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: Thomson, Georgia
Date: February 20, 2013
Time: 2006 EST (0106 GMT)
Airplane: Beechcraft 390 Premier 1A, N777VG
NTSB Number: ERA13MA139

B. GROUP

No vehicle performance group was formed.

C. SUMMARY

On February 20, 2013, at 8:06 pm eastern standard time (EST), a Beechcraft 390 Premier 1A, registration N777VG, crashed after a go-around attempt from runway 10 at Thomson-McDuffie Regional Airport, Thomson, Georgia. The airplane was operated under the provisions of 14 CFR Part 91 on an instrument flight rules flight plan. The flight originated at the John C. Tune Airport, Nashville, Tennessee. The airplane struck a utility pole about 1/4 mile east of the departure end of the runway, separating the left wing. The remainder of the airplane impacted trees and came to rest in a wooded area about 1/2 mile east of the departure end of the runway. The airplane was destroyed by impact forces and fire. The 2 crew members were seriously injured, and the 5 passengers were fatally injured.

D. PERFORMANCE STUDY

The accident airplane[1] was not equipped with a flight data recorder. However, N777VG did have a cockpit voice recorder (CVR) and an enhanced ground proximity warning system (EGPWS) installed. This study is largely based on information recovered from the EGPWS and comments recorded on the CVR.

Times in the study are reported in EST as well as Greenwich Mean Time (GMT or "Z"): EST = GMT – 5 hr.

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[1] See Figure 1 for a picture of the accident airplane as previously registered.

The Landing

Federal Aviation Administration (FAA) regulation 14 CFR Part 91.103 required the pilot of N777VG to compute the necessary landing distance considering the airplane configuration, weight, and field conditions at Thomson-McDuffie Regional Airport (KHQU).

KHQU has a field elevation of 501 feet and a magnetic variation of 4°W. Runway 10/28 is 5503 ft x 100 ft. KHQU is equipped with an Automated weather Observation System (AWOS) and reported the following conditions 51 minutes prior to the accident:

KHQU 210015Z AUTO 24006KT 10SM BKN120 11/M03 A3015 RMK AO1 T01061035
Weather at 1915 EST, wind 240˚ at 6 kt, 10 statute miles visibility, broken clouds at 12,000 ft agl, temperature of 11 °C, dew point of -3 °C, altimeter setting 30.15 in Hg. Remarks: automated observation system.

As for the airplane configuration, the CVR recorded a conversation with the passenger in the right seat regarding an indication that the anti-skid system was inoperative a little over a minute before main gear touchdown at KHQU. However, the pilot stated that he had not planned on using anti-skid.

The FAA Approved Flight Manual (AFM) for the Beechcraft 390 Premier 1A states that the flap settings approved for landing with anti-skid inoperative are 0 and 10 deg. Flaps settings of 20˚ and 30˚ are prohibited with anti-skid inoperative. Recovered EGPWS data indicate that a flap setting of 30˚ was used for landing.

While not in accordance with the AFM, Beechcraft calculated stopping performance for several scenarios related to the accident. Figure 2 shows the estimated stopping distance for the accident airplane with no anti-skid and the lowest braking action recorded by Beechcraft during flight test. Beechcraft estimates that the airplane would require about 1560 ft to stop from the first speed recorded by the EGPWS on N777VG, which was 83 kt. Figure 3 shows that this estimate decreases to 1350 ft when moderate braking is applied.

Based on EGPWS data, after touching down, the pilot of N777VG did not stop the airplane within the first 2900 ft beyond the runway 10 threshold (5300 ft total usable for landing[2]) and initiated a balked landing[3] with more than 2400 ft[4] of hard surface remaining.

The Beechcraft airplane performance calculations discussed above indicate that N777VG, despite not being properly configured in accordance with the AFM, should have been able to stop on KHQU runway 10 that evening. However, all variables must be aligned properly to achieve the manufacturer's quoted performance. For example, once the airplane is on the

[2] The normal landing distance with flaps at 30˚ and anti-skid operating is approximately 3100 ft. This increases to about 5900 ft with flaps 10˚ and to 8000 ft with flaps 0 with anti-skid inoperative.
[3] Per the Airplane Flying Handbook, FAA-H-8083, page G-2, a balked landing is synonymous with a go-around.
[4] The EGPWS recording begins as the airplane is accelerating with 2400 ft of hard surface remaining. As a result, the decision to abort the landing had apparently been made prior to this point.

ground, the appropriate level of braking must be applied. Compared to take-offs, landing performance is not easily reproduced.

While Beechcraft does not publish a procedure for a go-around after touchdown, aerodynamic data for the 390 Premier 1A suggest that, properly configured, N777VG was capable of climbing after the failed landing attempt.

The Go-around

The Honeywell Mark V EGPWS (MK V) recorded the GPS-based ground track for N777VG shown in blue in Figure 4. Each of the blue MK V data points is labeled with a relative EGPWS time (in seconds), a calibrated airspeed (in knots), and a radio altitude (in feet). The track begins approximately 2900 ft from the runway 10 displaced threshold[5] and ends about 200 ft in front of the utility pole that was impacted[6]. (See discussion below on limitations of the MK V and other supporting data.)

