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~~(S)~~ NATIONAL RECONNAISSANCE OFFICE
WASHINGTON, D.C.

29 October 1974

MEMORANDUM FOR MAJOR ANDERSON

SUBJECT: Mission 7341 Study

1. Reference my memo dated 26 July 1974, same subject. The subject study was undertaken in an attempt to answer the following questions:

a. What is the probability of detection of 12-18 gHz signals in various geographical locations?

b. What is the optimum search strategy, if one exists?

c. How long should the search be continued to achieve a reasonable probability of detection?

2. The analysis began by concentrating on two areas; first to develop a mathematical model to predict accesses to geographic locations as a yardstick by which to measure the effectiveness of the RCASP mission simulator. Second was to incorporate some realistic measure of relative activity level during a 24-hour period to more accurately predict mission performance. Using the information derived from the mathematical model and the measure of relative activity a probability of detection was calculated for each band, (6, 7, 8), and each mode, DF or omni, for Raquel. An indicator of relative activity consisting of [redacted] 1973, Fig 1, was used in the analysis. The convolution of this relative activity measure with an assumed probability of the emitter being on and a probability that the emitter is in the band of interest provides the detection probability for a single pass of the

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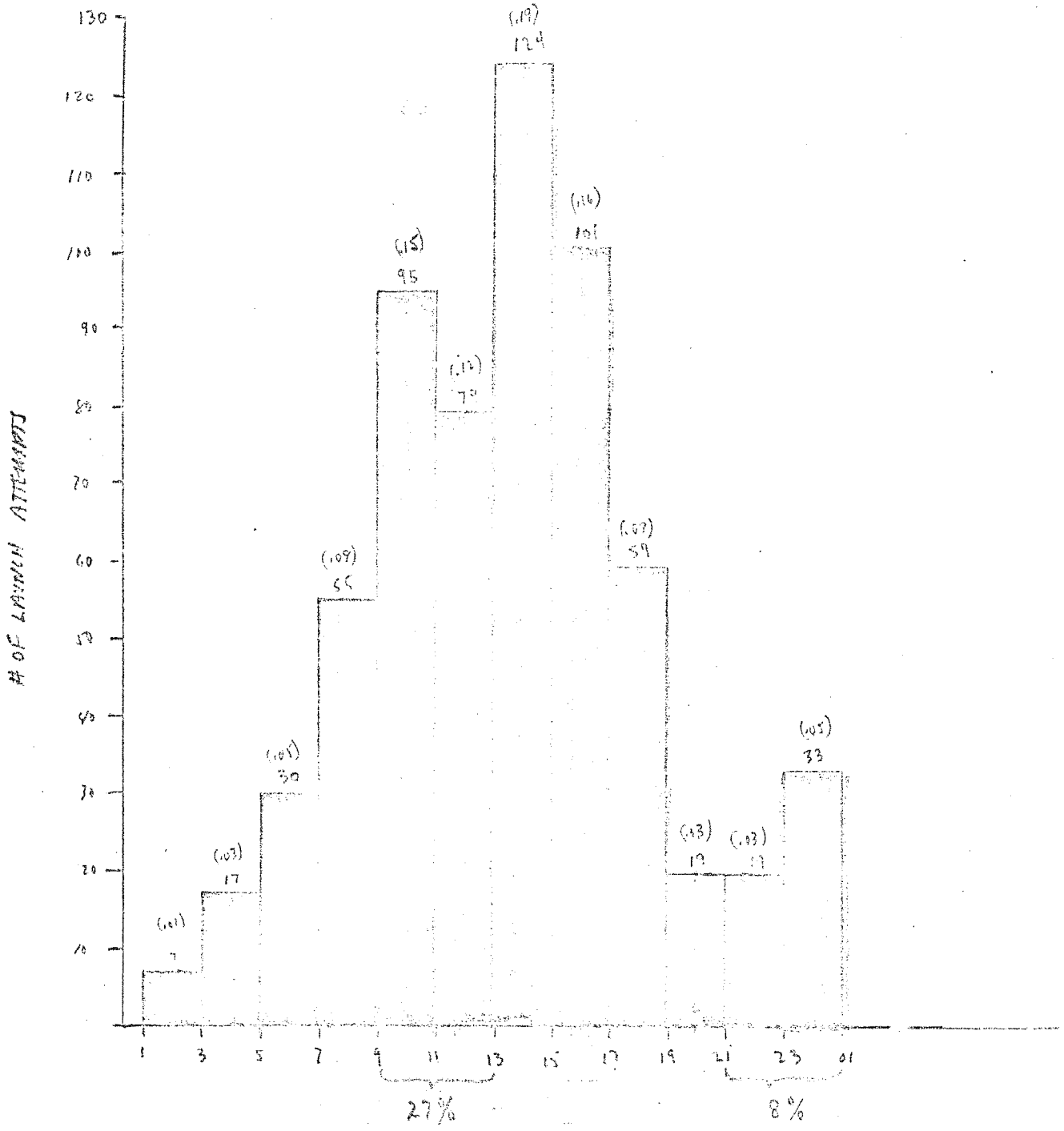

