National Transportation Safety Board
Office of Aviation Safety
Washington, DC 20594

ERA23LA135

FLIGHT TESTING

May 14, 2024

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A. ACCIDENT

Location:	Windsor Locks, Connecticut
Date:	March 3, 2023
Time:	1600 Local 2100UTC
Airplane:	BOMBARDIER INC, BD-100-1A10 (Challenger 300)

B. FLIGHT TESTING

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C. SUMMARY

On March 3, 2023, about 1600 eastern standard time, a Bombardier BD-100-1A10 (Challenger 300) airplane, N300ER, was involved in an accident while enroute from Dillant/Hopkins Airport (EEN), Keene, New Hampshire to Leesburg Executive

Airport (JYO), Leesburg, Virginia. The flight diverted to Bradley International Airport (BDL), Windsor Locks, Connecticut. One passenger was fatally injured. The two airline transport pilots and two other passengers were not injured. The airplane was not damaged and was operated as a personal flight under the provisions of Title 14 Code of Federal Regulations Part 91.

D. DETAILS OF THE INVESTIGATION

On November 1, 2023, flight testing was performed at Bombardier and the Wichita Dwight D Eisenhower National Airport (ICT), Wichita, Kansas. The purpose of the flight testing was to perform a rejected takeoff, with a pitot-static probe cover installed on the RH pitot-static probe, and then observe the airplane systems behavior during a subsequent takeoff and climb. The flight test purposely did not allow the airplane to enter a severely out of trim condition as experienced during the accident flight.

The NTSB observed the flight testing from the telemetry room, which displayed a live camera view into the cockpit with a variety of flight data. Bombardier flight test pilots completed the test flight in accordance with the Bombardier Test Card. Representatives with Transport Canada, Bombardier, Collins, and Moog were also present. These notes detail factual observations from the testing activities.

E. FLIGHT TESTING SEQUENCE OF EVENTS

Sequence of Events

Prior to taxi, a high temp pitot-static probe cover was installed on the RH pitot-static probe.

At 10:40:26[1], the first takeoff was initiated and at 90 kts a rejected takeoff (RTO) was performed. During the RTO, the pilots observed an IAS PFD flag indication (Yellow Boxed IAS) as expected. This flag displays on the PFD when there is a greater than 10 kts discrepancy between L/R displayed airspeed.

Review of flight data found that the airplane traveled at a speed greater than 90 kts for about 3 seconds. In order to obtain an EFIS MISCOMPARE caution CAS message, the airplane must travel above 90 kts for 5 seconds or greater, with greater than 10 kts discrepancy between L/R displayed airspeed. During previous flight testing carried out by Bombardier, during the RTO the airspeed was maintained above 90 kts for greater than 5 seconds, and video showed that the EFIS MISCOMPARE caution CAS message was posted. The message subsequently

[1] Time referenced to the integrated test acquisition system (ITAS) from the flight test vehicle. This is the time displayed in the white box in the upper left corner in the below figures.

cleared, once the speed differential dropped below 10 kts, and/or when the airplane slowed below 90 kts.

During the deceleration in the RTO, the RUDDER LIMITER FAULT Advisory CAS was displayed. The L/R Eng Thrust Fault advisory messages also displayed during the deceleration, however, the thrust fault messages cleared within a few seconds after they were first annunciated. The V-Speeds no longer displayed on the PFD. Shortly after the RTO, the pitot probe heat was turned off and the L/R Probe Heat Off caution CAS message was displayed.

Figure 1: Screenshot from the RTO as thrust was applied[2].

[2] The XBLEED OPEN status message was posted for the entirety of flight due to the bleed air configuration the test flight was flown with.

Figure 2: Screenshot taken as the crew announced 90 kts and at the moment thrust was reduced in the RTO.

At 10:45:00 the crew taxied to the ramp area, shut down the left engine, and ground crew removed the RH pitot-static probe cover. The cabin door was not opened. At 10:46:11, the crew remarked that the Control Display Unit (CDU)[3] displayed a message of 'VSPEEDS DESELECTED' as expected.

