Docket No. SA-533

Exhibit No. 13

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C.

Airplane Performance Study

by

Timothy Burtch

(19 Pages)

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

Airplane Performance Study

Specialist's Report of Investigation
Timothy Burtch

A. ACCIDENT

Location:	Lubbock, TX
Date:	January 27, 2009
Time:	1037 GMT (4:37 am CDT)
Airplane:	ATR-42-320, N902FX
NTSB Number:	CEN09MA142

B. GROUP

Chairman: Timothy Burtch
National Transportation Safety Board
Washington, DC

Member: Michael Bauer
National Transportation Safety Board
Washington, DC

Member: Cailhol Didier
ATR Safety & Continued Airworthiness Manager
Blagnac, France

Member: Leopold Sartorius
Chief of Recorder and Development Division
Bureau d'Enquetes et d'Analyses
Le Bourget, France

Member: Joe Jacobson
FAA Transport Airplane Directorate
Seattle, WA

C. SUMMARY

On January 27, 2009, at approximately 0437 Central Standard Time (CST), N902FX, an Aerospatiale Alenia ATR-42-320, operating as Empire Flight 8284, sustained substantial damage when it collided with terrain short of the runway while executing the Instrument Landing System (ILS) RWY 17R approach at Lubbock Preston Smith International Airport (LBB), Lubbock, Texas. The airplane was registered to Federal Express Corporation, Memphis, Tennessee, and operated by Empire Airlines, Hayden, Idaho. The airline transport pilot rated captain was seriously injured and the commercial rated first officer (FO) sustained minor injuries. An instrument flight rules flight plan was filed for the flight that departed Fort Worth Alliance Airport (AFW), Fort Worth, Texas, at approximately 0319 CST. Instrument Meteorological Conditions (IMC) prevailed for the supplemental cargo flight operated under 14 Code of Federal Regulations (CFR) Part 121.

D. PERFORMANCE STUDY

The performance study describes the airplane motion during the accident flight based on the available data sources. It introduces airplane position, speed, and attitude derived from the recovered Flight Data Recorder (FDR), radar, weather information services, and other data collected during the on-scene portion of the investigation. The FDR was an L-3 Communications Fairchild Model FA2100 FDR. The radar data were Airport Surveillance Radar (ASR-9) data from the Federal Aviation Administration (FAA) Standard Terminal Automation Replacement System (STARS).

The National Transportation Safety Board's (NTSB) aircraft performance specialist was not on scene for the investigation.

Assumptions and Limitations

The input data sources to the study have inherent limitations. In addition, assumptions were made in the performance calculations. Accordingly, the performance results presented in the study are only estimates, and the associated limitations for each parameter should be considered in the proper context.

The FA2100 FDR was configured to record 256 12-bit words, or parameters (i.e. altitude, airspeed, etc) every second. The grouping of the 256 words every second is called a sub-frame, with each word separated by 0.0039 seconds. Each word is specifically assigned a word location within each sub-frame. Words can be repeated within the sub-frame to obtain sample rates of greater than 1 Hz. Further information on the FDR can be found in the Flight Data Recorders Specialist's Factual Report

The STARS radar data consisted of short-range or about 60 nautical mile (NM) ASR-9 data. These data have an inherent uncertainty and precision error of ±2 Azimuth Change Pulses (ACP) = ± (2 ACP) x (360°/4096 ACP) = ±0.176° in azimuth, ±50 ft in altitude, and ±1/16 NM in range. Specifically, the results are based largely on secondary radar returns from the LBB ASR-9 radar located at the Lubbock International ASR facility. These data were filtered for transponder beacon code 5266, N902FX's assigned beacon code for the accident flight to Lubbock, Texas.

Secondary and Air Route Surveillance Radar data from Anson and Odessa, TX, respectively, were also used in conjunction with the LBB ASR-9 data. (These data are included in the Appendix.) However, the plots shown in the study include only the closer LBB ASR-9 radar data. All other radar facilities were at least 80 NM from the Lubbock airport.

Weather Observation

A weather observation taken about 16 min after the accident recorded the wind as 020° at 11 kt, gusting to 18 kt, visibility two miles in light freezing drizzle and mist, ceiling overcast at 500 ft above ground level (agl), temperature minus 08° Celsius, dew point minus 09° Celsius, and an altimeter setting of 30.13 in of mercury. A more detailed description of the weather can be found in the Group Chairman's Meteorological Factual Report.

Radar and Performance Results

Witnesses reported seeing the wings of Empire Flight 8284 rocking back and forth as the airplane emerged from the overcast prior to ground impact. The Captain stated to company maintenance personnel that the airplane had been picking up ice on the approach and that the crew was working on an "issue" with the flaps when the stick shaker activated and continued until impact.

The ground track of N902FX from radar is shown in Figure 1. Greenwich Mean Time (GMT) is shown in yellow, and the Mode C altitude is shown in cyan. Figures 2 and 4 show N902FX's radar ground track, with radar error bands denoted, from the Locator Outer Marker / Initial Approach Fix (LOM/IAF), POLLO, to the end of the LBB ASR data. Figure 3 is a picture of N902FX's impact marks and final resting position. The published ILS 17R approach is shown in Figure 5. Finally, the last six minutes of east and north track as a function of time are shown in Figure 6.

The FDR recorded a flap asymmetry at 1034:24, shortly after the first officer, the flying pilot, called for flap and gear extension just outside the LOM. The FDR data also show that while flying between 160 KIAS and 120 KIAS, approximately 20° of left control wheel was required to counter the flap asymmetry i.e., 8° to 10° of actual deflection on the left flap (or 4° to 5° on the flap deflection sensor located in the middle of the flap torque tube) and zero on the right flap[1]. When the flaps were deployed, the autopilot, which was coupled to the ILS 17R approach at this point, introduced approximately 6° of left-wing-down (LWD) aileron (12° total aileron) to counter the right-wing-down (RWD) rolling moment from the asymmetric flap deployment. (See the Group Chairman's Systems Factual Report for a more detailed description of the flap system failure.)

The control wheel and the flap indicator were two of several cues that the crew had indicating a problem with the flap deployment. Approximately 40 sec elapsed from the

[1] The ATR-42 flap design limits the maximum flap asymmetry to approximately 9°.

initial flap call before the CVR recorded the Captain commenting on a flap problem, and 66 sec elapsed before the stick shaker disconnected the autopilot. (See the Group Chairman's Operations Factual Report for a complete list of the asymmetric flap deployment cues.) The flap asymmetry is shown in Figure 7 at approximately 1034:25.

At about 1034:55, the FO reduced power from about 58% maximum torque to about 3%, while the autopilot increased the pitch attitude of the airplane to maintain the glideslope. This ultimately resulted in stick shaker, which disconnected the autopilot at about 1035:30[2], 1000 ft agl, and 125 KIAS[3]. The FO continued to fly the approach. The power reduction at the top of the approach is shown in Figures 8 and 9.

The autopilot was not re-engaged after the initial stick shaker activation at 1035:30, and it is unclear whether or not the crew attempted to re-engage the autopilot. No elevator trim inputs were recorded on the FDR subsequent to the autopilot disconnecting, and aileron and rudder trim were not recorded. However, the ATR-42 autopilot will not re-engage if the pedal force is in excess of 30 decaNewton or 13 lb.

The approach flap setting for the ATR-42 is (a symmetric) 15°. N902FX had 8° to 10° deflection on the left flap only. As a result, "typical" power settings used during approach would not have applied to the accident approach. This may have contributed to N902FX's apparently unstable approach.

Empire Flight 8284's approach into Lubbock is recorded in Figure 10. After the autopilot disconnected at 1035:30, it took less than a minute for N902FX to deviate three "dots" high and to the right of the ILS course. (Note: The sensitivity of the ILS is calibrated such that one dot is equivalent to approximately an 8 ft glide slope deviation and a 150 ft localizer deviation at the middle marker. The ILS middle marker is located 3500 ft or 0.58 NM from the end of the runway. See Figure 2 for scale.)

Estimated pilot control forces peaked about ten seconds after airplane control was transferred from the FO to the Captain at 1035:50. This corresponds to a time when the airplane was at an altitude of about 500 ft agl and at the reported ceiling. The airplane was over two dots to the right of the ILS localizer when it likely emerged from the overcast ceiling. This is also when the second stick shaker event occurred[4].

