

AI2021-7

**AIRCRAFT SERIOUS INCIDENT
INVESTIGATION REPORT**

**SILVER AIR CORP.
N 8 2 9 R A**

August 26, 2021

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 prevent future accidents and incidents. 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 SERIOUS INCIDENT INVESTIGATION REPORT

LOSS OF CABIN PRESSURIZATION SILVER AIR CORP. BOMBARDIER BD-700-1A10, N829RA AT FL250 ABOUT 92 KM NORTH-NORTHEAST OF NAHA AIRPORT AT AROUND 18:09 JST, FEBRUARY 20, 2020

July 16, 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 INVESTIGATION

1.1 Summary of the Serious Incident	<p>At 15:54, on Thursday, February 20, 2020, a Bombardier BD-700-1A10, registered N829RA, operated by Silver Air Corp. took off from Tokyo International Airport as a charter flight. While the Aircraft was flying at FL 400*¹ to Tan Son Nhat International Airport (the Socialist Republic of Vietnam), the instrument indicated loss of cabin pressurization. The flight crew member of the Aircraft declared an emergency and made an emergency descent until the Aircraft reached an altitude of approximately 10,000 ft. The Pilot in Command changed its destination to Naha Airport and the Aircraft landed at Naha Airport at 18:32.</p>
1.2 Outline of the Serious Incident Investigation	<p>The occurrence covered by this report falls under the category of “Loss of cabin pressurization.” as stipulated in Article 166-4, item (xi) of the Ordinance for Enforcement of Civil Aeronautics Act (Ordinance of Ministry of Transport No. 56 of 1952) prior to revision by the Ministerial Ordinance on Partial Revision of the Ordinance for Enforcement of Civil Aeronautics Act (Ordinance of Ministry of Land, Infrastructure, Transport and Tourism No. 88 of 2020), and is classified as a serious incident.</p> <p>On February 21, 2020, the Japan Transport Safety Board (JTSB) designated an investigator-in-charge and an investigator to investigate this serious incident.</p> <p>An accredited representative of the United States of America, as the State of Registry and Operator of the aircraft involved in the serious incident, and</p>

*1 “FL” denotes a pressure altitude in the standard atmosphere. FL is expressed in the value obtained by dividing the reading on the altimeter (in 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, FL400 stands for an altitude of 40,000 ft.

an accredited representative and an advisor of Canada, as the State of Design and Manufacture of the aircraft involved in this serious incident, participated in the investigation.

Comments were invited from parties relevant to the cause of the serious incident and the Relevant States.

2. FACTUAL INFORMATION

2.1 History of the Flight

According to the statements of the Pilot in Command (PIC) and the First Officer (FO), records of the Digital Flight Data Recorder (hereinafter referred to as “DFDR”) and the cockpit voice recorder (CVR), the history of the flight is summarized as below.

At 15:54 Japan Standard Time (JST, UTC+9 hours, unless otherwise stated all times are indicated in JST on a 24-hour clock), February 20, 2020, a Bombardier BD-700-1A10, registered N829RA, operated by Silver Air Corp. took off from Tokyo International Airport as a charter flight, with five people in total on board, consisting of the PIC and three other crew members and one passenger. The FO sat as the PF*2 in the left seat and the PIC as the PM*2 in the right seat in the cockpit.

The cruising altitude was FL400 and the weather conditions were stable in VMC and there was no turbulence.

