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

Radar Performance Study

Specialist Report
Timothy Burtch

A. ACCIDENT

Location: Teterboro, NJ
Date: May 15, 2017
Time: 1930 GMT (3:30 pm EDT)
Airplane: Learjet LJ35, N452DA
NTSB Number: CEN17MA183

B. GROUP

No vehicle performance group was formed.

C. SUMMARY

On May 15, 2017, at 1530 eastern daylight time (EDT), a Learjet LJ35A (N452DA) crashed on approach to Teterboro Airport, Teterboro, NJ (TEB). The airplane was destroyed, and the two pilots suffered fatal injuries. The flight was a 14 CFR 91 re-positioning flight from Philadelphia International Airport and was operated by Trans-Pacific Jets.

The flight crew was attempting a circling approach to runway 1 from the instrument landing system (ILS) approach to runway 6. Visual meteorological conditions prevailed at the time of the accident.

[Note: Times in the report are quoted in EDT as well as Greenwich Mean Time (GMT or "Z"): EDT = GMT – 4 hr.)]

D. THE AIRPLANE

A picture of the accident airplane, a Gates Learjet LJ35A, is shown in Figure 1. The airplane was manufactured by Gates Learjet Corporation in 1981 and was registered to A&C Big Sky Aviation, LLC. The airplane was equipped with the Century III Softflite wing.

E. WEATHER OBSERVATION

METAR KTEB 151852Z 35020G30KT 10SM SCT045 19/06 A2975

On May 15th, at 1452, the surface weather observation at TEB was reporting wind 350˚ at 20 knots (kt) gusting to 30 kt; 10 statute miles visibility; scattered clouds at 4,500 feet (ft) above the ground (agl); temperature 19˚ Celsius (C); dew point 6˚ C; altimeter 29.75" mercury. (See the Meteorology Group Chairman's Factual Report for more details.)

F. RADAR STUDY

The accident airplane was not equipped with a flight data recorder[1]. As a result, the airplane performance study is based largely on radar data with limited data from the enhanced ground proximity warning system or EGPWS. (See the EGPWS Specialist's Factual Report for more details.) Assuming steady and coordinated flight, radar data and the reported steady state wind were used to estimate airspeed, attitude, and angle-of-attack.

The specific radar data used in the study are secondary returns (transponder code 4226) from the short-range Airport Surveillance Radar (ASR-9) located at the Newark Liberty International Airport (EWR) located 11 nautical miles (NM) southwest of the accident site. Short-range 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.

Teterboro utilizes the ILS runway 6 with a circle-to-land runway 1 when the crosswinds on the ILS runway are high. This was the case at the time of the accident: runway 6 had a 19 kt, steady state, left crosswind component, not including gusts.

Figures 2 and 3 highlight N452DA's ground track (with the radar uncertainty highlighted in red) during the approach. Altitude and estimated airspeed for N452DA are also included.

Figure 4 shows the ground track recorded by radar and the EGPWS data without the map overlay. Note that the radar and the EGPWS tracks are similar.

Figure 5 captures N452DA's vertical flight profile relative to the ILS 6 glide slope. The flight flew through the 3º glide slope just prior to the fix DANDY and never actually captured it.

Figure 6 highlights the CVR comments in the context of N452DA's radar position.

Approaching flights were instructed by air traffic control to fly the ILS to runway 6 and then to break off at the outer marker TORBY for a visual approach to runway 1. As shown on the approach plate for Teterboro's ILS 6 in Figure 7, TORBY is 3.8 NM from runway 6. N452DA did not initiate the turn to align with runway 1 until about 1 NM from runway 6 or 2.8 NM beyond TORBY.

[1] The airplane was equipped with a Cockpit Voice Recorder (CVR). See the CVR Group Chairman's Factual Report for more detailed information.

Figures 8 thru 12 show airplane performance parameters derived from radar as well as EGPWS data where available. Airspeeds in Figure 8 were estimated from radar using winds from a sounding over TEB released from EWR at 1530. (From the estimated airspeed time history, it appears that N452DA exceeded the 250 kt airspeed limit that exists below 10,000 ft msl[2].)

The airplane attitude time histories shown in Figure 9 are also based on the EWR short-range radar. Because ASR-9 radar returns are only recorded every four to five seconds, the attitude estimates are less accurate during dynamic flight (high-rate turns, stalls, etc.). This could explain the discrepancy between video footage that shows an impact bank angle in excess of 90˚ and the final radar-based bank angle estimate of 57˚.

Figures 10 and 11 suggest that the airplane never reached stall speed. However, accelerated flight, uncoordinated flight, flight control inputs, and/or a momentary wind gust[3] could have negated the small stall speed margins highlighted in Figure 11. For example, the wings-level stall speeds for flaps 20˚ and flaps 40˚ are 97 kt and 92 kt, respectively[4]. The wings-level stall speed of 92 kt at flaps 40˚ increases to 102 kt in a 35˚ level turn, and the other conditions listed above would further increase the stall speed. The higher stall speed is within knots of the estimated airspeed just before the airplane abruptly banked right (away from the runway) and impacted terrain.

Figure 12 is a comparison between estimated airspeed[5] and groundspeed. The difference between the two speeds is due to the wind. The figure highlights the large crosswind from the northwest that resulted in approximately a 20 kt tailwind when N452DA made the late circling turn to runway 1. However, because the speeds were calculated from airplane position and reported steady wind velocities (not from varying wind velocity measurements at the time of the event), Figure 12 does not capture momentary gusts that could have affected the airspeed and possible stall.

G. SUMMARY AND CONCLUSIONS

The radar data indicate that the airplane slowed to within 9 kt of the 102 kt stall speed published in the FAA Approved Flight Manual for the Gates Learjet 35A in a level and coordinated 35˚ banked turn. However, the 9 kt margin does not account for wind gusts or flight control inputs which could quickly eliminate the stall margin[6].

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[2] A flight plan was filed from Philadelphia International Airport to TEB with a cruising altitude of 27,000 ft, well above the 250 kt speed limit altitude of 10,000 ft. However, the accident flight remained at 4,000 ft or below for the entire 28-minute flight.

[3] At 1545, a special weather observation reported the wind as 320˚ at 15 kt gusting to 32 kt. There were reports of wind gusts to 38 knots in the area. See the Meteorology Group Chairman's Factual Report for more details.