- 38 lb maximum column force during landing maneuver
- 150 lb maximum pedal force during landing maneuver
- 36 lb maximum wheel force during landing maneuver

[2] No aural tone for the autopilot disconnect was heard on the CVR. One explanation is that the 1.1 sec disconnect chime was replaced by the stick shaker aural warning which has priority.
[3] The published flaps-retracted minimum airspeed is 143 KIAS with ice. Approach speed plus 5 kt at the approach flap setting, no ice, is 121 KIAS.
[4] The recorded flap position increased by approximately one degree during the Captain's landing maneuver at 500 agl.

The estimated average wheel force required to counter the flap asymmetry (after the autopilot disconnected) was estimated to be 13 lb. See "ATR Simulation Results" below for additional estimates derived from the ATR-42-320 Full-Flight Simulator (FFS) models.

To summarize, the Airplane Performance Group concluded that the FDR data do not show behavior consistent with an airplane stall, loss of lateral control, or a sudden change in aileron hinge moment. The stick shaker triggered at the appropriate local angle-of-attack and airspeed on the FDR and, as a result, provided sufficient stall margin. The bank angle followed the commanded wheel and aileron deflections throughout the approach and landing. (See Figure 11.)

Flight 8284's approach into the Lubbock International Airport was unstable. It degraded even more when the autopilot disconnected with the first of five stick shaker events. While the crew discussed aborting the landing, the Captain made the decision to continue the approach.

