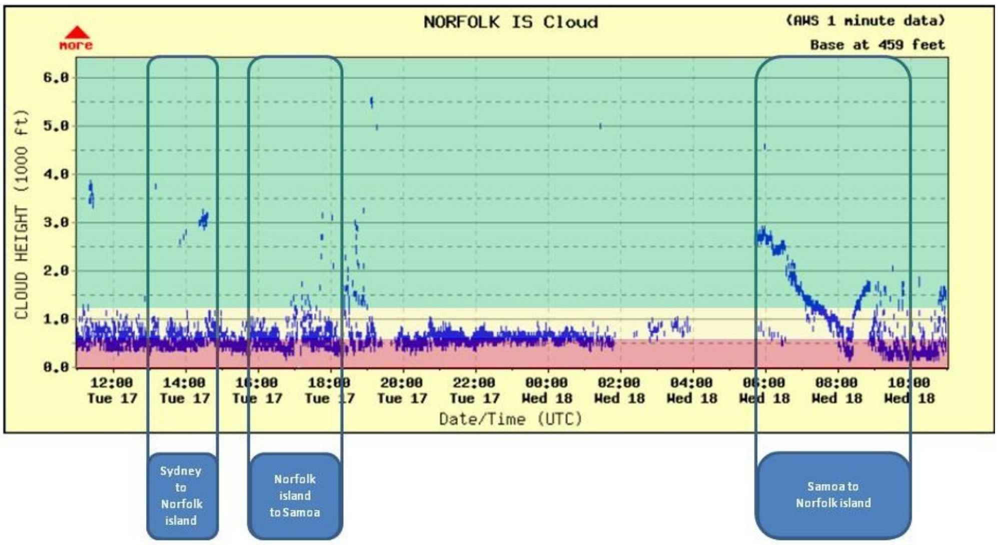
During the day, the aerodrome weather reports and TAFs indicated that the airflow was moving toward Norfolk Island from the north-west. The TAFs predicted that the wind direction would change to the west at 0600.

The pilot in command received a TAF that was issued at 0437 when submitting the flight plan. The TAF was valid from 0600 until long after the aircraft would have landed at Norfolk Island. The TAF forecast that at 1500, the wind would change direction from the west to the south or the south-east, with the onset of low cloud and rain. This change was attributed to the passage of a weak cold front from a low pressure system passing over the north of New Zealand.

The approaching band of low cloud associated with the cold front could be observed from infrared satellite imagery; however, the images indicated a relatively low amount of cloud and rain. The 0437 TAF was based on the expectation that the frontal change would be weak and not associated with any significant precipitation or low cloud. This view was supported by the numerical models used by the Bureau of Meteorology that indicated a weak change with the passage of the front. Climatological analysis also showed that winds coming from between the north-west and the east would be more likely to produce low clouds at Norfolk Island, compared with the forecast winds from the west or the south.

The aerodrome weather reports indicated a slight increase in cloud developing at Norfolk Island between 0600 and 0700. The end of daylight at Norfolk Island Airport was at 0750. The cloud base continued to descend (Figure 8), and at 0739, the automatic weather station (AWS) issued an extra report beyond its normal half-hourly reports. The extra report was issued as the weather conditions had deteriorated to the extent that the reported aerodrome weather report had changed from requiring the issue of a METAR to that of a SPECI (special), because overcast cloud had been observed 1,100 ft above the ARP, which was less than the highest alternate minima. The wind direction had not changed.

**Figure 8: Graphical representation of the cloud base observations at Norfolk Island during the period of the flights**




Note:

- The green area in the figure indicates a cloud base higher than the alternate minima.
- The yellow area in the figure indicates a cloud base lower than the alternate weather minima and higher than the landing minima.
- The red area in the figure indicates a cloud base lower than the landing minima.

In the light of this unforecast change in the weather conditions, an amended TAF was issued at 0803, valid from 0800. The amended TAF forecast Broken cloud at 1,000 ft above the ARP, and that the wind direction was not forecast to change from a westerly direction until 1500, with the passing of the cold front. This amended TAF forecast that the weather conditions would be less than the alternate minima, but not less than the landing minima at the ETA of VH-NGA at Norfolk Island.