The MK V is designed to record select airplane parameters when a user-defined event is triggered, typically the exceedance of a measured parameter. The recording should include 20 seconds before and 10 seconds after the event at a sample rate of once per second. However, in the case of N777VG, the accident occurred before the end of the recording window, and the final seconds were not captured (likely due to a loss of power).

The EGPWS triggering event for the accident was excessive bank angle. The bank angle threshold for triggering such an event on the Beechcraft 390 Premier 1A is a function of radio altitude. The threshold begins at 10˚ bank on the ground and remains constant up to a radio altitude of 30 ft. It then increases linearly to 45˚ bank at 150 ft radio altitude. (See the NTSB EGPWS Specialist Factual Report for more details on the bank angle threshold as well as the MK V unit itself.)

Figure 5 includes the bank angle recorded by the MK V EGPWS. The bank angle is approximately zero until the last second of the recording when it jumps from zero to 72˚ left-wing-down. It is assumed that the rapid roll rate (i.e., 72 deg/sec) and excessive bank recorded during the last second are the result of the airplane's left wing impacting the utility pole. However, the position recorded by the MK V EGPWS at the extreme bank angle puts the airplane (still) in front of the utility pole. This discrepancy is most likely the result of the low sample rate and delays associated with the EGPWS. Other factors include the accuracy of the GPS position data and the Google Earth terrain data.

The altitude and airspeed recorded by the MK V EGPWS are shown in Figure 6. The pilot of N777VG had apparently made the decision to execute a balked landing before the EGPWS

[5] The instrument approach plate for KHQU lists the length of runway 10 as 5,503 ft, not including the 100 ft overrun area available for landing. However, runway 10 has a 300 ft displaced threshold. This leaves approximately 5300 ft of paved surface for landing on runway 10.

[6] The EGPWS recorded two points beyond the impacted utility pole. However, the two points were located at the same geographic coordinates, and the integrity of these data could not be verified. Because the two points do not add to a deeper understanding of the accident sequence, they were omitted from the study.

recording began as the airplane was on the runway and accelerating between 2 and 4 kt/sec when the MK V began recording. However, the airplane did not begin climbing until t = 10 sec in the recording and only reached a 500 feet per minute climb rate at t = 13 sec, 7 sec before the EGPWS bank angle event.

The Go-around Configuration

Examination of the left and right lift dump actuators indicate that lift dump was extended during the go-around attempt. The examination results can be found in Beechcraft memorandum 940201301328/RB-208.

The airplane would have only marginal climb performance with lift dump: the inboard spoilers are deflected to 60˚ and the middle and outboard spoilers are deflected to 45˚. See Figure 7.

In order to assess N777VG's configuration during the go-around, an estimate of airplane drag coefficient was made using the EGPWS information and compared to aerodynamic data provided by Beechcraft for the Premier 1A with lift dump extended.

An estimate of the total airplane drag coefficient, C_D, can be made from the EGPWS data by summing forces along the flight path, ΣF_x, and assuming that acceleration is small (i.e., $dV/dt \approx 0$):

$$\Sigma F_x = 0$$
$$T - D - W\sin(\gamma) = 0$$
$$\sin(\gamma) = (T - D)/W \qquad \text{(I)}$$

where T is the thrust, D is the total airplane drag, and W is the weight.

By definition, rate of climb, RC, is:

$$RC = V\sin(\gamma) \qquad \text{(II)}$$

Substituting equation I into II:

$$RC = V[(T - D)/W]$$
$$D = -(RC/V)W + T$$

In coefficient form,

$$C_D = D/qS$$
$$C_D = [-(RC/V)W + T]/qS$$

where q is the dynamic pressure, and S is the reference wing area.

Substituting in approximate values,

$$C_D = [-(800\ \text{ft/min})(1\ \text{min}/60\ \text{sec})/\{(140\ \text{kt})(1.688\ \text{ft/sec/kt})\}(10{,}500\ \text{lb}) + 4000\ \text{lb}] / [1/2(0.002377\ \text{slug/ft}^3)\{(140\ \text{kt})(1.688\ \text{ft/sec/kt}\}^2\ (225\ \text{ft}^2)] = \mathbf{0.2280}\ \text{(EGPWS)}$$

where, 800 ft/min is the approximate rate of climb at t = 17.5 sec ($dV/dt \approx 0$ in Figure 6)
140 kt is approximately the airspeed at t = 17.5 sec
10,500 lb is the estimated airplane gross weight
4,000 lb is the total thrust assuming 2000 lb/engine[7]
0. 002377 $slug/ft^3$ is the standard sea level air density
225 ft^2 is the Beechcraft 390 Premier 1A wing reference area

Alternatively, drag data[8] for the Premier 1A provided by Beechcraft in memorandums 940201300432/RB-208 and 940201300730/RB-208 yield the following:

$$C_D = C_{D0} + (\Delta C_D/\Delta C_L^2)(C_L^2)$$

At the beginning of the EPGWS recorded data, the flap position was recorded to be 30˚. For flaps 30˚, lift dump extended, gear down

$$C_{D0} = 0.2247$$
$$(\Delta C_D/\Delta C_L^2) = 0.018$$
$$C_L = 0.70$$[9]

Substituting in the appropriate values and solving for the airplane drag coefficient yields

$$C_D = 0.2247 + (0.018)(0.70)^2 = \mathbf{0.2335} \text{ (from Beechcraft data, flaps 30˚)}$$

Note: the equivalent drag coefficient calculated from Beechcraft data with lift dump retracted is 0.1247.

