AA2021-5

AIRCRAFT ACCIDENT
INVESTIGATION REPORT

JAPAN AIR COMMUTER CO., LTD.
J A 0 1 J C

July 29, 2021

Japan Transport Safety Board

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.

TAKEDA Nobuo
Chairperson
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

CABIN ATTENDANT INJURY
BY THE SHAKING OF THE AIRCRAFT
JAPAN AIR COMMUTER CO., LTD.
ATR 42-500, JA01JC
AT AN ALTITUDE OF APPROX. 10,800 FT (APPROX. 3,300 M)
OVER ABOUT 57 KM NORTH-NORTHWEST OF
TANEGASHIMA AIRPORT
AROUND 11:19 JST, OCTOBER 12, 2019

July 2, 2021
Adopted by the Japan Transport Safety Board
Chairperson TAKEDA Nobuo
Member MIYASHITA Toru
Member KAKISHIMA Yoshiko
Member MARUI Yuichi
Member NAKANISHI Miwa
Member TSUDA Hiroka

1. PROCESS AND PROGRESS OF THE AIRCRAFT ACCIDENT INVESTIGATION

1.1 Summary of the Accident	On Saturday, October 12, 2019, an ATR 42-500, registered JA01JC, operated by Japan Air Commuter Co., Ltd., shook in the flight from Kagoshima Airport to Tanegashima Airport, and a cabin attendant was injured.
1.2 Outline of the Accident Investigation	Upon receiving the report of the accident, the Japan Transport Safety Board (JTSB) designated an investigator-in-charge and an investigator on October 15, 2019 to investigate this accident. An accredited representative of the French Republic, as the State of Design and Manufacturer of the aircraft involved in this accident, participated in the investigation. Comments were invited from parties relevant to the cause of this accident and the Relevant State.

2. FACTUAL INFORMATION

2.1 History of the Flight	According to the statements of the pilot in command (PIC), the first officer (FO) and the injured cabin attendant and the records of flight data recorder (FDR), the history of the flight was summarized as follows. An ATR 42-500, registered JA01JC, operated by Japan Air

commuter Co., Ltd. as a scheduled flight 3763, with 19 persons in total on board, consisting of the PIC, two crew members and 16 passengers, took off from Kagoshima Airport for Tanegashima Airport on October 12, 2019 at 11:06 JST (JST: UTC+9 hours; unless otherwise noted, all times are indicated in JST in this report on a 24-hour clock). In the cockpit, the FO sat in the left pilot's seat as PF*1 for the captain promotion training and the PIC in the right pilot's seat as PM*1. The flight crew members had made a round flight between Kagoshima Airport and Kikai Airport, and they anticipated that there was no shaking to be hazardous on their operation even if some shaking might be expected at a lower altitude when they checked the weather information before their first flight of the day from Kagoshima Airport. Actually, when they made a round flight between Kagoshima Airport and Kikai Airport, there was no such a shaking as to hazard the flight other than the one during the climb and the descent around Kagoshima Airport. In addition, from the weather information including the pilot report (PIREP) checked prior to the departure of the flight, the flight crew members judged that there would not be such a shaking that would hazard their operations in this flight.

After taking off from Kagoshima Airport, the seat belt sign was turned off at an altitude of about 10,000 ft and the Aircraft started a cruise flight at 11,000 ft. There was no cloud on the route to Tanegashima Island. After switching the Auto Pilot System from the ALT mode maintaining the altitude to the VS mode maintaining the climb or descent rates about 60 km before Tanegashima Island, the Aircraft started to descend toward Tanegashima Airport at a descent rate of 1,300 ft/min. The FO who did not anticipate any shaking during the descent manually adjusted the engine power so that the indicated airspeed (IAS) should be at 240 kt, however, the FO set the engine power at the flight idle because it was going to exceed 240 kt. The Aircraft encountered the shaking at an altitude of approximately 10,800 ft, the IAS rapidly increased, and it was going to exceed a Maximum Operating Speed (V_{MO}) of

Figure 1: Estimated flight route

*1 "PF" and "PM" are the terms used to identify pilots by their different roles in aircraft operated by two persons. PF is an abbreviation of Pilot Flying and is mainly responsible for maneuvering the aircraft. PM is an abbreviation of Pilot Monitoring mainly responsible for monitoring flight status of the aircraft and cross-checking of PF's maneuvering and undertakes other non-operational tasks.

