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SOUTH AMERICAN FLIGHT TEST REPORT

Allen L. Johnson et al.
Information Transmission Branch
Systems Avionics Division

October 1980

TECHNICAL REPORT AFWAL-TR-80-1079

Interim Test Report 1 March - 30 April 1979

Approved for public release; distribution unlimited.

AVIONICS LABORATORY
AIR FORCE WRIGHT AERONAUTICAL LABORATORIES
AIR FORCE SYSTEMS COMMAND
WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433

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This technical report has been reviewed and is approved for publication.

Allen L Johnson

ALLEN L. JOHNSON
Project Engineer, AFWAL/AAAD

CHARLES C. GAUDER
Chief, Information Transmission Branch
Avionics Laboratory

FOR THE COMMANDER

Raymond E Siferd

RAYMOND E. SIFERD, Colonel, USAF
Chief, System Avionics Division
Avionics Laboratory

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20. ABSTRACT (*Continue on reverse side if necessary and identify by block number*)

A flight test was conducted into the equatorial region to investigate UHF ionospheric scintillation fading. The test involved the Avionics Laboratory SATCOM-equipped aircraft and the Air Force Geophysics Laboratory flying ionospheric laboratory.

Equatorial ~~UHF~~ ionospheric scintillation fading was encountered approximately 25% of test period. A multipath fading mitigation technique was tested which utilizes signals received on bottom and top mounted antennas to reduce the

fading effect.

The ASC-28 Dual Frequency SATCOM terminal was evaluated during the test flights. The performance of the EHF and SHF antennas during zenith operation was successfully demonstrated.

The ASC-31 1-kw UHF power amplifier was tested using the ARC-171 UHF transceiver as a driving source.

FOREWORD

The results reported herein were accomplished between 1 March and 30 April 1979 under Advanced Space Communication Project 1227, Terminal Segment Technology, Work Unit #12270313 -- SATCOM Flight Test, T. A. Grizinski, Work Unit Engineer.

The Instituto Geofisico Del Peru (IGP) was instrumental in arranging test frequency clearances in Peru (IGP) and making ground scintillation observations in support of this test. The cooperation and support of Ing. Alberto Giesecke, Ing. Alfredo Bushby and other IGP personnel were significant in the successful accomplishment of these tests.

The tests were accomplished by an extensive team of government and contractor engineers. The individuals most directly involved in the testing or support included:

R. L. Swanson	AFWAL
T. A. Grizinski	AFWAL
W. Hunt	AFWAL
Maj. W. Beeson	AFWAL
P. A. Heidkemp	AFWAL
J. Buchau	AFGL
Capt. E. J. Weber	AFGL
J. Moore	AFGL
Capt. T. Walilko	4950th
S/Sgt J. Cary	4950th
T/Sgt O. Sammon	4950th
S. Wilson	4950th
R. Chin	4950th
C. Begin	Raytheon
R. Cullen	Raytheon
E. Perdue	Raytheon
W. Rembacz	Collins
R. Foster	RCA
J. Arnold	TRW
J. Brown	TRW
D. Wilson	Linkabit
J. Oldenwalter	Linkabit
R. Pelletier	Lincoln Labs
B. Barrett	Lincoln Labs

FOREWORD (Continued)

M/Sgt J. Wyett	SACCA
R. Kissell	AVCO
R. Frazier	AVCO
H. Bennett	AVCO
R. Gilmore	AVCO

Solar forecast data was provided by R. Winn of the Avionics Laboratory Staff Meteorlogical Office.

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SECTION I

INTRODUCTION

A series of ten test flights was accomplished with Aircraft C135/662 from 15 March to 1 April 1979. A total of 63 flight hours was logged as the aircraft flew to South America along the route shown in Figure 1. The Air Force Geophysics Laboratory Airborne Ionospheric Observatory C135/131 participated in the South American campaign. Results of the AFGL tests are reported in a separate AFGL Tech Report.

A number of test objectives were accomplished during the flight test and will be reported in this document. However, a dual UHF modem precorrection test accomplished with Linkabit Corporation is reported in a separate report (Johnson and Foshee, 1979). The "CASTOR" Barium Cloud Test accomplished with the Max Planck Institute of West Germany is also reported separately (Johnson and Swanson, 1979).

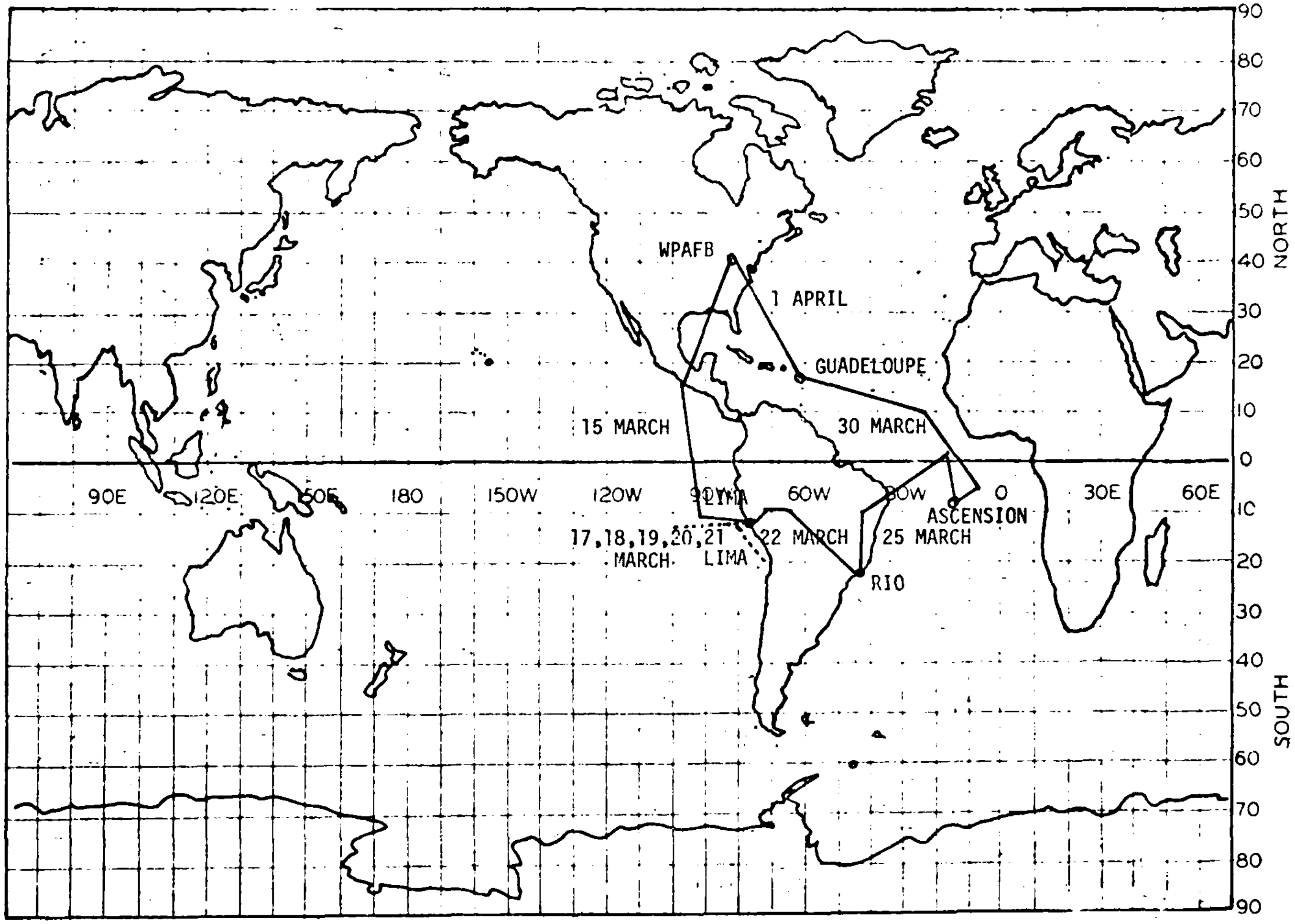


Figure 1. 1979 South American Flight Test Route

SECTION II

TEST RESULTS

UHF IONOSPHERIC SCINTILLATION FADING

Instabilities in the night-time equatorial ionosphere often develop into the well-known bubbles or plumes, large-scale field aligned electron density depletions, which after development extend throughout the F region to heights of up to 1000 km (Woodman and LaHoz, 1976). These depletions with horizontal dimensions of 100 to 200 km east/west and several 1000 km north/south are the seat of irregularities with scale sizes from meters to tens of kilometers. The irregularities move as a whole towards the east with nominal speeds of 100 m sec^{-1} (Whitney et al., 1977; Weber et al., 1978). Satellite signals, which propagate through this medium, suffer refraction and scattering which for an observer on the earth or in an airplane result in the well-known scintillations. To obtain additional information about the characteristics of these irregularities, tests were accomplished using UHF signals from the LES 8, LES 9, MARISAT and FLTSAT satellites. Separate receivers on aircraft C135/662 recorded the signal strength from these satellites on 12 days. The periods of test and the occurrence of scintillation fading are shown in Figure 2.

Scintillation fading in the equatorial region is seldom encountered during the daytime. As noted in Figure 2, the scintillation fading always began from 1 to 2 hours after local sunset. The first series of tests (17-22 March) occurred in Peru where local time is 5 hours earlier than Universal Time (UT). The onset of scintillation on 25 March occurred out of Brazil over the Atlantic where the local time is about 2 hours earlier than Peruvian time, (UT-3).

Scintillation fading was experienced for fourteen hours of the sixty hours of scintillation test time, or about 25% of the test time. Scintillation fade depths of 20 to 30 db peak-to-peak were experienced,

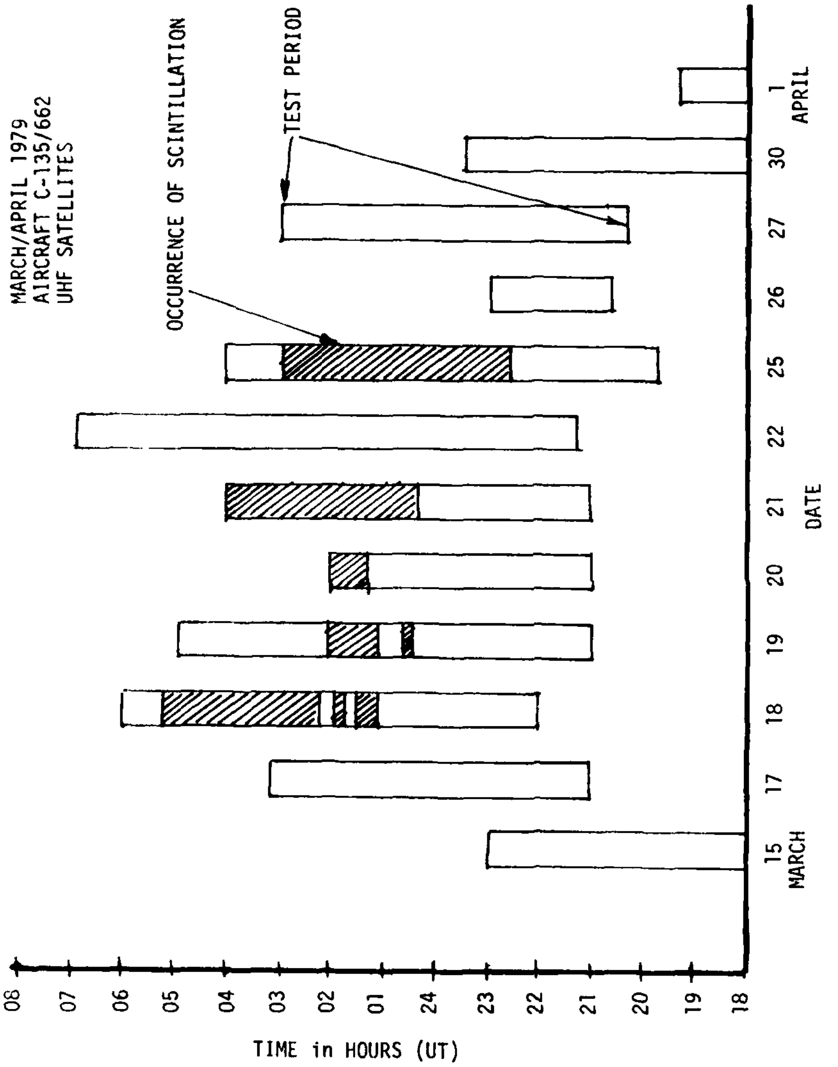


Figure 2. Test Periods and Occurrence of Scintillation Fading

Figures 3 and 4. These figures are examples of fast and slow type fading usually experienced. Histograms of the fade distribution, cumulative probability distributions, power spectral density, and the auto correlation function of the sample fades are shown in Figures 5 through 12.

MULTIPATH BOUNCE FADE MITIGATION TECHNIQUE

Measurements of the reflection from sea water have indicated that at a high elevation angle to the satellite a downward looking antenna will see a signal only 3 to 6 db weaker than an upward looking antenna (Johnson, 1979). The water reflected signal has rapid fading on it which can be overcome with a coding/interleaving technique.

The noise-like reflected signal experiences considerably less effect from ionospheric scintillation fading than the direct signal. This appears to be due to the fact that the reflected signal is coming from a fairly large area (the first Fresnel zone) and the different reflected component over this area is fading incoherently (Prettie, 1977).

The geometry of the direct and reflected signals is shown in Figure 13. The performance of the LES 8 UHF forward link was measured from a top antenna (direct path) and from a bottom antenna (reflected path) under the condition of no scintillation fading. The results of the test are shown in Figure 14 which indicates the bottom antenna performance is approximately 7 db worse than the top antenna performance. Plots of the top and bottom antenna received signal cumulative distribution function under similar conditions show that the 50% occurrence points are 7 db apart in signal level (Figures 15 and 16). The received signal from the top and bottom antennas is shown in Figure 17.

The signal received on the top and bottom antennas under severe ionospheric scintillation conditions is shown in Figure 18. Histograms of the signal levels are shown in Figures 19 and 20. Cumulative

