AI2023-6

AIRCRAFT SERIOUS INCIDENT
INVESTIGATION REPORT

IBEX Airlines Co., Ltd.
J A 0 7 R J

September 28, 2023

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.

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

MULTIPLE MALFUNCTIONS
IMPEDING THE SAFE FLIGHT OF AIRCRAFT,
BOMBARDIER CL-600-2C10, JA07RJ
IBEX AIRLINES CO., LTD.
AT AN ALTITUDE OF APPROX. FL 360
OVER ODA CITY, SHIMANE PREFECTURE
AT 20:12 JST, APRIL 18, 2022

August 25, 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 SERIOUS INCIDENT INVESTIGATION

1.1 Summary of the Serious Incident	On Monday, April 18, 2022, at 18:51 Japan Standard Time (JST: UTC + 9 hours; all times are indicated in JST on a 24-hour clock), a Bombardier CL-600-2C10, JA07RJ, operated as scheduled flight 18 by IBEX Airlines Co., Ltd., took off from Sendai Airport, however, while the airplane was flying over Oda City, Shimane Prefecture toward Fukuoka Airport at FL 360*1, unreliable airspeed indication occurred temporarily on both Primary Flight Displays for the Pilot in Charge (PIC) and the First Officer (FO). For that reason, the PIC declared a state of emergency, continued the flight, and landed at Fukuoka Airport at 20:39.
1.2 Outline of the Serious Incident Investigation	The occurrence covered by this report falls under the category of "Multiple malfunctions in one or more systems equipped on aircraft impeding the safe flight of aircraft" as stipulated in clause (X), Article 166-4 of Ordinance for Enforcement of Civil Aeronautics Act (Ordinance of Ministry of Transport No. 56 of 1952), and is classified as a serious incident. On April 19, 2022, the Japan Transport Safety Board (JTSB) designated an investigator-in-charge and an investigator to investigate this serious incident.

*1 "FL" (Flight Level) is the pressure altitude in the standard atmosphere. The FL is expressed in the value given by dividing the reading on the altimeter (the unit is ft) by 100 when the altimeter is set to 29.92 inHg. In Japan, flying altitudes of 14,000 ft or higher are usually indicated in the flight level. For example, FL 360 means an altitude of 36,000 ft.

	An accredited representative and an adviser of Canada, as the State of Design and Manufacture of the airplane involved in this serious incident, participated in the investigation. Comments on the draft Final Report from parties relevant to the cause of the serious incident were invited. Comments on the draft Final Report were invited from the Relevant State.

2. FACTUAL INFORMATION

2.1 History of the Flight	According to the statements of the PIC and the FO as well as the records of the flight data recorder (FDR), the history of the flight up to the serious incident is summarized below. There were 38 persons on board, consisting of the PIC, three other crewmembers, and 34 passengers. When the serious incident occurred, in the cockpit, the PIC was seated in the left seat as the PM*2, and the FO was seated in the right seat as the PF*2. The airplane took off from Sendai Airport at 18:51 and was flying on autopilot at an altitude of FL 360 toward Fukuoka Airport. When the airplane commenced to descent to FL 240 about 60 km southwest of Izumo Airport, the EICAS*3 displayed the messages of "STALL FAIL" indicating an inoperative stall warning, and "RUD LIMIT FAULT" (described later in 2.7 (9)) indicating a loss of the redundancy of the device to limit the rudder authority according to the airspeed. The PIC took over the control and immediately started the actions according to the Operation Procedures for responding to the EICAS message of "STALL FAIL". While taking these actions, the PIC noticed that the airspeed (IAS*4) indicated on both PFDs (Primary Fight Display) for the PIC and the FO was slowly decreasing from 258kt despite not changing the airplane's speed setting. Judging the failure IAS indication occurred, the PIC disengaged the auto-pilot and flight director*5 to prevent unintended airplane behavior. While monitoring the airplane attitude and the engine power, the PIC judged that the IAS indication of the ISI (Integrated Standby Instrument) was operating normally, continued to descend using it, and declared a state of emergency to the ATC facility. During the descent, the IAS indication values on both PFDs further decreased up to the lowest limit

*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, which stands for the Pilot Flying, is mainly responsible for maneuvering the aircraft. The PM, which stands for the pilot monitoring, 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 Indication and Crew Alerting System, meaning an integrated system designed to display the operational conditions of the engines and part of other systems and notify the pilot of the occurrence of abnormalities by visual and auditory means.

*4 "IAS" stands for Indicated Airspeed, meaning the airspeed displayed on an airspeed indicator in the cockpit after the difference between total pressure on the pitot probe and atmospheric pressure on the static ports are measured.

*5 "Flight Director" refers to the system to display steering commands for pitch and roll to keep the pre-set flight attitude on an attitude director indicator.

of 40 kt. One to two minutes after the value reached the lowest limit, the IAS indication on both PFDs recovered to the normal status. As the IAS indication on both PFDs came to continuously display the values that seemed to be normal at approx. FL 240, the PIC continued the landing approach using the auto-pilot and made a landing at Fukuoka Airport.

As for the weather conditions along the flight route of the airplane, a light rain was observed at Sendai Airport. The airplane flew in clouds up to FL 300 after the take-off, but from then on not fly in clouds, and the onboard weather radar did not show any weather radar echoes indicative of rain clouds en-route.

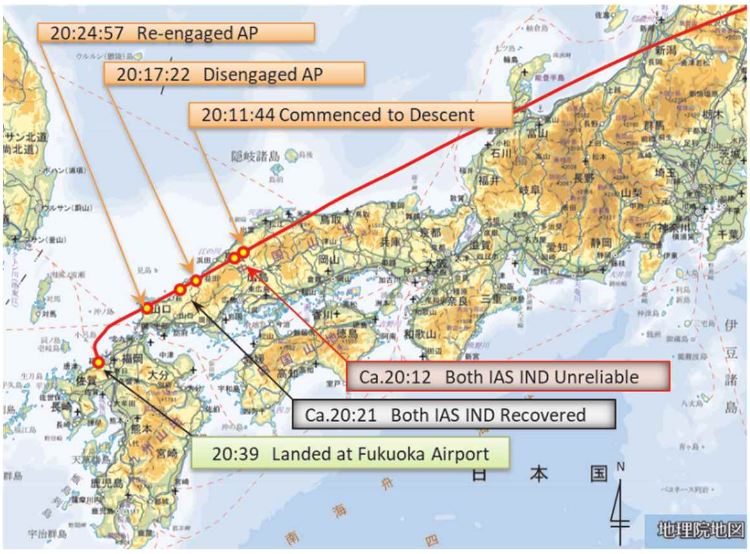

Figure 1: Estimated Flight Route

The serious incident occurred at about 20:12 on April 18, 2022, over Oda City, Shimane Prefecture (35°01'03" N, 132°24'18" E), at an altitude of FL 360.

