

CT
140
88
13

COPY 1

CT-140-88-13

FEDERAL AVIATION ADMINISTRATION

JUL 1 Recd

TECHNICAL CENTER LIBRARY
ATLANTIC CITY, N.J. 08405

ALS CONTROL BOX EFFECTS ON
MLS AZIMUTH GUIDANCE SIGNALS

Edmund Zyzys

June 1988

FAA Technical Center
Engineering Division
Atlantic City International Airport, NJ 08405

BACKGROUND A full MLS consisting of a 1-deg. beamwidth $\pm$ 60 deg. front azimuth, a 1-1/2 deg. beamwidth elevation, and a 2-deg. beamwidth $\pm$ 40 deg. back azimuth antenna, was installed for runway 31 service at the FAA Technical Center in early March 1988. The system was procured from Allied Bendix Aerospace and designed to meet the requirements of FAR Part-171, International Civil Aviation Organization (ICAO) Standards and Recommended Practices (SARPs), and the guidance accuracies in FAA STD-022b (in effect at contract award). The system replaced the old Phase III MLS test bed and is used to support projects requiring MLS guidance.

On March 2 after the full system was installed and configured, an instrumented test van with an MLS receiving antenna mounted on a telescoping mast (50-ft. max. height) was positioned on the runway centerline at the landing threshold and used to align the azimuth antenna.

DISCUSSION: On March 18 MLS flight test and precision ground tracking data were recorded using the FAA Technical Center instrumented Convair 580 (N-91) aircraft and the automated laser tracking system. Processed data were used to generate diagnostic and error plots: the diagnostic plot shows both the tracker derived angle and the MLS receiver angle; the difference plot shows the MLS receiver angle minus the tracker derived angle for the same instant in time; path following error (PFE) and control motion noise (CMN) plots show difference data after processing through PFE and CMN filters, respectively.

Difference, PFE, CMN, and diagnostic plots from 3-deg. centerline approaches are shown in figures 1, 2, 3, and 4, respectively from the March 18 flight tests. Upon reaching the minimum descent altitude of 19 ft. above the runway at 1,889 ft. inside the runway threshold, the pilot held the aircraft at a relatively constant altitude (19-29 ft.) above the runway until reaching 1,870 ft. before the stop end when climb was initiated. All altitude values used in this report are relative to the MLS receiving antenna in the aircraft nose. The difference plot (figure 1) shows a course bias of about 0.04 deg outside of 2 miles from the antenna and a pronounced course bend about 2 miles from the antenna (1,144 ft. before the runway 31 threshold). The course bias is considerably less over the runway (where the system was aligned) but increases with distance beyond 2 miles. It was determined that the course bend was caused by Approach Light System (ALS) power control boxes installed 88.6 ft. in front of the azimuth antenna. Figure 5 shows a sketch of the boxes as configured during the March flight tests.

Although the PFE plot exceeds the error tolerance in figure 2, realignment with runway centerline would place the data within the tolerance limits. The CMN plot in figure 3 shows the data only marginally exceeding the tolerance limit about 2,000 ft. from the stop end of the runway. The tolerance limits shown on the plots are derived from FAA STD-022b (the PFE limits are the recommended tighter values of $\pm$ 13.5 ft.).

The boxes could not be removed due to the airport operational constraints; however, they were lowered 2 ft. and had some of the vertical conduit supports removed on May 10. Figure 6 shows the reconfigured boxes and their location with respect to the azimuth antenna. Antenna alignment was repeated on May 11 with the test van, as before, at the runway 31 threshold. On May 12 the flight test was repeated and figures 7 through 10 show the resultant error and diagnostic plots. The plotted data ends 600 ft. inside the runway threshold when the

aircraft reached the minimum descent point (26 ft. above the runway) and the pilot initiated climb. As can be seen in the difference plot in figure 7, the course is aligned within 0.01 deg at the landing threshold (11,008 ft. from the antenna) but has a bias of about 0.04 deg. beyond 2 miles. The course bend excursion at 2 miles is appreciably reduced from the March data and both the PFE and CMN filtered plots (figures 8 and 9) fall well within the error tolerances.

Modeling of the ALS control boxes with the MLS math model is in progress at the Technical Center to determine whether the measured signal in space degradation can be predicted by the math model and used to aid future installations.

RUN 28 START TIME: 10:25:58 STOP TIME: 10:32:27
N31 03/18/88 SYS 2 3 DEG CL APP
MBJY
AZIMUTH : 0.00 ELEVATION : 3.00

DATA PROCESSED BY THE FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, N.J. 08405
8-JUN-1988 08:55