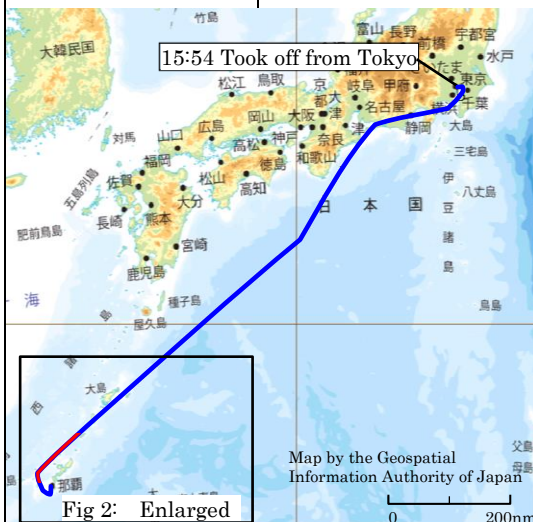


Figure 1: Estimated flight route

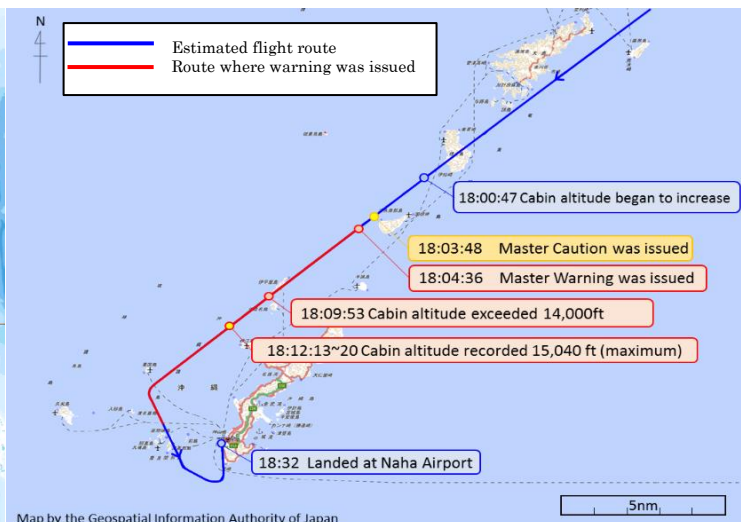


Figure 2: Enlarged view of estimated flight route

According to records of the DFDR and CVR, the cabin altitude began to climb at 18:00, and on EICAS*3 the message of “CABIN ALT” (Caution*4) was indicated at 18:03:48. At this time, there were no CVR voice recording that the flight crew members read out the messages and performed check list

*2 “PF” (Pilot Flying) and “PM” (Pilot Monitoring) are terms used to identify pilots with their roles in aircraft operated by two persons. The PF is mainly responsible for maneuvering the aircraft. The PM mainly monitors the flight status of the aircraft, cross checks operations of the PF, and undertakes other non-operational works.

*3 “EICAS” stands for Engine Indicating and Crew Alerting System, a device that displays the operational conditions of the engine and other systems, and notify the pilot of the occurrence of abnormalities in each system by visual and auditory means.

*4 “Caution” be displayed by a yellow, meaning that there is an abnormality or a failure of the aircraft which does not require an emergency operation but need to let the pilot know it immediately.

	<p>items. According to the PIC, the cabin altitude was approximately 8,300 ft at that time and it was further climbing 500 ft/min, therefore, the flight crew members put on oxygen masks.</p> <p>At 18:04:36, the message on EICAS changed to “CABIN ALT” (Warning *5), then the PIC turned “ON” the switch for the passenger oxygen according to the check list corresponding to that message, declared an emergency, and initiated the descent to 10,000 ft.</p> <p>At 18:09:53, when the cabin altitude exceeded 14,000 ft, the flight altitude was at FL 250.</p> <p>At 18:12:13, the cabin altitude recorded a maximum of 15,040 ft at this time.</p> <p>At 18:17, the PIC cancelled the emergency declaration as the Aircraft continued to descend and the flight altitude reached 10,000 ft.</p> <p>According to CVR records, around 18:24, the PIC performed the descent check list and then said “Recirc is...coming off” which means that the fuel recirculation system was turned off.</p> <p>The PIC changed the destination to Naha Airport, and the Aircraft landed at Naha Aircraft at 18:32.</p> <p>This serious incident occurred at FL250 about 92 km north-northeast of Naha Airport (Latitude 26°59'18”N, Longitude 127°54'34”E) around 18:09 on February 20, 2020.</p>																								
2.2 Injuries to Persons	None																								
2.3 Damage to the Aircraft	None																								
2.4 Personnel Information	<p>(1) PIC: age 61</p> <table> <tr> <td>Airline transport pilot certificate (Airplane)</td> <td>February 25, 2019</td> </tr> <tr> <td>Type rating for Bombardier BD-700</td> <td>February 25, 2019</td> </tr> <tr> <td>Class 1 aviation medical certificate</td> <td></td> </tr> <tr> <td>Validity:</td> <td>July 15, 2020</td> </tr> <tr> <td>Total flight time</td> <td>16,679 hours 12 minutes</td> </tr> <tr> <td>Total flight time on the type of aircraft</td> <td>412 hours 18 minutes</td> </tr> </table> <p>(2) FO: age 43</p> <table> <tr> <td>Airline transport pilot certificate (Airplane)</td> <td>August 19, 2018</td> </tr> <tr> <td>Type rating for Bombardier BD-700</td> <td>August 19, 2018</td> </tr> <tr> <td>Class 1 aviation medical certificate</td> <td></td> </tr> <tr> <td>Validity:</td> <td>May 31, 2020</td> </tr> <tr> <td>Total flight time</td> <td>11,550 hours 00 minutes</td> </tr> <tr> <td>Total flight time on the type of aircraft</td> <td>487 hours 00 minutes</td> </tr> </table>	Airline transport pilot certificate (Airplane)	February 25, 2019	Type rating for Bombardier BD-700	February 25, 2019	Class 1 aviation medical certificate		Validity:	July 15, 2020	Total flight time	16,679 hours 12 minutes	Total flight time on the type of aircraft	412 hours 18 minutes	Airline transport pilot certificate (Airplane)	August 19, 2018	Type rating for Bombardier BD-700	August 19, 2018	Class 1 aviation medical certificate		Validity:	May 31, 2020	Total flight time	11,550 hours 00 minutes	Total flight time on the type of aircraft	487 hours 00 minutes
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2.5 Aircraft Information	<p>Aircraft type: Bombardier BD-700-1A10</p> <p>Serial number: 9029</p>																								

