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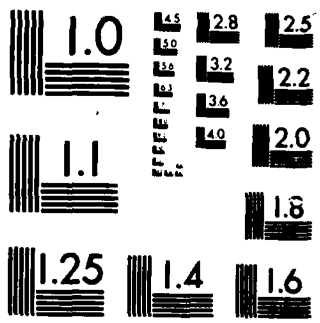

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Technical Support of the Wall Street/Battery Park City Heliport MLS Project

Barry R. Billmann
James H. Enias
Michael M. Webb

December 1985

DOT/FAA/CT-TN85/58

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Technical Report Documentation Page

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16. Abstract

During the winter and spring of 1985, the Federal Aviation Administration (FAA) Eastern Region in conjunction with the Guidance and Airborne Systems Branch at the FAA Technical Center conducted a demonstration of a Microwave Landing System (MLS) located at a downtown heliport.

This report describes both the industry/user and FAA Technical Center activities during the evaluation period. It describes the evaluation methodology and addresses topics concerning both technical and operational issues. It also describes the helicopter procedures flown during this evaluation and provides an analysis of signal coverage and the user's subjective opinions concerning the acceptability and perceived workload associated with these procedures.

It was concluded that MLS to heliports is a viable asset to the helicopter Instrument Flight Rules (IFR) community, however, its full benefits may not be realized in the Battery Park/Wall Street area without revisiting the necessity and demand for the New York Terminal Control Area (TCA) Visual Flight Rules (VFR) operating exclusion area.

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EXECUTIVE SUMMARY

During the winter and spring of 1985, the Eastern Region in conjunction with the Guidance and Airborne Systems Branch at the Federal Aviation Administration (FAA) Technical Center conducted a demonstration of a Microwave Landing System (MLS) location at a downtown heliport. The purpose of the demonstration was to assess the feasibility of utilizing MLS equipment for conducting precision approaches to downtown heliports. An important objective of the demonstration was to expose the aviation community to the operational flexibility of locating MLS equipment at downtown heliports and to obtain participant feedback for development of operational procedures for conducting precision approaches to heliports.

This report describes both the industry/user and FAA Technical Center activities during the evaluation period. It describes the evaluation methodology and addresses topics concerning both technical and operational issues. It also describes the helicopter procedures flown during this evaluation and provides an analysis of signal coverage and the user's subjective opinions concerning the acceptabiity and perceived workload associated with these procedures.

It was concluded that MLS approaches to heliports is a viable asset to the helicopter Instrument Flight Rules (IFR) community, however, its full benefits may not be realized in the Battery Park/Wall Street area without revisiting the necessity and demand for the Terminal Control Area (TCA) Visual Flight Rules (VFR) operating exclusion area along the Hudson and East Rivers around Manhatten.

The results of the analysis contained in this report can be useu to further define and establish procedures for flying precision approaches to heliports.

1. INTRODUCTION.

1.1 PURPOSE.

This report reviews the results of activities conducted by the Federal Aviation Administration (FAA) Technical Center, Engineering Division, Guidance and Airborne Systems Branch (ACT-140), in support of the Wall Street/Battery Park City Heliport Microwave Landing System (MLS) project. These activities were designed to support the Eastern Region's Heliport MLS Demonstration Program. The support activities can be grouped into three separate areas:

a. Planning assistance support.

b. User support.

c. Flight data collection.

The support was furnished over the period of November 1984 to June 1985.

1.2 BACKGROUND.

In October 1984, the Eastern Region's Consumer Affairs Office (AEA-8) requested that the Technical Center provide support to assist with the heliport MLS demonstration. The Helicopter Instrument Flight Rule (IFR) Operations Program was tasked to provide this support based on the expertise which has been developed during helicopter MLS testing at the Technical Center. Planning sessions were held with the Consumer Affairs Office. Initial activities include the designing of candidate approach procedures to be flown for the demonstration at the future Wall Street (Pier 9) heliport site. These procedures utilized procedural design aspects currently under development. Although the site did not permit landings, its close promixity to the future Wall Street heliport permitted the evaluation of several technical issues.

Later in the demonstration program the MLS equipment was relocated to the Battery Park City Heliport. At this location, users could complete the MLS approaches to a full stop landing.

Based on the results of the early planning sessions, ACT-140 personnel developed a user's package that identified the operational issues in making an MLS approach to a heliport. This user's package provided a detailed description of the program and included three approach procedures and two pilot questionnaires. These approaches and questionnaires were developed based on subject pilot comments and the results of heliport testing at the Technical Center. ACT-140 personnel conducted user briefings at five locations: Battery Park City Heliport, Morristown Airport, Trenton Airport, Teterboro Airport, and United Technologies Corporation (UTC), Sikorsky Aircraft in Bridgeport, Connecticut. Throughout the demonstration program, ACT-140 personnel maintained close contact with the user group.

The third activity which involved the Technical Center was the collection of inflight MLS data from both the Wall Street (Pier 9) and Battery Park sites.

Using an S-76 and UH-1, several flights were conducted to determine signal in space coverage and quality. This data collection activity could not satisfy a Terminal Instrument Procedures (TERPS) data collection requirement since a ground "truth" tracking system was not available. Some of the issues investigated included possible interference from in-beam multipath caused by obstructions in the vicinity and possible multipath problems due to the large water surface area in close proximity to the landing sites. The data collection flights also permitted the verification that correct navigation guidance information was being generated by the MLS.

The MLS used in this test was the Hazeltine Model 2500 System. This system is currently in non-federal use at several U.S. sites. The system provides $\pm 10^\circ$ of proportional azimuth coverage with a 2° beamwidth. Elevation coverage ranges from 0.9° to 15° above the horizon. After completion of the demonstration program the MLS ground station equipment was relocated to Richmond, Virginia. Two different cabin class MLS receivers were used by demonstration participants. One receiver was manufactured by Bendix and the other by Sperry. For data collection, the Technical Center used several different Service Test and Evaluation Program (STEP) receivers which were manufactured by Bendix. However, because of some inconsistencies detected with these receivers, an additional flight was conducted using a Bendix Cabin Class MLS receiver.

1.3 OBJECTIVES.

The primary objective was to provide technical support to the Eastern Region Consumer Affairs Office with their Heliport MLS demonstration program. Additional objectives included:

a. Acquainting the industry/user with precision MLS approaches to heliports.

b. Familiarization of the industry user with the operational techniques required to successfully complete precision approaches to heliports.

c. To obtain user feedback in an operational environment to verify findings from the Technical Center's MLS tests concerning flyability and practicality of a range of MLS approach procedures.

d. To acquaint air traffic control (ATC) personnel with the operational characteristics of precision MLS approaches to heliports.

e. To collect flight data to verify signal coverage and signal quality.

f. To collect flight data to help identify possible problems with siting an MLS at a downtown heliport.

2. USER PARTICIPANT ACTIVITIES.

This demonstration program showed the utility and flexibility of an MLS located at a downtown heliport. The users involved in the program and the types of aircraft flown are shown in table 1.

TABLE 1. MLS HELIPORT DEMONSTRATION PARTICIPANTS

User	Aircraft Type
Port Authority of NY/NJ	Bell 222
State of New York	Bell 212
Allied/Bendix	Sikorsky S-76
RCA	Sikorsky S-76
Johnson and Johnson	Sikorsky S-76
Resorts Air	Sikorsky S-76
UTC Sikorsky	Sikorsky S-76

2.1 User Briefings.

During the period of March 20 to April 3, 1985, the Guidance and Airborne Systems Branch conducted briefings for the Battery Park Helicopter MLS Industry/User Program participants. The purpose of the briefings was to distribute the User Information Package, explain program objectives, and describe the MLS approach procedures. In particular, these briefings covered the anomalies of steep angle (greater than 4°) precision MLS approaches to a helipad (e.g., steep glideslope tracking techniques, importance of speed control, and distance to decelerate). Appendix A contains the Pilot Briefing Outline.

2.2 USER INFORMATION PACKAGE.

Based on a visual flight inspection, the minimum usable MLS glidepath angle at Wall Street was determined to be 4.6° due to obstacles along the final approach course. The minimum glide path determination was not based on TERPS. Approach procedures for 6° and 9° glidepath angles were included in the user package to evaluate flyability and overall user acceptance of the steeper approach angle. To provide both operational and technical feedback from the users and assess the benefits and limitations of these MLS approaches, two questionnaires were distributed with the user information package. Appendix B contains the user information package.

The first questionnaire was to be completed each time the approach was flown and addressed the pilots' overall opinion of the procedure. In addition, information concerning departure point, weather, and traffic or MLS signal problems were requested. These questionnaires were to be returned on a weekly basis so that we could identify a pattern of problems, if any, with a procedure or the MLS equipment.

The second questionnaire, to be completed after flying each approach three times, was designed as a post-program critique and addressed both operational parameters such as course width, deceleration distance, rate of descent, and approach speed that had been investigated during Technical Center testing and the pilots' perceived workload in flying an MLS. Also, pilot background information and comments concerning crew requirements, training, aircraft equipment, and heliport procedures were requested.

2.3 USER DEBRIEFINGS.

During the period June 3 to 14, 1985, program debriefings were conducted to supplement the questionnaire data received from the Battery Park MLS user/participants. The additional information gathered during these debriefings supported questionnaire data and, in general, all users commented that:

a. Training is very important. All pilots must receive some training in flying these approaches.

b. Distance Measuring Equipment (DME) is required for the approach.

c. They felt there is no need for a 9.0° glide slope approach to Battery Park or Wall Street.

d. Some heliport unique lighting is required to assist in identifying the heliport from decision height (DH).

e. Signal quality was good at all times. The New York/New Jersey Port Authority pilots were very conscientious about noting when ships were passing in front of the antennas and other aircraft were maneuvering on the ground. They did not notice any degradation of the signal quality at any time.

Some recommendations made by the users during these debriefings were that:

a. Pilots recommended that an instrument approach to the southern edge of Governor's Island would be quite acceptable. They felt this would increase safety by keeping the aircraft farther away from obstacles and increase flexibility by allowing more space for aircraft to depart and arrive at the heliport. They felt that if the antennas are located at the Wall Street heliport, IFR departures would be delayed while other aircraft are arriving. Also, with this configuration, missed approaches would be more difficult due to the large number of obstacles in the lower bay area.

b. Pilots suggested a need for some kind of IFR departure from the ground and felt MLS could provide this capability.

c. They recommended an improvement in Terminal Radar coverage in the Hudson River/Bay area to provide the IFR aircraft better advisories on low flying, uncontrolled aircraft.

d. Several pilots felt there should be two categories of approaches based on experience and training of crews. As an alternative, they suggested higher minimums for the first 6 months of the system's operation, and after the user's have gained experience, decrease the minimums to the desired level.

e. It was suggested that an alternative to initial training requirement might be to operate "VFR Only" for 90 days to give users an opportunity to gain experience flying in a visual environment first.

3. QUESTIONNAIRE RESULTS.

A total of 39 approaches were documented in response to questionnaire No. 1. Since these questionnaires did not reveal any trends towards major problems or safety issues, the users were advised to continue flying the approaches and submit their comments during the post-flight critique. A total of 19 pilots completed questionnaire No. 2, documenting 195 approaches. An approach frequency distribution for the 19 pilots is listed on table 2. In table 2, note that 69 percent of the pilots evaluated each of the three MLS approach procedures.

TABLE 2. APPROACH FREQUENCY DISTRIBUTION

Pilot No.	050/4.6°	050/6°	050/9°
01	5	5	5
02	30	2	0
03	12	8	7
04	3	0	0
05	2	1	1
06	6	3	2
07	2	1	2
08	2	2	2
09	3	0	0
10	3	0	0
11	6	5	3
12	1	0	1
13	4	4	3
14	3	6	3
15	8	3	3
16	6	7	1
17	4	2	0
18	6	2	1
19	2	1	1
Total	108	52	35
Flown by % of Users	100%	79%	74%

Following is the operational environment information obtained from questionnaire No. 1 concerning the pilots, the weather, the mission, and the aircraft participating in this evaluation, together with the user response to quesionnaire No. 2.

3.1 Pilots.

The pilots who participated in this program represent active corporate, local government, and air carrier helicopter pilots. Each pilot possessed, as a minimum, a helicopter Commercial Pilot certificate with instrument rating; and 74 percent held an Airline Transport Pilot certificate. Their median rotorcraft flight time was 6,000 hours, with an average 299 hours of actual instrument time and 1,326 hours of experience in the type helicopter flown during the evaluation. However, if pilots No. 18 and 19 are excluded from the data base, the averages drop to 5,500 hours of total time, 187 hours of instrument time, and 982 hours of time in type. Pilots No. 18 and 19 flew extensively in the North Sea area and logged an exceptional amount of actual instrument flight.

Although low when compared to fixed-wing pilots, 200 hours of instrument time is average for a helicopter pilot with 5,500 hours total time. Additional information concerning the individual pilot is contained in table 3, User/Participant Pilot Profiles.

3.2 MISSION.

The users participating in the evaluation normally flew the MLS approaches to Battery Park as a part of their daily operations and were inbound from two general directions: southwest--Teterboro, Trenton, Morristown, and Atlantic City, New Jersey; northeast--Albany, New York, and Bridgeport/Stratford, Connecticut.

Existing IFR routes V313R and V314R lend themselves well to this northeast/southwest traffic flow arriving at the Battery Park/Wall Street area.

3.3 WEATHER.

Weather information was recorded from 39 separate approaches during the period April 4 to June 3, 1985. All flights were conducted in visual meteorological conditions (VMC) conditions during which records indicated a maximum headwind of 10 knots, a maximum tailwind of 15 knots, and a maximum crosswind component of 14 knots, existed. The majority of the flights were conducted between 8:00 a.m. and 4:30 p.m., eastern daylight time (EDT), however, some approaches were evaluated during night flight. These conditions represent a random sample of winds for the Battery Park area.

Pilots did note that strong crosswinds required excessive (greater than Instrument Landing System (ILS) intercept and/or crab angles to maintain azimuth alignment and that large/radical wind shifts were accented by steep approach gradients and lower airspeeds.

TABLE 3. USER/PARTICIPANT PILOT PROFILES

Pilot No.	Total Helicopter Hours	Helicopter IFR Hours Actual	Helicopter IFR Hours Hooded	Helicopter IFR Hours Last 6 Months	FAA Helicopter Rating	Helicopter Type	Time In Type
01	2500	10	50	12	ATP	B222	250
02	2000	10	100	10	ATP	B222	300
03	5000	200	500	25	COMM	B222	300
04	8800	4	40	2	ATP	B222	150
05	3800	50	60	9	COMM	S-76	250
06	6000	200	100	30	ATP	S-76	1400
07	2600	35	12	6	COMM	S-76	850
08	5000	300	300	23	COMM	S-76	1300
09	9000	25	100	10	COMM	S-76	1500
10	8900	50	150	8	ATP	S-76	1700
11	3450	336	200	15	ATP	S-76	1200
12	3400	300	200	20	ATP	S-76	1000
13	4500	500	400	30	ATP	S-76	1800
14	5500	300	40	25	ATP	S-76	1200
15	9000	307	100	8	ATP	S-76	1000
16	6000	400	250	30	ATP	S-76	1300
17	9000	150	340	20	ATP	S-76	1200
18	8200	1400	400	20	ATP	S-61N	4700
19	9900	1100	80	45	ATP	S-61N	3800
Mean	5924	299	180	18.3	74% ATP/ 26% COMM	——	1326

Note: ATP = Airline Transport Pilot
COMM = Commercial

3.4 AIRCRAFT.

Two primary categories of helicopter are represented in the evaluation. The Bell B222 and the Sikorsky S-76 represent medium size utility helicopters with a maximum gross weight of 8,000 to 10,500 pounds. Both of these helicopters were designed for civil applications to support the offshore oil industry, and have evolved to executive transportation for many major corporations. Considered by many as the DC-3 of offshore operations in the North Sea, the Sikorsky S-61 represents a transport category helicopter with a 20,000 pound maximum gross weight capable of passenger/payloads of up to 26 persons.

These helicopters are considered representative of the range of civil IFR certified helicopters currently in use in the New York area.

3.5 QUESTIONNAIRE NO. 2 RESPONSES.

This section contains results of the user responses to questionnaire No. 2. Recommendations derived from these results are made and discussed in section 6; individual pilot's response to each question are contained in appendix C.

In response to question No. 1, 84 percent responded that the 4.6° approach was acceptable as published and 88 percent responded that the 6.0° approach was acceptable as published. However, 93 percent responded that the 9° approach was unacceptable mainly because the rate of descent to stay on glidepath was too high.

In response to question No. 2, 89 percent responded that the 4.6°/200-foot elevation height (EL)/DH combination was acceptable; 80 percent responded that the 6.0°/300-foot EL/DH combination was acceptable; and 73 percent responded that the 9.0°/350-foot EL/DH was acceptable.

Response to the recommended maximum allowable rate of descent (question No. 3) resulted in following mean responses: 657 fpm, 765 fpm, and 872 fpm for the 4.6°, 6°, and 9.0° approaches, respectively.

The mean response to the maximum/minimum airspeeds recommended for these approaches (question No. 4) was 88/63 knots for the 4.6° approach; 79/55 knots for the 6.0° approach, and 71/55 knots for the 9.0° approach.

User response to questions 5, 6, and 7 regarding how the amount of effort required to fly each of the MLS approaches compares with flying a typical 3° ILS in terms of tracking azimuth, tracking glidepath, workload, and airspeed control is summarized in figure 1.

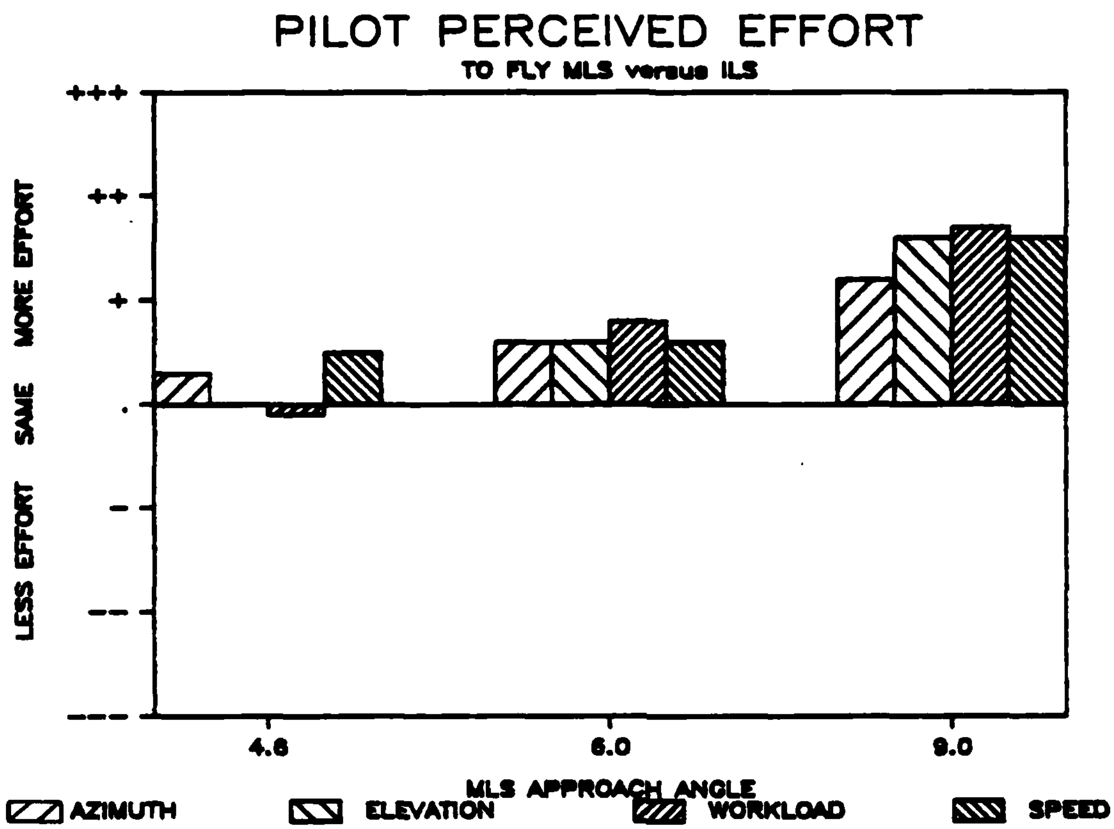


FIGURE 1. PILOT PERCEIVED EFFORT

In response to question 8, 95 percent of the users stated that the final approach segment length (glidepath intercept to DH) for these approaches was correct.

In response to question 9, 84 percent of the users felt some special training was required prior to a pilot flying these MLS approaches to a heliport.

For question 10, 58 percent of the users felt that these approaches should not be approved for single pilot IFR operations.

For question 11, "Do you feel there should be any special pilot requirements not already mentioned?", 95 percent responded no.

In response to questions 12 and 13, the minimum avionics that the users felt would allow them to transition to and fly these approaches during IMC conditions were the basic MLS and DME. In addition, 89 percent of the pilots felt a radar altimeter should also be required. Pilots also commented that very high frequency omnidirectional range (VOR)/DME area navigation (RNAV) or Loran C complimented the MLS procedures. (Note: The Battery Park MLS installed did not include DME equipment).

User response to question 14 regarding what they would do if they were in IMC conditions, established on the approach inbound and the MLS signal becomes unreliable, was varied. See Pilot Summary of Comments (appendix C).

For question 15, "Would you feel comfortable flying these approaches to the DH's indicated in actual IMC conditions?", 78 percent responded yes and 22 percent responded no. The "no's" were mainly due to the uncontrolled airspace environment and close proximity of buildings.

The words "lousy, uncomfortable, irresponsible, and never" were used to responded to question 16: "How would you feel about executing this approach, when there may be uncontrolled VFR traffic flying below you following the "See and Avoid" rule?".

For question 17, if a "Heliport Traffic Area" were to be developed to provide a safe transition from DH or MDA (minima of 300 feet and 1/2 mile) to the helipad and separation of arriving and departing IFR helicopters, what dimensions would you suggest? The averaged limits suggested is a radius of 2.0 nautical miles from the ground to 1,000 feet.

For question 18, the users were asked to consider the proposed Wall Street site and suggest the best means of departing the heliport IFR. The most favored comments were: outbound on the MLS with a transition to V313R for a southerly departure or to V314R for a northerly departure; VFR to either the Varazano or George Washington Bridges.

4. TECHNICAL ACTIVITIES.

4.1 SIKORSKY AIRCRAFT.

Sikorsky aircraft's participation in this evaluation was two fold: first, to fly the Battery Park MLS as a user in the evaluation; and second, to determine what testing would be necessary to certify the S-76 for 40 knots, minimum IFR speed (V_{mini}). Results from their study were:

a. At first, all of their pilots had trouble flying the approaches while using a hood. VFR flying was acceptable. They stated that some training was definitely necessary and felt the amount of training required seemed to be dependent on the pilot's aircraft familiarity and instrument flying ability. Areas of interest which proved to make the transition easier were training in flying the backside of the power curve and maintaining a constant heading along the approach. This is especially important at low airspeeds.

b. They felt the maximum cross wind component for the approaches evaluated should be 15 knots, based on the lower airspeeds.

c. The limiting angle for steep approaches should be based on the pilot's forward visibility. Their recommendation for a maximum glide slope angle for the S-76 is 7.5°.

d. Concerning the approaches, Sikorsky extensively used the Liberty transition to waypoint Bayonne. They found the turn to final approach from Bayonne was too tight and frequently overshot the final approach course. They suggested more distance be allowed for the intermediate approach segment.

e. Sikorsky normally operated at 80-120 knots on downwind and performed a deceleration to the desired approach speed approximately 0.2 nmi prior to glidepath intercept. They felt that to be able to fly the glidepath effectively at lower airspeeds; a deceleration must be completed prior to the glidepath intercept.

f. They felt the backside glidepath tracking technique and heading hold worked quite well. If there was a significant airspeed deviation however, it became very difficult to maintain glidepath. They stated that when flying to DH's of 150 feet, the azimuth became too sensitive.

g. A maximum tailwind of 6 to 8 knots is their recommendation as a limit, especially for lower airspeed approaches.

h. The missed approach segments as published were acceptable, but most pilots preferred to climb straight ahead and then commence the turn. However, they realized that buildings prevented this type of missed approach procedure for these approaches.

i. During their test flying, boats crossing in front of the heliport created an obstruction avoidance problem during the transition from DH to the helipad when conducting the 4.6° approaches to a DH of 150 feet.

j. They also commented that they feel some type of control is necessary flying below 1,100 feet. Suggestions were to have Newark tower monitor traffic to 150 feet, or use advisory calls similar to the procedure used at a non-tower facility.

k. A problem they noted is that visibility from a 200-foot DH is poor. They felt an approach to the right side of the pad would allow the pilot to see the landing site or lights from DH.

4.2 FAA TECHNICAL CENTER.

A total of eight FAA Technical Center flights were conducted in the Technical Center aircraft in support of this project. The flights were designed to detect anomalies in signal coverage and quality associated with MLS siting at a downtown heliport. The flights were conducted at both the Wall Street site and Battery Park location. The initial flights at both sites were conducted to verify the acceptability of the proposed candidate procedures and familiarize New York Terminal Radar Approach Control (TRACON) personnel with the demonstration approach profiles. Visual obstruction clearance for the approaches was also verified at this time. Table 4 lists the flights that were conducted. Each of the flights will be reviewed separately.

