National Transportation Safety Board
Office of Research and Engineering
Washington, D.C. 20594

Airplane Performance Study Addendum 1

Specialist Report
Timothy Burtch

A. ACCIDENT

Location:	Gaithersburg, MD
Date:	December 8, 2014
Time:	1041 EST
Airplane:	Embraer EMB-500 Phenom 100, Registration N100EQ
NTSB Number:	DCA15MA029

B. GROUP

Chairman: Timothy Burtch
National Transportation Safety Board
Washington, DC

Member: Daniel Satoshi Marimoto
Embraer Air Safety Department
Ft. Lauderdale, FL

C. SUMMARY

On December 8, 2014, about 1041 Eastern Standard Time (EST), an Embraer EMB-500 Phenom 100, N100EQ, impacted terrain and houses about 0.75 miles short of runway 14 while on approach to Montgomery County Airpark (GAI), Gaithersburg, Maryland. The airline transport rated pilot and two passengers were fatally injured as were three persons on the ground. The airplane was destroyed during the impact and ensuing fire. Marginal visual meteorological conditions prevailed at the time, and the flight was operating on an instrument flight rules (IFR) flight plan. The airplane was registered to and operated by Sage Aviation LLC., of Chapel Hill, North Carolina, under the provisions of 14 Code of Federal Regulations Part 91 as a personal flight. The flight originated from Horace Williams Airport (IGX), Chapel Hill, North Carolina, with GAI as the intended destination.

D. AIRPLANE PERFORMANCE STUDY ADDENDUM

The purpose of this addendum is to document the process and results of extracting the lift coefficient for the Embraer Phenom 100 from the data recorded by the L3 Solid-State Cockpit Voice and Data Recorder (CVDR) that was recovered in the Gaithersburg accident.

In addition to the CVDR data, portions[1] of a simulation for the Phenom 100 provided by Embraer were used in the extraction process. Embraer describes it as "an engineering/desktop simulation model of the Phenom … that comprises (in part) aerodynamic and engine models. The aerodynamic model was initially created based on wind tunnel results … and has been matched to flight test results according to (FAA Federal Aviation Regulations) 14 CFR Part 60 for an Interim Level C qualification under the FAA National Simulation Program". The simulation runs in a MATLAB Simulink environment.

The CVDR did not record the accident pilot's flight control inputs[2]. As a result, a mathematical pilot was used to drive the simulation column, wheel, and pedal positions in order to match the airplane state recorded on the CVDR. This included the airplane's position, speed, and attitude. The CVDR did record flap position and engine throttle lever angles (TLA), and these were used as inputs in the lift coefficient extraction[3].

Before performing the extraction, a comparison between the CVDR data and the simulation was done during portions of the accident flight where the airplane was free of ice. This was done to ensure a good match between the models and flight data. As stated by Embraer, the Interim Level C models matched within the tolerances specified in 14 CFR Part 60.

Figure 1 highlights the aerodynamic lift coefficient that was extracted from approximately the last 21 minutes of CVDR data (in red)[4]. At the beginning of the extraction (15:20:19), the airplane was at an altitude of 10,767 ft and an airspeed of 266 kt. At this point the airplane was above the overcast. As documented in the Airplane Performance study, the airplane entered the clouds around 15:23:41 at 5,500ft msl and, at 15:38:27 while descending through 2,700 ft msl, the pilot reported being in IMC. That put the airplane in visible moisture, an essential element for ice, for approximately 15 min.

[1] Embraer's aerodynamic and engine models for the Phenom 100 were used in the extraction. Both models were integrated into the NTSB simulation environment and tested using checkout data provided by Embraer.

[2] Even if the CVDR had recorded the pilot's control inputs, the required simulation inputs would likely be different because of the ice that was accreting on the accident airplane during the approach into Gaithersburg- namely, the elevator would be different. This is because a higher angle-of-attack would be required to generate the same amount of lift at the same airspeed when ice is present (in the accident flight but not in the simulation). The higher angle of attack is achieved with elevator.

[3] Flap position and TLA were used as inputs to the extraction; however, the recorded TLA was reduced slightly with time to match the recorded speed as the accident airplane accreted ice and, as a result, more drag.

[4] Key is that the extraction method used resulted in a match of the recorded airplane accelerations using the appropriate speeds, geometry, and aerodynamic coefficients. This ensures that aerodynamic forces, moments, and coefficients are consistent with the recorded accelerations.

