National Transportation Safety Board

Office of Research and Engineering
Washington, D.C. 20594

Airplane Performance Study

Specialist Report
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A. ACCIDENT

Location:	West Columbia, SC
Date:	May 23, 2015
Time:	0921 EDT (1321 GMT)
Airplane:	Experimental BR Legend LLC Turbine Legend, Registration N42BR
NTSB Number:	ERA15FA221

B. GROUP

No vehicle performance group was formed.

C. SUMMARY

On May 23, 2015, about 0921 eastern daylight time (EDT), an experimental amateur built BR Legend LLC Turbine Legend, N42BR, registered to BR Legend LLC, operated by a private individual, collided with trees and a pond approximately 1.2 nautical miles (NM) west of the Columbia Metropolitan Airport (CAE), West Columbia, South Carolina. Visual meteorological conditions prevailed at the time, and a visual flight rules (VFR) flight plan was filed for the 14 Code of Federal Regulations (CFR) Part 91 personal flight from CAE to Asheville Regional Airport (AVL), Asheville, North Carolina. The airplane was destroyed, and the commercial pilot and a dog were fatally injured.

The flight originated from CAE about 0914 EDT. See Figures 1 and 2 for pictures of the accident airplane and the accident site.

D. PERFORMANCE STUDY

The airplane performance study describes the accident airplane ground track, altitude, and speed for the accident flight. The study also makes an assessment of the propeller blade angle based on airplane glide[1] and lift to drag (L/D)[2] ratios.

No recorded flight data were recovered from the wreckage. As a result, the data presented in the study are based largely on secondary radar returns (transponder code 2655) from the short-range Airport Surveillance Radar (ASR-11) located at CAE. The radar data have approximately a 60 NM range and an inherent uncertainty of ±2 Azimuth Change Pulses (ACP) = ± (2 ACP) x (360º/4096 ACP) = ±0.176° in azimuth, ±50 ft in altitude, and ±1/16 NM in range.

Times in the study are reported in EDT as well as Greenwich Mean Time (GMT or "Z"): EDT = GMT – 4 hr.

Weather Observation

The Automated Surface Observing System at CAE issued the following report approximately 25 minutes before the accident:

KCAE 231256Z VRB03KT 10SM CLR 19/12 A3039 RMK AO2
Taken at CAE on the 23rd at 0856 EDT. The wind is variable at 3 knots (kt), the visibility is 10 statute miles (SM), and the skies are clear. The temperature is 19˚ Celsius (C) and the dew point is 12˚C. The altimeter setting is 30.39 inches of Mercury. Remarks: Automated station with precipitation discriminator.

Wind data from the nearest weather balloon sounding taken at 0800 EDT as well as wind data from a computer model at the accident site were also used in the study. The winds aloft from both sources compared well.

Airplane Ground Track, Altitude, and Airspeed

Figure 3 highlights the radar ground track for the seven minute flight. The radar "points" are actually boxes as shown in red in the figure. This is because of the uncertainty associated with the radar data mentioned earlier. The figure also shows select radio communications between N42BR and the Columbia North Approach Control facility.

The pilot of N42BR reported a loss of fuel pressure less than four minutes after takeoff at an altitude approaching 6,500 above mean sea level and approximately 8 NM from CAE. Seven seconds later, he indicated that he was returning to the airport. The radar data indicated that the pilot immediately pitched the airplane nose down 10 deg and achieved the best glide airspeed of 130 kt indicated (KIAS) as recommended in the Pilot Operating Handbook (POH). See Figures 4 and 5.

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[1] The unpowered airplane glide ratio is the ratio of an airplane's forward horizontal motion to the change in altitude at a constant airspeed/AOA
[2] The glide ratio is equal to airplane (L/D).

Figure 6 includes an estimate of airplane angle-of-attack (AOA). The AOA increased from 1˚-2˚ before the fuel pressure loss to between 5˚-10˚ after, and it remained there for the remainder of the flight. Likewise, the estimated airspeed remained 20 kt above the published stall speed of 79 KIAS for the entire flight following takeoff.

Propeller Blade Angle and Airplane Power-Off Glide

The Turbine Legend POH recommends feathering the propeller in order to minimize drag in the event of engine failure. However, the dual acting propeller as installed on N42BR did not have a feathering capability[3]. Instead, the blade angle suspected in the accident was closer to the "flat" minimum flight angle which would limit the airplane's glide capability. See Figure 7 for a description of propeller blade angle.

