AA2014-1

AIRCRAFT ACCIDENT
INVESTIGATION REPORT

KOREAN AIR LINES CO, LTD.

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January 31, 2014

The objective of the investigation conducted by the Japan Transport Safety Board in accordance with the Act for Establishment of the Japan Transport Safety Board and with Annex 13 to the Convention on International Civil Aviation is to determine the causes of an accident and damage incidental to such an accident, thereby preventing future accidents and reducing damage. It is not the purpose of the investigation to apportion blame or liability.

Norihiro Goto
Chairman,
Japan Transport Safety Board

Note:

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

AIRCRAFT ACCIDENT INVESTIGATION REPORT

PASSENGER INJURY BY THE SHAKING OF THE AIRCRAFT KOREAN AIR LINES CO, LTD. BOEING 747-400, HL7473 (THE REPUBLIC OF KOREA) AT AN ALTITUDE OF APPROX. 22,000 FT, ABOUT 160KM NORTH-NORTHEAST OF TOKYO INTERNATIONAL AIRPORT AT 20:30 LOCAL TIME, JULY 5, 2012

December 20, 2013
Adopted by the Japan Transport Safety Board

Chairman Norihiro Goto
Member Shinsuke Endoh
Member Toshiyuki Ishikawa
Member Sadao Tamura
Member Yuki Shuto
Member Keiji Tanaka

1. PROCESS AND PROGRESS OF THE INVESTIGATION

On July 10, 2012, the Japan Transport Safety Board received the accident notification, and then designated an investigator-in-charge and two investigators to investigate this accident. An accredited representative of the Republic of Korea, as the State of the Operator and Registry of the aircraft involved in this accident, participated in the investigation. Comments from parties relevant to the cause of the accident and the relevant State were invited.

2. FACTUAL INFORMATION

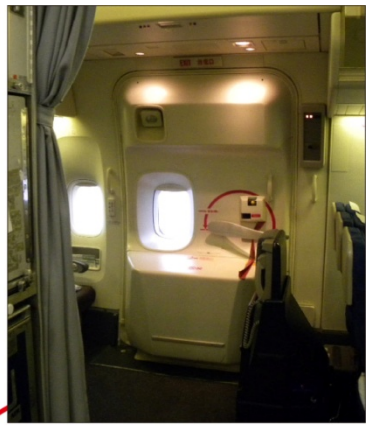
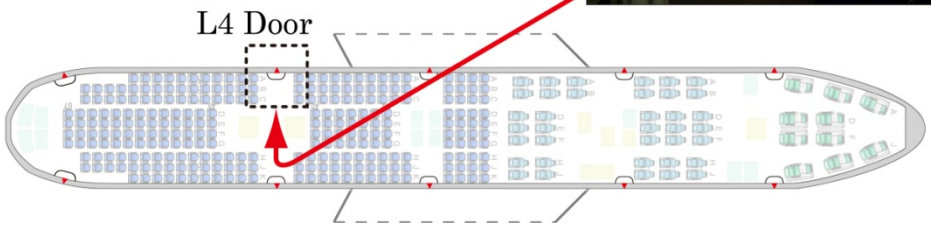
2.1 History of the Flight

The history of the flight is summarized as below, based on the data from onboard digital flight data recorder (DFDR), the air traffic control (ATC) communication records and the statements of the pilot in command (PIC), the first officer (FO), two flight attendants and an injured passenger.

On July 5, 2012 at 19:11 Japan Standard Time (JST, UTC+9 hours), a Boeing 747-400, registered HL7473, operated by Korean Air Lines Co, Ltd. took off from Gimpo International Airport (the Republic of Korea) for Tokyo International Airport (Japan) as a scheduled Flight 2711, with 194 persons on board, consisting of the PIC, the FO, 15 flight attendants and 177 passengers.

In the cockpit, the PIC sat in the left seat as the PF (pilot flying: pilot mainly in charge of flying) and the FO in the right seat as the PM (pilot monitoring: pilot mainly in charge of duties other than flying).