*5 “Warning” be displayed by a red, meaning that there is an abnormality or a failure of the aircraft which requires the pilot to make an emergency operation immediately.

	Date of manufacture: May 11, 1999 Certificate of airworthiness: AEA-FSDO-27 Total flight time: 5,168 hours 48 minutes Total cycles: 2,198 cycles Flight time since last periodical check (250-hour inspection on January 24, 2020): 27 hours
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2.6 Meteorological Information The weather at the time of the serious incident was in VMC and there was no turbulence.

2.7 Additional Information (1) Air conditioning and cabin pressurization systems
 The Aircraft is equipped with two air-conditioning unit that are operating by pneumatic air (hereinafter referred to as “PACK”), which are installed in the left and right respectively. In order to be delivered to the cabin, the cool air brought by the PACKs is conditioned by adding hot air to

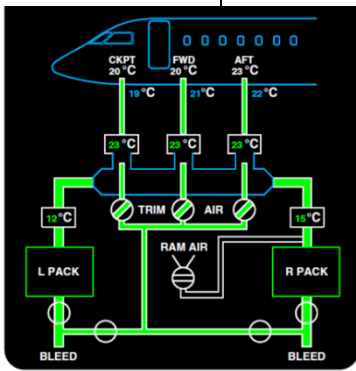


Figure 3: Air conditioning systems (EICAS indication)

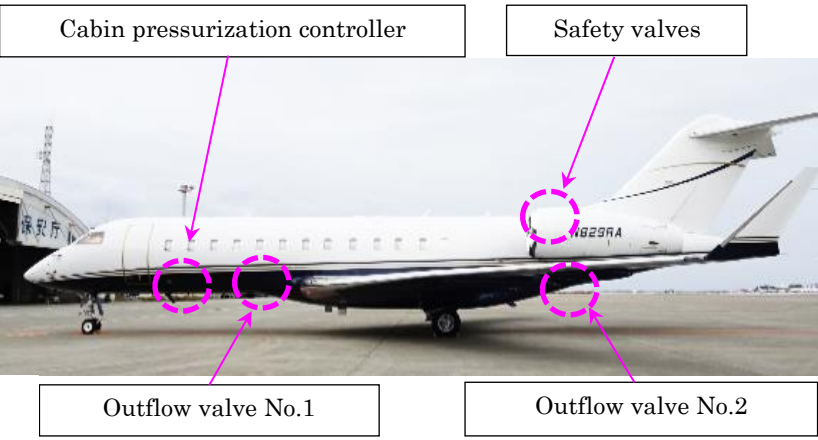


Figure 4: Cabin pressurization components

be a desired temperature set for each zone (hereinafter referred to as “Trim Air” (See Figure 3). The air delivered to the cabin is used by cabin pressurization systems that keep the interior cabin pressure appropriately using two outflow valves installed in the fore and aft of the Aircraft respectively, which control the air volume discharged to overboard of the aircraft (See Figure 4). The cabin pressurization controller automatically works to maintain a cabin altitude of 7,230 ft at a flight altitude of 51,000 ft. The operation panels for air conditioning and cabin pressurization systems are positioned on the overhead panel (See Figure 5). When the PACK switch is selected off, the switch lights up with a white “OFF” character.