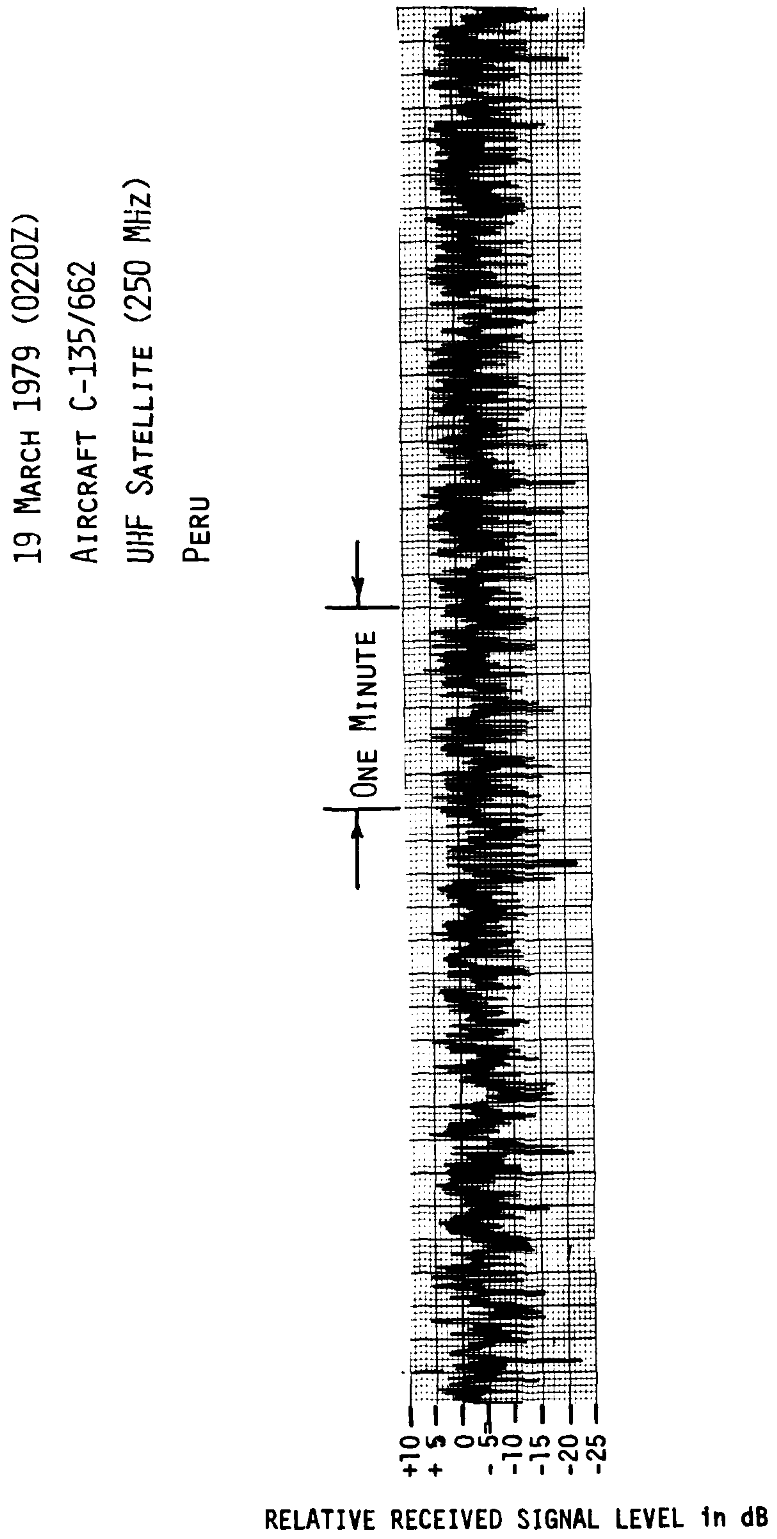


Figure 3. Fast Equatorial Ionospheric Scintillation Fading

19 March 1979 (0315Z)
Aircraft C-135/662
UHF Satellite (250 MHz)
Peru

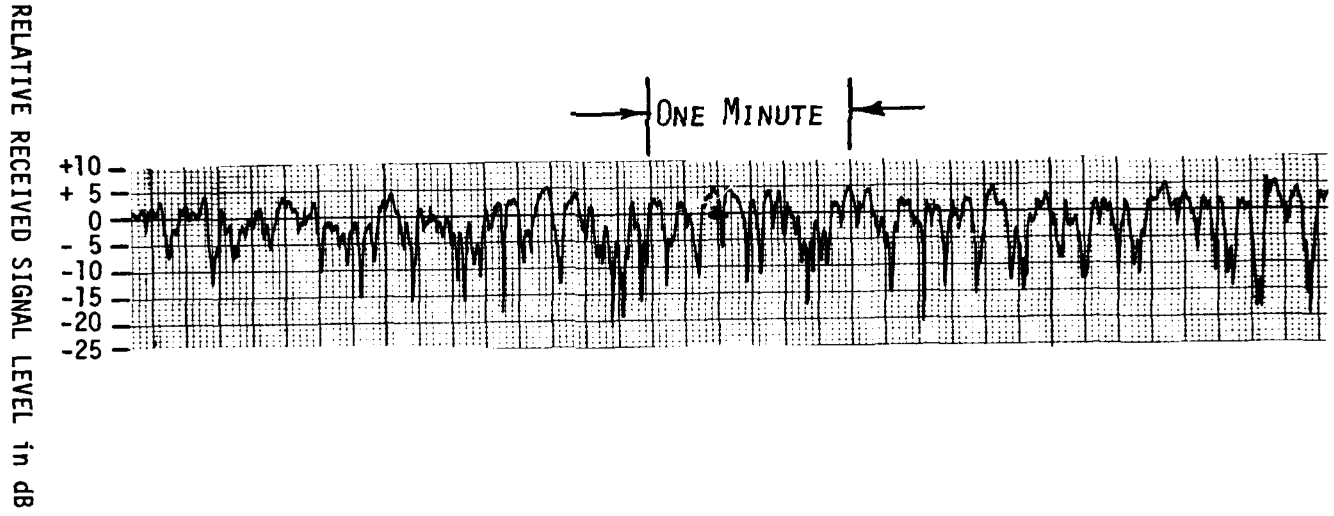


Figure 4. Slow Equatorial Ionospheric Scintillation Fading

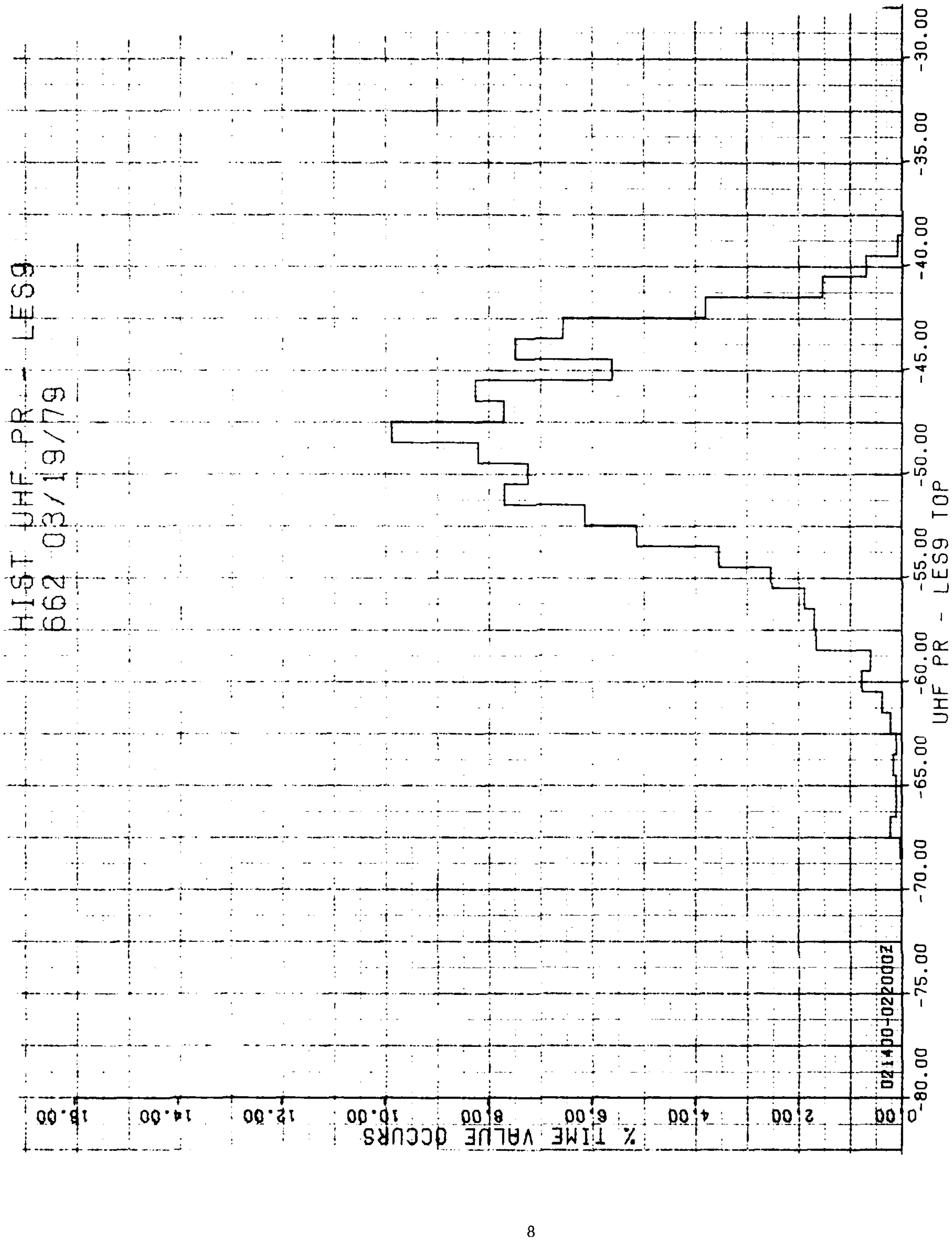


Figure 5. Histogram of Fast Scintillation Fading

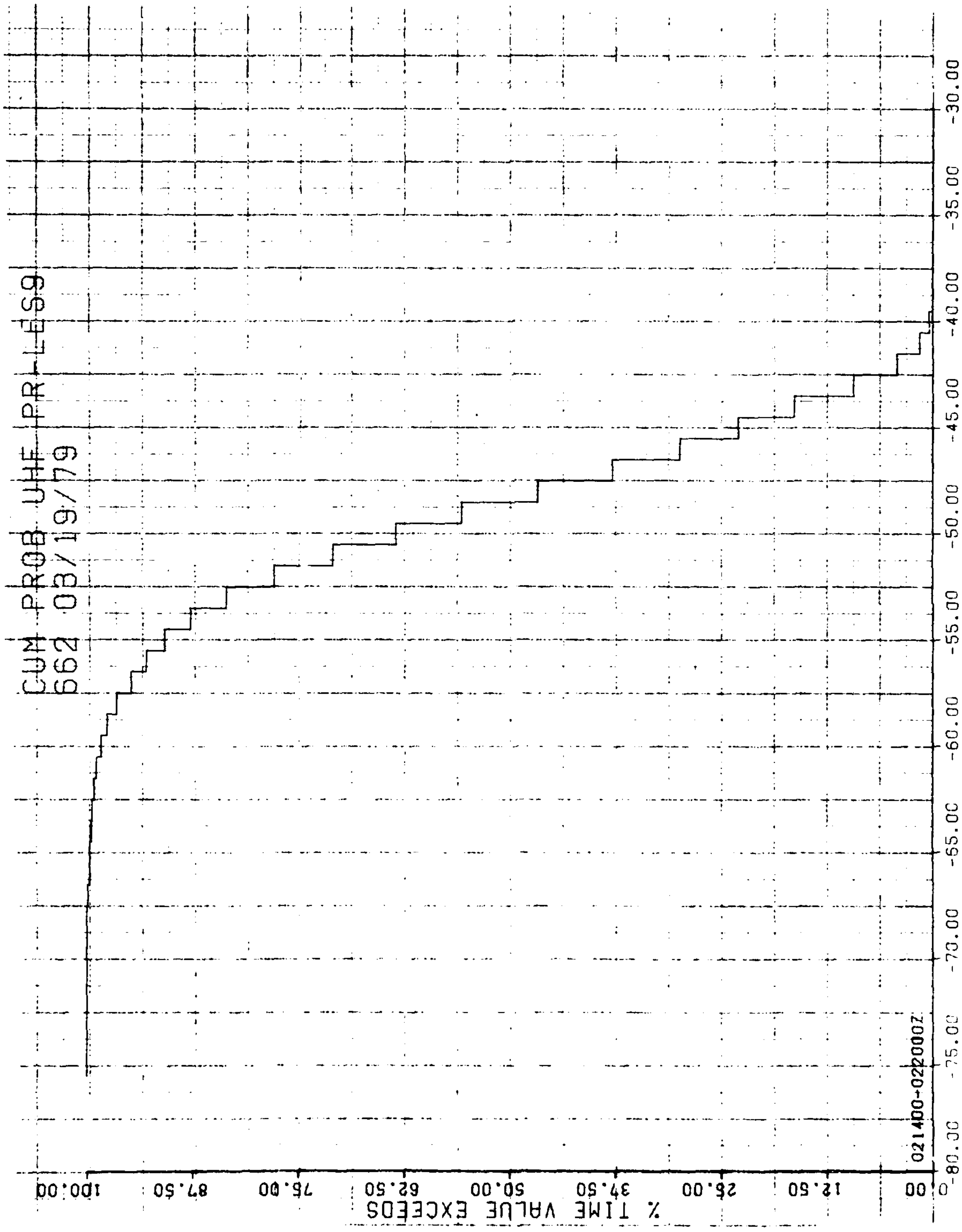


Figure 6. Cumulative Probability Distribution of Fast Scintillation Fading

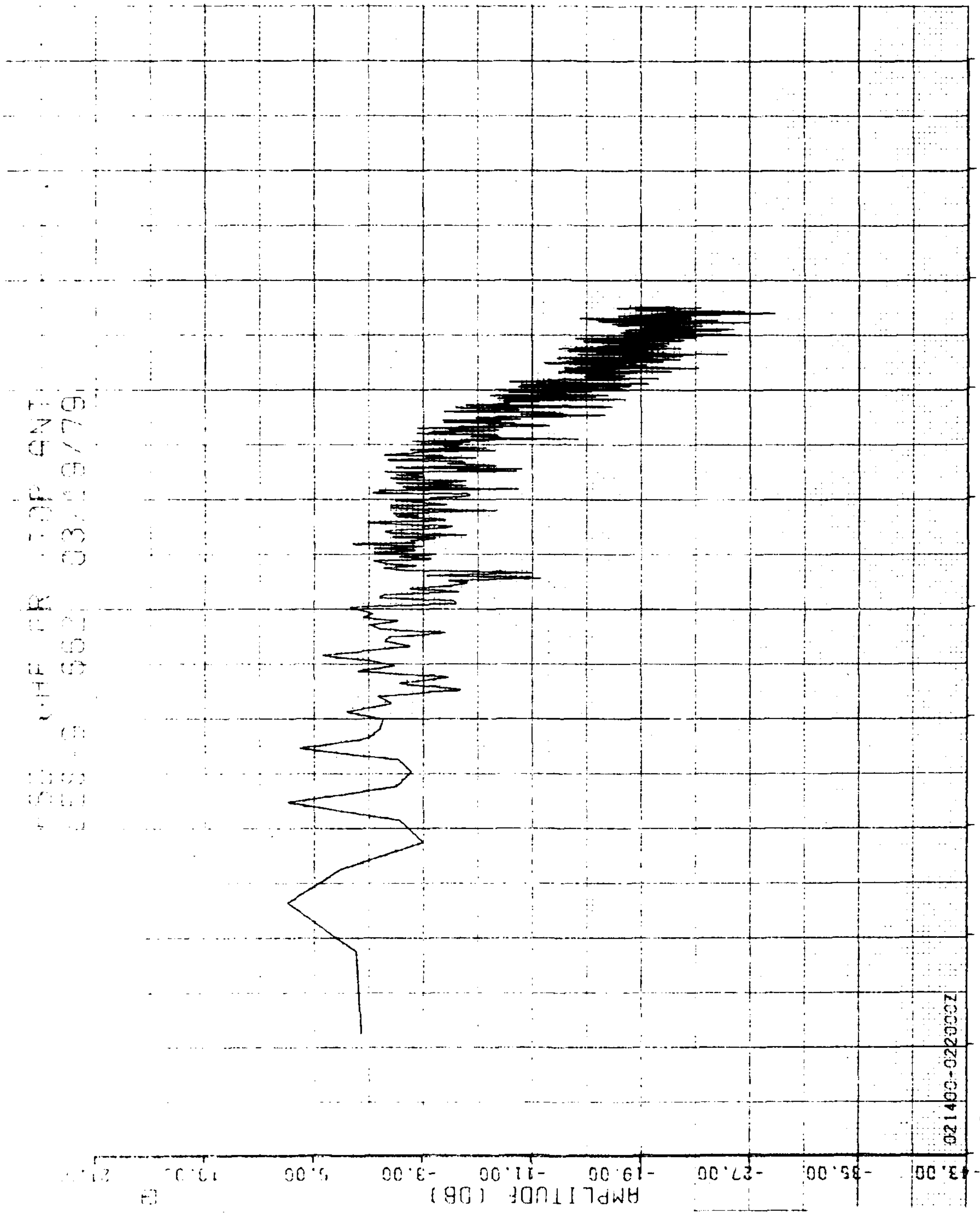


Figure 7. Power Spectral Density of Fast Scintillation Fading