250 kt. The FO pulled his control column in order to reduce the speed while pushing the TCS (Touch Control Steering: temporarily enabling manual control without switching off the autopilot system) button, but the Aircraft did not raise its nose as the FO expected. Watching it, the PIC felt that it was heavier than usual when he pulled his control column immediately, and the Aircraft's nose-up was slower than his expectation.

During the maneuvers, the flight crew members felt a strong shaking and heard a warning sound indicating the Aircraft had exceeded the VMO. During this period, the seat belt sign of the Aircraft remained turned off. In addition, the FDR recorded that the IAS increased up to 251 kt, and it exceeded the VMO for one second.

After the shaking subsided and the flight condition was stabled, the PIC judged that the cabin attendant was injured when he watched a cabin attendant was walking toward the aft cabin with help from a passenger by the camera installed in the cabin, then decided to return to Kagoshima Airport. The PIC reported the situation to the Company, then requested an ATC facility for clearance to return to Kagoshima Airport while reporting that the Aircraft encountered severe turbulence. Around 11:23, the Aircraft had been cleared to return to Kagoshima Airport and landed at Kagoshima Airport around 11:45.

The cabin attendant, who was providing the in-flight service, fell down while feeling her body was floating and felt a pain in her right ankle because the Aircraft was suddenly shaken when she was walking toward the aft cabin along the aisle around seat row 4 (See Figure 2). The cabin attendant, who was not able to stand up by herself, went to the cabin attendant seat located in the aft cabin with support from a passenger then remained seated in it until the Aircraft landed. After the Aircraft parked, the cabin attendant was taken to a hospital by an ambulance waiting there, and was diagnosed with suspected right anterior talus ligament injury. A fracture of the posterior malleolus of the right ankle was diagnosed, when going to the hospital again on October 15, 2019 for an MRI examination.

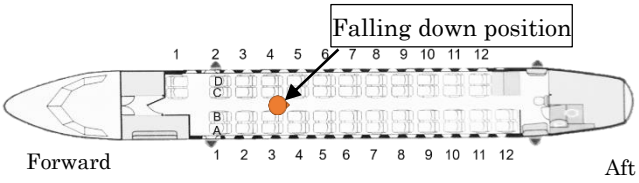
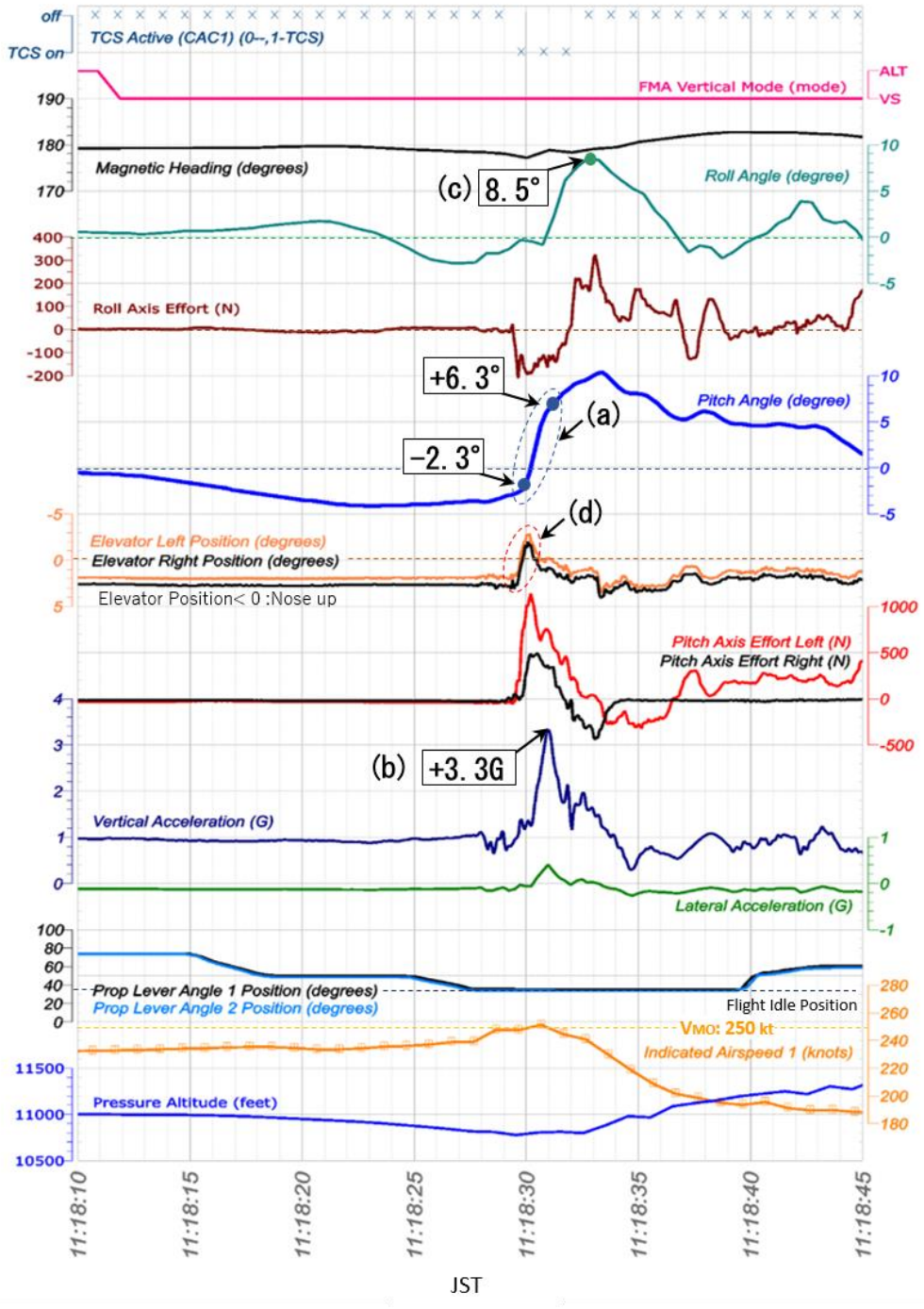