[4] The flaps were found in the 40˚ position; however, it is not known when landing flap was selected by the crew.

[5] While winds are derived from true airspeed, calibrated airspeed provides approximate winds.

[6] At 19:29:39, the airplane was in a 35˚ left turn and at its slowest airspeed. The left-wing-down aileron that would be required to make the turn to final and to counter the strong left crosswind would increase the angle-of-attack on the right wing and potentially lead to stall on that wing first. N452DA's final turn before impacting a building was to the right, away from the runway.

The data recorded by the EGPWS and the equivalent values derived from radar compare well for the 42 sec for which EGPWS data exist. Some of the differences between the two are due to the sample rates and the winds that were assumed in the radar calculations.

The crew of N452DA had filed for a cruising altitude of 27,000 ft; however, the accident flight never climbed above about 4,000 ft msl during the half hour flight from Philadelphia to Teterboro. The crew exceeded the Federal Aviation Administration's (FAA) 250 kt speed limit for flights below 10,000 ft msl.

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H. FIGURES

Figure 1: Accident Airplane, N452DA, a Gates Learjet LJ35A

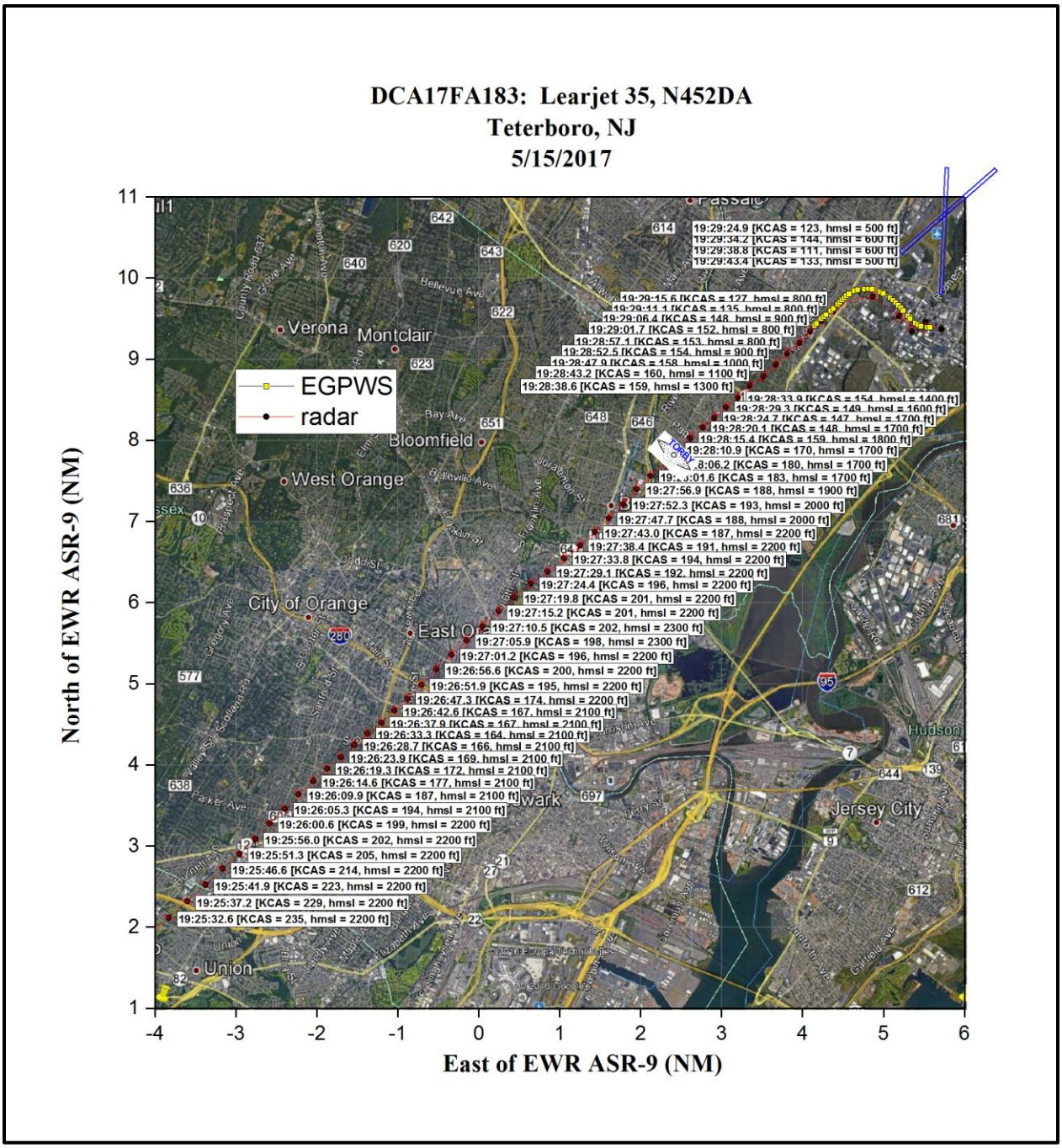

Figure 2: Ground Track with Estimated Airspeed and Altitude

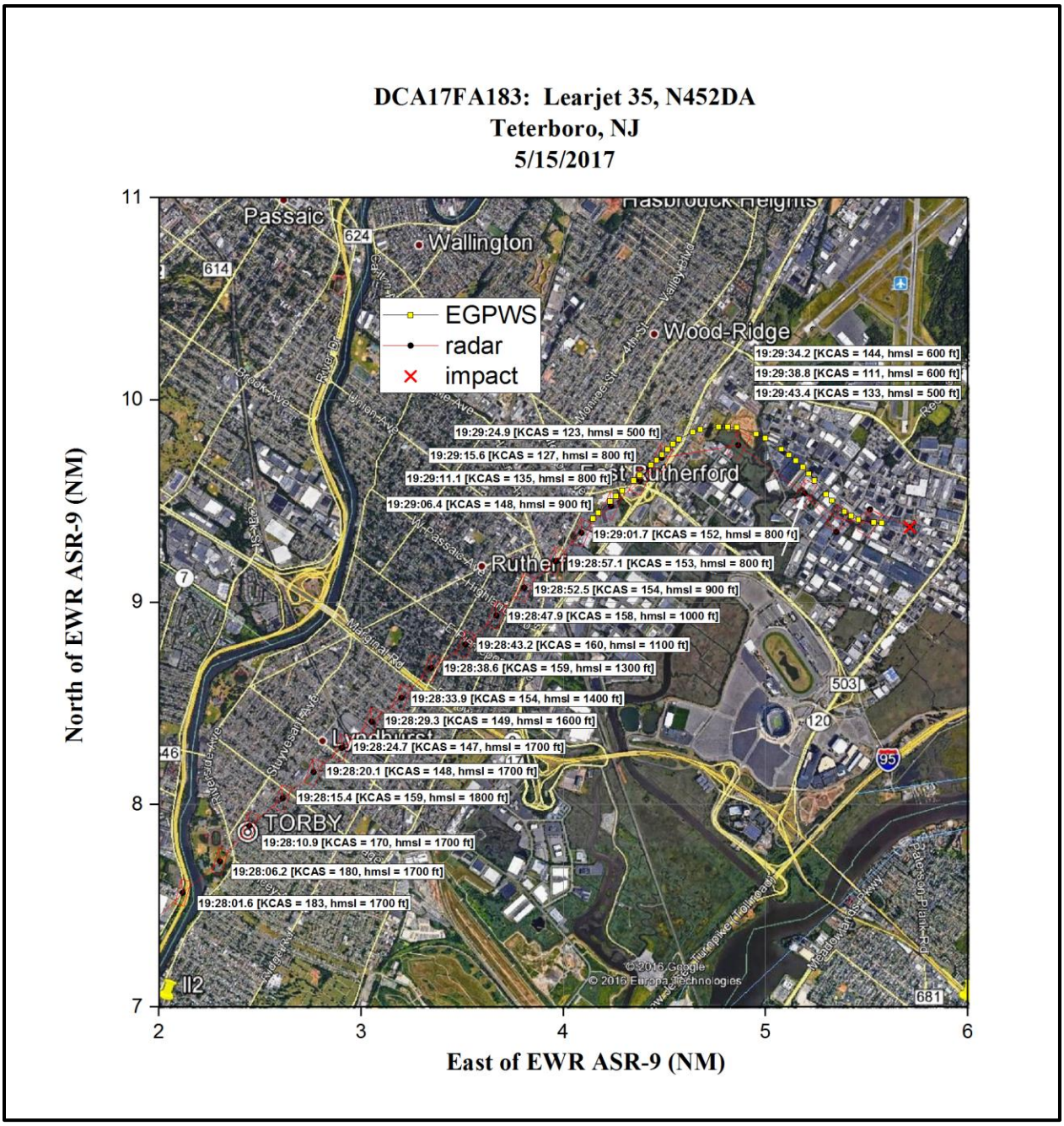