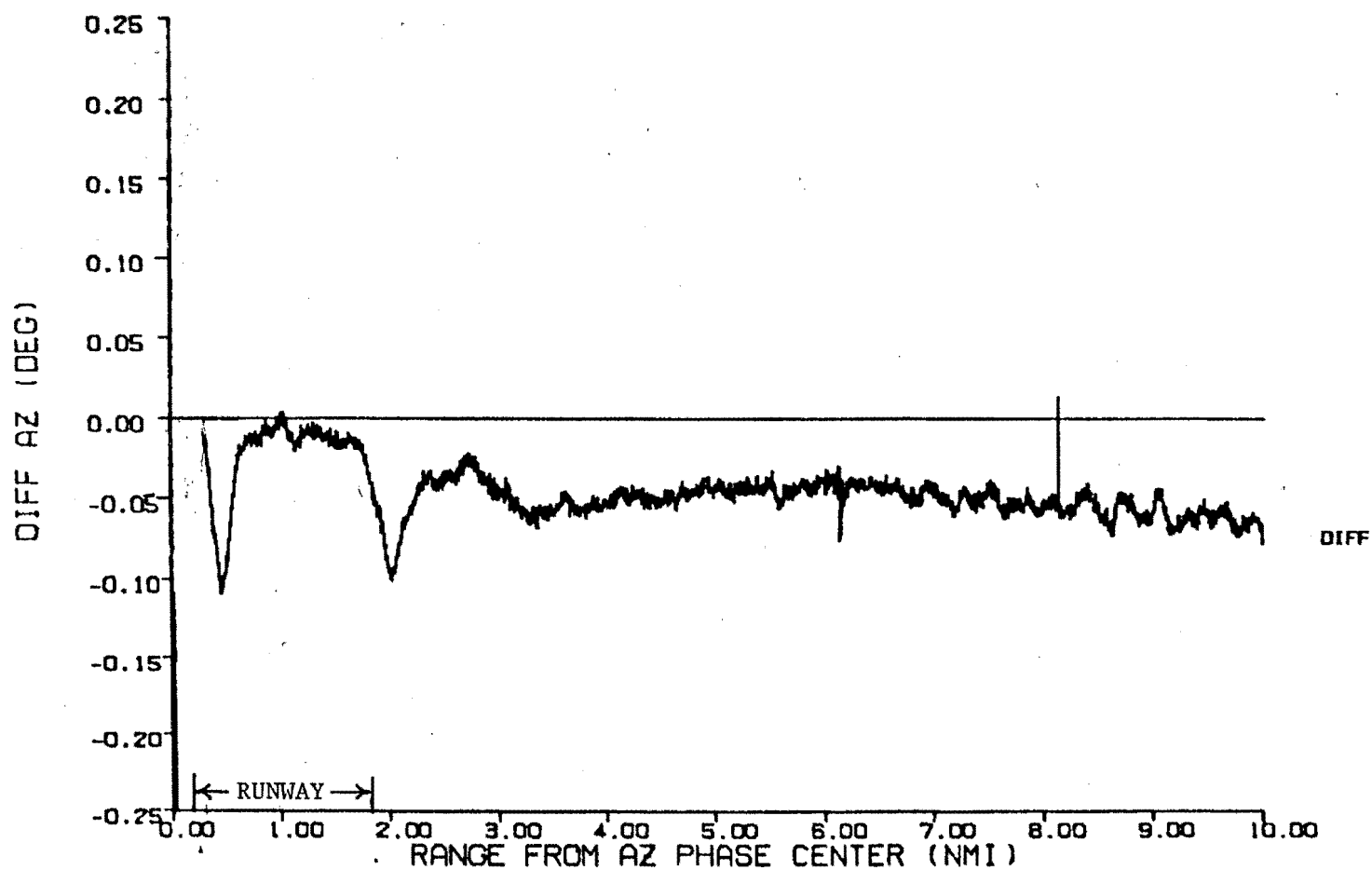


FIGURE 1. MLS AZIMUTH DIFFERENCE PLOT BEFORE ALS BOXES LOWERED

RUN #6 START TIME: 10:25:58 STOP TIME: 10:32:27
N91 03/18/88 SYS 2 3 DEG CL APP
MBJY
AZIMUTH : 0.00 ELEVATION : 9.00

DATA PROCESSED BY THE FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, N.J. 08405
8-JUN-1988 08:40

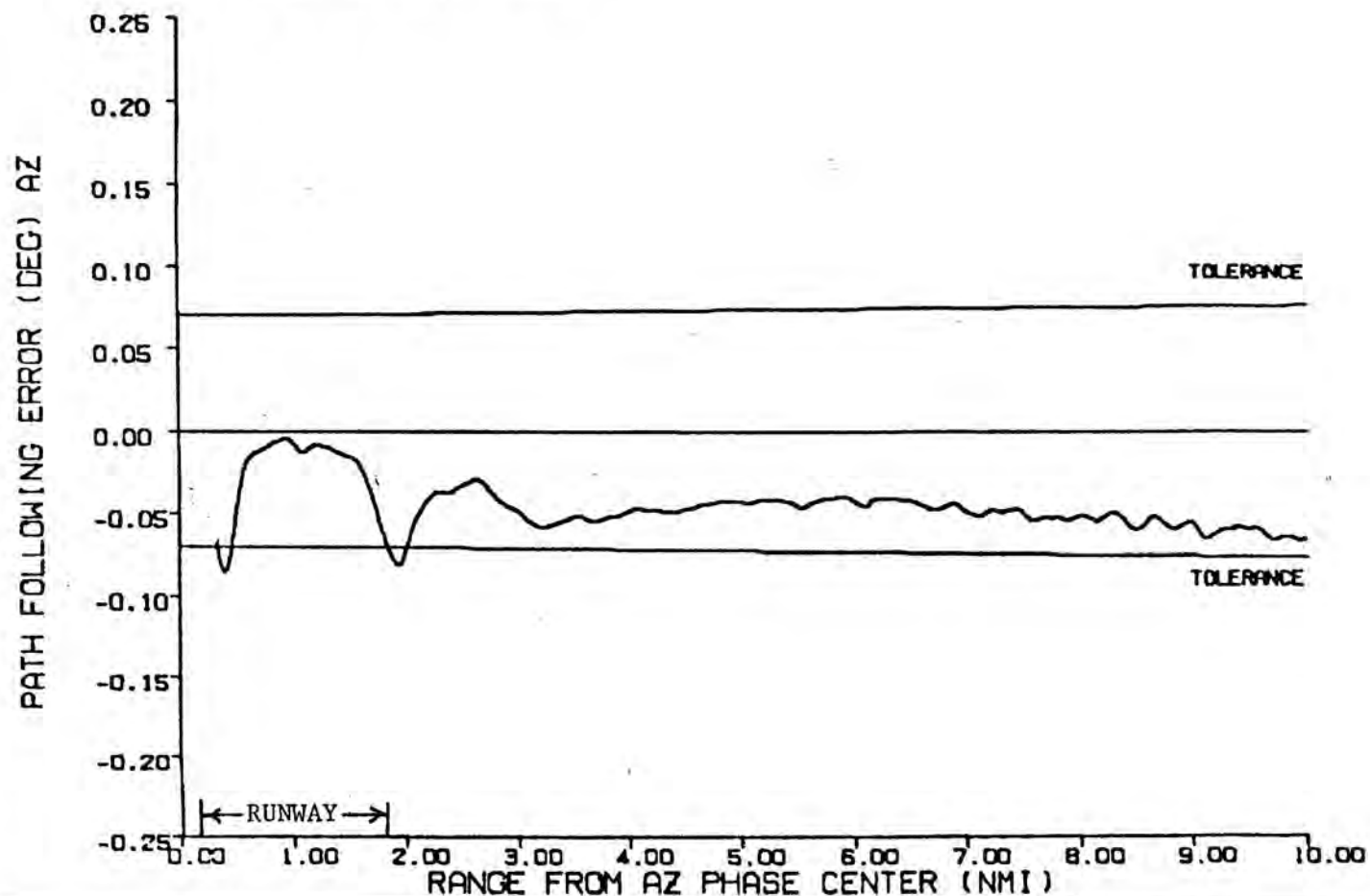


FIGURE 2. MLS AZIMUTH PFE PLOT BEFORE ALS BOXES LOWERED

Run #6 START TIME: 10:25:58 STOP TIME: 10:32:27
#91 03/18/88 SYS 2 3 DEO CL APP
MBJY
AZIMUTH : 0.00 ELEVATION : 9.00

DATA PROCESSED BY THE FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, N.J. 08408
8-JUN-1988 08:24