At t = 17 sec in the EGPWS recording, a flap setting of 10˚was selected (or possibly up[10]). For flaps 10˚, lift dump extended, gear down

$$C_{D0} = 0.1547$$
$$(\Delta C_D/\Delta C_L^2) = 0.0335$$
$$C_L = 0.70$$

$$C_D = 0.1547 + (0.0335)(0.70)^2 = \mathbf{0.1711} \text{ (from Beechcraft data, flaps 10˚)}$$

Note: the equivalent drag coefficient calculated from Beechcraft data with lift dump retracted is 0.0893.

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7 The assumed installed maximum thrust is 2,000 lb. The rated thrust for the Williams-Rolls FJ44-21 engine is 2,300 lb.

8 The drag polars with lift dump deployed are based on wind tunnel data. No in-flight test drag polar data were collected during the Model 390 development and certification program with lift dump extended.

9 0.70 is the airplane lift coefficient necessary for equilibrium at the conditions used above for airplane drag.

10 Flaps were retracting from flaps 20˚ and were at 15˚ when the EGPWS recording ended as shown in Figure 8. During the on-site examination, the flap handle was found in the flaps 10˚detent.

In other words, the estimated airplane drag coefficient for N777VG in the seconds before impacting the utility pole (based on EGPWS data) is between the flaps 30˚ and flaps 10˚ drag coefficients provided by the airplane manufacturer for lift dump extended. The equivalent drag coefficient provided by Beechcraft with lift dump retracted is on the order of half the EGPWS-based values.

Beechcraft estimates that the flaps were transitioning from 20˚ at impact. Based on EGPWS data and known flap retraction rates, the flaps were between 15˚ and 17.5˚. See Figure 8.

E. CONCLUSION

Lift dump is a critical system for stopping the Beechcraft 390 Premier 1A during landing. The wreckage examination as well as drag estimates based on recovered EGPWS data indicate that lift dump remained extended during N777VG's go-around attempt at Thomson-McDuffie Regional Airport. The airplane drag associated with lift dump, flaps, and landing gear likely resulted in only marginal climb performance. As a result, N777VG struck a utility pole about 1/4 mile east of the departure end of the runway, separating the left wing.