(2) Fuel recirculation system
 In order to prevent the bulk fuel temperatures from approaching or reaching the freezing point of the fuel, the Aircraft is equipped with the fuel recirculation system that can be manually operated by the flight crew during the flight, if necessary, when monitoring it. The operation panel for fuel circulating system is positioned on the overhead panel in the cockpit (See Figure 5). When the RECIRC switch is selected on, the switch lights up with a white “ON” character and “FUEL RECIRC ON” message is

indicated on the EICAS.

(3) Overhead panel in the cockpit

On the overhead panel of the Aircraft, the system switches related to the serious incidents are located as shown in Figure 5.

The air conditioning system panel and the fuel system panel are located side by side on the overhead panel. These switches are similar in shape and size and action.

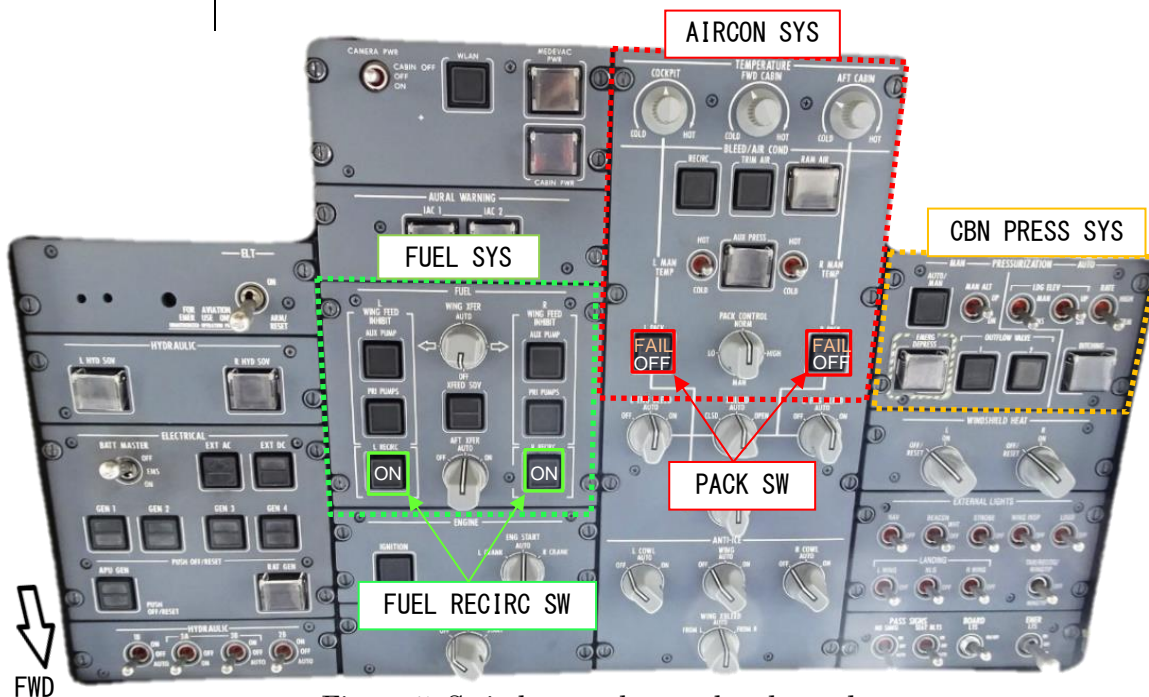


Figure 5: Switches on the overhead panel

(4) Messages indicated on EICAS

The Aircraft has the function to review the messages indicated during the flight again on the ground (CAS message viewer). The CAS message viewer was showed as in Figure 6. The following are excerpted items related to the serious incident. (The times are indicated in JST, UTC+9 hours, although all times on the CAS message viewer are indicated in UTC (Coordinated Universal Time)).