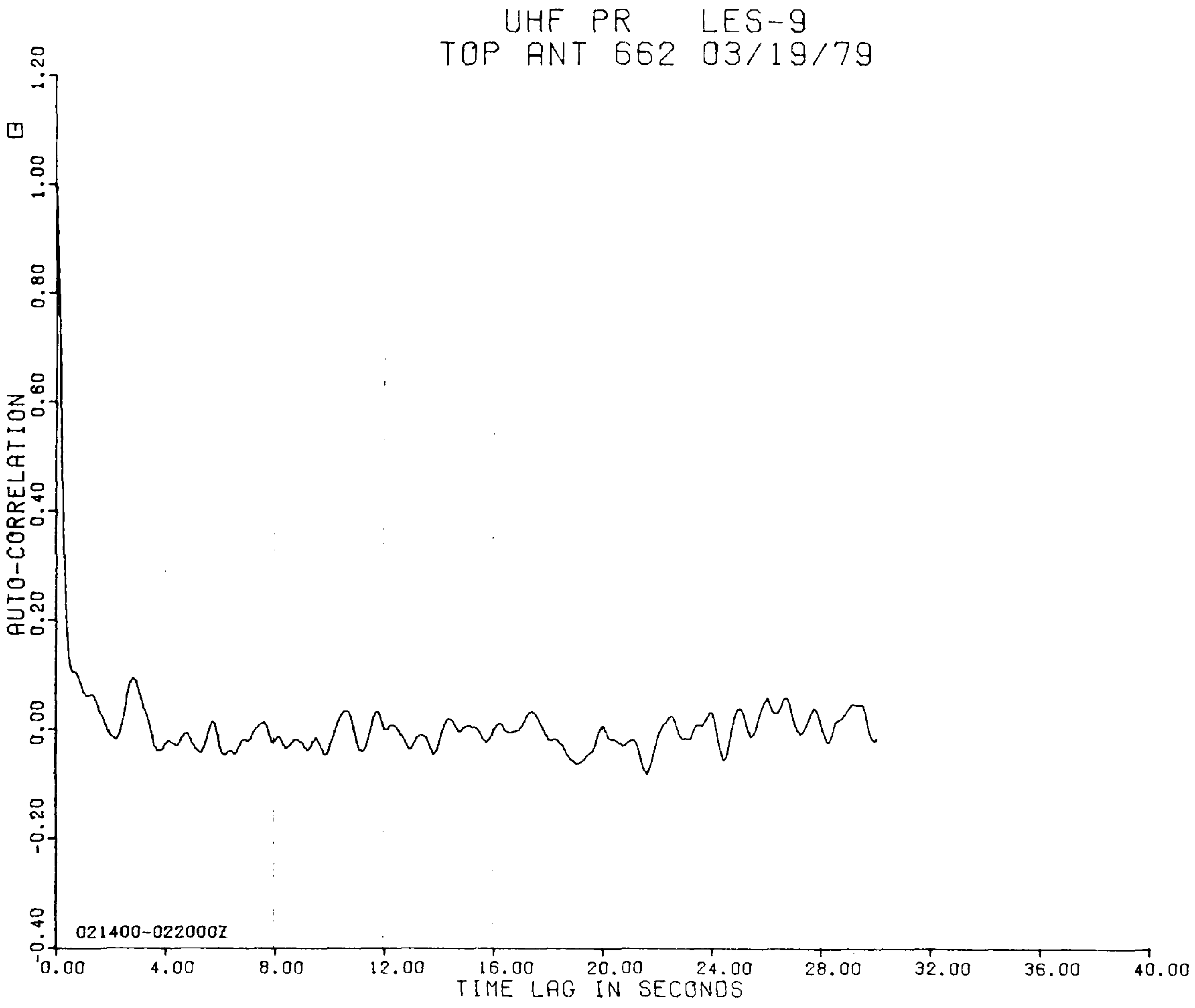


Figure 8. Autocorrelation of Fast Scintillation Fading

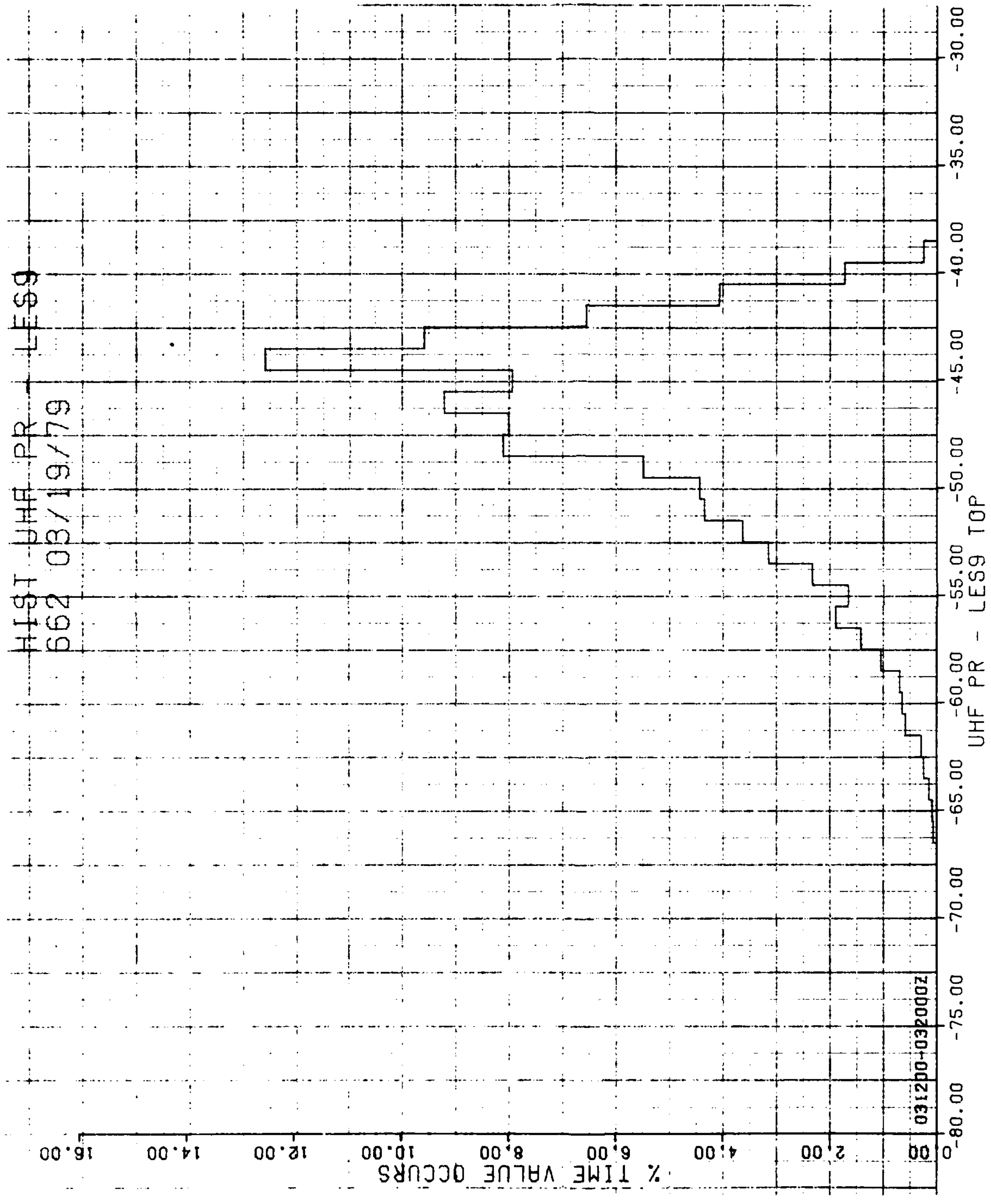


Figure 9. Histogram of Slow Scintillation Fading

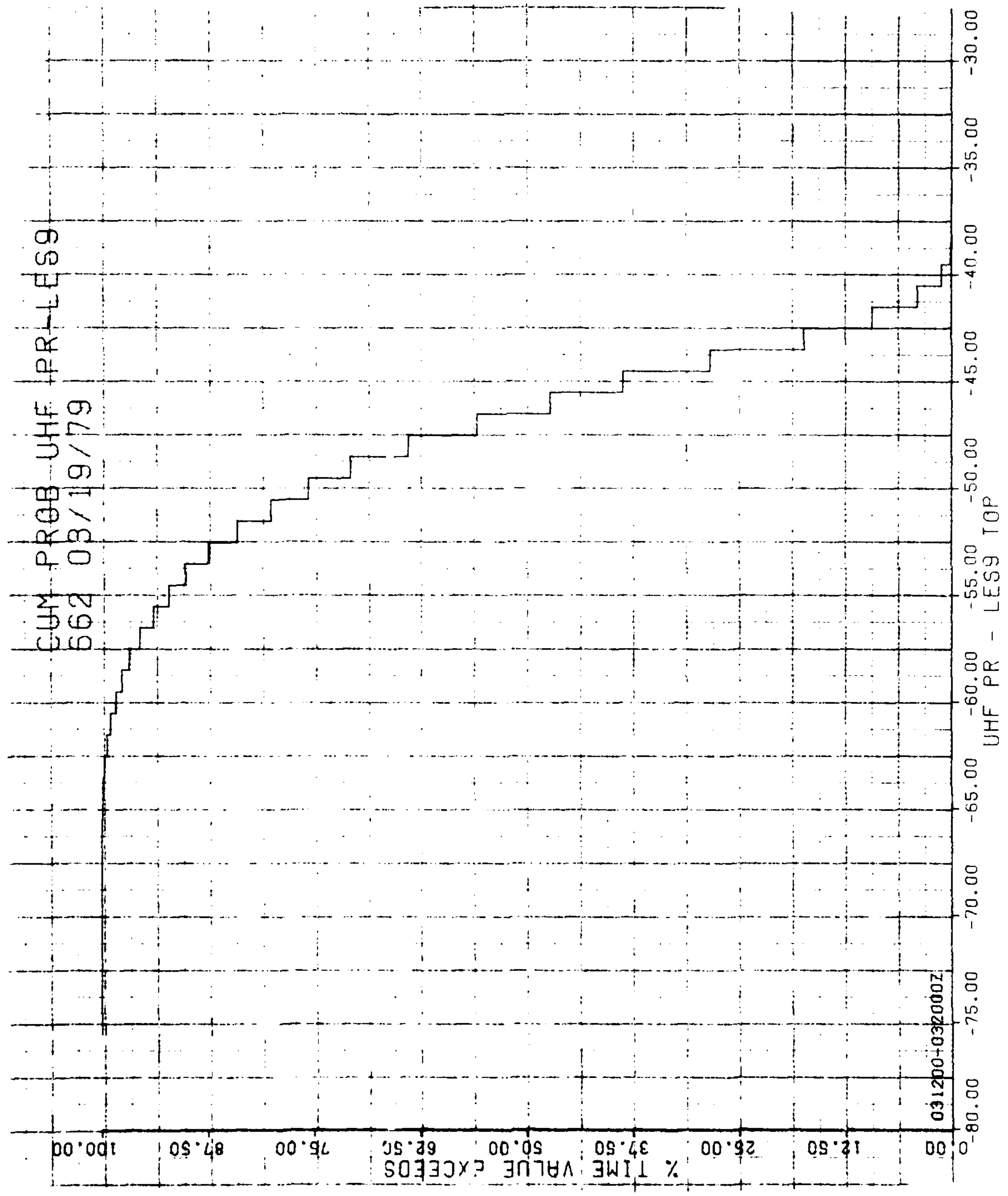


Figure 10. Cumulative Probability Distribution of Slow Scintillation Fading

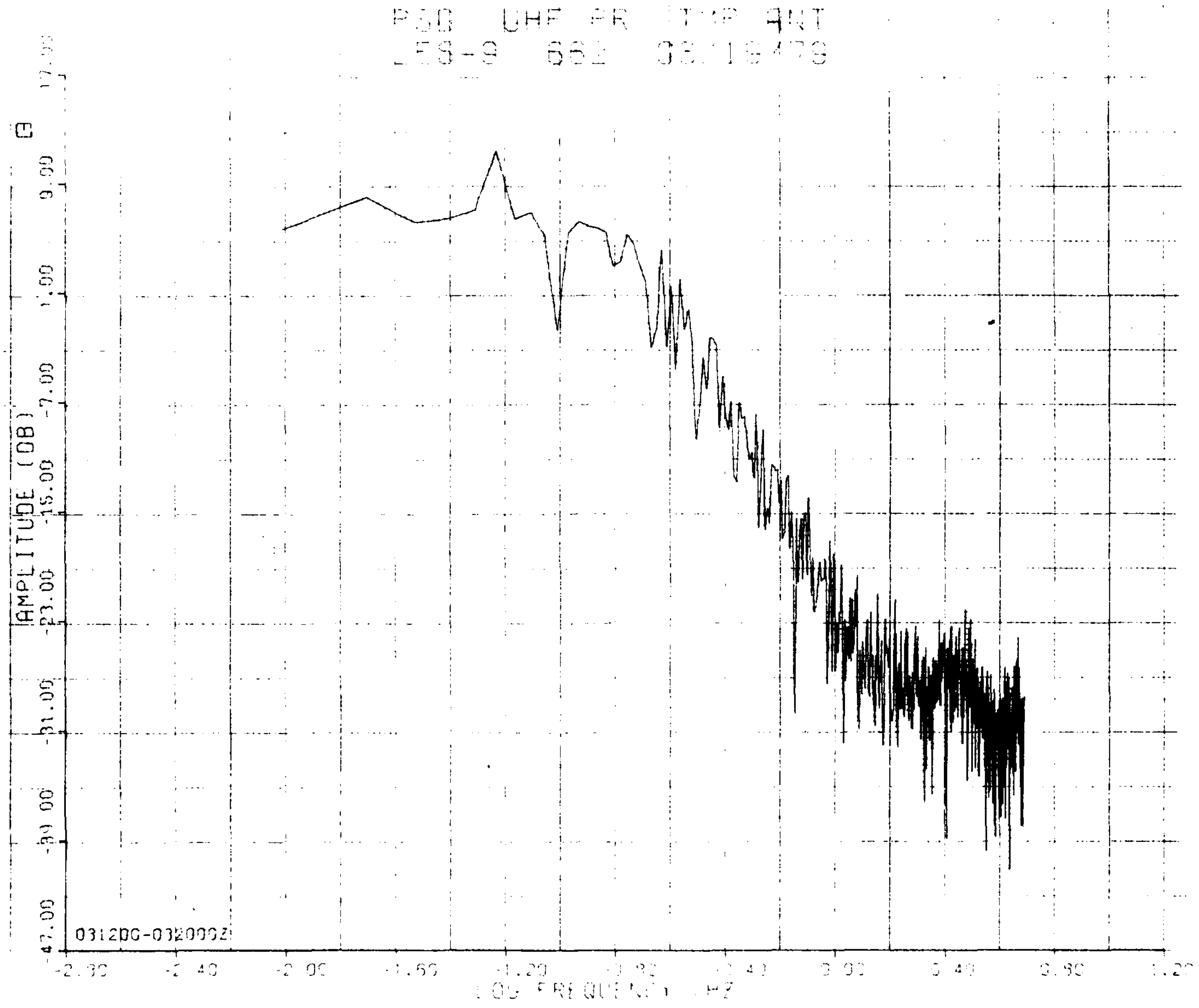


Figure 11. Power Spectral Density of Slow Scintillation Fading

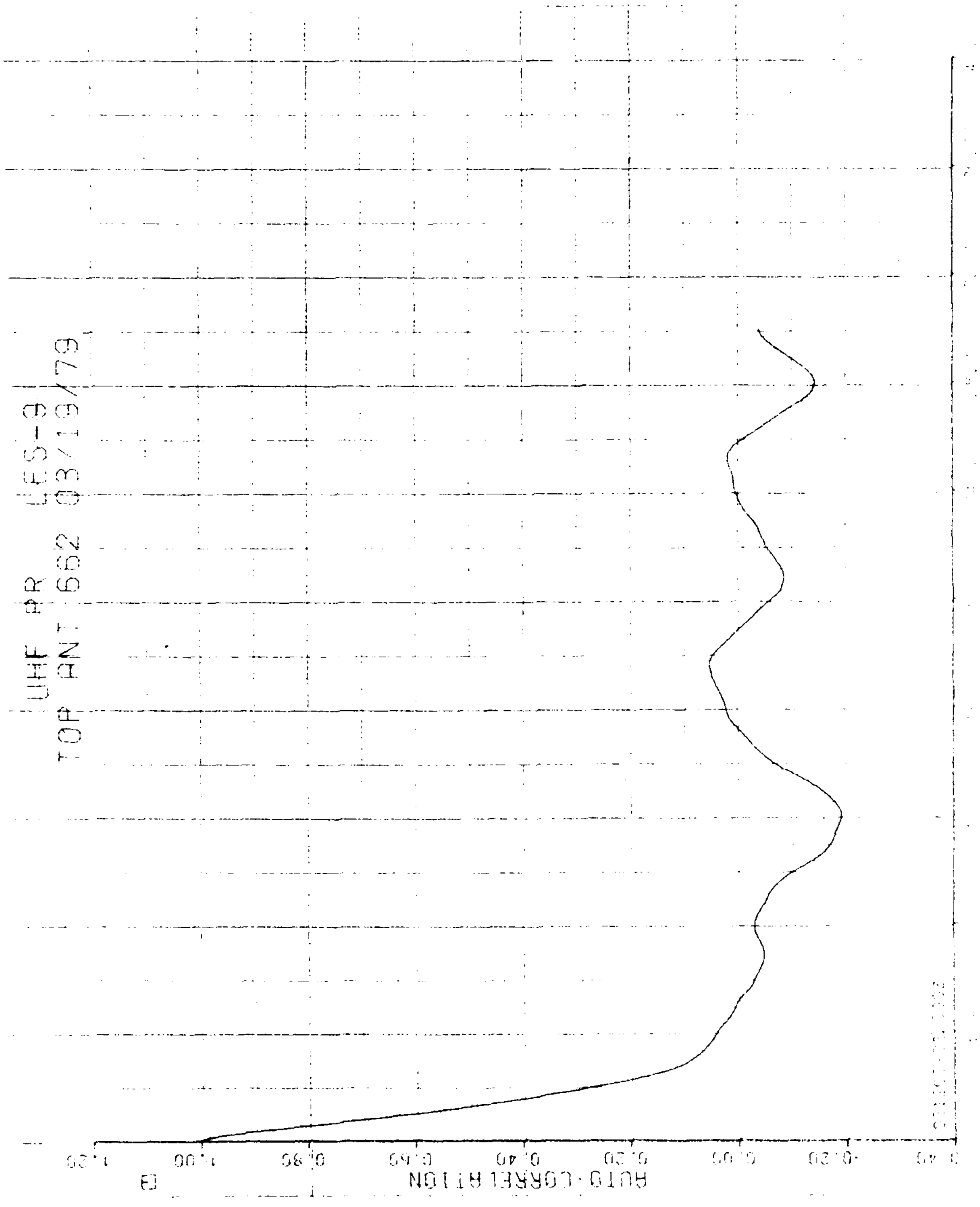


Figure 12. Autocorrelation of Slow Scintillation Fading

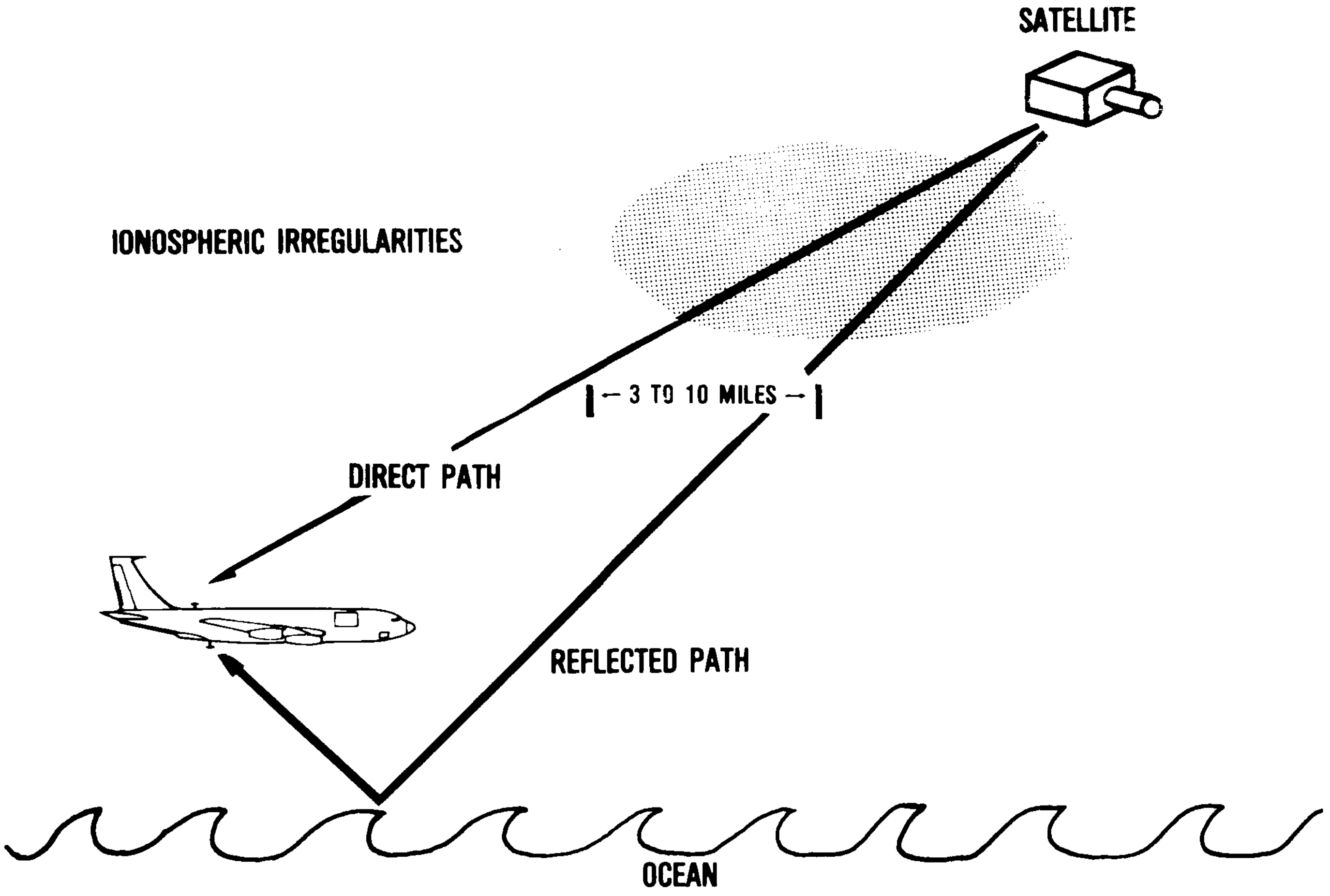
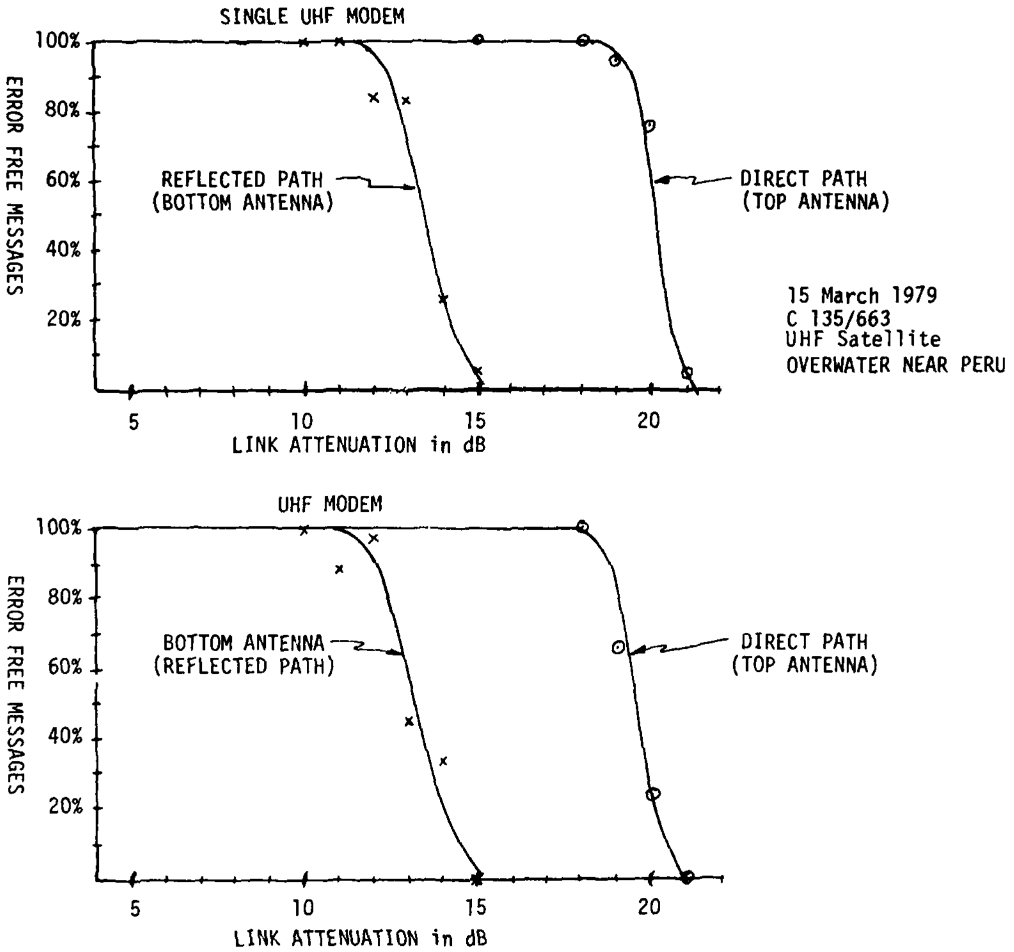


