AA2022-1

AIRCRAFT ACCIDENT
INVESTIGATION REPORT

TIGERAIR TAIWAN
B 5 0 0 0 1

March 24, 2022

JTSB 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.

《Reference》

The terms used to describe the results of the analysis in "3. ANALYSIS" of this report are as follows.

i) In case of being able to determine, the term "certain" or "certainly" is used.
ii) In case of being unable to determine but being almost certain, the term "highly probable" or "most likely" is used.
iii) In case of higher possibility, the term "probable" or "more likely" is used.
iv) In a case that there is a possibility, the term "likely" or "possible" is used.

AIRCRAFT ACCIDENT INVESTIGATION REPORT

CABIN CREW MEMBER INJURY BY THE AIRCRAFT SHAKING

TIGERAIR TAIWAN

AIRBUS A320-232, REGISTERED B50001

AT FL300 OVER ABOUT 100 KM NORTH-NORTHEAST OF

MIYAZAKI AIRPORT, MIYAZAKI PREFECTURE

ABOUT 16:12 JST, DECEMBER 25, 2019

February 4, 2022
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 INVESTIGATION

1.1 Summary of the accident	On December 25, 2019, an Airbus A320-232, registered B50001 and operated by Tigerair Taiwan, flying as its scheduled flight 237 from Hakodate Airport to Taiwan Taoyuan International Airport shook during the flight, and a cabin crew member were seriously injured and a passenger and two cabin crew members sustained minor injuries.
1.2 Outline of the accident investigation	Upon receipt of the notification of the accident on December 27, 2019, the Japan Transport Safety Board (JTSB) designated an investigator-in-charge and an investigator to investigate the accident. Accredited representatives of Taiwan as the authority responsible for the operator of the aircraft and French Republic as the State of the Design and Manufacture of the aircraft involved in the accident participated in the investigation. The event occurred on December 25, 2019, and was set to be treated as the accident on December 27, 2019, by the notification from the operator of the aircraft to the Civil Aviation Bureau of Japan that a cabin crew member was confirmed to have sustained a serious injury (a right ankle bone fracture). Interviews the Pilot in Command (hereinafter referred to as "the PIC"), the First Officer of Aircraft A (hereinafter referred to as "the FO"), the injured cabin crew member, and other cabin crew members onboard were conducted by the accredited representative of Taiwan.

	Comments were invited from the parties relevant to the cause of the accident. Comments were invited from the relevant state and other.

2. FACTUAL INFORMATION

2.1 History of the flight	According to the statements of the PIC, the FO, and the injured cabin crew member, and Flight Data Recorder (hereinafter referred to as "the FDR"), the flight is summarized as follows: An Airbus A320-232, registered B50001 and operated by Tigerair Taiwan, with 170 persons onboard, consisting of the pilot, five crew members and 164 passengers, took off from Hakodate Airport to Taiwan Taoyuan International Airport as its scheduled flight 237 on December 25, 2019, at 14:17, JST (JST: UTC+9 hours; unless otherwise noted, all times are indicated in JST in this report on a 24-hour clock), two-hour delay from the original departure time. In the cockpit, the PIC sat in the left seat as PF*1 and the FO in the right seat as PM*1. In preflight briefing with cabin crew conducted prior to the departure of the preceding flight (the fight from Taiwan Taoyuan International Airport to Hakodate Airport), the PIC alerted the cabin crew to be vigilant against a sudden shake of the aircraft as a lot of turbulence was predicted to generate in the flight routes of the preceding flight and return flight with a chance to encounter severe turbulence an hour and 25 minutes after takeoff from Taiwan Taoyuan International Airport and two hours after takeoff from Hakodate Airport. While the PIC predicted from weather information provided by the entrusted weather information provider of the company at Hakodate Airport and aviation related information pages obtained from the Internet that a lot of turbulence would be generating in the flight route from the ground up to FL370*2 as was generating in the preceding flight of the round flight, the PIC did not repeat the weather conditions in preflight briefing for the return flight to Taiwan Taoyuan International Airport since the information on the weather conditions for the return flight remained unchanged from the one the PIC conveyed in preflight briefing for the preceding flight although the PIC informed cabin crew of the flight plan up to Taiwan Taoyuan International Airport. The Japan Meteorological Agency released SIGMET*3 at 14:00 that severe turbulence was predicted in the areas from Kyushu through southern

*1 "PF" and "PM" are terms used to identify pilots with their different roles in aircraft operated by two persons. The PF abbreviates Pilot Flying and is mainly responsible for maneuvering the aircraft. The PM abbreviates Pilot Monitoring and mainly monitors the flight status of the aircraft, cross checks operations of the PF, and undertakes other non-operational duties.

*2 "FL" means a pressure altitude in the standard atmosphere. FL is expressed in the value obtained by dividing the reading on the altimeter (unit: ft) by 100 when the altimeter is set to 29.92 inHg. Flight altitude over 14,000 ft is generally expressed in FL in Japan. For instance, FL370 stands for an altitude of 37,000 ft.

*3 SIGMET (Significant meteorological information) is released by the Japan Meteorological Agency on all the altitudes in the entire Fukuoka flight information region (Fukuoka FIR) when any significant weather phenomenon is observed or predicted to impair aircraft operations.

