Australian Government
Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY INVESTIGATION REPORT

Aviation Occurrence Report – AO-2007-001

Preliminary

Microburst event
Sydney Airport, NSW
15 April 2007
VH-OJR
Boeing Company 747-438

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Abstract

On 15 April 2007, a Boeing Company 747-438 aircraft, registered VH-OJR, was being operating on a scheduled passenger flight from Singapore to Sydney, NSW. At 1923 Eastern Standard Time, the aircraft was positioned on a short final approach for a landing on runway 16R when it encountered rapidly changing wind conditions. The aircraft touched down firmly and the crew conducted a go around.

The investigation is continuing.

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

History of the flight

On 15 April 2007, a Boeing Company 747-438 aircraft, registered VH-OJR, was being operated on a scheduled passenger flight from Singapore to Sydney Airport, NSW. On board the aircraft were 19 crew and 355 passengers. The flight crew consisted of a captain, a first officer, and two second officers. The first officer was the flying pilot. At 1923 Eastern Standard Time[1], the aircraft was positioned on a short final approach for a landing on runway 16 Right (16R) when it encountered rapidly changing wind conditions. The aircraft touched down firmly and the crew commenced a go around.

At the time of departure from Singapore, there were no weather-related operational requirements in effect for the aircraft's estimated arrival time at Sydney. At about the time that the aircraft crossed the Western Australian coast, company operations personnel advised the flight crew that there would be a 30-minute weather-related holding requirement applied to Sydney.

Shortly before they commenced a descent towards Sydney, the crew reviewed the 1830 METAR (routine weather report). This report indicated that the wind at Sydney was 030 degrees True (T) at 17 kts, and that there were thunderstorms 18 NM south-west, which were moving east-north-east at 15 kts. The associated trend type forecast (TTF) indicated that between 1830 and 2000, it was expected that there would be 30-minute periods during which thunderstorms, rain, and associated low visibility and cloud would occur. The crew also obtained the Sydney Automatic Terminal Information Service (ATIS) Papa, which advised that runways 34 Left (34L) and 34 Right (34R) were in use, and that the wind was from 030 degrees Magnetic (M) at 15 kts, and that there were showers in the area. The crew commenced descent towards Sydney at 1857.

At 1908, the first officer, asked the Sydney Approach Controller for an appreciation of the weather conditions in the terminal area. At 1909, the controller broadcast to all aircraft that Sydney ATIS Quebec was now current, and that the changes were that the QNH was 1016 and that the crew of another aircraft had reported moderate overshoot windshear on final approach at 1,000 ft.

At 1910, the controller broadcast to all aircraft that there was cumulonimbus (CB) clouds in the area, that there was currently 20 kts downwind on all runways, and that he would advise the runways to be used shortly.

The flight crew discussed their preference to stop descending the aircraft if the variable conditions required them to hold. In this context, the captain asked the controller whether they were still processing approaches to 34L and 34R. The controller advised that they were changing to use runways 16R and 16L. The captain advised that he would 'prefer not to get down in the weeds before we get

1 The 24-hour clock is used in this report to describe the local time of day, Eastern Standard Time (EST), as particular events occurred. Eastern Standard Time was Coordinated Universal Time (UTC) + 10 hours.

positioned onto 16'. The controller acknowledged this request, and instructed the crew to turn the aircraft left onto a downwind leg for a right circuit to runway 16R.

At 1914, the controller broadcast to all aircraft that ATIS Romeo was now current. He advised that the changes were that runways 16R and 16L were now in use, that the wind was 190 degrees at 10 to 20 kts, and that the QNH was 1017.

At 1916, the approach controller instructed the crew to contact the Sydney Director Controller (director). The director cleared the crew to continue descending and issued vectors for the aircraft to intercept the runway 16R localiser. The crew felt that the director was vectoring them too close to the runway, and requested 'a bit of room'.

At 1919, the director broadcast to all aircraft that ATIS Sierra was now current, that there were showers and CBs in the area, the temperature was 22, and that windshear below 3,000 ft could be expected. At 1920, after a prompt from the director, the crew advised that they were visual. The director cleared them to conduct a visual approach to runway 16R, advised that they were the first aircraft in the landing sequence for that runway, and instructed them to contact the aerodrome controller (ADC). At 1920:57, the aircraft was 6.3 NM from the runway 16R threshold, and passing 2,020 ft on descent.

