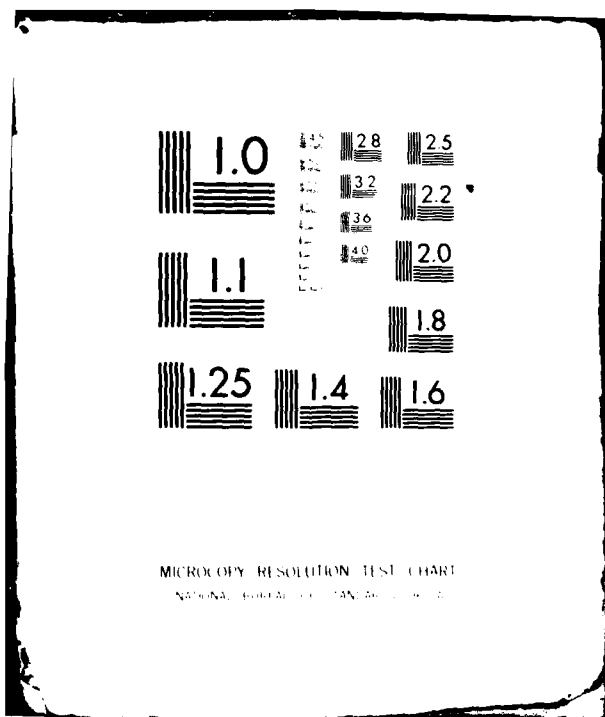


FACILITY CHECKING SQUADRON (1866TH) (AFCS) SCOTT AFB IL F/6 17/7
TRACALS EVALUATION REPORT, COMMUNICATIONS INITIAL EVALUATION RE--ETC(U)
FEB 81 R S ANTONIO, P M DERMODY
80/66C-231 NL

NL

1. 2. 3.

END
DATE
FILMED
4-8
DTIC



12
SC

AIR FORCE COMMUNICATIONS COMMAND

TRACALS EVALUATION REPORT

COMMUNICATIONS INITIAL EVALUATION REPORT

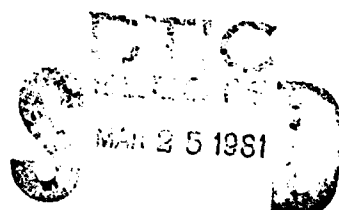
Luke AFB, Arizona

80/66C-231

29 September - 8 October 1980

AD A 096809

DTIC FILE COPY



A

This document has been approved
for public release and sale; its
distribution is unlimited.

O 2488 ACC

81 3 25 001

DEPARTMENT OF THE AIR FORCE
1866 Facility Checking Squadron
Scott AFB, Illinois 62225

27 February 1981

COMMUNICATIONS INITIAL EVALUATION REPORT

Luke AFB, Arizona

80/66C-231

29 September - 8 October 1980

Prepared by:

Robert S. Antonio

ROBERT S. ANTONIO, Capt, USAF
Electrical Engineer

Phillip M. Dermody

PHILLIP M. DERMODY, MSgt, USAF
Communications Evaluation Team Chief

Approved by:

Cecil C. Robins

CECIL C. ROBINS, Lt Col, USAF
Commander

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER 80/66C-231 ✓	2. GOVT ACCESSION NO. AD-A096 809	3. RECIPIENT'S CATALOG NUMBER (9)
6. TYPE OF REPORT & PERIOD COVERED COMMUNICATIONS INITIAL EVALUATION REPORT, Luke AFB, Arizona 29 September-8 October 1980 1980.		5. TYPE OF REPORT & PERIOD COVERED FINAL rept, 29 September-8 October 1980
7. AUTHOR(s) ROBERT S. ANTONIO, Capt, USAF PHILLIP M. DERMODY, MSgt, USAF		6. PERFORMING ORG. REPORT NUMBER
9. PERFORMING ORGANIZATION NAME AND ADDRESS 1866 Facility Checking Squadron Scott AFB, Illinois 62225		8. CONTRACT OR GRANT NUMBER(s)
11. CONTROLLING OFFICE NAME AND ADDRESS HQ Air Force Communications Command/FFNM Scott AFB, Illinois 62225		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) (12) 85		12. REPORT DATE 27 February 1981
		13. NUMBER OF PAGES 85
		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release, distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report) Same as report.		
18. SUPPLEMENTARY NOTES Additional Team Members: ROBERT ROMANSKI, TSgt, USAF GARY J. PARSON, TSgt, USAF GEORGE S. OTTO, SSgt, USAF		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Traffic Control and Landing Systems (TRACALS) Air Traffic Control (ATC) Communications System Evaluation		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) A Communications Initial Evaluation was performed at Luke AFB, Arizona from 29 September to 8 October 1980. The purpose was to define the capabilities and limitations of the ATC communications system. This report includes the analysis and results of ground equipment and system measurements, and the correlation of predicted and measured received signal levels which defines horizontal and vertical coverage. This report can be used as a guide for anticipated performance of the ATC communications system until a deletion, addition, relocation of equipment, or a change occurs in the horizon profile.		

DD FORM 1 JAN 73 1473

EDITION OF 1 NOV 65 IS OBSOLETE

11

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

408827

Jm

DISTRIBUTION

<u>Copies</u>	<u>Addressee</u>
8	2037 CS/CC, Luke AFB AZ 85309
1	82 FTW/CC, Luke AFB AZ 85309
1	58 TTW/CC, Luke AFB AZ 85309
1	NCA/EIE, Griffiss AFB NY 13441
2	SCA/EIEL, Oklahoma City AFS OK 73145
1	SCA/EIPT, Oklahoma City AFS OK 73145
2	TACCA/FFM, Langley AFB VA 23665
2	TACCA/FFF, Langley AFB VA 23665
2	TACCA/BCM, Langley AFB VA 23665
1	PCA/EIS, Hickam AFB HI 96853
10	1866 FCS/CC, Scott AFB IL 62225
1	1842 EEG/EEIT, Scott AFB IL 62225
1	1843 EES/EIELT, Hickam AFB HI 96853
1	1844 EES/EIELT, Griffiss AFB NY 13441
1	HQ AFCC/DAPL, Scott AFB IL 62225
1	HQ AFCC/DAPE, Scott AFB IL 62225
1	HQ AFCC/EP, Scott AFB IL 62225
1	HQ AFCC/FFC, Scott AFB IL 62225
1	HQ AFCC/FFO, Scott AFB IL 62225
1	HQ AFCC/IGP, Scott AFB IL 62225
1	HQ AFCC/LGMKF, Scott AFB IL 62225
1	HQ AFCC/LGMLE, Scott AFB IL 62225
1	HQ AFCC/SA, Scott AFB IL 62225
2	HQ AFCC/FFNM, Scott AFB IL 62225
12	DDC-TC, Cameron Station, Alexandria VA 22314
2	FAA/ARD-5, 800 Independence Ave SW, Washington DC 20590
2	FAA/FSNFO/AFS-530, P.O. Box 25082, Oklahoma City OK 73125
1	Dr. Jose Perini, Rm 111, Link Hall, Syracuse University, Syracuse NY 13210

Accession For	
NTIS GRA&I	☒
DTIC TAB	☐
Unannounced	☐
Justification	
Distribution/	
Availability Codes	
Dist	Avail and/or
A	Special

TABLE OF CONTENTS

<u>SUBJECT</u>	<u>PAGE</u>
TITLE PAGE	i
REPORT DOCUMENTATION PAGE	ii
DISTRIBUTION	iii
TABLE OF CONTENTS	iv
SUMMARY	I
1. Evaluation Profile	1
2. ATC Communications System	1
3. Power Systems	2
RECOMMENDATIONS	2
1. ATC Communications System	2
2. Power Systems	2
PERFORMANCE PREDICTIONS	2
ATTACHMENTS	
1. Geographic Location	
2. Transmitter Site Antenna Layout/Data	
3. Receiver Site Antenna Layout/Data	
4. GCA Antenna Layout/Data	
5. Skyline Graph	
6. Null Angle Predictions	
7. Radio Line of Sight Range	
8. Equipment Analysis Specification List	
9. AVI Radio Communications Equipment Analysis	
10. RF Transmission Systems Analysis	
11. Amplifier Data	
12. AM Radio Communications System Loop Analysis	
13. Flight Profile	
14. Measured Signal Strength	
15. Horizontal Coverage Prediction	
16. Correlation of Predicted and Measured RSL	
17. Vertical Radiation Pattern Prediction	
18. Vertical Radiation Pattern	

SUMMARY

1. Evaluation Profile. This evaluation was conducted to define the capabilities and limitations of the Air Traffic Control (ATC) Communications System in its installed environment at Luke AFB, Arizona. This evaluation was accomplished in two phases: a ground phase and a flight phase. The ground phase consisted of extensive testing of a representative sample of the ATC communications equipment. The ground phase also included commercial/backup power system checks and site surveys. The ground equipment checks are designed to eliminate equipment degradation as a factor which might adversely affect the data gathered during the flight phase. The flight phase consisted of radial and orbital tracks flown from the Luke AFB Tactical Air Navigation (TACAN) facility by the flight inspection aircraft while received signal levels (RSLs) were recorded on the ground and in the aircraft. Analysis of the recorded data provides a composite, three-dimensional picture of the communications coverage for the Luke AFB Operational Area.

2. ATC Communications System:

a. Equipment Performance. Equipment tests were accomplished using procedures described in the equipment technical order (TO). Where no procedures are given, AFCCP 100-61, Vol XIII was used as guidance. Equipment specifications and test results are contained in Attachments 8 thru 13. The majority of the equipment checked was providing adequate service; however, several areas require special attention.

(1) All transmitters evaluated were below TO specification on power output. Power output level measurements ranged from 6.8 to 8.0 watts. All transmitters were adjusted to the TO specification of 10 watts. Low power output will decrease communications coverage.

(2) Five antenna multicoupler cavities at the transmitter site and thirteen antenna multicoupler cavities at the receiver site exceeded the maximum insertion loss of 2 dB specified by the TO. Eight of the antenna multicoupler cavities, one at the transmitter site and seven at the receiver site, remained out of tolerance after retuning. Any insertion loss reduces communications coverage.

(3) All multichannel transceivers and two single channel transmitters were out of specification on percent of modulation. The radios were adjusted to TO specification with the exception of two Very High Frequency (VHF) transceivers. These transceivers required internal adjustments and were turned over to local maintenance for corrective action.

(4) Four PP-4558G Power Supply modules in the ground control approach (GCA) four channel communications control system were found to have a high ripple voltage on the regulated -28 volt DC output. Although three power supplies were not yet affecting noise levels in the audio frequency (AF) amplifiers, the fourth power supply was causing high noise levels in one bank of AF amplifiers. Although there are no procedures in the equipment TO or equipment workcards for checking the ripple voltages in the PP-4558G Power Supplies; the power supplies were determined to be defective by first measuring noise levels in the AF amplifiers, then replacing the power supply with one having almost no ripple voltage and measuring the noise levels again.

Following this procedure, one power supply was found to be causing excessive noise levels in the AF amplifiers. Replacing the power supply decreased the noise levels more than 40 dB.

b. Evaluation Results. Terrain surrounding the ground antennas appears conducive to adverse multipath propagations which created significant nulling along some azimuths. For example, on the 208 and 310 radials, measured RSLs clearly showed deep nulling at predicted null locations (see Attachment 6 and pages A16-5 and A16-7). Also during orbital track 8, recorders at the receiver site and the GCA facility indicated a loss of signal for a 20 degree sector between 355° and 015° . These losses of reception on the orbital track were due to adverse multipath propagations rather than any RLOS limitations. It should be noted that during the orbital flight between 355° and 015° , the flight check aircraft had actually ascended to 5200 feet mean sea level (MSL) and placed itself near predicted null locations (see Attachments 6 and 14). Reduced communications range due to horizon screens are evident in recorded data. Surveys conducted at the transmitter and receiver sites show significant screening in the sectors between 138° to 164° and 230° to 300° (see Attachment 7). These screening angles can severely limit coverage at the minimum vectoring altitude (MVA). For example, on the 270 radial, screening angles measured 2.5° for the transmitter site and 2.2° for the receiver site. At the MVA of 5200 feet MSL, actual range of communications was 17 nautical miles (NM) for the transmitter site and 18 NM for the receiver site.

c. Capabilities and Limitations. Although radio coverage is adequate for most of Luke AFB's operating airspace, some limitations in coverage exist. Attachment 6 illustrates the predicted null locations due to multipath propagation. Severity of these nulls along different azimuths vary with the type of reflecting terrain about the ground antennas. In the sector between 230° and 300° , terrain screening reduces communications range at the MVA to 13 NM of Luke AFB. In the sector between 138° to 161° , range of communications at the MVA is reduced to 25 NM of Luke AFB. From analysis of data gathered on 20 NM arcs flown in the vicinity of Luke Auxiliary Field # 1 and site surveys of screening angles, primary communications is determined to be available down to 1000 feet AGL at 20 NM from 303° to 346° . GCA backup communications to the Auxiliary Field #1 is available down to 1000 feet AGL at 20 NM from 300° to 330° . The control tower screens the GCA backup communications in a 13° sector from 360° to 013° (see Attachment 7).

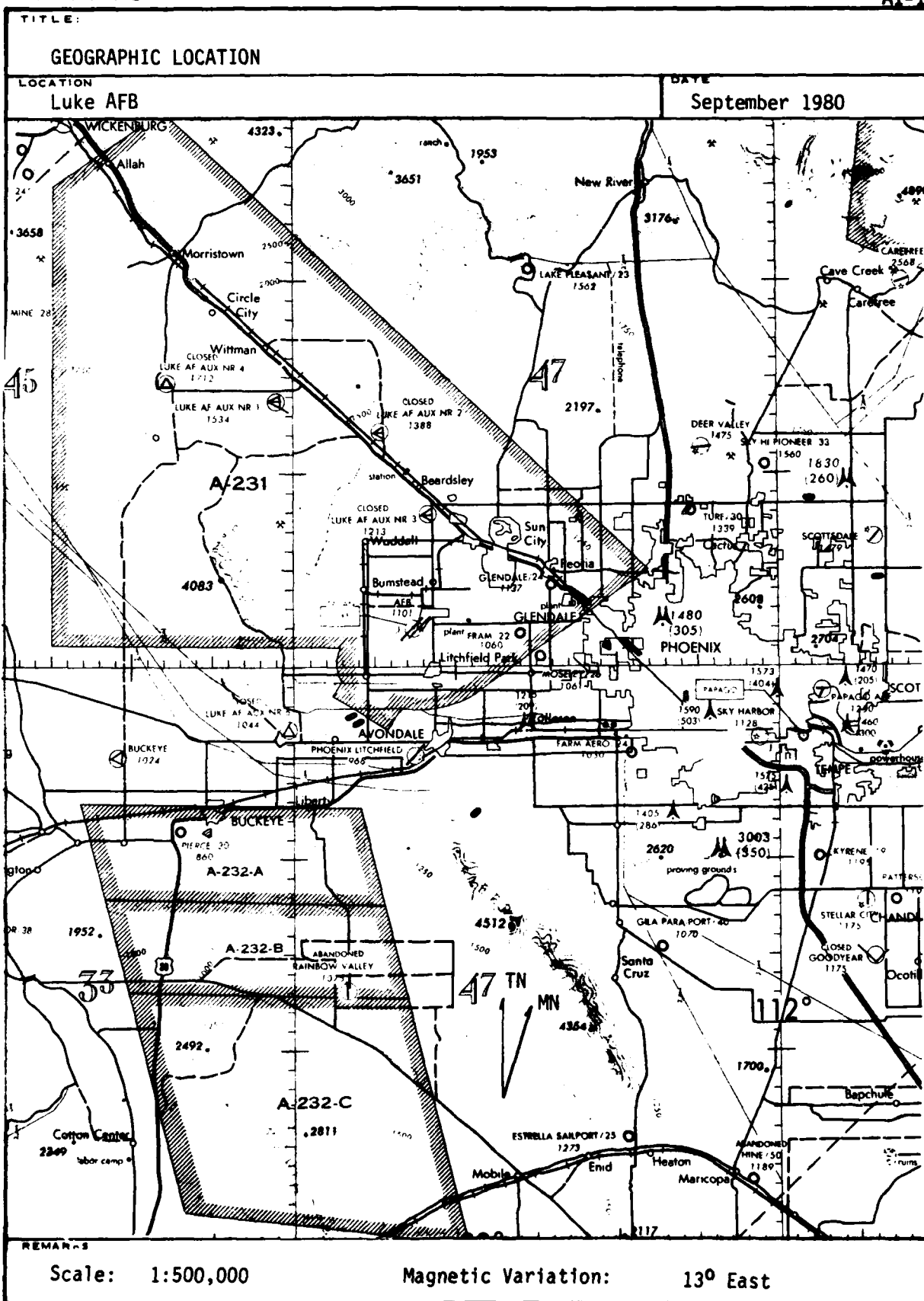
3. Power Systems. Commercial and backup power was adequate and reliable at all facilities. Backup power at the transmitter site was being temporarily provided by a portable generator.

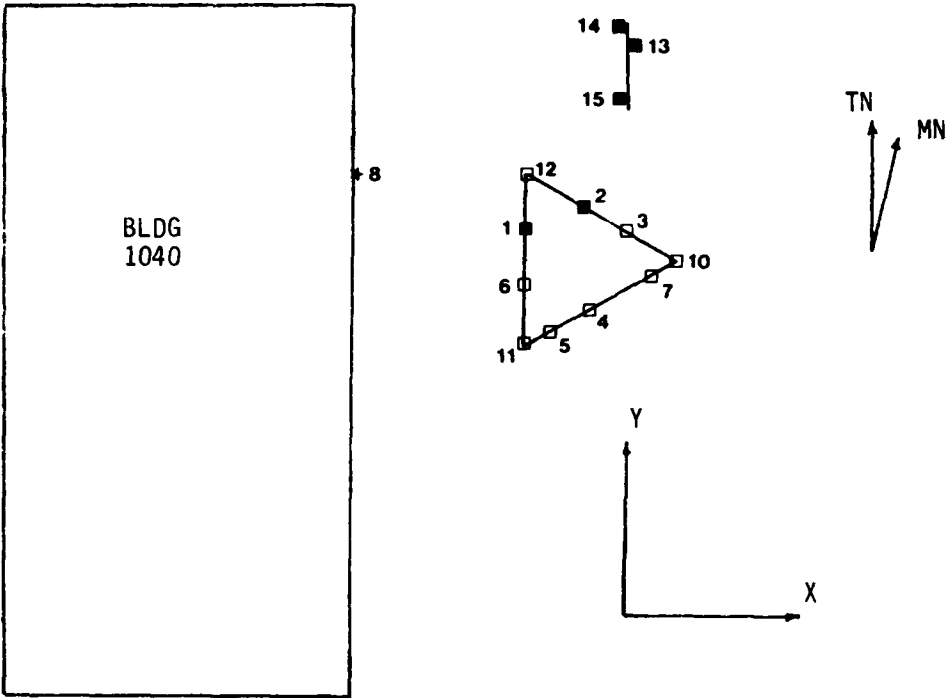
RECOMMENDATIONS

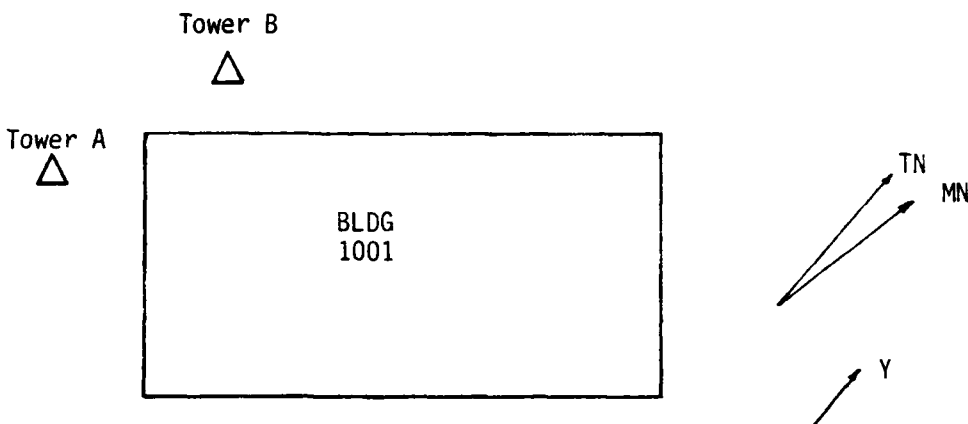
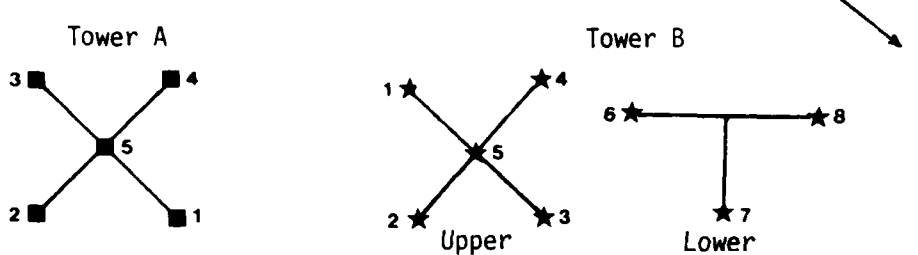
1. ATC Communications System. Recommend revision of published MVAs to coincide with communications coverage capability.

2. Power Systems. No recommendations.

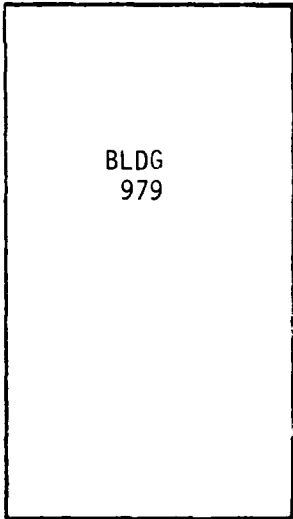
PERFORMANCE PREDICTIONS. Existing communications capabilities and limitations should continue unless there is an addition, deletion, relocation of equipment, or a change in horizon profile.



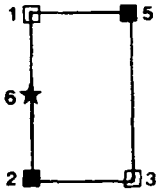
TITLE TRANSMITTER SITE ANTENNA LAYOUT/DATA					
LOCATION Luke AFB				DATE September 1980	
					
ANTENNA	ANTENNA COORDINATES (ft)			ANTENNA TYPE	FREQ (MHz)
	X	Y	Z (AGL)		
1	0	0	23.87	AS-1181	126.2
2	7.42	0.39	23.52	AS-1181	121.5
3	13.84	-1.68	23.39	AS-1097	395.0/289.6/243.0/335.8
4	11.86	-11.20	23.41	AS-1097	Spare
5	6.76	-16.01	23.42	AS-1097	Spare/337.7/242.3/375.2
6	1.20	-6.78	23.50	AS-1097	296.1/325.9/266.4/372.2
7	17.62	-6.57	23.41	AS-1097	Spare
8	NOT AVAILABLE			AT-197	Spare
10	19.96	-4.07	40.77	AS-1097	349.7/389.8/301.5/316.9
11	4.00	-17.41	41.83	AS-1097	291.1/372.9/269.9/Spare
12	-0.65	2.07	31.42	AS-1097	311.2/257.2/349.0/388.9
13	10.79	41.84	40.22	AS-1181	134.1
14	10.48	41.84	50.78	AS-1181	Spare
15	11.45	31.42	50.56	AS-1181	120.5
REMARKS					
Site Elevation: 1104 feet MSL					

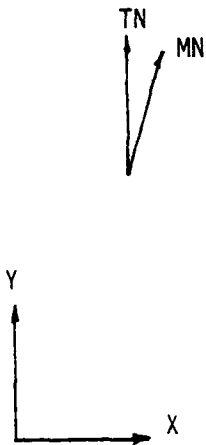
TITLE RECEIVER SITE ANTENNA LAYOUT/DATA					
LOCATION Luke AFB				DATE September 1980	
					
					
ANTENNA	ANTENNA COORDINATES (ft)			ANTENNA TYPE	FREQ (MHz)
	X	Y	Z (AGL)		
A-1	20.41	-29.40	71.75	AS-1181	134.1
A-2	18.32	-37.53	71.68	AS-1181	121.5
A-3	10.40	-35.69	71.73	AS-1181	126.2
A-4	11.98	-27.45	71.68	AS-1181	120.5
A-5	15.23	-32.01	73.39	AS-1181	Spare
B-1	0	0	71.70	AT-197	395.0/289.6/256.9/243.0
B-2	6.41	-4.77	71.81	AT-197	335.8/349.7/389.8/301.5
B-3	10.94	-1.32	71.39	AT-197	337.7/242.3/375.2
B-4	4.77	6.15	71.65	AT-197	296.1/325.9/266.4/372.2
B-5	5.96	0.68	73.08	AT-197	257.2/349.0/388.9/311.2
B-6	0.14	-3.44	58.35	AT-197	316.9/291.1/372.9
B-7	11.50	-2.28	56.67	AT-197	Spare
B-8	10.06	5.41	56.65	AT-197	Spare
REMARKS Site Elevation: 1074 feet MSL					

TITLE					
GCA ANTENNA LAYOUT/DATA					
LOCATION				DATE	
Luke AFB				September 1980	



BLDG
979

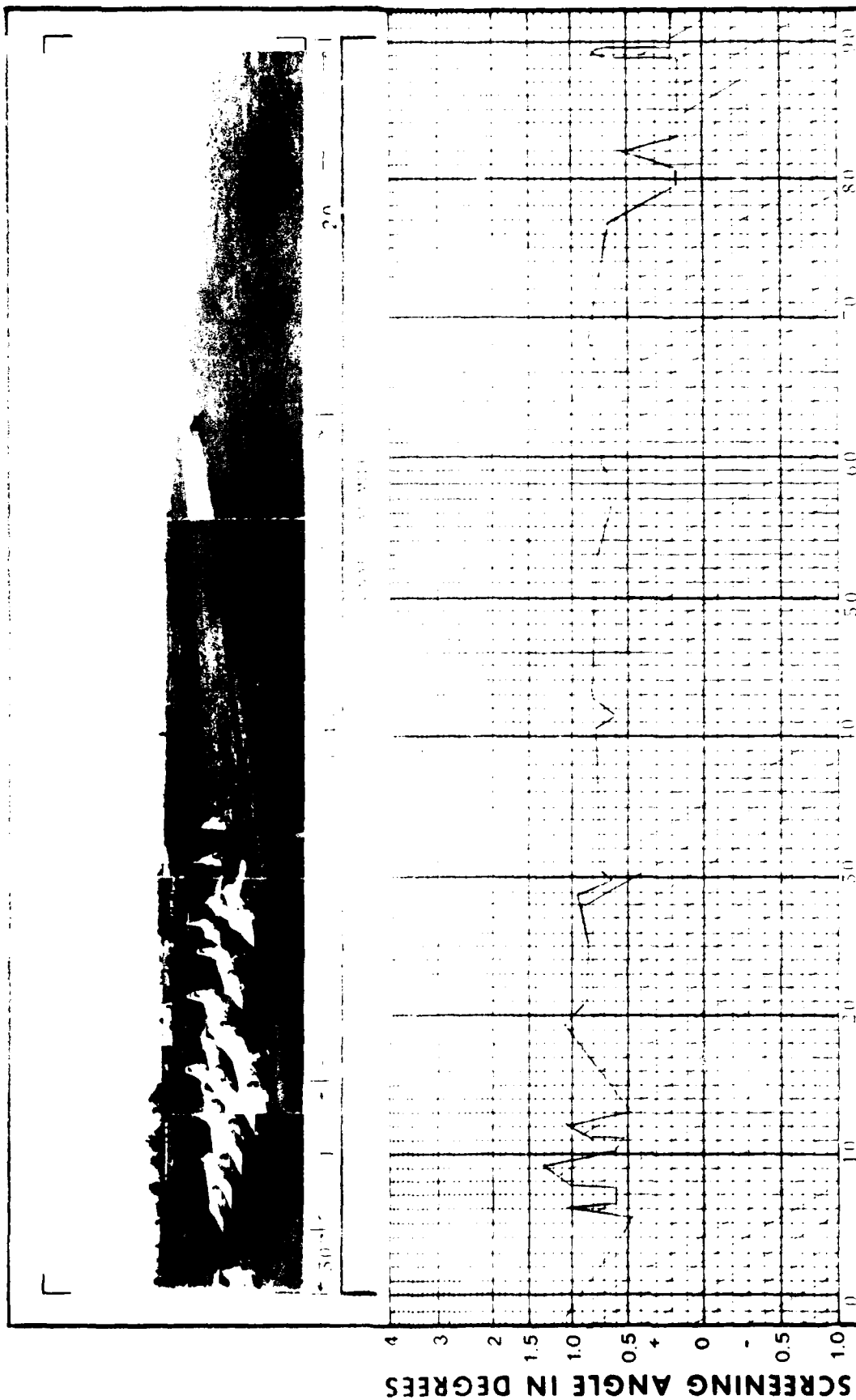




<u>ANTENNA</u>	<u>ANTENNA COORDINATES (ft)</u>			<u>TYPE</u>	<u>FREQ (MHz)</u>
	<u>X</u>	<u>Y</u>	<u>Z(AGL)</u>	<u>ANTENNA</u>	
1	0	0	56.14	AS-1097	349.7
2	3.60	-14.37	54.93	AS-1181	VHF Multichannel
3	10.58	-12.62	56.22	AS-1097	UHF Multichannel
5	7.01	1.76	54.93	AS-1181	120.5
6	1.72	-6.87	54.98	AT-197	Spare