In order to assess the impact of propeller blade angle on the accident flight, the glide ratio was first estimated from radar and then compared to the airplane (L/D). Figure 8 depicts (L/D) ratios for various airplanes.

From the radar data, the glide ratio was estimated to be 7.5:

$$\Delta x/\Delta y = 8.0\ \text{NM}^{4}/[(6{,}500\ \text{ft})(1\ \text{NM}/6{,}076\ \text{ft})]$$
$$\Delta x/\Delta y = 7.5$$

From the aerodynamic data used in the study and shown in Figure 9, (L/D) with the propeller at the minimum flight angle is also 7.5 at 5˚ angle-of-attack[5]. Therefore, the glide ratio estimated from radar and the (L/D) from aerodynamic data with the propeller at minimum flight angle are the same or very close.

Likewise, the aerodynamic data used in the study from Figure 9 shows an airplane (L/D) of 12.0 with the propeller feathered. This is 60% greater than the (L/D) of 7.5 estimated in the accident. The feathered (L/D) results in a power-off glide distance of approximately 12.8 NM from an initial altitude of 6,500 ft:

$$\Delta x/\Delta y = 12.0$$
$$\Delta x = (12.0)\Delta y = (12.0)(6{,}500\ \text{ft})$$
$$\Delta x = 78{,}000\ \text{ft} = 12.8\ \text{NM}$$

E. SUMMARY AND CONCLUSIONS

The results of the study indicate that the accident airplane propeller blade angle was likely not in the feathered position. As a result of the increased drag, N42BR did not make it back to the airport after the pilot reported an engine problem. Had the propeller been feathered, the airplane could have made it back to CAE runway 11 using the best glide airspeed of 130 KIAS.

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[3] The airplane did not have an electric feathering oil pump, and the emergency oil return line was plugged.
[4] The pilot did not fly directly back to CAE after reporting an engine problem. The curved radar ground track back to CAE is estimated to be 8.0 NM.
[5] The angle-of-attack was approximately 5˚ subsequent to the pilot reporting a problem with fuel pressure.

Finally, Figure 10 shows the proximity of the crash site to the airport and the surrounding area. The pilot of N42BR reported that he wanted to return to the airport and later that he thought he could make it. Another possible option may have been a series of athletic fields[6] located just before the impact site (and circled in the figure) had the pilot chosen to execute an off-airport landing.

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[6] The athletic fields in the figure appear to have light poles present, although largely aligned with the direction of flight. This may be the reason the pilot elected to continue his attempt to make the airport. The fields can also be seen in Figure 3 along with the radar ground track.

F. Figures

Figure 1: Accident Airplane N42BR, an Experimental BR Legend LLC Turbine Legend

Figure 2: Accident Site (source: Kathryn's Report http://www.kathrynsreport.com/2015/05/br-legend-turbine-legend-n42br-fatal.html)