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Fig. 1

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satellite. This single pass probability of detection is

$$P_s = P(\text{on}) \times P(\text{on}/\text{access}) \times P(\text{band}/\text{on}) \quad (1)$$

then used in the cumulative probability of detection equation for each band.

$$P_n = 1 - (1-P_{s_d})^{N_d} (1-P_{s_n})^{N_n} \quad (2)$$

Where Pn = cumulative probability of detection
P_{s_d} = single pass detection probability in the band of interest during day
P_{s_n} = " " " , during night

Table A reflects the ninety day probability of detection for specific locations using an assumed 5% on time and an assumed band activity from NSA, (ref CONSOL 0286) with the relative activity measure from figure 1. Included in table A is the length of time in days required to achieve a 95% probability of detection.

3. The development of an optimum search strategy requires an objective statement which was assumed to be: maximize the cumulative probability of detection in any band, day or night. Mathematically,

$$\text{Max } P_n = 1 - \prod_{i}^{} \prod_{j}^{} (1-P_{s_{ij}})^{N_{ij}} \quad (3)$$

i = day, night
j = Band 6, 7, 8
N_{ij} = Number of looks

An equivalent statement is to:

$$\underset{N_{ij}}{\text{Min}} \prod_{i}^{} \prod_{j}^{} (1-P_{s_{ij}})^{N_{ij}} \quad (4)$$

Since this expression is monotonically decreasing for all N_{ij} we are looking for a value for N_{ij} which gives us the greatest decrease per look. Therefore, the slope of curve represented by the functions for each Nij will tell us what we need to know. The slope for each N_{ij} is represented by the partial differential of (4);

$$\frac{\partial}{\partial N_{ij}} = (1-P_{s_{ij}})^{N_{ij}} \ln (1-P_{s_{ij}}) \quad (5)$$

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NOTES: ① THEORETICAL ACCESSES - ALL LOOKS IN ONE BAND
② REAL PREDICTED ACCESSES - ALL LOOKS IN ONE BAND
③ REAL - AS SCHEDULED

P_s D/N		OMNI	DF
BAND	6	.0052/.0012	.0041/.0012
	7	.0033/.0012	.0068/.002
	8	.0039/.0012	.0027/.0008

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This equation should be solved for each N_{ij} and the ij which yields the largest negative number is the one which should be searched until a new N_{ij} yields a higher negative number than the current N for the ij being searched. At that point the new hand should be searched until $\partial n_{ij} = \partial n_{ij}$ for each hand being searched. This represents the optimum search strategy. For the conditions assumed for this study, 197 day DF LOOKS and 255 night DF LOOKS in hand 7 should be made before searching in hand 6. For the omni mode 67 day looks and 205 night looks in hand 6 should be made before beginning to search in hand 7 or 8.

J. D. HARDEN
LCDR USN
Analysis Branch

Cys to: Col Blankenship
Col Millson
LCol Prochko

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26 July 1974

MEMORANDUM FOR COLONEL BLANKENSHIP

SUBJECT: Mission 7341 Study

At the request of Major Anderson I have begun a study in support of the SOC to answer the following questions:

A. What is the probability of detection of new/ unusual signals in the 12-18 GHz range by mission 7341 in the following geographic locations/areas?

LOCATION	POSITION	LOCATION	POSITION

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B. What is the optimum search strategy, if one exists?

C. When should the search be terminated based on a reasonable probability of detection and confidence level?

I hope to complete the study by August 23.

J. D. Harden
LCDR USN
SS-6 Analysis Branch

Cy to: [redacted]
Maj. Anderson

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