January 10. The purpose of this flight was to coordinate the candidate Wall Street approach procedures with the New York TRACON. Additionally, TRACON personnel accompanied Technical Center pilots during approach procedure verification flights.

TABLE 4. FLIGHT ACTIVITIES

Date	Location	Aircraft Type	Mission
January 10	Wall Street	S-76	Air Traffic Coordination Procedures and Approach Procedure Verification
February 28	Wall Street	UH-1	Data Collection
March 21	Battery Park	UH-1	Final Approach Course Alignment
March 27	Battery Park	UH-1	Data Collection
April 18	Battery Park	UH-1	Data Collection
May 9	Battery Park	UH-1	Data Collection
June 10	Battery Park	UH-1	Data Collection - Bendix Cabin Class Receiver

February 28. On this flight a portable DME system was placed at the Pier 9 MLS site. This system provided a position reference for data recording and reduction. A total of nine approaches were flown on this flight (see figure 2 for Wall Street approach plate). The approaches included a left 08° azimuth and a right 08° azimuth approach. These two approaches were flown to verify azimuth signal coverage. The remaining seven approaches were accomplished using a variety of elevation approach angles ranging from 3° up to 9°. These seven approaches were all flown on the 0° azimuth. It is noted that the 3° approach is not a candidate procedure for the Wall Street site because of obstacles. This procedure was flown for signal coverage purposes only.

Several plots of data collected on this flight were made. Two different types of plots will be presented. The first type presents the amount of course deviation indicator (CDI) or vertical deviation indicator (VDI) deflection that occurred on the approach as a function of range from the antennas. The solid horizontal lines on these plots represent full scale deflection regions. The dashed lines represent half-scale needle deflection regions. The second type of plot presents the physical displacement of the aircraft in either the horizontal or vertical plane. This displacement is plotted as a function of range and assumes a perfect navigation system since no ground truth tracking system was available.

Offset Azimuth Approaches. Figures 3 through 6 present the results for the offset azimuth approaches. In figure 3 the crosstrack deviations are presented. The circled portion of the right 08° offset approach trace shows the limits of the 10° proportional coverage provided by the system. Azimuth deviations presented in figure 4 depict only minor deviations from left 08° and right 08° radial azimuths and represent the pilot's azimuth tracking corrections. Figures 5 and 6 present elevation data associated with the two offset azimuth approaches. Both of these approaches were flown to a DH of 425 feet. Very little deviation from the selected glidepath (4.6°) is apparent in figure 6.

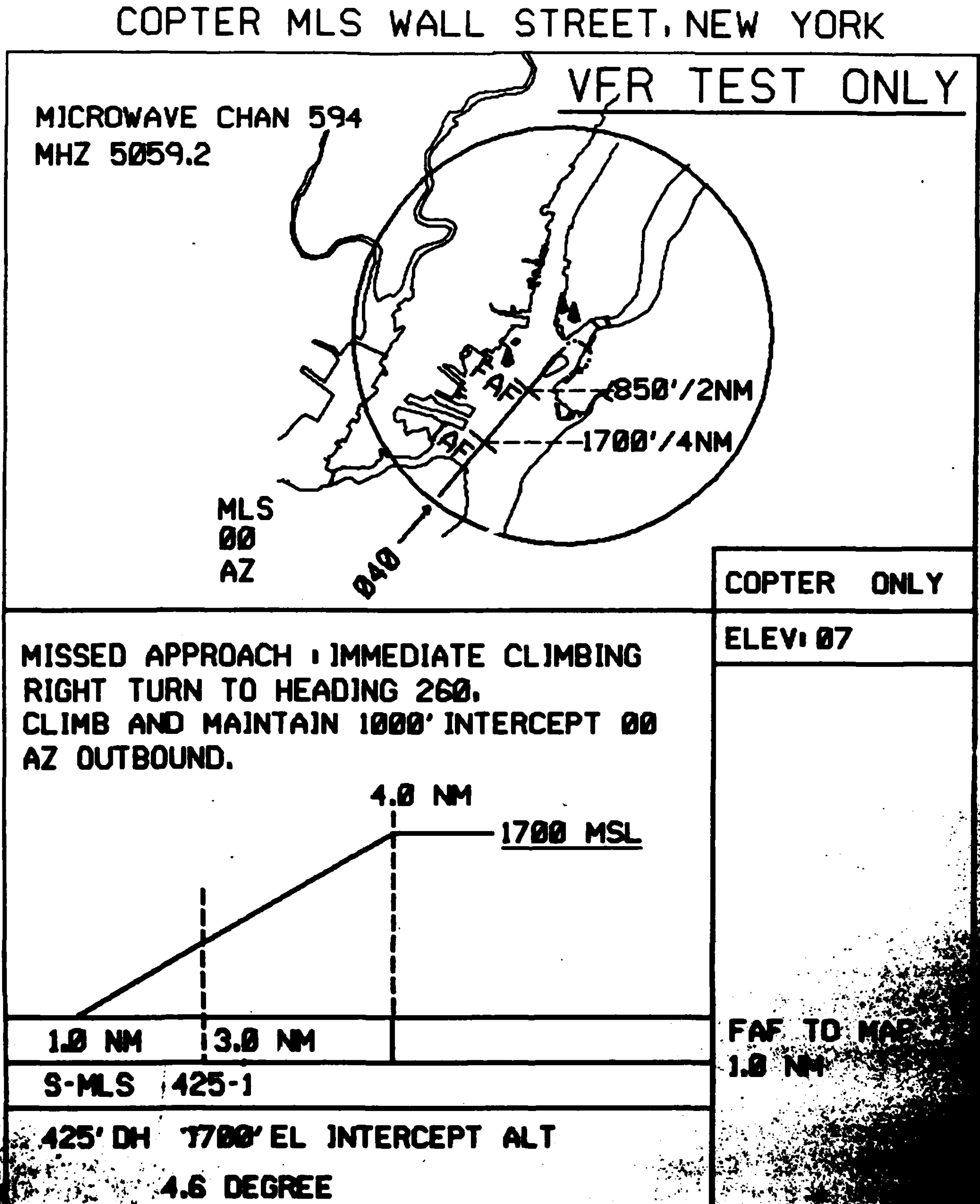


FIGURE 2. WALL ST. 041°/4.6° MLS APPROACH

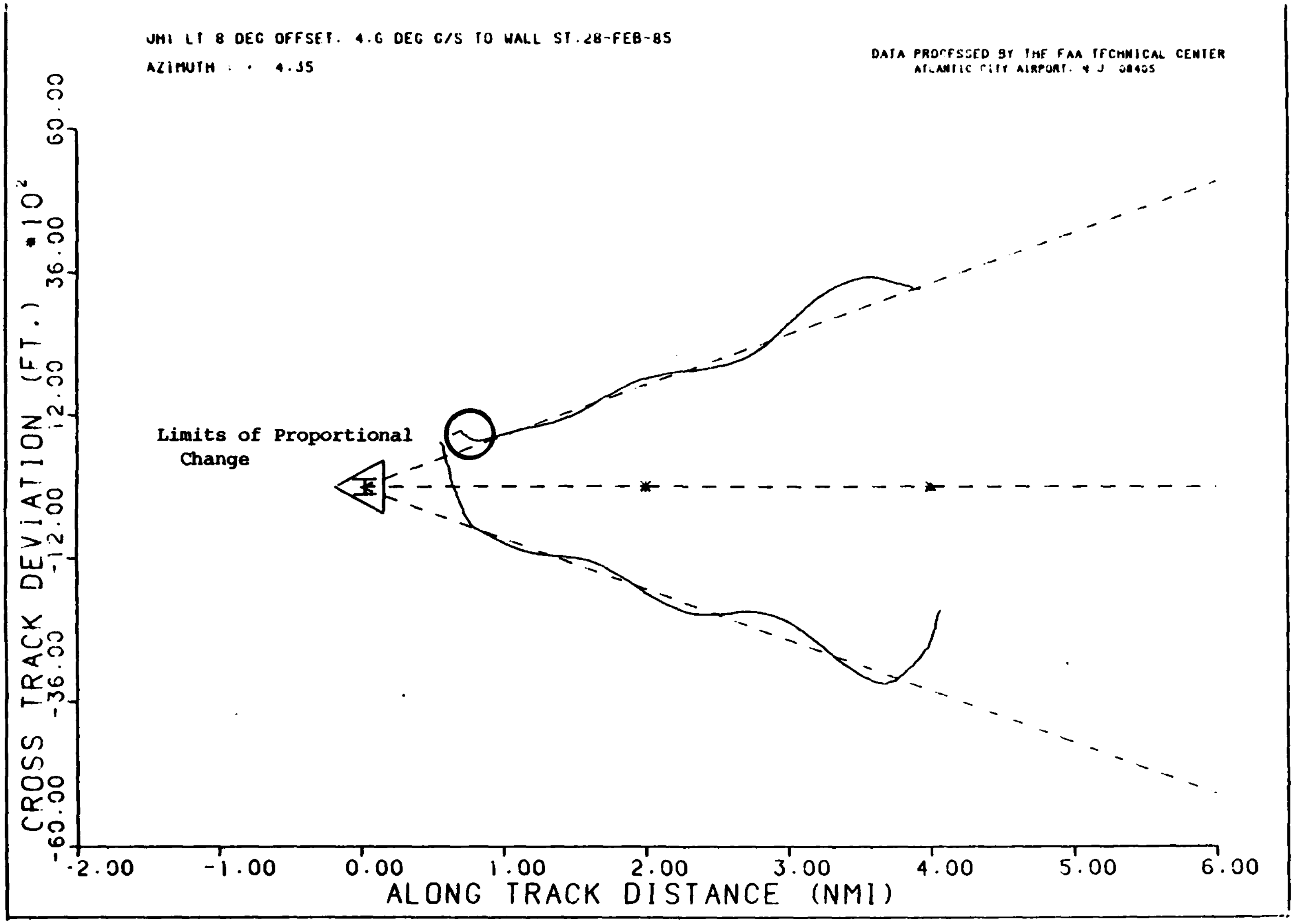


FIGURE 3. WALL ST. LEFT 08° AND RIGHT 08° OFFSET APPROACHES (CROSSTRACK DEVIATIONS)

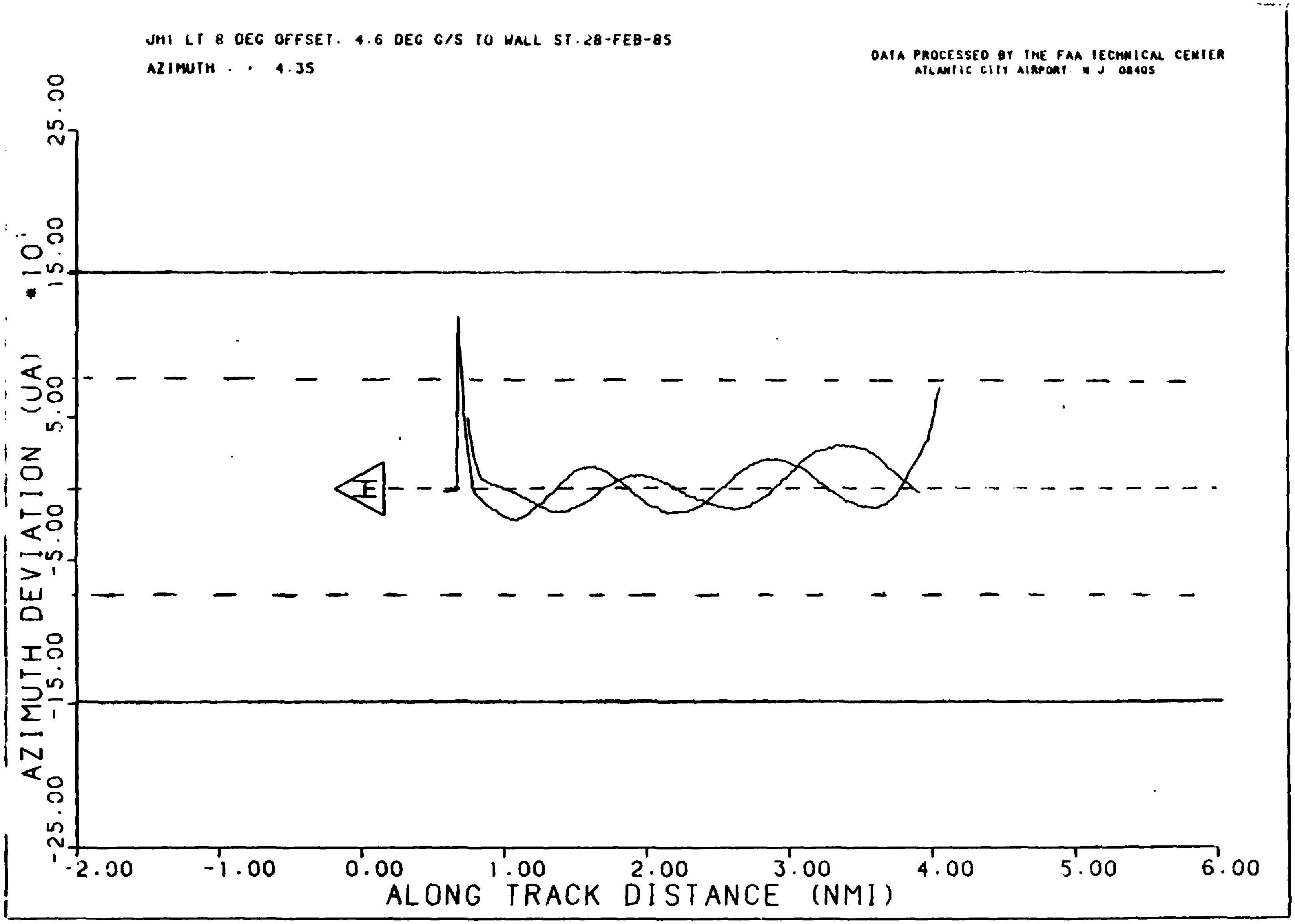


FIGURE 4. WALL ST. LEFT AND RIGHT 08° OFFSET APPROACHES (CDI DEVIATIONS)

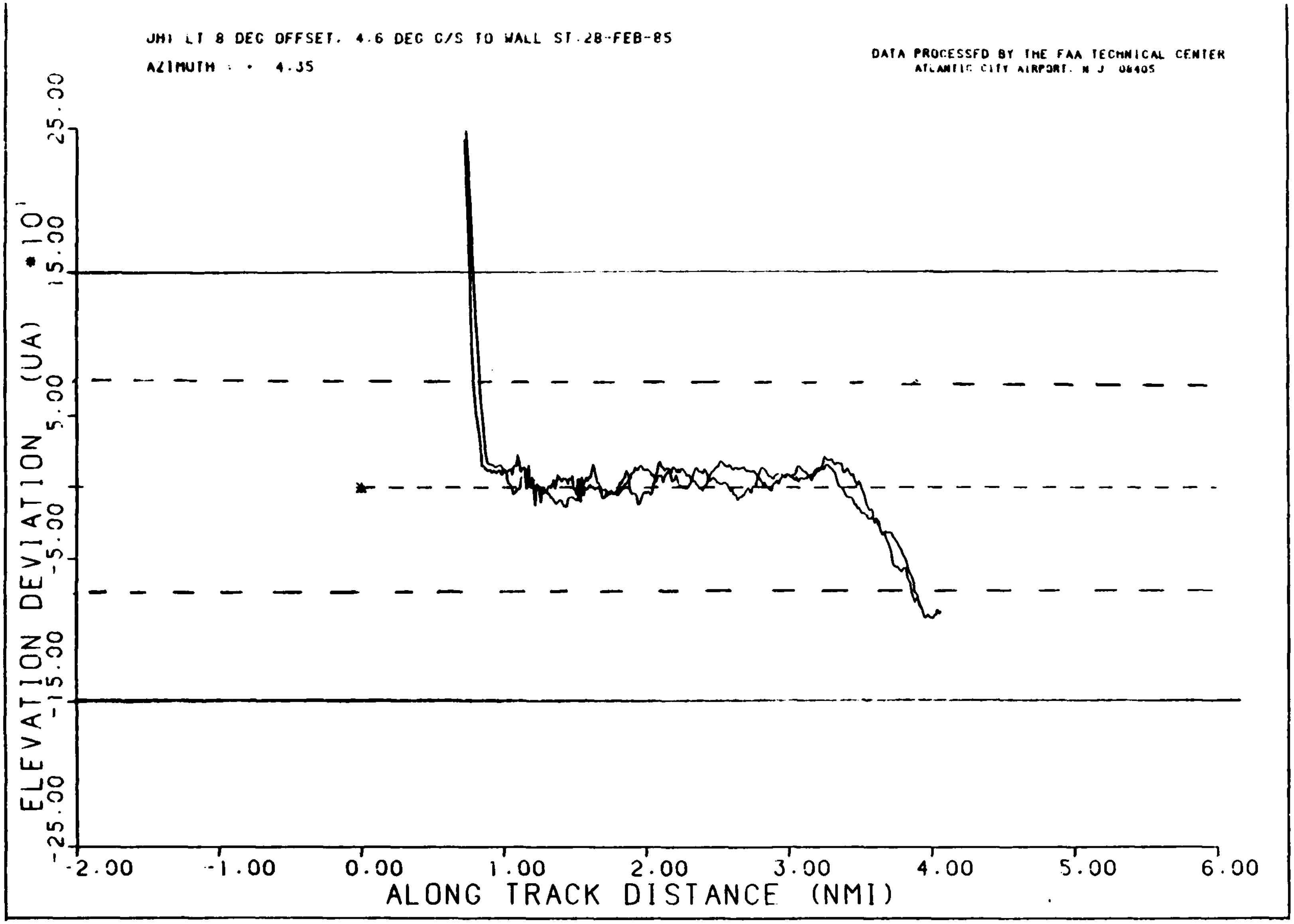


FIGURE 5. WALL ST. OFFSET APPROACHES (ELEVATION DEVIATION)

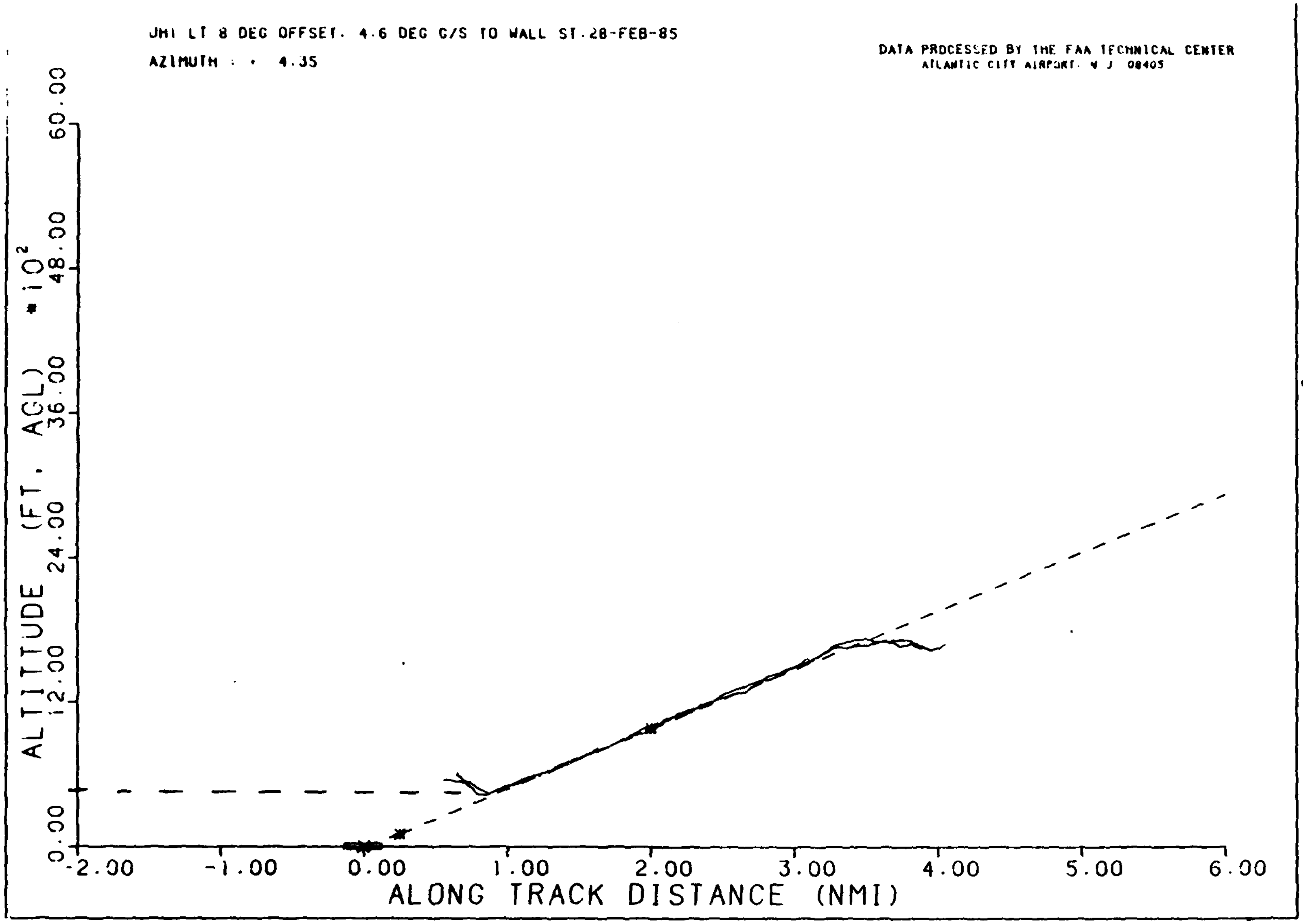


FIGURE 6. WALL ST. OFFSET APPROACHES (ALTITUDE DEVIATION)

4.6° Approaches. A total of four 4.6° approaches were made. Because of obstructions on Governor's Island, this elevation angle probably represents the minimum elevation angle which could be used for an approach to the Wall Street site. It should be noted the candidate procedures did not provide obstruction clearance as required by FAA Handbook 8620.3B, United States Standard for TERPS. The procedures were designed to provide visual obstruction clearance and user familiarity with the flexibility of a heliport site MLS. In figure 7 the deflections of the CDI on the four approaches represent the routine tracking corrections by the pilot. The limits of proportional coverage are again identified within the circles on figure 8. In all cases the final approach course was intercepted from the right.

In figures 9 and 10 the elevation data for the 4.6° approaches are presented. Two of the approaches were flown to a DH of 425 feet and two of the approaches were continued for signal coverage purposes to a DH of 200 feet. Figure 10 shows that on all four approaches there were only minimal deviations from the selected glide slope. The deviations represented the normal tracking capability of the pilot. With a glidepath intercept of 1,700 feet mean sea level (m.s.l.) the final approach segment was a little more than 2.3 nmi. At a DH of 425 feet, the 4.6° glide slope places the aircraft 0.86 nmi from the landing area when the missed approach is initiated.

6.0° Glide Slope Approaches. Two approaches of this type were made on the 0° azimuth. The results are shown in figures 11 to 14. Azimuth data plotted on figures 11 and 12 reveals deviations which represent the pilot's tracking ability. The approaches were made to a DH of 200 feet for signal coverage purposes only. With the candidate procedure glidepath intercept altitude of 1,700 feet and a DH of 425 feet, the resulting final approach segment length is 1.99 nmi and the distance to the landing area at DH is 0.67 nmi. In figure 13 a circle encloses the result of receiving the elevation grating lobe during missed approach. This results in a short false glidepath indication. Although this grating lobe is radiated 20° above the selected elevation angle and is not operationally significant, its existence without an out of coverage indicator (OCI) protection violates the requirements of FAR part 171.

9° Glide Slope Approaches. One approach of this type was made. Results are presented in figures 15 to 18. Review of the data show that the pilots easily tracked the selected course. This type approach results in a 1.32 nmi final approach segment and places the aircraft 0.44 nmi from the landing area if a 1,700-foot glide slope intercept altitude and a 425-foot DH are used.

