

AA2023-4

**AIRCRAFT ACCIDENT
INVESTIGATION REPORT**

**Star Flyer Inc.
J A 2 4 M C**

June 29, 2023

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

PASSENGER INJURY BY THE SHAKING OF THE AIRCRAFT STAR FLYER INC.

AIRBUS A320-214, JA24MC
AT FL 280 OVER KURASHIKI CITY,
OKAYAMA PREFECTURE, JAPAN
AT ABOUT 19:48, JANUARY 16, 2022

May 26, 2023

Adopted by the Japan Transport Safety Board

Chairperson TAKEDA Nobuo
Member SHIMAMURA Atsushi
Member MARUI Yuichi
Member SODA Hisako
Member NAKANISHI Miwa
Member TSUDA Hiroka

1. PROCESS AND PROGRESS OF THE AIRCRAFT ACCIDENT INVESTIGATION

1.1 Summary of the Accident	On January 16 (Sunday), 2022, an Airbus A320-214, JA24MC, operated by Star Flyer Inc., took off from Tokyo International Airport as scheduled Flight 87. While flying for Kitakyushu Airport, the aircraft was shaken, and a passenger was seriously injured.
1.2 Outline of the Accident Investigation	<p>On February 4, 2022, the Japan Transport Safety Board (JTSB) designated an investigator-in-charge and an investigator to investigate this accident.</p> <p>An accredited representative and an advisor of the French Republic, as the State of Design and Manufacture of the aircraft involved in this accident, participated in the investigation.</p> <p>The accident occurred on January 16, 2022, and was set to be treated as the accident on February 4, 2022.</p> <p>Comments were invited from parties relevant to the cause of the accident and the Relevant State.</p>

2. FACTUAL INFORMATION

2.1 History of the Flight	According to the statements of the pilot in command (PIC), the first officer (FO), All cabin crewmembers (three) and an injured passenger as well as QAR*1 records of the Aircraft and the air traffic control (ATC) communication records, the history of the flight is summarized as below.
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*1 "QAR(Quick access recorder)" refers to a recording device that can store almost the same amount of flight data as that of FDR, and the operator can select items of flight data to be recorded.

At 18:48 Japan Standard Time (JST: UTC + 9hrs, unless otherwise stated all times are indicated in JST on a 24-hour clock) on January 16, 2022, an Airbus A320-214, JA24MC, operated by Star Flyer Inc., took off from Tokyo International Airport for Kitakyushu Airport as scheduled



Figure 1: Accident aircraft

Flight 87, with 56 people on board, consisting of the PIC, four other crewmembers, and 51 passengers. In the cockpit of the Aircraft, the PIC sat in the left seat as PM*² and the FO*² in the right seat as PF.

The flight crewmembers had flown the Aircraft from Kitakyushu Airport to Tokyo International Airport before the flight on the scheduled Flight 87, and held a briefing with the flight dispatcher for the previous flight and the scheduled Flight 87 that was a return flight before the departure at Kitakyushu Airport. In order to avoid turbulence due to the effect of the jet axis (maximum region of the wind speed of the jet stream) located near the pressure altitude of 32,000 ft (Flight Level (FL)*³ 320), the PIC increased altitude higher than usual and provisionally set as its planned cruising altitude for the Flight 87 at FL 380 where head wind was strong but the airflow was stable. It was decided that the final planned cruising altitude would be decided obtaining the latest weather information after the previous flight arrived at Tokyo International Airport. In addition, the flight crews obtained the information that during cruising, there was only a temporary light*⁴ -minus turbulence, and there was no turbulence during climb and descent from the flight crews who had flown from Tokyo International Airport to Kitakyushu Airport at FL 300 at the boarding bridge in the Kitakyushu Airport before departure for Flight 87.

During the flight from Kitakyushu Airport to Tokyo International Airport prior to the scheduled Flight 87, the cruising altitude was FL 390 and the airstreams were smooth. The flight crews felt that the airstreams around FL 280 was good while descending to Tokyo International Airport.

After arriving Tokyo International Airport, the flight crews confirmed the latest weather information including the Pilot Report (PIREP), and changed the planned cruising altitude for the scheduled Flight 87 to FL 280.

When providing a pre-flight briefing on the scheduled Flight 87 to the Crew in Charge (CIC), the FO told them that the seat belt sign would be turned

*² "PF and PM" is a term for identifying a pilot from role sharing in an Aircraft controlled by two people. The PF (Pilot Flying) is mainly responsible for maneuvering the aircraft. The PM (Pilot Monitoring) mainly performs monitoring of flight condition of the aircraft, and makes cross check of operation of PF and operations other than maneuvering.

*³ "FL" is the altitude expressed as a numerical value obtained by dividing the altimeter instruction (unit: ft) when the altimeter setting value is set to 29.92 inHg at the pressure altitude of the standard atmosphere by 100. Flight levels are usually used in flight altitudes above 14,000 ft in Japan. As an example, FL 320 represents altitude 32,000 ft.