CAS Message	Time	Date
-> FUEL XFER ON	7:01	02/20/20
L PACK OFF	9:00	02/20/20
TRIM AIR OFF	9:00	02/20/20
L-R PACK OFF	9:00	02/20/20
CABIN ALT	9:03	02/20/20
CABIN ALT	9:04	02/20/20
<- FUEL XFER ON	9:05	02/20/20
PASSENGER OXY ON	9:07	02/20/20
SEAT BELTS SIGN ON	9:11	02/20/20
CABIN ALT	9:20	02/20/20
R PACK HIGH FLOW	9:24	02/20/20
L-R PACK HIGH FLOW	9:24	02/20/20

Figure 6: Indicated Messages on this flight

The conditions for the above messages to be indicated are as follows.

- “FUEL XFER ON” is indicates that the fuel transfer system is in the AUTO mode of operation. The wing transfer system provides a means of correcting lateral fuel imbalance.
- “TRIM AIR OFF” (Status*⁶) is indicates when the Trim Air switch is set to position “OFF”, however, it is also indicated even when the Trim Air switch is set to position “ON”, if the switches of both PACKs are set to position “OFF”.
- “PACK OFF” or “L-R PACK OFF” (Status) indicates that the affected PACK has been selected OFF and the solenoid of the flow control valves (FCV) energized (Figure 7). The solenoids only energize when the PACK switches are selected “OFF”. If these switches remain “ON”, these message will not be displayed even if PACK is automatically stopped (described later in 2.7(5)).

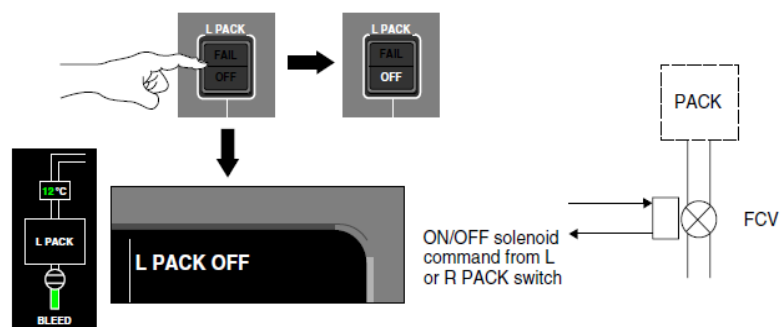


Figure 7: PACK operation

- “CABIN ALT” (Caution) indicates that the cabin altitude is between 8,200 and 9,000 ft.
- “CABIN ALT” (Warning) indicates that the cabin altitude is 9,000 ft or greater.
- “R PACK HIGH FLOW” or “L-R PACK HIGH FLOW” (Status) indicates that the PACK is manually selected to high flow mode or is automatically changed to high flow mode by the controller.

(5) The logic of the automatic shutdown of the PACK

The PACK is automatically shut down under the following conditions, even if the PACK switch is not set to position “OFF”.

- PACK closing demand from BMC
- Ditching mode selected
- PACK inlet overheat.
- Compressor discharge overheat
- PACK discharge overheat
- PACK discharge under pressure

When the PACK is automatically shut down due to these conditions, a fault message corresponding to each condition will be indicated and stored in the memory function of the aircraft. There were no records of these at the time of the aircraft investigation after the event.

*⁶ “Status” be displayed by a white, meaning that non-normal pilot selections and are reminder to the crew.

(6) Statement of the PIC

According to the statement of the PIC, there were no anomalies found in the Aircraft during the pre-flight check. There were no anomalies indication witnessed after taking off from Tokyo International Airport until 18:03, when “CABIN ALT” (Caution) message was indicated. As the message was soon changed to “CABIN ALT” (Warning), the PIC selected “ON” the switch for the passenger oxygen, declared the emergency, and descended to the flight altitude of 10,000 ft according to the check list procedures for “CABIN ALT” (Warning).

The PIC stated that he confirmed the switches of air conditioning and pneumatic system were set to normal positions after arriving at Naha Airport. Neither pilot, nor any crewmember, at any time turned off the PACKSs or the cabin pressurization system during the flight.