REMARKS
Site Elevation: 1080 feet MSL

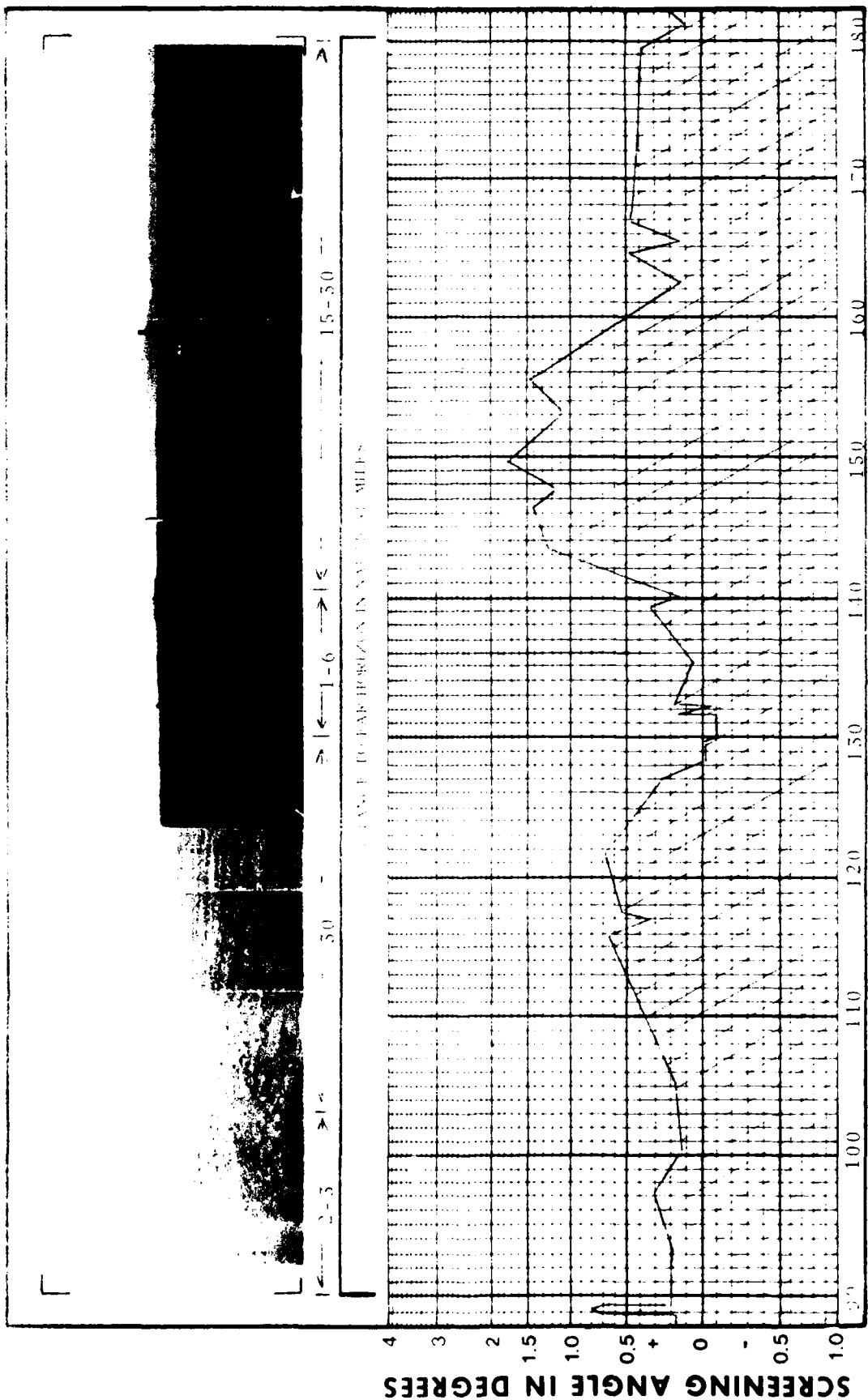
SKYLINE GRAPH



ORIENTED TO MAGNETIC NORTH
MAGNETIC VARIATION: 13° E

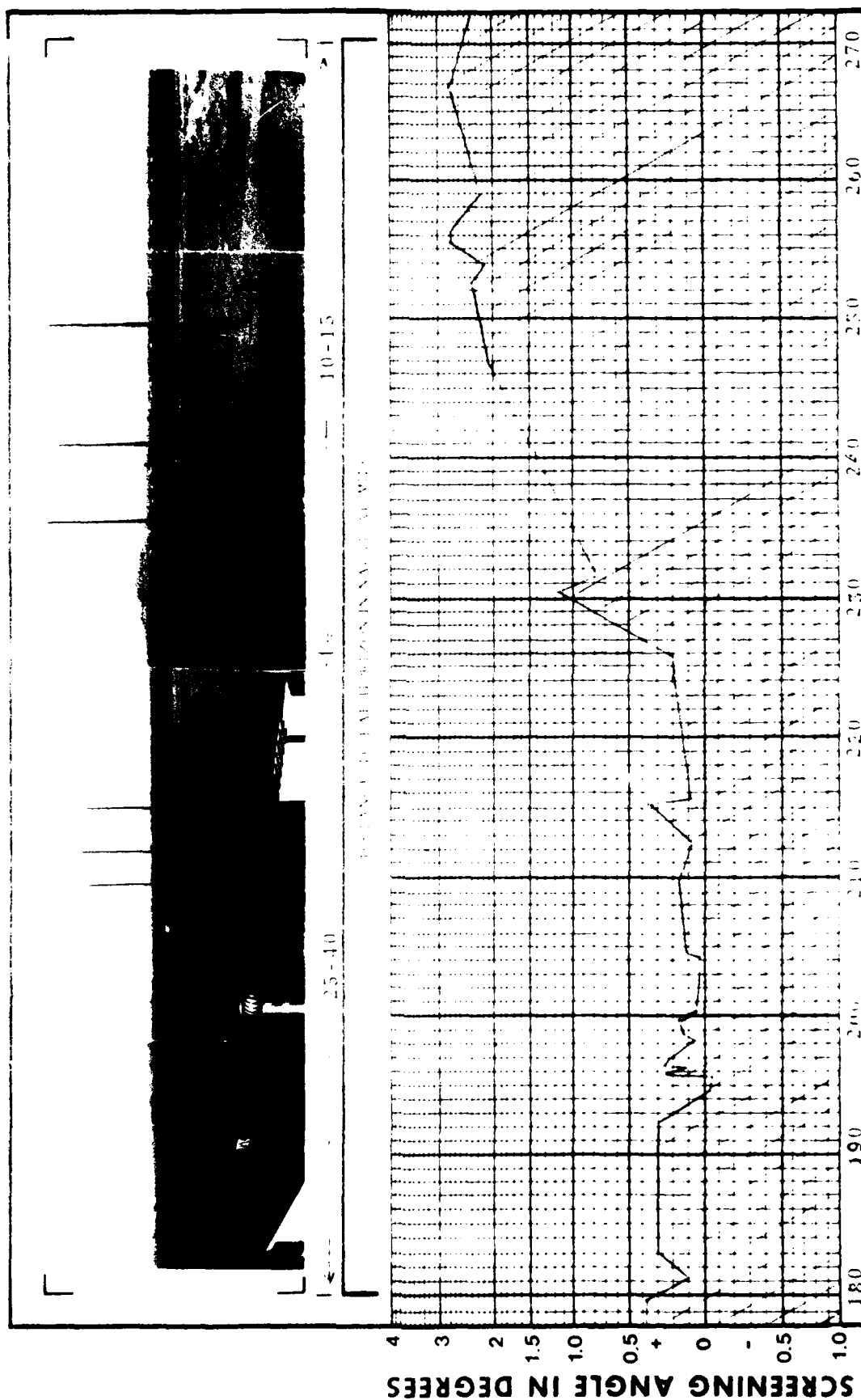
STATION LUKE AFB
EQUIPMENT TRANSMITTER SET

SKYLINE GRAPH



ORIENTED TO MAGNETIC NORTH
MAGNETIC VARIATION: 130° E

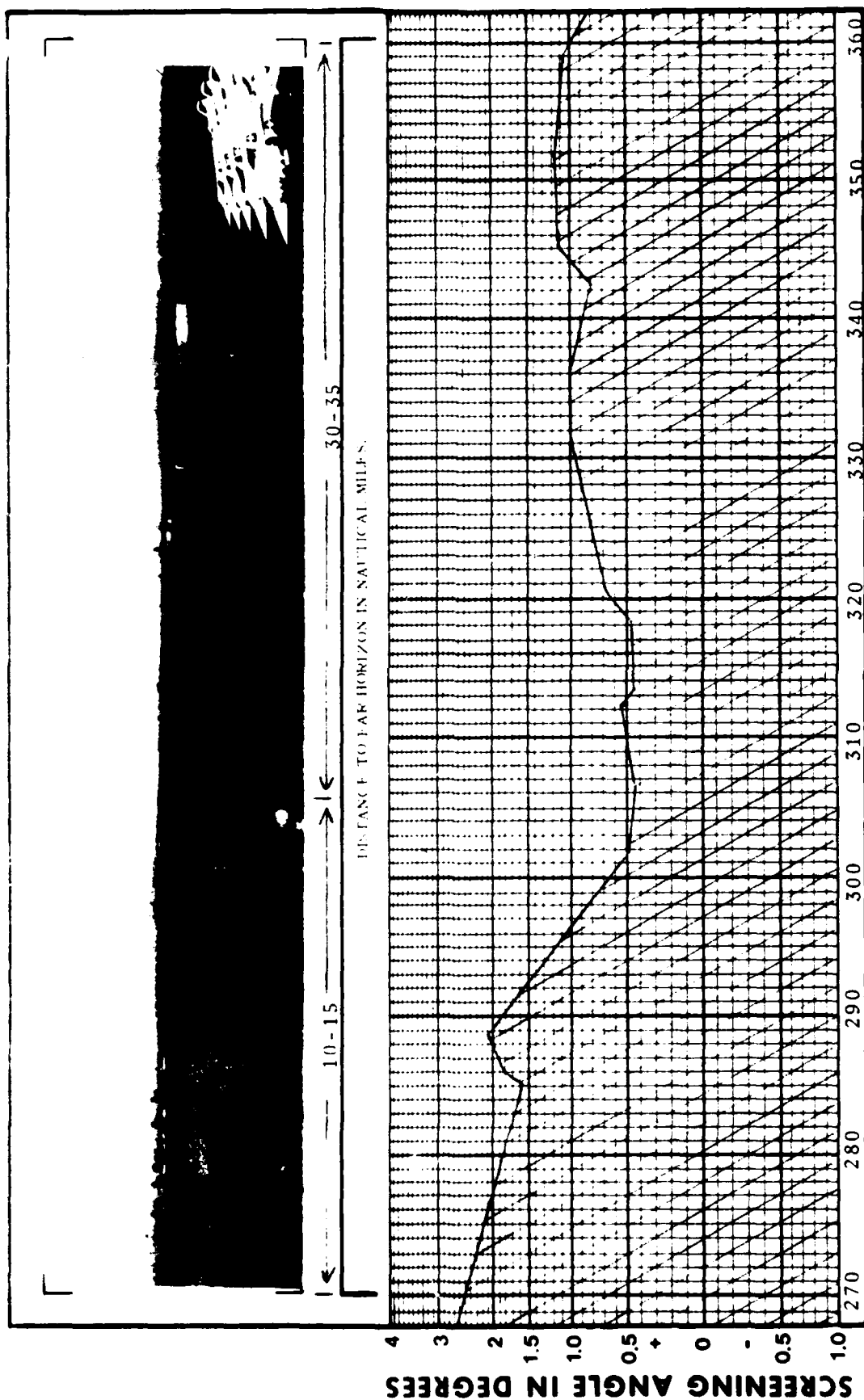
STATION LUKE AFB
EQUIPMENT TRANSMITTER SITE



STATION LUKE AFB
EQUIPMENT TRANSMITTER SITE

ORIENTED TO MAGNETIC NORTH
MAGNETIC VARIATION: 150°

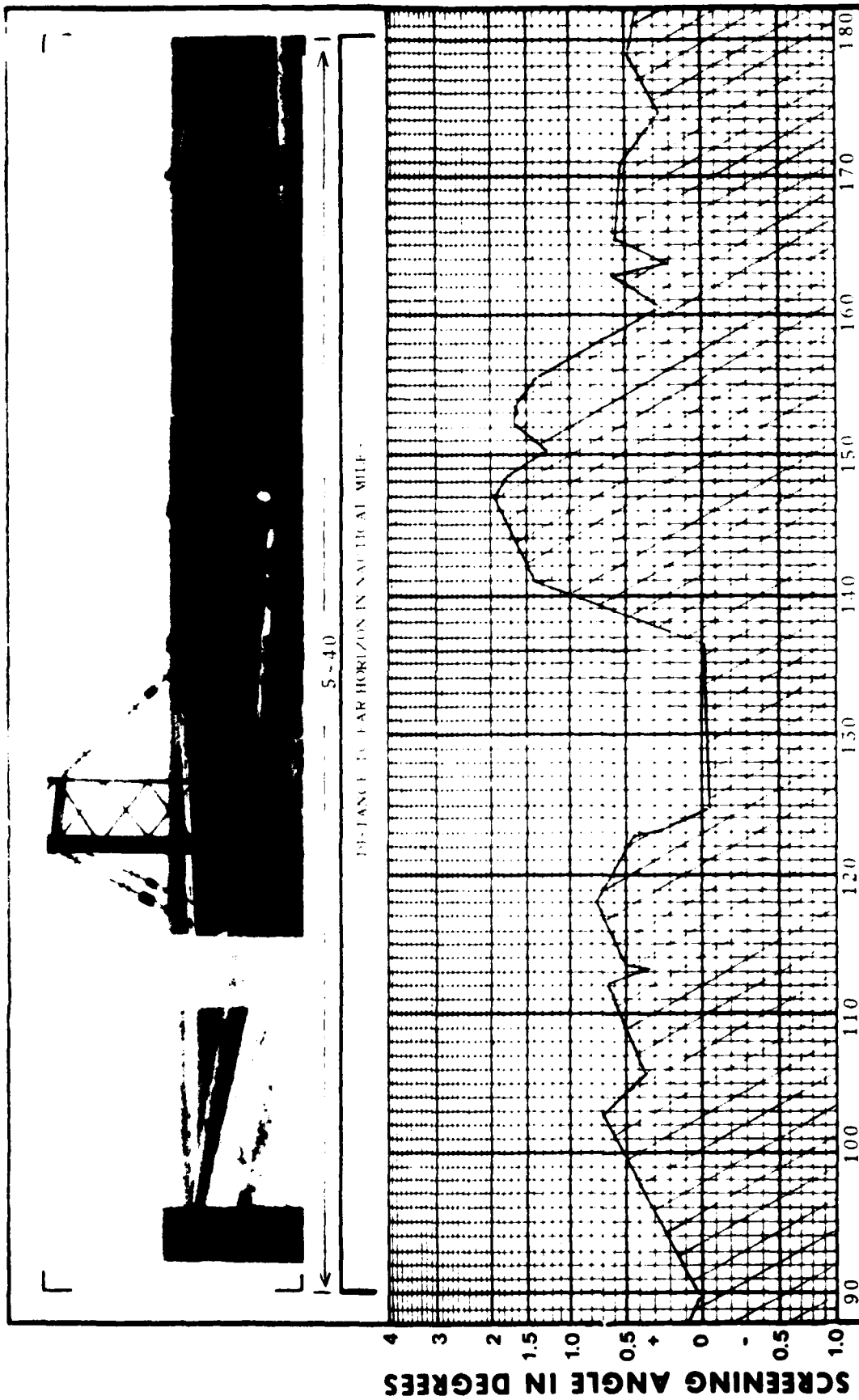
SKYLINE GRAPH



ORIENTED TO MAGNETIC NORTH
MAGNETIC VARIATION: 13° E

STATION LUKE AFB
EQUIPMENT TRANSMITTER SITE

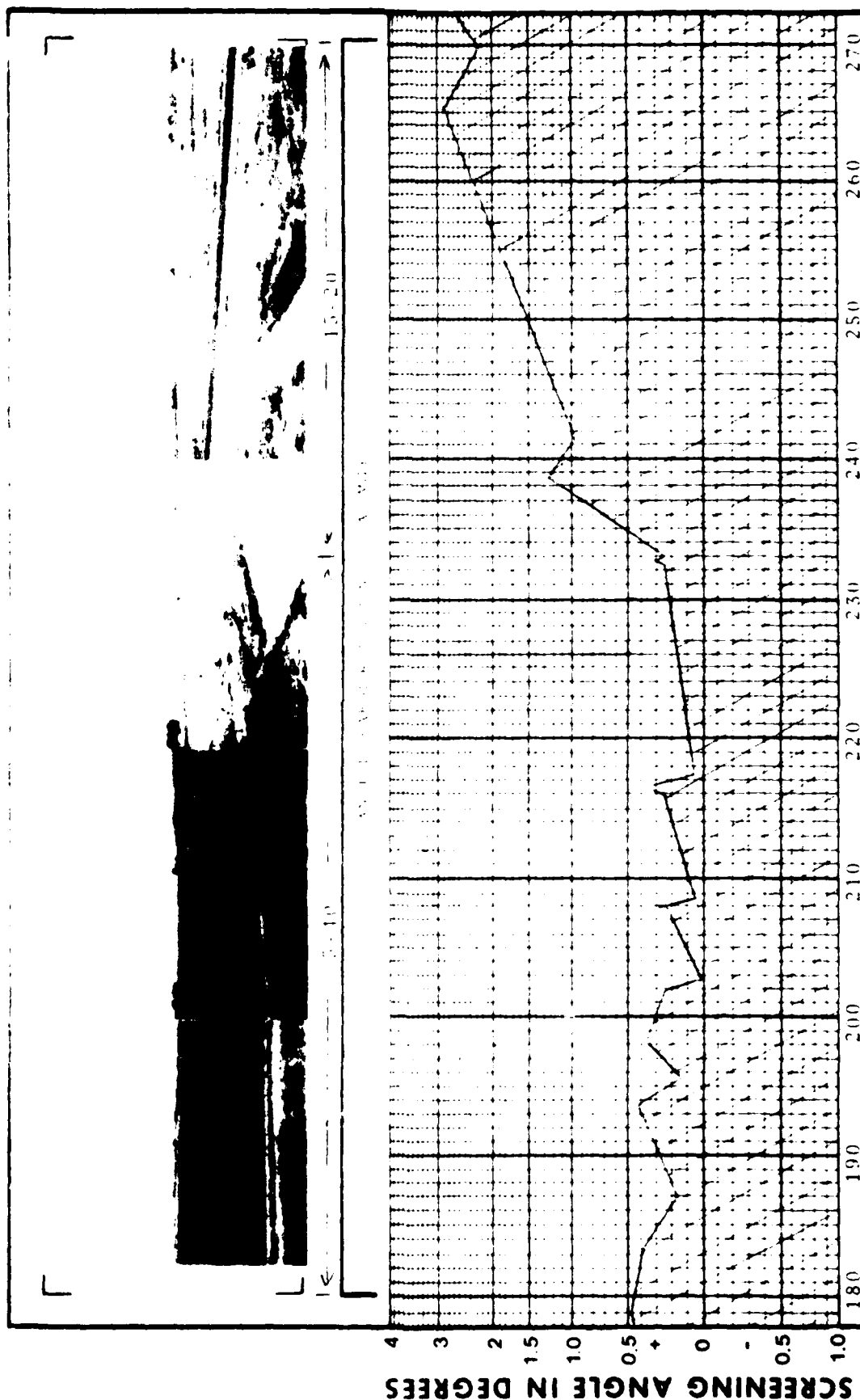
SKYLINE GRAPH



ORIENTED TO MAGNETIC NORTH
MAGNETIC VARIATION: 130° E

STATION LUKE AFB
EQUIPMENT RECEIVER SITE

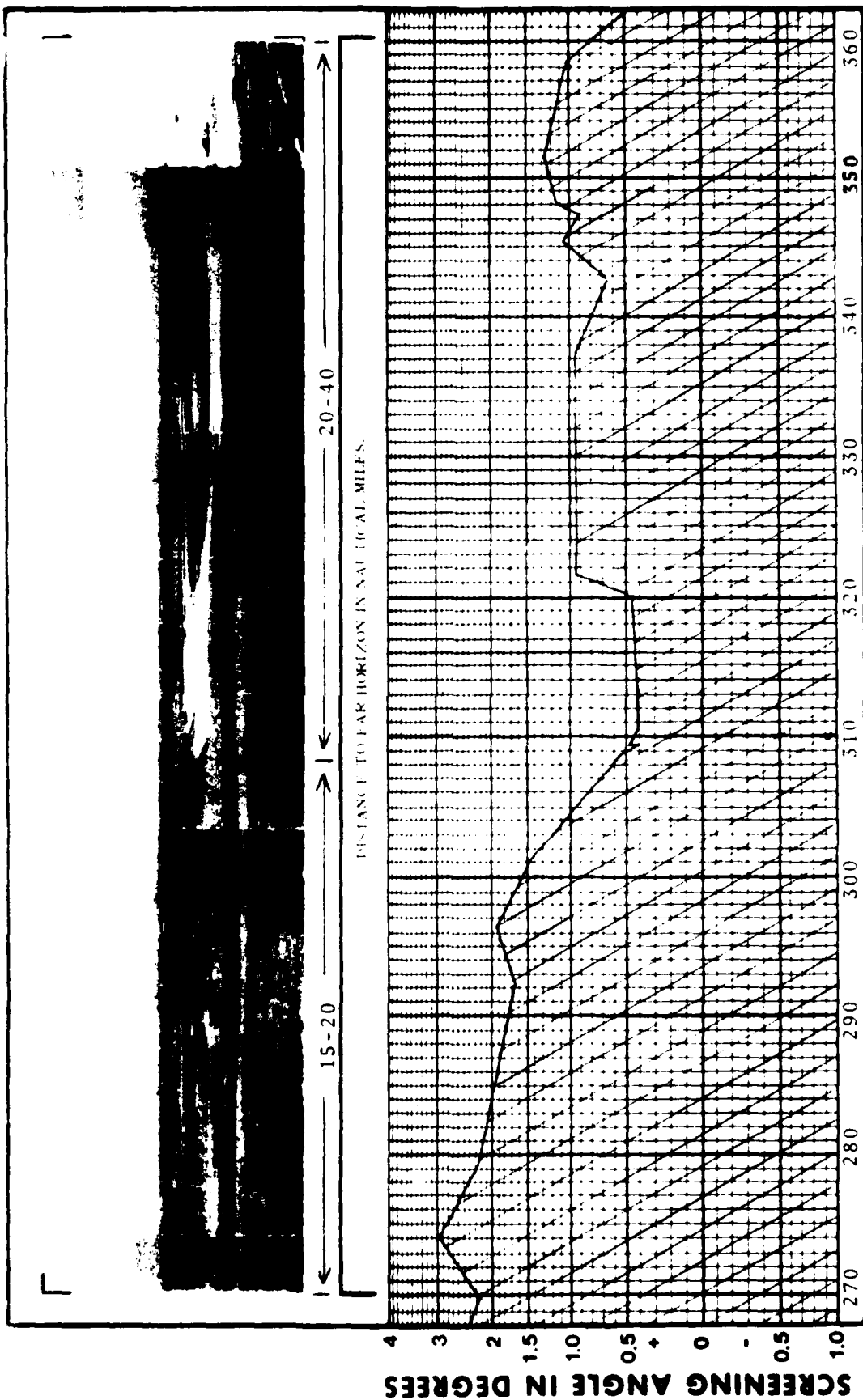
SKYLINE GRAPH



ORIENTED TO MAGNETIC NORTH
MAGNETIC VARIATION: 15° E

STATION LUKE AFB
EQUIPMENT RECEIVER SITE

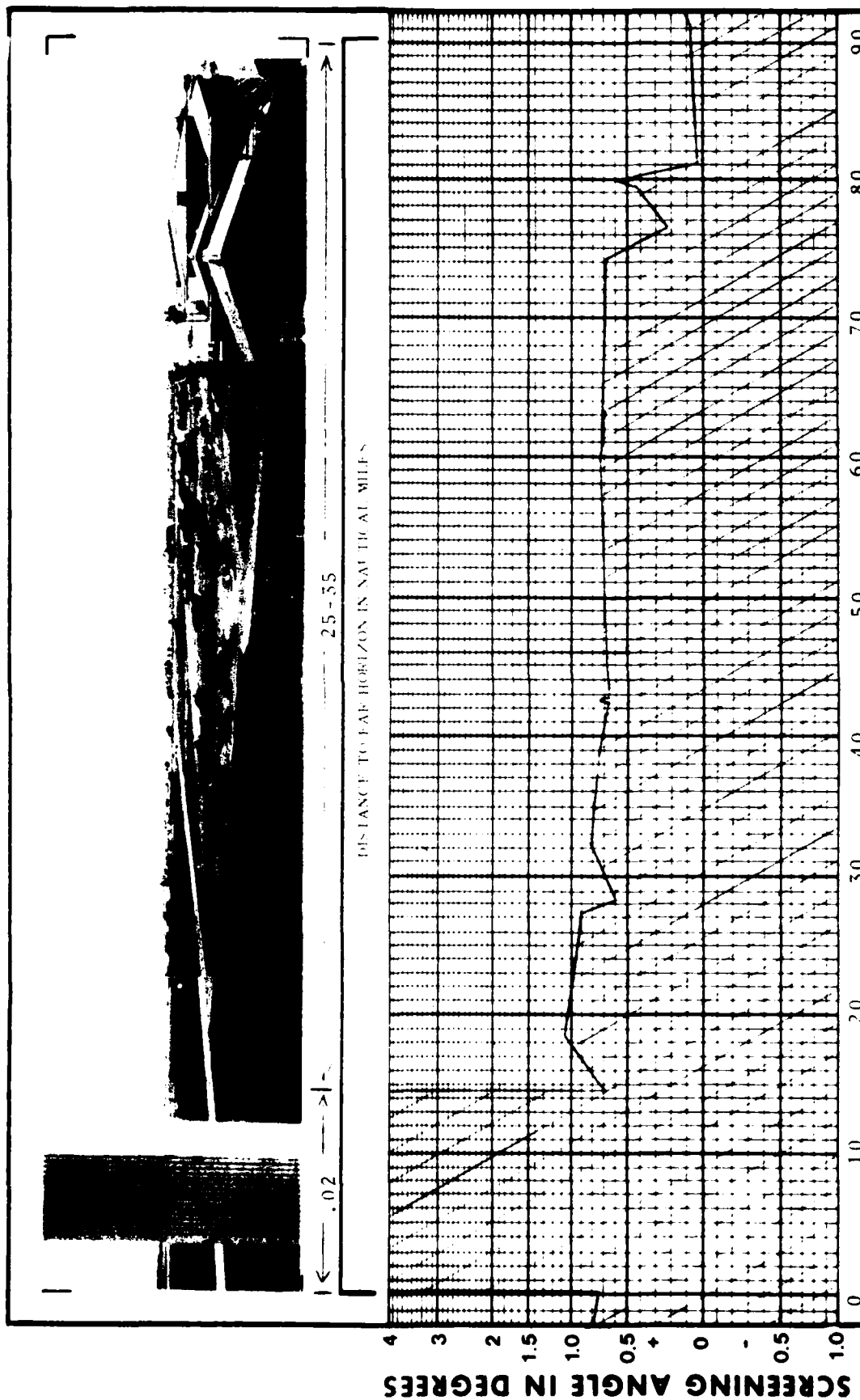
SKYLINE GRAPH



ORIENTED TO MAGNETIC NORTH
MAGNETIC VARIATION: 13° E

STATION LUKE AFB
EQUIPMENT RECEIVER SITE

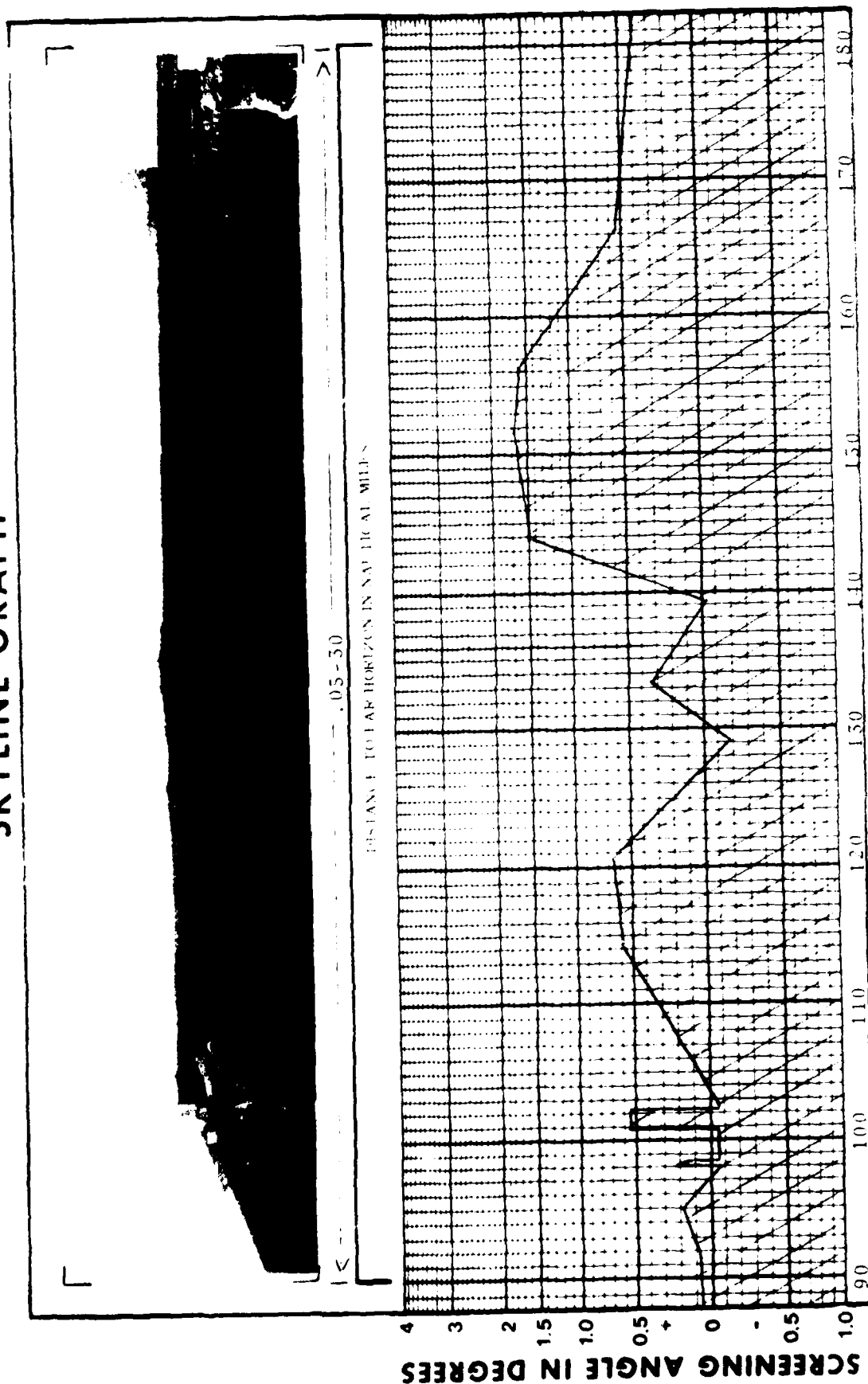
SKYLINE GRAPH



ORIENTED TO MAGNETIC NORTH
MAGNETIC VARIATION: 15° E

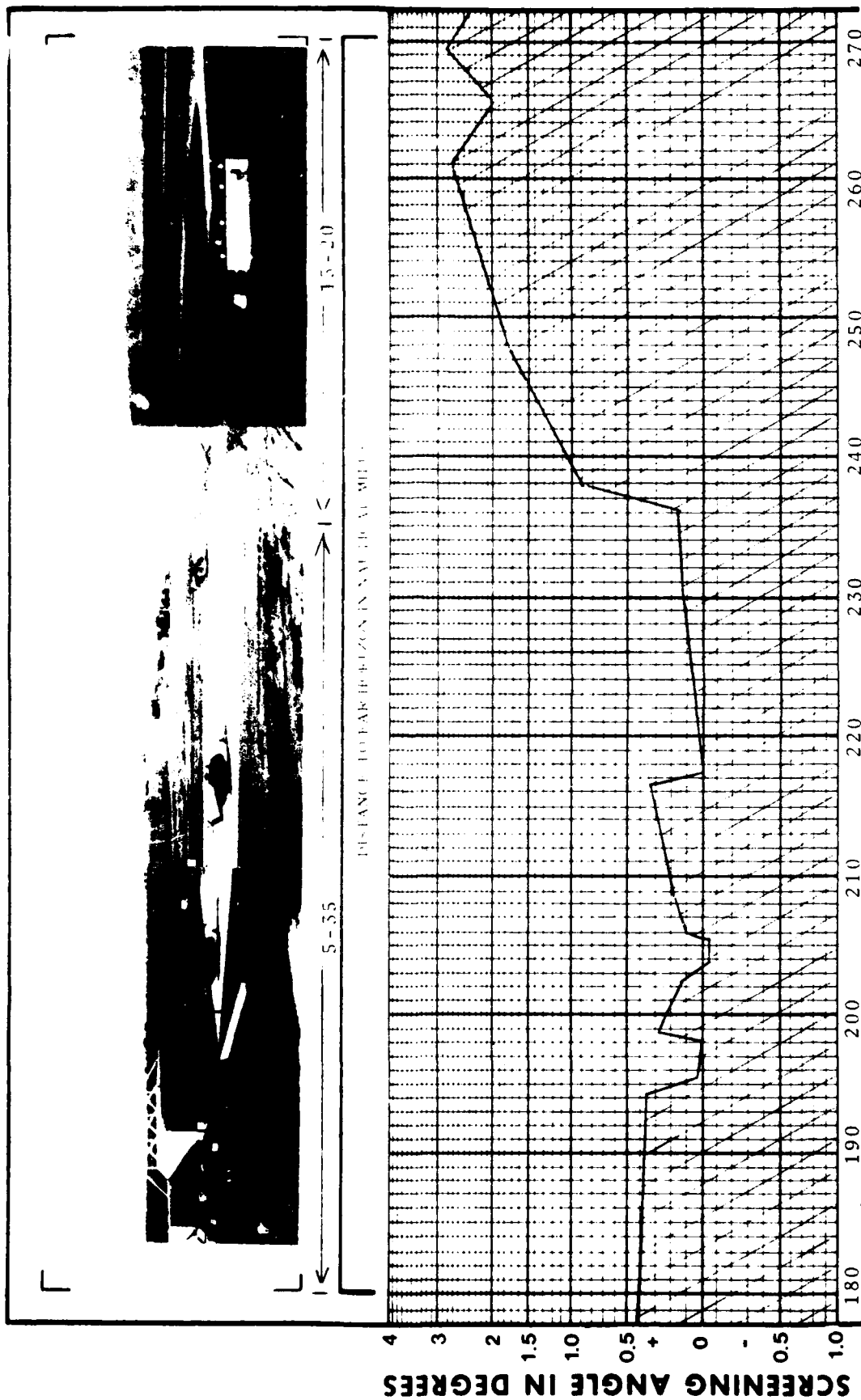
STATION LUKE AFB
EQUIPMENT GCA

SKYLINE GRAPH

STATION 1001 AUBEQUIPMENT GCA

ORIENTED TO MAGNETIC NORTH
 MAGNETIC VARIATION: 150 E.

