AI2018-7

AIRCRAFT SERIOUS INCIDENT
INVESTIGATION REPORT

FUJI DREAM AIRLINES CO., LTD.
J A 0 6 F J

November 29, 2018

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 prevent future accidents and incidents. It is not the purpose of the investigation to apportion blame or liability.

Kazuhiro Nakahashi
Chairman
Japan Transport Safety Board

AIRCRAFT SERIOUS INCIDENT INVESTIGATION REPORT

ABNORMAL DECOMPRESSION INSIDE AN AIRCRAFT AT AN ALTITUDE ABOUT 33,000 FT ABOVE SEA AT ABOUT 100 KM SOUTHWEST OF AKITA AIRPORT AT AROUND 15:24 JST, JULY 7, 2015 FUJI DREAM AIRLINES CO., LTD. EMBRAER ERJ170-200STD, JA06FJ

November 29, 2018
Adopted by the Japan Transport Safety Board
Chairman Kazuhiro Nakahashi
Member Toru Miyashita
Member Toshiyuki Ishikawa
Member Yuichi Marui
Member Keiji Tanaka
Member Miwa Nakanishi

1. PROCESS AND PROGRESS OF INVESTIGATION

1.1 Summary of the Serious Incident	On Tuesday, July 7, 2015, Embraer ERJ170-200STD, registered JA06FJ, operated by Fuji Dream Airlines CO., LTD. took off from New Chitose Airport bound for Matsumoto Airport as a scheduled flight 212. While the Aircraft was climbing in airspace approximately 33,000 ft at around 100 km southwest of Akita Airport, the supply of the bleed air stopped in both of the right and left systems and the cabin pressure lowered. The Aircraft declared the emergency to the Air Traffic Control Center (hereinafter referred to as "ATC"), and after making the emergency descent until the Aircraft reached 10,000 ft, the Aircraft landed Niigata Airport, which was not the destination.
1.2. Outline of the Serious Incident Investigation	The occurrence covered by this report falls under the category of "Abnormal decompression inside an aircraft" as stipulated in Clause 11, Article 166-4 of the Ordinance for Enforcement of Civil Aeronautics Act of Japan (Ordinance of the Ministry of Transport No. 56 of 1952), and is classified as a serious incident. On July 7, 2015, the Japan Transport Safety Board (JTSB) designated an investigator-in-charge and two investigators to investigate this serious incident. An accredited representative of the Federative Republic of Brazil, 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 State.

2. FACTUAL INFORMATION

2.1 History of the Flight	According to the statements of the crewmembers; records of the flight recorder and ATC communications records, the history of the flight is summarized as below: At 14:44 on July 7, 2015, Embraer ERJ170-200STD, registered JA06FJ, operated by Fuji Dream Airlines Co., Ltd. took off from Runway 01L of New Chitose Airport bound for Matsumoto Airport as a scheduled flight 212. The PIC was in the left seat as PF*1 and First Officer was in the right seat as PM*1. When the Aircraft passed FL*2 320 at 15:21:53, while ascending from FL280 toward FL360, the EICAS message "BLEED 1 FAIL," which indicated an anomaly in the left-side bleed air system, was displayed with the warning sound and lighting of the master caution light. In 27 seconds, the EICAS message "BLEED 2 FAIL," which indicated an anomaly in the right-side bleed air system, was displayed with the warning sound and lighting of the master caution light when the Pilot and First Officer were checking the status after terminating the ascend. The Pilot confirmed that the cabin altimeter was indicating the altitude slightly above 6,000 ft and that the cabin vertical speed indicator was indicating the about 1,700 FPM in climb. At 15:23, the Pilot decided to make the emergency descent; the Pilot and First Officer put on the oxygen mask before starting the descent after obtaining the permission for the descent from the ATC and they set the emergency code 7700 in the transponder. At the same time when the Aircraft declared the emergency to the ATC at FL330 at 15:24, the EICAS message "CABIN ALT HI," which indicated that the cabin altitude exceeded 9,700 ft, was displayed with the warning sound and lighting of the master warning light. The Pilot made the in-flight announcement informing that the Aircraft was in an emergency descent cabin attendant reported the passenger oxygen masks had not and requested that passengers had to fasten the seat belt and to put on the oxygen mask. Right after the announcement, it was reported by a cabin attendant that the oxygen masks in the passenger cabin did not drop from the ceiling and the Pilot manually dropped them the oxygen masks in the passenger cabin perform. The Pilot ordered the First Officer to run the check list for EMERGENCY DESCENT and CABIN ALTITUDE HI, and confirmed that both messages disappeared.