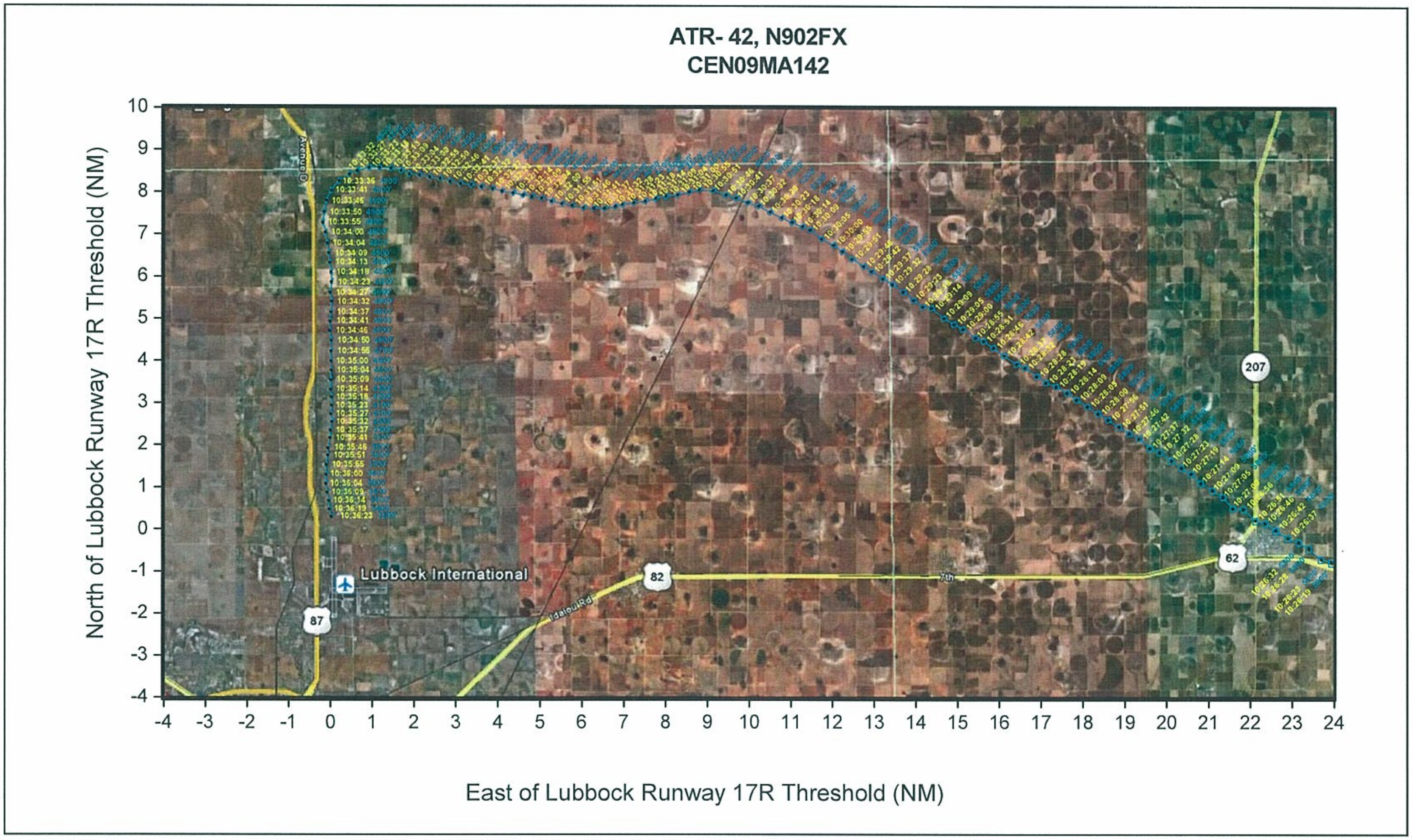


Figure 1: Ground Track of N902FX Accident Flight Based on STARS Data

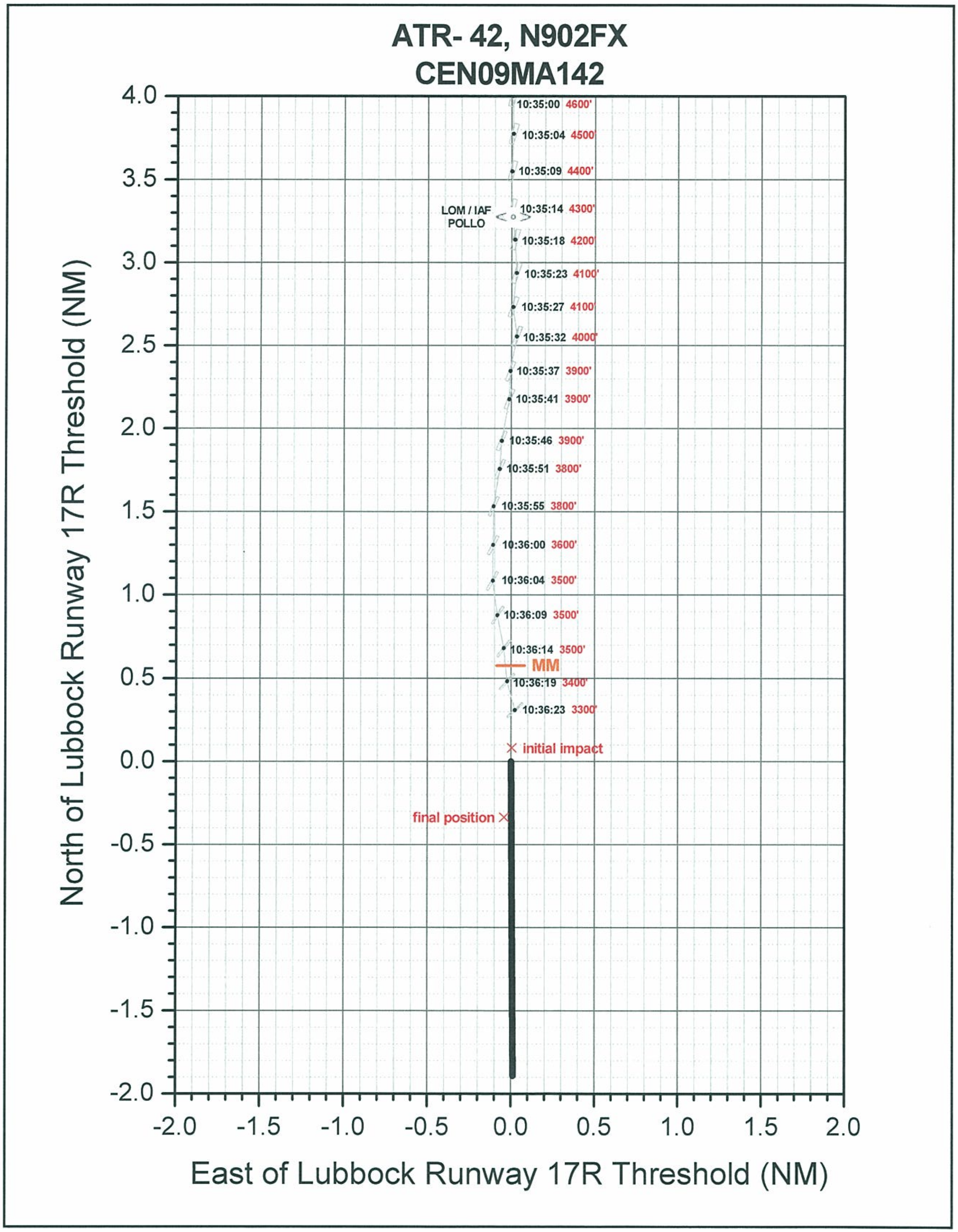


Figure 2: Ground Track of N902FX Accident Flight from LOM

Figure 3: N902FX Impact Marks and Final Position

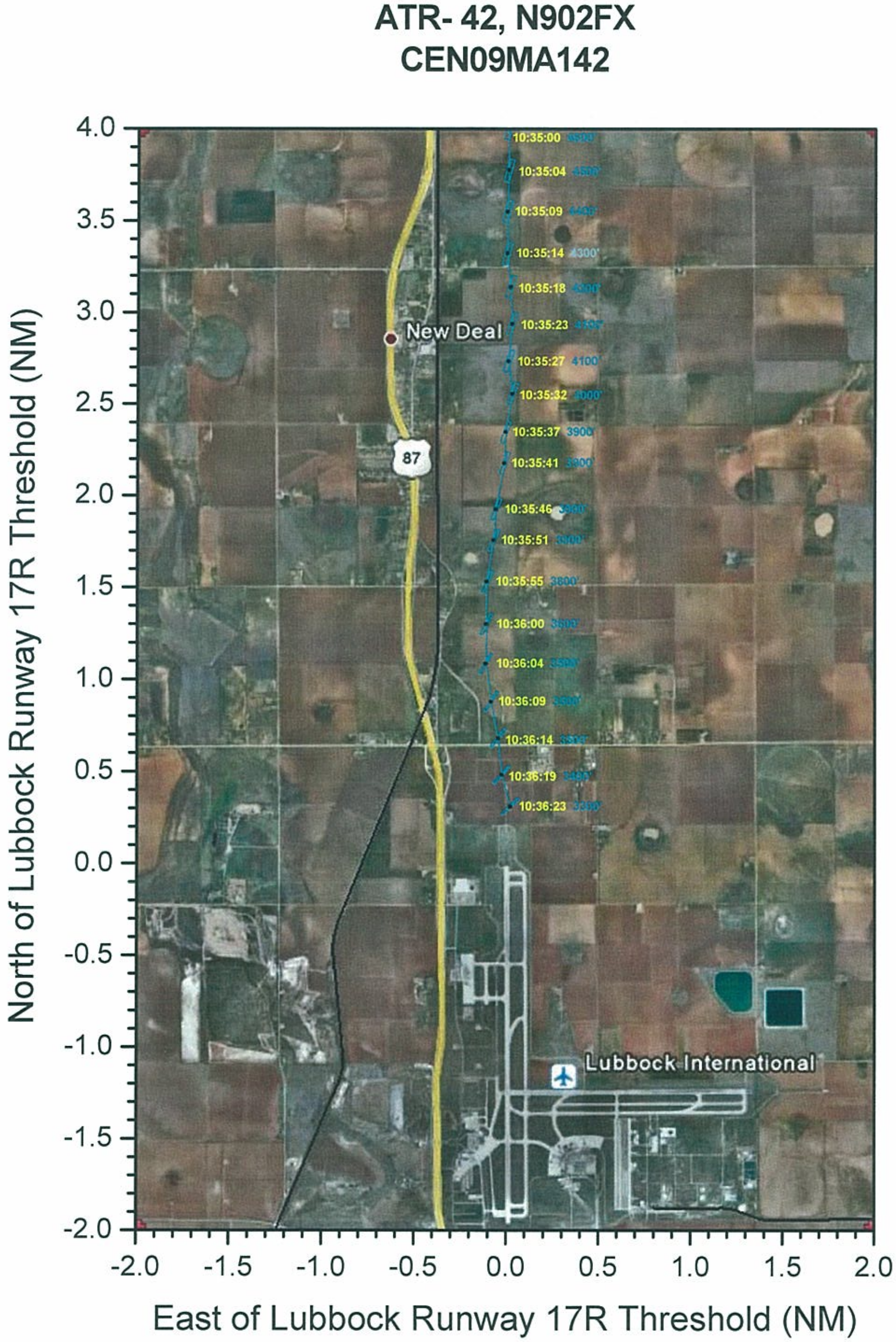
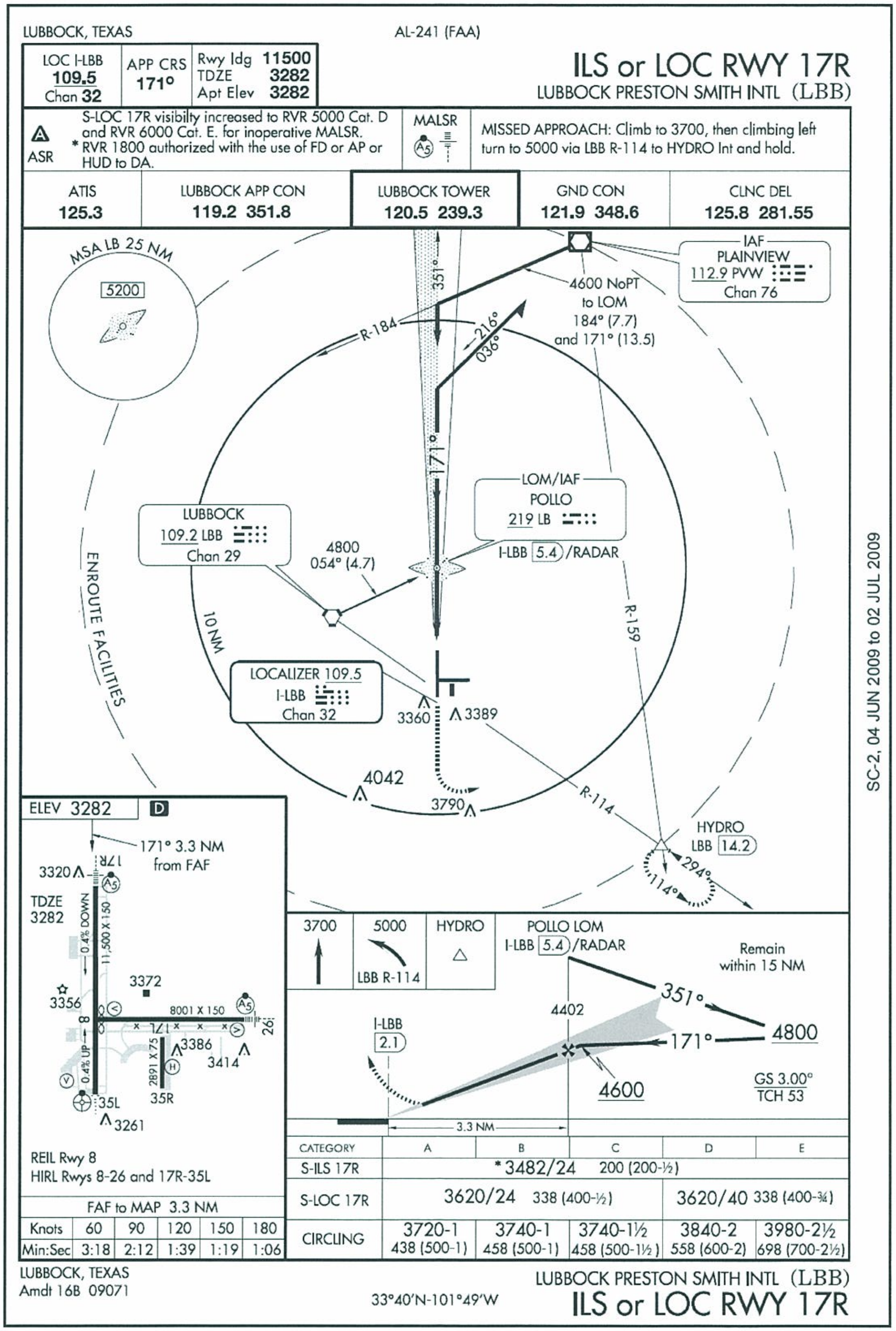