Between 0800 and 0830 the aerodrome weather reports indicated the wind direction had changed 70° from just north of west to just west of south. During this period, the ambient air temperature dropped by 1°. The change in wind direction was consistent with the passage of the cold front, which would have created the rain and low cloud that existed at the time of the aircraft’s arrival at Norfolk Island (an indication of the position of the front 10 hours prior to, and 2 hours after the aircraft’s arrival at Norfolk Island are at Figures 9 and 10 respectively). The presence of the front would have had a greater cloud-producing effect than the lifting mechanism that had influenced the weather on the previous night, and would not have provided a mechanism for cloud dissipation to the south-east of the aerodrome as had happened on the previous night.

The aerodrome weather reports indicated that the cloud base continued to descend after 0830. At 0925, the AWS issued another report beyond its normal half-hourly reports. The weather conditions had deteriorated to the extent that a safe landing was unlikely to be achieved following an instrument approach because Broken cloud was observed 300 ft above the ARP. The horizontal visibility had deteriorated from over 10 km to 6,000 m in the previous 31 minutes. It also started to rain at around this time.

Due to this further unforecast change in the weather conditions, another amended TAF was issued at 0958, valid from 1000. This TAF forecast the same weather conditions in the amended 0803 TAF; however, it also included a TEMPO, forecasting an intermittent deterioration in the weather conditions for no longer than 60 minutes, with the cloud changing to Broken at 500 ft above the ARP, a horizontal visibility of 4,000 m and associated showers of rain. The TEMPO conditions in this forecast were not worse than the landing minima, but were worse than the alternate minima.

At the time the pilot commenced the first approach (at 1000), the aerodrome weather report indicated the weather conditions had deteriorated further, with overcast cloud 200 ft above the ARP, and a horizontal visibility of 4,500 m.

At around the time of the ditching, the aerodrome weather report indicated no change in the cloud but the horizontal visibility had deteriorated to 3,000 m. The Unicom operator's description of the weather conditions reflected the reported weather conditions.

The aerodrome weather reports indicated that the weather conditions started to improve shortly before 1100, and the crew should have been able to obtain a visual reference with the runway that would have enabled a safe landing from an instrument approach by 1110. The rain stopped at around this time, with a total rainfall of 3 mm in the previous 90 minutes.