[3] The interface for the flight management system (FMS).

Figure 3: Left Engine Shutdown.

At 10:46:50, the crew restarted the left engine. At 10:47:50, the STALL/ RUD LIM test was performed two times. The second test was completed at 10:48:27. During the test, the RUD LIMITER IN TEST status message displayed. The RUDDER LIMITER FAULT Advisory CAS remained posted following the completion of the two tests. The flight crew taxied to the runway for the next phase of the test flight.

Figure 4: Screenshot taken during the STALL/ RUD LIM test.

Figure 5: Screenshot taken following the conclusion of the two STALL/ RUD LIM tests, with the RUDDER LIMITER FAULT advisory CAS remaining posted.

At 10:58:20, the takeoff was initiated without the V-speeds displayed on the PFD and the RUDDER LIMITER FAULT advisory CAS still posted. No other additional CAS messages were posted.

Figure 6: Screenshot taken following the application of thrust during the second takeoff.

At 10:58:47, about 1,780 indicated altitude[4] (about 400 ft radio altitude), the MACH TRIM FAIL caution CAS message posted. It was accompanied by a master caution light and a master caution aural alert (single chime)[5]. The message persisted for the remainder of the flight.

[4] All altitudes are indicated. Note: FDR data displays pressure altitude.
[5] This message is inhibited on the ground up to 400 ft radio altitude.

Figure 7: Screenshot of MACH TRIM FAIL posting.

At 10:59:30, about 153 kts and 3750 ft, the autopilot was turned on. Immediately following the AP engagement, the AP STAB TRIM FAIL caution CAS message posted. It was accompanied by a master caution light and a master caution aural alert (single chime).

Figure 8: Screenshot at first AP engagement.

At 11:00:09, about 159 kts and 5,140 ft, the AP was disconnected with the left seat yoke mounted pitch trim switch. When the AP was disengaged, the AP STAB TRIM FAIL caution CAS message was cleared.

Figure 9: Screenshot following first AP disengagement.

At 11:00:29, the AP was reengaged a second time at 162 kts, at 5,750 ft. Immediately following the AP engagement, the AP STAB TRIM FAIL caution CAS message posted. It was accompanied by a master caution light and a master caution aural alert (single chime).

Figure 10: Screenshot at second AP engagement.

The airplane continued to accelerate at a rate of one knot per second in the climb. At 11:01:02, at 182 kts the AP HOLDING NOSE DOWN caution CAS message was posted. At 11:01:07, the message cleared when the speed dropped below 182 kts[6].

[6] The AP HOLDING NOSE DOWN caution CAS message displays when forces on the pitch servo exceed mis-trim threshold limits.

Figure 11: Screenshot taken when AP HOLDING NOSE DOWN posted.

Figure 12: Screenshot taken when AP HOLDING NOSE DOWN cleared.

The airplane was slowed to 165 kts about 9,000 ft. At 11:02:39, the flight crew executed the AP STAB TRIM FAIL checklist and at the conclusion of the checklist, the master AP disconnect switch was pressed and the AP disconnected. The calvary charge AP disconnect was heard. In addition, when the AP was disengaged, the AP STAB TRIM FAIL caution CAS message was cleared. The airplane returned for landing.

Figure 13: Screenshot at the time the AP was disconnected for the second and final time.

F. FLIGHT TESTING VEHICLE

Flight Test Vehicle Comparison to N300ER

The flight test vehicle was compared to the equipment installed on the accident airplane (N300ER) and it was found to be a valid comparison make and model. In addition, the flight test vehicle was flown in a similar weight and balance configuration.

N300ER Equipment Status

The accident airplane was a BOMBARDIER INC, BD-100-1A10 (Challenger 300), serial number 20428. The airplane was manufactured in 2013. The following configuration for N300ER was reported by the operator.

