Australian Government
Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY INVESTIGATION REPORT
Aviation Occurrence Report – 200605473
Final

Below minima landing – Perth Airport, WA
16 September 2006
VH-QPJ
Airbus Industrie A330

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Published by: Australian Transport Safety Bureau
Postal address: PO Box 967, Civic Square ACT 2608
Office location: 15 Mort Street, Canberra City, Australian Capital Territory
Telephone: 1800 621 372; from overseas + 61 2 6274 6440
Accident and incident notification: 1800 011 034 (24 hours)
Facsimile: 02 6247 3117; from overseas + 61 2 6247 3117
E-mail: atsbinfo@atsb.gov.au
Internet: www.atsb.gov.au

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Abstract

On 16 September 2006 at 0038 Western Standard Time, an Airbus Industrie A330 landed on runway 21 at Perth Airport in weather conditions that were below the applicable landing minima. The aircraft, registered VH-QPJ, was being operated in accordance with the instrument flight rules (IFR) on a scheduled passenger flight from Singapore to Perth, WA.

Before departure from Singapore, the aerodrome forecast (TAF) for Perth Airport predicted a 30% probability of fog after 0200. The aircraft was due at Perth at 0020 so in accordance with the operator's fuel policy; fuel was not specifically carried for a diversion from the destination to an alternate aerodrome. While the aircraft was in cruise, the TAF was revised to forecast fog from 2400, but the trend type forecasts (TTF) which superseded the TAF trended fog from 0030.

At about 2350, when the flight crew commenced descent, the aircraft passed the point where it had the fuel to divert to Learmonth, WA. About 10 minutes later, the TTF was amended to forecast fog to occur before the aircraft's arrival time. The fog occurred at about 0015. The crew attempted two Instrument Landing System (ILS) approaches before they used autoland to land on runway 21 in weather conditions that were below the prescribed landing minima for the ILS

The ILS at Perth (and other Australian airports) was approved to the Category I standard that did not allow landings where the visibility was less than 800 m. The Perth runway 21 ILS glide path critical area was not fully protected from multipath effects during low visibility operations.

Perth and Learmonth were the only aerodromes in Western Australia that could be classified as suitable for the A330, and Learmonth was 599 NM (1,110 km) from Perth.

As a result of this occurrence, the operator implemented an interim flight planning fuel policy specifically for Perth.

THE AUSTRALIAN TRANSPORT SAFETY BUREAU

The Australian Transport Safety Bureau (ATSB) is an operationally independent multi-modal Bureau within the Australian Government Department of Transport and Regional Services. ATSB investigations are independent of regulatory, operator or other external bodies.

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 enhance safety. To reduce safety-related risk, ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated.

It is not the object of an investigation to determine blame or liability. However, 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 proactively initiate safety action rather than release formal recommendations. However, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation, a recommendation may be issued either during or at the end of an investigation.

The ATSB has decided that when safety recommendations are issued, they will focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on the method of corrective action. As with equivalent overseas organisations, the ATSB has no power to implement its recommendations. It is a matter for the body to which an ATSB recommendation is directed (for example the relevant regulator in consultation with industry) to assess the costs and benefits of any particular means of addressing a safety issue.

About ATSB investigation reports: How investigation reports are organised and definitions of terms used in ATSB reports, such as safety factor, contributing safety factor and safety issue, are provided on the ATSB web site www.atsb.gov.au.

FACTUAL INFORMATION

Sequence of events

On 16 September 2006 at 0038 Western Standard Time[1], an Airbus Industrie A330-303 landed on runway 21 at Perth Airport in weather conditions that were below the applicable landing minima[2]. The aircraft, registered VH-QPJ, was being operated in accordance with the instrument flight rules (IFR) on a scheduled passenger flight from Singapore to Perth, WA.