Figure 3: Ground Track During Landing Attempt

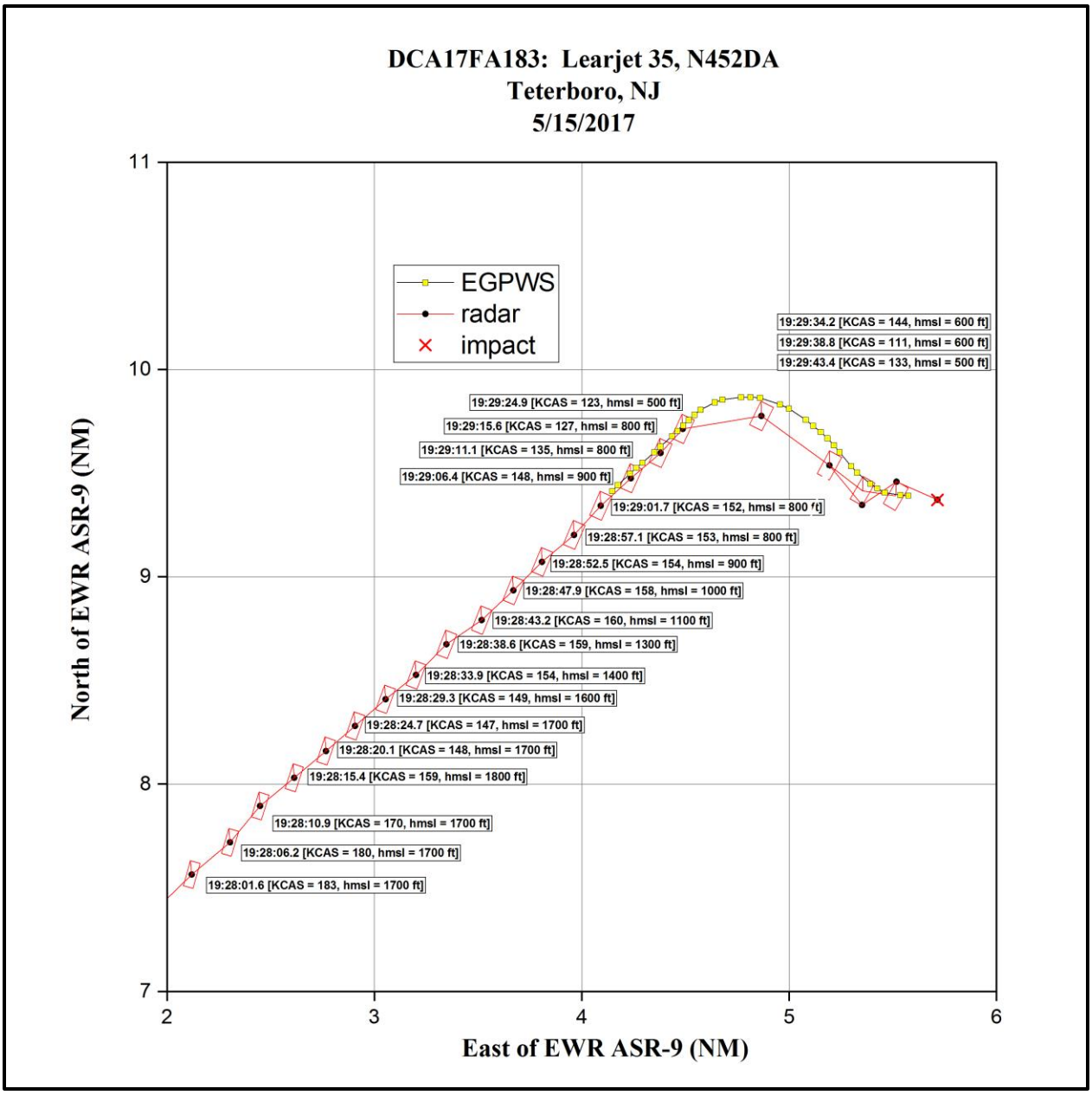

Figure 4: Ground Track During Landing Attempt

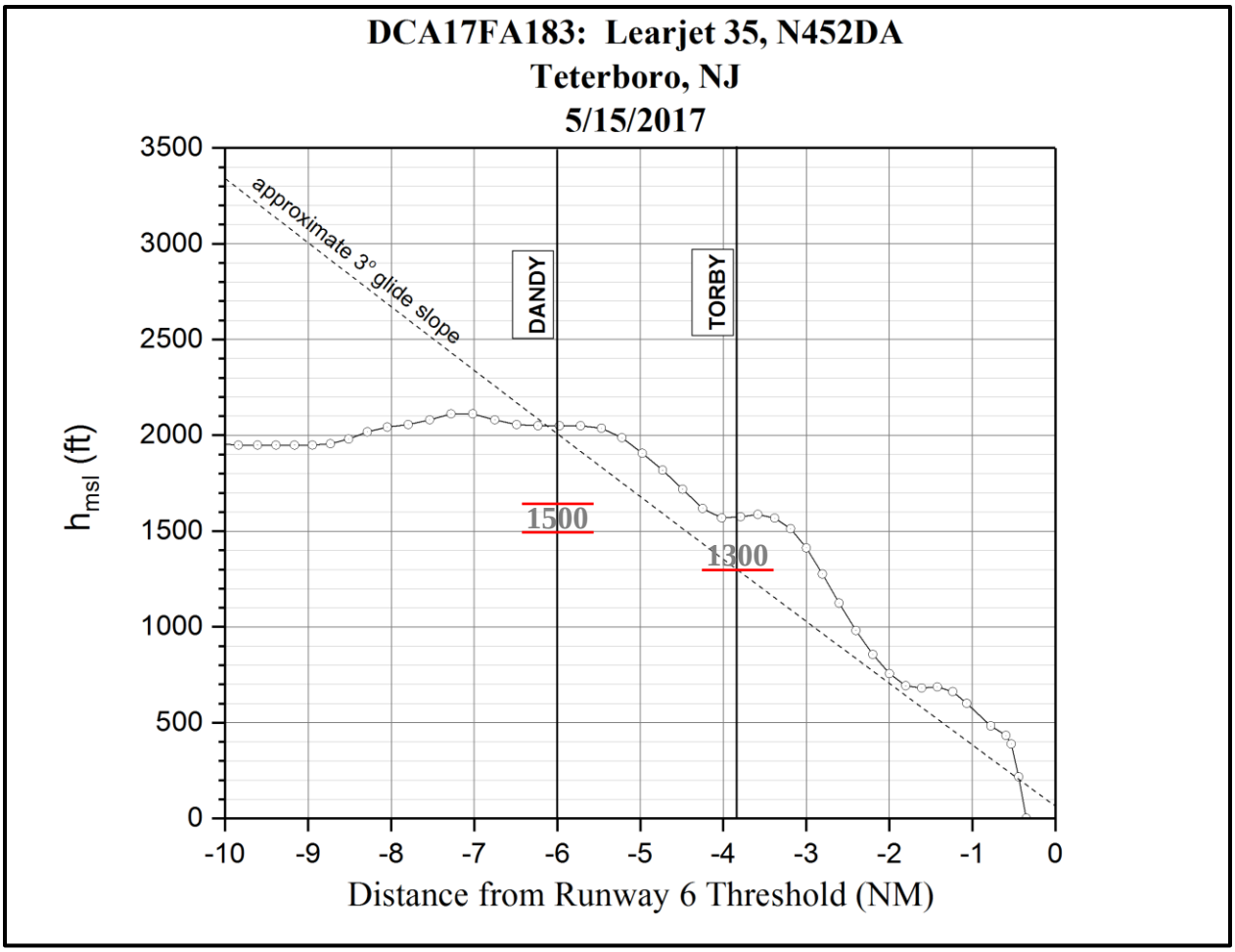

Figure 5: Vertical Profile Relative to the ILS 6 Glide Slope

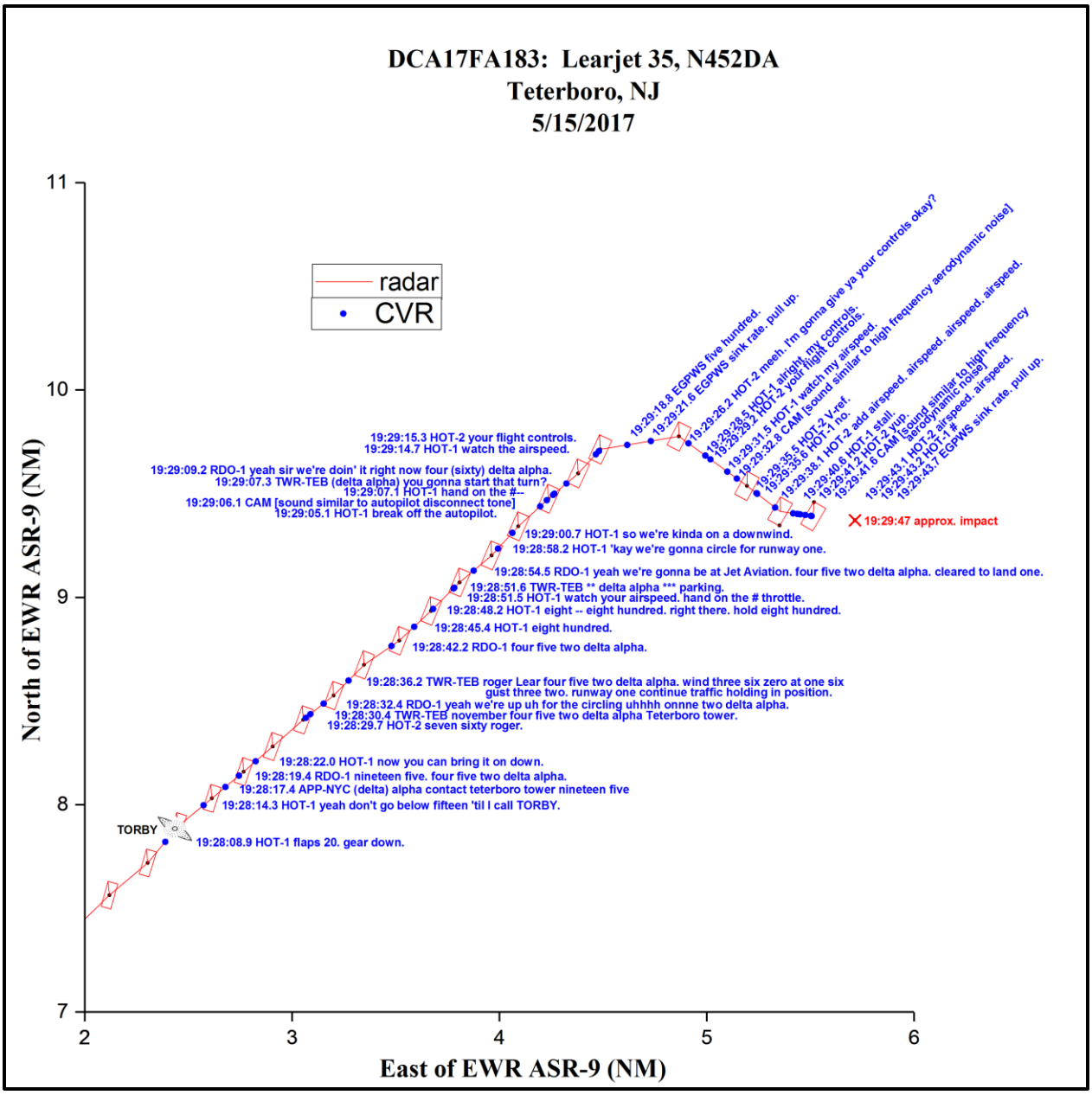

Figure 6: Radar Ground Track with CVR Comments (time in GMT)

CVR Comment Legend

APP-NYC: New York Approach controller transmission
CAM: Cockpit area microphone source
EGPWS: Enhanced Ground Proximity Warning System source
HOT-1: Voice identified as the pilot-in-command
HOT-2: Voice identified as the second-in-command
RDO-1: Radio transmission from pilot-in-command to air traffic control
TWR-TEB: Teterboro airport tower controller transmission