	Shikoku from FL270 to FL350, which, however, was not obtained by Operation Control Center*4 (hereinafter referred to as "the OCC") of the company that monitored flights. After having confirmed with Fukuoka Area Control Center that no Pilot Report (PIREP) was issued at FL300, the aircraft flying at FL340 commenced descending to FL300 at 15:54 due to the strong headwind at the said altitude and the performance of the aircraft of being unable to climb to FL360 or higher resulting from the aircraft weight (see Figure 3 (1)). The aircraft reached FL300 at 15:59 and entered level flight (see Figure 3 (2)). The airstream began to be aggravated at 16:08 and the FO illuminated seatbelt sign. The aircraft was flying in thin and misty clouds. Besides, no echo was displayed on airborne weather radar of the aircraft. As the aircraft began to shake fiercely about 16:09, the FO decelerated to the recommended speed for passing through turbulence with autopilot system (hereinafter referred to as "the Autopilot") being engaged. The airstream was further aggravated, and the FO rang seatbelt chime twice to let cabin crew be seated in accordance with FOM*5. The turbulence was further worsened, and when the aircraft steeply climbed, the FO moved control column (hereinafter referred to as "the sidestick") forward, which disengaged the Autopilot with the sound of Autopilot disengagement, and Autopilot disengagement was displayed on flight mode annunciator. Although flight crew recognized that the Autopilot was disengaged, the situation was such that manual control by the FO was not performed, the vertical speed of the aircraft increased to 9,300 ft/min maximum, the pressure altitude rose to 31,200 ft, and the roll angle leaned 15° to the right (see Figure 9). Then, the FO transferred the control to the PIC. Although the PIC attempted to stabilize the aircraft attitude, the aircraft subsequently climbed to 33,200 ft (about 16:12:38). The FO notified Fukuoka Area Control Center that the aircraft was encountering severe turbulence, and simultaneously requested FL320, which was approved by Fukuoka Area Control Center. The PIC, then, recovered the attitude of the aircraft and returned to FL300 following the instruction from Fukuoka Area Control Center to do so. After the attitude had been stabilized, the PIC engaged the Autopilot. Although the aircraft was encountering the turbulence for one minute, the airstream became stable thereafter. Although the PIC called cabin crew, there was no response. Therefore, the PIC instructed any of them to come to the cockpit using passenger address system. About 16:30, FA2 (a cabin crew member covering the aft area of the passenger cabin) came into the cockpit and reported the situation of the passenger cabin as follows:

*4 "Operation Control Center" is one of the divisions of the company that controls the entire flight operations of the company, gathers and integrates necessary information for aircraft flight operations, and engages in schedule control, providing information with flight crew, and crisis management.

*5 "FOM" is an abbreviation of Flight Operation Manual that defines basic policy, practical maneuvering, procedures, and criteria, etc. that persons engaged in flight operations follow in executing their duties when the company undertakes aviation transport businesses.

- There were many things scattered such as foods, etc. in the cabin.
- A passenger sitting in the seat 1C sustained a minor lumbar injury, and there was no passenger else injured.
- CIC (Crew in Charge) performing safety check in the aft passenger cabin fell and had the ankle sprained when the CIC began walking forward to return to a cabin crew seat (hereinafter referred to as "the Jump Seat") in the forward as seatbelt sign was illuminated.
- FA1 (a cabin crew member covering the forward area of the passenger cabin) fell near the aft galley and hurt the back.
- FA2 was seated in the Jump Seat and had the right hand slightly injured.
- The ceilings over passenger seats and door panels, etc. were damaged.

(see Figure 1).

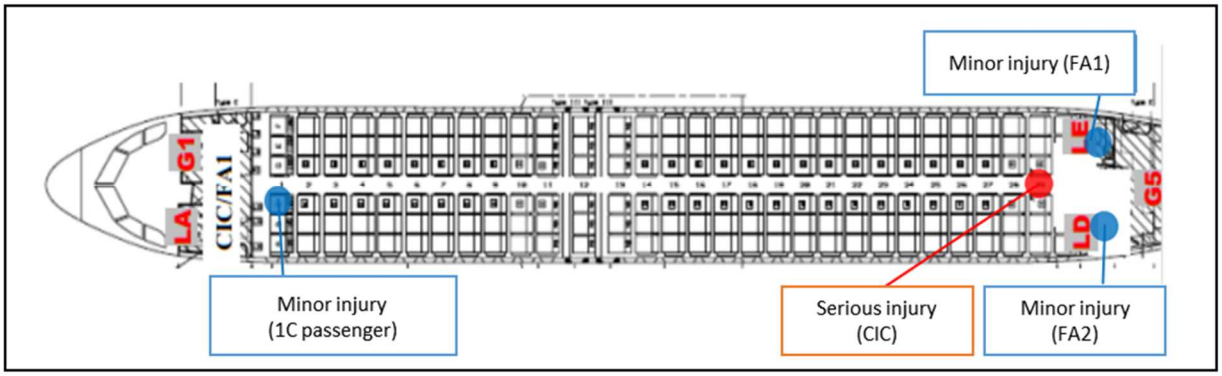


Figure 1 Positions of the injured when the accident occurred

A nurse, who was onboard as a passenger, engaged in nursing the injured. The PIC switched the roles of the CIC to FA2 as the PIC was debriefed that the CIC had a bad condition of the injury.

Besides, the PIC had a mechanic onboard check the damaged points and was reported by the mechanic that the checking, even visual, found nothing unusual as might adversely affect the flight.

Although considering landing at the nearest airport from the condition of the injured CIC, the PIC decided to continue the flight to Taiwan Taoyuan International Airport as the PIC was reported that the CIC could endure the pain even if the aircraft continued the flight.

The FO reported via ACARS*6 to the OCC the situations inside the aircraft and requested for arrangements of mechanics, ambulances, and wheelchairs when the aircraft arrived at Taiwan Taoyuan International Airport. Besides, the FO reported to Fukuoka Air Control Center the location of encountering the turbulence and the extent of the shaking.