Figure 2: Falling down position of the cabin attendant

According to FDR records, the pitch angle changed in width from -2.3° to +6.3°for about one second around 11:18:30 (See Figure 3 (a)), the vertical acceleration was +3.3 G around 11:18:31(See Figure 3 (b)), and immediately after that, the roll angle changed by 8.5° in the right direction (See Figure 3 (c)). Besides, around 11:30:43, when the Aircraft was flying at an altitude of 8,000 ft in the vicinity of the accident site on

	the way back to Kagoshima Airport, the vertical acceleration of +1.6 G was recorded (See Figure 6).  Figure 3: FDR records This accident occurred over about 57 km north-northwest of Tanegashima Airport (31° 06' 33" N, 130° 53' 34" E) at an altitude of approximately 10,800 ft on October 12, 2019 around 11:19.
2.2 Injuries to Persons	A cabin attendant was seriously injured (the posterior malleolus of the right ankle was fractured)
2.3 Damage to Aircraft	None

2.4 Personnel Information	(1) PIC Age 42 Airline transport pilot certificate (Airplane) October 23, 2015 Type rating for ATR 72 March 19, 2018 Class 1 aviation medical certificate Validity December 1, 2019 Total flight time 8,053 hours 45 minutes Flight time in the last 30 days 41 hours 38 minutes Total flight time on the type of aircraft 978 hours 58 minutes Flight time in the last 30 days 41 hours 38 minutes (2) FO Age 35 Airline transport pilot certificate (Airplane) September 13, 2019 Type rating for ATR 72 June 23, 2017 Class 1 aviation medical certificate Validity July 5, 2020 Total flight time 3,746 hours 21 minutes Flight time in the last 30 days 31 hours 36 minutes Total flight time on the type of aircraft 849 hours 46 minutes Flight time in the last 30 days 31 hours 36 minutes
2.5 Aircraft Information	(1) Aircraft Type ATR 42-500 Serial number 1215 Date of manufacture December 29, 2016 Certificate of airworthiness DAI-2018-451 Validity: From October 25, 2018 until the time when the aircraft is maintained in accordance with the Maintenance Manual (Japan Air commuter Co., Ltd.) Total flight time 3,949 hours 09 minutes (2) At the time of the accident, the weight and balance of the Aircraft are estimated to have been within the allowable ranges. (3) There were no records about failure related to the flight control system in the maintenance record for the Aircraft. (4) The Aircraft was equipped with FDR and Cockpit Voice Recorder (CVR). However, as the Aircraft's operation continued until this was classified as an accident, and clearly the CVR records would have been overwritten, the CVR was not dismounted from the Aircraft. (5) As the detailed examination of the Aircraft for its encountering turbulence found no abnormality, the Company decided to have the Aircraft made available for air transport service.