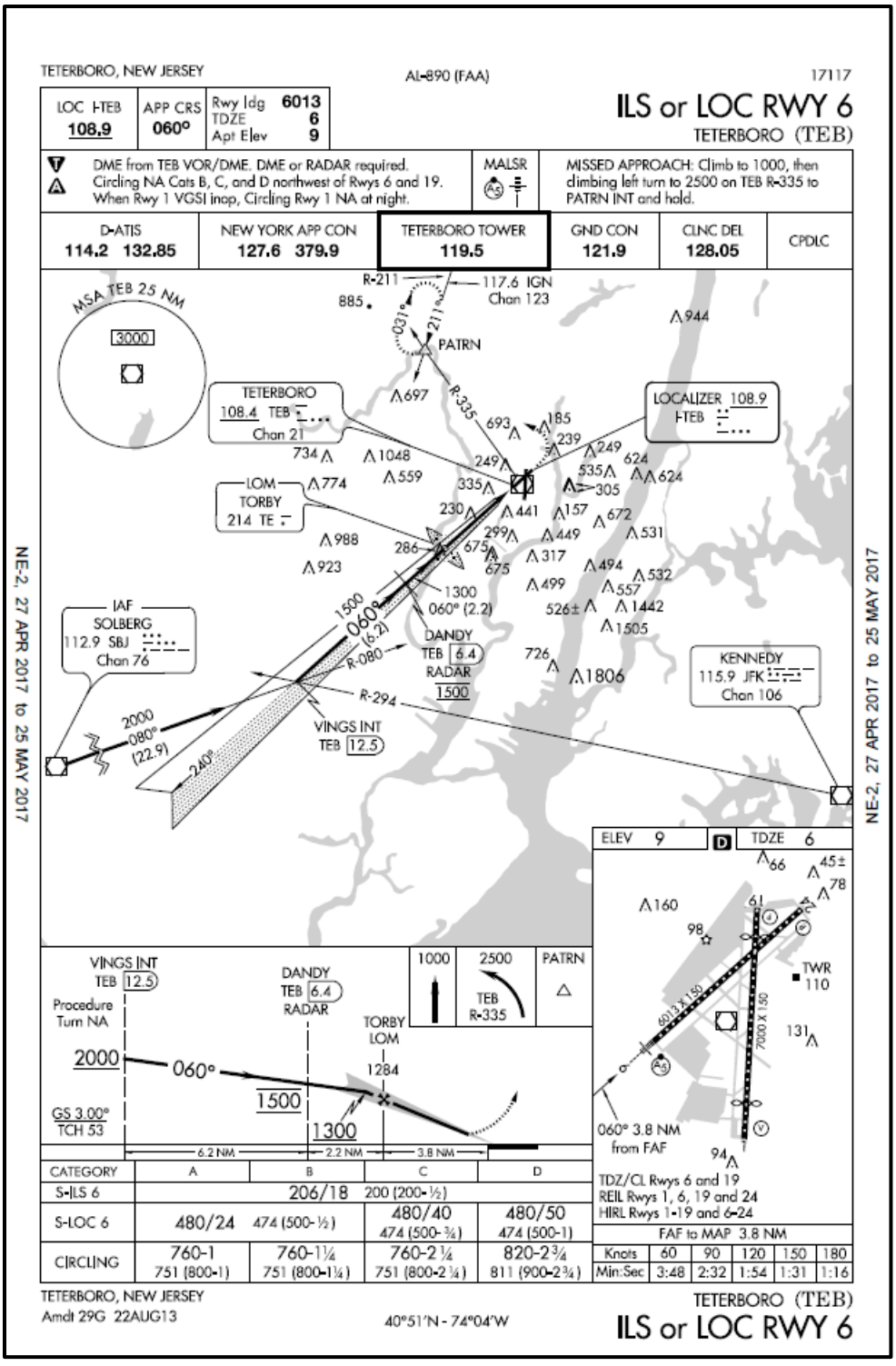

Figure 7: N452DA Cleared for the ILS 6, Circle to Land Runway 1

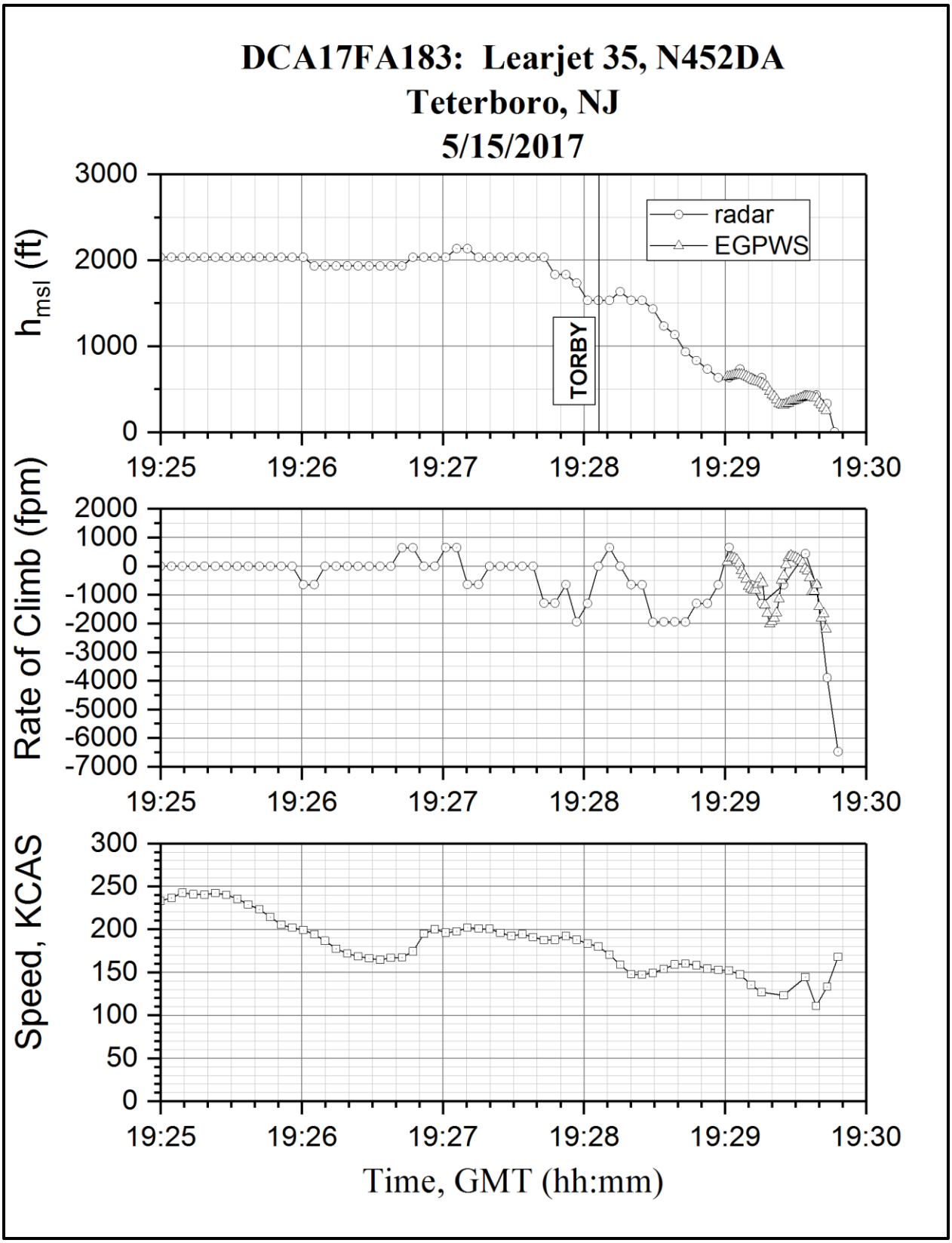

