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

November 10, 1998

Airplane Performance Study

I. Accident

NTSB #: DCA97MA055
Location: Newark, New Jersey
Date: July 31, 1997
Time: Approximately ~~0132~~ 0131 local time
Operator: Federal Express
Aircraft Type: McDonnell Douglas MD-11, N611FE

II. Group

Charles M. Pereira
NTSB

III. Summary

At approximately 0132 local time, Federal Express Flight 14, a McDonnell Douglas MD-11, N611FE, crashed during a landing on runway 22R at Newark International Airport, Newark, New Jersey (airport designator "EWR"). This study uses ground scar and wreckage location data (see Attachment I), McDonnell Douglas MD-11 dimensions and system data, Federal Aviation Administration (FAA) radar data (see Attachment II), flight data recorder (FDR) data and cockpit voice recorder (CVR) information (see Attachment III), meteorological data (see Attachment IV), and integrated vertical speed and position data (see Attachment V) to develop a time history of the accident airplane's motion and pilot control inputs during the accident approach and landing. Prior landings of the accident aircraft are also reviewed (see Attachment VI).

The results of this study indicate that the final approach of the accident airplane was conducted in the flaps 50 configuration with the landing gear down, airspeed maintained between 157 and 159 KIAS, and vertical speed averaging 800 feet per minute. Automatic radio altitude callouts were made by the airplane during the approach, and radar and FDR data show the airplane stabilized on the approach. Pitch attitude averaged 2-3 degrees nose-up and thrust resolver angles averaged 55-58 degrees until flare was initiated at 38 feet radio altitude (radalt). Pitch attitude then increased to 4.9 degrees, thrust resolver angles decreased, airspeed began to

decrease, and vertical acceleration increased to 1.18 G[1] (FDR subframe time 341, local time 01:32:16.6)[2].

As the airplane descended through 17 feet radalt, nose down elevator deflection was initiated, pitch attitude began to decrease, and vertical acceleration began to decrease. Pitch attitude decreased to 4.2 degrees and vertical acceleration decreased to 0.93 g as the airplane descended through 7 feet radalt, at which point nose up elevator deflection (26 degrees maximum[3]), nose left rudder deflection (5.5 degrees maximum), right wing down aileron deflection (4 to 5 degrees), and throttle resolver angle increases (74 degrees maximum) were observed (FDR subframe time 342, local time 01:32:17.6). Airspeed was decreasing through 152 KIAS at the time of this activity.

Pitch attitude, engine speeds, and vertical acceleration began increasing and the airplane touched down on runway 22R about 1 second after the nose up elevator deflection and throttle resolver angle increase (FDR subframe time 343, local time 01:32:18.6). The airplane first touched down approximately 1,126 feet beyond the runway 22R displaced threshold near the center of the runway, with a roll angle of 1 degree right wing down, and at a magnetic heading of 217.4 degrees (published runway magnetic heading is 219 degrees). Vertical speed at the first touchdown was approximately 7.6 feet per second[4] and vertical acceleration peaked at 1.67 g.

About a half second after the first touchdown, the captain made an expletive comment, nose down elevator deflection (18 degrees maximum) was recorded, throttle resolver angle decreased, rudder deflection decreased to near 0, and magnetic heading stabilized at 217.4 degrees (FDR subframe time 343.5, local time 01:32:19.1). However, throttle resolver angle was greater than 49 degrees upon touchdown and the ground spoilers did not deploy[5]. Pitch attitude peaked at 8.44 degrees and began decreasing, but thrust continued to increase (N1's accelerating through 65%), airspeed began increasing, and the airplane became airborne.

---

[1] All recorded FDR data values presented herein are subject to the resolution and sample rate limitations of the FDR system. Dynamic parameters such as accelerations may not show peaks that actually occurred due to the sample rate.

[2] A subframe is a one second block of FDR data. Time correlation for this accident indicates that 5195.6 seconds must be added to the FDR subframe number to correlate with the CVR transcript local time.

[3] MD-11 control surface deflection limits are as follows: Inboard ailerons in the landing configuration, 20.2 deg. trailing edge up (TEU) and trailing edge down (TED); Outboard ailerons in landing configuration, 20.0 deg. TEU and TED (note that the outboard ailerons operate with a 4 degree TED bias relative to the inboard ailerons for improved cruise performance); Ground spoiler and lateral control mode spoilers, 60.0 deg TEU; Speed Brake mode spoilers, 30.0 deg TEU; Horizontal Stab., 16.0 deg. TEU to 3.0 deg. TED; Elevators, 37.49 deg. TEU and 27.06 TED; Rudder (double hinged, two piece), 62% hingeline section moves 23.0 deg. trailing edge left and right (TEL & TER), 80% hingeline section moves 22.4 deg. TEL & TER.

[4] This figure is the vertical speed at the right main gear and includes 6.6 feet per second vertical speed at the center of gravity plus 1.0 feet per second vertical speed at the right main landing gear due to nose up pitch rate and right wing down roll rate.

[5] Ground spoiler deployment was inhibited because the throttle lever positions were increased beyond the 44-49 degree position. The #2 engine throttle lever mechanically prevents ground spoiler deployment if its position is greater than 44-49 degrees and retracts the ground spoilers if they are extended and its position subsequently exceeds 44-49 degrees. The logic behind this feature is that throttle lever position in excess of 44-49 degrees during the landing phase means a go-around is most likely in progress, and ground spoiler deployment should be prevented during a go-around regardless of whether or not the gear are in contact with the runway.

As the airplane climbed, it pitched nose down and rolled right wing down, consistent with the nose down elevator deflection and right wing down aileron deflection. Engine speeds peaked at about 80% N1 and began decreasing, the airplane began to descend back towards the runway, the captain made an expletive comment, and nose up elevator, nose left rudder, and additional right wing down aileron deflections were recorded (FDR subframe time 345.3, local time 01:32:20.9). The airplane touched down for the second time and the first officer commented "jesus" (FDR subframe time 346, local time 01:32:21.6). The second touchdown occurred approximately 1,889 feet beyond the runway 22R displaced threshold at a roll angle of 9.5 degrees right wing down, a pitch attitude of -0.7 degrees, and a magnetic heading of 216.7 degrees. Peak vertical speed at the right main gear was approximately 13.5 feet per second[6], roll rate was approximately 7 degrees per second right wing down, and vertical acceleration peaked at 1.70 g. Elevator deflection at the second touchdown was approximately 24 degrees nose up and throttle resolver angles were approximately 51 degrees.

Some portion of the right main landing gear and/or wing structure collapsed immediately after the second touchdown, the right (#3) engine cowling contacted the runway, and the right wing began breaking away from the fuselage. After the second touchdown, nose up elevator deflection continued for approximately 1 second, throttle resolver angles increased to 81 degrees[7], and left wing down aileron deflection was initiated. The airplane pitched up through 5 degrees and then began rolling right wing down due to lift from the left wing and lack of lift from the mostly separated right wing, at which point the captain made 2 expletive comments (FDR subframe 348-349, local time 01:32:23.6-24.6). The airplane issued an automatic voice annunciation of "tire failure" as the airplane rolled through 45 degrees right wing down and the first officer made several expletive comments as roll angle increased through 55 degrees (FDR subframe 350-351, local time 01:32:25.6-26.6).

The FDR data end with roll angle increasing through 90 degrees right wing down and pitch attitude decreasing through 5 degrees nose down, just after the CVR started recording sounds of "metallic break-up" (FDR subframe 352, local time 01:32:27.6). The CVR recording ended 1.3 seconds later. The CVR "metallic break-up" sounds are consistent with runway ground scars, airplane structure scrapes/damage, and first officer testimony indicating that the right forward section of the fuselage near and aft of the first officer's side window contacted the runway as the airplane was rolling over (white, purple, and orange paint from the FEDEX logo was clearly visible on the runway at this point, and the airplane structure/paint showed scrapes and damage consistent with this contact). Shortly thereafter, the fuselage and left wing cartwheeled nose-right until coming to rest inverted approximately 5,126 feet beyond the runway 22R displaced threshold and 580 feet to the right of the runway centerline.

IV. Details Of Investigation

A. Ground Scar and Wreckage Location Data

[6] This figure is the vertical speed at the right main gear and includes 11.5 feet per second vertical speed at the center of gravity plus 2.0 feet per second vertical speed at the right main landing gear due to right wing down roll rate.

[7] McDonnell Douglas indicates that maximum throttle resolver angle at the normal stop point is approximately 81 degrees. Throttle resolver angle can be further increased to its absolute maximum of approximately 85 degrees by "breaking-through" and over-boosting the engines.

The location, geometry, and other characteristics of numerous runway/taxiway ground scars and airplane components were documented by the Airplane Performance Group between 7/31/97 and 8/3/97 (see Attachment I). The ground scars consisted primarily of tire rubber marks, structure scrapes, gouges, sooting, fluid marks, paint marks, and engine impact craters.

Tire rubber marks consistent with touchdown of the accident airplane's right main landing gear tires were first visible approximately 1,126 feet from the runway 22R displaced threshold. Tire rubber marks consistent with touchdown of the left main gear tires and center main gear tires became visible shortly thereafter at 1,151 and 1,160 feet from the displaced threshold, respectively (gear and tire spacing and tread diameter are consistent with those of an MD-11). These tire marks are dark and intermittent up to 1,222 feet from the displaced threshold, then they become less dark and continue with very light outlines off and on until ending about 1,301 feet from the threshold. The tire marks indicate the airplane was near the center of the runway on the first touchdown.

Tire rubber marks consistent with the second touchdown of the accident airplane's right main landing gear became visible approximately 1,924 feet from the displaced threshold (798 feet after tire marks consistent with first touchdown), and those of the center main gear became visible shortly thereafter at 1,983 feet from the displaced threshold. The tire marks indicate the airplane was near the center of the runway on the second touchdown. The right main landing gear tire marks then swerve to the right starting at 1,995 feet from the displaced threshold, with the center main landing gear tire marks also moving to the right but not as rapidly as those of the right main landing gear.

Ground scars consistent with the right (#3) engine nacelle contacting the runway surface began at 2,164 feet from the displaced threshold and end approximately 3,476 feet from the displaced threshold. Small pieces of composite structure and hard foam from the right inboard trailing edge flap were found 2,226 feet from the displaced threshold. Runway ground scars consistent with impact of the right inboard trailing edge flap began 2,299 feet from the displaced threshold, and continued to the location of the right inboard trailing edge flap 2,376 feet from the displaced threshold. Soot marks consistent with burning fluid began 2,506 feet from the displaced threshold and continued to the end of the wreckage path (5,126 feet from the displaced threshold).