The flight had been planned using a valid aerodrome forecast (TAF)[3] for Perth Airport, which predicted broken[4] cloud with a base of 1,000 ft above airport elevation, visibility greater than 10 km and after 0200, a 30 % probability of fog occurring. As the estimated arrival time at Perth was 0020, those weather conditions were above the applicable alternate minima of 750 ft cloud ceiling and 2.5 km visibility. Accordingly, the flight departed Singapore at 1937 without fuel being specifically carried to enable a diversion from Perth to an alternate aerodrome if unforecast weather precluded an approach and landing. The crew later reported that they were concerned about the forecast and did load some additional fuel.

At 2130 (when the aircraft was approximately midway between Singapore and Perth), staff at the Bureau of Meteorology (BoM) in Perth commenced a reassessment of the Perth weather situation. They concluded that the onset of fog would be closer to 2400 than 0200 and issued the 2200 Perth Trend Type Forecast (TTF) with fog forecast from 0030. Shortly after, the TAF was amended to forecast fog from 2400. At 2208, the crew received an ACARS[5] message with the 2200 Perth TTF. About an hour later, the crew requested and received the amended Perth TAF. The operator's operational support personnel made a satellite communication call to the crew to advise them of the amended Perth TAF and TTF.

At 2330, fog was over the city and was observed moving slowly east towards the airport. Five minutes later, BoM staff phoned the operator's despatch centre in Sydney and advised them of the fog.

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1 The 24-hour clock is used in this report to describe the local time of day. Western Standard Time was Coordinated Universal Time (UTC) + 8 hours.

2 Landing minima are the meteorological conditions of cloud ceiling and visibility specified by the Civil Aviation Safety Authority, which are the minimum conditions required before an aircraft is permitted to land. The meteorological conditions for a particular aerodrome are below the minima for the aerodrome when, in the airspace encompassing the intended flight path:
a. the total cloud amount below the ceiling minimum specified is continuously greater than SCT (3 to 4 eights to the visible sky) ; or b. the visibility is continuously below the visibility specified.

3 TAF and TTF are described in the Weather forecasts and observations section following.

4 Cloud amounts are reported as few, scattered, broken or overcast. Broken = 5 to 7 eights of the visible sky covered by cloud.

5 Aircraft communications and automatic reporting system - similar to an inflight facsimile system.

While enroute, the crew recalculated the Designated Point All Engines Operating[6] (DPA) which, based on a diversion to Learmonth (1,110 km north of Perth), was coincident with the calculated descent point for Perth. At 2338, as the aircraft was nearing that point, the crew requested, via ACARS, the reports of the actual weather conditions at Perth Airport, Pearce Airport (located 31 km north of Perth Airport) and Learmonth. The crew received the 2330 Perth TTF that retained the prediction of fog from 0030. The Pearce weather report was automatically generated and recorded scattered[7] cloud at 400 ft above aerodrome elevation. The automatically generated weather report for Learmonth had no significant weather.

At approximately 2352, air traffic control (ATC) advised the crew that the Perth ATIS[8] was reporting 10 km visibility reducing to 8 km in mist. At about 2350, the crew commenced descent into Perth, with an estimated time of arrival (ETA) of 0020. From that point on, there were no alternate aerodromes, defined by the operator to be suitable for the A330, available to the crew.

The following table shows the progressively deteriorating visibility at Perth Airport while the aircraft was on descent, then operating in the Perth terminal area.

Table 1: Perth Airport weather information

Time	Source	Details
2400	TTF	Visibility 300 m in fog forecast at 0015
0003	ATIS	Visibility 5,000 m in mist
0008	ATIS	Visibility 3,000 m in mist
0012	ATIS	Visibility 2,000 m in fog
0016	ATIS	Runway visual range (RVR)[9] 800 m in fog
0026	ATIS	RVR 400 m in fog
0030	TTF	Visibility 300 m in fog

At about 0010, the crew began a runway 21 instrument landing system (ILS) approach. The crew reported that at the 250 ft minima, the visibility was less than the required 800 m and they initiated a missed approach. The crew of a departing aircraft reported that the visibility was better on the southern end of the runway and VH-QPJ was radar vectored for a runway 03 ILS approach. At the 320 ft minima, the visibility was less than the required 1,500 m so the crew initiated another missed approach.