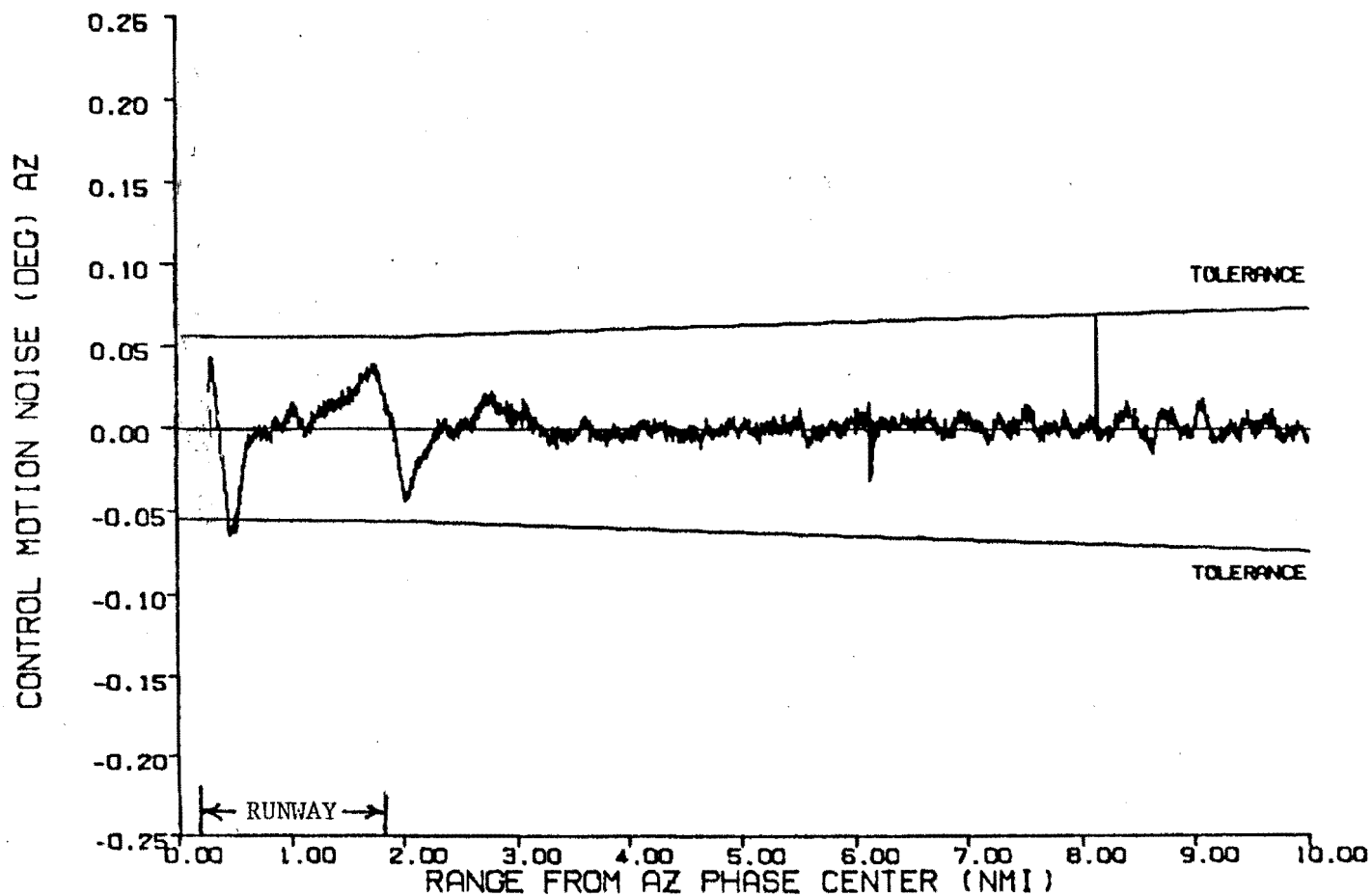


FIGURE 3. MLS AZIMUTH CMN PLOT BEFORE ALS BOXES LOWERED

RUN 45 START TIME: 10:25:58 STOP TIME: 10:32:27
M1 03:18:88 SYS 2 3 DEG CL APP
OBJ
AZIMUTH : 0.00 ELEVATION : 9.00

DATA PROCESSED BY THE FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, N J 08405
8-JUN-1988 10:40