Figure 13. Geometry of Fade Mitigation Technique



15 March 1979
C 135/663
UHF Satellite
OVERWATER NEAR PERU

Figure 14. Performance of AFSATCOM II Modulation with Multipath Reflected Signal

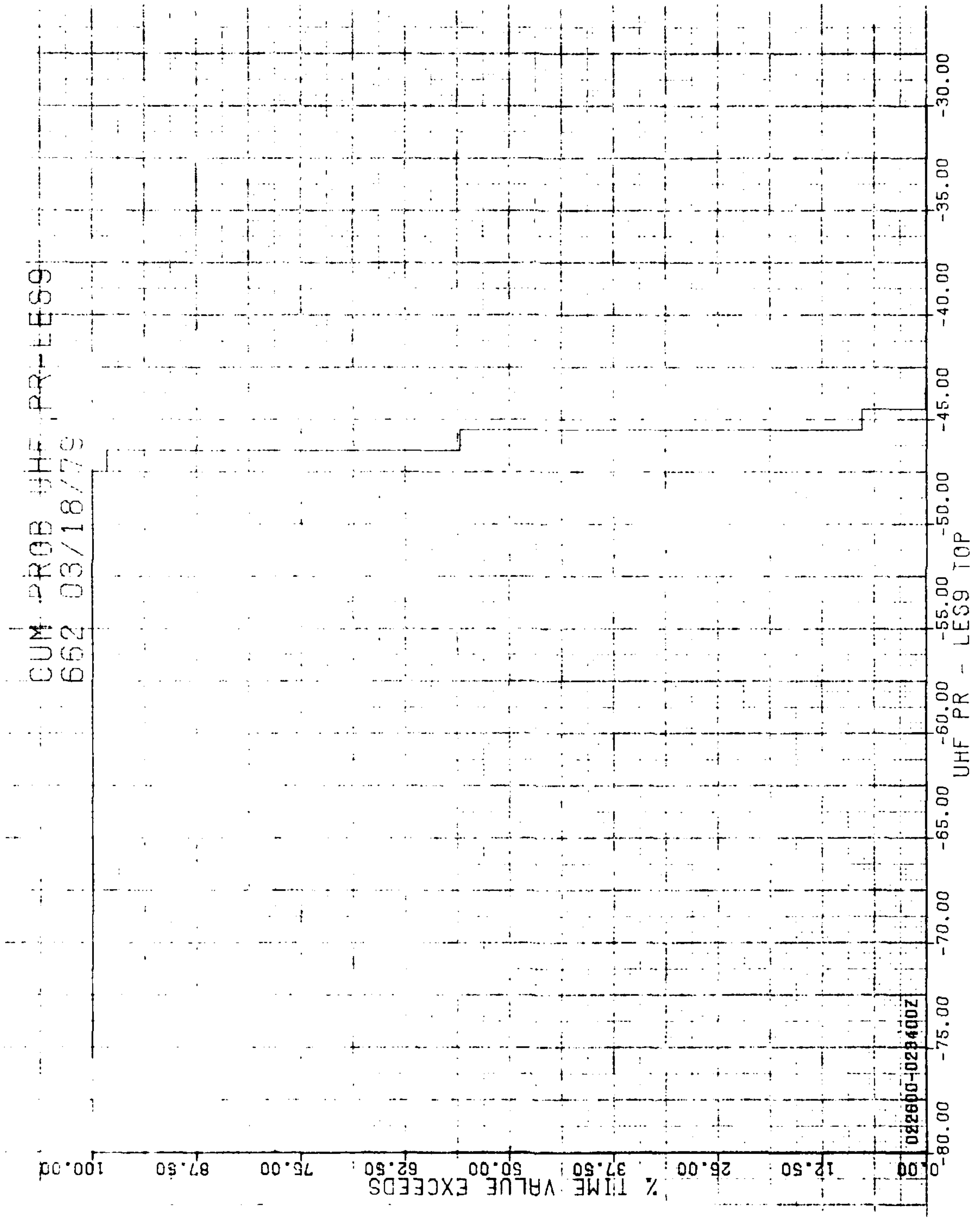


Figure 15. Cumulative Probability Distribution of Top Antenna Signal

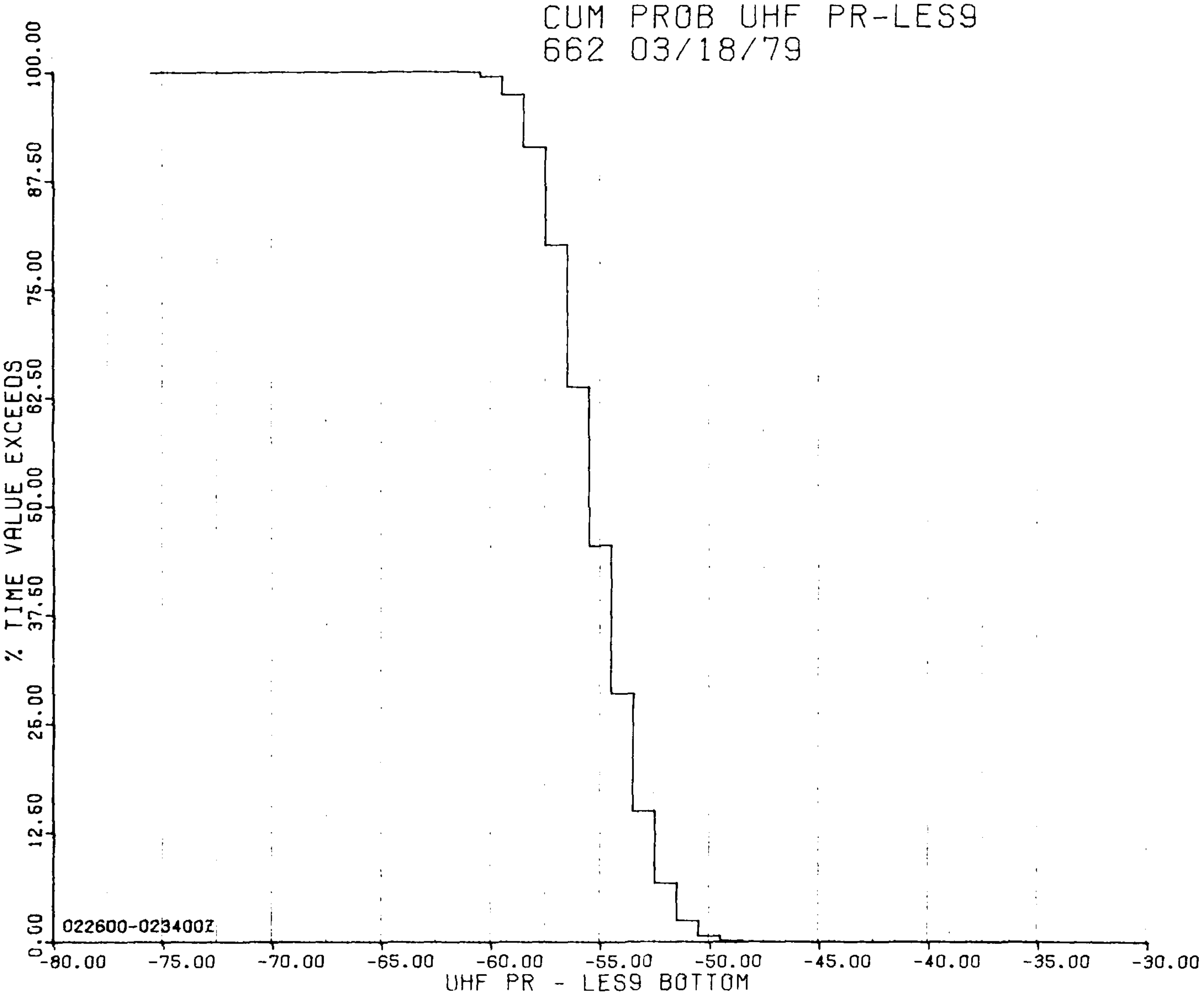
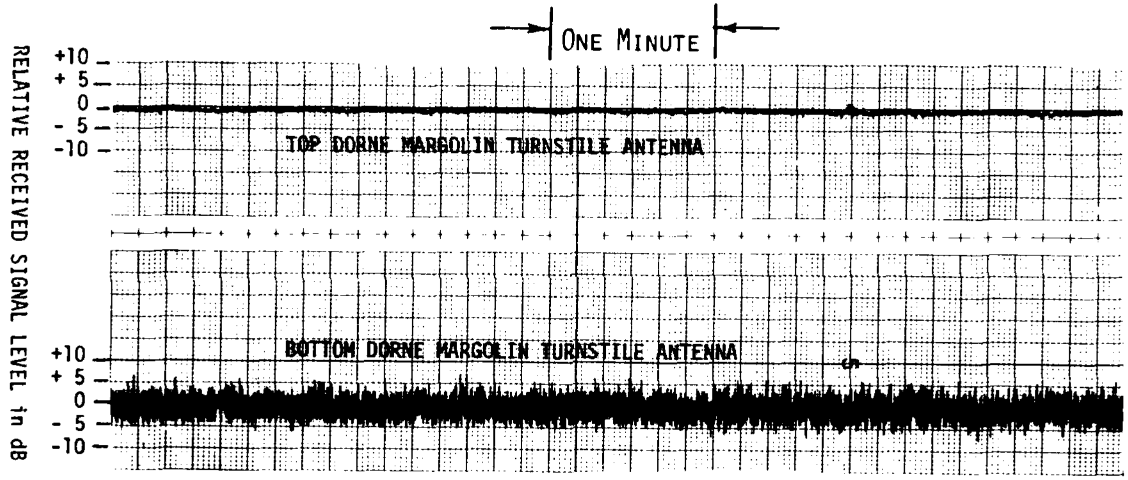
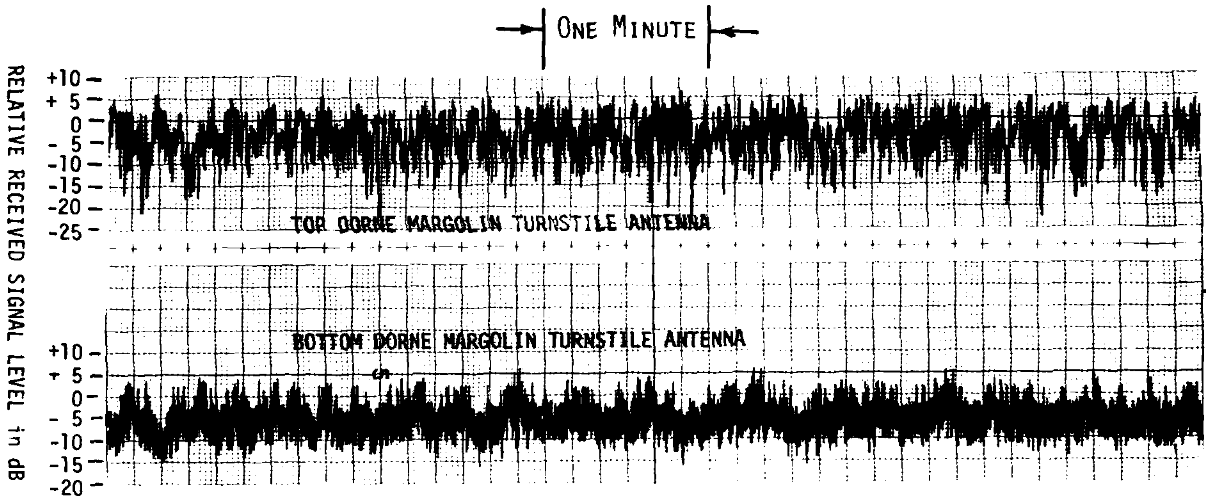


Figure 16. Cumulative Probability Distribution of Bottom Antenna Signal



18 March 1979 (0230Z)
Aircraft C-135/662
UHF Satellite (250 MHz)
Peru-Elevation Angle 46°

Figure 17. Received Signal Level from Top and Bottom Antenna



19 MARCH 1979 (0220Z)
AIRCRAFT C-135/662
UHF SATELLITE (250 MHz)
PERU- ELEVATION ANGLE 48°

Figure 18. Received Signal Level from Top and Bottom Antenna During Scintillation

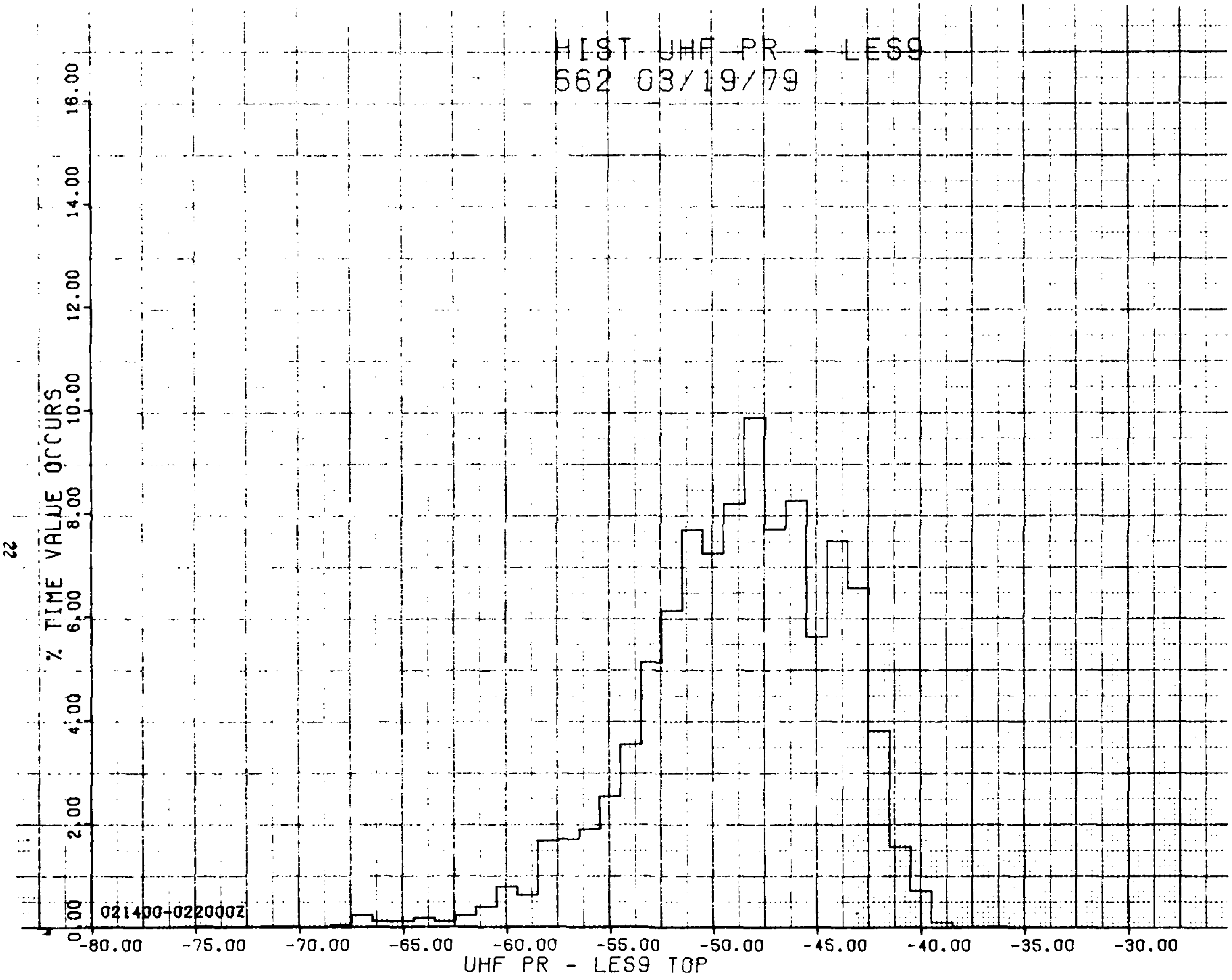


Figure 19. Histogram of Received Signal Level from Top Antenna

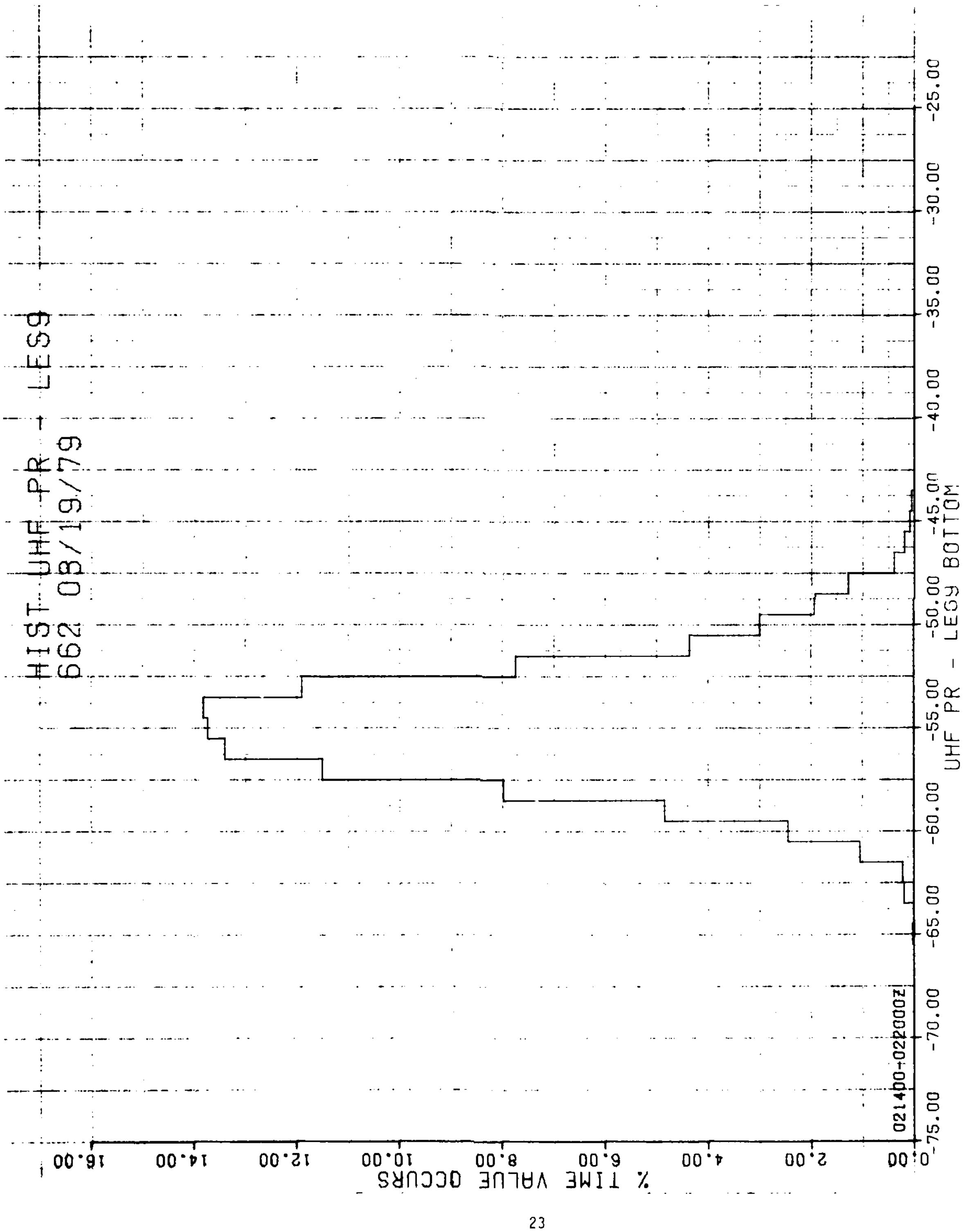


Figure 20. Histogram of Received Signal Level from Bottom Antenna

probability distribution, power spectral density plots and auto correlation functions of the two signals are shown in Figures 21 through 26.

The error-rate performance of signals received on the top and bottom antennas is shown in Figure 27. Note that the performance of the signal received on the top antenna is degraded approximately 7-9 db from the unfaded performance. The performance of the signal received on the bottom antenna is degraded 0-2 db from its performance under nonfading conditions. The results show that under severe scintillation fading the reflected signal received on the bottom antenna performs as well or better than the signal received on the top antenna.

JOINT SCINTILLATION TEST

On 25 March a joint AFGL/AFAL scintillation test was flown from Brazil to Ascension Island to characterize the development and geographic extent of equatorial ionospheric scintillation. The AFGL Airborne Ionospheric Observatory aircraft C135/131 is equipped to measure the ionosphere using an HF sounder, all-sky photometer and UHF scintillation receivers (Buchau et al., 1979).

The flight track of the AFGL and AFAL equipped aircrafts is shown in Figure 28. The AFAL equipped aircraft flew a flight track parallel to the magnetic equator at 5° south magnetic latitude, while the AFGL equipped aircraft flew in parallel at 15° south magnetic latitude, both aircraft crossing the same magnetic longitudes at roughly the same times. The wide portion of the flight track line indicates periods when UHF scintillation fading was experienced on the UHF downlink signal from MARISAT. The non-crosshatched portion indicates shallow fading (5 to 10 db peak-to-peak).

Note that the onset of fading was observed earlier near the magnetic equator. At 22:29Z (19:49LT) the equatorward (AFAL) aircraft encountered scintillation fading. Thirty-seven minutes later the fading had spread southward 700 miles to the more southerly aircraft.