3° Glide Slope Approach. This approach was not a candidate procedure at the Wall Street site and was flown for data collection purposes only. Figures 19 to 22 present the results for the two approaches which were flown. On figure 20 the proportional coverage limits of the 10° azimuth are circled. The elevation data are presented in figures 21 and 22. Two different DH's were used, 200 and 425 feet. The elevation signal quality is not as good as that which resulted with other approach angles. In figure 21, large discontinuities in the VDI position have been marked. These deviations are not representative of actual aircraft movement. On the approach to 200 feet, a large, almost instantaneous, deflection in the VDI occurred about 1 nmi from the landing area. The sampling rate is 2 hertz (Hz). In 1/2 second the VDI swung from

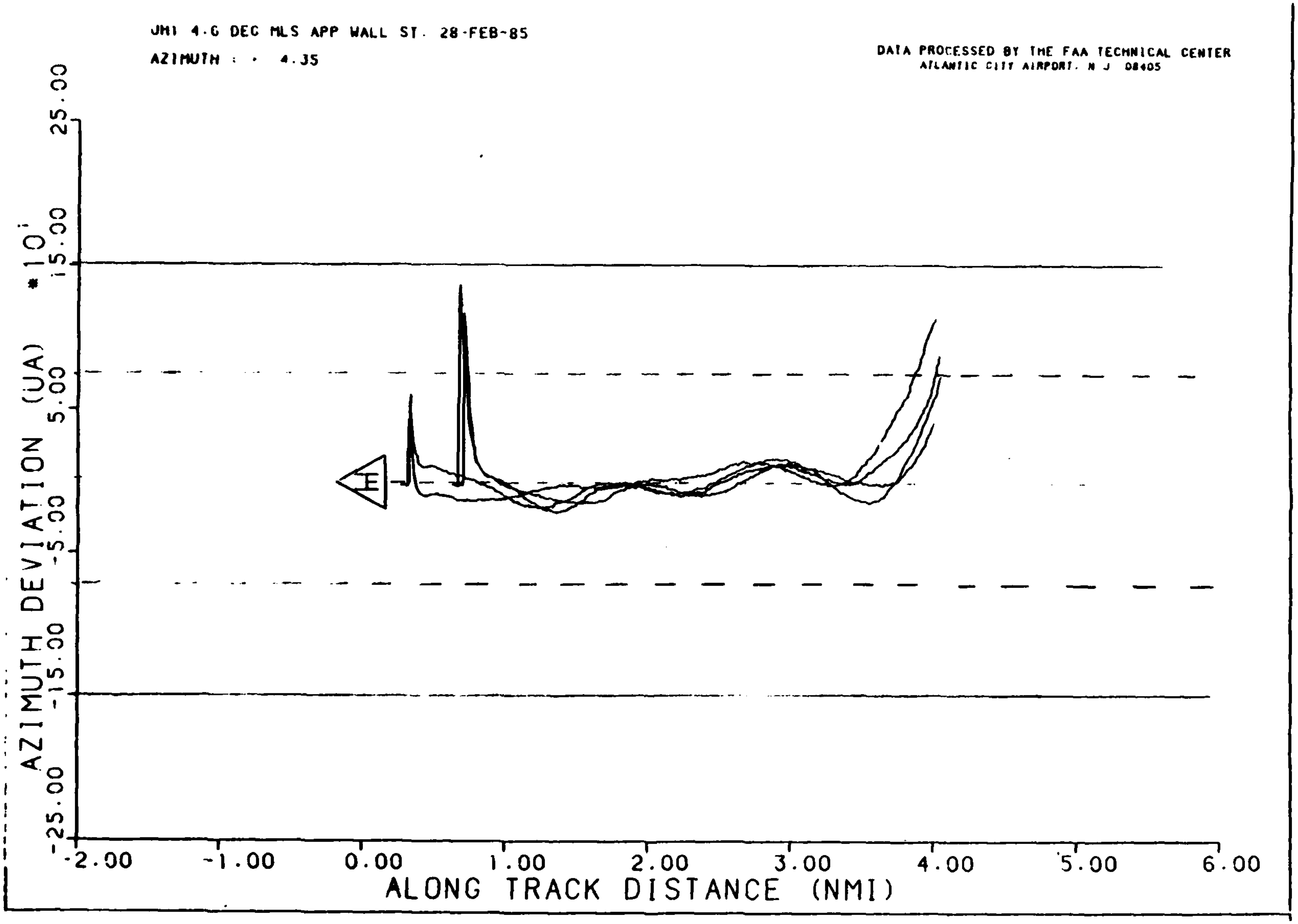


FIGURE 7. WALL ST. 4.6° ELEVATION ANGLE APPROACHES (CDI DEVIATION)

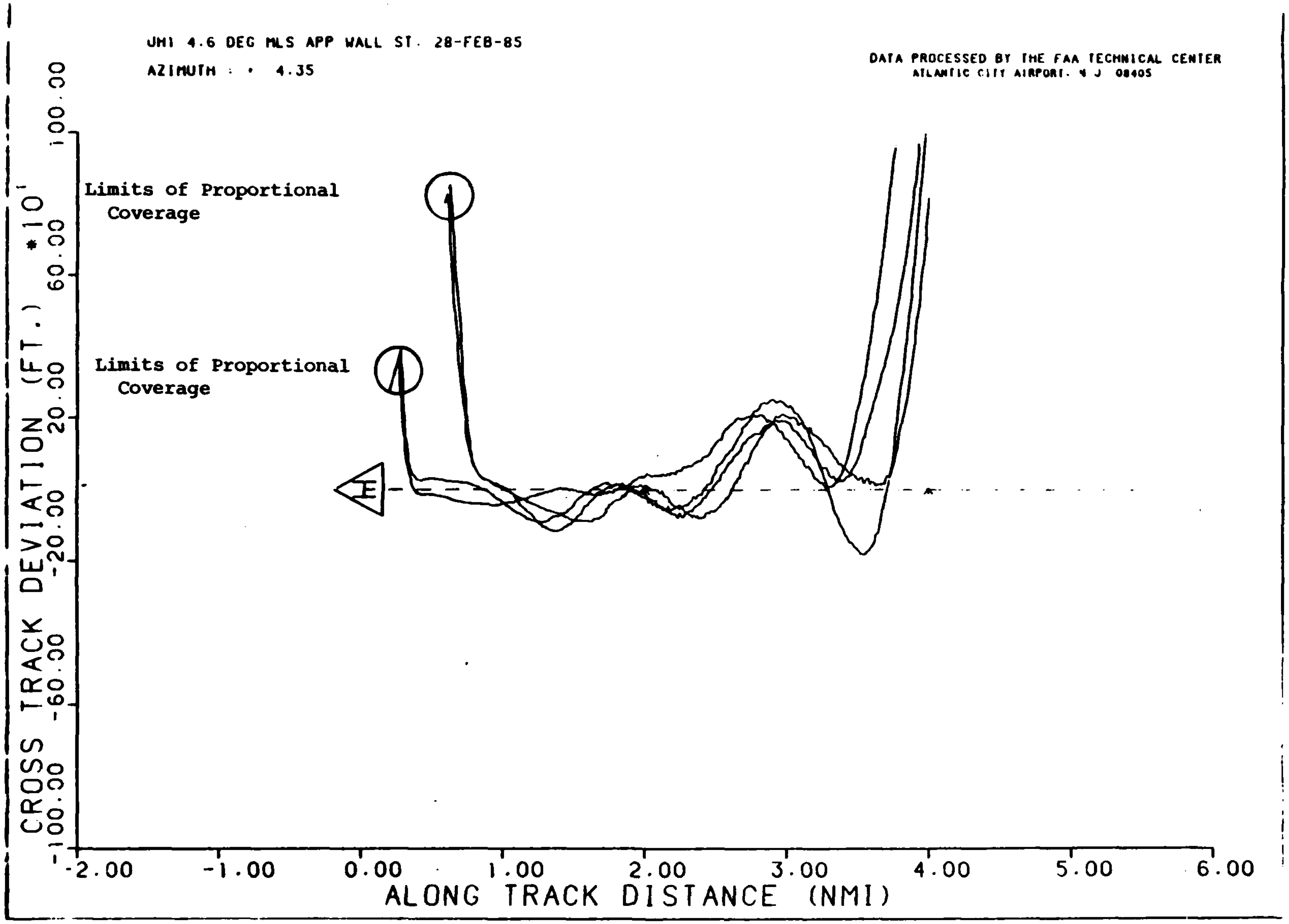


FIGURE 8. WALL ST. 4.6° ELEVATION ANGLE APPROACHES (CROSSTRACK DEVIATION)

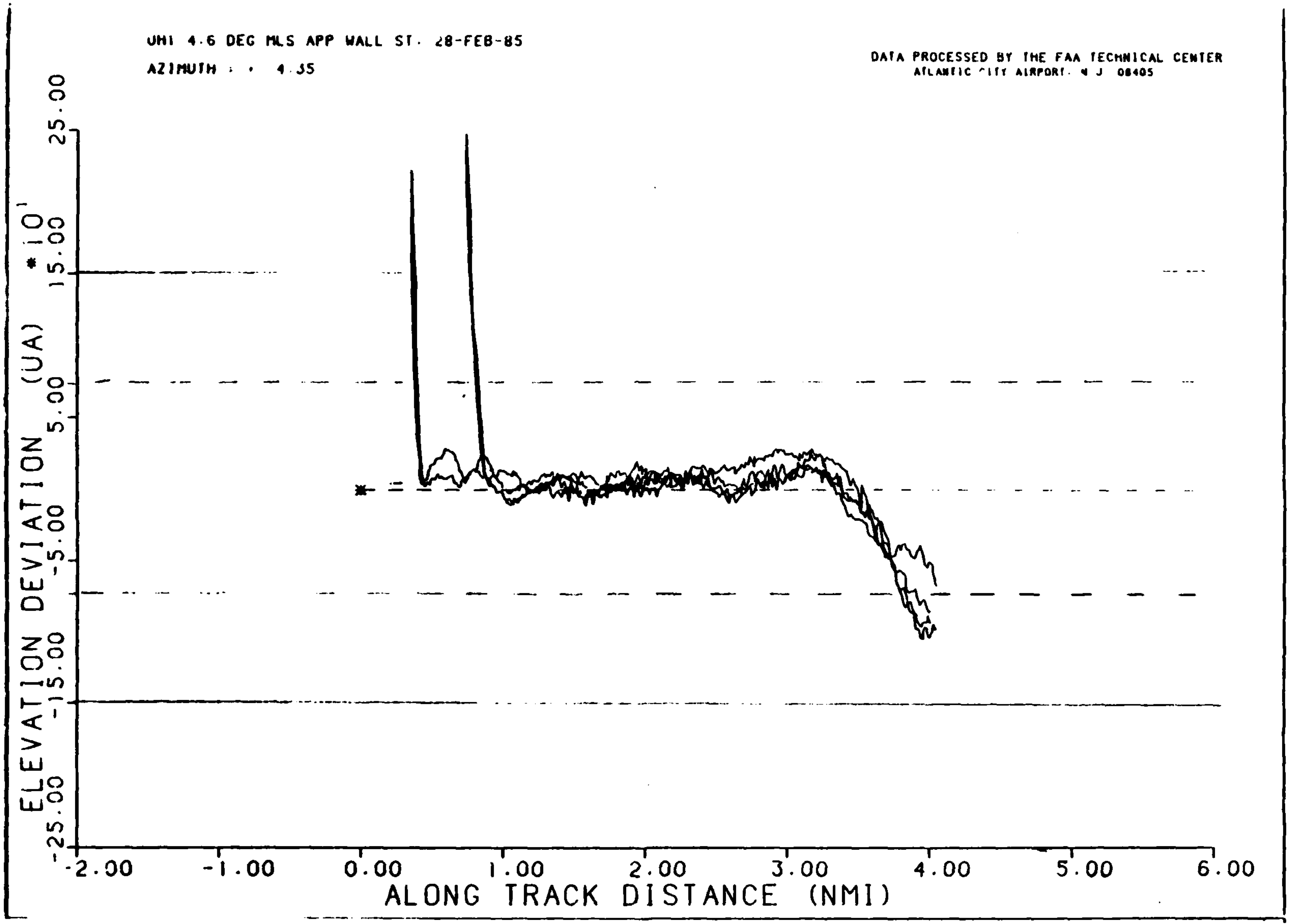


FIGURE 9. WALL ST. 4.6° ELEVATION ANGLE APPROACHES (VDI DEVIATION)

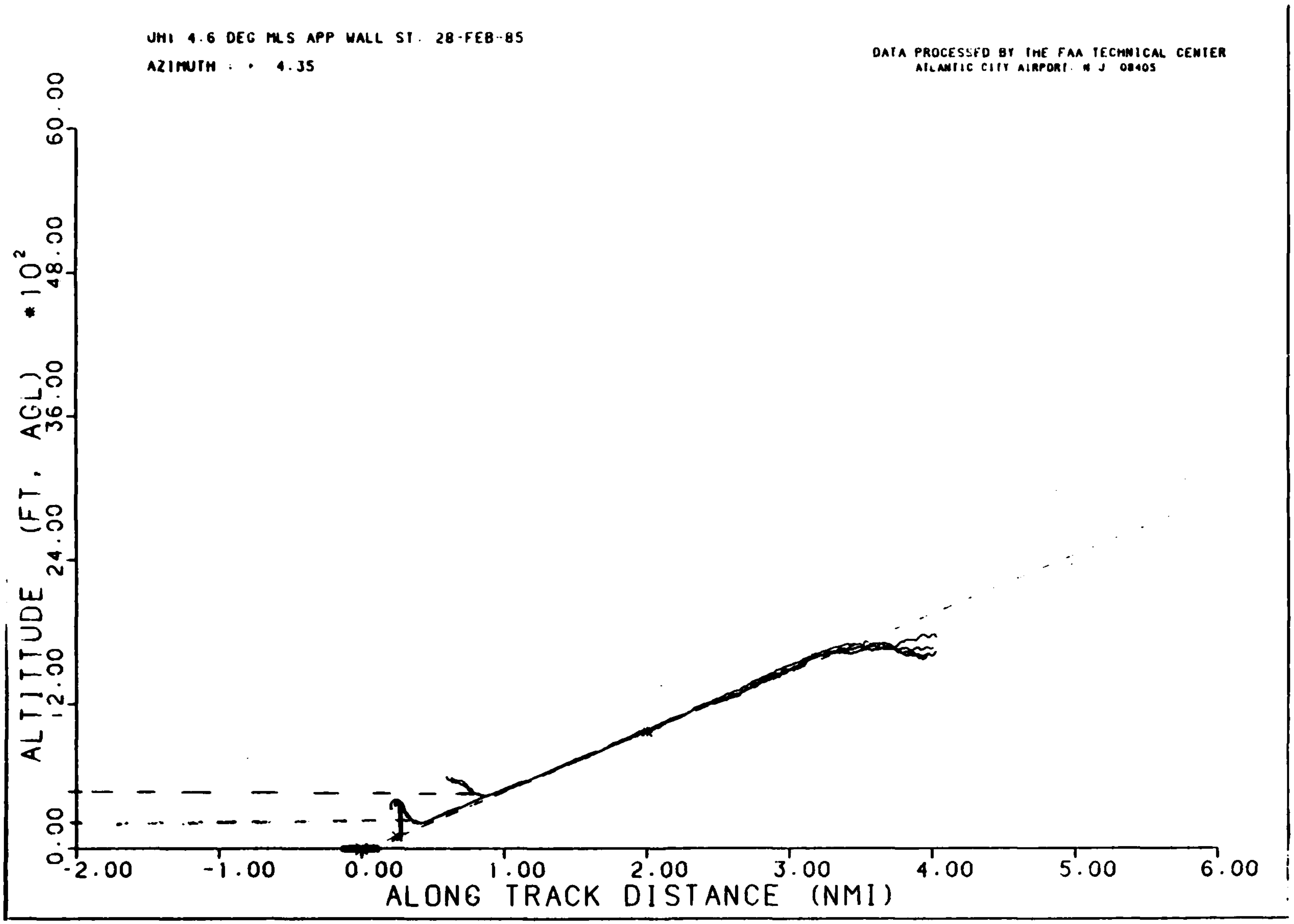


FIGURE 10. WALL ST. 4.6° ELEVATION ANGLE APPROACHES (ALTITUDE DEVIATION)

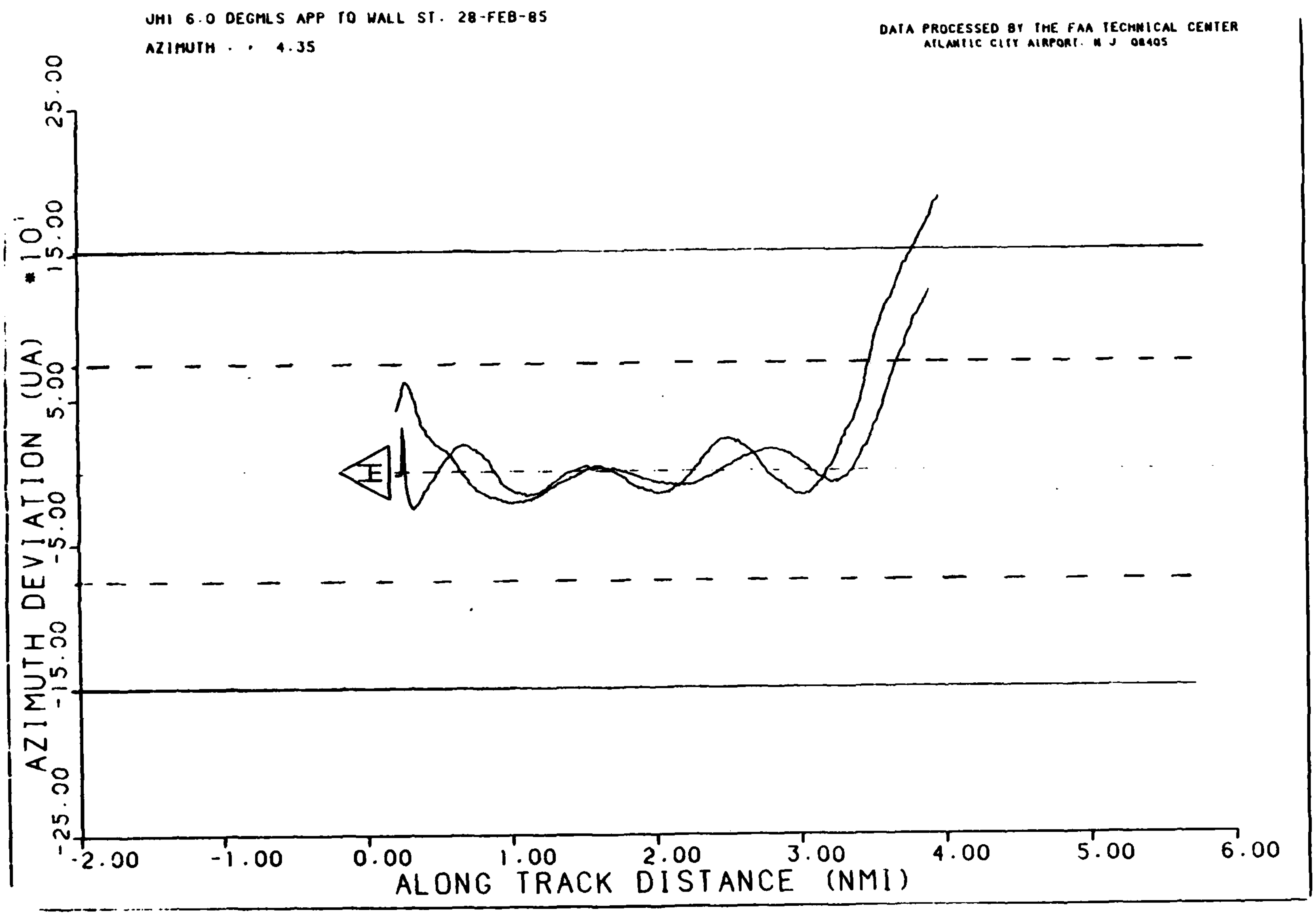


FIGURE 11. WALL ST. 6.0° ELEVATION ANGLE APPROACHES (CDI DEVIATION)

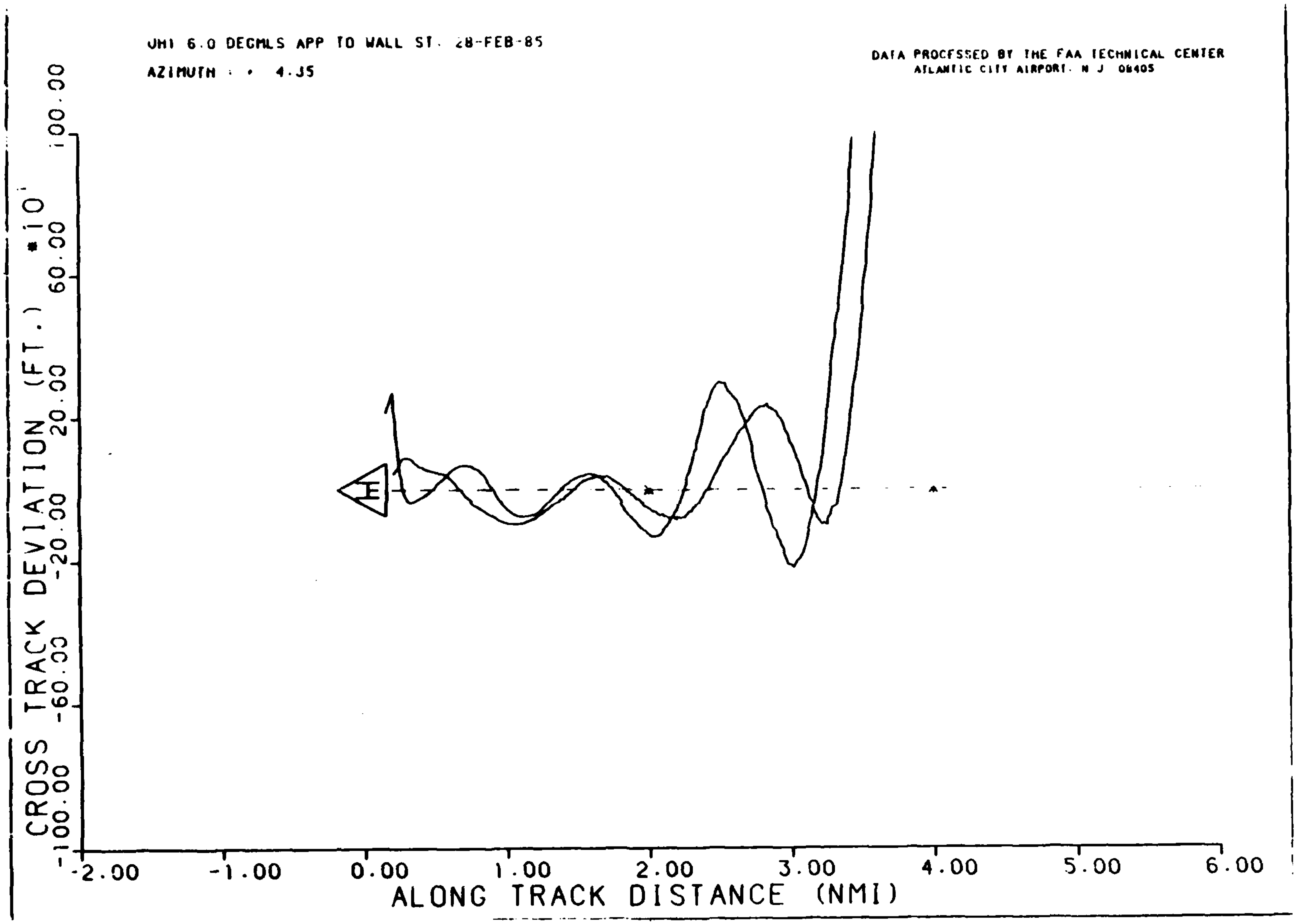


FIGURE 12. WALL ST. 6.0° ELEVATION ANGLE APPROACHES (CROSSTRACK DEVIATION)

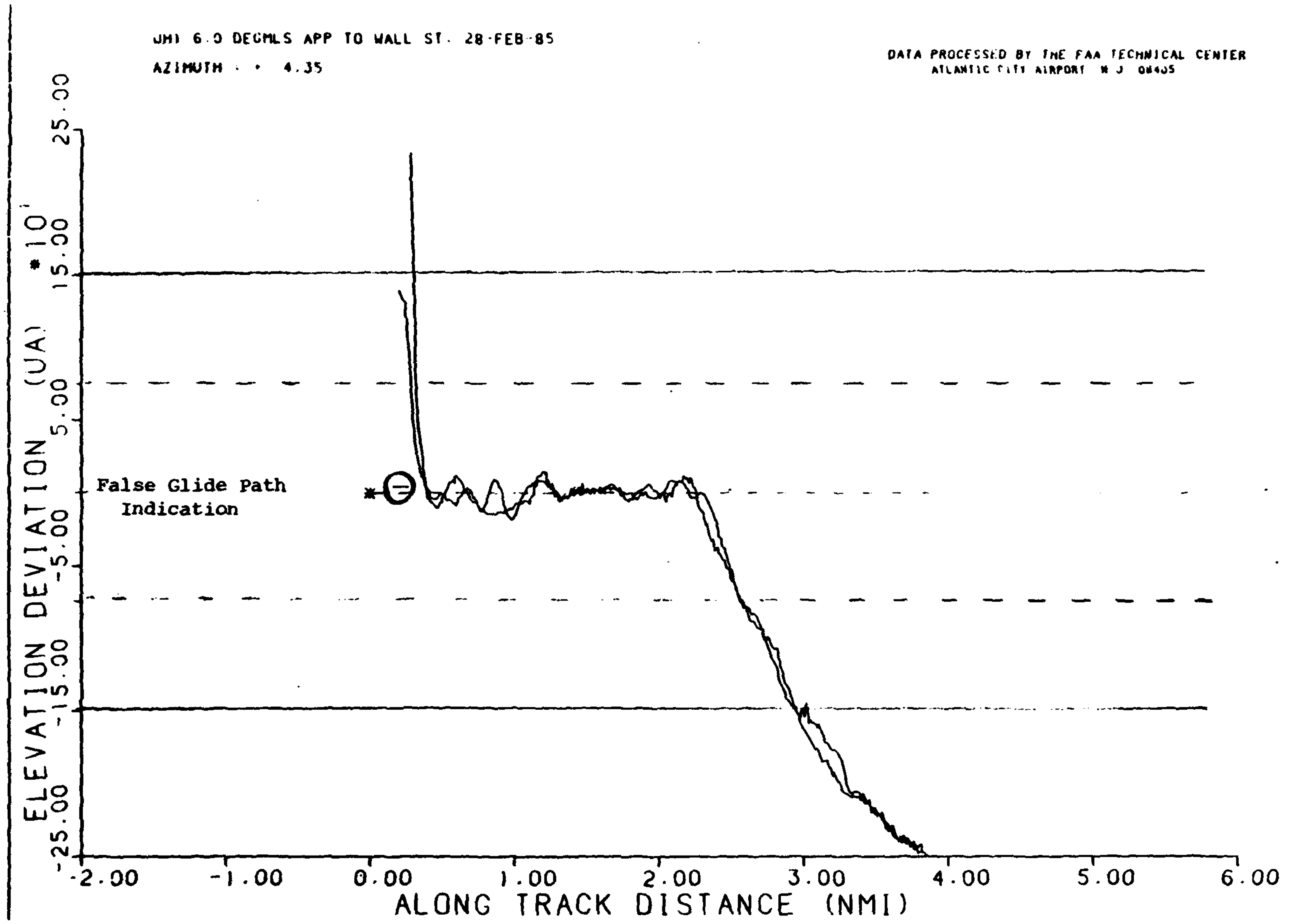


FIGURE 13. WALL ST. 6.0° ELEVATION ANGLE APPROACHES (VDI DEVIATION)