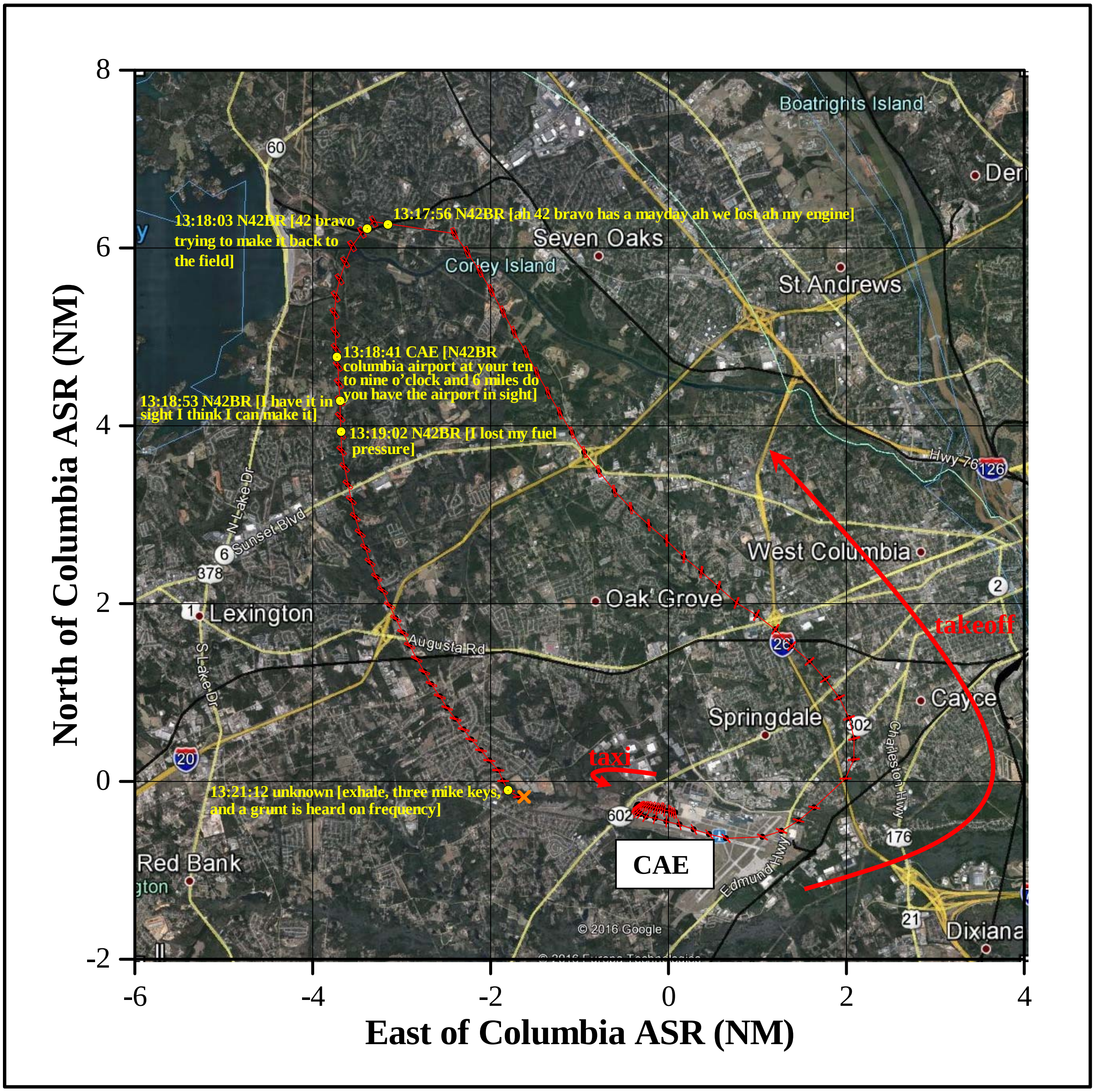

Figure 3: N42BR Radar Ground Track with Select Radio Communications

