# Aviation Safety Investigation Report 199602144

## Boeing Co
## B747-238B

## 06 July 1996

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**NOTE: All air safety occurrences reported to the ATSB are categorised and recorded. For a detailed explanation on Category definitions please refer to the ATSB website at www.atsb.gov.au.**

# Aviation Safety Investigation Report

# 199602144

The Bureau did not conduct an on scene investigation of this occurrence. The information presented below was obtained from information supplied to the Bureau.

**Occurrence Number:** 199602144 **Occurrence Type:** Accident
**Location:** Vasko, (IFR)
**State:** Other **Inv Category:** 3
**Date:** Saturday 06 July 1996
**Time:** 2115 hours **Time Zone** EST
**Highest Injury Level:** Serious
**Injuries:**

| | Fatal | Serious | Minor | None | Total |
|---|---|---|---|---|---|
| Crew | 0 | 1 | 5 | 11 | 17 |
| Ground | 0 | 0 | 0 | 0 | 0 |
| Passenger | 0 | 2 | 22 | 216 | 240 |
| **Total** | **0** | **3** | **27** | **227** | **257** |

**Aircraft Manufacturer:** Boeing Co
**Aircraft Model:** 747-238B
**Aircraft Registration:** VH-ECB **Serial Number:** 21977
**Type of Operation:** Air Transport High Capacity International Passenger Scheduled
**Damage to Aircraft:** Nil
**Departure Point:** Cairns Qld
**Departure Time:**
**Destination:** Narita Japan

**Approved for Release:** Wednesday, September 3, 1997

FACTUAL INFORMATION

History of the flight

The Boeing 747 aircraft was operating from Cairns to Narita, cruising at flight level (FL)310. The flight is normally a daylight service but because the departure was delayed for 3 hours, the latter part of the flight, including this incident, was in darkness. Shortly after the aircraft passed Vasko, a position reporting point located at 25 degrees N and 142 degrees 02 minutes E, it encountered severe turbulence which lasted for a period of approximately 12 seconds. The encounter resulted in injuries to some unrestrained passengers and cabin crew and disruption of the rear cabin due to unsecured meal trolleys. The encounter occurred approximately 650 miles south of the destination. The pilot in command was in the crew rest section of the aircraft and the co-pilot was the pilot on watch, supported by the third pilot and flight engineer.

The co-pilot said that the first indication he noted was when the aircraft pitched up and climbed about 300 ft. He immediately switched the seat belt signs on and the flight engineer switched on the ignition and nacelle anti-ice. The aircraft then encountered the turbulence which the crew thought lasted for about 5 seconds. The autopilot remained engaged throughout the encounter. After the encounter, the co-pilot was informed by a cabin crew member of the situation in the rear cabin. As there were no radar returns in the immediate vicinity of the aircraft that may have indicated the possibility of further turbulence, the co-pilot turned off the seat belt signs and the pilot in command returned to the flight deck.

Approximately 20 minutes before the occurrence, at the direction of air traffic control, the aircraft descended from FL350 to FL310 for traffic separation. The co-pilot said that at that level the aircraft was in and out of cloud but there were no radar returns indicating any weather on the aircraft's track. The consensus of opinion from the crew was that the aircraft was in clear air at the time of the encounter and that there was a complete overcast about 500 ft above their cruising level. However, a few minutes before the encounter, there were returns indicating isolated buildups approximately 40 NM ahead and 15 NM to the right of track.

The co-pilot believed the wind velocity at FL310 at the time of the occurrence was north-westerly at 4-10 kts. This was consistent with the forecast wind velocity. After the encounter, the aircraft continued to its destination where the more seriously injured passengers and crew received medical attention.

Injuries to persons

At the time of the encounter, the cabin staff were just commencing a meal service. Injuries were sustained by six cabin staff and 24 passengers, most of whom did not have their seat belts fastened. The severity of the encounter was such that some passengers, cabin crew and meal trolleys hit the cabin ceiling and then landed heavily back on the floor. This resulted in some serious injuries being sustained, including bone fractures, lacerations, neck and back strains, a dislocated shoulder and shattered teeth. On arrival at the destination, three passengers and one flight attendant were admitted to hospital.

Damage to aircraft

A severe turbulence conditional check, completed in accordance with the maintenance manual, revealed no structural damage was sustained by the aircraft. There was minor superficial damage to the cabin interior including three damaged passenger service units, three damaged oxygen masks and damaged meal trolleys. The aircraft was returned to Sydney the following day where it was subjected to further inspection and minor maintenance, and then returned to service.

Meteorological information

Flying conditions both before and after the encounter were smooth. Examination of Bureau of Meteorology satellite imagery indicated there was a typhoon (Tropical Storm Dan) centred to the east of the aircraft's track. The aircraft traversed the western flank of that system and encountered an isolated area of vertical development that was not showing on aircraft radar. Information on the storm was included in the pre-flight meteorological briefing material received by the crew.