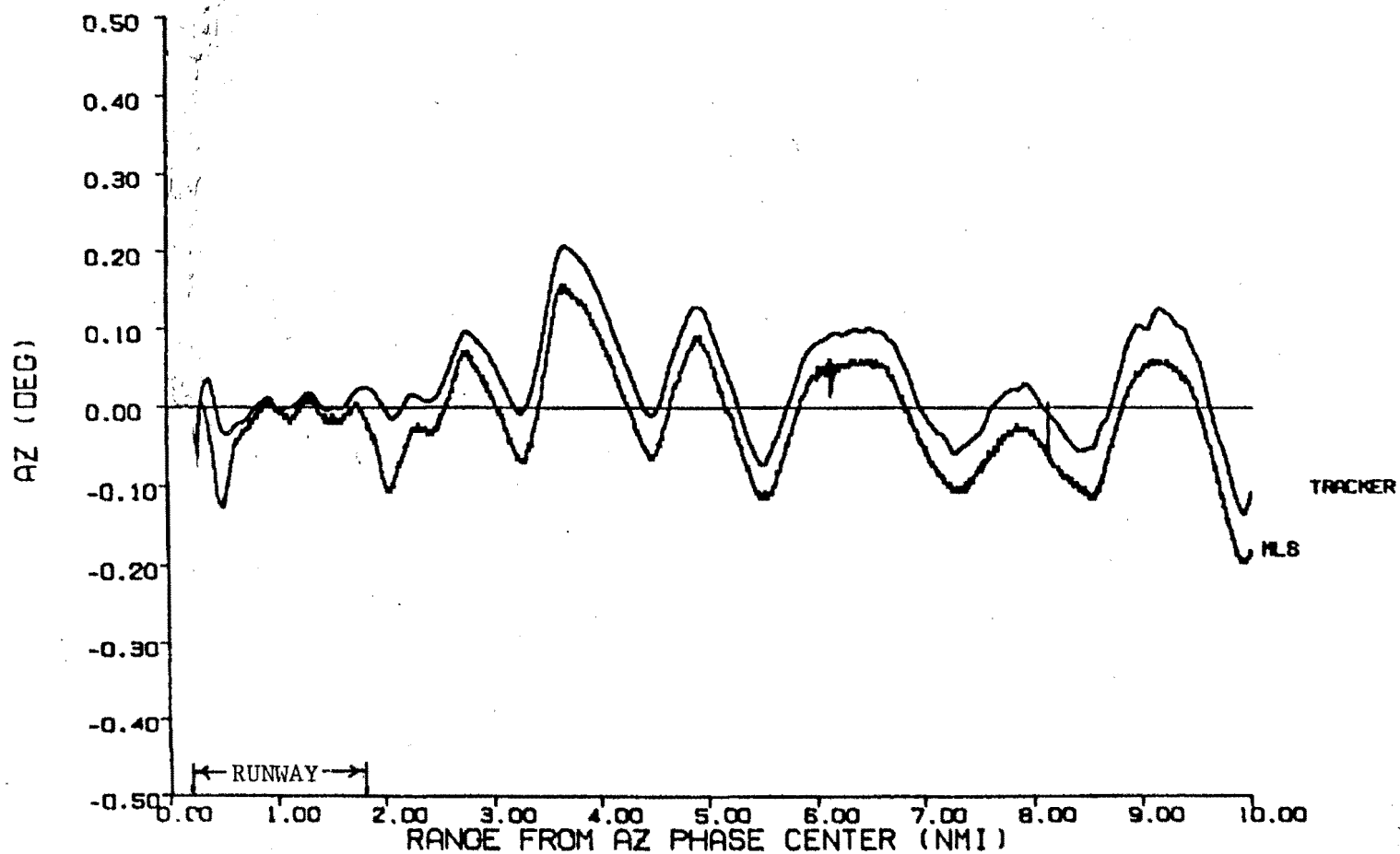


FIGURE 4. DIAGNOSTIC PLOT FOR MLS AZIMUTH DATA BEFORE ALS BOXES LOWERED

PROTECTED
AZIMUTH ANTENNA
PHASE CENTER →

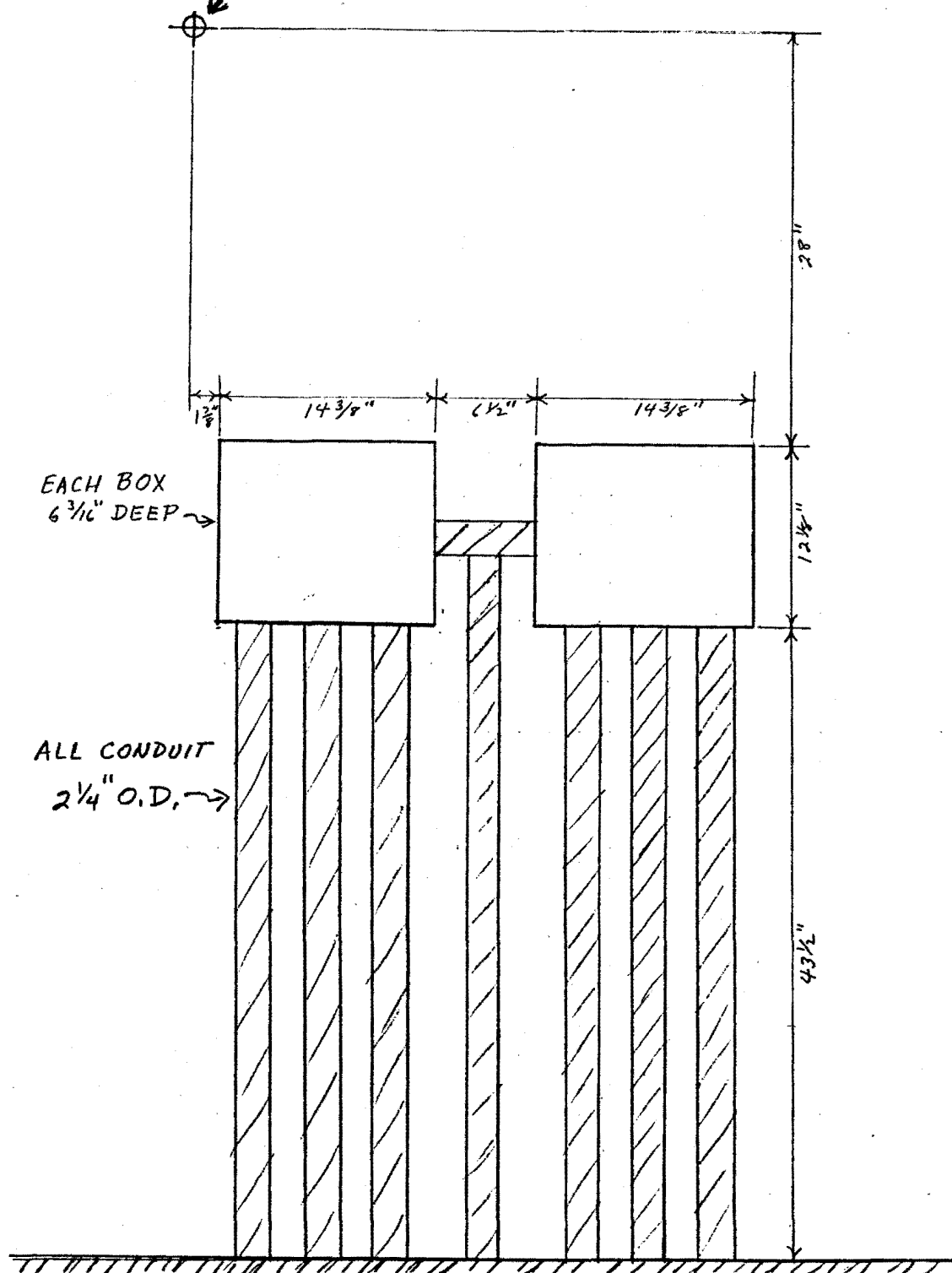


FIGURE 5. ALS BOXES AS CONFIGURED IN FRONT OF MLS AZIMUTH ANTENNA BEFORE MAY 10, 1988

