AD-787 182

PERFORMANCE TESTS ON THE AN/APS-119 RADAR SYSTEM

N. C. Currie, et al

Georgia Institute of Technology

Prepared for:

Coast Guard

15 February 1974

DISTRIBUTED BY:

NTIS

National Technical Information Service
U. S. DEPARTMENT OF COMMERCE
5285 Port Royal Road, Springfield Va. 22151

NOTICE

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no liability for its contents or use thereof.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
CG-D-23-75 ~~DOT-CG-04132-A-1~~		AD-787 182

4. Title and Subtitle

Performance Tests on the AN/APS-119 Radar System

5. Report Date

February, 1974

6. Performing Organization Code

8. Performing Organization Report No.

A-1255 Final

7. Author(s)

N. C. Currie, F. B. Dyer

9. Performing Organization Name and Address

Georgia Institute of Technology
Engineering Experiment Station
Sensor Systems Division
Atlanta, Georgia 30332

10. Work Unit No. (TRAIS)

11. Contract or Grant No.

DOT-CG-04132-A

12. Sponsoring Agency Name and Address

United States Coast Guard
Office of Research and Development
Washington, D. C. 20590

13. Type of Report and Period Covered

Final Report

14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

A series of ground tests performed on the AN/APS-119 Search and Rescue Radar is summarized and an evaluation of its performance is made. Predictions are presented for the radar performance from an airborne platform and recommendations are made concerning future testing and potential modifications to the radar system.

17. Key Words

Radar Tests
Search and Rescue Radar
Sea Return

18. Distribution Statement

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	126	$5.75

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

ENGINEERING EXPERIMENT STATION
Georgia Institute of Technology
Atlanta, Georgia 30332

PERFORMANCE TESTS ON THE AN/APS-119 RADAR SYSTEM

Final Report

on

EES/GIT Project A-1255

by

N. C. Currie and F. B. Dyer

Prepared for

United States Coast Guard
Department of Transportation
Washington, D. C. 20591

Under

Contract DOT-CG-04132-A

15 February 1974

TABLE OF CONTENTS

24 JUN 1974

The work reported herein was accomplished for the U.S. Coast Guard's Office of Research and Development, Marine Safety Technology Division, as part of its program in Search and Rescue Detections Systems.

The contents of this report reflect the views of Georgia Institute of Technology, Atlanta, Georgia, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policy of the Coast Guard. This report does not constitute a standard, specification, or regulation.

Reviewed by: L. A. KIDD, LCDR, USCG
Project Officer

Submitted By: R. L. COOK, CDR, USCG
Chief, SAR Projects Branch

Released By: C. J. GLASS, CAPT, USCG
Chief, Marine Safety Technology Division
Office of Research and Development
U. S. Coast Guard Headquarters
Washington, D. C. 20590

LIST OF FIGURES

LIST OF FIGURES (Cont.)

LIST OF FIGURES (Cont.)

LIST OF FIGURES (Cont.)

LIST OF TABLES

I. INTRODUCTION

This report summarizes the results of measurements made by the Engineering Experiment Station (EES) at Georgia Tech during the shorebased test program of the AN/APS-119 airborne search and rescue radar program. Emphasis in the report is placed on those results obtained during the latter portion of the testing which was accomplished at the Coast Guard Electronic Engineering Center at Wildwood, New Jersey during November and December of 1972, and January of 1973. This report is a more detailed treatment of the test results (including much of the supporting data) than that provided in the preliminary report of 24 January 1973 [1]*; however, the general conclusions and recommendations set forth there were found to still be valid.

A. Background

The shorebased test program reported here was part of the intermediate step between the development phase of the AN/APS-119 Program and the Flight Test and Evaluation Program. Personnel from EES have been involved in this program from its inception through a series of Coast Guard contracts. EES personnel initially identified several potential radar approaches for solution of the problem at hand as a part of the design study under DOT-CG-83141-A. The Coast Guard selected one of these recommended approaches, prepared specifications, and let a contract to the Airborne Instrument Laboratory (AIL) Division of Clutter-Hammer Corporation for the purpose of fabricating prototypes to be subjected to an extensive test and evaluation program. EES personnel under P.O. CG-02, 150B and later under the current contract provided technical assistance to the Coast Guard in monitoring the development phase. Initial evaluation in support of the test program and the planning development of specific test instrumentation and test plans, as well as all subsequent activities on the AN/APS-119 program, has been accomplished as a part of the current contract, DOT-CG-04132-A.

A series of letter reports and other memorandum documents was prepared setting forth the basic test and evaluation philosophy, as well as the technical objectives, of each test, and also specific recommended experimental

*Numbered references in brackets may be found in Section IV.

approaches for each test phase [2,3,4]. A comprehensive engineering parameter evaluation test phase was detailed in the initial version of the plan for the shorebased tests which was provided to the Coast Guard on 19 January 1972 [3]. Based on an extended series of testing at Wildwood during February and March 1972 and on computer prediction techniques developed earlier [5], a series of performance prediction curves was prepared which detailed the potential effectiveness of the radar from an airborne platform; these curves provided a technical basis for design of the Flight Test Program [6,7]. The initial draft of the flight test program plan was prepared by the U. S. Air Force (4950th Test Wing, ASD) for the Coast Guard using this input [8].

A more comprehensive shore test program, prepared for the Coast Guard after the initial series of tests, set forth requirements for both performance evaluations and additional engineering test data at the shore site at Wildwood. The final period of shorebased testing reported here resulted from these recommendations. The test plan for the expanded test series was provided to the Coast Guard on 9 October 1972, and included recommendations for a test duration of not over about six weeks, to be initiated immediately. [9] The actual test series was delayed due to modulator problems in the test radar, so that actual testing was not initiated until mid-November. Testing and data acquisition continued through the second week of January 1973. Based on the resulting series of ten weeks of testing, revised performance predictions were prepared and sent to the Coast Guard and Air Force as guidance to performance of the flight test program [10].

B. Summary and Recommendations

The results of the series of shore tests described herein include new, detailed data on the backscatter from selected targets and from the sea for the various operating modes of the AN/APS-119, especially as functions of pulse length and polarization, and evaluations of the performance of the key signal-processing features. In addition, data are included on the actual values of key engineering parameters together with qualitative and quantitative assessments of the overall performance of the system as observed at Wildwood, N. J.

Among the new developments included in the AN/APS-119 program was the coordinated use of polarization selective, rapid scanning antenna and signal processing based on an area integrator (i.e., a scan-converter integrator and/or a direct view storage tube.) While much of the testing was devoted to documentation of the general characteristics of the radar and to the acquisition of new data about the behavior of returns from targets and clutter, a number of specific tests were undertaken to establish the effectiveness of the unique signal processing concept. Two versions of the scan-converter integrator were evaluated along with the standard DVST display. Performance comparisons of the various integrators were made relative to a conventional A-scope display.

Some of the more pertinent observations and conclusions are as follows:

1. During the ground test, neither scan converter No. 1 or No. 2 appeared to improve detectability of a target in clutter over A-scope. However, differences were noted between the two for a noise background, especially the short pulse end, where No. 2 was better by as much as 6 dB. The DVST PPI appears to give about 5 dB improvement in signal-to-background ratio in clutter.

2. Performance predictions for the APS-119 were verified for the conditions at Wildwood. Extrapolations indicate that the range region for which the probability of detection exceeds 50 percent (for a $1m^2$ cross-section target located 2 feet above the sea surface and an aircraft height of 1000 ft and a pulse length of 0.2 μsec) is 7.5-16 nmi for Sea State 1. A 50% probability of detection will not be achieved at any range in a State 2 or 3 sea. For a aircraft height of 500 ft, 50 percent probability of detection is predicted for ranges between 4-10 nmi for Sea State 1, 6-11 nmi for Sea State 2. The target is not detectable at all for Sea State 3.

3. The peak radar cross-section of a 14 ft boat appears to vary between -3 to -12 dBsm as a function of aspect angle and was not appreciably enhanced by the use of such augmentation techniques as metal blankets, etc.; however, a trihedral corner reflector which was elevated several feet above the boat was of significant help.

4. Sea clutter returns under "standard" propagation conditions were found to match predictions reasonably well. The occurrence of ducting which can radically affect performance, was demonstrated in a number of the sea clutter measurements. Sea clutter "spiking" on horizontal polarization was consistently observed which decreased target visibility and resulted in a significant increase in false alarm rates.

5. Radar reliability was found to leave much to be desired and should be improved as a first step in any future development plans.

6. Best mode for operations was determined heuristically to be 0.2 μsec, 1.8 kHz, 270 scans/min, 3 sec integration time, and VV polarization.

Based on the results of the shorebased test program, it is recommended that the Coast Guard should:

1. Proceed with meaningful flight tests of the AN/APS-119 to determine maximum ranges for buoys and boat targets as a function of sea state, aircraft height, etc., in order to define the practical performance bounds on state-of-the-art radar.

2. Further study the design of radar processing circuits and interfaces in the AN/APS-119 to determine the sources of all losses, and improve performance of the basic system.

3. Look at different types of scan converters and/or other signal integrators as substitutes for the types currently used.

4. Undertake further system evaluations and experimental investigations of the use of radar for the SAR mission beyond the limitations of the current AN/APS-119 hardware and/or evaluation program. Specifically, continuing development of high performance radar systems by the Navy should be followed closely.

II. SUMMARY OF FIELD OPERATIONS

Ground tests were performed on the APS-119 SAR radar at the Coast Guard Electronics Engineering Center (EEC) in Wildwood, N. J., over the period March 1972 through January 1973. The tests were designed to achieve several results: (1) to provide enough data to allow interpretation of the flight tests; (2) to make measurements essential for an accurate system performance prediction; (3) to obtain enough engineering data to evaluate certain radar components such as the scan converter; and (4) to determine the "best" operating modes for a given set of operating conditions.

Several types of tests were performed in order to achieve these goals (1) Minimum detectable signal (MDS) measurements on an A-scope, the scan-converter PPI, and direct view storage tube (DVST) displays were made for both noise and sea return in order to evaluate the scan-converter integration performance and to provide information on the sensitivity of the radar receiver. (2) Measurements of the return power from radar buoys of known cross-sections were obtained in order to verify the predicted performance for the APS-119 radar. (3) Tests were conducted to determine the return power from a 14-ft boat for different aspects and configurations so as to check the detection performance for an actual target. (4) Radar tests were made on larger boats to help in calibrating the radar performance. (5) Clutter profiles were taken to calibrate the radar return data.

A. Test Site

The Coast Guard EEC is located on the Atlantic coast just south of Wildwood, N. J. The APS-119 radar was mounted in the Microwave Building, a few hundred feet from the water. The antenna and transmitter-receiver components were located in an equipment shelter on the top of the test tower rising above the building, while the IF and video amplifiers, displays, and radar control units were located inside the building. The antenna height was approximately 71 ft above mean sea level, which gave a good view of the coastline to the north and south, including the intracoastal waterway to the south. Figure 1 shows the building and tower and Figure 2 illustrates the view from the top of the tower eastward.

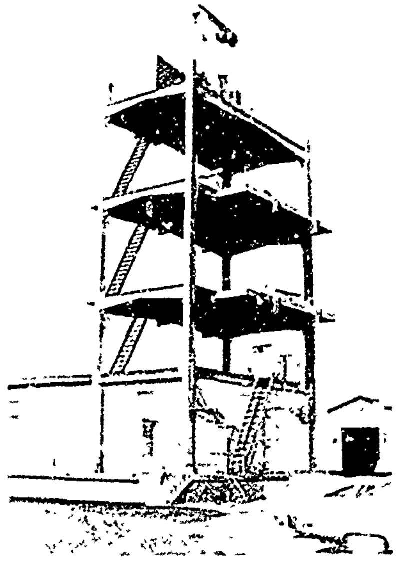

Figure 1. View from the southeast of the building housing the AN/APS-119 radar for the ground tests.

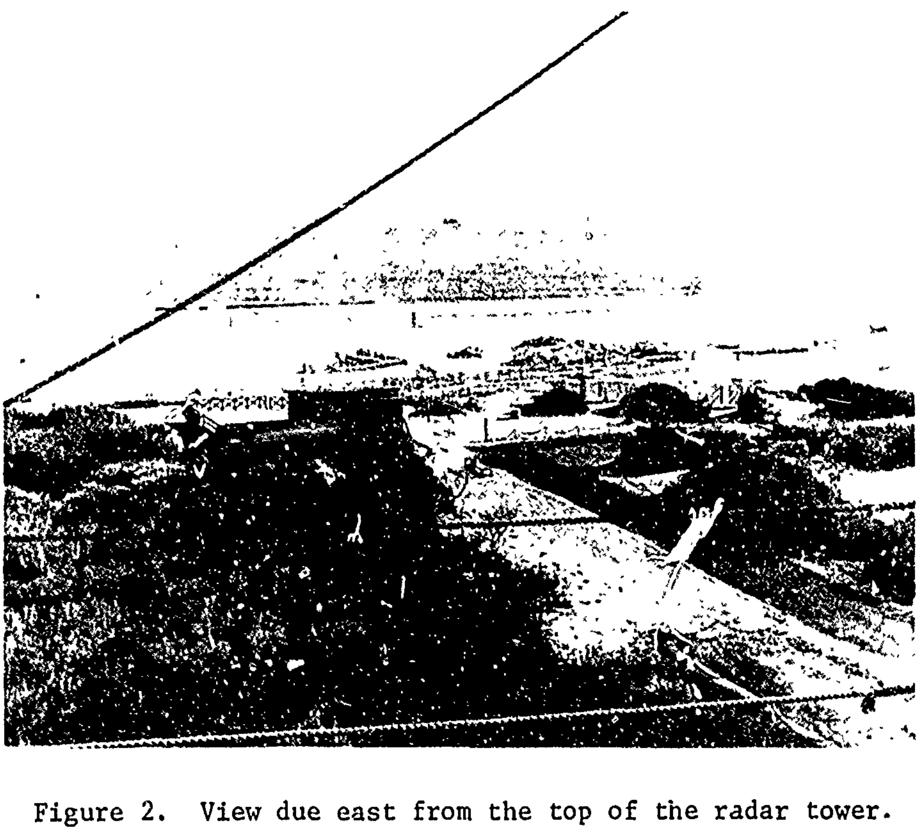

Figure 2. View due east from the top of the radar tower.

B. Test Procedure

All the calibrated measurements made on the APS-119 radar utilized an injected signal generator pulse of known power either as an artificial target (for MDS measurements), or as a reference signal for determining the power from a real target. The pulse from the signal generator was coupled to the receiver through a 40-dB coupler. Plumbing losses between signal generator and receiver, and between antenna and receiver, were carefully measured so that the power received from the signal generator and from the external world, could be accurately determined. Figure 3 gives the connection configuration for the various rf components and lists the plumbing losses. As shown in the figures, a pin diode modulator was used to provide signal-generator modulation for generating artificial targets. The total attenuation loss between signal generator and receiver was determined to be 53.5 dB, of which 0.55 dB was due to a variable attenuator. This figure was used as the calibration constant in determining the power at the receiver from the signal generator. The coax cable running between pin modulator and signal generator was sometimes connected to a power meter to allow measurement of transmitter power.

1. Experimental Set-Up

The test equipment was configured so as to provide an artificial target of varying power, range, and azimuth position on the various displays, and allow recording of target and clutter returns on a strip-chart recorder and a magnetic-tape recorder. Figure 4 gives the triggering scheme used to provide the artificial target. A transmitter pretrigger from the radar sychronizer was used to trigger a gated pulse generator. This same trigger was also fed to a variable-delay pulse generator used to gate the first signal generator. The delay of the second generator was set to be approximately one half of a scan period. The net effect of this set-up was to cause the first range trigger at the end of the transmitter blanking period to fire the variable delay generator, and at approximately the middle of the scan period several range triggers were gated through the first pulse generator. The next incoming range trigger fired the delayed pulse generator again, but its second gate occured during the blanked sector so that no triggers were

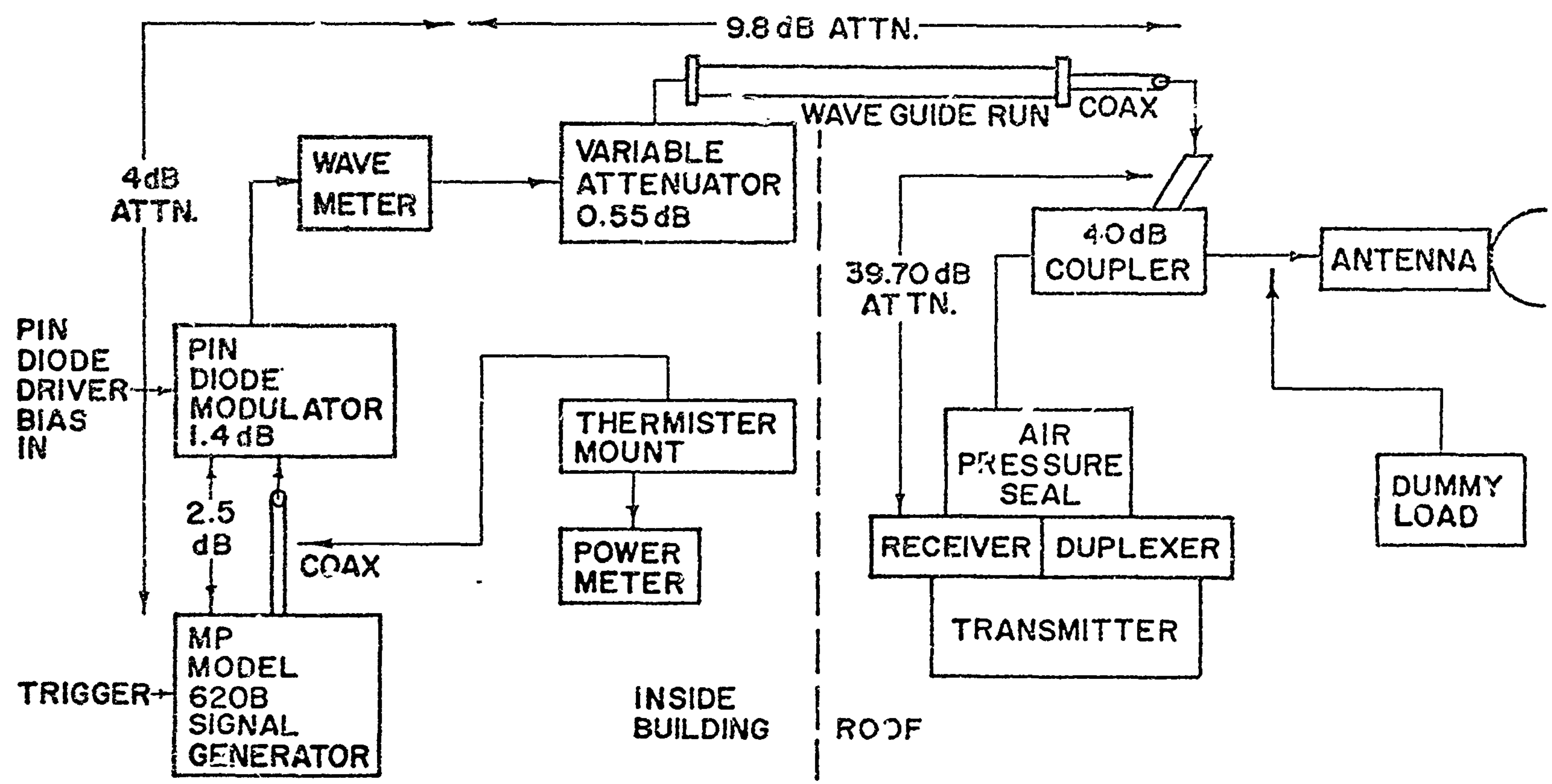

Figure 3. Interconnection scheme for rf components of the AN/APS-119 radar as configured at Wildwood, N. J.

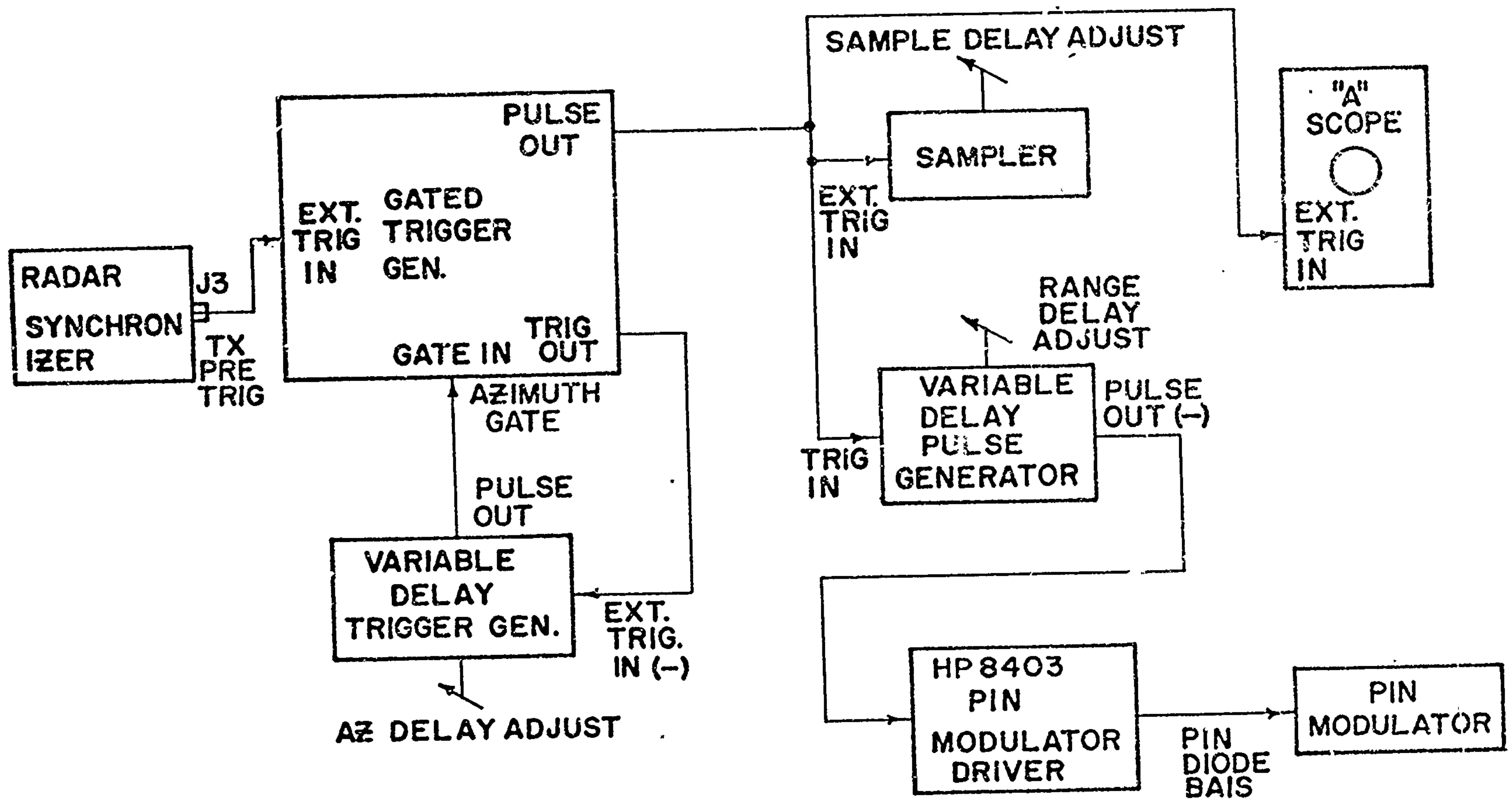

Figure 4. Triggering scheme for data-taking equipment during ground tests.

passed by the gated generator. By slightly varying the delay of the variable-delay generator, the azimuth position of the gated pulses could be changed. The width of the gating pulse determined the number of triggers passed each sweep and therefore the azimuthal width of the artificial target.

The pulses from the gated generator were used to trigger an A-scope, a sampler, and a second variable-delay pulse generator. This generator allowed the artificial target triggers to be positioned in range. Its output was connected to a pin modulator driver which generated the simulated target modulation. The signal generator was operated in the CW mode, so that all pulse modulation was accomplished in the pin modulator.

Data was recorded by sampling video from the log receiver with a narrow-aperture (<50 nanosecs) sampler, constructed by EES, which has negligible "droop" between scan periods. The sampling point was positioned in range by a built-in delay control, and sampling markers were generated so that the sample point could be viewed on an A-scope display along with the video. The output of the sampler was fed to a strip-chart recorder and to a portable tape recorder through an FM modulator. Recorded tapes were analyzed at EES later. Figure 5 is a block diagram of the data-gathering equipment set-up, and Figures 6 and 7 give a view of the equipment set-up, the radar consoles, and receiver-control units.

2. Measurement Procedure

The measurements made on the APS-119 during the ground tests were of two types: (1) measurement of the minimum detectable signal (MDS) in noise and in clutter, and (2) measurement of the power return from targets or sea clutter.

MDS measurements were made on all three available displays: an A-scope, the scan-converter PPI, and the direct view storage tube (DVST). When making MDS measurements, an artificial target was positioned on the display and a scope operator, who was unaware of its exact position, was asked to find it. Starting with a signal known to be below MDS, the signal generator power was raised in small steps until the display observer was able to distinguish the artificial target from the background. The power setting on the signal generator, minus the plumbing loss calibration, was recorded as the minimum detectable signal. The clutter or noise level was determined by sampling

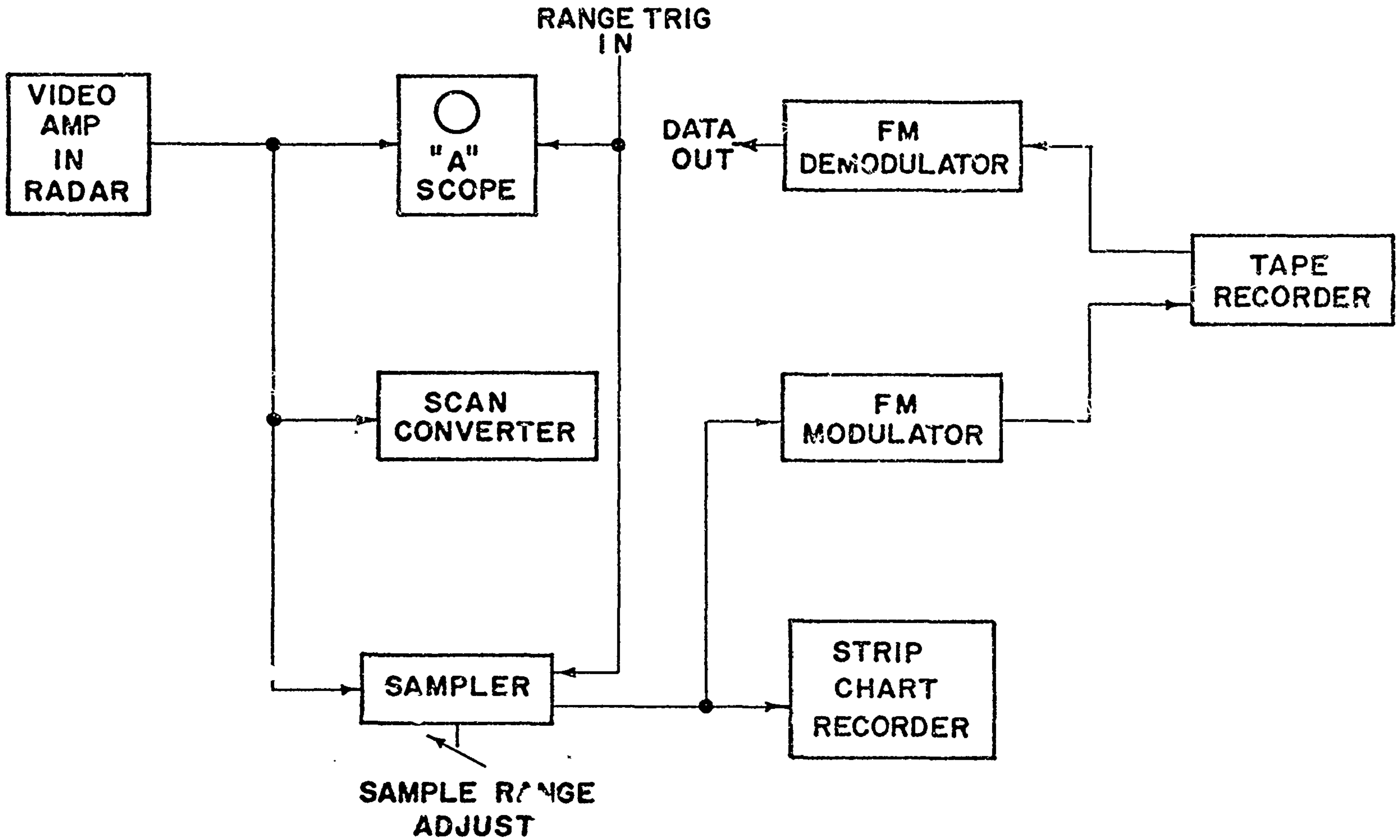

Figure 5. Block diagram of data gathering equipment interconnection for ground tests.

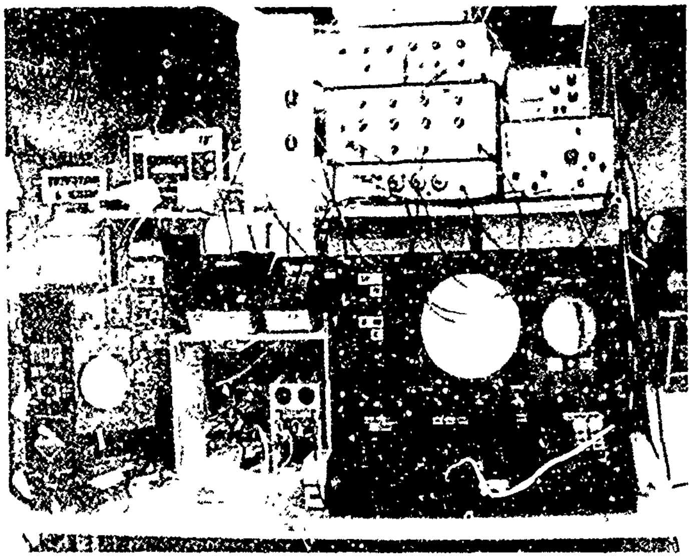

Figure 6. Front view of experimental set up showing data gathering gear and radar displays.

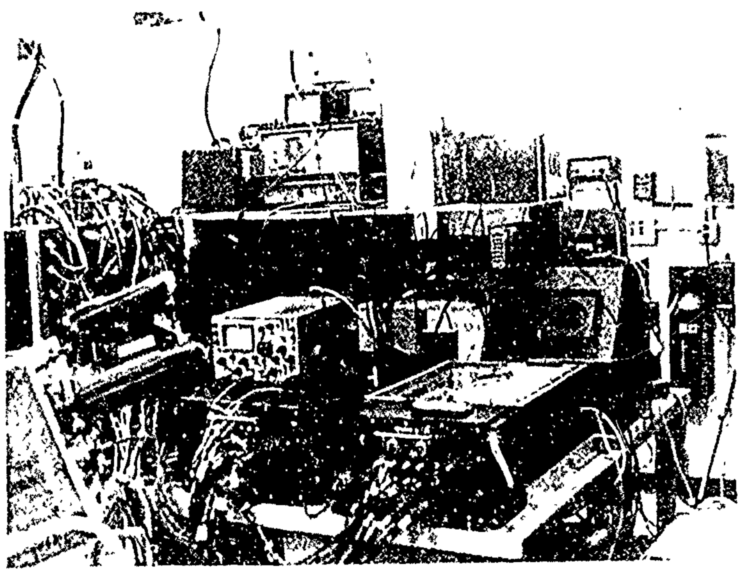

Figure 7. Rear view of experimental set up showing radar synchronizer and IF units.

the clutter or noise from that radar cell with the signal generator absent, recording the return on the strip-chart recorder, and estimating the average value. This process was repeated a number of times with different observers and different modes of pulse width, prf scan rate, etc., in order to generate a family of points for the different modes. Another method of measuring MDS in clutter, used when a number of distracting targets were present, consisted of setting the signal generator to a power level which was easily visible in noise, and, starting with the signal generator pulse far enough out in range to be clear of the clutter, slowly positioning the artificial target closer in range until it was barely detectable. The clutter return power was then measured as before.

Figure 8 is a view of the PPI display during a typical MDS measurement. The arrow indicates the signal-generator signal, which is clear of the clutter. Figure 9 is a view of the PPI display in which the signal-generator pulse has been moved in range until it is an MDS signal. Figures 10 and 11 are views of the direct view storage tube (DVST). Figure 10 shows a PPI-type display in which the signal-generator artificial target is indicated by the arrow. In Figure 11, a small wedge of the PPI containing the artificial target has been expanded into a B-type display. The artificial target is shown at the center of the display. Measurements of MDS on the DVST were made using this expanded mode. For MDS-in-noise measurements, the transmitter was turned off in order to be sure no clutter was present.

The average received clutter power for MDS measurements was measured by a method that resulted in the signal-to-clutter ratio, for MDS, prior to integration by the storage tube. Thus, if the integrator was working properly, the signal-to-clutter ratio actually viewed, after integration, on the display should have been much higher than the value measured by this technique.

Range profiles of clutter return were recorded on strip-chart paper and on the magnetic-tape recorder in conjunction with the MDS-in-clutter measurements in order to characterize its properties for later analysis. In addition, wind speed, direction, estimated wave height, and other applicable parameters were recorded at the same time.

Measurements of received power from real targets were recorded on the strip-chart recorder and the magnetic-tape recorder in the following steps.

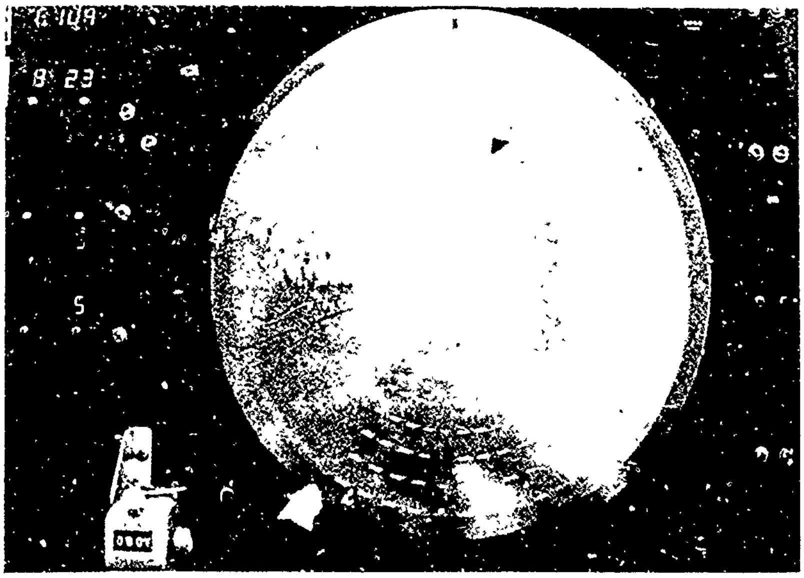

Figure 8. View of PPI display showing -80 dBm signal generator pulse free of clutter. Integration time was 3 minutes, scan rate, 240/rpm.

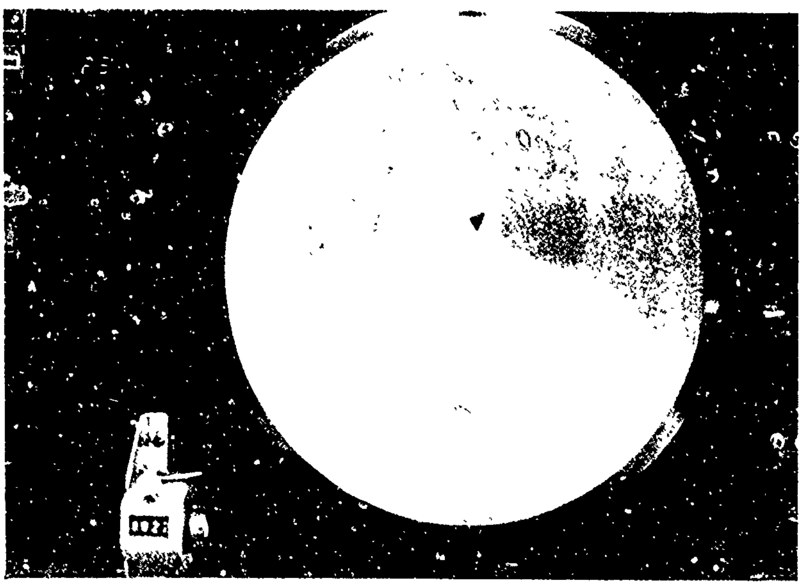

Figure 9. View of PPI display in which -80 dBm signal generator pulse is positioned in range so as to be at MDS. Integration time was 3 minutes, scan rate 240/rpm.

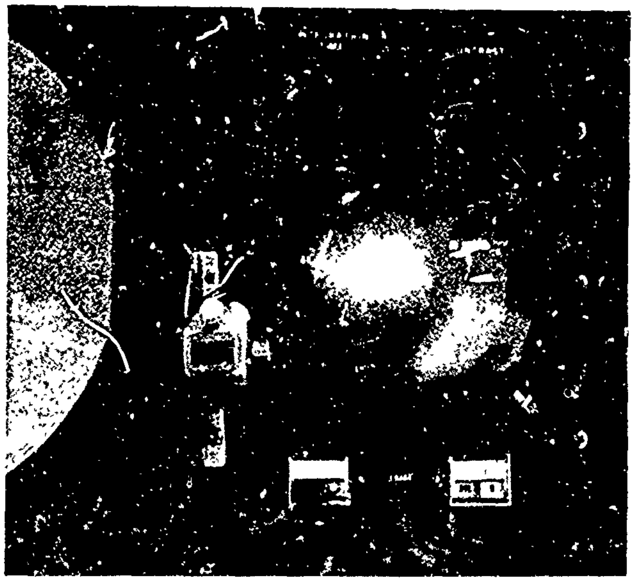

Figure 10. View of DVST with PPI type display containing -80 dBm artificial target (arrow.) Integration time was 50% of maximum.

Figure 11. View of DVST with expanded B-type display. -80 dBm artificial target is at center of tube. Integration time was minimum.

(1) A calibration was recorded on both recorders by positioning the sampling gate on the signal-generator pulse and recording the sampler output as the signal-generator power level was varied from the noise level to the maximum signal-generator level in 10-dB steps. Figure 12 shows a strip-chart recording of a typical calibration. (2) The antenna scan was stopped and the antenna was aimed at the target. (3) The sampler aperture was positioned on the target to be measured by adjusting range delay as previously discussed. (4) The sampler output was recorded on both recorders for several minutes while tracking the target in range with the sampling gate. (5) The sampling gate was moved off the target and recordings were made of clutter in an adjacent radar cell. The magnetic tapes produced by the above procedures were later digitized and analyzed by computer at EES to yield probability density and cumulative probability plots of the received power from the targets and the clutter in adjacent cells [11].

Figure 13 shows a typical clutter profile made prior to taking data on the received power from two deployed buoys. Figure 14 shows two strip-chart recordings of the return power from Buoy No. 2 (about 1 m^2 cross-section) for the same day. The range is 2.4 nmi for both recordings. Figure 15 shows an A-scope display of the log video and contains the return from a radar buoy (arrow). The antenna was aligned in azimuth by jockeying the antenna back and forth until the target return on the A-scope appeared to be "peaked." The sampling gate was then moved onto the target in range.

Along with each set of runs on received power from real targets, clutter profiles were generated by measuring the return power from the sea at half-mile intervals. Probability densities and cumulative probability plots were generated for these profiles; examples are contained in Appendix B for both horizontal and vertical polarizations.

Whenever possible during the tests, rain and other weather was viewed to attempt to determine the ability of the APS-119 radar to perform as a weather radar. No quantitative measurements were made, but numerous pictures were made of weather for different polarizations and modes. Figure 16 is a typical DVST display of a rainstorm. The range was 40 nmi and maximum integration was used.

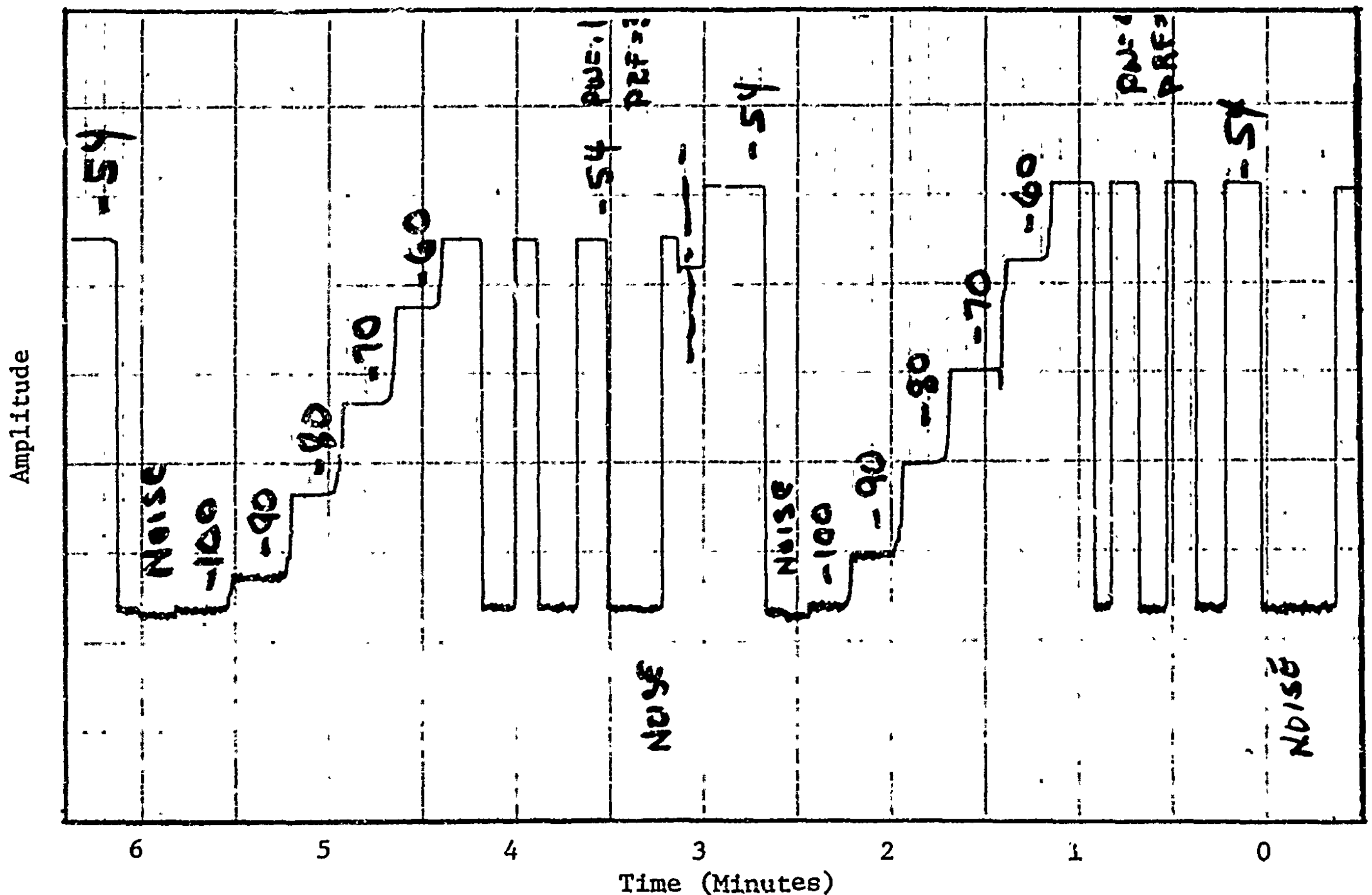

Figure 12. Strip chart recording of a typical calibration prior to taking radar measurements of received power. The indicated levels are in dBm.

