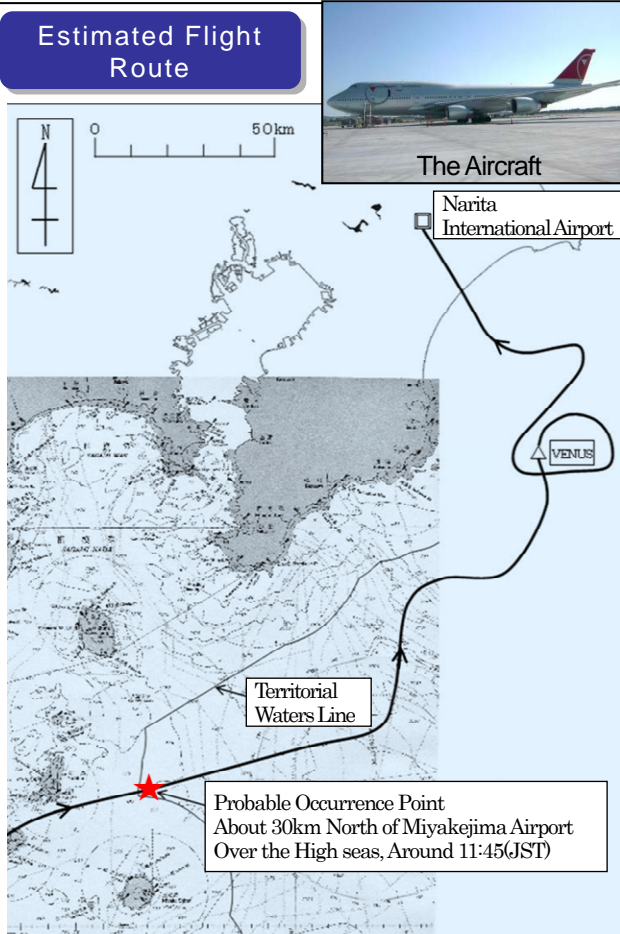


3. Case Studies of accidents

Case 1

Injuries suffered by passengers and cabin attendants from the shaking of the aircraft encountering turbulence during its descent in convective clouds

Summary : On Friday February 20, 2009, a Boeing 747-400, operated by Company A, took off from Manila (Ninoy Aquino) International Airport (Republic of the Philippines) bound for Narita International Airport (Japan) as the company's scheduled Flight. Around 11:45 Japan Standard Time (JST: UTC+9hr, unless otherwise stated, all times are indicated in JST on a 24-hour clock), the aircraft was hit by turbulence when it was flying at an altitude of about 30,300 ft about 174 km south-southwest of Narita International Airport (about 30 km north of Miyakejima Airport). Four passengers sustained serious injuries while 27 other passengers and seven flight attendants (FA) sustained minor injuries. There were 422 people on board, consisting of the pilot in command (PIC), 13 other crewmembers and 408 passengers. The aircraft interior was partially damaged.



Events leading to the Accident

Around 08:47

The aircraft departed from Manila International Airport bound for Narita International Airport as the company's scheduled flight.

Around 11:30

The aircraft was instructed by the Tokyo Area Control Center (hereinafter "Tokyo Control") to descend from 37,000ft to 35,000ft, and the aircraft requested Tokyo Control to change its heading from 055° to 040° to avoid cumulonimbi.

Around 11:42

While descending from an altitude of approximately 34,000ft, the aircraft changed its heading to 080° based on instructions from Tokyo Control, and the aircraft began to jolt.

Around 11:44

The wind velocity began to change and dropped to approximately 100kt from approximately 150kt when the aircraft was descending by approximately 500ft from an altitude of approximately 30,700ft. At around that time, the bumpiness became intensified with altitude fluctuations.

When the Aircraft was descending at an altitude of about 30,300 ft, the vertical acceleration changed: from +1.36G to -0.52G, then to +1.70G. At that time, the pitch angle of the Aircraft decreased by about 0.5 degree in the nose-down direction and after the decrease, quickly increased by about two degrees in the nose-up direction.

Until landing, the vertical acceleration changed intermittently while decreasing, and the aircraft landed at Narita International Airport at around 12:19.

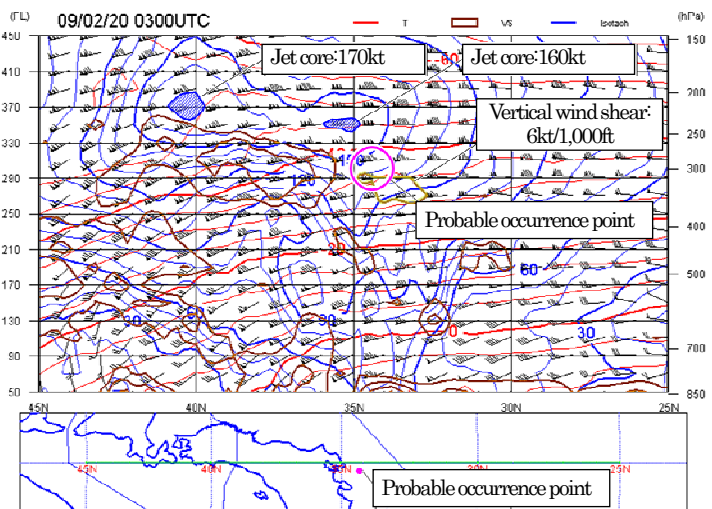
Meteorological Phenomena

Because warm and damp winds were blowing from the south into the low pressure near the Tokai region, generating unstable atmospheric condition. As a result, it is considered highly probable that clumpy convective clouds were developing there.