(7) Aircraft examination

During the aircraft investigation, by means of the Aircraft malfunction memory system, we confirmed no fault record on this flight. Besides, during the visual inspection of the air conditioning, cabin pressurization and pneumatic systems, air leak test of ducts, and operational tests, there were no anomalies and all systems functioned normally

(8) Maintenance records of the Aircraft

In the maintenance records for air conditioning and cabin pressurization systems of the Aircraft, there weren't any records of failures and repair alteration works related to the serious incident.

(9) DFDR records

According to DFDR records, around 18:00, the cabin altitude began to climb. Any other records indicating the abnormality of the aircraft were not recognized.

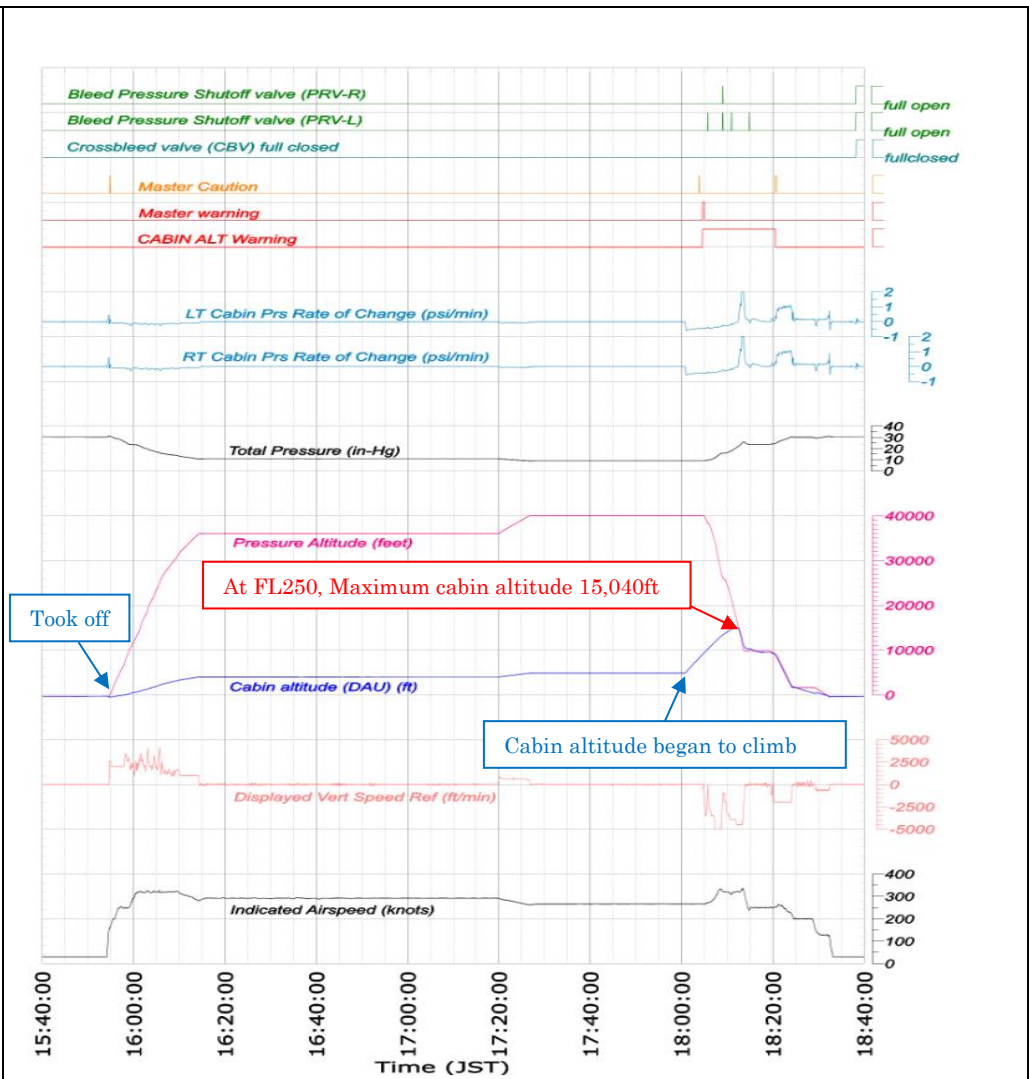


Figure 8: DFDR records

3. ANALYSIS

3.1 Involvement of Weather	None
3.2 Involvement of Pilots	Yes
3.3 Involvement of Aircraft	None
3.4 Analysis of Findings	(1) As a result of the aircraft examination, it was confirmed that there were no records that indicated the aircraft anomalies in the air conditioning, cabin pressurization and pneumatic systems at the time of the serious incident. Besides, it is highly probable that there was no failure of the aircraft at the time of the serious incident because during the visual inspection of the air conditioning, cabin pressurization and pneumatic systems, air leak test of ducts, operational tests, all systems functioned normally.

- (2) The PIC stated that “Neither pilot, nor any crewmember, at any time turned off the PACKS or any portion of the cabin pressurization system during the flight”, however, the message of “L-R PACK OFF” (Status) was indicated around 18:00. Because the logic is that this message is not indicated unless both PACKS switches are turned "OFF", it is highly probable that the flight crew member erroneously pushed both PACK switches to position “OFF” and both PACKS were shut down resulting in cabin altitude climb.
- (3) Fuel RECIRC and PACK switches are similar in placement and shape as well as operations, and according to the CVR records at 18:24, the flight crew member said a word about fuel recirculation system, therefore it is possible that the flight crew member was going to push “ON” the switches of fuel RECIRC system but erroneously pushed both PACK switches to position “OFF”.
- (4) It is possible that the flight crew member failed to recognize that he pushed OFF both PACK switches, because the mutual confirmation for the switch operations was insufficient among the flight crew members.