1 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 undertake other non-operational works.

2 "FL" stands for flight level and is pressure altitude of the standard atmosphere. It is the altitude indicated by value divided by 100 of the index of the altitude indicator (unit: ft) when QNH is set to 29.92 inHg. FL is usually applied when flight altitude is 14,000 ft or above in Japan. E.g., FL 390 indicates an altitude of 39,000 ft.

	At 15:31 while the Aircraft was flying at about 74 km north of Niigata Airport after descending at an altitude of 10,000 ft, the Pilot decided that it was appropriate to land Niigata Airport after checking the weather conditions and reported this change of the destination to the ATC. Then, the Pilot had directed the First Officer to perform the check list for "BLEED 1 FAIL" and "BLEED 2 FAIL" and confirmed that both messages disappeared. At 15:47, the Aircraft landed on Runway 28 of Niigata Aircraft. There were 72 people on board consisting of the Pilot, four other crewmembers, and 67 passengers but no one was injured. This serious incident occurred at an altitude about 33,000 ft above sea at about 100 km southeast of Akita Airport (Latitude 39°05'55" N and Longitude 139°19'44" E) at about 15:24 on July 7, 2015.
2.2 Injuries to Persons	None
2.3 Damage to the Aircraft	None
2.4 Personnel Information	(1) Pilot: Male, Age 64 Airline Transport Pilot Certificate (Airplane) June 12, 1978 Type rating for Embraer ERJ170 June 10, 2014 Class 1 aviation medical certificate Validity: May 18, 2016 Total flight time 25,743 hr. 30 min. Flight time in the last 30 days 58 hr. 08 min. Total flight time on the type of aircraft 3,094 hr. 31 min. Flight time in the last 30 days 58 hr. 08 min. (2) First Officer: Male, Age 40 Commercial Pilot Certificate (Airplane) February 20, 2001 Type rating for Embraer ERJ170 July 18, 2014 Instrument flight certificate (Airplane) March 30, 2007 Class 1 aviation medical certificate Validity: March 31, 2016 Total flight time 2,808 hr. 21 min. Flight time in the last 30 days 61 hr. 51 min. Total flight time on the type of aircraft 693 hr. 23 min. Flight time in the last 30 days 61 hr. 51 min.
2.5 Aircraft Information	(1) Type: Embraer ERJ170-200STD Serial number: 17000332; Date of manufacture: November 19, 2011 Certificate of airworthiness: AI-2014-316; Validity: September 15, 2015 Category of airworthiness Aircraft Transport T Total flight time 10,363 hr. 50 min. (2) At the time of occurrence of this serious incident, both of the weight and position of the center of gravity of the Aircraft were within the allowable range.
2.6 Additional Information	(1) Summary of the bleed air system

The Aircraft is equipped with two bleed air systems, in the left and right of the Aircraft and they pressurize and air-condition (AC) the Aircraft. The hot bleed air bled from the engine compressor in the right and left engine flows into the precooler via the nacelle pressure regulating shut-off valve (NAPRSOV), and other valves. The bleed air, after being adjusted to the prescribed temperature in the AC pack, flows into the cabin. The air in the cabin is discharged outside via the outflow valve and the cabin pressure is automatically controlled at the prescribed pressure by adjusting the opening of the outflow valve.