*⁴ "Light" refers to the "light" level of turbulence, which is classified into "light", "moderate", "severe" and "extreme". "Light" is further subdivided into "light-minus," "light," and "light-plus." Light-minus indicates the level of turbulence that allows in-flight services without difficulty. Light indicated the level of turbulence that allows in-flight services but requires attention, and Light Plus represents the level of turbulence that requires extreme caution for providing in-flight services, which may be temporarily put on hold.

off 10 minutes after the take-off, after that, for 30 minutes until reaching the sky above Osaka Prefecture, the airstreams would be good, and for 42 minutes after that, some light-minus to light level of turbulence would be expected.

After the passengers on board the scheduled Flight 87 and the doors were closed, the CIC made an announcement to the passengers, saying, "In the air, turbulence is expected in some areas, please make sure that your seat belt is securely fastened tight and low. Thank you." The phrase "low" is not in the Company's announcement handbook, but was added by the CIC from experience.

Before the take-off, all cabin crewmembers visually checked whether the passengers fastened their seat belts, whether the seat belts were not twisted or loose, whether they maintained a seated position, and the status of fastening seat belts for infants (with only the parent or guardian wearing the belt and holding the infant on his or her lap). As a result, no special precautions were found regarding the passengers' seat belt use.

After taking off from Tokyo International Airport, the Aircraft reached the planned cruising altitude of FL 280. However, as there was light turbulence, taking into consideration the weather conditions, fuel consumption and others, the flight crews changed the altitude to FL 300 after obtaining permission from the ATC facility. After the Aircraft reached FL 300, the flight crews confirmed the airstream was calm and turned off the seat belt sign.

The CIC made an announcement, saying, "The seat belt sign has been turned off. However, for your safety, please keep your seat belt fastened while seated. Thank you."

All cabin crewmembers finished the in-flight service until reaching the sky above Shiga Prefecture.

From around when the Aircraft passed over Otsu City, Shiga Prefecture, the Aircraft encountered light-minus turbulence, thus lowered the altitude to FL 280 after obtaining a permission from the ATC facility. The airstream around FL 280 was calm. There were no prominent clouds on the flight route.

Over Okayama Prefecture, the FO left the pilot seat to use the lavatory entrusting the PF duties to the PIC. At the time, the FO asked the PIC to descend to FL 260, which would be less susceptible to jet stream, if there was any turbulence. The cabin crewmember (R1), who was in charge of mainly the forward end of the cabin, entered the cockpit in exchange with the FO in accordance with the Company's regulations and got seated in the observer's seat.

When the FO was out of the lavatory, there was clattering turbulence. The PIC flying the Aircraft felt that the turbulence was some light but braced themselves for a bigger shaking, as it was suddenly shaken when the airstream was calm. Although there was no significant turbulence, it could not be contained even after a few seconds, thus, the PIC turned on the seat belt sign, requested the ATC facility for a descent to FL 260, and commenced to descend after obtaining permission from the ATC facility at 19:47:44. As the fasten seat belt sign was turned on, the recorded announcement was automatically made

in the cabin as follows: "Ladies and gentlemen, the captain has turned on the seat belt sign. Please return your seats and keep your seat belts fastened while the sign is on. Thank you. "

The CIC, who was near the lavatory in the forward cabin section, grabbed the assist handle by the window to hold themselves against the continued shaking, but was feeling that the shaking was not such that passengers would feel sick or scream. The passengers in the cabin appeared to be calm.

The passenger in Seat 23A was seated with their seat belt fastened even after the fasten seat belt sign was turned off. However, due to that continued shaking, the passenger hit their right side against the armrest (at about 19:47:50). The passenger felt that the continued shaking was not vertical but lateral, and the greatest ever the passenger had experienced.

The cabin crewmember in charge of mainly the aft cabin area (AC), who was near the aisle in the aft cabin section, returned to AC's attendant seat in the aft cabin section by walk and got seated, as there were shaking. The shaking was not vertical but lateral, and AC felt that it was not so strong as to need to crouch or grab something to hold. When there were shaking, a passenger, who was using the lavatory in the right aft cabin section, returned to Seat 26D with no particular difficulty in walking after the fasten seat belt sign was turned on.

While the shaking continued, the FO was able to return to the cockpit with neither staggering due to the shaking nor holding onto something. Therefore, the flight crews judged that it was some light turbulence that they had encountered at that time.

After descending to FL 260, the flight crews turned off the fasten seat belt sign and reported to the Company that the turbulence they had encountered was light by radio.

The CIC made a normal announcement described in the Company's announcement handbook, saying, "The seat belt sign has been turned off, but for your safety, please keep your seat belt fasten at all times while seated. Thank you."