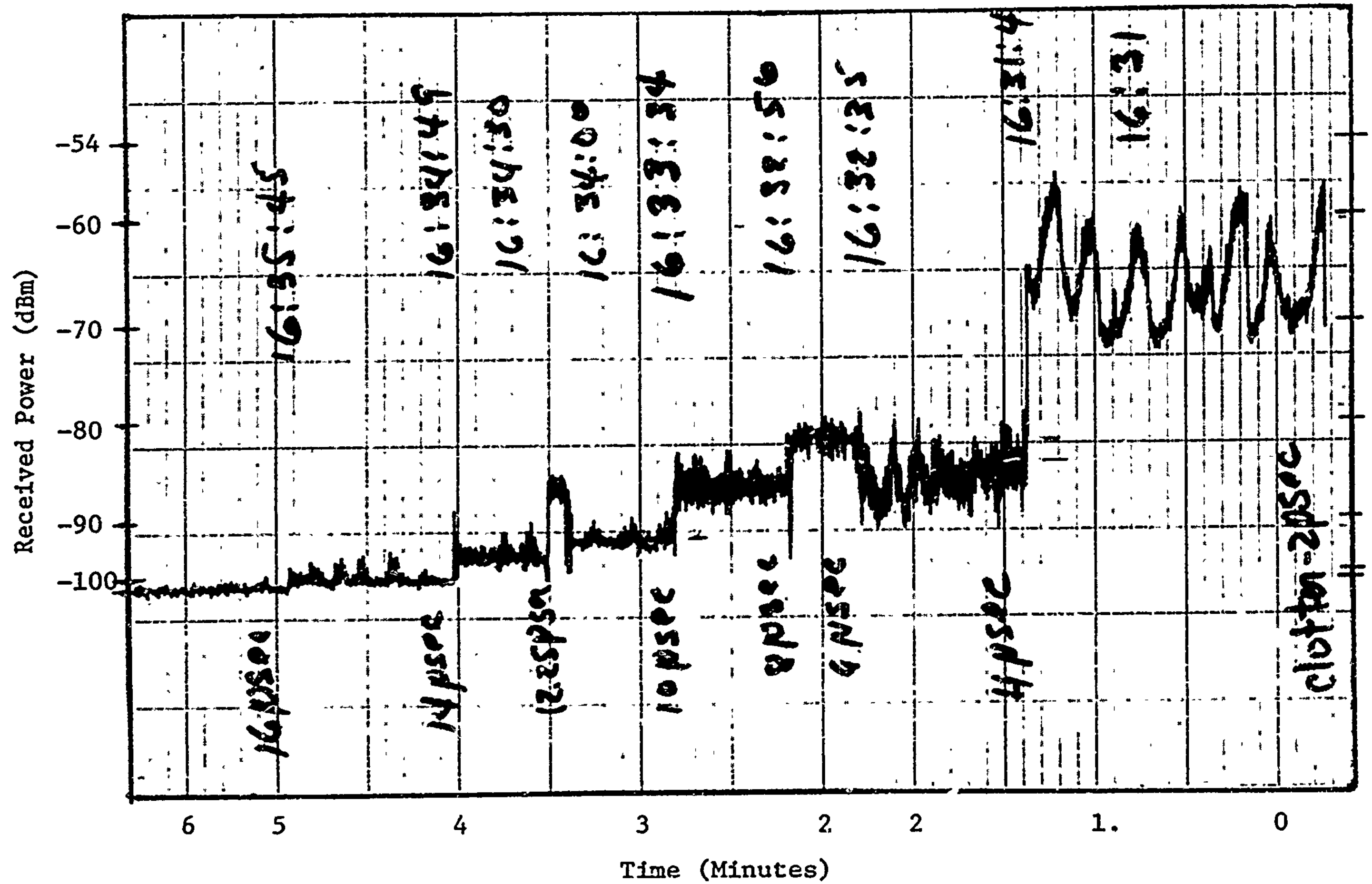

Figure 13. Strip chart recording of a typical clutter profile measured prior to recording data on the received power from two radar buoys. The round trip propagation time for the radar signal at each range increment is indicated beneath the waveforms; 12 μsec ∿ 1 nmi.

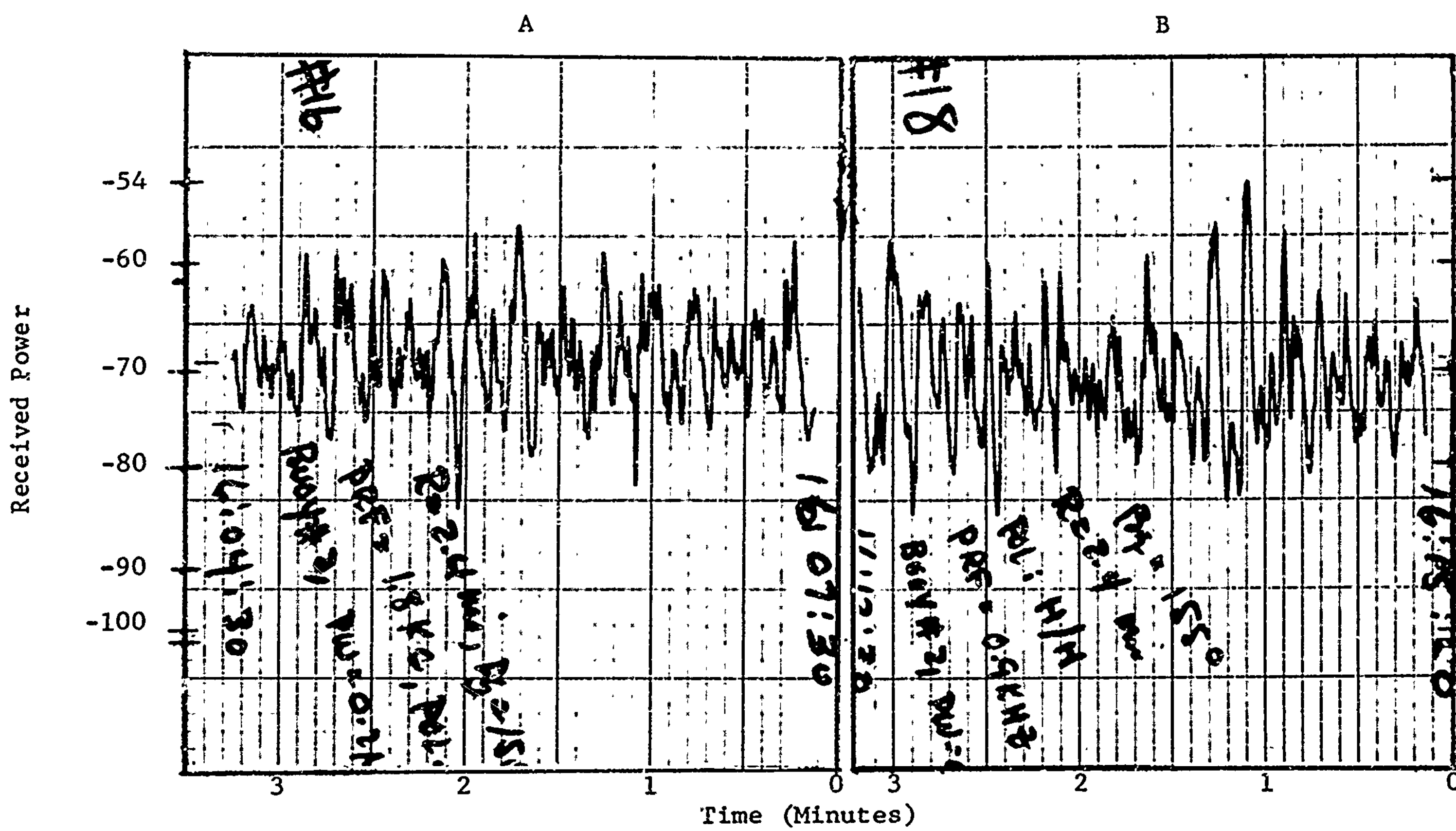

Figure 14. Strip chart recordings from a $1 m^2$ cross section buoy at 2.4 nmi for (A) 0.4 μsec pulse width, 0.9 kHz prf, and (B) 0.2 μsec pulse width, 1.8 kHz prf.

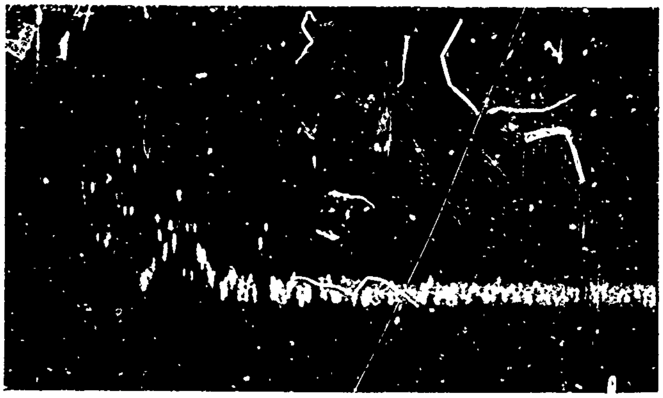

Figure 15. A-scope display of log video from AN/APS-119 radar showing return from a radar buoy (154° Az, 1.7 nmi range).

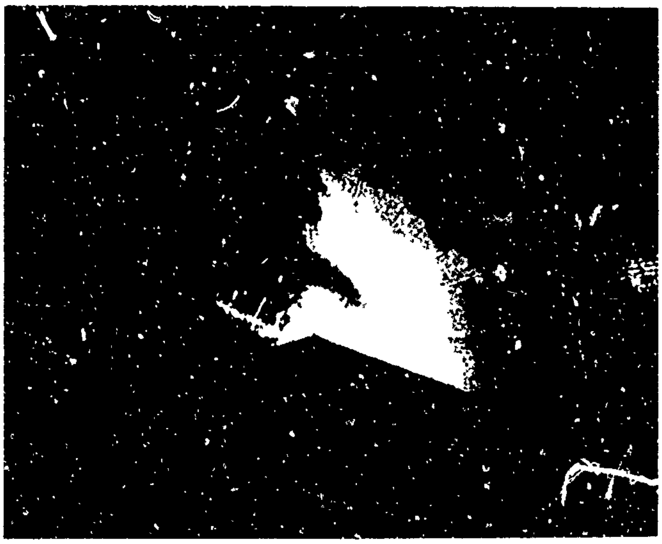

Figure 16. DVST display of a rainstorm in weather mode. Maximum integration, display range - 40 miles.

C. Engineering Data

In addition to the tests conducted to determine the ability of the AN/APS-119 radar to detect targets in a sea-return background, tests of an engineering nature were conducted periodically by both EES and AIL personnel to determine whether the radar was continuing to perform up to design specification. In addition, a list was kept of component failures and other system failures. Since these events were dealt with extensively in the numerous progress letters written during the course of the project, they will not be discussed here.

As part of the engineering tests, a number of measurements were made on the radar parameters. These included: (1) peak transmitter power for each pulse length, (2) receiver noise equivalent power, (3) loss budget for the radar plumbing, (4) antenna scan rate, (5) transmitter pulse width, and (6) receiver linearity. Table I gives typical values of these parameters as measured on 9 November 1972.

TABLE 1

Measure Engineering Parameters for AN/APS-119 Radar

19 November 1972

Test	Mode/Range[2] (nmi)				
	10	20	40	80	160
1. Peak Transmitter Power[1] (kW)	180	188	180	176	176
2. Transmitter pulse width (nsec)	110	220	320	860	840
3. Antenna scan rate (RPM)	-	220	160	85	35
4. Receiver transfer characteristic					
Signal Generator Power	Output Voltage (Volts)				
-53.5 DBm	0.64	0.66	0.68	0.80	0.80
-58.5 DBm	0.58	0.61	0.61	0.70	0.70
-63.5 DBm	0.49	0.52	0.52	0.55	0.55
-68.5 DBm	0.42	0.43	0.40	0.50	0.50
-73.5 DBm	0.35	0.35	0.33	0.45	0.45
-78.5 DBm	0.30	0.28	0.27	0.35	0.35
-83.5 DBm	0.22	0.24	0.20	0.30	0.30
-88.5 DBm	0.17	0.05	0.10	-	-
-93.5	0.05	0.05	0.10	0.18	0.18
5. Noise Equivalent power dBm	-93.0	-96.5	-99.5	-102.5	-102.5
6. Signal Generator Loss Budget	-53.5 dB				

[1]The peak transmitter power is calculated from the measured average power by the formula:

$$P_{pk} = \frac{[P_{ave} + 53.5 \text{ dB}]}{\left[\frac{\text{Pulse width}}{\text{prf}}\right]}$$

[2]The modes compatible with each range scale are

10 nmi - 300 scans/min, 6.7 kHz prf, 0.1 μsec pulse width.
20 nmi - 240 scans/min, 3.4 kHz prf, 0.2 μsec pulse width.
40 nmi - 120 scans/min, 1.7 kHz prf, 0.4 μsec pulse width.
80 nmi - 60 scans/min, 0.84 kHz prf, 0.8 μsec pulse width.
160 nmi - 30 scans/min, 0.42 kHz prf, 0.8 μsec pulse width.

III. SUMMARY OF MEASUREMENTS

The ground tests for the AN/APS-119 radar at Wildwood, N.J., were plagued by numerous problems from the beginning, so that it was not possible to perform all of the experiments originally planned. The combination of radar component failures, bad weather, and the difficulties encountered in obtaining adequate auxiliary support for the tests had the net result of minimizing the amount of meaningful data obtained. However, enough data were gathered to answer a number of specific questions about the AN/APS-119 radar. In particular, determinations were made in the following areas: (1) Characterization of the performance of the first and second scan converters both in noise and in clutter. (2) Verification of the prediction model for the AN/APS-119 from data on the received power from calibrated radar buoys. (3) Determination of the ability of the AN/ASP-119 radar to detect a 14 ft boat for different polarizations, aspects, and with the use of certain radar enhancement devices. (4) Verification of predictions of received power from sea return for the AN/APS-119. (5) Determination of the "best" mode of operation for the AN/APS-119 as far as polarization, scan speed, integration time, prf, and pulse width are concerned. (6) Finally, generation of corrected predictions of AN/APS-119 performance for the flight tests.

A. MDS Measurements on the Scan Converters

Minimum detectable signal tests were conducted on the second scan convertor to determine whether its noise performance was improved over the first scan converter as was hoped. Figure 17 gives the MDS versus pulse width for the first scan converter (reprinted from AIL engineering report [12]), and Figure 18 gives the MDS as a function of the same parameters for the second scan converter as measured by EES personnel at Wildwood. The two curves are, in general, similar except at the narrow-pulse end of the scale, where, for example, at 0.2 μsec, scan converter No. 2 measures to be 6 dB better than the data reported in Figure 17. However, it is felt that the data in Figure 18 are representative of what can be obtained from either one of the scan converters when optimized. This impression is substantiated by the data shown in Figures 19 and 20 in which the minimum detectable signal is shown for each of the scan converters versus range in both sea-clutter and receiver-noise

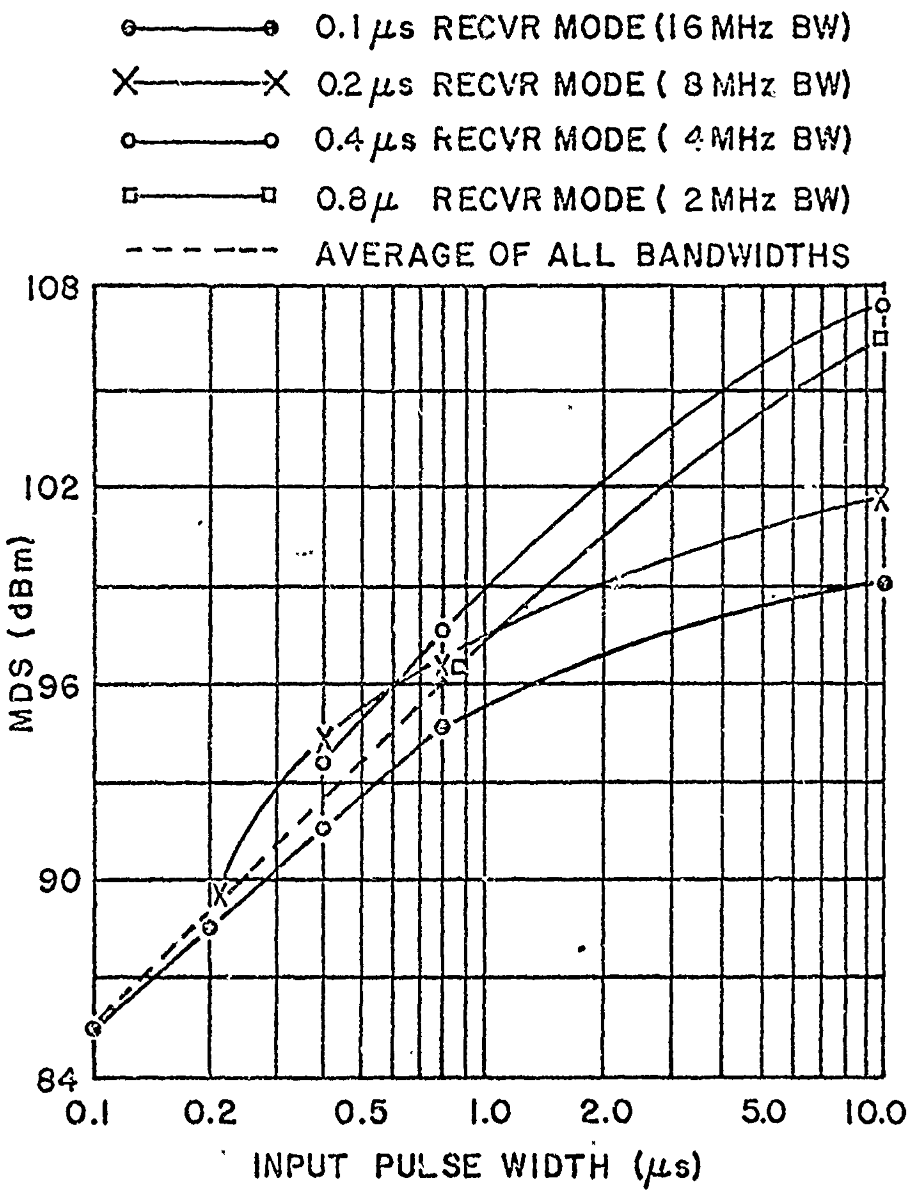

Figure 17. Measured minimum detectable signal level in receiver noise as a function of pulse width scan converter No. 1. (AIL [12])

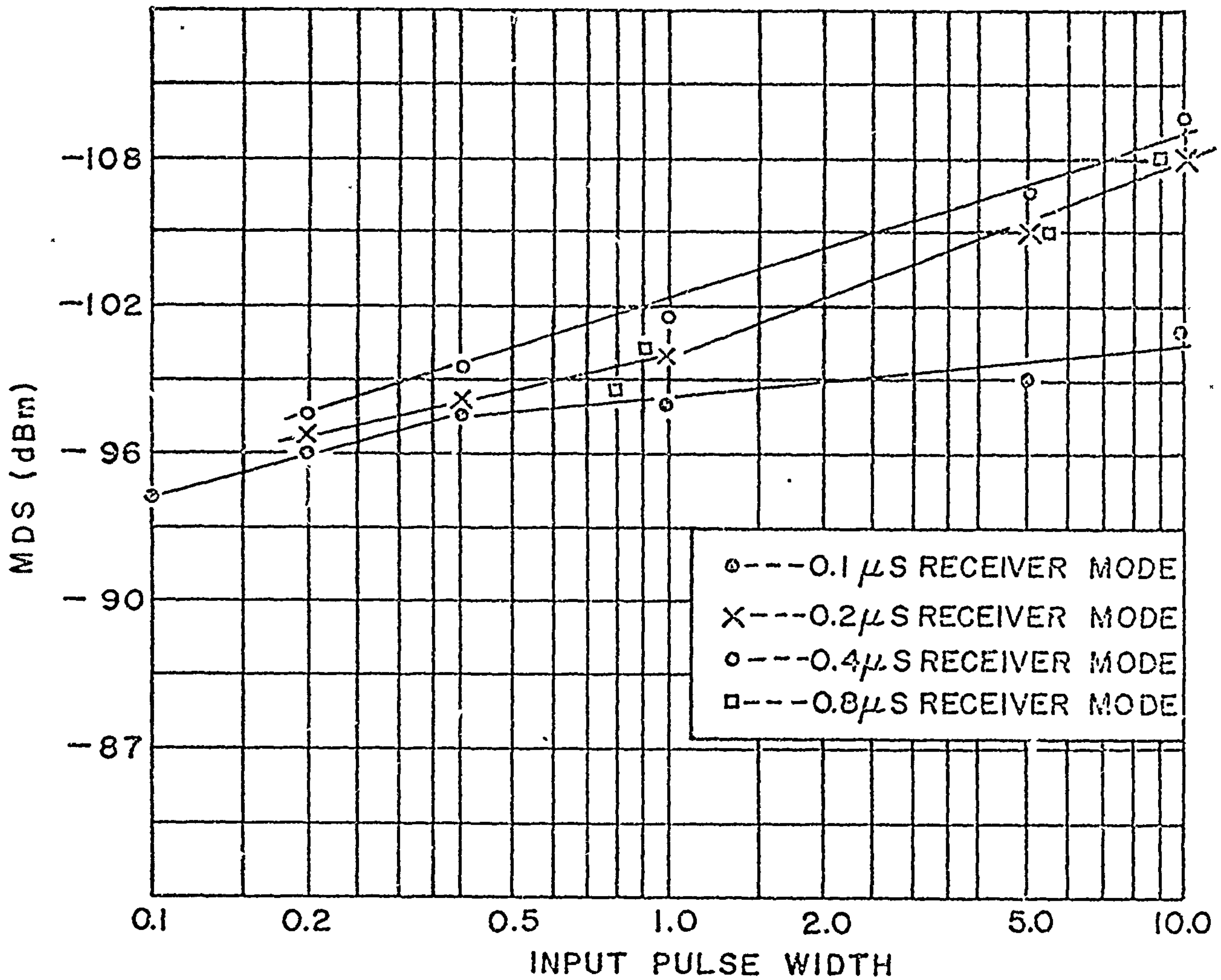

Figure 18. Measured minimum detectable signal level in receiver noise as a function of pulse width for scan converter No. 2. (GIT)

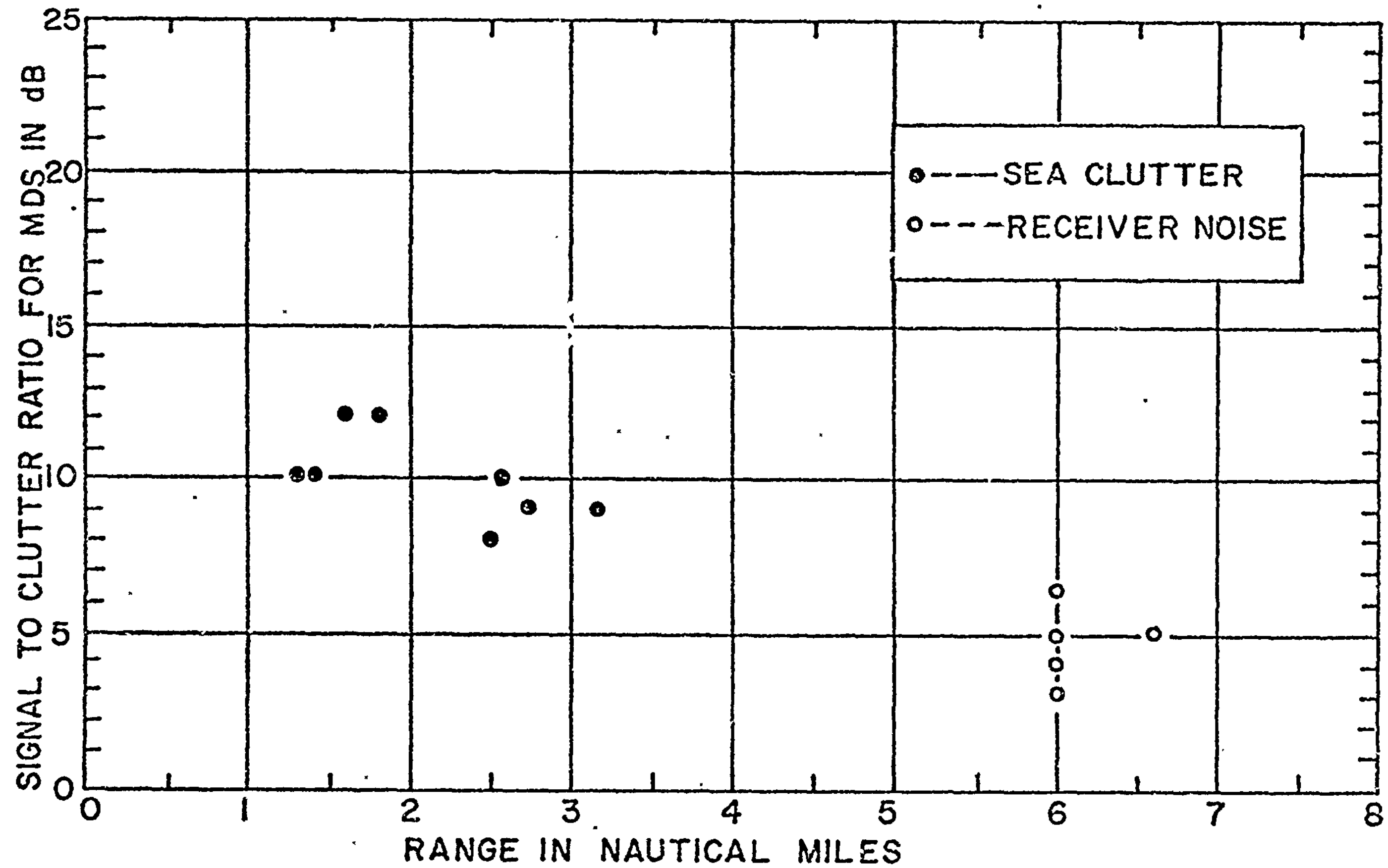

Figure 19. Measured minimum detectable signal level in sea clutter and receiver noise for a 0.2 μs pulse for scan converter No. 1. (GIT)

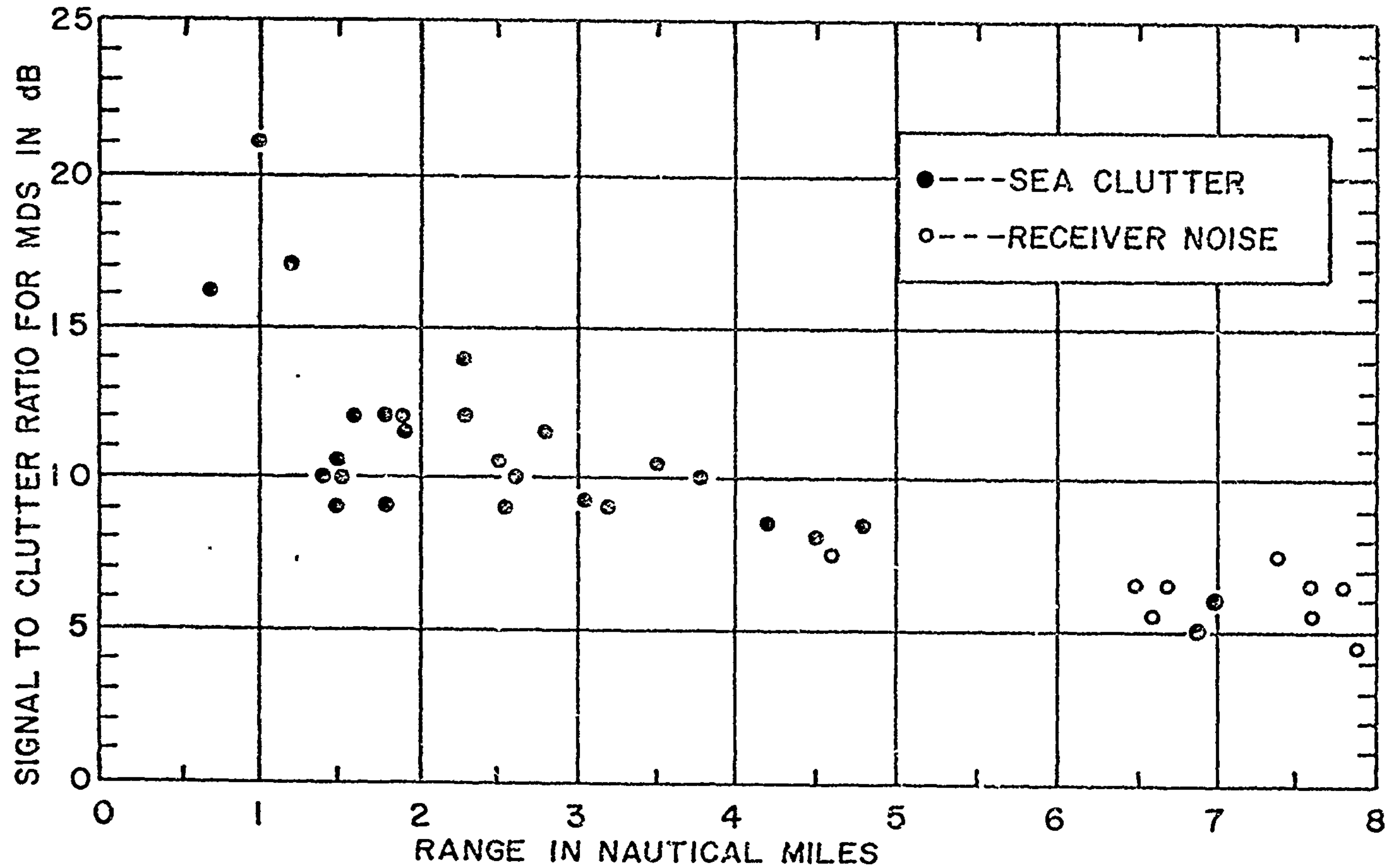

Figure 20. Measured minimum detectable signal level in sea clutter and receiver noise for a 0.2 μs pulse for scan converter No. 2. (GIT)

environments. Figure 19 shows selected data for measurements made on scan converter No. 1 while Figure 20 shows data for scan converter No. 2.

These data were obtained in what is considered to be the optimum operating mode for detecting a small boat, i.e., a pulse length of 0.2 μsec, a scan speed of 240 RPM, vertical polarization, and an integration time of 3 seconds. Comparison of Figures 19 and 20 shows that the general trends of MDS with range are approximately the same, in spite of the lack of data for the first scan converter at ranges less than 1 mile and between 3 and 6 miles. In addition, the average levels are approximately the same for the two. The very poor performance observed at short ranges is undoubtedly due to a combination of the effects of heavy clutter, poor resolution at the center of the PPI display, and sidelobe returns from nearby large ground targets. Performance from an aircraft platform should be improved since the sidelobe problem would disappear, and the detection ranges should be more compatible with the display range scales of the scan converter when the radar is operated at the altitudes it was designed for. Figure 21 is a scatter diagram of measurements made on scan converter No. 2 which shows the trend of MDS versus the sea clutter level. A line drawn through the average of the data points would indicate that, at the receiver noise level, the anticipated MDS would be approximately 5 or 6 dB above the average noise level, for the second scan converter with a time constant of three seconds, and would rise to about 15 dB signal-to-clutter ratio in heavy clutter (a received power level of -70 dBm). Since these values are approximately the same as those required for detection on an A-scope display, it can be concluded that little or no improvement in detection capability is contributed by the scan converter integrator.

Figure 22 shows a scatter diagram of MDS signal-to-clutter ratio versus sea clutter level for the DVST integrator. An average line drawn through the points would yield a 0 dB signal-to-noise ratio at the receiver noise level for 50% integration and a 10 dB signal-to-clutter ratio for sea return levels of -70 dBm. Thus, it is apparent that the signal-to-clutter ratio required for MDS is about 5 dB lower for the DVST PPI than for the scan converter PPI display. The DVST B-display should be even better, although no data was obtained on it.

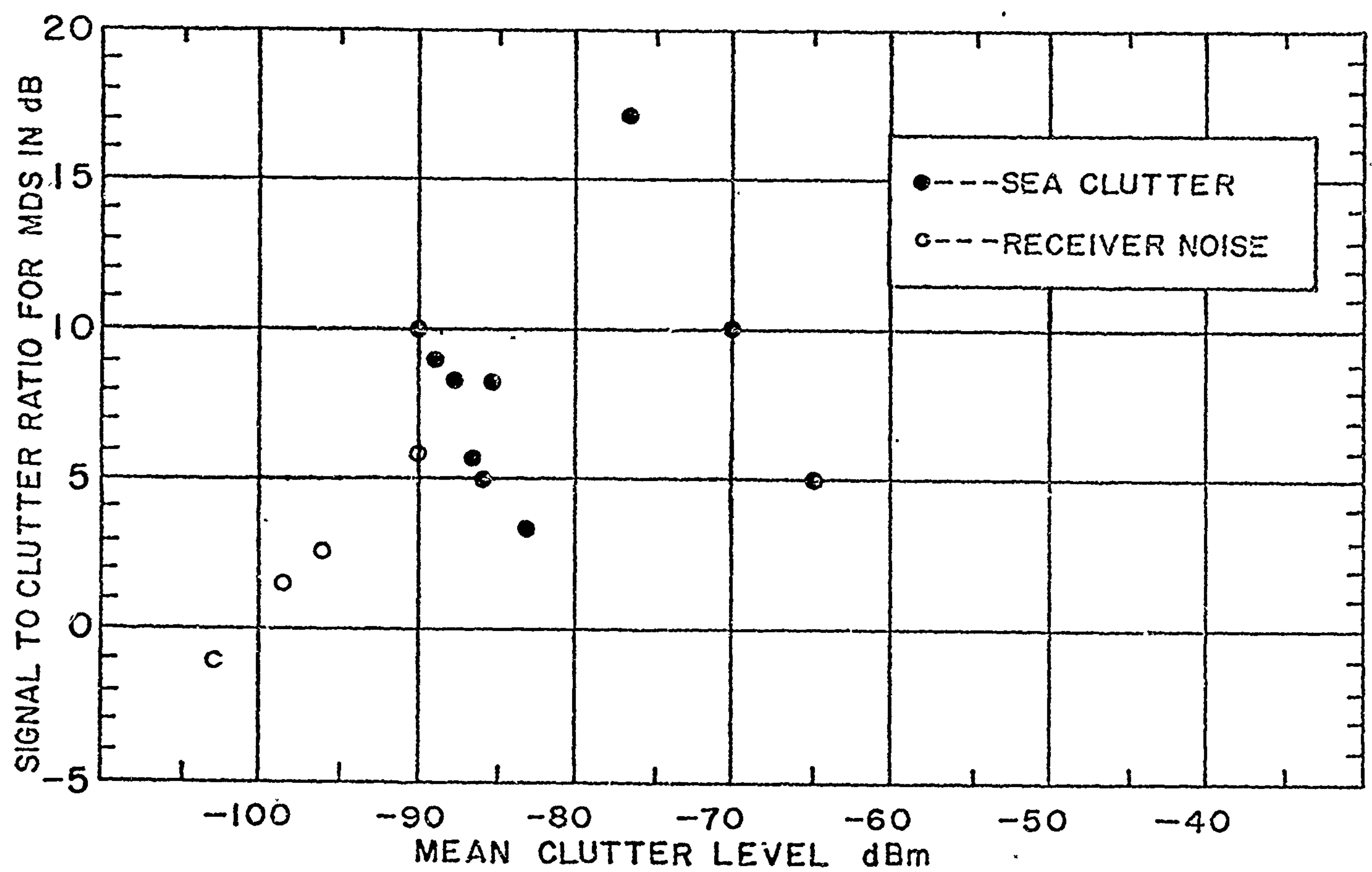

Figure 21. Comparison of minimum detectable signal levels for various sea clutter levels and receiver noise for a 0.2 μsec pulse and for scan converter No. 2. (GIT)

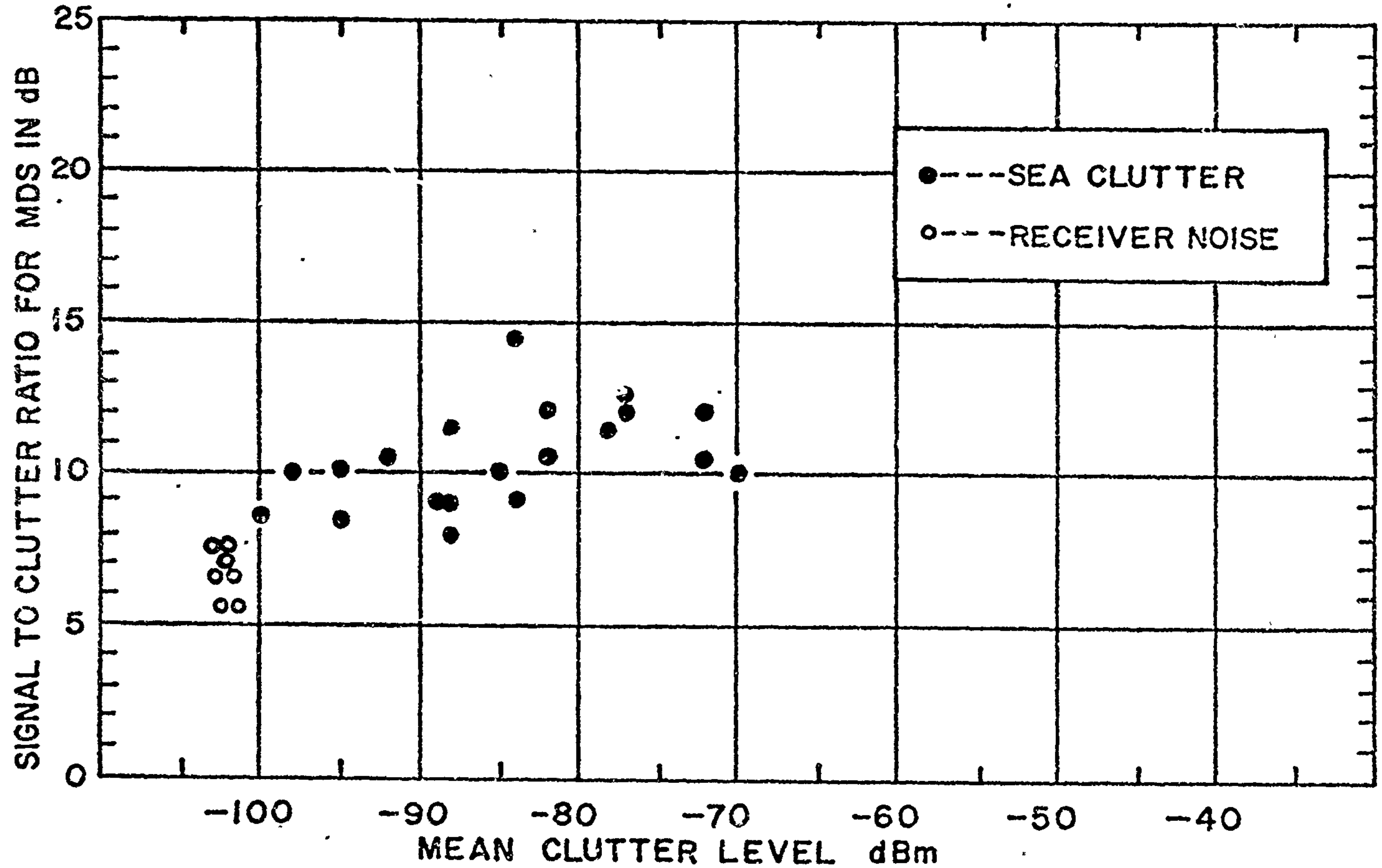

Figure 22. Comparison of minimum detectable signal levels for various sea clutter levels and receiver noise for a 0.2 μsec pulse and for 5 inch DVST PPI. (GIT)

B. Received-Power Measurements

The received-power measurements were conducted for two purposes: (1) to verify the predicted returns generated for the AN/APS-119 radar, and (2) to measure the ability of the radar to detect a 14-foot boat for different aspects, polarizations, and with the use of RCS-augmenting devices on the boat.

Figure 23 gives a summary of the measured power return from two radar buoys for horizontal (HH) and vertical (VV) polarizations. For this figure, data obtained for pulse lengths of 0.1, 0.2, and 0.4 μsec, were combined. The solid line indicates the predicted return for a 1 m^2 radar cross-section target. The radar cross-section for Buoy I was determined to be approximately 1/2 m^2, while the cross-section for Buoy II was 1 m^2. From Figure 23, it can be concluded that the prediction is fairly accurate, since all data points for Buoy II are grouped around the predicted return for a 1 m^2 target. Likewise, the data points for Buoy I fall between 3 and 5 dB below the 1 m^2 prediction. In addition, it can be concluded that the received power from the buoys is independent of polarization.

Figure 24 gives the measured power return for a 14-foot boat, occupied by two men, for different aspects as compared to the predicted return for a 1 m^2 target. Although the points are scattered, it appears that the radar cross-section is greatest for the broadside view and least for bow aspect. In any case the cross-section varies from -12 dBsm to -20 dBsm.

Figure 25 gives the received power versus range for a 14-foot boat for horizontal and vertical polariztations. As was the case for the radar buoys, the received power appears independent of polarizacion. (However, this is not the case for sea return.)