2.2 Injuries to Persons	None
2.3 Damage to the Aircraft	None

2.4 Personnel Information

(1) PIC, Age 53

Airline Transport Pilot Certificate (Airplane)	February 12, 2010
Type rating for Canadair CL-65	February 16,2001
Class 1 Aviation Medical Certificate	
Validity	August 27, 2022
Total Flight Time	14,810 hours 30 minutes
Total flight time on the type of aircraft	13,685 hours 56 minutes

(2) First Officer, Age 36

Commercial Pilot Certificate (Airplane)	November 17, 2016
Type rating for Canadair CL-65	August 13, 2018
Instrument Flight Certificate	November 8, 2017
Class 1 Aviation Medical Certificate	
Validity	March 17, 2023

	Total flight time 2,983 hours 00 minute Total flight time on the type of aircraft 2,649 hours 33 minutes
2.5 Aircraft Information	Aircraft type: Bombardier CL-600-2C10 Serial number : 10327 Date of manufacture: May 17, 2011 Certificate of airworthiness: No.DAI-2021-122 Validity: June 11,2022 Category of airworthiness: Airplane, Transport-T Total flight time 25,411 hours 45 minutes Total cycles 23,922 cycles Flight time since last periodical check (6,000 hours inspection. on November 19, 2019) 5,477 hours
2.6 Meteorological Information	(1) Aeronautical Weather Observations a. Sendai Airport 19:00 Wind direction: 200°, Wind velocity: 10 kt, Prevailing visibility: 10 km or more, Present weather: light rain Cloud: Amount 1/8 to 2/8; Cloud base 1,200 ft; Cloud: Amount 3/8 to 4/8; Cloud base 5,000 ft; Cloud: Amount 5/8 to 7/8; Cloud base 7,000 ft Temperature 13℃; Dew point 11℃; Altimeter setting (QNH): 29.91 inHg b. Izumo Airport 20:00 Wind direction: 160°, Wind velocity: 5 kt, CAVOK*6 Temperature 12℃; Dew point 8℃; Altimeter setting (QNH): 30.00 inHg c. Iwami Airport 20:00 Wind direction: 330°, Wind velocity: 2 kt, CAVOK Temperature 14℃; Dew point 11℃; Altimeter setting (QNH): 29.97 inHg (2) Radar Composite Chart (Echo Top Altitude*7) and Domestic Significant Weather Analysis Chart According to the Japan Meteorological Agency's radar composite chart (echo top altitude) at 20:00, the maximum altitude of the echo top altitude in the vicinity of the serious incident site was 8 to 10 km (Figure 2). And according to the domestic significant weather analysis chart at 21:00, jet streams centered at FL 350 and FL 390 were observed respectively on the north and the south in the vicinity of the serious incident site (Figure 3).

*6 "CAVOK" means visibility, cloud and present weather better than the prescribed values or condition, and refers to good weather conditions with good visibility and no low clouds.

*7 The echo top altitude means the maximum altitude where drops of rain (flakes of snow) are observed with the weather radar.

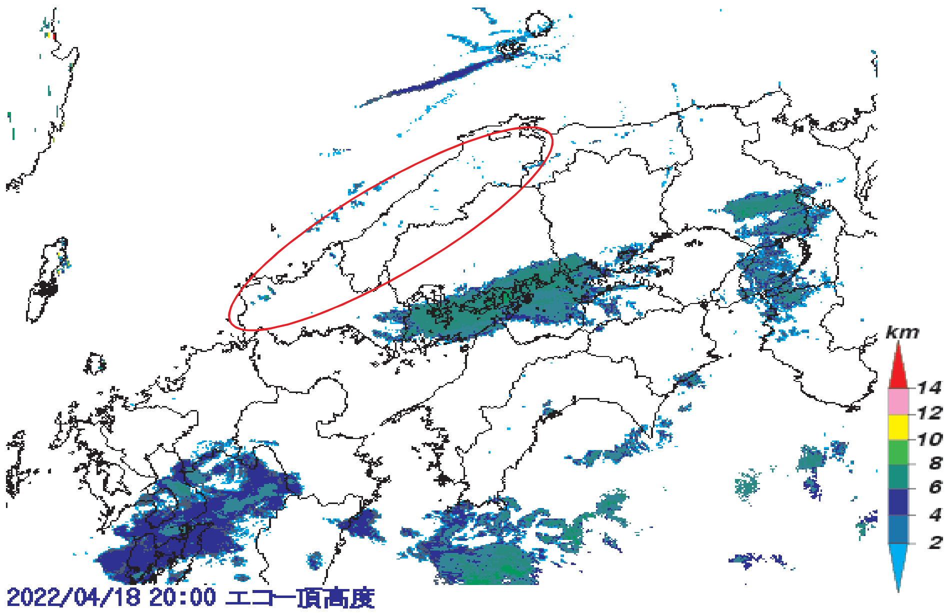

Figure 2: Radar Composite Chart (Echo Top Height)