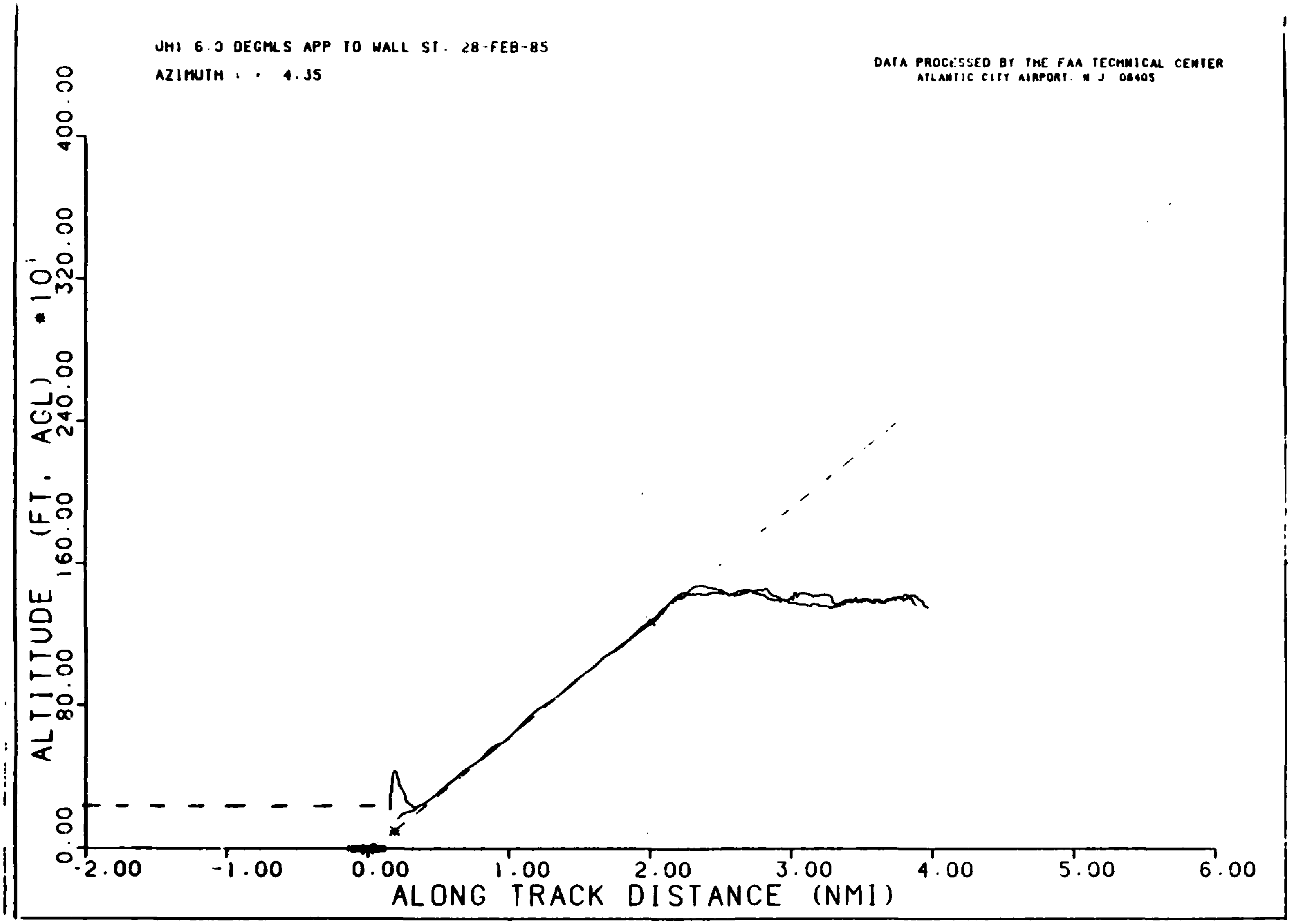


FIGURE 14. WALL ST. 6.0° ELEVATION ANGLE APPROACHES (ALTITUDE DEVIATION)

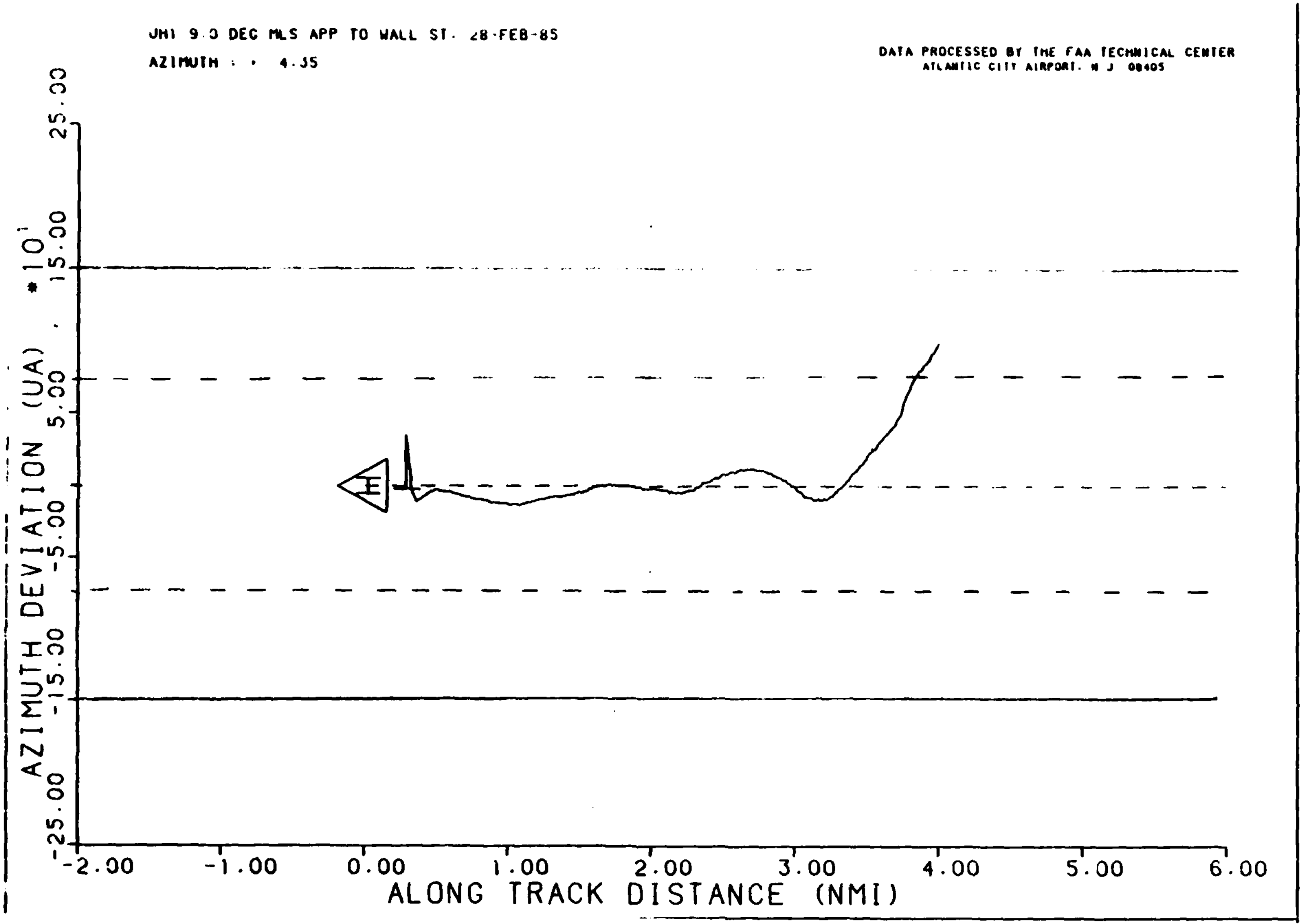


FIGURE 15. WALL ST. 9.0° ELEVATION ANGLE APPROACHES (CDI DEVIATION)

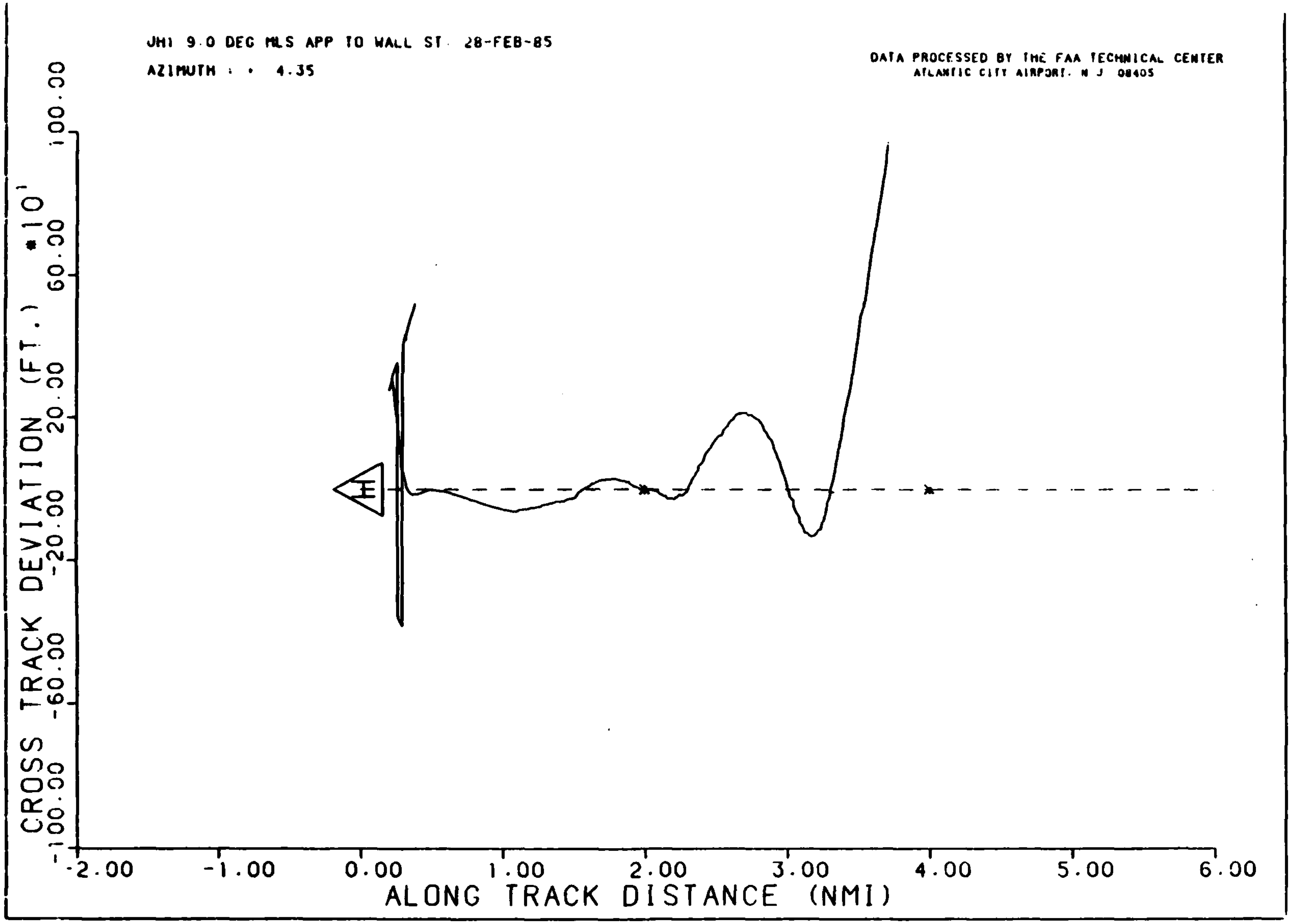


FIGURE 16. WALL ST. 9.0° ELEVATION ANGLE APPROACH (VDI DEVIATION)

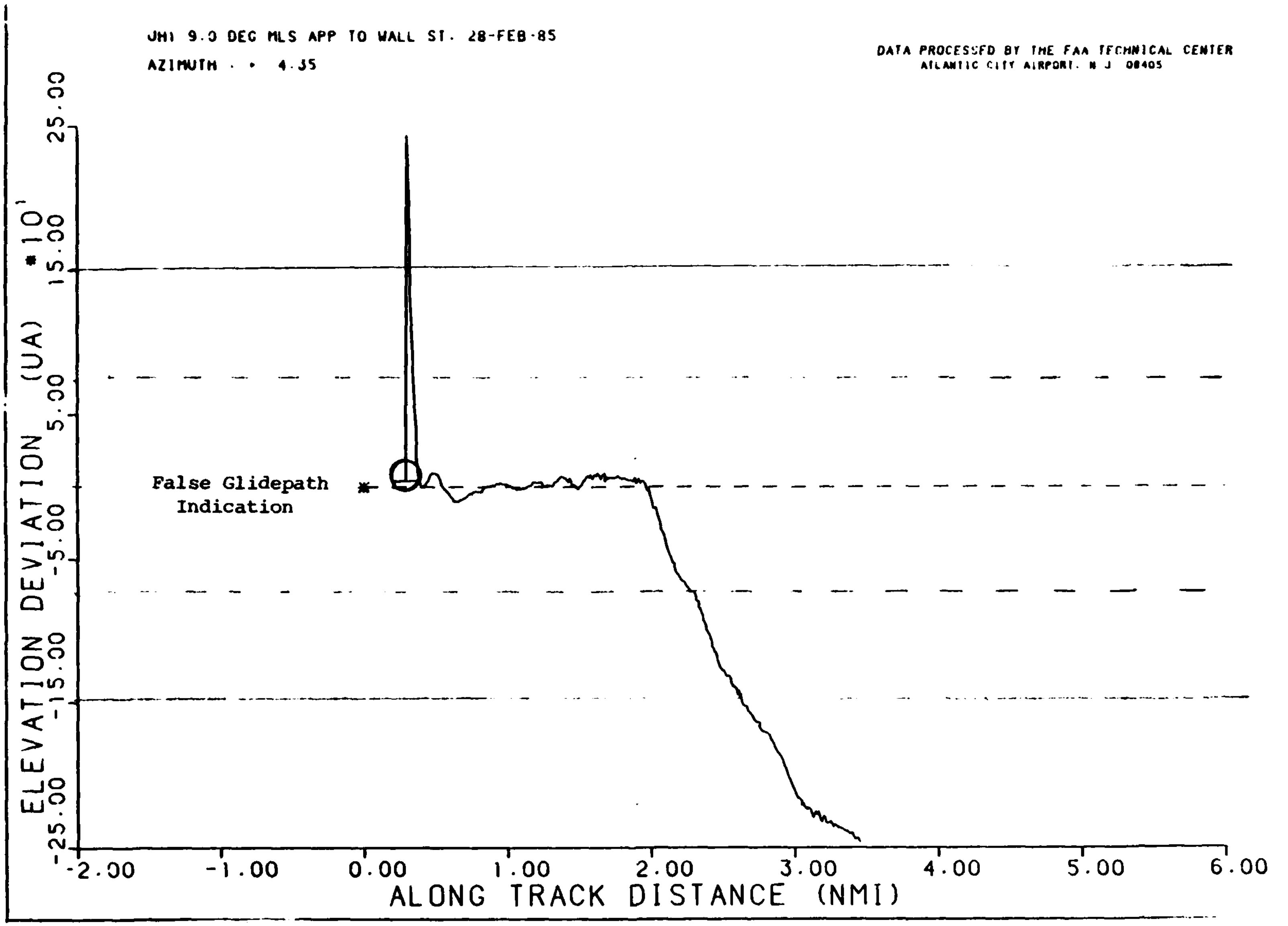


FIGURE 17. WALL ST. 9.0° ELEVATION ANGLE APPROACH (VDI DEVIATION)

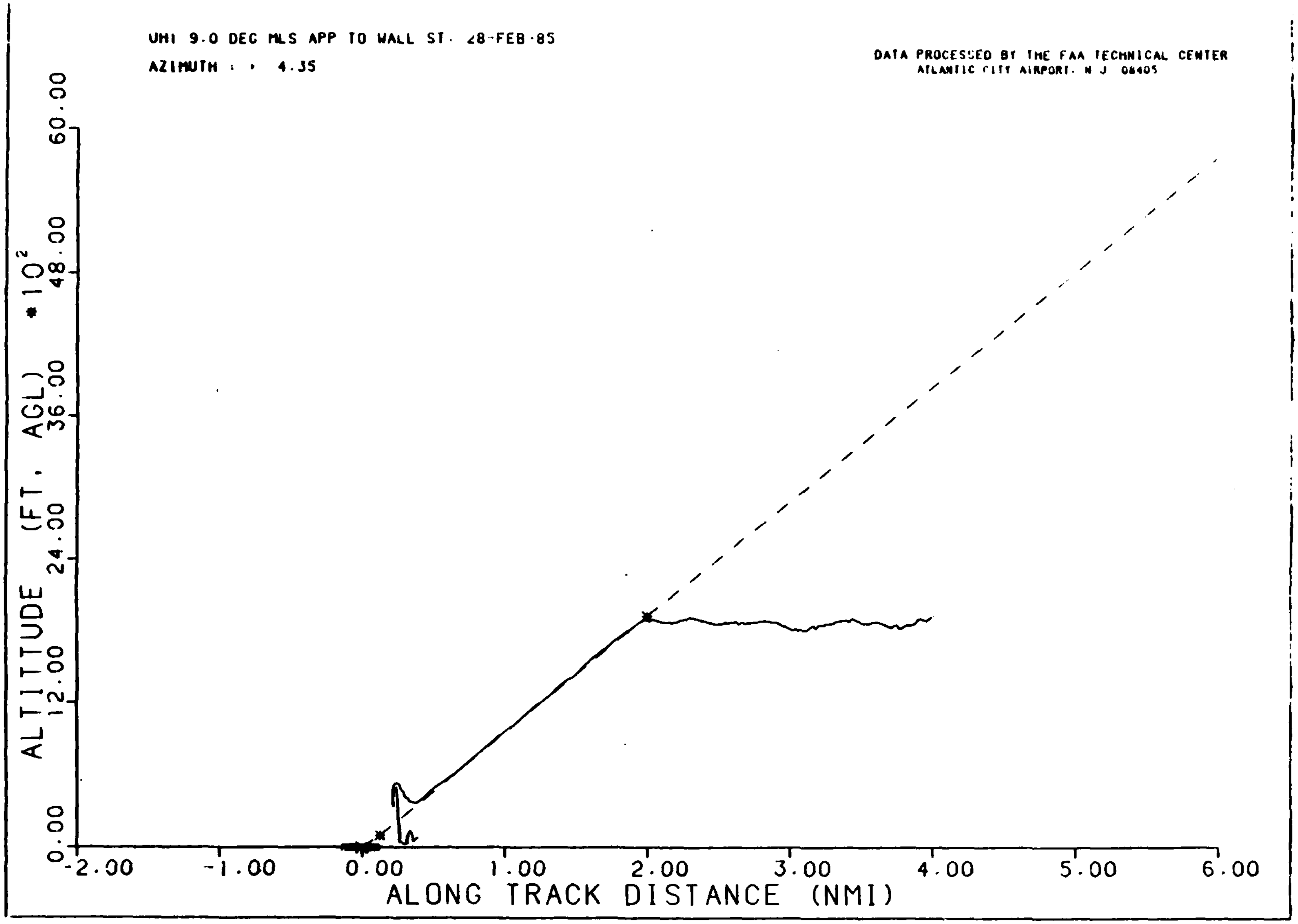


FIGURE 18. WALL ST. 9.0° ELEVATION ANGLE APPROACH (ALTITUDE DEVIATION)

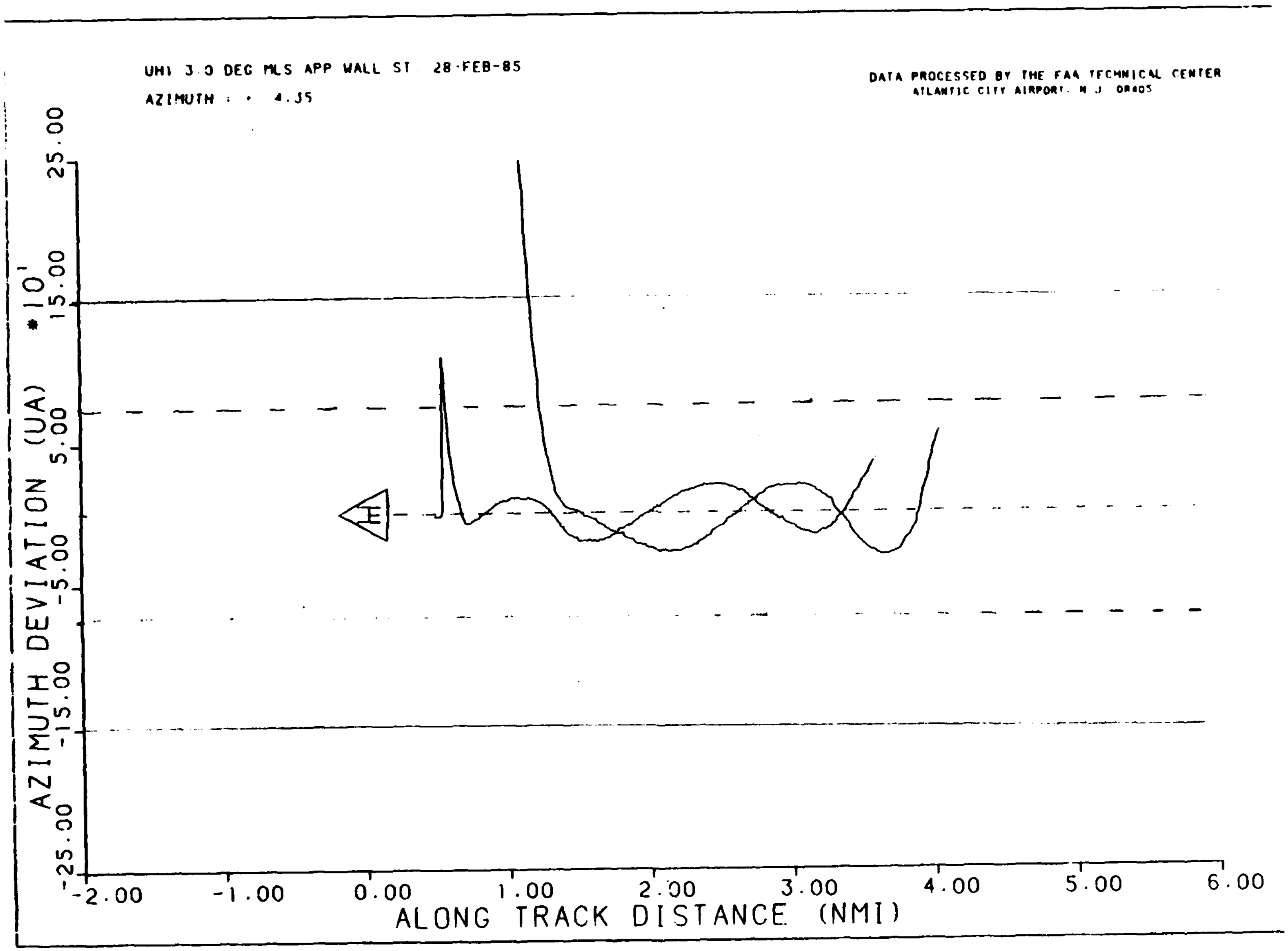


FIGURE 19. WALL ST. 3.0° ELEVATION ANGLE APPROACHES (CDI DEVIATION)