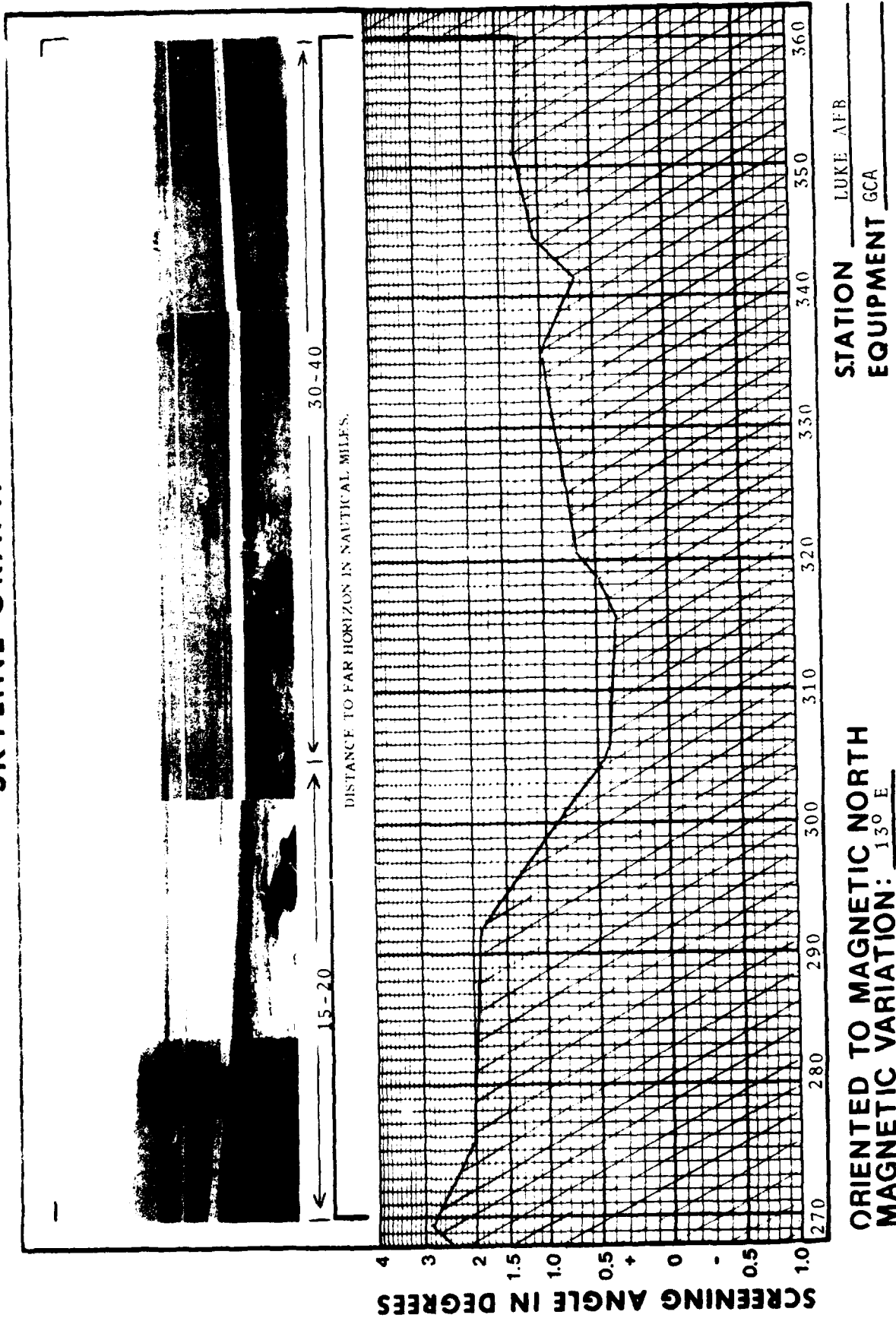
SKYLINE GRAPH



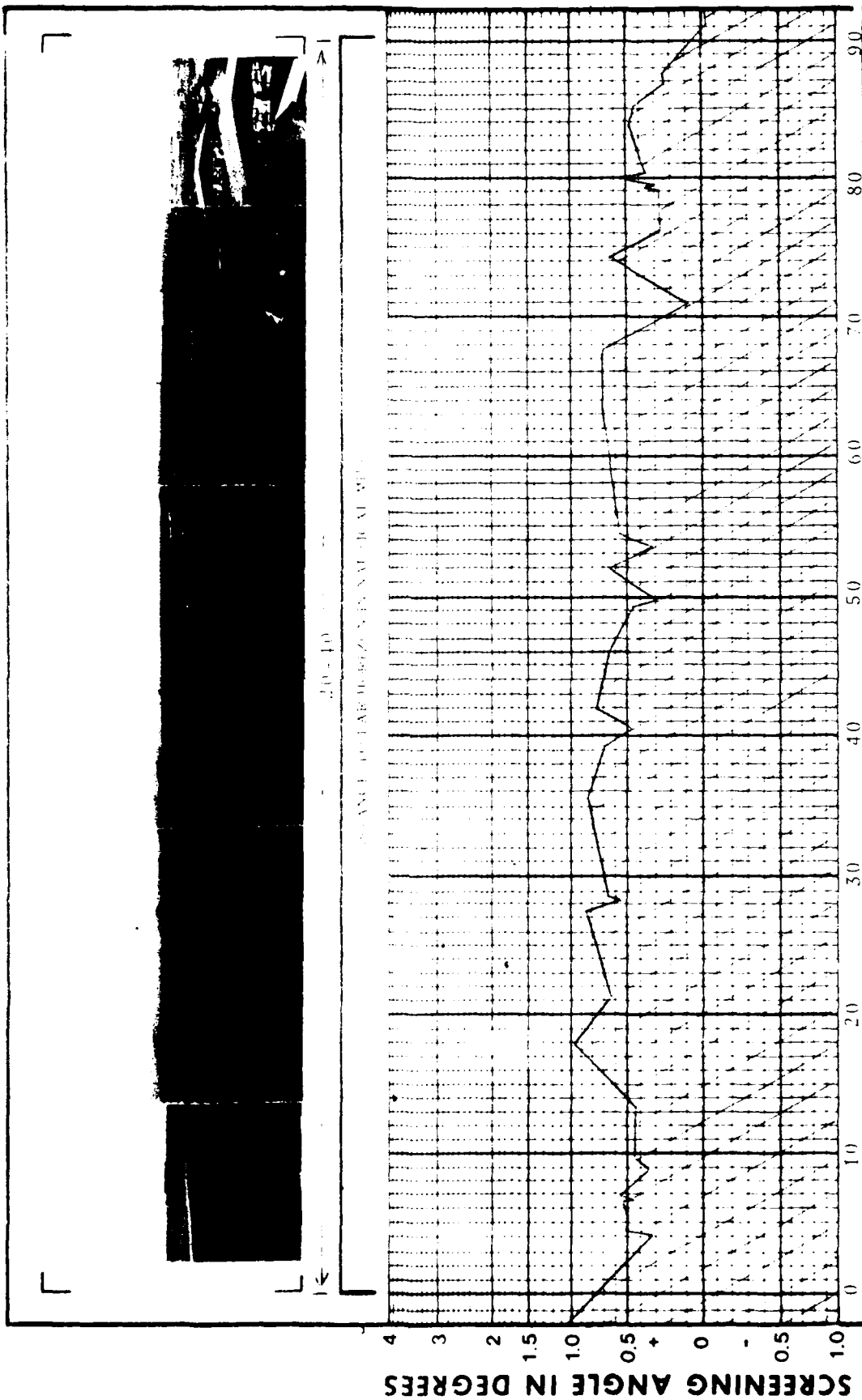
ORIENTED TO MAGNETIC NORTH
MAGNETIC VARIATION: 13° E

STATION LUKE AFB
EQUIPMENT GCA

SKYLINE GRAPH



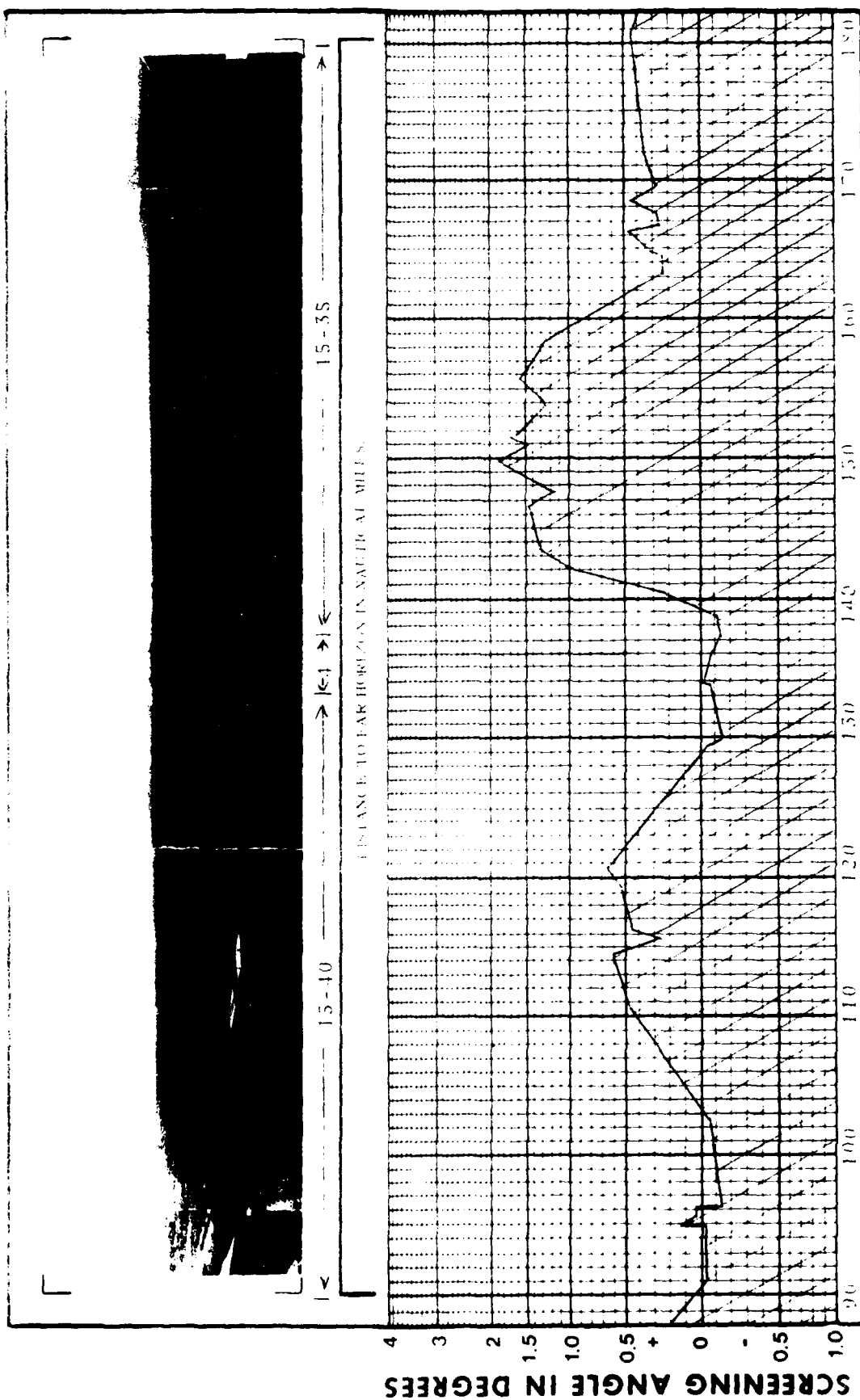
SKYLINE GRAPH



ORIENTED TO MAGNETIC NORTH
MAGNETIC VARIATION: 13° E

STATION LUKE AFB
EQUIPMENT CONTROL TOWER

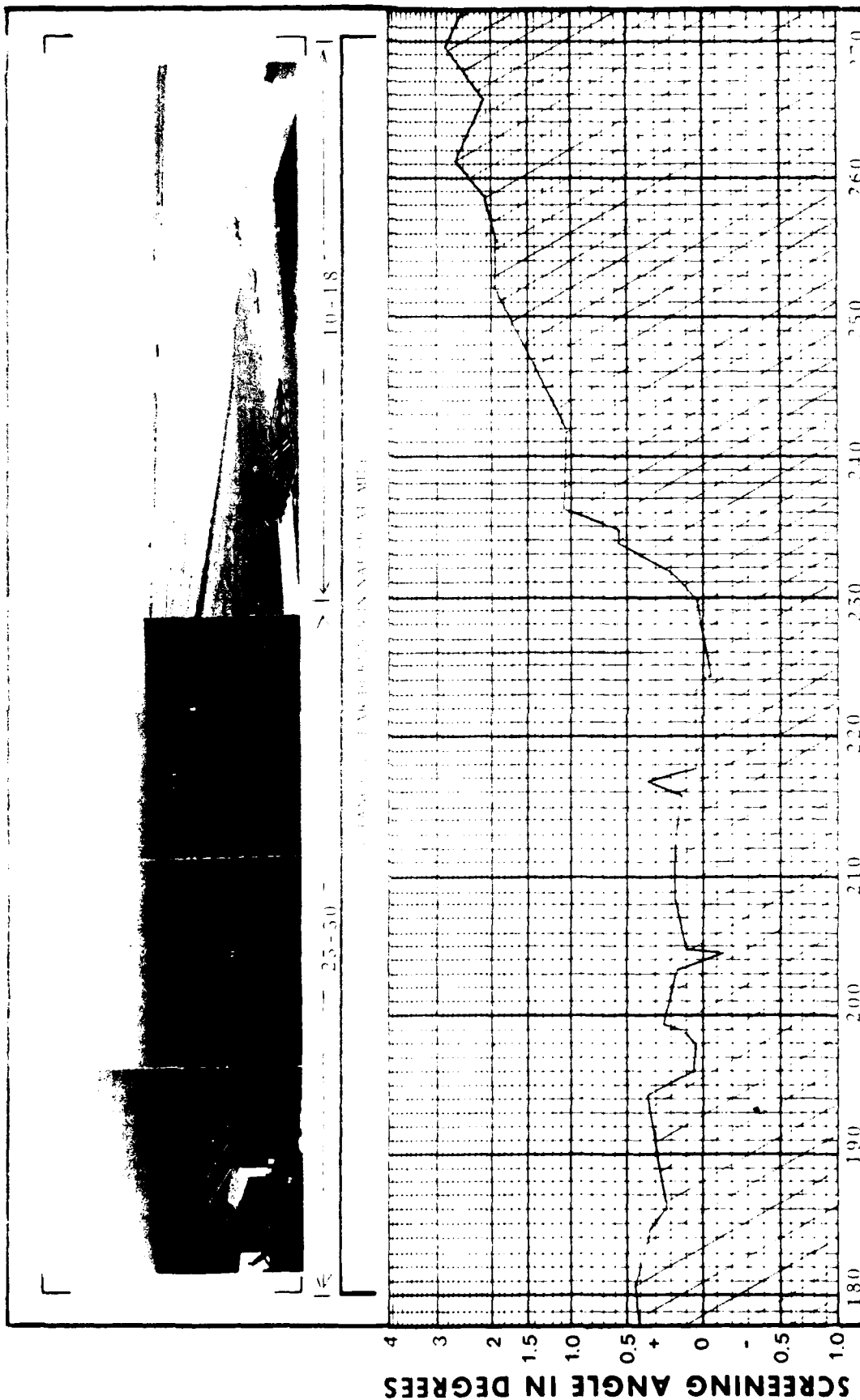
SKYLINE GRAPH



ORIENTED TO MAGNETIC NORTH
MAGNETIC VARIATION: 15.0 E

STATION LUKE AFB
EQUIPMENT CONTROL COMBAT

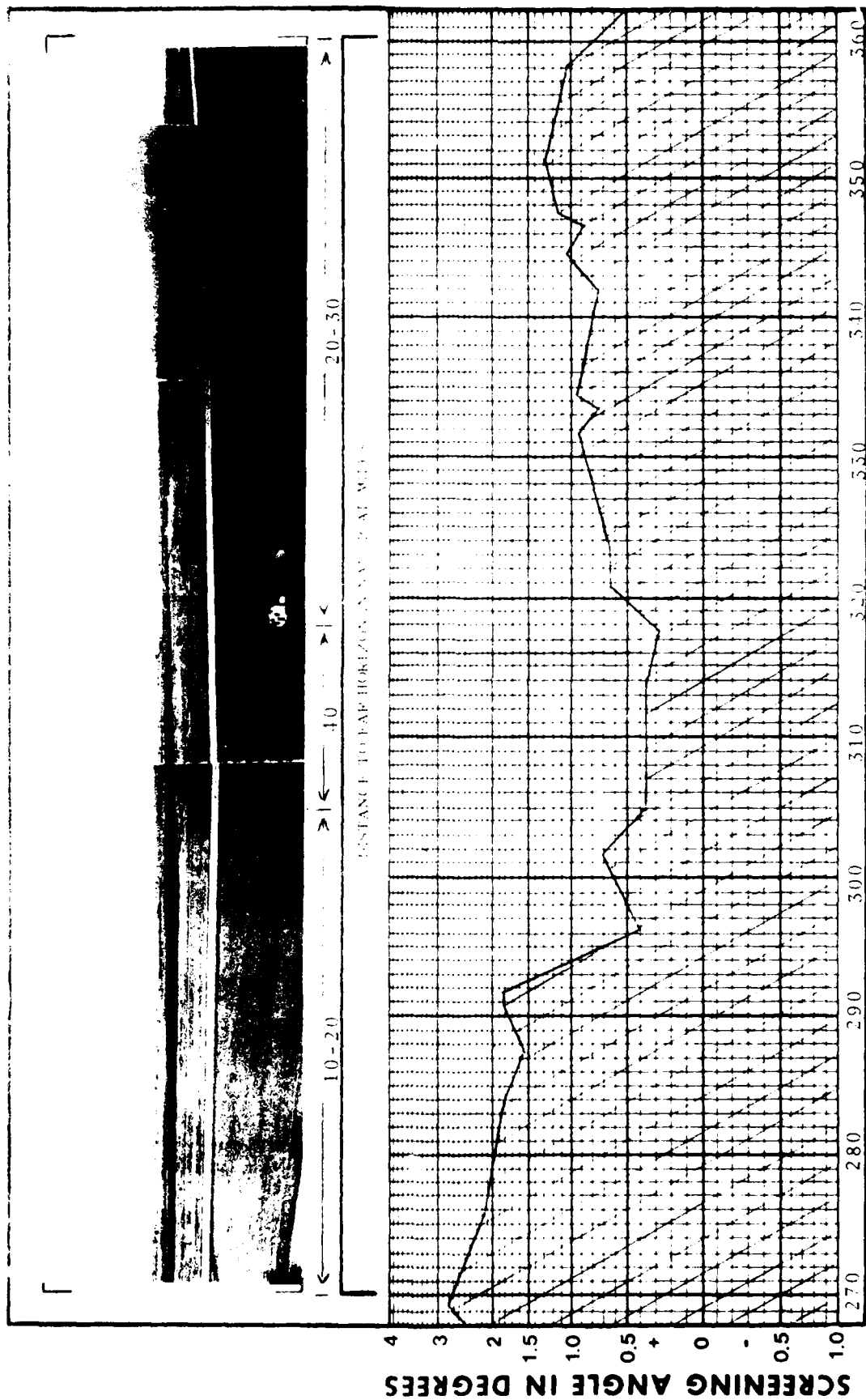
SKYLINE GRAPH



ORIENTED TO MAGNETIC NORTH
MAGNETIC VARIATION: 130° E

STATION LUKE AFB
EQUIPMENT CONTROL TOWER

SKYLINE GRAPH



ORIENTED TO MAGNETIC NORTH
MAGNETIC VARIATION: 15° E

STATION LUKE AFB
EQUIPMENT CONTROL TOWER

NULL ANGLE PREDICTIONS

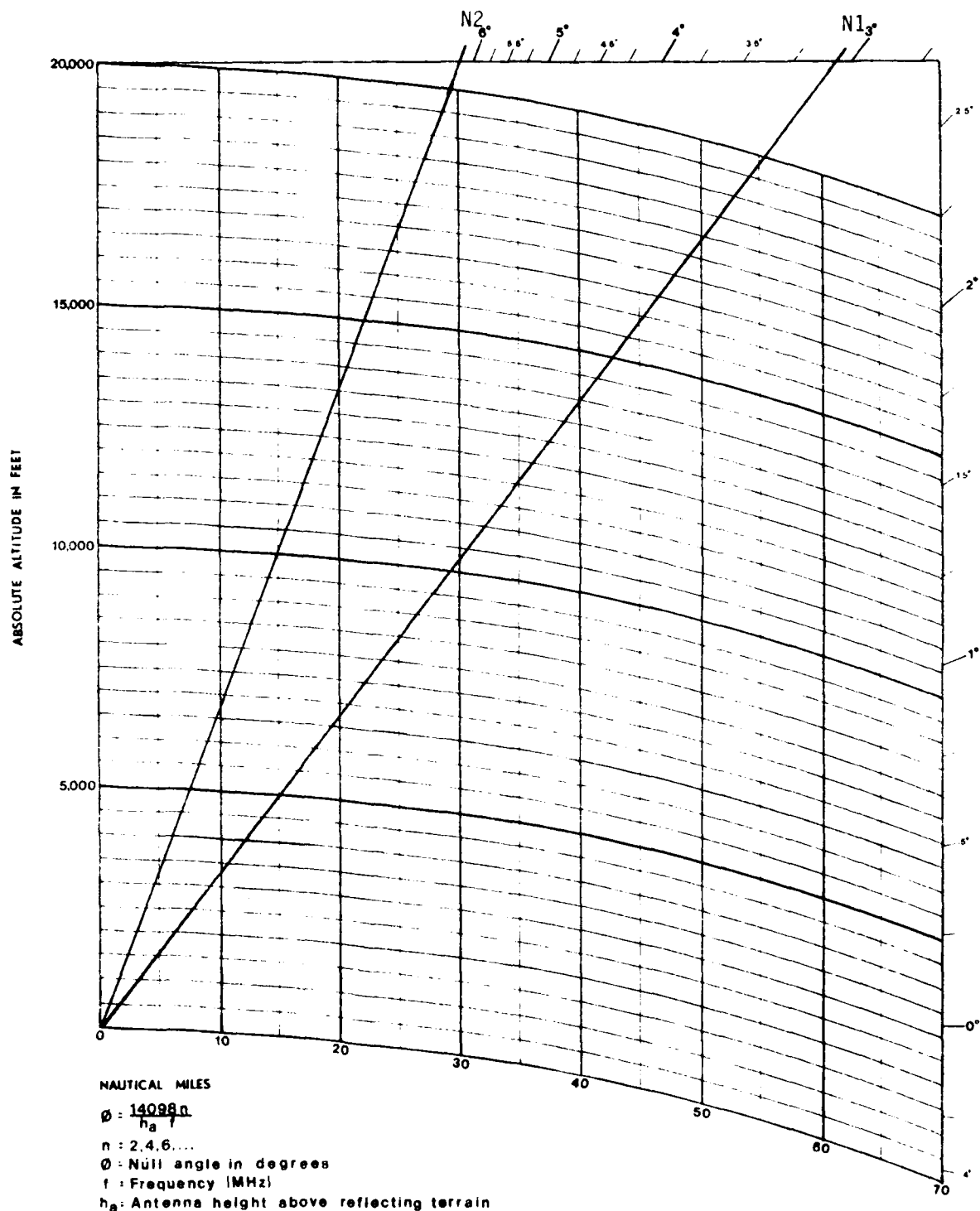
LOCATION:

Luke AFB

(Transmitter Site)

Date:

September 1980



Remarks:

 $f = 395.0$

N1 and N2 = Predicted null angles

 $h_a = 23.39$ feet

NULL ANGLE PREDICTIONS

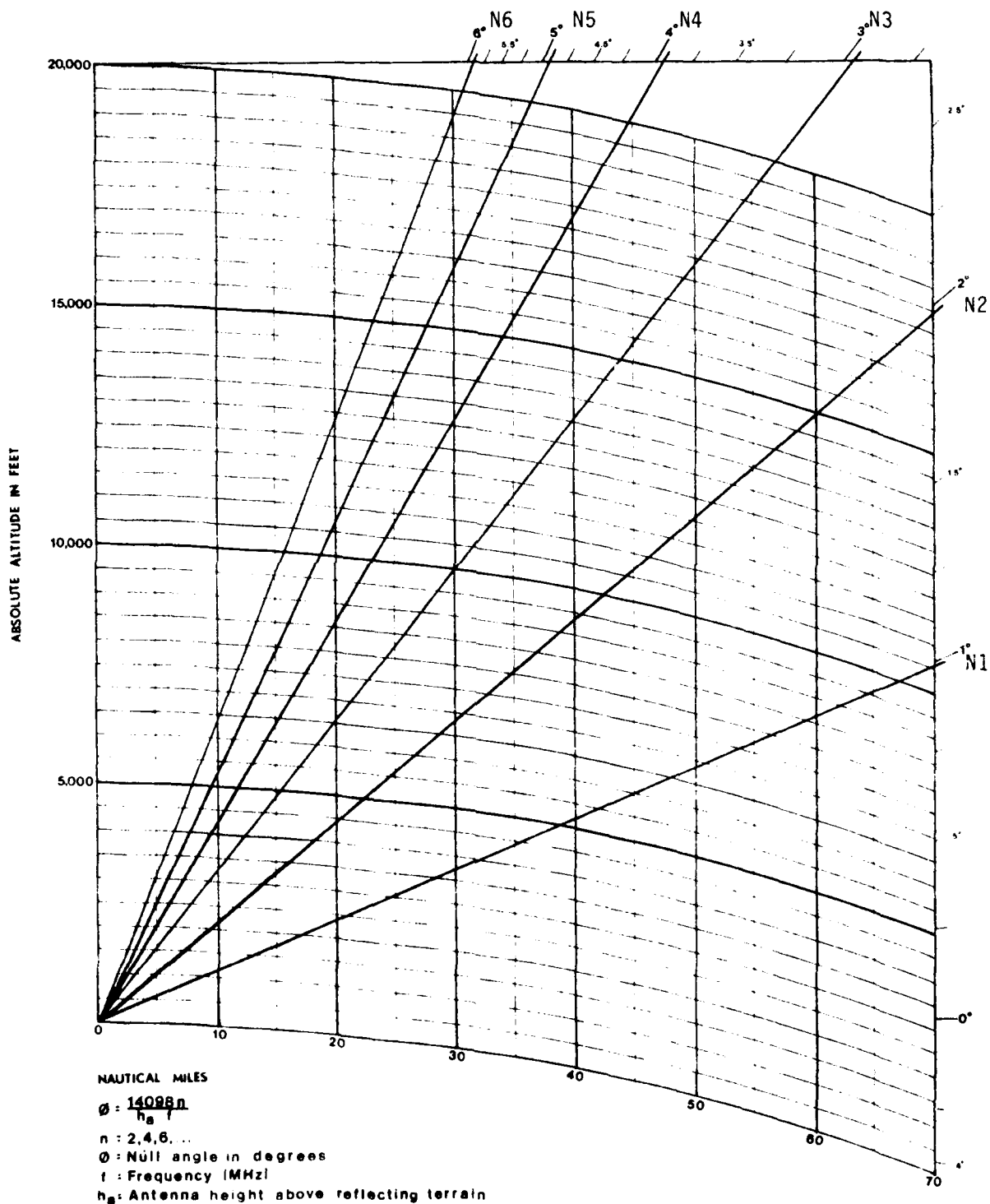
LOCATION:

Luke AFB

(Receiver Site)

Date:

September 1980



Remarks:

 $f = 395.0$ $h_a = 71.75$ feet

N1 thru N6 = Predicted null angles

NULL ANGLE PREDICTIONS

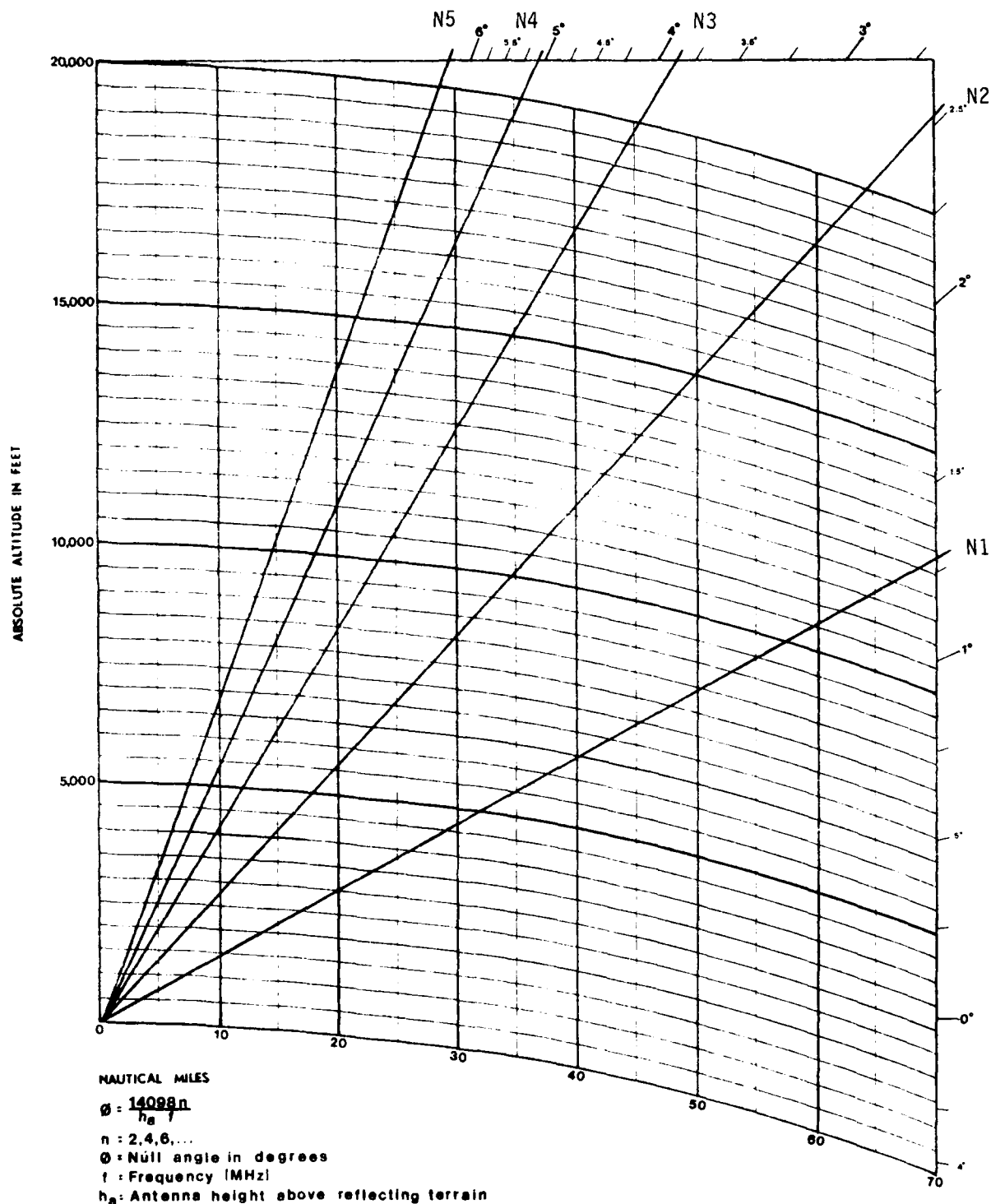
LOCATION:

Luke AFB

(GCA)

Date:

September 1980



Remarks:

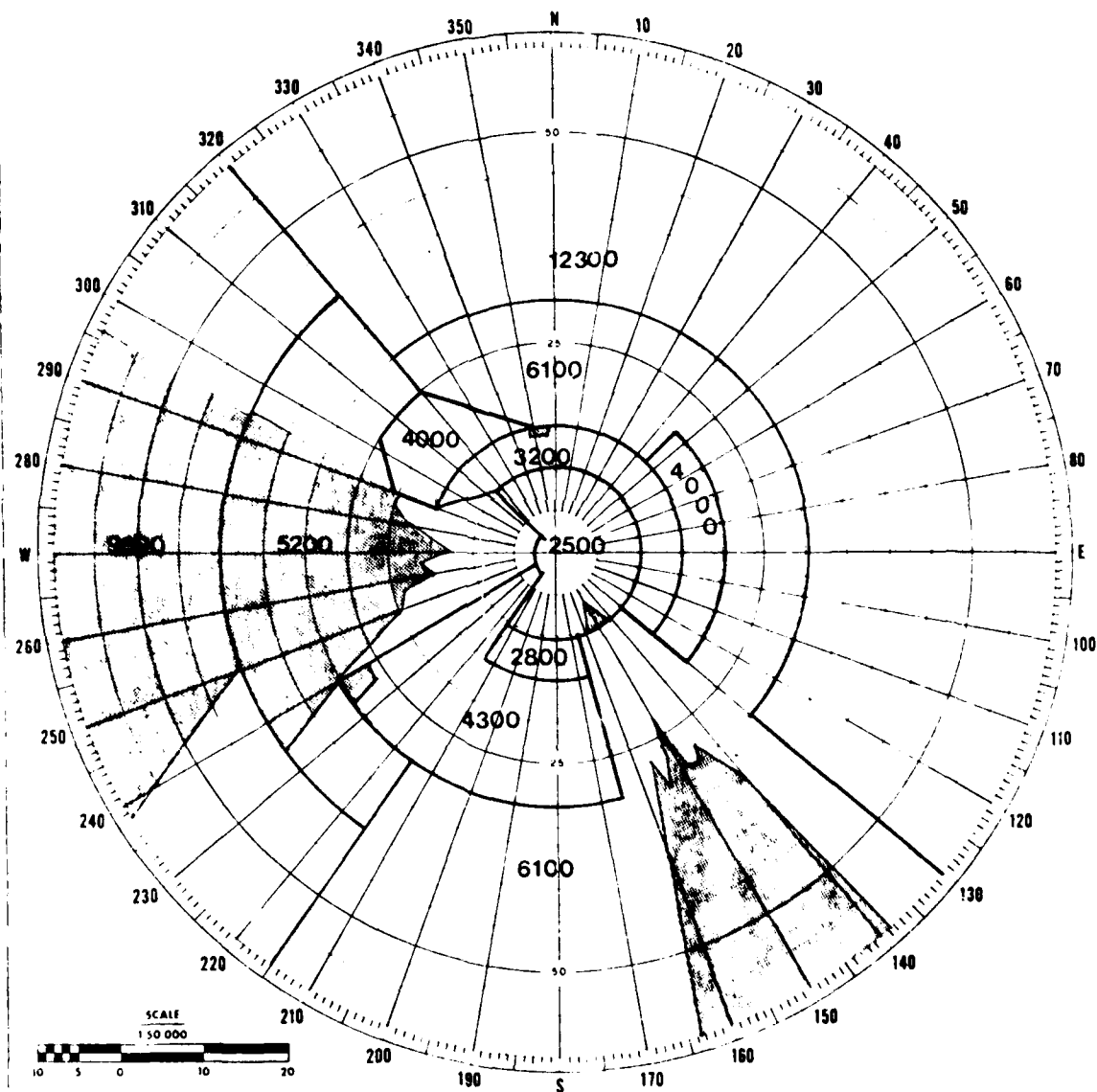
f = 395.0

N1 thru N5 = Predicted null angles

 h_a = 56.22 feet

RADIO LINE OF SIGHT RANGE

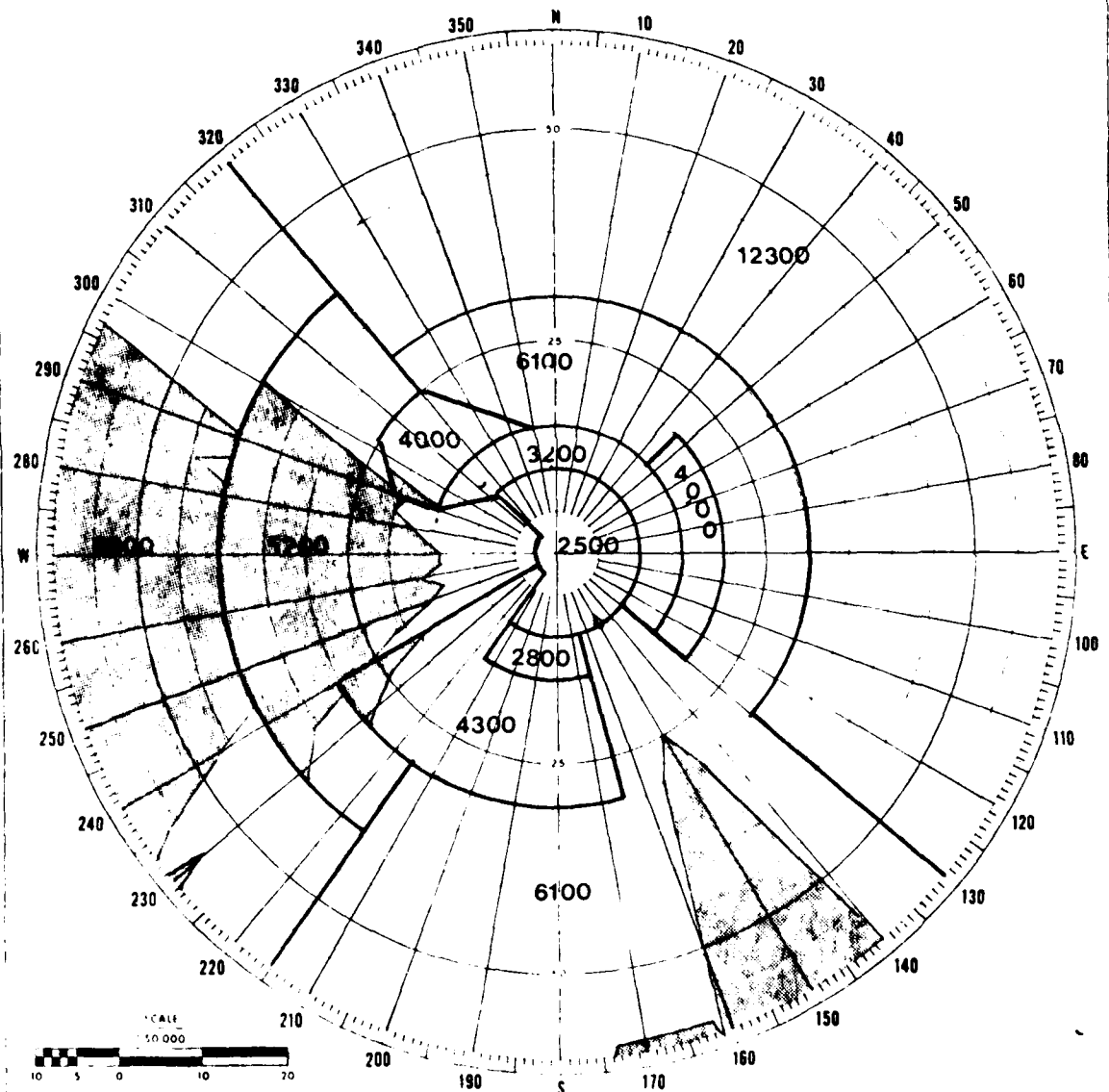
LOCATION Luke AFB	FIELD ELEVATION 1080 feet MSL	TYPE COVERAGE Control Tower
LATITUDE 33° 32' 0" W	MAGNETIC VARIATION 13° East	ALTITUDE: As shown
LONGITUDE 112° 22' 31" N	ORIENTED TO Magnetic North	Ant Height: 1206 feet MSL



Shaded areas represent areas of coverage limitations due to RLOS screening.

RADIO LINE OF SIGHT RANGE

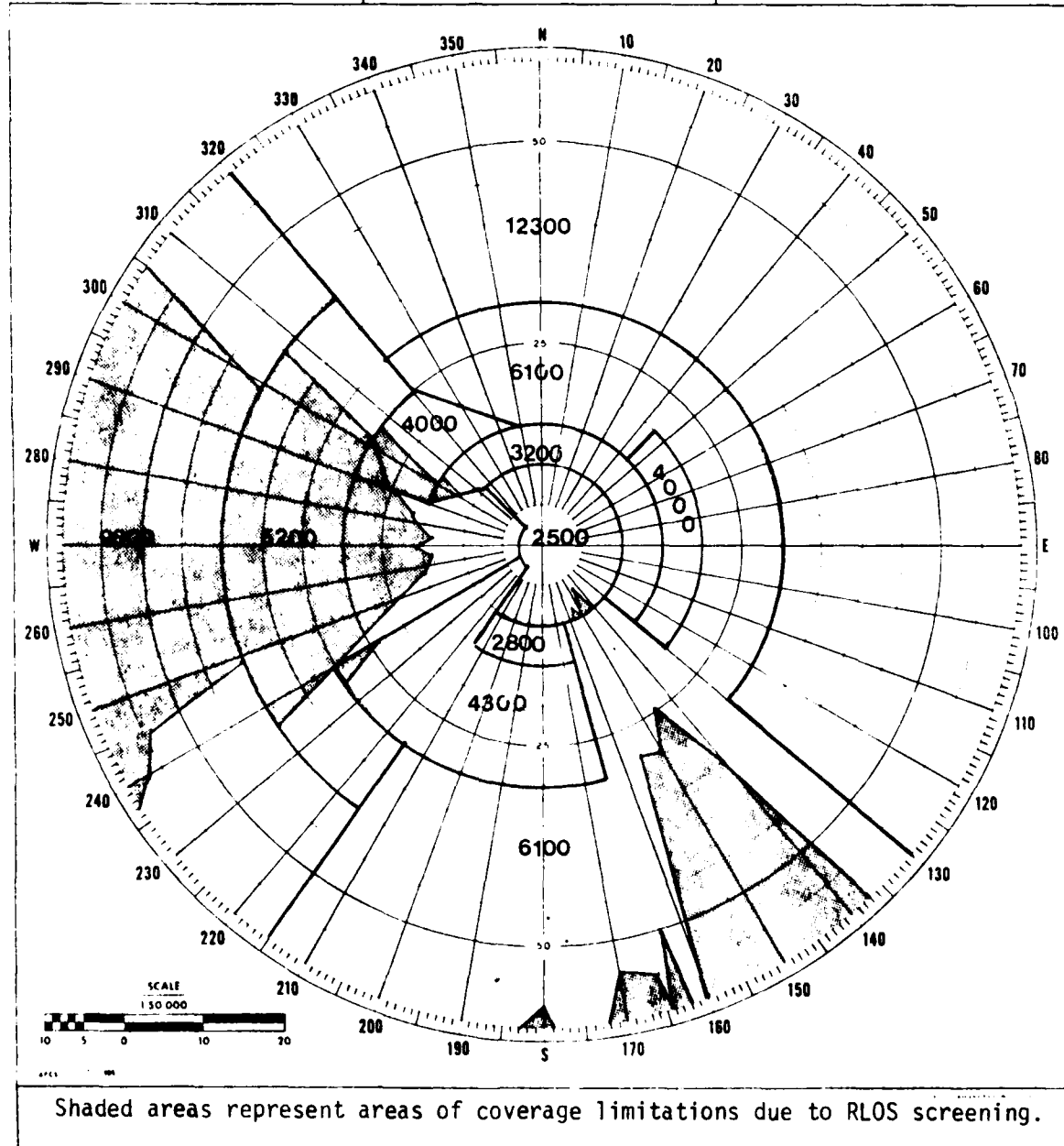
LOCATION Luke AFB	FIELD ELEVATION 1080 feet MSL	TYPE COVERAGE Transmitter Site
LATITUDE 33° 32' 47" W	MAGNETIC VARIATION 13° East	ALTITUDE As shown
LONGITUDE 112° 22' 53" N	ORIENTED TO Magnetic North	Ant Height: 1128 feet MSL



Shaded areas represent areas of coverage limitations due to RLOS screening.

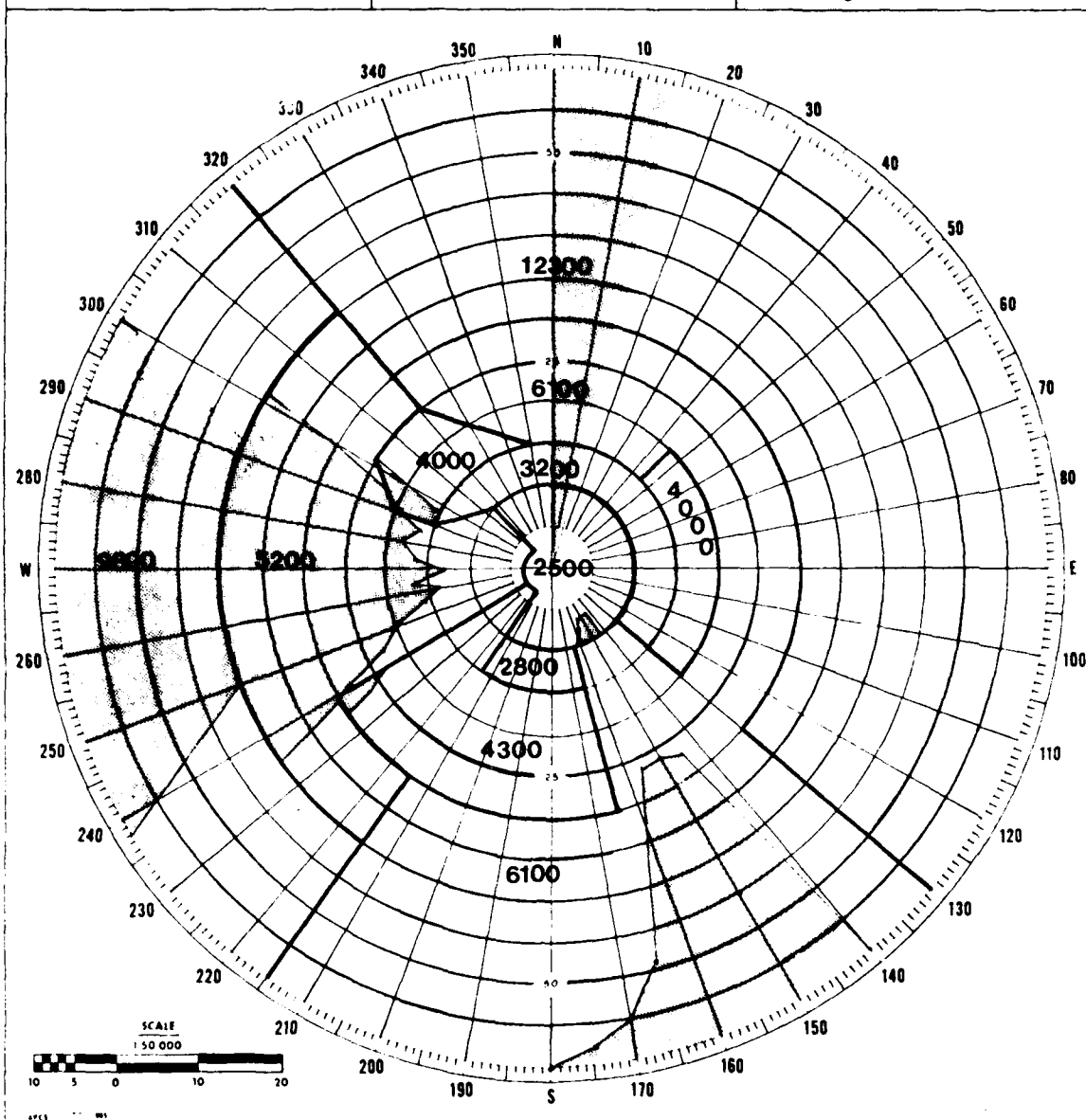
RADIO LINE OF SIGHT RANGE

LOCATION Luke AFB	FIELD ELEVATION 1080 feet MSL	TYPE COVERAGE Receiver Site
LATITUDE 33° 31' 25" W	MAGNETIC VARIATION 13° East	ALTITUDE As shown
LONGITUDE 112° 23' 12" N	ORIENTED TO Magnetic North	Ant Height: 1146 feet MSL



RADIO LINE OF SIGHT RANGE

LOCATION Luke AFB	FIELD ELEVATION 1080 feet MSL	TYPE COVERAGE GCA
LATITUDE 33° 31' 30" N	MAGNETIC VARIATION 13° East	ALTITUDE As shown
LONGITUDE 112° 22' 31" W	ORIENTED TO Magnetic North	Ant Height: 1136 feet MSL



Shaded areas represent areas of coverage limitations due to RLOS screening.

EQUIPMENT ANALYSIS SPECIFICATION LIST

A. Transmitters: AN/GRT-21 and AN/GRT-22 (TO 31R2-2GRT-102)

Percent of modulation, 0 dBm input: : 90%±10%
 Percent of modulation, -15 dBm input: : 90%±10%
 Percent of modulation, +10 dBm input: : 90%±10%
 Distortion: : 10% at lower limiting
 : 15% at upper limiting
 Frequency accuracy tolerance: : +0.0005% with freq synthesizer
 Power output: : 10 watts minimum, low power
 : 50 watts minimum, high power
 Reflected power: : 2.5 watts maximum, low power
 : 12.5 watts maximum, high power
 Transmission system VSWR: : Normal operation at carrier
 : power with VSWR not greater
 : than 3 to 1
 Coupler loss
 CU-547: : 2 dB maximum (TO 31R1-2GR-142)
 Antenna VSWR
 AS-1097/GR: : 2:1 maximum (TO 31R1-2GR-241)
 AT-197/GR: : 1.6:1 maximum (TO 31R1-2GR-161)
 AS-1181/UR: : 2:1 maximum (TO 31R1-2UR-31)

B. Receivers: AN/GRR-23 and AN/GRR-24 (TO 31R2-2GRR-112)

Frequency accuracy tolerance: : +0.0005% with freq synthesizer
 Sensitivity: : 3uv maximum
 Signal to noise: : 10 dB with a 3uv input
 Squelch threshold: : 3uv (TO 31R2-2GRR-116WC-1)
 AGC characteristics: : 3 dB maximum variation with
 : signal of 6uv to 1v
 Audio output: : +20 dBm with older preamplifier
 : module, +14 dBm with newer
 : preamplifier module
 Distortion: : for frequencies 300, 1500, and
 : 3000 Hz with a 1v input, 10
 : maximum with 30% modulation,
 : 20% maximum with 90% modulation
 Transmission system VSWR: : no specification available
 Coupler loss
 CU-547: : 2 dB maximum (TO 31R1-2GR-142)
 Antenna VSWR
 AS-1097/GR: : 2:1 maximum (TO 31R1-2GR-241)
 AT-197/GR: : 1.6:1 maximum (TO 31R1-2GR-161)
 AS-1181/UR: : 2:1 maximum (TO 31R1-2UR-31)

TITLE

EQUIPMENT ANALYSIS SPECIFICATION LIST

A. Transceiver: AN/GRC-171 (TO 31R2-2GRC171-2)

Percent of modulation, 0 dBm input:	85% to 95%
Percent of modulation, -15 dBm input:	85% to 95%
Percent of modulation, +10 dBm input:	85% to 95%
Transmit audio distortion:	10% maximum
Frequency accuracy tolerance:	+ 0.0005%
Power output:	16 watts minimum
Sensitivity:	3 uV maximum
Signal plus noise to noise:	10 dB minimum (notch tone method) with a 3 uV RF input
Squelch threshold:	3 uV
AGC characteristics:	3 dB maximum variation with RF input signal changing from 6 uV to 1 Volt
Audio Output:	+20 dBm (100 mw)
Receive Audio Distortion:	10% maximum with a 1 Volt RF input modulated at 30%. 15% maximum when modulated at 90%
Antenna VSWR:	
AS-1097/GR (TO 31R1-2GR-241)	2.00:1 maximum
AT-197/GR (TO 31R1-2GR-161)	1.60:1 maximum

B. Transceiver: AN/GRC-175 (TO 31R2-2GR-1042)

Percent of modulation, 0 dBm input:	90% minimum
Percent of modulation, +10 dBm input:	100% maximum
Transmit audio distortion:	No Specification Available
Frequency accuracy tolerance:	+ 0.001%
Power output:	25 watts minimum
Sensitivity:	3 uV maximum
Signal plus noise to noise:	6 dB minimum with a 3 hard uV RF input
Squelch threshold:	3 uV
AGC characteristics:	3 dB maximum variation with RF input signal of 5 uV to 100 mV
Audio output:	+20 dBm (100 mw)
Receive audio distortion:	7.5% maximum with a 1 Volt RF input modulated at 30%. 20% when modulated at 90%
Antenna VSWR:	
AS-1181/UR (TO 31R1-2UR-31)	2.00:1 maximum

TITLE

EQUIPMENT ANALYSIS SPECIFICATION LIST

A. Communications Control Equipment: AN/GRA-81 and AN/GRA-83

1. Line, Speaker, Phone Amplifiers: AM-4571/G (TO 31R1-2G-102)

Gain: -20 dBm input at 1 kHz; output should not be less than +30 dBm (or 50 dBm minimum gain)
Noise level: -40 dBm maximum
Distortion: 5% maximum at rated output (2 watts; +33 dBm)

2. Microphone Amplifiers: AM-4568/G (TO 31R1-2G-112)

Gain: -64 dBm input at 1 kHz; output should not be less than +8 dBm (or 72 dB minimum gain)
Noise level: -40 dBm maximum
Distortion: 5% maximum at rated output (200 milliwatts; +23 dBm)

B. Communications Control Equipment: OJ-314

1. Microphone Amplifiers: 7A1A8

Gain: 18 dB minimum
Noise level: -40 dBm maximum
Distortion: 5% maximum with amplifier adjusted for compression

2. Speaker Amplifiers: 7A1A2

Gain: 40 dB minimum
Noise level: -40 dBm maximum
Distortion: 5% maximum

3. Headphone Amplifiers: 7A1A4A

Gain: 20 dB minimum
Noise level: -40 dBm maximum
Distortion: 5% maximum

4. Monitor Amplifiers: 7A1A4B

Gain: No specifications available
Noise level: -40 dBm maximum
Distortion: 5% maximum

5. Receiver Amplifiers: 2A1-2A2

Gain: 20 dB minimum
Noise level: -40 dBm maximum
Distortion: 3% maximum

TITLE

EQUIPMENT ANALYSIS SPECIFICATION LIST

A. Line, Speaker, Phone Amplifiers: AM-4571/G (TO 31R1-2G-102)

Gain: -20 dBm input at 1 kHz, output should not be less than +30 dBm (or 50 dB minimum gain)

Noise level: -40 dBm maximum

Distortion: 5% maximum at rated output (2 watts; +33 dBm)

B. Microphone Amplifiers: AM-4568/G (TO 31R1-2G-112)

Gain: -64 dBm input at 1 kHz, output should not be less than +8 dBm (or 72 dB minimum gain)

Noise level: -40 dBm maximum

Distortion: 5% maximum at rated output (200 milliwatts; +23 dBm)

REMARKS

AM RADIO COMMUNICATIONS EQUIPMENT ANALYSIS (Multichannel)

LOCATION Luke AFB (GCA)					DATE September 1980		
TRANSCIVER NOMENCLATURE		AN/GRC-171					
SERIAL NUMBER		1138					
FREQUENCY MHz		225.0		312.0		395.0	
		INITIAL	ADJUSTED	INITIAL	ADJUSTED	INITIAL	ADJUSTED
MODULATION LEVEL %		81*	86	86	90	86	90
UPPER LIMITING %		81*	86	86	90	86	90
LOWER LIMITING %		81*	86	86	90	86	90
TRANSMIT DISTORTION %		5.2		5.4		5.2	
FREQUENCY ACCURACY %		.00003		.00004		.00004	
RF POWER OUT FORWARD WATTS		27		24		23	
SENSITIVITY μV		2.2		2.1		2.3	
SIGNAL TO NOISE dB		15		13.6		14.5	
SQUELCH THRESHOLD μV		3		3		4*	3
AGC dB		0.6		1.0		0.8	
AUDIO OUT Equip / Line dBm		-2 / -16	20 / 0	20 / 0		20 / 0	
RECEIVE DISTORTION %		6.4		6.8		9.0	
ANTENNA VSWR		1.5:1		1.5:1		1.5:1	
REMARKS * Out of tolerance							

AM RADIO COMMUNICATIONS EQUIPMENT ANALYSIS (Multichannel)							
LOCATION					DATE		
Luke AFB (GCA)					September 1980		
TRANSCIVER NOMENCLATURE		AN/GRC-175					
SERIAL NUMBER		66184					
FREQUENCY MHz		116.0		124.0			
		INITIAL	ADJUSTED	INITIAL	ADJUSTED	N T A L	ADJUSTED
MODULATION LEVEL		60*		60*			
UPPER LIMITING		N/A		N/A			
LOWER LIMITING		68*		68*			
TRANSMIT DISTORTION		4.8		9.4			
FREQUENCY ACCURACY		.0001		.0001			
RF POWER OUT FORWARD WATTS		36		41			
SENSITIVITY μV		3		3			
SIGNAL TO NOISE dB		7		10			
SQUELCH THRESHOLD μV		3		3			
AGC dB		1.0		0.4			
AUDIO OUT Line dBm		0.8		1.8			
RECEIVE DISTORTION		10		13			
ANTENNA SWR		1.17:1		1.17:1			
REMARKS							
* Out of tolerance - referred to maintenance							

AM RADIO COMMUNICATIONS EQUIPMENT ANALYSIS (Multichannel)						
LOCATION Luke AFB (Control Tower)					DATE September 1980	
TRANSCIVER NOMENCLATURE		AN/GRC-171				
SERIAL NUMBER		547				
FREQUENCY MHz		225.0		312.0		395.0
		INITIAL	ADJUSTED	INITIAL	ADJUSTED	INITIAL ADJUSTED
MODULATION LEVEL		99*	90	90		90
UPPER LIMITING		99*	90	90		90
LOWER LIMITING		99*	90	90		90
TRANSMIT DISTORTION		8.0	4.2	3.8		4.2
FREQUENCY ACCURACY		.00002		.00002		.00002
RF POWER OUT FORWARD WATTS		18		16		17
SENSITIVITY μV		1.6		2.2		1.6
SIGNAL TO NOISE dB		15		12		15
NOISE FLOOR THRESHOLD μV		5*	3	3		3
AGC dB		0.6		1.0		0.7
AGC OUT Line dBm		-10 *	0.0	0.0		0.0
RECEIVE DISTORTION		7		8		8
ANTENNA VSWR		**		**		**
REMARKS * Out of tolerance ** Not measured						