6 DPA was defined by the operator as 'The position on the fuel flight plan furthest removed from the departure airport to which an aircraft may fly and then divert to a suitable airport with all engines operating whilst meeting the inflight fuel requirements.'

7 Scattered = 3 to 4 eights of the visible sky covered by cloud.

8 Automatic terminal information service, which is an automated transmission indicating the prevailing weather conditions at the aerodrome and other relevant operational information for arriving and departing aircraft.

9 The range over which the pilot of an aircraft on the centre-line of a runway can expect to see the runway surface markings or the lights delineating the runway or identifying its centre-line.

The crew decided to carry out another runway 21 ILS approach and conduct an autoland[10] to below the approved minima if required. The crew calculated that at the completion of the approach the aircraft would have about 30 minutes margin over the minimum fuel reserves. Based on the lack of alternatives and the intention to conduct an approach below minima, the crew transmitted a Mayday[11] to ATC.

The crew reported that the approach was flown using low visibility procedures with autoland selected. At the 250 ft altitude minima, the pilot in command had approximately 400 m visibility and some of the approach lighting was visible. At approximately 100 ft above the runway, the pilot in command could see the runway threshold lights. The landing was reported to be normal and the crew had sufficient visibility to navigate to the terminal.

Weather forecasts and observations

The BoM produced two types of forecasts for Perth Airport. The TAF was routinely issued every 6 hours for periods of up to 24 hours and included predictions of local cloud, visibility and temperature. Flight planning in regard to requirements for alternate aerodromes was usually predicated on the TAF. Any operational requirements for additional fuel were also applicable in a 30-minute buffer period prior to the forecast onset of any adverse weather.

The Perth TTF was routinely issued every 30 minutes and was valid for 3 hours from the time of observation. It superseded the TAF for that time. The 30-minute buffer period applicable to the TAF did not apply.

The BoM explained that broken low cloud and fog was forecast due to the movement of a trough inland from the west coast and a cold front approaching the south-west corner of the state. At 1800, bureau staff considered that low cloud was unlikely, but the surface temperature and dew point conditions were consistent with fog onset between 0100 and 0200. Between 2130 and 2200, the dewpoint depression at Perth Airport decreased from 0.9 C to 0.5 C and surface conditions at Gooseberry Hill (to the east) were increasingly conducive to fog.

The first direct indication of fog was at 2230, when the visibility sensor at Jandakot Airport (located 18 km south-west of Perth Airport) indicated visibility of 3,300 m due to mist or fog. At 2300, the cloud sensor at Pearce Airport was detecting scattered cloud at 400 ft. Fog was observed over the city at 2330 and was moving slowly east towards the airport. The duty observer at Perth Airport and the duty ATC were asked to estimate the fog rate of progress. As the fog was moving very slowly, the forecaster continued to trend fog from 0030 on the TTF.

The BoM advised that current forecasting methods were ‘inadequate to correctly forecast the fog onset precisely at long range’. The fog forecasting for Perth Airport was an innovative process where a number of methods were used to produce a corresponding number of fog probabilities. Those results were recorded and assessed to produce a final forecast outcome. Using those methods, the reanalysis of

10 An autoland is an aircraft approach, landing and roll out managed by the onboard autopilot system.

11 International radio broadcast for urgent assistance.

the low level conditions between 2130 and 2200 correctly concluded the fog would occur earlier.

There were significant differences in the local fog forecasting techniques that had been developed for Perth, Sydney and Melbourne Airports. Development of a Forecast Decision Support System (FDSS) for fog forecasting has begun with the aim of providing a more unified process.