Scrape marks and purple paint consistent with the accident airplane's tail striking the ground began 2,644 feet from the displaced threshold and ended 3,060 feet from the displaced threshold (the accident airplane was painted with FedEx's new paint scheme, in which the tail cone, #2 engine, and vertical stabilizer are painted purple). A gouge in the runway surface consistent with the location of an antenna on the underside of the MD-11 tail began 2,676 feet from the displaced threshold and ended 2,711 feet from the displaced threshold. At 2,826 feet from the displaced threshold, all of the scrapes, soot marks, and gouges on the runway surface start to turn right. Approximately half of one of the center main landing gear tires was found 3,084 feet from the displaced threshold at the far left edge of the runway.

A scrape mark with purple paint consistent with the right side of the top of the vertical stabilizer was found 3,342 feet from the displaced threshold, and corresponding scrape marks were found on that area of the vertical stabilizer. A change in the shape of the right engine scrape mark began approximately 3,351 feet from the displaced threshold, and a large, white, purple, and orange scrape mark consistent with the right side of the forward fuselage began 3,376 feet from the displaced threshold just to the right of the runway (corresponding scrape marks were found on the right side of the forward fuselage).

The right wing, vertical stabilizer, and all 3 engines, were found in or near a grassy area between taxiways "G" and "F" to the right of the runway, and all had fire damage consistent with a post-accident fuel fire (see Structures Group factual report for coordinate location of these components). The right main landing gear strut with associated diagonal link, inboard section of the diagonal tube, retract cylinder, half of the bogie beam, and 2 of the main landing gear wheels and tires was found on the right edge of the runway 4,805 feet from the displaced threshold. The remaining half of the right main landing gear bogie beam with the other 2 wheels and tires was found 235 feet to the right of the runway centerline 4,957 feet from the displaced threshold.

The rest of the airplane, consisting of the fuselage, left wing, horizontal tail sections (right and left), left main landing gear, center main landing gear, and nose gear (all extended), was found just beyond taxiway "E" 580 feet to the right of the runway centerline with the farthest edge being approximately 5,126 feet from the displaced threshold (see Structures Group factual report for coordinate location of the fuselage section). The fuselage was resting upside down with the nose pointing towards 95 degrees magnetic heading.

B. Radar Data

Federal Aviation Administration (FAA) radar data from the Newark Airport Surveillance Radar (ASR) indicate that the accident airplane's descent from 1500 feet MSL to 200 feet MSL was conducted at an average vertical speed of 790 feet per minute. The last secondary radar return shows the airplane at an altitude of approximately 200 feet MSL (secondary radar data are rounded to the nearest hundred feet). The EWR runway 22R field elevation is 11 feet MSL. Attachment II contains tabular and graphical radar data.

C. FDR and CVR Data

The FDR and CVR data are presented in the FDR and CVR group factual reports. FDR and CVR microphone keying data were aligned in order to establish a time correlation between the FDR and CVR. The alignment established that 5195.6 seconds must be added to the FDR subframe reference number (the readout elapsed time in seconds shown in the FDR Factual Report) in order to correlate with the CVR transcript local time. For example, FDR subframe time 335 correlates to the CVR transcript time of 5530.6 seconds, which is 01:32:10.6 local time. Overlays of CVR transcript excerpts

onto graphs of the FDR data are shown in Attachment III. The overlays show good correlation of key FDR and CVR events.

Review of the right #5 spoiler FDR data show an almost linear deflection from 3 degrees to 11 degrees between FDR subframes 340 and 345 followed by an almost linear deflection back to 0 degrees between FDR subframes 346 and 350. McDonnell Douglas indicates that this spoiler activity is normal and consistent with the spoilers working in conjunction with the ailerons to generate roll rate.

D. Meteorological Data

Meteorological data are presented in Attachment IV. Data from time 0551Z (19 minutes after the accident) indicate the EWR surface winds were 7 knots at 260 degrees, surface temperature was 67 degrees F, and the altimeter setting was 30.22 inches of Mercury.

E. Integrated Vertical Speed and Position Data

An NTSB computer program was used to calculate airplane vertical speed and position using FDR 3-axis acceleration data and meteorological data. The integrated output (see Attachment V) provides a good match of the FDR pitch-corrected radio altitude[8] and the times and distances between the 1st and 2nd touchdowns compared to the FDR data and ground scar measurements.

For example, the ground scar data indicate tire marks from the 2nd touchdown were visible 798 feet after the beginning of the tire marks from the first touchdown. The FDR and integration data show about 768 feet and 763 feet, respectively, between the first and second touchdown tire contacts[9]. It is possible that the absolute beginning of the tire marks was not discernable on scene and/or sampling rate limitations or sensor inaccuracies existed, thus the small differences.

The integrated vertical speed of the CG at the first touchdown was 6.6 ft/sec and decreasing rapidly due to the large nose-up elevator input just prior to touchdown. The first touchdown occurred at about 1 degree right wing down (rwd) with 1.4 deg/sec rwd roll rate and 4.2 deg/sec nose-up pitch rate, so the vertical speed at the right main gear at the first touchdown was approximately 7.6 ft/sec. Pitch and roll rates affect vertical

[8] McDonnell Douglas data indicate that the MD-11 radio altitude system is calibrated to read 0 feet when the main landing gear tires just touch the runway with the struts fully extended at 4 degrees pitch attitude. The radio altitude sensor is 22.8 feet ahead of the main landing gear, thus when pitch is greater than 4 degrees the radio altitude will read too high and when pitch is below 4 degrees it will read too low. The equation to convert from FDR radio altitude to pitch-corrected radio altitude is RADALTcorrected = RADALT - 22*sin(pitch - 4 degrees).

[9] FDR distance between the touchdowns was estimated by converting indicated airspeed (IAS) to true airspeed (TAS) and multiplying TAS times the time interval between the vertical acceleration spikes consistent with the first and second touchdowns (3 second time interval between FDR subframes 343.0 and 346.0). The integration distance between touchdowns was estimated to be the distance between the integration program distance outputs at FDR subframes 343.0 and 346.0.

speed of the main landing gear because the main landing gear rear tires are 7.7 feet behind the CG and 17 feet outboard of the CG. The main landing gear wheels ride perpendicular to the strut so that upon retraction they will fit into the wheel wells, thus with a nose-up pitch attitude on landing the rear tires will hit the runway first.

The integrated vertical speed of the CG at the beginning of the 2nd touchdown was 9.7 ft/sec and increasing due to a large nose-down elevator input just after the first touchdown. The beginning of the second touchdown occurred at about 8 degrees rwd with 7.0 deg/sec rwd roll rate and zero pitch rate, so the vertical speed at the right main gear at the beginning of the 2nd touchdown was approximately 11.7 ft/sec. Vertical speed at the CG peaked about 0.2 seconds later at 11.5 ft/sec and assuming that the roll rate remained at 7.0 deg/sec until this point (the twice per second roll angle sample rate of the FDR limits knowledge of roll rate to half second intervals), the result is a peak vertical speed of approximately 13.5 ft/sec at the right main gear.

Within 0.25 seconds of the peak right main gear vertical speed, lateral acceleration increased 0.3 g and the roll angle decreased to 4.6 degrees rwd. This corresponds in time and distance to the point on the runway where the right main landing gear tire marks oscillate and swerve rapidly to the right, followed immediately by contact of the right engine nacelle with the runway, loss of wing/flap structure, and spilling of fuel. Thus, the right main landing gear and/or wing structure experienced some form of structural failure within approximately 0.45 seconds of the beginning of the second touchdown and within 0.25 seconds of the calculated peak vertical speed. The right engine cowling then contacted the runway, and the right wing began breaking away from the fuselage.

F. Review of Prior Landings

Graphs of FDR data for the accident landing and the 2 previous landings are presented in Attachment VI. The data for the 2 previous landings show less than 40% of the pre-touchdown elevator deflection magnitude seen in the accident landing, less than 20% of the pre- and post-touchdown elevator deflection rates seen in the accident landing, and no throttle resolver angle and thrust increases just prior to or after touchdown. Thus, the previous successful landings show much smaller, slower control inputs than the accident landing. Additionally, the previous successful landings do not show any control inputs consistent with an attempt to rapidly decrease vertical speed just prior to touchdown.