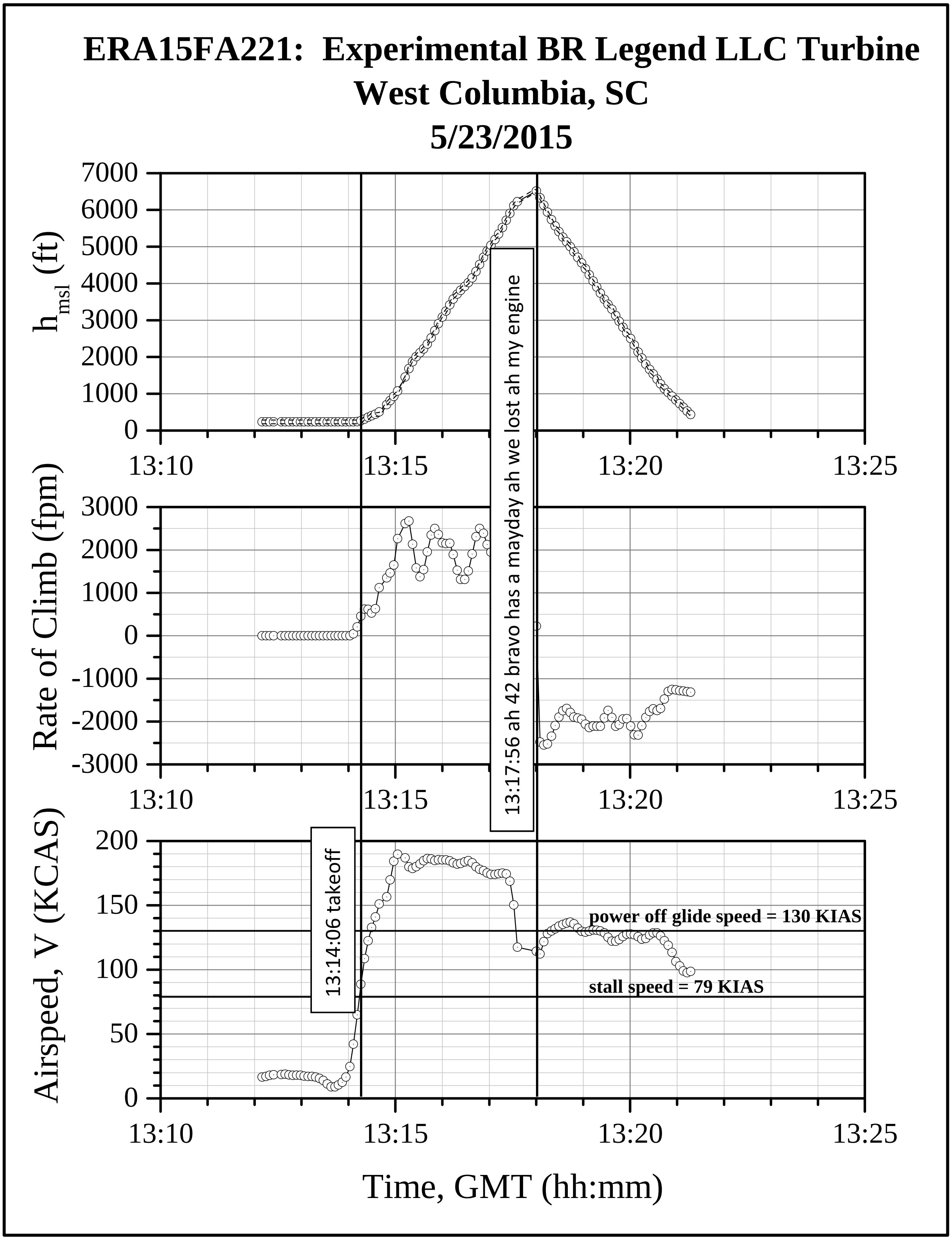

Figure 4: Altitude and Speed Based on Radar

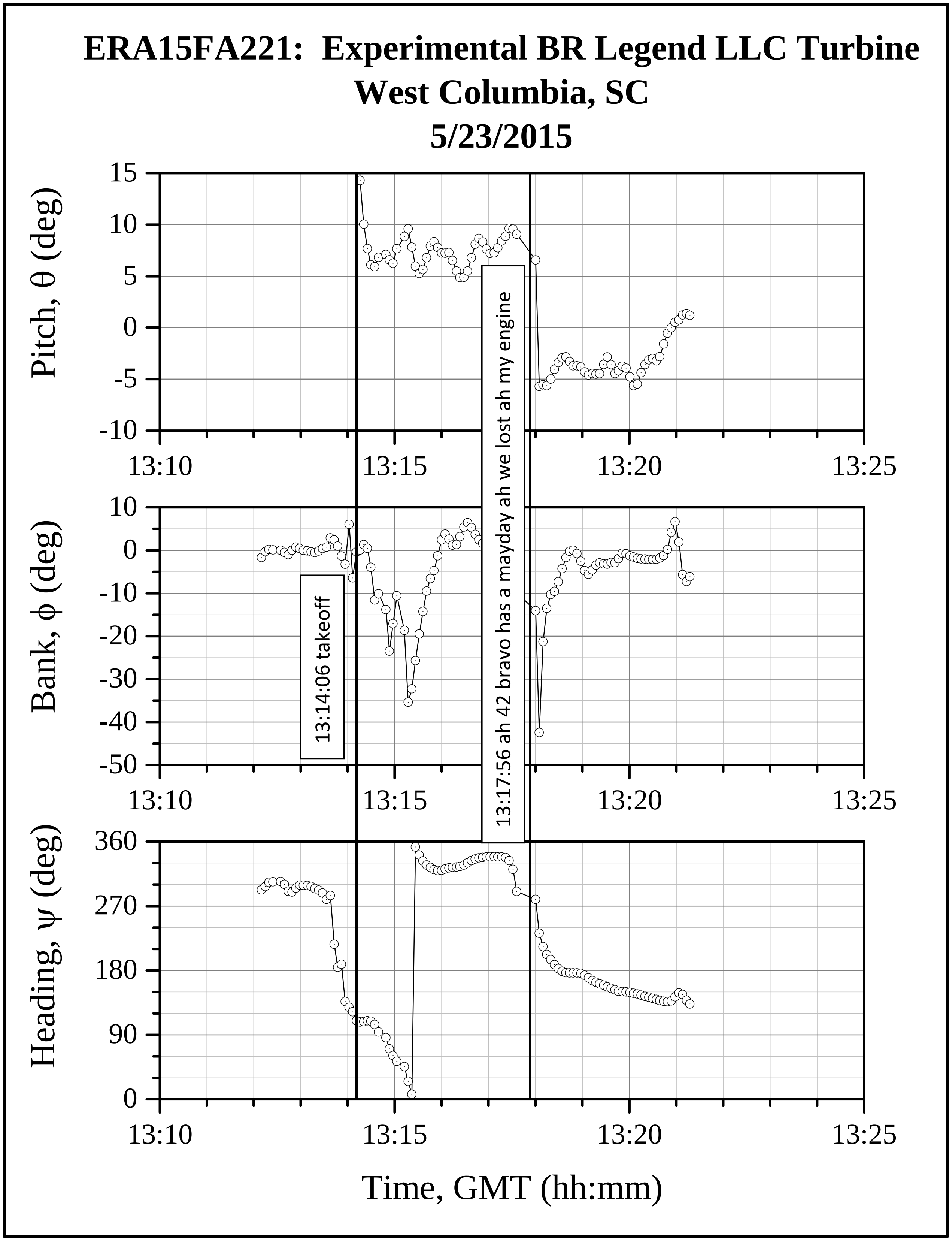

Figure 5: Pitch, Bank, and