After that, when making rounds to confirm, all cabin crewmembers performed a visual inspection to check whether the passengers fastened their seat belts, whether there were abnormal noises or smell in the cabin, whether there were any problems, and whether any passengers had any requests, but it found no particular abnormality.

Even 10 minutes before the Aircraft landed, all cabin crewmembers performed a cabin check, which found no abnormality.

The airstream at FL 260 was calm, and after that, the Aircraft landed at Kitakyushu Airport at 20:22.

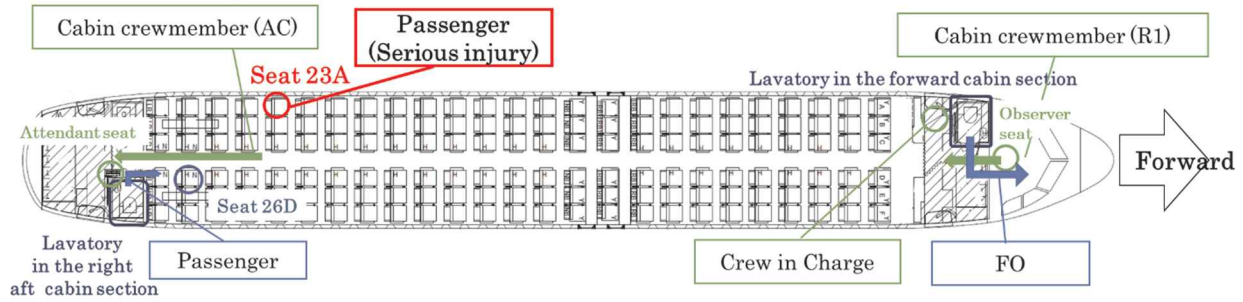


Figure 2: Seating chart

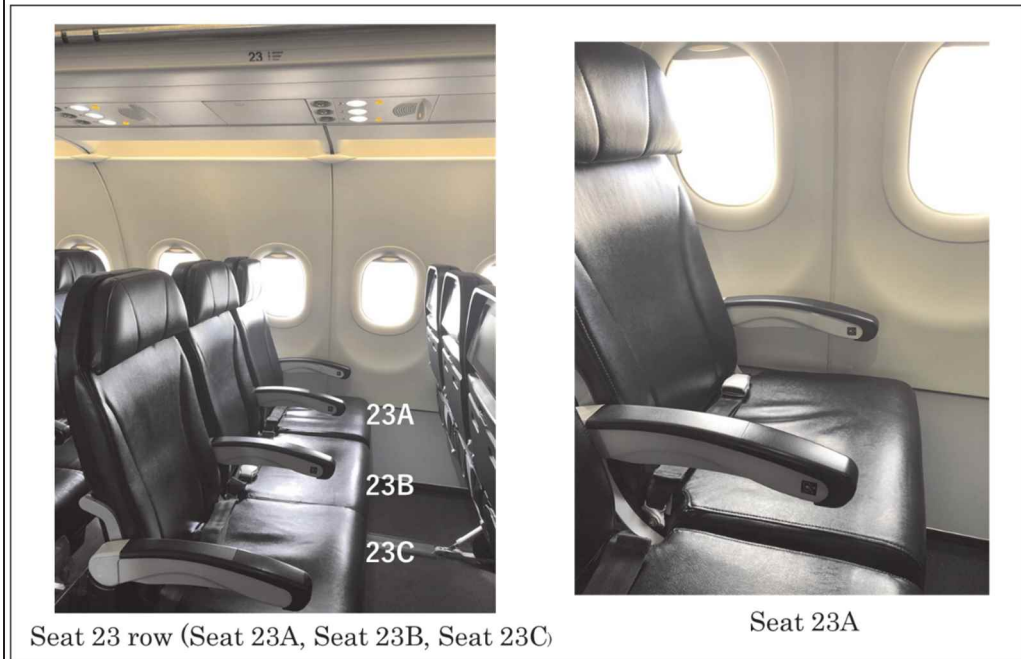


Figure 3: Seat 23A

When all passenger disembarked, all cabin crewmember felt that there was nothing wrong with the passengers, therefore, the CIC on behalf of all cabin crewmembers, informed the PIC of the situation accordingly.

After disembarking, the flight crews reported to the Company that they did not encounter particularly strong turbulence as for the scheduled Flight 87.

The passenger, who had hit their right side against the armrest, felt pain but thought that it would be cured with poultice applied, however, the pain would not go away. Therefore, on January 24, 2022, the passenger visited a medical institution, and was diagnosed with a rib fracture.

This accident occurred about 19:48, on January 16, 2022, at FL 280 over Kurashiki City, Okayama Prefecture (Latitude 34°34' 49" N and Longitude 133°49' 38" E).



