[redacted]

June 28, 1965
A18547

Advanced Plans and Programs Office (ASZ-5)
Deputy for System Management
Hq., Aeronautical Systems Division
Wright-Patterson Air Force Base, Ohio

STAT Subject: [redacted]
Proposed Extension of Radar
Interpretation Program
STAT [redacted] Reference J-0194-66, Item 4

Enclosure (1): Three (3) copies "Proposed Radar Interpretation Program, Phase II, for SOARD AN/APQ-93(XA-1)" dated June 18, 1965

Enclosure (2): Three (3) copies Cost Analyses for Radar Interpretation Program, J-0194-66, Item 4

ILLEGIB Gentlemen:

[redacted] The enclosed proposal covers extension of the Radar Interpretation Program from 1 July 1965 through 28 February 1966. The last two months of this eight month period is devoted to the preparation of a comprehensive report on this phase.

For this program we submit a cost-plus-fixed fee quotation of [redacted] STAT
STAT [redacted] Enclosure (2) provides an analysis and back-up information on this quotation.

For your further information this program has been broken down into five (5) subitems:

STAT

Item	Description	
4A	Radar Interpretation Analysis	
4B	Radar Interpretation Handbook	
4C	Flight Analyzer	
4D	Flight Test Exclusively for Radar Interpretation Program (Operation Only)	
4E	Recorder Bandwidth Improvement and Dead Reckoning Computer	
TOTAL		

This quotation contains only costs unique to the Radar Interpretation Program and it does not duplicate any effort previously quoted for extension of the SCARD Evaluation Program, reference our letter Serial [redacted] dated June 17, 1965.

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We will be glad to discuss any aspects of this proposal further if you wish. We wish to note that no copies of this proposal or quotation have been submitted separately to the Technical Director of the Radar Interpretation Program.

STAT

Very truly yours,

[redacted]

Marketing Specialist
Research & Development Programs
Marketing Department

/b

Copy 2 of 6.

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PROPOSED

RADAR INTERPRETATION PROGRAM

(PHASE II)

FOR

SOARD AN/APQ-93(XA-1)

STAT [redacted]

(REFERENCE: J-0194-66 TASK 4)

JUNE 18, 1965

STAT [redacted]

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1.0 ABSTRACT

An eight month program is proposed to further investigate the utility of coherent radar imagery on targets of military significance. The program is divided into 9 major sub-tasks which encompass the following; radar data evaluation, special analysis techniques, target signature, an R.I. handbook, and two radar modifications which will improve R.I. effectiveness.

2.0 INTRODUCTION

Phase one of an R. I. program directed toward advancing analysis methods for the interpretation of coherent radar data has set forth the essential generalities of the problem. The basic goal of that program was to build upon the techniques of previous investigators through extrapolation and the addition of advanced procedures. This proposal describes a second phase which is directed toward further improvement of image interpretation and the extension of special methods of analysis.

Also two radar modifications are outlined which are an outgrowth of Task IV of the initial program, "Radar Improvements to Enhance R.I.". One addition provides for contrast stabilization of the AN/APQ-93 to maintain density gradations in the output map proportional to a pre-selected range of target reflectivities (radar reflection coefficient). The other provides for an estimation of the ship's doppler and a widening of the primary data recorder azimuth bandwidth. The doppler estimation and bandwidth increase is required to prevent output image degradation due to the doppler spectrum being incorrectly located with respect to the recording passband of the radar.

3.0 SUMMARY

In order to further improve the mathematical probability of the information reported on in Phase I, it is planned that missions will be flown to supply data on areas of specific interest. Typically a group of missions will be flown over Army vehicles of known type and fixed location at the Aberdeen Proving Grounds. Emphasis will also be placed on the comparison of detail correlations with the KA-45-A and close-up color photography.

Special analysis procedures are to be studied, i.e. non-linear shaping of the amplitude characteristic of the data. This shaping is considerably more difficult in a coherent system due to the nature or accessibility of the signal.

The capability of materials classification utilizing measurements of relative density in the output image will be investigated. To facilitate these measurements it is recommended that the signal handling process of the radar be stabilized by the addition of dynamic contrast control. This control maintains those signals of interest within the available dynamic range, so that meaningful relative density measurements can be obtained.

A method for obtaining optimum coherent radar images of ocean surface ships is recommended. This requires a simple radar modification and a change in the F-101 installation in order to maintain the ships doppler spectrum within the recording pass band of the radar.

