

ERA23LA135

OPERATIONAL FACTORS

Attachment 11

Simulator Evaluation at CAE

April 11, 2024

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Location: Dallas, Texas
Date: January 11, 2024
Time: 1130 CST

Overall Objectives:

- Document simulator fidelity.
- Verify procedures available in the sim are same as QRH and if paper or electronic.
- Document procedures for stab trim checklists.
- Document any rudder trim fault messages.
- Document any possible difference with airplane indications.
- Document any control force required to overcome pitching motion (in lbs. if possible)

Aircraft: CL-30 simulator
Airport: EEN

Invited Participants:

Adam Gerhardt (NTSB, IIC)
Shawn Etcher (NTSB, Operational Factors)
Katherine Wilson (NTSB, Human Performance)
Todd Gentry (FAA, AVP-100)¹
Andrew Field (Bombardier)
Eric Stokley (Bombardier Test Pilot)
Quinn Hamon (Air Share)

Initial Simulator Setup:

- Configuration:
 - Takeoff Weight 30,611 lbs.
 - Takeoff Fuel 6,030 lbs.
 - Estimated Weight at Time of Accident 29,500 lbs.
 - CG 590.6 (provided by operator)
 - Trim 5.6
 - Outside temp 6°C, Dewpoint -3°C
 - V1 (estimate 116), Vr, V2, Vfs

- Cloud heights: clear.
- Weather:

**METAR KEEN 032056Z AUTO 00000KT
10SM CLR 06/M13 RMK AO2 SLPNO
T00561128 \$=**

- Day
- Left seat was Pilot Flying (PF); Right seat was Pilot Monitoring (PM).

¹ Due to other events Mr. Gentry was unable to attend.

- Fuel freeze to be utilized during the entire simulator evaluation in order to repetitively simulate the accident flight's weight near the time of the accident.
- All runs were conducted with motion **on** unless noted otherwise.
- All runs maximum altitude of FL270 in VMC (might want to put a footnote in here as to why we are using FL270. We can just say that this is the max altitude of the accident flight.
- All runs conducted up to cruise and until aircraft is stabilized after pitch oscillations.
- Repeat any runs as needed and note each. Record any issues with the test run.
- Maintain 250 kts. Until 10,000 ft msl and then 275-280 kts.

Run 1: Normal Takeoff Runway 02 EEN with no Co-pilot Airspeed

Procedure

- Place aircraft on taxiway A1 holding short of runway 2.
- Set right airspeed tape to simulate pitot tube cover still installed as a result of the pitot tube being blocked.
- Normal takeoff procedures
 - a. Allow for acclimation of normal procedures and indications.

Notes
a. Aircraft indications noted: <i>There were no indications of a fault, CAS message indicated EFIS MISCOMP. After clearing the runway No. 1 engine was shut down, then restarted, and stall test was accomplished. Aircraft repositioned to runway threshold.</i>

Run 2: Normal Takeoff to Altitude

Procedure

- Normal taxi to end of runway after RTO.
- Normal Takeoff
- **Clear** airspeed malfunction on right airspeed tape (simulating pitot tube cover removal)
- Autopilot engagement when able to do so.

- Engage/ disengage autopilot consistent with FDR data, via the pilot-controlled pitch trim switch.
- Do not reset V-speeds unless the computer does automatically and note.
- Press TOGA switches for power and command bars.

RUDDER LIMITER FAULT

Condition: A minor failure resulting in the loss of redundancy has occurred in the rudder limiter system.

NOTE: The rudder travel limiter will continue to function. This message will also be displayed after 10 consecutive landings without cycling the aircraft electrical power.

– COMPLETE –

	Notes
	<p>a. Aircraft indications noted: <i>No rudder limiter fault message was able to be displayed after various attempts.</i></p>

Run 3: Autopilot Holding Nose Down/Nose Up

AP HOLDING LWD

or

AP HOLDING RWD

or

AP HOLDING NOSE DOWN

or

AP HOLDING NOSE UP

Condition: Autopilot is holding control force in the direction indicated.

Objective: Correct mistrim condition.

⚠WARNING: An abrupt change in control force, or an out of trim situation may be experienced when disconnecting the autopilot.

SMKG / BELTS should be selected on.

⚠CAUTION: Minimize changes to airspeed and configuration to minimize control forces and out of trim situation.