Figure 4: Ground Track of N902FX Accident Flight from LOM



CATEGORY	A	B	C	D	E
S-ILS 17R	*3482/24 200 (200-½)				
S-LOC 17R	3620/24 338 (400-½)			3620/40 338 (400-¾)	
CIRCLING	3720-1 438 (500-1)	3740-1 458 (500-1)	3740-1½ 458 (500-1½)	3840-2 558 (600-2)	3980-2½ 698 (700-2½)

FAF to MAP 3.3 NM

Knots	60	90	120	150	180
Min:Sec	3:18	2:12	1:39	1:19	1:06

Figure 5: Lubbock ILS 17R Approach Plate

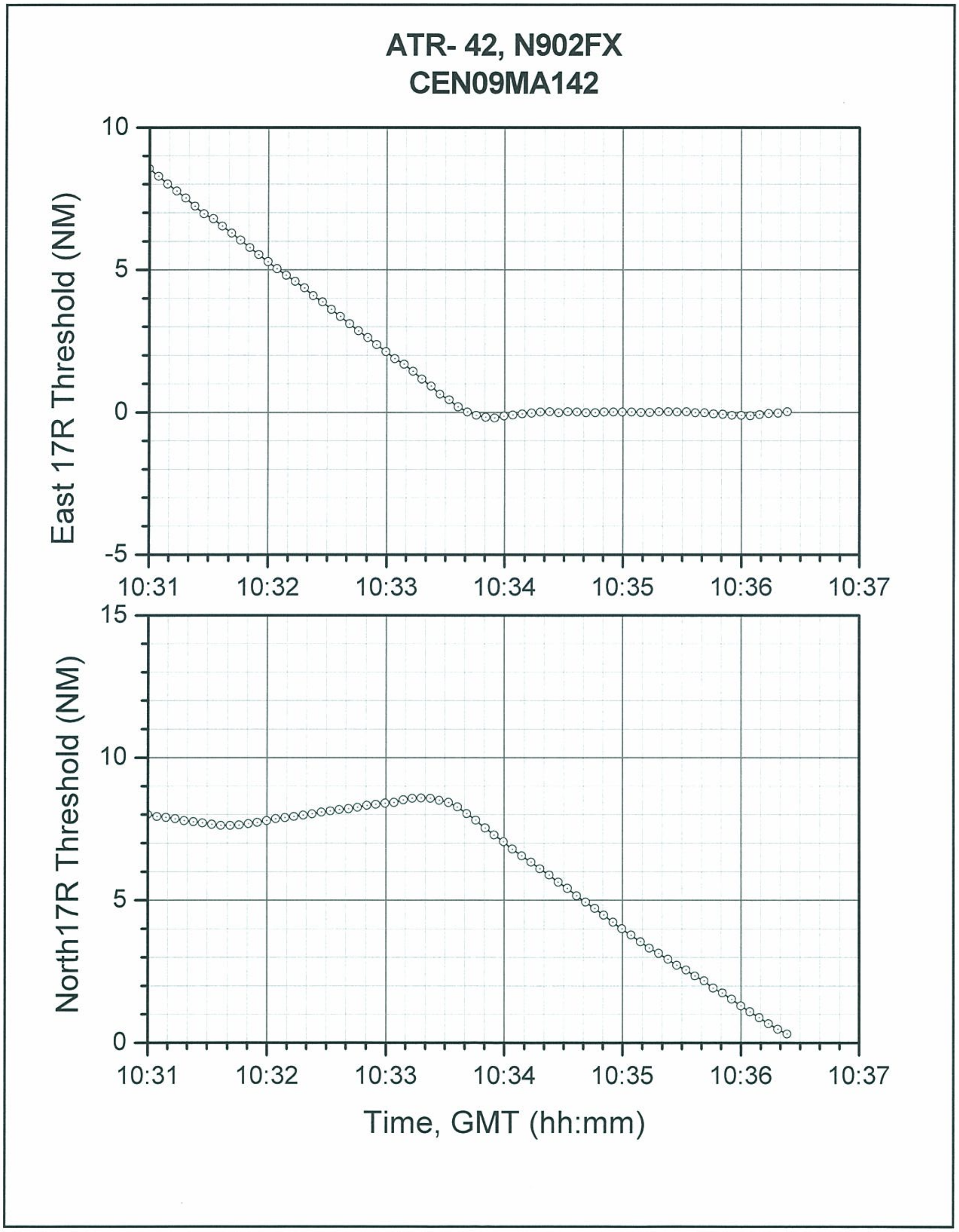


Figure 6: Ground Track of N902FX Accident with Time

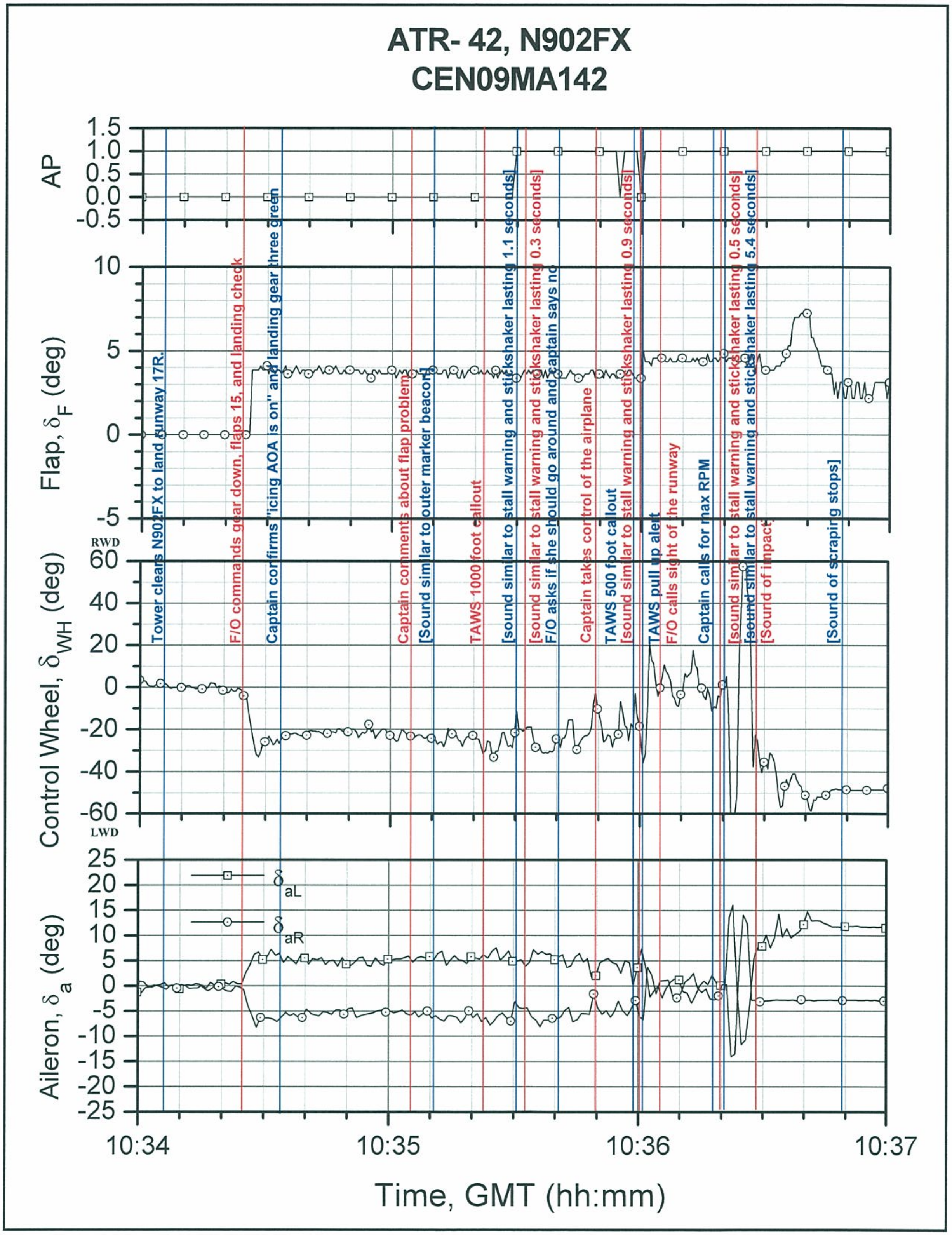


Figure 7: N902FX FDR Flap Asymmetry

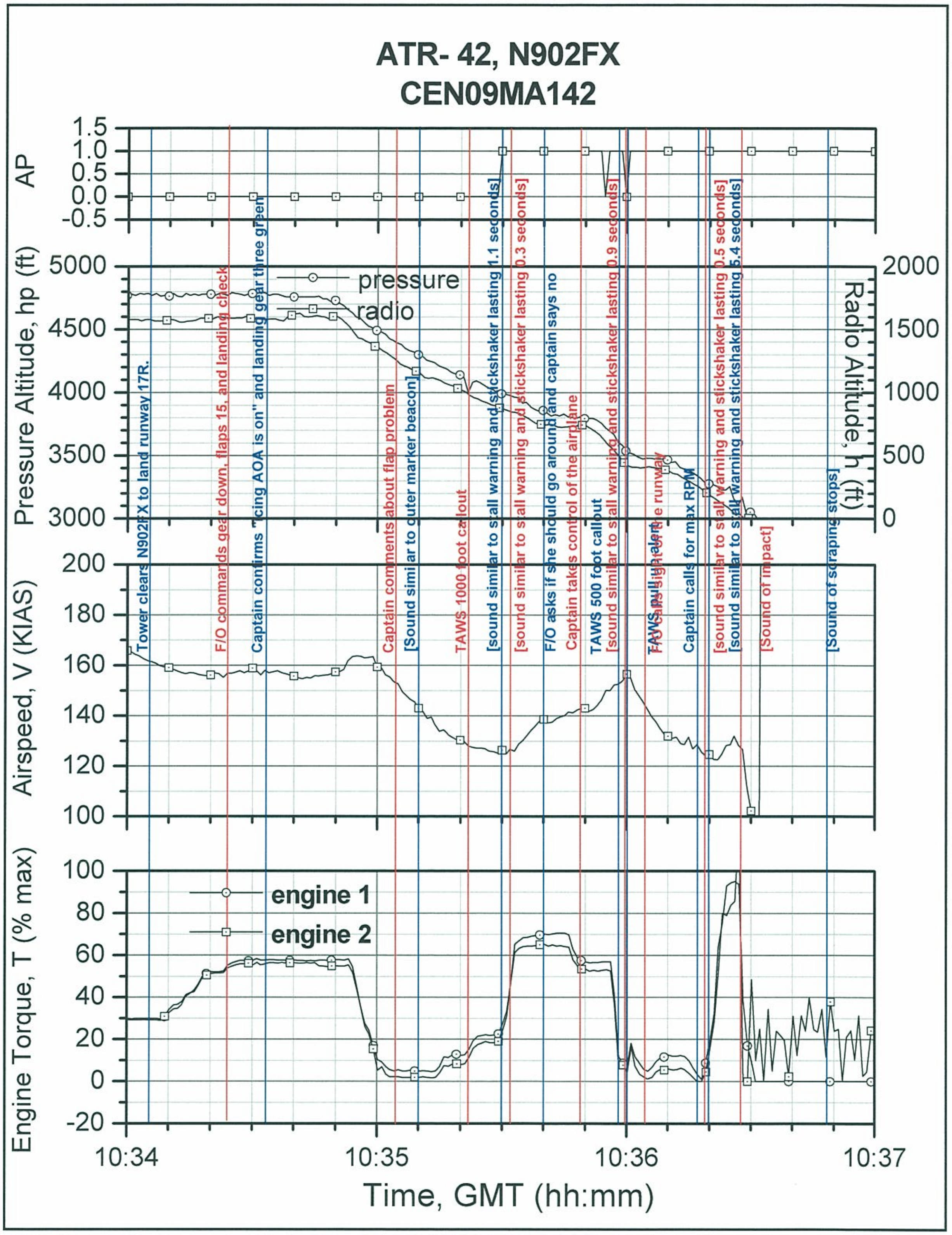