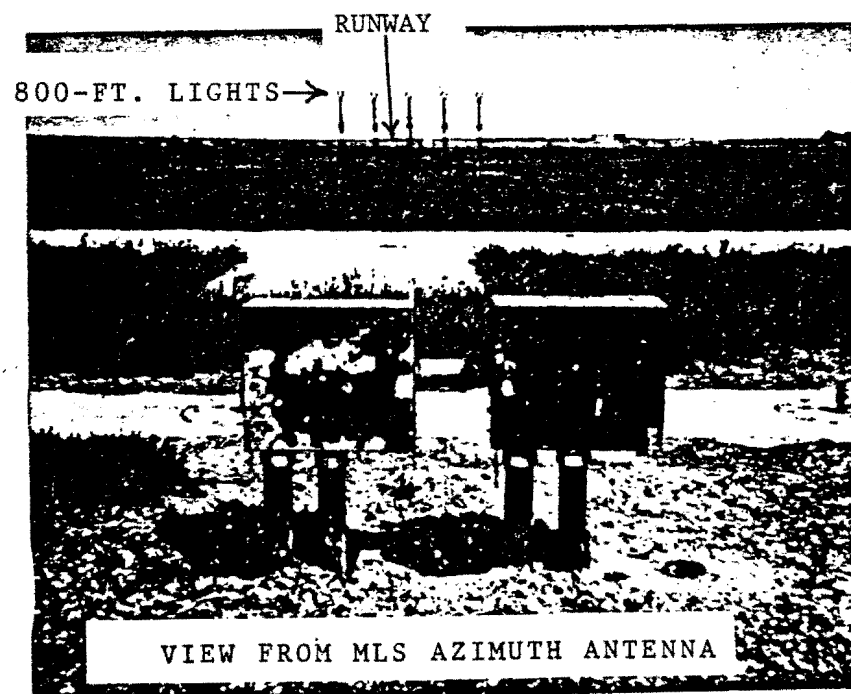
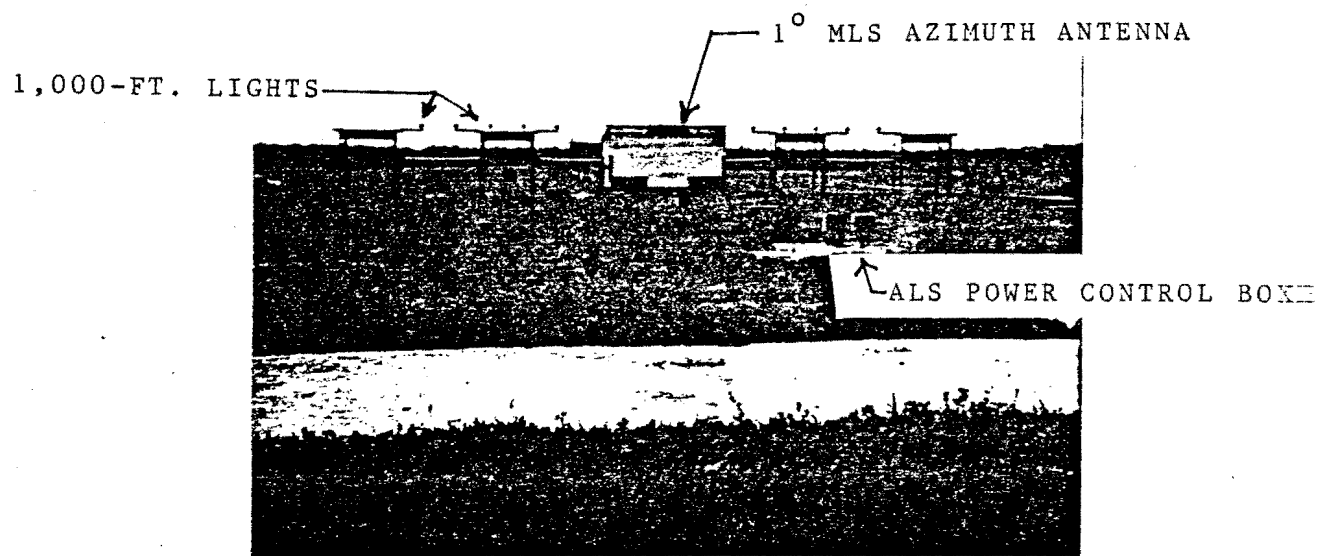


FIGURE 6. ALS BOXES AND MLS AZIMUTH ANTENNA AFTER LOWERING AND RECONFIGURATION ON MAY 10, 1988

RUN #1 START TIME: 12:41:08 STOP TIME: 12:48:30