Short range forecasting was carried out with observations from the meteorological observer and air traffic controllers at Perth Airport, and cloud/visibility sensors at Jandakot, Pearce and Perth. The BoM advised that an increase in the Perth observational network would be advantageous to the fog forecast process in the future.

Statistics provided by the BoM showed that in the period from May to September of the years 2003, 2004, 2005 and 2006, there was an average of 15 fog or mist events observed. Of those events, there was one fog event which was not forecast on the TAF.

Prior to this incident, the last reported fog-related incident at Perth was on 22 March 2002. After a Boeing 747 departed Melbourne for Perth, the TAF was amended to forecast fog that would clear before the aircraft's arrival time. While the aircraft was enroute and out of contact, the TTF was amended to forecast fog remaining up to 15 minutes after the aircraft's arrival time. The aircraft had passed its last diversion point and continued to Perth where it landed uneventfully. The ATSB investigation report[12] into that incident records that the BoM reviewed the Perth fog forecasting process and, in May 2002, implemented a systematic structured approach to fog forecasting.

On 6 April 2004, an Airbus Industrie A330 was being operated on a scheduled passenger flight from Perth to Sydney. During the latter stage of the flight, unforecast fog developed at Sydney aerodrome, which resulted in significant deterioration of visibility. The flight crew conducted an autoland below the specified landing minima.

Operational support

The aircraft operator provided flight crews with operational support through the flight dispatch planning and delivery function of an integrated operations centre. Along with the provision of pre-flight operational information, it provided an inflight weather and operational hazard surveillance service and passed information to flight crews as required.

Aircraft fuel policy

The aircraft operator maintained an aircraft fuel policy in its *Flight Administration Manual*. The policy established the minimum aircraft fuel requirements with the intent that an aircraft should not land with less than fixed reserve at the completion of the landing roll.

12 Available at www.atsb.gov.au/publications/investigation_reports/2002/AAIR/aair200201556.aspx

The pre-flight fuel requirements included diversion fuel to an alternate if required and contingency fuel when necessary to meet aircraft systems failure requirements. Inflight, the minimum requirement was sufficient fuel to proceed to a suitable airport with reserves.

A variation to the fuel policy was approved for operations to designated isolated airports located on remote islands. If an alternate was required, inbound flights required special holding fuel and before passing the DPA, the destination weather was to be forecast above the landing minima for the estimated time of arrival and for the 2 hours following.

Availability of airports

The aircraft operator provided information about airports approved for A330 operations in a *Route Manual Supplement* (RMS), which was carried on board for flight crew use. If an airport was approved as a 'main' or 'alternate' airport, and the weather conditions were forecast to be better than the alternate minima, the airport was classified as 'suitable' for that aircraft type. Learmonth was the only airport in Western Australia, other than Perth, able to be classified as suitable for A330-300 operations.

The RMS identified aerodromes that were classified as 'adequate' for use in event of a critical system failure during Extended Range Operation with Twin Engine Aeroplanes operations. Kalgoorlie and Port Hedland were the only airports in Western Australia nominated as adequate for A330-300 operations. The RMS also nominated Pearce and Broome as emergency airports.

Low visibility approach and landing

In Australia at the time of the incident, the lowest instrument approach landing minima were those offered by the ILS. The ILS comprised ground-based radio beam transmitters that provided electronic track and slope guidance for landing. It was supplemented by approach lighting and runway lighting/marking.

The International Civil Aviation Organization[13] classified ILS facilities as Category I, II or III. A Category I ILS facility typically provided a decision altitude/height[14] of 200 ft above the threshold plane, with a minimum visibility requirement of 800 m. All ILS facilities at Australian airports were approved to the Category I standard only. Category II and III facilities permitted lower decision heights and less visibility, but required ground based equipment capable of consistently operating to more exact tolerances with closer monitoring and runways[15] with more extensive lighting and marking.

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13 Annex 10 to the Convention on International Civil Aviation, *Aeronautical Telecommunications*, Volume 1 Radio Navigation Aids, Sixth edition July 2006.