Figure 26 gives the results of an experiment to determine the effect of several radar enhancement devices on the received power from a 14-foot boat. Included in the test were a corner reflector, a 3-1/2 foot luneberg lens, metallized blanket material, and a metal foil sheet. As is shown in the figure the corner reflector and lens increased the received power from the boat but when either the metallized blanket or the foil sheet was draped over the side of the boat, if anything, the received power was reduced. The most likely explanation is that neither the blanket or sheet were high

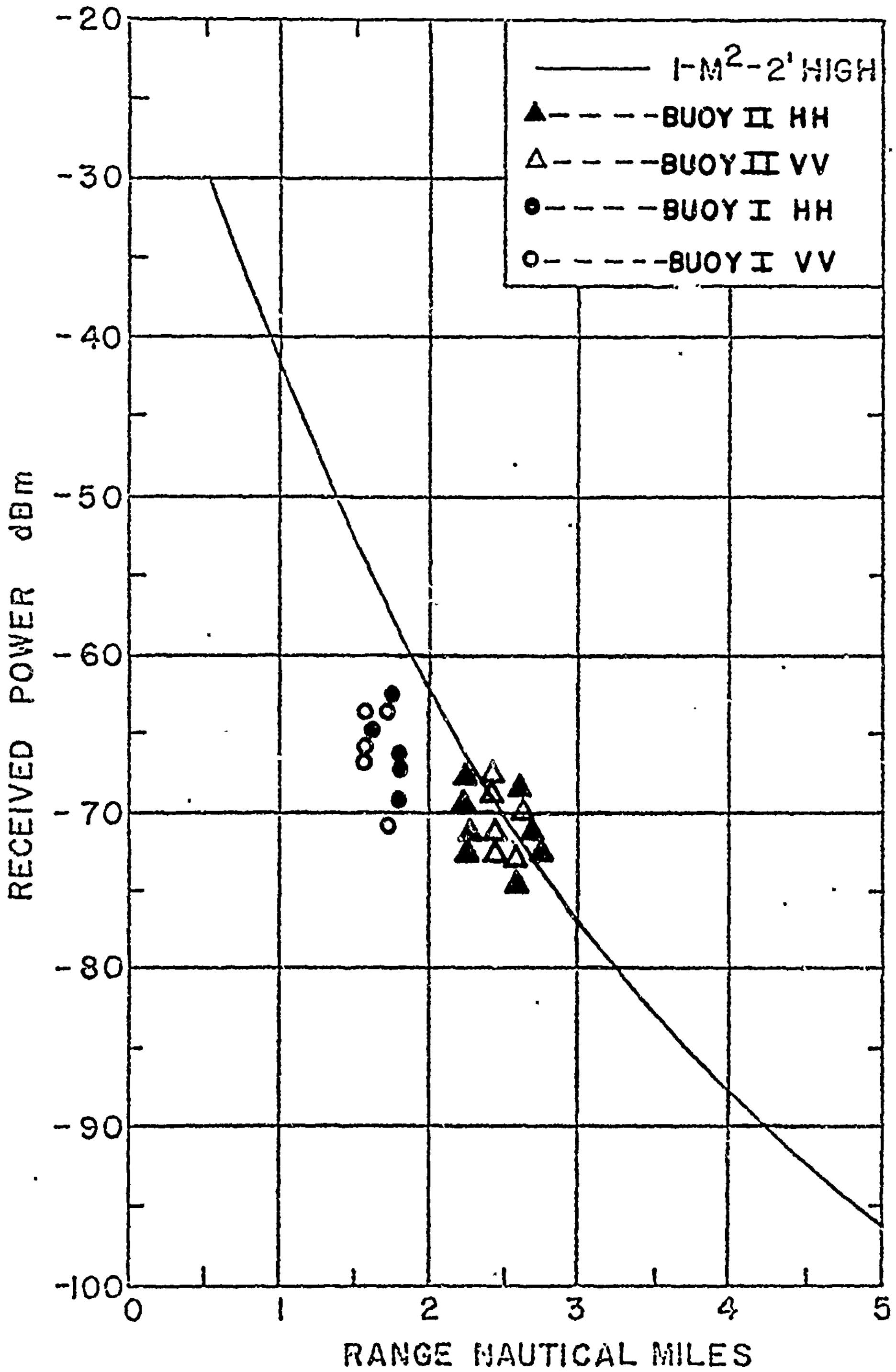

Figure 23. Received power from several targets as a function of range for pulse lengths of 0.1, 0.2, 0.4 μsec from the AN/APS-119.

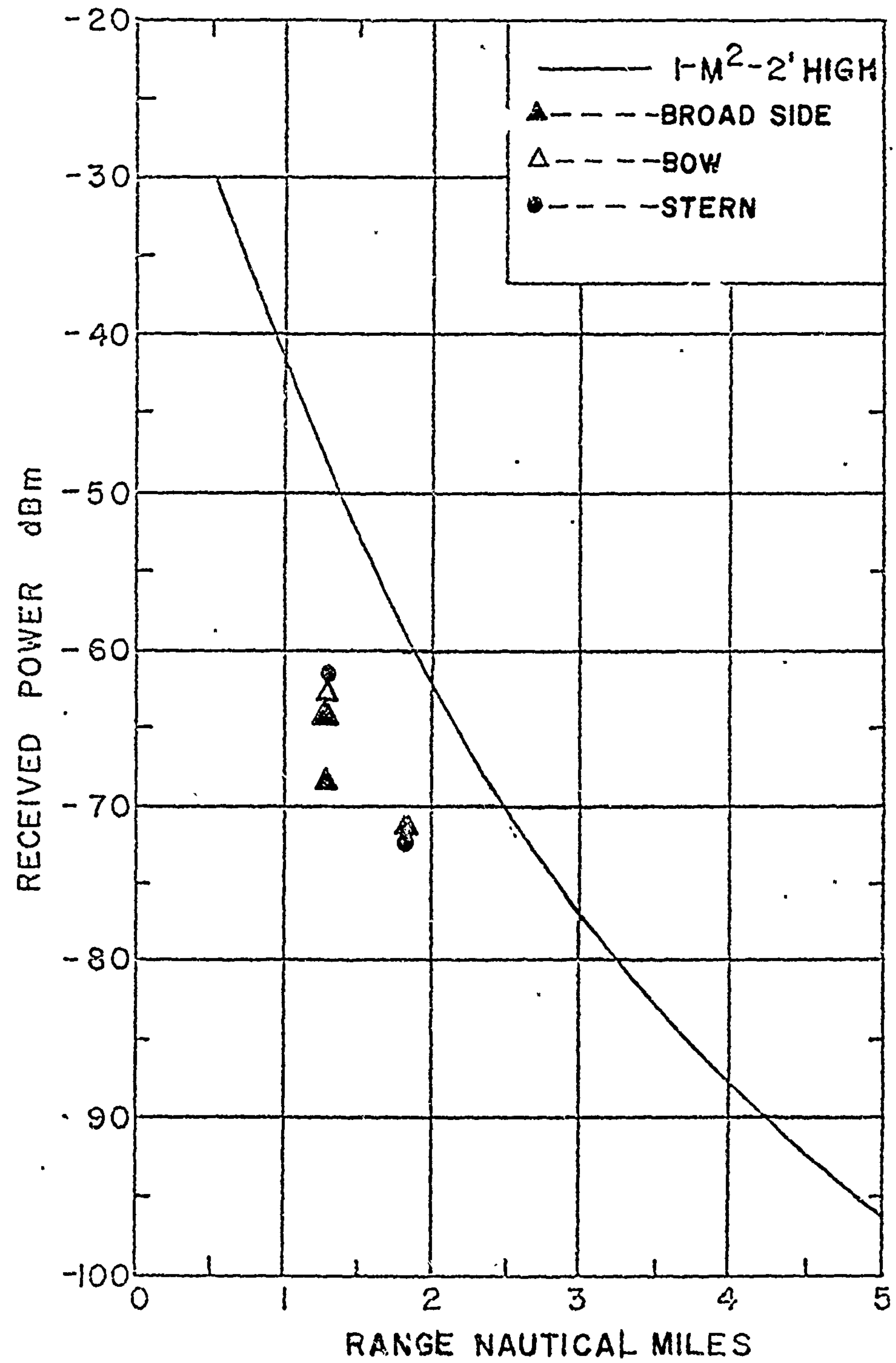

Figure 24. Received powe1 as a function of range from the AN/APS-119 from a 14-ft boat, containing 2 men.

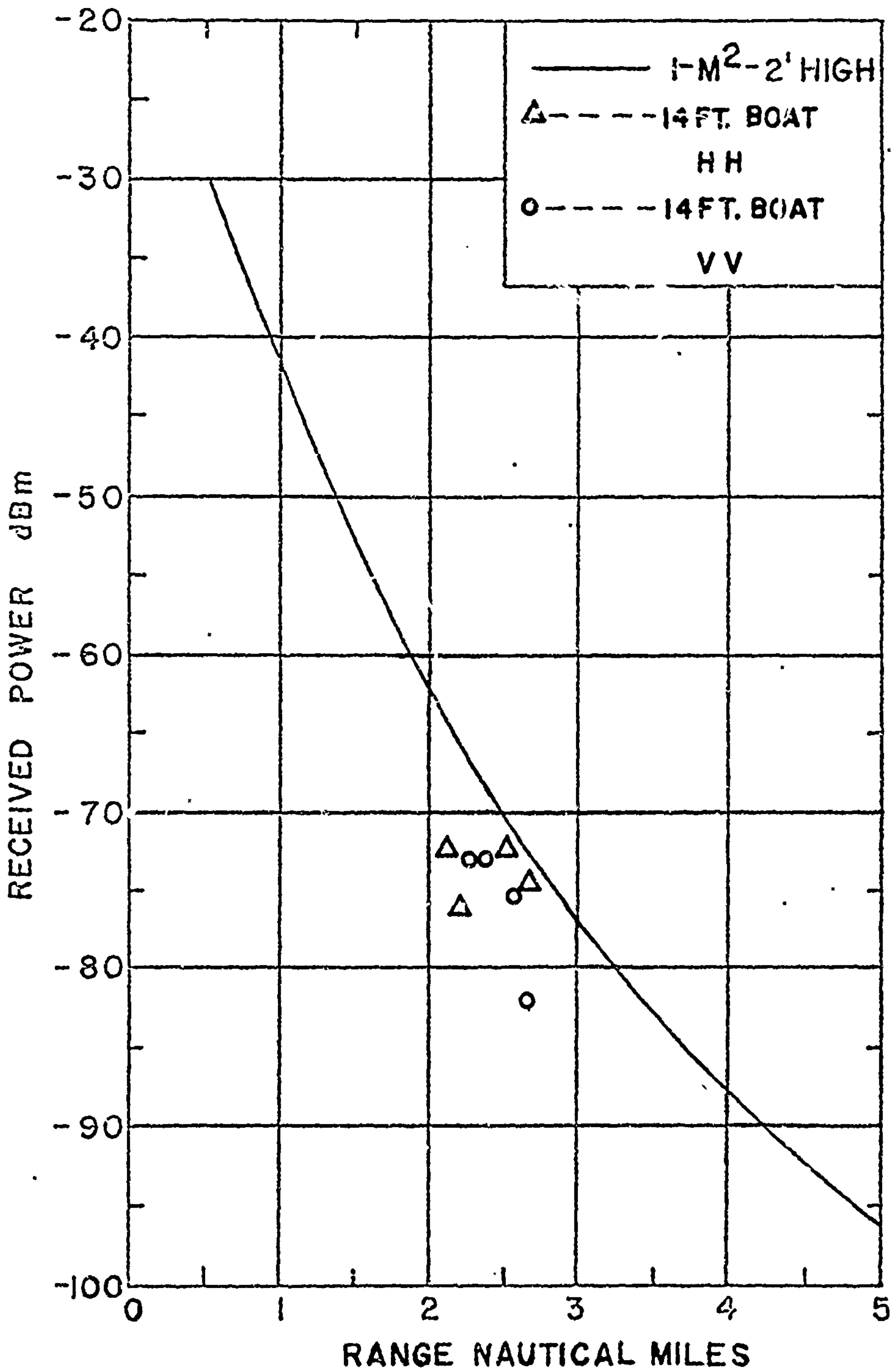

Figure 25. Received power from a 14-ft boat as a function of range for 0.2 and 0.4 μsec pulse lengths with the AN/APS-119, and VV and HH polarizations.

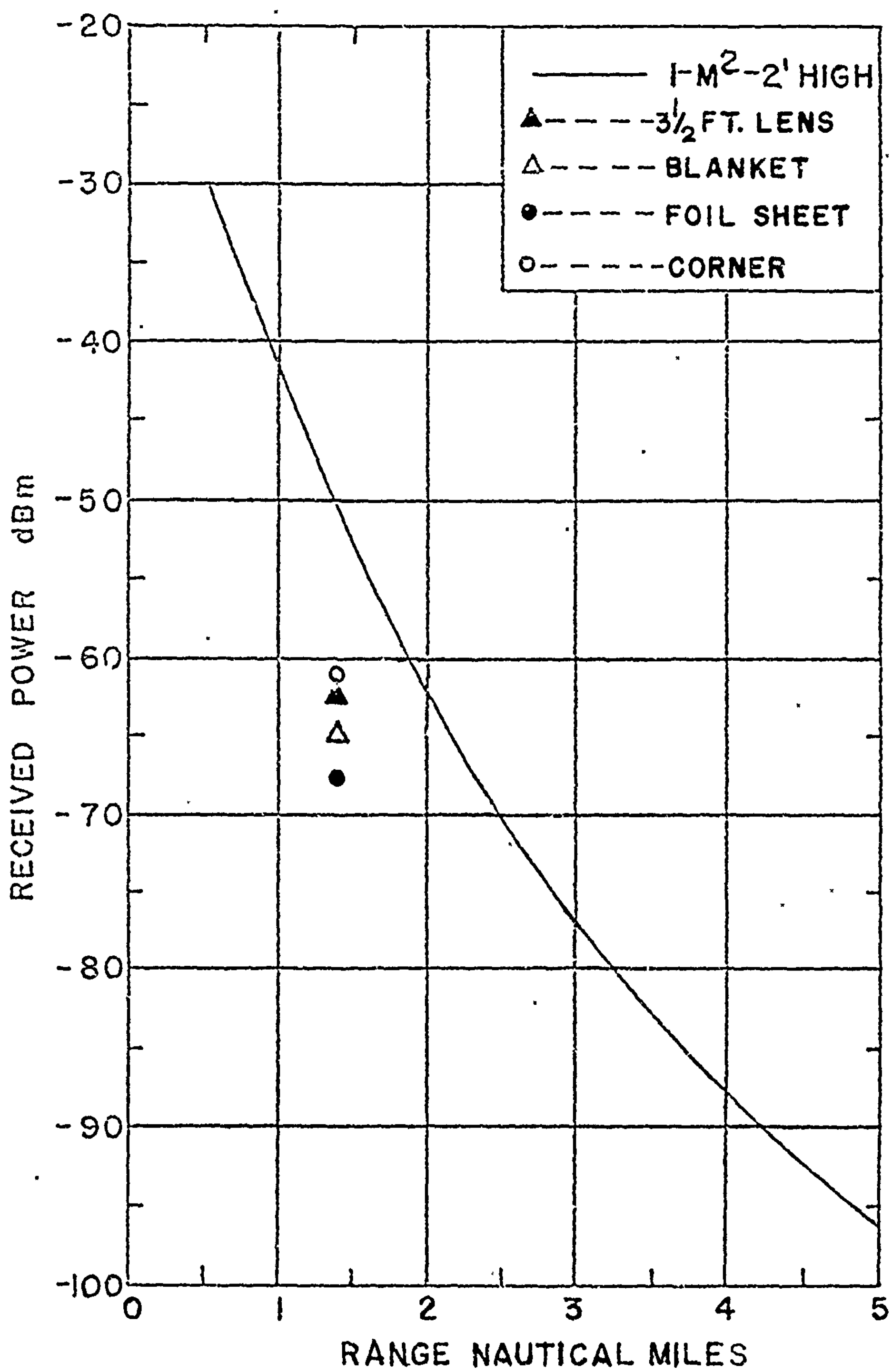

Figure 26. Received power from a 14-ft. boat broadside containing 2 men plus various RCS augmenting devices as a function of range from the AN/APS-119.

enough out of the water to be properly illuminated and therefore contributed little to the overall cross-section. Likewise, the corner reflector and lens which were held chest-high did better but were still not high enough to be fully illuminated. Subjectively, it was concluded that a good way for augmenting the cross-section of a small boat would be by means of a corner reflector or lens mounted some 10 ft high on a pole.

C. Sea-Return Measurements

Measurements of the received power from sea return and σ^o were performed throughout the tests to verify predictions made for the APS-119 radar and to determine the effect of polarization on sea return. It should be noted that the indicated polarization of the radar was determined to be labeled incorrectly during all of the ground tests, so that the recorded polarization on all of the data had to be transposed before it was analyzed.

Figures 27 and 28 give cumulative probability distributions of the received power from sea return at range intervals of 0.5 nmi recorded on 27 November 1972. The data were taken with the optimum radar mode i.e., 0.2 μsec pulse width, 1.8 kHz prf, and 240 scans/min. scan rate. The data in Figure 27 were recorded with vertical polarization and those in Figure 28 with horizontal polarization. The distribution for each range interval, in general, should not cross distributions for other ranges. The fact that this happens in several instances illustrates the nonuniformity of sea clutter, but may also be due to the presence of antenna sidelobe returns at certain ranges.

Density plots such as those illustrated in Figures 27 and 28 can be used to calculate values for σ^o, the average radar cross-section per unit area of the sea surface by recalling that

$$\sigma^o = \frac{RCS}{A}, \qquad (1)$$

where RCS is the average radar cross-section of the sea surface in dBsm, A is the area of the radar cell in m^2, and

$$RCS = P_r + RC - 30 \log_{10} (R), \qquad (2)$$

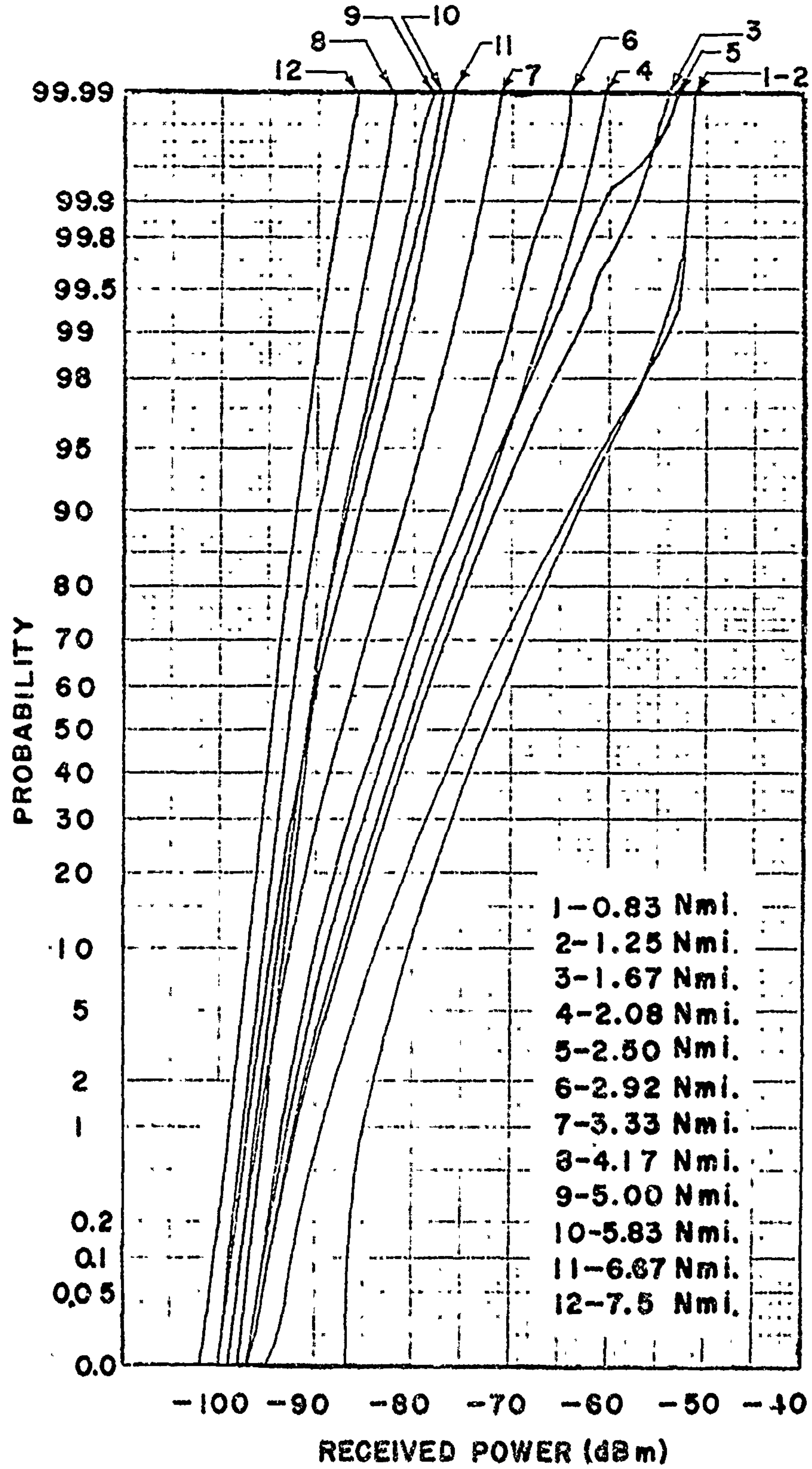

Figure 27. Cumulative probability distributions of received power from sea return at 0.5 nmi intervals; VV polarization, 0.2 μsec pulse length,1.8 kHz prf.

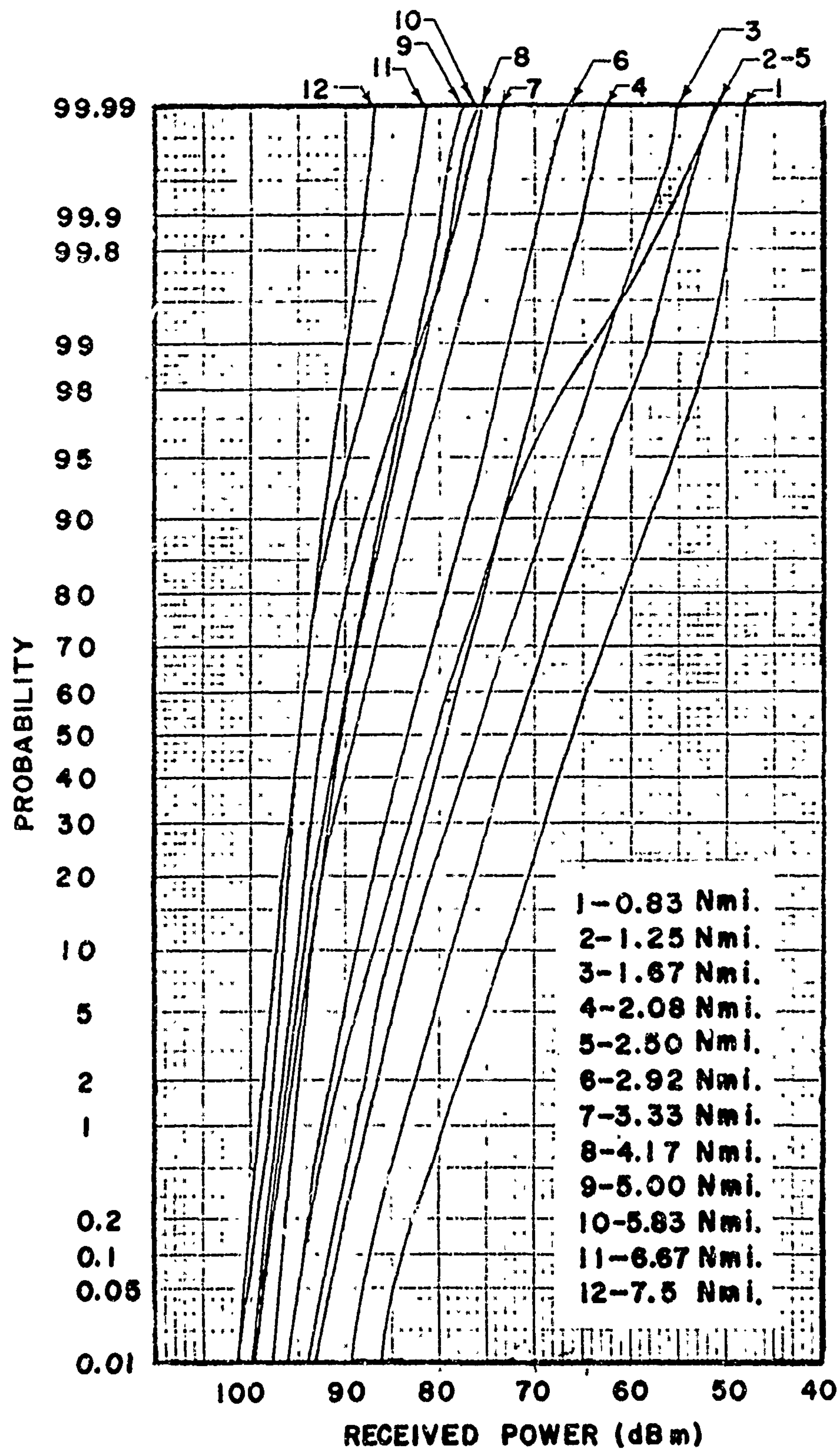

Figure 28. Cumulative probability distributions of received power from sea return at 0.5 nmi intervals; HH polarization, 0.2 μsec pulse length, 1.8 kHz prf.

where

P_r is the average received power in dBm,

RC is the received power at 1 nmi from a $1m^2$ cross-section target, in $dBm/m^2/nmi$

R is the range (normalized to 1 nmi),

and

$$A = \frac{\theta_a R \tau C}{2\sqrt{2}} \cos E, \tag{3}$$

where

θ_a is the azimuth beam width in radians,

R is range in meters,

τ is the pulse width in seconds,

C is the speed of light in meters/second, and

E is the grazing angle ($\cos E \sim 1$ for grazing angles less than 1^o) [13].

In order to calculate σ^o, the received power is determined by taking the 90% point from the cumulative probability distribution for each range. Equation 1 is then used to calculate σ^o for that range. The values for σ^o can then be used as inputs into the radar detection model [5].

Figure 29 shows measured values of σ^o obtained with the AN/APS-119 radar at Wildwood, N. J., in comparison with predicted values for horizontal polarization for three different sea states [14]. Data taken on 30 November 1972 and 6 December 1972 match the predicted curves for Sea State 2. Weather conditions for those days--cloudy, 15-17 knot winds, 2 ft estimated wave height--tend to substantiated a State 2 sea. Thus, for those days the

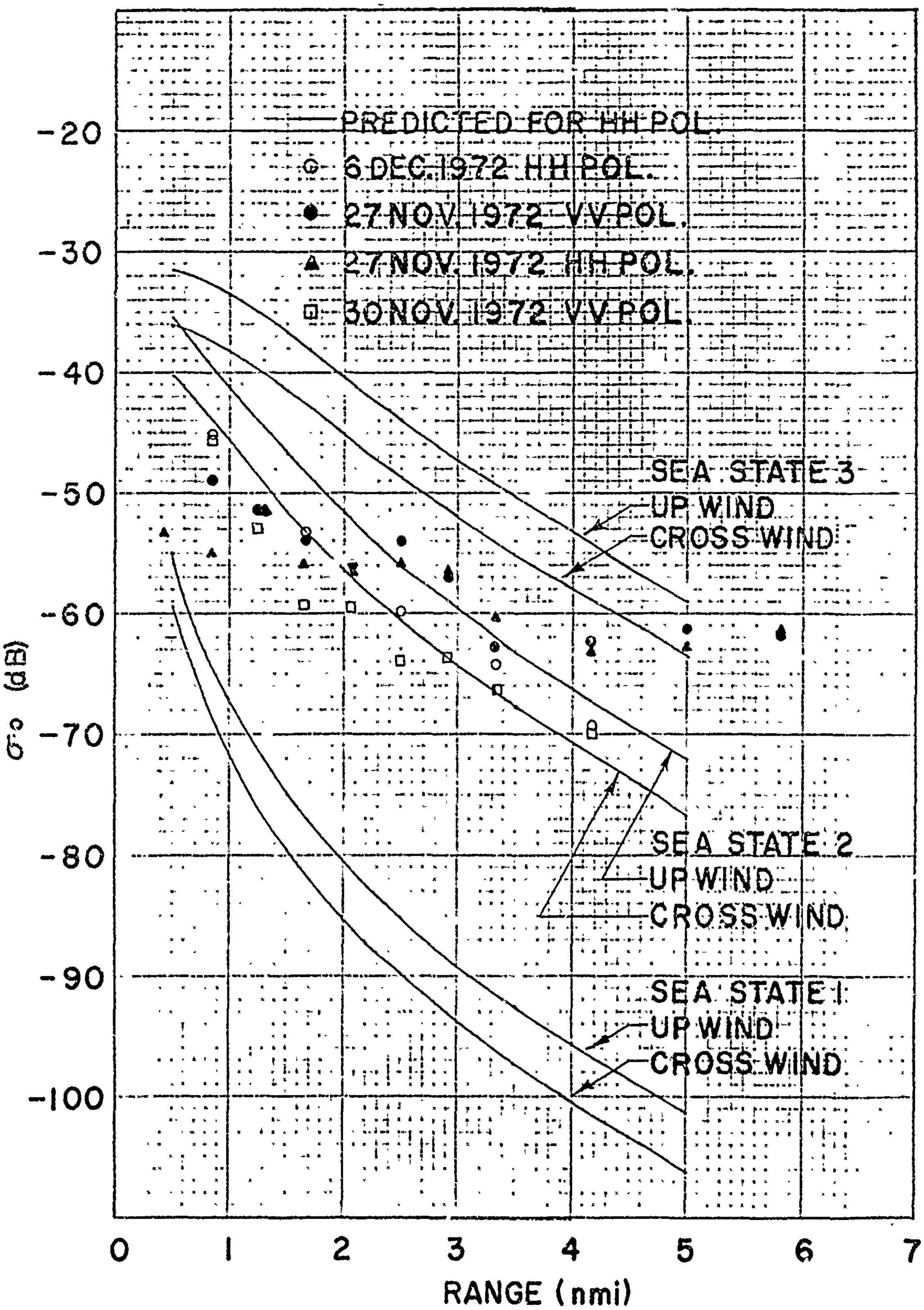

Figure 29. Predicted and measured values of σ^o versus range for the AN/APS-119 radar. Predictions are for HH polarization, 0.2 μsec pulse length, 1.8 kHz prf.

predictions seem to be accurate. (Note, σ^o in general is sensitive to polarization as well as grazing angle; however, horizontal and vertical measurements are similar here because of the particular sea state region [15,16]. For the measurements taken on 27 November 1972, the curves were not predictive. Once again weather conditions were such as to indicate a State 2 sea. Yet the measured data indicated that σ^o increased beyond a range of 3 miles rather than decreasing as expected. The obvious explanation is that ducting was taking place, although, since the temperature and humidity data required to predict ducting were not available, this cannot be stated with certainty. If the 27 November data deviation was due to ducting, then it would appear that the sea-return model can correctly predict sea return for moderate seas and normal propagation conditions.

D. Determination of the "Best" Operating Mode

Prior to the ground tests, plans were made to conduct exhaustive tests to determine the optimum parameters to maximize the detection performance of the AN/APS-119 radar. Such tests were to utilize the artificial signal-generator target to determine the MDS for different radar modes and clutter environments. Unfortunately, time did not permit these experiments to be completed, so that quantitative data on the different modes was not obtained. However, several radar operators spent many hours operating the radar in different modes, and it was the consensus of these operators that, of the available operational modes, the radar mode consisting of 0.2 μsec pulse width, 1.8 kHz prf, 240 scans/min scan rate appeared to be the best.* Since this result corresponds to the best mode from a theoretical standpoint, it assumed to be valid.

E. Flight Test Predictions

Predictions for MDS as a function of aircraft altitude, signal-to-background ratio, pulse length, sea state, and wind direction for the AN/APS-119 radar were prepared in order to aid the Flight Test Director in planning for the AN/APS-119 flight tests [7]. These predictions assume a $1 m^2$

---

*The 0.1 μsec pulse width, 300 scans/min scan rate mode was not working during the tests.

cross-section buoy at a height of two feet as a target, and are based on propagation and sea clutter models previously developed under other contracts. [5,14,15,18] The measurements of MDS and clutter returns made for the AN/APS-119 radar during the ground tests were used to adjust the model parameters so as to accurately describe the detection capabilities of the radar. These predictions are given in Figures 30-44.

As an example of the use of the predictions, referring to Figure 30, if the aircraft has a height of 500 feet and the radar antenna is looking upwind (0°), for a 0.1 μsec pulse length and Sea State 1, the minimum range for a 50% probability of detection (MDS) is 2 nmi. while the maximum range is 10.5 nmi. Referring to Figure 31, under similar conditions except for Sea State 2, the minimum range would be 5.5 nmi. and the maximum range 10.6 nmi. In general, these predictions show that small target detection is limited by sea clutter at close ranges and noise at the long ranges. Also, Figure 32 illustrates that for Sea State 3, the target would not be detectable at all from a 500 foot aircraft height.

In a like manner the prediction can be used to determine the maximum and minimum ranges for either 50% or 80% probability of detection for different aircraft heights, pulse lengths, wind directions, and sea states.

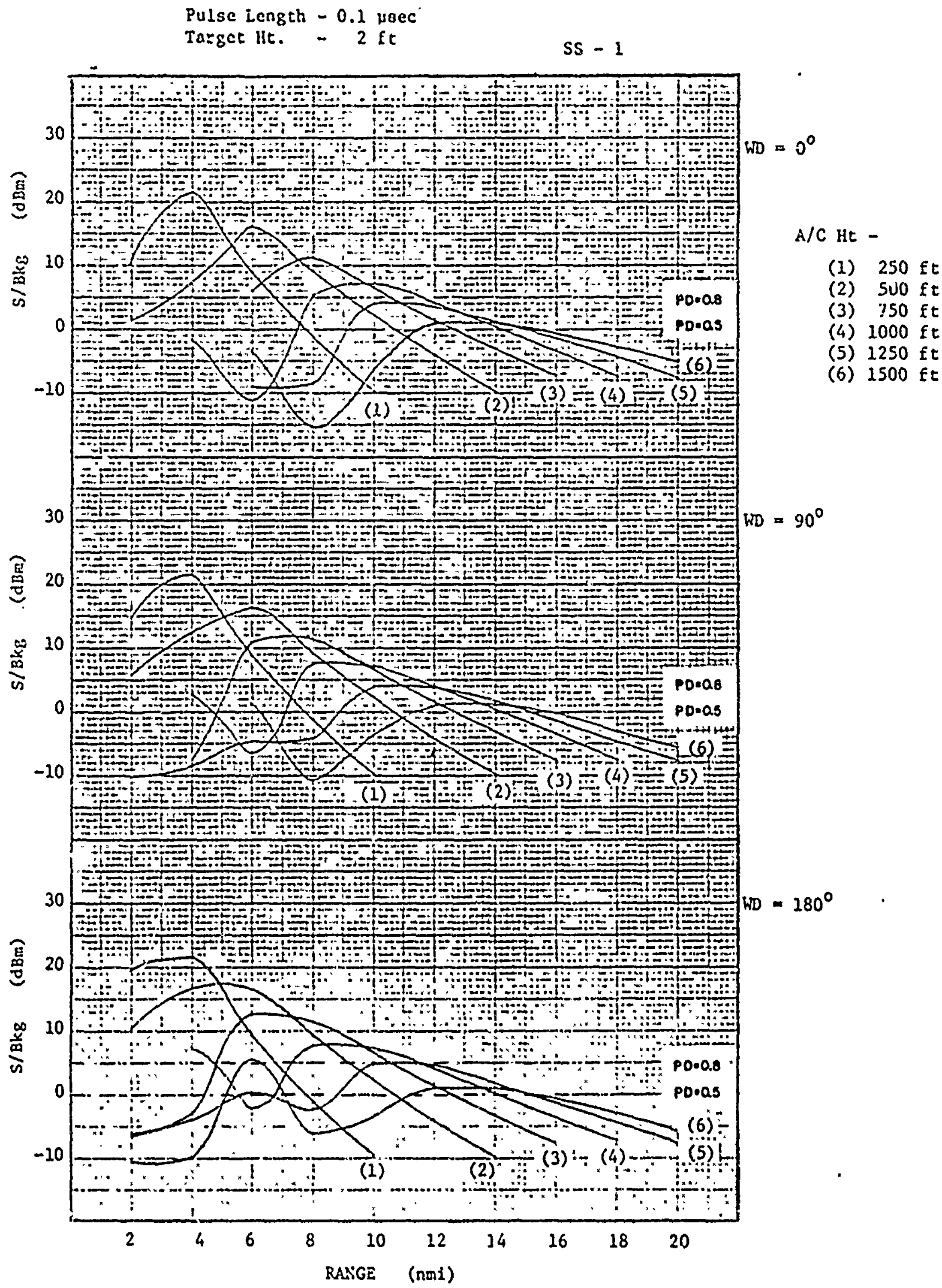

Figure 30. Predicted signal-to-background ratio for the AN/APS-119 radar as a function of range and aircraft height; 0.1 μsec pulse length, Sea State 1.

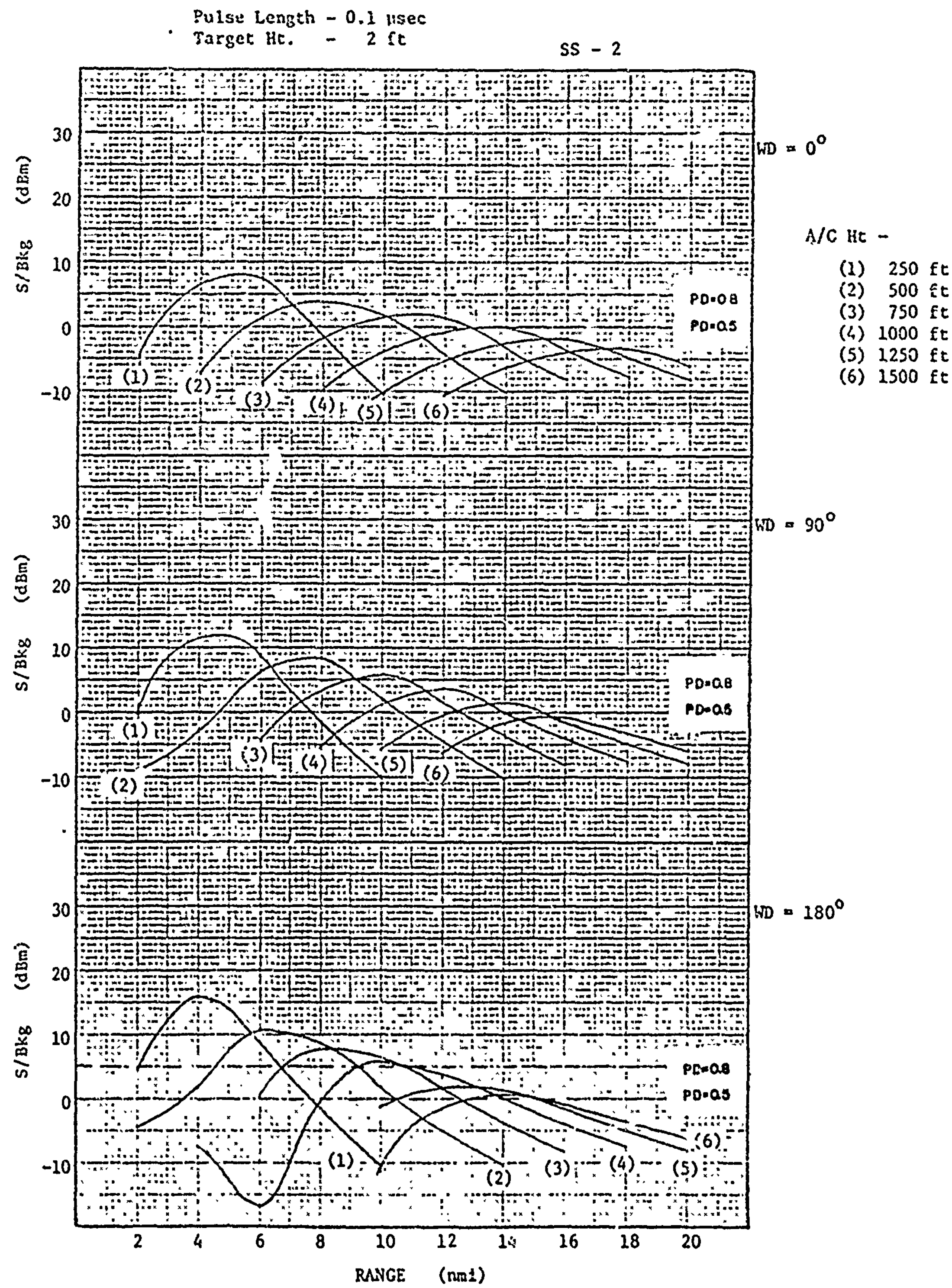

Figure 31. Predicted signal-to-background ratio for the AN/APS-119 radar as a function of range and aircraft height; 0.1 µsec pulse length, Sea State 2.

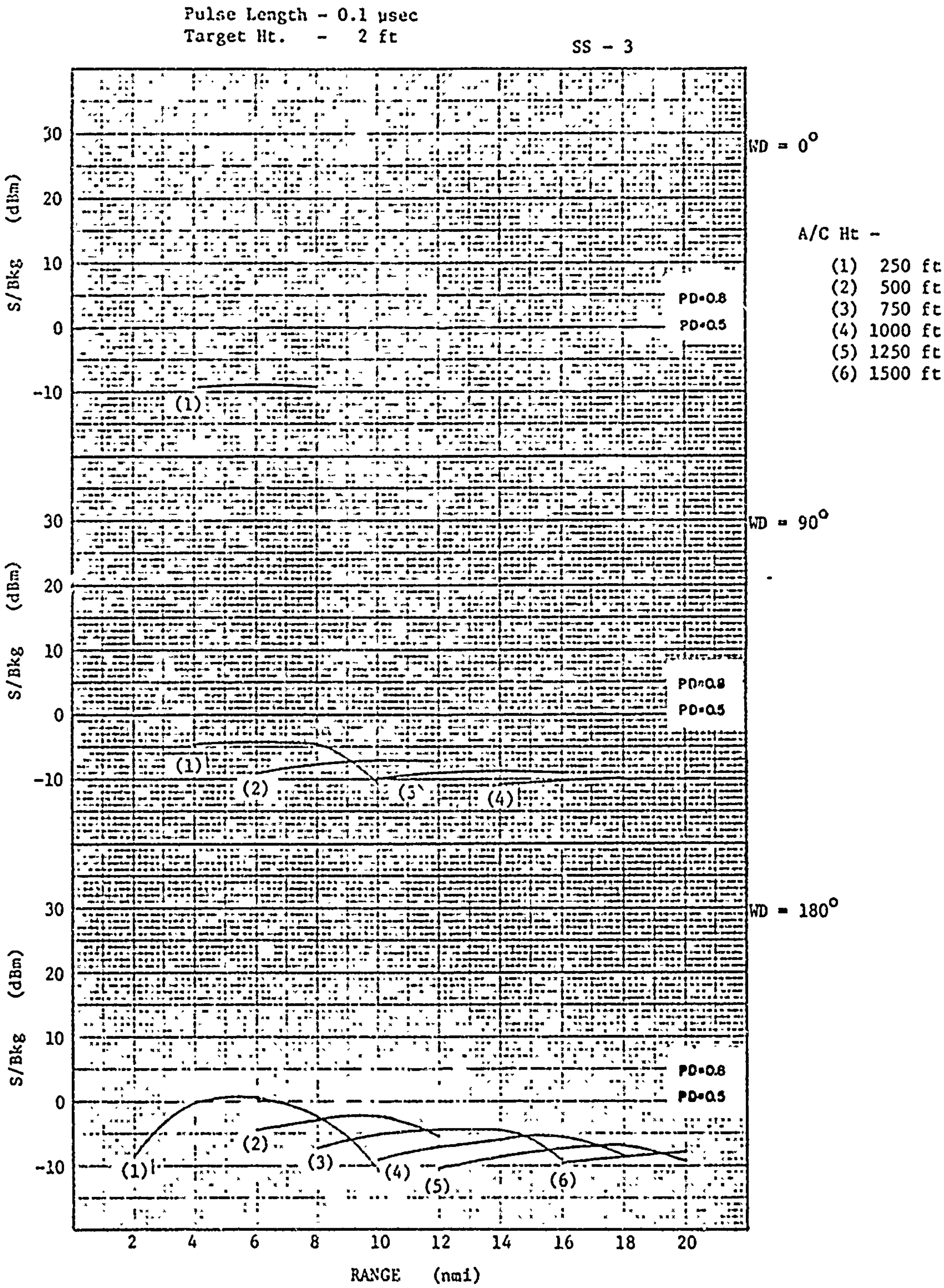

Figure 32. Predicted signal-to-background ratio for the AN/APS-119 radar as a function of range and aircraft height; 0.1 μsec pulse length, Sea State 3.