Also suggested is a handbook for radar interpretation of coherent information. This handbook is intended to indicate those general features unique to coherent radar imagery and those specific parameters associated with the APQ-93.

4.0 TECHNICAL DESCRIPTION

The program during the first half of 1965 initiated the major portion of the fundamentals for interpretation of coherent SLR data. That effort presented the essential SLR data required to illustrate the principles involved. It is the purpose of the proposed program for the latter part of 1965 to expand on the substantiation of these principles, and enlarge upon the methods available for R.I.

Other items proposed for this program are:

a) The publication of an R.I. manual for coherent radar.

b) The addition to the APQ-93 of a stabilized contrast or grey tone control to aid in target recognition, identification, and materials determination.

c) The addition to the APQ-93 of the capability of doppler frequency estimation on marine surface ships to provide optimum imaging of these ships.

4.1 Radar Data Evaluation

It will be the purpose of this part of the program to extend the available information describing the evaluation of coherent SLR data. This extension is intended to further improve the mathematical probability of the tabulated information which originated in the program during the first half. An additional effort will be to advance the methods and procedures used previously. The radar data evaluation will be greatly aided by the availability of the KA-45-A camera data, and the detail correlator during the complete program. These two items were not available until the beginning of third and fifth months of the initial program.

4.2 Target Identification Matrix

A target I.D. matrix is a cataloging method for the radar data representing a definite target which is several resolution elements in area. The coordinates for this data are usually azimuth and elevation aspect angle. The purpose of the matrix is to provide the R.I. with a record of the coherent microwave image and its typical variations. Ideally this would be done on all possible targets of interest. However, for this program it will be restricted to those targets of higher interest where the principles and methods of recognition and identification for coherent radar imagery can be tested and expanded as required. Also, the target I.D. matrix will be used to determine capabilities and deficiencies of the collection equipment.

4.3 Special Analysis Techniques

The program thus far has proven that additional interpretation capability can be obtained through special photo processing and control. Also other imagery programs in allied fields have shown benefits from variations in the spatial frequency response of the recorded image. A coherent radar equipment using optical correlation requires equivalent techniques for adjusting the frequency content of the image and the signal amplitude response. The conventional radar can be adjusted easily to be selective in both the amplitude and frequency characteristic. Identical control in the coherent system is accomplished in a more difficult manner and at different points in the equipment. Some of this control can be accomplished by changes within the equipment (radar and/or correlator) however, there is a reasonable amount that can be accomplished by special recording and photo processing

of the correlated data. It is proposed that these techniques be investigated further during the extension

4.4 Military Exercises

During the first half of the program a Camp Drum Army maneuver [redacted] and a Navy exercise [redacted] were surveilled by the AN/APQ-93. Also at this writing it is anticipated that flights will be made in the near future on parked (appropriately spaced) Army vehicles at Aberdeen Proving Grounds to determine signature. These flights were selected with the objective of defining the equipments capability and gaining some insight to R.I. problems. It is suggested that more flights of a similar nature be conducted over a suitably spaced time period.

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4.5 KA-45-A Camera

This camera is mounted in the F-101 to record the same F.O.V. as the radar for the purpose of verification, target identification, and optical/microwave comparison. The following effort is required to maintain this camera capability.

a) Non-routine flight line maintenance and application support effort.

b) Factory adjustment and minor overhaul near mid program.

c) Film procurement, handling, processing, evaluation, and data cataloging.

4.6 R.I. Handbook

A handbook for use by radar interpreters of coherent mapping information was not included as a part of the initial program. It is recommended that this manual be written during the coming period and include the following topics; system characteristics, map defects, mensuration, and environmental effects on data collection.

4.7 Flight Analyzer

A significant amount of information or target identification and materials analysis can be accomplished by qualitative and quantitative density measurements on the correlated data film. To obtain meaningful density measurements, the contrast or grey tone rendition on the correlated film must be stabilized by reasonably accurate control within the total equipment. In a conventional radar the relative density control on the output map is accomplished simply by sensitivity and gain stabilization, however, with a coherent equipment it is not as readily accomplished. It is therefore the intent of this part of the program to design and install in the F-101 what is termed a "flight analyzer" after a study phase has been completed to determine the method and practicality of contrast stabilization. Essentially the "flight analyzer" is to be a form of built-in radar monitor available to the radar operator on a simple display and control panel for signal stabilization on the doppler data recording. The data displayed on this monitor is the result of a reference signal injected into the radar at RF frequencies. The control of the doppler data is anticipated to accomplish the required degree of stabilized contrast or grey tone rendition in the correlated data.