2.6 Meteorological Information

(1) General weather conditions

According to the Asia-Pacific surface analysis chart at 09:00 on October 12, 2019, typhoon No. 19 (Central pressure: 945 hPa, Maximum wind velocity near the center: 85 kt) located off the coast of the Tokai region was moving north-northeast at 12 kt. In addition, the isobars around the Kyushu region were slightly dense.

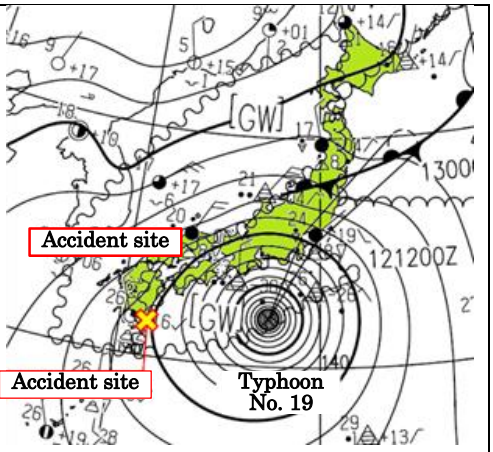


Figure 4: Asia-Pacific surface analysis chart (Excerpts from the chart at 9:00 on October 12, 2019, partially edited)

(2) Hourly Atmosphere Analysis Chart

According to the hourly atmosphere analysis chart (vertical cross section) at 11:00 on October 12, 2019, there was no Vertical Wind Shear (VWS) area indicating the changes in wind direction and velocity over 6 kt per 1,000 ft in the vicinity of the accident site.

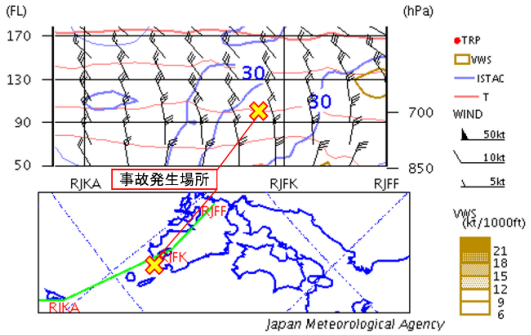


Figure 5: Hourly Atmosphere Analysis Chart (Cross sectional view of flight route) (Excerpts from the chart at 11:00 on October 12, 2019, partially edited)

(3) PIREP

There was no PIREP over the vicinity of accident site before the accident occurred

(4) Wind direction and wind velocity and outside air temperature on the flight route

Figure 6 shows the elements of headwind (sign -) / tailwind (sign +) estimated from the true air speed and ground speed recorded in FDR and the outside air temperature from the take-off from Kagoshima Airport to the landing at Kagoshima Airport.