Figure 4: Estimated flight route

2.2 Injuries to Persons	One passenger was seriously injured (9 th rib fracture)																																		
2.3 Damage to the Aircraft	None																																		
2.4 Personnel Information	<p>(1) PIC: Age 47</p> <table border="0"> <tr> <td>Airline transport pilot certificate (airplane)</td> <td>June 13, 2018</td> </tr> <tr> <td>Type rating for Airbus A320</td> <td>August 2, 2013</td> </tr> <tr> <td>Class 1 aviation medical certificate</td> <td></td> </tr> <tr> <td>Validity</td> <td>July 12, 2022</td> </tr> <tr> <td>Total flight time</td> <td>11,349 hours 56 minutes</td> </tr> <tr> <td>Flight time in the last 30 days</td> <td>38 hours 37 minutes</td> </tr> <tr> <td>Total flight time on the type of the aircraft</td> <td>6,102 hours 05 minutes</td> </tr> <tr> <td>Flight time in the last 30 days</td> <td>38 hours 37 minutes</td> </tr> </table> <p>(2) FO: Age 31</p> <table border="0"> <tr> <td>Commercial pilot certificate (airplane)</td> <td>October 19, 2015</td> </tr> <tr> <td>Type rating for Airbus A320</td> <td>December 22, 2017</td> </tr> <tr> <td>Instrument flight certificate (airplane)</td> <td>December 12, 2016</td> </tr> <tr> <td>Class 1 aviation medical certificate</td> <td></td> </tr> <tr> <td>Validity</td> <td>April 24, 2022</td> </tr> <tr> <td>Total flight time</td> <td>2,663 hours 29 minutes</td> </tr> <tr> <td>Flight time in the last 30 days</td> <td>49 hours 51 minutes</td> </tr> <tr> <td>Total flight time on the type of the aircraft</td> <td>2,381 hours 41 minutes</td> </tr> <tr> <td>Flight time in the last 30 days</td> <td>49 hours 51 minutes</td> </tr> </table>	Airline transport pilot certificate (airplane)	June 13, 2018	Type rating for Airbus A320	August 2, 2013	Class 1 aviation medical certificate		Validity	July 12, 2022	Total flight time	11,349 hours 56 minutes	Flight time in the last 30 days	38 hours 37 minutes	Total flight time on the type of the aircraft	6,102 hours 05 minutes	Flight time in the last 30 days	38 hours 37 minutes	Commercial pilot certificate (airplane)	October 19, 2015	Type rating for Airbus A320	December 22, 2017	Instrument flight certificate (airplane)	December 12, 2016	Class 1 aviation medical certificate		Validity	April 24, 2022	Total flight time	2,663 hours 29 minutes	Flight time in the last 30 days	49 hours 51 minutes	Total flight time on the type of the aircraft	2,381 hours 41 minutes	Flight time in the last 30 days	49 hours 51 minutes
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of 9-12 kt/1,000 ft was forecast at FL260 to FL290 in the vicinity of the accident site.