NS1 05/12/88 SYS 2 RN CL 3 DEO EL APP
MBJY
AZIMUTH : 0.00 ELEVATION : 3.00

DATA PROCESSED BY THE PMA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, N.J. 08408
8-JUN-1988 08:53

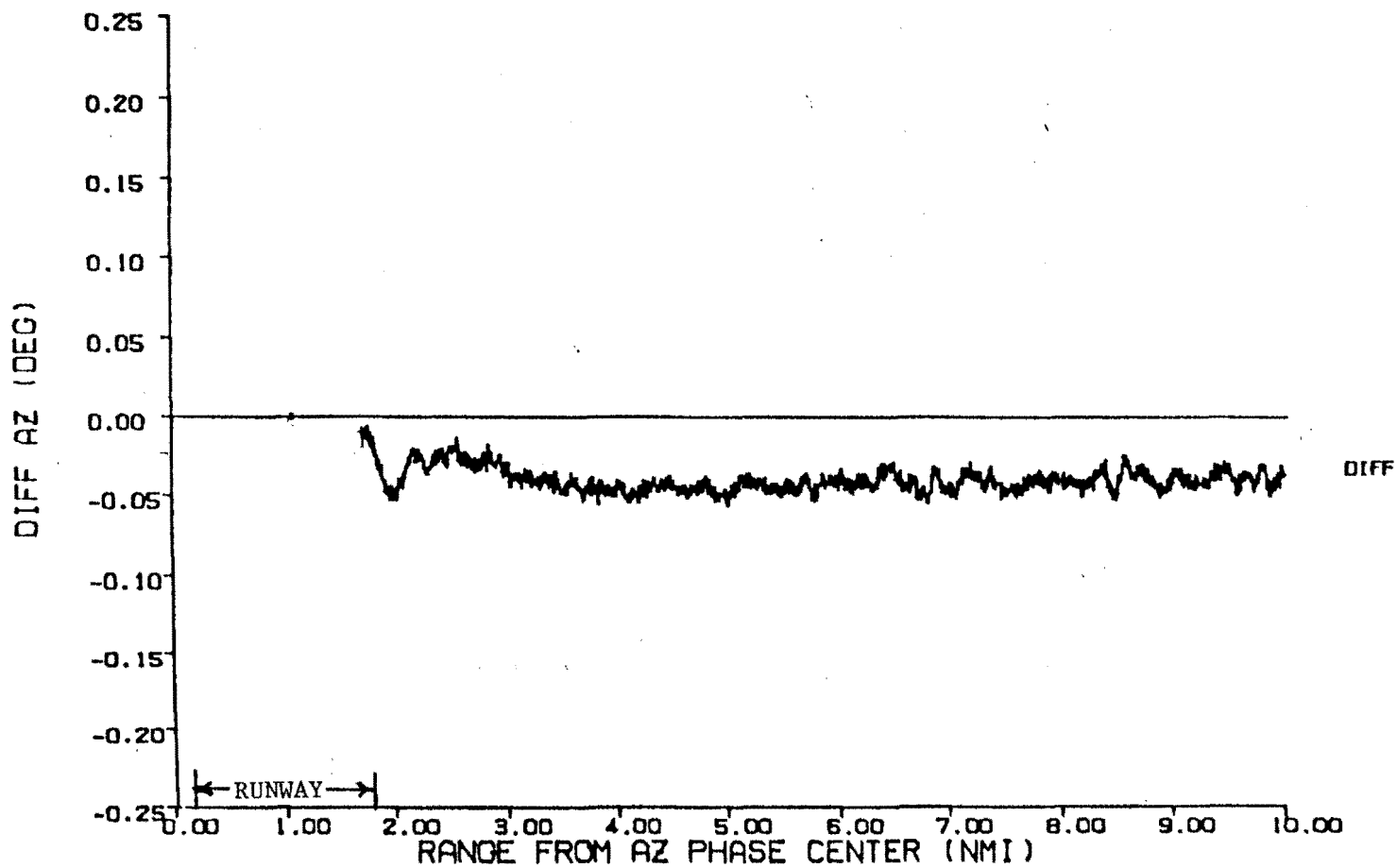
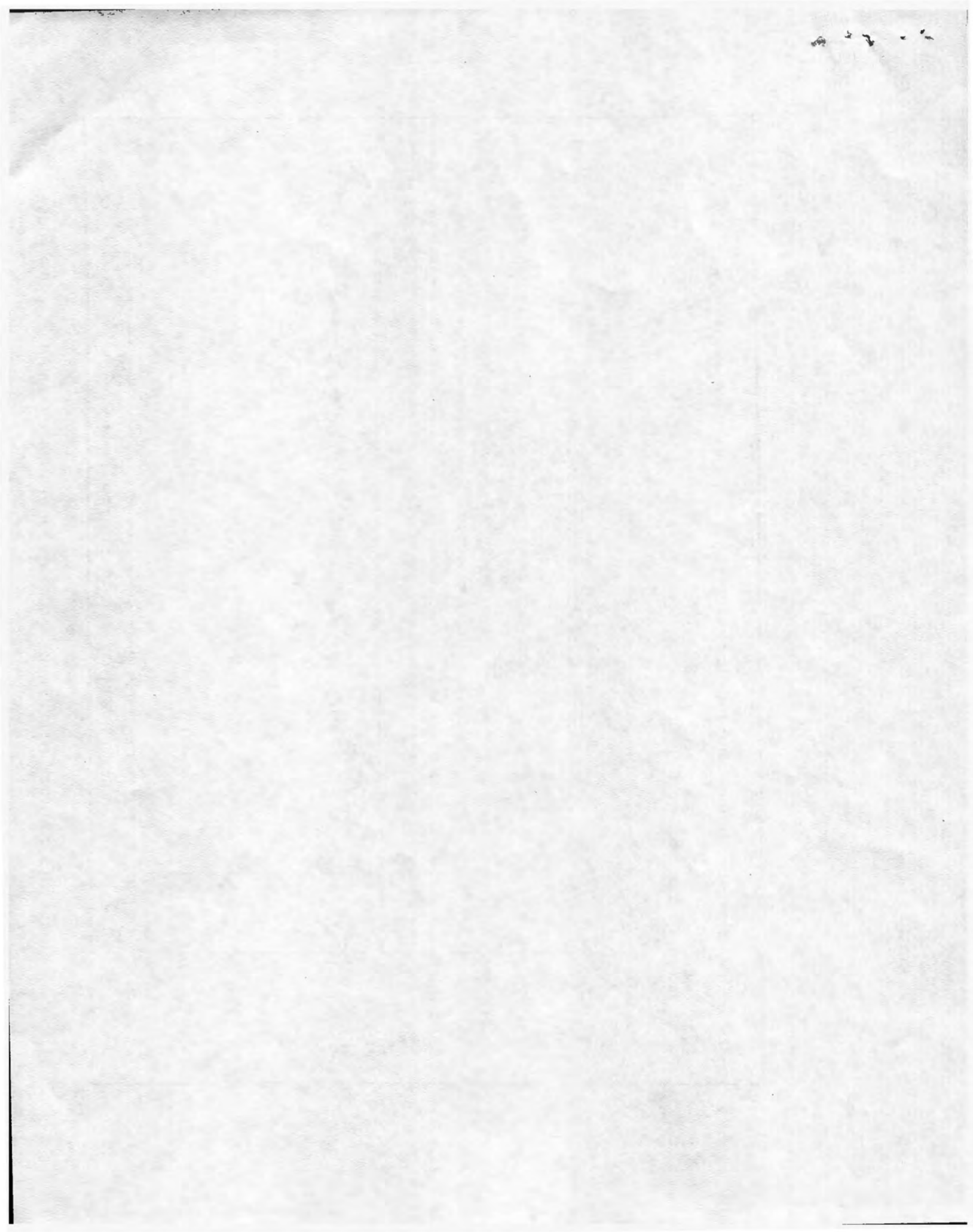