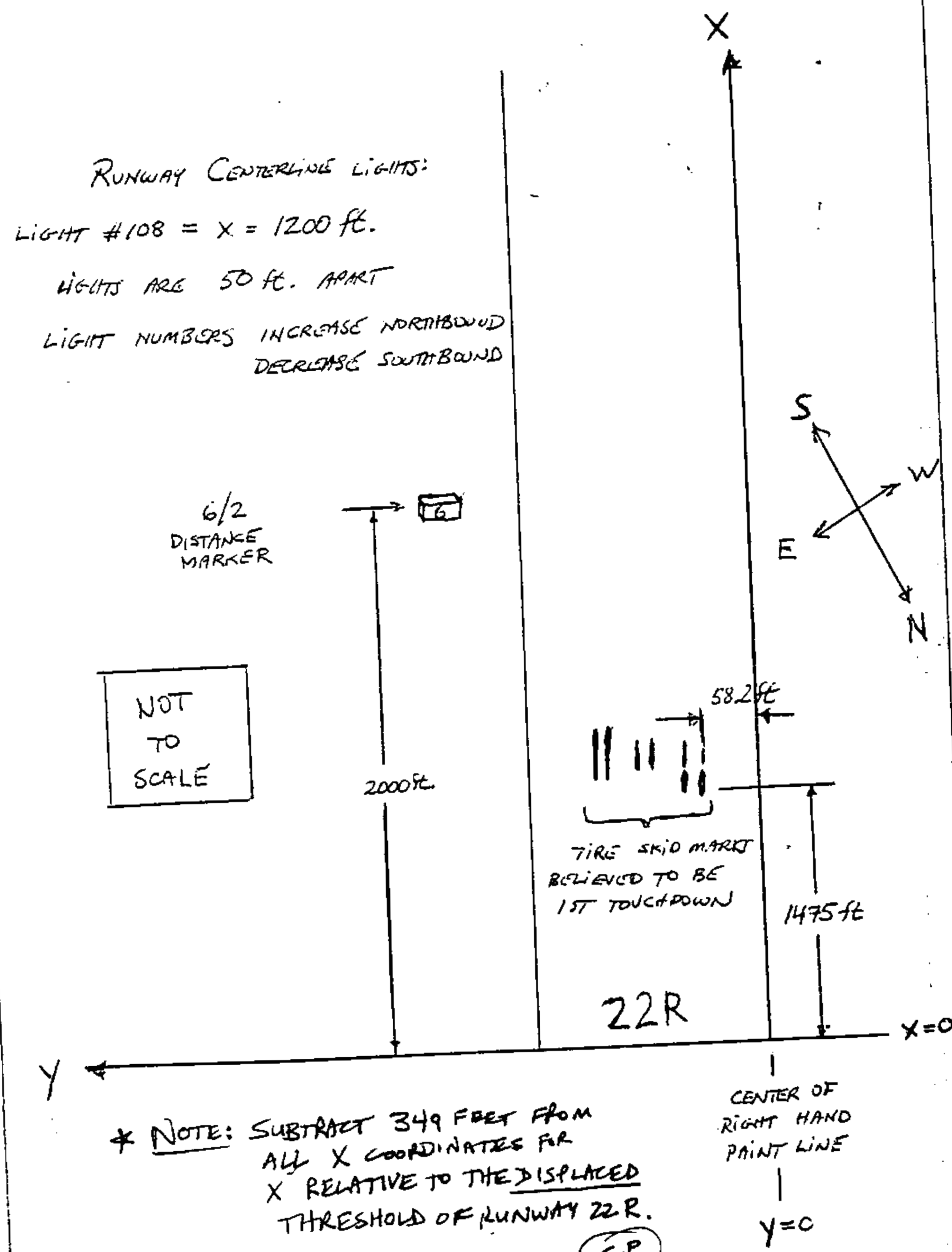
Charles M. Pereira
Aerospace Engineer

Attachments

Attachment I

Ground Scar and Wreckage Location Data

PERFORMANCE REFERENCE COORDINATE SYSTEM



Federal Express MD-11
Newark, N.J. (EWR) 7/31/97

Summary of Prominent Runway Scars and Component Locations; Runway 22R is 8200'x150'

	distance from threshold* of rwy 22R, feet	distance from center of paint stripe on right edge of runway 22R, feet
Runway 22R Threshold, right edge	0	0
RH MLG Outer Tire Skid Mark	1475	58.167
RH MLG Inner Tire Skid Mark	1477	62.75
Center MLG Right Tire Skid Mark	1509	76.417
Center MLG Left Tire Skid Mark	1514	79.75
LH MLG Inner Tire Skid Mark	1500	92.8
LH MLG Outer Tire Skid Mark	1507	97.55
Second Touchdown	2273	-
Right MLG Tire marks swerve right	2344	-
Start of Right Engine Skid Mark	2513	53.2
Small wing flap debris starts all across runway	2575	n/a
Start of Trailing Edge Flap Skid/Scar Marks	2648	31.3
Right Trailing Edge Flap Segment	2725	-105
Start of Fuel Burn Marks	2855	64
First Tail Strike Scar	2993	87
Long, Deep Gauge Marks	3025	88.5
Beginning of heading divergence to right	3175	n/a
Center MLG Tire Tread Piece	3438	154
Purple scrape (vert stab?)	3691	76.4
Change in shape of Right Engine scrape	3700	approx. 20
Large, wide white, purple & orange scrape (fuselage?)	3725	-4.4
Green scrape by grass	3765	-43
Crater in grass with fan blade parts	3832	-63
Purple and Green scrape (#2 eng cowl?)	3838	52.3
Wide green scrape after intersection Golf	4041	35.5
Right Wing wing root	4845	(see Structures Group)
Right MLG Strut with 2 wheels	5148	-11.9
Right MLG remaining 2 wheels	5313	-160
Fuselage Nose	5375	(see Structures Group)
Fuselage Tail	5475	(see Structures Group)

* SUBTRACT 349 FEET FOR X COORDINATES RELATIVE TO DISPLACED THRESHOLD.

Narrow Structural Gouges

Series of small gouges
Thickness = 2 inches (all)

x	y
2920	61.6
2975	62.7
3025	64.3
3060	65
3075	65.6
3125	67.8
3175	69.3
3225	70.8
3275	72.4
3325	74.2
3375	75.7
3425	77.3
3475	79.2
3525	81.8
3575	84.9
3625	87.5
3681	88.2

Gouges by Tail Strike
Thickness = 3 inches

x	y	
3025	74.5	
3042	75.2	
3060	74.9	
3075	74.9	
3125	75.4	
3175	74.5	
3225	72	Jog
3275	69.8	
3325	68.1	
3375	65	
3425	61	"Squirrely"
3475	57.7	
3505	54.3	

* SUBTRACT 349 FEET FOR X COORDINATES RELATIVE TO DISPLACED THRESHOLD.

SECOND TOUCHDOWN

~~Tire Scrubs~~

Right Main Gear Tire Scrub w/ Swerve

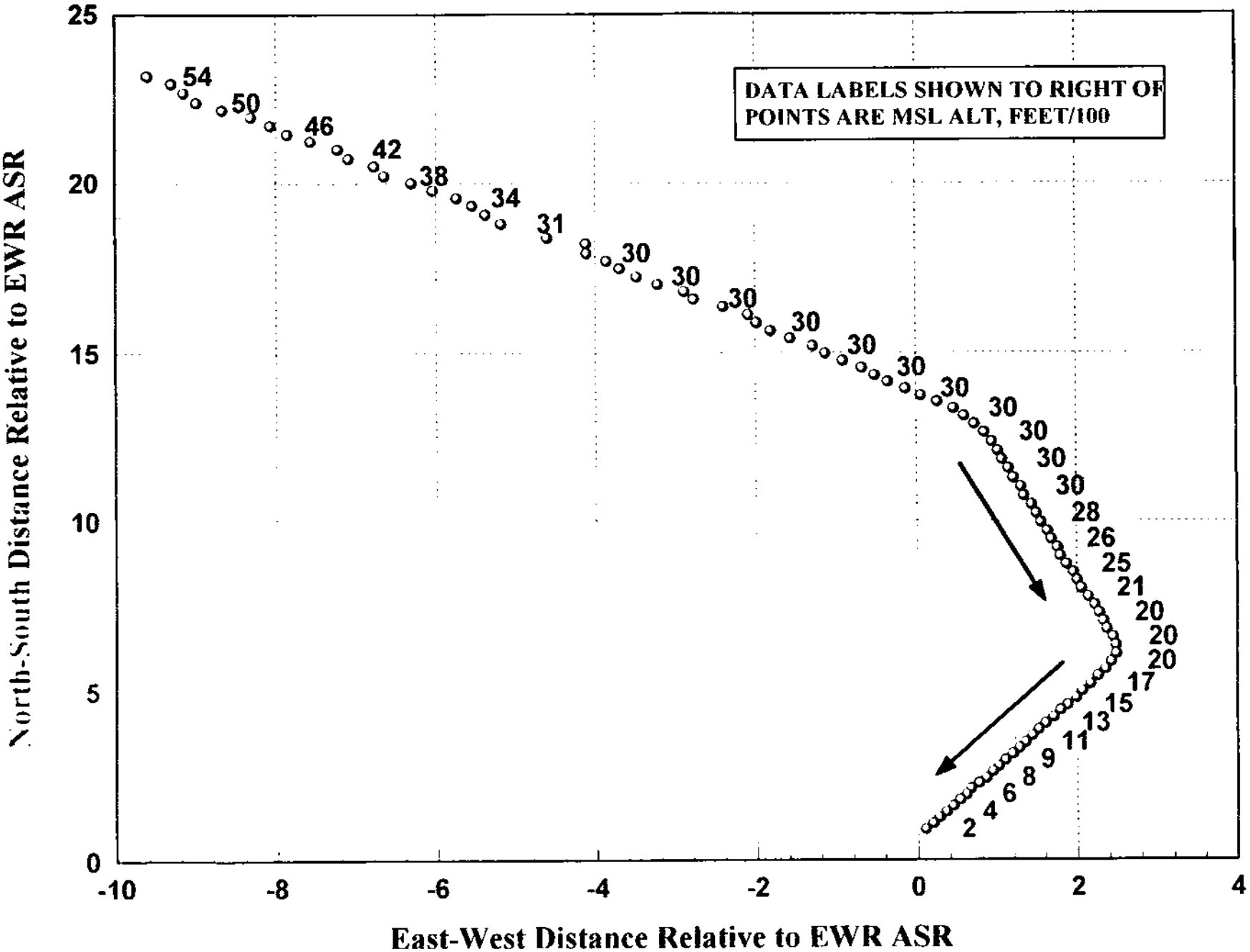
	Outboard Tire		Inboard Tire	
x	y right edge	y left edge	right edge	y left edge
2273	62.6	64		
2303	62.3	64	67	68
2325	61.8	63.6	66.5	
2341	61	62.9	65.7	67.1
2344	60.6	62.5	65.2	66.6
2348	60.4	61.7	64.9	66.9
2354	60.1	61.7	64.5	66.2
2357	59.9	61.2	64.3	65.9
2359		61.2		
2375			64.1	65.6
2392			63.6	65
2403			63.4	64.85
2475				63.6
2502				63.3
2525				63.2
2693				65.8
2852			66.4	67.5
2875			66.4	67.4
2894			66.1	67.4
2925			65.2	66.7
2964			65.9	66.7
2975			65.1	65.7
3025			62	62
3042			62.6	62.6

* SUBTRACT 349 FEET FOR X COORDINATES RELATIVE TO DISPLACED THRESHOLD.