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F. FIGURES

Figure 1: Accident Airplane as Previously Registered

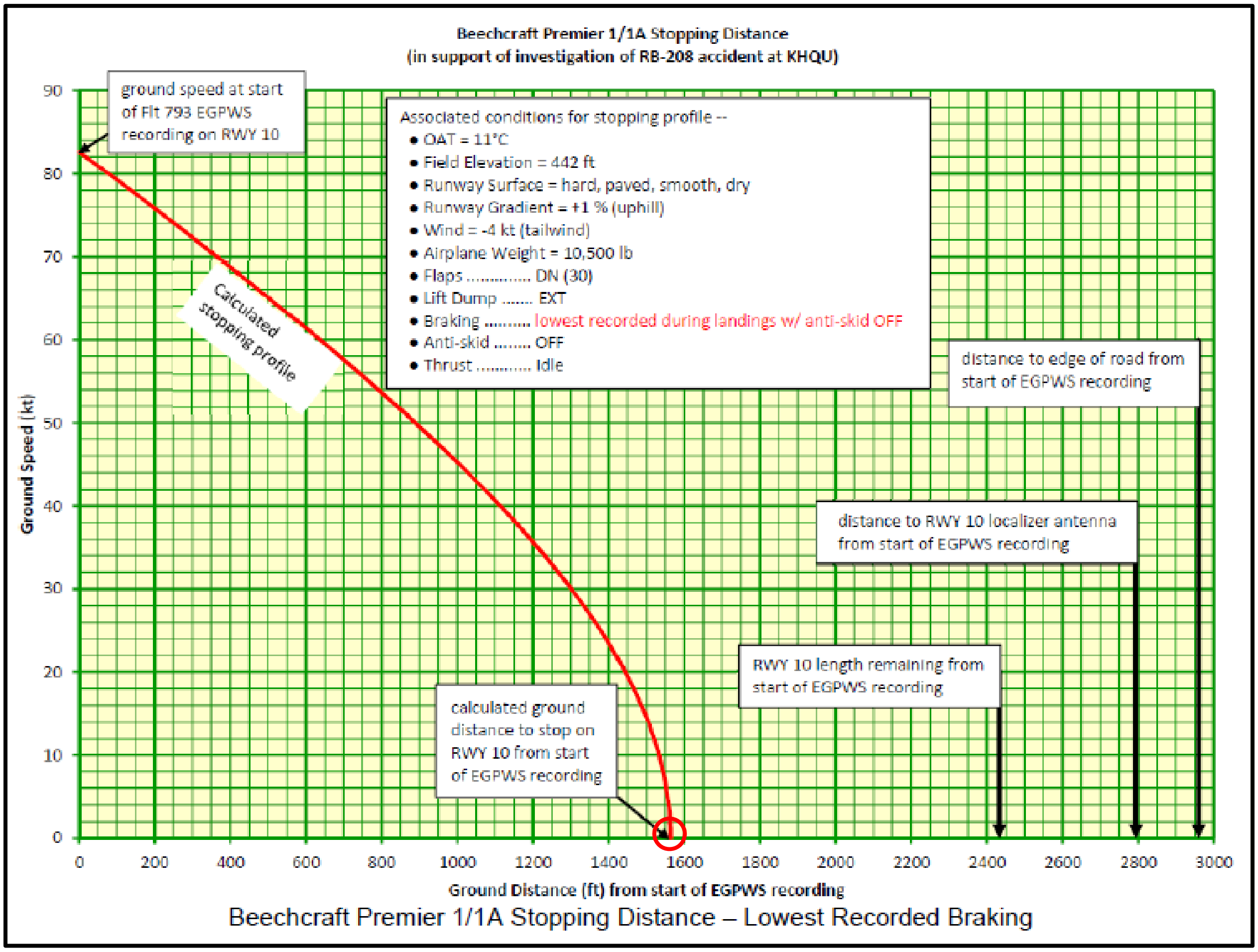

Figure 2: Estimated Stopping Distance, No Anti-Skid and Low Braking: 1560 ft

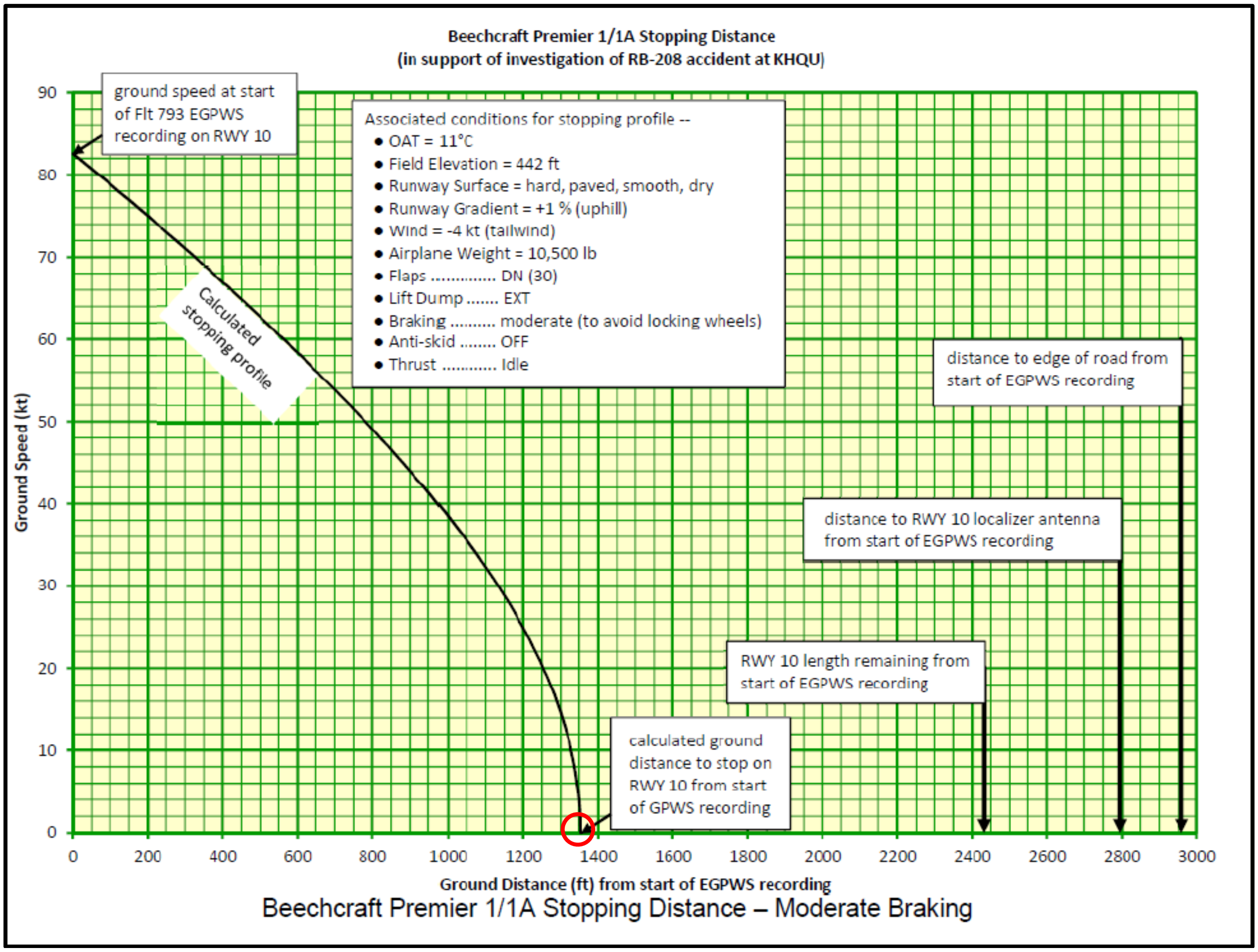

Figure 3: Estimated Stopping Distance, No Anti-Skid and Moderate Braking: 1350 ft