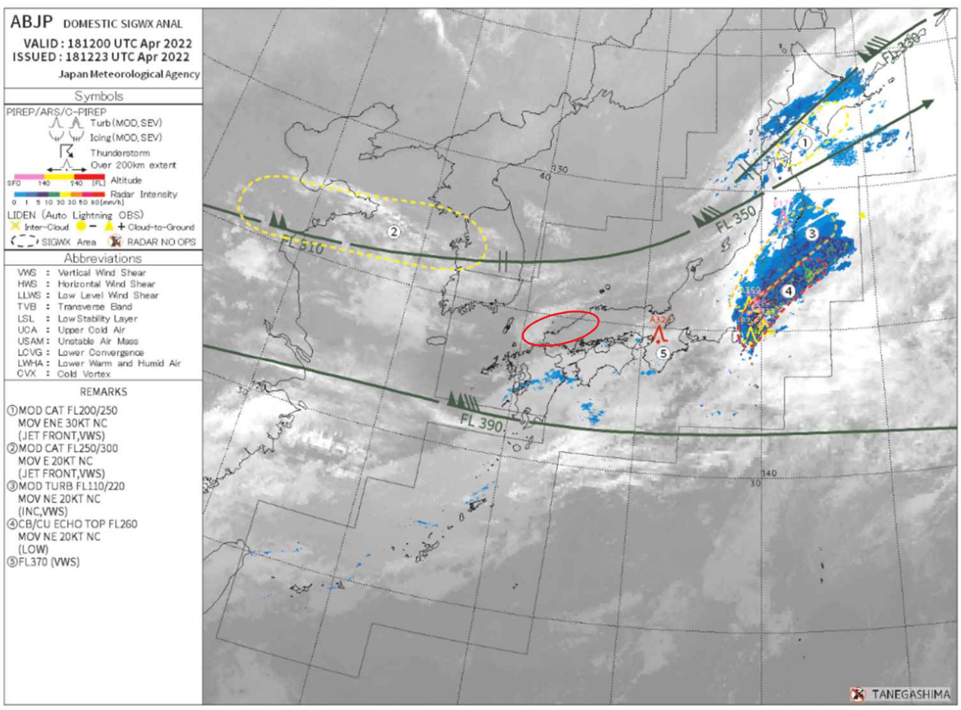

Figure 3: Domestic Significant Weather Analysis Chart

(3) Hourly-Analysis Chart

According to the Japan Meteorological Agency's hourly analysis chart, at 20:00 (JST), the wind direction and velocity at FL 360 in the vicinity of the serious incident site showed a wind at about 100 kt blowing from the west, and FL 360 was the altitude near the tropopause, the boundary between the troposphere and the stratosphere (Figure 4).

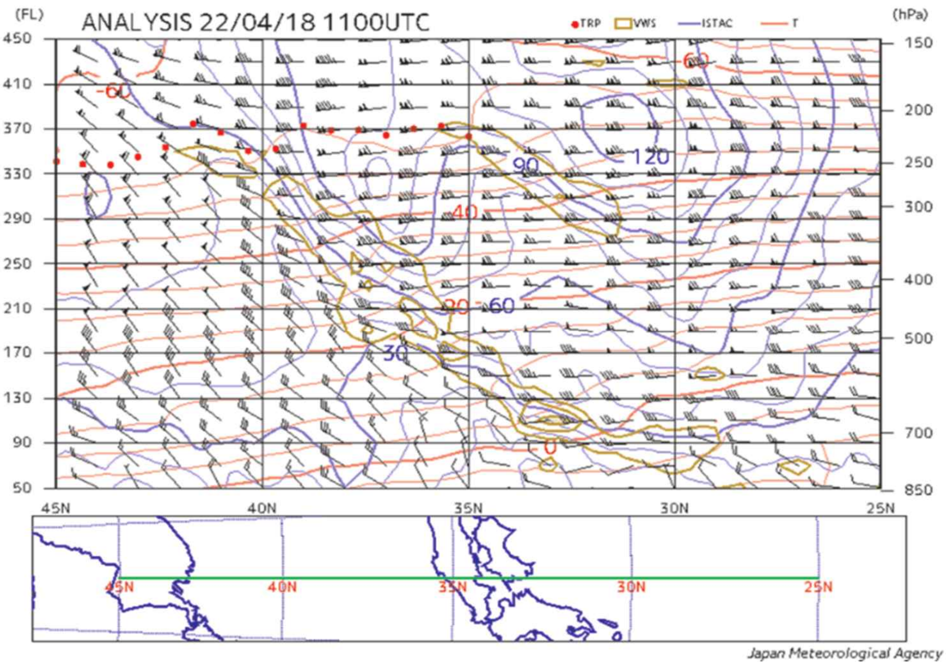

Figure 4: Hourly-Analysis Chart

2.7 Additional Information

(1) About IAS

IAS is displayed on the two PFDs and the ISI. The airplane is equipped with two ADCs (Air Data Computer), and the IAS is computed after the ADC1 received the pitot pressure (total pressure) inputs of the Pitot/Static probe on the left side of the airplane, the ADC2 received the pitot pressure (total pressure) inputs of the Pitot/Static probe on the right side of the airplane, and both ADCs received the static pressure inputs of the Pitot/Static probes on the right and left sides of the airplane. Usually, the IAS computed in the ADC1 is displayed on the left PFD, and the IAS computed in the ADC2 is displayed on the right PFD, respectively. The ISI computes and displays the IAS within the ISI after obtaining the pressure inputs from the standby pitot probe installed on the left side of the airplane and the standby static ports on the right and left sides of the airplane (Figure 5, Figure 6).

