

National Transportation Safety Board

Office of Research and Engineering

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AIRCRAFT PERFORMANCE GROUP B737-200 ADV SIMULATION MODEL VALIDATION

April 6, 2023

A Transair (TEW) 737-200C (PY151/N810TA) experienced a water landing after air turn back (ATB) shortly after takeoff from Honolulu International Airport (HNL), Hawaii on July 2, 2021. The National Transportation Safety Board (NTSB) opened an investigation into the accident, and invited Boeing to participate as a technical advisor, with representatives on multiple groups. The Performance group included participants from Boeing Stability and Control Post-Certification Support (PCS), which provided airplane performance observations using the latest Boeing 737-200 ADV desktop simulation model.

A request for validation of the 737-200 ADV flight simulation model was made by the National Transportation Safety Board (NTSB) Performance Group Chair. The email stated, in part, the following:

For the Transair B737-200 simulation work, I propose the following cases for further discussion:

- a. Engine Power Change Dynamics (increase and decrease)*
- b. Flap Change Dynamics (deployment and retraction)*
- c. Gear Change Dynamics (deployment and retraction)*
- d. Normal Takeoff (this may include gear and flap retraction)*
- e. Normal In-Air Turn, AEO*
- f. OEI Straight and Level Flight (or similar)*
- g. OEI In-Air Turn, Constant Altitude (or similar)*

Please review the text and propose proof-of-match or checkout cases that can assist us in validating the airframe/engine/flight controls models being used for the Transair B737-200 investigation.

Discussion

Simulation model proof-of-match (POM) documentation is intended to provide validation that the simulation model reflects the real airplane flight characteristics. The original Boeing 737-200 ADV simulation-to-flight POM document was published in 1984 and was developed based on flight conditions required for flight crew training simulation device certification defined in Advisory Circular AC120-40, "Aircraft Simulator and Visual System Evaluation and Approval," dated 1983. The POM document introduction section includes the following statement:

It is considered that the flight-test-to-simulator comparisons shown in this document provide evidence that the simulator accurately represents the 737-200 ADV.

Revision A of the POM document was created in 1985 to reflect updates to simulation model aerodynamic data and flight test condition changes and additions. Revision B of the POM document was created in 1999 to reflect simulation model aerodynamic updates and add flight test conditions. No further updates have been made to the POM document since 1999.

The POM document includes cases requested by the NTSB, as listed in the following table. The right-hand column, "Proof-of-Match Case," denotes the corresponding case(s) where POM data exist, if any. Boeing POM cases were identified for all cases requested except for one engine inoperative (OEI) in-air turn.

NTSB Requested Cases and Corresponding Boeing POM Cases

NTSB Requested Case	Boeing Proof of Match Case
a. Engine Power Change Dynamics (increase and decrease)	Section 6.1 – Power Effects
b. Flap Change Dynamics (deployment and retraction)	Section 6.2 – Flap Effect
c. Gear Change Dynamics (deployment and retraction)	Section 6.3 – Landing Gear Effect
d. Normal Takeoff (this may include gear and flap retraction)	Section 3.5 – Normal Takeoff
e. Normal In-Air Turn, AEO	Section 7.1 - Roll Response
	Section 7.2 - Roll Overshoot

f. One engine inoperative (OEI) Straight and Level Flight (or similar)	Section 4.2 - Engine Out 2nd Segment Climb Section 7.6 - Engine Out Trim
g. OEI In-Air Turn, Constant Altitude (or similar)	No data available

Simulation model checkout documentation is intended to provide a means for flight crew training simulation device manufacturers to check their model outputs against the airframe manufacturer's simulation data. The Boeing 737-200 ADV simulation aerodynamics model checkout document Revision D was published in 1983 and corresponded to the simulation version used for the original POM document. Revision F of the checkout document was published in 1999 and incorporated simulation aerodynamic model updates.

Since 1999, the simulation hardware and operating system have undergone several transitions. During each transition, the simulation platform was audited, per Boeing internal practice, to ensure simulation integrity. Simulation model versions used for POM and checkout documentation are no longer available. The simulation model used in support of this investigation was released in 2021.

The NTSB request for simulation validation was addressed using historical simulation POM and checkout data, where available, for each maneuver requested. The primary source of simulation validation was the historical POM data, which were all sourced from Boeing proprietary documents used to support flight crew training simulation device qualification. Checkout data using the latest simulation were generated for each maneuver requested and were found to have negligible differences when compared to Boeing proprietary historical checkout data. NTSB and Boeing investigators reviewed the POM and checkout data during an in-person meeting on March 29, 2023 and concurred that the 737-200 ADV simulation has been validated for use in the Transair (TEW) 737-200C (PY151/N810TA) investigation.