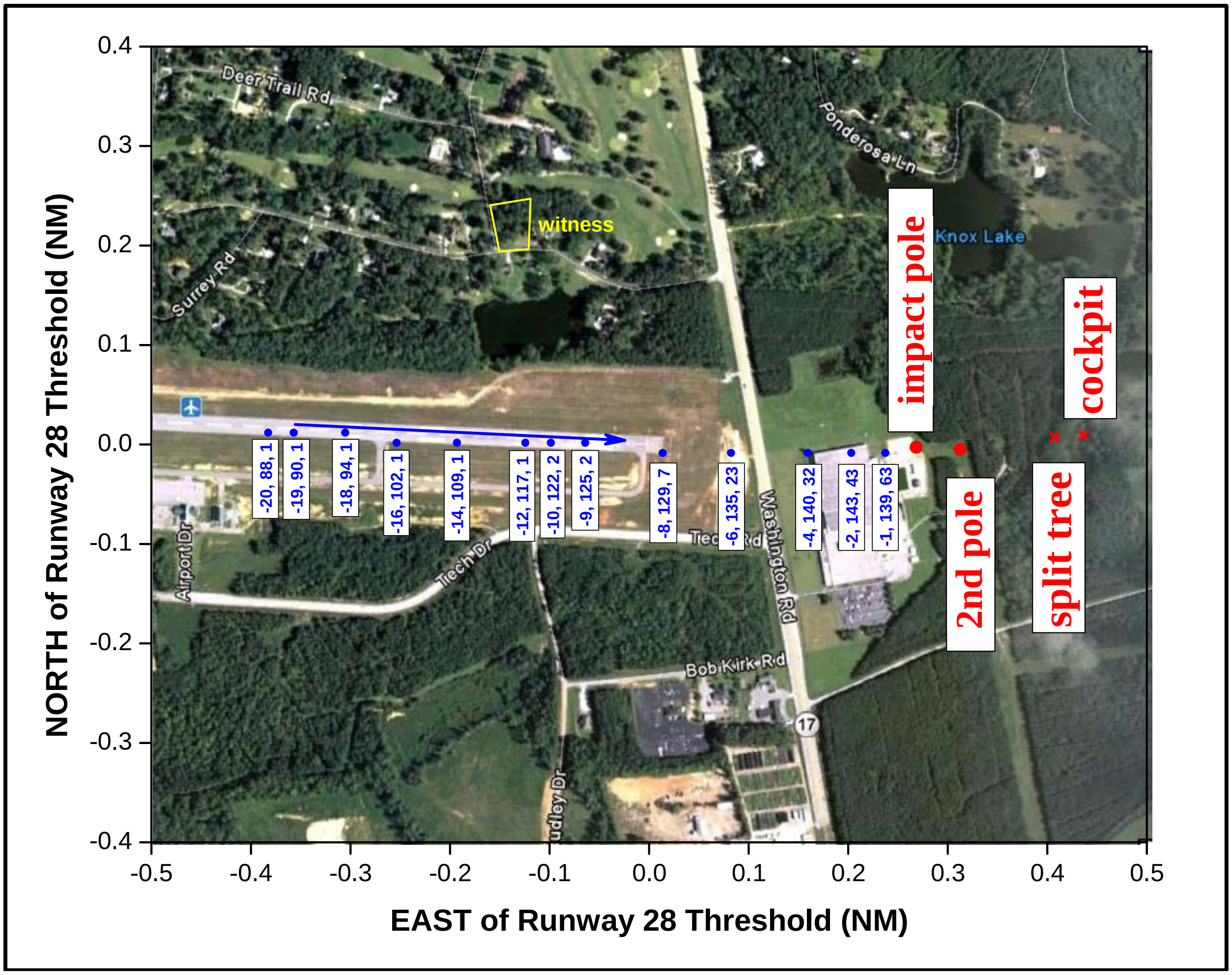

Figure 4: Ground Track Recorded by Honeywell Mark V EGPWS
With Relative EGPWS Time, Calibrated Airspeed, and Radio Altitude (sec, kt, ft)