Figure 5: Pitot/Static Probe Installation Layout

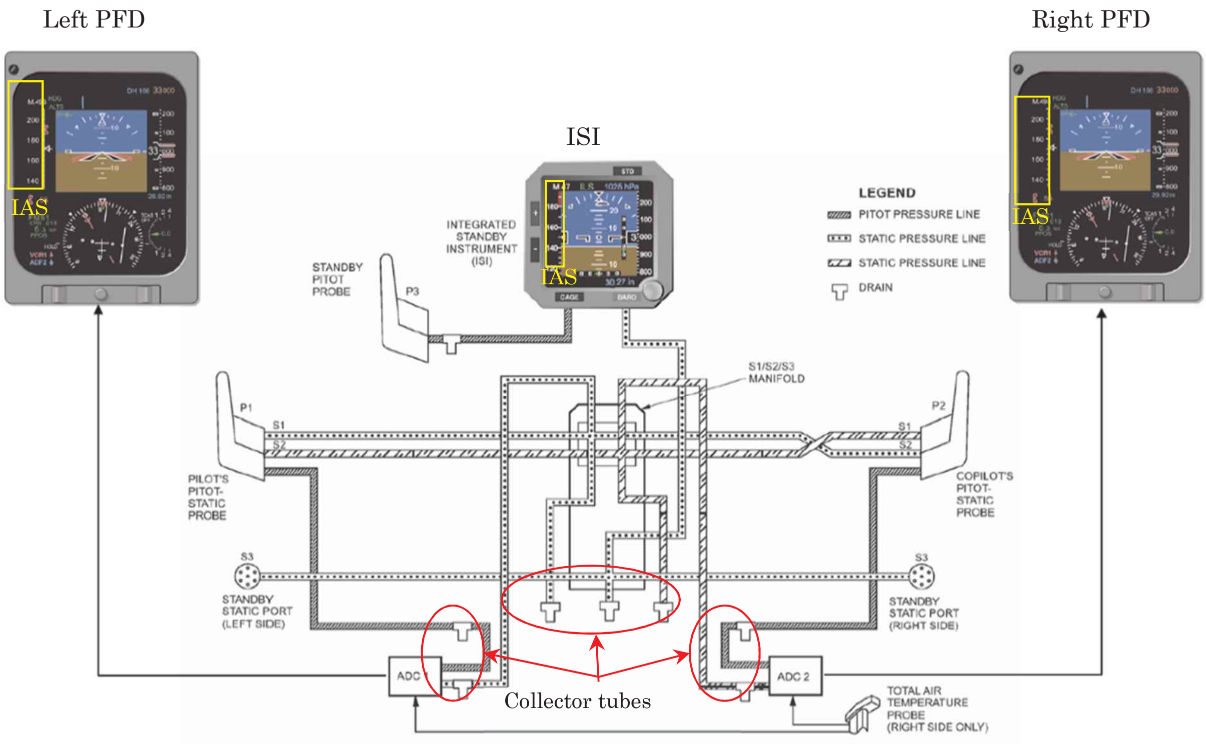

Figure 6: Air Data system diagrams

(2) Pitot/Static probe of the Airplane

The Federal Aviation Administration (FAA) of the United States of America where the designer and manufacturer of the Pitot/Static probe of the airplane is located defined the following three types of icing requirements for the Pitot/Static probes to be approved by FAA. Among these icing requirements, the Pitot/Static probe of the airplane is designed and manufactured in accordance with FAA TSO-C16.

- TSO C16 : This is the requirement included only for de-icing and anti-icing caused by liquid water.
- TSO C16a : This is the requirement included for de-icing and anti-icing caused by some moderate ice crystals and mixed-phase (solids and liquids) conditions.
- TSO C16b : This is the requirement included for de-icing and anti-icing caused by severe ice crystal conditions in addition to liquid and mixed-phase, all based upon the aircraft operating envelope.

(3) Pitot/Static probe Deicing and Anti-icing Equipment

The Pitot/Static probes are equipped with a heater system and are electrically heated to prevent icing. As the temperature of the Pitot/Static probe at the time of the heater's functioning normally exceeds 200℃ during flight, therefore, even if any water enters the probe will be immediately evaporated, not resulting in icing. When a heater failure occurs, EICAS messages are displayed. After this serious incident, an electrical continuity test and insulation resistance test for the heaters wiring as well as the heaters operation test were conducted, but all functioned normally.

(4) Leak Tests for Pitot System and Static System

Air leaks in the lines between the Pitot/Static probe to the ADC would give to inaccurate pressure inputs and erroneous instrument indications, therefore, leak tests for the pitot system and static system were conducted, however, there were no air leaks and all worked normally.

(5) Purging for Pitot System

No foreign object was found in the pitot system after checking the pitot system for foreign objects (purging) with nitrogen gas.

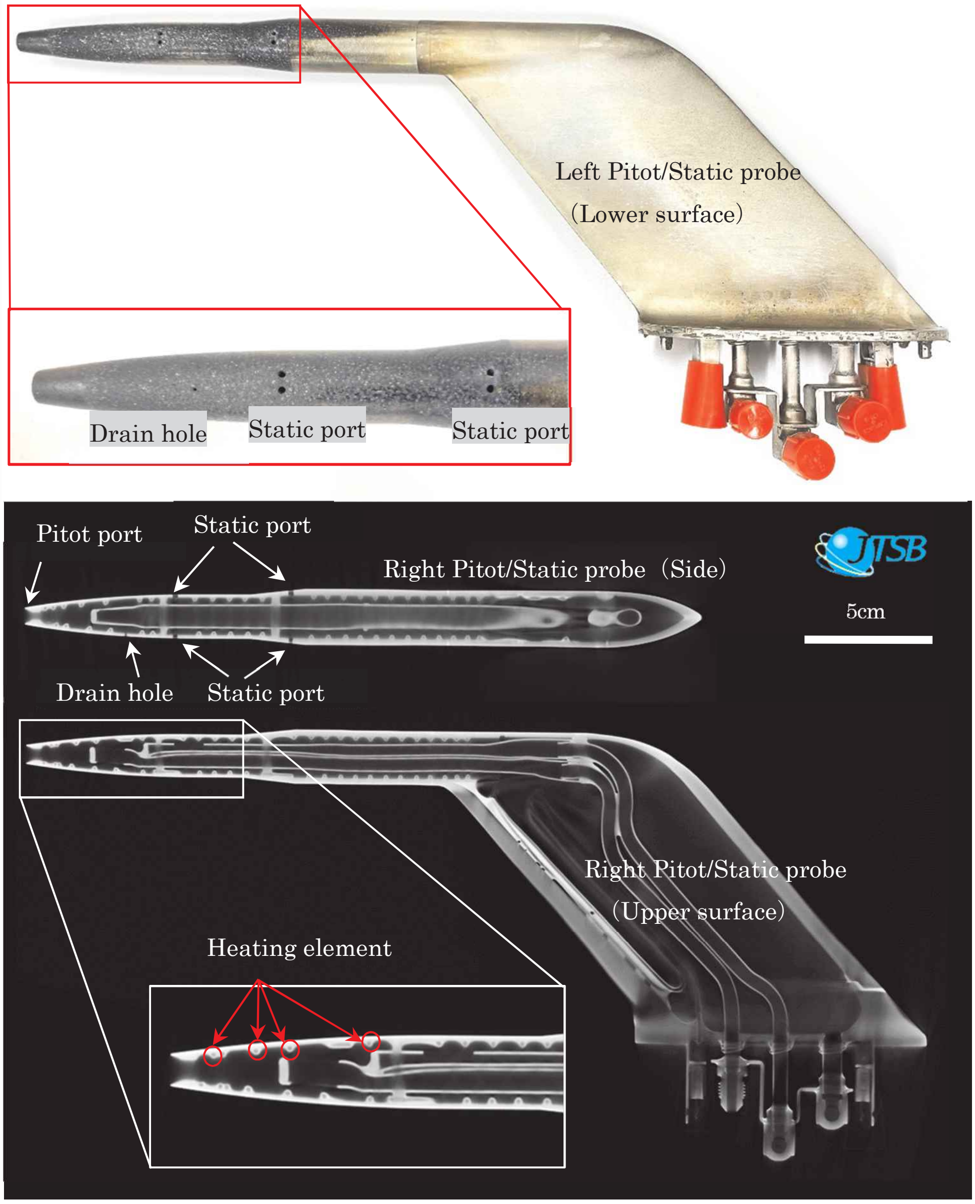

Figure 7: Photo and X-ray CT Scanner Image (the bottom of the Figure) of Pitot Static Probe of the Airplane