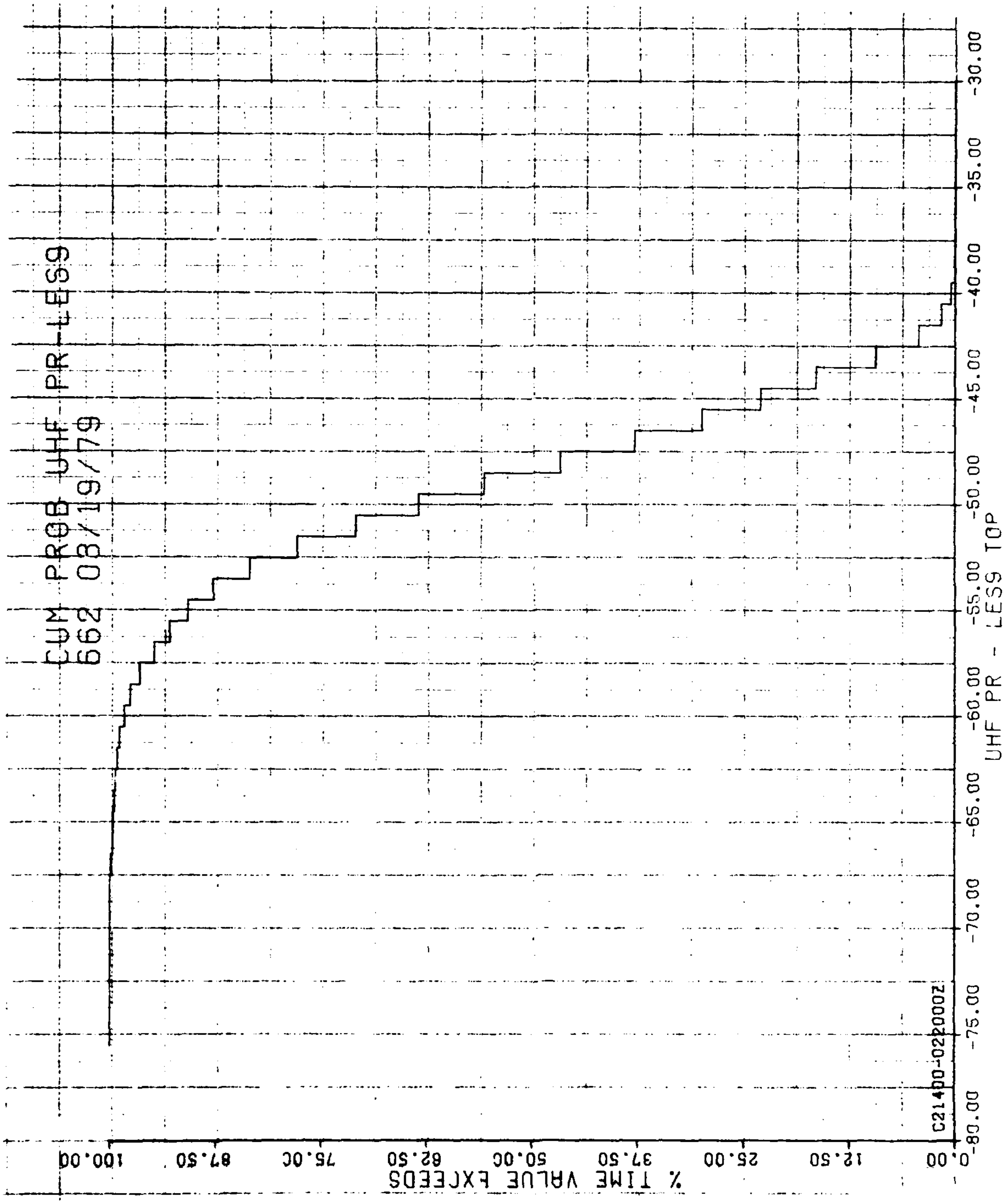


Figure 21. Cumulative Probability Distribution of Received Signal from Top Antenna

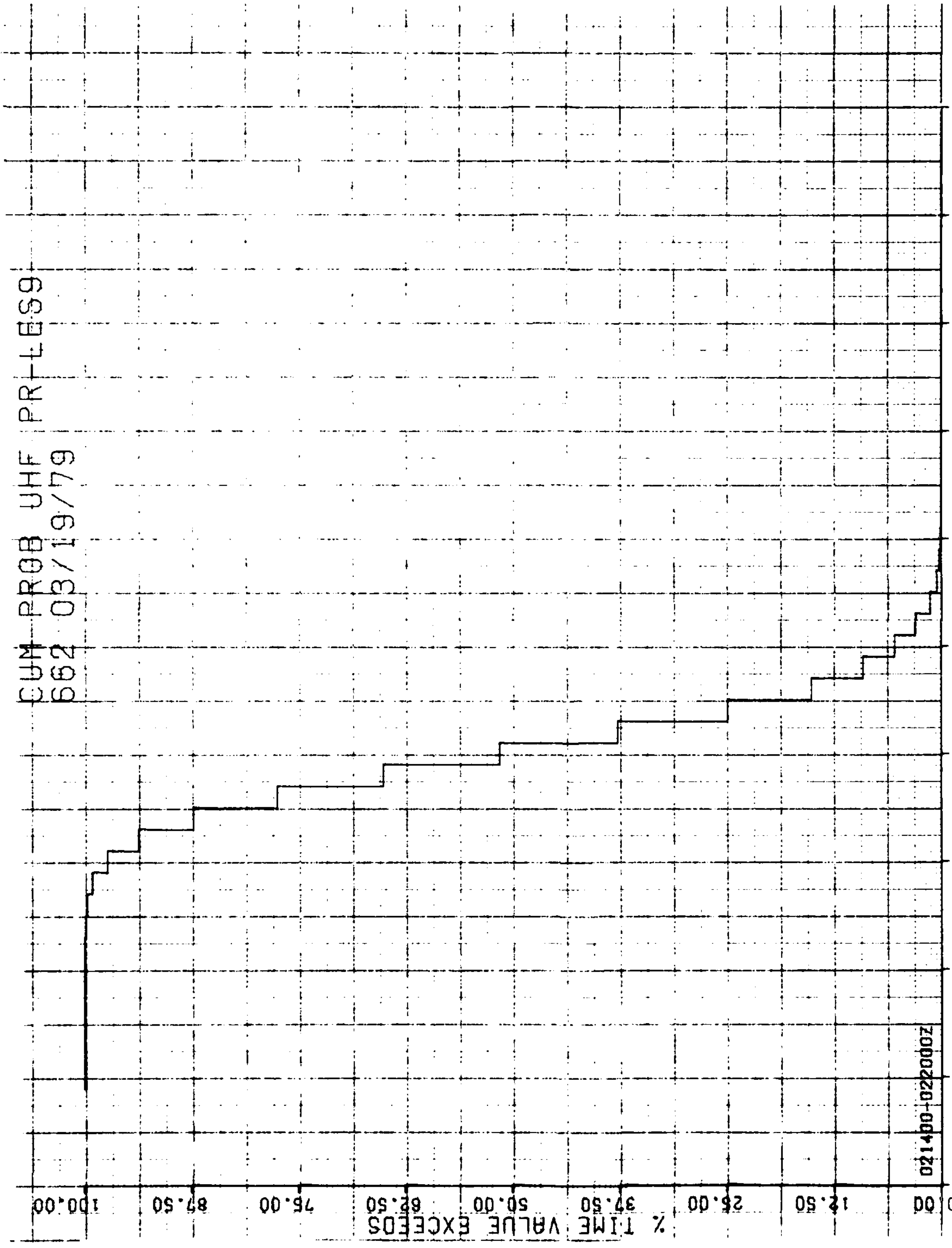


Figure 22. Cumulative Probability Distribution of Received Signal from Bottom Antenna