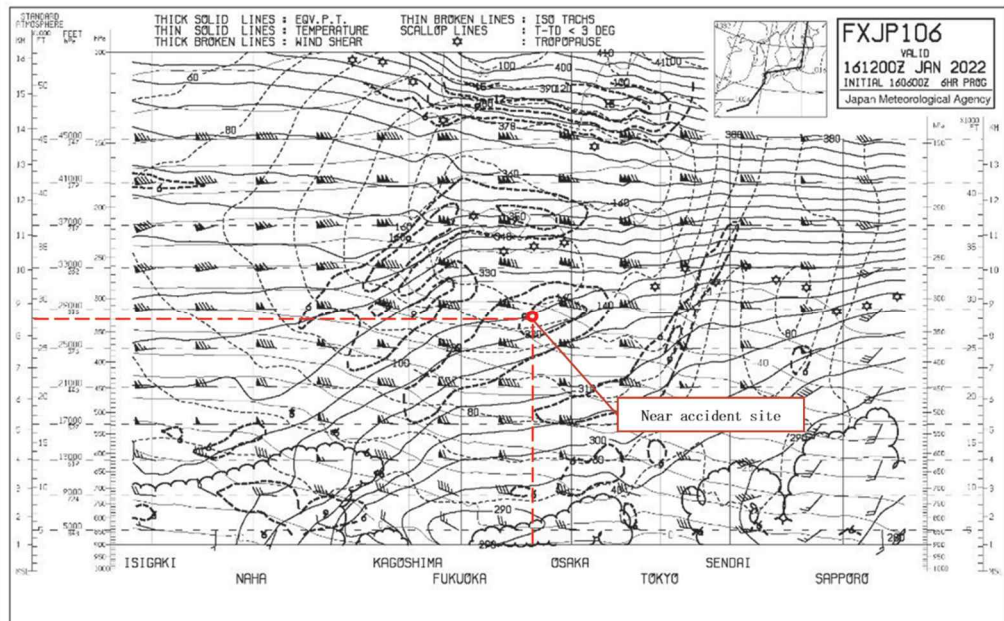
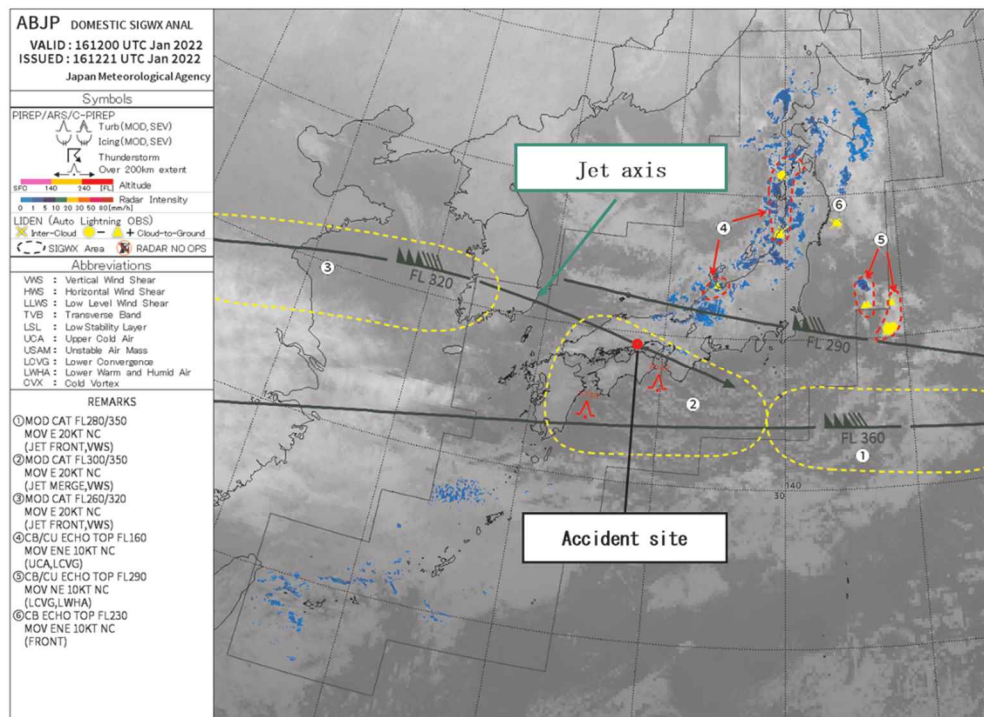


Figure 6: Domestic Air-route Forecast Cross Section Chart (FXJP106)

(3) Domestic significant weather analysis

According to the domestic significant weather analysis for 21:00 on January 16, 2022 (Figure 7), issued by the Meteorological Agency, there was jet stream with the jet axis of 190 kt at FL 320 from San-in through Kinki regions.



(Figure 8) for 20:00 on January 16, 2022, issued by the Meteorological Agency, VWS of 9-12 kt/1,000 ft was shown at FL260 to FL290 in the vicinity of the accident airspace.

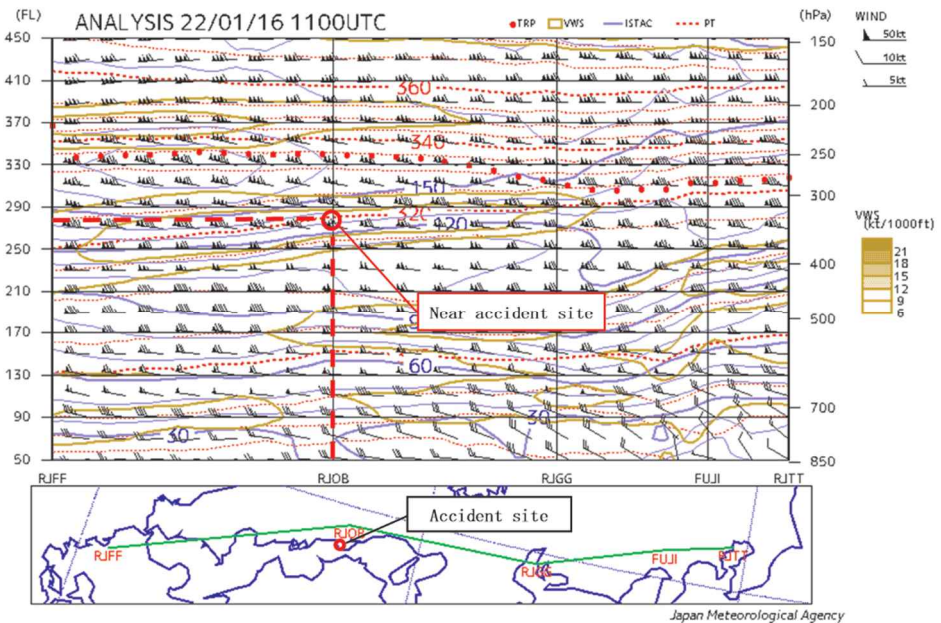


Figure 8: Hourly analysis chart (cross section: Fukuoka – Tokyo)

(5) PIREP

According to a PIREP provided by the Meteorological Agency, at 19:48, there was the report about moderate*6 (MOD) turbulence at FL 300, a point of 14 nm northwest of the accident site.