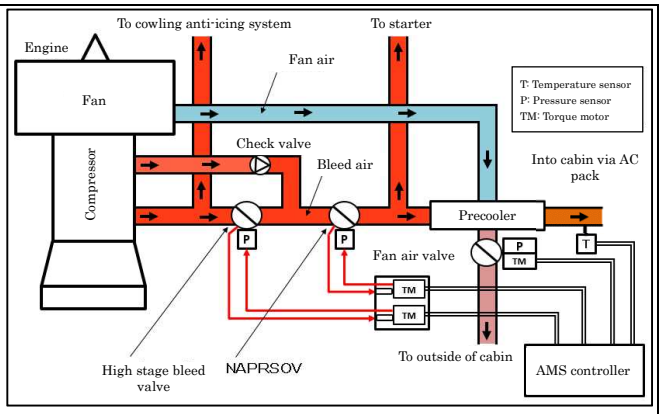


Figure 1 Bleed Air System Diagram

In case when either one of right or left bleed air is not supplied, the cabin pressure and temperature are controlled by the remaining bleed air from one of two engines.

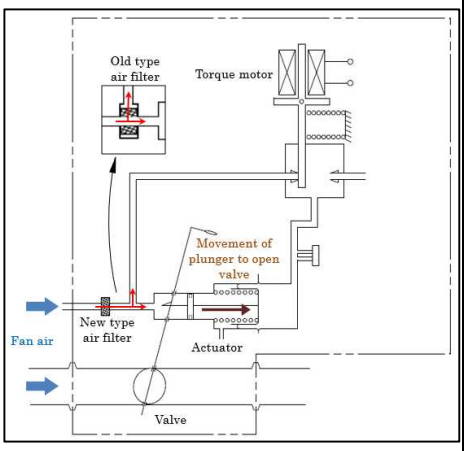


Figure 2 Fan Air Valve Internal Structure

(2) Operation of the fan air valve

The precooler cools the bleed air with the low temperature fan air from the engine fan. The fan air valve adjusts the flow rate of the fan air. The opening of the fan air valve is controlled by the torque motor integrate d into the valve, and the torque motor is automatically controlled by the AMS (Air Management System) motor drive module that is a part of the AMS controller.

Temperature of the bleed air is detected with the temperature sensor located downstream of the precooler. The AMS controller adjusts the opening of the fan air valve based on the temperature detected by the temperature sensor and controls the bleed air temperature by increasing or decreasing the flow rate of the low temperature fan air. As in this serious incident, when the wing anti-ice valve is in the OFF state, in case of the temperature of this bleed air is between 235 °C and 259 °C continuously for more than two minutes or at or above 260 °C continuously for more than three seconds, the warning sound ; the master caution light turns on; and the EICAS massage, "BLEED 1 (2) FAIL" is displayed, and the NAPRSOV is closed by the AMS controller stopping the supply of the bleed air.

(3) Data recorded in the flight recorder

At 15:21:53, the message, "BLEED 1 FAIL" was displayed followed by the closure of No. 1 NAPRSOV. In about 30 seconds the message "BLEED 2 FAIL" was displayed and the bleed air was stopped due to the closure of No. 2 NAPRSOV.

The cabin altitude of the Aircraft kept rising, and at 15:24:18 the EICAS message, "CABIN ALT HI" indicating that the cabin altitude exceeded 9,700 ft was displayed. The highest cabin altitude was 14,550 ft. (See Figure 3.)