14 A specified altitude (referenced to mean sea level) or height (referenced to runway threshold elevation) at which a missed approach must be initiated if the required visual reference to continue the approach has not been established.

15 Annex 14 to the Convention on International Civil Aviation, *Aerodromes*, Volume 1 Aerodrome Design and Operations, Fourth Edition July 2004.

The operator's A330 aircraft were approved by the Civil Aviation Safety Authority (CASA) for Category II and III operations at airports outside Australian territory, subject to a number of conditions. Those conditions included minimum pilot training, experience, recency and competency requirements. Operations below the Category I minima were defined as low visibility operations and required specific crew operating procedures and use of the aircraft's autoland capability. The crew reported that they used low visibility procedures and autoland for the final approach to runway 21.

The operator was approved by CASA to conduct autolands to runways equipped with Category I ILS, subject to a number of other conditions. Those conditions included:

- aircraft was certified for autoland and maintained accordingly
- runway was evaluated for conformance to a number of criteria
- flight crew qualification, recency and standards requirements
- ongoing monitoring of autoland performance
- documentation of autoland operating procedures.

There was a requirement for ATC and the airport operator to implement low visibility operations when the RVR was reported as 800 m or less. At Perth, those operations included that all aircraft and vehicles on the manoeuvring area were stationary before a clearance to land was issued and that arriving traffic had a minimum of 5 minutes spacing. The tower controller reported that low visibility operations were implemented.

Before starting the final approach, the crew were advised that the 'critical area is not protected'. The tower controller related that the phrase was routinely transmitted when autolands were conducted because vehicular traffic on the perimeter road in the undershoot area of runway 21 was not controlled. The glide path critical area extended up to 700 m from the antenna.

The management of traffic in localizer protected areas and glide path critical areas during low visibility conditions was intended to avoid multipath effects on ILS signals. Multipath effects are fluctuations of the glidepath or localiser that may be produced by aircraft passing within a certain distance of the ILS antennae.

Landing minima regulatory aspects

Civil Aviation Regulation 257 (4) stipulated that:

> If an element of the meteorological minima for the landing of an aircraft at that aerodrome was less than that determined for the aircraft operation at that aerodrome, the aircraft was not to land at that aerodrome.

Civil Aviation Regulation 257 (5) specified that:

> If an emergency arises that, in the interests of safety, makes it necessary for an aircraft to land at an aerodrome where the meteorological minima is less than that determined for that aircraft operation at that aerodrome, then CAR 257 (4) does not apply.

The operator's *Flight Administration Manual* (FAM) stated that:

> An aircraft may not land, or continue an approach below the approved minimum altitude, when any element constituting the meteorological minima is less than the approved minima or, if during the visual segment, visual reference is lost.

It made no reference to being able to land at an aerodrome in below minima conditions.

ANALYSIS

The aircraft landed at Perth Airport in weather conditions that were below the prescribed landing minima for the instrument approach. Due to the formation of fog before the aircraft landed and the absence of a suitable airport within range, the situation was considered to be an emergency and Civil Aviation Regulation 257 permitted the crew to land below the prescribed minima. This analysis examines the circumstances leading up to the landing and the management of the risk that fog posed to this flight and airline operations generally.

The forecasts used in planning the flight predicted fog would occur about 1.5 hours after the aircraft's arrival at Perth. After the aircraft's departure, however, the forecasters identified a trend towards an earlier onset and updated subsequent aerodrome forecasts (TAF) and trend type forecasts (TTF) accordingly. Enroute, the flight crew actively sought weather information or received it from the operator's operational support. As a result, the crew maintained an awareness of the developing meteorological situation. Significantly, it was only at 2400, after the aircraft had passed the Designated Point All Engines Operating (DPA), that the TTF predicted fog onset before the arrival time. Once the crew commenced descent they were committed to a landing at Perth.