(6) Radar composite chart (Echo strength and top height)

According to the radar composite chart (Echo strength and top height)(Figure 9) for 19:50 on January 16, 2022, issued by the Meteorological Agency, no cloud of the echo was observed in the vicinity of the Aircraft's flight route that would cause the aircraft to shake.

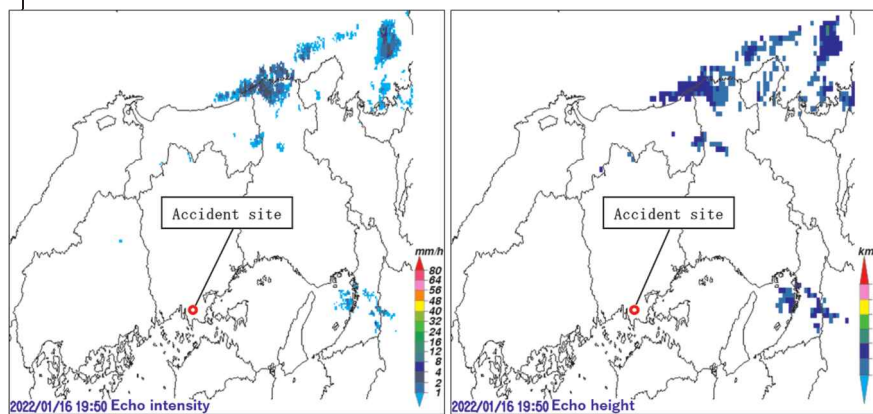


Figure 9: Radar composite chart (Echo strength and top height) at 19:50 on January 16, 2022

*6 “Moderate” represents the "moderate" level of turbulence classified as "light" "moderate" "severe" and "extreme" Moderate turbulence is turbulence such levels that causes changes in the aircraft attitude or altitude, variations in airspeed, but the aircraft remains in positive control at all times. And in the conditions with moderate turbulence, aircraft occupants would have difficulty walking and feel definite strains against seat belt, in addition, unsecured objects would be dislodged.

2.7 Additional Information

(1) QAR record

According to the QAR record of the Aircraft, the vertical acceleration showed a remarkable change from 19:47:28, and changed from +0.75G (see Figure 10 ①) to 1.36G (see Figure 10 ②) at 19:47:54. The horizontal acceleration at that time changed between 0.22G to the left (see Figure 10 ③) and 0.15G to the right (see Figure 10 ④). The pitch angle changed between +0.4° (see Figure 10 ⑤) and 1.8° (see Figure 10 ⑥). The roll angle changed between 7.7° to the left (see Figure 10 ⑦) and 3.5° to the right (see Figure 10 ⑧). The roll rate at that time was 4.5°/sec.