The black lift curves in the figure are interpolations of the extracted lift coefficients for the clean wing and three flap settings. The extraction began high in the approach before the pilot had extended the flaps and transitions through all flap settings.

Finally, Figure 1 also includes the lift curve for the Phenom 100 at landing flap (36˚) provided by Embraer for comparison (in green). This curve does not include ice.

_____

Timothy Burtch
Specialist – Airplane Performance
National Transportation Safety Board

FIGURES

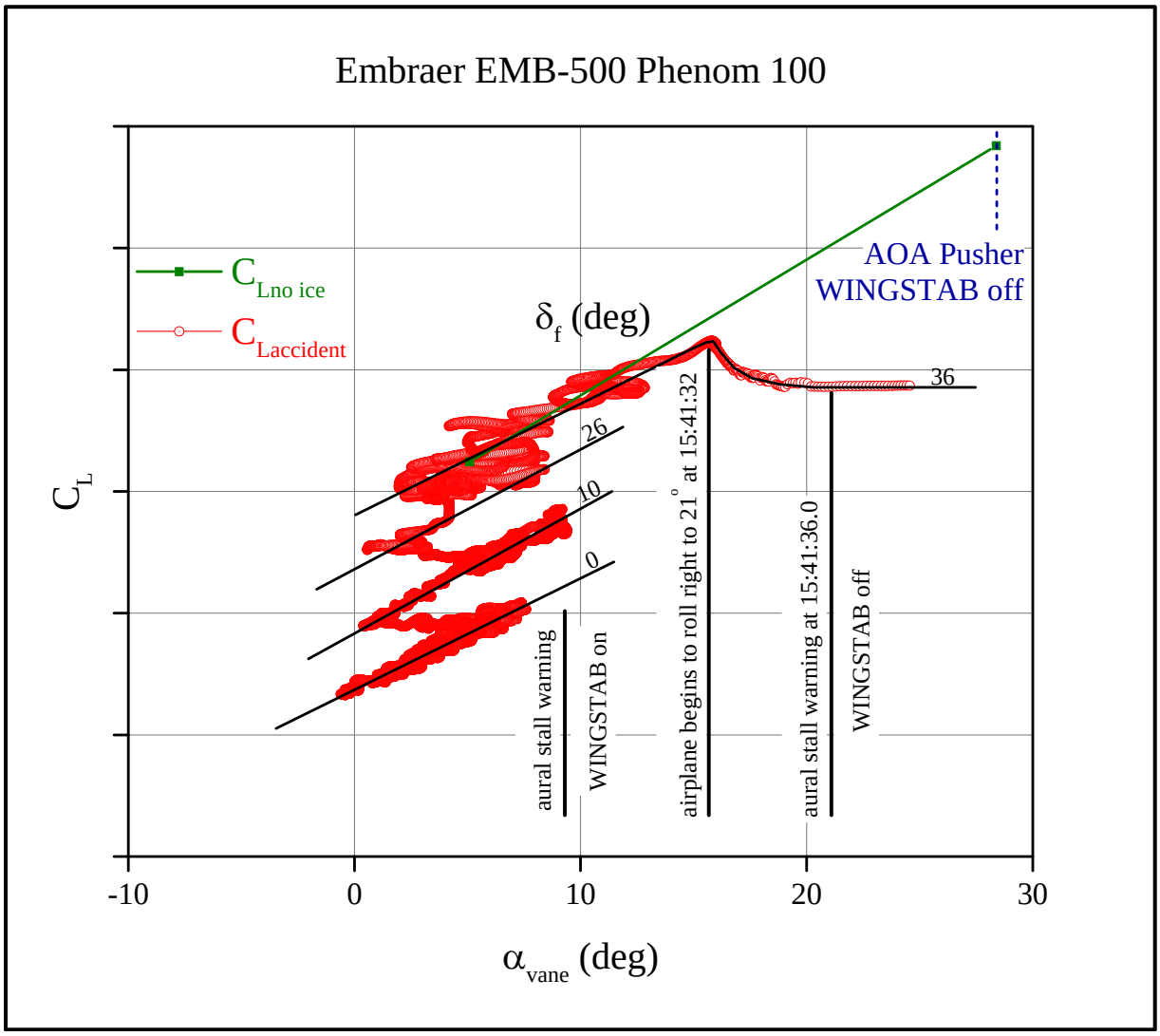

Figure 1: Embraer EMB-500 Phenom 100 Lift Coefficient Data