At 1921:56, the aircraft passed 1,000 ft radio altitude on descent. The crew contacted the ADC, who advised that the wind at the landing threshold was 180 degrees at 22 kts. He issued them a clearance to land, and requested the wind conditions from the aircraft's navigation systems. The captain advised that the wind at 1,000 ft was a 20 kt tailwind.

At 1922:18, the crew disconnected the autopilot. The first officer requested a continuous call out of the wind. The captain advised that the wind was now calm. At 1922:28, the captain advised that there was now a 10 kt headwind. At 1922:35, the aircraft passed 500 ft radio altitude on descent, and the captain called that the approach was stable. At 1922:43, the captain advised that the crosswind from the right was increasing. At 1922:58, the captain advised that they still had a headwind which was slightly from the right. At 1923:10, the aircraft passed 100 ft radio altitude on descent.

At 1923:14, the aircraft descended through 50 ft radio altitude. One second later, at 1923:15, the captain advised that the airspeed was bleeding, indicating that the airspeed was reducing. The rate of descent did not decrease, despite an increase in aircraft pitch and thrust, and the aircraft touched down firmly on the main landing gear at 1923:16. Just after the touch-down, the aircraft's enhanced ground proximity warning system (EGPWS) issued a windshear alert, and the captain advised that he was taking over control of the aircraft. The crew conducted a go around, and subsequently landed the aircraft on runway 34L at 1940.

During the landing, several overhead cabin fittings detached. A subsequent maintenance inspection[2] did not identify any other defect or damage to the aircraft, and there were no reported injuries to passengers or crew.

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2 The maximum vertical acceleration recorded by the aircraft recorders (see Figure 1) was above the value at which a hard landing maintenance inspection was required.

Just before the aircraft touched down on runway 16R, the ADC advised the crew of another aircraft that was preparing to take off from runway 25, that the wind at the upwind end of that runway was 030 degrees at 16 kts, and that the wind was 'just all over the place at the moment'. The crew of another aircraft, who had called the ADC to advise that they were ready for taxi onto the threshold of runway 16R to take off, cancelled their ready call, advising that they would wait until the wind settled down a bit. The aircraft following VH-OJR on a landing approach to runway 16R went around from 300 ft, citing a 13 kt tailwind and windshear. The active runways were subsequently changed to 34L and 34R.

Recorded information

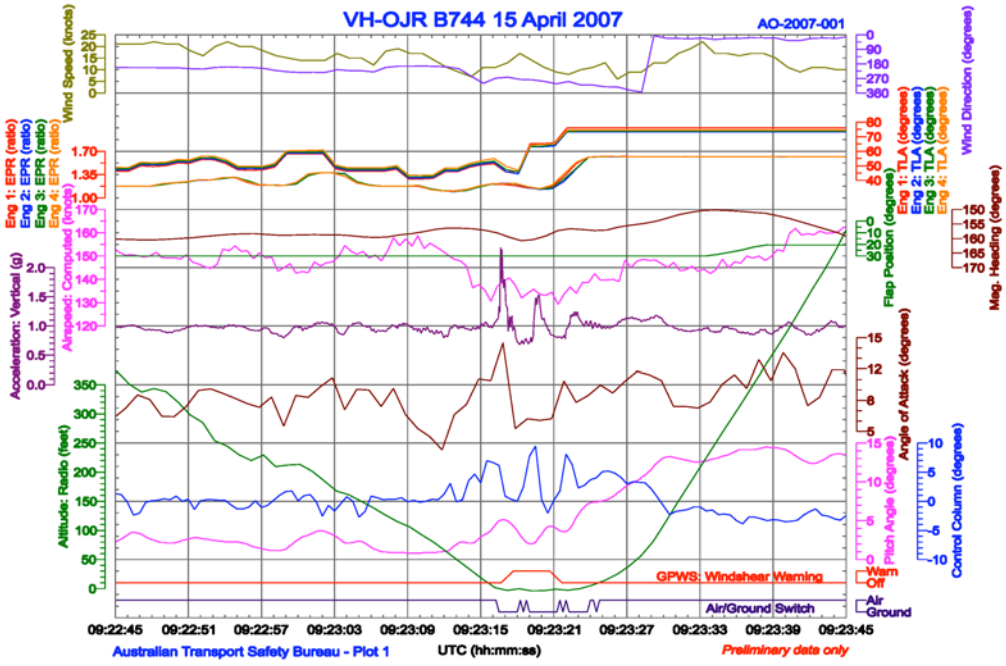
Air Traffic Services recorded information