Because the turbulence was expected on the flight route 50 minutes to

	one hour and 14 minutes after the take-off, the PIC provided this information to the flight attendants at the pre-flight briefing and assured their duties in case of actual turbulence. The fasten seat-belt sign had been illuminated until the aircraft reached the cruising altitude due to light shaking. Shaking stopped when it started cruising flight and the fasten seat-belt sign was turned off. Later with the onset of light shaking, it was turned on again. According to the DFDR vertical acceleration records, which indicate the vertical oscillation of the aircraft, small vertical acceleration started to be recorded around 20:05 (54 minutes after the takeoff). The aircraft left the cruising altitude for descent in visual meteorological conditions (VMC). Light shaking continued. As the onboard weather radar (in auto calibrated mode with the range setting at 80 nm and the tilt angle at -1°) showed no echo on the display, the fasten seat-belt sign was turned off. Several minutes later, the aircraft encountered a sudden violent shaking for two to three seconds; accordingly, a passenger standing in the aisle to go to the lavatory was thrown off-balance, bumped into the L4 door on the back, and fell on the floor. The only significant vertical acceleration changes (an increase to +1.54G followed by a decrease to +0.34G in two seconds) recorded in the DFDR took place around 20:30 (one hour and 19 minutes after the takeoff), while the aircraft was in a right turn descent. The autopilot remained engaged.   Two flight attendants assisted the passenger return to his seat and then asked the PIC to get him a wheelchair for his disembarkation. The aircraft encountered no violent shaking after that and it landed at Tokyo International Airport at 20:58. The passenger walked out of the aircraft and rode in the wheelchair. He went through immigration and customs clearance, but due to continuous pains he was taken by ambulance to a hospital and diagnosed as a bone fracture. The accident occurred around 20:30 at an altitude of approximate 22,000 ft (6,700 m) about 160 km north-northeast of Tokyo International Airport (Latitude 36°58'02" N and Longitude 140°17'19" E). (See Figure 1 and 2)
2.2 Injuries to Persons	Serious injury: 1 Passenger Male, Age 55

2.3 Damage	None
2.4 Personnel Information	PIC Male, Age 53 Airline transport pilot certificate Type rating for Boeing 747-400 January 27, 2004 Class 1 aviation medical certificate Validity: Until August 31, 2012 Total flight time 11,729 hr 26 min Total flight time on the type of aircraft 4,895 hr 10 min FO Male, Age 41 Airline transport pilot certificate Type rating for Boeing 747-400 November 13, 2002 Class 1 aviation medical certificate Validity: Until December 31, 2012 Total flight time 6,461 hr 21 min Total flight time on the type of aircraft 5,456 hr 35 min
2.5 Airplane Information	(1) Type: Boeing 747-400 (Serial number: 28335, Date of manufacture: December 23, 1996) Certificate of airworthiness: No. AB09050 Category of airworthiness: Airplane Transport T Total time in service 69,288 hrs 00 min (2) When the accident occurred, the weight and the center of gravity of the aircraft, both of which were estimated to have been within the allowable ranges. (3) The aircraft was equipped with a DFDR (part number: 980-4700-042) manufactured by Honeywell of the United States of America and a cockpit voice recorder (CVR) (part number: 5200-0012-00) manufactured by L-3 Communications of the United States of America. The DFDR retained the data from the take-off to the landing. The time was adjusted by synchronizing the VHF transmission keying signals of the DFDR to the time signal recorded on the ATC communication records. The overwritten CVR provided no useful information.
2.6 Meteorological Information	(1) General Weather Conditions A seasonal rain front was stretching from the Yellow Sea to the Kinki region via the Korean Peninsula. In the airspace off the Sanin region to the Kanto region, moderate turbulences within the clouds or near the base of middle clouds were expected at altitudes 13,000-23,000 ft. They were expected to move eastwards becoming weaker. In the eastern and northern Japan, the atmosphere was unstable due to the passage of a trough accompanied by cold air (-9°C or less at an altitude around 5,500 m), and convective clouds (cumulonimbus and cumulus) developed in several places. (2) Hourly Analysis Chart (vertical cross section) as of 21:00 JST July 5 At around accident occurrence point, a jet stream of 100 kts or faster