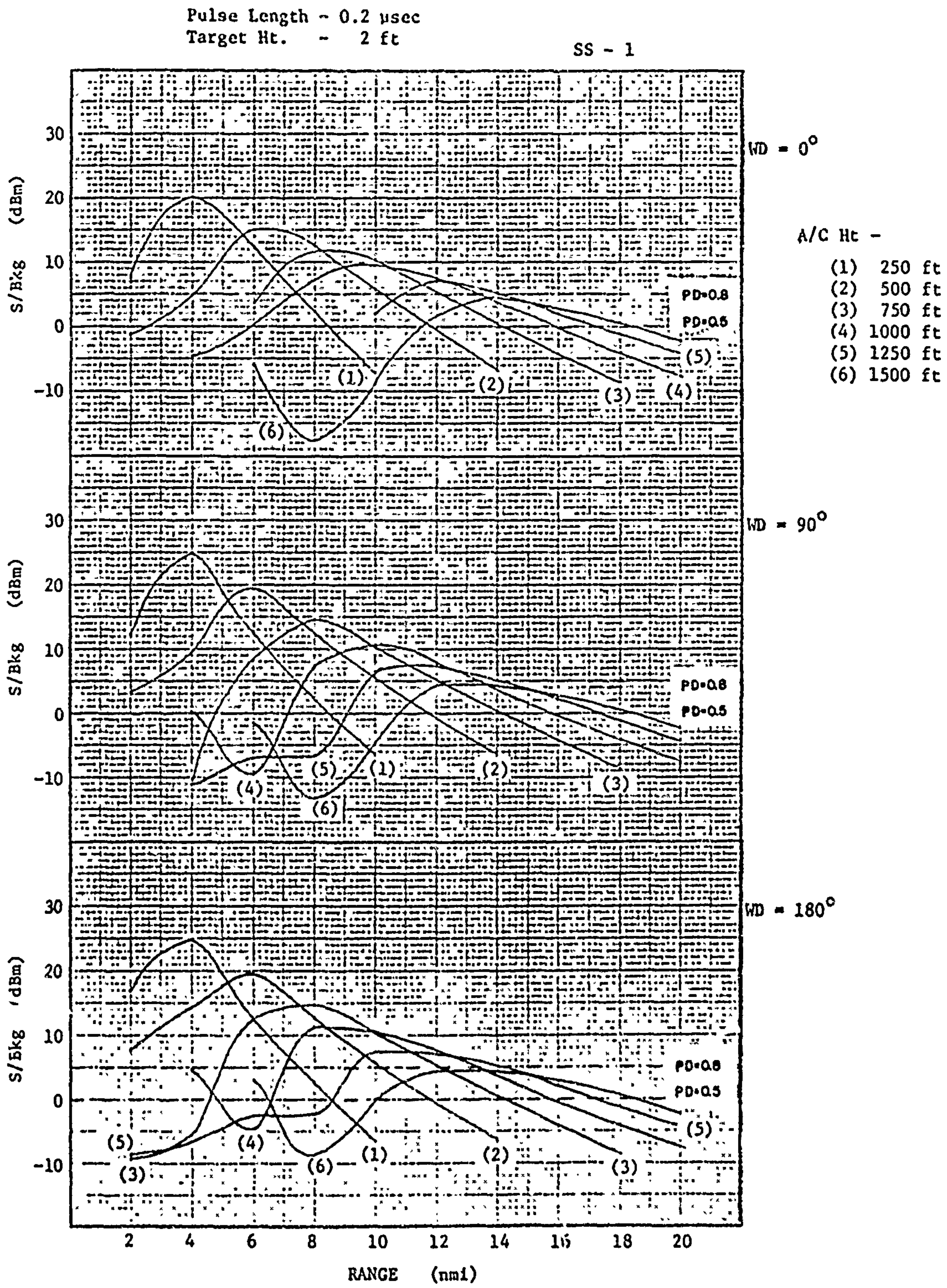

Figure 33. Predicted signal-to-background ratio for AN/APS-119 radar as a function of range and aircraft height; 0.2 μsec pulse length, Sea State 1.

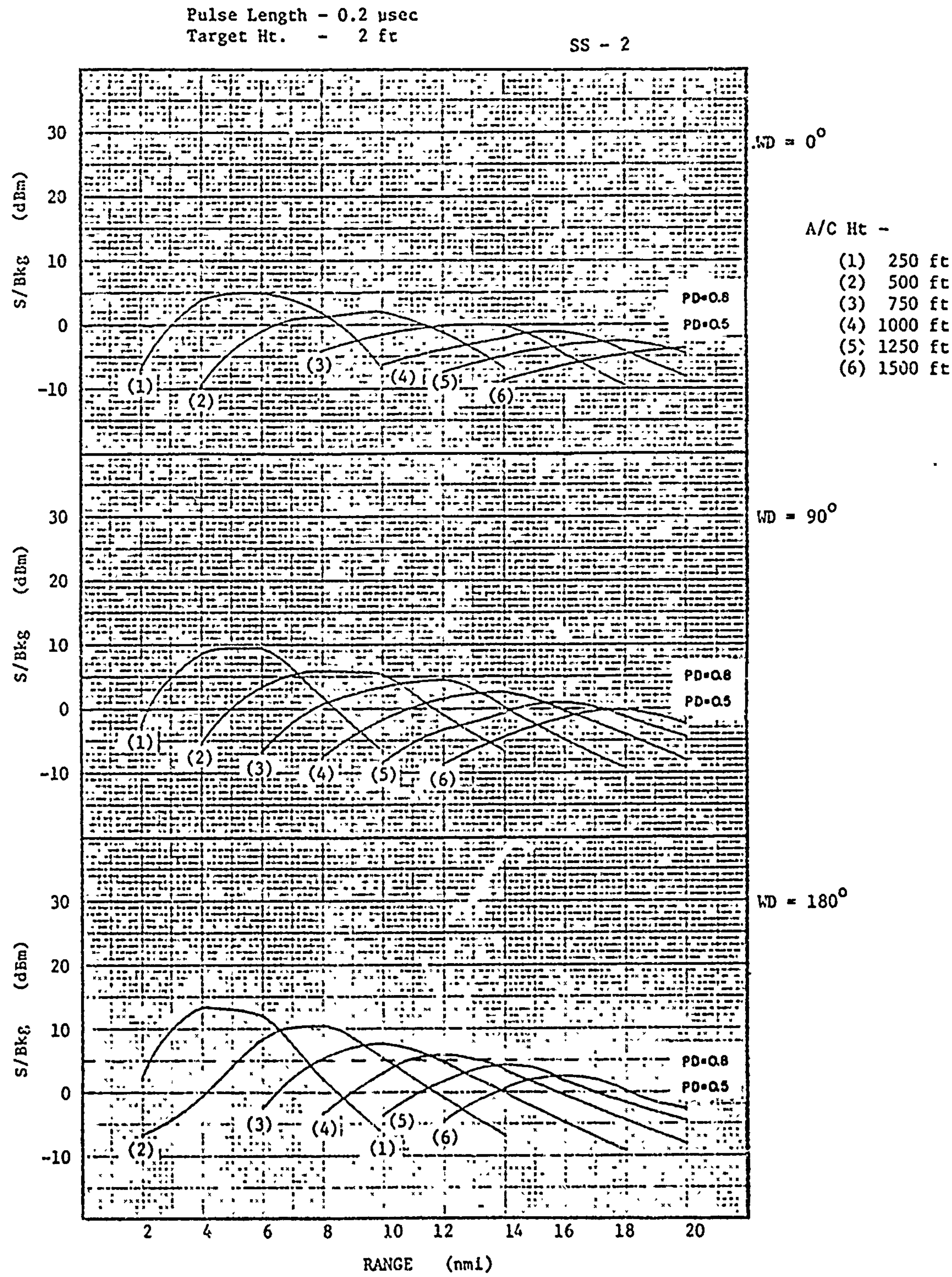

Figure 34. Predicted signal-to-background ratio for the AN/APS-119 radar as a function of range and aircraft height; 0.2 μsec pulse length, Sea State 2.

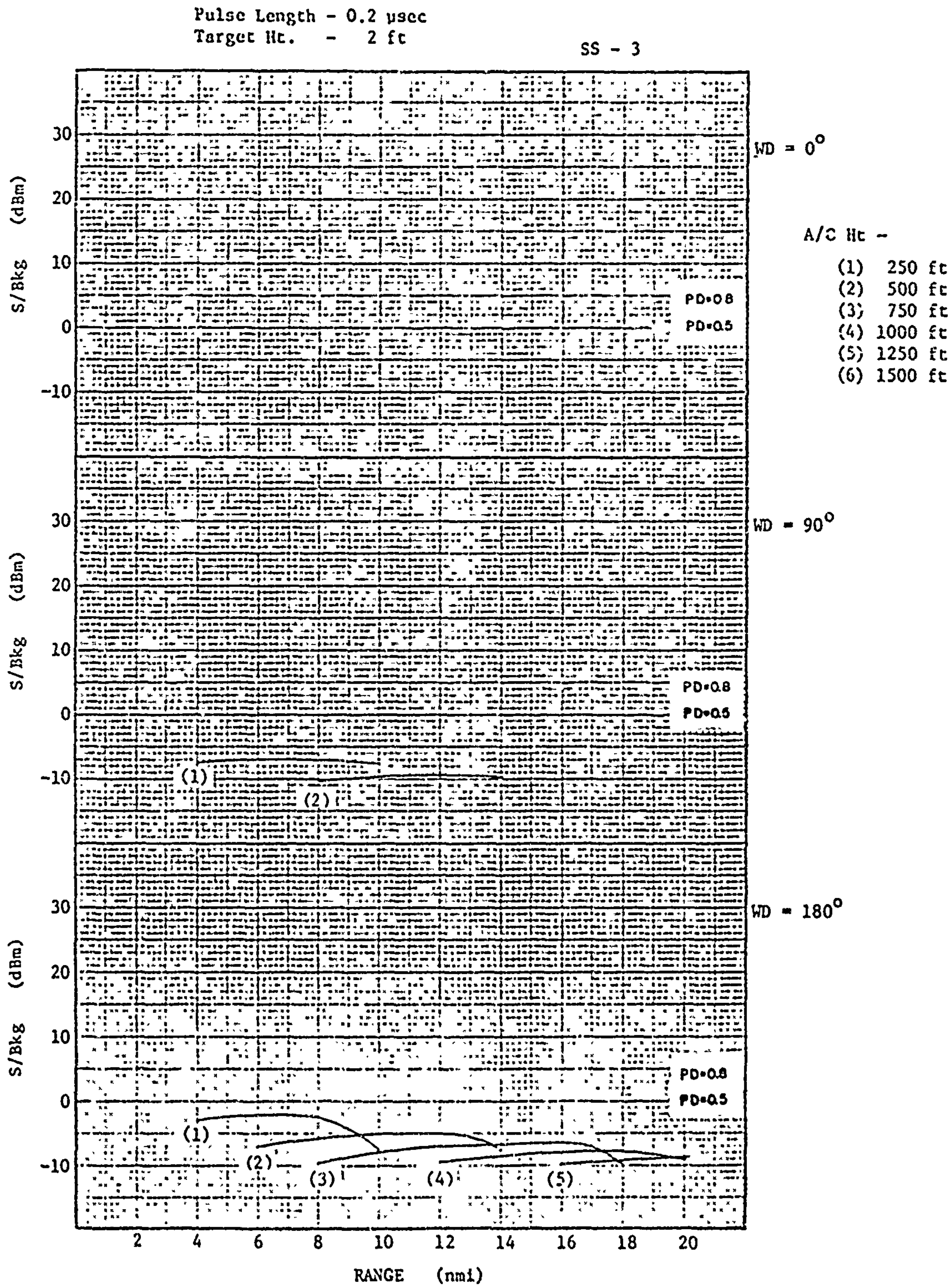

Figure 35. Predicted signal-to-background ratio for the AN/APS-119 radar as a function of range and aircraft height; 0.2 μsec pulse length, Sea State 3.

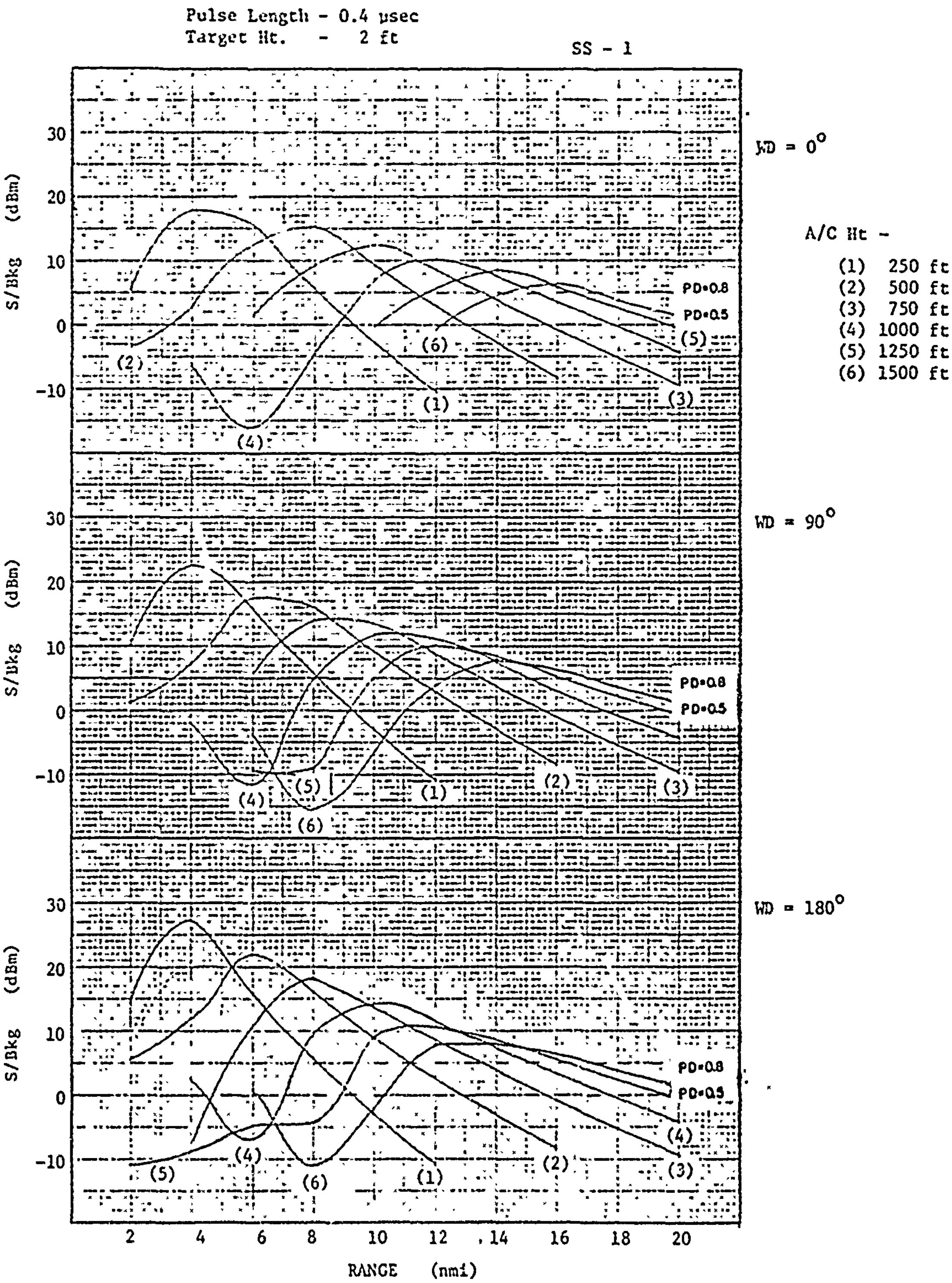

Figure 36. Predicted signal-to-background ratio for the AN/APS-119 radar as a function of range and aircraft height; 0.4 μsec pulse length, Sea State 1.

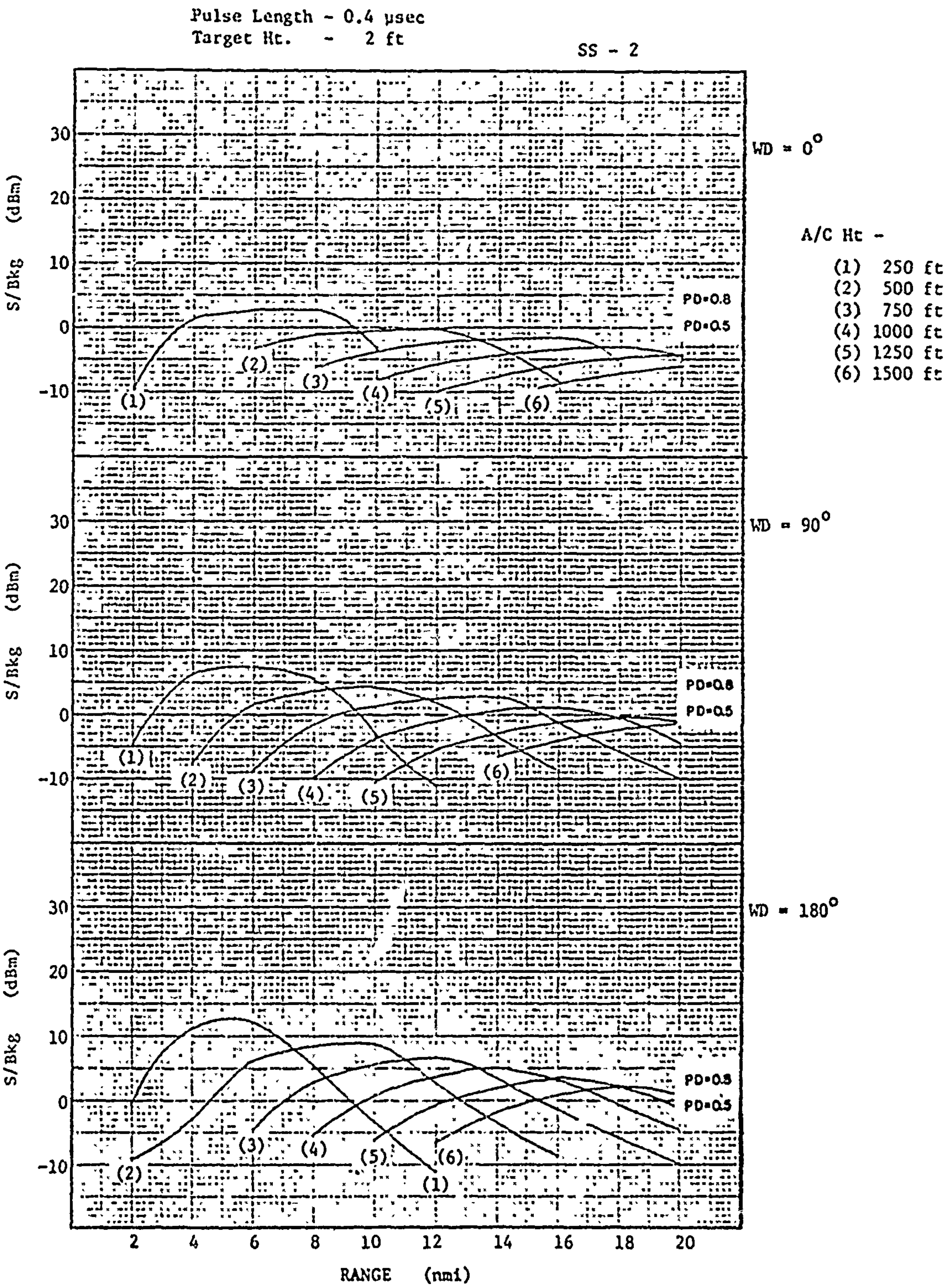

Figure 37. Predicted signal-to-background ratio for the AN/APS-119 radar as a function of range and aircraft height; 0.4 μsec pulse length, Sea State 2.

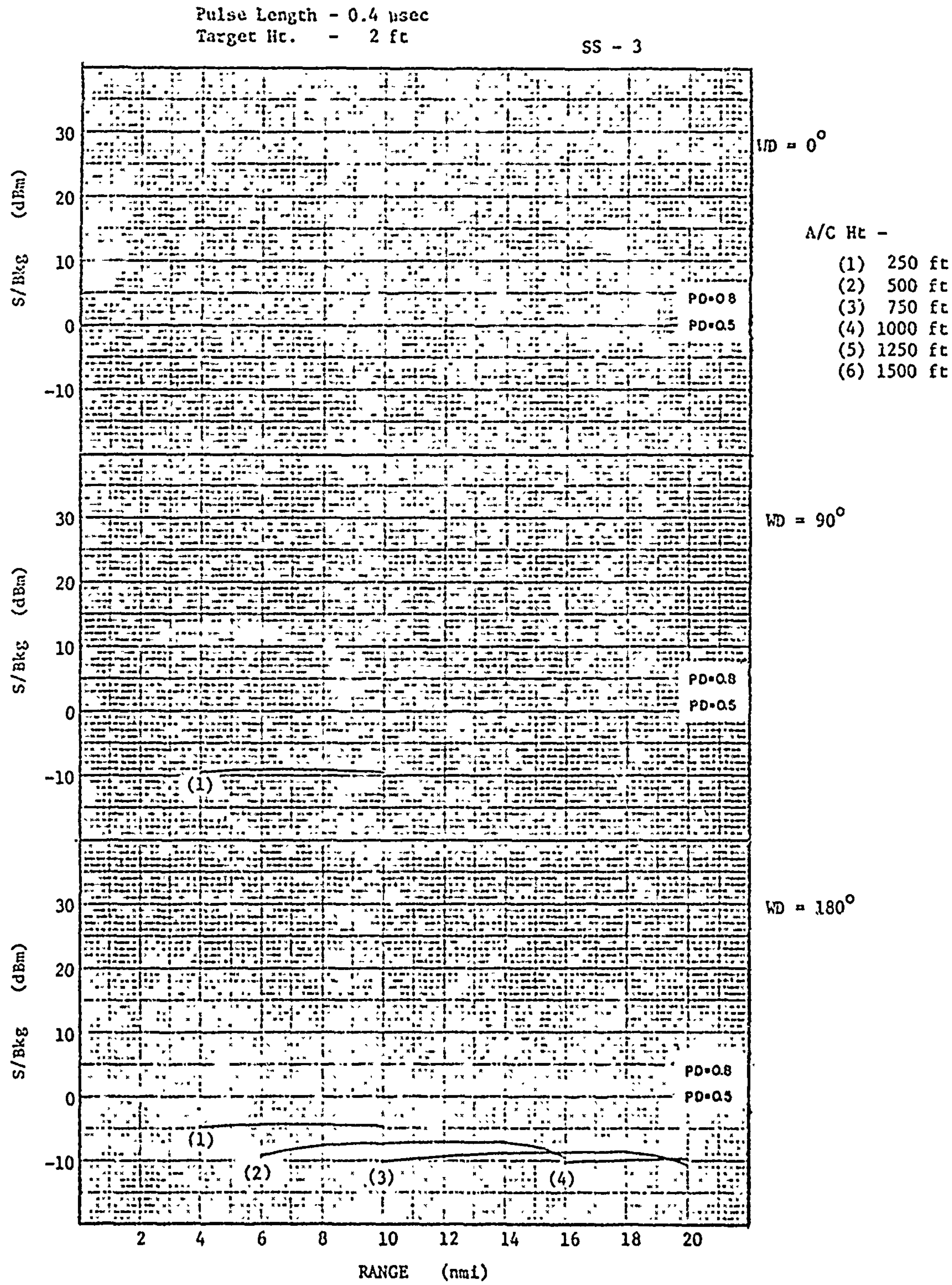

Figure 38. Predicted signal-to-background ratio for the AN/APS-119 radar as a function of range and aircraft height; 0.4 µsec pulse length, Sea State 3.

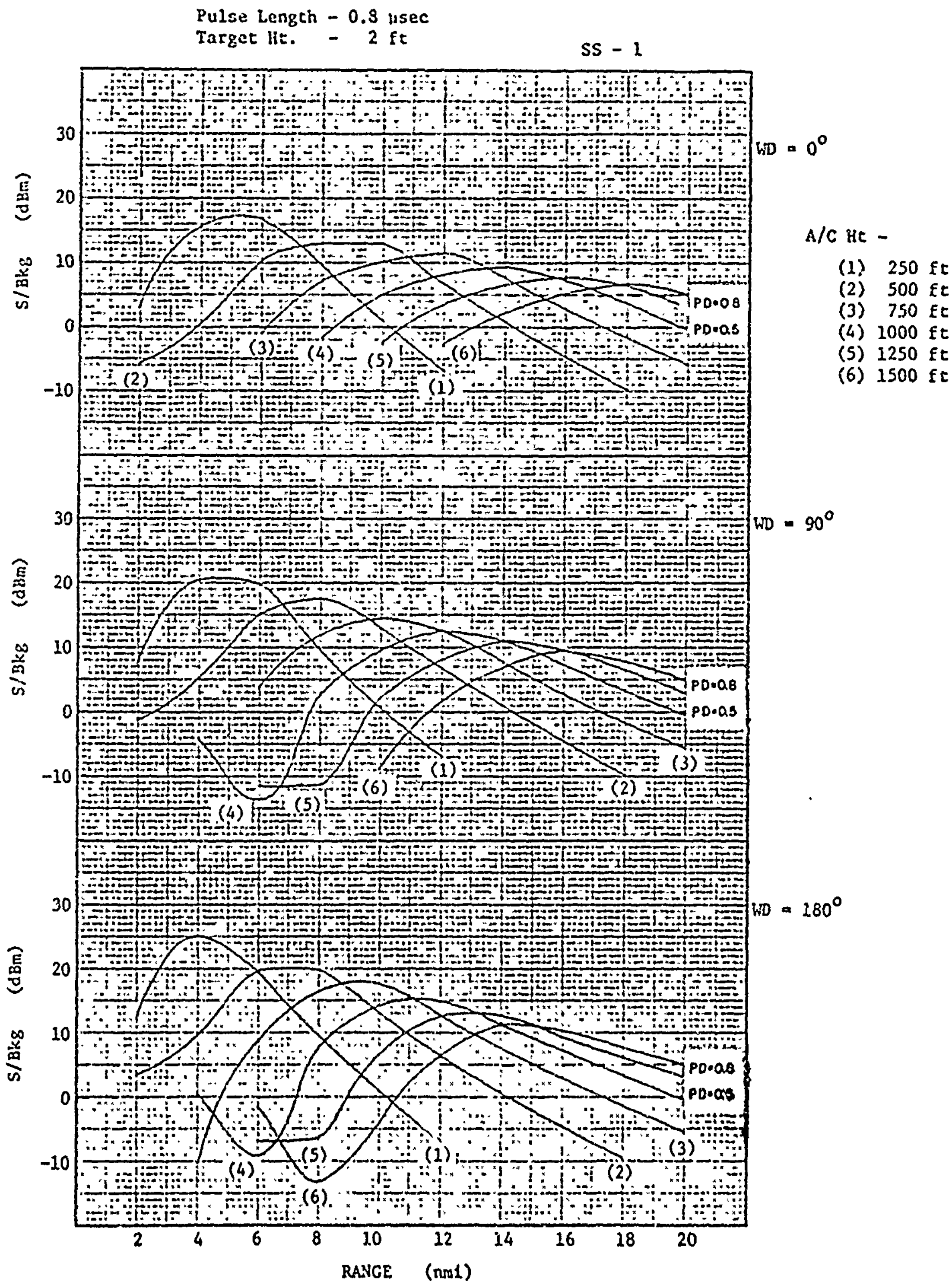

Figure 39. Predicted signal-to-background ratio for the AN/APS-119 radar as a function of range and aircraft height; 0.8 μsec pulse length, Sea State 1.

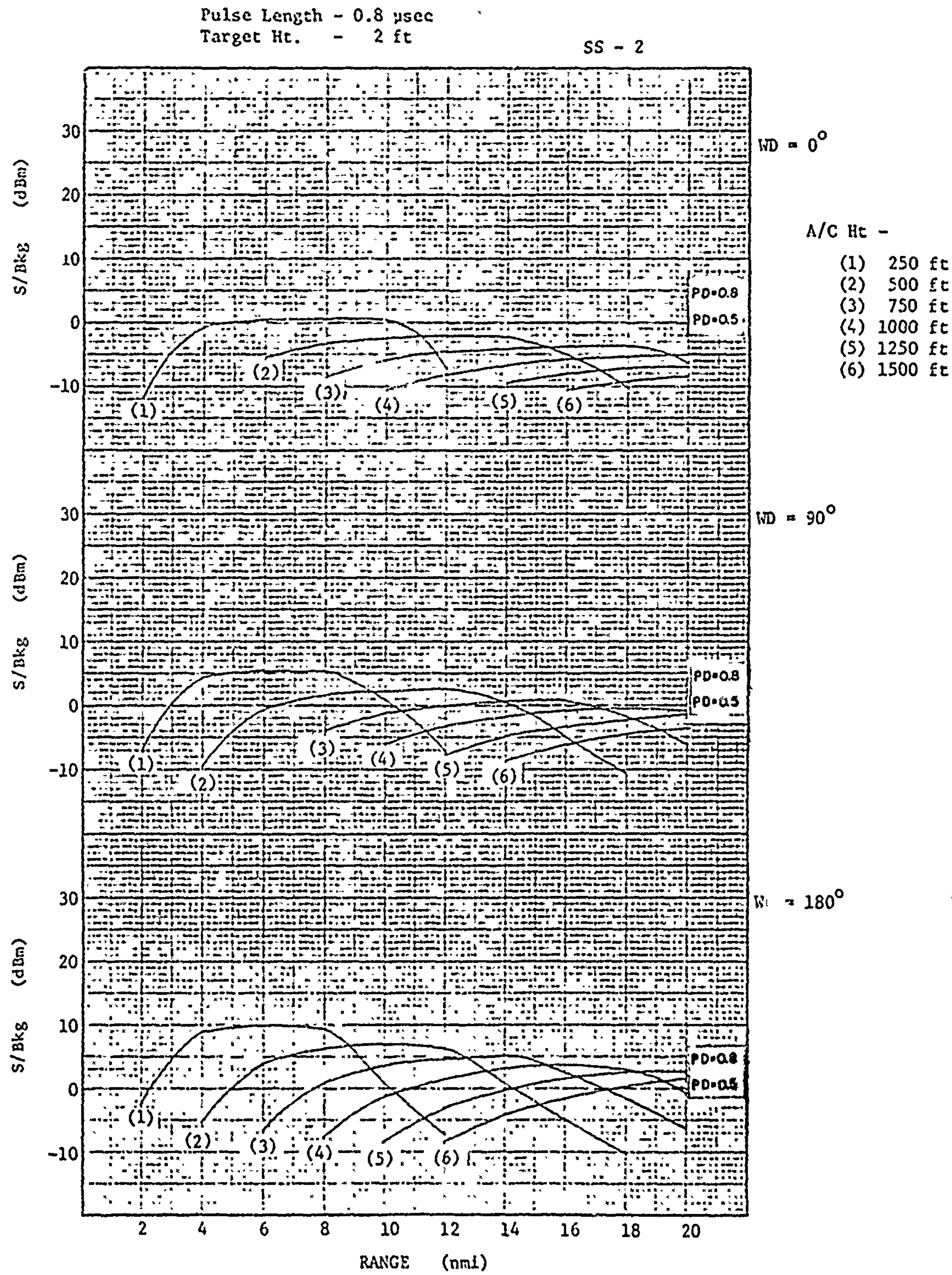

Figure 40. Predicted signal-to-background ratio for the AN/APS-119 radar as a function of range and aircraft height; 0.8 μsec. pulse length, Sea State 2.

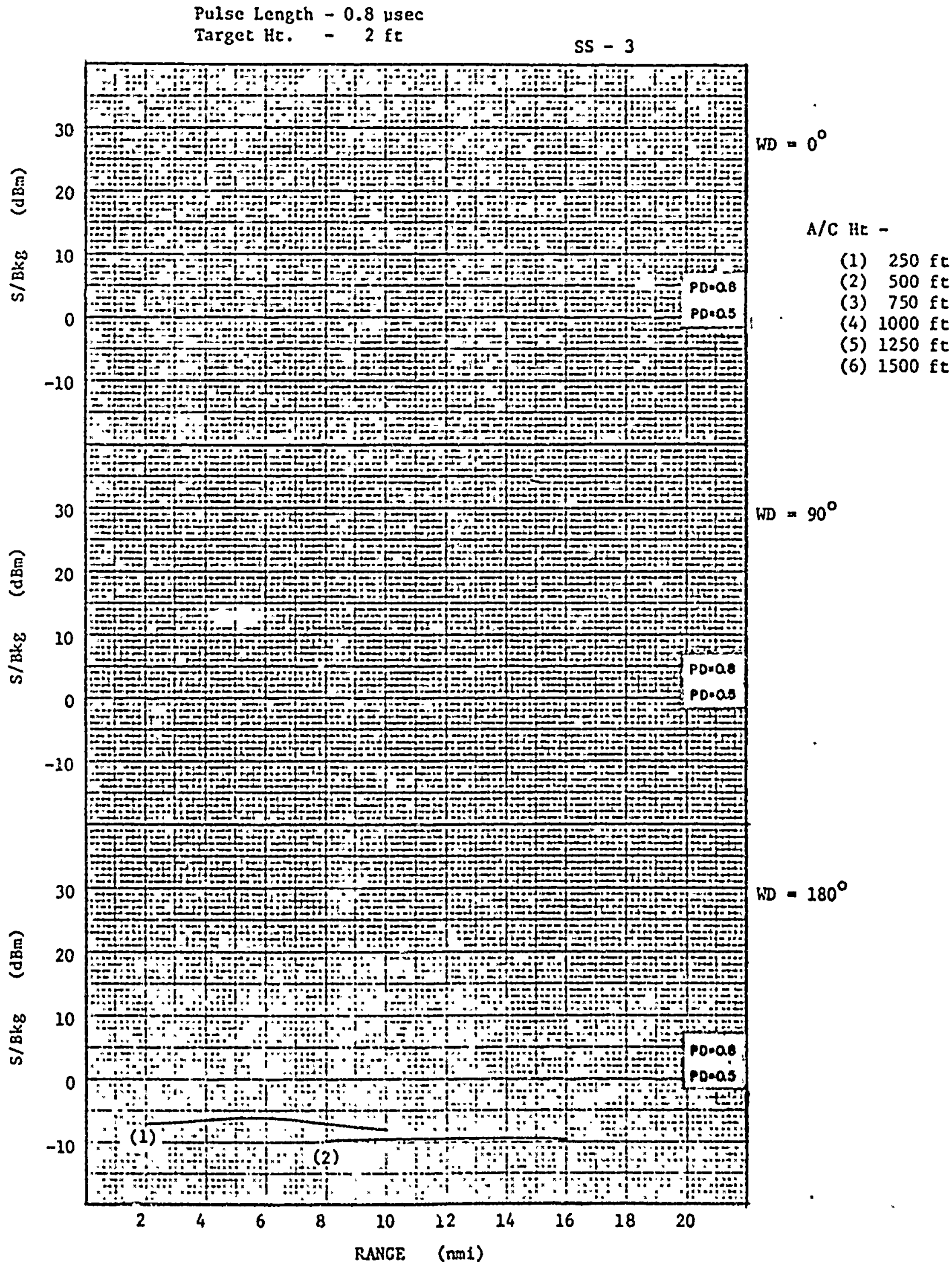

Figure 41. Predicted signal-to-background ratio for the AN/APS-119 radar as a function of range and aircraft height; 0.8 μsec pulse length, Sea State 3.

IV. REFERENCES

1. F. B. Dyer, "Preliminary Report on the Results of the Shore Tests at Wildwood, N. J. of the APS-119," Memorandum Report (letter) on DOT-CG-04132-A, Engineering Experiment Station, Georgia Institute of Technology, 10 August 1972.

2. W. Rivers, "Testing of the APS-119 Search and Rescue Radar," Memorandum Report (letter) on DOT-CG-04132-A, Engineering Experiment Station, Georgia Institute of Technology, 29 November 1971.

3. W. Rivers, "Testing of the APS-119 at Wildwood, N. J.," Memorandum Report (letter) on DOT-CG-04132-A, Engineering Experiment Station, Georgia Institute of Technology, 19 January 1972.

4. F. B. Dyer, "Testing of APS-119 Radar at Wildwood, N. J.," Memorandum Report (letter) on DOT-CG-04132-A, Engineering Experiment Station, Georgia Institute of Technology, 10 August 1972.

5. W. K. Rivers and F. B. Dyer, "Radar Detectability Study (U)," Final Report on Contract N00024-70-C-1219, Engineering Experiment Station, Georgia Institute of Technology, 30 July 1971, Secret, Excluded from GDS (formerly Group 3), AD 518 599.

6. F. B. Dyer, "Performance Predictions for the APS-119 Radar," Memorandum Report (letter) on DOT-CG-04132-A, Engineering Experiment Station, Georgia Institute of Technology, 27 June 1972.

7. F. B. Dyer, "Revised Performance Predictions for the APS-119 Radar," Memorandum Report (letter) on DOT-CG-04132-A, Engineering Experiment Station, Georgia Institute of Technology, 16 January 1973.

8. C. L. Pybus, "AN/APS-119 Radar Evaluation," Flight Test Plan No. XR 71-12-9, 4950th Test Wing, ASD, WPAFB, 5 February 1973.

9. F. B. Dyer, "Plan for Shorebased Test of the APS-119 SAR Radar (October-December 1972), Technical Report 1 on DOT-CG-04132-A, Engineering Experiment Station, Georgia Institute of Technology, 9 October 1972.

10. J. L. Reece, "APS-119 Search and Rescue Radar," Flight Test Report, ENE FTR 73-45, 4950th Test Wing, ASD, WPAFB, 22 August 1973.

11. Wayne Rivers, "Low-Angle Radar Sea Return at 3-mm Wavelength," Final Report on Contract N62269-70-C-0489, Engineering Experiment Station, Georgia Institute of Technology, 15 November 1970.

12. ________, "AN/APS-119 Radar System Engineering Report," AIL, Division of Cutler-Hammer, Report 6590-1, August 1972.

13. David K. Barton, Radar System Analysis, Prentice-Hall, Inc., New Jersey, (1964), pp. 96-97.

14. Wayne Rivers, "Aids-To-Navigation Radar Requirements," Technical Report No. 1 on Contract DOT-CG-10657-A, Engineering Experiment Station, Georgia Institute of Technology, 31 January 1971.

15. Wayne Rivers, et al., "Airborne Search Radar Design Study," Final Report on DOT-CG-83, 141 A, Engineering Experiment Station, Georgia Institute of Technology, 20 February 1969, AD 685 911.

16. F. Nathanson, Radar Design Principles, McGraw-Hill, New York, 1969.

17. N. C. Currie and F. B. Dyer, "Methods for Comparison of Clutter Processing Techniques," Technical Report 5 on Contract N00024-68-C-1125, Engineering Experiment Station, Georgia Institute of Technology, February 1971, AD 883 474L.

18. W. K. Rivers, S. P. Zehner, and F. B. Dyer, "Modeling for Radar Detection," Final Report on Contract N00039-69-C-5430, Engineering Experiment Station, Georgia Institute of Technology, 31 December 1969.

V. APPENDICES

APPENDIX A

Description of the AN/APS-119 Radar

This appendix contains a description of the AN/APS-119 radar which was the primary subject of the ground tests at Wildwood, N.J., described in this report.* The major characteristics of the AN/APS-119 system are listed in Table A-I.

The AN/APS-119 is a rapid-scanning search radar system designed for the primary purpose of detecting small targets in heavy seas, and for a secondary purpose of performing navigation and weather-avoidance functions.

Detection in sea clutter is achieved by use of a motion-compensated storage-tube integrator which stores successive looks at targets plus sea clutter for each scan rotation. The sea clutter as a rule substantially decorrelates in this interval, thereby allowing target build-up with respect to sea clutter.

Radar operation can be controlled from either the navigator's station or the radar operator's console. A 10-inch radar display and a 5-inch DVST display are provided at the radar operator's console, while five-inch displays are provided at the navigator's and pilot's stations. A scan converter unit provides radar displays with several selectable range scales between 10 and 160 miles.

The radar system, as shown in Figures A-1 and A-2, consists of eleven major units. (1) The pedestal assembly--located in the radome--contains the antenna, pedestal, vertical reference, and servoamplifiers. (2) The receiver-transmitter assembly located on the Station 93 bulkhead, contains the receiver duplexer and the modulator-transmitter and its power supplies. (3) The synchronizer, located in the overhead equipment rack, contains the system and display timing generators and the video processor. (4) The scan-converter, also located in the overhead equipment rack, contains the display generating equipment. (5) The radar console, located in the cargo compartment, contains the radar operator's displays and control equipment. (6) The navigator's display, located at the navigator's station, contains a radar

*Summarized from "AN/APS-119 Radar System Engineering Test Report," Report No. 6590-1, AIL, Inc., Division of Culter-Hammer.

Preceding page blank

TABLE A-1

AN/APS-119 (SN-1) Characteristics

<u>Transmitter</u>

Frequency	8.5 to 9.0 GHz, tuneable
Power Output	300 W peak, 200 W average
Pulse Width	0.1, 0.2, 0.4, and 0.8 μsec
prf	6.7, 3.4, 1.7, 0.84, and 0.42 kHz
Duty Cycle	6.7×10^{-4} max, 4.2×10^{-5} min.

<u>Antenna</u>

Gain	34 db
Sidelobe Level	-20 db
Beamwidth	2.5° azimuth by 3.7° elevation
Rotation Rate	30, 60, 120, 240, and 300 rpm
Polarization	Vertical, Horizontal, and Circular

<u>Stabilization</u>

Axes	Tilt, Azimuth, Pitch, and Roll
Roll Limits	±30 degrees (at 0 pitch)
Pitch Limits	±15 degrees (at 0 roll)
Tilt Limits	+4 to -12 degrees
Azimuth Look-Angle	230 degrees

<u>Receiver</u>

Local Oscillator		Solid-state with AFC
Mixer		Image rejection, 60 MHz IF output
Noise Figure		8 db
IF Preamp		1.5 db NF, 10 db gain
IF Amplifier:	Bandwidth	1.5/T, matched to pulse width
	Response	Logarithmic
	Dynamic Range	98 db (at max. bandwidth)

<u>Video Processing</u>

Weather Avoidance	Iso-echo with dual threshold
Multiple Range Gate STC	Automatic or manual Gain vs range
Tapped Delay Line FTC	Weighted-sum, zero mean
Video Integration	Dual-gun storage tube

<u>Scan Converter</u>

Storage Tube		Dual-gun, PPI write, raster read
Raster:	Lines	945
	Horizontal Scan Rate	27.000 kHz*
	Vertical Scan Rate	57.143 Hz*
	Frame Rate	28.571*
	Phase Lock*	To primary 400 Hz AC

TABLE A-1

AN/APS-119 (SN-1) Characteristics (Cont.)