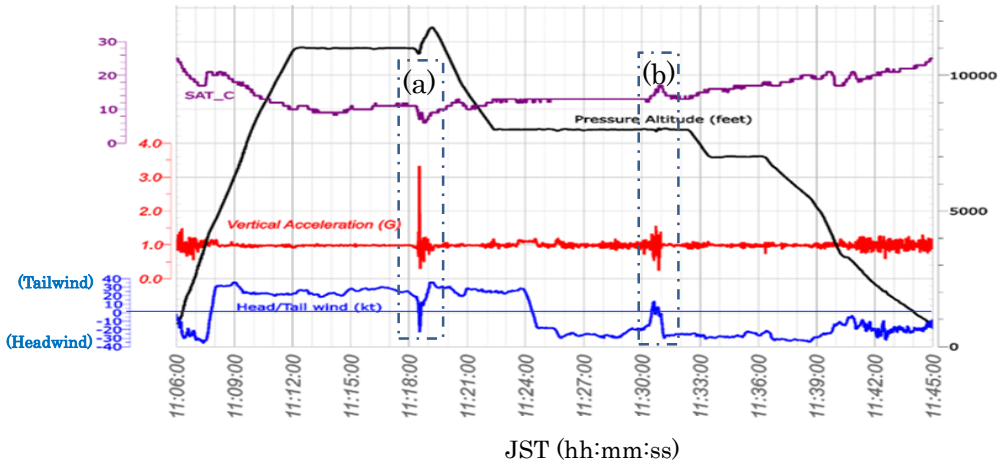


Figure 6: Changes in tailwind/headwind, outside air temperature and vertical acceleration

2.7 Additional Information

(1) VMO

In the Aircraft Operating Manual (AOM) of the Company, it is described that VMO is the operating limit speed that may not be deliberately exceeded in any phase of flight and is defined to be 250 kt. Exceeding the VMO limit sounds an alarm.

On the other hand, in the Airworthiness Inspection Manual, the VMO is required to be the speed that shall have a sufficient margin against the limits of structural integrity and control criteria of the aircraft. In addition, the VMO should include a safety margin considering the time for the pilot to respond after the alarm is activated, so the pilot can reduce the speed to the VMO level without excessive flight control force and special flight skills before the aircraft would reach the limits of structural integrity and control criteria.

(2) Information and Training related to VMO provided by the Company

Before this accident occurred, when the same type of the Aircraft operated by the Company exceeded the VMO during a cruise, the Company provided the flight crew members with the information, however, no specific procedure and others were provided to respond for the case of approaching or exceeding the VMO.

Besides, in the simulator trainings for the transition of aircraft type and FO promotion, the Company provided trainings for the operations to recover from the abnormal aircraft attitude, however, which did not include those regarding the responses in the case of approaching or exceeding the VMO.

(3) Maneuvering Limit Load Factors

There is the following description in the Chapter 1 Operating Limitations in the AOM of the Company.

1-3-2 Maneuvering limit load factors

GEAR and FLAPS Retracted	*+2.5G ～ -1.0G*
GEAR and/or FLAPS Extended	*+2.0G ～ 0.0G*

(4) Vertical Acceleration with Attitude Change

From about two seconds before the vertical acceleration of about +3.3 G

was recorded, the elevator had deflected about 5 degrees in about one second (See Figure 3 (d)) and the pitch angle had increased 8.6 degrees in about one second.

The manufacturer has estimated the vertical acceleration should be about +2.7G (acceleration increment: about +1.7 G) result from the elevator deflection under the stable atmosphere.

Moreover, the vertical acceleration, which was obtained simulating the aircraft attitude change (pitch angle) same as the record in the FDR when verifying the behavior of the Aircraft at the time of the accident by a simulator of the Company, was about +2.8G (acceleration increment: about +1.8 G). This results of examination have not been able to reproduce perfectly the situation at the time of the accident because the simulator cannot simulate the exact aircraft environment (especially during severe turbulence), though.

(5) Descent Speed

There is the following descriptions in Chapter 7 Flight Plan, 7-3 Operating Procedures, 4 Descent Speed, of the AOM of the Company.

Type of Decent	*Descent speed (IAS)*
Low Speed Descent	*200 kt*
Mid Speed Descent	*220 kt*
High Speed Descent	*240 kt*

In 2-16 Before Descent of the Flight Technical Guide*2 (FTG) of the Company, it is described that the descent speed shall be selected by taking into account the airstream change.

Besides, in the flight plan for the flight, the descending speed was 240 kt.

(6) Dual Input

The AOM of the Company contains the following descriptions.

4-5-6 FLIGHT CONTROLS

PITCH CONTROL

In flight, aggressive or large elevators input should be avoided because such input may lead to high load (G) and result in structural damage.

*CAUTION: The aircraft must be controlled from one control column only. Dual input in opposite direction may result in a Pitch Disconnect*3.*

(7) Take Over

The Operations Manual (OM) of the Company contains the following descriptions.

III Implementation of Flight

III-1 General

*2 The "Flight Technical Guide" is not a regulation or standard, however, it aims to standardize actual operation and education and training, and supplements the AOM with respect to the basic procedure regarding maneuver and others.