Figure 8: Altitude and Airspeed

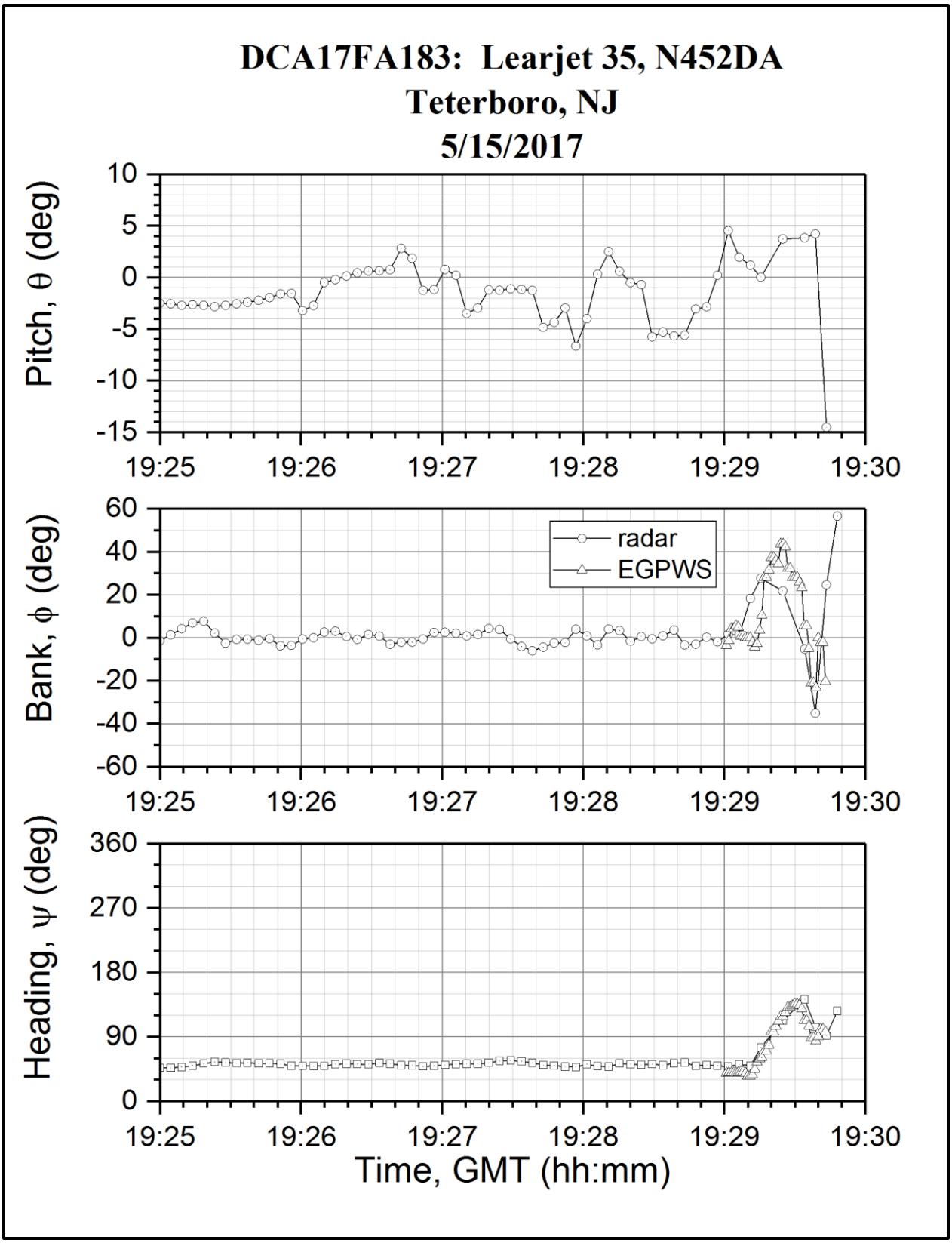

Figure 9: Pitch, Bank, and Heading