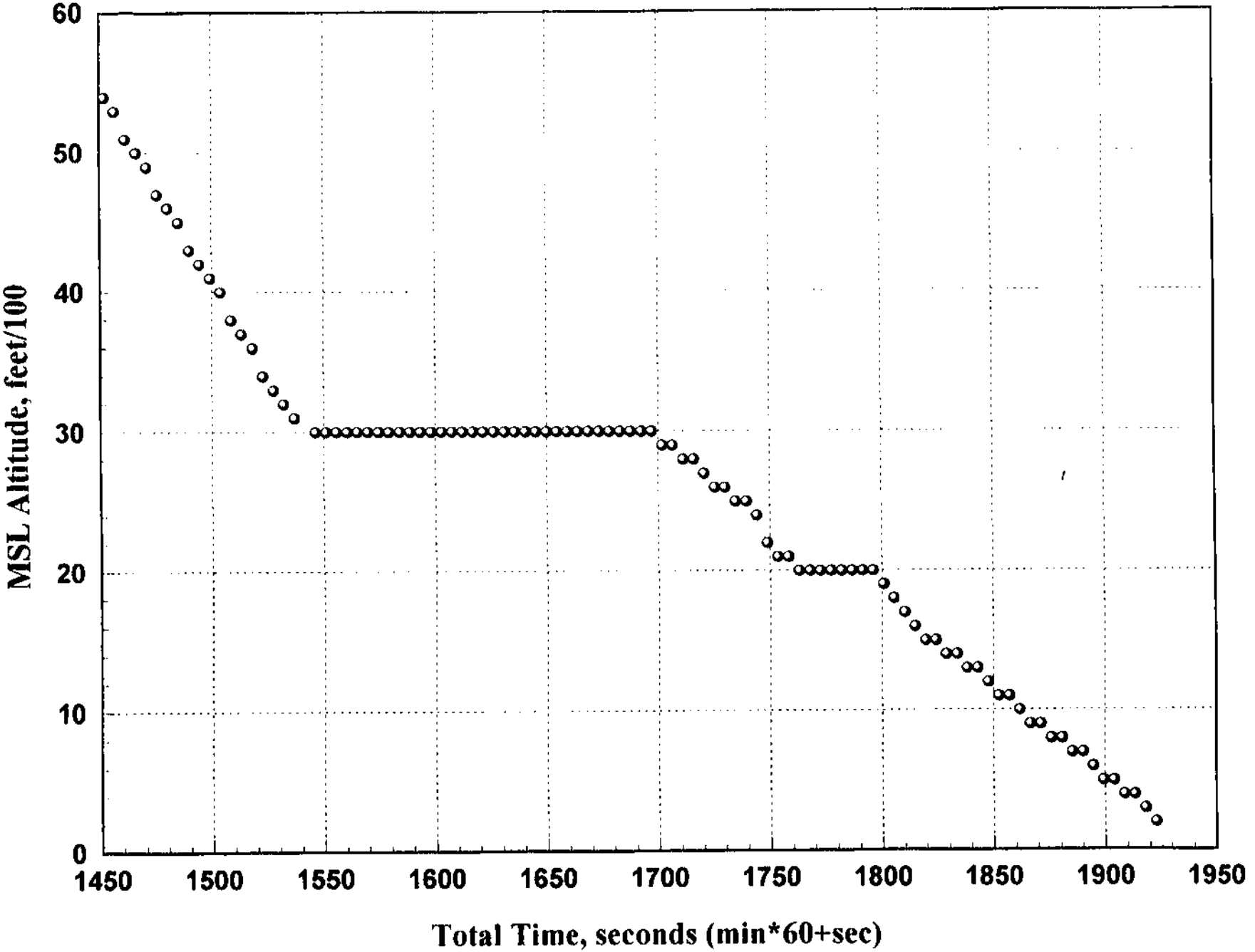
Attachment II

Radar Data

FedEx MD-11 at Newark, NJ, 7/31/97
FAA Radar Data From EWR ASR



FedEx MD-11 at Newark, NJ, 7/31/97
FAA Radar Data From EWR ASR



0611raz . CSV

RANGE/AZIMUTH RELATIVE TO EWR ASR

HOURS	MINUTES	SECONDS	RANGE,NM	AZIMUTH,DEG	ALT/100,FT	MIN*60+SEC
5	24	12.168	25.09	350.50781	54	1452.168
5	24	16.861	24.77	350.94727	53	1456.861
5	24	21.587	24.47	351.03516	51	1461.587
5	24	26.305	24.13	351.12305	50	1466.305
5	24	30.995	23.8	351.65039	49	1470.995
5	24	35.685	23.48	352.26562	47	1475.685
5	24	40.402	23.16	352.61719	46	1480.402
5	24	45.122	22.84	352.88086	45	1485.122
5	24	49.808	22.55	353.4082	43	1489.808
5	24	54.497	22.22	354.02344	42	1494.497
5	24	59.212	21.91	354.11133	41	1499.212
5	25	3.929	21.59	354.72656	40	1503.929
5	25	8.615	21.28	354.81445	38	1508.615
5	25	13.329	20.98	355.51758	37	1513.329
5	25	18.193	20.69	356.04492	36	1518.193
5	25	22.879	20.39	356.66016	34	1522.879
5	25	27.597	20.11	357.01172	33	1527.597
5	25	32.285	19.81	357.27539	32	1532.285
5	25	37.003	19.5	357.62695	31	1537.003
5	25	46.415	18.95	358.94531	30	1546.415
5	25	51.132	18.67	0.2636719	30	1551.132
5	25	55.824	18.39	0.0878906	30	1555.824
5	26	0.542	18.11	0.703125	30	1560.542
5	26	5.232	17.86	1.0546875	30	1565.232
5	26	9.953	17.58	1.5820313	30	1569.953
5	26	14.642	17.31	2.2851563	30	1574.642
5	26	19.362	17.05	3.2519531	30	1579.362
5	26	24.048	16.8	3.515625	30	1584.048
5	26	28.767	16.53	4.6582031	30	1588.767
5	26	33.458	16.25	5.625	30	1593.458
5	26	38.178	16	5.8886719	30	1598.178
5	26	42.868	15.75	6.4160156	30	1602.868
5	26	47.585	15.5	7.2070312	30	1607.585
5	26	52.422	15.25	8.1738281	30	1612.422
5	26	57.139	15.02	8.7011719	30	1617.139
5	27	1.827	14.78	9.4921875	30	1621.827
5	27	6.541	14.56	10.371094	30	1626.541
5	27	11.259	14.34	10.986328	30	1631.259
5	27	15.95	14.13	11.601563	30	1635.95
5	27	20.639	13.92	12.480469	30	1640.639
5	27	25.357	13.72	13.271484	30	1645.357
5	27	30.048	13.53	14.150391	30	1650.048
5	27	34.769	13.34	15.029297	30	1654.769
5	27	39.46	13.12	15.644531	30	1659.46
5	27	44.18	12.88	16.259766	30	1664.18
5	27	48.872	12.64	16.875	30	1668.872
5	27	53.59	12.37	17.402344	30	1673.59
5	27	58.282	12.11	17.841797	30	1678.282
5	28	3.001	11.86	18.193359	30	1683.001
5	28	7.837	11.61	18.720703	30	1687.837

0611raz.CSV

5	28	12.559	11.34	19.160156	30	1692.559
5	28	17.246	11.09	19.775391	30	1697.246
5	28	21.967	10.83	20.126953	29	1701.967
5	28	26.656	10.58	20.830078	29	1706.656
5	28	31.374	10.33	21.357422	28	1711.374
5	28	36.065	10.08	21.884766	28	1716.065
5	28	40.78	9.84	22.587891	27	1720.78
5	28	45.468	9.61	23.115234	26	1725.468
5	28	50.187	9.38	23.818359	26	1730.187
5	28	54.874	9.14	24.345703	25	1734.874
5	28	59.591	8.92	25.136719	25	1739.591
5	29	4.276	8.7	26.015625	24	1744.276
5	29	8.996	8.48	26.71875	22	1748.996
5	29	13.713	8.27	27.421875	21	1753.713
5	29	18.4	8.05	28.476562	21	1758.4
5	29	23.12	7.84	29.53125	20	1763.12
5	29	27.959	7.64	30.410156	20	1767.959
5	29	32.675	7.42	31.376953	20	1772.675
5	29	37.367	7.22	32.255859	20	1777.367
5	29	42.084	7.02	33.486328	20	1782.084
5	29	46.778	6.81	34.453125	20	1786.778
5	29	51.49	6.58	35.332031	20	1791.49
5	29	56.179	6.34	35.595703	20	1796.179
5	30	0.898	6.11	35.771484	19	1800.898
5	30	5.589	5.89	35.683594	18	1805.589
5	30	10.303	5.64	35.683594	17	1810.303
5	30	14.994	5.41	35.507812	16	1814.994
5	30	19.711	5.19	35.595703	15	1819.711
5	30	24.401	4.95	35.419922	15	1824.401
5	30	29.119	4.77	35.15625	14	1829.119
5	30	33.809	4.55	35.068359	14	1833.809
5	30	38.529	4.34	34.804687	13	1838.529
5	30	43.214	4.14	34.628906	13	1843.214
5	30	47.938	3.95	34.453125	12	1847.938
5	30	52.625	3.73	34.277344	11	1852.625
5	30	57.345	3.55	34.101562	11	1857.345
5	31	2.06	3.36	33.837891	10	1862.06
5	31	6.755	3.16	33.486328	9	1866.755
5	31	11.447	2.97	33.134766	9	1871.447
5	31	16.161	2.8	32.783203	8	1876.161
5	31	20.874	2.59	32.519531	8	1880.874
5	31	25.568	2.42	31.640625	7	1885.568
5	31	30.282	2.23	30.498047	7	1890.282
5	31	34.971	2.05	30.498047	6	1894.971
5	31	39.542	1.87	29.619141	5	1899.542
5	31	44.233	1.67	28.564453	5	1904.233
5	31	48.953	1.48	27.246094	4	1908.953
5	31	53.644	1.3	25.136719	4	1913.644
5	31	58.364	1.11	23.291016	3	1918.364
5	32	3.052	0.92	19.423828	2	1923.052

0611XY. CSV

HOURS	MINUTES	SECONDS	X.NM	Y.NM	ALT/100, FT	MIN*60+SEC
5	24	12.168	-9.5985	23.1814	54	1452.17
5	24	16.861	-9.3002	22.9578	53	1456.86
5	24	21.587	-9.1528	22.6938	51	1461.59
5	24	26.305	-8.9913	22.3923	50	1466.31
5	24	30.995	-8.6647	22.1667	49	1470.99
5	24	35.685	-8.3129	21.9592	47	1475.69
5	24	40.402	-8.0665	21.7098	46	1480.4
5	24	45.122	-7.8565	21.4463	45	1485.12
5	24	49.808	-7.5615	21.2444	43	1489.81
5	24	54.497	-7.2256	21.0123	42	1494.5
5	24	59.212	-7.093	20.7301	41	1499.21
5	25	3.929	-6.7697	20.5012	40	1503.93
5	25	8.615	-6.6415	20.2171	38	1508.61
5	25	13.329	-6.3028	20.0109	37	1513.33
5	25	18.193	-6.0337	19.7907	36	1518.19
5	25	22.879	-5.7365	19.5664	34	1522.88
5	25	27.597	-5.5392	19.3321	33	1527.6
5	25	32.285	-5.3689	19.0686	32	1532.29
5	25	37.003	-5.1696	18.8023	31	1537
5	25	46.415	-4.6021	18.3827	30	1546.42
5	25	51.132	-4.1162	18.2106	30	1551.13
5	25	55.824	-4.1094	17.925	30	1555.82
5	26	0.542	-3.8571	17.6945	30	1560.54
5	26	5.232	-3.6967	17.4732	30	1565.23
5	26	9.953	-3.4803	17.2321	30	1569.95
5	26	14.642	-3.2184	17.0082	30	1574.64
5	26	19.362	-2.8869	16.8038	30	1579.36
5	26	24.048	-2.7684	16.5703	30	1584.05
5	26	28.767	-2.3982	16.3551	30	1588.77
5	26	33.458	-2.086	16.1156	30	1593.46
5	26	38.178	-1.9808	15.8769	30	1598.18
5	26	42.868	-1.806	15.6461	30	1602.87
5	26	47.585	-1.5646	15.4208	30	1607.58
5	26	52.422	-1.2831	15.1959	30	1612.42
5	26	57.139	-1.1259	14.9777	30	1617.14
5	27	1.827	-0.9044	14.7523	30	1621.83
5	27	6.541	-0.6679	14.5447	30	1626.54
5	27	11.259	-0.5039	14.3311	30	1631.26
5	27	15.95	-0.3449	14.1258	30	1635.95
5	27	20.639	-0.1263	13.9194	30	1640.64
5	27	25.357	0.065	13.7198	30	1645.36
5	27	30.048	0.2716	13.5273	30	1650.05
5	27	34.769	0.4724	13.3316	30	1654.77
5	27	39.46	0.6053	13.106	30	1659.46
5	27	44.18	0.7324	12.8592	30	1664.18
5	27	48.872	0.8542	12.6111	30	1668.87
5	27	53.59	0.9495	12.3335	30	1673.59
5	27	58.282	1.0221	12.0668	30	1678.28
5	28	3.001	1.0735	11.8113	30	1683
5	28	7.837	1.1573	11.5522	30	1687.84