Displays

Radar Main	10 inch TV
Radar Auxiliary	5 inch DVST (PPI/B-Scope)
Pilots	5 inch TV
Navigator's	(Interchangeable with Pilot)
Displayed Range	10, 20, 40, 80, or 160 miles

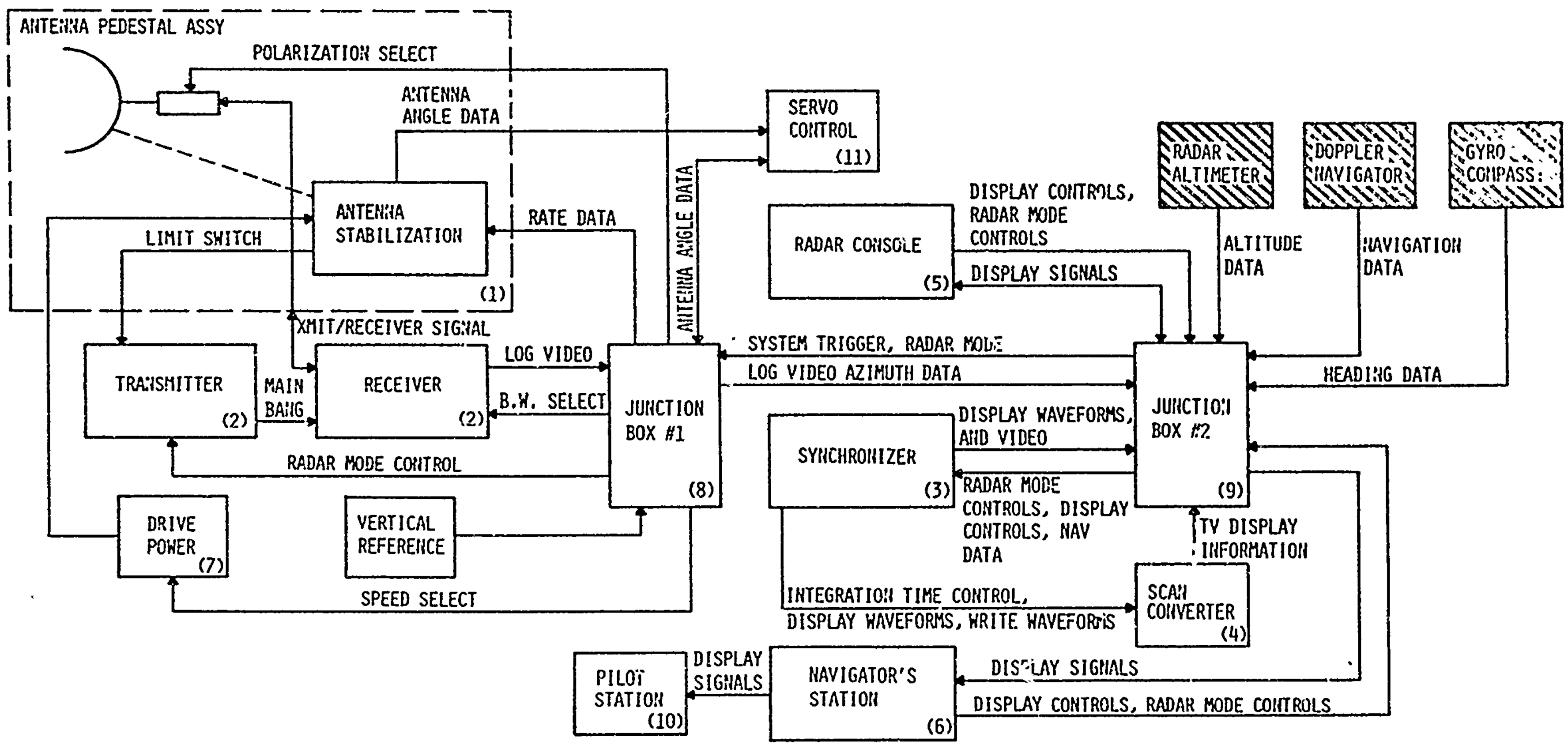

Figure A-1. Block diagram of AN/APS-119 radar system showing the eleven major units.

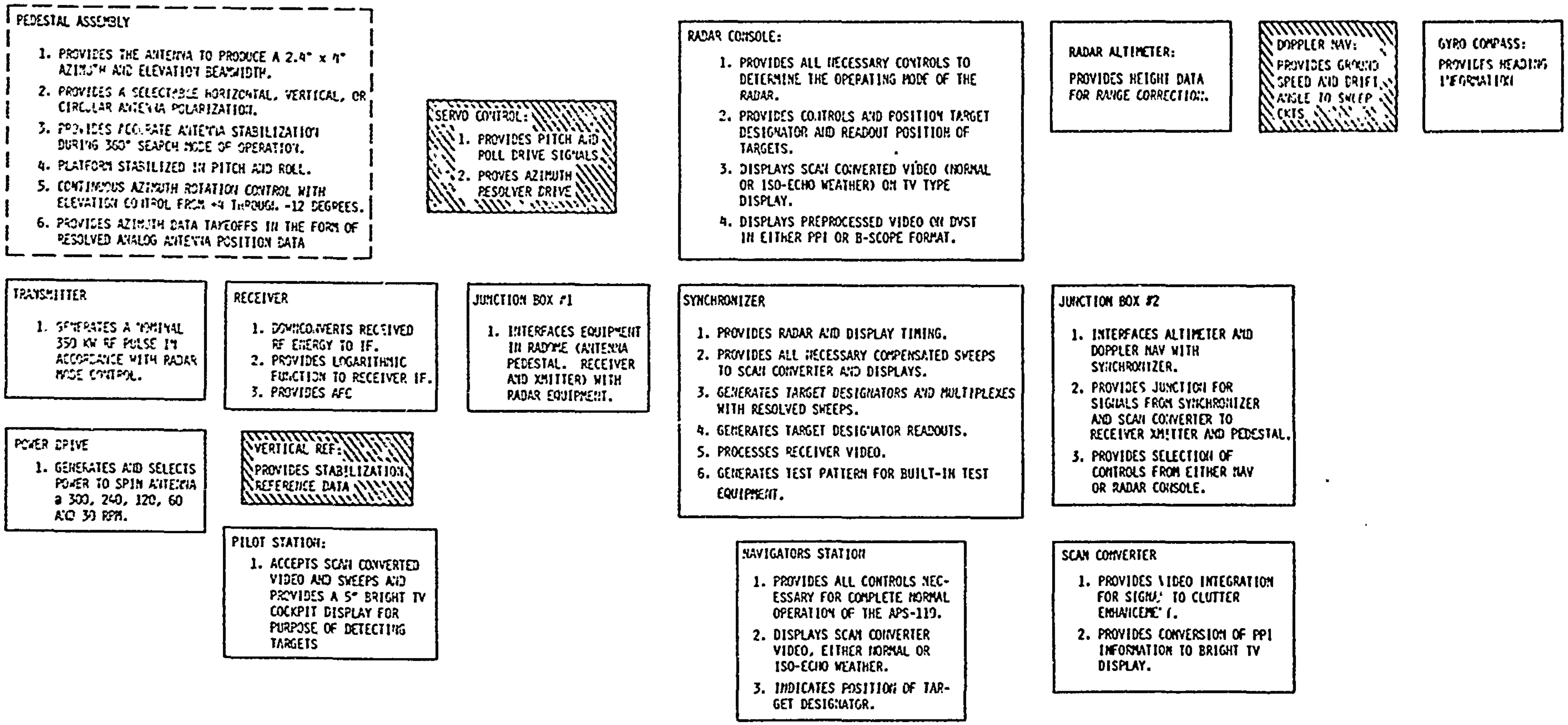

Figure A-2. Functional description of each of the major units of the AN/APS-119 radar.

display and controls. (7) The pilot's display, located in the cockpit at the pilot's station, contains a 5-inch radar display. In addition to the main assemblies, two junction boxes allow easy removal of major assemblies. Table A-2 lists the size and weight of the various radar components, and Figure A-3 shows the location of each unit within the airframe.

The peak transmitter power is 180 kW measured at the transmitter output port, and the frequency can be manually tuned between 8.5 and 9.0 GHz. The transmitting tube is a coaxial magnetron, and the modulator is a line-type thyratron device providing four different pulse widths.

Duplexing is accomplished in the rf-head assembly by a four-part non-reciprocal device that provides isolation between transmitter and mixer ports. The TR limiter prevents damage to the mixer crystals from excessive power during the transmitter pulse. Mixing is accomplished in a balanced diode imageless mixer in order to provide suppression of local-oscillator noise; the result is a maximum receiver noise figure, including duplexer loss, of 9 dB. Schottky diodes are used in the mixer for burnout protection.

The IF preamplifier and logarithmic postamplifier are contained in a small integral unit located with the rf head. The IF frequnecy is 60 MHz and the overall bandwidth is matched to each transmitter pulse width. The local oscillator is a Gunn-effect device operating in the range of 8.2 to 9.3 GHz which is regulated by an AFC circuit.

The antenna system contains two center-fed parabolic reflectors. The 40 x 24-inch dishes are shaped in elevation to provide increased illumination on the ocean surface. The azimuth beam width is 2.5 degrees and the elevation beam width is 3.7 degrees. Side lobes in the azimuth plane are down 20 dB from the main lobe, while the first elevation side lobe is down 15 dB. The peak gain is 34 dB, and horizontal, vertical, and circular polarizations are available. The antenna feed is sealed by a small feed-dome capable of being pressurized. The antenna is mounted on a lightweight four-axis pedestal and is stabilized.

The log receiver system covers a dynamic operating range of 100 dB, saturating at a -15 dBm level. Video processing is performed in the synchronizer unit. The synchronizer video processor normalizes the target video level with respect to the average clutter level or as a function of range

TABLE A-2

AN/APS-119 Weight and Size Data

UNIT		Weight	L x W x H
1	Antenna Pedestal	152	40 x 40 x 46
2	Receiver/Transmitter	185	11 x 27 x 34
MT	Mtg. Base	16	
3	Synchronizer	95	34 x 20 x 11
MT	Mtg. Base	18	
4	Scan Conv.	90	36 x 20 x 11
MT	Mtg. Base	19	
5	Radar Console	239	30 x 29 x 23
MT	Mtg. Base	40	
6	Nav. Console & Controls	118	19 x 18 x 20
7	Drive Power	126	18 x 32 x 11
MT	Mtg. Base	19	
8	Jct. Box-1	16½	20 x 4 x 10
9	Jct. Box-2	189	26 x 9 x 30
10	Pilot's Display	20	20 x 7 x 11
11	Servo Control	15	14 x 10 x 8
--	Pressure Bottle	80	35 x 7 dia.
--	Vert. Gyro & Rate Sw.	6	
Cables:	W1-W7, W58-W61	16	
Cables:	W8-W19, W30-W57	38	
		1,497	

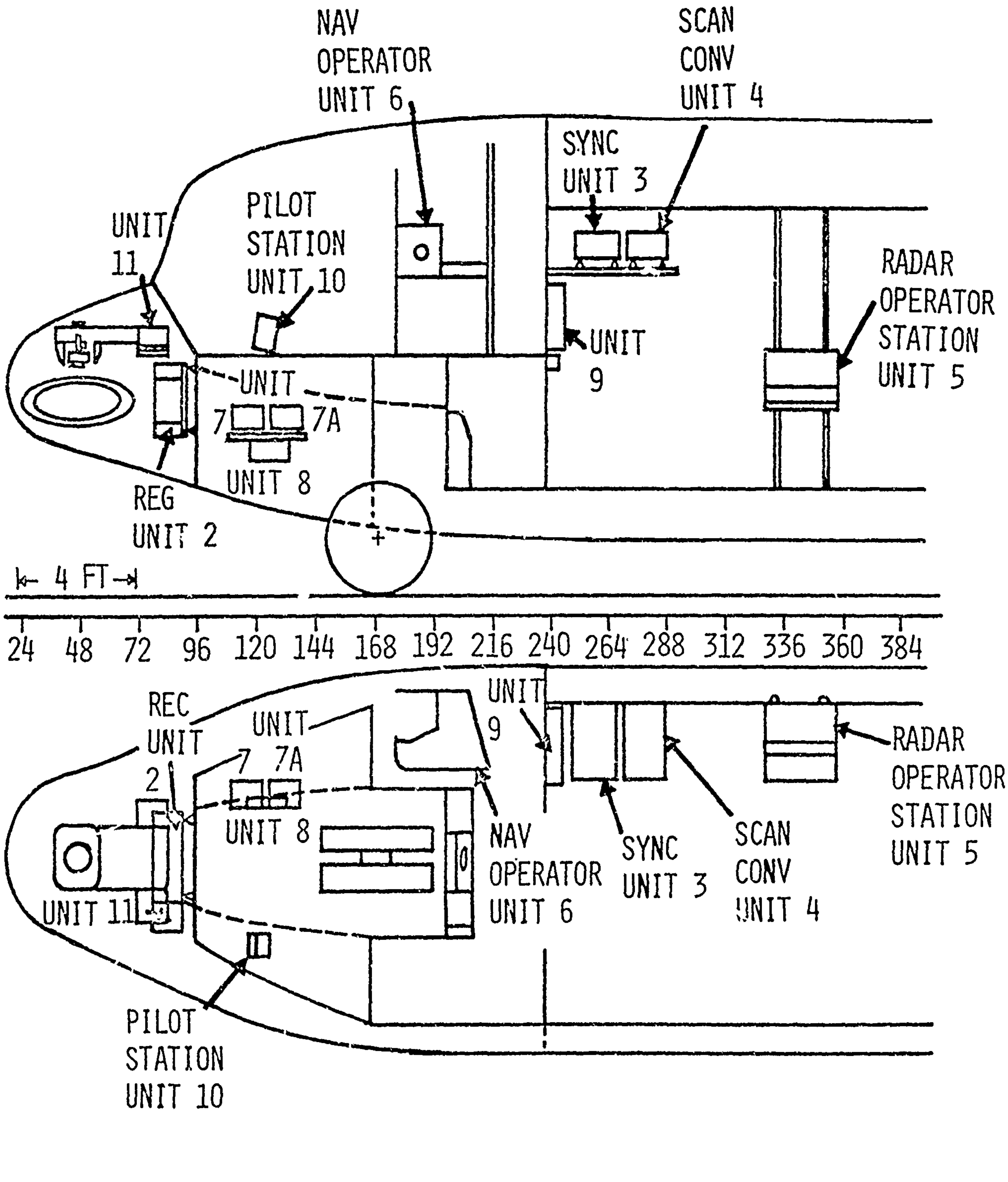

Figure A-3. Location of the AN/APS-119 radar components within the airframe.

through the use of STC or FTC circuits. This is done in order to reduce the video dynamic range to a 15 to 20 dB range so as to be compatible with the storage-tube integrator in the scan converter and the displays. The storage-tube mesh acts as an integrator to increase target-to-clutter ratios on successive scans of the antenna.

In addition to the video processor, the synchronizer houses all system timing circuitry, PPI and B-scan sweep, and sweep stabilization circuitry, as well as track designator generation equipment.

The scan converter unit provides the function of translation from PPI to television display, as well as the video integration function.

The radar console control panel and the navigator control panel determine the operating modes of the radar and the associated video processing, as well as the positioning of the track designators on the displays. The radar, navigator, and pilot displays provide the monitoring function of the received video.

APPENDIX B

Clutter Profile Density Functions

This appendix contains uncalibrated density function (Figures B-1 to B-24)and strip-chart playouts (Figures B-29 to B-36) of the two clutter profile measurements which are discussed in Chapter III (Figures 27 and 28.) In addition, density functions are included for a -60 dBm signal generator pulse plus clutter and a -80 dBm signal generator pulse plus clutter for both linear polarizations (Figures B-25 - B-28.) Analysis techniques similar to those described previously were used to obtain the data summarized here [11,17].

General trends which can be determined from these distribtuions include: (1) The distributions become narrower with increasing range, indicating that clutter return covers a much wider dynamic range than noise. (The return at 7.5 nmi is essentially due to noise.) (2) The clutter-return distribution is much wider for horizontal (HH) polarization than for vertical polarization (VV); particularly where the high energy "tail" is concerned. This is an indication of the "spiking" which occurs principally for horizontal polarization. (3) Detection of targets in heavy clutter is decreased for horizontal polarization because of the high energy tail (Figure B-25).

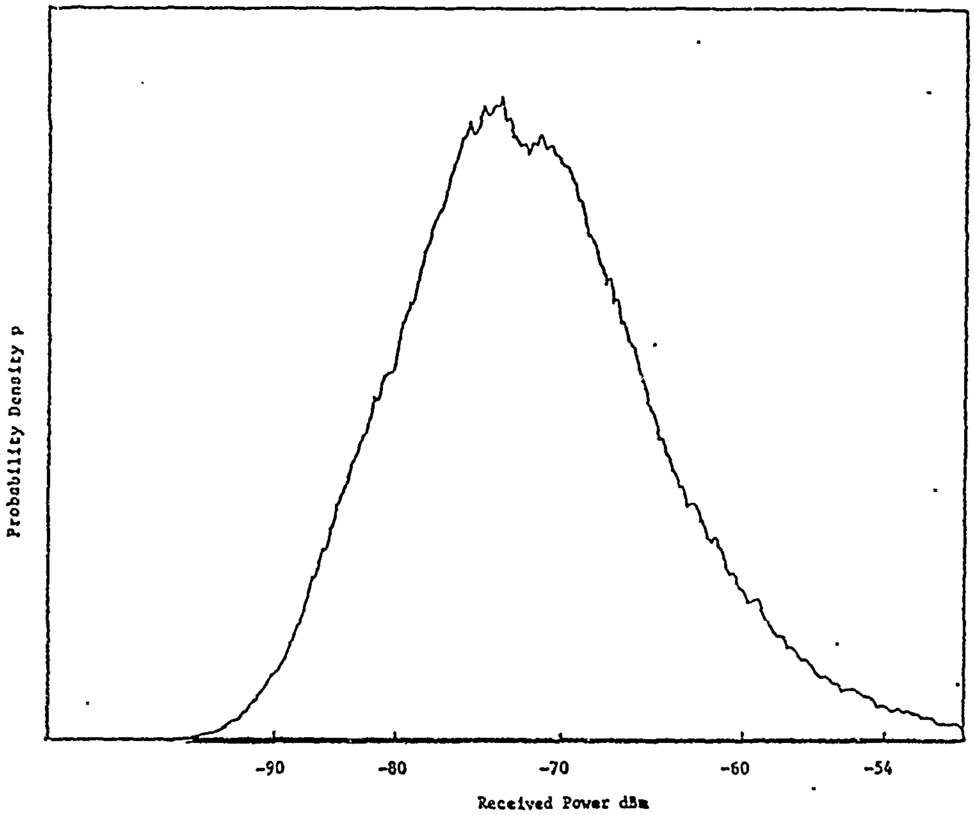

Figure B-1. Uncalibrated density function of clutter return at 0.83 nmi, 0.2 μsec. pulse, 1.8 kHz prf, HH polarization.

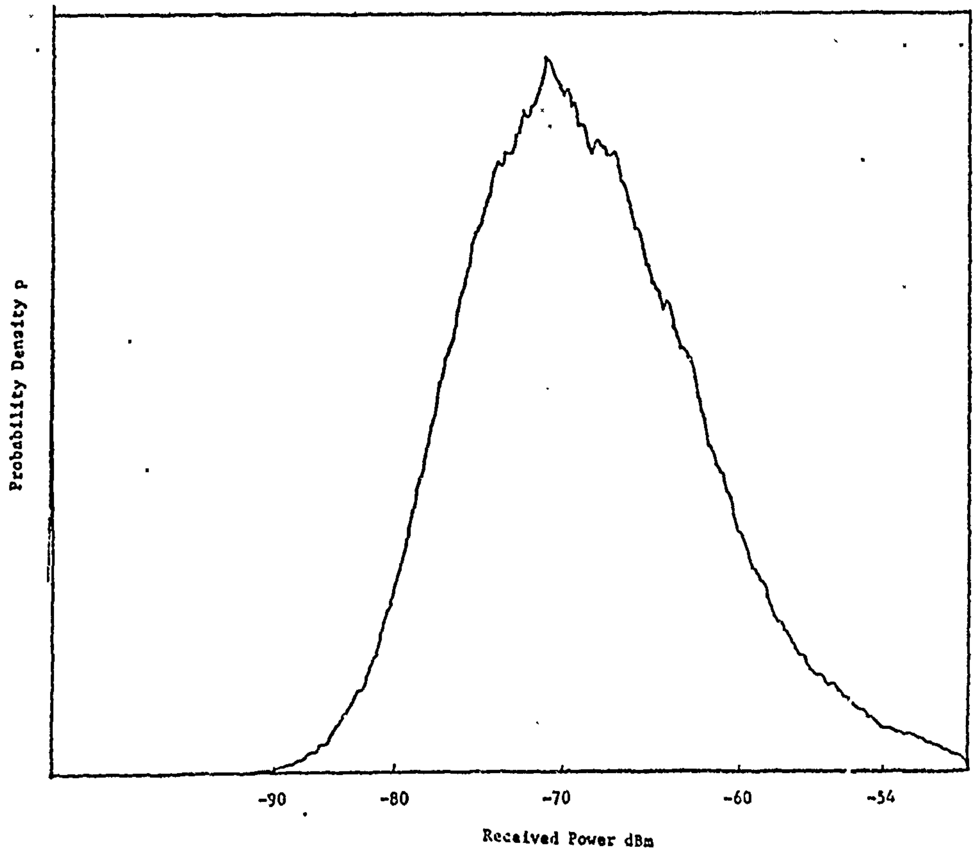

Figure B-2. Uncalibrated density function of clutter return at 1.25 nmi, 0.2 μsec pulse, 1.8 kHz prf, HH polarization.

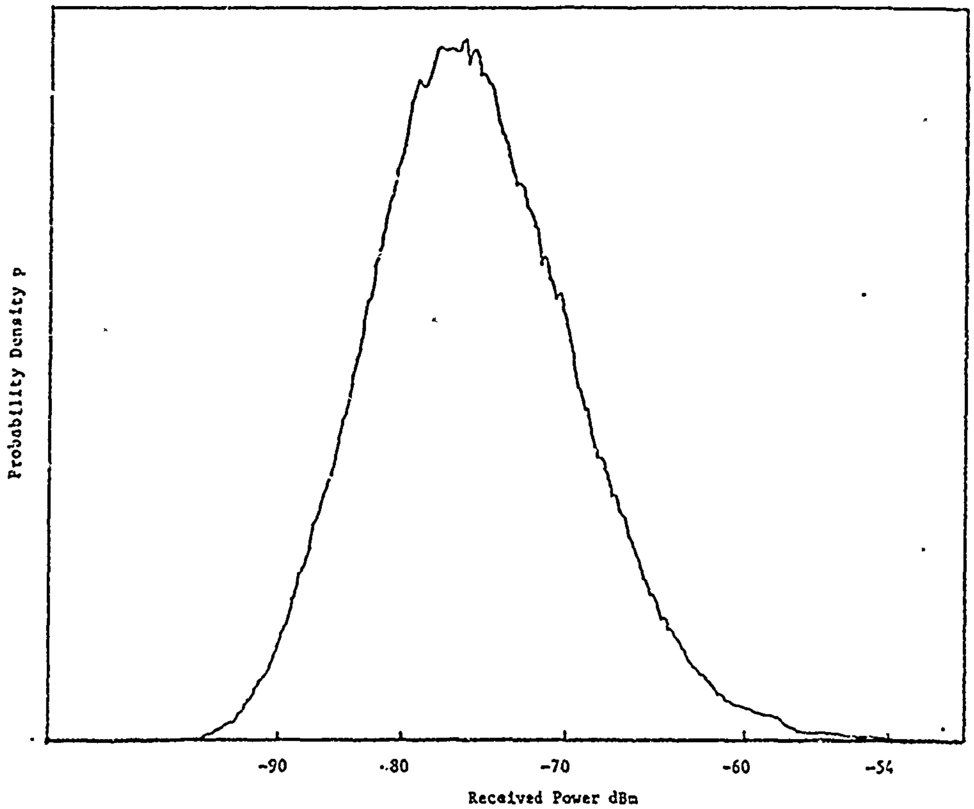

Figure B-3. Uncalibrated density function of clutter return at 1.67 nmi, 0.2 μsec pulse, 1.8 kHz prf, HH polarization.

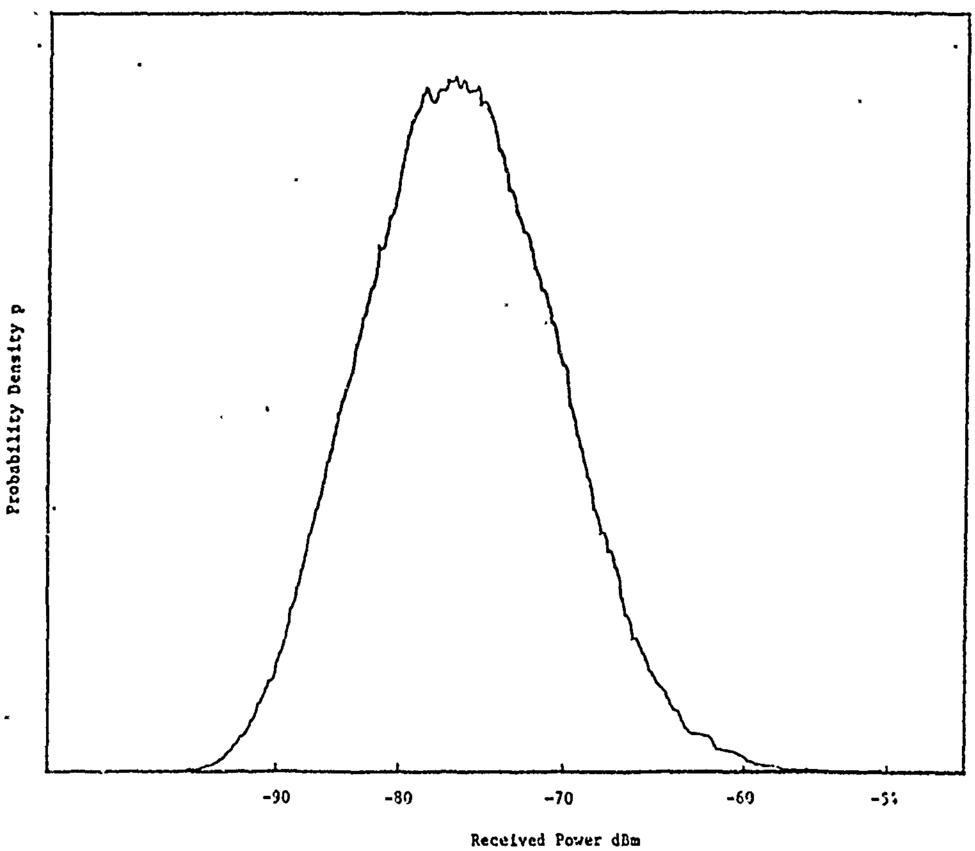

Figure B-4. Uncalibrated density function of clutter return at 2.08 nmi, 0.2 μsec pulse, 1.8 kHz prf, HH polarization.

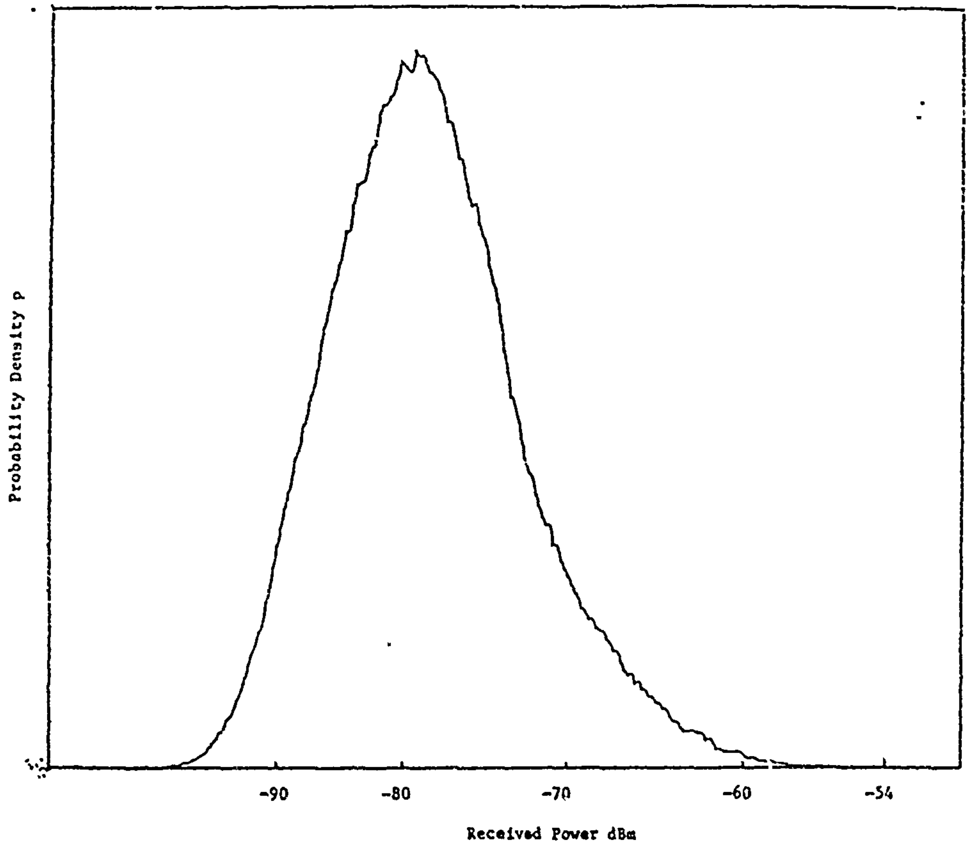

Figure B-5. Uncalibrated density function of clutter return at 2.5 nmi, 0.2 μsec pulse, 1.8 kHz prf, HH polarization.

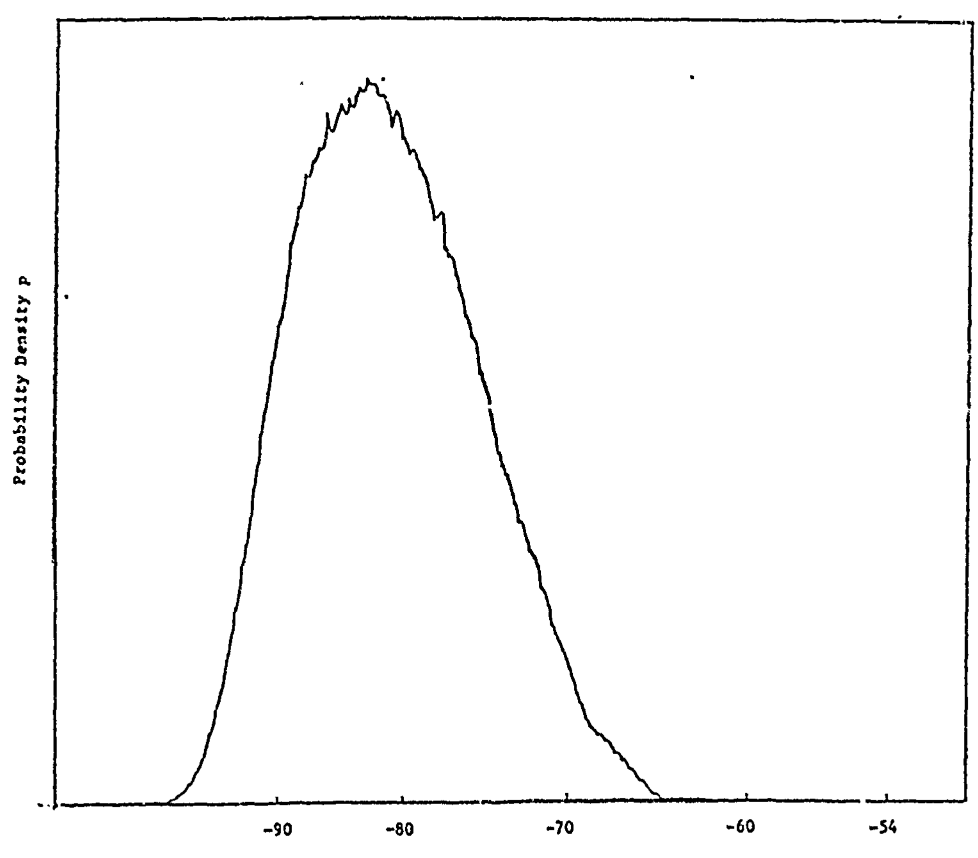

Figure B-6. Uncalibrated density function of clutter return at 2.92 nmi, 0.2 μsec pulse, 1.8 kHz, HH polarization.

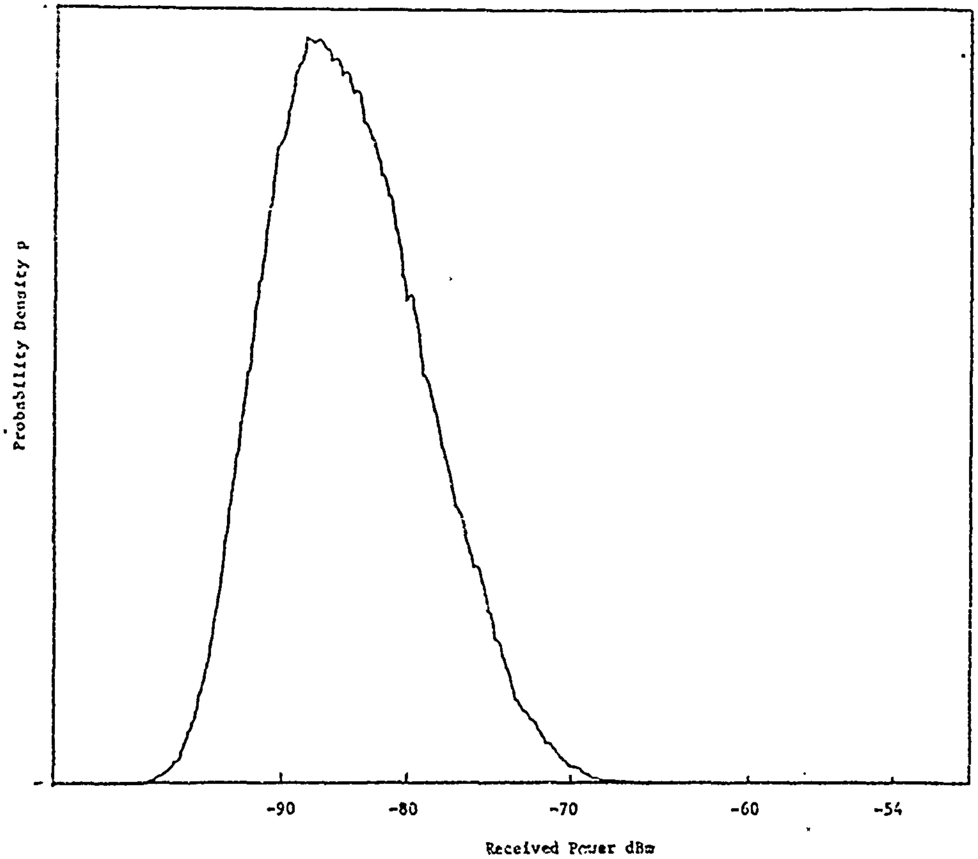

Figure B-7. Uncalibrated density function of clutter return at 3.33 nmi, 0.2 μsec pulse, 1.8 kHz prf, HH polarization.

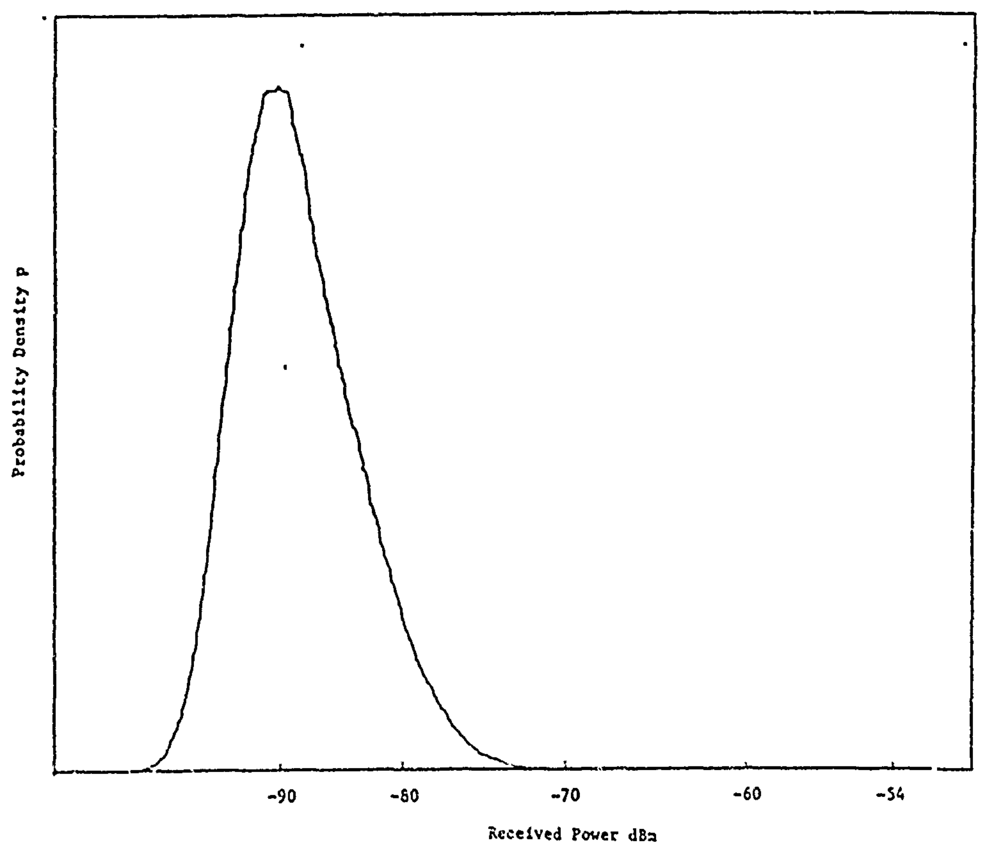

Figure B-8. Uncalibrated density function of clutter return at 4.17 nmi, 0.2 μsec pulse, 1.8 kHz prf, HH polarization.

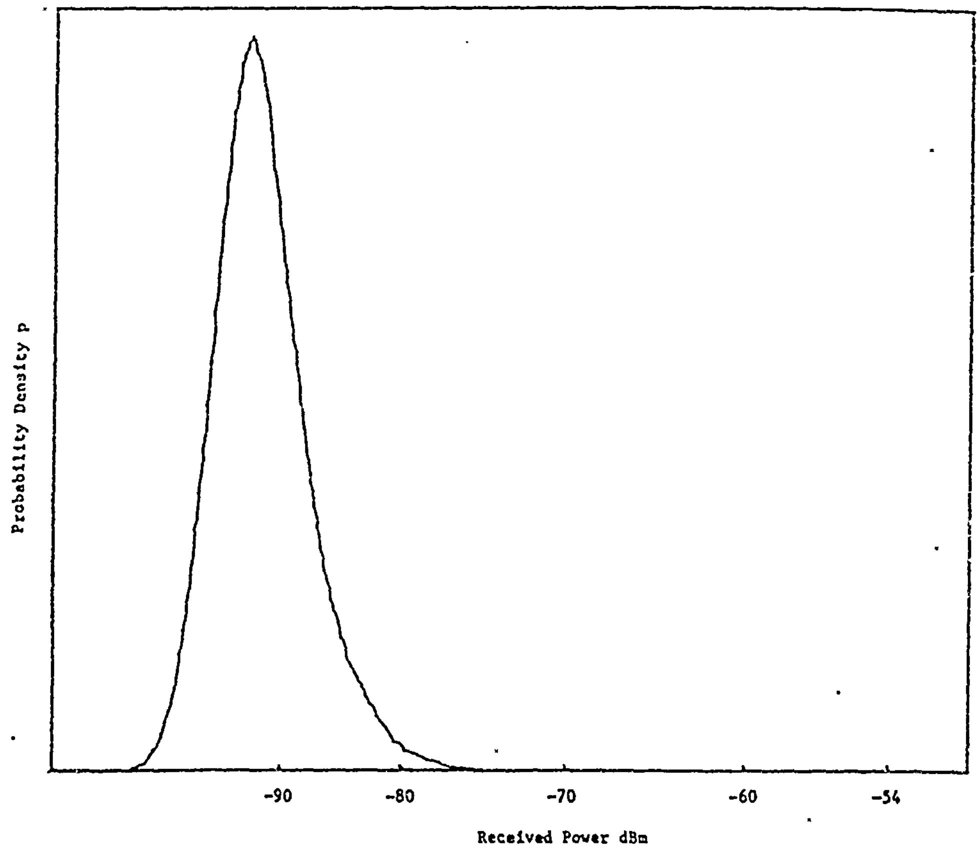

Figure B-9. Uncalibrated density function of clutter return at 5.08 nmi, 0.2 μsec pulse, 1.8 kHz prf, HH polarization.

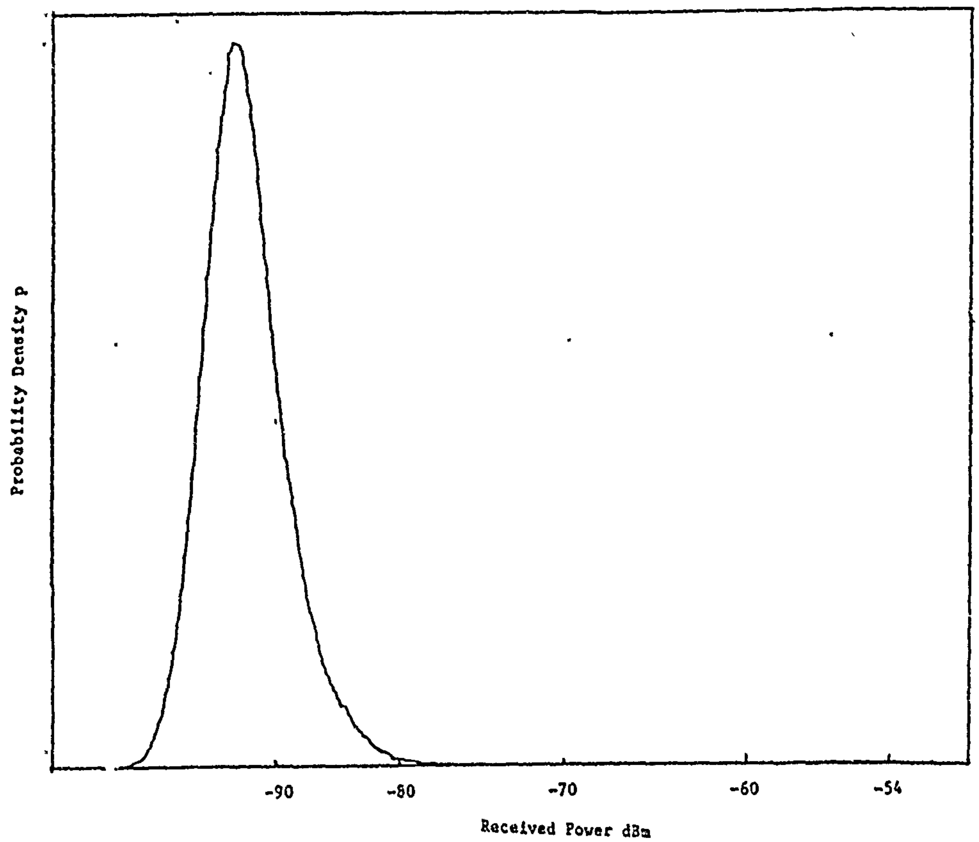

Figure B-10. Uncalibrated density function of clutter return at 5.83 nmi, 0.2 μsec pulse, 1.8 kHz prf, HH polarization.