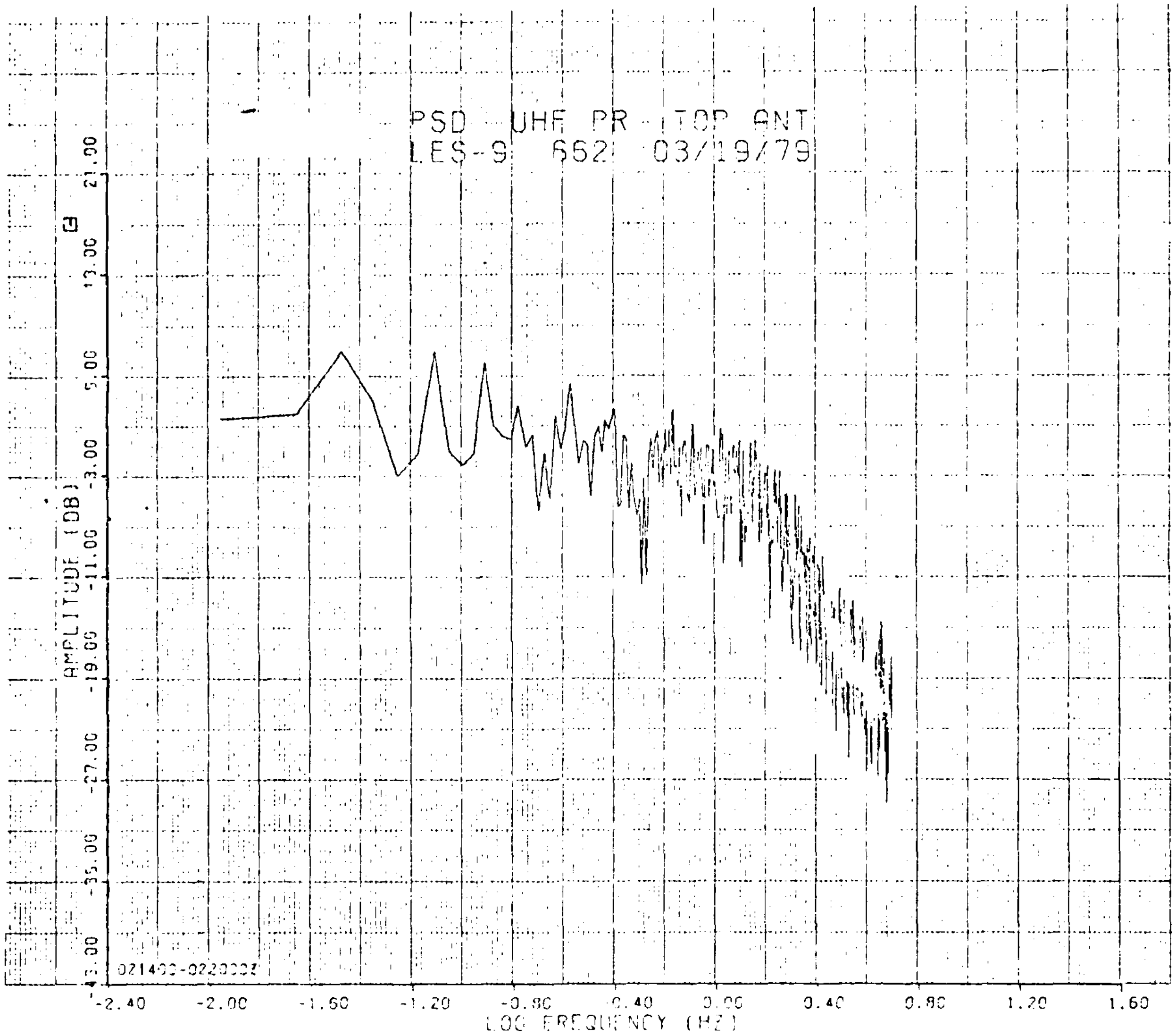


Figure 23. Power Spectral Density of Received Signal from Top Antenna

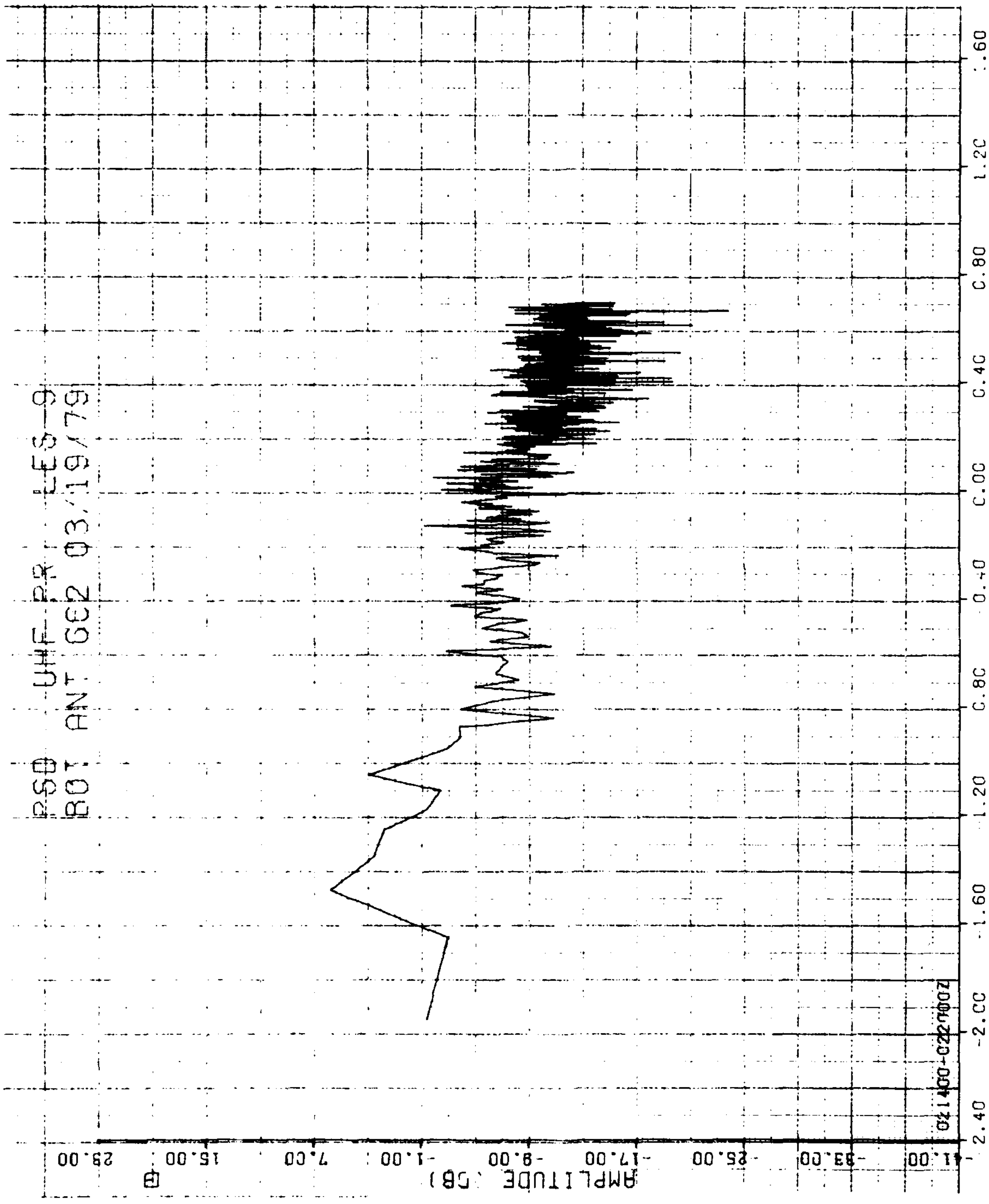


Figure 24. Power Spectral Density of Received Signal from Bottom Antenna

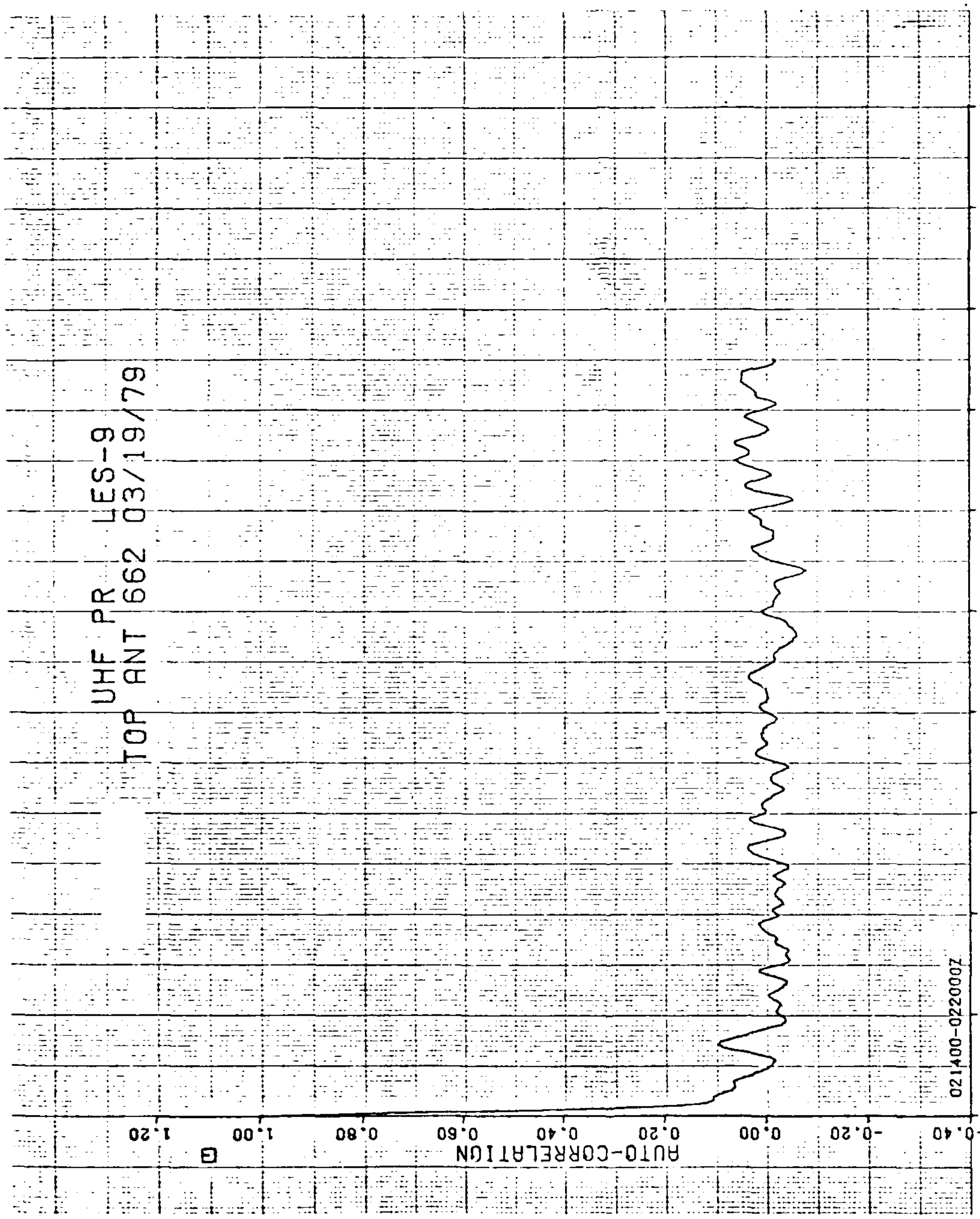


Figure 25. Autocorrelation Function of Received Signal from Top Antenna

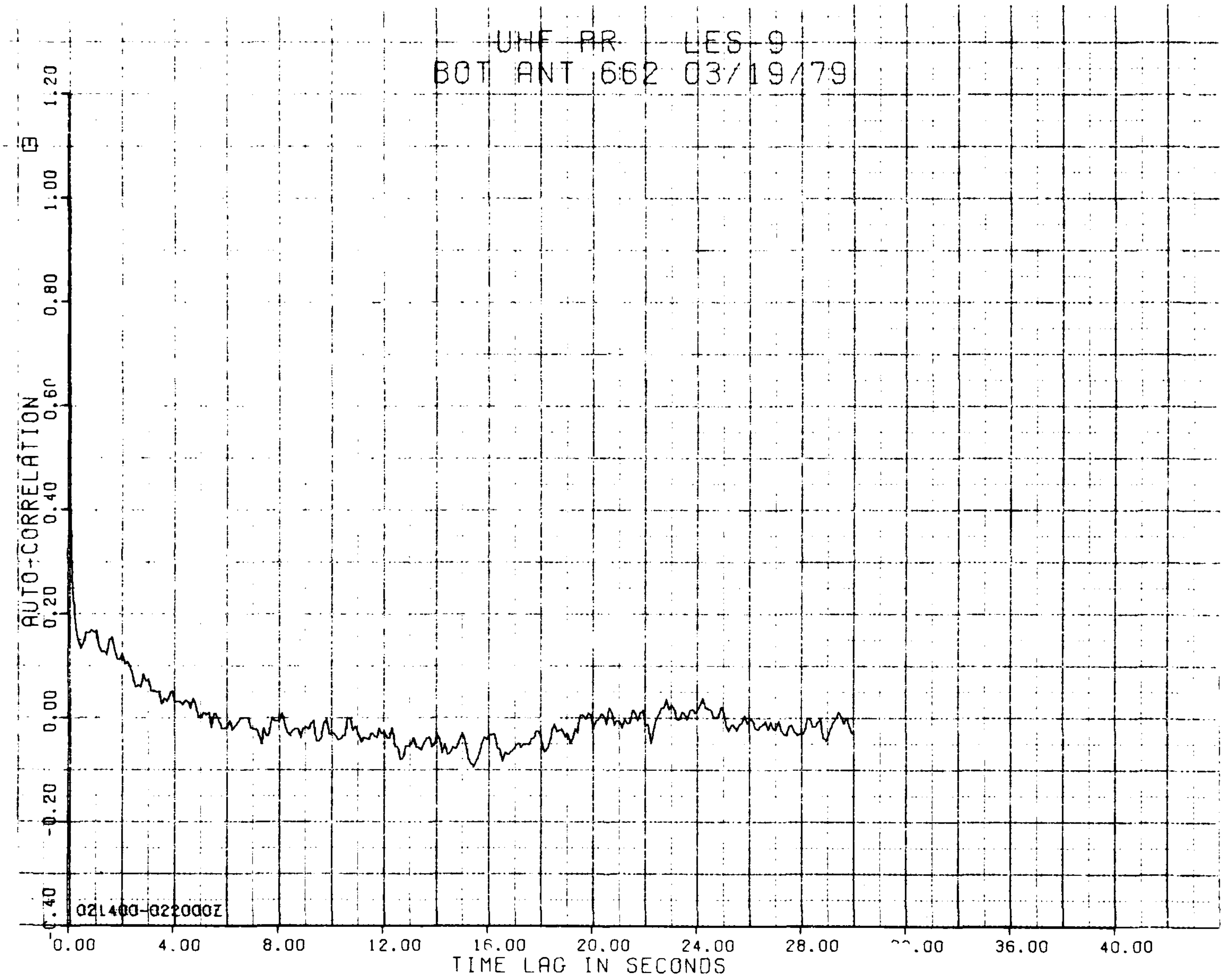


Figure 26. Autocorrelation Function of Received Signal from Bottom Antenna

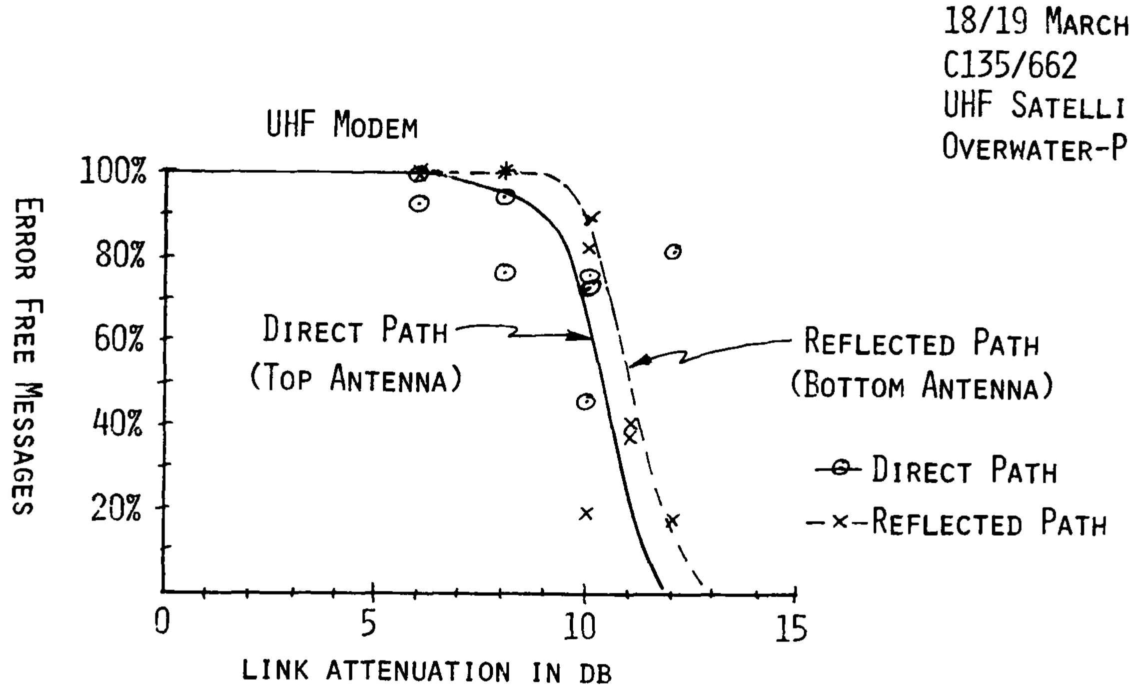


Figure 27. Performance of AFSATCOM II Modulation During Scintillation Fading

This supports the evolving concept of irregularity formation, that irregularity bubbles develop shortly after sunset at the equator and as they rise through the ionosphere, map down along magnetic field lines to higher and higher latitudes. The separation of scintillation onset time (37 minutes) measured by the two aircraft translates into a vertical rise velocity at the magnetic equator of 170 m/sec (Buchau, private communication), well within previously established ranges (McClure et al., 1977).

However, once the initial development had occurred, the data suggests that a large-scale, field-aligned and stable irregularity structure existed, which both aircraft left towards the east within minutes of each other (note 2352Z vs. 2356Z). The AFGL equipped aircraft turned around (west) and reentered the same scintillation region at 00:09Z. A further turn brought the AFGL aircraft back on the initial track, and the aircraft left the scintillation region at 00:46Z (see Figure 28). The eastward velocity of the depletion was determined from these times and the respective coordinates to 80 m/sec^{-1} (Buchau, private communication). Owing to the turning of the AFGL aircraft the two aircraft were, for the remainder of the flight, out of synchronism as far as simultaneous magnetic meridian crossings are concerned, so it is not possible to exactly correlate the common intercept of the irregularities. However, assuming that the next irregularity encountered by both aircraft at 00:02Z (AFAL) and 01:02Z (AFGL) was well established and field aligned when the AFGL aircraft encountered it, an eastward velocity of 102 m/sec^{-1} can be derived from the respective aircraft locations. This, again, is a speed typical for equatorial F region drift and close enough to the previously determined 80 m/sec^{-1} to support the assumption that both aircraft again encountered the large-scale structure. The further interruption of scintillations on the AFGL track, which was not observed by the AFAL aircraft, is likely due to the different height extent of the irregularities at both locations. A more detailed investigation by AFGL is underway and will be reported with additional material in a separate AFGL technical report.

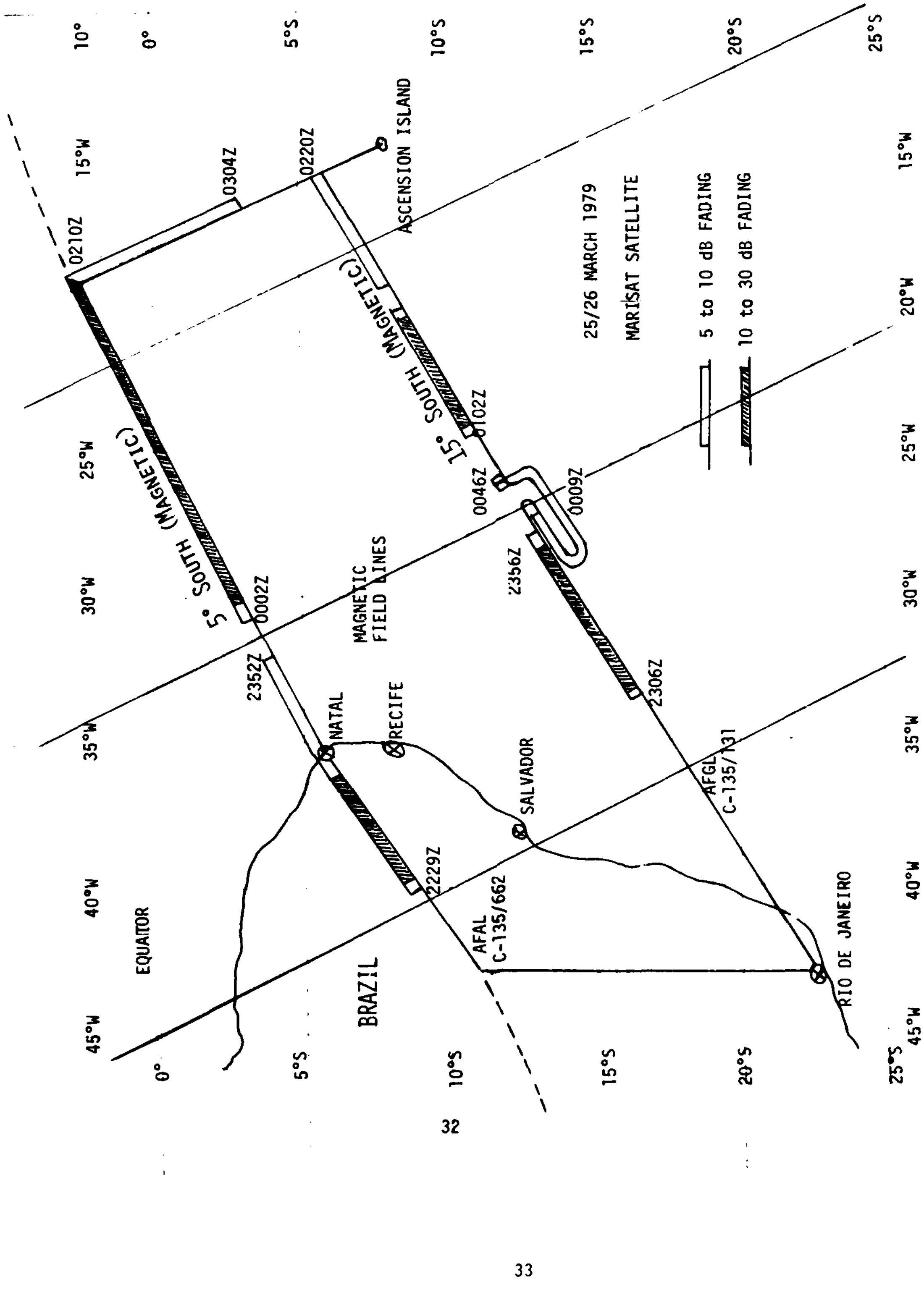


Figure 28. Joint Scintillation Flight Track

DUAL-FREQUENCY SATCOM TERMINAL PERFORMANCE

The dual-frequency SATCOM terminal (AN/ASC-38) was designed to operated through the DSCS II satellite at SHF and through the LES 8/9 satellites at EHF (Castro, et al 1978; Perdue, et al 1978).

The 14 KW SHF TWT was reinstalled in the dual-frequency power amplifier prior to the TDY. A substitute 3 KW TWT had been used while the 14 KW tube was being repaired.

The SHF transmitter was tested on the 15 March flight. It was noticed that the transmitted noise drove the SHF receiver AGC down, reducing the received signal-to-noise by about 5 db. A test was conducted with the variable rate modem, but the frequency jitter, apparently from the ASC-28 low-level terminal, made the PSK test impossible. On 19 March the aircraft transmitted SHF power of 8 KW to the rooftop terminal in the earth coverage-to-narrow beam mode of DSCS II. The rooftop received only a 39 db Pr/No signal, again, probably due to frequency instability in the ASC-28 low-level terminal. The SHF receiver appeared to function properly, but the transmitter was not used successfully on the trip.

The ASC-28 was switched to EHF (K band) on 17 and 18 March. Tests were run via LES 9, but the modem was unable to lock in hop or help. The frequency stability problem in the low-level terminal is suspected as the cause of lack of lock. On 1 April the EHF was tried, but the transmitter would not come up. A high-voltage problem was the cause of that failure.

The performance of the ASC-28 terminal was very poor for the entire trip with numerous problems in the low-level terminal and the high-voltage portion of the high-power amplifier.

DUAL-FREQUENCY ANTENNA PERFORMANCE

The dual frequency antenna (AN/ASC-28) was also designed to operate at both the SHF and EHF bands (Berguist et al., 1979). Operation of the dual-frequency antenna system during this TDY was quite successful. Over 75 hours of operation of the antenna system were logged without a problem. Three different satellites were tracked during the TDY -- LES 8, LES 9, and DSCS II 9437. On 15 March the antenna system tracked the LES 9 satellite at EHF up to an elevation angle of 90°. The DSCS II satellite 9437 was tracked at SHF up to an elevation angle of 89.4° on 30 March.

The EHF zenith tracking test on 15 March was successful. The test plan required aircraft C135/662 to fly on a southbound bearing that would meet the northbound track of LES 9 head on. The result would be a nose-to-tail overhead track for the aircraft antenna pointing system as the satellite passed at a maximum relative convergent rate. The 0.6° beamwidth of the aircraft dual-frequency antenna at EHF sets a tight tracking requirement for the antanna pointing system. Plots of the antenna elevation angle, the elevation pointing error, the received signal and the antenna azimuth angle are shown in Figures 29 through 32. The dashed line is the point where the elevation error variation occurred and reduced the received signal level. The elevation error variation occurred when the antenna reached the elevation angle design limit. The fact that the antenna pointing system did track to the zenith and performed so well with the 0.6° tracking specification is significant.

The SHF zenith tracking test on 30 March was also successful. The SHF 3 db beamwidth tracking specification is 3°. Plots of the antenna elevation angle, the received signal level, and the antenna azimuth angle are shown in Figures 33 through 35. The aircraft made several course corrections as noted. Except for the aircraft maneuvers, the plots show a smooth track of elevation angle and received signal level