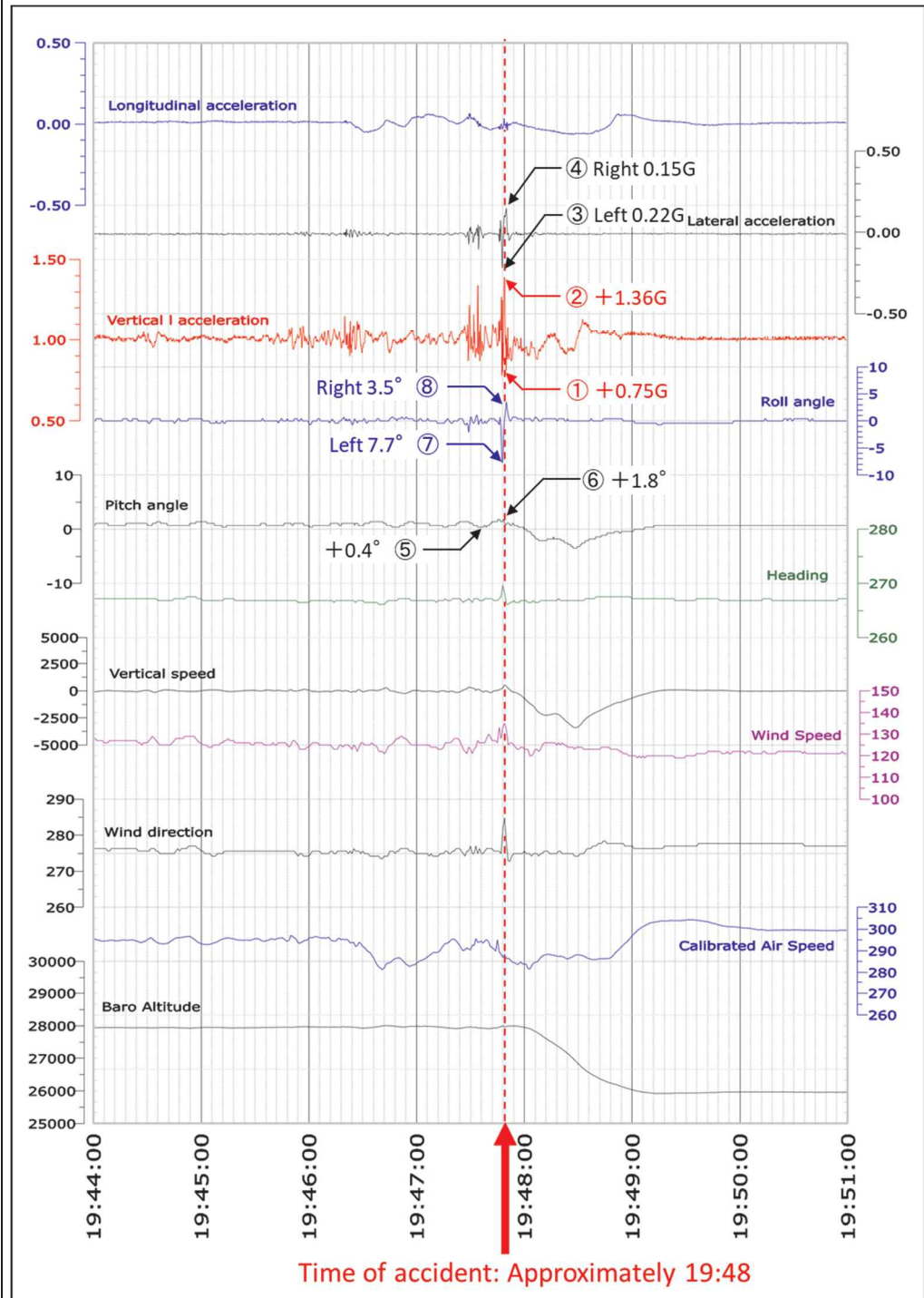


Figure 10: QAR record

(2) Regulations on confirmation of the passengers' seat belt fastening manner

The regulations of the Company on the duties of the cabin crewmembers (Cabin Attendant Manual) stipulates that "Seat belts fastened." shall be the item to be confirmed for the passengers during safety confirmation before take-off.

The Company's training materials for cabin crewmembers also lists "Seat belts fastened." as an inspection item while making rounds in the cabin during cruising. And the inspection contents regarding the seat belt use include "tighten securely fastened so that they are not twisted or loose", "pay attention to loose in child passengers' seat belts", "check the seat belt use status of seat belts when they are covered by blankets" and others, and regarding the way how to check the seat belt use, "a visual check shall be made, but when the visual check cannot be made, the check shall be made on whether the passengers use the seat belt asking them directly about it to check verbally."

(3) Regulations on announcement

The Company's announcement handbook at the time of the accident listed the following announcement phrases regarding the seat belt announcements to be made at the following each point.

a In normal condition

- Welcome announcements: "Please make sure that your seat belt is securely fastened."
- Announcement of permits for use of electronic devices, etc. and equipment during cruising: "Please remain seated with your seat belt (securely) fastened."
- Announcement when the fasten seat belt sign is turned off during cruising (for domestic flights): "The seat belt sign is now off. However, for your safety, please keep your seat belt fastened while seated."
- Announcement when the fasten seat belt sign is turned on during cruising: "Please return to your seats, fasten to your seat belt securely"
- Announcement when safety confirmation can be performed during landing preparation: "Please make sure that your seat belt is securely fastened."
- Announcement when safety confirmation cannot be performed during landing preparation: "The Captain has instructed all cabin attendants to be seated due to the turbulence. Please make sure that your seat belt is securely fastened."

b In irregular condition

- Announcement when turbulence is encountered during cruising and the shaking continues: "We are experiencing some turbulence. Please make sure that your seat belt is securely fastened."

(4) About the seats of the Aircraft

In Seat 23A, a passenger with a height of 156 cm and a weight of 42 kg was seated. This seat was an all-leather-covered seat with a seat height of 43 cm and armrest height of 63 cm.

(5) Similar cases

According to the Design and Manufacture of the seats, there have been no reports of similar cases involving the same type of the seat.

3. ANALYSIS

(1) Meteorological Information

The JTSB concludes that any radar echo was not observed in the vicinity of the accident airspace, however, clear air turbulence more likely occurred due to the jet stream.

In addition, according to the PIREP, when the accident occurred, at about 19:48, clear air turbulence occurred around the Aircraft at FL 300 at a point of 14 nm northwest from the occurrence point of the accident.

Based on the pre-flight weather information, the flight crews probably judged that there would not be such turbulence as to influence on the in-flight service until reaching the skies above Osaka Prefecture and they probably judged that some light-minus to light level of turbulence could be encountered during the subsequent flight.