Heading Based on Radar

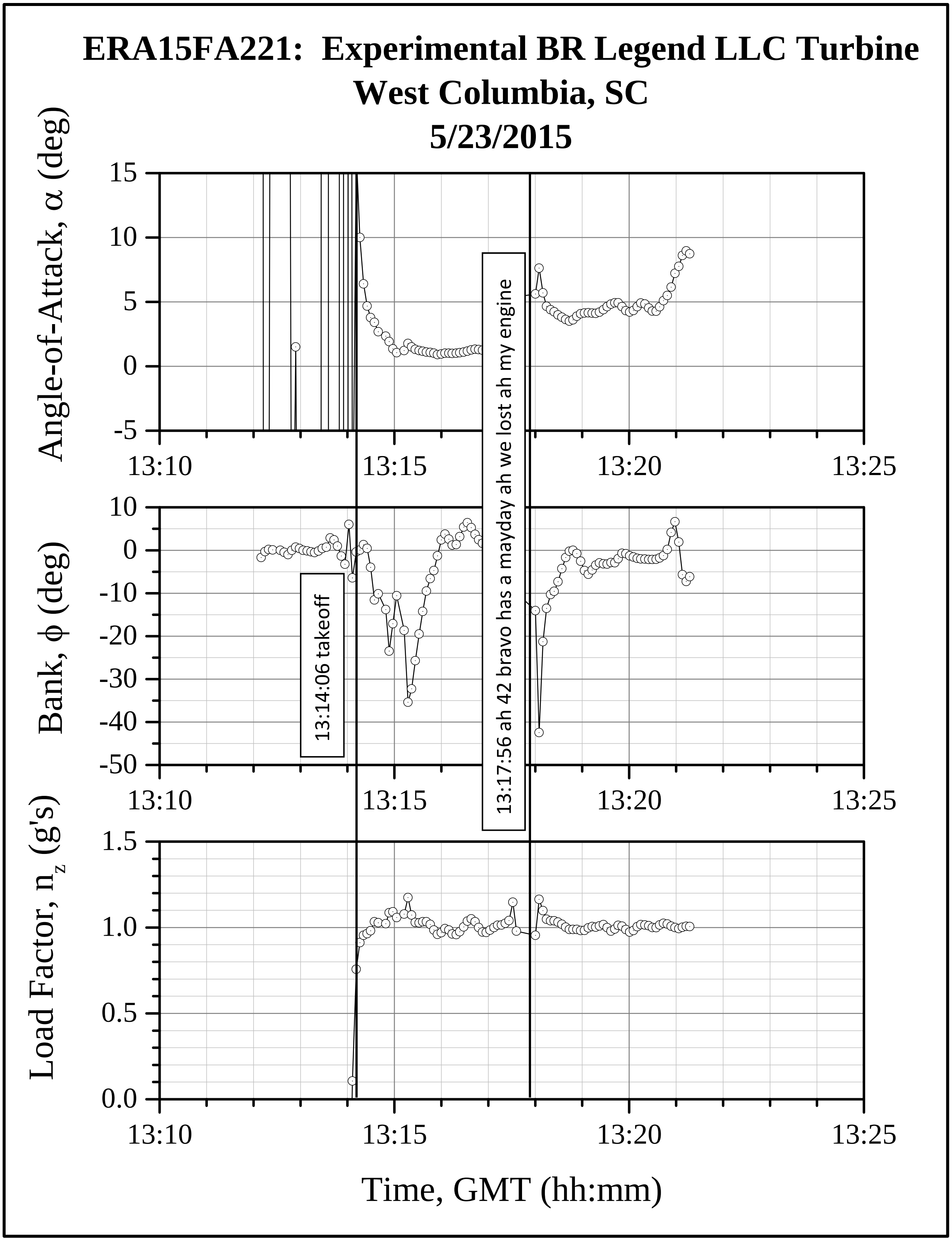

Figure 6: Estimated Angle-of-Attack and Load Factor Based on Radar