AM RADIO COMMUNICATIONS EQUIPMENT ANALYSIS (Multichannel)							
LOCATION Luke AFB (Control Tower)						DATE September 1980	
TRANSCIVER NOMENCLATURE		AN/GRC-175					
SERIAL NUMBER		585					
FREQUENCY		116.0		124.0			
	MHZ	INITIAL	ADJUSTED	INITIAL	ADJUSTED	INITIAL	ADJUSTED
MODULATION LEVEL		60*	*	60*			
UPPER LIMITING		N/A		N/A			
LOWER LIMITING		100*		100*			
TRANSMIT DISTORTION		7.3		14			
FREQUENCY ACCURACY		.00001		.00001			
RF POWER OUT FORWARD		25		34			
SENSITIVITY		3.0		2.5			
SIGNAL TO NOISE		10		14.5			
SIGNAL THRESHOLD		6		3			
AFC		0.8		0.2			
AUDIO OUT Line		-6.0		-6.0			
RECEIVED DISTORTION		10		8			
ANTENNA VSWR		**		**			
* Out of tolerance - referred to maintenance ** Not measured							

AM RADIO COMMUNICATIONS EQUIPMENT ANALYSIS				DATE September 1960					
LOCATION Luke AFB									
FREQUENCY	MHz	126.2		134.1		289.6			
1. TRANSMITTER NOMENCLATURE		AN/GRT-21		AN/GRT-21		AN/GRT-22			
2. SERIAL NUMBER		531		329		3521			
3. MODULATION LEVEL		INITIAL	ADJUSTED	INITIAL	ADJUSTED	INITIAL	ADJUSTED		
		79*	88	95		86			
4. LOWER LIMITING		81	88	90		83			
5. UPPER LIMITING		77*	86	95		88			
6. DISTORTION		4.6		9.2		3.5			
7. FREQUENCY ACCURACY		.00007		.00002		.00006			
8. RF POWER OUT FORWARD		Watts	8*	10	6.8*	10	7*	10	
9. COUPLER VSWR		N/A		N/A		1.7:1		1.3:1	
10. COUPLER LOSS		dB		N/A		2.4*		1.8	
11. ANTENNA VSWR		1.66:1		1.1:1		2.4:1*			
12. RECEIVER NOMENCLATURE		AN/GRR-23		AN/GRR-23		AN/GRR-24			
13. SERIAL NUMBER		66-353		6270		4913			
14. FREQUENCY ACCURACY		.0011		.00005		.00016			
15. SENSITIVITY		UV		1.8		1.3		4.0*	2.0
16. SIGNAL TO NOISE		dB		21.0		13.5		7.5*	15.0
17. SILENCE THRESHOLD		UV		1.8*		3.0		2.0*	3.0
18. AGC		1.0		1.0		0.5			
19. AUDIO OUT		Equip	-2.0*	20	5.5*	19.5	20.0	19.5	
		Line	-0.6*	0.0	-1.5*	0.0	-1.0*	0.0	
20. DISTORTION		11.5*		1.2		3.4			
21. COUPLER VSWR		N/A		N/A		1.06:1			
22. COUPLER LOSS		dB		N/A		1.6			
23. ANTENNA VSWR		1.3:1		1.4:1		1.04:1			
REMARKS * Out of tolerance									

AM RADIO COMMUNICATIONS EQUIPMENT ANALYSIS				DATE September 1980			
LOCATION Luke AFB							
FREQUENCY	MHZ	349.7**		389.8		395.0	
1. TRANSMITTER NOMENCLATURE		AN/GRT-22		AN/GRT-22		AN/GRT-22	
2. SERIAL NUMBER		14584		14841		3409	
3. MODULATION LEVEL		INITIAL	ADJUSTED	INITIAL	ADJUSTED	INITIAL	ADJUSTED
		100*	90	88		86	90
4. LOWER LIMITING	%	97	81	83		81	86
5. UPPER LIMITING	%	100*	92	90		86	90
6. DISTORTION	%	14.5*	12.0	3.8		3.9	6.4
7. FREQUENCY ACCURACY	%	.00009		.00002		.000002	
8. RF POWER OUT FORWARD	Watts	8*	10	8*	10	8.2*	10
9. COUPLER VSWR		1.08:1		1.2:1		1.27:1	
10. COUPLER LOSS	dB	1.8		1.5		1.7	
11. ANTENNA VSWR		1.1:1		1.6:1		1.2:1	
12. RECEIVER NOMENCLATURE		AN/GRR-24		AN/GRR-24		AN/GRR-24	
13. SERIAL NUMBER		4338		3243		4912	
14. FREQUENCY ACCURACY		.00007		.00005		.00005	
15. SENSITIVITY	UV	30*	1	1.2		2.4	
16. SIGNAL TO NOISE	dB	3.5*	13	17.2		11.5	
17. SQUELCH THRESHOLD	UV	3.0		3.0		3.0	
18. AGC		0.5		0.5		0.7	
19. AUDIO OUT	Equip Line dBm	21 -3.5*	21 0.0	16* -0.5*	19.8 0.0	20 -3.6*	20 0.0
20. DISTORTION	%	2.5		3.2		2.0	
21. COUPLER VSWR		4.4 1*		4.4:1*		3.54:1*	1.04:1
22. COUPLER LOSS	dB	5.7*	5.0*	5.5*	5.0*	4.0*	1.9
23. ANTENNA VSWR		1.08:1		1.04:1		1.02:1	
REMARKS							
* Out of tolerance ** Metering circuit switch affects modulation.							

RF TRANSMISSION SYSTEMS ANALYSIS

LOCATION Luke AFB							(Transmitter Site)			DATE September 1980	
ANTENNA					COUPLER						
NO.	TYPE	VSWR	CABLE LENGTH	FREQ (MHz)	SERIAL NO.	CAVITY	LOSS (dB)		VSWR		
							INIT.	ADJ.	INIT.	ADJ.	
1	AS-1181	1.66:1		126.2							
2	AS-1181	1.30:1		121.5							
3	AS-1097	1.20:1	42 feet	395.0	1065	1	1.7		1.27:1		
		2.40:1*		289.6		2	2.4*	1.8	1.70:1	1.30:1	
		1.70:1		243.0		3	2.1*	1.8	1.70:1	1.02:1	
		1.80:1		335.8		4	1.8	1.6	1.70:1	1.10:1	
4	AS-1097	1.60:1		Spare							
5	AS-1097	1.50:1		Spare	1050	1					
		1.80:1		337.7		2	1.5		1.15:1		
		1.50:1		242.3		3	4.8*	1.6	4.00:1*	1.02:1	
		1.30:1		375.2		4	1.5		1.13:1		
6	AS-1097	1.70:1		296.1	1266	1	1.9	1.5	1.60:1	1.06:1	
		1.20:1		325.9		2	1.5		1.02:1		
		1.30:1		266.4		3	1.6		1.02:1		
		1.10:1		372.2		4	1.4		1.06:1		
7	AS-1097	1.30:1		Spare							
8	AT-197	1.10:1		Spare							
10	AS-1097	1.10:1		349.7	365	1	1.8		1.08:1		
		1.60:1		389.8		2	1.5		1.20:1		
		1.10:1		301.5		3	2.9*	1.5	1.80:1		
		1.30:1		316.9		4	1.4		1.70:1		

MARKS

* Out of tolerance

RF TRANSMISSION SYSTEMS ANALYSIS										
LOCATION Luke AFB (Transmitter Site)					DATE September 1980					
ANTENNA					COUPLER					
NO.	TYPE	VSWR	CABLE LENGTH	FREQ (MHz)	SERIAL NO.	CAVITY	LOSS (dB)		VSWR	
							INIT.	ADJ.	INIT.	ADJ.
11	AS-1097	2.00:1*		291.1	99	1	1.8		1.80:1	
		1.10:1		372.9		2	1.5		1.02:1	
		1.06:1		269.9		3	2.3*	2.3*	1.30:1	1.30:1
		1.06:1		Spare		4				
12	AS-1097	1.17:1		311.2	1888	1	1.5		1.17:1	
		1.35:1		257.2		2	1.9		1.13:1	
		1.40:1		349.0		3	1.5		1.04:1	
		1.70:1		388.9		4	1.7		1.50:1	
13	AS-1181	1.10:1		134.1						
14	AS-1181	1.70:1		Spare						
15	AS-1181	1.70:1		120.5						

REMARKS
* Out of tolerance

RF TRANSMISSION SYSTEMS ANALYSIS

LOCATION Luke AFB					(Receiver Site)		DATE September 1980			
ANTENNA					COUPLER					
NO.	TYPE	VSWR	CABLE LENGTH	FREQ (MHz)	SERIAL NO.	CAVITY	LOSS (dB)		VSWR	
							INIT.	ADJ.	INIT.	ADJ.
B-1	AT-197	1.02:1	110 feet	395.0	429	1	4.0*	1.9	3.54:1*	1.04:1
		1.04:1		289.6		2	1.6		1.06:1	
		1.04:1		256.9		3	1.8		1.22:1	
		1.04:1		243.0		4	7.3*	4.0*	6.7:1*	
B-2	AT-197	1.13:1		335.8	591	1	2.8*	2.4*	1.60:1	
		1.08:1		349.7		2	5.7*	5.0*	4.40:1*	
		1.04:1		389.8		3	5.5*	5.0*	4.40:1*	
		1.40:1		301.5		4	2.5*	1.6	2.70:1*	1.20:1
B-3	AT-197			Spare	1329	1				
		1.04:1		337.7		2	1.4		1.30:1	
		1.08:1		242.3		3	3.3*	1.3	3.00:1*	1.08:1
		1.35:1		375.2		4	1.4		1.20:1	
B-4	AT-197	1.13:1		296.1	623	1	1.5		1.06:1	
		1.02:1		325.9		2	3.6*	3.4*	2.90:1*	
		1.02:1		266.4		3	3.2*	3.2*	2.27:1*	
		1.02:1		372.2		4	10.0*	9.0*	10.7:1*	
B-5	AT-197	1.06:1		257.2	1427	1	1.7		2.70:1*	
		1.06:1		349.0		2	1.7		1.06:1	
		1.50:1		388.9		3	4.4*	1.9	2.90:1*	1.04:1
		1.10:1		311.2		4	1.5		1.13:1	

REMARKS

* Out of tolerance

AMPLIFIER DATA

LUKE AFB

(GCA)

September 1980

Audio Frequency Amplifier AM-4568/G
(Microphone Amplifier)

M E A S U R E M E N T S	S Y S T E M	Serial Number	605	647	460			
		Position	ASR-1	ASR-3	ASR-2			
		Input Level dBm	-35.0	-35.0	-35.0			
		Output Level dBm	19.4	19.4	19.8			
		Distortion %	3.0	2.5	2.9			
		Noise Level dBm	-47.5	-48.0	-58.0			
		Input at Limiting dBm	-39.0	-39.0	-39.0			
		Output at Limiting dBm	19.2	19.1	19.8			
	G A I N	Input Level dBm	-64.0	-64.0	-64.0			
		Output Level dBm	21.2	20.4	21.6			
		Distortion %	8.6 *	9.2 *	15.0 *			
		Noise Level dBm	-42.0	-28.0 *	-50.0			

REMARKS

* Out of tolerance

AMPLIFIER DATA

Luke AFB

(GCA)

September 1980

Audio Frequency Amplifier AM-4571/G

M E A S U R E M E N T S	S Y S T E M	Frequency	MHz	349.0	372.9	291.1	368.9	134.1	120.5
		Input Level	dBm	-2.4	-2.6	-2.4	-2.6	-2.2	-2.5
		Output Level	dBm	27.0	27.0	27.0	27.0	27.0	27.0
		Distortion	%	5.0	5.0	4.9	4.8	5.0	4.0
		Noise Level **	dBm	-6.0 -60.0	-6.5 -60.0	-5.0 -57.8	-3.0 -53.4	-13.2 -53.0	-10.0 -45.0
	G A I N	Input Level	dBm	-20.0	-20.0	-20.0	-20.0	-20.0	-20.0
		Output Level	dBm	30.0	30.0	30.0	30.0	30.0	30.0
		Distortion	%	4.8	4.7	4.6	4.7	4.7	4.5
		Noise Level	dBm	-7.6*	-7.0*	-7.0*	-4.8*	-14.3*	-11.5*

** High noise levels caused by a defective power supply. After the power supply was replaced, noise levels were measured through the amplifier alone.

Audio Frequency Amplifier AM-4571/G

M E A S U R E M E N T S	S Y S T E M	Frequency	MHz	***	257.2	243.0	349.7	301.5	389.8	101.5
		Input Level	dBm	-2.0	-5.6	-2.4	-2.5	-2.4	-5.5	
		Output Level	dBm	27.0	27.0	27.0	27.0	27.0	27.0	
		Distortion	%	6.8*	5.0	4.1	5.0	3.2	4.8	
		Noise Level	dBm	-48.6	-58.5	-49.0	-44.0	-57.0	-53.0	
	G A I N	Input Level	dBm	-20.0	-20.0	-20.0	-20.0	-20.0	-20.0	
		Output Level	dBm	30.0	30.0	30.0	30.0	30.0	30.0	
		Distortion	%	7.0*	4.7	4.3	5.0	2.5	5.0	
		Noise Level	dBm	-41.5	-43.0	-38.0*	-40.0	-41.4	-41.5	

* Out of tolerance

***Replaced with spare

AMPLIFIER DATA

LUKE AFB

(GCA)

September 1980

Audio Frequency Amplifier AM-4571/G

M E A S U R E M E N T S	S Y S T E M		ASR-1 Phone	ASR-1 Speaker	Assr ASR Phone	ASR-3 Speaker	ASR-3 Phone	ASR-2 Phone
		Input Level	dBm	-34.6	-34.6	-34.6	-34.6	-34.6
		Output Level	dBm	-5.0	-5.0	-5.0	-5.0	-5.0
		Distortion	%	2.8	3.8	3.1	4.0	3.0
		Noise Level	dBm	-48.0	-47.5	-49.0	-40.5	-40.0
	G A I N	Input Level	dBm	-20.0	-20.0	-20.0	-20.0	-20.0
		Output Level	dBm	30.0	30.0	30.0	30.0	30.0
		Distortion	%	4.0	4.4	4.5	5.0	4.0
		Noise Level	dBm	-38.0*	-35.0*	-36.0*	-36.0*	-38.0*

Audio Frequency Amplifier AM-4571/G

M E A S U R E M E N T S	S Y S T E M		ASR-2 Speaker	ASR-2 Phone				
		Input Level	dBm	-34.6	-34.6			
		Output Level	dBm	-5.0	-5.0			
		Distortion	%	2.8	2.9			
		Noise Level	dBm	-47.0	-44.5			
	G A I N	Input Level	dBm	-20.0	-20.0			
		Output Level	dBm	30.0	30.0			
		Distortion	%	6.0*	4.1			
		Noise Level	dBm	-38.0*	-33.0*			

* Out of tolerance

AMPLIFIER DATA

LOCATION

Luke AFB

(Control Tower)

DATE

September 1980

Audio Frequency Amplifier AM-4571/G

M E A S U R E M E N T S	S Y S T E M	Position	Pos 1 Spkr 3	Pos 1 Spkr 2	Pos 1 Spkr 1	Pos 1 Phone 1	Spare Phone 1	Spare Phone 1
		Input Level dBm	-49.5	-49.5	-33.6	-31.0		-31.0
		Output Level dBm	0	0	0	0		0
		Distortion %	1.2	0.8	0.5	3.0		0.5
		Noise Level dBm	-50.0	-50.5	-53.0	-52.0		-60.0
	G A I N	Input Level dBm	-20	-20	-20	-20	-20	-20
		Output Level dBm	30	30	30	30	28.5*	30
		Distortion %	2.4	2.2	4.6	8.0*	11.5*	5.0
		Noise Level dBm	-48.0	-49.0	-47.0	-49.0	-32.5*	-52.0

Audio Frequency Amplifier AM-4571/G

M E A S U R E M E N T S	S Y S T E M	Input Level dBm						
		Output Level dBm						
		Distortion %						
		Noise Level dBm						
	G A I N	Input Level dBm						
		Output Level dBm						
		Distortion %						
		Noise Level dBm						

* Out of tolerance

** Replaced with spare.

TITLE							
AMPLIFIER DATA							
LOCATION						DATE	
Luke AFB (Control Tower)						September 1980	
Audio Frequency Amplifier AM-4568/G (Microphone Amplifier)							
MEASUREMENTS	SYSTEM	Serial Number	6	9	7		
		Position	1	2	3		
		Input Level dBm	-35	-35	-35		
		Output Level dBm	19.2	20.0	19.4		
		Distortion %	3.0	3.0	2.9		
		Noise Level dBm	-50.0	-75.0	-72.2		
		Input at Limiting dBm	-39	-39	-39		
		Output at Limiting dBm	19.0	19.3	19.2		
	GAIN	Input Level dBm	-64	-64	-64		
		Output Level dBm	22	21	22		
		Distortion %	5	5	5		
		Noise Level dBm	-7 *	-40	-21 *		
REMARKS							
* Out of tolerance							

AMPLIFIER DATA

LUKE AFB

(Control Tower)

September 1980

Audio Frequency Amplifier AM-4571/G

M E A S U R E M E N T S	S Y S T E M	Frequency	MHz	259.6**	259.6	121.5**	121.5	243.0**	243.0**
		Input Level	dBm	-2.4	-2.4	-6.0	-6.0	-6.0	-6.0
		Output Level	dBm		27.0	27.0	27.0	27.0	27.0
		Distortion	%		4.6	7.3*	1.2	6.6*	5.8*
		Noise Level	dBm		-46.0	-58.5	-53.0	-60.0	-58.0
	G A I N	Input Level	dBm	-20.0	-20.0	-20.0	-20.0	-20.0	-20.0
		Output Level	dBm	30.0	30.0	30.0	30.0	30.0	30.0
		Distortion	%	11.0*	4.8	6.8*	1.8	6.4*	5.2*
		Noise Level	dBm		-44.0	-48.0	-48.0	-51.0	-50.0

Audio Frequency Amplifier AM-4571/G

M E A S U R E M E N T S	S Y S T E M	Frequency	MHz	243.0	289.6	126.2**	126.2	338.0	338.0
		Input Level	dBm	-6.0	-3.0	-3.2	-3.2	-2.8	-2.6
		Output Level	dBm	27.0	27.0	27.0	27.0	27.0	27.0
		Distortion	%	2.2	4.8	6.4*	4.4	4.2	4.2
		Noise Level	dBm	-57.5	-31.0 *	-58.0	-59.0	-56.5	-59.0
	G A I N	Input Level	dBm	-20.0	-20.0	-20.0	-20.0	-20.0	-20.0
		Output Level	dBm	30.0	30.0	30.0	30.0	30.0	30.0
		Distortion	%	2.3	4.6	6.4*	4.5	4.1	4.4
		Noise Level	dBm	-50.0	-30.0 *	-51.4	-56.0	-48.5	-47.5

**Replaced

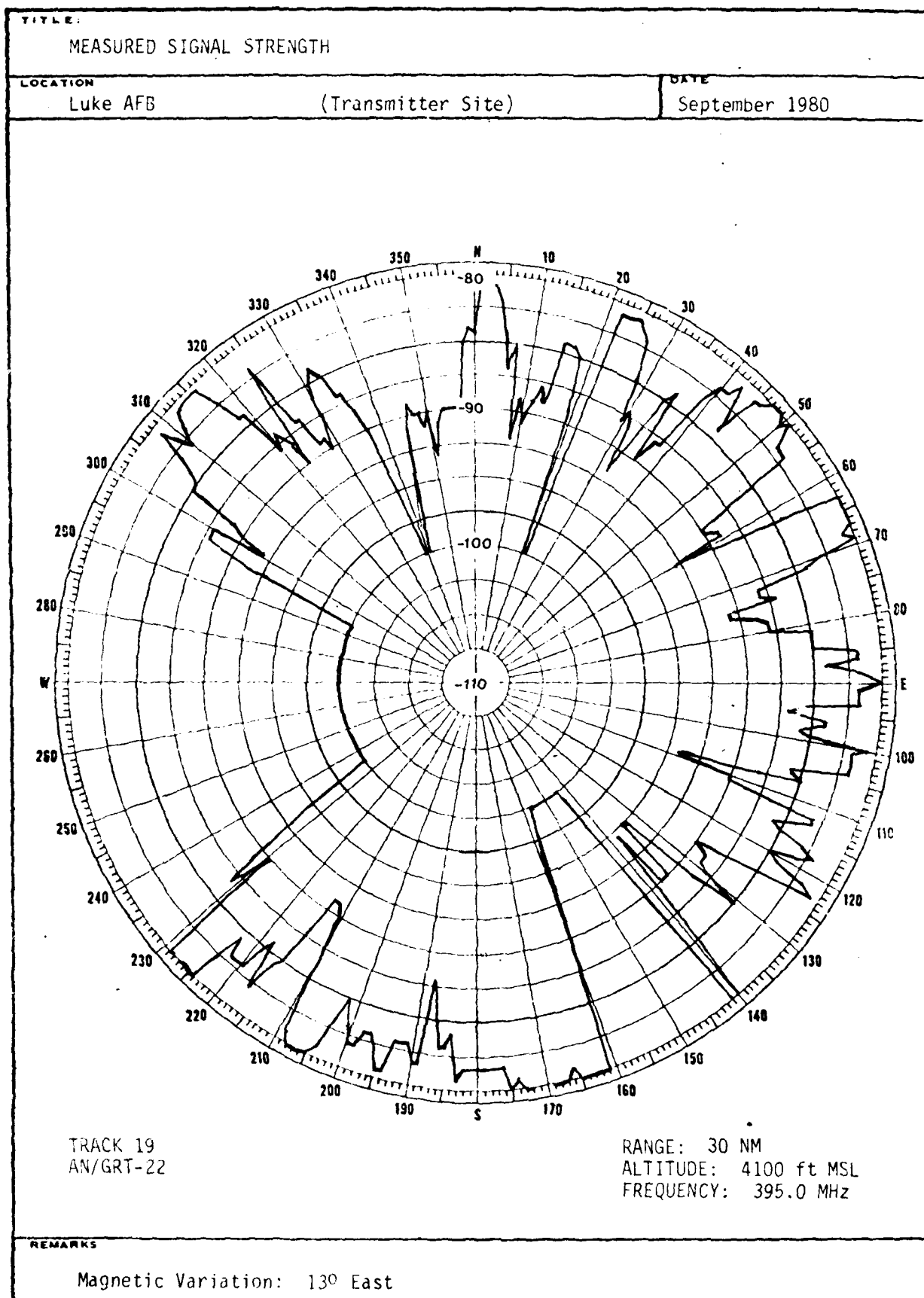
AM RADIO COMMUNICATIONS SYSTEM LOOP ANALYSIS								
LOCATION						DATE		
Luke AFB (Control Tower)						September 1980		
TRANSMIT SIDE								
FREQUENCY	MHz	256.9	121.5	243.0	299.6	126.2	335.8	395.0
Control Tower								
MIC AMP IN	dBm		-35.0	-35.0	-35.0	-35.0	-35.0	-35.0
MIC AMP OUT	dBm		19.2	19.2	19.2	19.2	19.2	19.2
CABLE OUT	dBm		0.0	0.0	3.0*	0.0	0.0	0.0
NOISE FLOOR	dB Down		32.2	32.0	33.0	32.2	32.0	32.0
NOISE LEVEL	dBm		-79.0	-75.0	-85.0	-87.0	-85.0	-84.0
Transmitter Site								
CABLE IN	dBm		-9.4	-7.6	-6.4	-1.8	-2.0	-2.0
NOISE FLOOR	dB Down		32.6	32.8	33.2	33.0	32.2	32.0
NOISE LEVEL	dBm		-63.0	-65.0	-63.0	-76.0	-75.0	-76.0
RECEIVE SIDE								
Receiver Site								
CABLE OUT	dBm	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NOISE FLOOR	dB Down	23.0	23.0	21.6	23.6	21.2	18.0	21.0
NOISE LEVEL	dBm	-55.0	-37.2*	-53.0	-55.4	-64.0	-50.0	-54.5
Control Tower								
CABLE IN	dBm	-2.4	-6.0	-6.0	-3.0	-3.2	-2.8	-2.6
NOISE FLOOR	dB Down	25.0	24.0	22.0	25.0	23.0	19.0	23.0
NOISE LEVEL	dBm	-38.0*	-43.0	-45.0	-38.0*	-40.0	-37.0*	-38.0*
Line AMP IN	dBm	-2.4	-6.0	-6.0	-3.0	-3.2	-2.8	-2.6
Line AMP OUT	dBm	27.0	27.0	27.0	27.0	27.0	27.0	27.0
NOISE FLOOR	dB Down	23.0	20.0	22.0	22.0	18.0	18.0	21.6
NOISE LEVEL	dBm	-32.0*	-27.0*	-29.0*	-28.0*	-46.0*	-27.0*	-33.0*
REMARKS								
** ICU set at minimum attenuation * Out of tolerance								

TITLE AM RADIO COMMUNICATIONS SYSTEM LOOP ANALYSIS								
LOCATION Luke AFB (GCA)						DATE September 1980		
TRANSMIT SIDE								
FREQUENCY:	MHZ	121.5	389.8	301.5	349.7	243.0	257.2	120.5
GCA								
MIC AMP IN	dBm	-35.0	-35.0	-35.0	-35.0	-35.0	-35.0	-35.0
MIC AMP OUT	dBm	19.4	19.4	19.4	19.4	19.4	19.4	19.4
CABLE OUT	dBm	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NOISE FLOOR	dB Down	31.0	30.8	30.0	28.0	29.0	28.0	29.0
NOISE LEVEL	dBm	-64.0	-67.0	-67.0	-67.0	-63.0	-66.0	-67.0
Transmitter Site								
CABLE IN	dBm	-2.2	-2.2	-2.8	-2.2	-2.6	-2.0	-2.0
NOISE FLOOR	dB Down	33.0	33.0	33.0	33.0	32.0	33.0	30.0
NOISE LEVEL	dBm	-62.0	-67.5	-68.0	-67.0	-63.0	-66.0	-67.0
RECEIVE SIDE								
Receiver Site								
CABLE OUT	dBm	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NOISE FLOOR	dB Down	21.0	24.6	23.5	20.0	21.0	26.0	23.0
NOISE LEVEL	dBm	-36.5*	-56.0	-53.0	-60.0	-53.5	-57.0	-47.0
GCA								
CABLE IN	dBm	-5.5	-2.4	-2.5	-2.4	-5.6	-2.0	-2.5
NOISE FLOOR	dB Down	24.0	25.1	24.5	21.0	21.0	26.0	22.0
NOISE LEVEL	dBm	-45.0	-58.5	-56.0	-62.0	-58.5	-59.0	-51.0
LINE AMP IN	dBm	-5.5	-2.4	-2.5	-2.4	-5.6	-2.0	-2.5
LINE AMP OUT	dBm	27.0	27.0	27.0	27.0	27.0	27.0	27.0
NOISE FLOOR	dB Down	18.0	24.5	21.0	17.5	20.0	21.5	21.0
NOISE LEVEL	dBm	-27.0*	-33.5*	-28.5*	-34.0*	-29.0*	-40.0	-10.0*
REMARKS * Out of tolerance								

TITLE								
AM RADIO COMMUNICATIONS SYSTEM LOOP ANALYSIS								
LOCATION							DATE	
Luke AFB (GCA)							September 1980	
TRANSMIT SIDE								
FREQUENCY:	MHZ	134.1	388.9	291.1	372.9	349.0		
GCA								
MIC AMP IN	dBm	-35.0	-35.0	-35.0	-35.0	-35.0		
MIC AMP OUT	dBm	19.4	19.4	19.4	19.4	19.4		
CABLE OUT	dBm	0.0	0.0	0.0	0.0	0.0		
NOISE FLOOR	dB Down	31.0	29.0	29.0	29.0	29.0		
NOISE LEVEL	dBm	-66.0	-66.0	-65.0	-66.0	-66.0		
Transmitter Site								
CABLE IN	dBm	-2.1	-2.1	-2.0	-2.0	-2.3		
NOISE FLOOR	dB Down	33.0	32.8	32.8	33.0	29.0		
NOISE LEVEL	dBm	-67.0	-66.0	-65.0	-67.0	-66.0		
RECEIVE SIDE								
Receiver Site								
CABLE OUT	dBm	0.0	0.0	0.0	0.0	0.0		
NOISE FLOOR	dB Down	19.0	17.0	17.0	18.0	23.5		
NOISE LEVEL	dBm	-49.0	-54.0	-52.0	-51.5	-53.0		
GCA								
CABLE IN	dBm	-2.2	-2.6	-2.4	-2.6	-2.4		
NOISE FLOOR	dB Down	18.0	18.0	16.5	18.0	24.2		
NOISE LEVEL	dBm	-52.4	-57.0	-55.5	-55.0	-56.4		
LINE AMP IN	dBm	-2.2	-2.6	-2.4	-2.6	-2.4		
LINE AMP OUT	dBm	27.0	27.0	27.0	27.0	27.0		
NOISE FLOOR	dB Down	18.8	15.5	16.0	18.0	22.2		
NOISE LEVEL	dBm	-13.0**	-3.0**	-5.0**	-6.5**	-6.0**		
REMARKS								
** Replaced power supply and levels dropped to -60dBm or less.								

TITLE					
FLIGHT PROFILE					
LOCATION				DATE	
Luke AFB				September 1980	
Track	Track Description	Altitude (ft MSL)	Antenna	Power (Watts)	Date Flown
1	R-208 Out	5100	RX-B1/GCA-3	10	5 Oct
2	R-208 In	4100	RX-B1/GCA-3	10	5 Oct
3	R-044 Out	6500	RX-B1/GCA-3	10	5 Oct
4	R-044 In	4500	RX-B1/GCA-3	10	5 Oct
5	R-310 Out	6200	RX-B1/GCA-3	10	5 Oct
6	R-310 In	4200	RX-B1/GCA-3	10	5 Oct
7	R-130 Out	4100	RX-B1/GCA-3	10	5 Oct
8	30 NM Orbit	4100	RX-B1/GCA-3	10	5 Oct
9	R-130 In	3100	RX-B1/GCA-3	10	5 Oct
10	R-270 Out	5200	RX-B1/GCA-3	10	5 Oct
11	R-270 In	4200	RX-B1/GCA-3	10	5 Oct
12	R-208 Out	7100	TX-3	10	5 Oct
13	R-208 In	4100	TX-3	10	5 Oct
14	R-044 Out	6500	TX-3	10	5 Oct
15	R-044 In	4500	TX-3	10	5 Oct
16	R-310 Out	6200	TX-3	10	5 Oct
17	R-310 In	4200	TX-3	10	5 Oct
18	R-130 Out	4100	TX-3	10	5 Oct
19	30 NM Orbit	4100	TX-3	10	5 Oct
20	R-130 In	3100	TX-3	10	5 Oct
21	R-270 Out	5200	TX-3	10	5 Oct
22	R-270 In	4200	TX-3	10	5 Oct
23	ARC 290 ⁰ -330 ⁰ 20 NM	1000 AGL	RX-B1	10	5 Oct
24	ARC 290 ⁰ -330 ⁰ 20 NM	1000 AGL	TX-3	10	5 Oct

REMARKS	
* R = Radial	395.0 MHz used for all tracks.