*3 "Pitch Disconnect" means a state in which the pitch coupling mechanism that transmits the movement of each control column and the elevator to the other control column and the elevator is disconnected.

	3. Cockpit Management and Crew Coordination (Excerpt) *(4) At the time of the Transfer Control such as temporary withdrawal from the PF Duty or Take Over, calls such as "I Have"/"You Have" shall be clearly made and the transfer of control shall be mutually confirmed.*

3. ANALYSIS

3.1 Involvement of Weather	Yes
3.2 Involvement of Pilot	Yes
3.3 Involvement of Aircraft	None
3.4 Analysis of Findings	(1) Cabin Attendant's Injury It is highly probable that the cabin attendant, who was walking along the aisle toward the aft of the cabin, fell off balance and injured due to the sudden shaking of the Aircraft in relation to major changes in vertical acceleration (Maximum vertical acceleration: +3.3 G) and roll angle that had been recorded in FDR from around 11:18:28 when the seat belt sign remained off. (2) Flight Crew Members' Forecast of Weather Conditions Based on the weather information provided prior to this flight, PIREP, and flight condition in the round flight which the Aircraft made before this flight between Kagoshima Airport and Kikai Airport, it is probable that the flight crew members anticipated that they would be less likely to encounter turbulence that could affect the Flight. (3) Atmosphere Conditions According to Figure 6, at the time of the accident, the outside air temperature decreased, and the wind conditions estimated from FDR records changed from a tailwind (about 20 kt) to a headwind (about 20 kt), and to a tailwind (about 30 kt) in a short time (See Figure 6(a)). In addition, when the Aircraft was flying in the vicinity of the accident site on the way back to Kagoshima Airport, the outside air temperature increased, and the wind conditions estimated from FDR records changed from a headwind (about 20 kt) to tailwind (about 10 kt), and to headwind (about 30 kt) (See Figure 6 (b)). Therefore, it is highly probable that the Aircraft encountered localized changes in the wind direction and wind velocity and the outside air temperature which were difficult to forecast not being shown in weather information like hourly atmosphere analysis chart. (4) Responses of the Flight Crew Members It is highly probable that because the fight crew members did not anticipate the shaking during the descent, the descent speed of 240 kt was selected in accordance with its flight plan for the flight. As shown in Figure 3, because the IAS of the Aircraft was about to exceed 240 kt after starting to descend, it is highly probable that the FO set the engine

	power to the flight idle. However, due to changes in the wind direction and wind velocity, and the outside air temperature, the IAS of the Aircraft further increased, therefore, it is highly probable that the PIC and the FO pulled the control columns strongly in the nose-up direction almost at the same time in order to avoid exceeding the VMO. At this time, according to the FDR records, the attitude of the Aircraft changed by 8.6° in the nose-up direction for about one second, and the Aircraft exceeded the VMO for about one second. It is highly probable that the change in the Aircraft's attitude was caused by the nose-up pitch control provided by the flight crew members and the nose-up effects resulting from an increase in the aircraft speed. The flight crew members stated the Aircraft did not easily take a nose-up, however, there were no descriptions about failure related to the flight control system in the maintenance record of the Aircraft, in addition, the Aircraft examination conducted after this accident found no abnormality. Accordingly, it is somewhat likely that the nose-up was unsuccessful and the flight crew members felt adequate control was needed, not because there was a failure in the flight control system, but because they pulled the control columns at a higher speed, thus the aerodynamics hinge moment became large. VMO should not be deliberately exceeded, but is required to be set at the speed that should include a safety margin considering the time for the pilot to respond even when the alarm is activated, so the pilot can reduce the speed to the VMO level without excessive flight control force and special flight skills. Besides, in the AOM of the Company, it is described that aggressive or large elevators input should be avoided because such input may lead to high load (G) and result in structural damage. Furthermore, as a CAUTION, it is also described that the aircraft must be controlled from one control column only and dual input in opposite direction may result in a Pitch Disconnect. At the time of the accident, as the Aircraft increased speed and was about to exceed the VMO, the FO pulled the control column, but was not able to reduce the speed as intended, and having seen it, the PIC also pulled his control columns immediately. Those operations by the flight crew members could reduce the degree of exceeding the VMO, however, the FDR recorded the vertical acceleration exceeding the limit load factor. In the examination of the Aircraft conducted after the flight, no failure was confirmed with the Aircraft, however it is probable that exceeding the limit load factor could result in structural damage. It is probable that with due consideration of the criteria set out for the VMO, the flight crew members should have reduced the speed by operations without rapid and excessive flight control force. In addition, as dual input may cause a Pitch Disconnect, it is important with regard to safety that the aircraft shall be controlled from one control column only by either one of the flight crew members in accordance with the AOM of the Aircraft. Furthermore, it is probable that the PIC pulled his control column immediately in order to support the FO, however, from the view point of preventing dual input, when a flight crew member who is not the PF operates the control column, it is required