*6 "ACARS" is an abbreviation of Aircraft Communication Addressing and Reporting System that enables information necessary for flight operations to be exchanged between aircraft and the ground station as air-ground digital data link system via communication networks of ARINC. Data such as departure and arrival times, departure and destination aerodromes, flight number, and fuel loaded are transmitted to ACARS radio station on the ground via radio communication system of data link.

The PIC altered the cruising altitude to FL340 considering weather conditions ahead.

The subsequent flight was smooth, and the aircraft uneventfully landed at Taiwan Taoyuan International Airport about 18:27.

The CIC disembarked from the aircraft using a wheelchair and was diagnosed as the right ankle sprain at the airport clinic. The CIC, however, went to hospital following day because of the pain the CIC kept suffering, and was diagnosed as the right ankle bone fracture. Immediately after the aircraft had landed at Taiwan Taoyuan International Airport, mechanics at the maintenance station of Taiwan Taoyuan International Airport inspected the aircraft. As a result of the inspection, the engines and airframe were found to be free from damage. The inspection found damage to the ceilings above passenger seats and door panels at seven points that were assumed to have been caused by the impact of cabin crew and passengers during the turbulence (see Figure 2).

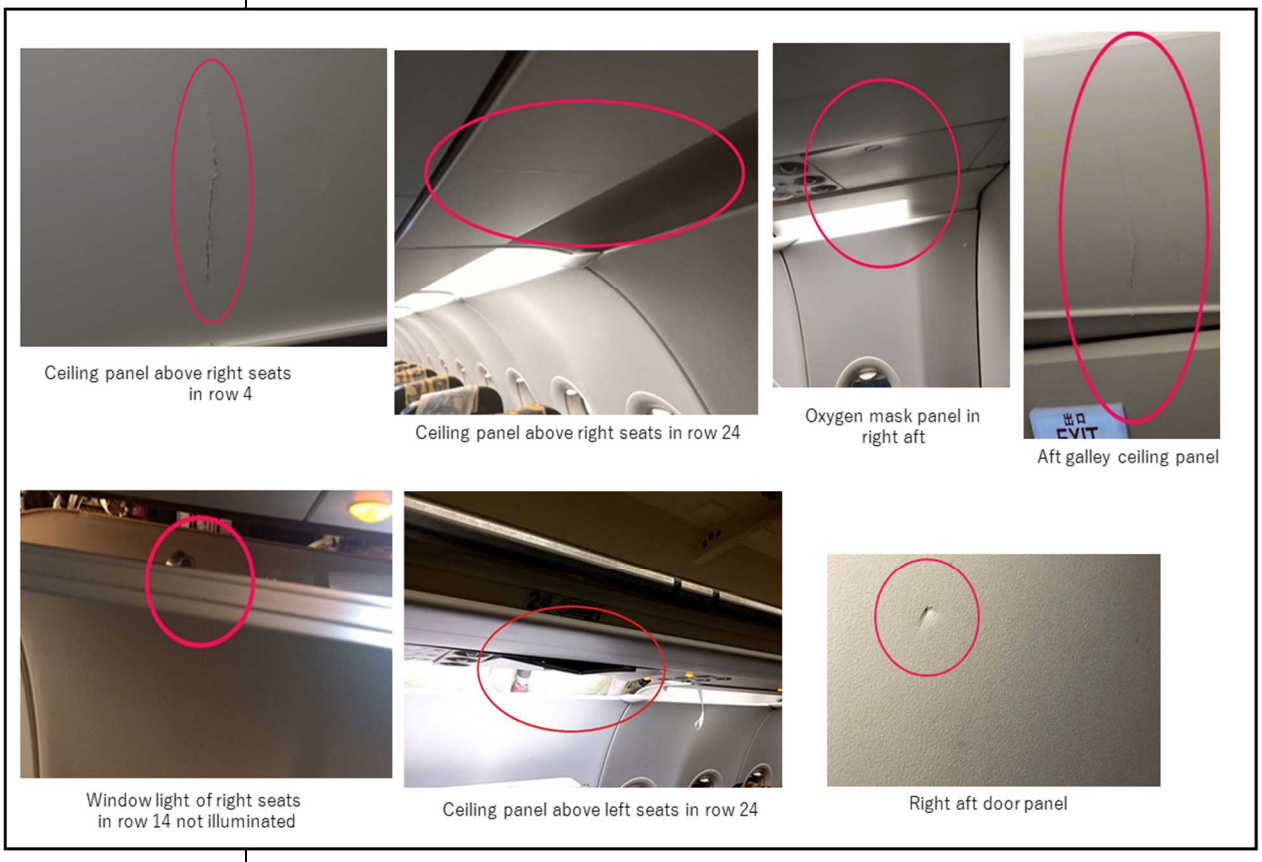


Figure 2　Damage inside passenger cabin

The accident occurred at FL300 over approximately 100 km north-northeast of Miyazaki Airport (32’38”01 N, 131’58”20 E) about 16:12 on December 25, 2019 (see Figure 3(3)).