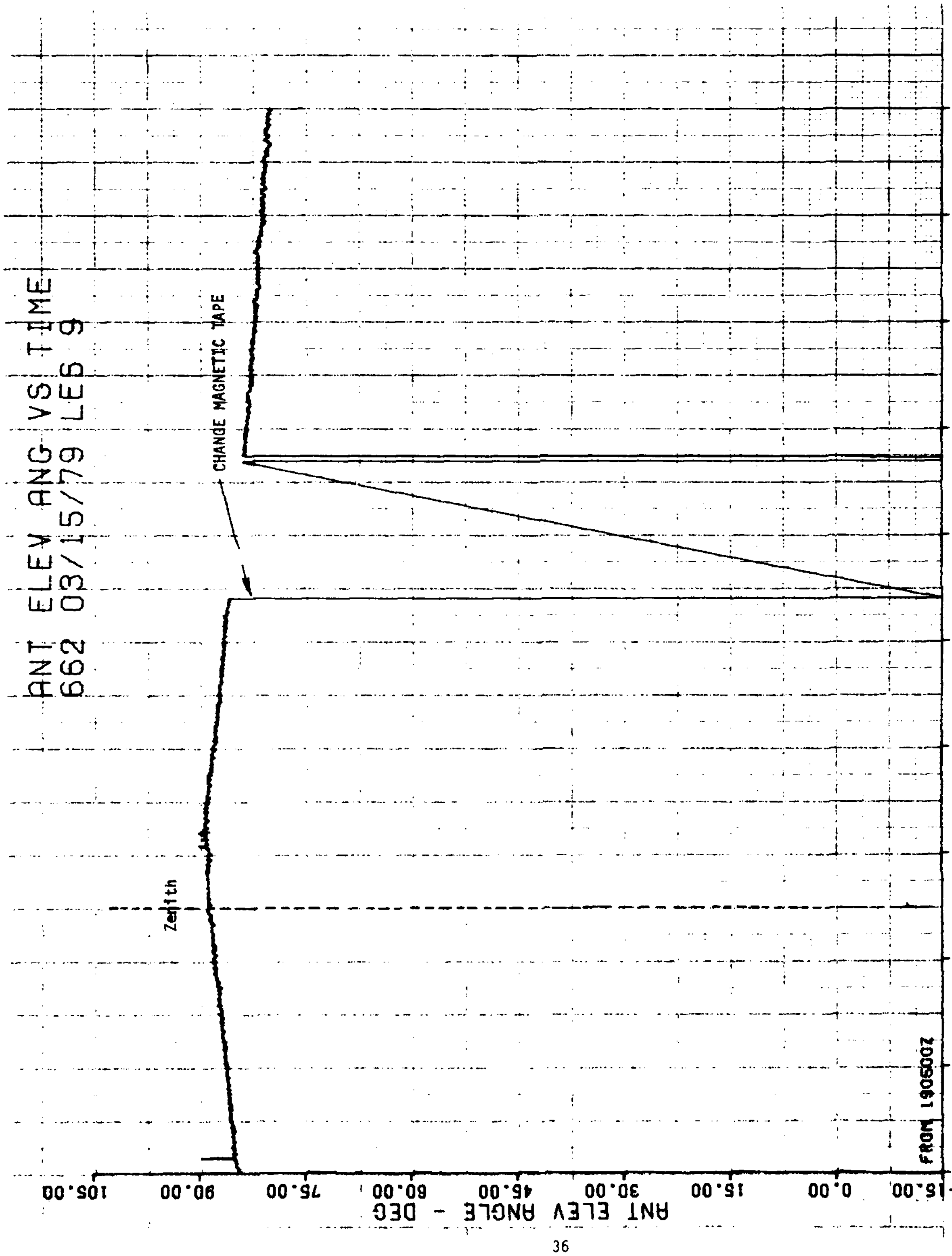


Figure 29. Antenna Elevation Angle

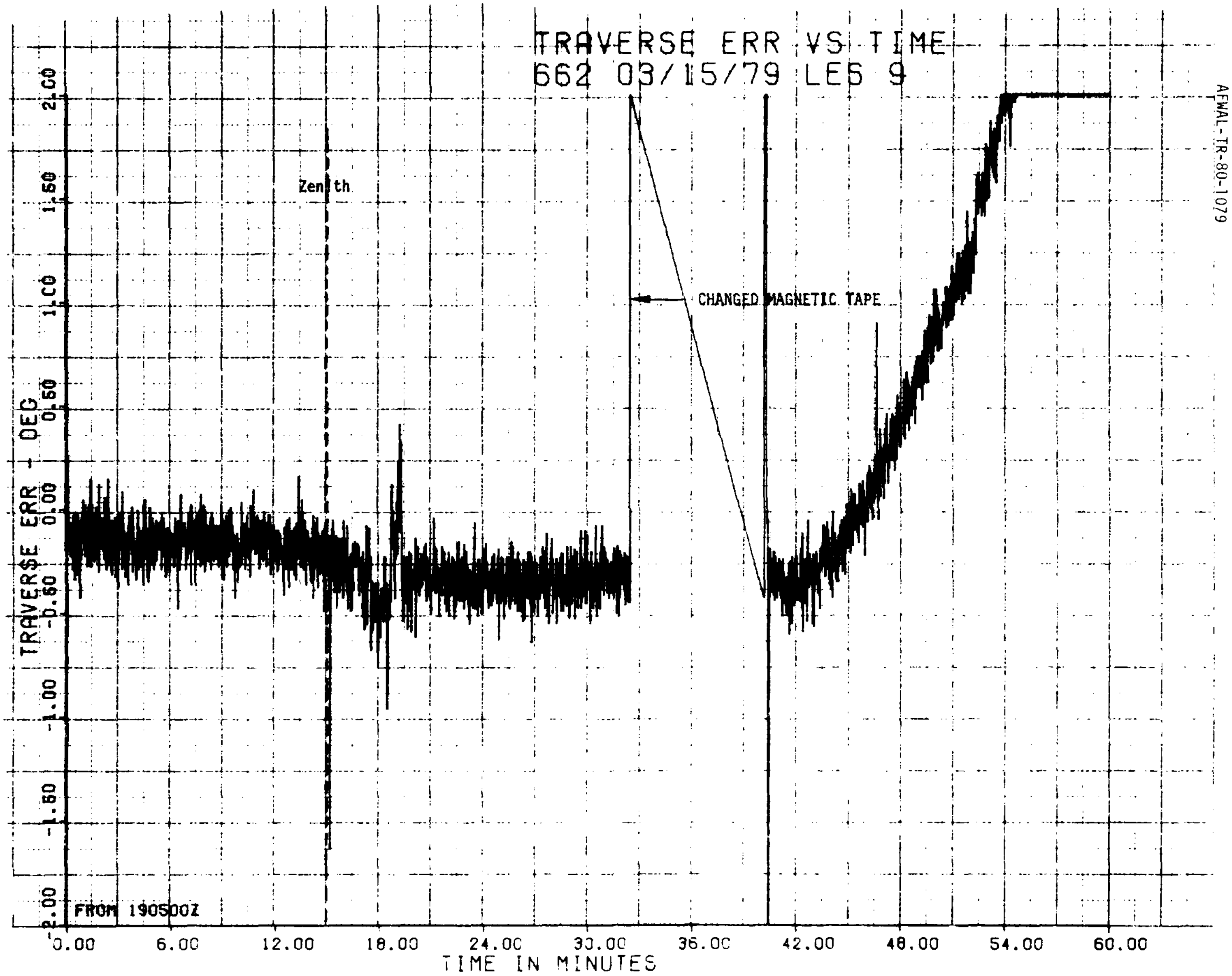


Figure 3[illegible]. Elevation Angle Error

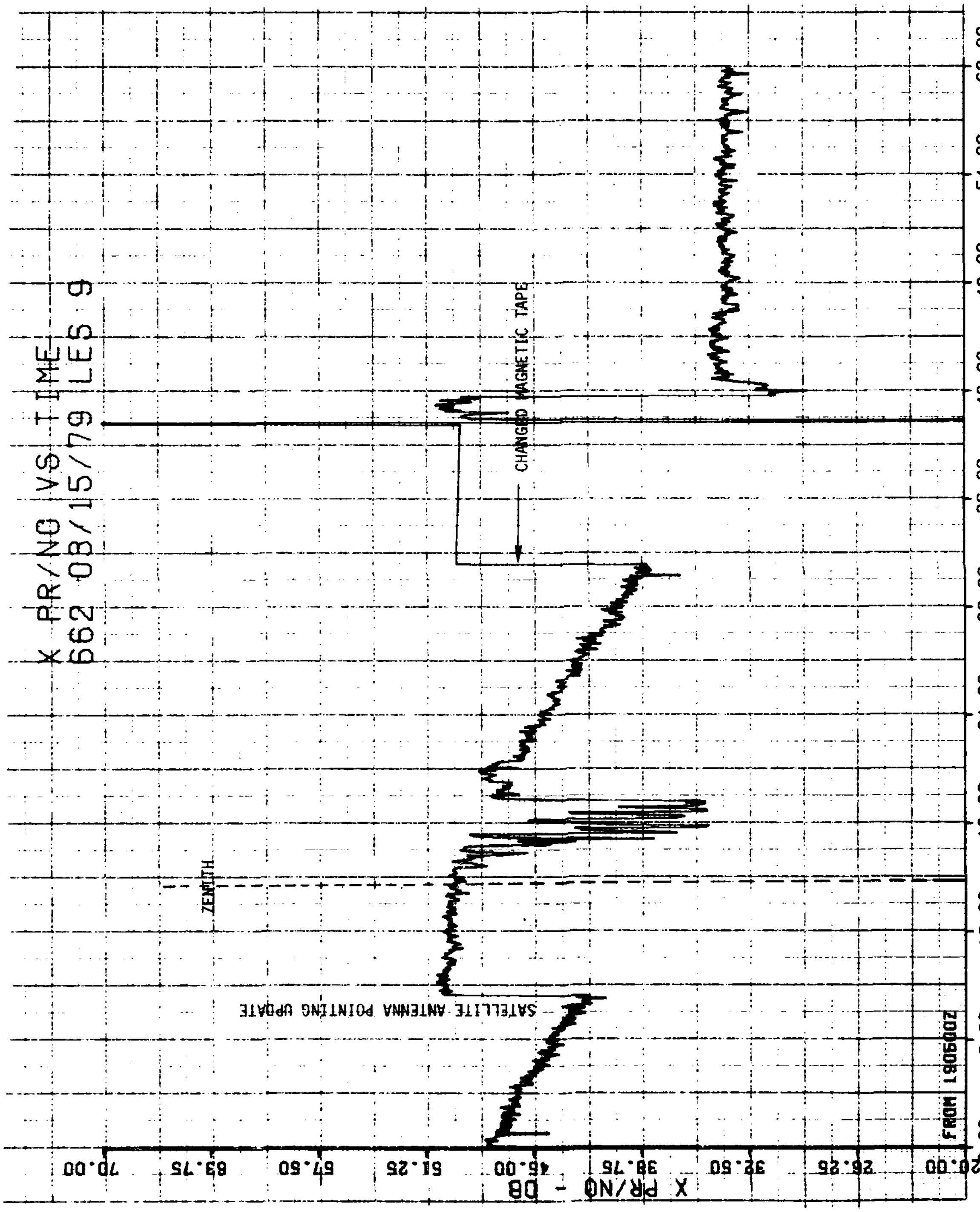


Figure 31. EHF Received Signal Level

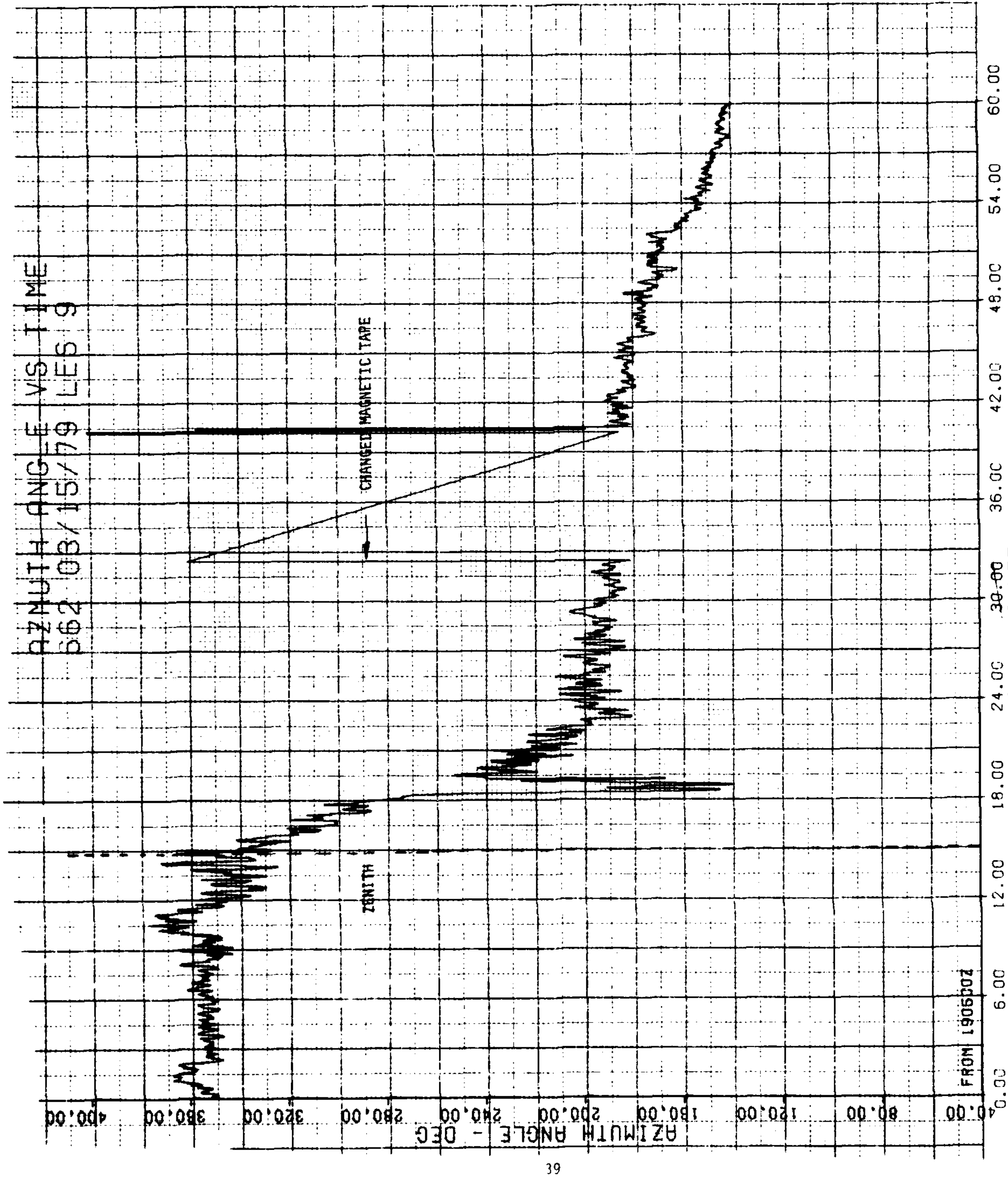


Figure 32. Antenna Azimuth Angle

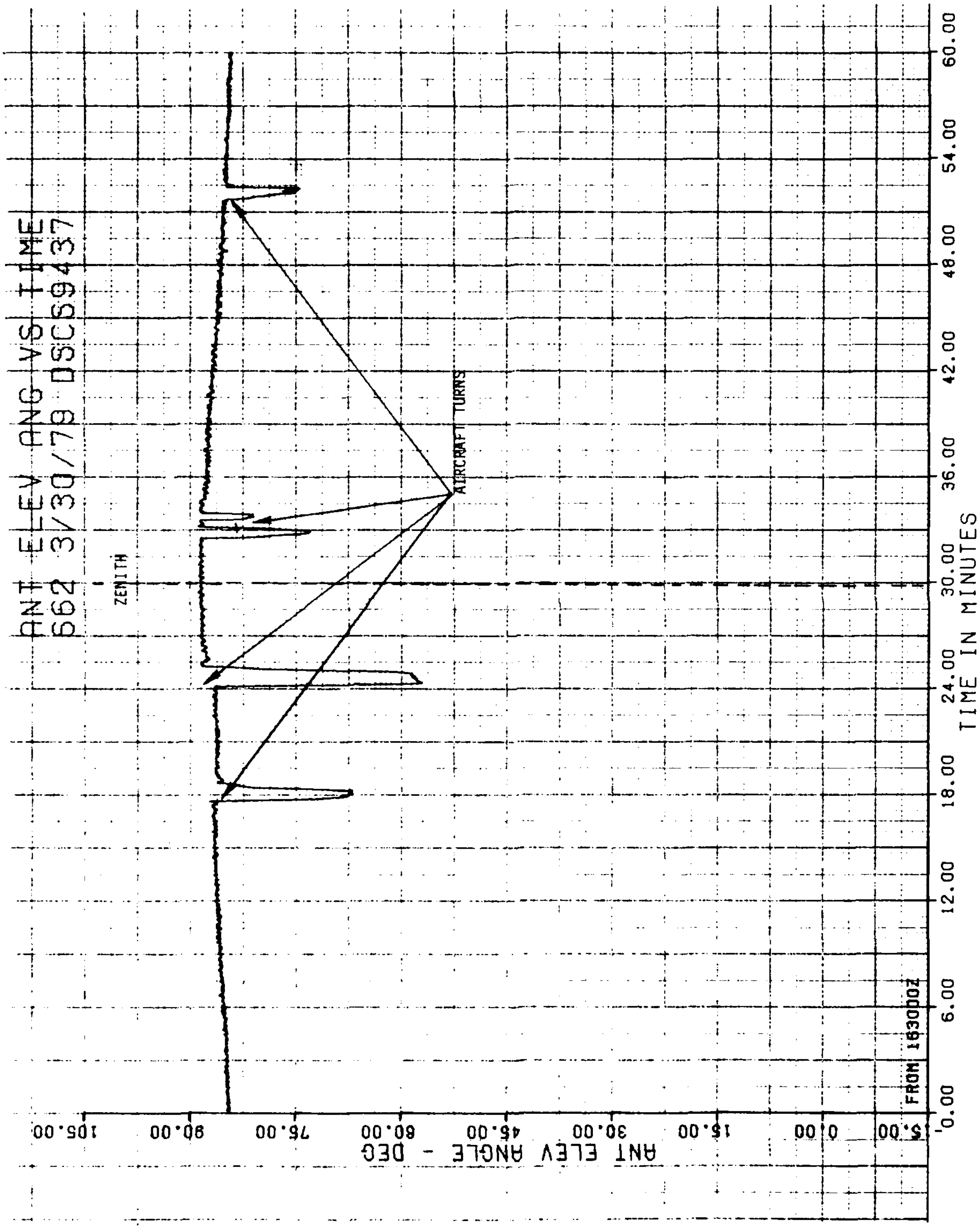


Figure 33. Antenna Elevation Angle

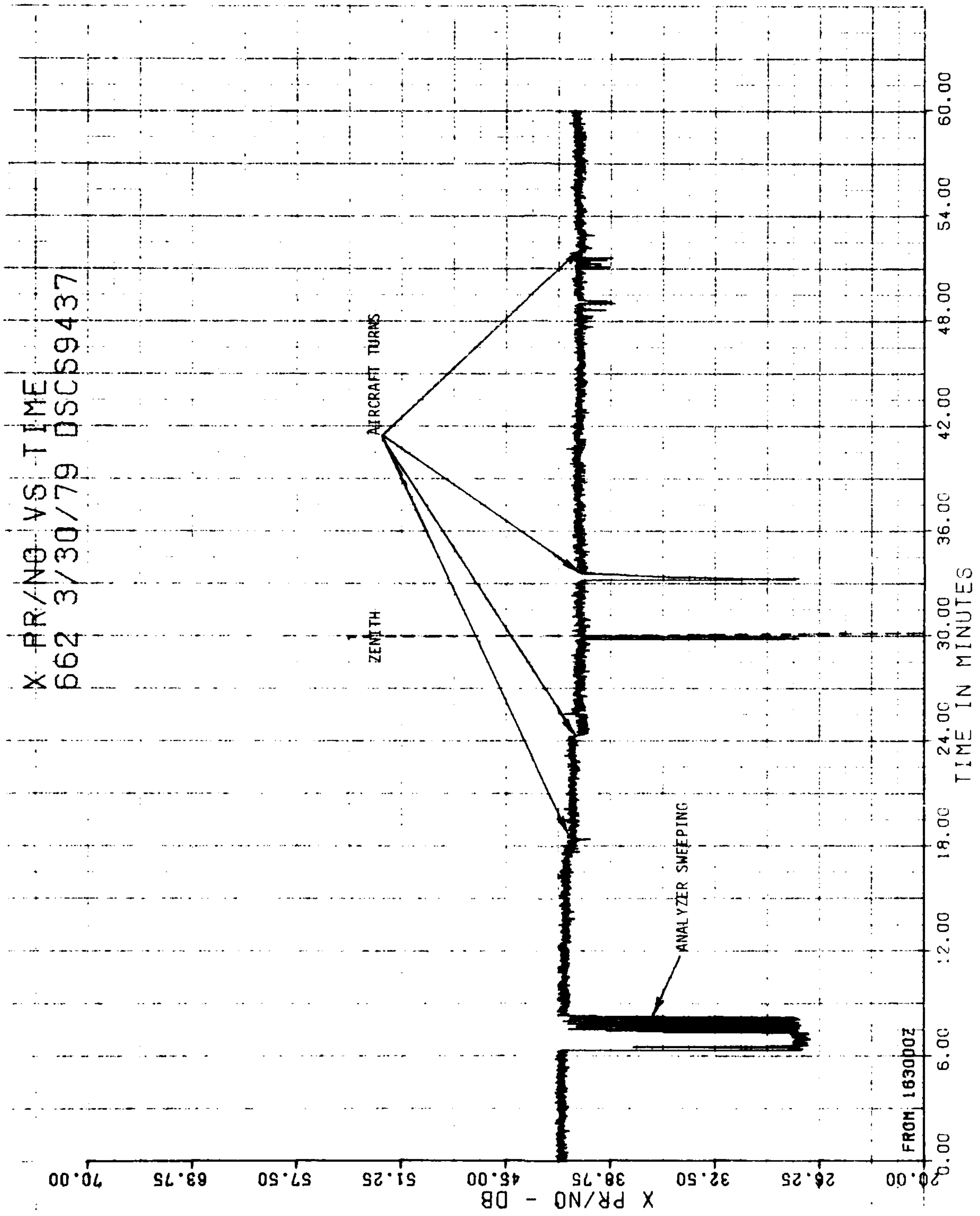


Figure 34. SHF Received Signal Level

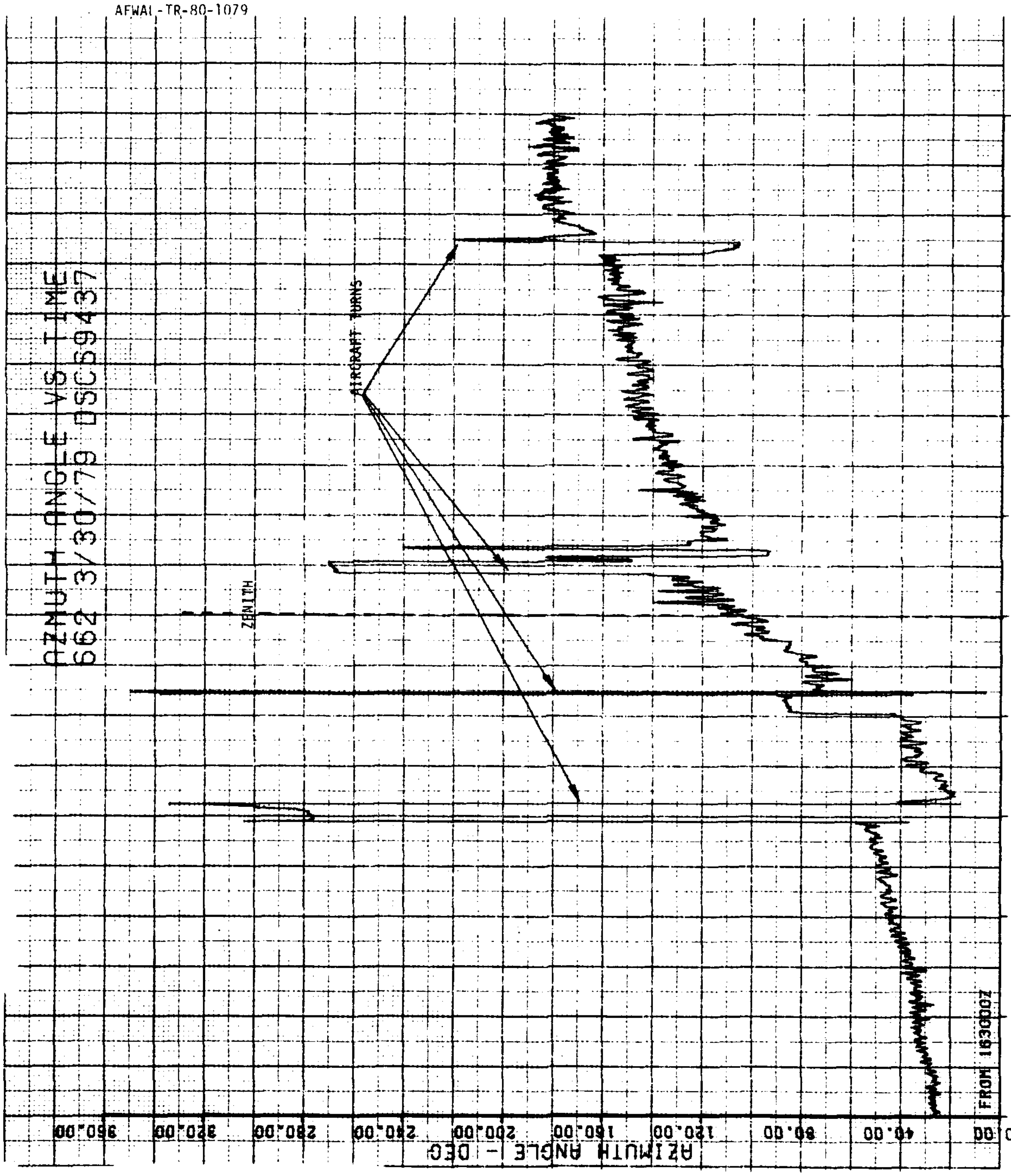


Figure 35. Antenna Aximuth Angle

as the aircraft passed under the DSCS II 9437 satellite. The fact that the highest elevation recorded was a few tenths of a degree less than achieved on the 15 March EHF test and the wider beamwidth (3°) for SHF account for the smooth signal plots obtained.

The performance of the dual frequency antenna tracking system on the TDY was excellent. This is the second successful antenna test, each accumulating over 70 hours of trouble-free operation (Johnson, Swanson and Beach, 1979). Additional antenna zenith tracking tests are planned in conjunction with future TDY's.

1 KW UHF POWER AMPLIFIER

The Motorola 1 KW amplifier S/N #1 underwent limited testing during the TDY. The amplifier was tested with the AFAL/AAD fabricated frequency control box which simulates the digital commands generated by an external modem, i.e., a dual modem. The RF source used was the Collins ARC-146 UHF radio which has limited tunability, so the test was run at a preset frequency of 303 MHz.

A test to determine the input power vs. output power levels was performed. The S/N #1 amplifier transmitted a full 1 KW output with a minimum of 15 watts and a maximum of 150 watts input power at this frequency, Figure 36. At any power level below the 15 watts, the 1 KW amplifier switches into its bypass mode. In that mode the RF input is connected directly to the RF output, completely bypassing the filter and amplifier sections. Due to the 150-watt input specs on the amplifier, no power input level over 150 watts was attempted. Since the amplifier is spec'd to transmit 1 KW out with a 50 to 150 watt input level, the test results exceeded the specifications.

A spurious noise test was attempted, but due to some erratic test equipment, no conclusive results were obtained on this trip.