	existed at altitudes 37,000-41,000 ft. At altitudes 23,000-26,000 ft, sporadic vertical wind shears (VWS) of 6-9 kts/1000 ft had been forecast. (3) Weather Radar Imagery (Strength and Top Height) According to the weather radar imagery before and after the accident time, no radar echo overlapped the accident airspace as of 20:00, but at 20:20, an echo with top heights of 20,000-30,000 ft and central strength of 80 mm/h overlapped the airspace. The area of the echo further expanded as of 20:40; however, there was no echo to the south where its future course extended. (4) According to the DFDR records, gradual changes in the wind direction and velocity showed a temporal quick wind fluctuation, around 20:30 by 20° in the direction and 10 kts in the velocity. (5) An in-cloud light-plus turbulence, which is weaker than a moderate one denoting shakings demanding attention for cabin walking had been observed regarding its flight route and filed as a PIREP (a weather-related pilot report). According to the PIC, the turbulence information he received from an automatic terminal information service (ATIS) was the weather condition at a point off its flight route: about 100 km south of Tokyo International Airport. (See Figure 2, 3 and 4)

3. ANALYSIS

3.1 Involvement of Weather	Yes
3.2 Involvement of Pilots	None
3.3 Involvement of Airplane	None
3.4 Analysis of Findings	(1) In view of the history of the flight, it is highly probable that the sudden violent shaking of the aircraft corresponds to the sole significant change of the DFDR vertical acceleration data. During this shaking, a passenger standing in the aisle to go to the lavatory was thrown off-balance, bumped into the L4 door on his back, and fell on the floor. (2) According to the hourly analysis chart, the sporadic VWSs had been observed in the vicinity of the accident airspace; therefore, it is possible that factors related to the emergence of the turbulence existed there. According to the statements, no radar echo was observed on the onboard weather radar screen; however, the weather radar imagery by the Japan Meteorological Agency (JMA) showed emerging and enlarging echoes between 20:00 and 20:40, indicating the existence of atmospheric conditions where convective clouds could develop. Further, when the aircraft encountered a violent shaking, the DFDR recorded a

	temporary quick change in the wind direction and velocity. Based on these findings, it is probable that the atmospheric conditions in the accident airspace were unstable enough to generate significant turbulence. (3) According to the statement, the descent from the cruising altitude was in VMC with light shaking and there was no echo on the weather radar display. Moreover, the turbulence information reported in the ATIS was the weather condition off the flight route. Furthermore the expected time for a significant turbulence had already passed. It is probable that the crew concluded that they were able to turn off the fasten seat-belt sign under these circumstances. (4) It is somewhat likely that the weather radar setting at that time could not allow detection of the developing clouds below the aircraft altitude.

4. PROBABLE CAUSES

It is highly probable that this accident occurred because the aircraft was shaken as it encountered turbulence during a descent, causing one passenger who was not in his seat to be thrown off-balance to sustain serious injuries.

It is probable that the turbulence was caused by VWS or unstable atmospheric conditions where convective clouds developed.