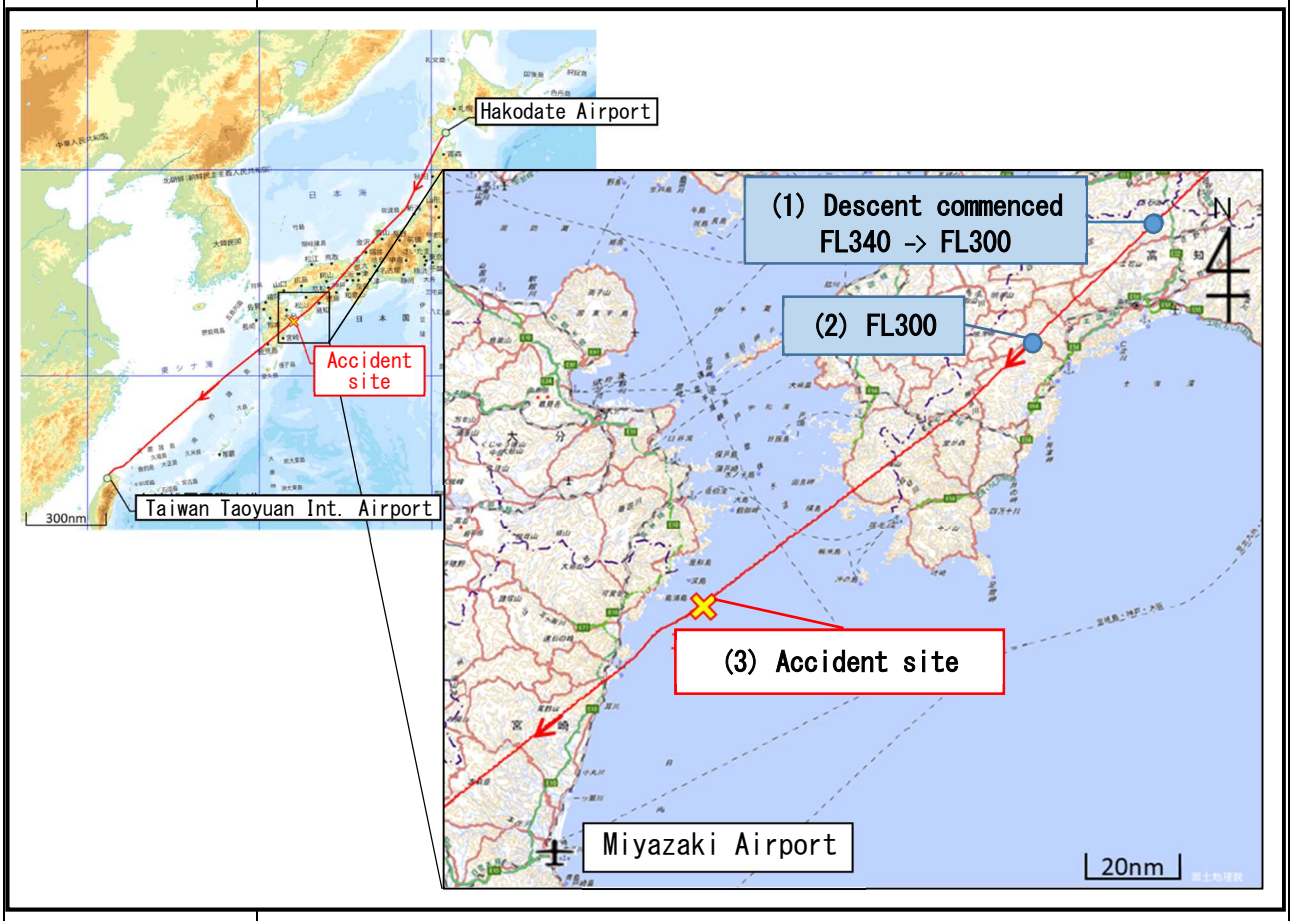


Figure 3 Estimated flight route

2.2 Injuries to Persons

	Persons onboard			Others	Total
	Flight crew	Cabin crew	Passengers		
Dead or missing	0	0	0	0	0
Seriously injured	0	1	0	0	1
Slightly injured	0	2	1	0	3
Not injured	2	1	163	0	166
Total	2	4	164	0	170