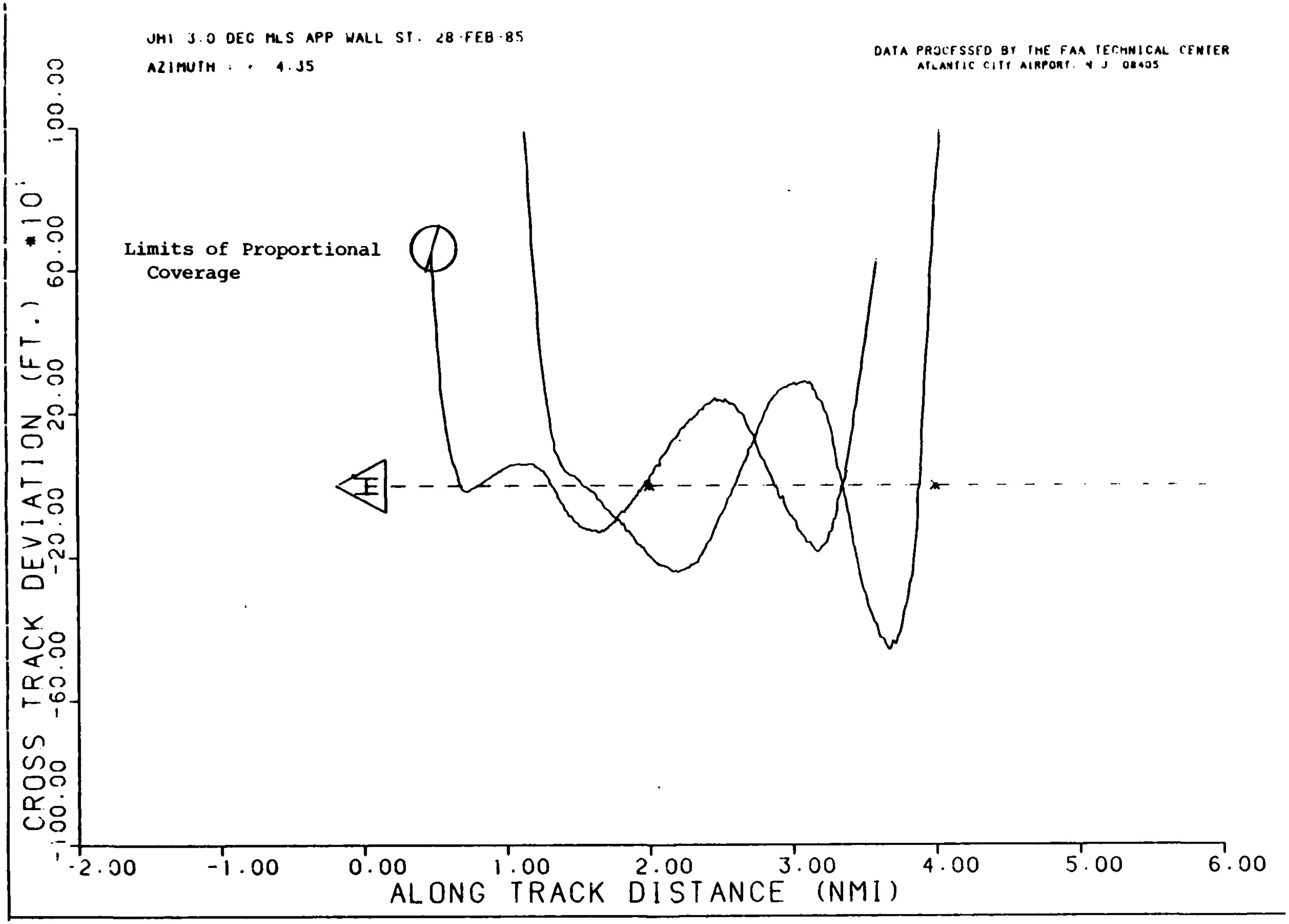


FIGURE 20. WALL ST. 3.0° ELEVATION ANGLE APPROACHES (CROSSTRACK DEVIATION)

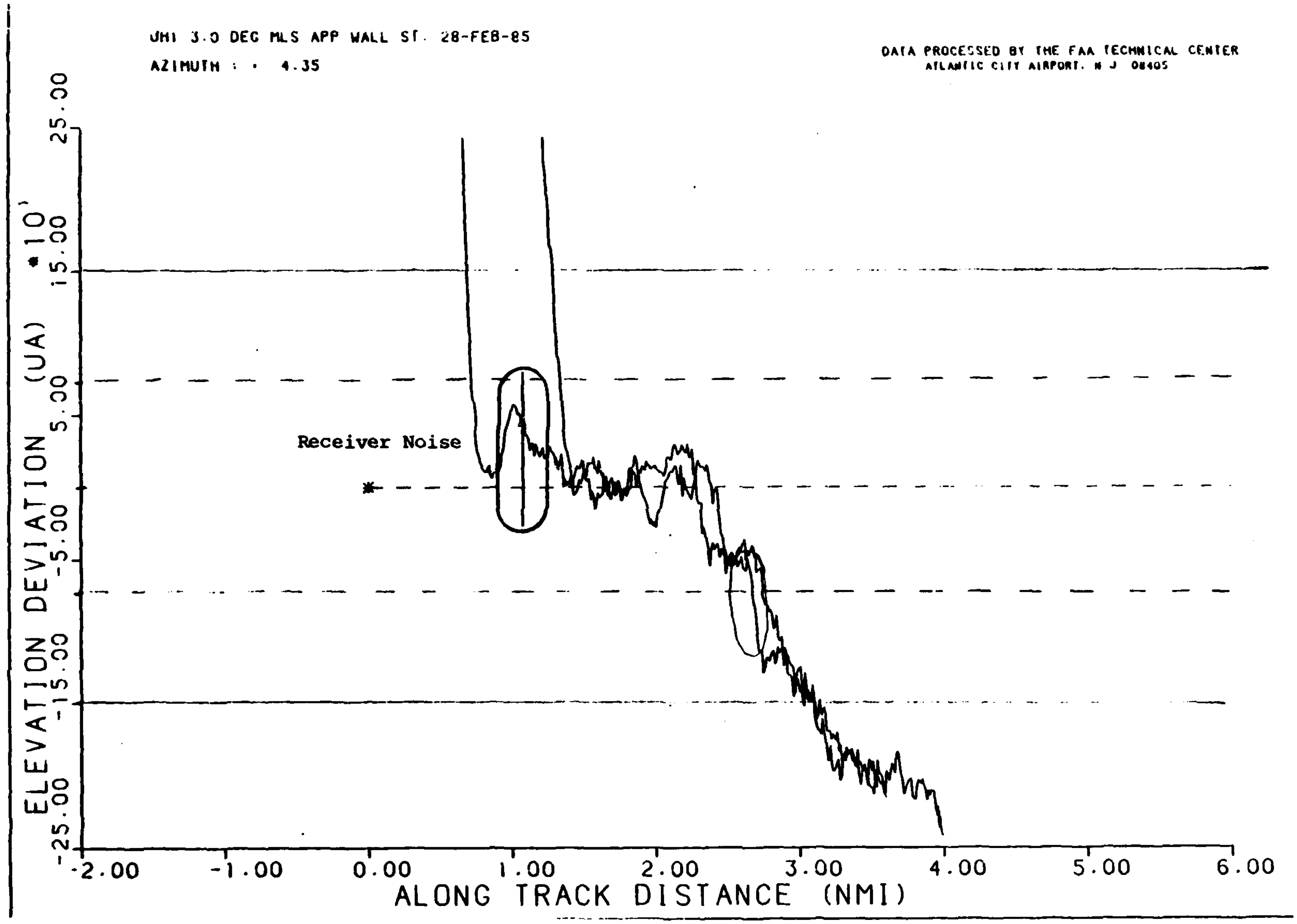


FIGURE 21. WALL ST. 3.0° ELEVATION ANGLE APPROACHES (VDI DEVIATION)

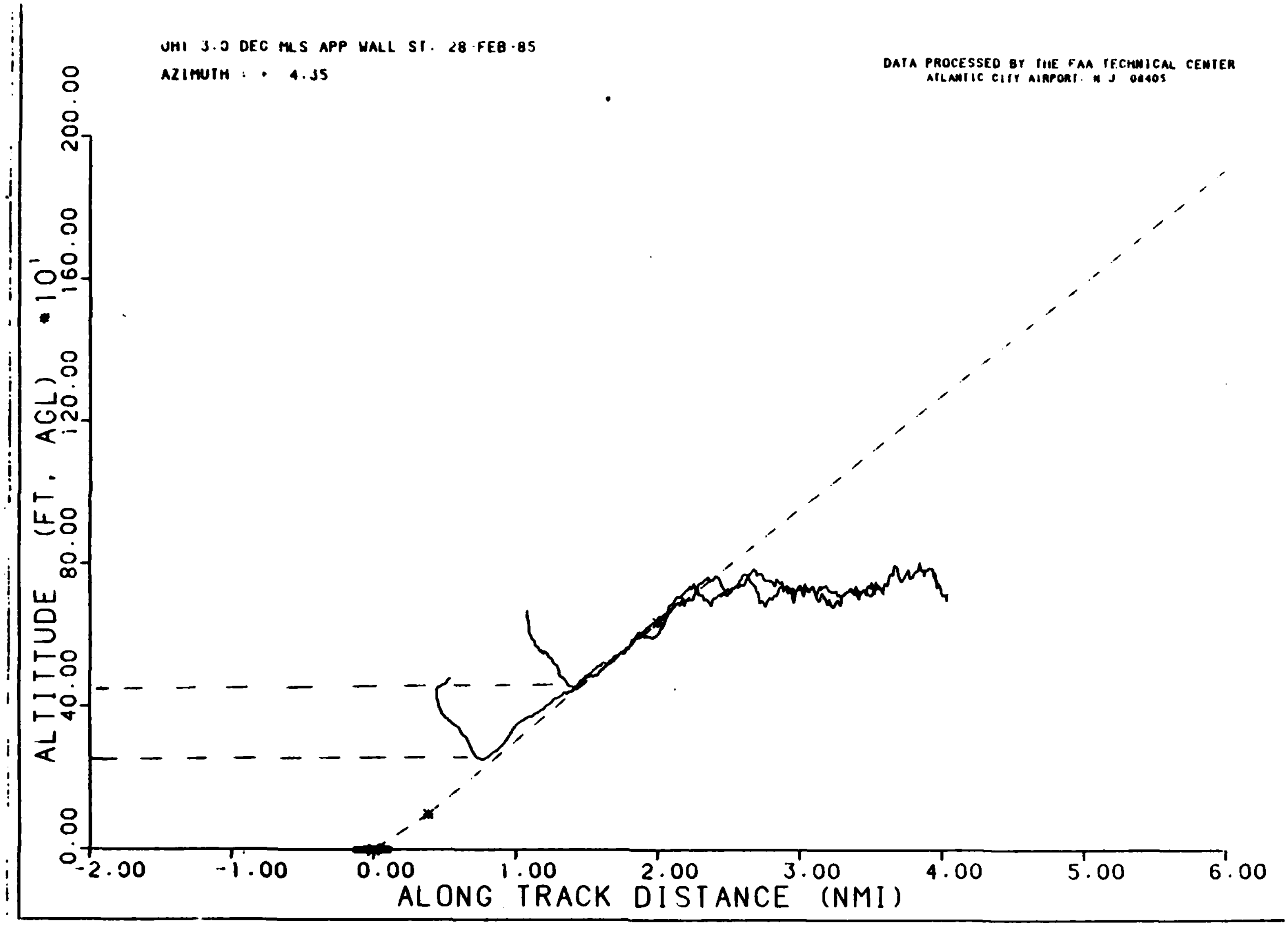


FIGURE 22. WALL ST. 3.0° ELEVATION ANGLE APPROACHES (ALTITUDE DEVIATION)

1/4 scale above the glide slope to 1/2 scale below the glide slope. The pilots reported intermittent off flags (both CDI and VDI) through the approach.

March 21, 1985. During the period March 1 to 15 the MLS equipment was resited from the Pier 9 site to the Battery Park site. This site permitted the users to fly MLS approaches to DH's of 200 feet and to complete the approach with a full stop landing. After this relocation several additional data collection flights were made with the UH-1. The first flight at the Battery Park site was designed to review the candidate procedures for this site. As a result of this flight, it was necessary to redraw the Battery Park approach plates with the appropriate azimuth centerline of 050° magnetic. The revised approach plates are shown in figures 23 to 25. Another change that was made at Battery Park was to reduce the azimuth course width to ±3.6°, the azimuth course width which produced the best results at the FAA Technical Center. Previously, a course width of ±4.35° had been used at the Wall Street site.

March 27, 1985. The purpose of this flight was to collect data on the resited MLS equipment. Several approaches were conducted and signal coverage was verified.

April 18, 1985. The purpose of this flight was data collection at the Battery Park site. This flight consisted of azimuth coverage patterns using 3°, 4.6°, 6°, and 9° approaches. Level flight profiles to check for elevation grating side lobes were also flown. The significant results of the flight are discussed below.

4.6° Approach. Two 4.6° approaches were made. During the flight the crew reported several cases of large CDI and VDI oscillations and intermittent off flags on the displays. The flight log contained the following remarks:

a. First 3° approach two glitches in azimuth data.

b. One full left CDI oscillation at 1.6 miles DME on second 3° approach.

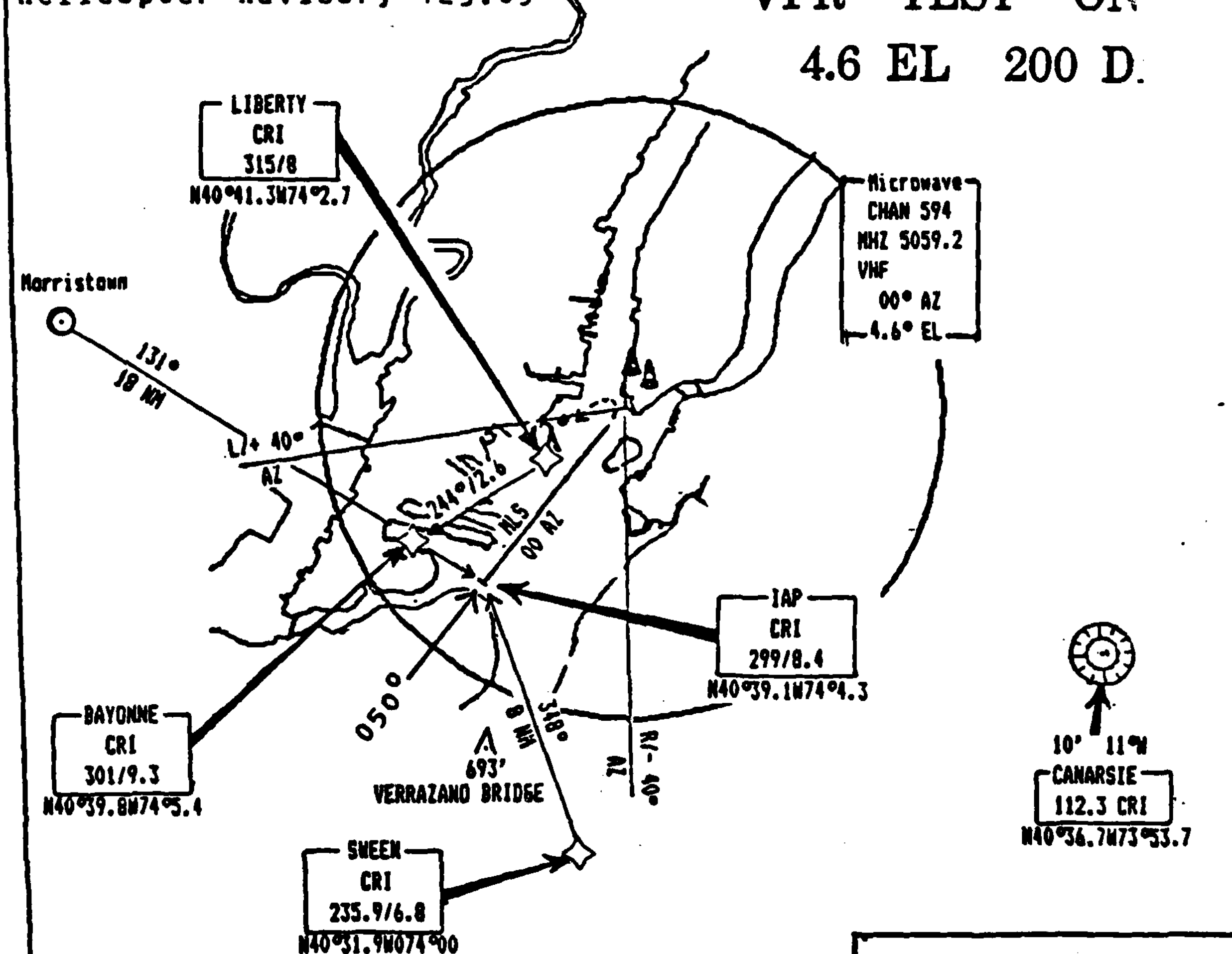
c. Simultaneous azimuth and elevation glitches about 1.9 miles DME on second 4.6° approach.

The plots of the 4.6° approach deviations are shown in figures 26 and 27. The azimuth deflection mentioned in "c" above is shown in figure 26. At 1.86 miles DME the digital data showed the recorded successive azimuth currents were -13 microamps (μA), 41 μA, and -14 μA. This represents a 54 and 55 μA change in 0.5 seconds. Since the data collection system is not collecting data at the full data rate (39 Hz), some data are missing. As a result, the elevation problems identified in the flight log are not apparent in figure 27. The reason for the oscillations are unknown. The large deviation in figure 27 above glide slope at 1 nmi is caused by pilot tracking technique.

Level Flight Profiles. Three level flight profiles were flown to check the existence of the elevation grating lobes. All three profiles were flown at 2,000 feet m.s.l. One profile each was accomplished on the 08° L, the 08° R, and 0° azimuth. The results of the azimuth and elevation deviations are shown in figures 28 to 31. In figures 29 and 31 the results of the grating lobe

Newark Tower 127.85
Helicopter Advisory 123.05

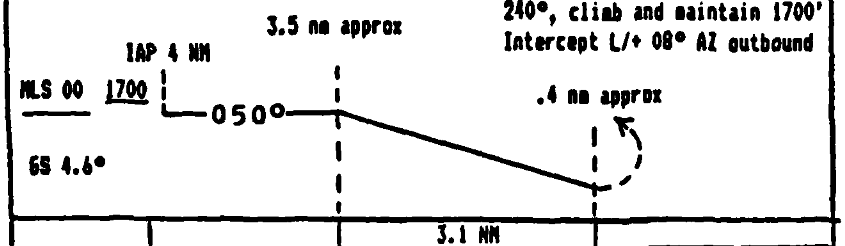
VFR TEST ON
4.6 EL 200 D.



COPTER ONLY

ELEV 07

Missed Approach: Immediate climbing left turn to heading 240°, climb and maintain 1700' Intercept L/+ 08° AZ outbound



CATEGORY	COPTER
S-MLS 050°	200 - 3 200 (1500-3)

Arrivals over SWEEN contact New York Approach on 127.4.
ATC clearence is required for all flights within the TCA.
Notify Battery Park Heliport on 123.05 with location and intentions.
If executing the MAP for another approach advise Newark Tower before reentering the TCA.

MAX GROUND SPEED 75 kts

RATE OF DESCENT 595 FT/MIN AT 75 KTS

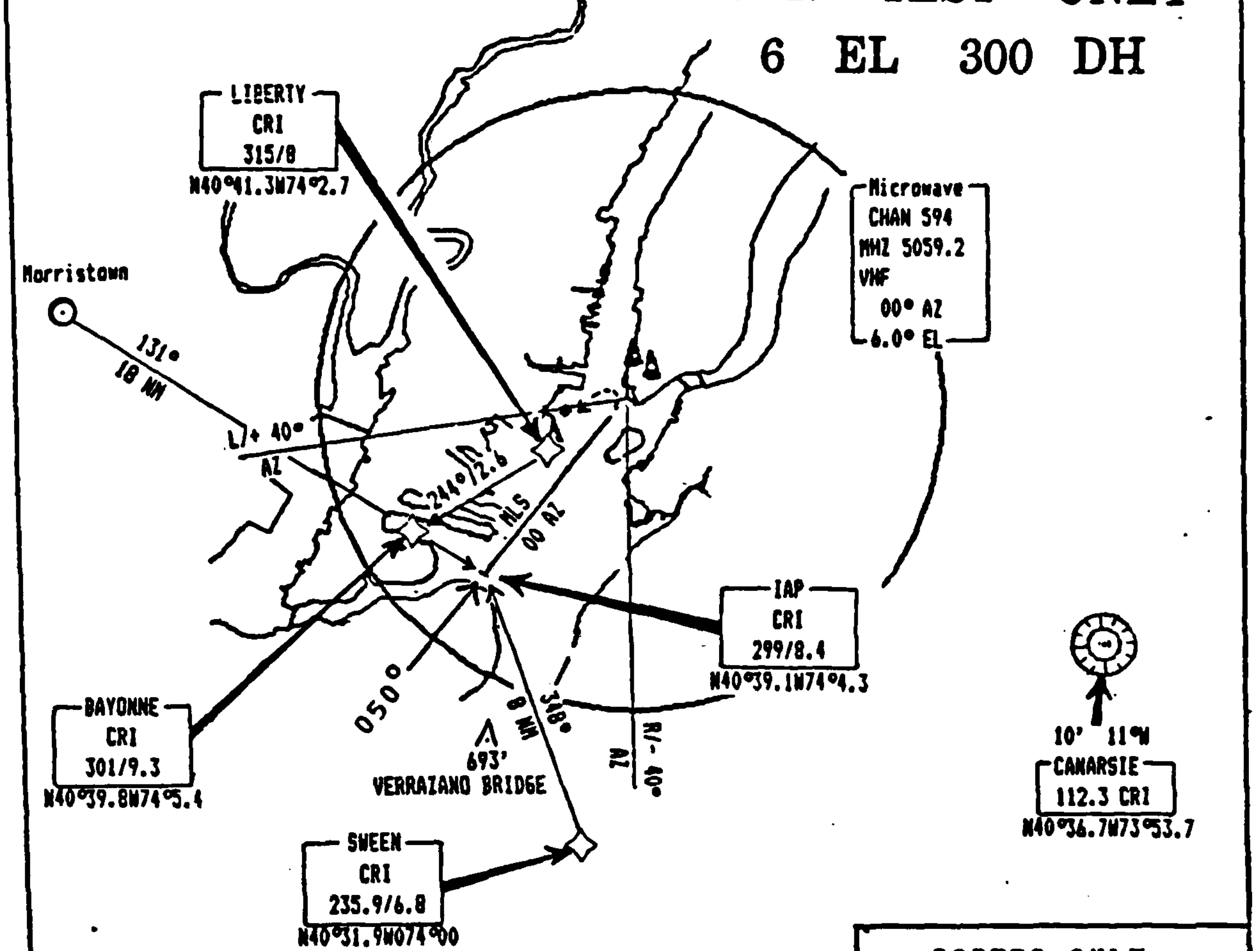
FAP to MAP 3.1 NM

Knots	60	75
Min:Sec	3:06	2:28

FIGURE 23. BATTERY PARK 050°/4.6° MLS APPROACH

Newark Tower 127.85
Helicopter Advisory 123.05

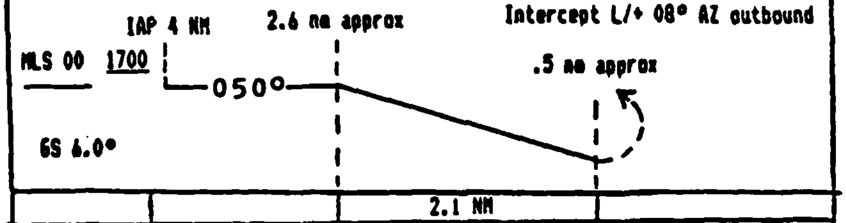
VFR TEST ONLY
6 EL 300 DH



COPTER ONLY

ELEV 07

Missed Approach: Immediate climbing left turn to heading 240°, climb and maintain 1700' Intercept L/+ 08° AZ outbound



CATEGORY COPTER

S-MLS 050° 300 - 3 300 (1500-3)

Arrivals over SWEEN contact New York Approach on 127.4.
ATC clearence is required for all flights within the TCA.
Notify Battery Park Heliport on 123.05 with location and intentions.
If executing the MAP for another approach advise Newark Tower before reentering the TCA.