See Figure 1: Estimated flight route
See Figure 2: DFDR Records
See Figure 3: Hourly Analysis Chart
See Figure 4: Weather Radar Imagery

Figure 1　Estimated flight route

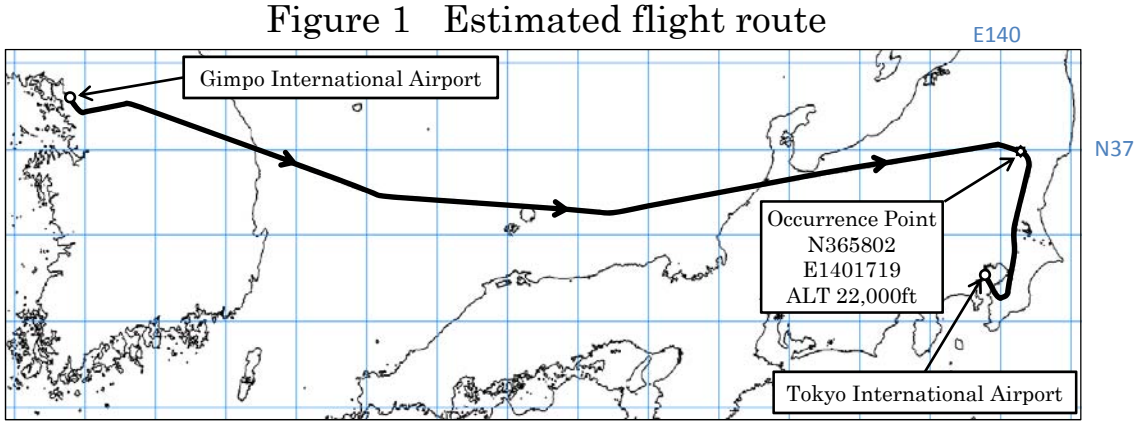


Figure 2　DFDR Records

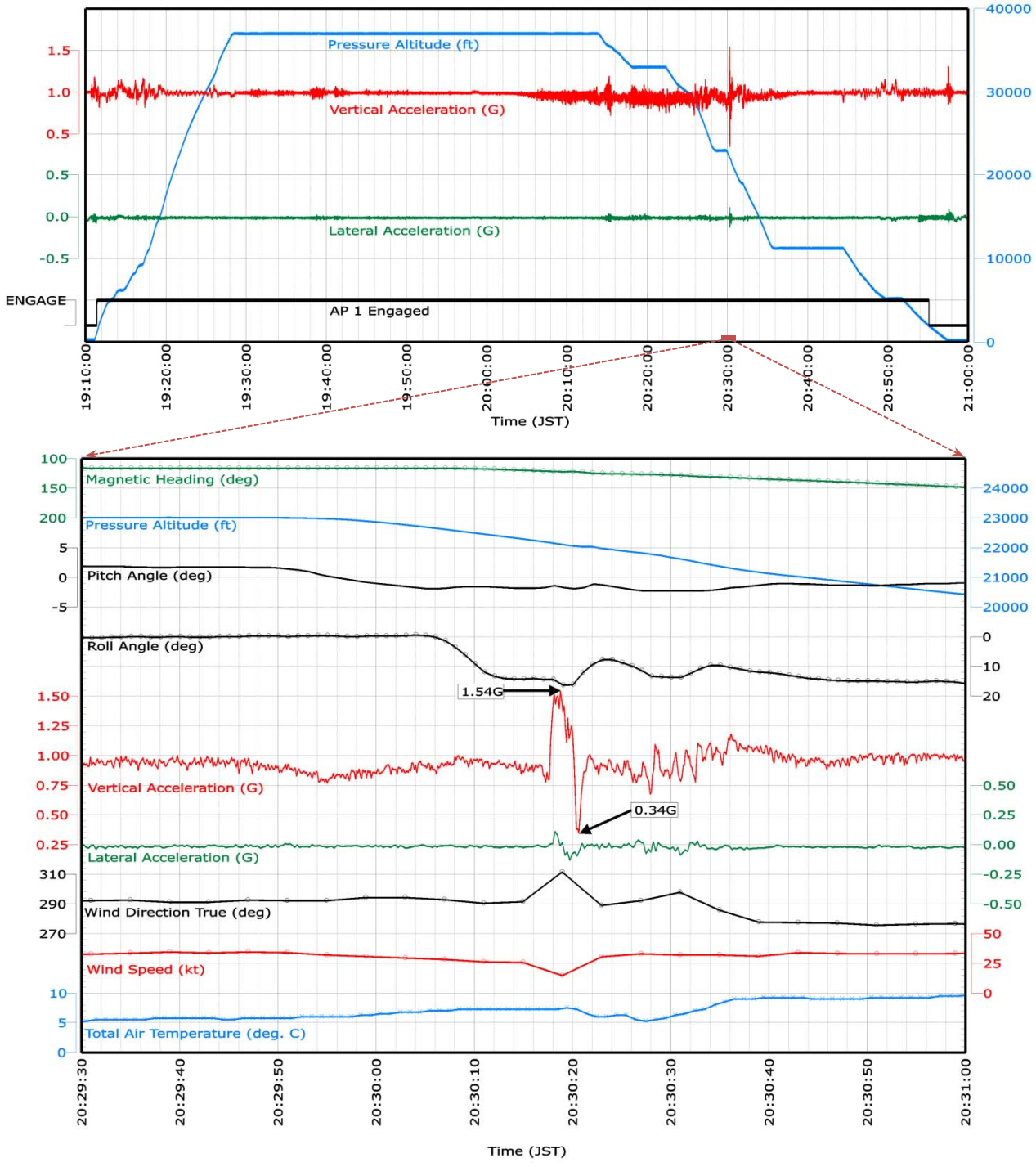
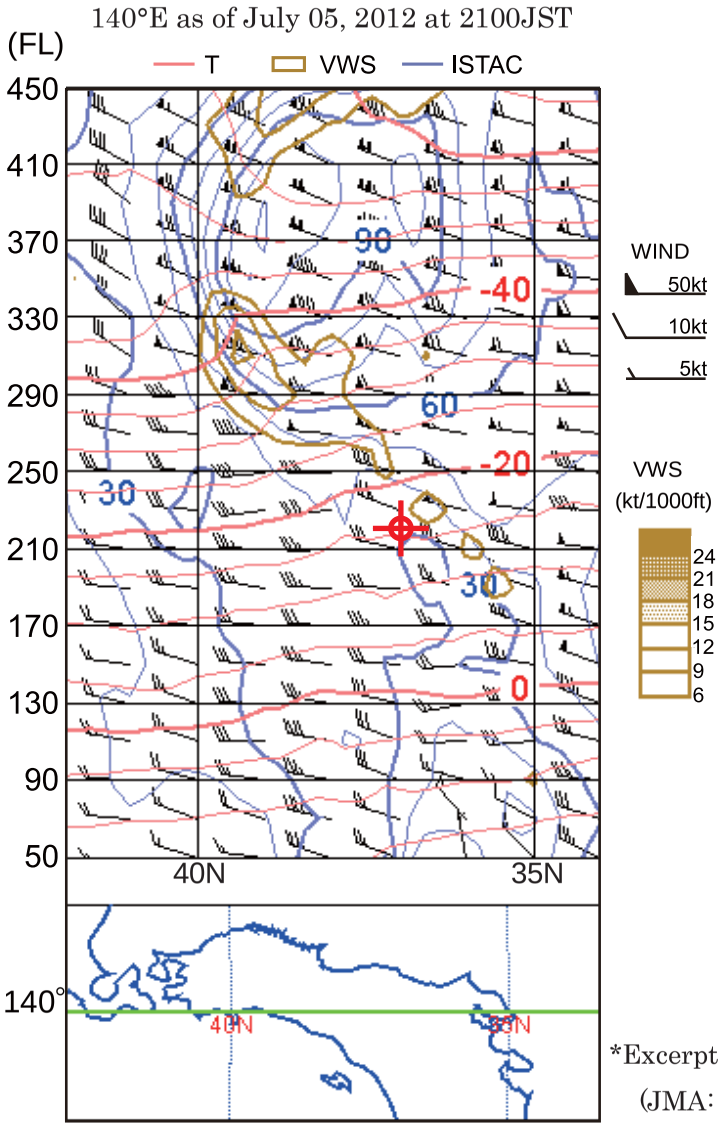