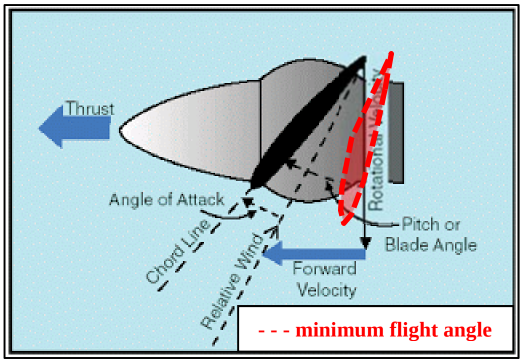

Figure 7: Propeller Blade Angle

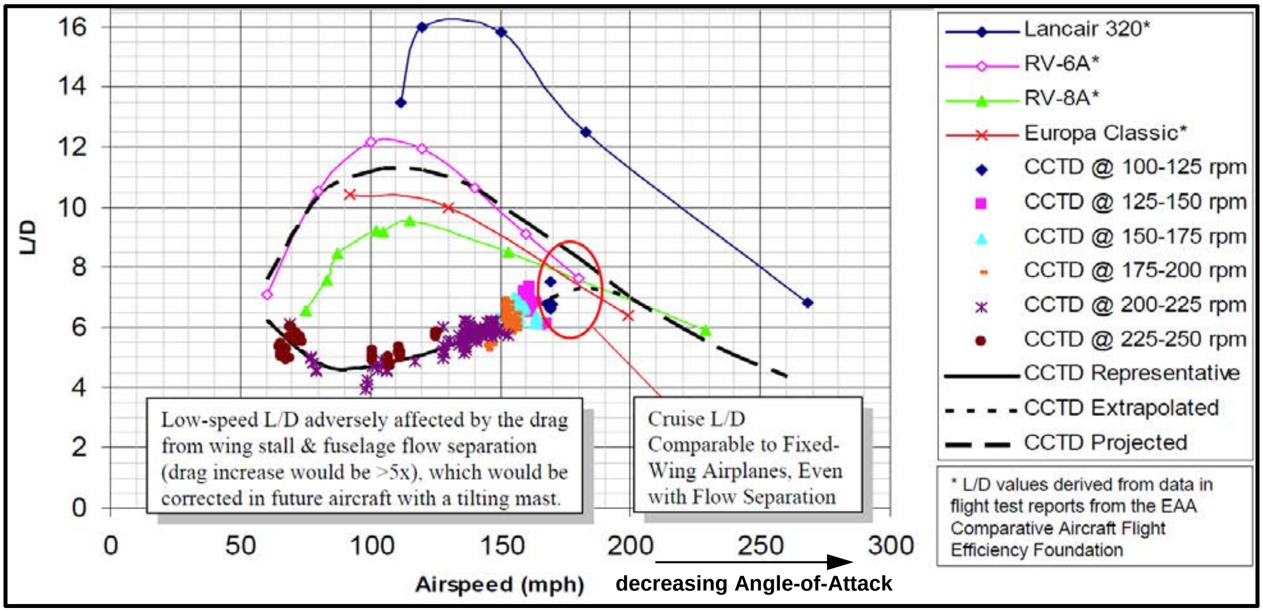