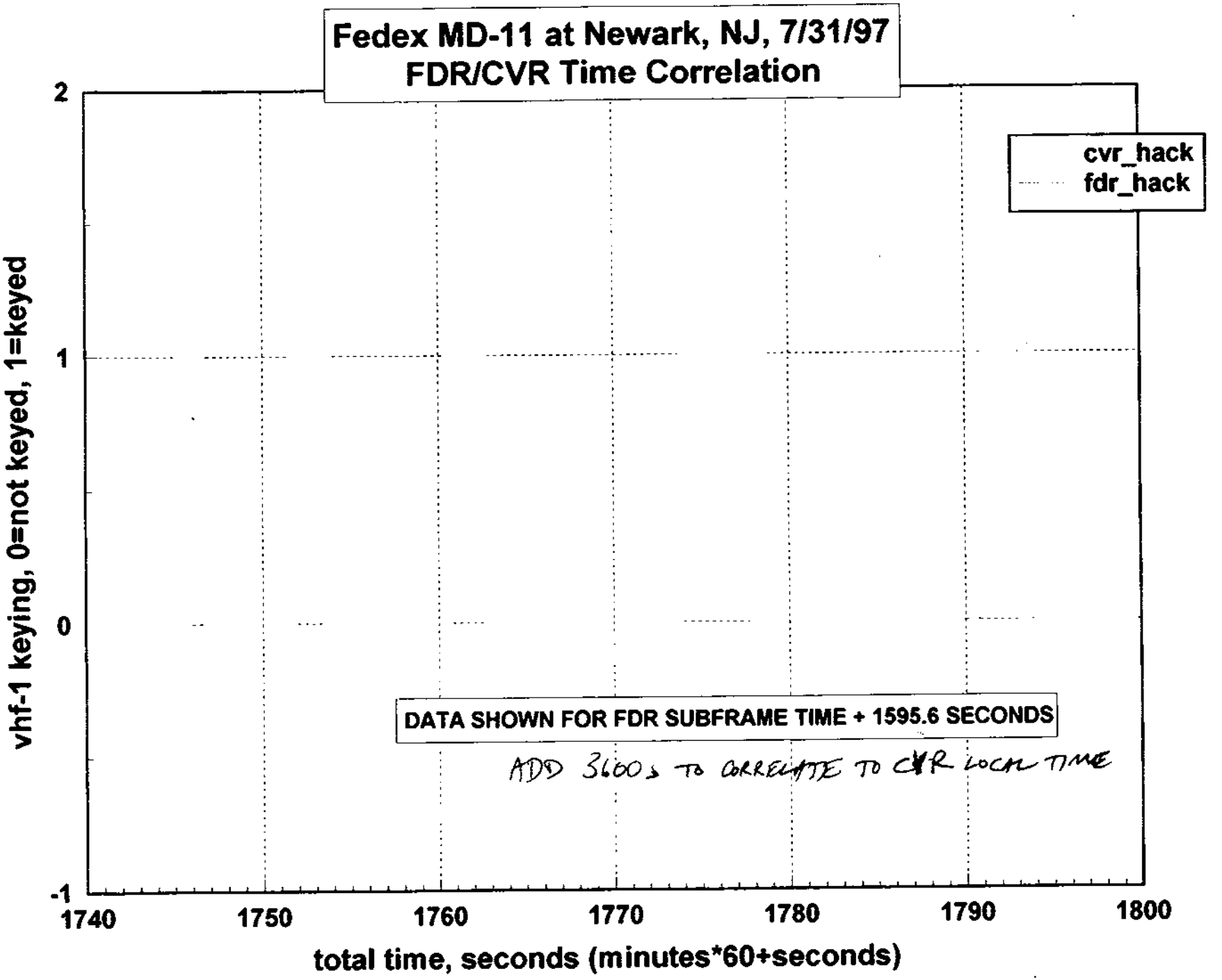
X/Y RELATIVE TO EWR ASR

0611XY.CSV

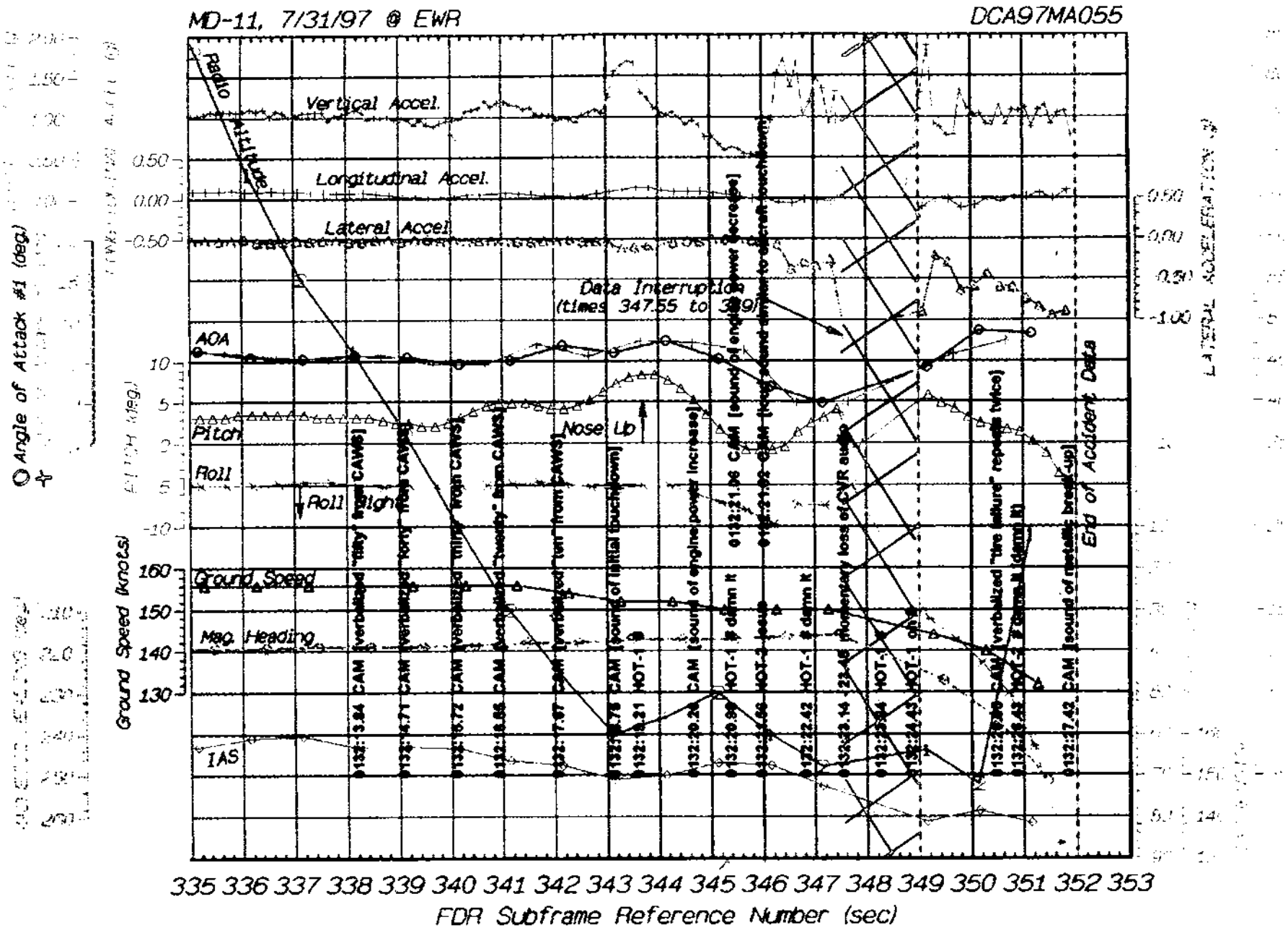
5	28	12.559	1.2169	11.2745	30	1692.56
5	28	17.246	1.3084	11.0126	30	1697.25
5	28	21.967	1.3437	10.7463	29	1701.97
5	28	26.656	1.4414	10.4814	29	1706.66
5	28	31.374	1.5014	10.2203	28	1711.37
5	28	36.065	1.5568	9.9591	28	1716.06
5	28	40.78	1.639	9.7025	27	1720.78
5	28	45.468	1.6878	9.4606	26	1725.47
5	28	50.187	1.7606	9.2133	26	1730.19
5	28	54.874	1.7981	8.9614	25	1734.87
5	28	59.591	1.8754	8.7206	25	1739.59
5	29	4.276	1.9594	8.4765	24	1744.28
5	29	8.996	2.0111	8.2381	22	1749
5	29	13.713	2.0597	8.0094	21	1753.71
5	29	18.4	2.1481	7.7581	21	1758.4
5	29	23.12	2.2308	7.5159	20	1763.12
5	29	27.959	2.286	7.29	20	1767.96
5	29	32.675	2.3393	7.0416	20	1772.68
5	29	37.367	2.3811	6.8161	20	1777.37
5	29	42.084	2.4569	6.576	20	1782.08
5	29	46.778	2.4907	6.3382	20	1786.78
5	29	51.49	2.5002	6.0865	20	1791.49
5	29	56.179	2.436	5.8533	20	1796.18
5	30	0.898	2.3649	5.6338	19	1800.9
5	30	5.589	2.2714	5.4344	18	1805.59
5	30	10.303	2.175	5.2037	17	1810.3
5	30	14.994	2.071	4.9979	16	1814.99
5	30	19.711	1.9941	4.7916	15	1819.71
5	30	24.401	1.8879	4.5758	15	1824.4
5	30	29.119	1.7989	4.4178	14	1829.12
5	30	33.809	1.7095	4.2167	14	1833.81
5	30	38.529	1.6121	4.0295	13	1838.53
5	30	43.214	1.526	3.8485	13	1843.21
5	30	47.938	1.4447	3.6763	12	1847.94
5	30	52.625	1.3536	3.4757	11	1852.63
5	30	57.345	1.2781	3.312	11	1857.34
5	31	2.06	1.1952	3.1402	10	1862.06
5	31	6.755	1.1059	2.9601	9	1866.76
5	31	11.447	1.0224	2.7885	9	1871.45
5	31	16.161	0.9477	2.6347	8	1876.16
5	31	20.874	0.8654	2.4411	8	1880.87
5	31	25.568	0.7735	2.2931	7	1885.57
5	31	30.282	0.6705	2.1268	7	1890.28
5	31	34.971	0.6164	1.9551	6	1894.97
5	31	39.542	0.5348	1.7919	5	1899.54
5	31	44.233	0.4481	1.6088	5	1904.23
5	31	48.953	0.3642	1.4345	4	1908.95
5	31	53.644	0.2733	1.2709	4	1913.64
5	31	58.364	0.1983	1.0921	3	1918.36
5	32	3.052	0.1029	0.9142	2	1923.05

