ANZSASI SEMINAR 2000
Christchurch, New Zealand

B747 VH-EBS – Podstrike
Perth 2 September 1999

Phil Robertson/Barry Sargeant

FACTUAL INFORMATION

History of the Flight

On arrival at Perth, the crew of a Boeing 747-238B, VH-EBS, were cleared to conduct an instrument approach for landing on runway 03. The pilot in command was the handling pilot for the sector, and the crew subsequently reported that although they were in visual meteorological conditions during the approach, turbulence was encountered. Information "Whisky" was being broadcast on the automatic terminal information service (ATIS), and provided information to the crew that the wind speed and direction at the aerodrome was 330 degrees magnetic at 20 knots. The ATIS included information that the wind speed and direction at 200 ft above ground level was 330 degrees magnetic at 30 knots, and advised crews to expect moderate turbulence below 4,000 ft.

During the approach the co-pilot requested a wind check from the aerodrome controller. The controller advised the crew that the runway 03 threshold wind was 300 degrees at 12 kts, giving a crosswind of 12 kts. The controller requested the crew to advise the spot wind at 1,000 ft, and the co-pilot reported that the 1,000 ft spot wind was 280 degrees at 35 kts.

On short final, at approximately 500 ft above ground level, the pilot in command discontinued the approach when the aircraft experienced turbulence rendering the approach unstable. The co-pilot notified air traffic control (ATC) that EBS was conducting a missed approach, and the controller issued an instruction to the crew to climb to 1,500 ft. The controller then issued further instructions for EBS to climb to 3,000 ft and instructed the crew to take up an easterly heading to intercept the 9 mile arc, from the Perth distance measuring equipment beacon, to position the aircraft for another approach onto runway 03.

As EBS proceeded towards the south to intercept the 9 mile arc for the second approach to runway 03, the controller reassessed the prevailing wind conditions. The wind had been steadily backing to a more southerly direction, and the controller considered that the wind had begun to favour operations on runway 24. The controller notified the crew of EBS that runway 24 was available for landing, and the crew advised that they would accept an approach for that runway. The controller then issued radar vectors to the crew to position EBS onto the approach for runway 24. As EBS was on final approach the controller advised the crew that the threshold wind for runway 24 was 290 degrees at 23 kts, and that the wind at 200 ft was 290 degrees at 35 kts.

The crew reported that the approach to runway 24 was conducted normally and with the autopilot engaged. However, turbulence had prevailed throughout the approach. Flaps 30 was the landing flap setting, and as the aircraft flared for touchdown it suddenly experienced an unexpected roll to the right and the pilot in command applied a control wheel input to the left to counter the roll. The aircraft then suddenly experienced a severe roll to the left. Although the pilot in command applied an immediate control wheel input to the right to arrest the roll, the aircraft touched down in a left wing down attitude, and the number 1 engine pod briefly struck the runway surface.

The crew reported that the touchdown was smooth, and appeared to be on the centreline of runway 24. They also reported being unaware that the number 1 engine pod had struck the ground during the touchdown. As the aircraft taxied in to the international apron a flight attendant advised the crew that a passenger had reported seeing brown fluid leaking from the number 1 engine. After the aircraft had parked the number 1 engine was inspected for damage. The casing of the high speed external gearbox fitted to the engine was fractured adjacent to the gearbox mount position, and the number 1 engine thrust reverser was damaged. The pilot in command then notified the controller that EBS had sustained a podstrike during the landing on runway 24.

The subsequent inspection of runway 24 revealed a scrape mark on the runway approximately 490 metres from the threshold of runway 24. The scrape mark was approximately 30 metres in length and was located approximately 18 metres left of the runway centreline just outside the outer edge of the runway touchdown zone markings. Examination of the manufacturer's data for the B747-200 series showed engine number 1 to be 21.2 metres outboard from the aircraft centreline. This was consistent with position of the scrape mark on runway 24.

Flight Data

Air traffic control radar plots and the flight path derived from EBS's flight data recorder (FDR) were examined during the investigation. They revealed that the pilot in command discontinued the first approach onto runway 03 at 04:07 co-ordinated universal time when EBS was at approximately 500 ft above ground level. Following the discontinued approach onto runway 03, EBS was vectored to the southeast of the airport, then back towards the northeast when ATC reconfigured the terminal airspace for operations onto runway 24. EBS commenced the approach onto runway 24 at 04:23, and the approach concluded at 04:28 when the aircraft landed.