2.3 Damage to the Aircraft

Slightly damaged

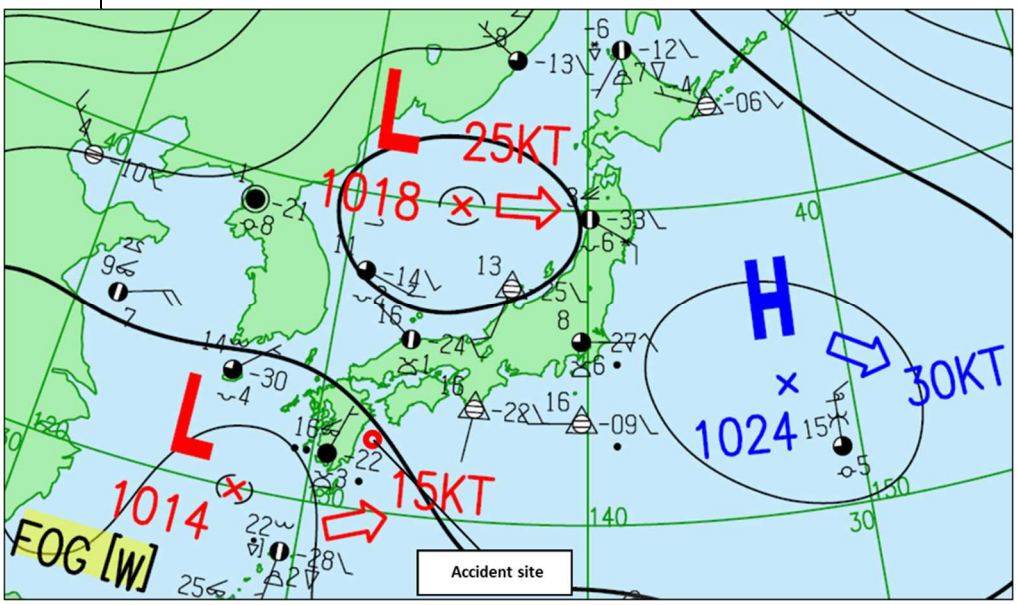
2.4 Personnel Information

(1) The PIC: Age 43

Airline transport pilot certificate (airplane) June 30, 2019

Type rating for Airbus A320 May 19, 2016

Total flight time 15,245 hours 34 minutes

	Flight time in the last 30 days 89 hours 47 minutes Total flight time on the type of the aircraft 6,183 hours 04 minutes Flight time in the last 30 days 89 hours 47 minutes (2) The FO: Age 35 Commercial pilot certificate (airplane) February 18, 2017 Type rating for Airbus A320 August 21, 2017 Instrument flight certificate included in Proficiency certificate Total flight time 2,361 hours 54 minutes Flight time in the last 30 days 83 hours 30 minutes Total flight time on the type of the aircraft 2,110 hours 36 minutes Flight time in the last 30 days 83 hours 30 minutes
2.5 Aircraft Information	(1) Aircraft type Airbus A320-232 Serial number 06187 Date of manufacture August 28, 2014 Certificate of airworthiness No. 108-08-175 Validity: August 15, 2020 Total flight time 18,186 hours 08 minutes (2) When the accident occurred, the weight and position of the center of gravity of the aircraft are estimated to have been within the allowable ranges. (3) The aircraft, which was installed with the FDR and cockpit voice recorder (CVR), had continued its flights (eight hours or longer) until the flight in question was recognized as the accident. Due to the continued flights, CVR (capable of recording for two hours) was not removed from the aircraft as the record had been obviously overwritten and erased.
2.6 Meteorological Information	(1) General weather forecasts The Asia Pacific Surface Analysis Chart (Figure 4) as of 15:00 on December 25, 2019, showed that low pressure, which generated in the west of Kyushu, was developing and moving to the east.  Figure 4 Excerpt from the Asia Pacific Surface Analysis Chart as of 15:00 on December 25, 2019 (2) Significant Weather Analysis Chart

Significant Weather Analysis Chart (Figure 5) as of 15:00 on December 25, 2019, showed two strong wind axes in the vicinity of Japan accompanying a jet stream. The southern strong wind axis out of the two was reaching the east of Japan from the west of Kyushu via the vicinity of the accident site and through the south of Shikoku.

Moderate to severe clear air turbulence area existed at FL270 through FL360 in the southern strong wind axis over Kyushu and was moving to the east at 20 kt (area of circled "1" in Figure 5).

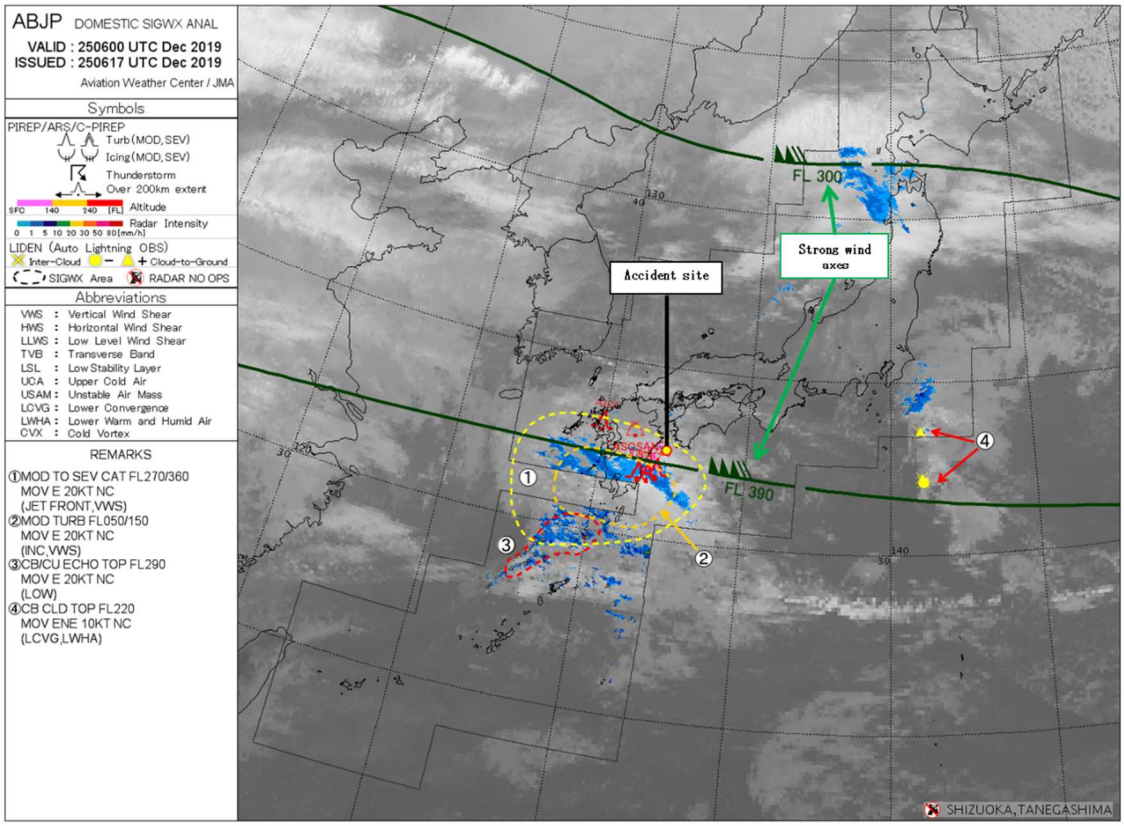


Figure 5 Significant Weather Analysis Chart as of 15:00 on December 25, 2019

(3) Satellite image (visualized image)

Satellite image (visualized image in color covering the areas of Japan and from 130° through 134° E to 31° through 34° N) (Figure 6) as of 16:00 on December 25, 2019, showed the high clouds with cloud top height of 33,000 ft along the southern jet stream shown in the Significant Weather Analysis Chart, the shape of which formed a transverse line*7 indicating disturbance of the atmosphere, that reached the south of Shikoku from the west of Kyushu via the accident site.