Figure 8: N902FX FDR Power Reduction at the Top of the Approach

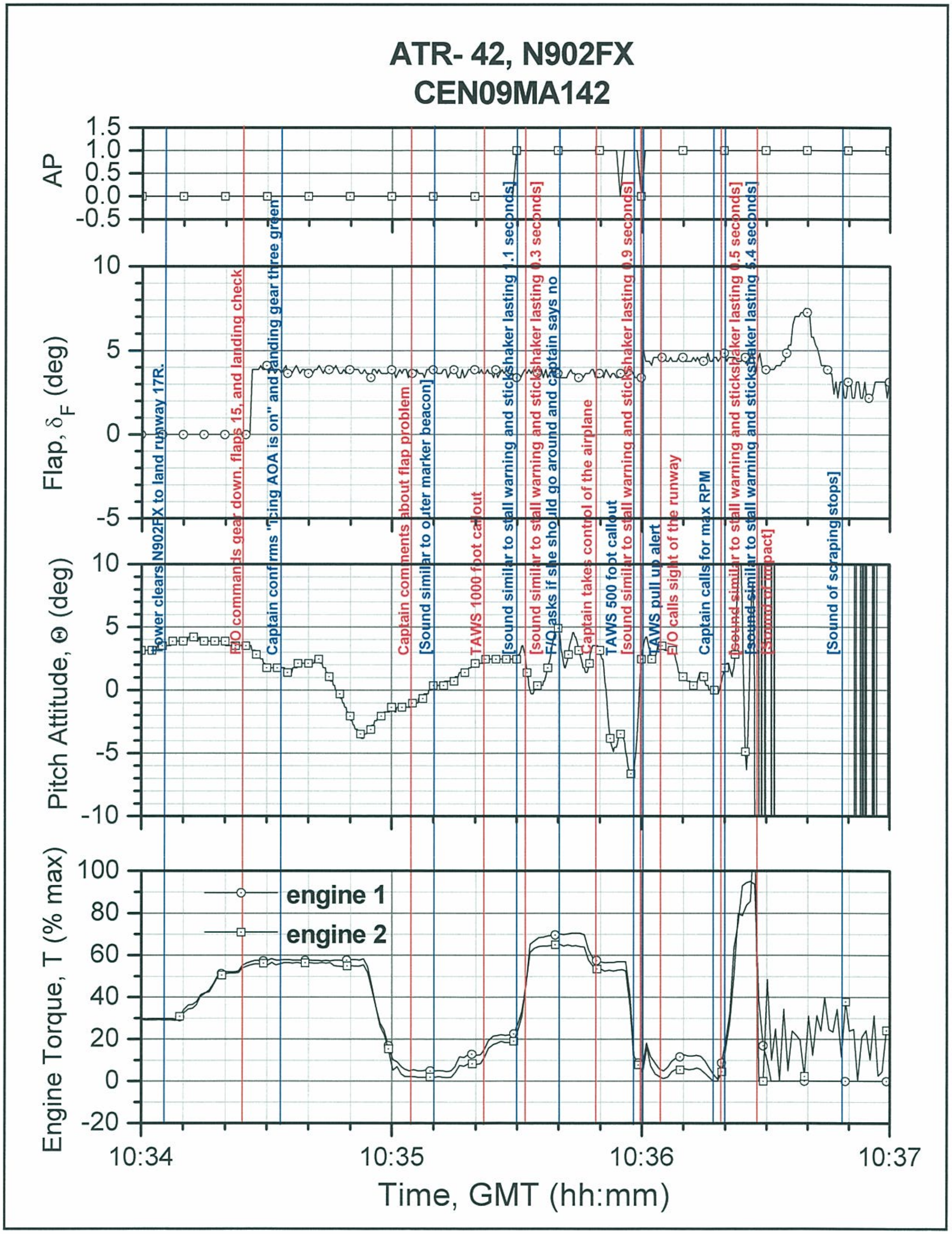


Figure 9: N902FX FDR Power Reduction at the Top of the Approach

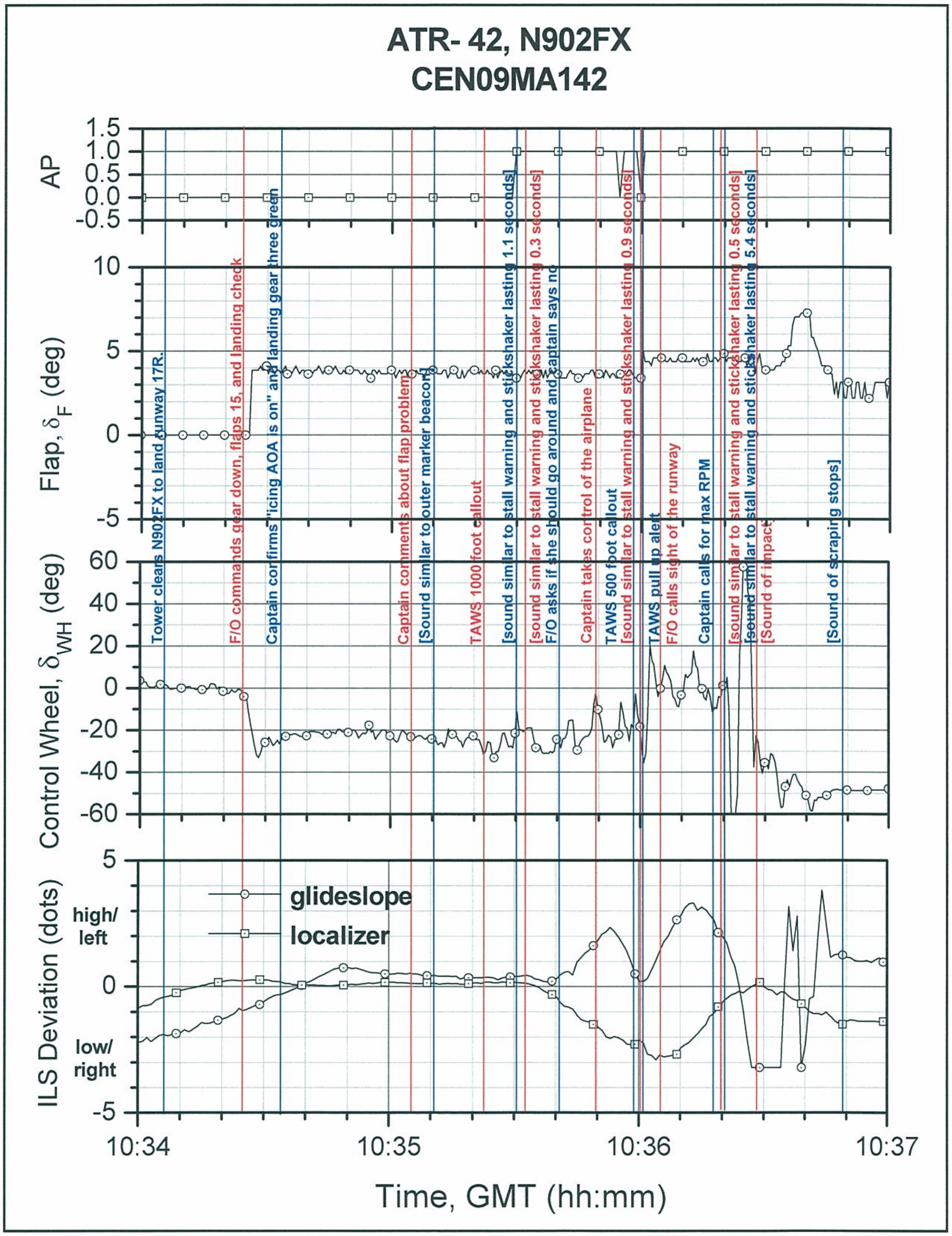


Figure 10: N902FX Approach and ILS Deviations

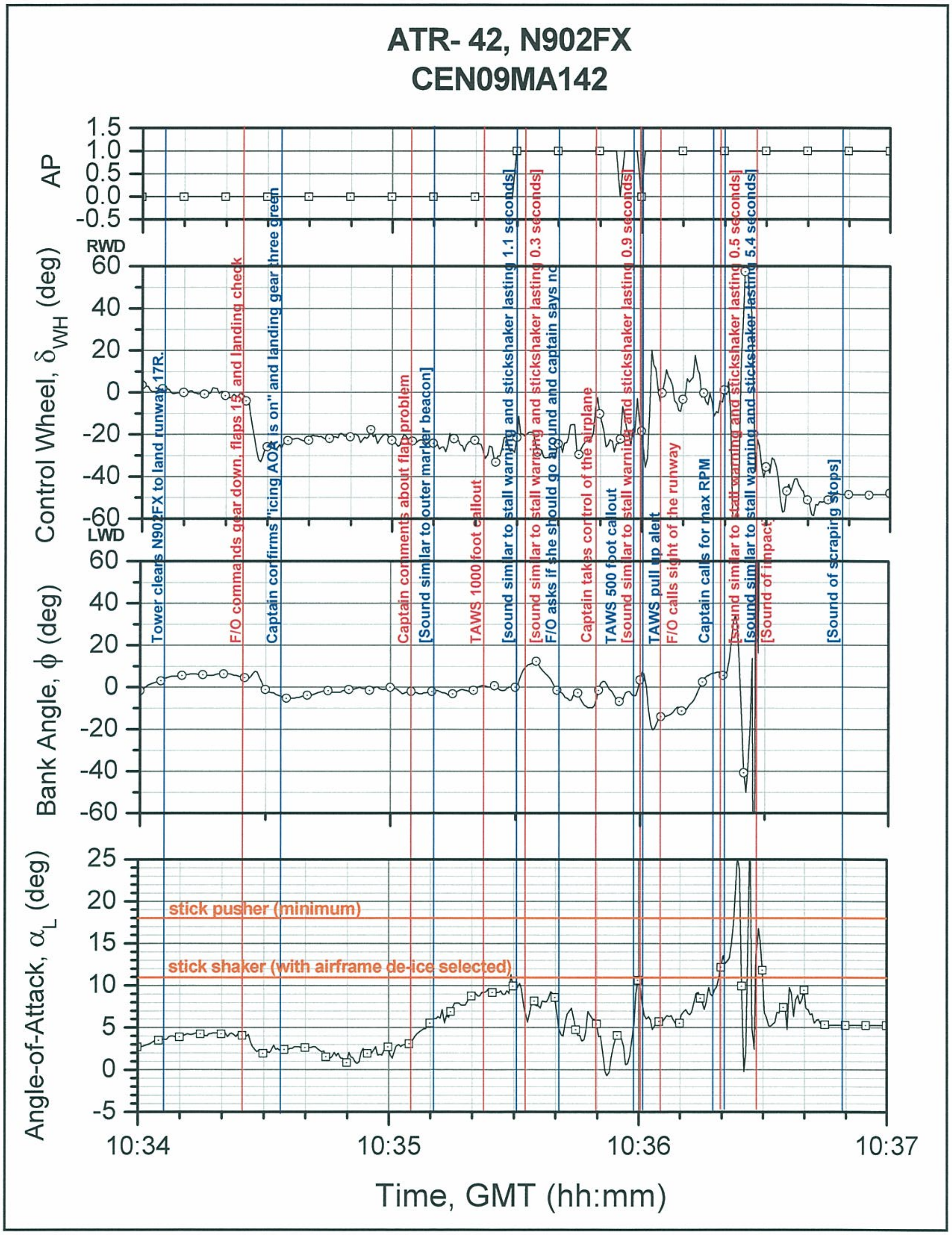


Figure 11: N902FX Lateral Control Input and Stall Warning Thresholds

ATR Simulation Results

In addition to the asymmetric flap deployment, the crew of Empire Airlines Flight 8284 was flying an airplane with some level of ice accretion. ATR was able to use their six-degree-of-freedom ATR-42-320 airplane simulation[5] to make an estimate of the control forces and angle-of-attack during the approach, as well as ice levels for the entire flight.

ATR first used the FDR surface positions, engine parameters, and initial conditions (altitude, airspeed, temperature, etc.) to introduce a tail wind of 10 kt with gusts to 18 kt. This was required to match the recorded flight data during the approach and is consistent with the weather observation around the time of the accident. ATR also assumed a landing gross weight of 14,800 kg (32,600 lb), a center-of-gravity of 33.8% of the mean aerodynamic chord, a flap asymmetry of 9°, and that no roll or yaw trim inputs were introduced after the flap asymmetry.