Attachment III

FDR and CVR Data


Fedex MD-11 at Newark, NJ, 7/31/97
FDR/CVR Time Correlation
cvr_hack
fdr_hack
DATA SHOWN FOR FDR SUBFRAME TIME + 1595.6 SECONDS
ADD 3600s TO CORRELATE TO CVR LOCAL TIME
vhf-1 keying, 0=not keyed, 1=keyed
2
1
0
-1
1740
1750
1760
1770
1780
1790
1800
total time, seconds (minutes*60+seconds)

Federal Express Accident Landing



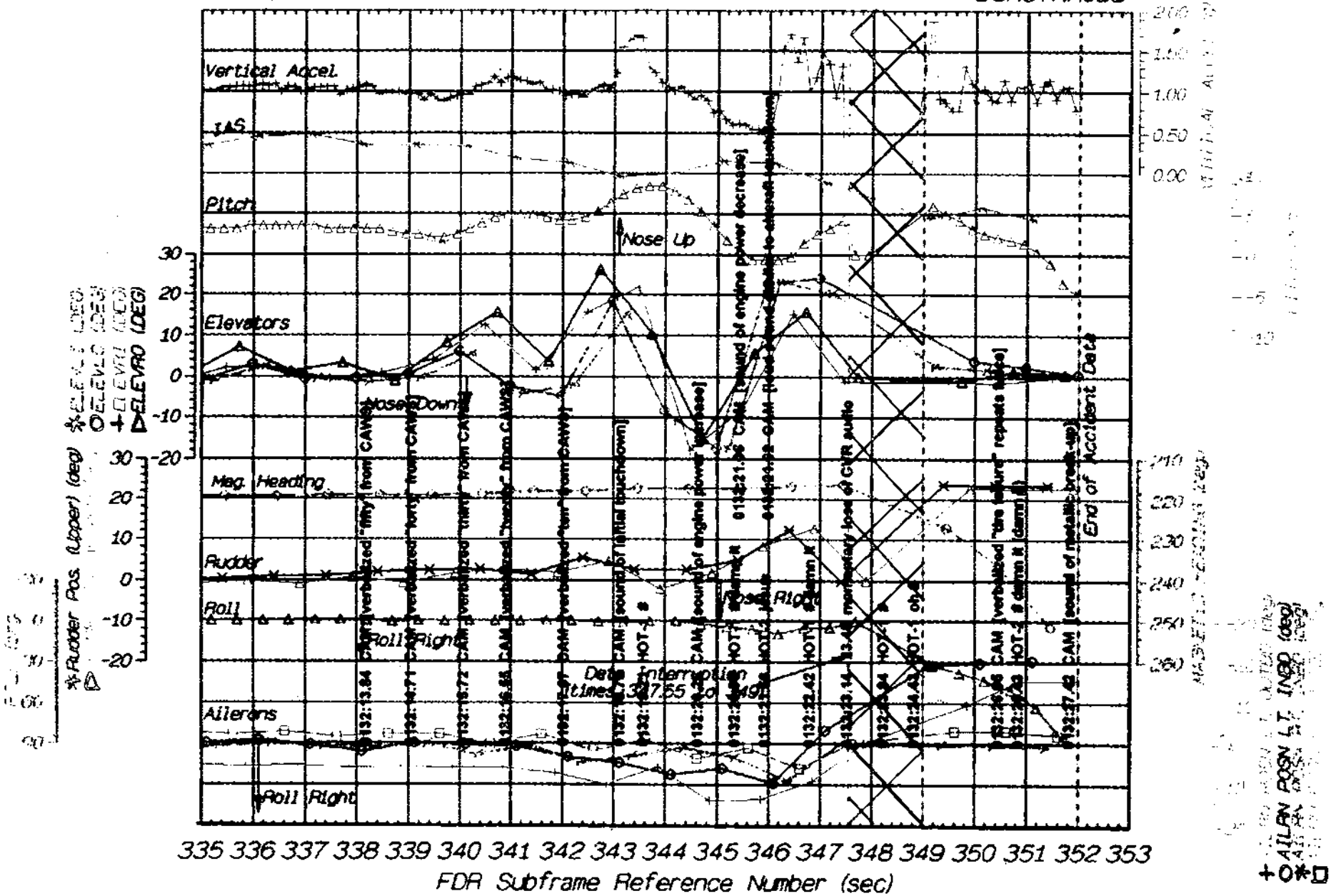
plt1p_18sec_final
Revised: October 23, 1997