*7 "Transverse line" is a type of cirrus that consists of many small cloud lines that cross the direction of the flow at the right angle, and mostly appears near a jet stream.

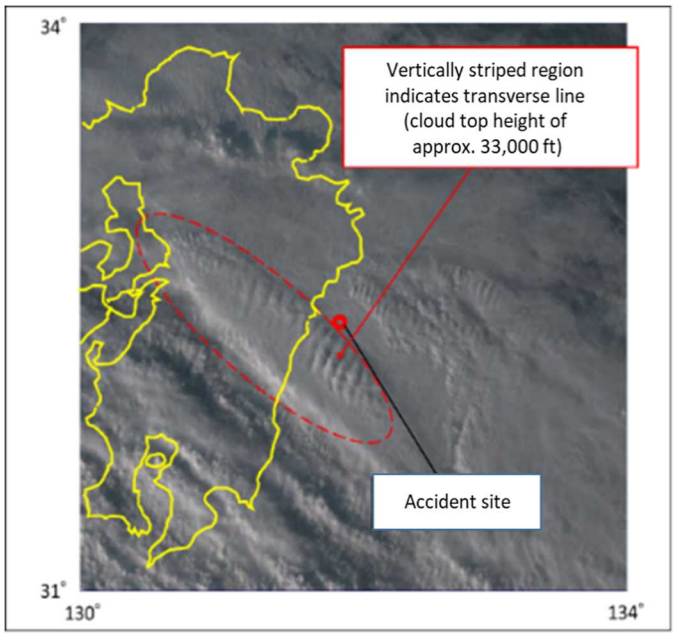


Figure 6　Satellite Image Excerpt as of 16:00 on December 25, 2019 (partially modified)

(4) Hourly atmosphere analysis chart (sectional view: 132.5° E)

Hourly atmosphere analysis chart (sectional view: 132.5° E) (Figure 7) as of 16:00 on December 25, 2019, showed Vertical Wind Shear (VWS) area, which indicated disturbance of the atmosphere, at an altitude near 33,000 ft where the transverse line generated, and in the skies below the southern strong wind axis. The VWS area at 15 through 18 kt/1,000 ft was shown in the vicinity of the accident site.

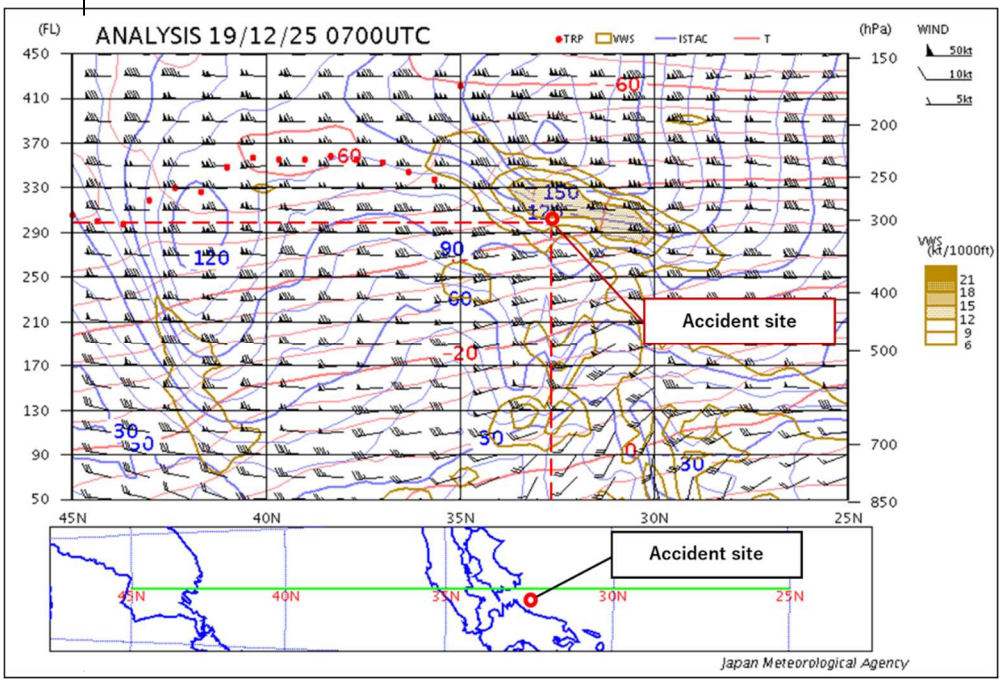


Figure 7　Hourly atmosphere analysis chart (sectional view: 132.5' E) as of 16:00 on December 25, 2019

(5) SIGMET

SIGMET released by the Japan Meteorological Agency at 14:00 on December 25, 2019, was as follows:

During the period from 14:00 until 18:00, severe turbulence was predicted at FL270 through FL350 in the area of 28°40" N, 127° 40" E, 32°20" N, 127°20" E, 34°00" N, 136°00" E, 29°40" N, 135°10" E, and 28°40" N, 127°40" E (see Figure 8), which would move to the east at 20 kt for further development.