MAX GROUND SPEED 75 kts

RATE OF DESCENT 795 FT/MIN AT 75 KTS

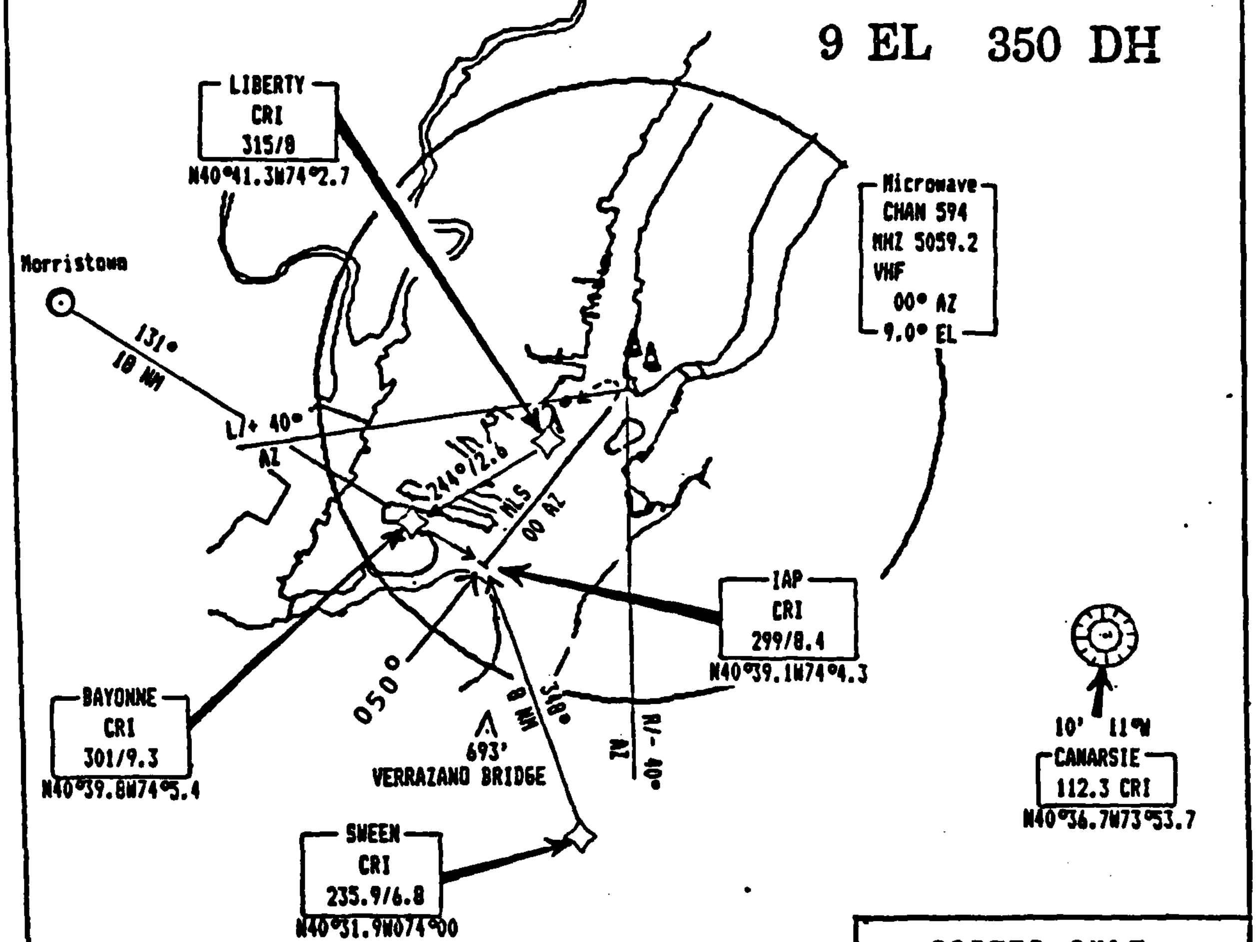
FAP to MAP 2.1 NM		
Knots	60	75
Min:Sec	2:08	1:40

FIGURE 24. BATTERY PARK 050°/6.0° MLS APPROACH

Newark Tower 127.85
Helicopter Advisory 123.05

VFR TEST ONLY

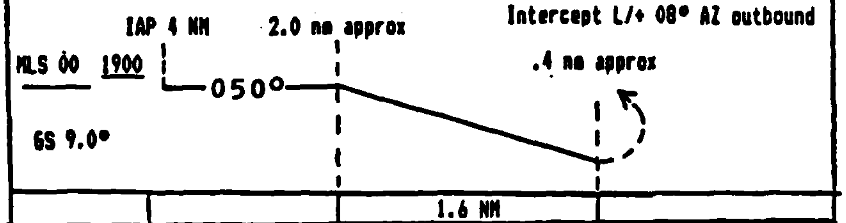
9 EL 350 DH



COPTER ONLY

ELEV 07

Missed Approach: Immediate climbing left turn to heading 240°, climb and maintain 1700' Intercept L/+ 08° AZ outbound



CATEGORY	COPTER
S-MLS 050° 350 - 3	350 (2000-3)

Arrivals over SWEEN contact New York Approach on 127.4.
ATC clearence is required for all flights within the TCA.
Notify Battery Park Heliport on 123.05 with location and intentions.
If executing the MAP for another approach advise Newark Tower before reentering the TCA.

MAX GROUND SPEED 75 kts

RATE OF DESCENT 1190 FT/MIN AT 75 KTS

FAP TO MAP 1.6 NM

Knots	60	75
Min:Sec	1:35	1:17

FIGURE 25. BATTERY PARK 050°/9.0° MLS APPROACH

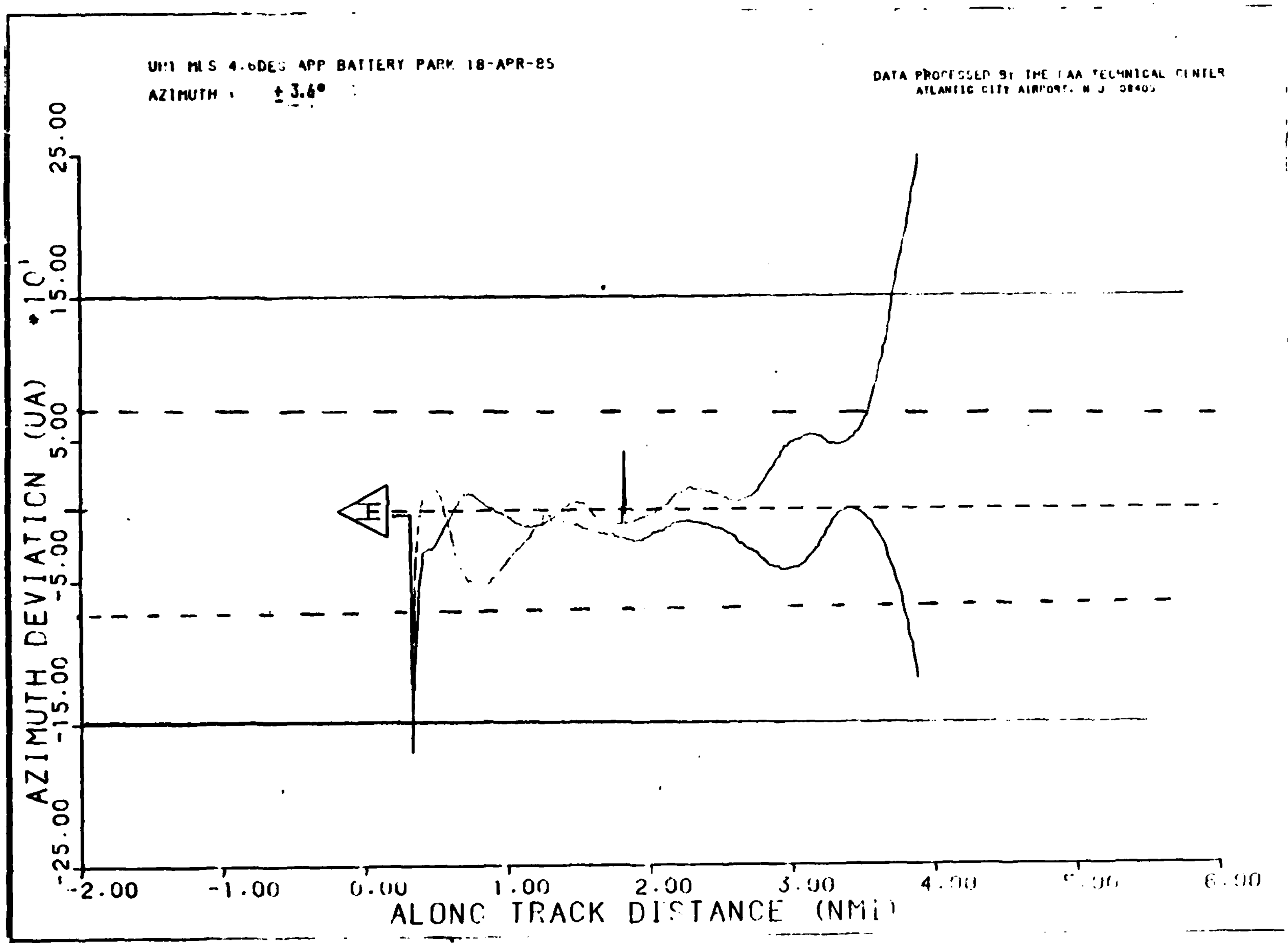


FIGURE 26. BATTERY PARK 4.6° ELEVATION ANGLE APPROACHES (CDI DEVIATION)

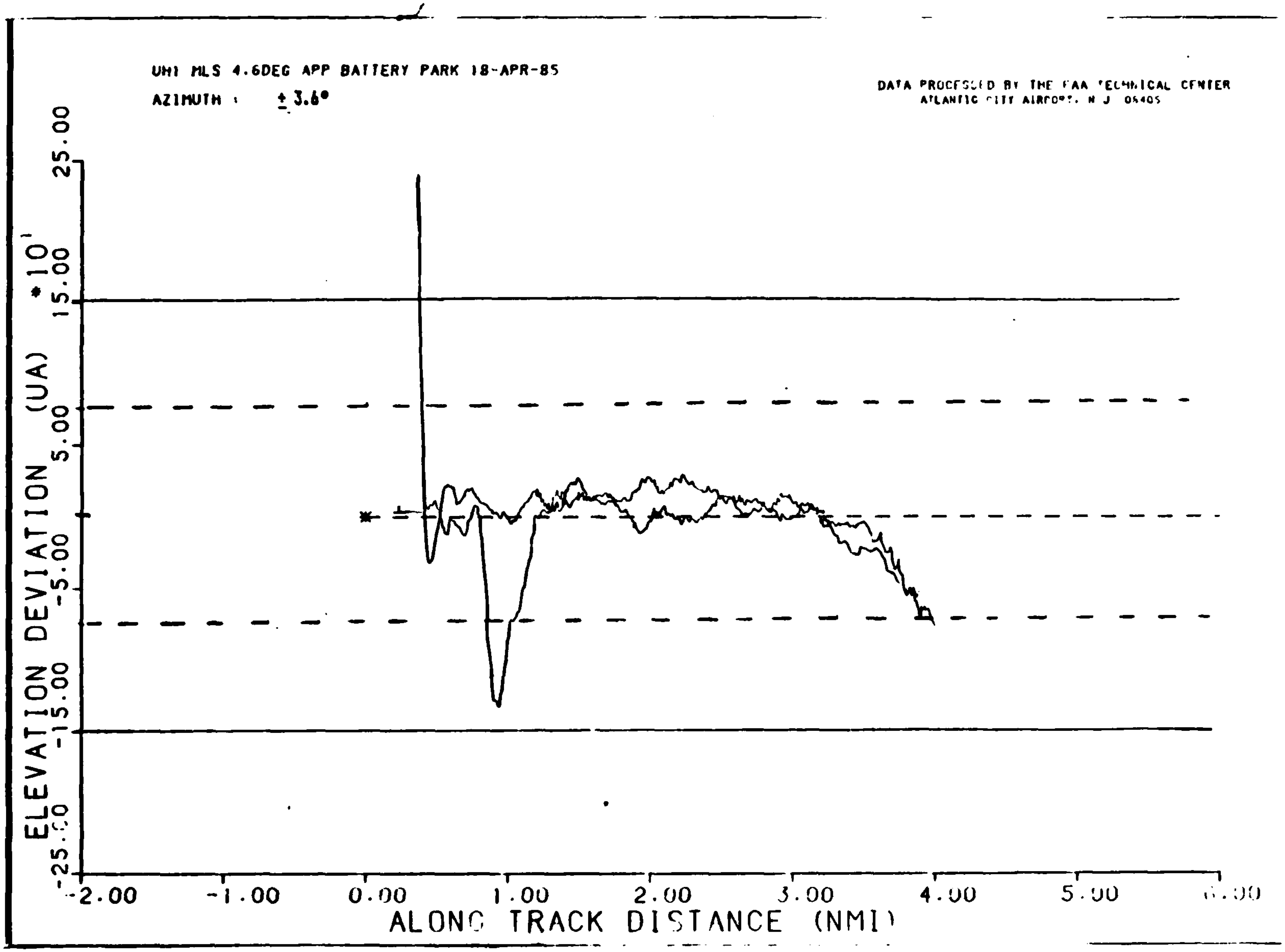


FIGURE 27. BATTERY PARK 4.6° ELEVATION ANGLE APPROACHES (VDI DEVIATION)

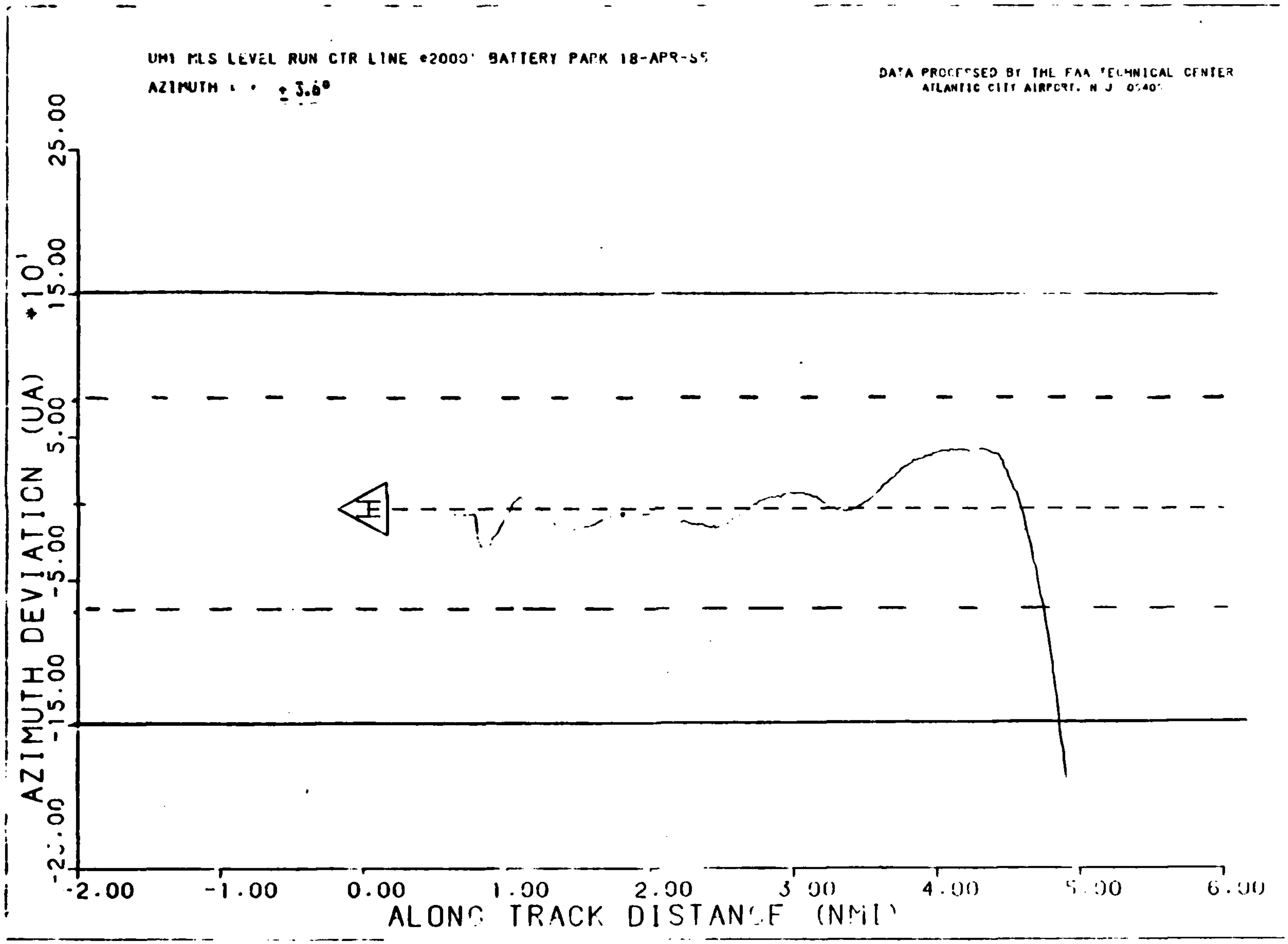


FIGURE 28. BATTERY PARK LEVEL RUN 0° AZ CDI DEVIATION

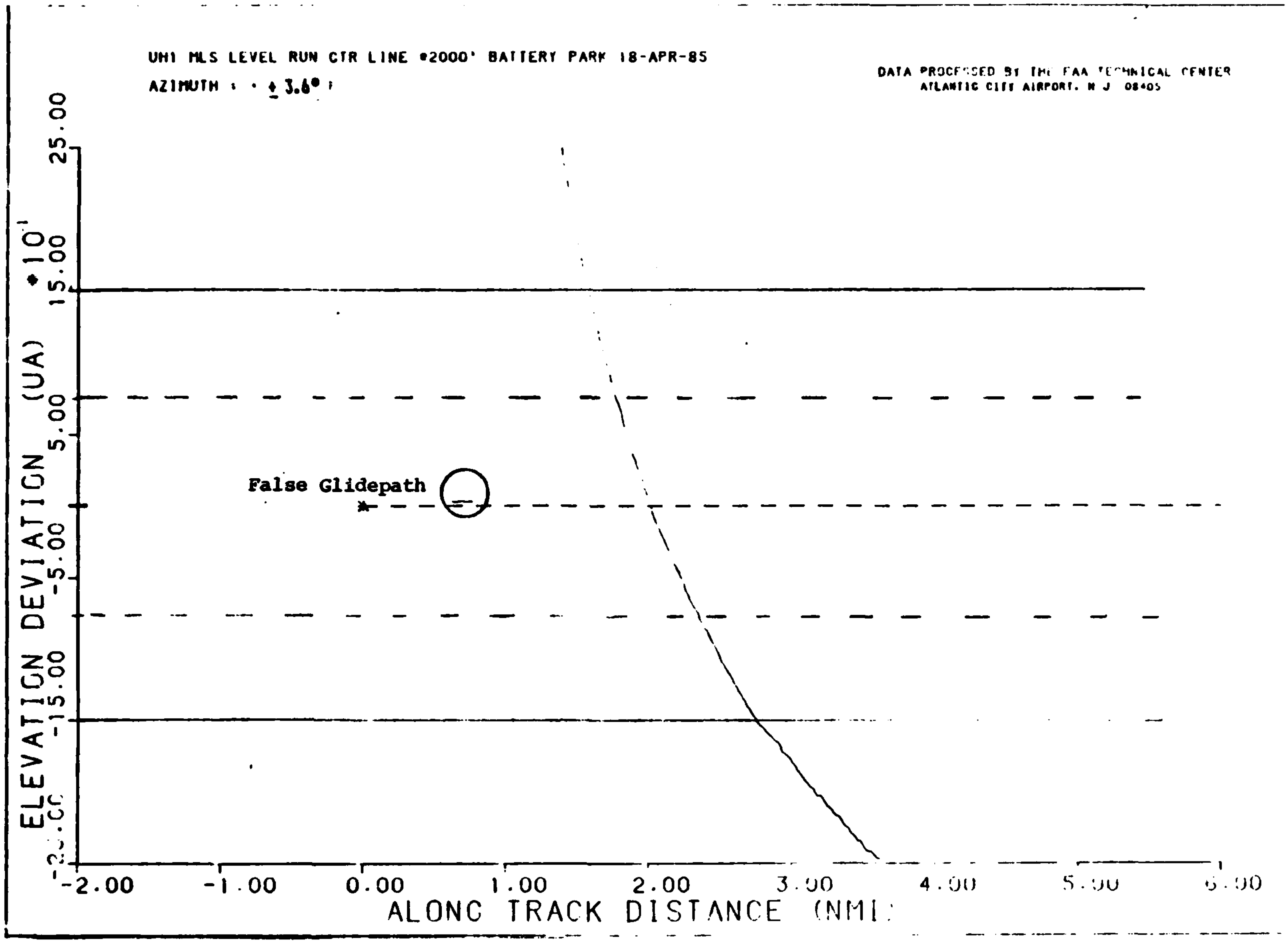


FIGURE 29. BATTERY PARK LEVEL RUN 0° AZ VDI DEVIATION

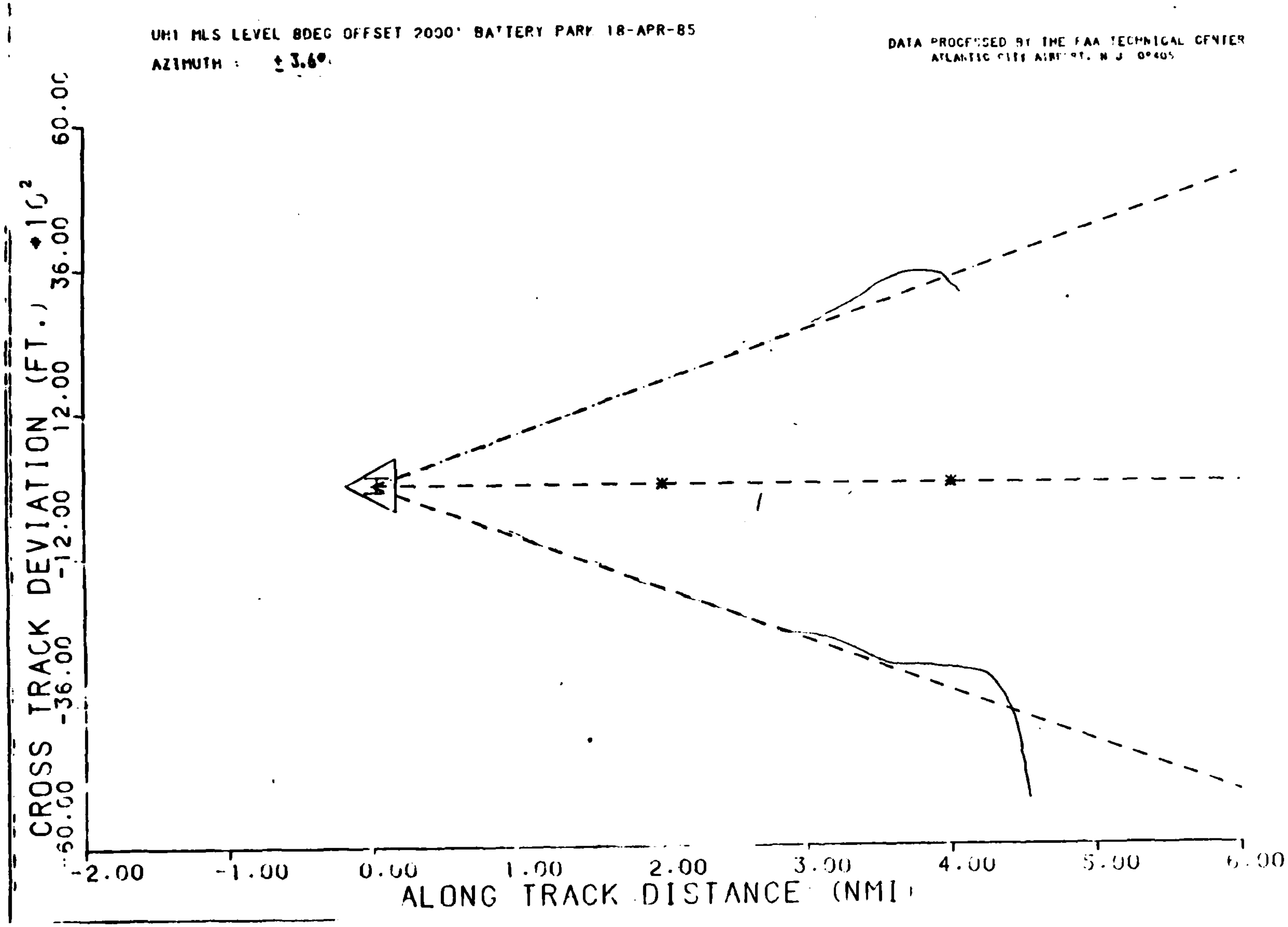


FIGURE 30. BATTERY PARK LEVEL RUN 08° LEFT AND 08° RIGHT CDI DEVIATIONS

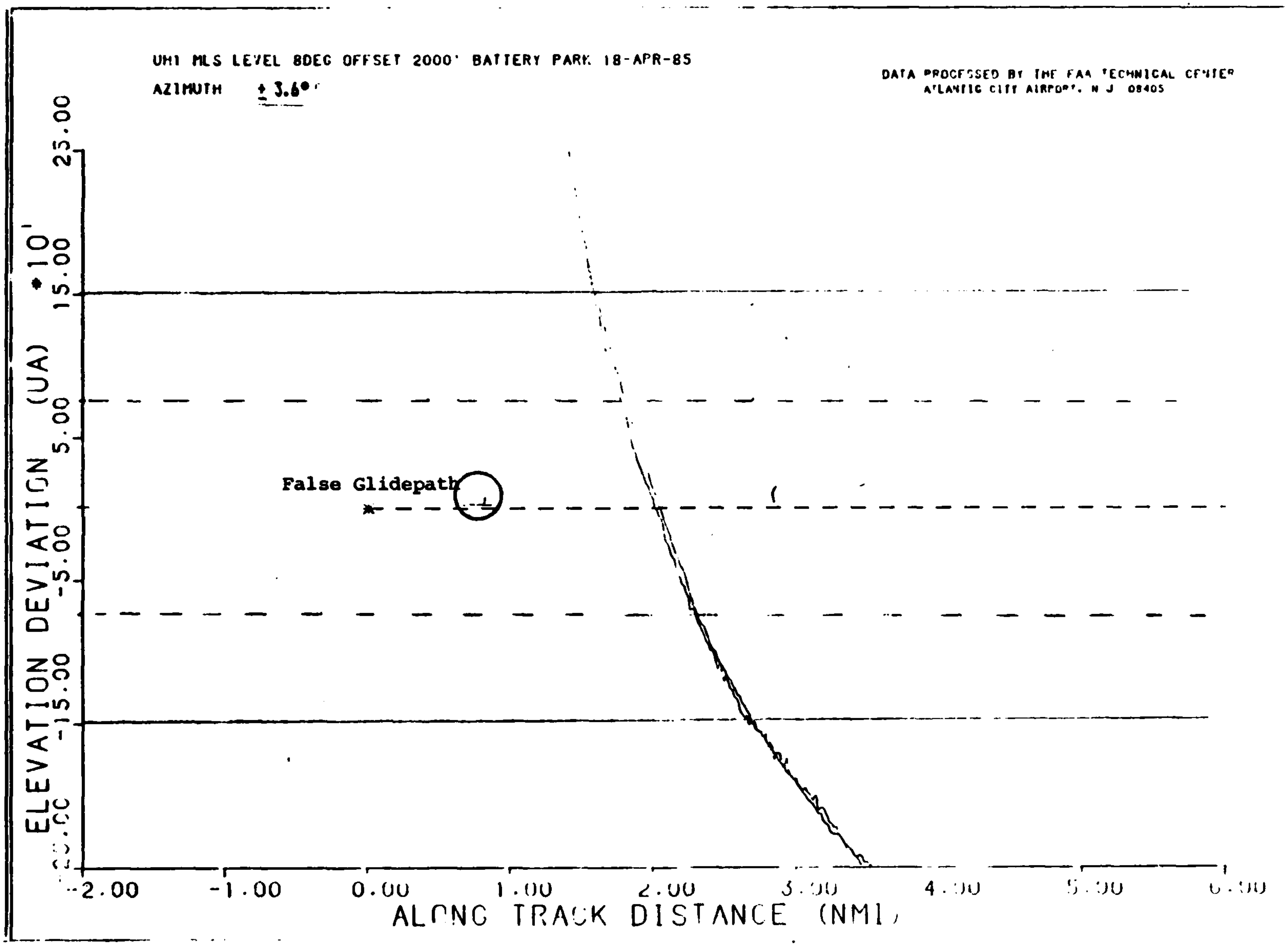


FIGURE 31. BATTERY PARK LEVEL RUN 08° LEFT AND 08° RIGHT OFFSET VDI DEVIATIONS

effects are apparent around 0.9 nmi and are circled on the figure. The side lobe occurs on an 20° elevation angle. Results were similar for both the offset azimuths and centerline azimuth.