It is highly probable that clumpy convective clouds developed from the waters off the Tokai region to the Kanto region.

A vertical wind shear of 6kt/1,000 ft was observed amid jet stream near Latitude 35° N at an altitude of 26,000 to 30,000 ft. Therefore, it is considered highly probable that turbulent air was generated in the airspace near the place where the accident occurred.

Unit Conversion
1G : 9.807m/s²
1kt : 1.852km/h



Hourly Analysis Chart

1200JST 20 FEB 2009(Longitude 140°E) Some information was overlaid onto the JMA document.

Comparison of Situation in Forward and Aft Cabin Sections

In the briefing conducted at the Aircraft, the PIC briefed the all of FAs about the possible turbulence and requested them to observe the seat belt signs and have all duties finished prior to descent.

Situation in the forward and upper deck cabin sections

While the aircraft has 65 seats, there were 64 passengers 5 FAs responsible for these sections.

Situation in the middle and aft cabin sections

While the aircraft has 338 seats, there were 338 passengers and 6 FAs responsible for these sections.

The seats on the Aircraft were almost fully occupied. Passenger density was higher in the middle and aft cabin sections compared to the forward and upper deck sections. The number of passengers per one FA was about 13 persons in the forward and upper deck sections, while the number was far higher at about 56 seats in the middle and aft cabin sections. It is considered probable that it took longer to finalize post-service duties and confirm the safety of passengers in the middle and aft cabin sections.

The FAs of the forward cabin section took their seats earlier than usual after confirming the safety of the galleys and finishing their duties.

When the seat belt sign was illuminated, FAs in the upper deck confirmed whether the passengers fastened their seat belts and took their own seats with the seat belts fastened.

The aircraft became bumpy soon after the seat belt sign was illuminated. The FAs of the middle and aft cabin sections hurriedly tried to take the nearest jumpseats, they were not able to become seated.

In the middle and aft cabin sections where one FA had to take care of more passengers and more time was necessary for post-service clean-up and safety confirmation, it is considered probable that big bumpiness started before safety was fully confirmed after the lighting up of the seat belt sign.

There was intense shaking, and FAs who happened to be in the aisles were keeping themselves by holding on to the rack, and then crawling to the jumpseats. There were no injured persons in the forward cabin section, nor was there anybody screaming.

In the mid cabin section, some unseated passengers fell on the floor after bumping their heads against the ceiling, and one of them was unable to move.

When the Aircraft dropped violently, nobody was standing in the upper deck, and all were safe.

Some people, including FAs, were thrown upward to the ceiling, and many passengers were injured.

It is considered probable that when big bumpiness occurred, the passengers in the forward and upper deck sections had been seated with their seat belts fastened, while some passengers in the middle and aft cabin sections had left their seats or had not fastened their seat belts, or their seat belts had not been fastened properly.

The Aircraft encountered big bumpiness around 11:44:54, and a vertical acceleration of -0.52G was registered concurrently the pitch angle decreased followed by quick increase. It is considered probable that the aft section of the Aircraft sank suddenly corresponding to this pitch change and as a result it was subjected to a large negative vertical acceleration than in the forward.



Cabin ceiling



Armrest



Lavatory ceiling

It is considered somewhat likely that these factors led to more injuries in the middle and aft cabin sections.

Aircraft bumpiness might be greater in the aft cabin section than in the forward cabin section.

FAs in the aft cabin section are required to keep this in mind when they prepare in-flight service plans and confirm the safety of passengers.

With the PIC's pre-flight briefing all crewmembers had knowledge of anticipated turbulence during the descent. Therefore, like the FAs in the forward and upper deck sections did, it is considered probable that the FAs in other sections of cabin were able to confirm passengers' safety before the Aircraft encountered the turbulence.