Flight Guidance Computer: FGC-3002 (in IAPS)

- #1 P/N 822-1592-626 S/N 426VF5 Installed Modified unit Nov 28,2016 ACTT 840.5

- #2 P/N 822-1592-626 S/N 426R15 Installed Modified unit Nov 28,2016 ACTT 840.5

Input Output Concentrator: IOC-4100 (in IAPS)

- FWD P/N 822-1362-152 S/N 412FC6 Installed Modified unit Nov 17. 2017 ACTT 1045.6
- AFT P/N 822-1362-152 S/N 4L87 Installed Modified unit Jan 16 2019 ACTT 1312.1

Data Concentrator Unit: DCU-5000

- P/N 822-1578-007 S/N 41GLPH Installed OH unit Aug 20, 2019 ACTT 1468.4

Adaptive Flight Display: AFD-5220E

- Left Inboard P/N 822-1917-328 S/N 4LT91 Installed Modified unit Nov 17, 2017 ACTT 1045.6
- Left Outboard P/N 822-1917-328 S/N 4M358 Installed Modified unit Nov 17, 2017 ACTT 1045.6
- Right Inboard P/N 822-1917-328 S/N 46TC1K Installed Modified unit July 25, 2021 ACTT 1813.2
- Right Outboard P/N 822-1917-328 S/N 4M359 Installed Modified unit Nov 17, 2017 ACTT 1045.6

Servo: SVO-3000

- Aileron Servo P/N 822-1168-032 S/N 3FY1P Installed Nov 25-2013 ACTT 0
- Elevator Servo P/N 822-1168-033 S/N 4K9D2 Installed Nov 25-2013 ACTT 0

HSTECU

- Part number: C47329-012, Software version: 013, Serial number: 303 (Date of Manufacture: 05/08)

<u>The Flight Test Vehicle</u>

Avionics:

- DCU-5000 P/N 822-1578-954-23 (Red Label) S/N D29M (F1116)
- IOC-4100 #1 P/N 822-1362-970-17 installed (F1116)
- IOC-4100 #2 P/N 822-1362-970-17 installed (F1116)
- RIU-4000 (#1) P/N 822-1469-653-01 (F1052)
- RIU-4100 (#2) P/N 822-1590-153-01 (F1052)
- Adaptive Flight Display PFD 1 (AFD-5220E) (TAKI), P/N 822-1917-925-48, PFD1 S/N 4C9DF (F1116)
- Adaptive Flight Display MFD 1 (AFD-5220E) (TENRI), P/N 822-1917-905-31, MFD1 S/N 10F7K (F1116)
- Adaptive Flight Display MFD 2 (AFD-5220E) (TAKI) P/N 822-1917-925-48, MFD2 S/N 41FXKN (F1116)

- Adaptive Flight Display PFD 2 (AFD-5220E) (TENRI) P/N 822-1917-905-31, PFD2 S/N 2WVWT (F1116)
- FDR P/N 2100-2045-22 S/N 000632562 installed (F0705)
- MDC-4110 P/N 822-1988-980-07 (Red Label) with MDT-3110 P/N 810-0042-276-01 (F1116)
- TAWS (EGPWS) Computer P/N 69000941-116R, S/N MK5A-11857 (F1120)
- RL2.4 Software: ROAAS RLD 69006774-E09, RCD 350T4 (Male Voice), TAWS Eng Test Terrain DB F033
- SPC P/N 822-1792-004 S/N 4NY7X (Black Label) (F980)

Flight Controls:

- Stabilizer/Aileron Trim - Modsum DVMSFF100E00127013 Rev A –
- Pilot and Co-Pilot Pitch-Roll Trim Switches, updated production equivalent relays for the trim switches with associated representative wiring. (F1087)

IASC / CPCS:

- Upgraded safety valves (x2) - 81141B010101 (F1043)
- Red label IASC - 92175A030600P2 (F1050)
- IASC and DCU strapping returned to production from RCA config (F1052)

HSTECU

- Part number: C47329-010, Software version: 013, Serial number: 086.

Submitted by:

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