May 9, 1985. Another data collection flight was made on this date. The flight was designed to collect data to further define problems detected on the April 18 flight.

The scenario consisted of:

a. One 4.6° approach.

b. Two 6° approaches.

c. One 9° approach.

d. One level flight centerline approach at 1,700 feet m.s.l.

e. One level flight centerline approach at 1,200 feet m.s.l.

The flight log contained the following notations:

a. Azimuth glitch at 4.3 miles DME on first 6° approach.

b. Full scale left CDI oscillation at 4.0 miles DME on the second 6° approach.

c. On 9° approach glide slope an azimuth glitch at 1.5 miles DME, intermittent off flags at 1.4 miles DME, and full left azimuth swing at 1.2 miles DME.

d. 4.6° approach azimuth glitch at 4.3 miles DME.

e. On level flight at 1,700 feet m.s.l. the azimuth glitched at 4.3 and 4.2 miles DME. Azimuth were noticed at 1.4 miles DME and CDI jumps at 1.2 miles DME. (Note: no personnel or equipment in front of antennas.)

f. On 1,200-foot MLS level segment system glitch at 1.2 DME.

The log comments caused us to focus our attention to 0° azimuth 1.2 to 1.5 mile DME and 4.0 to 4.3 mile DME regions. In addition to the analog plots, the digital data recordings were reviewed. Data recording included oscillations exceeding 170 μA changes in 0.5 seconds. In figure 32, a more than 50 μA change in azimuth signal is shown about 1.4 DME. In figure 33 the results of the elevation grating lobe is apparent. The grating lobe occurred at approximately 20° elevation.

June 10. Because of the anomalies that were detected with the use of the STEP receiver, a cabin class MLS receiver was installed in the UH-1H. Additionally, a second aft mounted antenna was installed in the UH-1H. The results of the flight indicate consistently better performance than had been observed with the STEP receivers. A total of 10 approaches were flown with the Cabin Class

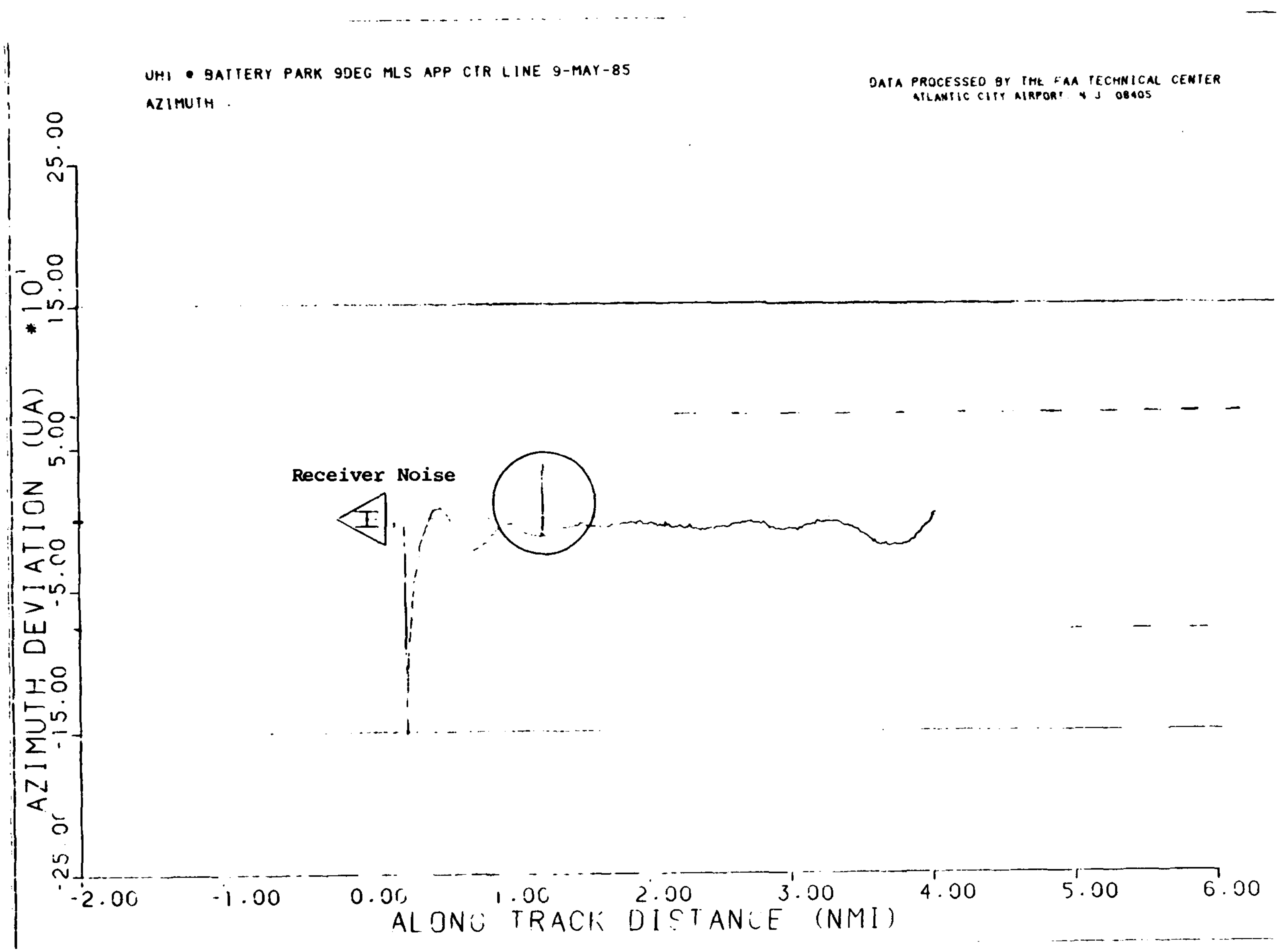


FIGURE 32. BATTERY PARK 9.0° ELEVATION ANGLE APPROACH (CDI DEVIATION)

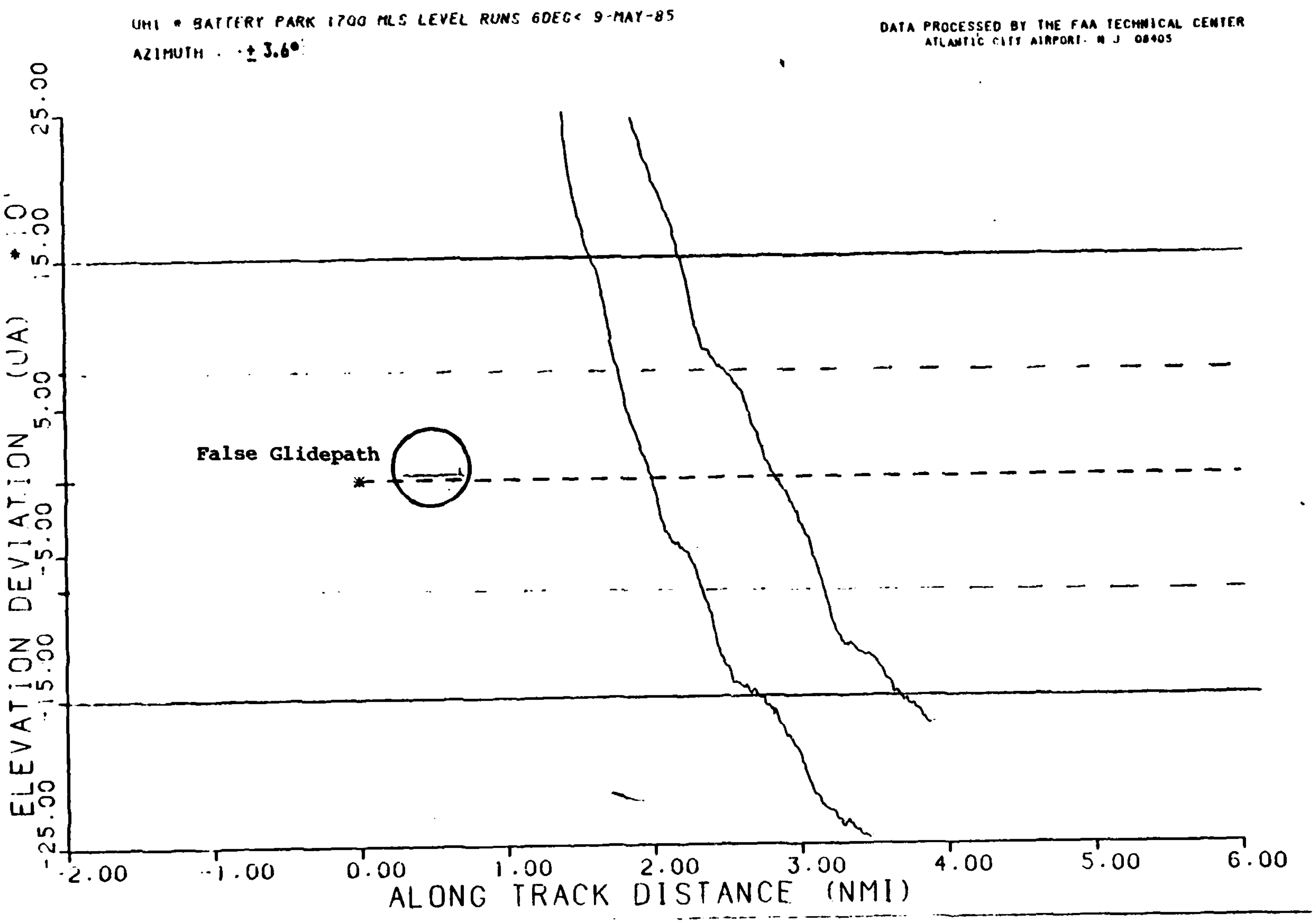


FIGURE 33. BATTERY PARK 1,700 FEET MLS LEVEL RUN VDI DEVIATION

receiver. Two approaches each were flown on the 0° azimuth and the elevation angles 3.0°, 4.6°, 6.0°, and 9.0°. One approach each was flown on the 08°L and 08°R azimuths.

Throughout the flight, the flight crew noted no erratic instrument display. A review of the recorded analog data did not reveal the inconsistencies in azimuth information. Particular attention was paid to results in the 4.0 to 4.3 DME range and in the 1.2 to 1.5 DME range. The only problem detected with the Cabin Class receiver data was the appearance of the grating lobe at approximately 20° elevation.

5. CONCLUSIONS.

The Battery Park Microwave Landing System (MLS) Industry/User Participation and Evaluation was completed in June 1985. During this evaluation, over 300 raw-data guided approach/missed approach procedures were conducted using ±3.6° azimuth and ±EL/4 elevation angular course widths for MLS precision guidance to decision heights (DH's) as low as 200 feet. In all cases, DH's were within 0.5 nautical miles (nmi) of the heliport. These approaches were documented by 19 pilots representing the industry/user group, Sikorsky Aircraft, and the FAA Technical Center. The azimuth course width used at Battery Park was ±3.6°. The elevation course width at both Wall Street and Battery Park was elevation angle/4. From the evaluation of the pilot questionnaires, it was concluded that:

a. The 4.6° and the 6.0° elevation angle approaches were acceptable, however, one pilot (who flew each approach twice) commented that the azimuth course was too narrow; 1 pilot commented that the rate of descent was too high; two pilots commented that the 6.0° approach was getting too steep for the S-61.

b. The 9.0° elevation angle approach was not acceptable to the users due to the high rate of descent. Further, during Sikorsky's low airspeed work, they found that the S-76 was limited to a maximum approach angle of 7.5° due to poor forward visibility at angles greater than this.

c. The <u>maximum</u> rate of descent for any helicopter approach procedure should be approximately 850 feet per minute.

d. The <u>maximum/minimum</u> indicated airspeed for a 4.6° approach should be 90/60 knots.

e. The <u>maximum/minimum</u> indicated airspeed for a 6.0° approach should be 80/55 knots.

f. The <u>maximum/minimum</u> indicated airspeed for the 9.0° approach should be 70/55 knots.

g. The pilot perceived effort/workload required to fly the 4.6° MLS approach to a heliport was rated to be approximately the same as flying a typical 3° ILS. The pilots perceived effort/workload are based on typical 3° ILS approaches to runway environments.

h. The pilot perceived effort/workload required to fly the 6.0° MLS approach to a heliport was rated to be more than flying a typical 3° ILS.

i. The pilot perceived effort/workload required to fly the 9.0° MLS approach to a heliport was rated to be considerably more than flying a typical 3° ILS, and is not a recommended procedure.

j. Steep MLS approaches (6.0° and greater) are not recommended for the S-61 class of helicopter.

k. Pilot training and familiarization are required for MLS approaches to a heliport, particularly on the approach angles greater than 4.6°.

l. The majority of the user pilots recommended that a copter MLS approach to a heliport in the New York City environment should require two pilots. This response may be influenced by the very high level of uncontrolled VFR traffic in the TCA exclusion areas in the vicinity of Battery Park.

m. The minimum avionics required to transition to and fly these approaches in Instrument Meteorological Conditions (IMC) conditions would be: MLS, Distance Measuring Equipment (DME), and a radar altimeter. Additionally, the majority recommended that some sort of RNAV equipment be used for routing to the MLS final approach course.

n. A drawback in conducting these approaches is descending IFR into uncontrolled airspace when weather conditions as low as 300 foot ceiling and 1 mile visibility to 500-foot ceiling and 1 mile visibility would permit VFR helicopters and sea planes to be operating in the same airspace.

o. If a "Heliport Traffic Area" were developed to eliminate the problem identified in conclusion "n," acceptable altitude/lateral boundries could be 1,000 feet and 2 nmi.

p. Newark Tower Air Traffic Control (ATC) personnel provided excellent radar advisory service to all users throughout the approach. Newark radar coverage permits controller observation generally down to decision height on the approaches to Battery Park.

6. RECOMMENDATIONS.

Two preliminary evaluations are recommended prior to the implementation of any public use Microwave Landing System (MLS) approach procedures to a New York City heliport:

a. Reevaluate the requirement, user demand, and specific airspace to be included in the New York Terminal Control Area (TCA) VFR operating exclusion area. Requirements for a transponder and radio communications in certain areas may enhance overall safety, and not be as severe an impact on the users as it may have been in the past. It is an opinion that many aircraft utilize the Hudson River portion of the exclusion area to circumvent, rather than operate within the system. This evaluation is recommended whether or not an MLS is installed at Wall Street.

b. Perform a simulation, utilizing MLS approaches and departures at the Wall Street area and existing airways V313R/V314R, to explore the benefits and limitations of precision Instrument Meteorological Conditions (IMC) operations to lower Manhattan.

The following recommendations are provided for consideration in the development of MLS procedures to a city center heliport:

a. Set the azimuth angular course width to $\pm 3.6°$ for precision approaches to a collocated MLS sited at the helipad. Airborne MLS angle receivers should provide an elevation angular course width of the selected elevation angle divided by 3 (SEL/3) for MLS glidepaths up to 9.0°.

b. MLS approach procedures should provide no less than a 2-nautical mile (nmi) and no greater than a 3-nmi final approach segment length (glidepath intercept to helipad).

c. For user acceptance and aircraft safety, develop public use MLS approach procedures with glidepath angles less than 9.0°. Steeper angles result in a high rate of descent and cockpit design may limit the pilots forward visibility required to acquire the helipad at decision height (DH). The lowest usable glidepath per Terminal Instrument Procedures (TERPS), chapter 11, should be utilized. However, environmental or air traffic procedures may benefit by an increased angle.

d. When TERPS criteria are met, allow raw-data MLS approaches to the heliports to glidepath/DH combinations no lower than 3°/200 feet and 6°/300 feet. For lower minima, better inflight instrumentation is required, e.g., scheduled course width sensitivities computed by range and/or a flight director system, a lower V_{mini}, or combinations thereof must be used. However, it should be noted that TERPS Missed Approach Airspace Requirements may cause greater restrictions to downtown heliport minima than course width sensitivity or aircraft instrumentation.

e. The maximum recommended airspeed/ground speed for helipad approaches is 75 knots.

f. The maximum recommended tailwind or crosswind component for a precision IMC approach to a helipad should not exceed 15 knots. Winds above this may adversely affect the aircraft performance and may cause an unnecessarily high pitch attitude to decelerate from the higher resultant ground speed. Additionally, due to the lower airspeeds that these approaches require, crosswinds above this result in large intercept and/or crab angles to maintain course centerline.

g. Pilots should receive some training on the techniques of tracking steep glidepaths and the importance of speed control during approaches to a helipad. All operational testing and evaluation has indicated a requirement for training. A suggested minimum amount of training would include steep angle (greater than 3.9°) MLS approaches. The pilot should be required to demonstrate 3°, 4.5°, 6.0°, and 7.5° MLS approaches to the DH, arriving at a position from which a normal landing at a heliport could be made. The pilot must demonstrate airspeed control within ±10 knots from the desired approach airspeed. Any full scale deflections of the Course Deviation Indicator (CDI) or Vertical Deviation Indicator (VDI) prior to the DH is not permitted. ACT-140 will pursue this with the Office of Flight Operations (AFO-200) through APM-720.

h. Develop VOR/DME RNAV/Loran C procedures to compliment the MLS approach.

i. Develop a "Helicopter Transition Area" with procedures that would allow the aircraft to transition from minimums to the heliport with at least the level of safety associated with an approach to an uncontrolled airport.

7. SUMMARY.

In summary, user comments indicate that Microwave Landing System (MLS) to heliports is a viable asset to the helicopter Instrument Flight Rule (IFR) community; however, its full benefits may not be realized in the Battery Park/Wall Street area without revisiting the necessity and demand for the Traffic Control Area (TCA) exclusion. Additionally, some special advantages to Instrument Meteorological Conditions (IMC) procedures, without a severe impact on VFR traffic at the Wall Street Heliport, must be identified to achieve user acceptance of MLS at Wall Street.

APPENDIX A

PILOT BRIEFING OUTLINE

Introduction

Hand out package

Go over purpose - provide user/FAA experience with city center heliport operations.

Objectives

Acquaint user with MLS

Obtain user comments

Provide FAA with heliport ATC evaluation

Provide preliminary look at potential/limitations

MLS Familiarization

AZ Limits Proportional and Clearance Sectors

Elevation limits

Course Widths AZ, EL

Operational Areas

4.6, 6.0 and 9.0 ^{o} approaches

Navigation to MLS coverage

ATC procedures

Airspace Utilization

MLS Siting

EL/DH Combinations

Missed Approach Point

Technical Considerations

Flyability

Workload

Aircraft/Aircrew Limitations

Acceptance of Course Widths

Signal Coverage - FAA will do this

Procedures

Importance of Speed Control

Reminder of Tighter Course Width

Review of Steep Angle Approach Technique

Basic Rules - max. speed 75kts. V_{mini} to DH

To Be Flown **VFR ONLY**

Does **NOT** provide TERPS obstical clearance

Provides: For Height Loss During MAP Deceleration

050/4.6 Approach

Identification

Transition Routes - "Liberty" - "Sween" - "Bayonne"

Plan View

- EWR Tower Frequency 127.85
- Battery Park 123.05
- Fixes Loran/RNAV
- MLS Freq. Channel 594
- MLS 00° Azimuth is 050°
- IAP
- Canarsie

Profile View

- MAP Procedure
- GS Intercept Altitude - 1700 Feet
- MLS 00 AZ/050° Mag.
- GS Angle - 4.6
- Final Apch Segment - 3.1 nm
- Minima - 300/1/2
- Rate of Descent - 595 fpm
- Copter Only VFR Test Only

Remarks Section

- Freq. For Arrivals Over Sween - NY Apch. 127.4
- ATC Coordination Required For ALL Flights in TCA
- Battery Park Freq. - 123.05
- Rate of Descent at 75 Knots
- Time to MAP 3:06 at 60 kts,2:29 at 75 kts

050/6.0 Approach

The Only Difference Is The Profile View

Profile View

- GS Intercept Altitude 1700 Feet
- Minima - 300/1/2
- Final Apch Segment - 2.1 nm
- Rate of Descent - 795 fpm
- Time to MAP 2:08 at 60kts, 1:40 at 75kts

050/9.0 Approach

Profile View

- GS Intercept - 1900 Feet
- Final Apch Segment - 1.6
- Minima - 350/1/2
- Rate of Descent - 1190
- Time to MAP 1:35 at 60kts, 1:17 at 75kts

Questionnaires

Daily

Final - After Each Approach Flown at Least 3 Times

Return To - FAA Eastern Region

Call Us Anytime With Comments/Suggestions, ect.

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APPENDIX B

USER INFORMATION PACKAGE

Helicopter MLS Installation at Battery Park

and

Industry/User Participation and Evaluation

USER INFORMATION PACKAGE

Sponsor: FAA Eastern Region

Monitor: Aviation Consumer Affairs Staff, AEA-8
John F. Kennedy International Airport, N.Y.

and

Guidance and Airborne Systems Branch, ACT-140
FAA Technical Center, Atlantic City, N.J.

March 25, 1985

Introduction

A Microwave Landing System (MLS) has been installed at the Battery Park City heliport. This is a temporary installation to assist the industry/users and the FAA in obtaining experience in flying MLS precision operations at a city center heliport. Industry has equipped their aircraft and instrument approach procedures have been developed for the user to evaluate and comment on during normal operations at Battery Park. However, much of the information and experience gained through this effort will be applied to the Wall Street heliport installation. The procedures are to be flown VFR only.

Objectives

Specific objectives of the industry/user flight evaluation are:

- To acquaint industry/user with precision MLS operations to a heliport.

- To obtain industry/user comments and suggestions on MLS operations in the Battery Park/Wall Street area.

- To provide the FAA with an inflight validation of some candidate approach procedures and Air Traffic Control (ATC) procedures.

- To provide some preliminary indications as to the problems and advantages associated with MLS approaches to city center heliports.

In addition, with the support of the FAA Technical Center, several site-specific technical aspects of the MLS installation will be evaluated. Those technical issues include signal propogation patterns and signal coverage.

Methods

To acquaint the user with the precision MLS operations to a heliport, three approach plates have been developed jointly by the Eastern Region and the FAA Technical Center. Each approach has a unique decision height (DH) and glideslope combination for the user to evaluate. To validate candidate ATC procedures, initial approach fixes have been developed, together with routing into the MLS coverage area. To obtain preliminary indications as to the advantages and problems, each user is requested to provide subjective input through questionnaires and make comments regarding operational and technical issues concerning each procedure.

Operational Areas

User comments and feedback on all aspects of the approach procedure from the initial approach fix to the suitability of the transition from the missed approach point to the heliport are desired. Specific areas of interest are:

- Precision MLS procedures to a city center heliport.
- 4.6°, 6.0°, and 9.0° approach gradients.
- Navigation to MLS coverage.
- Air Traffic Control Procedures.
- Airspace Utilization.
- MLS Siting.
- Glideslope/DH Combinations.
- Heliport Operations.
- Missed Approach Point.

Technical Considerations

The user community can provide valuable assistance to the FAA in identifying technical issues which may influence the utility of precision MLS approaches to heliports. Subjective pilot data is sought in several areas. The topics include:

- Overall Flyability of the Procedures.
- Perceived pilot workload in flying the approach.
- Aircrew performance limitations.
- Aircraft equipment limitations.
- Perceived optimal elevation angles.
- Validation of optimal MLS course widths.
- Signal Coverage/Propagation. (Technical Center Issues)

In order to provide feedback and assist the user in addressing the above topics two questionnaires have been developed. The first questionnaire is designed for completion following each MLS approach. The second questionnaire is designed for use after the operator has developed some familiarity with the approaches. Upon completion of the questionnaires, they should be returned to the FAA in the envelopes provided.