Flight of the Aircraft

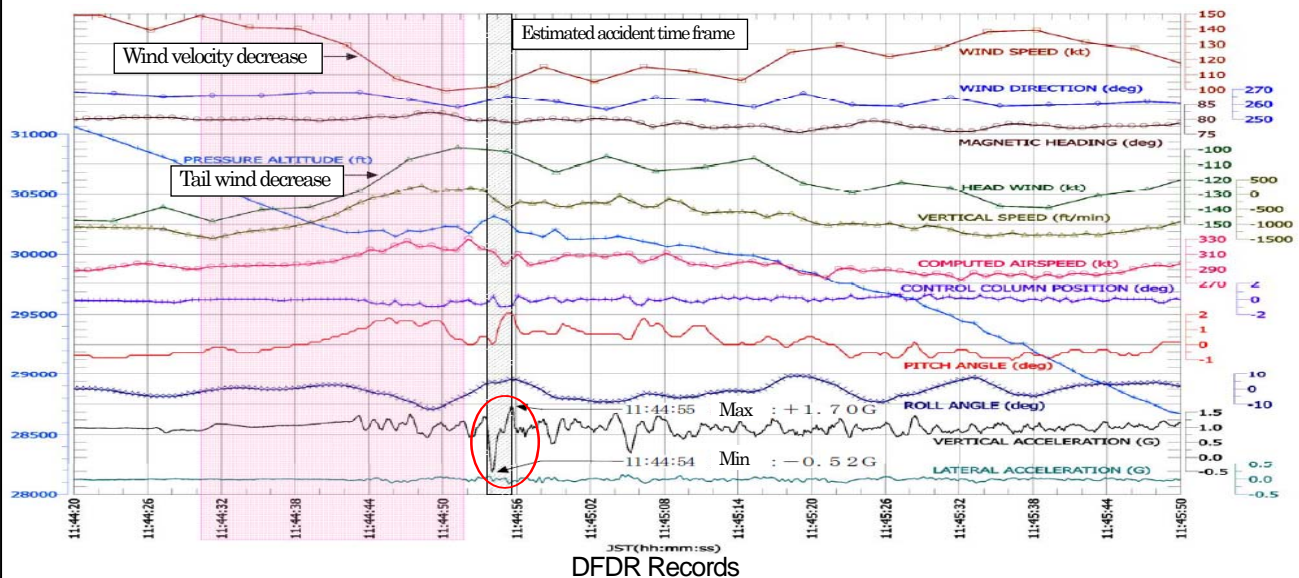
The aircraft requested permission to change its heading when it descended from the cruising altitude of 37,000ft to 35,000ft based on the instruction by Tokyo Control. It is highly probable that this was aimed to avoid cumulonimbi.

The Aircraft was instructed by Tokyo Control to descend to 18,000 and change its heading to 080°. Because clouds were observed in that direction, the Aircraft examined the clouds ahead with its radar, but there was no clear cumulonimbus on the radar screen. Therefore, it is considered highly probable that the Aircraft made a descent through the clouds keeping the direction as instructed.

According to the DFDR record concerning the vertical acceleration which indicates vertical bumpiness of flight, it is considered highly probable that the Aircraft encountered turbulence around 11:44:26 and the bumpiness began bigger from around 11:44:43 with the Aircraft's attitude change and then, reaching its culmination at 11:44:53 to 11:44:55 at an altitude of about 30,300 ft.

It is considered highly probable that this bumpiness resulted from the influence of the turbulence.

The wind velocity was 130 to 140kt in the vicinity of the airspace where the accident occurred. But the wind velocity that the Aircraft actually flew varied by about 50kt from about 150 kt to about 100kt. Therefore, it is considered highly probable that the Aircraft was influenced by the sudden large wind velocity change near the airspace where the accident occurred.



Probable Causes: It is considered highly probable that this accident occurred when the Aircraft pitched greatly upon encountering a turbulence during its descent through a turbulent airspace of convective clouds near the front and below the jet stream, causing serious injuries to four passengers in the aft cabin section: who were not seated; who were not being buckled up; or if done so, who did it in an inappropriate manner.

It is considered somewhat likely that the following factors contributed to the serious injuries of aft cabin passengers: safety of passengers was not fully confirmed in the aft cabin section during the time frame between the seat belt sign illumination and the abrupt big aircraft pitching; and the aft cabin was exposed to a stronger negative vertical acceleration compared to the forward.

In order to Prevent Recurrence

- It is necessary for FAs to have common understanding about the indication of the seat belt sign and to take measures to call passengers' attention to the need of fastening seat belts properly and carefully listening to in-flight announcements.
- When an aircraft is anticipated to encounter turbulence, the cockpit crew should turn on the seat belt sign at the earliest possible time so that FAs may have enough time to finish their duties before the encounter, because a lot of time is necessary for them to provide services to passengers, clean up and confirm the safety of passengers.
- When informed by the PIC of the possible turbulence and the need to be seated during the descent, in the pre-flight briefing, FAs need to plan to finish in-flight services well before the anticipated encounter with turbulence. If the situation required, FAs need to consider discontinuing or canceling in-flight services. When the seat belt sign is illuminated, FAs are required to urge non-seated passengers to be seated and perform safety checks mainly by confirming their seat belt fastening manner. Accordingly, it is necessary to make plans while taking into account the time needed for these activities.

The investigation report of this case is published on the Board's website (issued on Dec. 16, 2011).

http://www.mlit.go.jp/itsb/eng-air_report/N676NW.pdf

(This report is a translation of the Japanese original investigation report. The text in Japanese shall prevail in the interpretation of the report.)