The FDR data and ATR simulation analysis indicate the following:

1. The Empire crew engaged the airframe de-icing at the end of the climb (0931:24).
2. The airplane had a cruise speed that was 10 kt lower than nominal at the beginning of cruise at flight level 180 (0939:00).
3. The airplane had a cruise speed that was 20 kt lower than nominal at the end of cruise at flight level 180. This corresponds to a drag increase of 80 counts ($\Delta CD = 0.0080$) or approximately 15% of total power.
4. Cruise performance at flight level 140 was nominal.
5. The crew disengaged the airframe de-icing at 1022:12 (descending through 10,000 ft) and then re-engaged it at 1030:28 (descending through 5,000 ft).
6. Airplane performance was nominal until descending below 5,000 ft. At this point, the drag began to increase beyond nominal levels again.
7. Airplane performance indicates that an additional 120 counts ($\Delta CD = 0.0120$) was present when the flap asymmetry occurred. This is equivalent to approximately 23% of total power.
8. The autopilot disconnected at 1035:30 when the vane angle-of-attack reached a stick shaker/stall warning threshold of 11°. This is equivalent to approximately a 7° aerodynamic angle-of-attack.
9. The crew did not re-engage the autopilot.

The FDR data and ATR simulation analysis of the accident indicates that the ice accretion during portions of the flight was significant but that it never exceeded the control authority of the ATR-42. However, significant ice accretion will degrade the flying qualities of any airplane design. The full extent of Empire Airlines Flight 8284's degradations could not be determined.

---

[5] The ATR 42-320 FFS in Toulouse has been validated or "qualified" for pilot training by comparing simulator performance with actual airplane performance. This was done by ATR using the Royal Aeronautical Society's International Qualification Test Guide (IQTG) based on ICAO Doc 9625 AN/938: Manual of Criteria for the Qualification of Flight Simulators.

Appendix

<u>Anson, TX, SECRA Radar Site</u> (32° 42’ 146.67’’ North, 99° 52’ 51.12” West)

Time CST	Mode C Pressure Altitude (ft)	Range (NM)	Azimuth (ACP)	North Latitude	West Longitude
10:10:07.7	13800	47.5	3875	33* 27' 07"	100* 11' 39"
10:10:19.8	13800	47.88	3867	33* 27' 16"	100* 12' 27"
10:10:31.8	13800	48.25	3858	33* 27' 22"	100* 13' 21"
10:10:43.8	13800	48.62	3851	33* 27' 32"	100* 14' 06"
10:10:55.9	13800	49	3842	33* 27' 38"	100* 15' 01"
10:11:07.9	13800	49.25	3834	33* 27' 37"	100* 15' 48"
10:11:19.9	13800	49.62	3827	33* 27' 45"	100* 16' 33"
10:11:31.9	13800	50	3818	33* 27' 49"	100* 17' 29"
10:11:44.0	13800	50.38	3811	33* 27' 56"	100* 18' 15"
10:11:56.1	13800	50.88	3806	33* 28' 13"	100* 18' 56"
10:12:08.0	13800	51.25	3798	33* 28' 17"	100* 19' 48"
10:12:20.1	13800	51.62	3791	33* 28' 22"	100* 20' 36"
10:12:32.1	13800	52	3785	33* 28' 29"	100* 21' 18"
10:12:44.2	13800	52.38	3776	33* 28' 28"	100* 22' 17"
10:12:56.2	13800	52.88	3772	33* 28' 45"	100* 22' 54"
10:13:08.3	13800	53.25	3765	33* 28' 49"	100* 23' 43"
10:13:20.4	13800	53.62	3759	33* 28' 54"	100* 24' 27"
10:13:32.4	13800	54.12	3752	33* 29' 02"	100* 25' 21"
10:13:44.5	13800	54.5	3746	33* 29' 06"	100* 26' 06"
10:13:56.5	13800	54.88	3741	33* 29' 13"	100* 26' 45"
10:14:08.5	13800	55.38	3735	33* 29' 22"	100* 27' 35"
10:14:20.7	13800	55.75	3727	33* 29' 19"	100* 28' 30"
10:14:32.7	13800	56.25	3722	33* 29' 30"	100* 29' 16"
10:14:44.6	13800	56.75	3717	33* 29' 41"	100* 30' 02"
10:14:56.6	13800	57.12	3712	33* 29' 45"	100* 30' 42"
10:15:08.7	13800	57.62	3707	33* 29' 55"	100* 31' 29"
10:15:20.8	13800	58.12	3699	33* 29' 55"	100* 32' 31"
10:15:32.8	13800	58.62	3695	33* 30' 07"	100* 33' 13"
10:15:44.7	13800	59.12	3688	33* 30' 09"	100* 34' 10"
10:15:56.9	13800	59.5	3685	33* 30' 18"	100* 34' 43"
10:16:08.9	13800	60	3679	33* 30' 22"	100* 35' 35"
10:16:20.9	13800	60.5	3674	33* 30' 29"	100* 36' 23"
10:16:33.0	13800	61	3669	33* 30' 36"	100* 37' 11"
10:16:45.0	13800	61.5	3666	33* 30' 49"	100* 37' 49"
10:16:57.0	13800	62.12	3660	33* 30' 57"	100* 38' 50"
10:17:09.1	13800	62.62	3654	33* 30' 59"	100* 39' 44"
10:17:21.1	13800	63.12	3651	33* 31' 11"	100* 40' 23"
10:17:33.2	13800	63.62	3646	33* 31' 15"	100* 41' 13"
10:17:45.2	13800	64.12	3643	33* 31' 27"	100* 41' 52"
10:17:57.2	13800	64.62	3637	33* 31' 27"	100* 42' 47"
10:18:09.3	13800	65.12	3633	33* 31' 34"	100* 43' 33"
10:18:21.3	13800	65.62	3627	33* 31' 33"	100* 44' 29"
10:18:33.4	13600	66.12	3622	33* 31' 35"	100* 45' 20"
10:18:45.5	13400	66.75	3619	33* 31' 51"	100* 46' 06"
10:18:57.5	13200	67.25	3614	33* 31' 51"	100* 46' 58"
10:19:09.5	13000	67.88	3610	33* 32' 02"	100* 47' 51"
10:19:21.6	12800	68.5	3605	33* 32' 08"	100* 48' 48"
10:19:33.5	12600	69.12	3600	33* 32' 13"	100* 49' 47"
10:19:45.7	12400	69.75	3596	33* 32' 22"	100* 50' 40"
10:19:57.6	12200	70.38	3592	33* 32' 31"	100* 51' 33"
10:20:09.7	12000	71	3587	33* 32' 34"	100* 52' 33"
10:20:21.7	11800	71.75	3582	33* 32' 42"	100* 53' 39"
10:20:33.8	11600	72.38	3578	33* 32' 49"	100* 54' 33"
10:20:45.8	11400	73	3574	33* 32' 56"	100* 55' 28"
10:20:57.9	11200	73.75	3570	33* 33' 08"	100* 56' 29"
10:21:10.0	11000	74.38	3565	33* 33' 08"	100* 57' 30"
10:21:22.0	10800	75.12	3562	33* 33' 24"	100* 58' 26"
10:21:34.0	10600	75.88	3558	33* 33' 34"	100* 59' 28"
10:21:46.1	10400	76.5	3554	33* 33' 38"	101* 00' 24"
10:21:58.1	10200	77.25	3550	33* 33' 47"	101* 01' 27"
10:22:10.1	10000	77.88	3547	33* 33' 56"	101* 02' 18"
10:22:22.2	9800	78.62	3544	33* 34' 08"	101* 03' 16"
10:22:34.2	9600	79.25	3540	33* 34' 10"	101* 04' 12"
10:22:46.3	9400	80	3537	33* 34' 23"	101* 05' 10"
10:22:58.3	9200	80.75	3533	33* 34' 30"	101* 06' 14"
10:23:10.4	9000	81.5	3529	33* 34' 35"	101* 07' 19"
10:23:22.4	8800	82.12	3526	33* 34' 42"	101* 08' 11"
10:23:34.5	8600	82.88	3523	33* 34' 53"	101* 09' 10"
10:23:46.5	8400	83.62	3519	33* 34' 57"	101* 10' 14"
10:23:58.6	8200	84.38	3516	33* 35' 06"	101* 11' 15"
10:24:10.7	8000	85.12	3513	33* 35' 16"	101* 12' 14"
10:24:22.8	7800	85.88	3511	33* 35' 31"	101* 13' 08"
10:24:34.8	7600	86.75	3510	33* 35' 58"	101* 14' 04"
10:24:46.8	7400	87.62	3510	33* 36' 30"	101* 14' 53"
10:24:58.9	7200	88.38	3510	33* 36' 58"	101* 15' 35"
10:25:10.9	7000	89.25	3510	33* 37' 30"	101* 16' 26"
10:25:23.0	6800	90.12	3509	33* 37' 55"	101* 17' 21"
10:25:35.0	6600	90.88	3510	33* 38' 29"	101* 17' 58"
10:25:47.1	6400	91.75	3509	33* 38' 55"	101* 18' 54"
10:25:59.3	6200	92.5	3509	33* 39' 22"	101* 19' 37"
10:26:11.3	6000	93.38	3510	33* 40' 01"	101* 20' 20"