(6) Conditions of Drain Hole of Pitot/Static Probe

Rainwater and others entering the Pitot/Static system introduce inaccurate instrument indications, therefore, the Pitot/Static probe is provided with a drain hole to drain rainwater outside of the airplane. And the check of the drain hole (Figure 7) conditions found it in good condition.

(7) Investigation of Pitot/Static probe with X-ray CT scanner

No deformation of the Pitot/Static probe system tubing and traces of obstructions in the X-ray CT scanner image (the bottom of Figure 7) were confirmed, and there was no abnormality such as a short circuit or disconnection in the conditions of the heater.

(8)Conditions of Pitot/Static System Collector Tubes

Rainwater that has not vented through the drain hole of the Pitot/Static probes is collected, by gravity, in the collector tubes. These collector tubes are inspected by mechanics in each flight, and after this serious incident, the collector tubes were inspected, but no rainwater was confirmed (Figure 8).

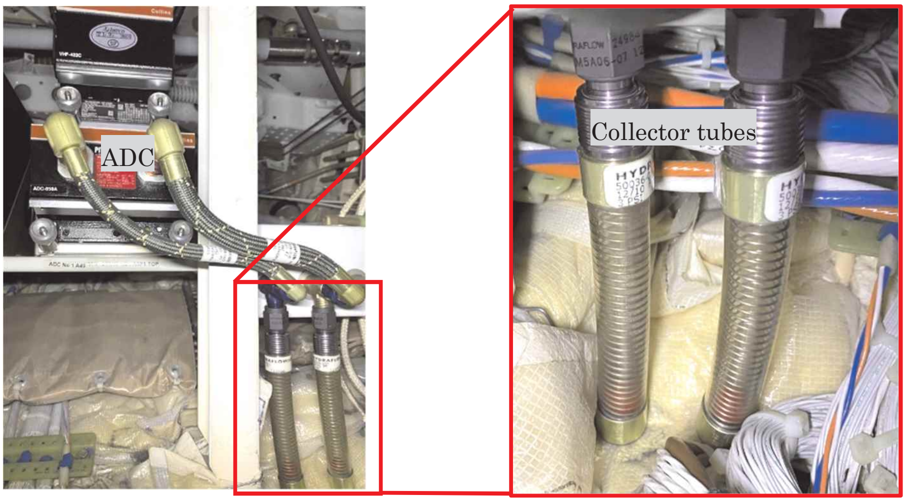

Figure 8: Pitot/Static System Collector Tubes of the Airplane

(9) Display of EICAS Messages

The EICAS message "STALL FAIL" that was displayed at the time of the occurrence of this serious incident indicates an inoperative stall warning. And the EICAS message "RUD LIMIT FAULT" indicates a loss of the redundancy of the device to limit the rudder travel according to the airspeed. Both of the EICAS messages will be displayed when there is a difference of the calculated airspeed value between the ISI and the two ADCs by 20kt or the equivalent Mach number*8.

(10) FAA Information

The AC*9 (AC91-74B Pilot Guide: Flight in Icing Conditions) issued by FAA states on convective weather and icing as follows:

2-4 CONVECTIVE WEATHER AND ICE CRYSTALS

a. Convective Weather Systems.

*8 The Mach number means the ratio of the true airspeed of the aircraft to the speed of sound in the same atmospheric conditions.

*9 "AC" stands for Advisory Circular, which is published by the FAA to provide professionals in the aviation industry with useful information.

Convective weather systems, especially those associated with tropical weather fronts, can pump large quantities of moisture to high altitudes that freezes into ice crystals that can remain aloft. These ice crystals can remain as a cloud well after the convective system has decayed.

b. Hazards.

Above flight level (FL) 250, clouds contain little liquid water and mostly contain ice particles. These clouds with no liquid water have about 20 times less radar reflectivity than rain drops, and therefore are difficult to detect. Airborne weather radar will receive little to no returns at these altitudes unless it is tilted down to lower altitudes near or below the freezing level.

3-11 EFFECTS OF ICING ON CRITICAL SYSTEMS.

a. Pitot Tube.

The pitot tube is particularly vulnerable to icing because even light icing can block the entry hole of the pitot tube where ram air enters the system. This will affect the airspeed indicator and is the reason most airplanes are equipped with a pitot heating system. The pitot heater usually consists of coiled wire heating elements wrapped around the air entry tube. If the pitot tube becomes blocked, and its associated drain hole remains clear, ram air no longer is able to enter the pitot system. Air already in the system will vent through the drain hole, and the remaining will drop to ambient (i.e., outside) pressure.

Under these circumstances, the airspeed indicator reading decreases to zero because the airspeed indicator senses no difference between ram and static air pressure. If the pitot tube, drain hole, and static system all become blocked in flight changes in airspeed will not be indicated, due to the trapped pressures. However, if the static system remains clear, the airspeed indicator would display a higher-than-actual airspeed as the altitude increased. As altitude is decreased, the airspeed indicator would display a lower-than-actual airspeed.

(11) Other Related Information

As the events where the pitot probes did not work normally due to ice crystals, resulting in failure airspeed indication, there is the airplane accident of the Air France Flight AF 447 that occurred over the Atlantic Ocean on June 1, 2009, and the serious incident of the Jetstar Flight 502 (AI2018-5-1) that occurred at an altitude of FL 370, about 96 km south-southeast of Chubu Centrair International Airport on July 9, 2016.

(12) Airworthiness Directive (TCD)

The Civil Aviation Bureau of the Ministry of Land, Infrastructure, Transport and Tourism has issued the TCD related to the failure airspeed indication of Bombardier Inc. model CL-600-2C10 aeroplanes.