Figure 8: Lift to Drag Ratio for Various Airplanes

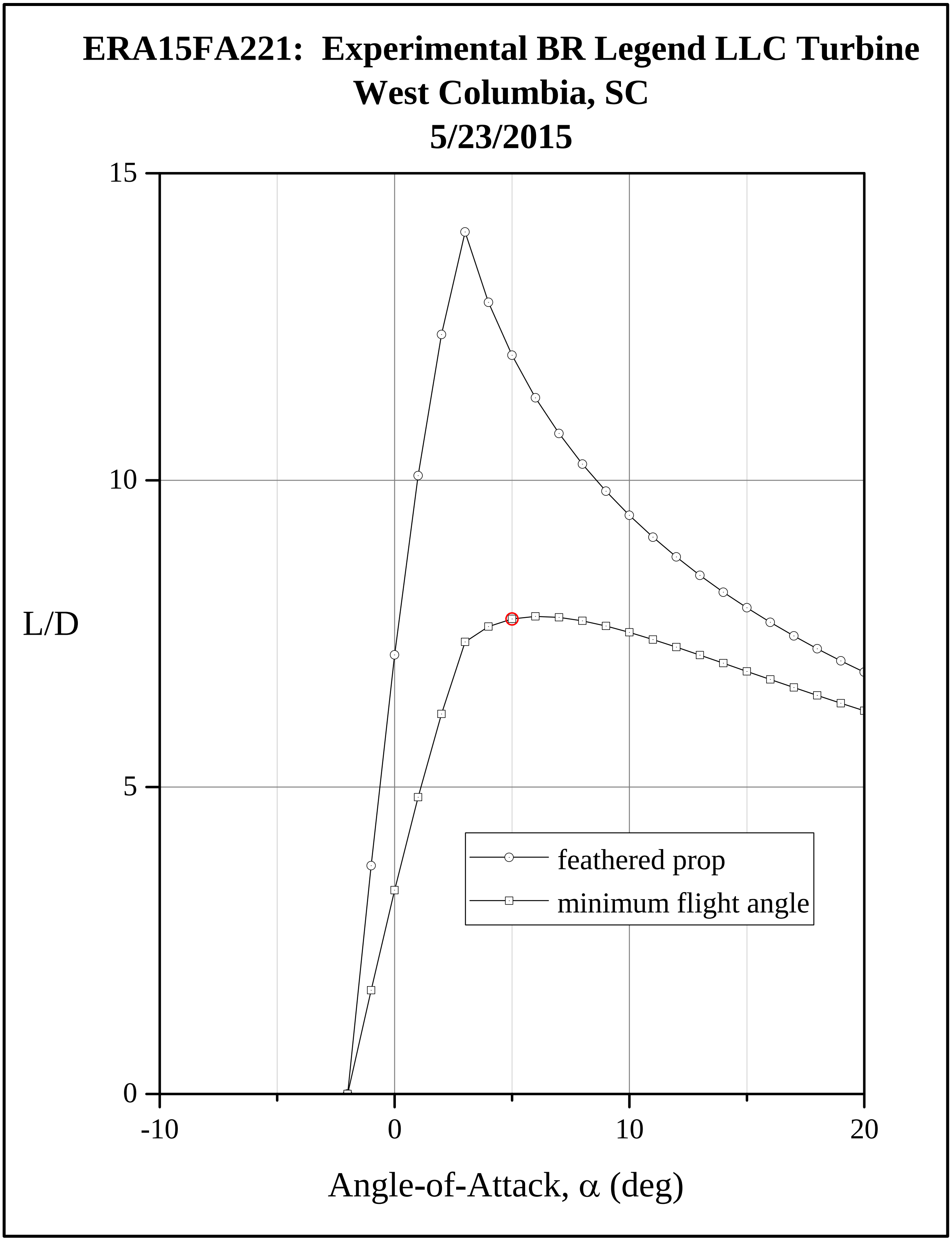

Figure 9: Lift to Drag Ratio As a Function