- (5) It is highly probable that at 18:03:48, “CABIN ALT” (Caution) was indicated because the cabin altitude reached approximately 8,200 ft. At this time, it is probable that the flight crew could have recognized that the PACK switches were set to “OFF” by confirming the status of the PACK switches on the overhead panel or EICAS indication for air conditioning systems (Figure 3). However, there were no CVR voice records that the flight crew members read out the messages and performed check list items. Therefore, it is likely that communication between flight crew members was not sufficient. In order to prevent switch operation errors made by flight crew members, it is required to sufficiently practice Crew Resource Management (CRM*7) skills on a daily basis.
- (5) It is highly probable that “CABIN ALT” (Warning) was indicated because at 18:04:36, the cabin altitude of the Aircraft reached approximately 9,000 ft or greater. It is also highly probable that the PIC made an emergency descent immediately, but the cabin altitude further climbed during descent from a flight altitude of FL400, and the cabin altitude reached a maximum of 15,040 ft.
- (6) Around 18:24, PIC carried out a descent check list and said “Recirc is...coming off” which means that the fuel recirculation system turned off, but the CAS message viewer has no record of the fuel recirculation system activated. At this time, the PIC operated the PACK switches, which were lit as ”OFF”, assuming that these were switches of the fuel recirculation system that were lit as ”ON”. Therefore, It is highly probable that “L-R PACK HI FLOW” was displayed on EICAS.

*7 “CRM” refers to the effective use of all available resources: human resources, hardware and information, in order to accomplish safe and efficient operations.(AIM-JAPAN)

4. PROBABLE CAUSES

The JTSB concludes that the probable cause of this serious incident was the shutdown of both PACKs of the Aircraft during the flight at FL400, which resulted in loss of cabin pressurization. Concerning the shutdown of both PACKs, it is highly probable that the flight crew member was going to operate the switches of fuel recirculation system but erroneously pushed both PACK switches to position "OFF" without noticing.

5. SAFETY ACTIONS

Safety actions taken by the Company after the serious incident

The following safety actions were taken for all crew members who operate the same type of aircraft.

- (1) Strict adherence to checklists and procedures during all phases of flight, especially in climb out and cruise, as was identified in this incident.
- (2) It was informed that it is important for a PIC to emphasis on Crew Resource Management (CRM) and crew communication is vital and will be briefed and emphasized during all phases of flight.
- (3) Review of fuel recirculation procedures on aircraft with manual fuel recirculation action, such as N829RA, crew shall do a thorough review of the fuel recirculation system to include limitations of such actions.
- (4) Re-emphasis the challenge and response items to various phases of the checklist to ensure proper cockpit switchology.