TITLE:

MEASURED SIGNAL STRENGTH

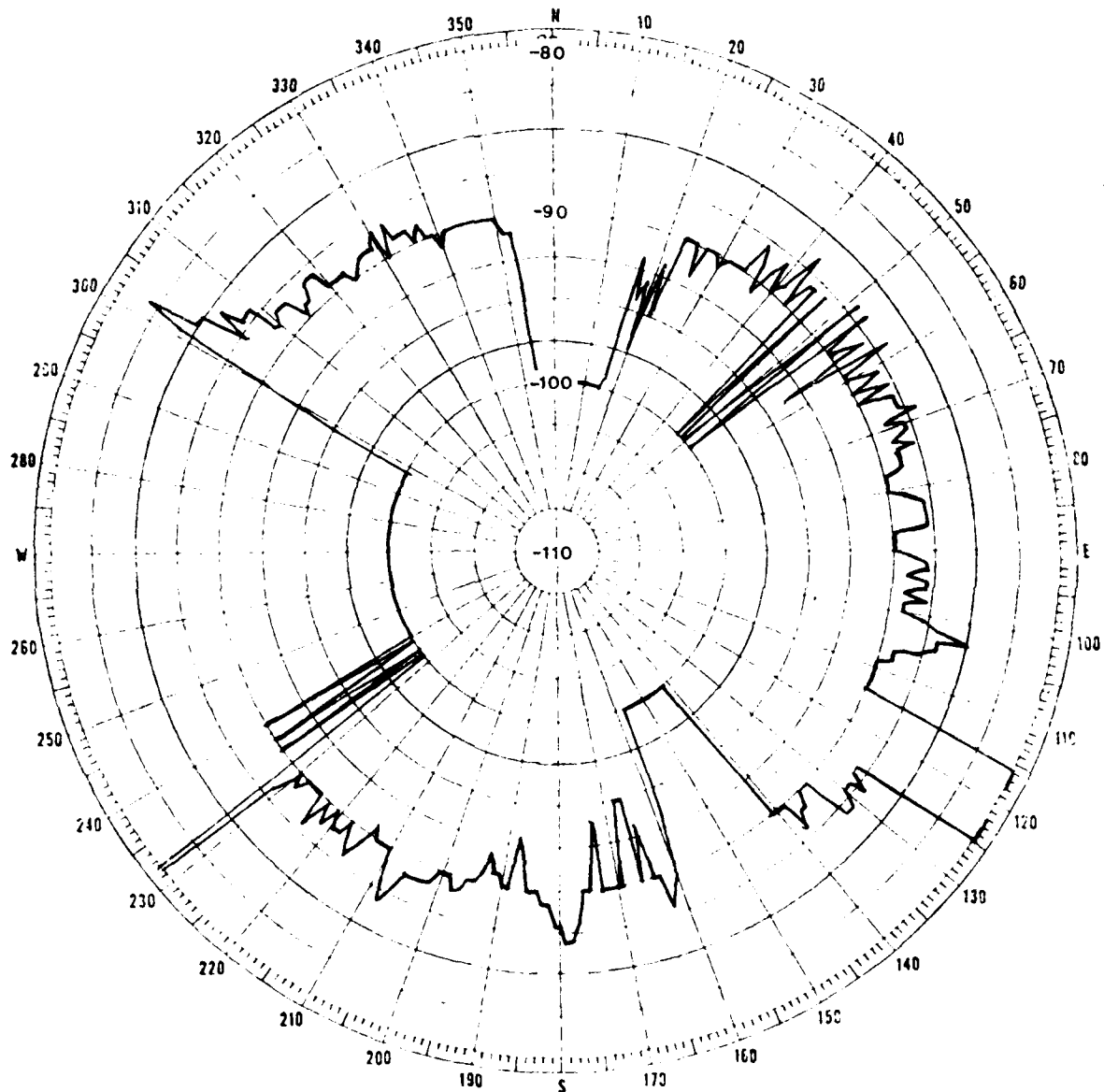
LOCATION

Luke AFB

(Receiver Site)

DATE

September 1980

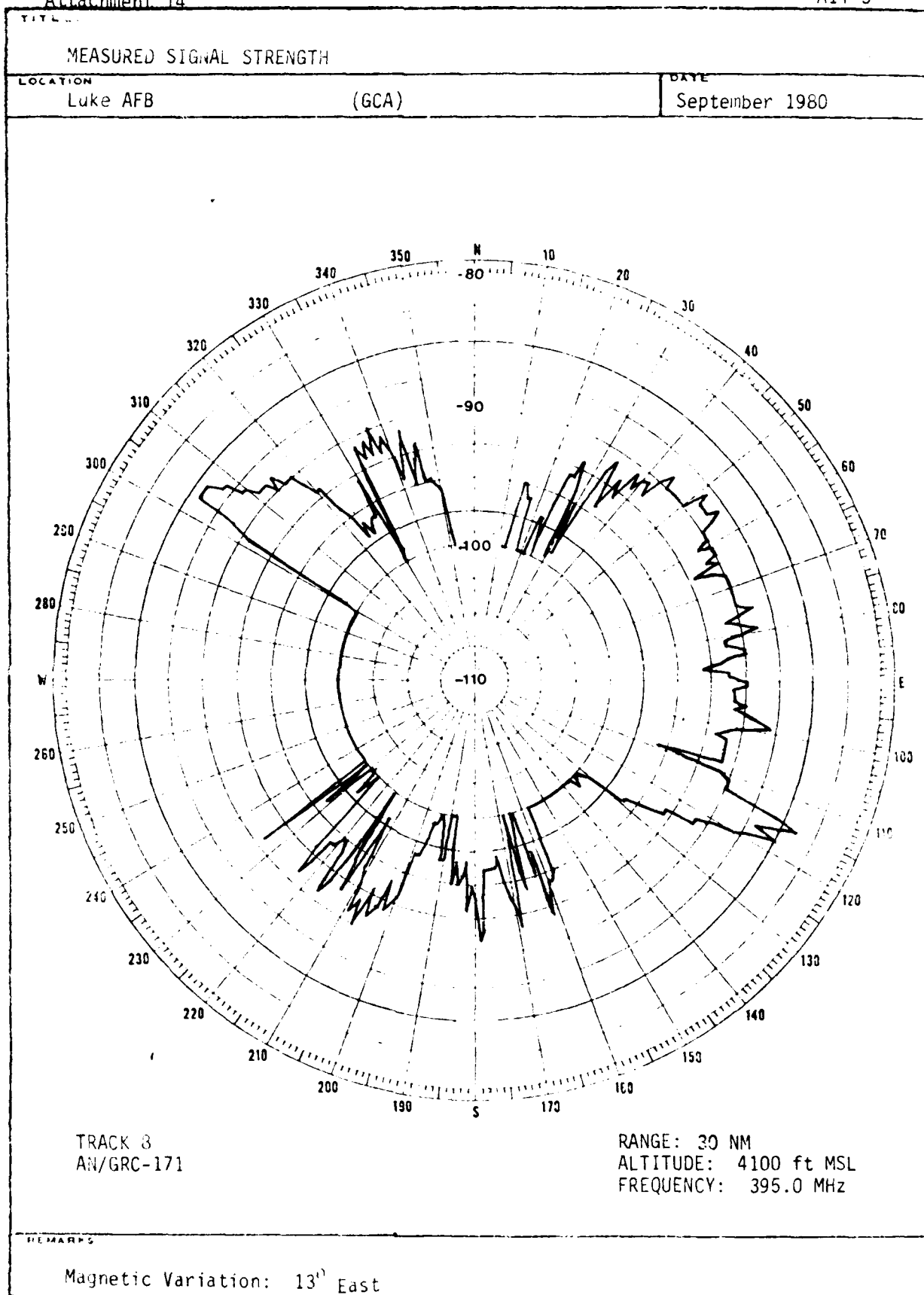
TRACK 6
AN/GRR-2ARANGE: 30 NM
ALTITUDE: 4100 ft MSL
FREQUENCY: 395.0 MHz

REMARKS

Magnetic Variation: 13° East

AFCS FORM
MAY 78 906

GENERAL INFORMATION



TITLE

HORIZONTAL COVERAGE PREDICTION

Communications coverage predictions can be divided into two areas, RLOS range and free space loss. The RLOS predictions are based on the surveyed horizon screening angles and the radio horizon with standard refractive conditions. Predicted RLOS range is derived from the following equation:

$$R = \frac{-160a + \sqrt{(160a)^2 + 4(A-E)(1.507784)}}{2}$$

a = Screening angle

R = Range (NM)

A-E = Difference between transmit and receive antenna heights (ft AGL)

The RLOS plots generated using this formula are a worst case prediction of communications range, but can be useful in determining areas of coverage degradation. In reality, communications coverage is usually ten to thirty percent better than RLOS predictions because of ray diffraction beyond the horizon screens. The RSL predictions are based upon free space loss and the logarithmic characteristics of RF propagation. The area beyond the screening object and below the horizon screening angle is commonly referred to as the shadow zone. In this area, coverage can be more accurately predicted by computing range as a function of minimum RSL. Minimum acceptable RSL is the lowest level at which the ground or airborne receiver squelch circuit will activate. The receiver squelch level for flight inspection aircraft is calibrated to -97.5 dBm; however, the majority of newer aircraft receivers in the Air Force inventory are calibrated to -97 dBm. The ground receiver squelch level is -97.5 dBm for the AN/GRR-23/24/25 receivers. Therefore, most aircraft and all ground receivers are capable of detecting audio on a carrier level of -97.5 dBm or greater. RSL is calculated by equating system losses, antenna gains, and transmit power as follows:

$$RSL = P + G - L - 20 \log(f) - 20 \log(r) - 37.8$$

Where P = Transmitter output power (dBm)

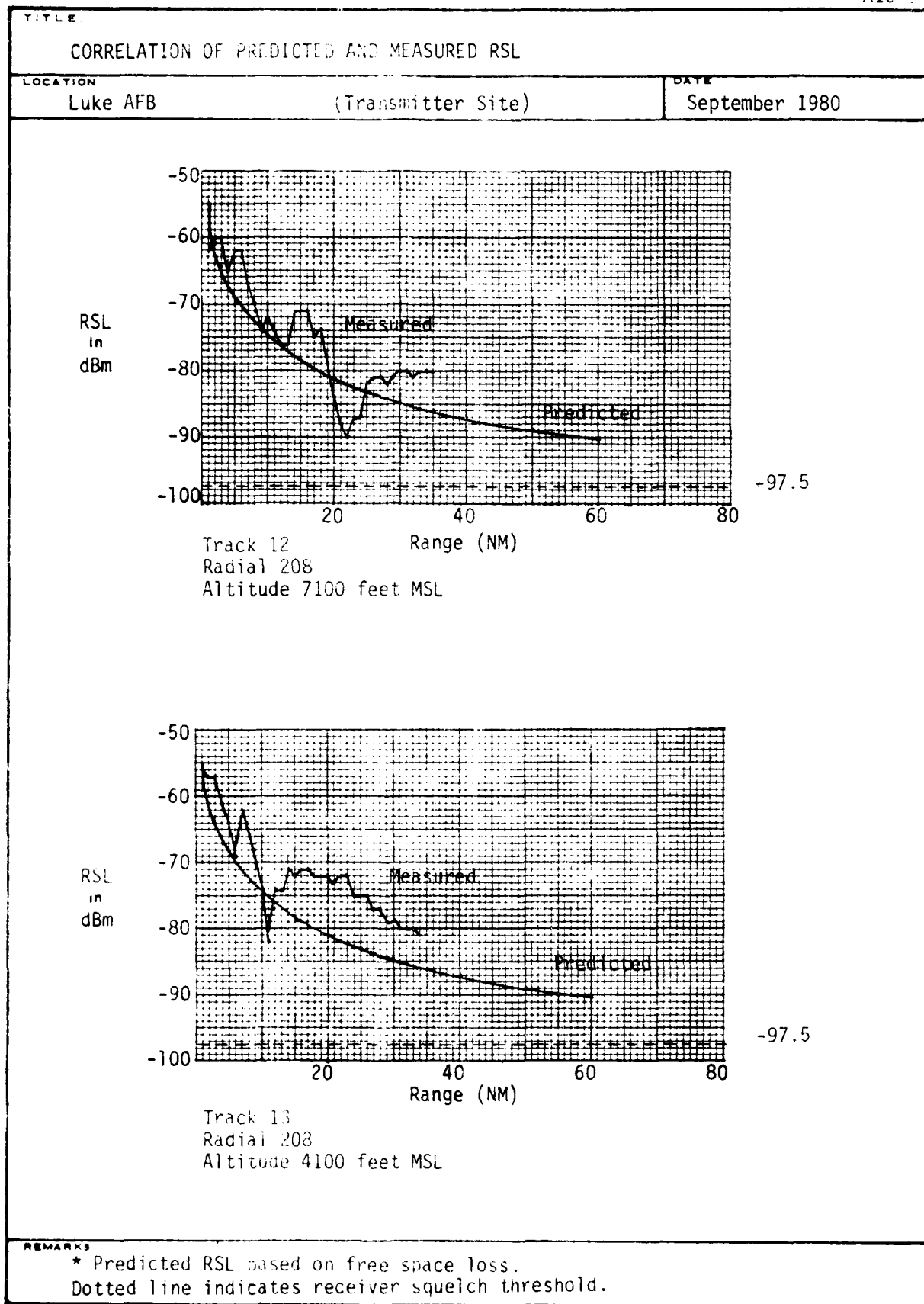
G = Antenna gain (dBi)

L = Coupler loss and transmission line loss (dB)

f = Frequency (MHz)

r = Range (NM)

The quantity 37.8 is an accumulation of scaling factors for range in nautical miles, frequency in megahertz, and conversion of RSL from microvolts to dBm.



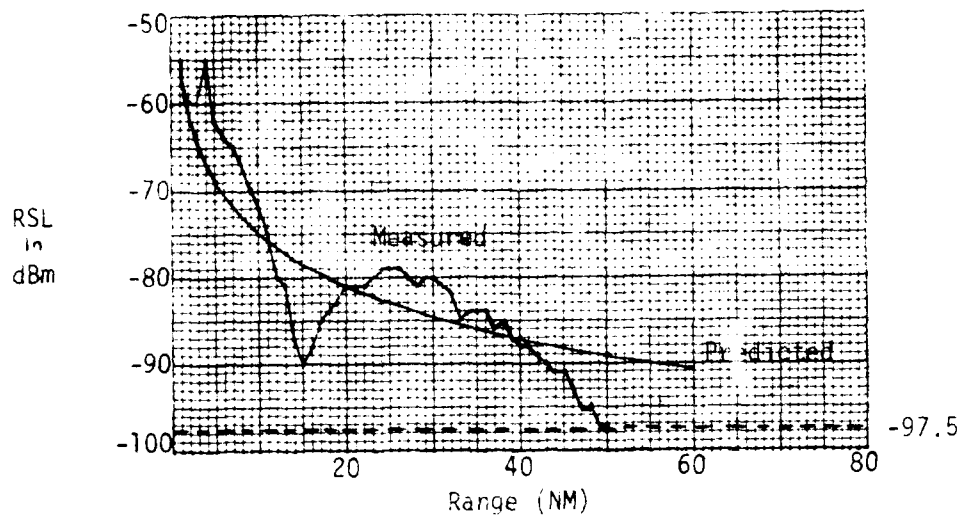
CORRELATION OF PREDICTED AND MEASURED RSL

LOCATION Luke AFB

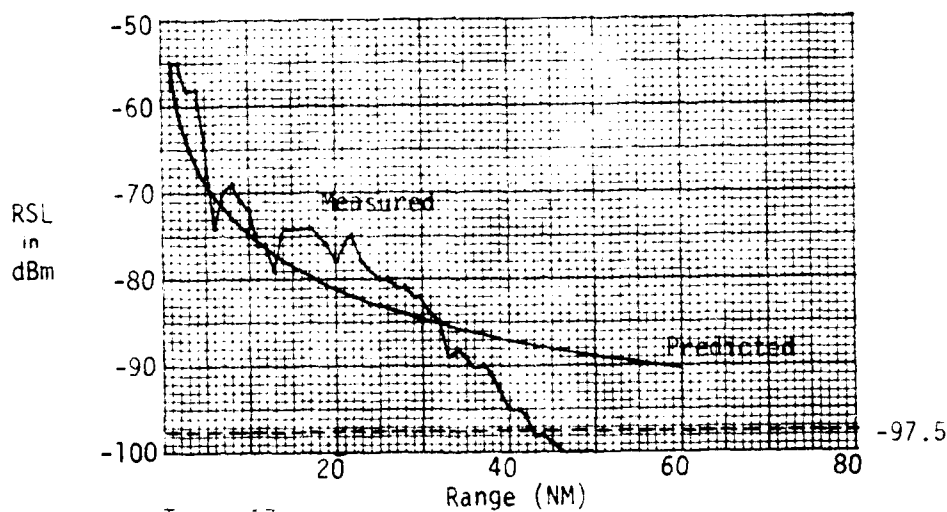
(Transmitter Site)

DATE

September 1980



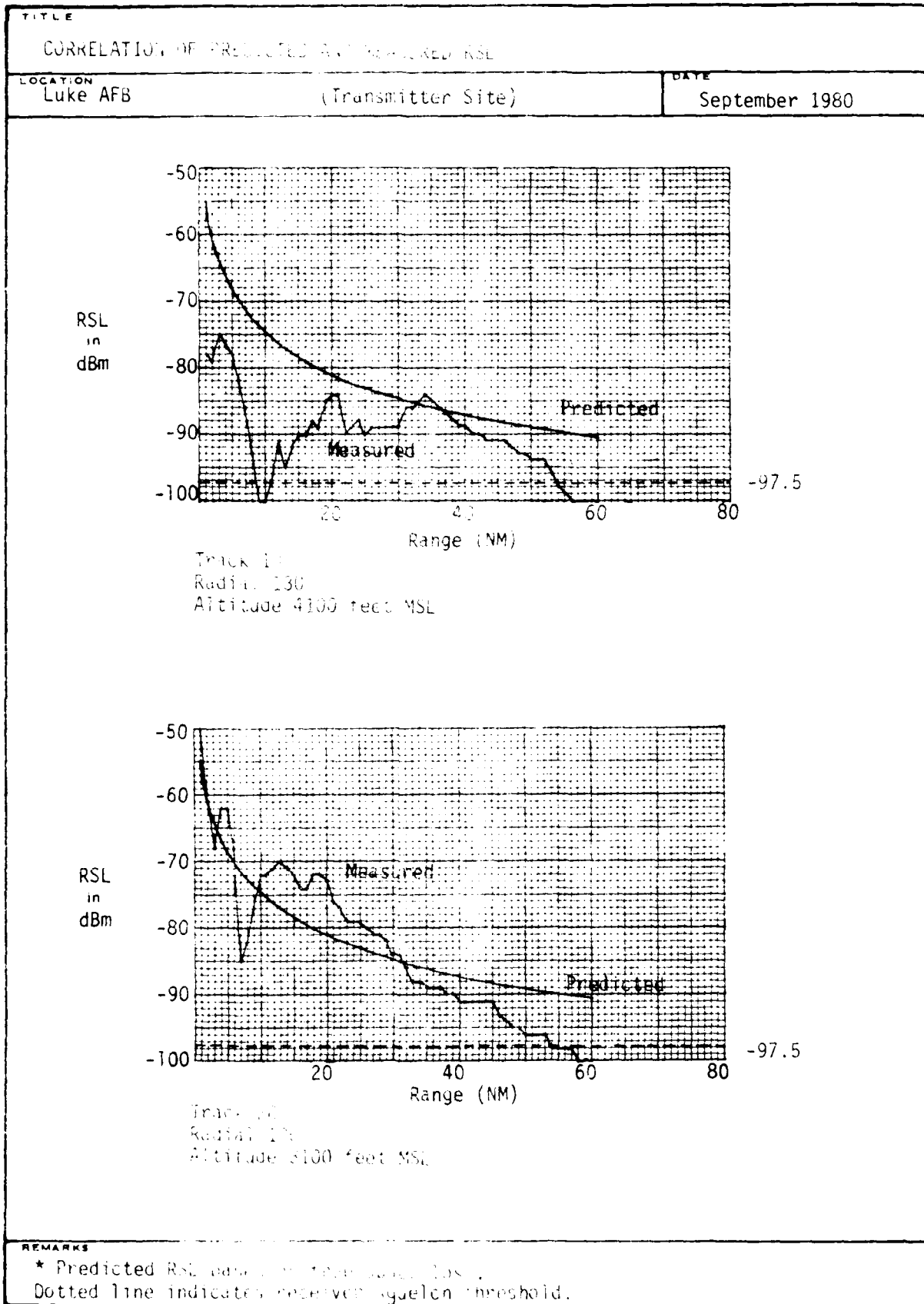
Track 16
Radial 310
Altitude 6200 feet MSL

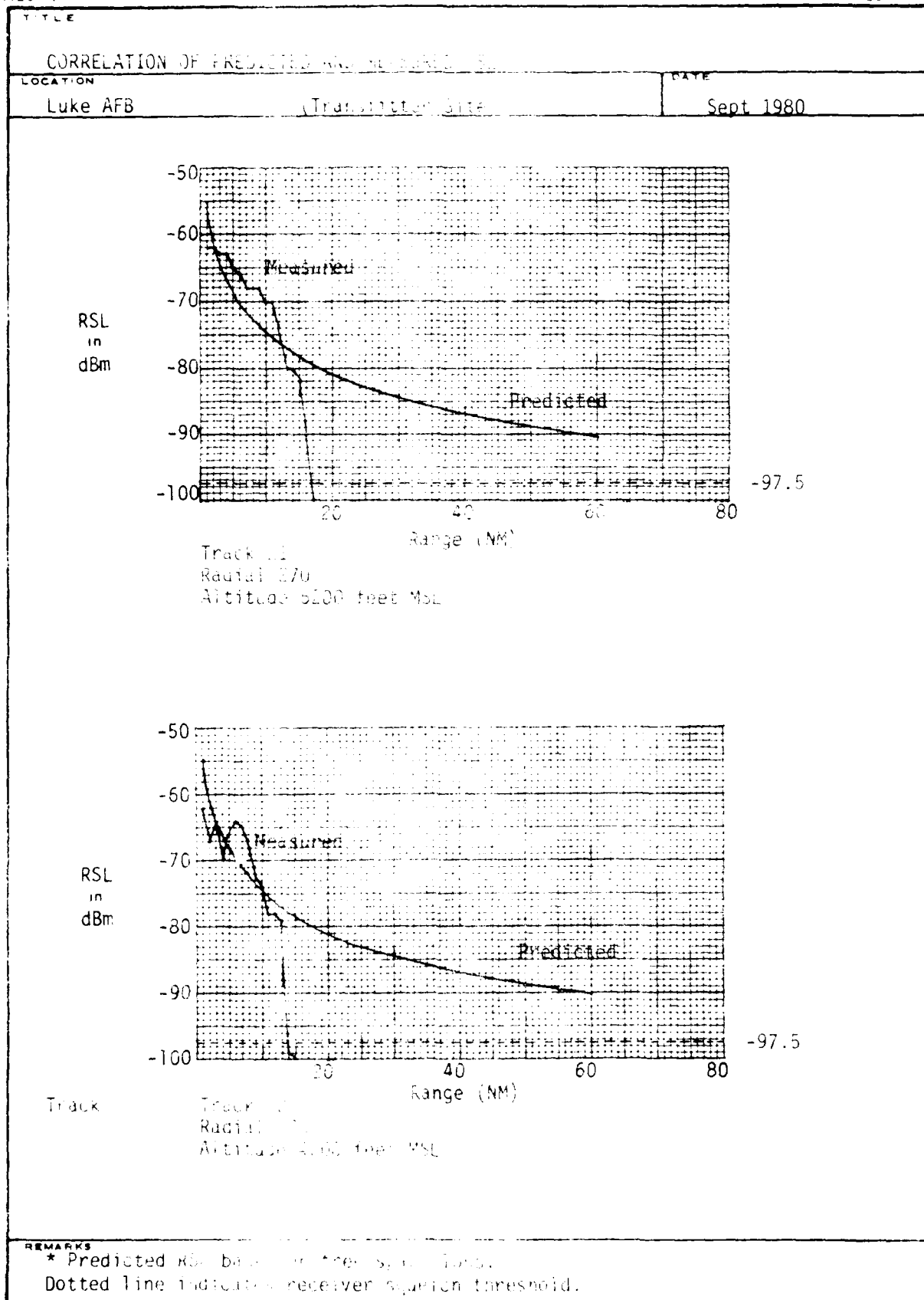


Track 17
Radial 310
Altitude 4200 feet MSL

REMARKS

* Predicted RSL based on free space loss.
Dotted line indicates receiver squelch threshold.





REMARKS

* Predicted RSL based on free space loss.

Dotted line indicates receiver squelch threshold.

TITLE

CORRELATION OF PREDICTED AND MEASURED RSL

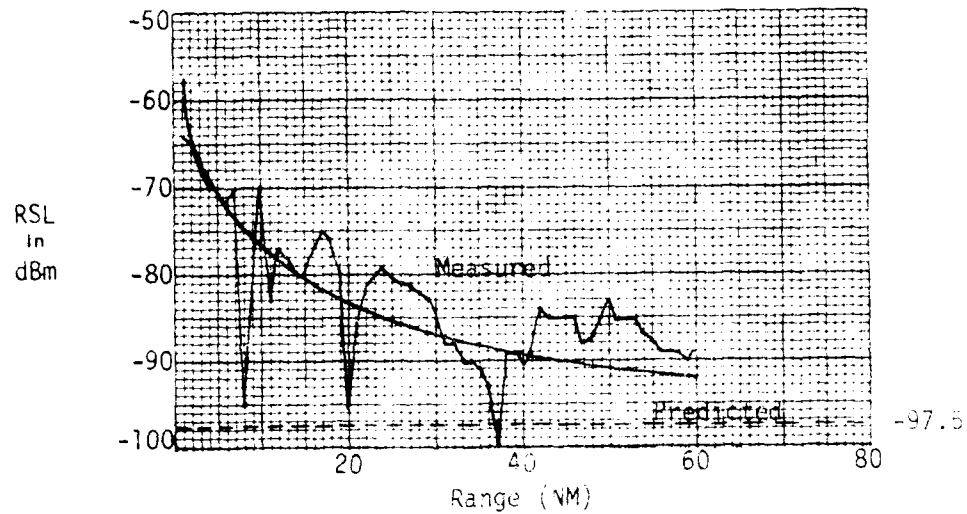
LOCATION

Luke AFB

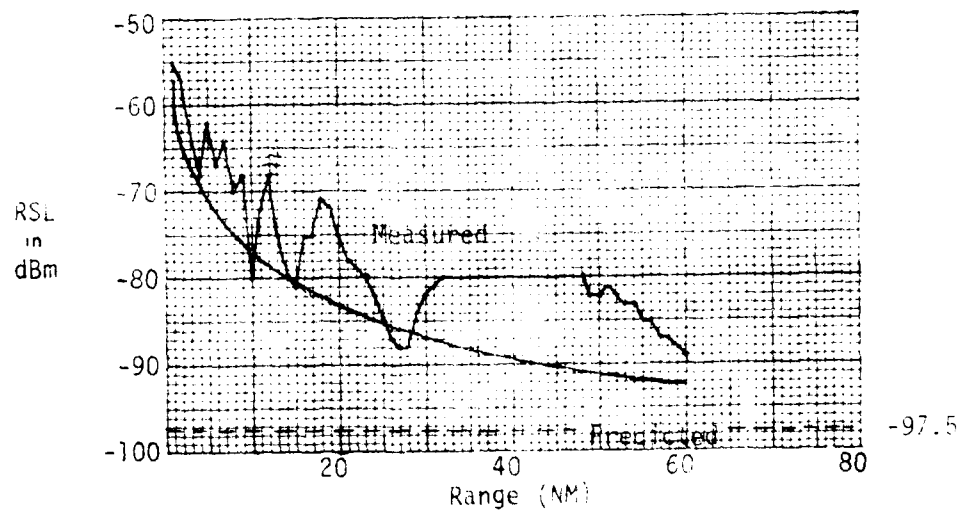
(Receiver Site)

DATE

September 1980



Track 1
Radial 205
Altitude 5100 feet MSL

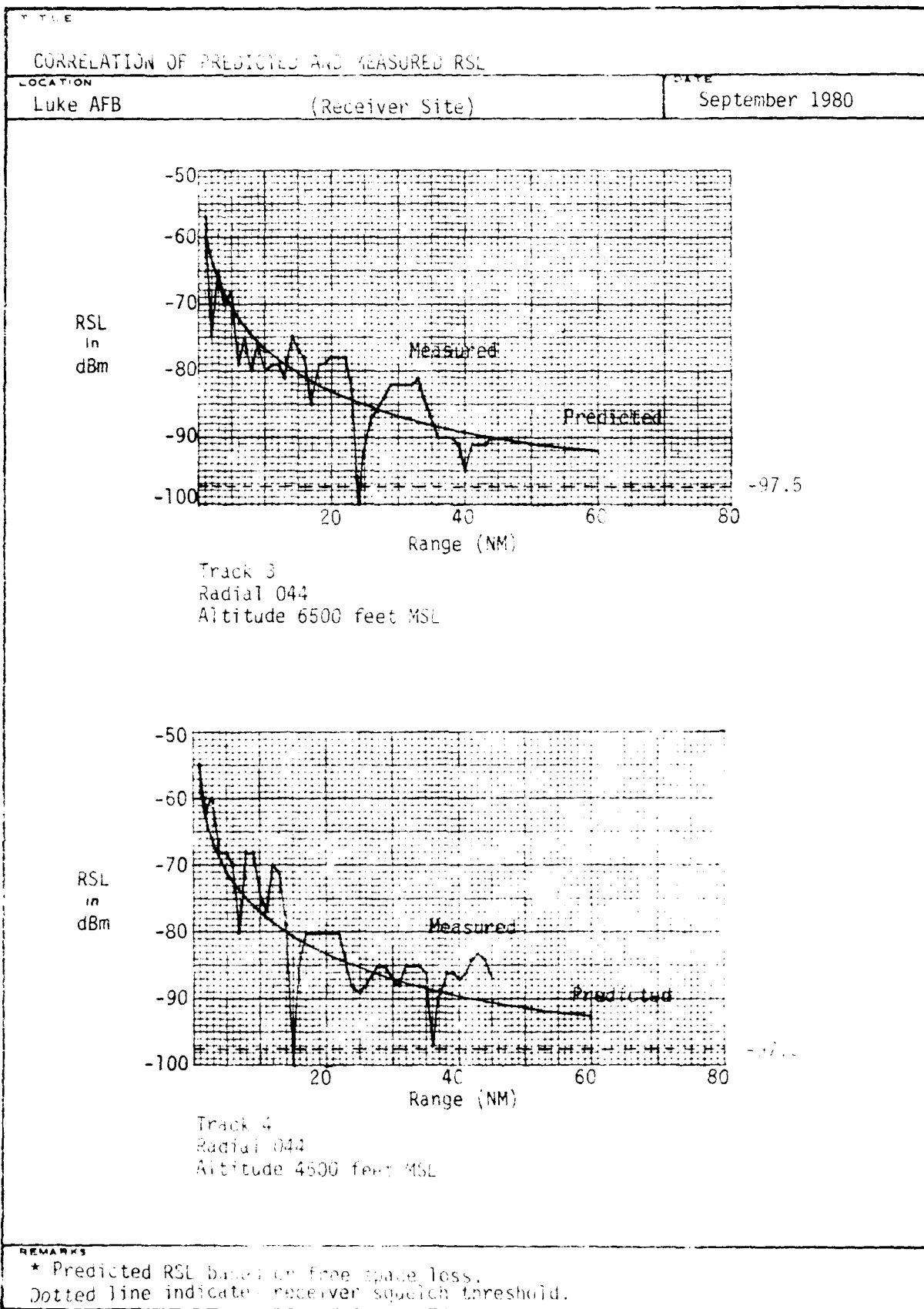


Track 2
Radial 205
Altitude 4100 feet MSL

REMARKS

* Predicted RSL based on free space loss.