An analysis of the encounter was completed by the Bureau of Meteorology Research Centre (BMRC). A report of their investigation was published as BMRC Research Report No 58. In summary, the BMRC report concludes that the incident was associated with a developing squall line within an outer spiral band or "feeder band" of a developing typhoon. Rather than being "clear air turbulence" as such, the incident is categorised as turbulence near thunderstorm tops (TNTT). The report goes on to say that based on current knowledge and operational procedures, meteorologists cannot predict the specific location for this type of turbulence.

However, from present knowledge of tropical convection, it seems likely that typhoon or tropical storm outer spiral bands would be a preferred location for such turbulence. Such bands are evident on satellite imagery but are not detectable on current aircraft radar systems. The squall line being in a stage of rapid development was probably a contributing factor in this case, as likely locations for such rapid development of turbulence are the intersections of cloud arcs with squall lines.

Flight recorders

The aircraft was equipped with a Lockheed 209E digital flight data recorder (DFDR). The recorded data showed that the aircraft left FL350 on descent to FL310 at 1045 UTC. At 1104 UTC, vertical acceleration values of +1.58g and -0.43g were recorded. Pressure altitude variations during this period were +400 ft to -100 ft from the cruising level. At the time of the encounter, the aircraft was cruising at Mach 0.84 with the B autopilot engaged in the command mode. The duration of the encounter was approximately 12 seconds with smooth flight conditions prevailing for several minutes both before and after the event.

ANALYSIS

The turbulence encounter

Because the type of turbulence encounter was one not detectable by aircraft equipment, the crew had no warning of the impending encounter and were therefore unable to take any avoiding action.

Injuries

The injuries occurred because there was no warning of the turbulence and hence no specific measures had been taken to protect against it. The activation of the seat belt signs, albeit as soon as there was evidence of unusual aircraft behaviour, came too late to allow passengers and crew time to fasten their seat belts.

## SIGNIFICANT FACTORS

1. The aircraft was experiencing smooth flying conditions and there was no indication of an impending severe turbulence encounter.

2. There had been no preparation in the cabin for a severe turbulence encounter.

3. The turbulence encountered (TNTT) was of a type that was not detectable on aircraft radar systems and could only be identified on satellite imagery.

## SAFETY ACTION

Safety action by the operator

As a result of this investigation, the operator's safety department made a number of recommendations.

1. Medical matters

Three recommendations made in respect of medical equipment and procedures. When cabin staff were trying to assist injured passengers, they encountered some difficulties locating appropriate medical supplies and opening first aid kits. In addition, the operator's investigation revealed that some crew were not aware that a company duty doctor was available at all times to provide advice to the crews of aircraft in flight. Company safety department recommendations in respect of these matters were:

i. [The company's] Medical Department should ensure the first aid kits are easy to open. The tape should have a tab on it so it can be opened easily.

ii. The medical amenities should be easy to locate. The drawer that contains such items should be placarded.

iii. Crew should be made aware that a [company] duty doctor is available at all time to help them and to provide any advice whilst they are in flight.

2. Technical matters

During this investigation it was noted that the cabin floor was not fitted with "mushroom" devices which are used to secure the meal trolleys to the floor when meals and/or refreshments are being served. When the aircraft encountered the turbulence, some unsecured trolleys hit the roof. In such circumstances the trolleys become a potential source of injury. Some [company] aircraft did have these fittings but they were removed some time previously. In this particular incident, "mushroom" devices would not have prevented the trolleys lifting off the floor because they were being moved at the time of the occurrence.

The [company's] Safety Department recommended that the Engineering and Maintenance Department provide a costing for fitting the entire fleet with cabin floor mushrooms. Upon receipt of that information the company will carry out an analysis on the feasibility of retrofitting this equipment.

The operator's report also recommended that the Safety and Flight Operations Departments form a Turbulence Committee to:

i. review past occurrences and data,

ii. assist internal customers with implementing emergency plans, and

iii.review reporting procedures to ensure all injuries are reported via air safety incident reports so as to allow correlation with workers compensation and human resources records.

Safety action by the Bureau of Meteorology Research Centre (BMRC)

The BMRC Research Report No. 58 suggested that the BMRC take the following steps to improve its understanding of gravity-wave type turbulence associated with tropical convection:

(i) develop an infrastructure to collect and process both meteorological and flight recorder data for all turbulence incidents on air routes used by international regular public transport operators servicing Australia. This would facilitate statistical analyses of frequency and location of incidents and case studies to identify key large-scale conditions leading to severe turbulence;

(ii) initiate correspondence with several international research institutions (with expertise in aviation meterology, tropical convection, typhoons and diagnosis of clear air turbulence operational numerical models) with which the BMRC has long-term working relationships, as part of further investigation of the incident;

(iii) present a report on the meteorological conditions leading to the incident to the American Meteorological Conference on Aviation, Range and Aerospace Technology;

(iv) improve BMRC staff knowledge of flight instrumentation and data recorders, through interaction with aircraft operators and overseas meteorologists and engineers who work with these data; and

(v) investigate the development of numerical algorithms to diagnose the conditions conducive to both spiral band development and upper tropospheric propagation of gravity waves, based upon the current Bureau of Meteorology's operational numerical analysis and prediction models.

Copies of BMRC Research Report No. 58 can be obtained from:

BMRC
GPO Box 1289K
MELBOURNE, Vic. 3001