Communications between the flight crew and the air traffic controllers were recorded by ground-based automatic voice recording equipment. The aircraft's radar position and transponder-broadcast altitude was also recorded by ground-based recording equipment.

Aircraft recorded information

The aircraft was fitted with a flight data recorder (FDR), a cockpit voice recorder (CVR), and a quick access recorder (QAR). High quality data was obtained from each recorder. Preliminary data from the QAR is presented graphically in Figure 1 (a larger scale image of Figure 1 can be found at Attachment 1).

Figure 1: Preliminary QAR data plot



The maximum vertical acceleration recorded by the QAR at the initial touchdown was 2.34 g.

Weather information

Meteorological forecasts and reports

The Bureau of Meteorology issued forecasts and reports of expected weather conditions at aerodromes.

Aviation weather forecasts included aerodrome[3] forecasts (TAFs), and trend type forecasts (TTFs). A TAF was a statement of expected weather conditions within a radius of 5 NM of the centre of the aerodrome runway complex for the duration of the specified period. A TTF was an aerodrome weather report to which a statement of the expected weather trend over the subsequent 3 hrs was appended.

Aerodrome weather reports were observations of actual meteorological conditions at aerodromes. Routine reports (METARs) at Sydney were issued half hourly and were broadcast on the VHF Automatic En Route Information Service. Special reports (SPECIs) were issued whenever weather conditions fluctuated about or were below specified criteria.

Aerodrome forecast

An amended TAF for Sydney aerodrome was issued at 1548 and was valid from 1600. It detailed the following expected conditions:

- Wind: 020 degrees T at 15 kts
- Visibility: greater than 10 km
- Cloud: 1 to 2 oktas[4] at 4,000 ft, 3 to 4 oktas at 8,000 ft
- Weather: light showers of rain.

The forecast also indicated that between 1600 and 2000 there was a 30% probability of thunderstorms with rain, visibility reduced to 4,000 m, 3 to 4 oktas of cloud at 3,000 ft, and 3 to 4 oktas of cumulonimbus cloud at 6,000 ft. It was expected that the duration of each deterioration of the weather would last for less than 30 minutes.

METAR reports, SPECI reports and Trend Type forecasts

The Sydney METAR issued at 1830 reported the following conditions:

- Wind: 030 degrees T at 17 kts
- Cloud: 1 okta of cumulus at 4,500 ft, 3 oktas of cirrus at 25,000 ft
- Remarks: thunderstorms 18 NM to the south-west of Sydney aerodrome, moving east-north-east at 15 kts.

The associated TTF indicated that between 1830 and 2000, for periods of less than 30 minutes, it was expected that there would be thunderstorms with rain, visibility

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3 Aviation weather reports use the term ‘aerodrome’ which applies to airports and aerodromes.

4 Cloud amounts are reported in oktas. An okta is a unit of sky area equal to one-eighth of total sky visible to the celestial horizon. Few = 1 to 2 oktas, scattered = 3 to 4 oktas, broken = 5 to 7 oktas and overcast = 8 oktas.

reduced to 4,000 m, 3 to 4 oktas of cloud at 3,000 ft, and 3 to 4 oktas of cumulonimbus cloud at 6,000 ft.

The Sydney METAR issued at 1900 reported the following conditions:

- Wind: 030 degrees T at 15 kts
- Cloud: 1 okta of cumulus at 4,500 ft, 3 oktas of altocumulus at 12,000 ft
- Remarks: thunderstorms 7 NM to the south-south-west of Sydney aerodrome, moving east-north-east at 15 kts.