Koku-ku- ki No. 793, Document Number: TCD-8654-2015

Airworthiness Directive, dated October 21, 2015

	(Omitted) *2. Applies to* *Bombardier Inc. model CL-600-2C10 aeroplanes, serial numbers 10002 and subsequent.* *3. Compliance required as indicated, unless already accomplished* *To prevent the failures that affect flight safety due to a loss of air data information caused by icing, the airplane flight manual revisions shall be incorporated in accordance with the items of "Compliance" and "Corrective Actions", which are described in the attached TCCA AD CF-2015-20 (hereinafter referred to as "AD"), unless revisions have already been made.* (Omitted) *4.1 This directive shall be effective as of November 4, 2015.* *4.2 The directive is according to the Transport Canada approved TCCA AD CF-2015-20.* (Omitted) *4.5 Bombardier Airplane Flight Manual CL-600-2C10, Revision 15, Section 03-19-1, dated 16 March 2015, or later revisions approved by Transport Canada are related to this TCD.* (Omitted) *AIRWORTHINESS DIRECTIVE* (Omitted) *Number: CF-2015-20* *ATA: 34* *Effective Date: 21 July 2015* *Type Certificate: A-131* *Subject: Navigation – Flight Instruments – Unreliable Air Data in the Cockpit* *Applicability: Bombardier Inc. model CL-600-2C10 aeroplanes, serial numbers 10002 and subsequent.* (Omitted) *Background: Two in-service incidents have been reported on CL-600-2C10 aeroplanes regarding a loss of all air data information in the cockpit. The air data information was recovered as the aeroplane descended to lower altitudes. An investigation determined that the root cause in both events was high altitude icing (ice crystal contamination). If not addressed, this condition may affect continued safe flight.* *Due to similarities in the air data systems, such events could happen on all Bombardier CRJ models, CL-600-2B19, CL-600-2C10, CL-600-2D15, CL-600-2D24 and CL-600-2E25. Therefore, the corrective actions for these models will be mandated once their respective Airplane Flight Manual (AFM) revisions become available.* *This AD mandates the incorporation of AFM procedures to guide the crew to stabilize the aeroplanes airspeed and attitude for continued safe flight.*

Corrective Actions: Amend the Transport Canada approved AFM by incorporating the procedure for Unreliable Airspeed as detailed in Revision 15, Section 03-19-1 - Emergency Procedures, dated 16 March 2015, or later revisions of this procedure approved by Transport Canada.

(13) Aircraft Operations Manual of the Operator

Based on the Airworthiness Directive (TCD-8654-2015), the aircraft operations manual of the Operator stipulates "Emergency Procedures for Unreliable Airspeed In-flight" as follows: (Figure 9)

CRJ700　飛行機運用規程　第２巻

EMERGENCY PROCEDURES
Unreliable Airspeed

Unreliable Airspeed In-flight

(1) Autopilot.. Disengage
(2) FDs.. Deselect
(3) Use ISI for pitch reference.

Initial take-off climb or go-around is required:

(4) Pitch / N1........................10 degrees / TOGA from SL to 15000 ft; 5 degrees / CLB above 15000ft
(5) Aircraft configuration........................ At clean up altitude Gear UP / FLAPS 0
(6) Airplane altitude........................ Maintain lowest safe altitude or higher

CAUTION

Respect stall warning / stick shaker.

Figure 9: Emergency Procedures for Unreliable Airspeed In-flight
(Excerpts of operation procedures to be performed by memory items)

3. ANALYSIS

(1) EICAS Messages

The JTSB concludes that both EICAS messages "STALL FAIL" and "RUD LIMIT FAULT" that were displayed at the time of the occurrence of this serious incident will be displayed when there is a difference in calculated airspeed value between the ISI and the two ADCs, therefore, they most likely occurred because the pitot system became blocked.

(2) Responses of Flight Crewmembers

The JTSB concludes that it is certain that the events the PIC recognized for the first time were the EICAS messages of "STALL FAIL" and "RUD LIMIT FAULT", and the PIC started the actions immediately according to the Operation Procedures for responding to the EICAS message of "STALL FAIL". The PIC noticed the incorrect IAS indication while taking the actions, but the IAS indication failure had been eliminated when almost completing the actions, therefore, the PIC most likely judged that it would be unnecessary to perform the Emergency Procedures for Unreliable Airspeed In-flight. However, the PIC disengaged the auto-pilot and flight director to prevent unintended airplane behavior and continued to fly while monitoring the ISI display and the engine instruments, which is the same procedure as the Emergency Procedures for Unreliable Airspeed In-flight (Figure 9), thus it was appropriate.

(3) FDR Records

The IAS of the airplane is recorded as CAS*10 1 for the left side of the Pitot/Static system and as CAS 2 for the right side of the Pitot/Static system, respectively. CAS 1 and CAS 2 in normal flying conditions are recorded as close values, respectively, while changing slightly depending on the atmospheric conditions even if flying at a constant speed. According to the FDR records, at 19:58:08, the CAS1 became constant (Figure 10 a.), and the CAS2 continued to change even after that. The JTSB concludes that it is highly probable that this is because the left side of the pitot system, based on which the CAS1 is calculated, became fully blocked. At 20:11:44, the airplane commenced to descent (Figure 10 b.). 20;12:10, the right side of the pitot system became fully blocked (Figure 10 c.), while the pressure of both sides of the pitot system was kept due to the blockage, the static pressure increased as the airplane descended, therefore, the values of the CAS1 and CAS2 highly probably decreased. The airplane continued to descend, and both values of the CAS1 and CAS2 were recovered almost simultaneously at 20:21:41, therefore, at this time, the blocked conditions were highly probable resolved (Figure 10 d.). After the blocked conditions were resolved, the IAS values had most likely indicated normal values until the landing.