- (1) Flight controls HOLD FIRMLY
- (2) AutopilotDISCONNECT
using control wheel MSW switch
- (3) Retrim airplane if necessary.
- (4) AutopilotAS DESIRED

– COMPLETE –

Procedure

- **Reposition to approximately 5,000 ft**
- Set altitude bug to FL270
- Normal climb speed
- Autopilot engaged

	Notes
	<p>a. Aircraft indications noted: <i>During climb out sim operator applied a jammed elevator; however, no indication was noted on the EICAS. Aircraft was accelerated to 280 kts with a 4,000 foot per minute (fpm) vertical speed. Pilot disconnected the autopilot and there was a vertical acceleration resulting in a +1.2 G force. Jammed elevator sim setting was cleared airplane was decelerated to 250 kts and Jammed elevator was simulated at a trim setting of 4.3. Accelerated to between 280 and 290 kts and applied manual back pressure to the control column. No jammed elevator EICAS message displayed. Disconnecting the autopilot resulted in a +2.1 G force and during recovery a -.25 G force was maximum recorded. The simulator was reset to 5,000 ft and 250 kts, with the autopilot engaged. The simulator operator simulated a jammed elevator and the two pilots applied control column forward pressure as the aircraft accelerated to 285 kts. The trim indication indicated 4.5 and the AP STAB TRIM FAIL and PRI STAB TRIM FAIL messages illuminated on the EICAS. In conjunction with the IIC the simulator operator, unbeknownst to the pilots, selected the primary stab trim to "OFF". That resulted in the autopilot disconnecting without crew input and indicated a +3.6G and -1.25 G force. The simulator was reset to 5,000 ft and 250 kts with the autopilot engaged. The simulator operator simulated a jammed elevator with a stab trim setting of 4.3. The pilot applied forward control column pressure as the airplane accelerated and the AP STAB TRIM FAIL and PRI STAB TRIM FAIL messages illuminated on the EICAS. As the pilot looked at his EFB for the next checklist and without the pilot's knowledge, the co-pilot turned the primary stabilizer trim to "OFF." That resulted in the autopilot disconnecting without crew input and indicated a +2.87 G and a -0.51G force. The pilot estimated that approximately 25 lbs. of forward control column force was needed for the two results.</i></p>

CONCLUSION:

The group determined that the simulator was incapable of producing similar indication that the accident flight crew would have received without a considerable amount of human interaction. Even after applying manual input it was determined, in conjunction with the Bombardier test pilot and the operator's chief pilot, that the simulator did not exactly replicate the accident airplane. Although it was determined that with startle effect and applying manual pressure both forward and aft on the control column could result in similar outcomes as the accident flight. It should be noted that recovery from the autopilot disconnecting resulted in exceeding the g-forces limitations of the airplane, the recovery was accomplished in about one pitching oscillation and did not require excessive piloting skills to recover. However, there was no indication from the accident crew nor the flight data recorded information that either crewmember applied manual force to the control column with the autopilot engaged during the accident flight.

Appendix A: PRI STAB TRIM FAIL

PRI STAB TRIM FAIL

(1) STAB TRIM OFF

➤ FROM Quick Reference Card ◀

(2) Airspeed 0.75 M/250 KIAS MAXIMUM

▼

PRI STAB TRIM FAIL (Cont'd)

(3) STAB TRIM SEC

NOTE: The autopilot, MACH trim, and configuration trim will be inoperative with SEC STAB TRIM selected.

(4) Control Wheel TrimOPERATE AS REQUIRED
TO MAINTAIN TRIM

(5) Stab trim is operative in both directions:

➡ **YES** – Go to (6)

➡ **NO** – Go to (8)

(6) Stab trim is operative in both directions:

(7) Control Wheel TrimOPERATE AS REQUIRED
TO MAINTAIN TRIM

– COMPLETE –

(8) Stab trim is not operative in both directions:

(9) STAB TRIM OFF

(10) Elevator PULL force is encountered and / or stabilizer jams during a high speed condition:

➡ **YES** – Go to (11)

➡ **NO** – Go to (15)

(11) Elevator PULL force is encountered and / or stabilizer jams during a high speed condition:

(12) Delay further reduction of airspeed as long as possible to minimize the time out of trim.

(13) Move C.G. aft if possible.

(14) Go to (19)

(15) Elevator PUSH force is encountered and / or stabilizer jams during a low speed condition:

(16) Do not increase airspeed to minimize the out of trim conditions.