(2) Aircraft's turbulence

The JTSB concludes that according to the QAR record (Figure 10), from 19:47:28 to 19:47:54, the vertical acceleration changed from +0.75 G to +1.36 G, and the horizontal acceleration changed between 0.22 G to the left and 0.15 G to the right, and that the Aircraft's turbulence was probably caused by encountering clear air turbulence created due to the jet stream, because the hourly analysis chart showed the area of vertical wind shear, and there were no clouds.

(3) Passenger injury

The armrests of the seat are 20cm high from the seat surface, which is near the height of the side of a relatively small person.

The JTSB concludes that the passenger remained seated with their seat belt fastened during the flight even after the fasten seat belt sign was turned off, however, in light of the changes in the Aircraft's horizontal acceleration (between 0.22G to the left and 0.15G to the right) and the roll angle (between 7.7° to the left and 3.5° to the right) as well as the situation of the roll rate (4.5°/sec), it is probable that when the Aircraft was shaken, the passenger was shaken from left to right and hit their right side against the armrest on the right side of the seat, resulting in their 9th rib fracture. At what speed did the passenger hit their right side against the armrest on the right side of the seat was unable to be estimated because it was unclear how strongly did the passenger fasten their seat belt.

In order to prevent horizontal movement of the hips as much as possible, it is important that passengers should always fasten the seat belt at a low waist position with no slack while seated for their own safety.

In addition, when the cabin crewmembers encourage the passengers seated to wear their seat belts it is important to actively call out to the passengers for wearing the seat belts including a proper way of fastening, even when the fasten seat belt sign is turned off.

Based on this case, it is desirable for seat makers to consider the design of seats that accommodate passengers of various body sizes by actively collecting data on similar cases.

(4) After the accident

The JTSB concludes that after the accident occurred, all cabin crewmembers made rounds and performed an inspection in the cabin, however, the passenger in Seat 23A did not report the injury, therefore, none of the cabin crewmembers were probably unable to be aware of their injury.

In order to find the passenger injuries at an early stage, it is desirable for the cabin crewmembers to actively call out to passengers during the inspections when making rounds in the cabin and disembarking.

4. PROBABLE CAUSES

The JTSA concludes that it is probable that in this accident, when encountering clear air turbulence created due to the jet stream, the Aircraft was shaken to the left, therefore, the passenger hit their right side against the armrest on the right side of the seat, resulting in their serious injury.

5. SAFETY ACTIONS

<p>5.1 Safety Actions Required</p>	<p>For the further safety of passengers, it is desirable that while informing the passengers that they should always fasten the seat belt at a low waist position with no slack when seated and paying attention to each body size of the passengers, the cabin crewmembers of the Company shall check carefully whether the passengers properly fasten their seat belts.</p>
<p>5.2 Safety Actions Taken after the Accident</p>	<p>After the occurrence of the accident, the Company has taken the following measures to prevent the recurrence of similar accidents.</p> <p>(1) Revision of cabin attendant manual</p> <p>The Company has revised the cabin attendant manual by adding one sentence, “Sharing the information on turbulence and the contents and timing of announcements to passengers” in the items to be confirmed during the pre-flight briefing.</p> <p>(2) Active use of cabin announcement</p> <p>① Announcements made by flight crews</p> <p>The Company has issued a notice to the flight crews that to the extent that it does not interfere with their flight operations, they should actively make an announcement to provide the passengers with the turbulence information and to encourage them to always fasten the seat belt while seated, revised the pilot announcement handbook and made it known.</p> <p>② Announcement made by cabin crewmembers</p> <p>The Company has issued a notice to the cabin crewmembers that they should make announcements including the following contents, and revised the announcement handbook, and made it known.</p> <p>a Be sure to put the sentence, “keep your seat belt fastened tight and low”, when making announcements related to seat belts.</p> <p>b Make an announcement, saying, “For your safety, please keep your seat belt fastened tight and low, when you are seated.” when the fasten seat belt sign is off.</p> <p>c Make announcement that are easy for passengers to understand.</p> <p>③ Information sharing in a cabin briefing</p> <p>The Company shall actively exchange the information such as the turbulence information and the contents and timing of announcements during the briefing among the flight and cabin crewmembers by</p>

	<p>issuing a notice to flight crews, and by revising the cabin attendant manual for cabin crewmembers.</p> <p>(3) Video dedicated to preparedness for turbulence It was decided to produce a special video on preparing for turbulence and show it in the cabin after the safety video (from July 1, 2022).</p> <p>(4) Company members awareness and education</p> <p>① The accident was made known in the Company's flight safety news (on April 5, 2022).</p> <p>② All the flight and cabin crewmembers discussed the accident in the group meeting. And the turbulence was included as a training material in the case study part of the regular training for the ground crewmembers (finished on November 30, 2022).</p> <p>③ The cases and the preventive measures against injuries of other companies were introduced in the Company flight safety news.</p>
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