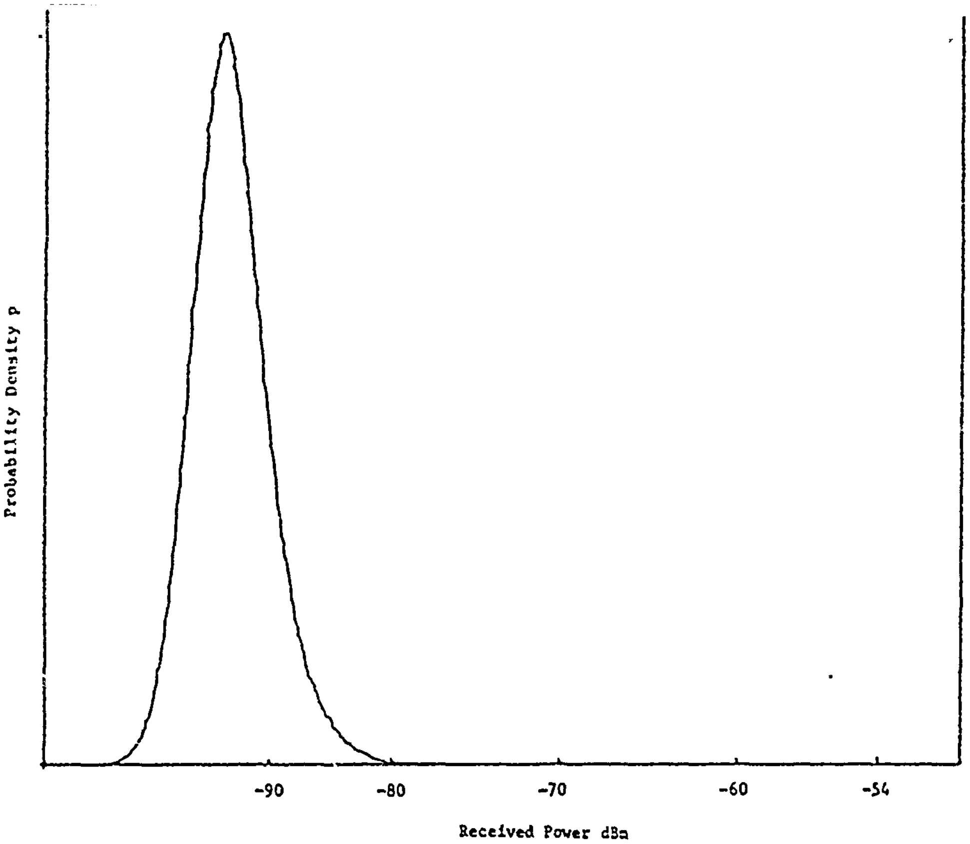

Figure B-11. Uncalibrated density function of clutter return at 6.67 nmi, 0.2 μsec pulse, 1.8 kHz prf, HH polarization.

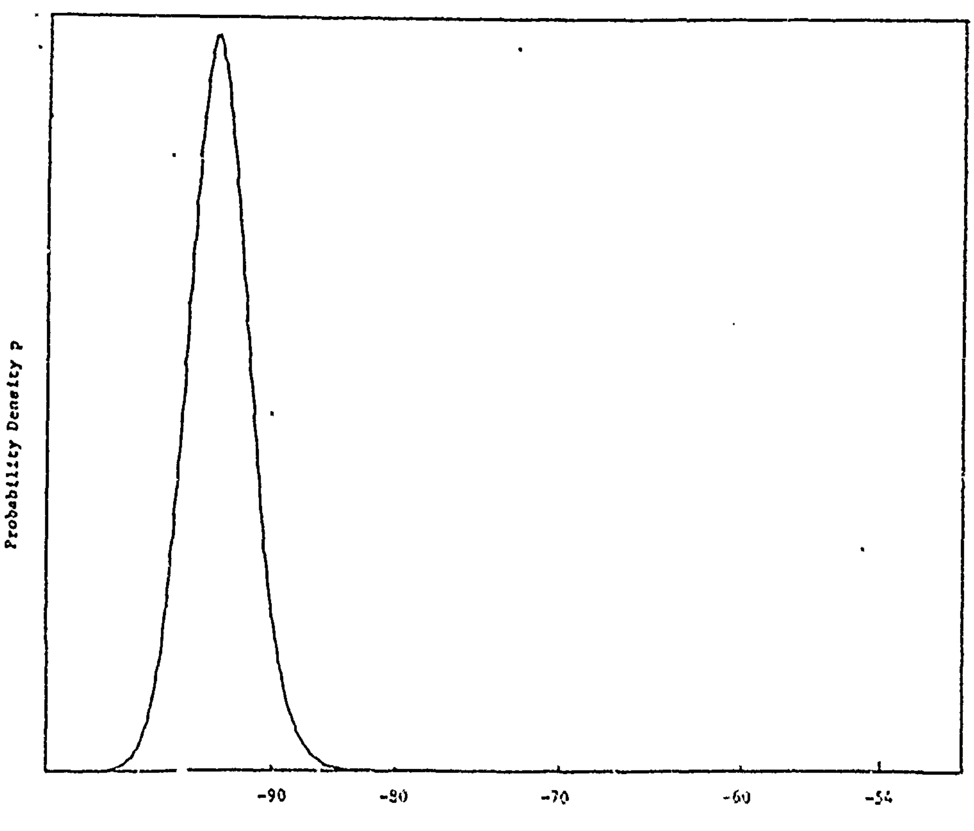

Figure B-12. Uncalibrated density function of clutter return at 7.5 nmi, 0.2 μsec pulse, 1.8 kHz prf, HH polarization.

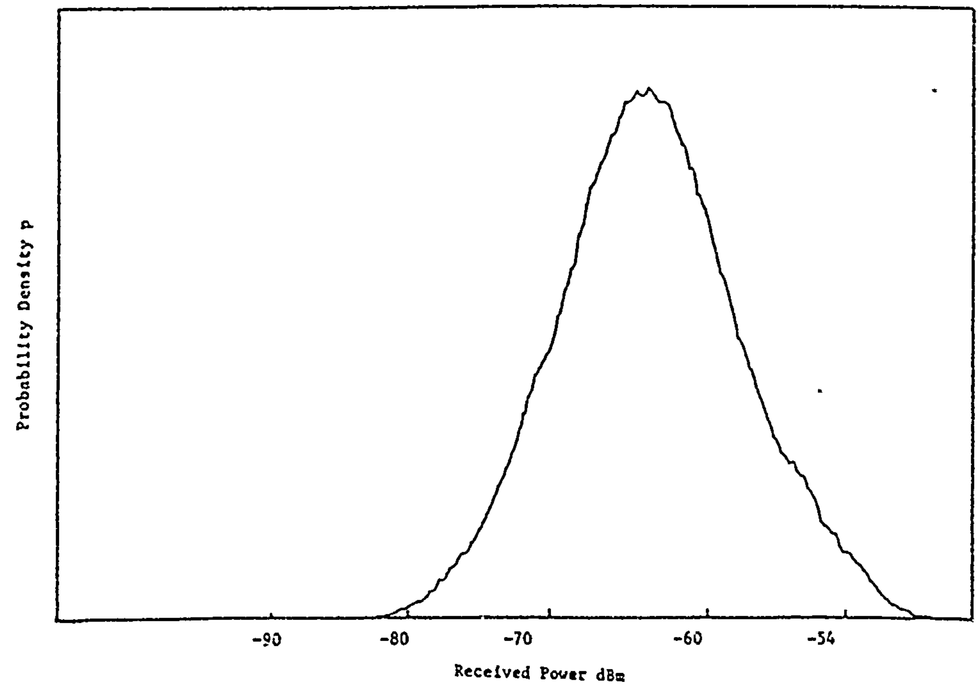

Figure B-13. Uncalibrated density function of clutter return at .833 nmi, 0.2 μsec pulse, 1.8 kHz prf, VV polarization.

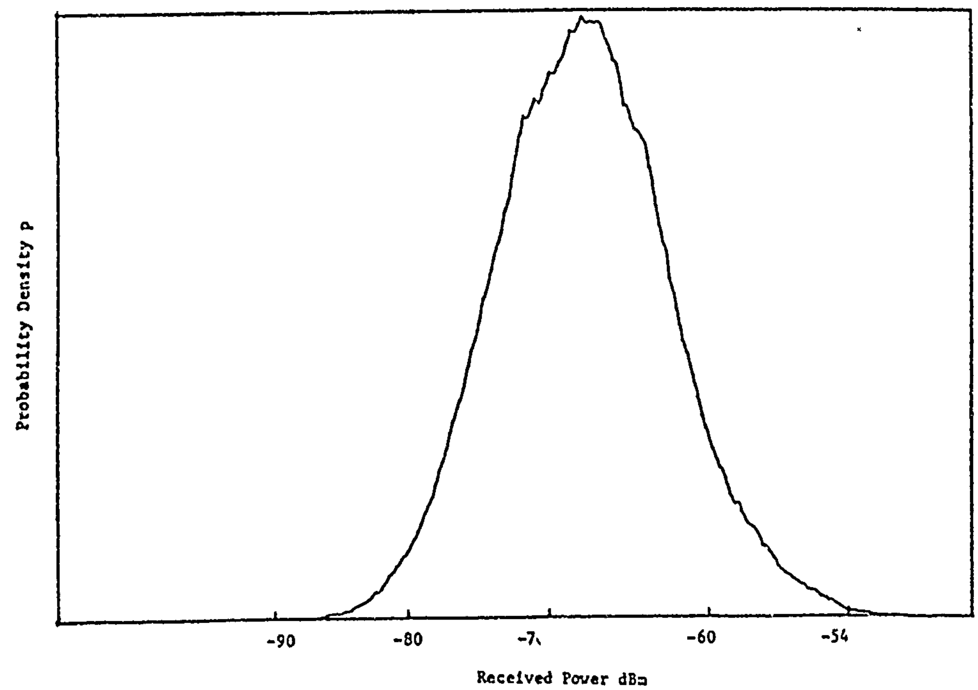

Figure B-14. Uncalibrated density function of clutter return at 1.25 nmi, 0.2 μsec pulse, 1.8 kHz prf, VV p larization.

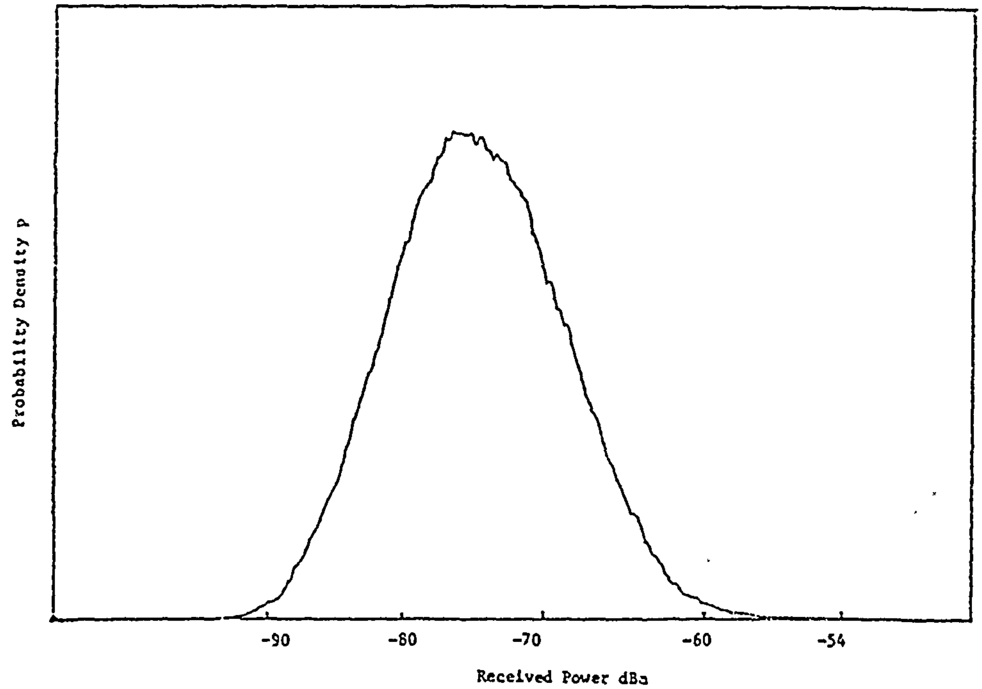

Figure B-15. Uncalibrated density function of clutter return at 1.67 nmi, 0.2 μsec pulse, 1.8 kHz prf, VV polarization.

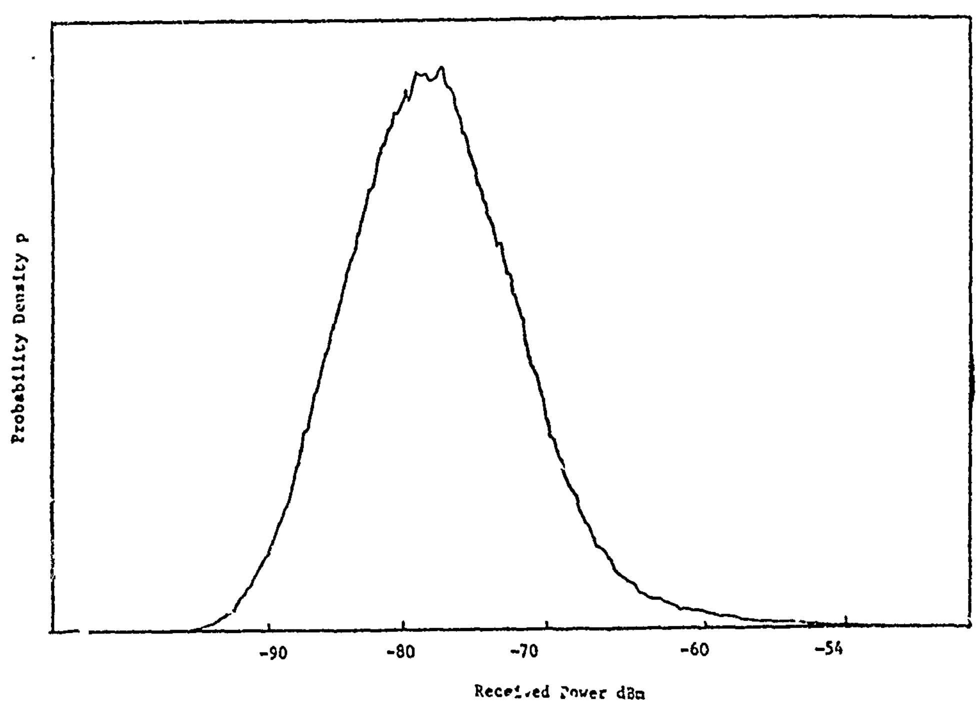

Figure B-16. Uncalibrated density function of clutter return at 2.08 nmi, 0.2 μsec pulse, 1.8 kHz prf, VV polarization.

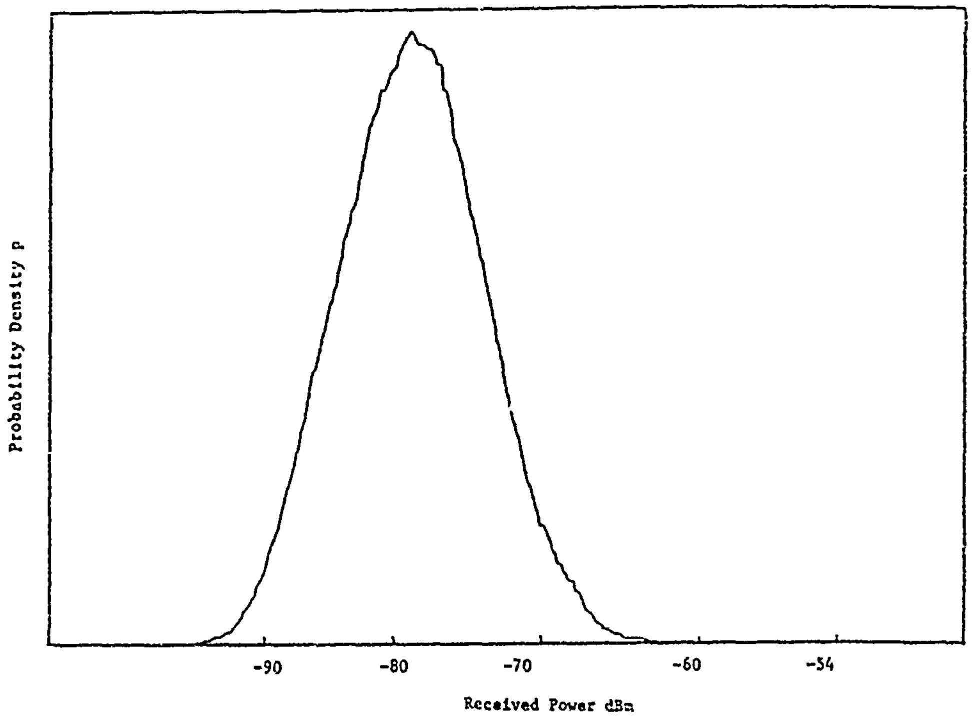

Figure B-17. Uncalibrated density function of clutter return at 2.5 nmi, 0.2 μsec pulse, 1.8 kHz prf, VV polarization.

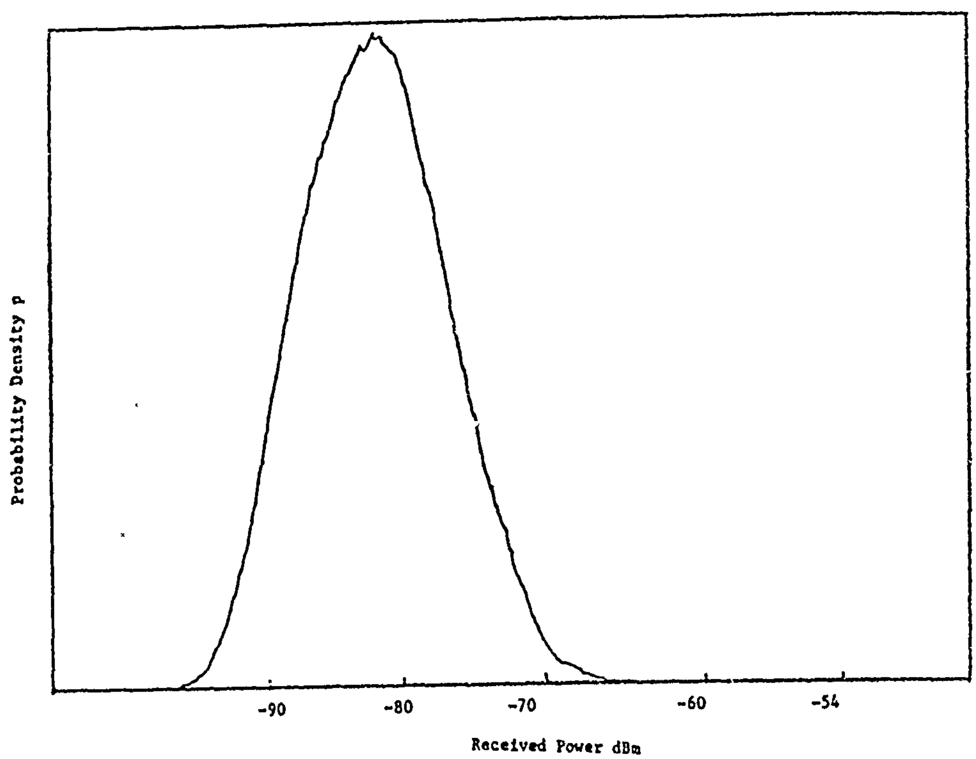

Figure B-18. Uncalibrated density function of clutter return at 2.92 nmi, 0.2 μsec pulse, 1.8 kHz prf, VV polarization.

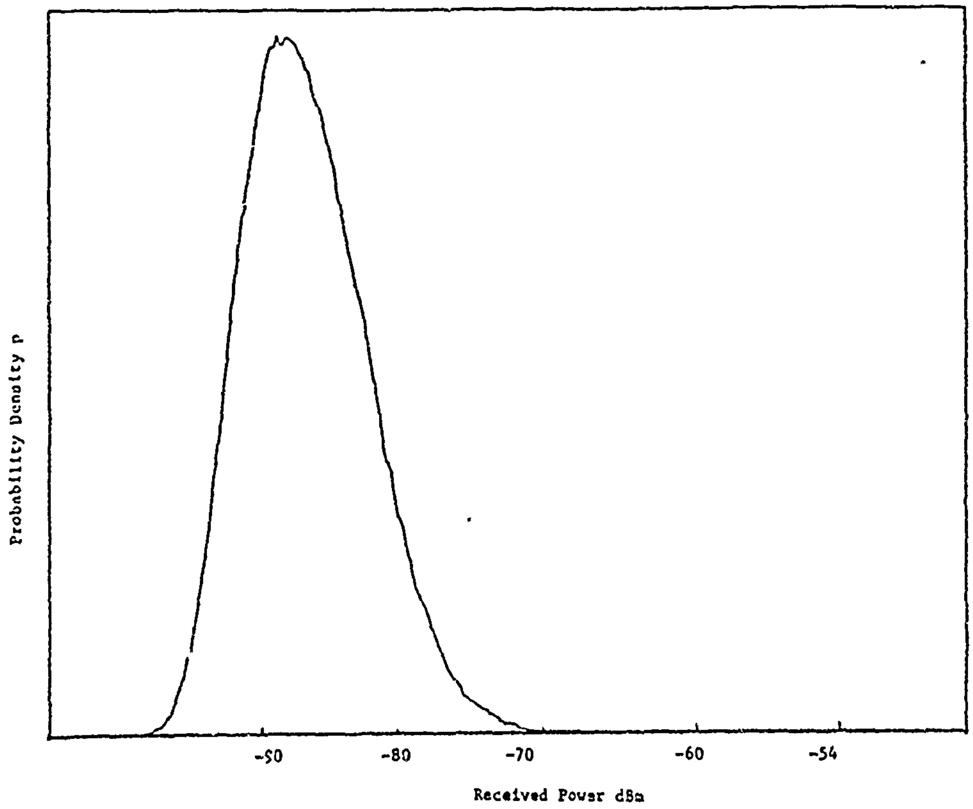

Figure B-19. Uncalibrated density function of clutter return at 3.33 nmi, 0.2 μsec pulse, 1.8 kHz prf, VV polarization.

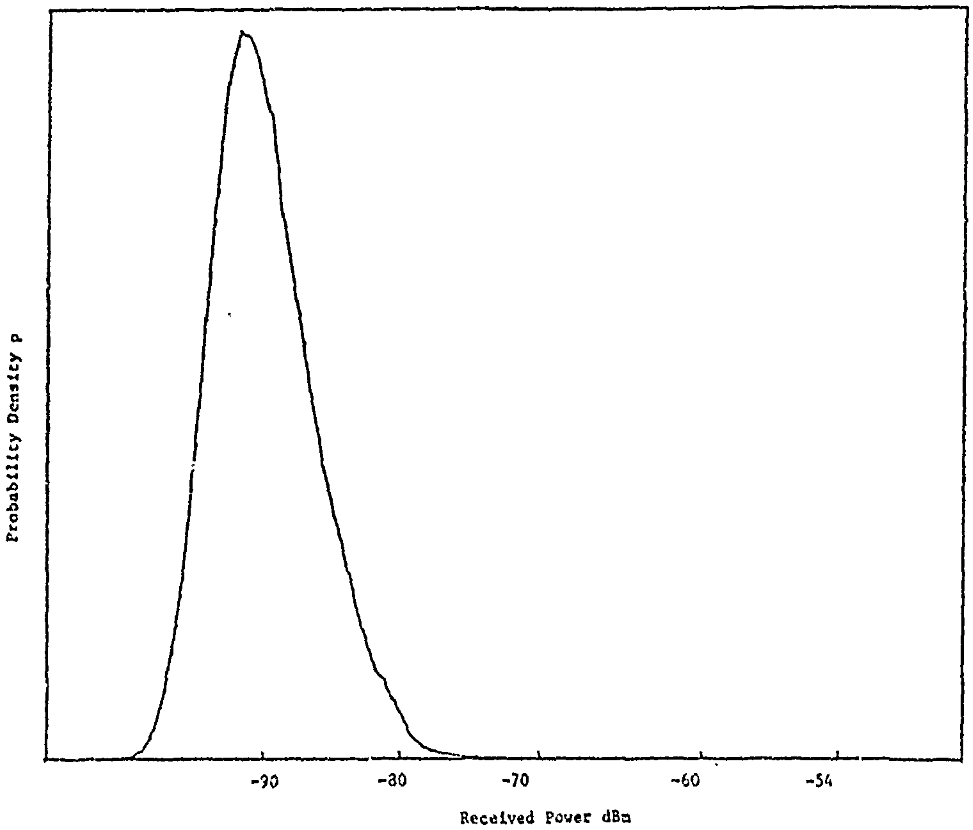

Figure B-20. Uncalibrated density function of clutter return at 4.17 nmi, 0.2 μsec pulse, 1.8 kHz prf, VV polarization.

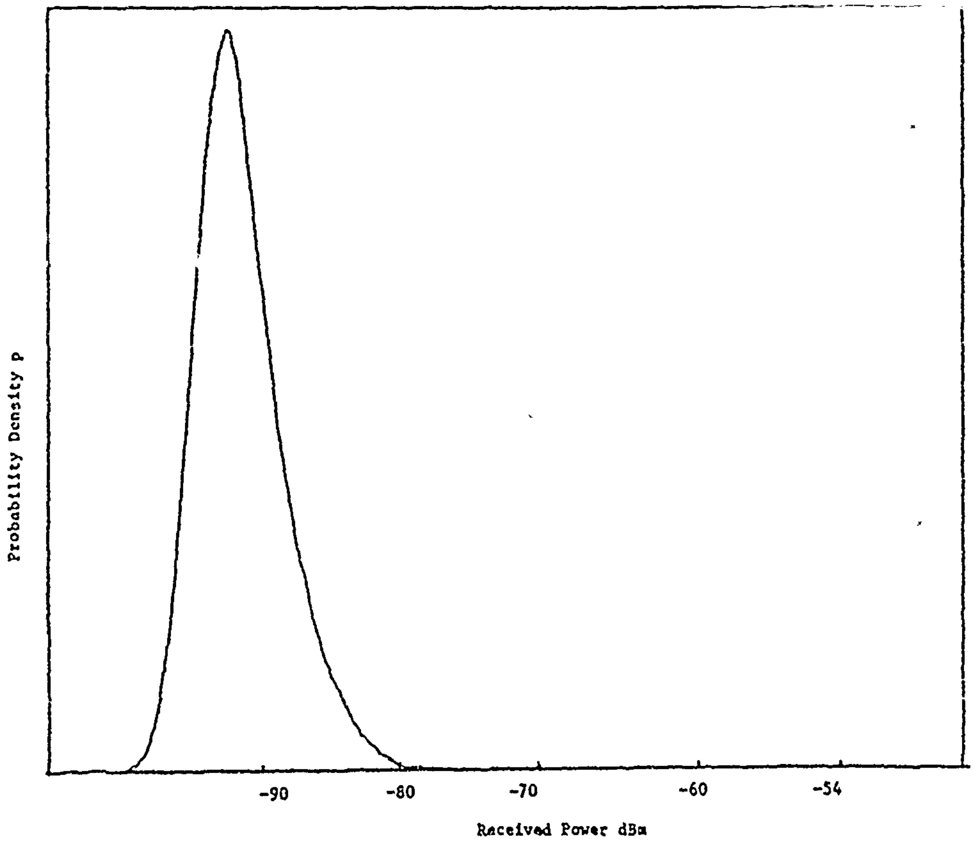

Figure B-21. Uncalibrated density function of clutter return at 5.00 nmi, 0.2 μsec pulse, 1.8 kHz prf, VV polarization.

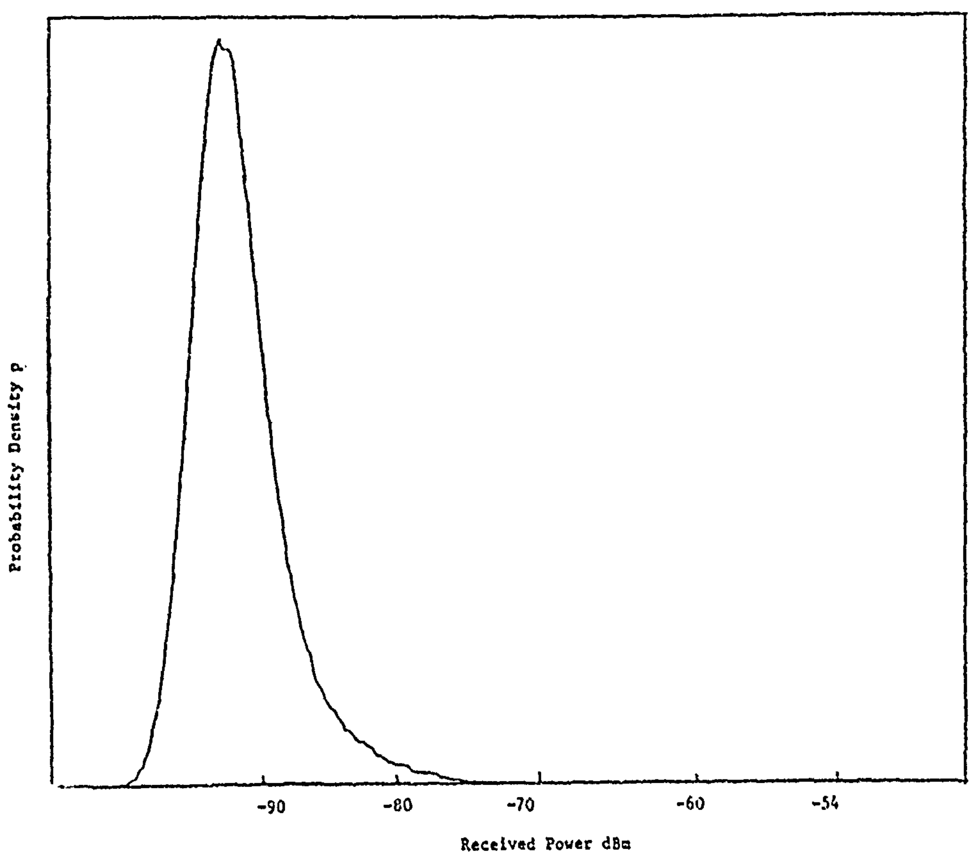

Figure B-22. Uncalibrated density function of clutter return at 5.83 nmi, 0.2 μsec pulse, 1.8 kHz prf, VV polarization.

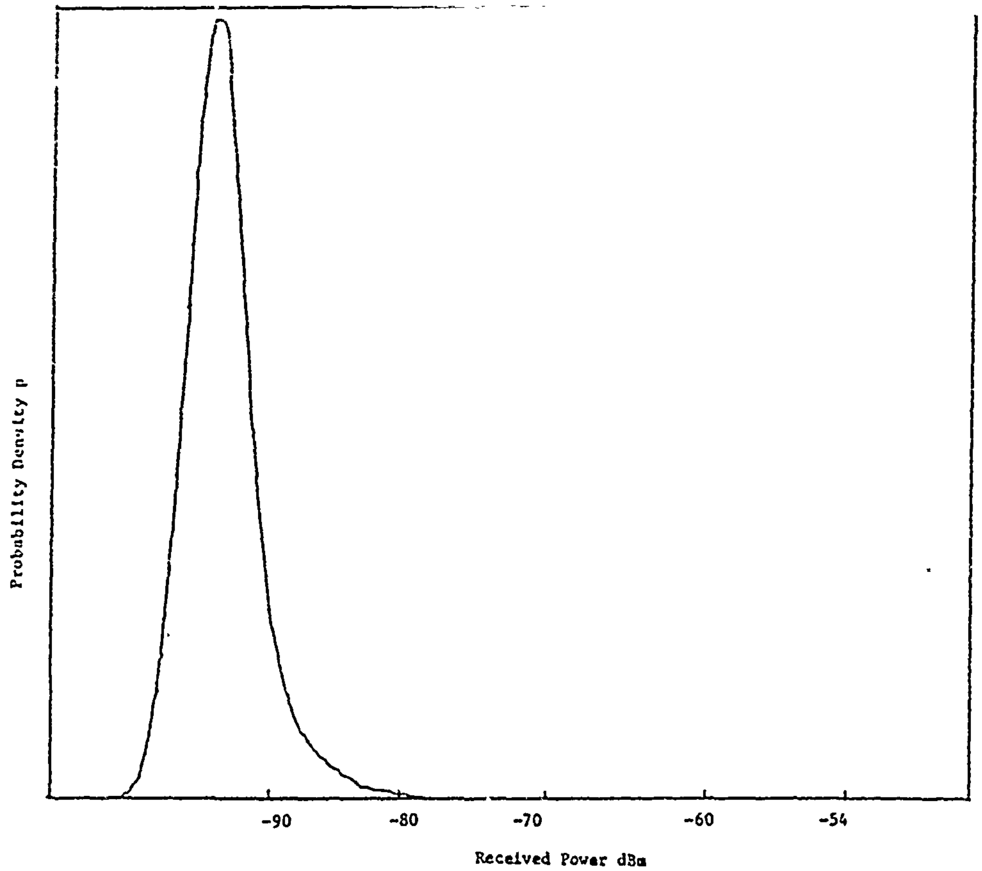

Figure B-23. Uncalibrated density function of clutter return at 6.67 nmi, 0.2 μsec pulse, 1.8 kHz prf, VV polarization.

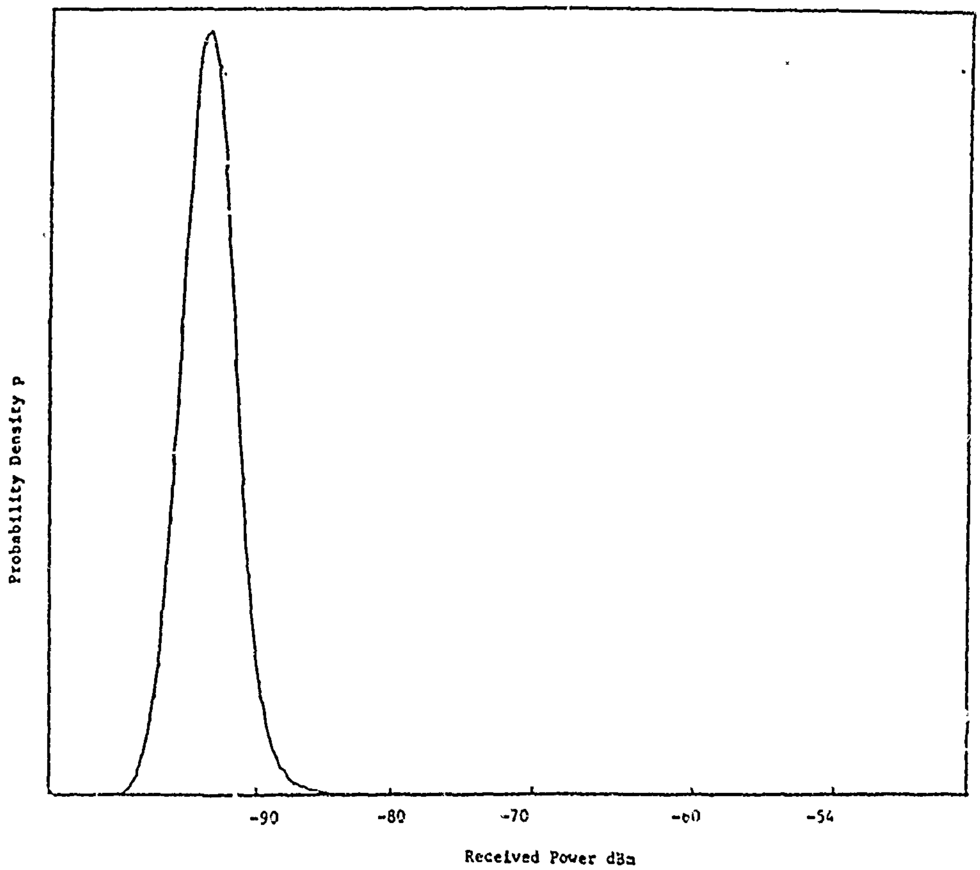

Figure B-24. Uncalibrated density function of clutter return at 7.5 nmi, 0.2 μsec pulse, 1.8 kHz prf, VV polarization.

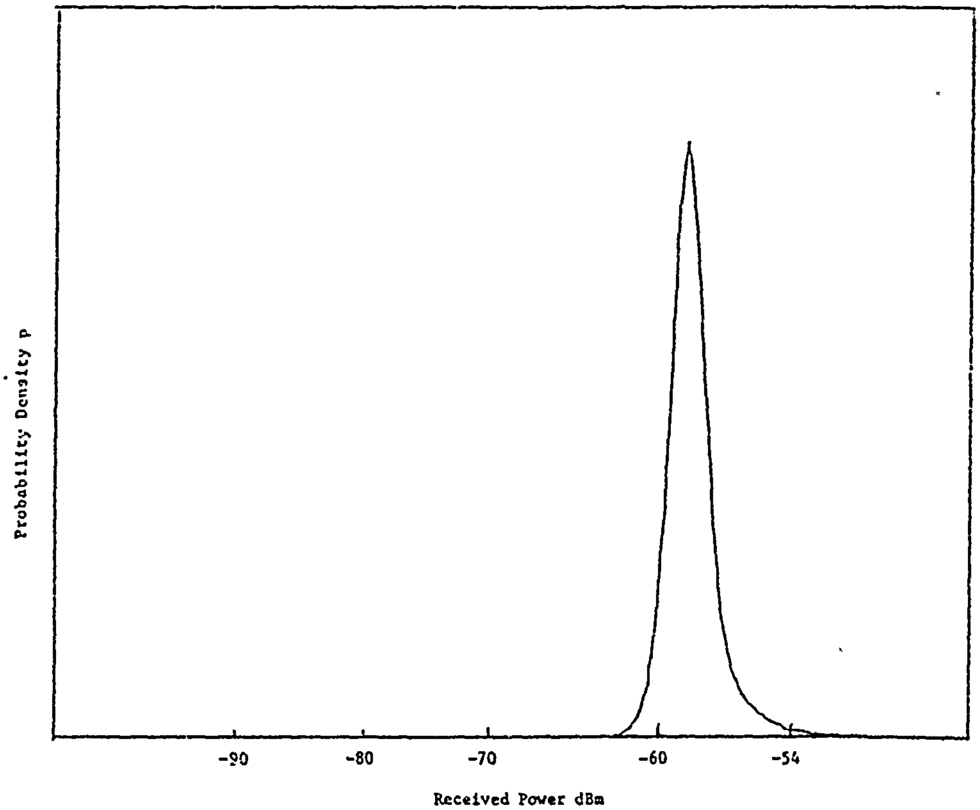

Figure B-25. Uncalibrated density function of received power from a -60 dBm signal generator pulse plus clutter, HH polarization.

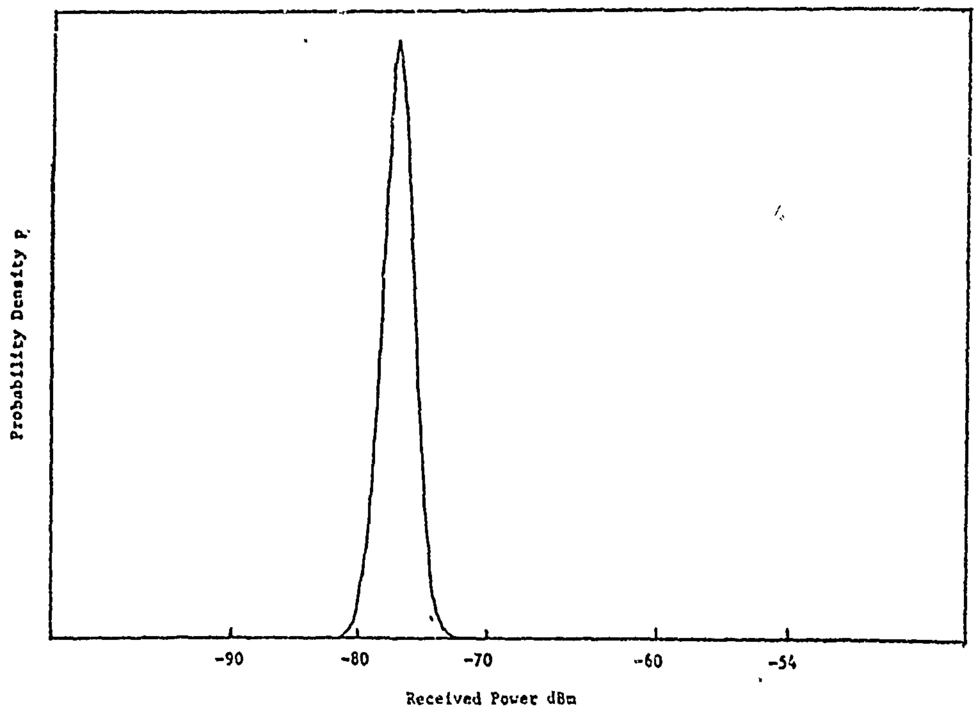

Figure B-26. Uncalibrated density function of received power from a -80 dBm signal generator pulse plus clutter, HH polarization.

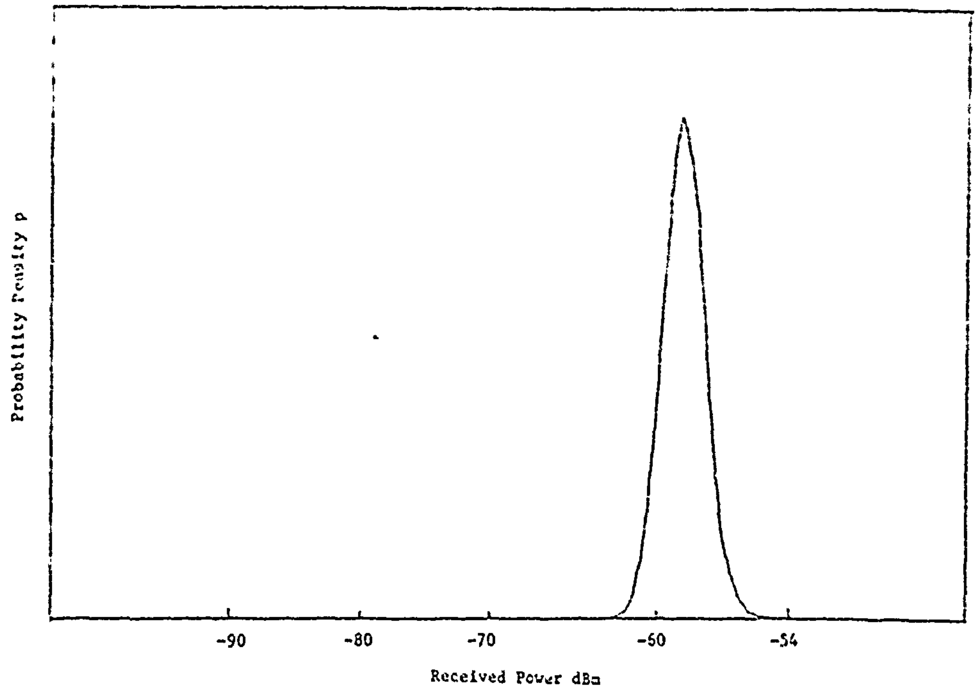

Figure B-27. Uncalibrated density function of -60 dBm signal generator pulse plus clutter return, 0.2 μsec pulse width, VV polarization.