of Angle-of-Attack

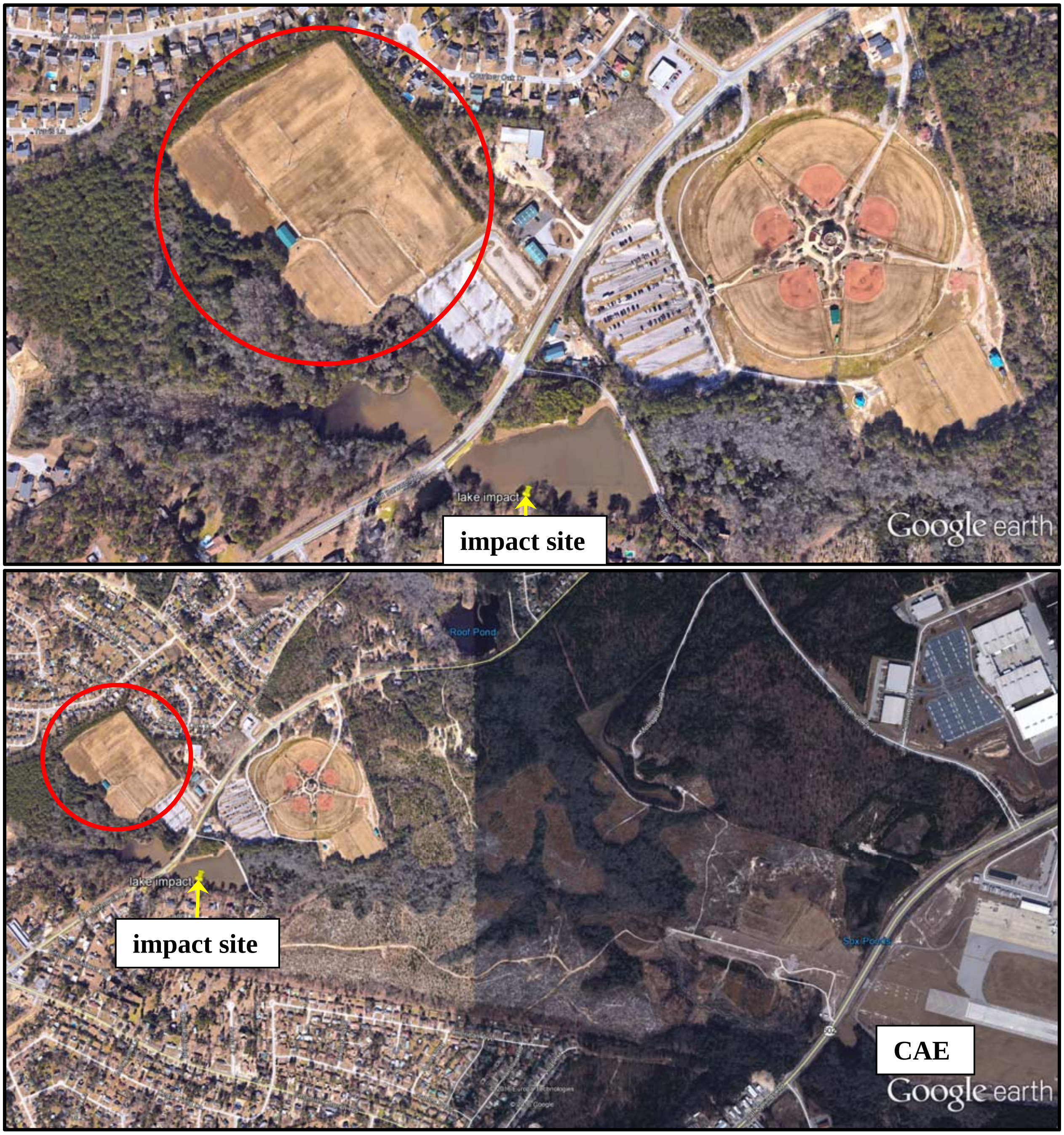

Figure 10: Proximity of Crash Site to Airport and Surrounding Area