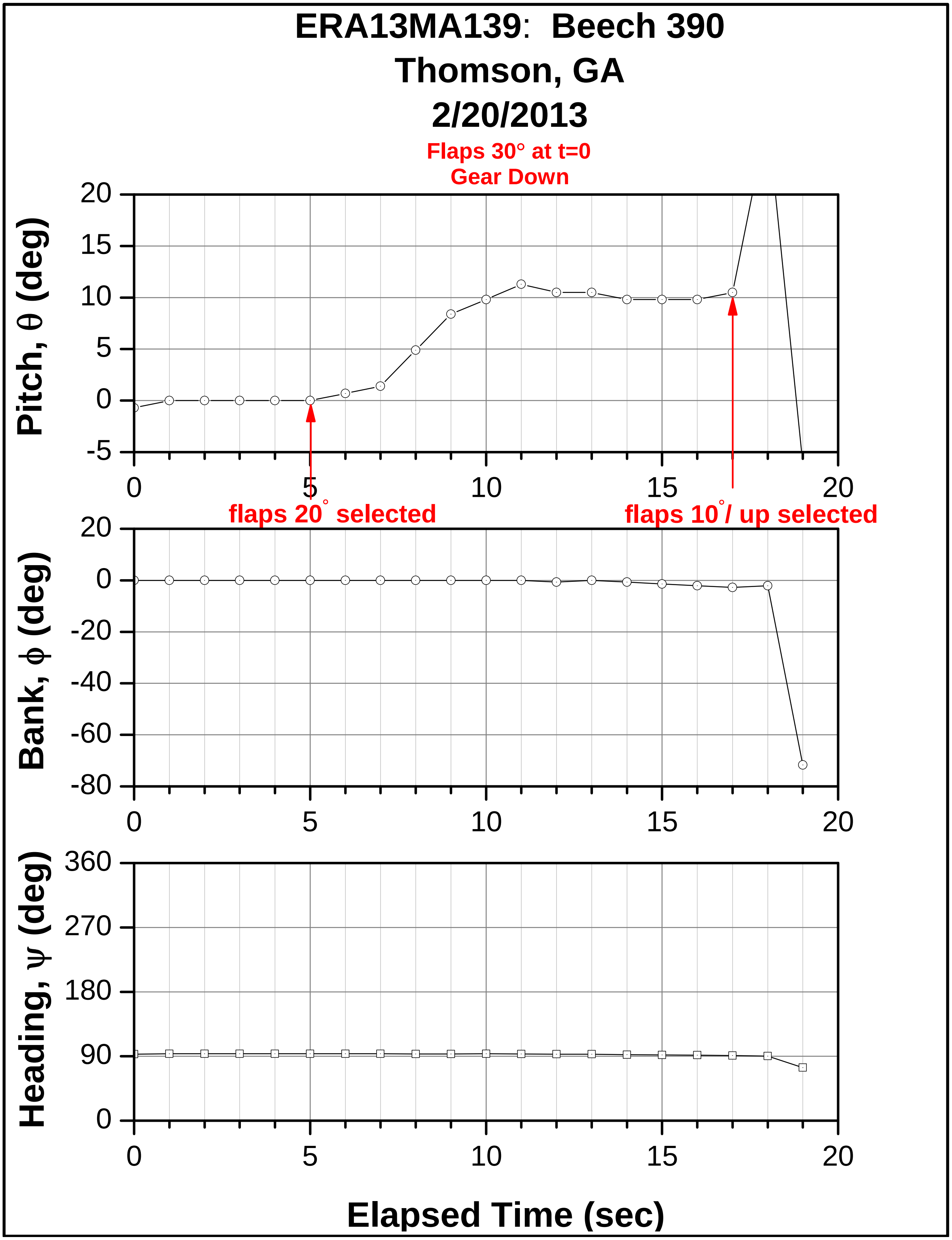

Figure 5: Airplane Attitude Recorded by Honeywell Mark V EGPWS

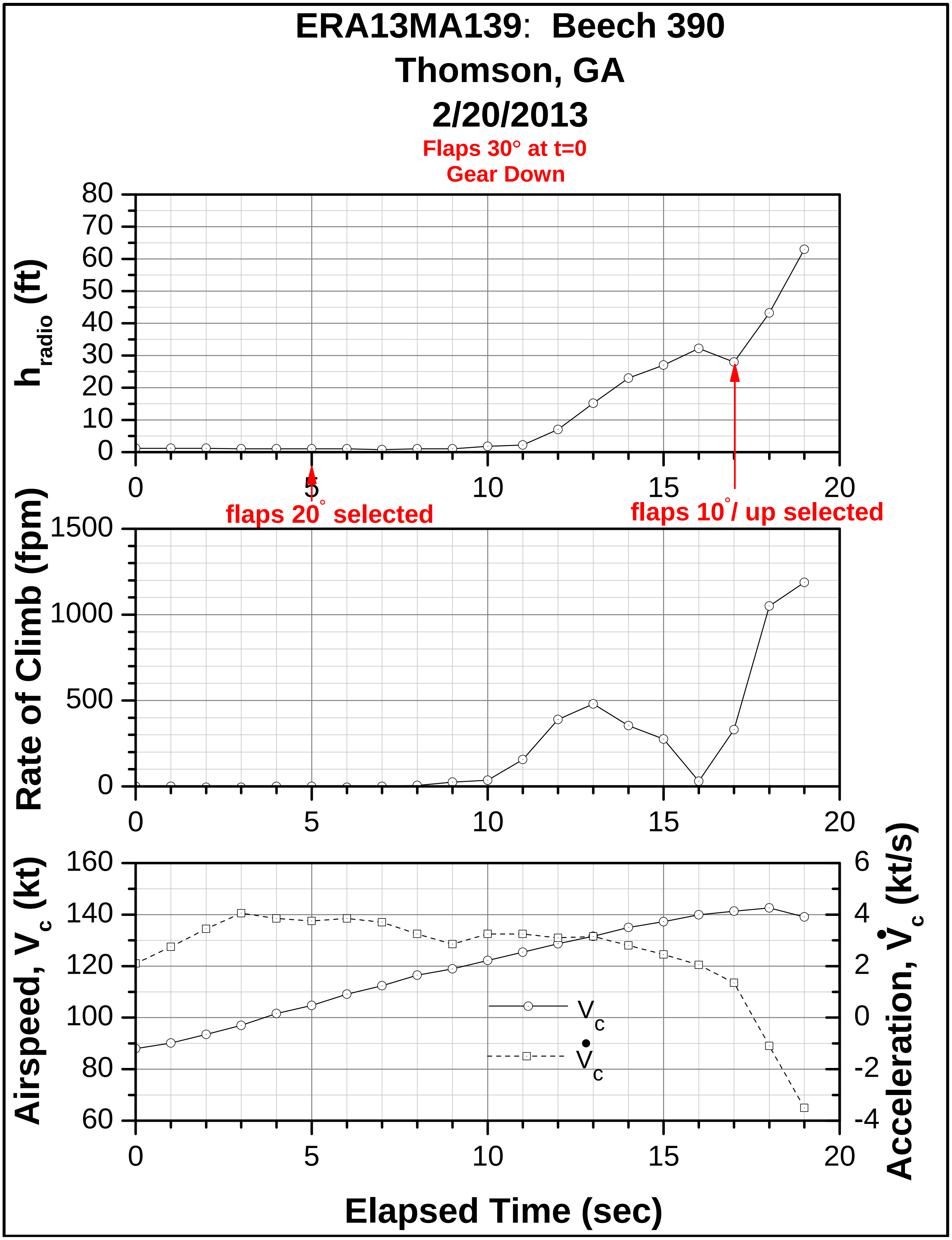