Dotted line indicates receiver squelch threshold.



TITLE

CORRELATION OF PREDICTED AND MEASURED RSL

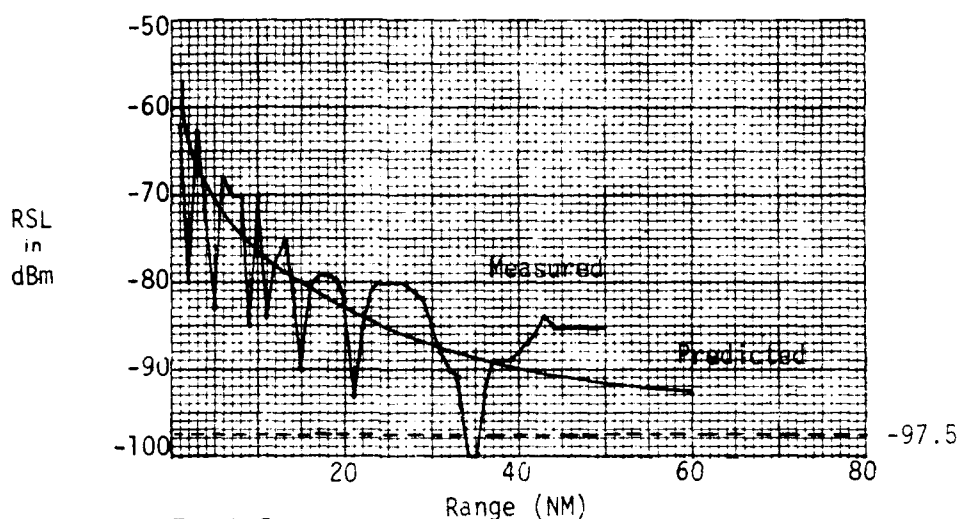
LOCATION

Luke AFB

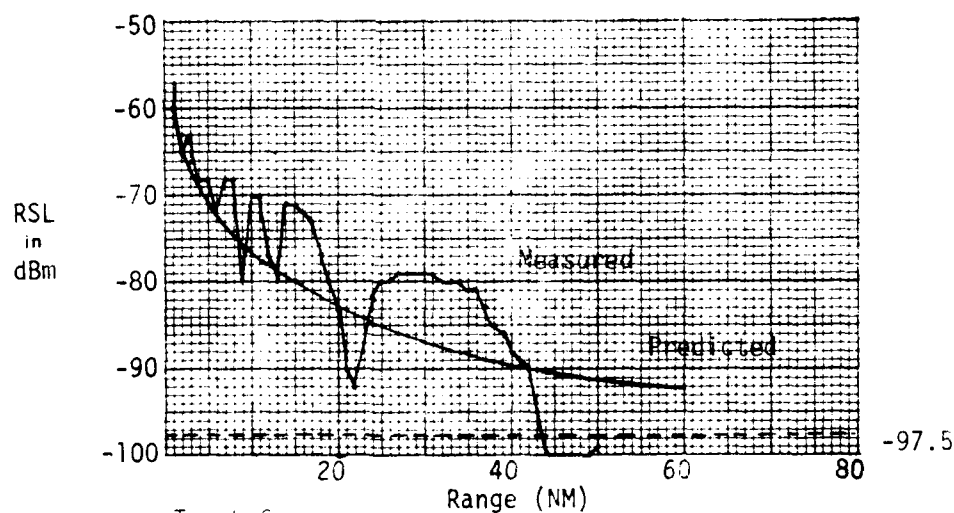
(Receiver Site)

DATE

September 1980



Track 5
 Radial 310
 Altitude 6200 feet MSL



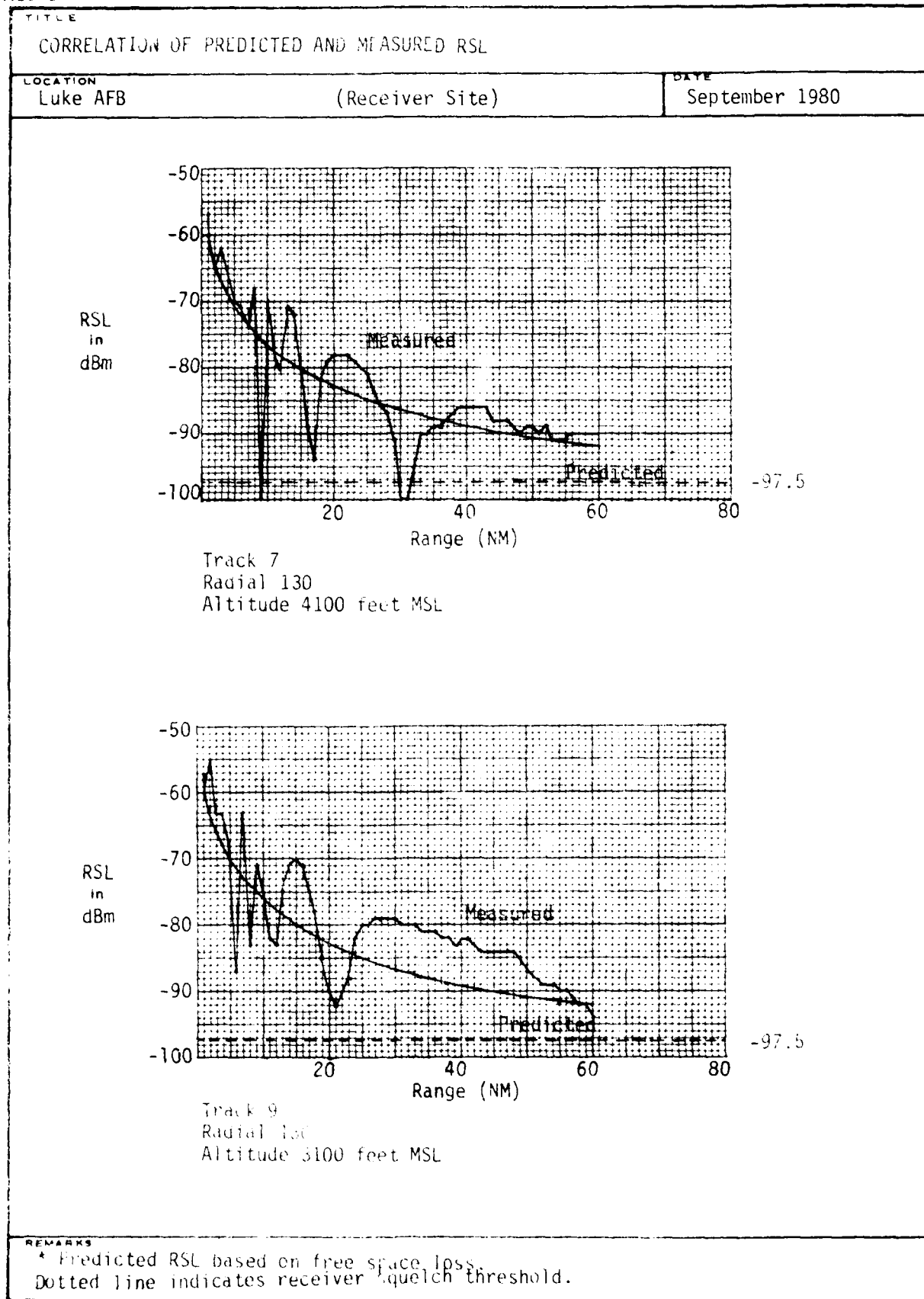
Track 6
 Radial 310
 Altitude 4200 feet MSL

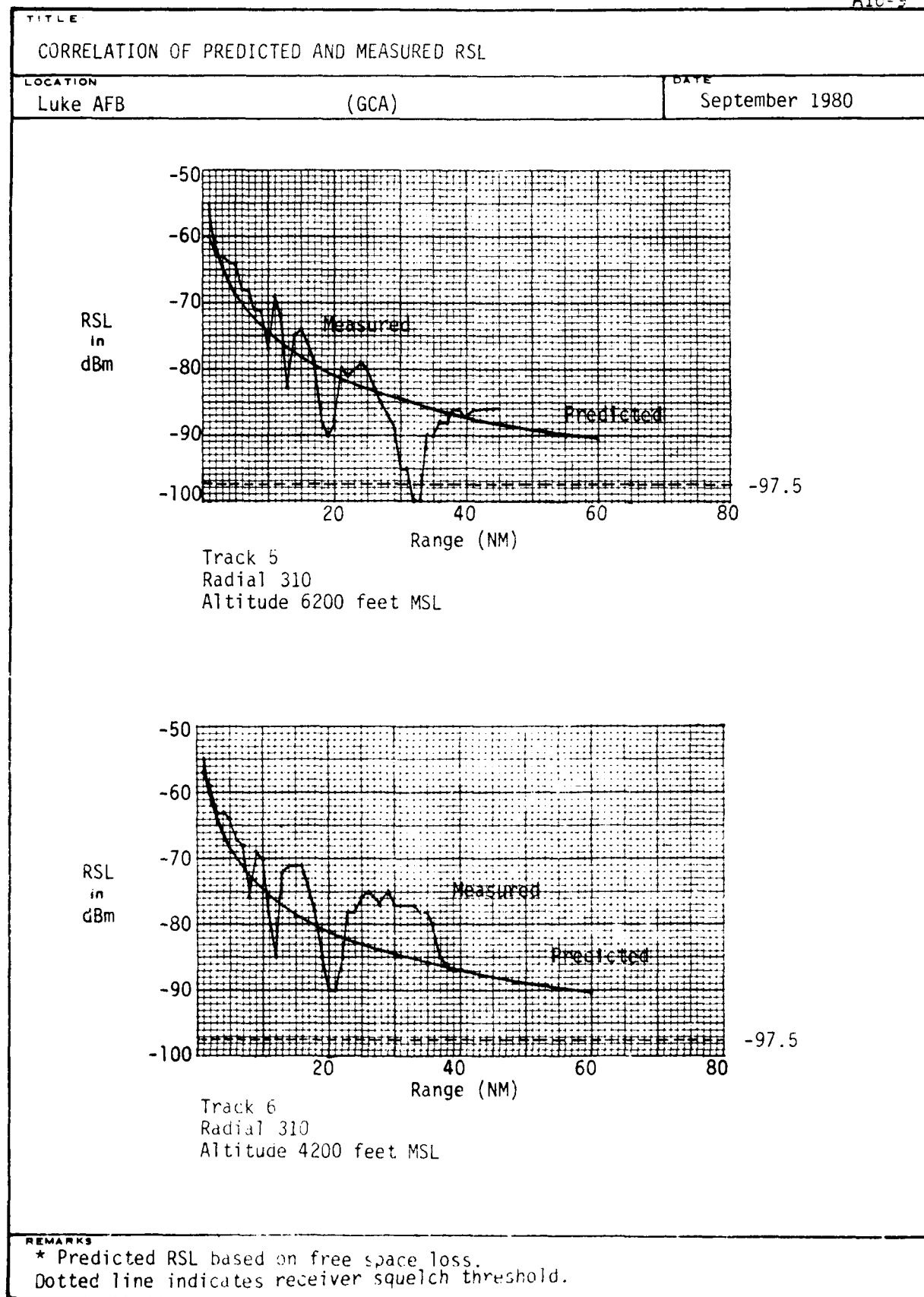
REMARKS

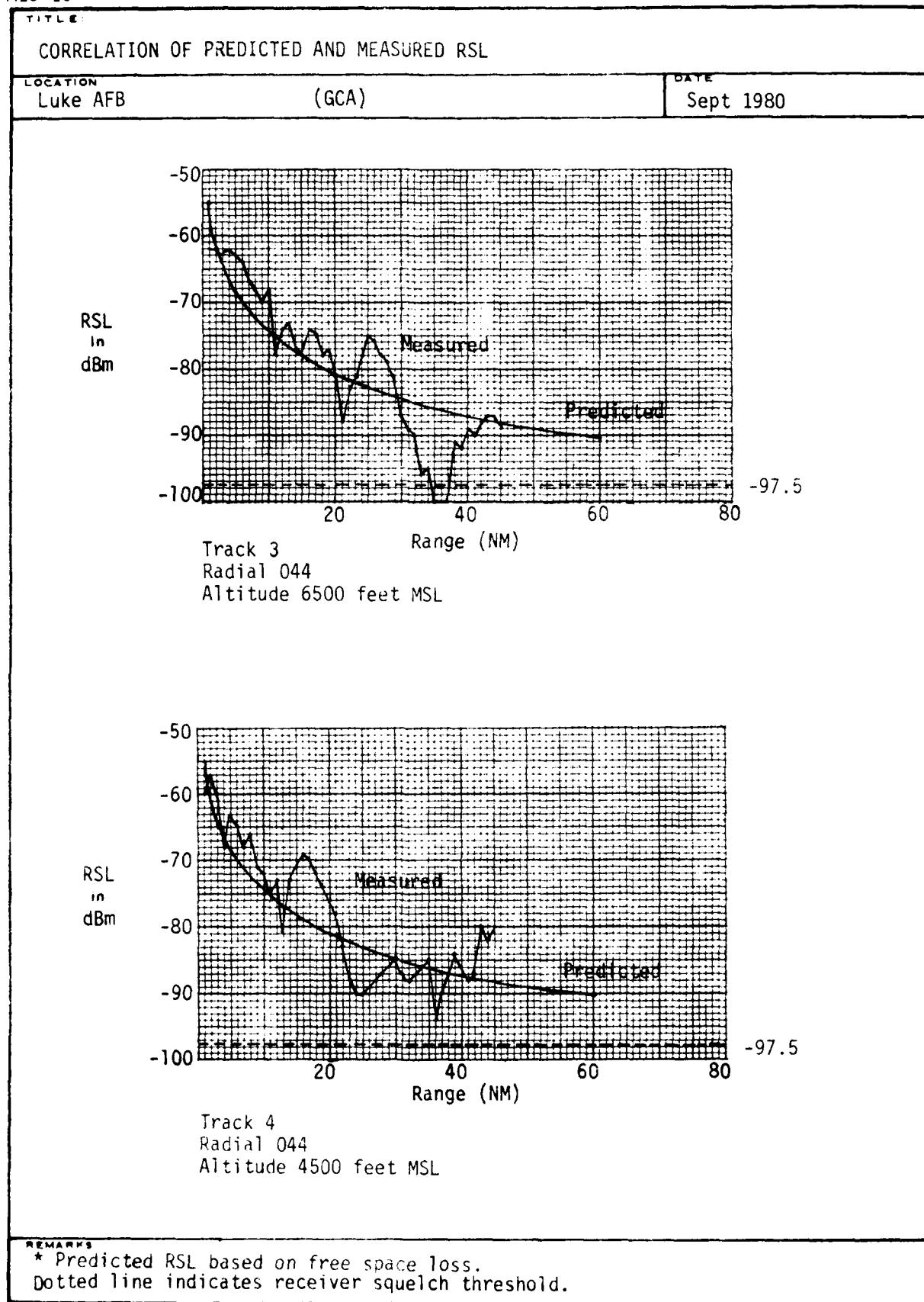
* Predicted RSL based on free space loss.
 Dotted line indicates receiver squelch threshold.

AFCS FORM MAY 73 906

GENERAL INFORMATION







TITLE

CORRELATION OF PREDICTED AND MEASURED RSL

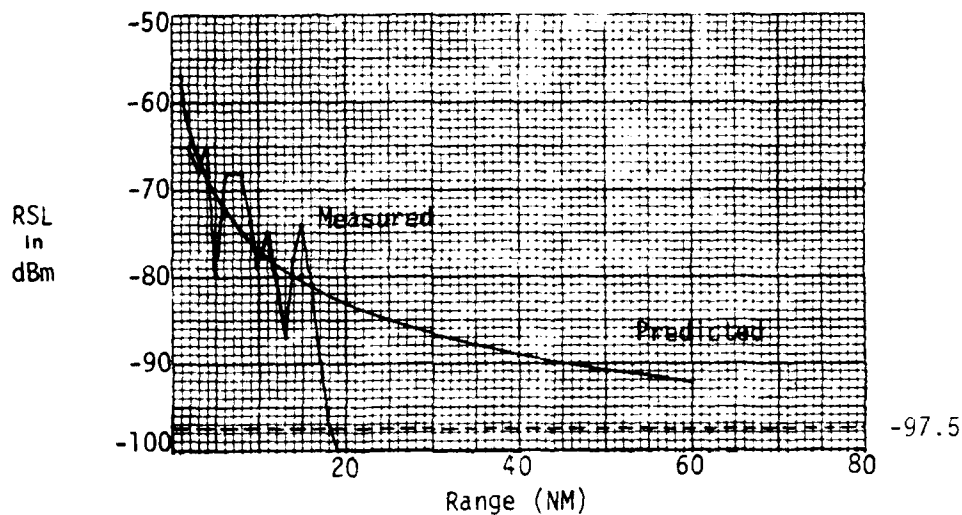
LOCATION

Luke AFB

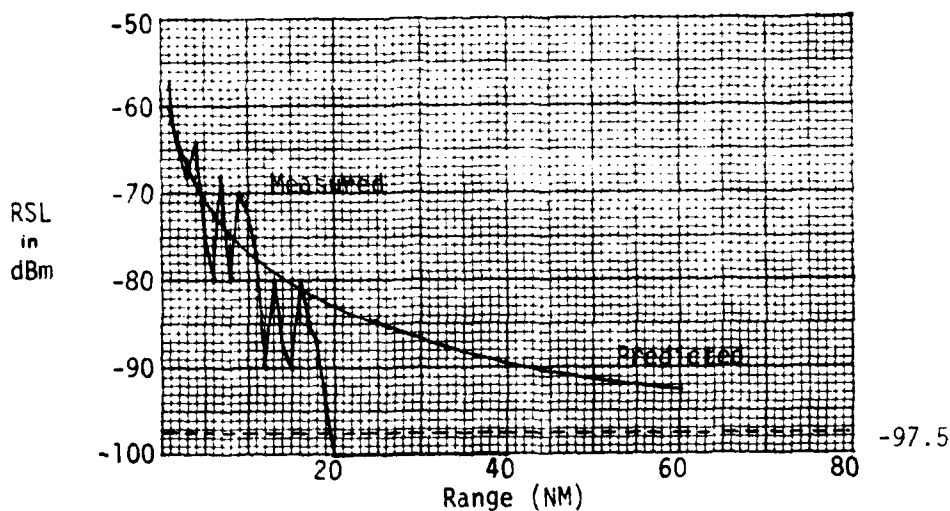
(Receiver Site)

DATE

Sept 1980



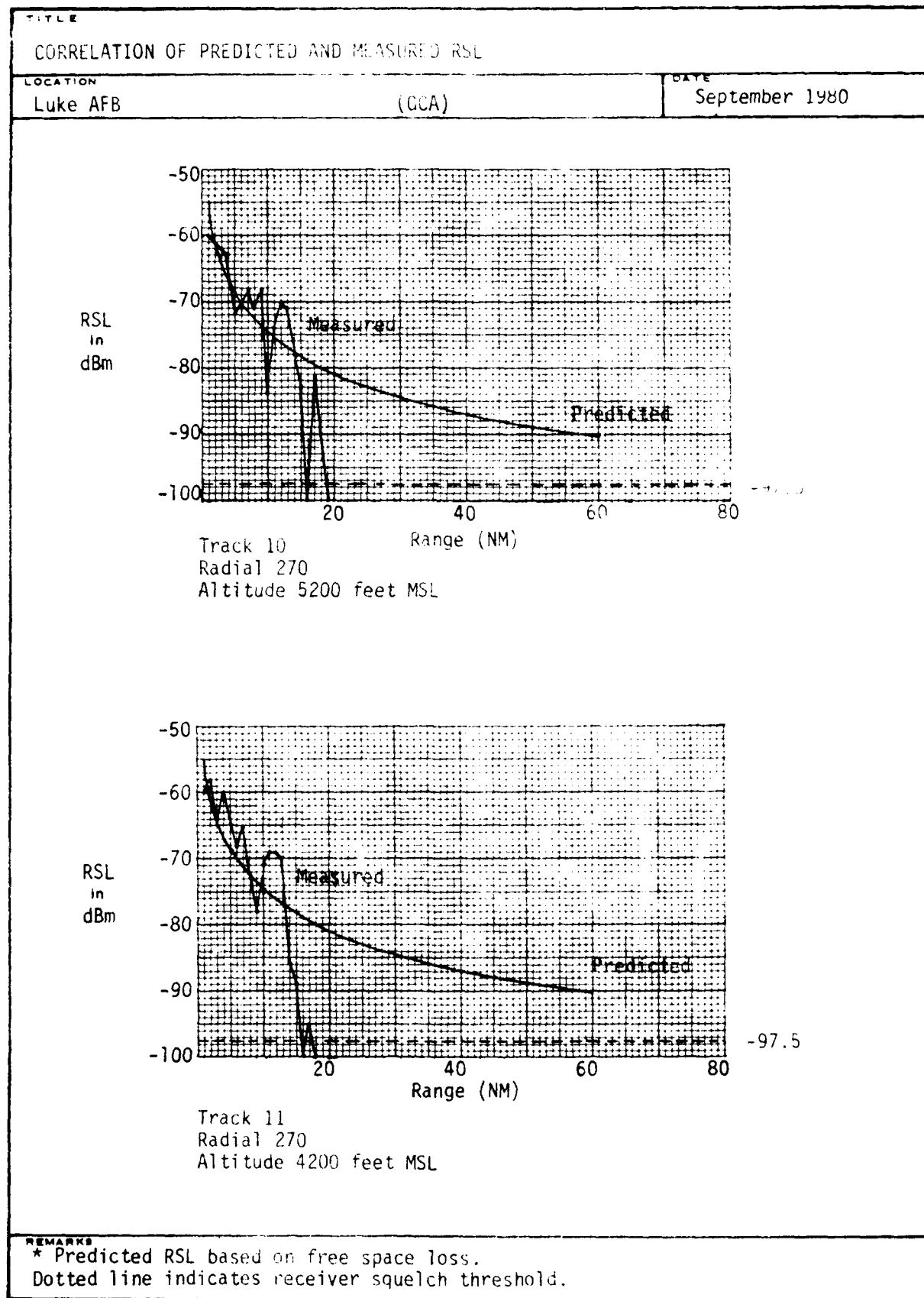
Track 10
 Radial 270
 Altitude 5200 feet MSL



Track 11
 Radial 270
 Altitude 4200 feet MSL

REMARKS

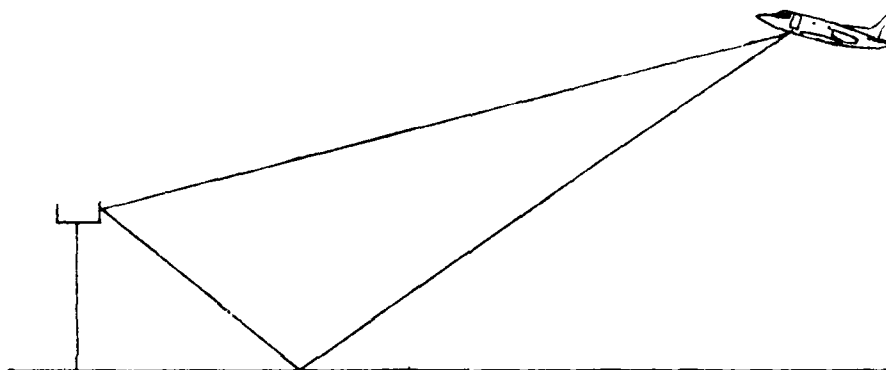
* Predicted RSL based on free space loss.
 Dotted line indicates receiver squelch threshold.



T - E

VERTICAL RADIATION PATTERN PREDICTION

1. The vertical radiation pattern is a function of the interference field which consists of a series of maximum and minimum signal strength areas commonly referred to as lobes and nulls, respectively. Multipath propagation causes the interference field to form. The transmitted signal travels over two or more paths, one directly from the transmit antenna to the receive antenna, and the others from the transmit antenna to ground reflection points and then to the receive antenna. The path lengths of the reflected rays are always longer than the direct ray, causing a phase angle difference at the receive antenna. Lobes form when the direct and reflected signal combine in phase (0° phase difference). Out of phase (180° phase difference) combination of direct and reflected signals will cause the formation of nulls.



2. Null angles may be calculated using the formula:

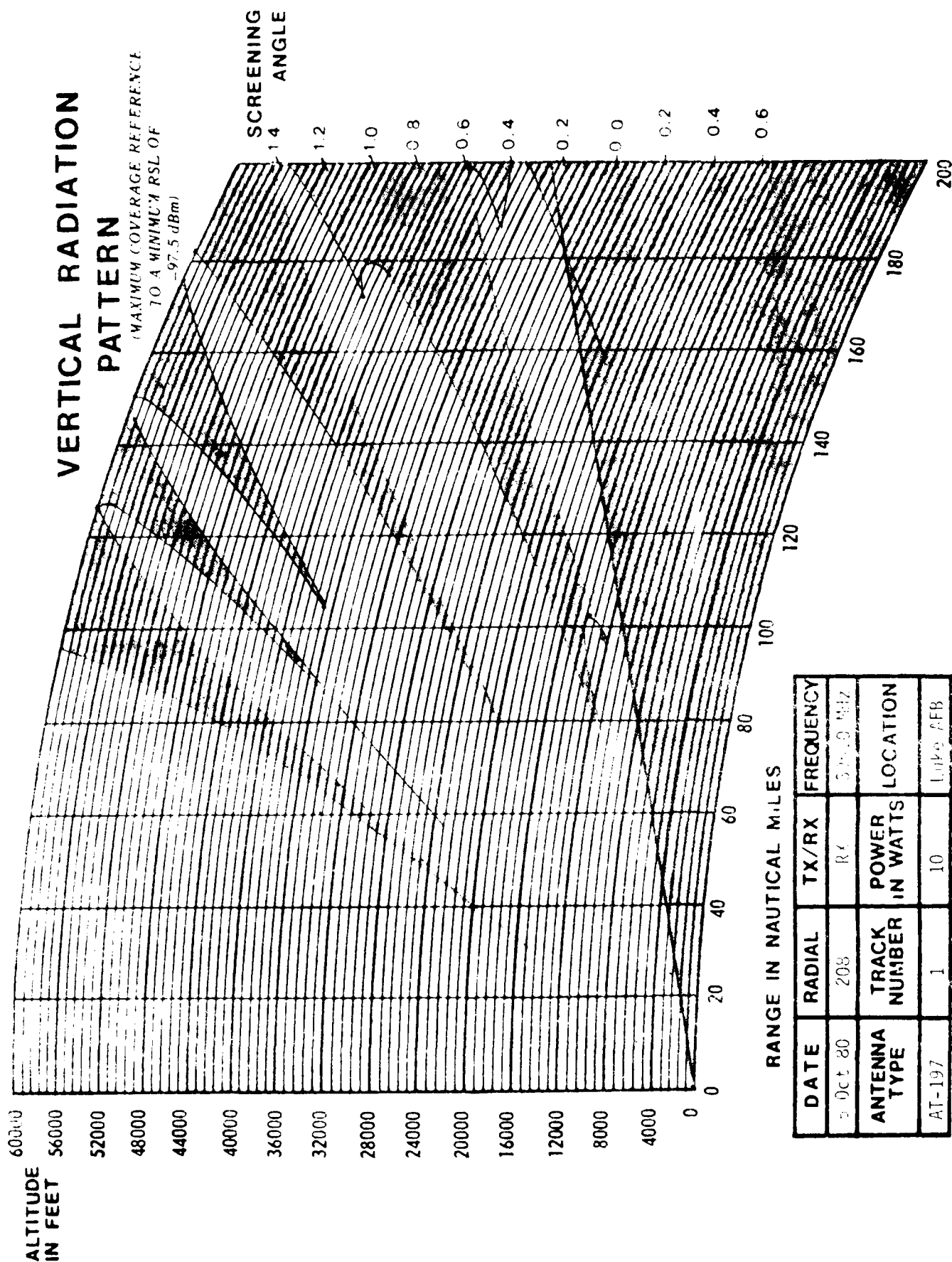
$$\theta = \frac{14098 n}{h_a f} \quad n = 2, 4, 6, \dots$$