The FDR roll angle plot revealed that as EBS was 35 ft above ground level it commenced an uncommanded roll to the right. The pilot in command immediately applied 29.5 degrees of left control wheel to counteract the roll. However, the roll continued to increase, and EBS was in an 8.0 degrees right wing down attitude as it reached 2 ft above ground level. The roll then suddenly reversed, and within 2 seconds EBS was in an 8.4 degrees left wing down attitude. Although the pilot in command immediately responded with 40.7 degrees of right control wheel to counteract the roll, the aircraft touched down still in an 8.4 degrees left wing down attitude.

Groundspeed was not a recorded parameter on the Lockheed LAS209F FDR that was fitted to EBS, and the investigation was therefore unable to determine the actual wind conditions that it encountered throughout the approach. However, variations in the FDR computed airspeed plot throughout the occurrence sequence were consistent with the reported turbulent conditions.

Aircraft Data

Roll control of the Boeing 747 aircraft is provided by inboard and outboard ailerons and spoilers. The manufacturer advised that a control wheel deflection of 40.7 degrees to roll the aircraft to the right would result in outboard aileron deflections of left outboard +13.8 degrees and right outboard -22.2 degrees. The maximum outboard aileron deflection is +15 and -25 degrees, with +ve signifying trailing edge down and -ve signifying trailing edge up. With the same control wheel deflection of 40.7 degrees to roll the aircraft to the right, the resultant inboard aileron deflections would be left inboard +18.2 degrees and right inboard -17.9 degrees. Normally the maximum inboard aileron deflection is +/- 20 degrees.

The spoilers consist of 12 panels on both wings starting with no 1 on the left outboard wing and extending to no 12 on the right outboard wing. For a control wheel deflection of 40.7 degrees to roll the aircraft to the right, spoilers 1-7 would be deflected 0 degrees (faired with wing), spoiler 8 would be deflected 9.7 degrees, and spoilers 9-12 would be deflected 15.3 degrees. Aileron and spoiler deflection would be reversed for a control wheel deflection of 40.7 degrees to roll the aircraft to the left.

Data for Boeing 747-200 series aircraft fitted with Rolls Royce RB211-524 engines showed that the ground clearance of the number one engine pod was 188 cm at an operating empty weight of 164,610 kgs. This clearance was reduced to 158 cm when the aircraft was at its maximum taxi weight of 352,894 kgs. The plan view of the Boeing 747-200 series aircraft showed the number 1 engine to be 21.2 metres outboard of the aircraft centreline, and 15.2 metres outboard of the outboard wheel of the wing landing gear assembly. Under static conditions and with 0 degrees nose pitch, a body roll of 7.05 degrees at the operating empty weight would cause the number one engine pod to contact the ground. A body roll of 5.93 degrees at the maximum taxi weight would also result in ground contact of the number one engine pod.

The weight of EBS at the time of the occurrence was approximately 230,000 kgs.

Meteorological Information

At the time of the occurrence, Perth was under the influence of an unstable air flow as a result of a complex low pressure system situated to the south of Western Australia. A series of fast moving cold fronts were embedded in the strong to gale force westerly airstream, and the unstable atmosphere resulted in widespread rain showers, squalls and occasional thunderstorm activity.

The trend type forecasts (TTF's) for Perth from 00:33 leading up to the time of the occurrence indicated that gusty wind conditions could be expected in the terminal area. Additionally, the TTF's from 01:31 indicated that thunderstorms were also likely to be present in the area. The aerodrome forecast current for Perth at the time of the occurrence also indicated the likely presence of gusty conditions and rain showers. At 01:00 an airport warning was issued for Perth containing information that a series of squall lines were expected to cause wind gusts to 45 knots during the day, and that thunderstorms were predicted. At 01:13 information concerning en route weather phenomenon with the potential to affect the safety of aircraft operations (SIGMET) was issued. The SIGMET, valid from 02:00 until 08:00, forecast the presence of severe turbulence below 4,000 ft for the Perth region, and was passed to the operator by the Bureau of Meteorology.

The Perth aerodrome ATIS was changed to information "Whiskey" at 03:03. It provided information that the wind speed and direction was 330 degrees magnetic at 20 kts, and warned pilots to expect moderate turbulence below 4,000 ft. A windshear alert was also provided, with the wind speed and direction at 200 ft being 330 degrees magnetic at 30 kts. The windshear alert was included on the ATIS because there was a 10 kts difference between the wind speed on the ground and the wind speed at 200 ft. The ATIS was amended to information "X-Ray" at 04:27, providing information that the wind speed and direction were 290 degrees magnetic at 25 kts. The revised ATIS continued to provide a warning of moderate turbulence below 4,000 ft and also a windshear alert.