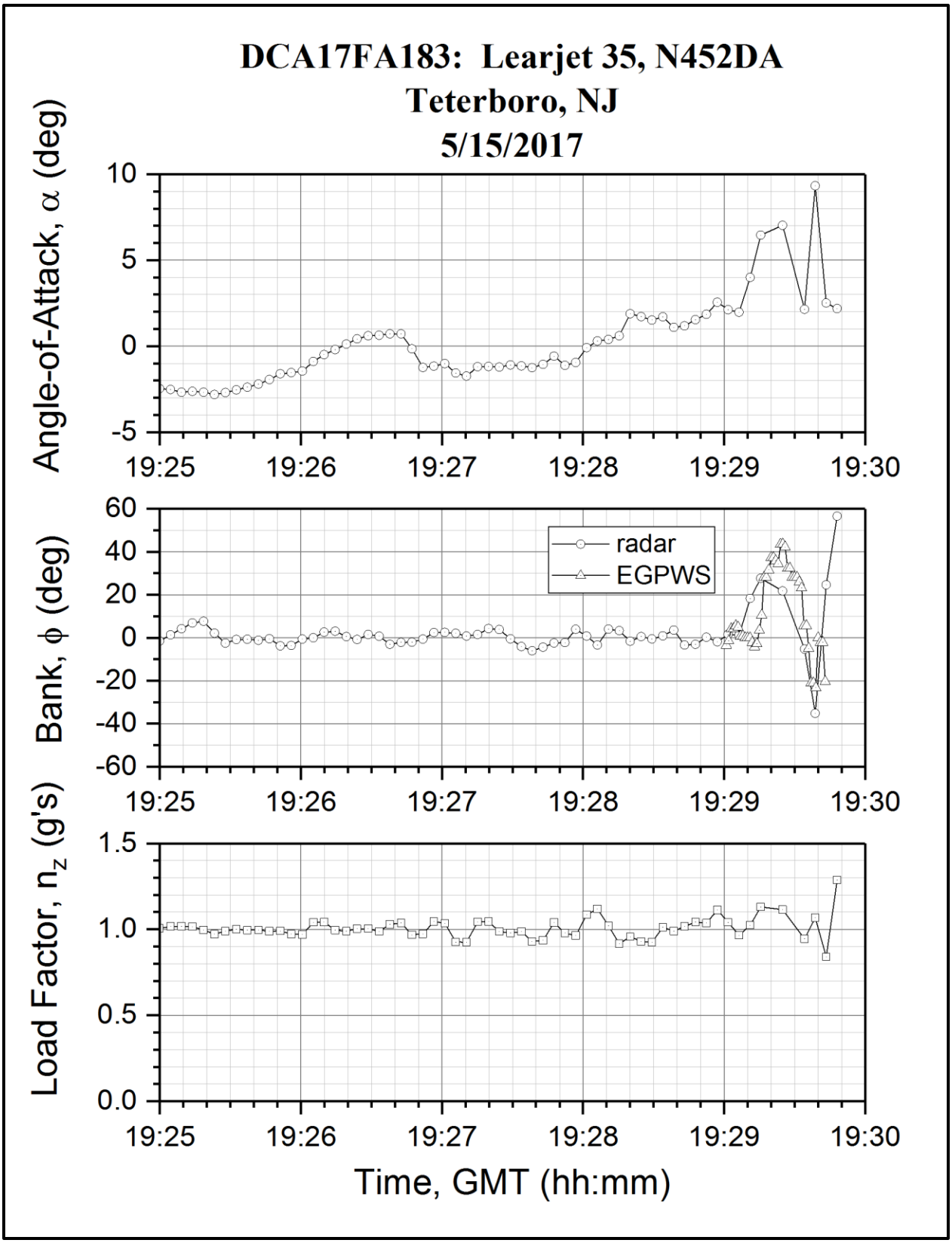

Figure 10: Estimated Angle-of-Attack and Load Factor

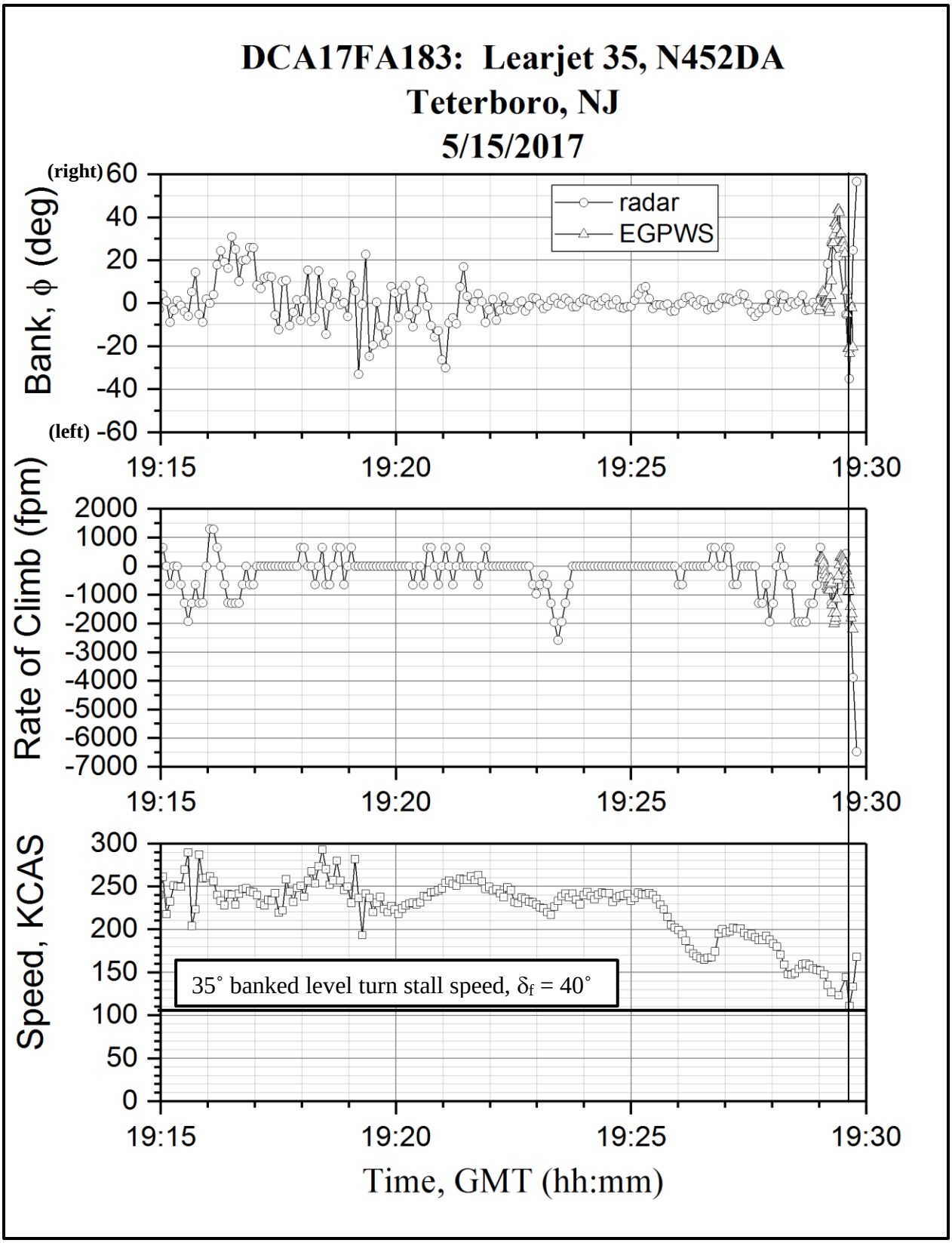