(17) Move C.G. forward if possible.

(18) Land as soon as possible to minimize aft C.G. movement.

Descent checks:

(19) Pressurization..... LNDG ALT SET

(20) WING ANTI-ICEAS REQUIRED

(21) L and R ENG ANTI-ICE.....AS REQUIRED

Transition Level (or FL 180) Checks:

(22) AltimetersSET

(23) L and R LANDING light ON



PRI STAB TRIM FAIL (Cont'd)

- (24) Passenger brief/cabin check

COMPLETE
- (25) SMKG/BELTS

SMKG/BELTS
- (26) Fuel quantities and balance

CHECK
- Approach checks:**
- (27) APU and BLEEDS

SET
- (28) Final approach speed

V_{REF}
- (29) Normal actual landing distance

MULTIPLY BY:
- 1.15 without thrust reversers
- 1.10 with thrust reversers
- (30) Approach setup and crew briefing

COMPLETE
- (31) L and R HYDRAULIC PUMP

AUTO
- Before Landing Checks:**
- (32) LANDING GEAR

DN
- (33) L LANDING, N LDG/TAXI, and R
LANDING lights

ON
- (34) FLAPS

30

– COMPLETE –

Appendix B: Transport Canada AD

AIRWORTHINESS DIRECTIVE

This Airworthiness Directive (AD) is issued pursuant to Canadian Aviation Regulation (CAR) 521.427. No person shall conduct a take-off or permit a take-off to be conducted in an aircraft that is in their legal custody and control, unless the requirements of CAR 605.84 pertaining to ADs are met. Standard 625 - Aircraft Equipment and Maintenance Standards Appendix H provides information concerning alternative means of compliance (AMOC) with ADs.

Number: CF-2023-26

Effective Date:

CF-2023-26

17 May 2023

ATA:

Type Certificate:

27

A-234

Subject:

Flight Controls – Pitch Trim – Mis-Trimmed Horizontal Stabilizer Leading to Controllability Issues

Applicability:

Bombardier Inc. model BD-100-1A10 (Challenger 300/350) aeroplanes, serial numbers 20003 through 20910.

Compliance:

Within 60 days from the effective date of this AD, unless already accomplished.

Background:

Bombardier is aware of several in-service events during which the crew experienced an unexpected pitch upset upon Auto-Pilot disconnect. Investigations of these events identified common factors which led to the pitch upset. In each event, after take-off, the aeroplane gained altitude via manual command of the elevator control surface without the use of the horizontal stabilizer pitch trim, even though the manual pitch trim was fully functional. The Auto-Pilot was then engaged while the aeroplane was still in an out-of-trim condition. Delays actioning subsequent engine indication and crew alerting system messages and later disengagement of the Auto-Pilot when the horizontal stabilizer is not correctly trimmed can lead to high control column forces and difficulties in controlling the aeroplane.

This AD mandates a revision of the Airplane Flight Manual (AFM) to incorporate a caution in the Auto Flight Non-Normal Procedures, in order to instruct crews to minimize changes to airspeed and configuration when using the Auto-Pilot disconnect switch in an out-of-trim situation.

Corrective Actions:

- A. Amend the Transport Canada approved AFM as detailed in Table 1 below, or later revisions of these procedures approved by Transport Canada.

Table 1

Aeroplane Model	AFM Procedure	AFM Revision
BD-100- 1A10 CH300	Non-Normal Procedures in Section 05-14	AFM CSP 100-1, Revision 68, dated June 14, 2022, or later revisions of this manual approved by Transport Canada.
BD-100- 1A10 CH350	Non-Normal Procedures in Section 05-14	AFM CH350 AFM, Revision 34, dated June 14, 2022, or later revisions of this manual approved by Transport Canada.

- B. Advise all flight crews of the changes introduced by the approved Transport Canada AFM Revisions listed above and thereafter operate the aeroplane accordingly.

AFM Guidance

AP STAB TRIM FAIL (C)

WARNING: An abrupt change in control force, or an out of trim situation may be experienced when disconnecting the autopilot.

SMKG/BELTS should be selected on.

CAUTION: Minimize changes to airspeed and configuration to minimize control forces and out of trim situation.

1. Flight controls Hold firmly
2. Autopilot..... Use control wheel MSW
switch to disconnect
3. Retrim airplane if necessary.
4. Autopilot..... Do not use

END

Appendix C: EEN Airport Diagram (10-9)