	to ensure that they carry it out after clearly expressing the intention of "Take Over" by calling "I Have" without fail. (5) Vertical Acceleration of the Aircraft As shown in Figure 3, the changes in the Aircraft's vertical acceleration (about +0.6 G to about +3.3 G) had been recorded in FDR from around 11:18:28. In addition, when the Aircraft was flying in the vicinity of the accident site on the way back to Kagoshima Airport, the changes in the vertical acceleration (about +0.2 G to about +1.6 G) were recorded, therefore, it is highly probable that the Aircraft had been shaking before its IAS approached the VMO. It is probable that the Aircraft was shaken because it encountered localized changes in the wind direction and wind velocity shown in Figure 6 (a). Besides, it is probable that the maximum vertical acceleration of +3.3 G recorded in FDR around 11:18:31 was the result that the vertical acceleration was added because the Aircraft attitude changed when the PIC and the FO pulled the control columns strongly in order to avoid exceeding the VMO when the IAS had approached the VMO while the Aircraft had been shaking. Furthermore, the result of the calculation by the Design and Manufacturer has given +2.7 G as the vertical acceleration caused by the fact which the PIC and the FO aggressively pulled the control columns, and the maximum vertical acceleration of +2.8 G has been obtained from the examination which simulated the Aircraft's attitude changes using a simulator. (6) Responses of the Company The Company had not provided the flight crew members with recommended operation procedures in the case of approaching or exceeding the VMO. It is probable that the Company needs to provide information and training regarding the VMO including operating procedures for safe aircraft operation.

4. PROBABLE CAUSES

The JTSB concludes that the probable cause of this accident was that the Aircraft was suddenly shaken, therefore, the cabin attendant who was walking along the aisle fell off balance and injured.

It is probable that regarding the Aircraft was suddenly shaken was because the Aircraft attitude changed due to the nose-up pitch control by the flight crew members to avoid exceeding the VMO and the nose-up effects resulting from an increase in the Aircraft speed, following the encounter of localized changes in the wind direction and velocity.

5. SAFETY ACTIONS

The Company took following safety actions to prevent recurrence.

(1) The Company issued Operating Information* 4 regarding procedures in the case of approaching or exceeding the VMO. (Excerpt)

*4 "Operating Information" provides a supplementary explanation about the contents of aircraft operations manual, and commentary and information on other materials.

i) It is specified that if approaching the VMO limit due to abrupt changes in wind conditions or outside air temperature could be anticipated, the speed with a sufficient safety margin against the VMO limit shall be selected early. And the speed recommended to select when passing territories was set forth.

ii) In the case of approaching or exceeding the VMO, the speed shall be corrected using autopilot system.

a. During cruise
   - Reduce engine thrust up to the flight idle as needed.

b. During descent
   - Reduce engine thrust up to the flight idle as needed.
   - Set the autopilot system in ALT HOLD mode to maintain an altitude, or set in VS mode and adjust vertical speed to zero.

iii) Deceleration by manual flying should be applied only when the autopilot system cannot correct the airspeed definitely because it might result in an abrupt pitch change.

Nose up maneuver should be done at the same nose up rate (2~3°/sec) recommended at takeoff to avoid changing an aircraft attitude abruptly even if manual flying (including using TCS) would be required to avoid an emergency avoidance.

iv) Dual inputs by the PF and the PM shall be strictly forbidden.

v) The transfer control procedures were specified (To ensure Take Over procedures with callouts such as “I have” and “You have”)

vi) Early taking over shall be carried out.

(2) Classroom lectures and simulator training covering the contents of Operating Information were provided to the flight crew members involved in this accident.