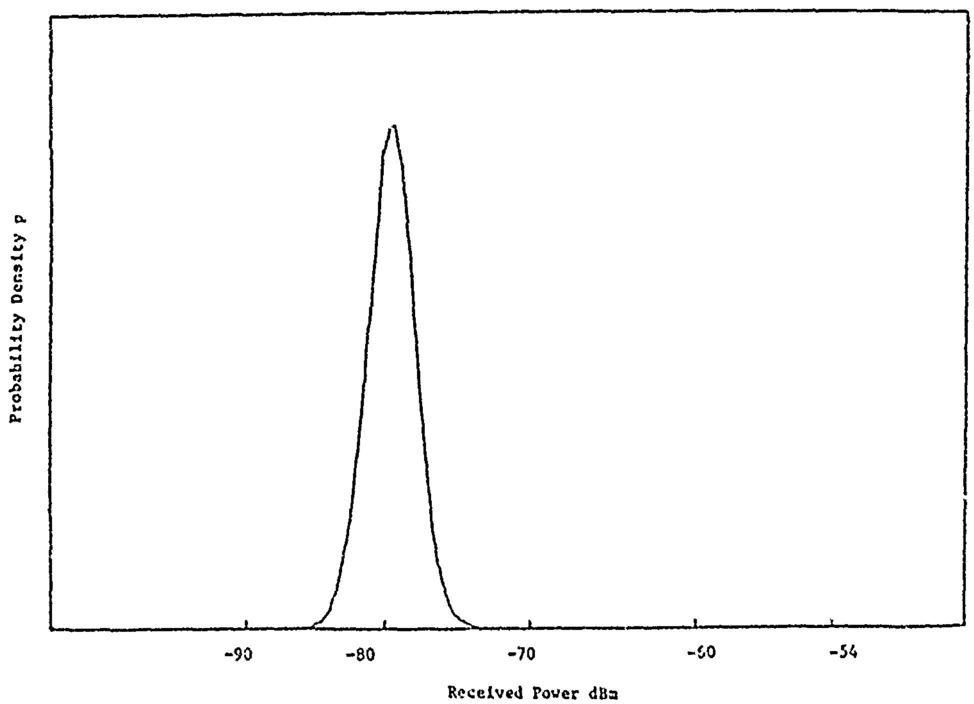

Figure B-28. Uncalibrated density function of -80 dBm signal generator pulse plus clutter return, 0.2 μsec pulse width, VV polarization.

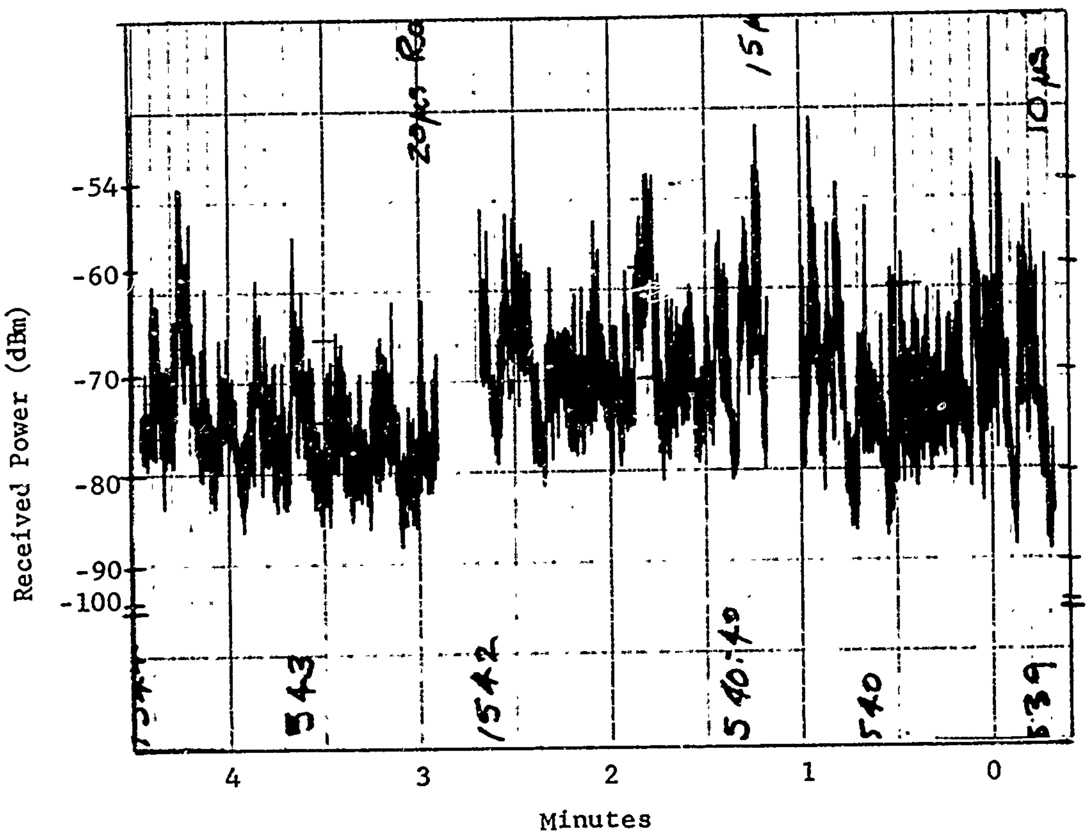

Figure B-29. Strip chart playout of sea return at 0.833 nmi, 1.25 nmi, and 1.67 nmi, HH polarization.

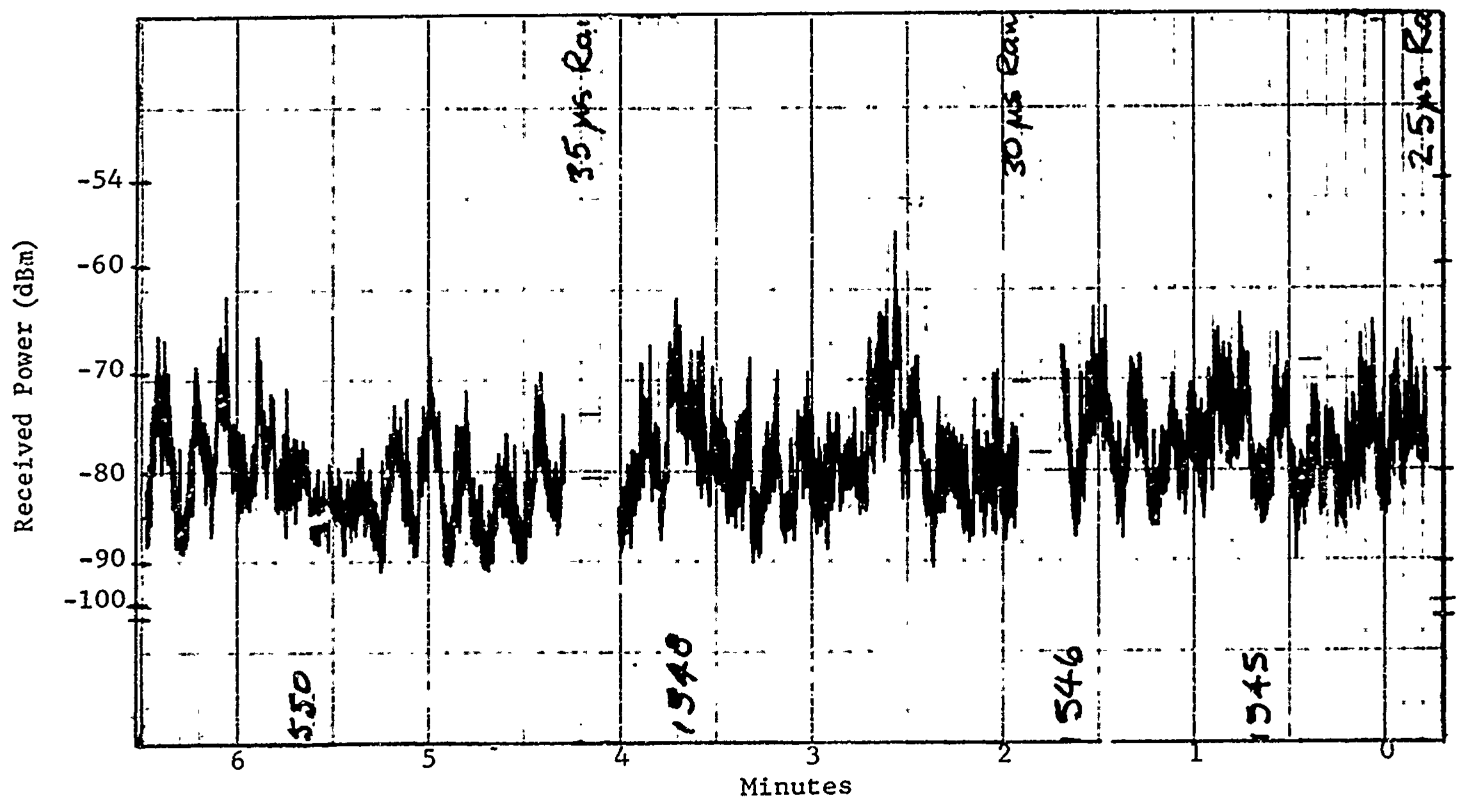

Figure B-30. Strip chart playout of sea return at 2.08 nmi, 2.5 nmi, and 2.92 nmi, HH polarization.

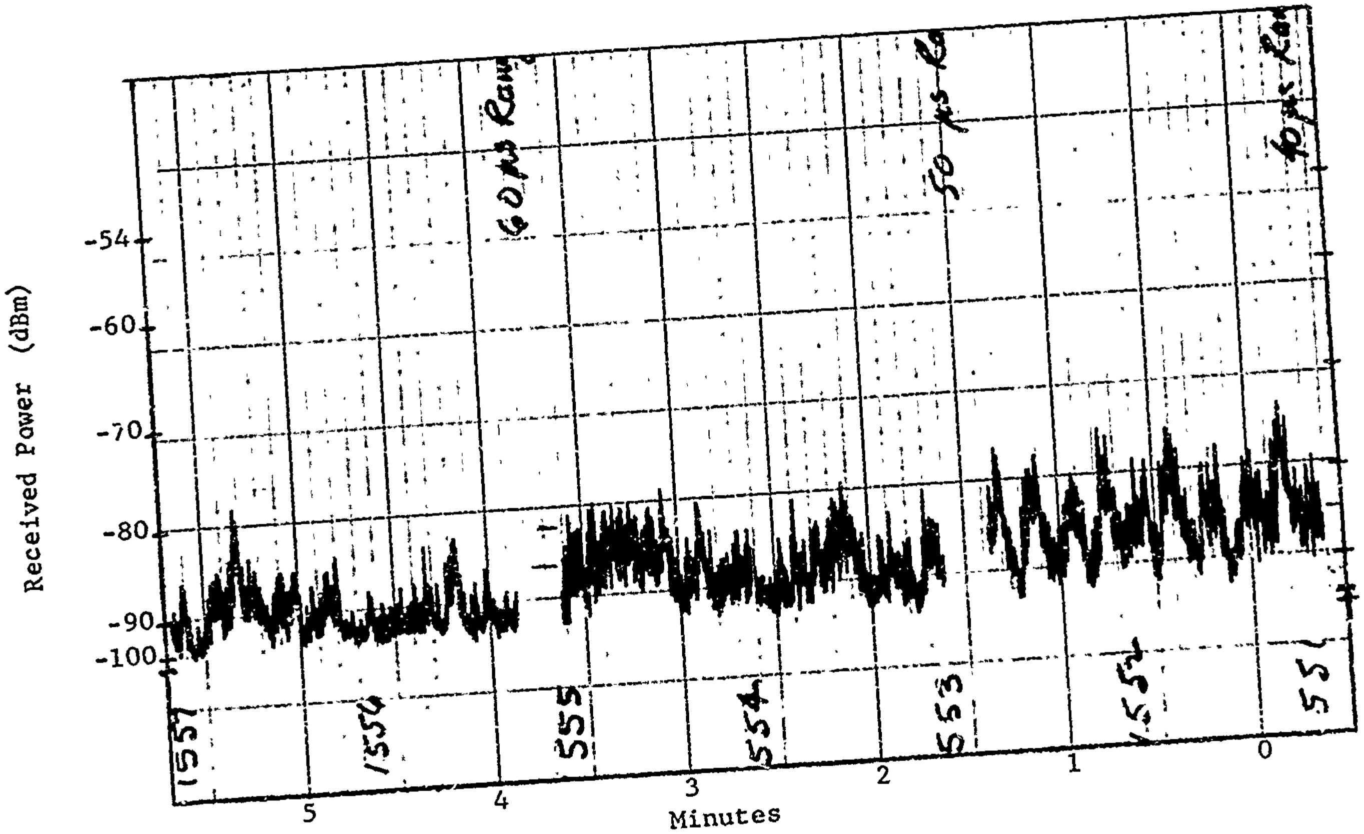

Figure B-31. Strip chart playout of sea return at 3.33 nmi, 4.19, and 5.0 nmi, HH polarization.

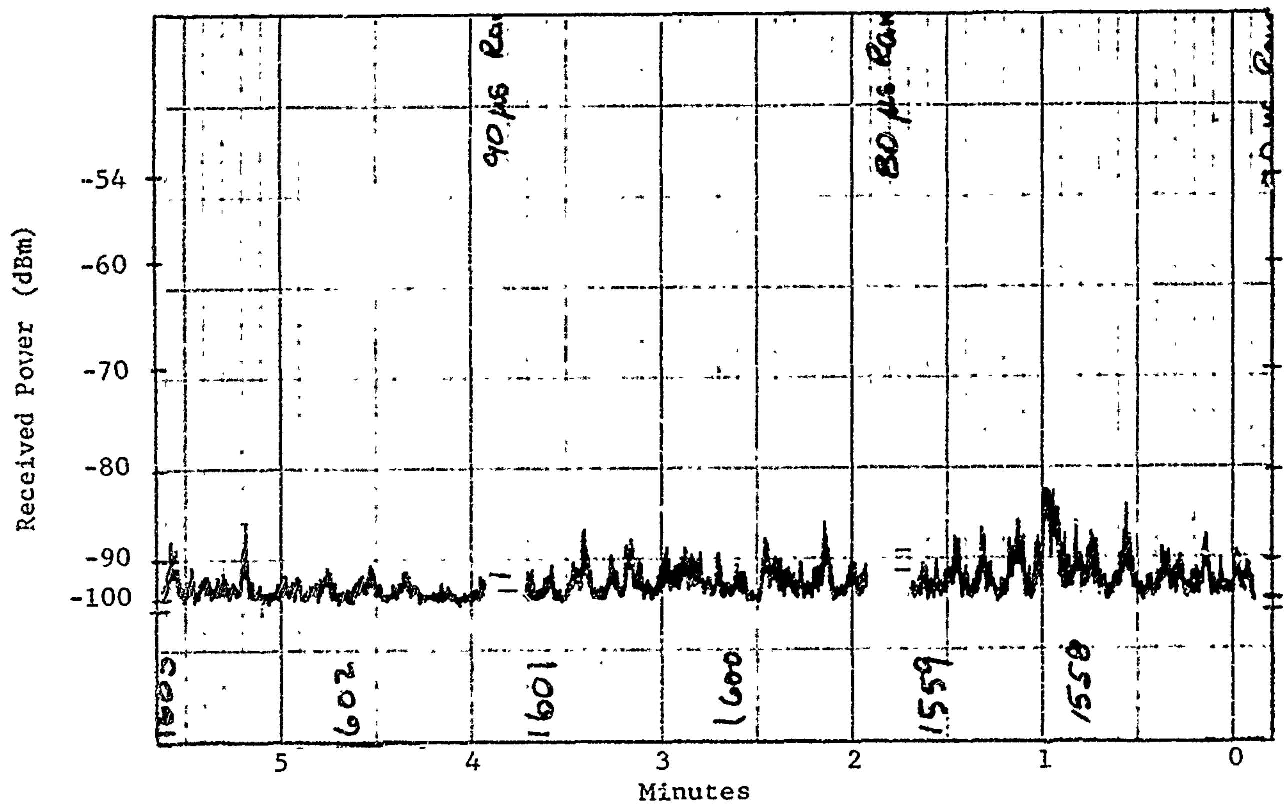

Figure B-32. Strip chart playout of sea return at 5.83 nmi, 6.67 nmi, and 7.5 nmi, HH polarization.

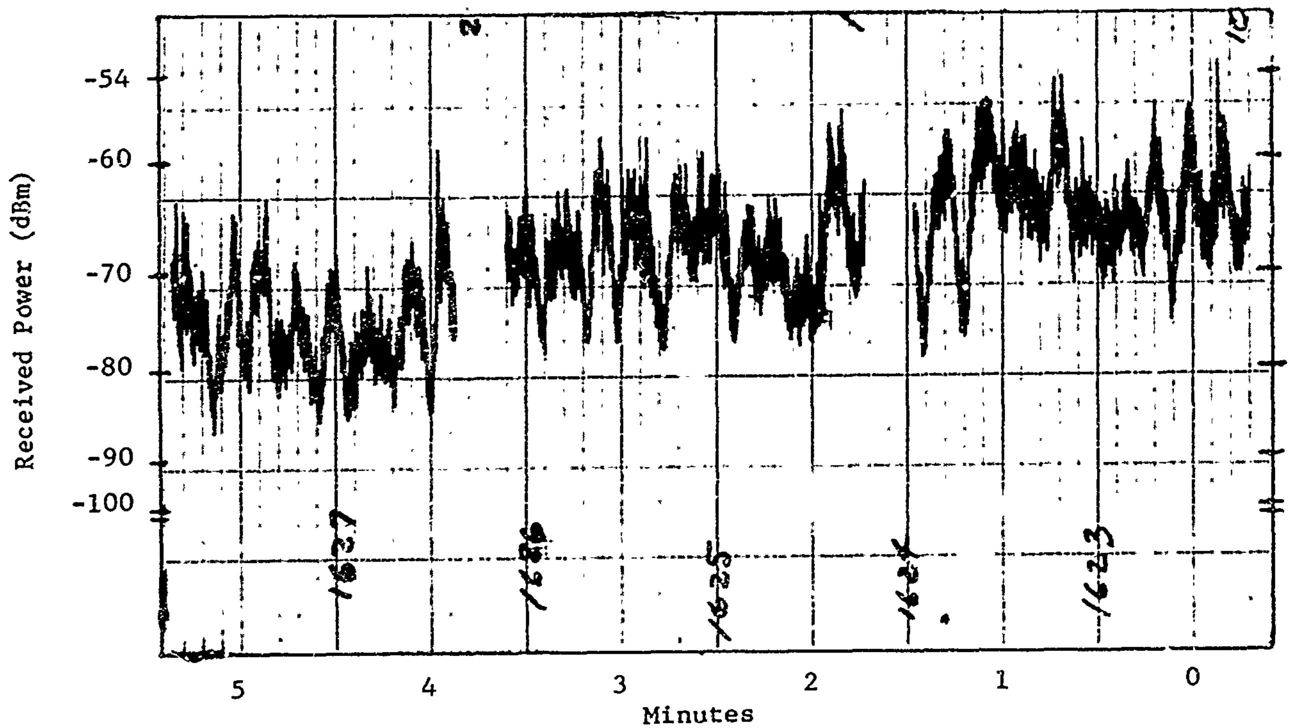

Figure B-33. Strip chart playout of sea return at 0.833 nmi, 1.25 nmi, and 1.67 nmi, VV polarization.

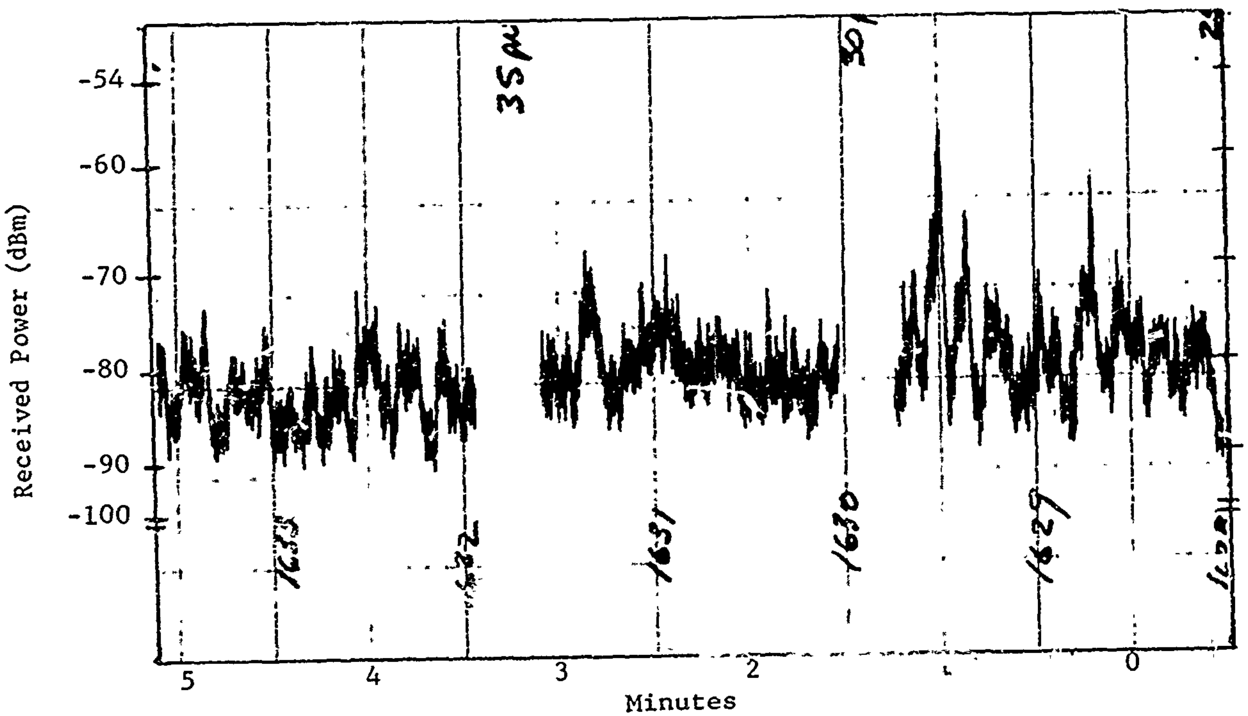

Figure B-34. Strip chart playout of sea return at 2.08 2.5 nmi, and 2.92 nmi, VV polarization.

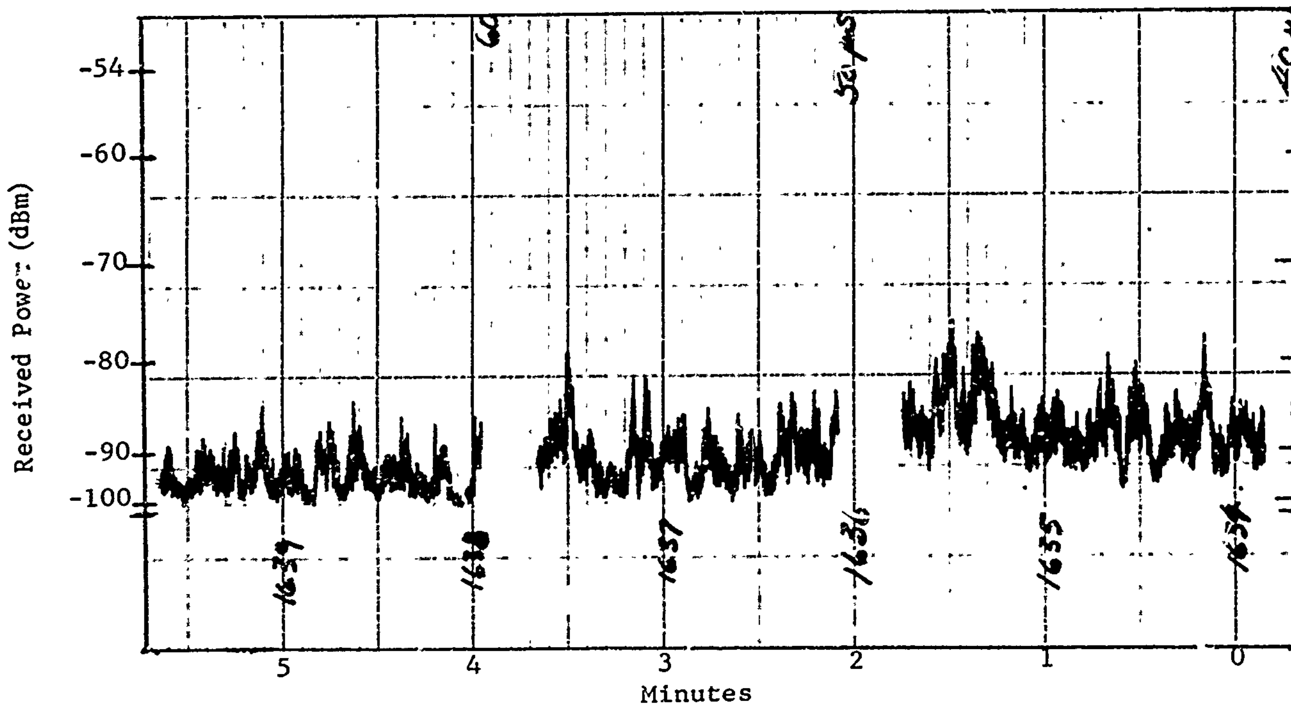

Figure B-35. Strip chart playout of sea return at 3.3 nmi, 4.17, and 5.0 nmi, VV polarization.

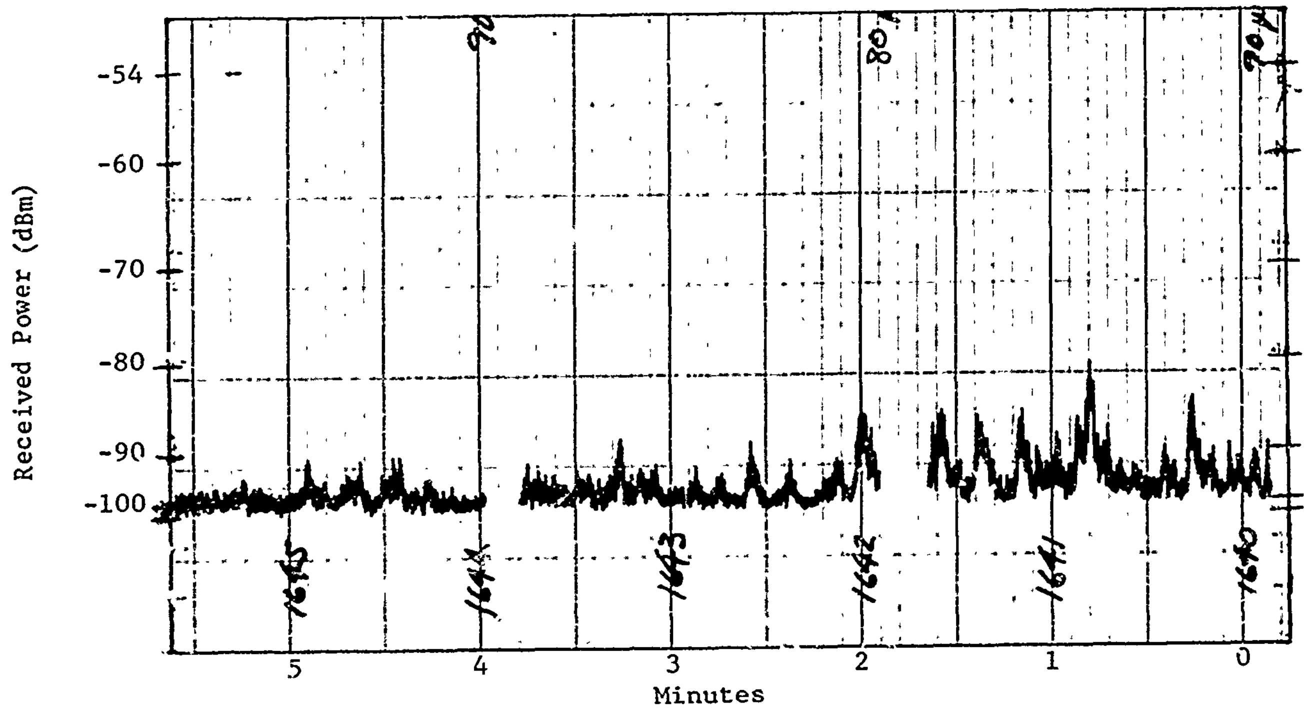

Figure B-36. Strip Chart playout of sea return at 5.83 nmi, 6.67 nmi, and 7.5 nmi, VV polarization.

APPENDIX C

Tabulated Raw Data

This appendix presents in table form all the valid measurements made on the AN/APS-119 radar during the ground tests. The data is organized by type, as follows: (1) cross-section data, (2) MDS in receiver noise, (3) MDS in clutter, and (4) sea-return data.

1. Cross-Section Data

Table C-1 gives all the cross-section data measured on the AN/APS-119, ordered first by date of measurement and then by target. The measured peak and average power return is listed next to the calculated peak and average cross-section for the targets. This data is utilized in Figures 23, 24, 25, and 26. It should be noted that in generating the figures, data measured in January 1973 was emphasized because the radar was operating reliably during this period.

2. MDS in Receiver Noise

Table C-2 lists all the MDS in receiver noise data obtained on the AN/APS-119, ordered, first by date of measurement, and then by display type. The measured signal level for MDS is given next to the calculated signal-to-noise ratio for each type of display. This data is incorporated in Figures 17, 18, 19, 20, 21, and 22.

3. MDS in Clutter

Table C-3 presents all the MDS in sea clutter data measured on the AN/APS-119 radar. This data is ordered first by display type and then by date of measurement. For each measurement the experimentally-determined values of signal generator level for MDS and measured clutter level are recorded along with the calculated signal-to-clutter ratio. This data is included in Figures 19, 20, 21, and 22.

4. Sea-Return Data

Table C-4 gives all of the data obtained on sea return during the ground tests, ordered by date of measurement. The measured values for peak and average received power are listed along with the calculated values of cross-section and $\sigma°$. Part of this data is plotted in Figures 27, 28, and 29.

Preceding page blank

TABLE C-1

Cross-Section Data

NOVEMBER 1972				PULSE			TILT	d BM SIGN. LEVEL		dBSM CROSS SEC.		WEATHER COMMENTS
DATE	TIME	TARGET	RANGE	LENGTH	P.R.F.	POL.	ANGLE	PEAK	AVE.	PEAK	AVE	
11-16	14:33	BUOY I	1.6	0.2	1.8	V		64	72	-7.5	-15.5	
11-16	14:36	" "	1.6	0.2	1.8	H		67	77	-10.5	-20.5	
11-16	14:42	" "	1.6	0.1	3.5	H		70	77	-13.5	-20.5	
11-16	14:46	" "	1.6	0.1	3.5	V		72	78	-15.5	-21.5	
11-16	14:49	" "	1.6	0.4	0.9	V		60	67	-3.5	-10.5	
11-16	14:59	" "	1.6	0.4	0.9	H		63	70	-6.5	-13.5	
11-17	09:35	" "	1.5	0.1	3.5	H		67	77	-13	-23	
11-17	09:38	" "	1.5	0.1	3.5	V		67	75	-13	-21	
11-17	09:43	" "	1.5	0.2	1.8	V		66	76	-12	-22	
11-17	09:46	" "	1.5	0.2	1.8	H		65	73	-11	-19	
11-17	09:47	" "	1.5	0.4	0.9	H		65	73	-11	-19	
11-17	09:50	" "	1.5	0.4	0.9	V		64	70	-10	-16	
11-16	15:27	BUOY II	2.4	0.1	3.5	V		73	80	-3	-10	
11-16	15:33	" "	2.4	0.1	3.5	H		72	78	-2	-8	
11-16	15:36	" "	2.4	0.2	1.8	H		71	79	-1	-9	
11-16	15:51	" "	2.4	0.1	3.5	V		71	79	-1	-9	
11-16	15:56	" "	2.4	0.1	3.5	H		72	80	-2	-10	
11-16	16:00	" "	2.4	0.2	1.8	H		69	76	+1	-6	
11-16	16:04	" "	2.4	0.2	1.8	V		68	75	+2	-5	
11-16	16:09	" "	2.4	0.4	0.9	V		67	74	+3	-4	
11-16	16:13	" "	2.4	0.4	0.9	H		67	75	+3	-5	

TABLE C-1

Cross-Section Data (Cont.)

NOVEMBER 1972				PULSE			TILT	d BM SIGN LEVEL		dBSM CROSS SEC.		WEATHER COMMENTS
DATE	TIME	TARGET	RANGE	LENGTH	P.R.F.	POL.	ANGLE	PEAK	AVE.	PEAK	AVE.	
11-17	10:16	BUOY II	2.5	0.1	3.5	V	-	73	81	-2	-10	
11-17	10:20	" "	2.5	0.1	3.5	H	-	75	83	-4	-12	
11-17	10:21	" "	2.5	0.2	1.8	H	-	69	77	+2	-6	
11-17	10:25	" "	2.5	0.2	1.8	H	-	72	78	-1	-7	
11-17	10:26	" "	2.5	0.4	0.9	H	-	72	78	-1	-7	
11-17	10:29	" "	2.5	0.4	0.9	V	-	70	80	+1	-9	
DEC	1972											
12-5	14:28	SMALL	2.1	0.2	1.8	H	+3°	73	84	-8	-17	CLEAR
12-5	14:35	BOAT	2.2	0.2	1.8	V	-15°	74	33	-7	-16	"
12-5	14:42	14'	2.3	0.4	0.9	V	+3°	73	82	-5	-14	"
12-5	15:[illegible]	"	2.5	0.2	1.8	H	+3°	73	82	-2	-11	"
12-5	15:37	"	2.6	0.2	1.8	V	+3°	76	84	4.5	-11.5	"
12-5	15:37	"	2.6	0.4	0.9	V	+3°	83	90	-10.5	-17.5	"
12-5	14:37	"	2.2	0.4	0.9	H	+3°	77	86	-10	-19	
12-5	15:43	"	2.6	0.4	0.9	H	+3°	75	85	-2.5	-12.5	
12-5	14:31	LARGE	2.3	0.2	1.8	H	+3°	-34	-44	+34	+24	CLEAR
12-5	14:32	BOAT	2.3	0.2	1.8	V	+3°	-34	-44	+34	+24	
12-5	14:40	83'	2.4	0.4	0.9	H	+3°	-30	-40	+39.5	+29.5	
12-5	14:49	"	2.4	0.4	0.9	V	+3°	-30	-40	+39.5	+29.5	

TABLE C-1

Cross-Section Data (Cont.)

DECEMBER 1972				PULSE			TILT	d BM SIGN. LEVEL		dBSM CROSS SEC.		WEATHER COMMENTS
DATE	TIME	TARGET	RANGE	LENGTH	P.R.F.	POL.	ANGLE	PEAK	AVE.	PEAK	AVE.	
12-7	10:02	BUOY	1.1	0.2	3.5	H	+4°	-67	-70	-24	-27	CLEAR WIND 15-20 MPH - NW
12-7	10:32	"	2.6	0.2	3.5	V	+4°	85	90	-12	-17	
12-7	10:39	"	2.6	0.2	3.5	H	+4°	88	90	-15	-17	
JAN.	1973											
1-11	12:10	14' BOAT	1.3	0.2	3.5	V	+3°	63	73	-13	-23	BROAD SIDE
"	12:13	BOW ON	1.3	0.2	3.5	V	+3°	68	76	-18	-26	WIND 15 MPH NNW
"	12:15	STERN	1.3	0.2	3.5	V	+3°	62	71	-12	-21	2-3' SWELL
"	12:19	BROADS	1.3	0.2	3.5	V	+3°	64	72	-14	-22	2 MEN IN 14' BOAT
"	12:22	LENS	1.3	0.2	3.5	V	+3°	62	69	-12	-19	BOAT & LENS -3 1/2'
"	12:32	BLANKET	1.3	0.2	3.5	V	+3°	65	72	-15	-22	BROADSIDE BOAT & BLANKET
"	12:40	"	1.3	0.2	3.5	H	+3°	65	72	-15	-22	" " "
"	12:45	LENS	1.3	0.2	3.5	H	+3°	61.5	68	-11.5	-18	BOW BOAT & LENS 3 1/2'
"	12:47	LENS	1.3	0.2	3.5	H	+3°	62	72	-12	-22	STERN BOAT & LENS 3 1/2'
"	12:50	LENS	1.3	0.2	3.5	H	+3°	62	68	-12	-18	BROAD SIDE & LENS 3 1/2'
"	12:56	FOIL	1.3	0.2	3.5	H	+3°	67	76	-17	-26	BROAD SIDE & FOIL
"	12:58	FOIL	1.3	0.2	3.5	V	+3°	67	74	-17	-24	BROAD SIDE & FOIL
1-11	13:05	CORNER	1.3	0.2	3.5	V	+3°	61	69	-11	-19	BROAD SIDE & CORNER
1-12	12:00	14' BOAT	1.9	0.2	3.5	V	+3°	68	76	-6	-14	2 MEN IN 14' BOAT
"	12:10	BOW	1.9	0.2	3.5	V	+3°	72	78	-10	-16	BOW BOAT 2 MEN
	12:15	LENS	1.9	0.2	3.5	V	+3°	68	72	-6	-10	BOW BOAT & LENS 3 1/2'
	12:20	STERN	1.9	0.2	3.5	V	+3°	-73	-79	-11	-17	

TABLE C-1

Cross-Section Data (Cont.)

JANUARY 1973				PULSE			TILT	dBM SIGN LEVEL		dBSM CROSS SEC.		WEATHER COMMENTS
DATE	TIME	TARGET	RANGE	LENGTH	P.R.F.	POL.	ANGLE	PEAK	AVE.	PEAK	AVE.	
1-12	11:30	BOAT 40'	1.8	0.2	3.5	V	+3°	66.5	75	-13.5	-22	BOW, WIND 15 MPH
1-12	11:32	BROADSIDE	1.8	0.2	3.5	V	+3°	55	61	-2	-8	2-3 FT SWELL
1-12	11:46	STERN	1.8	0.2	3.5	V	+3°	30	53	+23	0	NNW

TABLE C-2

MDS In Noise Data

NOVEMBER 1972 DATE	TIME	DISPLAY	RANGE	PULSE LENGTH	KH_z P.R.F	POL.	SCAN RATE	TILT ANGLE	INT TIME	SIG. GEN. LEVEL dBM	SIG. NOISE RATIO dB	WEATHER COMMENTS
11-3	08:00	"A"SCOPE	-	0.1	7.0	H	-	-	NA	88	14	
11-3	-	"	-	0.2	3.5	H	-	-	NA	89	13	
11-3	-	"	-	0.4	1.8	H	188	-	NA	87	15	
11-3	-	"	-	0.8	0.9	H	88	-	NA	79	23	
11-3	-	"	-	0.8	0.45	H	40	-	NA	79	23	
11-8	14:50	"	-	0.1	7.0	H	-	-	NA	97	5.0	WIND 25-35 MPH
11-8	-	"	-	0.2	3.5	H	-	-	"	94	8.0	RAIN
11-8	-	"	-	0.4	1.8	H	-	-	"	93	9.0	2-3 FT WAVES
11-8	-	"	-	0.8	0.9	H	-	-	"	96	6.0	
11-8	-	"	-	0.8	0.45	H	-	-	NA	95	7.0	
11-9	10:00	SCAN CONV. I	-	0.1	7.0	H	-		10 Sec	98	4.0	CLOUDY
11-9	-	"	-	0.2	3.5	H	220		10 Sec	96.5	5.5	WIND 25 MPH W
11-9	-	"	-	0.4	1.8	H	160		10 Sec	95	7.0	2 FT WAVES
11-9	-	"	-	0.8	0.9	H	85		10 Sec	93	9.0	
11-9	-	"	-	0.8	0.9	H	35		10 Sec	88.5	13.5	
11-10	09:45	"	-	0.1	7.0	H	-		10 Sec	95	7.0	CLOUDY
11-10	-	"	-	0.2	3.5	H	212		10 Sec	91	11.0	WIND 0-10 N
11-10	-	"	-	0.4	1.8	H	160		10 Sec	89	13	1-2 FT WAVES
11-10	-	"	-	0.8	0.9	H	80		10 Sec	89	13	
11-10	-	"	-	0.8	0.9	H	35		10 Sec	91	11.0	

TABLE C-2

MDS In Noise Data (Cont.)

NOVEMBER 1972 DATE	TIME	DISPLAY	RANGE	PULSE LENGTH	KH$_z$ P.R.F.	POL.	SCAN RATE	TILT ANGLE	INT TIME	SIG. GEN. LEVEL dBM	SIG. NOISE RATIO dB	WEATHER COMMENTS
11-10	11:20	D.V.S.T.	--	0.2	3.5	V	212	-	MIN	81	21	CLOUDY WAVES 1-2 FT
11-10	-	"B"SCOPE		0.4	1.8	V	160	-	MIN	80	22	WIND 0-10 N
DEC.	1972											
12-5	16:05	"	6.6	0.2	3.5	H	240	+3°	MAX	102	0	
NOV.	1972											
11-10	10:20	SCAN	6	0.1	7.0	V	240	-	MIN	98	4.0	CLOUDY WAVES 1-2 FT
11-10		CONV.I	6	0.2	3.5	V	212	-	MIN	92	10.0	Wind 0-10 N
11-10		"	6	0.4	1.8	V	160	-	MIN	89	13	
11-10		"	6	0.1	7.0	V	240	-	1 SEC.	95	7.0	
11-10		"	6	0.2	3.5	V	212	-	1 SEC.	94	8.0	
11-10		"	6	0.4	1.8	V	160	-	1 SEC.	93	[illegible]	
11-10		"	6	0.2	3.5	V	212	-	3 SEC.	93	9.0	
11-10		"	6	0.4	1.8	V	160	-	3 SEC	97	5.0	
11-10		"	6	0.1	7.0	V	240	-	10 SEC	93.5	8.5	
11-10		"	6	0.2	3.5	V	212	-	10 SEC	90	12.0	
11-10		"	6	0.4	1.8	V	160	-	10 SEC	96	6.0	
11-10	11:20	"	6	0.1	7.0	V	240	-	MIN	86	16.0	
11-10	11:20	"	6	0.2	3.5	V	212	-	MIN	87	15.0	
11-10	11:20	"	6	0.4	1.8	V	160	-	MIN	69	33	?
11-21		"	6	0.2	3.5	-	240	-	MIN	95.5	6.5	
11-21		"	6	0.2	3.5	-	240	-	1 SEC.	97	5.0	

TABLE C-2

MDS In Noise Data (Cont.)