The forecasting of fog is necessarily a complex process and the exact timing of fog formation at a particular location was difficult to predict. Had there been a more extensive local meteorological observation network in place, the Bureau of Meteorology may have been able to produce an accurate prediction of fog onset at Perth Airport before the aircraft began its descent and was committed to a landing. Although the statistics for the years 2003 to 2006 showed only one unforecast fog event at Perth, the continuing work by the bureau to improve their forecasting models and share information should increase fog forecast assurance at Perth and other major airports.

At the time of the incident, the operator's fuel policy did not discriminate between Perth, which was relatively isolated in terms of distance from airports suitable for the A330, and other Australian airports. That meant that, in the absence of any applicable operational requirements, flights to Perth did not routinely carry additional fuel for flight from the planned destination to a suitable airport.

The operator was aware of the safety risk posed by unforseen events, meteorological or otherwise, at destination airports and managed the risk through their integrated operations centre. In this case, the flight crew demonstrated their awareness of the risk in their conservative decision to carry fuel out of Singapore that was additional to the minimum fuel policy requirement. However, that extra fuel was insufficient to assure a landing at a suitable airport.

In the circumstances, the crew's action in attempting two approaches before committing to a landing below minima was sound. Crew selection of the runway 21 ILS as an operator-approved runway for autoland, and use of the A330 autoland capability reduced the risk inherent in landing in meteorological conditions that were below the specified minima.

Notwithstanding the successful use of autoland, there were risks in the below minima landing. Although the investigation was unable to quantify the risks, the lack of assurance in regard to the consistency of the ILS signals and the integrity monitoring/warning provided by Cat II and III conforming facilities were

considered to be important. The lack of Cat II and III runway and taxiway lighting and markings was also a potential risk.

Landings conducted in meteorological conditions below the specified approach minima have risks that are not considered acceptable in normal circumstances. So, in the absence of Cat II and III instrument approaches, the accurate forecasting of fog is an essential risk control. Another essential risk control is the fuel policy of aircraft operators. This occurrence shows that where fuel for diversion from the destination to a suitable alternate airport is not routinely carried, it is important that operators have contingency plans to manage the risk posed by unforecast events.

FINDINGS

Contributing safety factors

1. Fog formed at Perth Airport before the aerodrome forecast used for flight planning and before the trend type forecasts issued prior to 2400 forecast it to occur.
2. The aircraft was due at Perth at 0020 and had passed the Designated Point All Engines Operating (DPA) at top of descent before the TTF was amended to forecast fog prior to the arrival time.
3. The instrument landing system (ILS) at Perth (and other Australian aerodromes) did not allow landings in fog where the visibility at the decision altitude/height was less than 800 m.

Other safety factors

1. Perth and Learmonth were the only aerodromes in Western Australia that could be classified as suitable for the A330, and Learmonth was 599 NM (1,110 km) from Perth
2. The Perth Runway 21 ILS glide path critical area was not fully protected from multipath effects during low visibility operations.

Other key findings

1. The crew conducted a successful autoland.

SAFETY ACTIONS

Operator

After an internal investigation of the incident, the operator produced an internal notice to airmen (INTAM) applicable to all of the operator's flights to Perth.

The INTAM stated that:

> When any forecast requirements for an alternate (as per FAM 15.3.1) are forecast, the onset and cessation time for each event must be buffered by 2 hours (in lieu of 30 MINS). When determining alternate requirements in-flight: normal buffers apply.

The operator subsequently implemented an interim flight planning fuel policy for Perth. That policy stated that:

> All flights into Perth in the evening (arrivals after 12:00) must be planned with an alternate (payload permitting) if there is any indication of fog irrespective of how late the fog is forecast (eg. if the ETA was 14:00 and the TAF or briefing sheet showed a 30% probability of fog from 20:00, an alternate would be planned).
>
> The policy is to remain in place until such time as the BOM reconsider their forecast timings for the onset/cessation of fog ahead of completing their longer term analysis into fog onset/cessation times.