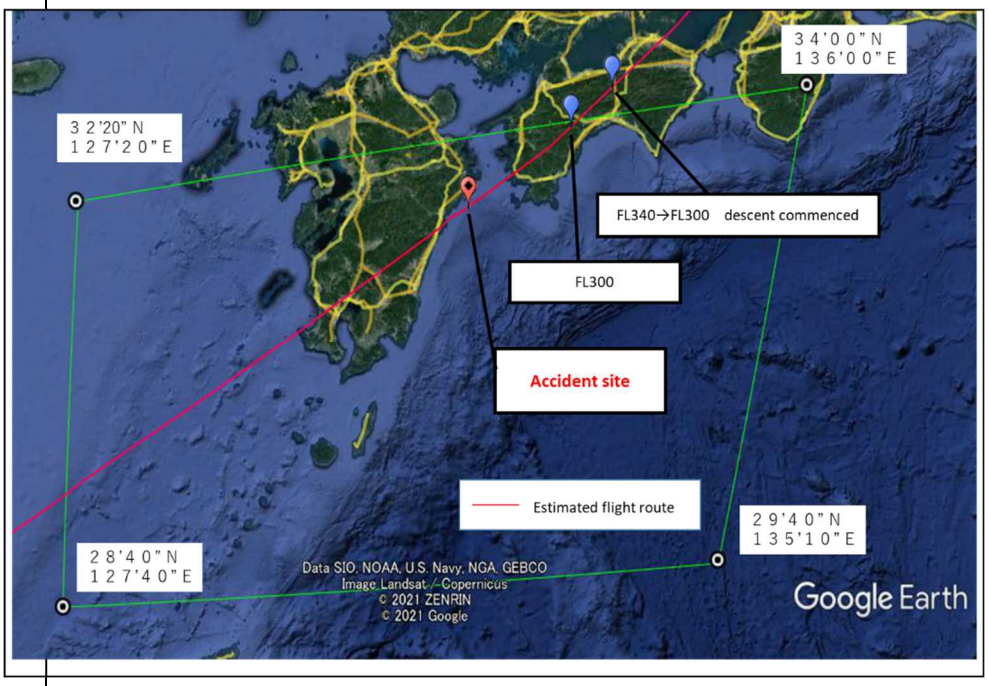


Figure 8 SIGMET released at 14:00 on December 25, 2019

(6) Pilot Report (PIREP)

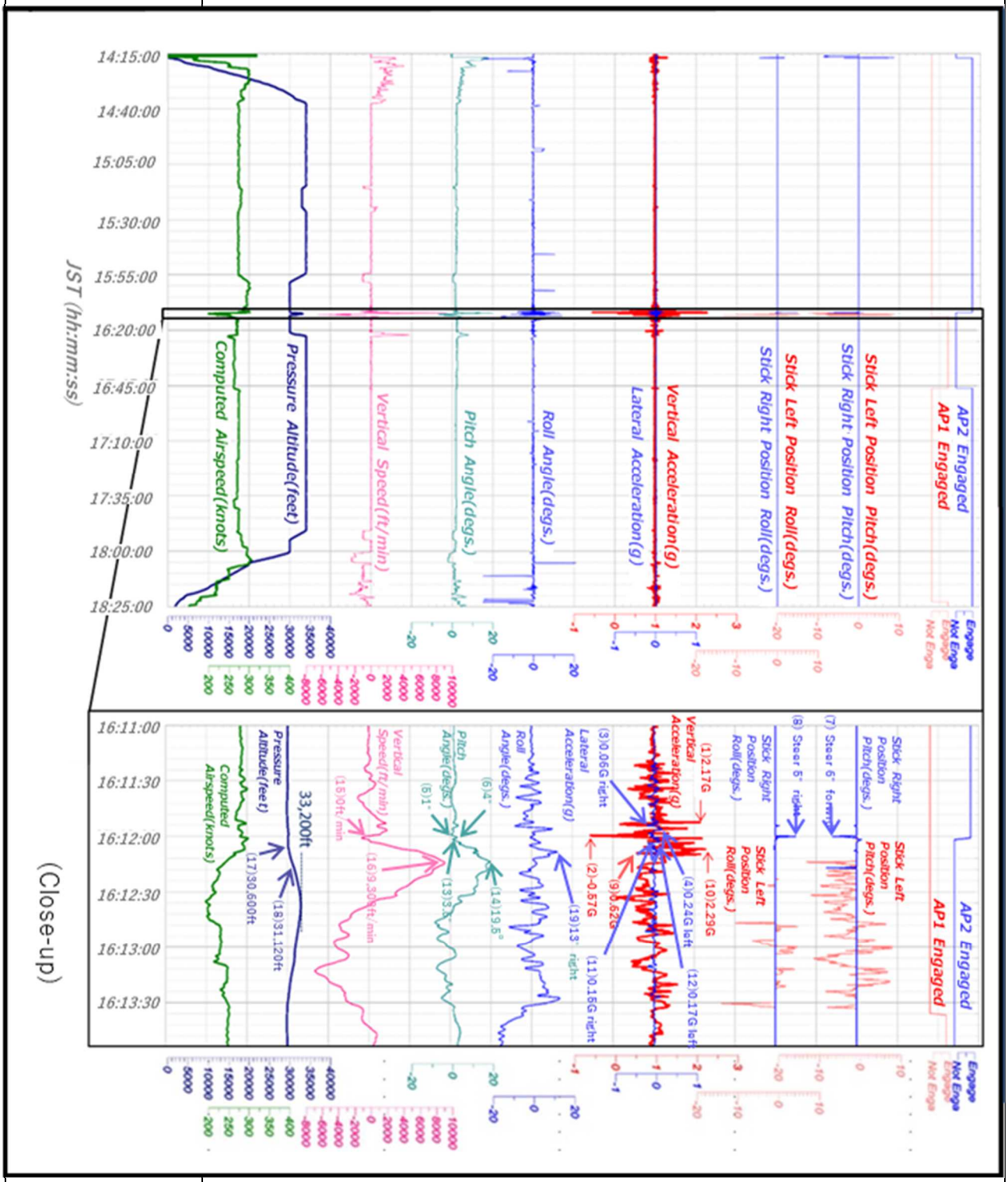
Up until the aircraft descended from FL340 at 15:54, there was no Pilot Report (PIREP) of turbulence at FL300.