NOVEMBER 1972										SIG. GEN. LEVEL dBM	SIG. NOISE RATIO d B	
DATE	TIME	DISPLAY	RANGE	PULSE LENGTH	KH_z P.R.F	POL.	SCAN RATE	TILT ANGLE	INT TIME			WEATHER COMMENTS
11-21	-	"A"SCOPE	-	0.1	7.0	-	-	-	-	99	3.0	
11-21	-	"	-	0.1	7.0	-	-	-	-	99.5	2.5	
11-21	-	"	-	0.2	3.5	-	-	-	-	101	1.0	
11-21	-	"	-	0.2	3.5	-	-	-	-	99	3.0	
11-21	-	"	-	0.4	1.8	-	-	-	-	99	3.0	
11-21	-	"	-	0.4	1.8	-	-	-	-	100	2.0	
11-21	-	"	-	0.8	0.9	-	-	-	-	90	12.0	
11-21	-	"	-	0.8	0.9	-	-	-	-	99	3.0	
11-21	-	"	-	0.8	0.45	-	-	-	-	96	6.0	
11-21	-	"	-	0.8	0.45	-	-	-	-	99	3.0	
DEC	1972	"										
12-5	-	"	6.6	0.4	1.8	H	-	+3°	-	98	4.0	CLEAR
12-5	-	"	6.6	0.8	0.9	H	-	+3°	-	96	6.0	
12-5	-	"	6.6	0.4	0.9	H	-	+3°	-	98	4.0	
12-5	-	"	6.6	0.2	3.5	H	-	+3°	-	99	3.0	
12-5	-	"	6.6	0.2	3.5	H	-	+3°		97	5.0	
NOV.	1972											
11-10	10:20	D.V.S.T	6.0	0.1	7.0	V	240	-	MIN	99	3.0	WIND 0-10 N
11-10	-	P.P.I.	6.0	0.2	3.5	V	212	-	MIN	96	6.0	WAVES 1-2 FT
11-10	-	"	6.0	0.4	1.8	V	160	-	MIN	86	16.0	CLOUDY
11-10	-	"	6.0	0.1	7.0	V	240	-	1 Sec	96	6.0	

TABLE C-2

MDS In Noise Data (Cont.)

JANUARY 1973 DATE	TIME	DISPLAY	RANGE	PULSE LENGTH	KH_z P.R.F	POL.	SCAN RATE	TILT ANGLE	INT TIME	SIG. GEN. LEVEL dBM	SIG. NOISE RATIO dB		WEATHER COMMENTS
1-9	-	SCAN	7	0.4	1.8	V	240	+3°	10 Sec	92	10.0	5.0	FTC ON
1-9	-	CONV. II	7	0.4	1.8	V	24C	+3°	10 Sec	93	9.0	10.0	" "
1-9	-	D.V.S.T.	7	0.8	0.9	V	60	+3°	MAX	96	6.0	0.4	FTC ON
1-9	-	"B"SCOPE	7	0.8	0.9	V	60	+3°	MAX	94	8.0	1.0	SIG. GEN.
1-9	-	"	7	0.8	0.9	V	60	+3°	MAX	92	10.0	5.0	PULSE LENGTH
1-9	-	"	7	0.8	0.9	V	60	+3°	MAX	88	14.0	10.0	VS. SYSTEM
1-9	-	"	7	0.4	1.8	V	240	+3°	"	94	8.0	0.4	MDS NOISE
1-9	-	"	7	0.4	1.8	V	240	+3°	MAX	95	7.0	1.0	" "
1-9	-	"	7	0.4	1.8	V	240	+3°	MAX	95	7.0	5.0	" "
1-9	-	"	7	0.4	1.8	V	240	+3°	"	90	12.0	10.0	" "
1-9	-	"	7	0.2	3.5	V	240	+3°	"	99	3.0	0.4	" "
1-9	-	"	7	0.2	3.5	V	240	+3°	"	102	0.0	1.0	" "
1-9	-	"	7	0.2	3.5	V	240	+3°	"	98	4.0	5.0	" "
1-9	-	"	7	0.2	3.5	V	240	+3°	MAX	95	7.0	10.0	" "
1-9	-	"	7	0.1	7.0	V	240	+3°	"	103	-1.0	0.4	" "
1-9	-	"	7	0.1	7.0	V	240	+3°	MAX	103	-1.0	1.0	" "
1-9	-	"	7	0.1	7.0	V	240	+3°	MAX	100	2.0	5.0	" "
1-9	-	"	7	0.1	7.0	V	240	+3°	MAX	100	2.0	10.0	" "
1-9	-	"	7	0.1	7.0	V	240	+3°	"	100	2.0	0.4	FTC OFF
1-9	-	"	7	0.1	7.0	V	240	+3°	MAX	103	-1.0	1.0	" "
1-9	-	"	7	0.1	7.0	V	240	+3°	MAX	104	-2.0	5.0	" "

TABLE C-2

MDS In Noise Data (Cont.)

JANUARY 1973													
DATE	TIME	DISPLAY	RANGE	PULSE LENGTH	KH_z P.R.F.	POL.	SCAN RATE	TILT ANGLE	INT TIME	SIG. GEN. LEVEL dBM	SIG. NOISE RATIO dB	SIG. GEN. PULSE LENGTH	WEATHER COMMENTS
1-9	-	D.V.S.T.	7	0.1	7.0	V	240	+3°	MAX	105	-3.0	10 USec	F.T.C. OFF
1-9	-	"B"SCOPE	7	0.2	3.5	V	240	+3°	MAX	99	3.0	0.4	
1-9	-	" "	7	0.2	3.5	V	240	+3°	MAX	103	-1.0	1.0	SIG. GEN.
1-9	-	" "	7	0.2	3.5	V	240	+3°	MAX	103	-1.0	5.0	PULSE LENGTH
1-9	-	" "	7	0.2	3.5	V	240	+3°	MAX	101	1.0	10.0	VS. SYSTEM
1-9	-	" "	7	0.4	1.8	V	240	+3°	"	96	6.0	0.4	MDS IN. NOISE
1-9	-	" "	7	0.4	1.8	V	240	+3°	MAX	96	6.0	1.0	
1-9	-	" "	7	0.4	1.8	V	240	+3°	"	100	2.0	5.0	
1-9	-	" "	7	0.4	1.8	V	240	+3°	MAX	97	5.0	10.0	
1-9	-	" "	7	0.8	0.9	V	60	+3°	MAX	93	9.0	0.4	
1-9	-	" "	7	0.8	0.9	V	60	+3°	"	94	8.0	1.0	
1-9	-	" "	7	0.8	0.9	V	60	+3°	MAX	97	5.0	5.0	
1-9	-	" "	7	0.8	0.9	V	60	+3°	MAX	92	10.0	10.0	
1-19	-	SCAN	7.6	0.1	7.0	H	240	+3°	3 Sec	94	8.0	0.1	FTC ON.
1-19	-	CONV.II	6.0	0.1	7.0	H	240	+3°	3 Sec	94	8.0	0.1	
1-19	-	" "	6.4	0.1	7.0	H	240	+3°	3 Sec	96	6.0	0.2	
1-19	-	" "	6.4	0.1	7.0	H	240	+3°	3 Sec	95	7.0	0.2	
1-19	-	" "	6.4	0.1	7.0	H	240	+3°	3 Sec	96	6.0	0.2	
1-19	-	" "	6.4	0.1	7.0	H	240	+3°	3 Sec	99	3.0	0.4	
1-19	-	" "	6.4	0.1	7.0	H	240	+3°	3 Sec	96	6.0	0.4	

TABLE C-2

MDS In Noise Data (Cont.)

NOVEMBER 1972												
DATE	TIME	DISPLAY	RANGE	PULSE LENGTH	KH_z P.R.F	POL.	SCAN RATE	TILT ANGLE	INT TIME	SIG. GEN. LEVEL dBM	SIG. NOISE RATIO dB	WEATHER COMMENTS
11-21	-	SCAN	6	0.2	3.5	-	240	-	3 Sec	99	3.0	
11-21	-	CONV. I	6	0.2	3.5	-	240	-	10 Sec	98	4.0	
11-21	-	"	40	0.4	1.8	-	120	-	MIN	89	13	
11-21	-	"	40	0.4	1.8	-	120	-	1	90.5	11.5	
11-21	-	"	40	0.4	1.8	-	120	-	3	91.5	10.5	
11-21	-	"	40	0.4	1.8	-	120	-	10	92	10.0	
DEC	1972											
12-5	15:59	"	6.6	0.2	3.5	H	240	+3°	3 Sec	99	3.0	CLEAR
12-5	16:07	"	6.6	0.2	3.5	H	240	+3°	1 Sec	97	5.0	
12-5	16:26	"	6.6	0.2	3.5	H	240	+3°	10 Sec	99	3.0	
JAN	1973											
1-3	11:48	SCAN	8.9	0.2	3.5	H	240	+3°	MIN	90	12.0	
1-8	17:18	CONV. II	6.9	0.2	3.5	C	240	+3°	3 Sec	91	11.0	
1-8	17:21	"	6.9	0.2	3.5	C	240	+3°	1 Sec	90	12.0	
1-8	17:24	"	7.1	0.2	3.5	C	240	+3°	MIN	89	13.0	
1-19	-	"	4.6	0.2	3.5	H	240	+3°	3 Sec	94.5	7.5	BROKEN CLOUDS
1-19	-	"	7.6	0.2	3.5	H	240	+3°	3 Sec	95.5	6.5	10 KNOT WINDS
1-19	-	"	6.5	0.2	3.5	H	240	+3°	3 Sec	95.5	[illegible].5	
1-19	-	"	6.6	0.2	3.5	H	240	+3°	3 Sec	96.5	5.5	
1-19	-	"	7.6	0.2	3.5	H	240	+3°	3 Sec	96.5	5.5	
1-19	-	"	7.4	0.2	3.5	H	240	+3°	3 Sec	94.5	7.5	

TABLE C-2

MDS In Noise Data (Cont.)

JANUARY 1973 DATE	TIME	DISPLAY	RANGE	PULSE LENGTH	KH$_z$ P.R.F.	POL.	SCAN RATE	TILT ANGLE	INT TIME	SIG. GEN. LEVEL dBM	SIG. NOISE RATIO dB	SIG. GEN. PULSE LENGTH	WEATHER COMMENTS
1-9	12:30	SCAN	7	0.1	7	V	240	+3°	10 Sec	94	8.0	0.4	SIGNAL GEN.
1-9	-	CONN II	7	0.1	7	V	240	+3°	10 Sec	97	5.0	104Se	PULSE LENGTH
1-9	-	"	7	0.1	7	V	240	+3°	10 Sec	97	5.0	5.0	VS. SYSTEM
1-9	-	"	7	0.1	7	V	240	+3°	10 Sec	97	5.0	10.0	MDS IN NOISE
1-9	-	"	7	0.2	3.5	V	240	+3°	10 Sec	96	6.0	0.4	FTC. ON.
1-9	-	"	7	0.2	3.5	V	240	+3°	10 Sec	97	5.0	1.0	
1-9	-	"	7	0.2	3.5	V	240	+3°	10 Sec	95	7.0	5.0	
1-9	-	"	7	0.2	3.5	V	240	+3°	10 Sec	97	5.0	10	
1-9	-	"	7	0.4	1.8	V	240	+3°	10 Sec	98	4.0	0.4	
1-9	-	"	7	0.4	1.8	V	240	+3°	10 Sec	97	5.0	1.0	
1-9	-	"	7	0.4	1.8	V	240	+3°	10 Sec	91	11.0	5	
1-9	-	"	7	0.4	1.8	V	240	+3°	10 Sec	93	9.0	10	
1-9	-	"	7	0.8	0.9	V	60	+3°	10 Sec	90	12.0	0.4	
1-9	-	"	7	0.8	0.9	V	60	+3°	10 Sec	90	12.0	1.0	
1-9	-	"	7	0.8	0.9	V	60	+3°	10 Sec	86	16.0	5	
1-9	-	"	7	0.8	0.9	V	60	+3°	10 Sec	92	10.0	10	
1-9	-	"	7	0.1	7	V	240	+3°	10 Sec	93	9.0	0.4	FTC. OFF
1-9	-	"	7	0.1	7	V	240	+3°	10 Sec	97	5.0	1.0	
1-9	-	"	7	0.1	7	V	240	+3°	10 Sec	99	3.0	5.0	
1-9	-	"	7	0.1	7	V	240	+3°	10 Sec	101	1.0	10.0	
1-9	-	"	7	0.2	3.5	V	24	+3°	10 Sec	93	9.0	0.4	

TABLE C-2

MDS In Noise Data (Cont.)

JANUARY 1973 DATE	TIME	DISPLA	RANGE	PULSE LENGTH	KH$_z$ P.R.F.	POL.	SCAN RATE	TILT ANGLE	INT TIME	SIG. GEN. LEVEL dBM	SIG. NOISE RATIO dB	SIG. GEN. PULSE LENGTH U Sec	WEATHER COMMENTS
1-9	-	SCAN	7	0.2	3.5	V	240	+3°	10 Sec	95	7.0	1.0	FTC OFF
1-9	-	CONV. II	7	0.2	3.5	V	240	+3°	10 Sec	100	2.0	5	SIG. GEN.
1-9	-	" "	7	0.2	3.5	V	240	+3°	10 Sec	101	1.0	10	PULSE LENGTH
1-9	-	" "	7	0.4	1.8	V	240	+3°	10 Sec	94	8.0	0.4	VS. SYSTEM
1-9	-	" "	7	0.4	1.8	V	240	+3°	10	95	7.0	1.0	MDS IN NOISE
1-9	-	" "	7	0.4	1.8	V	240	+3°	10	98	4.0	5.0	FTC OFF
1-9	-	" "	7	0.4	1.8	V	240	+3°	10	99	3.0	10.0	" "
1-9	-	" "	7	0.8	0.9	V	60	+3°	10	91	11.0	0.4	
1-9	-	" "	7	0.8	0.9	V	60	+3°	10	91	11.0	1.0	
1-9	-	" "	7	0.8	0.9	V	60	+3°	10	95	7.0	5.0	
1-9	-	" "	7	0.8	0.9	V	60	+3°	10	98	4.0	10.0	
1-9	-	" "	7	0.1	7.0	V	240	+3°	10 Sec	94	8.0	0.4	FTC ON
1-9	-	" "	7	0.1	7.0	V	240	+3°	10 Sec	97	5.0	1.0	SIG. GEN.
1-9	-	" "	7	0.1	7.0	V	240	+3°	10 Sec	94	8.0	5.0	PULSE LENGTH
1-9	-	" "	7	0.1	7.0	V	240	+3°	10 Sec	97	5.0	10.0	VS. SYSTEM
1-9	-	" "	7	0.2	3.5	V	240	+3°	10 Sec	94	8.0	0.4	MDS IN NOISE
1-9	-	" "	7	0.2	3.5	V	240	+3°	10 Sec	99	3.0	1.0	"
1-9	-	" "	7	0.2	3.5	V	240	+3°	10 Sec	91	1.0	5.0	THRESHOLD =1
1-9	-	" "	7	0.2	3.5	V	240	+3°	10 Sec	97	5.0	10.5	
1-9	-	" "	7	0.4	1.8	V	240	+3°	10 Sec	94	8.0	0.4	
1-9	-	" "	7	0.4	1.8	V	240	+3°	10 Sec	99	3.0	1.0	

TABLE C-2

MDS In Noise Data (Cont.)

JANUARY 1973													
DATE	TIME	DISPLAY	RANGE	PULSE LENGTH	KH_z P.R.F.	POL.	SCAN RATE	TILT ANGLE	INT TIME	SIG. GEN. LEVEL dBM	SIG. NOISE RATIO dB	SIG. GEN. PULSE LENGTH U Sec.	WEATHER COMMENTS
1-19	-	SCAN	6.4	0.1	7.0	H	240	+3°	3 Sec	98	4.0	0.4	
1-19	-	CONV.II	6.4	0.1	7.0	H	240	+3°	3 Sec	98	4.0	1.0	
1-19	-	"	6.4	0.1	7.0	H	240	+3°	3 Sec	98	4.0	1.0	
1-19	-	"	6.4	0.4	1.8	H	60	+3°	3 Sec	98	4.0	0.4	HEAVY RAIN
1-19	-	"	6.4	0.4	1.8	H	60	+3°	3 Sec	97	5.0	0.4	FTC OFF
1-19	-	"	6.4	0.4	1.8	H	60	+3°	3 Sec	100	2.0	0.4	" "
1-19	-	"	6.4	0.4	1.8	H	60	+3°	3 Sec	100	2.0	1.0	" "
1-19	-	"	6.4	0.4	1.8	H	60	+3°	3 Sec	101	1.0	1.0	" "
1-19	-	"	6.4	0.4	1.8	H	60	+3°	3 Sec	100	2.0	5.0	
1-19	-	"	6.4	0.4	1.8	H	60	+3°	3 Sec	101	1.0	5.0	
1-19	-	"	6.4	0.4	1.8	H	60	+3°	3 Sec	103	-1.0	10.0	
1-19	-	"	6.4	0.8	0.9	H	60	+3°	3 Sec	98	4.0	0.8	
1-19	-	"	6.4	0.8	0.9	H	60	+3°	3 Sec	100	2.0	1.0	TRANSMITTER OFF
1-19	-	"	6.4	0.8	0.9	H	60	+3°	3 Sec	105	-3.0	5.0	" "
1-19	-	"	6.4	0.8	0.9	H	60	+3°	3 Sec	108	-6.0	10.0	" "

TABLE C-3

MDS In Clutter Data

DECEMBER 1972 DATE	TIME	DISPLAY	RANGE	PULSE LENGTH	KH$_z$ P.R.F.	POL	SCAN RATE	TILT ANGLE	INT TIME	SIG. GEN. LEVEL dBM	CLUTTER LEVEL dBM	SIG. CLUTTER dB	WEATHER COMMENTS
12-6	10:15	D.V.S.T.	1.5	0.2	3.5	H	240	+4°	MIN	60	70	10	CLDY.
	10:18	P.P.I.	2.5	0.2	3.5	H	"	+4°	MIN	80	85	5	
	10:23	"	1.4	0.2	3.5	H	"	"	50%	60	65	5	
	10:25	"	1.4	0.2	3.5	H	"	"	50%	60	65	5	
	10:29	"	2.2	0.2	3.5	H	"	+4°	50%	80	86	6	
	10:34	"	1.0	0.2	3.5	H	"	+4°	MAX	60	65	5	
	10:38	"	2.3	0.2	3.5	H	"	"	MAX	80	85	5	
	11:04	"	1.7	0.4	1.8	V	"	"	50%	60	78	18	
	11:08	"	3.2	0.4	1.8	V	"	"	50%	80	90	10	
	14:08	"	1.8	0.2	3.5	H	"	+4°	50%	60	77	17	SCATTERED RAIN, 1-2 FT. WAVES
	14:11	"	2.8	0.2	3.5	H	240	"	50%	80	89	9	
	14:15	"	1.9	0.2	3.5	H	240	"	MAX	60	78	18	
12-6	14:22	"	2.8	0.2	3.5	H	240	+4°	MAX	80	83	[illegible]	
12-7	16:45	D.V.S.T.	1.7	0.2	3.5	V	240	+3°	MIN	80	96	16	FAIR WIND 15-20 MPH
		"B"SCOPE	1.0	0.2	3.5	V	240	+3°	50%	80	88	8	NW
		"	1.6	0.2	3.5	V	240	+3°	MIN	80	96	16	

TABLE C-3

MDS In Clutter Data (Cont.)

NOVEMBER 1972													
DATE	TIME	DISPLAY	Mi RANGE	PULSE LENGTH	KH_z P.R.F.	POL.	SCAN RATE	TILT ANGLE	INT TIME	SIG. GEN. LEVEL dBM	CLUTTER LEVEL dBM	SIG. CLUTTER dB	WEATHER COMMENTS
11-30	10:41	CONV. I	1.5	0.2	3.5	V	240°	0°	MIN	54	74	20	RAIN
"	10:49	"	2.31	0.2	3.5	V	240°	0°	MIN	70	82	12	25 MPH
11-30	14:42	"	2.80	0.2	3.5	V	240°	0°	MIN	80	90	10	HEAVY CLUTTER
"	15:24	"	1.81	0.2	3.5	H	"	+1°	MIN	60	67	7	
11-30	15:44	"	4.5	0.2	3.5	H	"	+1°	MIN	80	85	5	
"	15:55	"	1.4	0.2	3.5	V	"	+1°	1 Sec	54	64	10	
"	16:02	"	2.6	0.2	3.5	V	"	+1°	1 Sec	70	75	5	
11-30	16:11	"	3.9	0.2	3.5	V	240°	+1°	1 Sec	80	84	4	
11-30	16:18	"	1.2	0.2	3.5	H	"	+1°	1 Sec	60	68	8	CLDY.
12-6	09:18	"	1.3	0.2	3.5	H	"	+4°	MIN	60	68	8	
"	09:24	"	2.0	0.2	3.5	H	"	+4°	MIN	80	84	4	
"	09:29	"	1.4	0.2	3.5	H	"	+4°	1 Sec	60	70	10	
12-6	09:31	"	2.3	0.2	3.5	H	"	"	1 Sec	80	85	5	CLDY.
"	09:38	"	1.3	0.2	3.5	H	"	"	[illegible] Sec	60	70	10	
"	09:42	"	2.5	0.2	3.5	H	240°	+4°	3 Sec	80	88	8	
12-6	09:46	"	1.2	0.2	3.5	H	240°	+4°	10 Sec	60	68	8	
"	09:50	"	2.1	0.2	3.5	H	"	"	10 Sec	80	84	4	
"	09:56	"	1.3	0.2	3.5	V	240°	"	1 Sec	60	73	13	
"	10:01	"	2.1	0.2	3.5	V	"	"	1 Sec	80	85	5	
12-6	10:05	"	1.4	0.2	3.5	V	"	"	3 Sec	60	70	10	
"	10:09	"	2.6	0.2	3.5	V	240°	+4°	3 Sec	80	90	10	

TABLE C-3

MDS In Clutter Data (Cont.)

DECEMBER 1972 DATE	TIME	DISPLAY	RANGE	PULSE LENGTH	KH_z P.R.F	POL.	SCAN RATE	TILT ANGLE	INT TIME	SIG. GEN. LEVEL dBM	CLUTTER LEVEL dBM	SIG. CLUTTER dB	WEATHER COMMENTS
12-6	10:46	SCAN	1.4	0.4	1.8	V	240	+4°	1 Sec	60	70	10	CLDY.
"	10:50	CONV.I	2.8	0.4	1.8	V	"	"	1 Sec	80	84	4	
"	10:53	"	1.6	0.4	1.8	V	"	"	3 Sec	60	75	15	
"	10:58	"	2.1	0.4	1.8	V	240	+4°	3 Sec	80	84	4	
"	13:15	"	1.5	0.2	3.5	V	"	"	MIN	60	78	18	LIGHT RAIN
"	13:23	"	3.2	0.2	3.5	V	"	"	MIN	80	82	2	
"	13:28	"	1.6	0.2	3.5	V	240	"	1 Sec	60	70	10	
"	13:32	"	3.2	0.2	3.5	V	240	"	1 Sec	80	84	4	RAIN
"	13:35	"	1.8	0.2	3.5	V	"	"	3 Sec	60	72	12	
"	13:39	"	3.1	0.2	3.5	V	"	"	3 Sec	80	89	9	1-2 FT. WAVES
"	13:51	"	1.3	0.2	3.5	H	240	"	1 Sec	60	71	11	
"	13:54	"	2.0	0.2	3.5	H	"	"	1 Sec	70	78	8	
"	13:57	"	1.6	0.2	3.5	H	"	"	3 Sec	60	72	12	
12-6	14:01	"	2.7	0.2	3.5	H	240	"	3 Sec	80	89	9	
JAN	1973												
1-8	11:26	SCAN	0.8	0.2	3.5	H	240	+3°	MIN	60	75	15	WIND 15-20 MPH
"	11:36	CONV.II	2.0	0.2	3.5	H	"	"	MIN	80	86	6	NNE TEMP -15°
"	11:59	"	0.6	0.2	3.5	H	"	"	3 Sec	60	68	8	OVERCAST
"	1-:37	"	7.0	0.2	3.5	H	"	+3°	10 Sec	92	95	3	LIGHT SNOW
"	16:38	"	6.9	0.2	3.5	H	"	"	3 Sec	90	95	5	
1-8	16:40	"	6.9	0.2	3.5	H	240	+3°	1 Sec	88	95	7	

TABLE C-3

MDS In Clutter Data (Cont.)

JANUARY 1973													
DATE	TIME	DISPLAY	RANGE	PULSE LENGTH	KH_z P.R.F	POL.	SCAN RATE	TILT ANGLE	INT TIME	SIG. GEN. LEVEL dBM	CLUTTER LEVEL dBM	SIG. CLUTTER dB	WEATHER COMMENTS
1-8	16:49	SCAN	6.9	0.2	3.5	V	240	+3°	MIN	86	98	12	WIND 15-20 MPH
"	16:54	CONV.II	7.0	0.2	"	V	240	"	10 Sec	90	96	6	NNE
"	16:59	"	7.0	0.2	"	V	"	"	3 Sec	88	94	6	OVERCAST
"	17:03	"	6.9	0.2	"	V	"	"	1 Sec	87	93	6	LIGHT SNOW
"	17:07	"	7.1	0.2	3.5	V	"	"	MIN	87	95	8	" "
1-8	17:12	"	6.8	0.2	"	C	"	"	10 Sec	92	100	8	" "
1-9	09:15	"	1.5	0.2	3.5	H	240	+3°	MIN	60	83	23	WIND 12-15 MPH
1-9	09:34	"	1.9	0.2	"	H	"	+3°	MIN	80	87	7	NNE HAZY
1-9	09:43	"	0.7	0.2	"	H	240	"	3 Sec	60	76	16	TEMP -12°, 50% RELATIVE
"	09:49	"	1.8	0.2	3.5	H	"	"	3 Sec	80	89	9	HUMMIDITY
1-9	09:57	"	0.8	0.2	"	H	"	"	10 Sec	60	75	15	
"	10:09	"	1.2	0.2	"	H	"	"	10 Sec	80	86	6	
"	10:14	"	1.0	0.2	3.5	V	"	"	MIN	60	85	15	
"	10:22	"	1.6	0.2	"	V	240	"	MIN	80	95	15	
"	10:28	"	1.2	0.2	"	V	240	+3°	3 Sec	60	87	17	
1-9	10:34	"	1.5	0.2	3.5	V	240	"	3 Sec	80	90	10	
"	10:39	"	1.1	0.2	3.5	V	240	"	10 Sec	60	84	24	
1-9	10:46	"	1.5	0.2	3.5	V	240	"	10 Sec	80	90	10	
"	11:03	"	0.9	0.2	3.5	C	"	"	MIN	60	84	24	
"	11:08	"	1.6	0.2	3.5	C	240	"	MIN	80	92	12	
1-9	11:13	"	1.0	0.2	3.5	[illegible]	"	+3°	3 Sec	60	81	21	

TABLE C-3

MDS In Clutter Data (Cont.)

JANUARY 1973													
DATE	TIME	DISPLAY	RANGE	PULSE LENGTH	KHz P.R.F.	POL.	SCAN RATE	TILT ANGLE	INT TIME	SIG. GEN. LEVEL dBM	CLUTTER LEVEL dBM	SIG. CLUTTER dB	WEATHER COMMENTS
1-9	11:18	SCAN	1.5	0.2	3.5	C	240	+3°	3 Sec	80	89	9	WIND 12-15 MPH
1-9	11:24	CONV.II	0.8	0.2	3.5	C	240	+3°	10 Sec	60	79	19	NNE HAZY 12° TEMP
1-9	11:30	"	1.5	0.2	3.5	C	240	+3°	10 Sec	80	90	10	
1-20	09:18	"	4.8	0.2	3.5	H	240	+3°	3 Sec	91.5	100	8.5	WIND 20 MPH GUSTING
1-20	09:28	"	4.2	0.2	3.5	H	"	"	3 Sec	86.5	95	8.5	WNW CLUTTER TO
1-20	09:34	"	3.5	0.2	3.5	H	"	+3°	3 Sec	81.5	92	10.5	45 nmi.
"	09:38	"	2.8	0.2	3.5	H	"	"	3 Sec	76.5	88	11.5	
"	09:44	"	2.5	0.2	3.5	H	"	"	3 Sec	71.5	82	10.5	
1-20	09:50	"	1.9	0.2	3.5	H	240	+3°	3 Sec	66.5	78	11.5	
1-20	09:58	"	1.5	0.2	3.5	H	"	"	3 Sec	61.5	72	10.5	
1-20	10:14	"	4.5	0.2	3.5	H	"	"	3 Sec	90	98	8	
"	10:20	"	3.8	0.2	3.5	H	"	"	3 Sec	85	95	10	
"	10:24	"	3.0	0.2	3.5	H	"	"	3 Sec	80	89	9	
1-20	10:32	"	2.6	0.2	3.5	H		+3°	3 Sec	75	85	10	
"	10:38	"	2.3	0.2	3.5	H	"	"	3 Sec	70	84	14	
"	10:44	"	1.8	0.2	3.5	H	"	"	3 Sec	65	77	12	
"	10:50	"	1.4	0.2	3.5	H	"	"	3 Sec	60	70	10	
1-20	10:58	"	4.1	0.2	3.5	H	"	"	3 Sec	90	95	5	
1-20	11:10	"	3.1	0.2	3.5	H	"	"	3 Sec	85	88	3	
"	11:23	"	3.2	0.2	3.5	H	"	"	3 Sec	80	89	9	
1-20	11:31	"	2.6	0.2	3.5	H	"	+3°	3 Sec	75	84	9	

TABLE C-3

MDS In Clutter Data (Cont.)

JANUARY 1973													
DATE	TIME	DISPLAY	RANGE	PULSE LENGTH	KH_z P.R.F	POL.	SCAN RATE	TILT ANGLE	INT TIME	SIG. GEN. LEVEL dBM	CLUTTER LEVEL dBM	SIG. CLUTTER dB	WEATHER COMMENTS
1-20	11:39	SCAN	2.4	0.2	3.5	H	240	+3°	3 Sec	70	82	12	WIND 20 MPH
1-20	11:44	CONV.II	1.9	0.2	3.5	H	240	+3°	3 Sec	65	77	12	W.N.W.
1-20	11:52	"	1.6	0.2	3.5	H	240	+3°	3 Sec	60	72	12	

TABLE C-4

Sea Return Data

November 1972				PULSE			TILT	d BM SIGN. LEVEL		σ_o	DBSM		WEATHER COMMENTS
DATE	TIME	TARGET	RANGE	LENGTH	P.R.E	POL.	ANGLE	PEAK	AVE.		PEAK	AV	
11-16	16:31	CLUTTER	.2	0.1	3.5	H	STOW	54	60	-59	-39	-45	Az=155°
11-16	16:32	"	.4	0.1	3.5	H	"	77	79	-75	-50	-52	
11-16	16:34	"	.9	0.1	3.5	H	"	88	89	-81	-47	-48	
11-16	16:35	"	1.2	0.1	3.5	H	"	93	95	-83	-47	-49	
11-17	09:37	"	1.5	0.1	3.5	H	"	77	83	-63	-27	-33	
11-17	09:38	"	1.5	0.1	3.5	V	"	67	76	-53	-17	-26	
11-17	09:44	"	1.5	0.1	3.5	V	"	70	80	-56	-20	-30	
11-17	09:45	"	1.5	0.2	1.8	H	"	76	80	-64	-26	-30	
11-17	09:48	"	1.5	0.4	0.9	H	"	77	81	-65	-27	-31	
11-17	09:49	"	1.5	0.4	0.9	V	"	73	80	-59	-23	-30	
11-17	10:18	"	2.5	0.1	3.5	V	"	83	88	-66	-24	-29	
11-17	10:19	"	2.5	0.1	3.5	H	"	86	89	-69	-27	-30	
11-17	10:23	"	2.5	0.2	1.8	H	"	82	87	-65	-23	-28	
11-17	10:23	"	2.5	0.2	1.8	V	"	80	88	-63	-21	-29	
11-17	10:24	"	2.5	0.2	1.8	H	"	82	86	-65	-23	-27	
11-17	10:27	"	2.5	0.4	0.9	H	"	80	85	-63	-21	-26	
11-17	10:28	"	2.5	0.4	0.9	V	"	80	85	-63	-21	-26	
11-17	10:30	"	0.4	0.4	0.9	V	"	65	72	-63	-38	-45	Az-155° Clutter Profile
11-17	10:32	"	0.9	0.4	0.9	V	"	67	75	-64	-26	-34	
11-17	10:34	"	1.2	0.4	0.9	V	"	68	75	-57	-22	-29	
11-17	10:35	"	1.6	0.4	0.9	V	"	72	80	-58	-21	-29	
11-17	10:36	"	2.0	0.4	0.9	V	"	70	77	-54	-15	-22	

TABLE C-4

Sea Return Data (Cont.)

NOVEMBER 1972				PULSE			TILT	d BM SIGN. LEVEL		σ_o	DBSM		WEATHER COMMENTS
DATE	TIME	TARGET	RANGE	LENGTH	P.R.F.	POL.	ANGLE	PEAK	AVE.		PEAK	AV	
11-17	10:37	CLUTTER	2.5	0.4	0.9	V	STOW	80	85	-63	-21	-26	Az 155° CLUTTER PROFILE
11-17	10:38	"	2.9	0.4	0.9	V	STOW	81	85	-63	-19.5	-23.5	
11-17	10:39	"	3.3	0.4	0.9	V	"	87	90	-67	-23.5	-26.5	
11-17	10:40	"	3.7	0.4	0.9	V	"	87	92	-67	-21.5	-26.5	
11-17	10:41	"	4.1	0.4	0.9	V	"	89	95	-68	-21.5	-27.5	
11-17	10:42	"	5.0	0.4	0.9	V	"	90	94	-67	-19	-23	
11-17	10:43	"	5.8	0.4	0.9	V	"	93	94	-69	-19.8	-20.8	
11-17	11:15	"	0.4	0.4	0.9	V	"	62	65	-60	-35	-38	Az 155° CLUTTER PROFILE
11-17	11:16	"	0.9	0.4	0.9	V	"	67	73	-60	-26	-32	
11-17	11:17	"	1.2	0.4	0.9	V	"	71	77	-60	-25	-31	
11-17	11:18	"	1.6	0.4	0.9	V	"	73	79	-60	-22	-28	
11-17	11:19	"	2.0	0.4	0.9	V		79	84	-64	-24	-29	
11-17	11:20	"	2.5	0.4	0.9	V		83	88	-66	-24	-29	
11-17	11:21	"	2.9	0.4	0.9	V		81	85	-63	-19.5	-23.5	
11-17	11:22	"	3.3	0.4	0.9	V		86	91	-66	-22.5	-27.5	
11-17	11:23	"	3.7	0.4	0.9	V		87	91	-67	-21.5	-25.5	
11-17	11:24	"	4.1	0.4	0.9	V	STOW	91	95	-70	-23.5	-27.5	
11-17	11:25	"	5.0	0.4	0.9	V	"	94	97	-71	-23	-26	
11-17	11:26	"	5.8	0.4	0.9	V	"	98	100	-74	-24.8	-26.2	
11-17	11:29	"	0.4	0.4	0.9	H	"	68	71	-66	-41	-44	Az 155° CLUTTER PROFILE
11-17	11:30	"	0.9	0.4	0.9	H	"	70	75	-63	-29	-34	
11-17	11:31	"	1.2	0.4	0.9	H	"	75	78	-64	-29	-32	

TABLE C-4

Sea Return Data (Cont.)

NOVEMBER 1972				PULSE			TILT	d BM SIGN. LEVEL		σ_o	DBSM		WEATHER COMMENTS
DATE	TIME	TARGET	RANGE	LENGTH	P.R.F.	POL.	ANGLE	PEAK	AVE.		PEAK	AV	
11-17	11:32	CLUTTER	1.6	0.4	0.9	H	STOW	77	81	-63	-26	-30	A 155° CLUTTER PROFILE
11-17	11:33	"	2.0	0.4	0.9	H	"	82	85	-67	-27	-30	
11-17	11:34	"	2.5	0.4	0.9	H	"	86	88	-69	-27	-29	
11-17	11:35	"	2.9	0.4	0.9	H	"	88	90	-70	-26.5	-29.5	
11-17	11:36	"	3.3	0.4	0.9	H	"	89	92	-69	-25.5	-28.5	
11-17	11:36	"	3.7	0.4	0.9	H	"	91	95	-71	-25.5	-29.5	
11-17	11:37	"	4.1	0.4	0.9	H	"	92	96	-71	-24.5	-28.5	
11-17	11:39	"	5.0	0.4	0.9	H	"	97	98	-74	-26	-27	
11-17	1 :40	"	5.8	0.4	0.9	H	"	99	100	-75	-25.8	-26.8	
11-30	10:00	"	0.4	0.2	3.5	H	0°	40	43	-43	-13	-16	A 150° Est CLUTTER PROFILE
11-30	10:02	.	0.9	0.2	3.5	H	0°	55	58	-46	-14	-17	WIND 25 MPH
11-30	10:02	"	1.2	0.2	3.5	H	0°	66	69	-53	-20	-23	LIGHT RAIN
11-30	10:03	"	1.6	0.2	3.5	H	0°	73	78	-59	-22	-27	
11-30	10:04	"	2.0	0.2	3.5	H	0°	78	82	-60	-23	-27	
11-30	10:05	"	2.5	0.2	3.5	H	0°	85	89	-64	-26	-30	
11-30	10:06	"	2.9	0.2	3.5	H	0°	84	87	-64	-22.5	-25.5	
11-30	10:08	"	3.3	0.2	3.5	H	0°	90	92	-66	-26.5	-28.5	
11-30	10:09	"	3.7	0.2	3.5	H	0°	93	98	-68	-27.5	-32.5	
11-30	10:10	"	4.1	0.2	3.5	H	0°	96	99	-70	-28.5	-31.5	
11-30	10:13	"	0.4	0.2	3.5	V	0°	42	45	-40	-15	-18	A 150° Est CLUTTER PROFILE
11-30	10:15	"	0.9	0.2	3.5	V	0°	55	60	-48	-14	-1.9	WIND 25 M.P.H.
11-30	10:16	"	1.2	0.2	3.5	V	0°	65	70	-54	-19	-24	LIGHT RAIN

TABLE C-4

Sea Return Data (Cont.)

NOVEMBER 1972				PULSE			TILT	d BM SIGN LEVEL		σ_o.	DBSM		WEATHER COMMENTS
DATE	TIME	TARGET	RANGE	LENGTH	P.R.F.	POL.	ANGLE	PEAK	AVE.		PEAK	AV.	
11-30	10:17	CLUTTER	1.6	0.2	3.5	V	0°	70	76	-56	-19	-25	Az 150° Est CLUTTER PROFILE
11-30	10:19	"	2.0	0.2	3.5	V	0°	78	85	-63	-23	-30	WIND 25 MPH
11-30	10:21	"	2.5	0.2	3.5	V	0°	82	88	-65	-23	-29	LIGHT RAIN
11-30	10:22	"	2.9	0.2	3.5	V	0°	89	95	-71	-27.5	-33.5	
11-30	10:23	"	3.3	0.2	3.5	V	0°	92	98	-72	-28.5	-34.4	
11-30	10:25	"	3.7	0.2	3.5	V	0°	98	100	-76	-32.5	-34.5	
DEC	1972												
12-6	13:42	"	0.8	0.2	3.5	V	+4°	55	60	-45	-16	-21	Az 150° Est CLUTTER PROFILE
12-6	13:43	"	1.65	0.2	3.5	V	+4°	70	75	-53	-19	-24	RAIN
12-6	13:43	"	2.5	0.2	3.5	V	+4°	80	85	-60	-21	-26	1-2 FT. WAVES
12-6	13:44	"	3.30	0.2	3.5	V	+4°	89	95	-64	-25.5	-31.5	
JAN	1973												
1-9	08:41	CLUTTER	0.83	0.2	3.5	V	+3°	62	70	-54	-23	-31	Az 150° Est CLUTTER PROFILE
1-9	08:42	"	1.2	0.2	3.5	V	+3°	71	80	-60	-25	-34	WIND 12-14 MPH
1-9	08:43	"	2.0	0.2	3.5	V	+3°	72	80	-57	-17	-25	NNE
1-9	08:44	"	2.5	0.2	3.5	V	+3°	84	89	-67	-25	-30	HAZY
1-9	08:45	"	2.9	0.2	3.5	V	+3°	85	90	-67	-23.5	-28.5	TEMP. 12°, 50% RELATIVE
1-9	08:46	"	3.3	0.2	3.5	V	+3°	87	93	-67	-23.5	-29.5	HUMMIDITY
1-9	08:47	"	3.7	0.2	3.5	V	+3°	90	95	-70	-24.5	-29.5	
1-9	08:48	"	4.1	0.2	3.5	V	+3°	95	98	-74	-27.5	-30.5	

TABLE C-4

Sea Return Data (Cont.)

JANUARY 1973				PULSE			TILT	d BM SIGN LEVEL		σ_o.	DBSM		WEATHER COMMENTS
DATE	TIME	TARGET	RANGE	LENGTH	P.R.F.	POL.	ANGLE	PEAK	AVE.		PEAK	AV.	
1-9	08:51	CLUTTER	0.4	0.2	3.5	H	+3°	54	57	-52	-27	-30	Az 150° CLUTTER PROFILE
1-9	08:52	CLUTTER	0.8	0.2	3.5	H	+3°	62	68	-54	-23	-29	WIND 12-15 MPH
1-9	08:53	"	1.2	0.2	3.5	H	+3°	67	73	-55	-21	-27	NNE
1-9	08:54	"	1.6	0.2	3.5	H	+3°	72	78	-58	-21	-27	HAZY
1-9	08:55	"	2.0	0.2	3.5	H	+3°	78	85	-63	-23	-30	
1-9	08:55	"	2.5	0.2	3.5	H	+3°	86	90	-69	-27	-31	
1-9	08:57	"	2.9	0.2	3.5	H	+3°	90	94	-72	-28.5	-32.5	
1-9	08:59	"	3.3	0.2	3.5	H	+3°	94	96	-74	-30.5	-32.5	
1-9	09:01	"	3.7	0.2	3.5	H	+3°	96	98	-76	-30.5	-32.5	
1-9	09:02	"	4.1	0.2	3.5	H	+3°	98	100	-77	-30.5	-32.5	
1-20	09:02	"	0.4	0.2	3.5	H	+3°	49	52	-47	-22	-25	AZ 150° CLUTTER PROFILE
1-20	09:03	"	0.8	0.2	3.5	H	+3°	54	60	-47	-15	-21	WIND, 20 MPH WNW
1-20	09:04	"	1.23	0.2	3.5	H	+3°	60	65	-49	-14	-19	
1-20	09:05	"	1.65	0.2	3.5	H	+3°	68	72	-54	-17	-21	
1-20	09:06	"	2.0	0.2	3.5	H	+3°	75	78	-60	-20	-23	
1-20	09:07	"	2.5	0.2	3.5	H	+3°	78	85	-61	-19	-26	
1-20	09:08	"	2.9	0.2	3.5	H	+3°	82	87	-64	-20.5	-25.5	
1-20	09:09	"	3.3	0.2	3.5	H	+3°	87	90	-67	-23.5	-26.5	
1-20	09:10	"	3.7	0.2	3.5	H	+3°	90	93	-70	-24.5	-27.5	
1-20	09:11	"	4.1	0.2	3.5	H	+3°	91	95	-70	-23.5	-27.5	
1-20	09:13	"	5.0	0.2	3.5	H	+3°	95	98	-72	-24	-27	
1-20	09:14	"	5.4	0.2	3.5	H	+3°	98	100	-74	-26	-28	