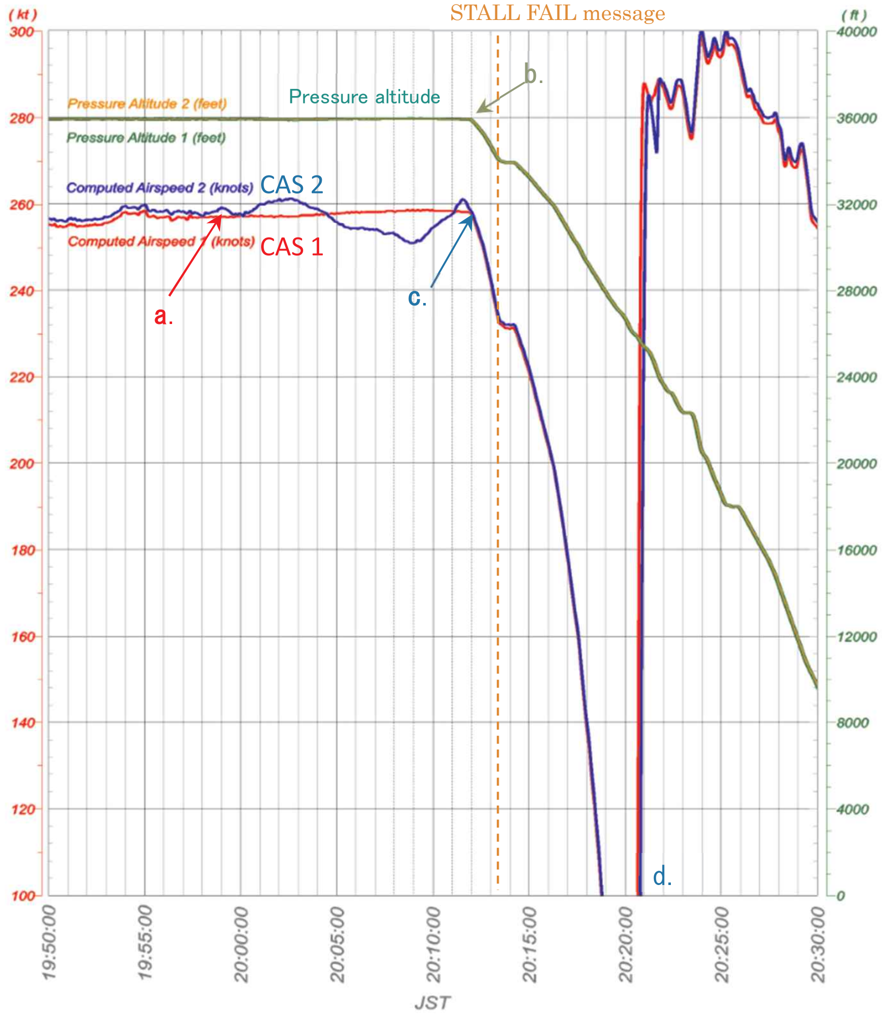

Figure 10: FDR Records before and after the Serious Incident
(Change in CAS and Pressure Altitude)

*10 "CAS" stands for Computed Airspeed, meaning the same as the IAS of the aircraft.

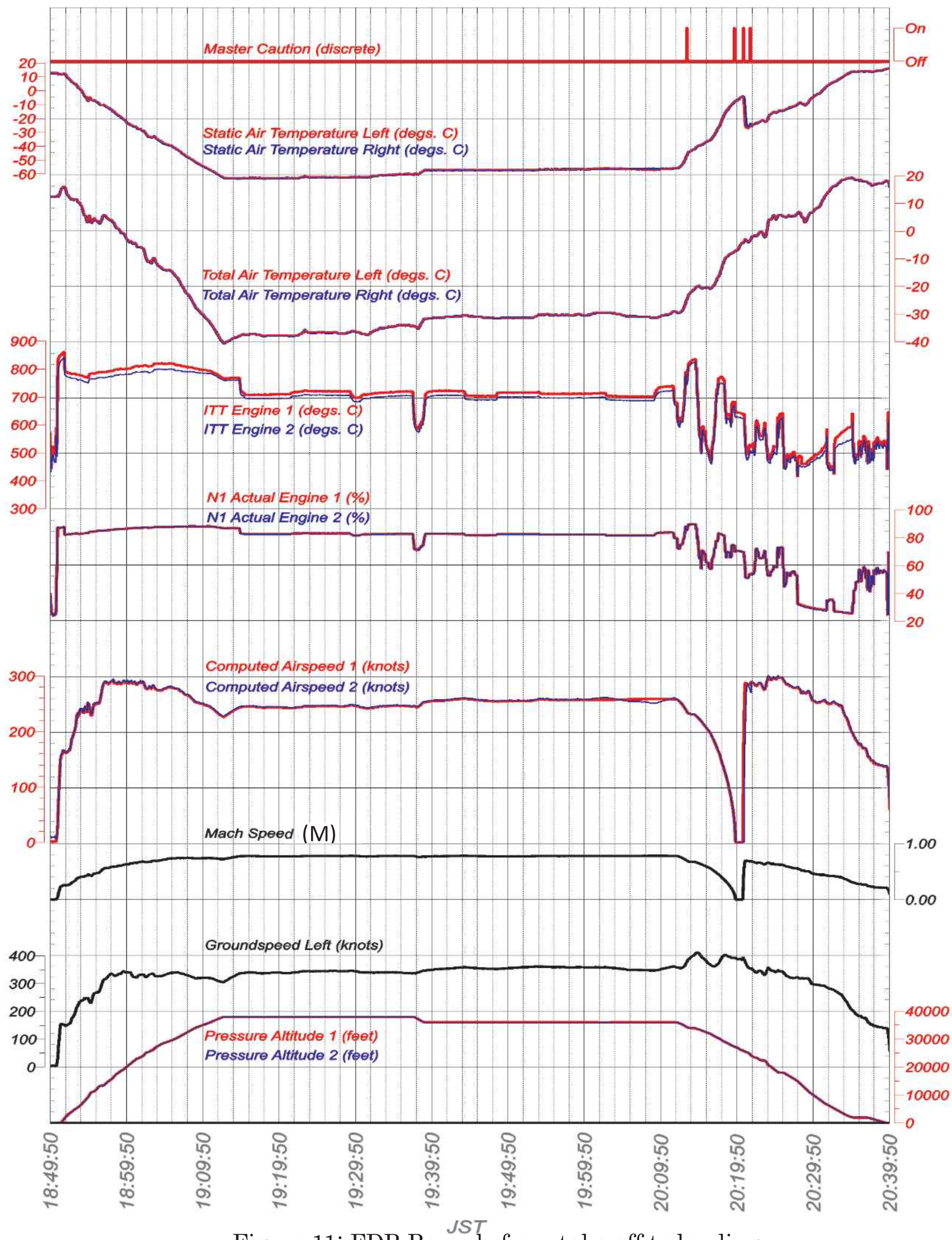

Figure 11: FDR Records from take-off to landing

(4) Blockage of the Pitot/Static Probes

The JTSB concludes that from the FDR records, the blockage most likely started after the airplane flew at a high altitude with no cloud with a temperature of around - 60℃ for more than 50 minutes. In the investigation of this serious incident, all the Pitot/Static systems including heaters operated normally, and there were no signs of blockages such as dust, insects, volcanic ash, moisture and others. According to the Designers and Manufacturers of the airplane and the Pitot/Static probes, there are no cases where during flight in high humidity or clouds, icing due to water droplets and others has occurred in the airplane whose Pitot/Static system including heaters operated normally. From these, it is probable that the airplane flew through the airspace presented ice crystals, therefore the Pitot/Static system became temporarily blocked due to the ice crystals.