Figure 6: Airplane Altitude and Airspeed Recorded by Honeywell Mark V EGPWS

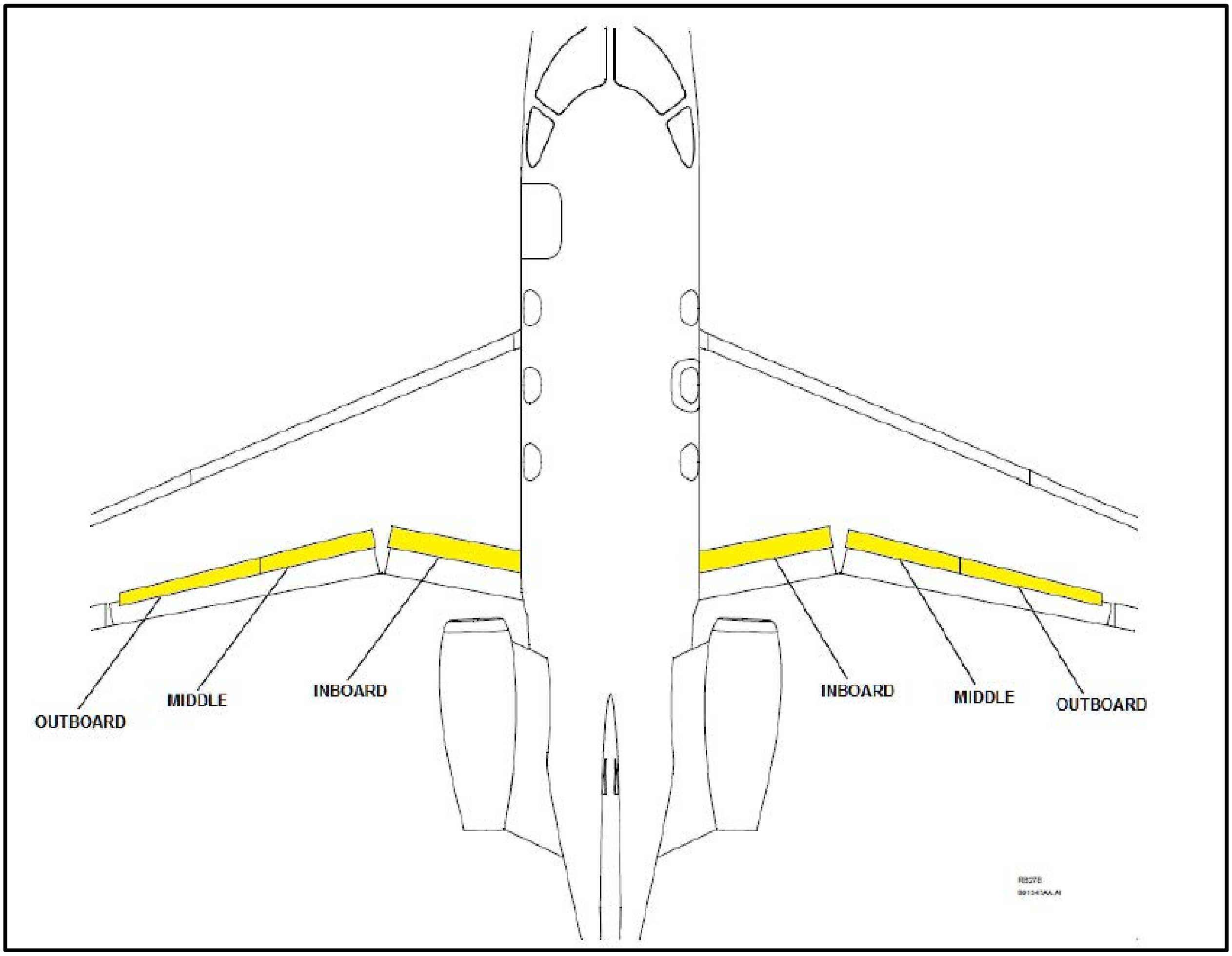

Figure 7: Lift Dump Panel (Inboard) and Roll/Speed