Figure 11: Bank, Rate of Climb, and Airspeed

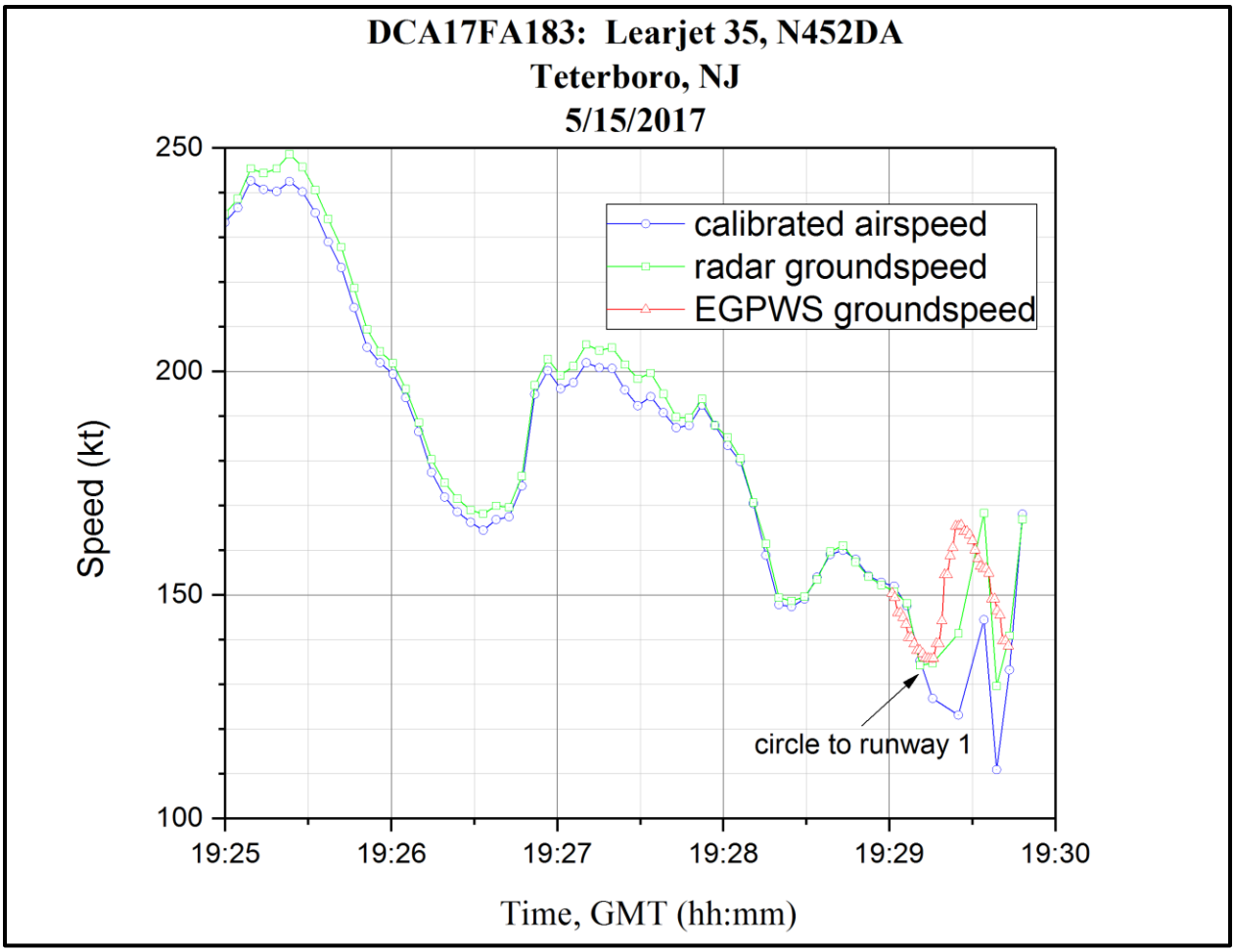

Figure 12: 20 kt Tailwind during the Circle to Land Runway 1