(5) Relationship between Blockage Sites of Pitot System and IAS indications

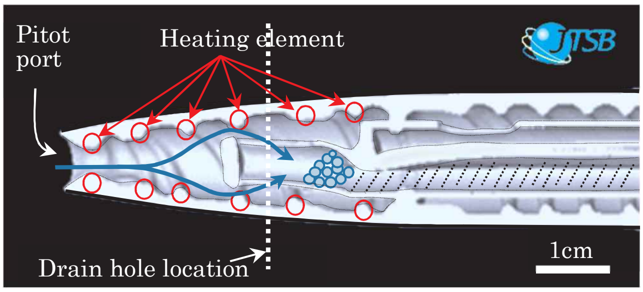

Figure 12: X-ray CT Scanner 3D Cross Section

The JTSB concludes that the difference in IAS indication probably occurs depending on the blockage sites of pitot system. When the upstream side of the drain hole is blocked, the pitot pressure will vent through the drain hole and will not be kept, resulting in an indication of decreased IAS immediately after the blockage. On the other hand, when the downstream side of the drain hole is blocked, the pitot pressure will be constant and kept, thus IAS indication will be constant (Figure 12). In this case, the static pressure increases as the airplane descends, thus resulting in an indication of decreased IAS. In addition, as the sites shown in Figure 12 (several circles in light blue that show an image of crystals) indirectly transfer the heat from the heater, its temperature is likely lower than the sites that directly touch with the heater. The rain droplets and others that entered the Pitot/Static probe are instantly evaporated, but it would take more time for icing crystals to be melted and evaporated depending on their temperature, sizes and others. From these, it is possible that at the time of the serious incident, ice crystals accumulated on the downstream side of the drain hole, and the pitot system became blocked.

(6) Standby Pitot/Static System

The JTSB concludes that according to the statement of the PIC, the IAS indication of the ISI at the time of the occurrence of the serious incident was highly probable stable and normal. This is possible because as for the standby Pitot/Static system of the ISI, its standby pitot probe and the standby static ports are independent of each other whose installation positions and internal structures are different from the primary (No1 & No2) Pitot/Static probes, therefore it did not become blocked.

(7) Clearing the Blockage of the Pitot/Static System

The JTSB concludes that it is possible that IAS indication on both the PIC side and the FO side came to continuously indicate the values to be normal is likely because the airplane was away from the airspace presented ice crystals, the atmospheric temperature increased as the airplane descended, and the ice crystals were melted due to fully heated air from the Pitot/Static probe heater, resulting in clearing the blockage.

(8) Influence of Weather

The JTSB concludes that it is most likely that according to the statements of the PIC and the FO as well as meteorological data, it rained at the time of taking off from Sendai Airport, and the airplane was flying in clouds until reaching FL 300 after the take-off. On this occasion, rainwater likely entered the pitot system, but after that, the airplane was not flying in clouds for about 50 minutes until reaching the vicinity of the serious incident site, no rainwater and other was confirmed in the collector tubes, therefore, it is more likely that entered water was evaporated by heat from the heater, or discharged from the drain hole.

At the time of the occurrence of the serious incident, the airplane was flying at an altitude in the vicinity of the tropopause, the boundary between the troposphere where air convection occurs and the stratosphere where convection does not easily occur, therefore ice crystals raised by air convection possibly stayed near the flight altitude of the airplane. Air convection reaching high altitudes is generally observed around the airspace presented ice crystals, but when a serious incident occurred, the air convection reaching high altitudes was not observed around the estimated flight route of the airplane.

4. PROBABLE CAUSES

The JTSB concludes that it is most likely that the probable cause of this serious incident was that the right and left sides of the pitot system became blocked while the airplane was flying at FL 360, the failure airspeed indication temporarily occurred on both of the PIC side and the FO side.

Regarding the pitot system being blocked, it is probable that the aircraft flew in an area where ice crystals existed.

5. SAFETY ACTIONS

5.1 Safety Actions Required	This serious incident occurred during the night, and in spite that visually recognizable information such as topography and others was unable to be obtained, the flight crewmembers continued to fly with their calm response and made a safe landing. It was difficult for weather prediction and airborne weather radar to detect the airspace presented ice crystals, and it is possible that ice crystals are suddenly encountered during flight. As there is a past event where wrong responses by flight crewmembers led to a serious accident, even if similar it is necessary to be prepared so as to address appropriately should a similar situation arise.
5.2 Safety Actions Taken after the Serious Incident	(1) After this serious incident, as countermeasures to be taken in the event of a similar situation, the Operator made through notification of the following matters to all flight crewmembers and implemented a case study. a. In any emergency situation, abrupt actions due to a confused state of mind shall be restrained and a philosophy of giving top priority to the continuation of flight (fly first) shall be kept in mind. b. The airplane status shall be accurately assessed based on the flight stage, airplane attitude, airplane settings (configuration), and EICAS messages and others, airplane control shall be conducted carefully and procedures shall be implemented according to the situation. c. Operation policy shall be established and changes and others in the plan necessary to accomplish the flight shall be made. d. Crewmembers shall share the situation among themselves in order to have a mutual understanding, as necessary, support from Air Traffic Control facilities and operation control (company) shall be called in. e. Regarding emergency procedures for failure airspeed indication, each intention of the operation shall be reconfirmed so as to address appropriately should a similar situation arise in every flight stage.

	(2) In light of the occurrence of this serious incident, the Operator added Emergency Procedures for Unreliable Airspeed In-flight to the recurrent training.