Wind shear is defined as a sudden change in wind direction and/or speed with height or horizontal distance. In most cases wind shear does not present a hazard to aircraft and the majority of pilots will be familiar with changes in wind direction and speed as they ascend or descend. However, at low altitudes (below 1000 ft) during critical stages of landing and takeoff, wind shear can present a significant hazard to aircraft because there is a limited ability to undertake a recovery manoeuvre if the aircraft configuration changes. Low altitude windshear events are small scale and short lived and only affect the approach / departure flight path for a short period of time. The ability to identify such events based on traditional airport observations is limited, although systems which can detect wind shear and provide alerts in a timely manner are available.

The Bureau of Meteorology anemometer at Perth airport was the source of wind data transmitted on the ATIS. The anemometer sampled the wind at 1-second intervals, and a display of the anemometer wind data was located in the control tower. Controllers were able to select the display for instantaneous, 2-minute average wind speed and direction, or 10-minute peak wind speed. Data from the Bureau of Meteorology anemometer was recorded and archived. The control tower also had displays of threshold wind data obtained from anemometers located adjacent to the threshold of each runway. A display also provided wind data from an anemometer located on the control tower cabin. The controllers could select the threshold anemometer and tower cab displays to provide instantaneous, 2-minute average wind speed and direction, or 10-minute peak wind speed. The controllers reported that their usual practice was to leave the tower cab displays selected to the instantaneous setting, with selection to the 2-minute average wind speed and direction or the 10-minute peak wind speed settings being made to determine the development of any significant trends. Data from the threshold and tower cab anemometers was not recorded and archived.

Radar imagery taken at 20 minute intervals during the occurrence period showed a significant line of enhanced rain echoes passing through Perth at 03:20 in a generally easterly direction at approximately 35 to 40 kts. Scattered convective showers were present behind the line of precipitation, with rain echoes being randomly spaced and largely unorganised. The radar imagery also revealed showers in the vicinity of Perth aerodrome at the time of the occurrence.

The 1-minute data recorded by the Bureau of Meterorology anemometer at Perth aerodrome showed that a fast moving front passed across Perth aerodrome at 04:12, shortly after the pilot in command discontinued EBS's approach onto runway 03. The front was associated with a change in wind direction and a significant increase in windspeed for a period of approximately 3 minutes. At 04:26 the 1-minute anemometer data revealed a marked increase in wind speed which persisted until approximately 04:30. The wind speeds increased to 23 - 25 kts during this period, with maximum wind speeds being recorded at 27 - 35 kt. At 04:28, the time of the occurrence, the maximum wind speed was approximately 29 kts. However, during the period 04:26 to 04:30 there was little variation in the recorded wind direction, and it remained relatively constant from the west. The duration of the increase in wind speed was considered characteristic of an outflow from a convective rainshower.

ANALYSIS

At the time of the occurrence the environmental wind was strong, and the investigation concluded that it was likely that the downdrafts and associated surface outflows from the entrained convective activity were distorted in the direction of the prevailing airstream, and that this accounted for the gusting conditions that were present at the time of the occurrence.

The flight data recorder fitted to EBS was not equipped to record the aircraft's groundspeed, and the investigation was unable to determine the actual external winds that affected it during the approach and landing. However, from the meteorological data that was available, it was probable that the roll rate encountered by EBS as it commenced the landing flare resulted from an encounter with low-level windshear. It is likely that this was produced by a downdraft from one of the convective storm cells passing through the terminal area at the time.

Although the pilot in command responded in a timely manner with appropriate control input, under the dynamic conditions that were encountered, it is unlikely there was sufficient available aileron/spoiler authority to counteract the high rate of roll that had suddenly been experienced. This resulted in the number 1 engine pod momentarily striking the ground as the aircraft touched down.

Low-level windshear may occur as a result of thunderstorms, land/sea breezes, low-level jet streams, mountain waves and frontal systems. There have been accidents and incidents associated with low-level wind shear in Australia. Pilots should be aware that it is a phenomena that may occur at any location, is difficult to predict, and can present a hazard to aircraft on approach and departure.

SAFETY RESEARCH ACTION

The Bureau is examining the feasibility of a study into the phenomena of low-level windshear to be undertaken by a suitable research institution and involving the Bureau of Meteorology, AirServices Australia, Civil Aviation Safety Authority, Australian Transport Safety Bureau and industry.