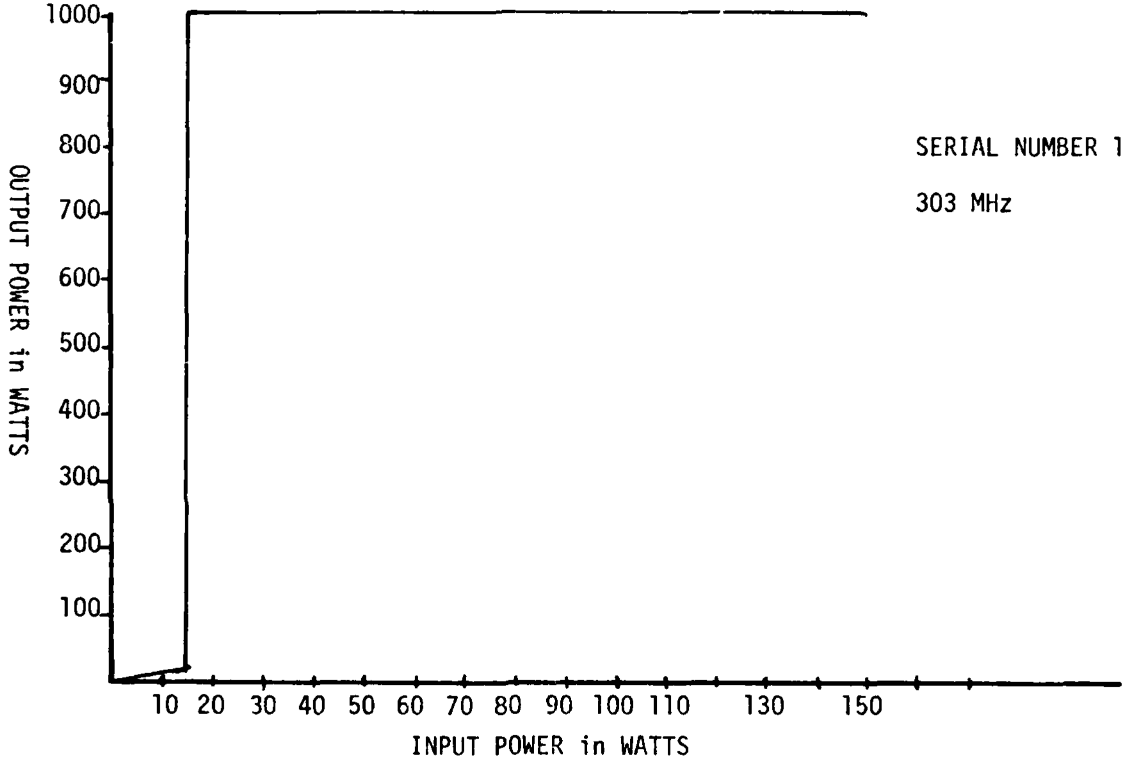


Figure 36. 1 KW UHF Power Amplifier Input versus Output Power

COMPUTER ANTENNA POINT ACCURACY WITH REDUCED ACCURACY EPHEMERIS

The OK 227 computer-aided antenna pointing system was designed to use ephemeris information supplied as a ninth order polynominal of X, Y and Z (Moll et al., 1970). The purpose of this test was to determine how the pointing and doppler accuracy might be affected if less than the full ninth order set of coefficients were used.

The data shown in Table I was accumulated on one of the flights during the South American TDY. Various amounts of ephemeris were entered into the computer: 1) 10 polynomials, 2) 3 polynomials from X, Y and Z columns, and 3) 2 polynomials from X, Y, and Z columns. The actual doppler was measured from the K-band terminal on a frequency counter. The computer pointing system (CPS) doppler and range were obtained from corresponding printouts from the computer. The system was in the K-band mode of operation during these tests. The preliminary data show that the range information results varied little regardless of whether all of the ephemeris is used (30 entries) or portions of it.

The information obtained from the doppler comparison test, however, is not conclusive. In most cases the doppler is not accurate when only two entries in each column are used. The entries, #4 and #8, do not show this error. Further testing will be performed to obtain better statistics on the number of entries needed to obtain the desired degree of accuracy. The pointing accuracy obtained during the tests is adequate to point the antenna in azimuth with little error, while the elevation pointing error is more pronounced. This error could be a problem in K-band operation due to the narrow beamwidth 0.6°. However, in X-band operation this error would have only a small effect on pointing and signal strength due to the 3° beamwidth.

TABLE 1

CPS POINTING ACCURACY

	(1) 10 POLY		(2) 3 POLY		(3) 2 POLY					
TIME (ZULU)	AZ	EL	AZ	EL	AZ	EL	DOPPLER ACTUAL	CPS DOPPLER		RANGE (CPS)
1. 1645	.0	.1	.1	.2	.1	.3	20.008261	8.658	(1)	38,102
								9.316	(2)	38,150
								17,913	(3)	38,529
2. 1655	.0	.2	.1	.3	.1	.3	20.009740	8.546	(1)	38,070
								8.567	(2)	38,111
								16.705	(3)	38,376
3. 1705	.0	.2	.1	.3	.1	.2	20.009258	8.932	(1)	38,033
								9.517	(2)	38,063
								15,698	(3)	38,027
4. 1715	.0	.2	.0	.2	.1	.25	20.009033	8.613	(1)	37,982
								9.502	(2)	38,008
								8.636	(3)	37,977
5. 1725	.0	.2	.1	.25	.1	.2	20.009905	8.769	(1)	37,941
								9.207	(2)	37,955
								13.077	(3)	38,021
6. 1735	.0	.2	.1	.2	.0	.2	20.009027	8.648	(1)	37,896
								9.177	(2)	37,906
								11.788	(3)	37,936
7. 1745	.1	.15	.1	.15	.0	.15	20.008544	8.483	(1)	37,896
								8.921	(2)	37,859
								10.330	(3)	37,867
8. 1755	.0	.15	.0	.1	.0	.2	20.007661	8.404	(1)	37,818
								8.760	(2)	37,819
								8.925	(3)	37,813

LOW DATA RATE UHF SATCOM TERMINAL

The low data rate UHF SATCOM terminal (Fischbach, 1978-1 and Fischbach, 1978-2) was utilized extensively during the TDY as the prime orderwire between the aircraft and the AFAL/AAD ground station (rooftop) at Wright-Patterson Air Force Base, Ohio via both the FLTSAT and GAPSAT satellites.

During the flights the new Phase II C/MOS logic version of the I/O portion of the portable terminal was used exclusively for the first time. The modem portion of the Phase II terminal was still in the brassboard stage; consequently the new I/O portion was interfaced with the Phase I modem unit. The system operated well. The problems of thermal cutout and limited operator functions in the I/O section of the Phase I system were shown to have been eliminated in the Phase II version.

During the flights, the brassboard modem section of Phase II terminal was utilized in the ground station system and it also worked well.

UHF RADIOMETER MEASUREMENTS

A radiometer was used to record the activity in the UHF band around the satellite uplink frequency. The radiometer steps from 286 MHz to 316 MHz in approximately 100 KHz steps at the rate of one step per second and measures the peak and average power at each frequency (Zamites, 1968). The results are recorded on a visicorder paper chart and on analog magnetic tape.

The radiometer data, shown in Figures 37 through 39, were taken during aircraft C135/662's flight from Lima, Peru to Rio de Janeiro, Brazil on 22-23 March 1979. The horizontal axis of the chart shows the time that each frequency sweep started (sweeps veried from 4:40 minutes to 5:00 minutes). The vertical axis indicates frequency.

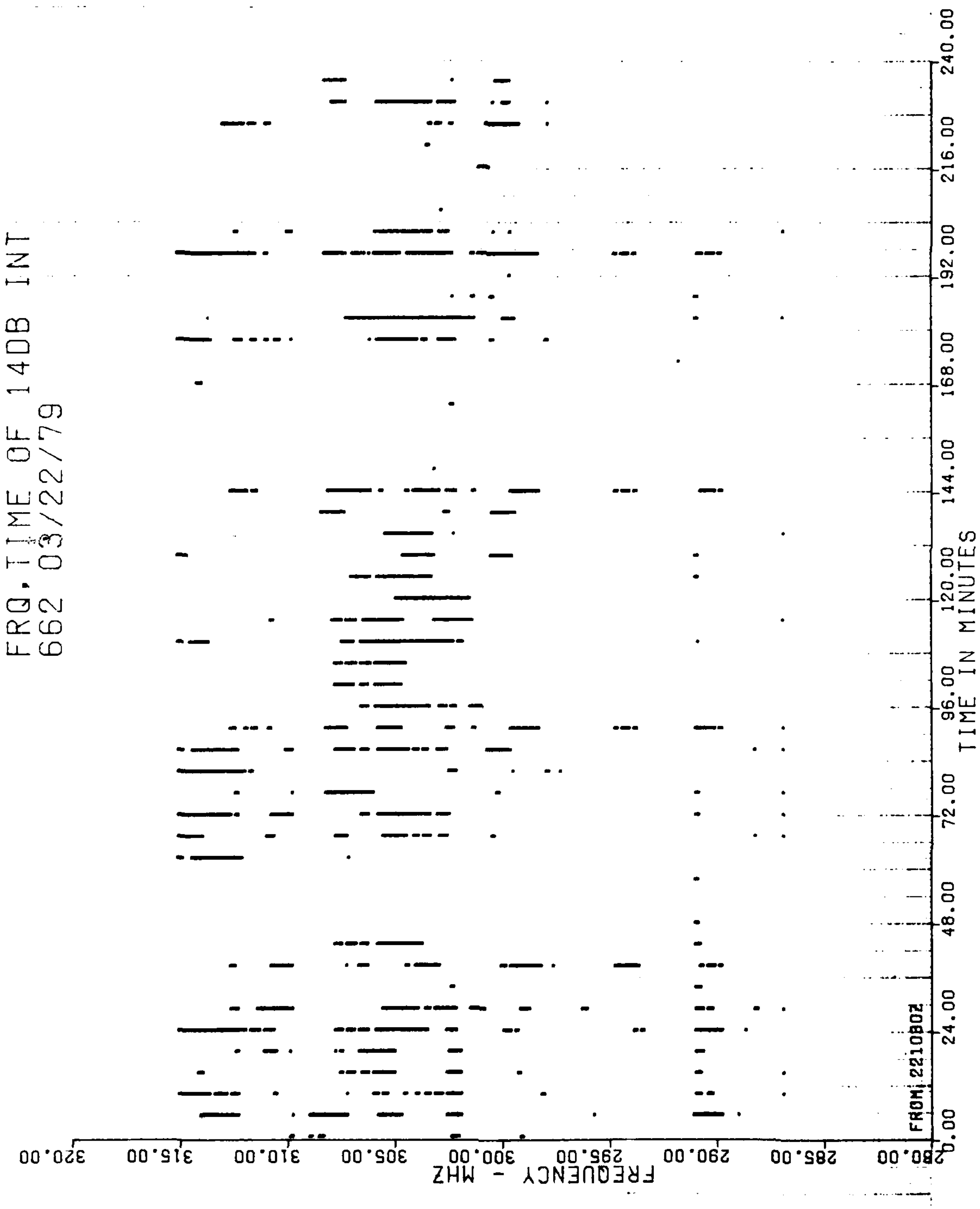


Figure 37. UHF Radiometer Output

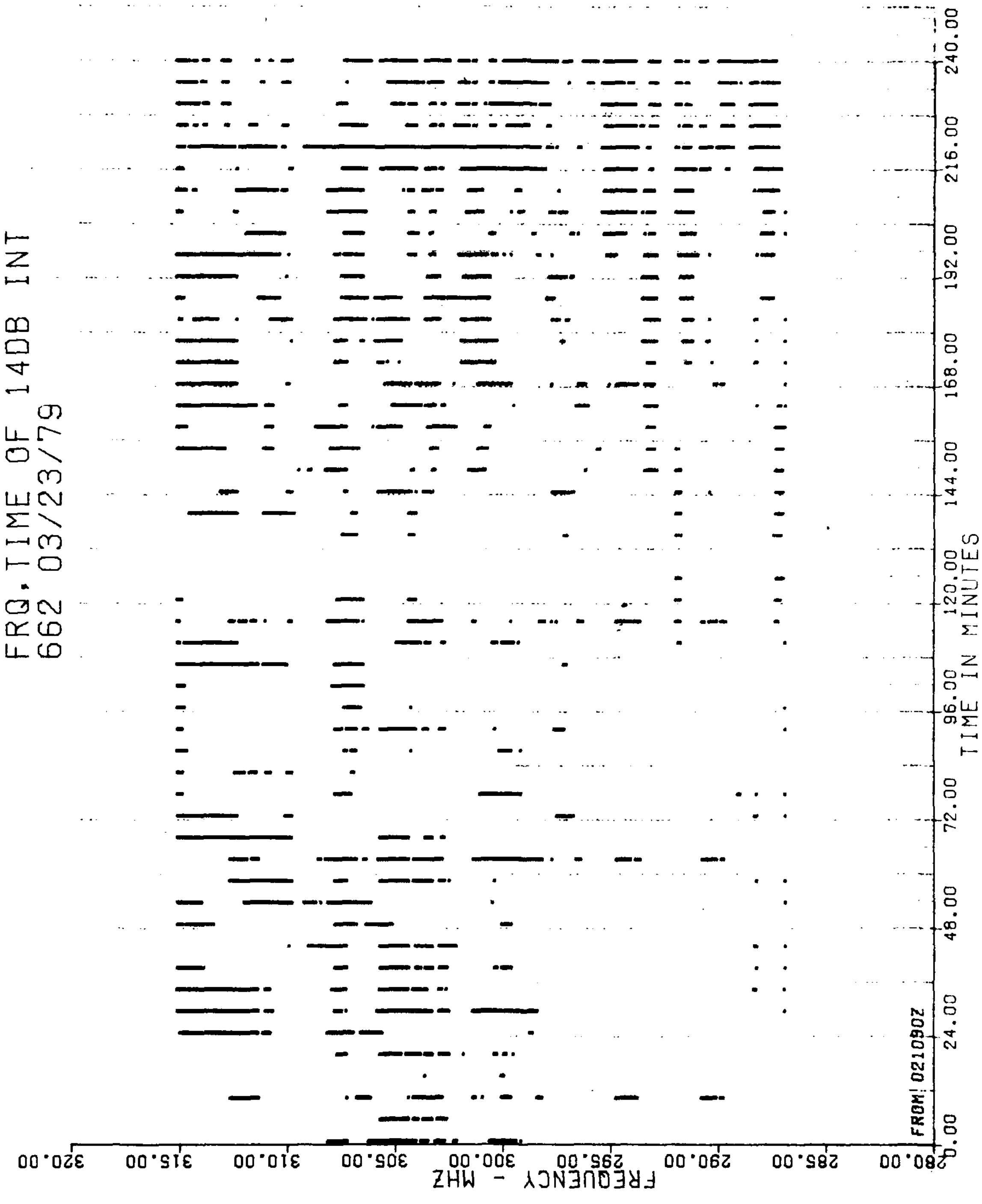


Figure 38. UHF Radiometer Output

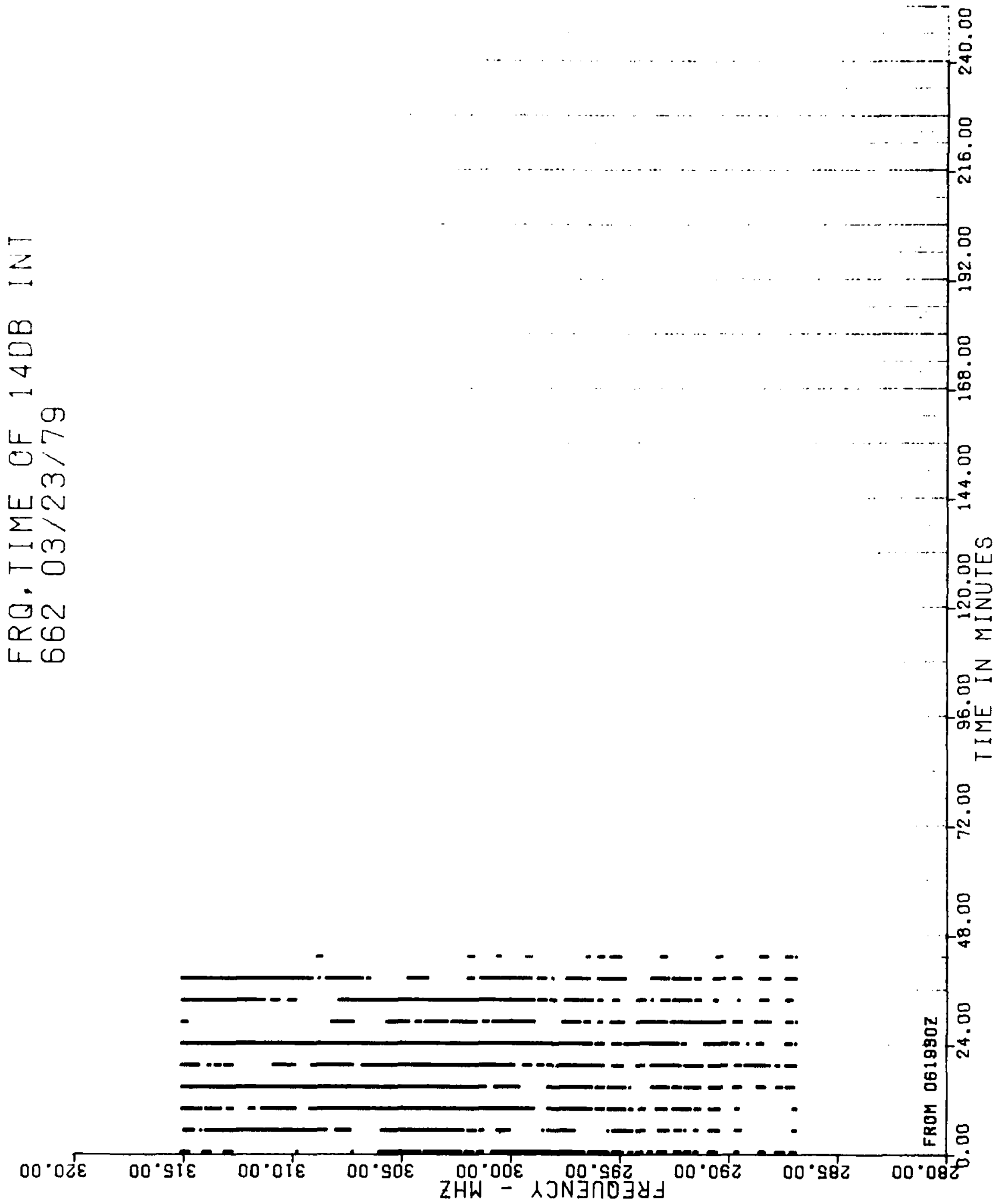


Figure 39. UHF Radiometer Output

The sweeps started at approximately 286.9 MHz and swept up to approximately 316.3 MHz. However, because of variations in the visicorder recording speed and inaccuracies in the "ruler" used to read frequencies, the frequencies on the graph should be considered to have a ±0.3 MHz tolerance. The same data recorded on the analog tape will give a much better accuracy.

The radiometer data was received on the bottom standard UHF blade (AT-1076) at Station 990 on the aircraft.

ROOFTOP SYSTEM OPERATION

During the tests, the Rooftop Facility located at Wright-Patterson Air Force Base, Ohio transmitted forward messages to the aircraft via the LES 8 satellite. Variable rate measurements at SHF were not made in the rooftop as planned because of a generator problem aboard the aircraft which affected the operation of the SHF transmit capability on the aircraft. A UHF orderwire link was maintained between the rooftop and aircraft 662 via FLTSAT and GAPSAT. Coordination for satellite mode setup, changes, etc. at Lincoln Labs for the aircraft was done through the rooftop facility. A CW signal at UHF frequencies was transmitted via FLTSAT and GAPSAT to the aircraft for making scintillation measurements. Coordination for precorrection testing of the dual modems between aircraft 662, Lincoln Labs and Linkabit Corporation, San Diego, California was accomplished via the rooftop facility. The rooftop was able to copy the precorrected message on the Ka Band forward link.

SECTION III

CONCLUSIONS

The overall South American Test was considered successful. Equatorial ionospheric scintillation fading at UHF was encountered approximately 25% of the scintillation test time. The multipath fade mitigation technique showed that the performance of a coded reflected signal on the bottom antenna was as good or better than the performance of the signal received on a top antenna during scintillation fading.

The joint scintillation test suggested that the equatorial irregularities are born along the magnetic equator and "grow" north and south along the magnetic field lines.

The dual-frequency SATCOM terminal performance was less than satisfactory for the entire trip. Numerous problems occurred in the high-power amplifier and the low-level terminal. The dual-frequency antenna operated very well during the trip. Over 70 hours of failure-free operation were logged.

A test of the 1 KW UHF power amplifier showed that it put out a constant 1 kilowatt of power for an input of from 15 to 150 watts.

A test of the computer antenna pointing system showed that it pointed reasonably well when only the 2nd order coefficients of the polynomial were used. However, the doppler calculations are unreliable unless all coefficients of the 9th order polynomial are used.

The low-rate terminal was used extensively for orderwire on the trip. It operated with only minor electrical problems.

A UHF radiometer was used to measure the activity in the frequency band around the satellite uplink frequency. The results showed only light usage of the band.

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