FIGURE 7. MLS AZIMUTH DIFFERENCE PLOT AFTER ALS BOXES LOWERED AND RECONFIGURED



RUN #1 START TIME: 12:41:08 STOP TIME: 12:48:30
NS1 05/12/88 SYS 2 RM CL 3 DEQ EL APP
HBJY
AZIMUTH : 0.00 ELEVATION : 3.00

DATA PROCESSED BY THE FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, N.J. 08406
8-JUN-1988 15:58

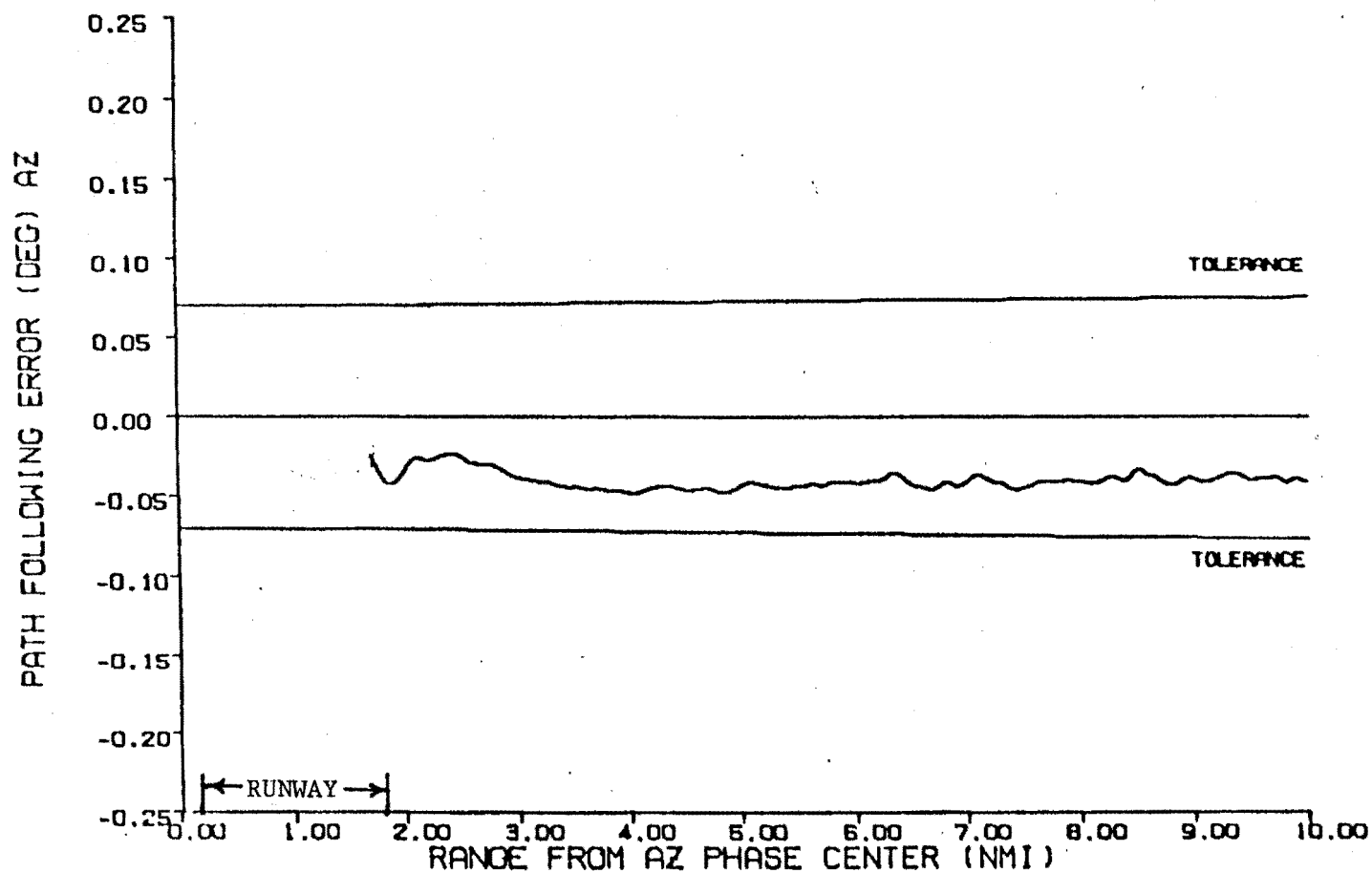


FIGURE 8. MLS AZIMUTH PFE PLOT AFTER ALS BOXES LOWERED AND RECONFIGURED

RUN #1 START TIME: 12:41:08 STOP TIME: 12:48:30
M91 05/12/88 SYS 2 RW CL 3 DEG EL APP
MBJY
AZIMUTH : 0.00 ELEVATION : 3.00

DATA PROCESSED BY THE FAN TECHNICAL CENTER
ATLANTIC CITY AIRPORT, N.J. 08408
8-JUN-1988 08:00

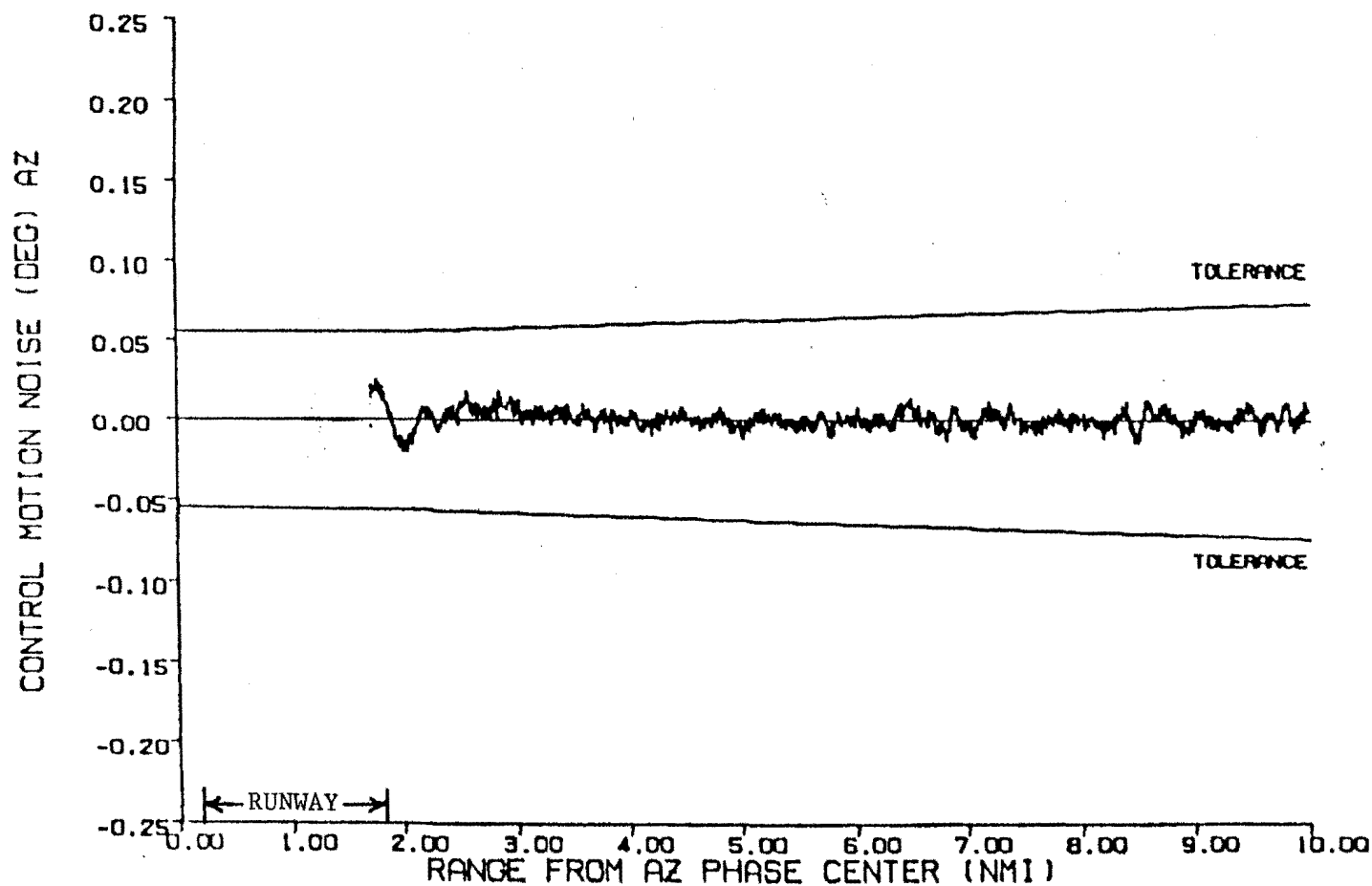
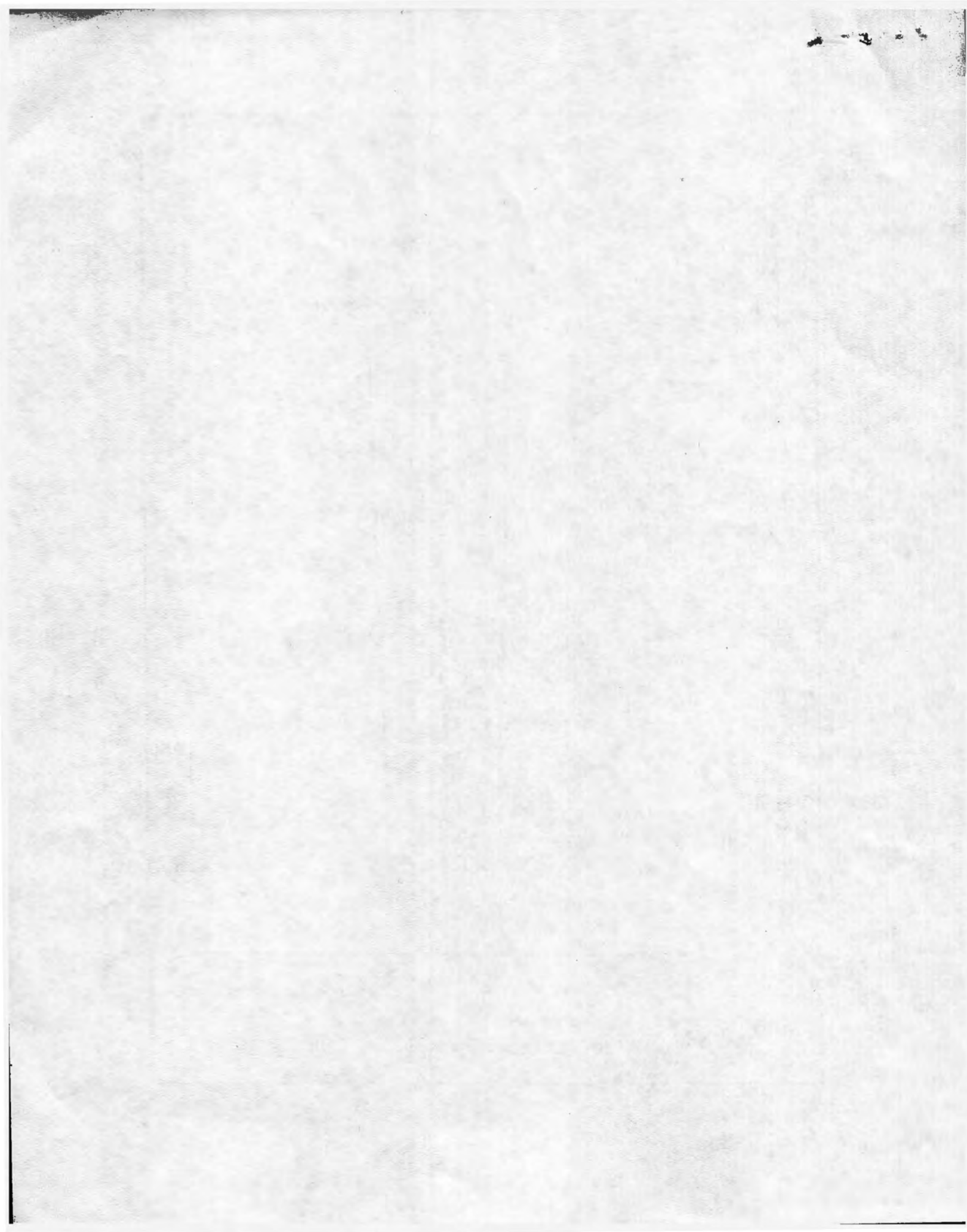