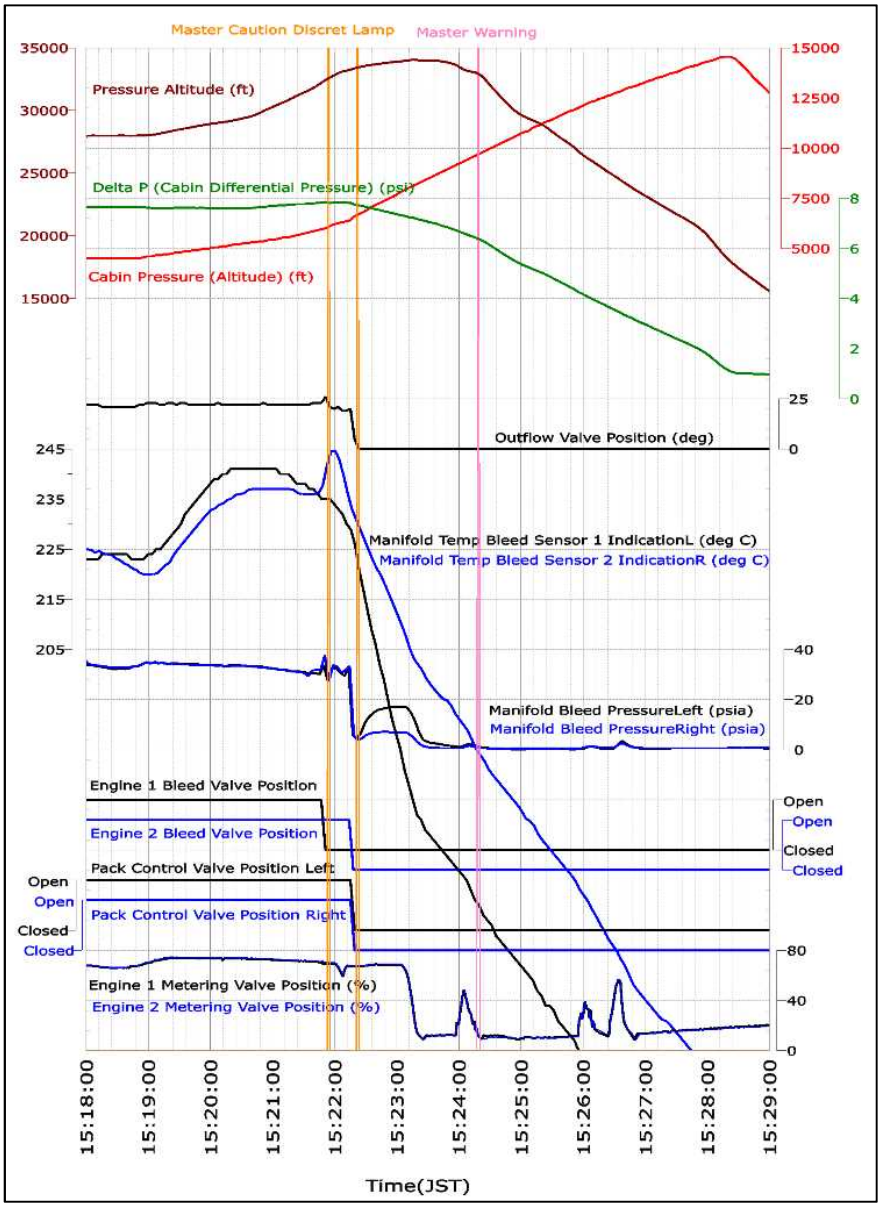


Figure 3　Data recorded in Flight Recorder

(4) Maintenance action after occurrence of the serious incident

It was confirmed by the BITE CK (Check by Built-In Test Equipment) that the right and left fan air valves were normally functioning, whereas it was recorded in the CMC (Central Maintenance Computer) that anomaly occurred in the right and left fan air valves almost at the same time. Therefore, the right and left fan air valves and AMS motor drive module that controlled the valves were removed.

The Pilot confirmed that the cabin vertical speed indicator was indicating that the Aircraft was ascending as fast as about 1,700 FPM after the bleed air was stopped and the outflow valve was completely closed, and thus the air frame was inspected for any leakage of air. The air leakage from ten drain valves out of the total of 13 drain valves was found. These valves were mounted on the lower fuselage to discharge (drain) water condensed in the inside of the air frame.