Airplane Performance Study
CEN09MA142, ATR-42-320, N902FX, 1/27/2009

<u>Odessa, TX, ARSR Radar Site</u> (32° 33’ 15.17’’ North, 102° 25’ 40.23” West)

Time CST	Mode C Pressure Altitude (ft)	Range (NM)	Azimuth (ACP)	North Latitude	West Longitude
10:10:09.0	13800	124.75	726	33* 27' 13"	100* 11' 56"
10:10:19.0	13800	124.25	725	33* 27' 10"	100* 12' 34"
10:10:29.3	13800	123.75	723	33* 27' 17"	100* 13' 18"
10:10:39.2	13800	123.38	721	33* 27' 29"	100* 13' 55"
10:10:49.5	13800	122.88	720	33* 27' 26"	100* 14' 33"
10:10:59.6	13800	122.38	718	33* 27' 33"	100* 15' 16"
10:11:09.7	13800	121.88	716	33* 27' 40"	100* 16' 00"
10:11:19.8	13800	121.50	714	33* 27' 51"	100* 16' 37"
10:11:29.9	13800	121.00	712	33* 27' 58"	100* 17' 20"
10:11:40.0	13800	120.50	711	33* 27' 54"	100* 17' 58"
10:11:50.1	13800	120.00	709	33* 28' 01"	100* 18' 42"
10:12:00.2	13800	119.62	707	33* 28' 11"	100* 19' 18"
10:12:10.3	13800	119.12	705	33* 28' 17"	100* 20' 01"
10:12:20.4	13800	118.62	703	33* 28' 22"	100* 20' 46"
10:12:30.6	13800	118.25	701	33* 28' 31"	100* 21' 22"
10:12:40.6	13800	117.75	700	33* 28' 28"	100* 21' 59"
10:12:50.7	13900	117.38	698	33* 28' 37"	100* 22' 34"
10:13:00.8	13800	116.88	696	33* 28' 42"	100* 23' 18"
10:13:11.0	13800	116.38	694	33* 28' 46"	100* 24' 02"
10:13:21.0	13800	116.00	692	33* 28' 55"	100* 24' 39"
10:13:31.2	13800	115.50	690	33* 28' 59"	100* 25' 22"
10:13:41.3	13800	115.12	689	33* 28' 58"	100* 25' 51"
10:13:51.4	13800	114.62	687	33* 29' 02"	100* 26' 35"
10:14:01.5	13800	114.12	685	33* 29' 06"	100* 27' 19"
10:14:11.6	13800	113.75	683	33* 29' 14"	100* 27' 54"
10:14:21.6	13800	113.25	681	33* 29' 18"	100* 28' 38"
10:14:31.8	13800	112.88	679	33* 29' 25"	100* 29' 13"
10:14:41.9	13800	112.38	677	33* 29' 29"	100* 29' 56"
10:14:52.0	13800	112.00	674	33* 29' 44"	100* 30' 39"
10:15:02.0	13800	111.50	673	33* 29' 38"	100* 31' 16"
10:15:12.1	13800	111.12	671	33* 29' 45"	100* 31' 50"
10:15:22.3	13800	110.62	668	33* 29' 56"	100* 32' 41"
10:15:32.4	13800	110.25	666	33* 30' 03"	100* 33' 15"
10:15:42.5	13800	109.75	664	33* 30' 05"	100* 33' 59"
10:15:52.6	13800	109.38	662	33* 30' 10"	100* 34' 35"
10:16:02.7	13800	108.88	659	33* 30' 21"	100* 35' 24"
10:16:12.8	13800	108.50	657	33* 30' 26"	100* 35' 59"
10:16:22.9	13800	108.12	655	33* 30' 32"	100* 36' 35"
10:16:33.0	13800	107.62	653	33* 30' 33"	100* 37' 17"
10:16:43.1	13800	107.25	651	33* 30' 38"	100* 37' 53"
10:16:53.2	13800	106.75	648	33* 30' 47"	100* 38' 42"
10:17:03.3	13800	106.38	646	33* 30' 52"	100* 39' 17"
10:17:13.4	13800	106.00	644	33* 30' 57"	100* 39' 53"
10:17:23.4	13800	105.62	641	33* 31' 09"	100* 40' 34"
10:17:33.6	13800	105.12	638	33* 31' 17"	100* 41' 23"
10:17:43.7	13800	104.75	636	33* 31' 21"	100* 41' 58"
10:17:53.9	13800	104.25	633	33* 31' 28"	100* 42' 47"
10:18:04.0	13800	103.88	631	33* 31' 32"	100* 43' 22"
10:18:14.1	13800	103.38	629	33* 31' 32"	100* 44' 04"
10:18:24.2	13800	103.00	627	33* 31' 35"	100* 44' 39"
10:18:34.2	13600	102.50	624	33* 31' 41"	100* 45' 28"
10:18:44.3	13500	102.12	622	33* 31' 44"	100* 46' 03"
10:18:54.4	13300	101.62	619	33* 31' 50"	100* 46' 51"
10:19:04.6	13100	101.12	617	33* 31' 49"	100* 47' 34"
10:19:14.7	13000	100.75	614	33* 31' 58"	100* 48' 15"
10:19:24.8	12800	100.25	611	33* 32' 03"	100* 49' 04"
10:19:34.9	12600	99.75	608	33* 32' 09"	100* 49' 52"
10:19:45.0	12500	99.25	605	33* 32' 14"	100* 50' 40"
10:19:55.1	12300	98.75	602	33* 32' 18"	100* 51' 28"
10:20:05.2	12100	98.38	598	33* 32' 34"	100* 52' 15"
10:20:15.2	12000	97.88	595	33* 32' 38"	100* 53' 03"
10:20:25.3	11800	97.38	591	33* 32' 48"	100* 53' 58"
10:20:35.5	11600	96.88	588	33* 32' 51"	100* 54' 46"
10:21:50.4	10400	93.38	564	33* 33' 25"	101* 00' 39"
10:22:00.5	10200	93.00	559	33* 33' 44"	101* 01' 32"
10:22:10.6	10000	92.50	555	33* 33' 51"	101* 02' 26"
10:22:20.6	9900	92.12	552	33* 33' 55"	101* 03' 06"
10:22:40.9	9500	91.12	544	33* 34' 07"	101* 04' 53"
10:22:50.9	9300	90.75	540	33* 34' 17"	101* 05' 41"
10:23:01.0	9200	90.25	537	33* 34' 15"	101* 06' 27"
10:23:11.0	9000	89.88	532	33* 34' 31"	101* 07' 20"
10:23:21.3	8800	89.50	528	33* 34' 40"	101* 08' 06"
10:23:31.3	8700	89.00	525	33* 34' 37"	101* 08' 52"
10:23:41.5	8500	88.62	520	33* 34' 52"	101* 09' 46"
10:23:51.4	8300	88.12	516	33* 34' 55"	101* 10' 39"
10:24:01.6	8200	87.75	512	33* 35' 03"	101* 11' 25"
10:24:11.5	8000	87.25	508	33* 35' 04"	101* 12' 17"
10:24:21.7	7800	86.88	503	33* 35' 16"	101* 13' 10"
10:24:31.8	7700	86.75	498	33* 35' 39"	101* 13' 50"
10:24:41.9	7500	86.62	492	33* 36' 08"	101* 14' 38"
10:24:51.9	7300	86.62	488	33* 36' 29"	101* 15' 05"
10:25:02.0	7100	86.50	483	33* 36' 52"	101* 15' 46"
10:25:12.0	7000	86.38	477	33* 37' 19"	101* 16' 35"
10:25:22.1	6800	86.38	472	33* 37' 46"	101* 17' 09"
10:25:32.1	6600	86.25	466	33* 38' 11"	101* 17' 58"
10:25:42.2	6500	86.25	461	33* 38' 38"	101* 18' 34"