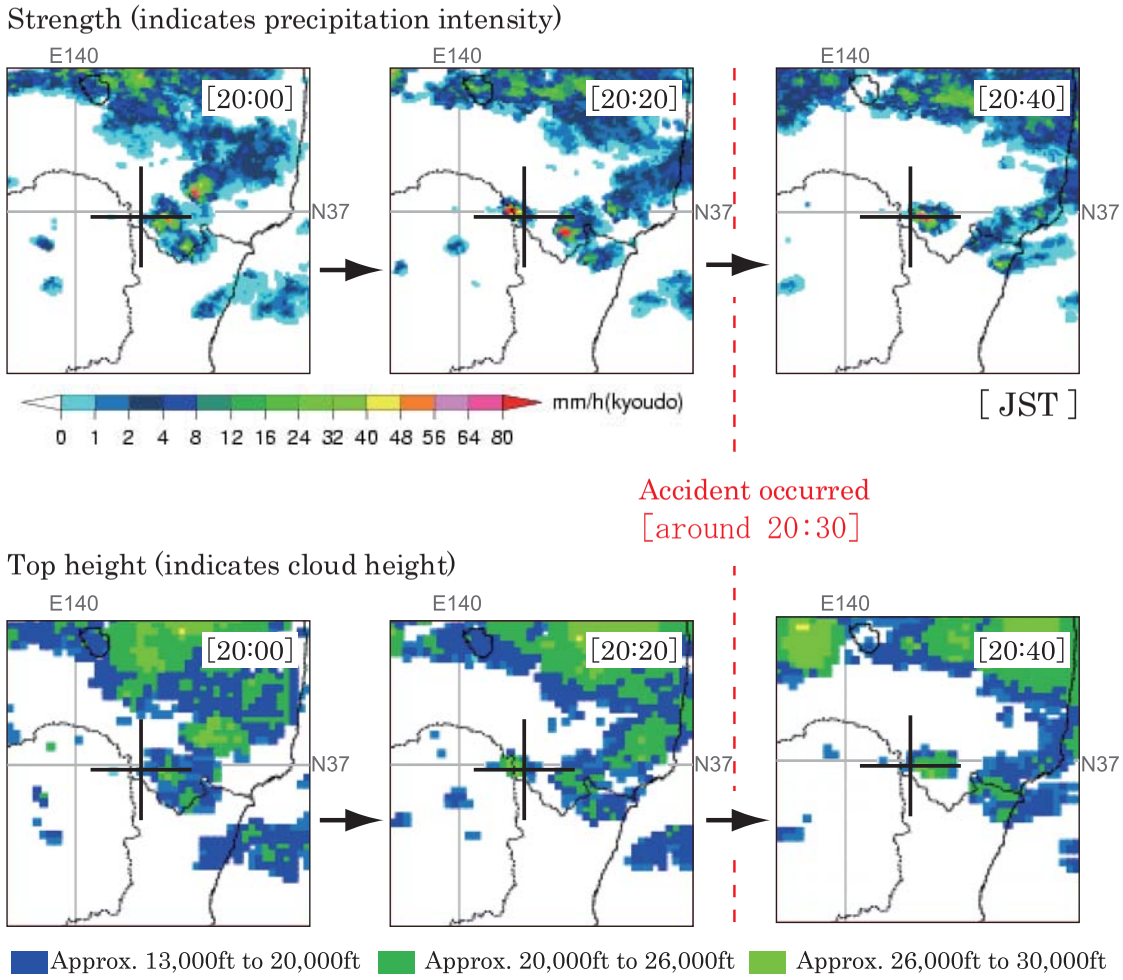
Figure 3 Hourly Analysis Chart (vertical cross section)



*Excerpt and postscript of materials provided by JMA

(JMA: Japan Meteorological Agency)

Figure 4 Weather Radar Imagery



Accident Occurrence Point