(5) Investigation of component

The right and left fan air valves and AMS motor drive module removed from the Aircraft were investigated by their manufacture.

In the investigation of the both fan air valves, the change of air pressure that controlled the valve in response to current running in the torque motor was measured. It was confirmed that the value exceeding the prescribed value was measured at both of the fan air valves. The inspection of the valve opening revealed that the both of fan air valves could not be fully opened and the left fan air valve could not be fully closed. In both of fan air valves, abrasion and corrosion were found on the linkage, and, in addition, small amount of fine particles were found on the air filter inside of the valve.

The NTSB examined the fine particles found on the air filter with the scanning election microscope and it was found that the particles were mainly composed of silicon and aluminum. In addition, sodium oxide, potassium, magnesium, and iron were also found. The form and composition of these fine particles were similar to those of volcanic ashes.

The functional test of the AMS motor drive module revealed no anomaly.

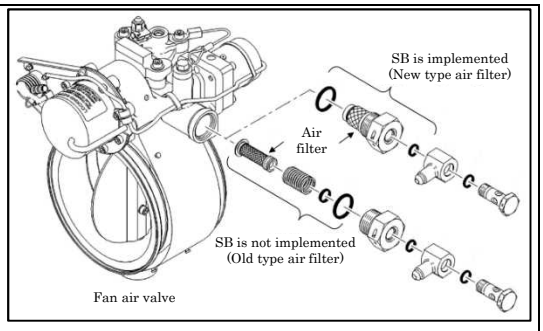
(6) Reliability of the fan air valve

The Company has introduced this type of aircraft since 2009 in a stepwise manner, and they were operating nine Embraer ERJ170-200STD aircraft when the serious incident occurred, and CMC messages were recorded regarding their many fan air valves. Five of the aircraft that had been introduced prior to the Aircraft experienced the replacement of fan air valves more than three times regardless of whether their right or left . In the Aircraft that has been introduced in November 2011, the right and left fan air valves were replaced respectively one time.

Furthermore, it was clarified by the investigation of the Company that they had experienced the state that the supply of right and left bleed air was stopped simultaneously like this serious incident four times on other aircraft even for only short period of time.

(7) Service Bulletin of the fan air valve

The quality of the torque motor has been improved and AMS software has been modified by 2010, and the Service Bulletin (SB170-36-0021) has been issued, in which it is recommended to replace the air filter inside of the valve with new type of air filter that has wider surface area and smaller mesh size in order to enhance the filtration capacity. Because

	this Service Bulletin does not require the "MANDATORY" action, the Company was planning to replace the fan air valve installed the new type of air filter when it became necessary to replace the fan air valve. The right and left air filter installed to the Aircraft were the old type air filter.  Figure 4 Air Filter The air filter has been cleaned periodically in accordance with the Maintenance Manual, and it has been cleaned by the subcontractor in accordance with the method prescribed in the Component Maintenance Manual. (8) Subsequent manufacturer's response. As a result of comparing the average time until removal of the fan air valve equipped with the new type of air filter or old of type air filter, the manufacturer found no significant change due to the difference between the old type and new type filters, as the other cause, the heat of the precooler in consideration of the deterioration of the torque motor due to the influence, they developed a fan air valve equipped with a torque motor with improved heat resistance. (9) Volcanic ashes Since November 2013 when the new type of air filters were recently installed after it had been cleaned , the volcanic activities have been active on Mount Ontake on the border between Nagano and Gifu Prefectures in September 2014, and Mount Aso and Sakurajima in Kyushu region since November of the year in the areas around Matsumoto Airport, Kumamoto Airport, and Kagoshima Airport which the Company is operating their aircraft, therefore, volcanic ashes have been observed in the surrounding areas.