The associated TTF indicated that the wind from 1910 was expected to change to 180 degrees at 15 kts T, with light showers of rain, and 1 to 2 oktas of cloud at 4,000 ft and 3 to 4 oktas at 10,000 ft. It also indicated that from 2000, the wind was expected to change to 020 degrees at 15 kts T, with light showers of rain, and 1 to 2 oktas of cloud at 4,000 ft and 3 to 4 oktas at 8,000 ft. The TTF also indicated that between 1900 and 2000, for periods of less than 30 minutes, it was expected that there would be thunderstorms with rain, visibility reduced to 4,000 m, 3 to 4 oktas of cloud at 3,000 ft, and 3 to 4 oktas of cumulonimbus cloud at 6,000 ft.

A SPECI was issued for Sydney aerodrome at 1919. It reported the following conditions:

- Wind: 200 degrees T at 15 kts
- Cloud: 1 okta of cumulus at 2,500 ft, 6 oktas of altocumulus at 12,000 ft
- Weather: showers in the vicinity of the aerodrome
- Remarks: lightning to the south-east of the aerodrome.

The associated TTF indicated that from 2000, the wind was expected to change to 020 degrees T at 15 kts, with light showers of rain, and 1 to 2 oktas of cloud at 4,000 ft and 3 to 4 oktas at 8,000 ft. The TTF also indicated that between 1919 and 2000, for periods of less than 30 minutes, it was expected that there would be thunderstorms with rain, visibility reduced to 4,000 m, 3 to 4 oktas of cloud at 3,000 ft, and 3 to 4 oktas of cumulonimbus cloud at 6,000 ft.

A subsequent SPECI was issued for Sydney aerodrome at 1924. It reported the following conditions:

- Wind: 130 degrees T at 7 kts
- Cloud: 1 okta of stratus at 1,800 ft, 6 oktas of altocumulus at 12,000 ft, and 1 okta of cumulonimbus at 5,000 ft
- Weather: light thunderstorms with rain
- Remarks: thunderstorms 3 NM to the south moving east-north-east at 15 kts.

The associated TTF indicated that the wind from 2000 was expected to change to 020 degrees T at 15 kts, with light showers of rain, and 1 to 2 oktas of cloud at 4,000 ft and 3 to 4 oktas at 8,000 ft. The TTF also indicated that between 1924 and 2000, for periods of less than 30 minutes, it was expected that there would be thunderstorms with rain, visibility reduced to 4,000 m, 3 to 4 oktas of cloud at 3,000 ft, and 3 to 4 oktas of cumulonimbus cloud at 6,000 ft.

Automatic Terminal Information Service

The Sydney Automatic Terminal Information Service (ATIS) provided a continuous and repetitive broadcast of pre-recorded information about operational and weather conditions. It included an identifying phonetic letter which was changed to the next letter whenever ATIS information was amended.

At the time that the aircraft commenced descent to Sydney, ATIS Papa was current. It was issued at 1837 and reported the following information:

- Runways: 34L and 34R
- Wind: 030 degrees M at 15 kts with a crosswind of 12 kts
- Visibility: greater than 10 km
- Weather: showers in the area
- Cloud: 1 to 2 oktas at 4000 ft.

ATIS Quebec was issued at 1908 and was the same as ATIS Papa other than a change in the QNH. ATIS Quebec also included a report from the crew of another aircraft who had advised that they had encountered moderate overshoot windshear at 1,000 ft on final. This report was from the crew of an aircraft using runway 34, but this was not specifically mentioned in the ATIS.

ATIS Romeo was issued at 1913 and reported the following information:

- Runways: 16R and 16L
- Wind: 190 degrees M at 10 to 20 kts
- Visibility: greater than 10 km
- Weather: showers in the area
- Cloud: 1 to 2 oktas at 4000 ft.

ATIS Sierra was issued at 1918 and was the same as ATIS Romeo, with the addition of advice that there were cumulonimbus clouds in the area, and that pilots should expect windshear below 3,000 ft.

ATIS Tango was issued at 1929, after the aircraft had gone around. The runways in use were changed to 34L and 34R, and the wind was reported as variable[5] at 10 kts, with a maximum downwind component of 5 kts.