During the period from 16:06 until 16:25, there were four PIREP to encounter a moderate turbulence in the airspace within a radius of 40 nm from the accident site; two PIREP at FL300 including one from the accident aircraft, and one each at FL310 and FL320.

2.7 Additional Information

(1) Record of the FDR

According to the FDR of the accident aircraft, vertical acceleration fluctuated in the range from 2.17 G (see Figure 9 (1)) to minus 0.57 G (see Figure 9 (2)). Lateral acceleration at that time fluctuated in the range of 0.06 G maximum to the right (see Figure 9 (3)) and 0.24 G maximum to the left (see Figure 9 (4)). Pitch angle fluctuations were from 1° (see Figure 9 (5)) to 4° (see Figure 9 (6)). When vertical acceleration began to increase from minus 0.57 G (see Figure 9 (2)) at 16:12:01, the FO as PF pushed the sidestick to 6° forward (see Figure 9 (7)) and 5° to the right (see Figure 9 (8)), which caused the Autopilot to be disengaged at 16:12:03. In the following 13 seconds, there was no record that flight crew pushed the sidestick in the right pilot and left pilot seats. During the period from 16:12:02 until 16:12:15, vertical acceleration

	fluctuated in the range between 0.62 G (see Figure 9 (9)) and 2.29 G (see Figure 9 (10)). Lateral acceleration at that time fluctuated in the range of 0.15 G maximum to the right (see Figure 9 (11)) and 0.17 G maximum to the left (see Figure 9 (12)). Pitch angle increased from 3.5° (see Figure 9 (13)) to 19.5° (see Figure 9 (14)). Vertical speed increased from 0 ft/min (see Figure 9 (15)) to 9,300 ft/min (see Figure 9 (16)), and pressure altitude rose from 30,600 ft (see Figure 9 (17)) to 31,120 ft (see Figure 9 (18)). About 16:12:10, roll angle temporarily leaned 13° to the right (see Figure 9 (19)).
	
	Figure 9　FDR record

	(2) Regulations of the company FCOM*8 of the company contains following description as condition for disengaging the Autopilot system. (excerpt) ● *The Autopilot disengages when the flight pushes on the sidestick harder than a defined threshold* (3) Disengaging the Autopilot by steering the sidestick According to the Design and Manufacturer of the aircraft, the Autopilot disengages when the flight crew applies a pitch the sidestick input larger than 5º front-side or back-side.

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) Weather conditions The JTSB concludes that it is highly probable that the severe wind shear existed along the jet stream around the time of the accident occurrence since the transverse line of the high clouds and vertical wind shear area were observed in the vicinity of the accident site. The aircraft is highly probable to have fiercely shaken by encountering the wind shear. (2) The aircraft shaking The JTSB concludes, from the record of the FDR, that it is probable that vertical acceleration abruptly fluctuated by encountering the disturbance about 16:12:00, which caused the aircraft to fiercely shake. The CIC, who was moving on the aisle to return to the Jump Seat in the forward from the aft passenger cabin, is highly probable to have fallen by the fierce shake and sustained the right ankle bone fracture. (3) Judgment of flight crew The JTSB concludes that it is probable that flight crew predicted not to encounter such severe turbulence as the one they encountered although they predicted a chance to encounter turbulence from meteorological data confirmed prior to the departure, airborne weather radar display and PIREP. However, if the flight crew had obtained SIGMET released by the Japan Meteorological Agency at 14:00, it would have been useful for them to make judgements beforehand on changing flight altitude and flight route and the necessity and timing for illuminating seatbelt sign and providing safety information. (4) Flight operation supporting system of the company The JTSB concludes that the OCC is probable not to have obtained

*8 "FCOM" is regulations abbreviating Flight Crew Operation Manual, which is established by the operating company and contains information relating to operation limitation, procedures, performance, and system required for safe and efficient operations of aircraft by flight crew.

	SIGMET released by the Japan Meteorological Agency at 14:00. Since SIGMET is the information on significant changes in weather conditions pertaining to safety of the flight, it is probable to be useful to prevent recurrence of similar accidents that the OCC has system in place to obtain SIGMET information in a timely manner and provide it with flight crew as appropriately. (5) Autopilot disengagement The JTSB concludes, from the record of the FDR, that the Autopilot is highly probable to have been disengaged at 16:12:03. It is probable that the FO unintentionally pushed the sidestick forward when the aircraft fiercely shook, and the steering amount exceeding the threshold value (5° forward) preset for the Autopilot disengagement led to the Autopilot disengagement. It is probable that the Autopilot disengagement affected subsequent behaviors of the aircraft. It could not determined whether the bone fracture of the CIC occurred before or after the Autopilot disengagement.

4. PROBABLE CAUSES

The JTSB concludes that the aircraft fiercely shook by encountering the wind shear near the jet stream, which caused the cabin crew member who was moving on the aisle in the passenger cabin to fall and sustain serious injury.

5. SAFETY ACTIONS

The company has taken following measures as safety actions.

(1) FOM was revised to incorporate that flight crew conduct a short briefing on flight time and weather conditions through CIC or passenger address system even in return flight of the round flight.

(2) As the OCC duty, they were decided to receive by system SIGMET released any time by the Japan Meteorological Agency and automatically transfer such information to flight crew in flight using ACARS.