4.8 Surface Ship Imaging

The normal mode of operation for the APQ-93 is the surveillance of land targets which are represented by a doppler frequency proportional to the aircraft ground speed. Moving targets such

as the Navy ships in operation [redacted] no longer met this requirement with the result that the hologram record contained the incorrect frequencies for the equipment, and hence degraded images. To prevent this, it is necessary to widen the bandwidth of the primary data recorder and adjust the radar to compensate for the doppler change equivalent to the target velocity. To obtain a wider recorder track bandwidth it is proposed that the data film speed be increased from 1.22 inches per second to over 2.0 inches per second. To compensate the radar for the target velocity it is proposed that a simple calculator based on the dead-reckoning principle be used. The manually set-in inputs to this calculator will be the velocity and heading of the aircraft and target.

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5.0 WORK STATEMENT

5.1 Radar Data Evaluation

Extend the evaluation of coherent SLR data to further improve the mathematical probability of tabulated information on:

a) Target detection, orientation, recognition and identification.

b) Vegetation, foliage, shadows, camouflage and precipitation effects.

c) Change detection and repetitive cover capability for rail yards, airports, ship yards, missile sites, and construction areas.

5.2 Target Identification Matrix

Prepare detail correlations on various finite targets and construct an identification matrix for each target where a sufficient quantity of data is available. The coordinates of this matrix are to be azimuth and elevation aspect angles.

5.3 Special Analysis Techniques

Continue evaluation of special analysis techniques which improve or enhance the SLR map presentation for use by the RI. These areas of evaluation are:

a) Photo processes, procedures and materials, which aid in enhancing small signal return and accentuation of contrast.

b) Spatial frequency response variations in the correlation of SLR data by addition of derivatives of the original to final picture.

5.4 Military Exercises

Conduct SLR surveillance of military field and sea exercises and issue a report for each exercise.

5.5 KA-45-A Camera

Support KA-45-A aerial reconnaissance camera in the following areas:

a) Non-routine flight support and maintenance.

b) Return of camera to manufacturer for repair and adjustment.

c) Process and evaluate flight film.

5.6 R. I. Handbook

Write and publish an interpreters handbook for coherent radar containing the following topics.

a) System description and characteristics (the radar, correlator, and resultant imagery).

b) Error and Distortion Recognition (radar and correlator).

c) Mensuration Methods.

d) Environmental Effects (weather, ground condition, time, altitude, clouds, vegetation, etc.).

5.7 Flight Analyzer

Conduct a two phase program which will add the capability of stabilized contrast to APQ-93 on command from the radar operator. The program phases are:

a) Study the feasibility of and methods for, stabilizing the contrast of the APQ-93.

b) After successful completion of phase "a" of the program, design, fabricate, and install a flight analyzer in APQ-93 system.

5.8 Surface Ship Imaging

Conduct a design, modification, and fabrication program which will add to the APQ-93 the capability of a wider azimuth data bandwidth and doppler frequency estimation on moving targets. These moving targets shall be limited to marine surface ships at a speed less than 40 knots.

5.9 Reporting

The reports issued for documentation of this program shall be issued according to the following:

a) Reporting for military exercises (5.4) shall be completed nominally 30 days after completion of the exercise.

b) Progress reporting for the program shall consist of 3 bimonthly reports each of which are to be completed during the month following the bimonthly period.

PROGRAM SCHEDULE

SUB TASK	MONTHS AFTER GO-AHEAD 1	2	3	4	5	6	7	8
TASK I (Radar Data Evaluation)	←					→		
TASK II (Target I. D. Matrix)		←				→		
TASK III (Special Analysis Techniques)		←			→			
TASK IV (Military Exercises)	←					→		
TASK V (KA-45-A Camera)	←					→		
TASK VI (R. I. Handbook)								→
TASK VII (Flight Analyzer)	Design →				Operation →			
		Fabrication →						
			(F-101) Installation →					
TASK VIII (Surface Ship Imaging)	Design →							
		Fabrication →						
			(F-101 Installation →					
				Operation →				
TASK IX (Reporting)	←	Military Exercises					→	
			Bimonthly Progress →