Threshold anemometer and Doppler radar information

An anemometer was installed near each runway threshold at Sydney Airport. Wind speed and direction information from these anemometers was available to the ADC.

The Bureau of Meteorology (BoM) conducted an initial review of the Doppler radar and threshold anemometer wind data relevant to the occurrence. Doppler radar data was recorded on the hour and every 5 minutes thereafter. Threshold anemometer data was recorded every 10 seconds and provided a 10-second average of the wind

5 A variable wind direction was used when the wind was light (3 kts or less) or when the wind was veering or backing by 180 degrees or more due to, for example, the passage of thunderstorms or localised wind effects.

at each location. Additional wind data was obtained from the Kurnell Automatic Weather Station, located on a shipping wharf in the south-east of Botany Bay.

Figures 2 to 10 show the Doppler radar data at 1920 and 1925, and selected anemometer data for the relevant period (wind speed and direction is indicated by the length and orientation of the arrows respectively. The numerical value is wind speed in kts).

Figure 2: Doppler radar and threshold winds at 1920:01

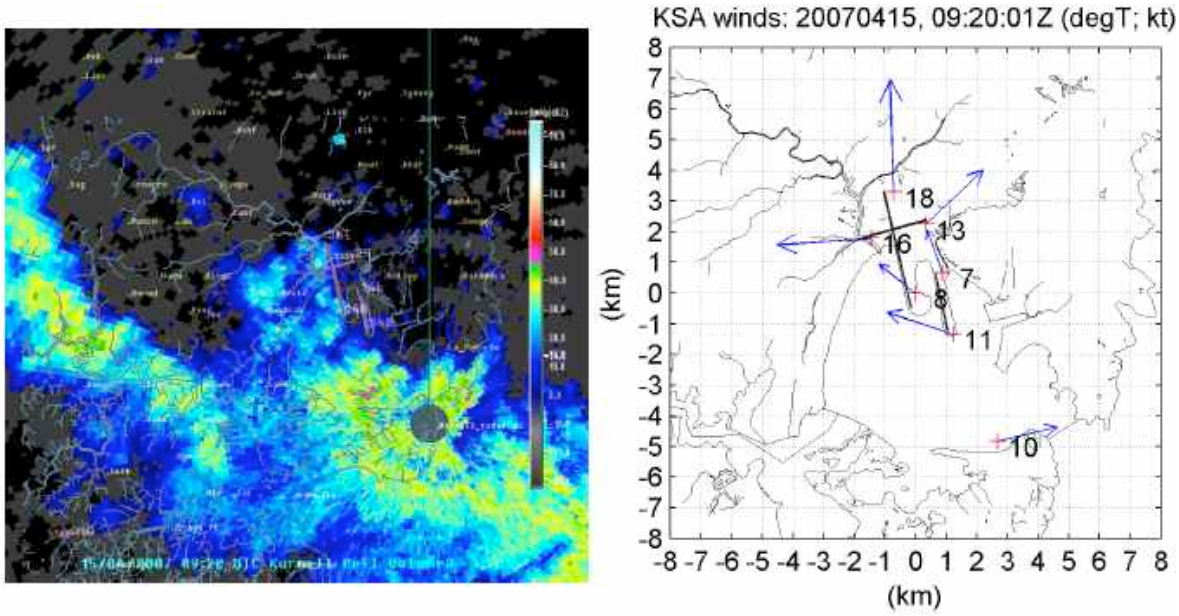


Figure 3: Threshold winds at 1921:01

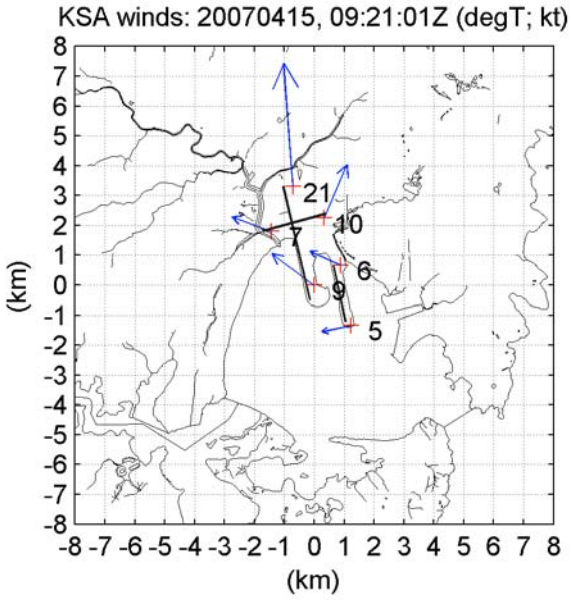


Figure 4: Threshold winds at 1921:31

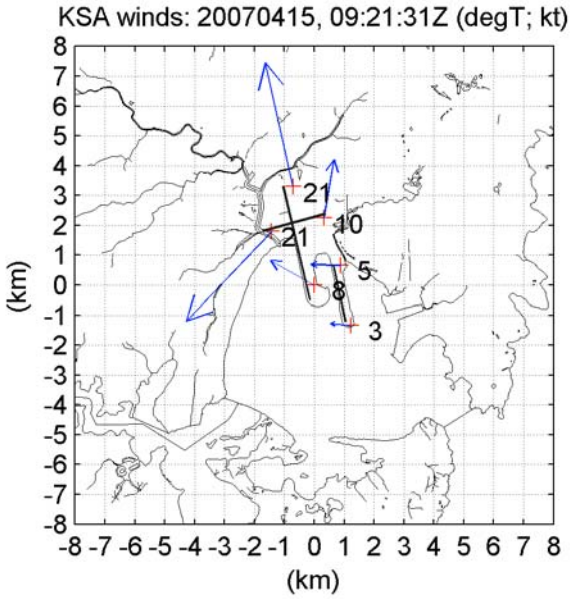


Figure 5: Threshold winds at 1922:01

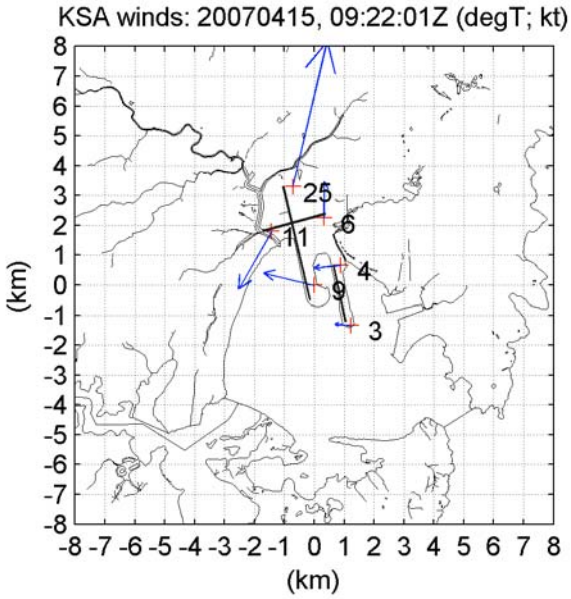


Figure 6: Threshold winds at 1922:31

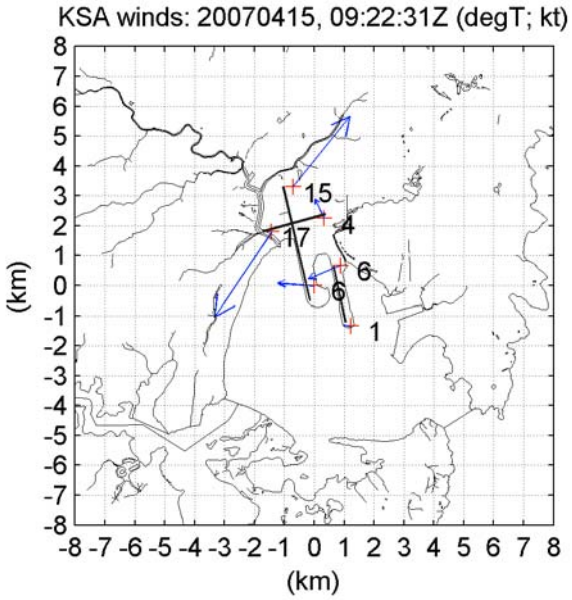


Figure 7: Threshold winds at 1923:01

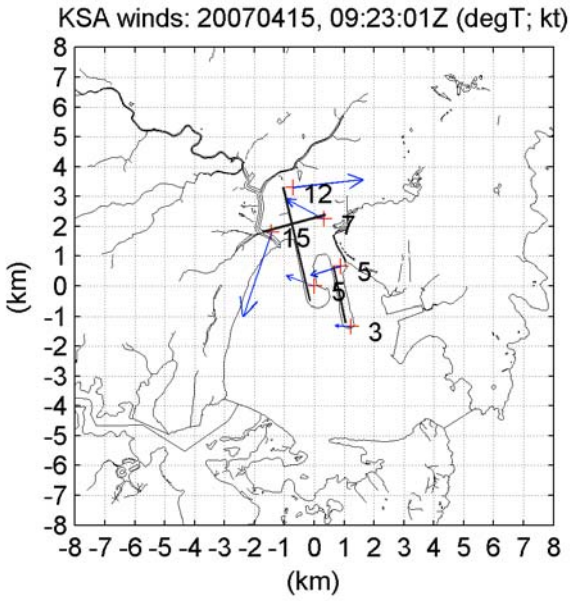


Figure 8: Threshold winds at 1923:11

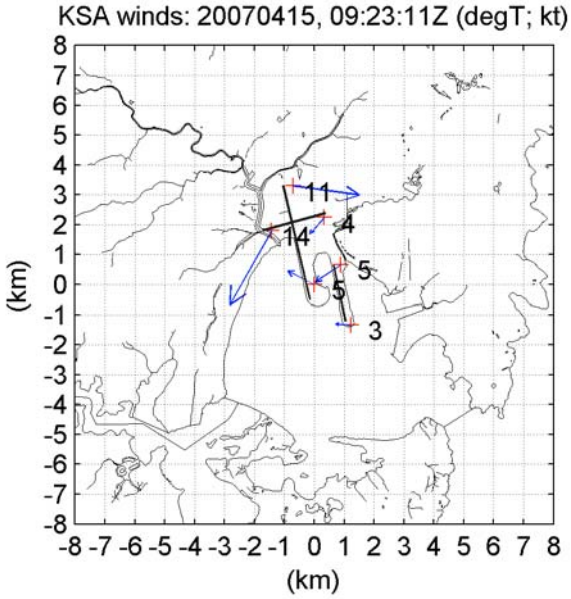


Figure 9: Threshold winds at 1923:21

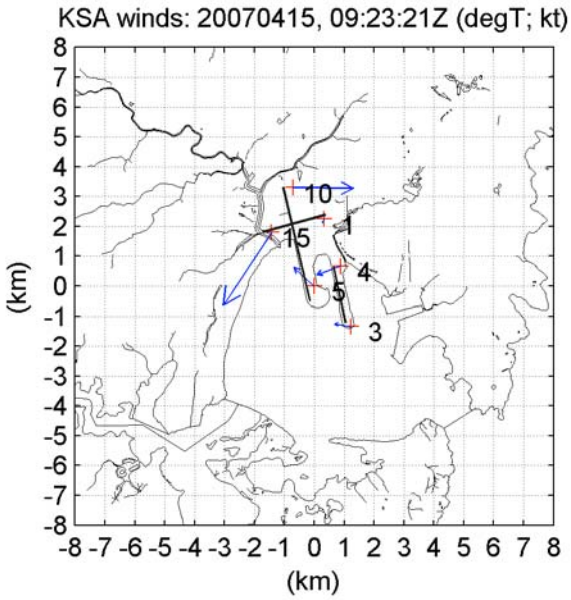
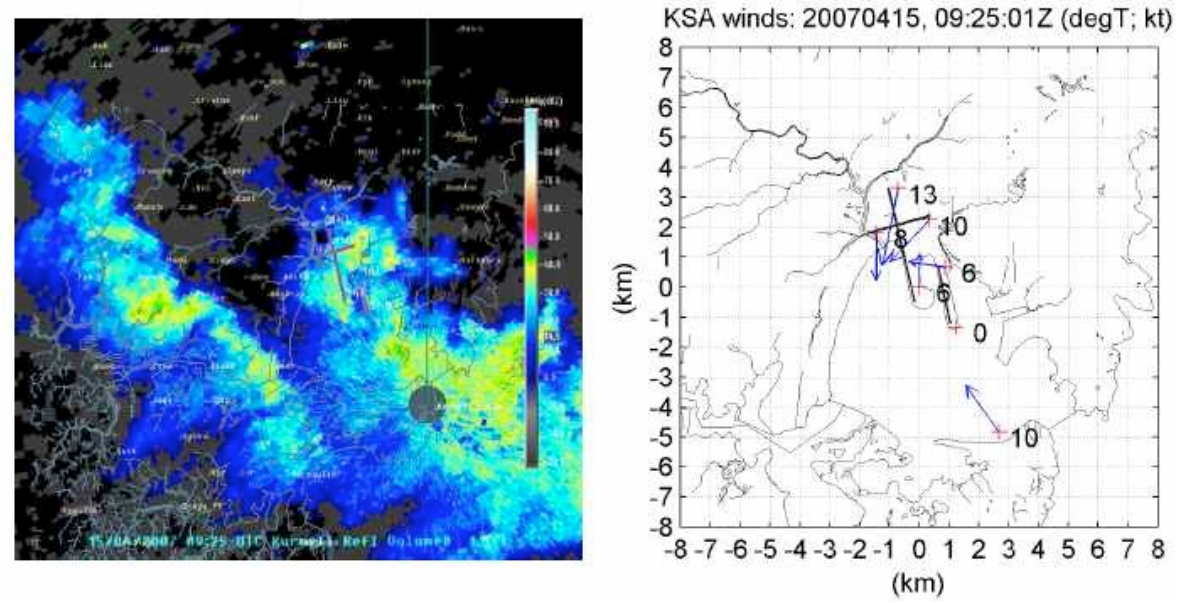


Figure 10: Doppler radar and threshold winds at 1925:01



The BoM reported that during the period 1900 to 2000, a line of showers and thunderstorms moved across the aerodrome from the south-west at 22 kts. These showers and thunderstorms had a cloud base of around 12,000 ft, and there was only light intermittent precipitation, and no reduction in visibility.