3. ANALYSIS

3.1 Involvement of Weather	No
3.2 Involvement of Pilots	No
3.3 Involvement of Aircraft	Yes
3.4 Analysis of Findings	(1) Series of events leading to the serious incident It is highly probable that the "NAPRSOV" of the left engine was closed when the message "BLEED 1 FAIL" was displayed in about two minutes after the temperature of the bleed air from the left engine exceeded 235 °C. It is highly probable that because the temperature of the bleed air

from the right engine also exceeded 235 °C in about 30 seconds after the temperature of the bleed air from the left engine exceeded 235 °C, the "NAPRSOV" of the right engine was closed when the message "BLEED 2 FAIL" was displayed in about two minutes.

At the time when the bleed air from the left engine became unavailable, all the pressurization and air-conditioning had to be implemented only with the bleed air from the right engine making the flow rate of the bleed air from the right engine increase. In addition, the fan air valve could not be fully opened making the fan air inflow into the precooler insufficient. It is somewhat likely that all of these events were attributable to the temperatures rise in the bleed air from the right engine.

The message, "BLEED 1(2) FAIL" were displayed for the left and right bleed air almost at the same time, and the NAPRSOV in the right and left were closed making the bleed air systems in the right and left sides stop operating and the cabin pressure uncontrollable. It is highly probable that the series of these events caused the abnormal depressurization of the cabin.

It is probable that the air leak from the drain valves related to the climb rate of about 1,700 FPM, which was shown on the cabin vertical speed indicator and confirmed by the Pilot when the bleed air was stopped.

(2) Fan air valve

It is probable that, based on the investigation made by the manufacture of the valve, the right and left fan air valves malfunctioned due the combination of the following multiple causes:

(i) Abrasion and corrosion found on the linkage of the right and left fan air valves brought adverse impact on the operation of the valve.

(ii) The torque motor could not operate as directed by the signal from the AMS controller because the valve could not be fully opened and air pressure to operate the valve was sometimes not as prescribed.

(iii) Left and right fan air valves were attached to the old type air filter, so fan air sent to the actuator was not filtered out, the particles entered the inside of the fan air valve and affected the operation of the valve.

(iv) Deterioration of the torque motor by the heat influence from the precooler.

(3) Maintenance system of the Company

The company experienced a large number of defects of the fan air valve of the same aircraft before the occurrence of this serious incident, and had replaced it many times. In addition, since the state in which the supply of the left and right bleed air is stopped for a short time also occurred, it is probable that believe there was a possibility that we could

	have foreseen the possibility that the cabin altitude could not be controlled by similar events if the reliability management of the equipment was done sufficiently in the company's maintenance system.

4. PROBABLE CAUSES

In this serious incident, it is highly probable that because the supply of the both of right and left bleed air had stopped almost at the same time, the abnormal depressurization in the Aircraft occurred.

In the fact regarding that the supply of the both of right and left bleed air had stopped, it is probable that because the airflow for cooling would have been restricted due to malfunction on both right and left fan air valves, the bleed air was hot and the corresponding NAPRSOV's closed.

5. SAFETY ACTIONS

Following this serious incident, the Company took the following measures:

- For the same type of the aircraft in service, the fan air valves which the record of CMC would have been similar with the Aircraft were replaced.
- The "CMC Maintenance Message Operation Procedure" in the SOP (Service Operation Procedure) was revised to read "the system that potentially has the dual failure shall be intensively monitored."
- New procedure, "Fan air Valve EICAS/CMC Message Operation Procedure" was defined and it was added in the "SOP" in order to define the fan air valve monitoring method; to replace the fan air valve if the replacement deems necessary as a result of monitoring; and to set up the system to obviate the fan air valve anomaly.
- Because a fan air valve equipped with the torque motor which improved heat resistance was developed, the company adopted this sequentially from April, 2017 and started trial operation.