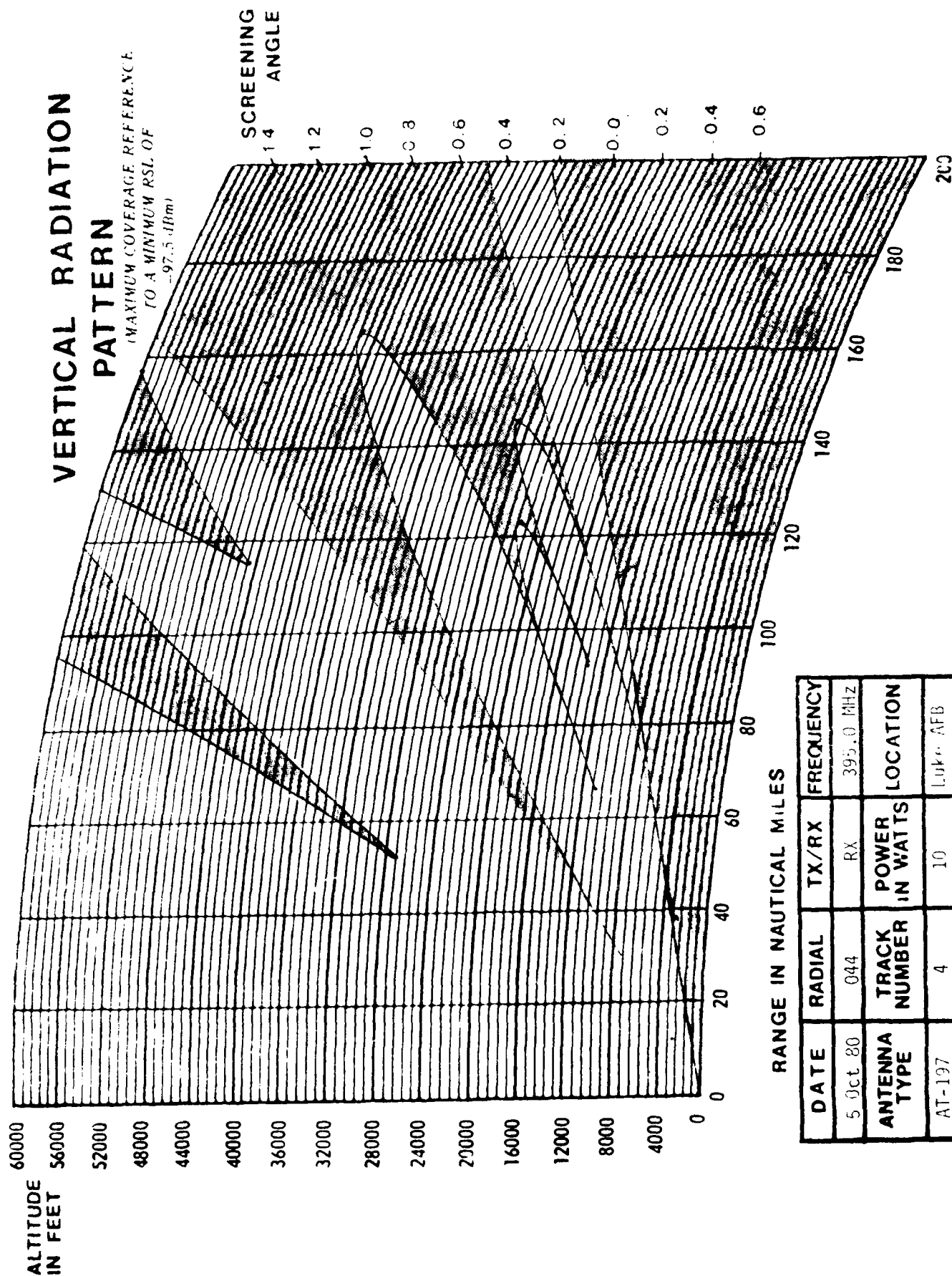
Where θ = null angle in degrees

f = frequency in MHz

h_a = antenna height above terrain in feet

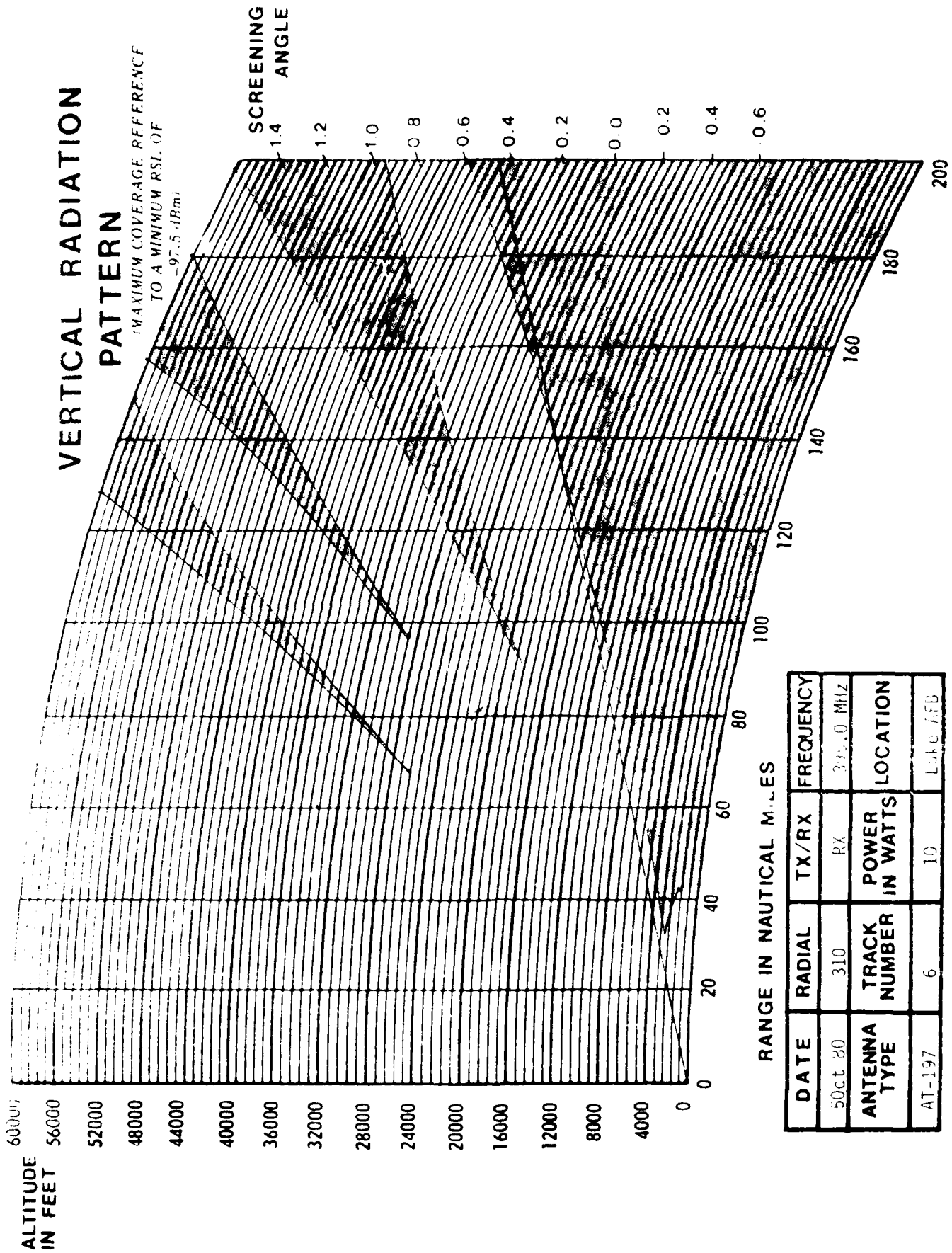
3. The aircraft's high angle of attack and the airborne receiving antenna location (center, bottom of fuselage) cause an overall reduction in signal strength on outbound tracks. Therefore, nulls are more pronounced in the RSL and radiation pattern plots constructed from data collected while flying away from the facility. The nulls appear as sharp reductions in signal strength on the RSL plots and areas of degraded coverage on the vertical radiation plots. The vertical radiation patterns which follow were calculated using the RSL data measured on radial tracks. The predicted null locations, which may represent areas of unacceptable communications, are plotted in the preceding Attachment. The measured null locations, as represented on the RSL and vertical radiation plots usually correlate closely with the predicted null locations on the radials flown.



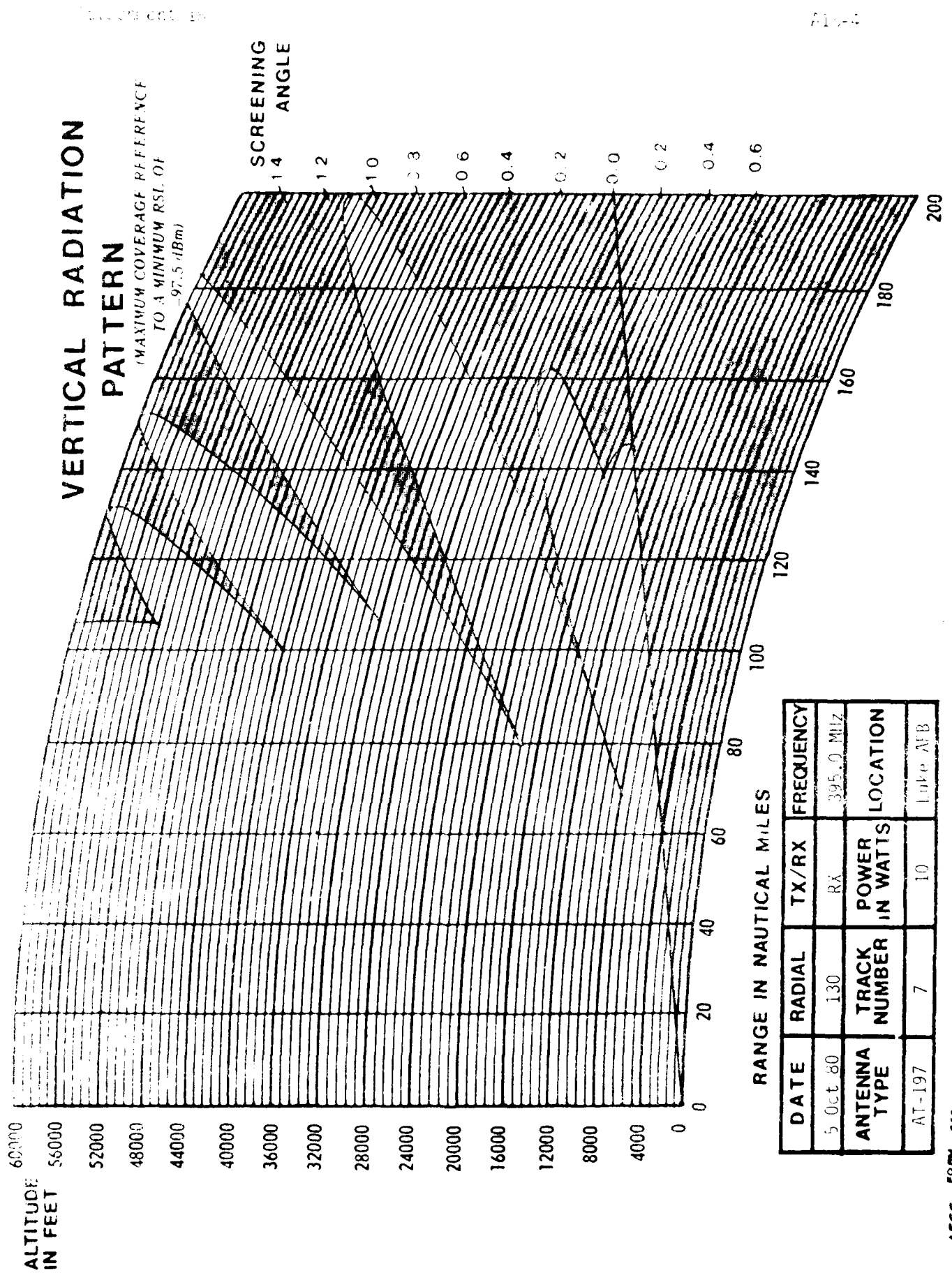


VERTICAL RADIATION PATTERN

(MAXIMUM COVERAGE REFERENCE
TO A MINIMUM RSL OF
-97.5 dBm)



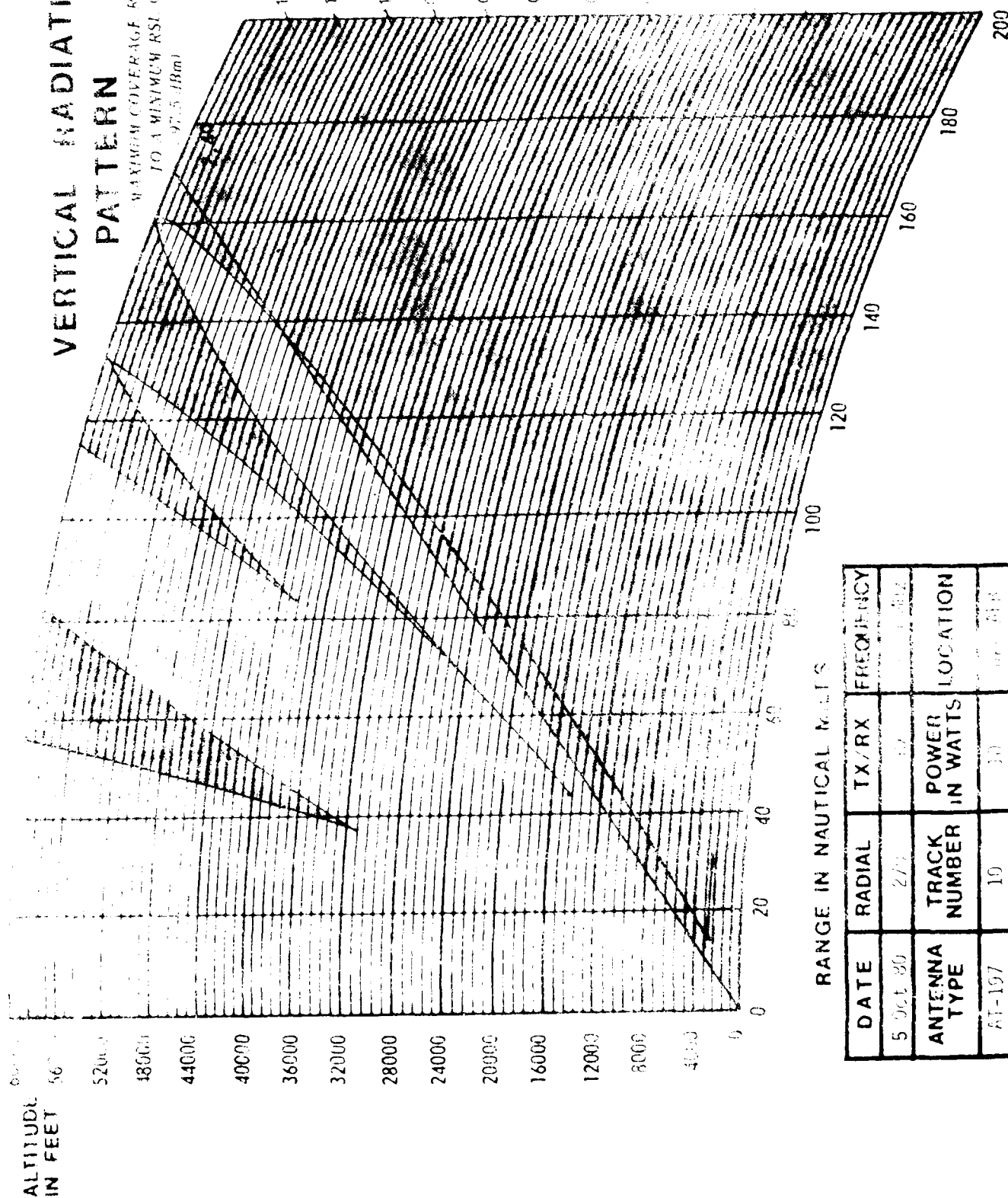
DATE	RADIAL	TX/RX	FREQUENCY
50 Oct 80	310	RX	295.0 MHz
ANTENNA TYPE	TRACK NUMBER	POWER IN WATTS	LOCATION
AT-197	6	10	LOPE AFB



VERTICAL RADIATION PATTERN

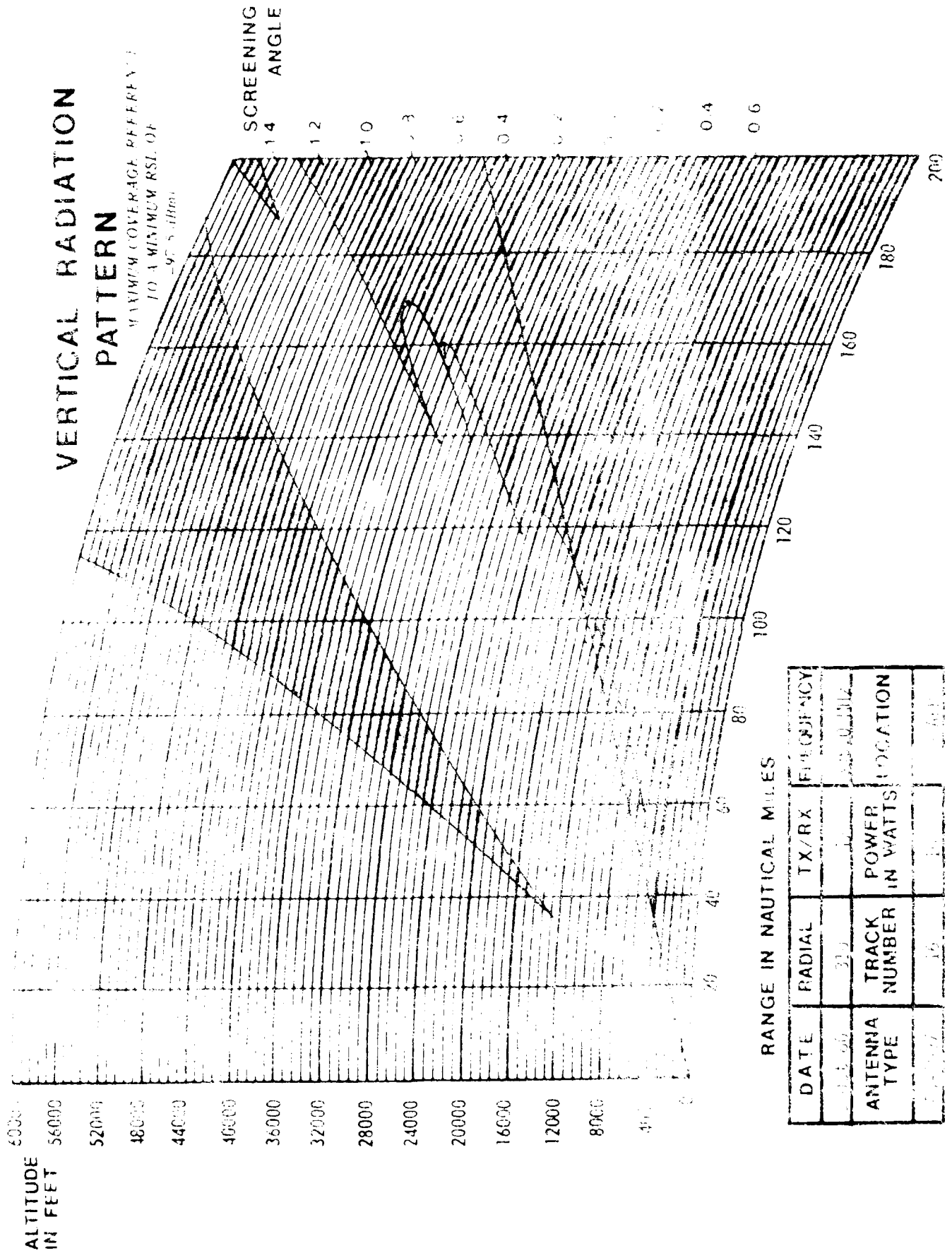
MAXIMUM COVERAGE REFERENCE
TO A MINIMUM RSL OF
-97.5 dBm

SCREENING
ANGLE



RANGE IN NAUTICAL MILES

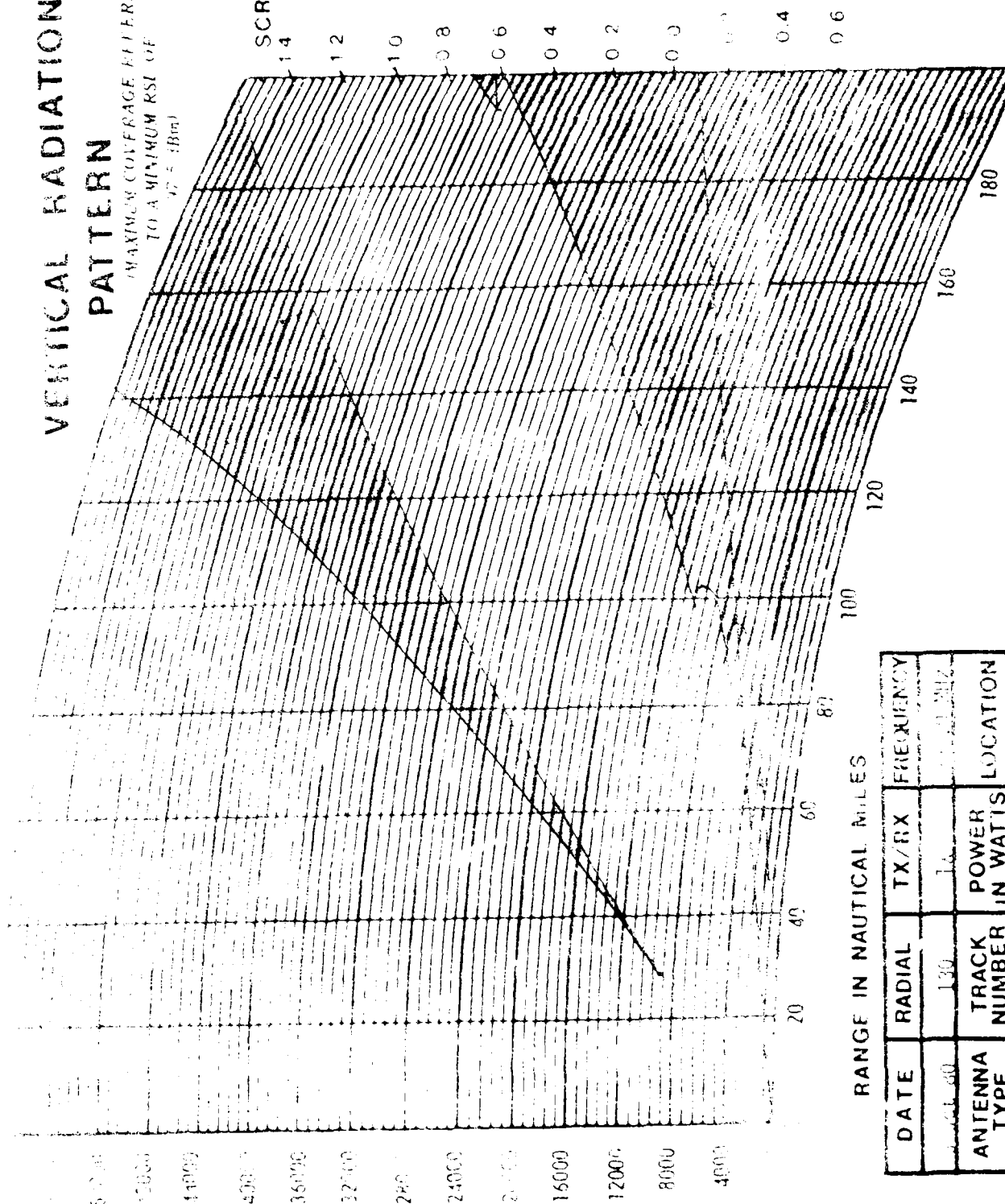
DATE	RADIAL	TX/RX	FREQUENCY
5 Oct 86	273	17	1.4012
ANTENNA TYPE	TRACK NUMBER	POWER IN WATTS	LOCATION
AT-197	19	10	000 000



VERTICAL RADIATION PATTERN

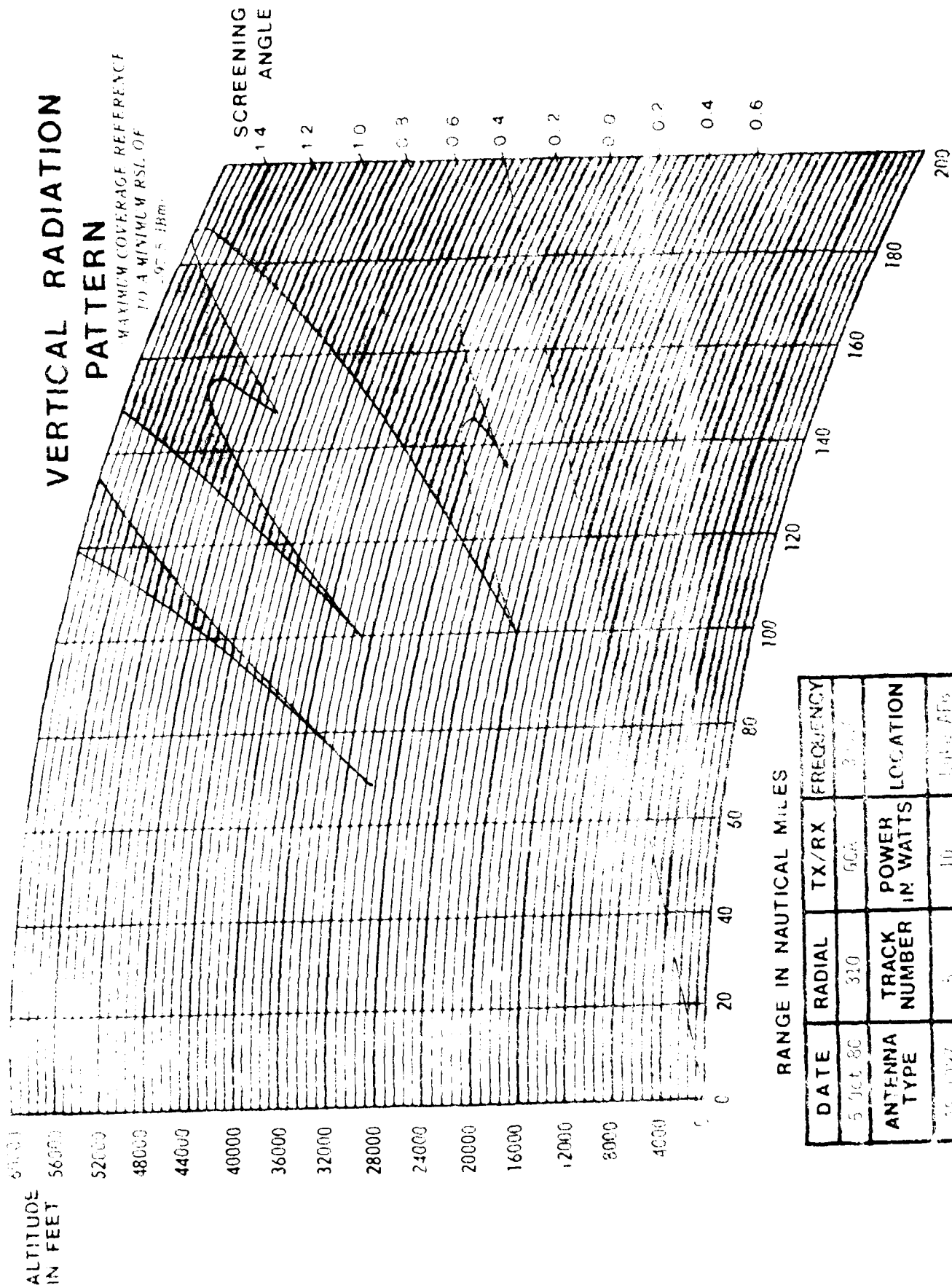
(MAXIMUM COVERAGE REFERENCE
TO A MINIMUM RSL OF
 $-17 \pm 1 \text{ dBm}$)

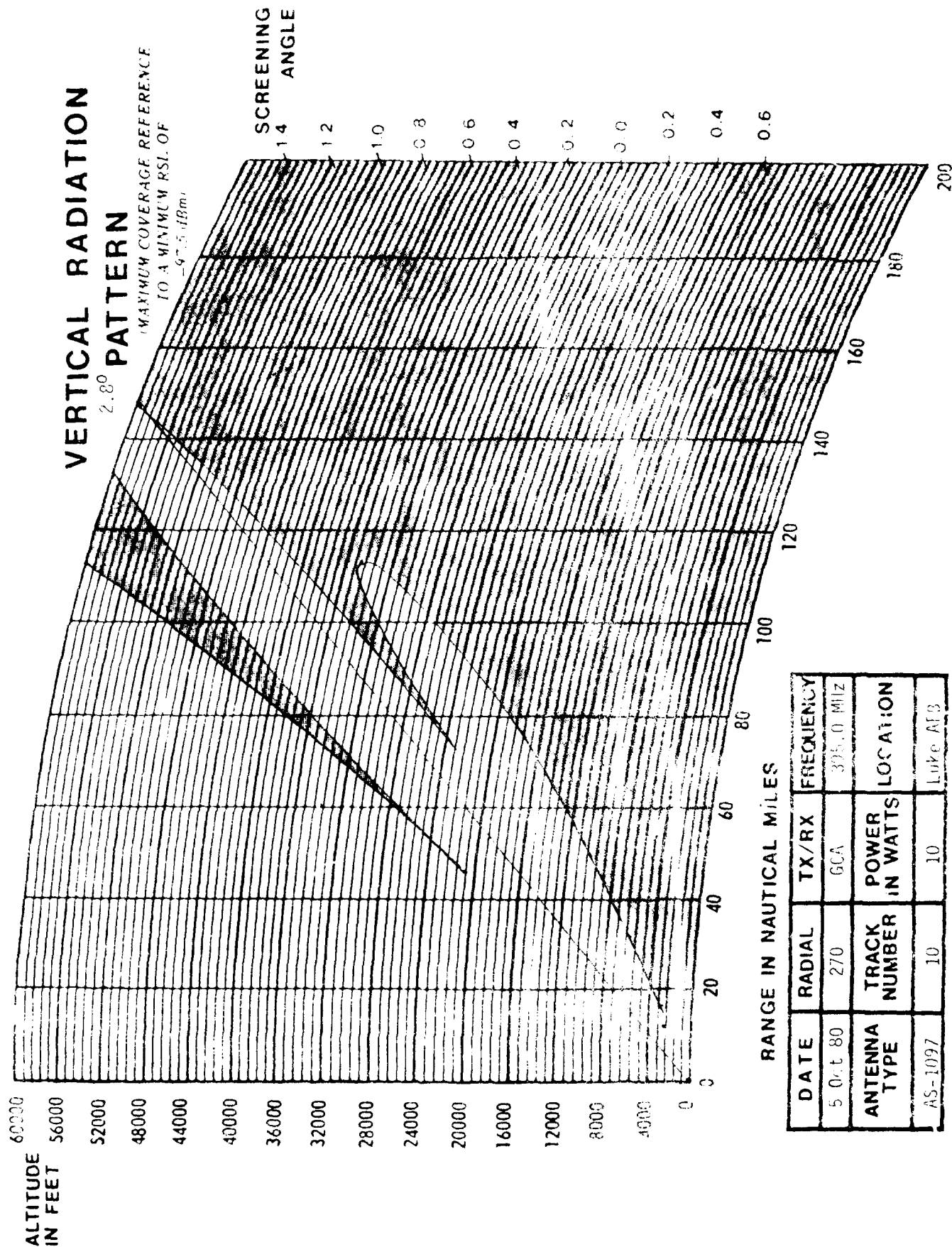
SCREENING
ANGLE



RANGE IN NAUTICAL MILES

DATE	RADIAL	TX/RX	FREQUENCY
1 JUL 60	130	16	1.4 MHz
ANTENNA TYPE	TRACK NUMBER	POWER IN WATTS	LOCATION





DATE
FILMED
- 8