National Transportation Safety Board

Federal Express Accident Landing

MD-11, 7/31/97 @ EWR

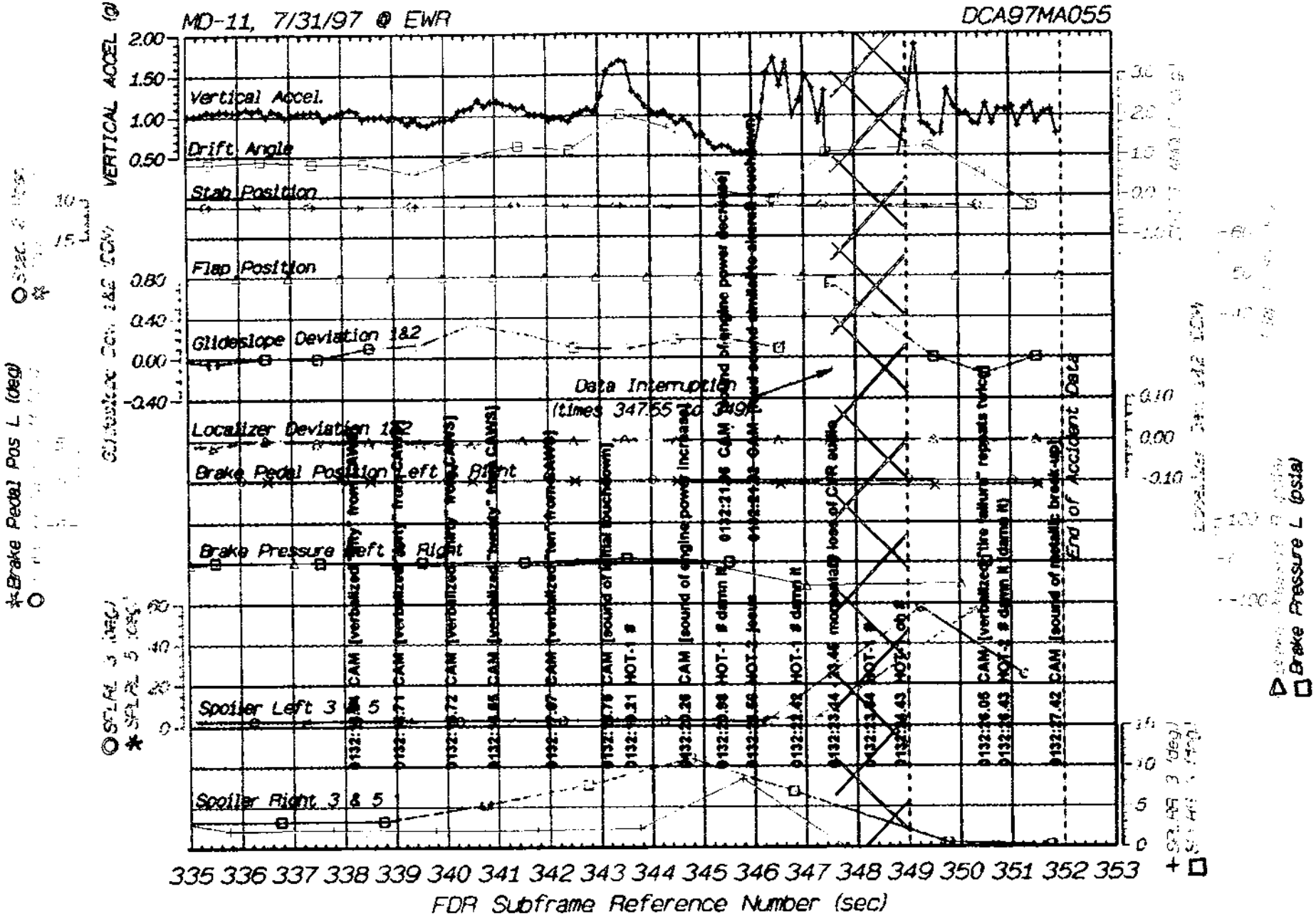
DCA97MA055



plt2p_18sec_final
Revised: October 23, 1997

National Transportation Safety Board

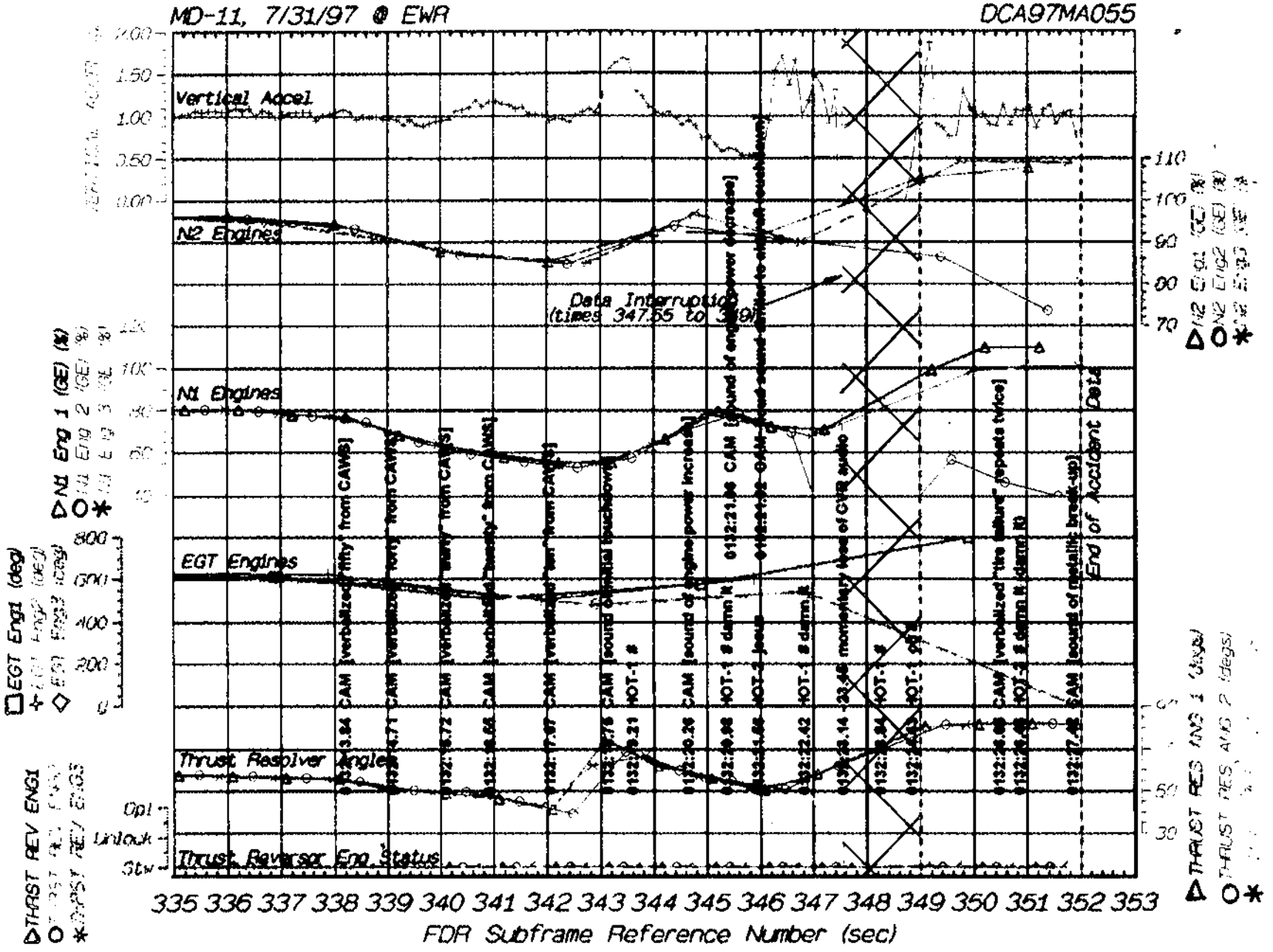
Federal Express Accident Landing



plt3p_18sec_final
Revised October 23, 1997

National Transportation Safety Board

Federal Express Accident Landing



plt4p_18sec_final
Revised: October 23, 1997

National Transportation Safety Board

Attachment IV

Meteorological Data

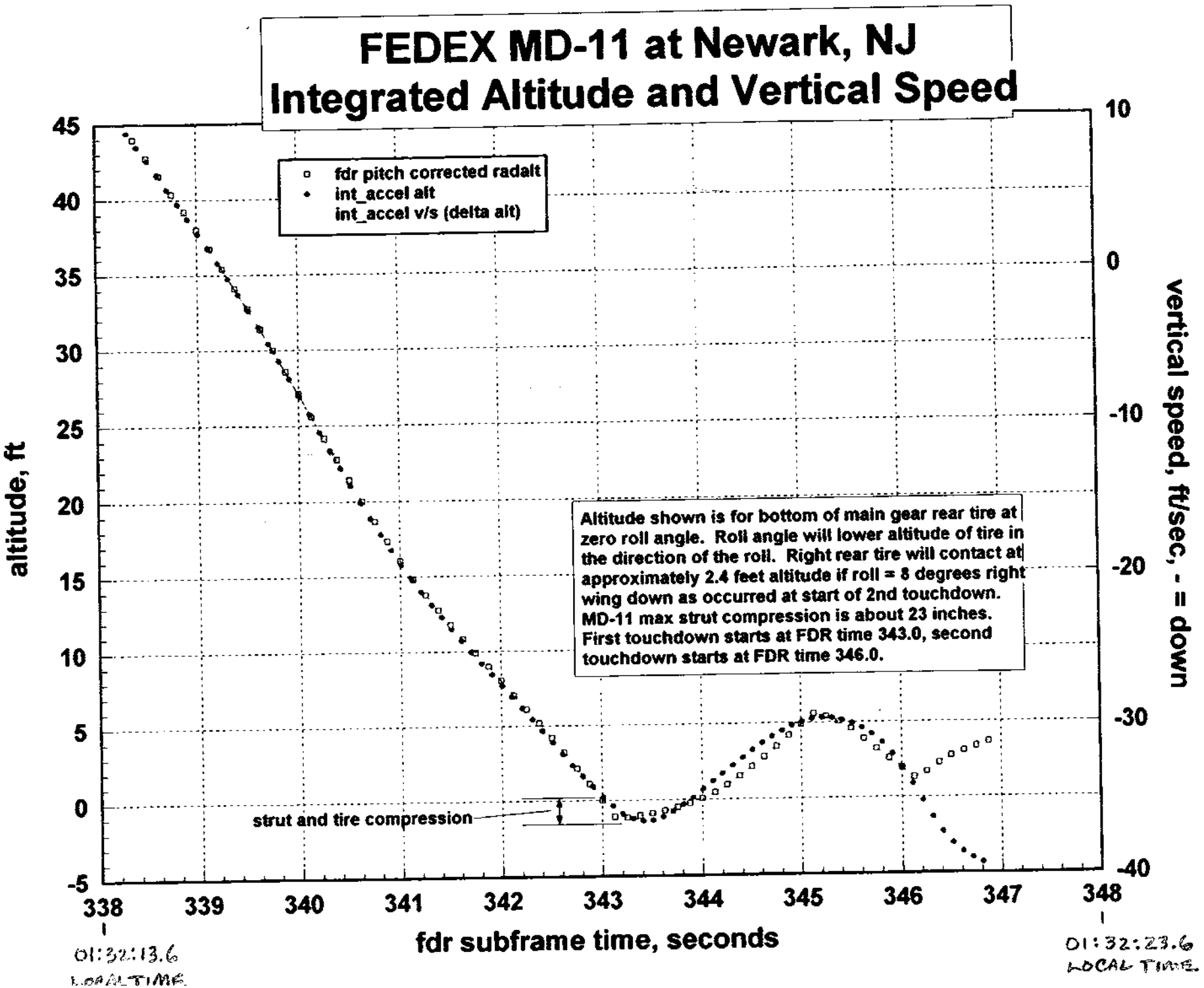
Data from McIDAS					
ETA Numerical Model data 6 hour forecast valid 7/31/97 0600Z					
Surface data from 0551Z KEWR Observation					
height ft	speed kt	direction	temp c		
surface	7	260	19.4		
637	8.1	285	21.3		
2090	9.1	299	18.2		
3599	8.6	333	14.8		
5176	10.2	358	11		
direction degrees true					
height feet msl					
speed knots					
temperature degrees c					

WX, FEDEX MD-11 @ NEWARK

ALTIMETER SETTING KEWR 3[illegible] @ 0551Z

Attachment V

Integrated Vertical Speed and Position Data


FEDEX MD-11 at Newark, NJ
Integrated Altitude and Vertical Speed
fdr pitch corrected radalt
int_accel alt
int_accel v/s (delta alt)
Altitude shown is for bottom of main gear rear tire at zero roll angle. Roll angle will lower altitude of tire in the direction of the roll. Right rear tire will contact at approximately 2.4 feet altitude if roll = 8 degrees right wing down as occurred at start of 2nd touchdown. MD-11 max strut compression is about 23 inches. First touchdown starts at FDR time 343.0, second touchdown starts at FDR time 346.0.
strut and tire compression
altitude, ft
vertical speed, ft/sec, - = down
fdr subframe time, seconds
45
40
35
30
25
20
15
10
5
0
-5
10
0
-10
-20
-30
-40
338
339
340
341
342
343
344
345
346
347
348
01:32:13.6
LOCAL TIME
01:32:23.6
LOCAL TIME