FIGURE 9. MLS AZIMUTH CMN PLOT AFTER ALS BOXES LOWERED AND RECONFIGURED



RUN #1 START TIME: 12:41:06 STOP TIME: 12:46:30
NS1 05/12/88 SYS 2 RM CL 3 DEO EL APP
MBJY
AZIMUTH : 0.00 ELEVATION : 9.00

DATA PROCESSED BY THE FAA TECHNICAL CENTER
ATLANTIC CITY AIRPORT, N.J. 08-08
6-JUN-1988 10:24

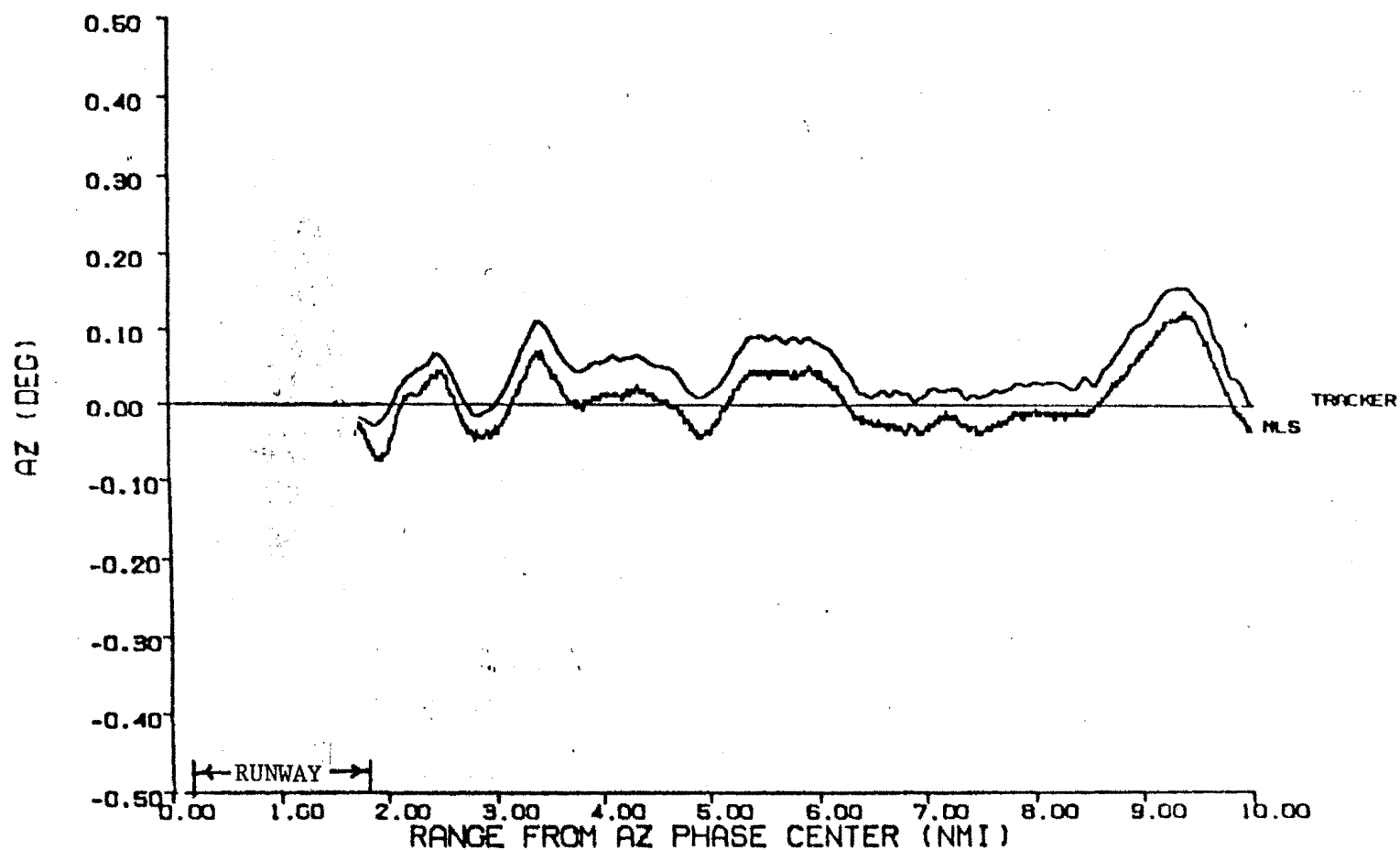


FIGURE 10. DIAGNOSTIC PLOT FOR MLS AZIMUTH DATA AFTER ALS BOXES LOWERED AND RECONFIGURED