Location

All testing will occur to the MLS installed at the Battery Park Heliport in New York.

Project Personnel

User comments and questions should be directed to the following personnel:

- Mr. D. Harvey, AEA-8
  Office of Aviation Consumer Affairs
  (718) 917-1136, FTS 667-1136

- Mr. J. Enias, Project Manager
  Helicopter MLS Collocated Flight Test
  FAA Technical Center, ACT-140
  Atlantic City, N.J.
  (609) 484-6808, FTS 482-6808

- Mr. M. Webb, Project Pilot
  Helicopter MLS Collocated Flight Test
  FAA Technical Center, ACT-140
  Atlantic City, N.J.
  (609) 484-6591, FTS 482-6591

3 Attachments: Battery Park Approaches, 4 pages
Questionnaire, 2 pages
Questionnaire, 6 pages

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BATTERY PARK APPROACHES

Steep angle (greater than 4 degree) MLS precision approaches to a helipad are different than precision ILS approaches to a runway. First, speed control is much more critical since the distance along the runway that is normally available to decelerate is no longer present. Second, tracking the azimuth and elevation is more difficult since the azimuth course width at DH has been decreased, i.e., the runway localizer course is tailored to provide a course width of approximately 900 feet at a point 1/2 mile from the runway. At Battery Park, the MLS azimuth and elevation antennas are collocated at the heliport and provide an azimuth course width of approximately 400 feet at a point 1/2 mile from the helipad. Lastly, the rate of descent is more critical since the rate of descent required for a 6 degree glideslope flown at 90 knots is 955 fpm., compared to 480 fpm. for a typical runway ILS 3 degree glideslope flown at that same speed. All of these are inevitable problems when flying precision steep angle approaches to a heliport. The simplest technique that can reduce the impact of these problems is to fly the procedures at a slower airspeed. For these approaches we recommend a maximum "ground speed" of 75 knots.

All the approaches should be flown at or above the minimum IFR airspeed for your aircraft (V_{mini}) until reaching DH. At DH either begin a smooth deceleration to land, or execute the missed approach procedure. For these procedures the steep angle glideslope tracking technique which is recommended is to utilize collective pitch for tracking the glideslope, and longitudinal cyclic for airspeed control.

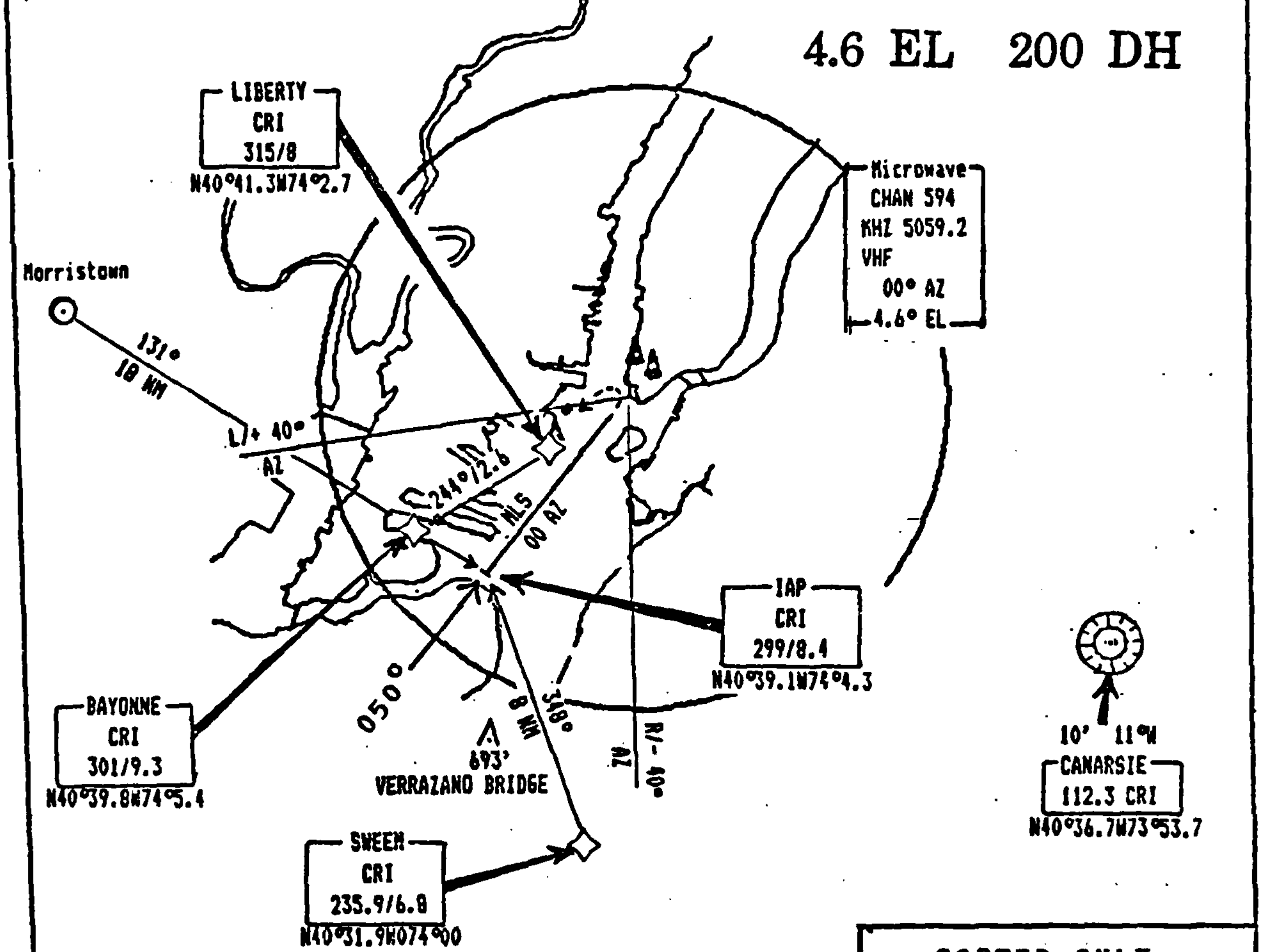
Since the approaches are to be flown **VFR ONLY**, the decision heights and missed approach procedure(s) do not necessarily meet existing TERPS obstacle clearance criteria. The decision heights identified have been determined to allow for altitude loss during the transition to missed approach, and the distance required to decelerate for landing at Battery Park.

Three transition routes have been developed to evaluate ATC applications and provide routing to the MLS coverage. All routes require ATC coordination before entering the TCA. The SWEEN transition will require contacting NY approach on 127.4 mhz, for the others contact Newark Tower on 127.85 mhz. Each fix is described by both latitude/longitude and radial/distance for LORAN or RNAV navigation. Additionally, these points are named for prominent ground reference points for visual navigation.

Newark Tower 127.85
Helicopter Advisory 123.05

VFR TEST ONLY

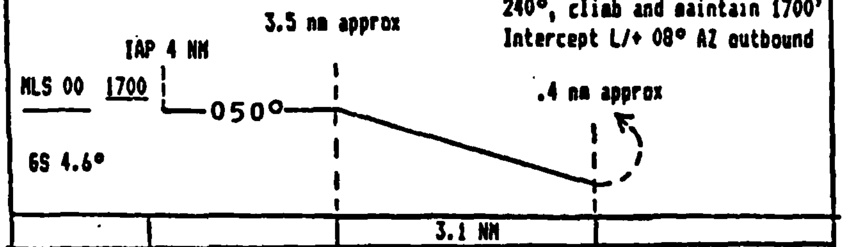
4.6 EL 200 DH



COPTER ONLY

ELEV 07

Missed Approach: Immediate climbing left turn to heading 240°, climb and maintain 1700' Intercept L/+ 08° AZ outbound



CATEGORY COPTER

S-MLS 050° 200 - 3 200 (1500-3)

Arrivals over SWEEN contact New York Approach on 127.4.
ATC clearence is required for all flights within the TCA.
Notify Battery Park Heliport on 123.05 with location and intentions.
If executing the MAP for another approach advise Newark Tower before reentering the TCA.

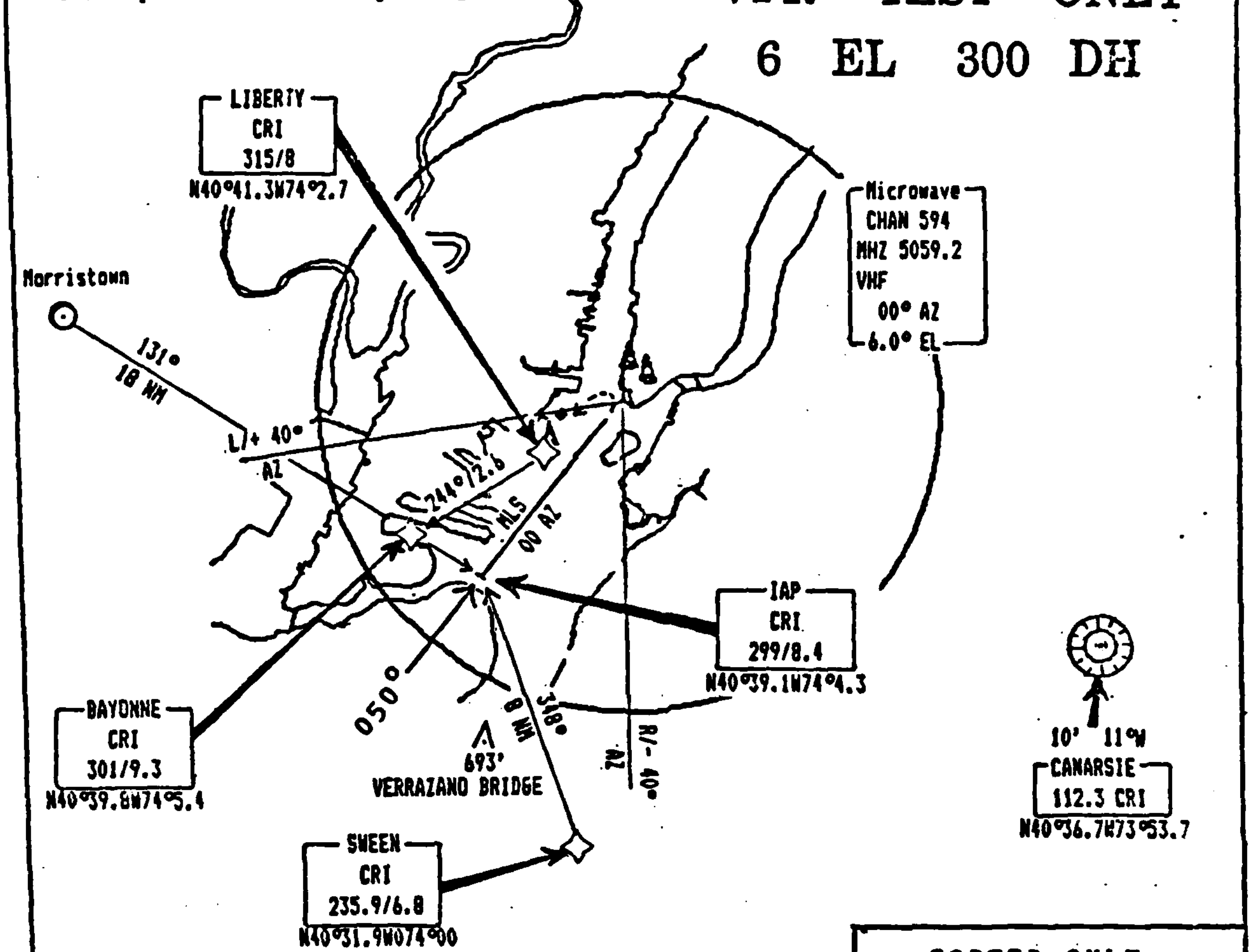
MAX GROUND SPEED 75 kts

RATE OF DESCENT 595 FT/MIN AT 75 KTS

FAP to MAP 3.1 NM		
Knots	60	75
Min:Sec	3:06	2:28

Newark Tower 127.85
Helicopter Advisory 123.05

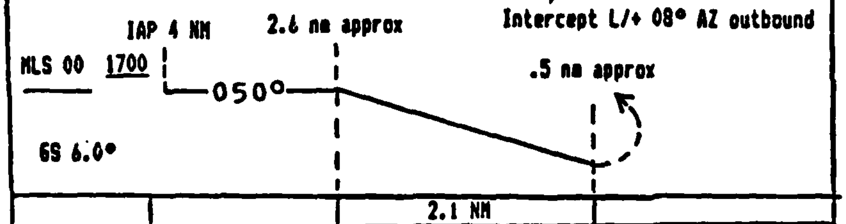
VFR TEST ONLY
6 EL 300 DH



COPTER ONLY

ELEV 07

Missed Approach: Immediate climbing left turn to heading 240°, climb and maintain 1700' Intercept L/+ 08° AZ outbound



CATEGORY	COPTER
S-MLS 050°	300 - 3 300 (1500-3)

Arrivals over SWEEN contact New York Approach on 127.4.
ATC clearence is required for all flights within the TCA.
Notify Battery Park Heliport on 123.05 with location and intentions.
If executing the MAP for another approach advise Newark Tower before reentering the TCA.

MAX GROUND SPEED 75 kts

RATE OF DESCENT 795 FT/MIN AT 75 KTS

FAP to MAP 2.1 NM

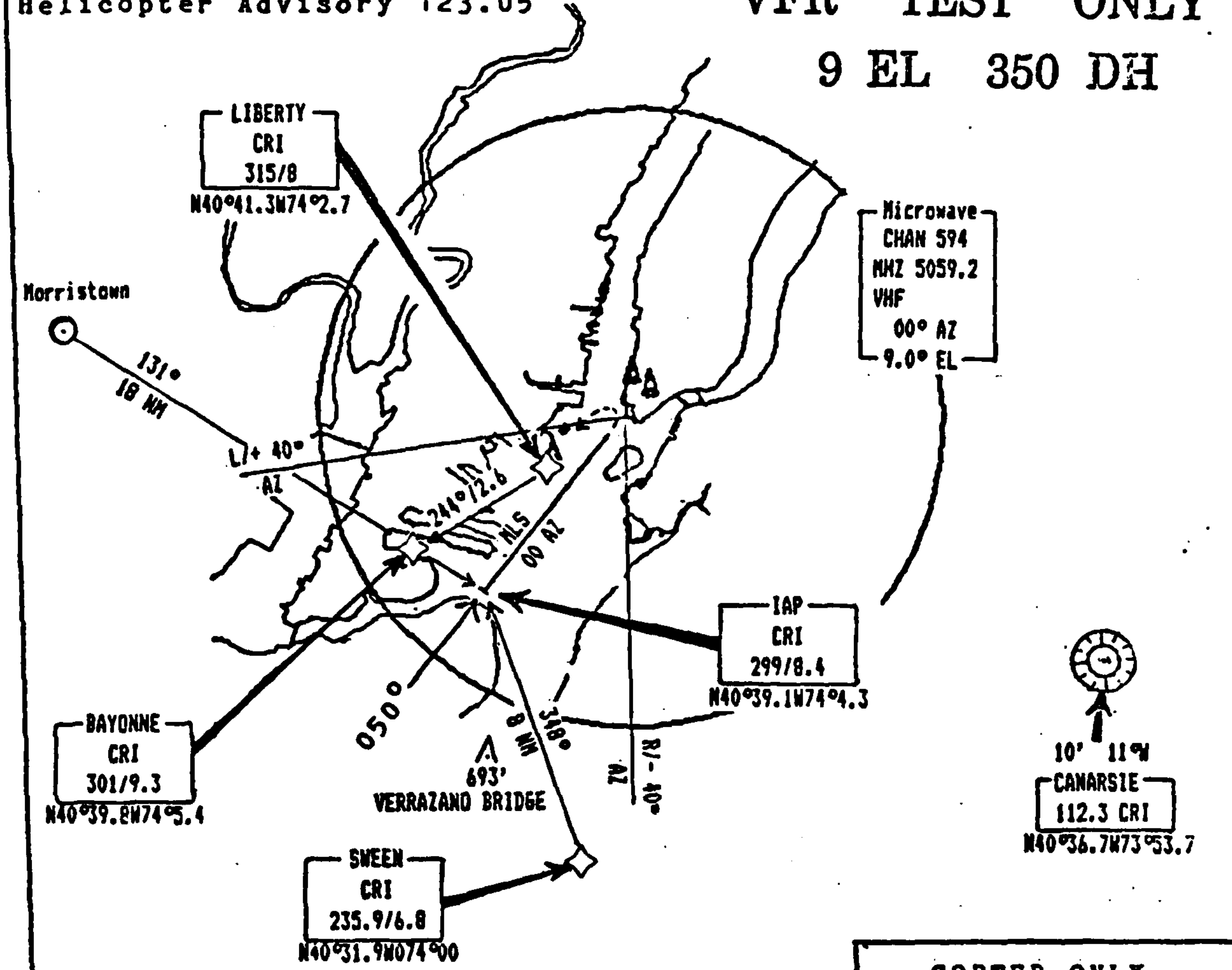
Knots	60	75
Min:Sec	2:08	1:40

COPTER 050°/6° MLS

BATTERY PARK, NY

Newark Tower 127.85
Helicopter Advisory 123.05

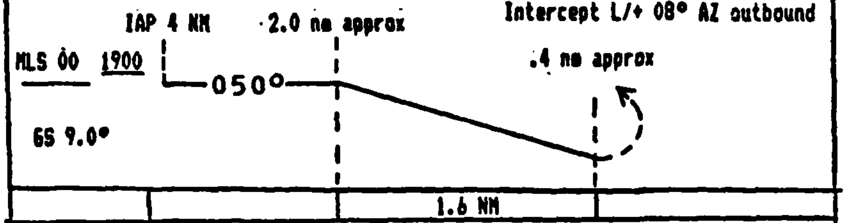
VFR TEST ONLY
9 EL 350 DH



COPTER ONLY

ELEV 07

Missed Approach: Immediate climbing left turn to heading 240°, climb and maintain 1700' Intercept L/+ 08° AZ outbound



CATEGORY	COPTER
S-MLS 050° 350 - 3 350 (2000-3)	

Arrivals over SWEEN contact New York Approach on 127.4.
ATC clearence is required for all flights within the TCA.
Notify Battery Park Heliport on 123.05 with location and intentions.
If executing the MAP for another approach advise Newark Tower before reentering the TCA.

MAX GROUND SPEED 75 kts

RATE OF DESCENT 1190 FT/MIN AT 75 KTS

FAP TO MAP 1.6 NM

Knots	60	75
Min:Sec	1:35	1:17

Battery Park Heliport MLS Program

Questionnaire for Each Approach

Please fill out each time you fly the approach.

DATE_____ TIME(local)_____ A/C N_______ CREW_______________

Departure Point?____

Approach Flown (circle one) 050/4.6° 050/6.0° 050/9.0°

1. Weather (Ceiling,Vis,Wind)?____________________________

2. How did you transition to MLS coverage?

_____Visual
_____RNAV
_____LORAN-C
_____Other ,(specify)

3. What was your opinion of the approach to DH?__________
____
____
____

4. What was your opinion of the transition from DH to landing? ____
____
____
____

5. If flown, what was your opinion of the missed approach?
____
____
____

6. What problems did you encounter?______________________
____
____

7. Do you have any suggestions to improve the missed approach?
____
____
____

(OVER)

8. Did you experience any traffic problems while flying this approach?

____YES ____NO

If yes explain:____
____
____

9. Did you experience any ATC related problems?

_____YES ____NO

If yes explain:____
____
____

10. Did you experience any of the following (circle one)
off flags loss of coverage intermittent signal

If you experienced any difficulty when and where did the problem occur?____
____

11. Did you utilize one of the transition routes?

_____YES ____NO

If Yes, which one:____

Battery Park Heliport MLS Program

To be filled out after flying each approach 3 or more times.

Operational Pilot Qualifications

NAME: ____________________

COMPANY: ____________________

ADDRESS: ____________________

CITY: ____________ STATE ________ ZIP: _____

PHONE: ____________________

FAA HELICOPTER RATINGS: (Private, Comm, ATP, Hel Inst) ___

____

TOTAL HELICOPTER FLIGHT HOURS: ____________

HELICOPTER ACTUAL IFR HOURS: ____________

HELICOPTER HOODED IFR HOURS: ____________

HELICOPTER IFR (Hooded or actual) HOURS LAST 6 MO. ________

TYPE HELICOPTER FLOWN: ____________ TIME in TYPE: ________

HOW MANY TIMES HAVE YOU FLOWN EACH APPROACH ?

050/4.6° _____ 050/6.0° _____ 050/9.0° _______

QUESTIONS

1. Do you feel that the approaches were acceptable as published?

050/4.6° _____YES _____NO

050/6.0° _____YES _____NO

050/9.0° _____YES _____NO

If no, please explain: ____________________

____

____

____

2. Were the following elevation/decision height combinations acceptable?

$4.6^{\circ}/200'$ ______YES ______NO

$6.0^{\circ}/300'$ ______YES ______NO

$9.0^{\circ}/350'$ ______YES ______NO

If you answered no why? ________________________________
____
____

3. What is your recommendation for the maximum allowable rate of descent for these approaches?

4.6° Elevation______

6.0° Elevation______

9.0° Elevation______

4. What do you recommend the maximum/minimum allowable airspeed for each approach should be?

4.6° Elevation __________/__________

6.0° Elevation __________/__________

9.0° Elevation __________/__________

Why?____
____

5. Using the scales below, how does the amount of effort required in flying the $050/4.6^{\circ}$ MLS approach compare to an ILS approach in terms of:

a. Tracking: Azimuth vs Localizer

1 2 3 4 5 6

Considerably More Considerably Less

b. Tracking: Elevation vs Glide Slope

1 2 3 4 5 6

Considerably More Considerably Less

c. Workload: MLS vs ILS

1 2 3 4 5 6

Considerably More Considerably Less

d. Airspeed Control: MLS vs ILS

1 2 3 4 5 6

Considerably More Considerably Less

COMMENTS:_______________________________________
____
____
____

6. Using the scales below, how does the amount of effort required in flying the 050/6.0° MLS approach compare to an ILS approach in terms of:

a. Tracking: Azimuth vs Localizer

1 2 3 4 5 6
Considerably More Considerably Less

b. Tracking: Elevation vs Glide Slope

1 2 3 4 5 6
Considerably More Considerably Less

c. Workload: MLS vs ILS

1 2 3 4 5 6
Considerably More Considerably Less

d. Airspeed Control: MLS vs ILS

1 2 3 4 5 6
Considerably More Considerably Less

Comments:____

____

____

____

7. Using the scales below, how does the amount of effort required in flying the 050/9.0° MLS approach compare to an ILS approach in terms of:

a. Tracking: Azimuth vs Localizer

1 2 3 4 5 6
Considerably More Considerably Less

b. Tracking: Elevation vs Glide Slope

1 2 3 4 5 6
Considerably More Considerably Less

c. Workload: MLS vs ILS

1 2 3 4 5 6
Considerably More Considerably Less

d. Airspeed Control: MLS vs ILS

1 2 3 4 5 6
Considerably More Considerably Less

Comments:____

____

____

____

8. Overall the final approach segments (glide slope intercept to DH) for the approaches were:

____Too Short ____About Right ____Too Long

If too short or too long, what would you recommend?______

____

9. Do you feel any special type of training is required prior to a pilot flying any of these MLS approaches to a heliport?

_____YES _____NO

If yes, explain:____

____

____

10. Do you feel these approaches should be approved for single pilot IFR operations?

_____YES _____NO

If no, please explain:______________________________________

____

____

11. Do you feel there should be any special pilot requirements not already mentioned? _______________________

____

____

____

12. What is the minimum avionics equipment that you feel would allow you to transition to and fly these approaches during IMC conditions?

_____ MLS
_____ DME
_____ RNAV
_____ LORAN C
_____ Radar Altimeter
_____ Other, Specify

13. What guidance information would you suggest for the Missed Approach Procedure?

_____ MLS
_____ DME
_____ RNAV
_____ LORAN C
_____ Radar Altimeter
_____ Other, Specify

14. Describe what you would do if you were in IMC conditions, established on the approach inbound and:

prior to the final approach point the azimuth signal becomes unreliable?______________________________________

____

____

or

after the final approach point both the azimuth and elevation signals become unreliable?___________________

____

____

15. Would you feel comfortable flying these approaches to the decision heights indicated in actual IMC conditions.

_____YES _____NO

If no, why?____

____

____

____

16. How would you feel about executing this approach, when there may be uncontrolled VFR traffic flying below you following the "See and Avoid" rule.____________________

____

____

____

____

17. If a "Heliport Traffic Area" were to be developed to provide a safe transition from DH or MDA (minima of 300 and 1/2) to the helipad, and separation of arriving and departing IFR helicopters. What dimensions would you suggest?

Altitude Limits:

Ground to _______

Lateral Limits:

________ NM Radius

If you have another idea please sketch it out giving the appropriate dimensions.

18. Considering the proposed Wall Street site what would you suggest would be the best means of departing the heliport IFR?

Route:

Procedure:

Comments, Suggestions, etc.:

nybpq, 28Mar85

END

FILMED

4-

DTIC