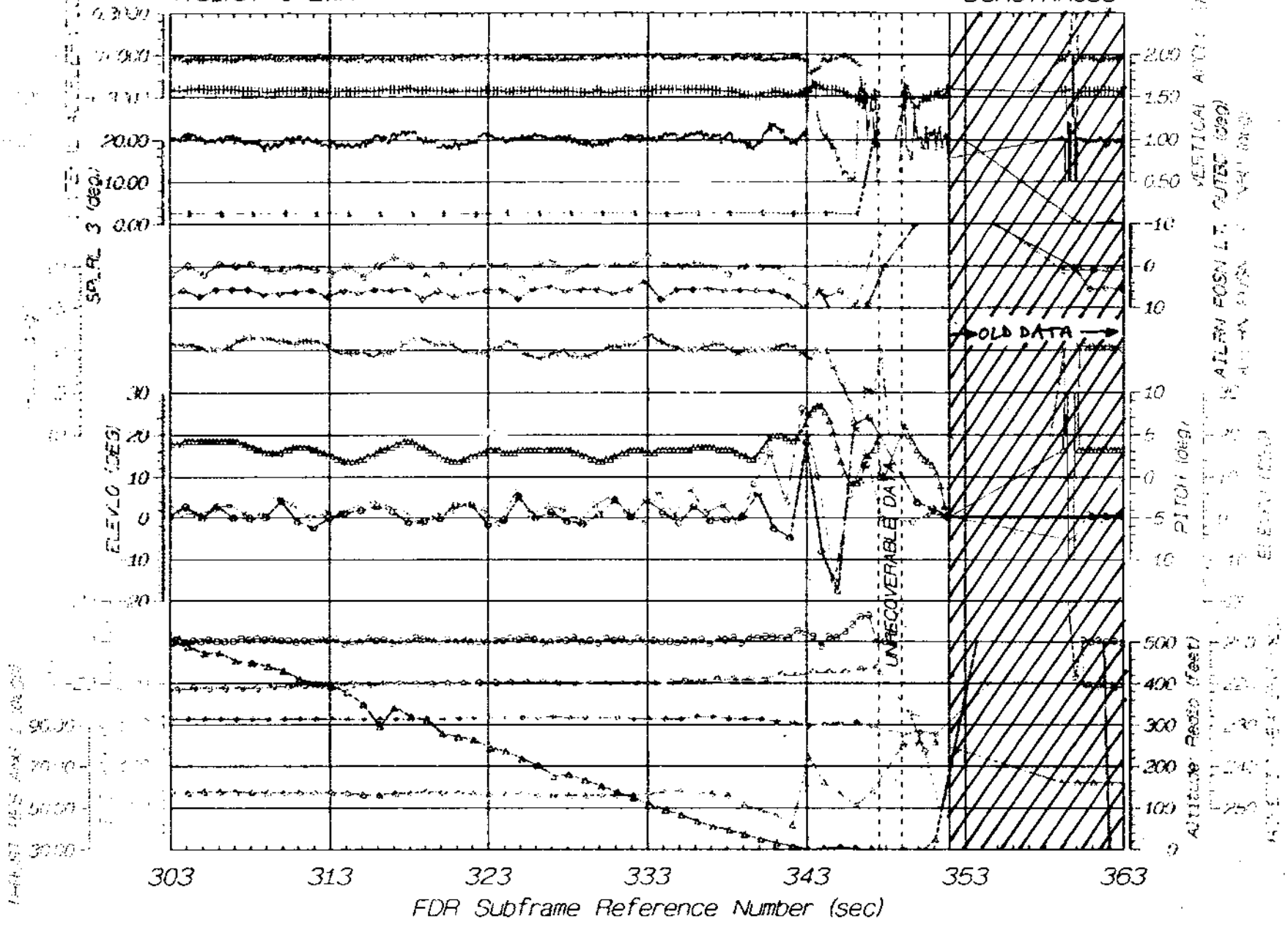
Attachment VI

Comparative Graphs Of FDR Data For Accident Landing And 2 Previous Landings

Federal Express MD-11 Accident Landing

7/31/97 @ EWR

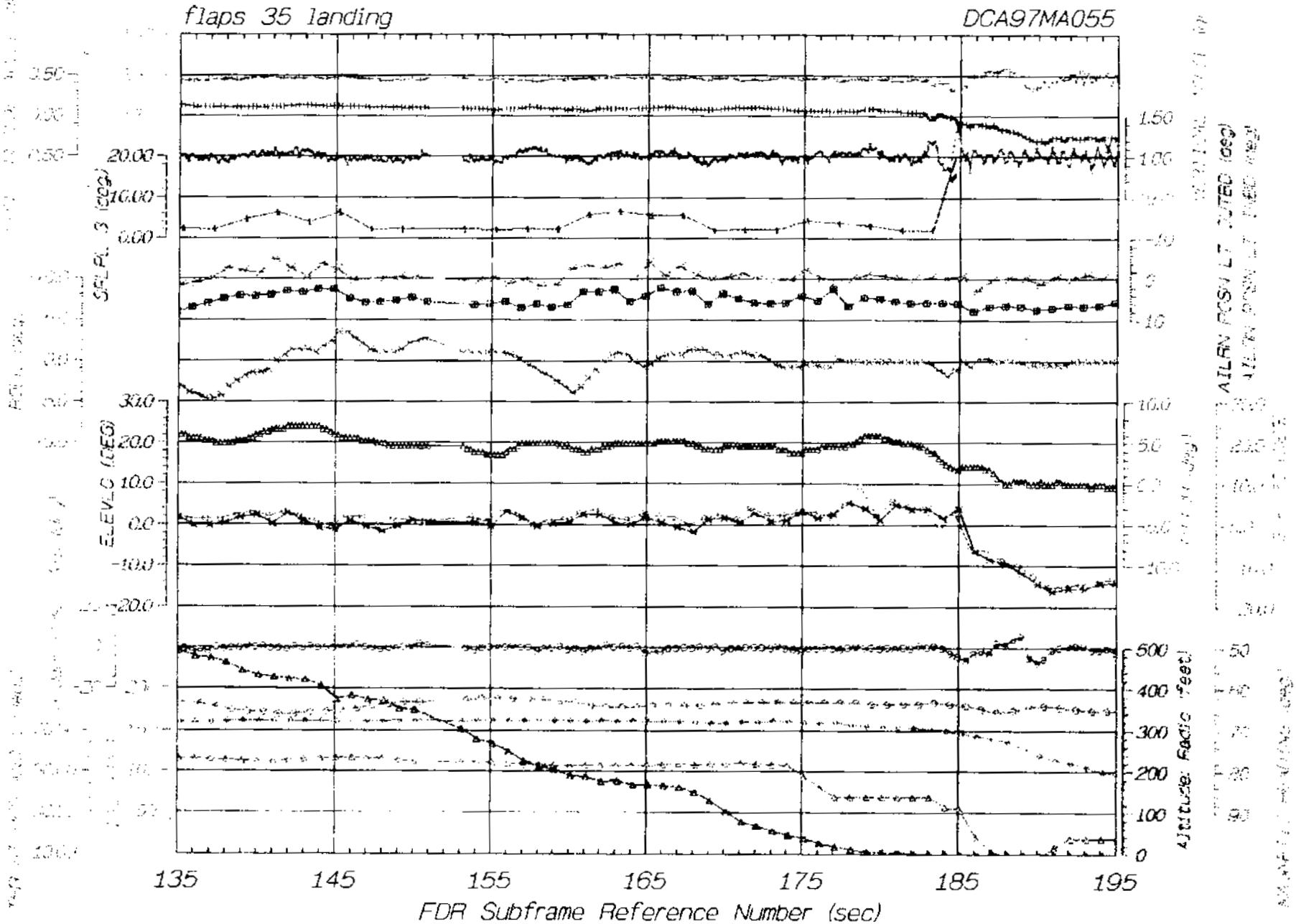
DCA97MA055



plt2p_1min
Revised: February 04, 1998

National Transportation Safety Board/ VPD

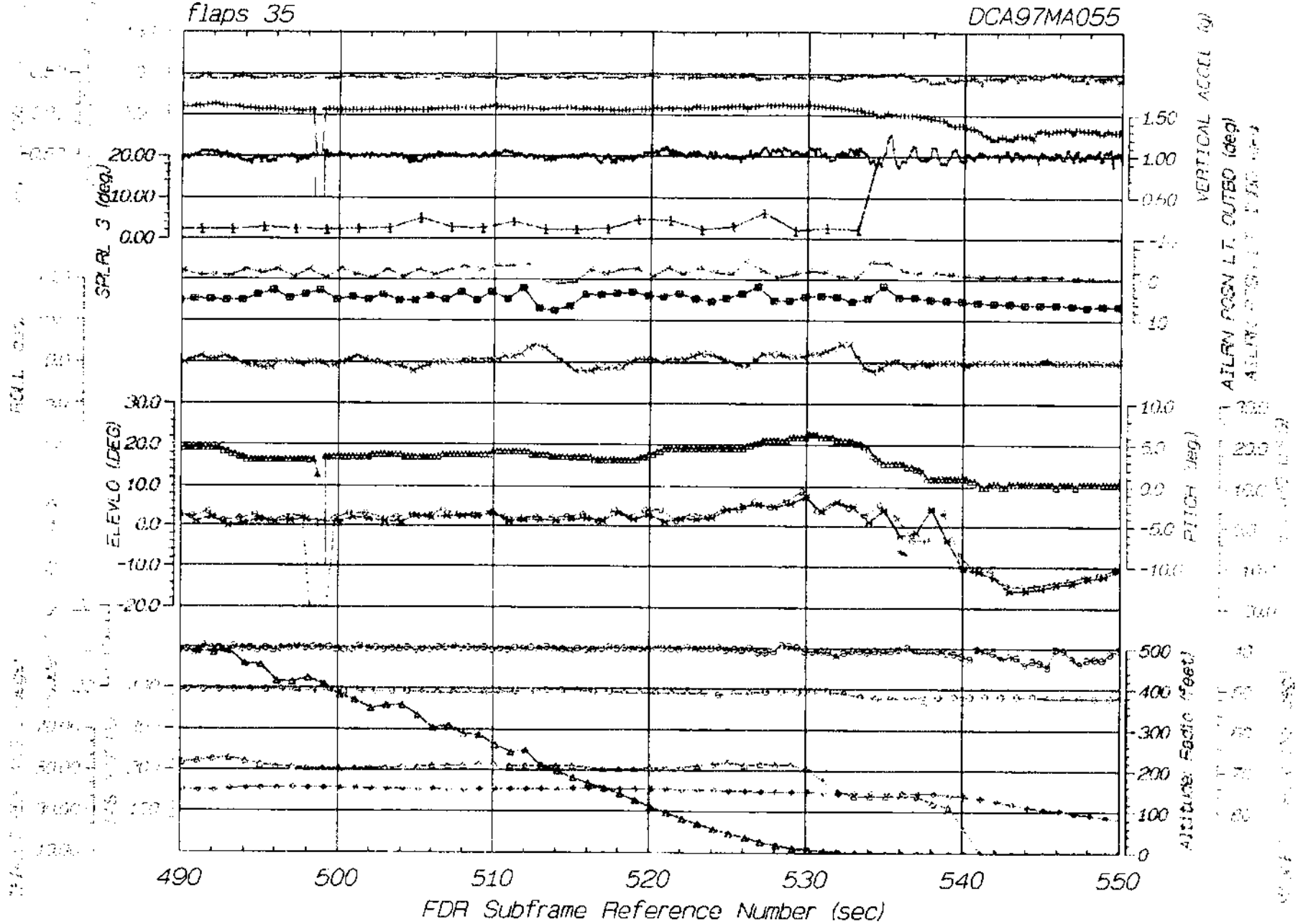
Federal Express MD-11, Landing Prior To Accident



Flight Parameters
Revised: February 04, 1998

National Transportation Safety Board/ VPD

Federal Express MD-11, 2 Landings Prior To Accident



Flight Parameters

Revised: February 04, 1998

National Transportation Safety Board/ VPU