At 1920, the leading edge of the line of showers and storms was over the aerodrome, and the anemometer data showed an intensifying divergent flow over the threshold of runway 16R, which was associated with a developing microburst.

The microburst over the threshold of runway 16R was most intense between 1921:31 and 1922:01.

At 1923:01, the wind at the threshold had changed to a westerly at 12 kts, suggesting that the microburst had moved to the west of the runway 16R threshold.

Low Level Windshear Alert System

Low level windshear alert systems (LLWAS) were ground-based systems which automatically detect windshear associated with gust fronts and microbursts. There were no operational LLWAS in Australia. However there was an experimental system located at Darwin Airport.

Aircraft information

The Boeing Company 747-438 was a large passenger aircraft fitted with four turbofan engines and equipped to operate in virtually all weather conditions.

The EGPWS fitted to the aircraft included a reactive windshear warning system. It was this windshear warning system which issued the windshear warning just after touchdown. The EGPWS manufacturer reviewed the data recorded by the unit and concluded that the windshear warning was triggered by a large horizontal

windshear, and that there was very little vertical windshear (downdraft) present. The aircraft's true airspeed decreased from 163 kts to 135 kts over a period of 7 seconds, commencing when the aircraft was at a radio altitude of 111 ft, about 8 seconds prior to touchdown.

The aircraft was also fitted with a weather radar system. Some 747 aircraft in the operator's fleet were equipped with a weather radar-based predictive windshear warning system. The occurrence aircraft was not equipped with this system.

Investigation continuing

The investigation is continuing and will include:

- further examination of recorded information
- further assessment of forecast and actual weather conditions
- assessment of aircraft- and ground-based windshear alerting systems
- a review of the information available to, obtained by, and provided to, the flight crew
- a review of flight crew training relating to windshear
- an analysis of operator and crew procedures for potential or actual encounters with windshear.

ATTACHMENT 1

Figure 11: Preliminary QAR data plot (larger scale of Figure 1)