Brake/Spoiler Panels (Middle and Outboard)

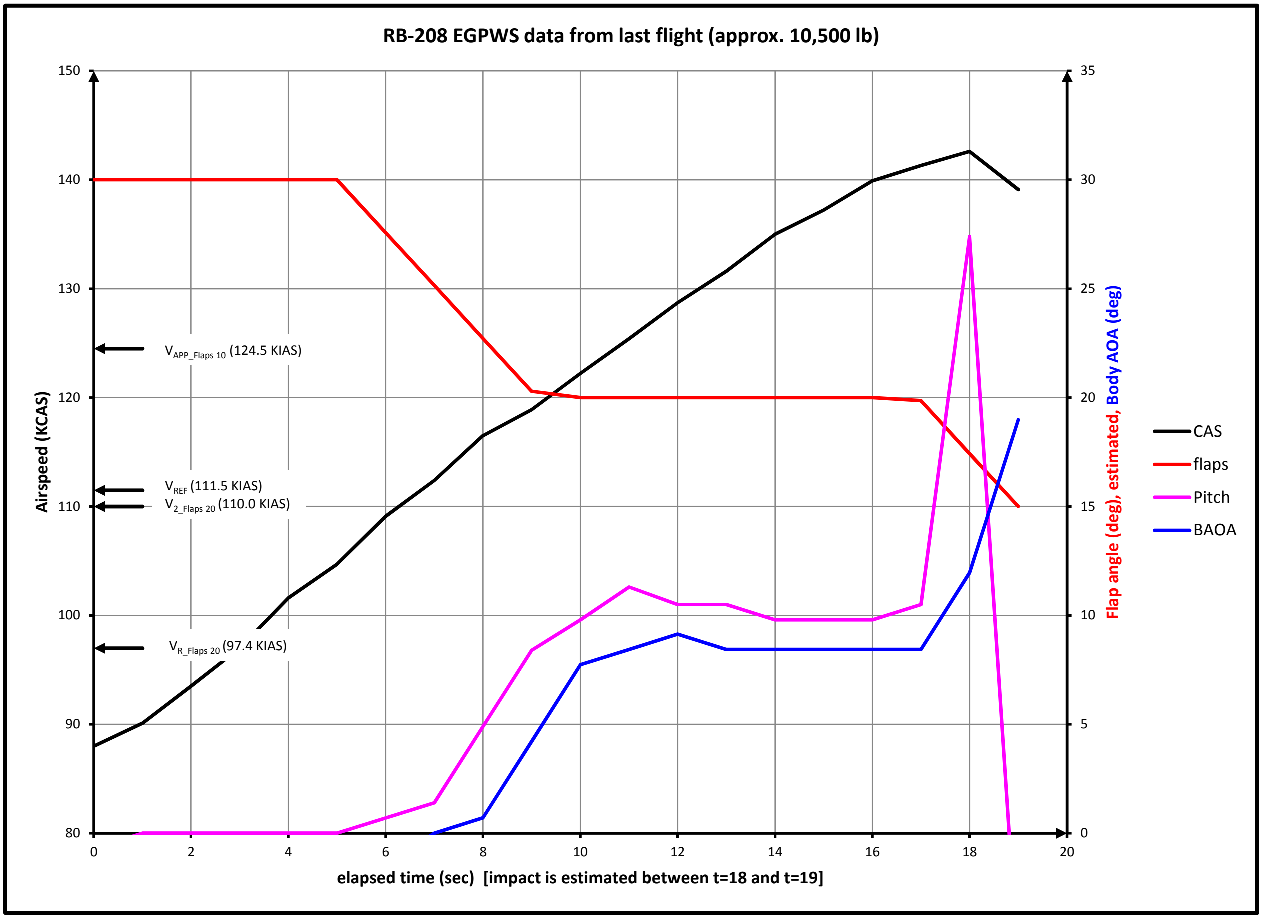

Figure 8: Estimated Flap Position Based on EGPWS and Flap Retraction Rates