**Figure 9: Mean sea level analysis 10 hours before the aircraft's arrival at Norfolk Island**

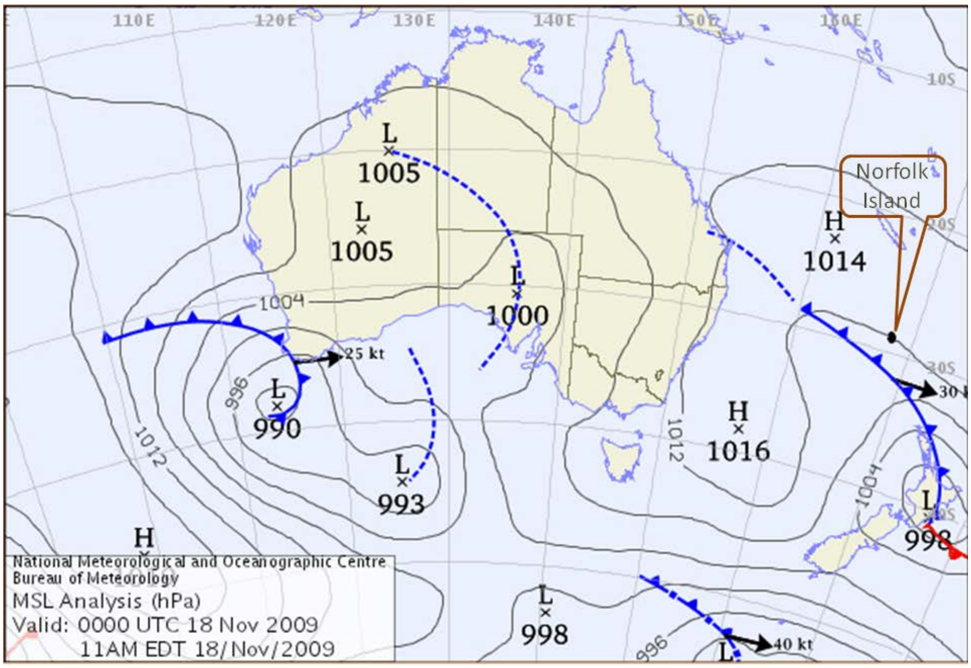
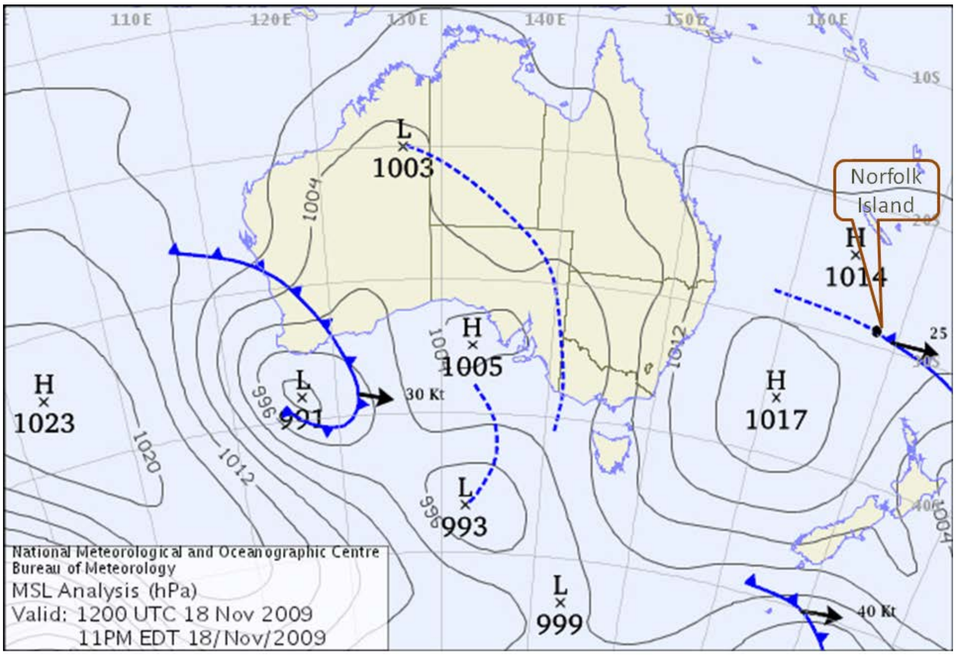


**Figure 10: Mean sea level analysis 2 hours after the aircraft arrived at Norfolk Island**



# APPENDIX C: SOURCES AND SUBMISSIONS

## Sources of information

The main sources of information during the investigation included:

- the flight crew and other aircraft occupants
- the operator
- the contracting company
- a number of staff at the Norfolk Island Airport
- a number of volunteers and staff from the Norfolk Island rescue facility
- the Civil Aviation Safety Authority (CASA)
- the Civil Aviation Authority of the Fiji Islands
- the Civil Aviation Authority of New Zealand
- the Australian Maritime Safety Authority (AMSA)
- the Bureau of Meteorology (BoM)
- an Australian flight training college
- a number of operators and flight crew involved in similar aerial work and other charter operations.

## References

Kahneman, D., & Tversky, A. (1984). *Choices, values and frames*. American Psychologist, 39, 341-350

Merrit, A. & Klinect, J., (2006), *Defensive Flying for Pilots: An Introduction to Threat and Error Management.*

## Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003* (the Act), the Australian Transport Safety Bureau (ATSB) may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. Section 26 (1) (a) of the Act allows a person receiving a draft report to make submissions to the ATSB about the draft report.

A draft of this report was provided to the flight crew and other aircraft occupants, the operator, the airport operator, the contractor, CASA, the BoM, the Transport Accident Investigation Commission of New Zealand, AMSA and the Civil Aviation Authority of the Fiji Islands.

Submissions were received from the flight crew, the operator, the BoM, CASA, the other aircraft occupants and the airport operator. The submissions were reviewed and where considered appropriate, the text of the report was amended accordingly.

**Australian Transport Safety Bureau**

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**Email** atsbinfo@atsb.gov.au

Investigation

**ATSB Transport Safety Report**
Aviation Occurrence Investigation

Ditching – Israel Aircraft Industries Westwind 1124A, VH-NGA
5 km SW of Norfolk Island Airport, 18 November 2009

AO-2009-072
Final