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7 December 1966

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Technical Proposal

for

STUDIES OF PHOTOINTERPRETER PERFORMANCE

DDR-Not a DUPE

Prepared by



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FOREWORD

Technical support and assistance is to be provided in the following functional areas:

- . Data Reduction and General Liaison
- . Interpreter Instruction
- . Stereoscopic and Non-Stereoscopic Mensuration and Interpretation

The proposal is arranged in five sections consisting of:

1. Introduction
2. Data Reduction and General Liaison Task
3. Interpreter Instruction
4. Evaluation of Stereoscopic and Non-Stereoscopic Mensuration and Interpretation
5. Project Management

A statement of qualifications to perform the proposed effort is included as a separate section.

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1. INTRODUCTION

The [] proposes to provide technical services and materials to assist in specific aspects of studies to determine photointerpreter performance in the interpretation and mensuration of various types of targets. The primary objective of the program is to determine the relationships between interpreter performance, photographic ground resolution, and the use of stereo and non-stereo instrumentation.

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2. DATA REDUCTION AND GENERAL LIAISON

[] will assist in arranging for the collection of suitable imagery for the program. This will involve [] imagery collected by [] In addition, the acquired imagery will be "packaged" for use in the testing and evaluation phases of the program. Targets will be selected by the customer. Imagery and data will be prepared for each selected target site and will consist of a plot of the imagery, stereo pairs of imagery, additional coverage of the target, and annotation overlays to the imagery for the purpose of identifying and locating the target and its components. It is currently planned that this preliminary data reduction effort be completed within a six week period during January and February 1967. The completion of this task is, however, dependent upon the timing of the acquisition effort.

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[] will provide continued liaison and technical assistance to all project personnel and the customer. In this regard, assistance will be provided in the conduct of experiments and analysis of results, assistance and

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advice will be provided for test design and the analysis plan, and [REDACTED] 25X1

personnel will provide other technical services to the customer and project personnel as required.

These tasks will be accomplished during the months of January 1967 through June 1967.

[REDACTED] will provide monthly progress letters to the customer in 25X1

order to report project status, problems and achievements. Since [REDACTED] 25X1

participation in the over-all program is directed to specific tasks, it is proposed that report inputs be provided to the other project contractor, and that they incorporate these inputs in one over-all program final report. In this manner, the program final report will be complete and comprehensive, and inefficient duplication of reporting will be avoided.

3. INTERPRETER INSTRUCTION

The customer's test subjects will be thoroughly briefed on the nature and the scope of the interpreter testing programs. Detailed explanation will also be made of the use of all imagery, graphics, and textual data and the form that the test responses will take.

4. STEREOSCOPIC AND NON-STEREOSCOPIC MENSURATION AND INTERPRETATION

A primary effort of the program will be to evaluate and analyze physical image, equipment, and human parameters involved in the interpretation and mensuration of various target types. In particular, the effects of the use of stereoscopic and non-stereoscopic measurement practices and equipment

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will be studied. State-of-the-art equipment will be supplied by the customer

[redacted] new stereo-mensuration equipment, etc.). 25X1

5. PROJECT MANAGEMENT

The proposed project will be managed by [redacted] He will 25X1

be assisted in technical matters by [redacted] and in 25X1

contractual and security matters by [redacted] respectively. A 25X1

statement of qualifications is attached. It includes descriptions of [redacted] 25X1

facilities, related contracts and resumes for the technical personnel to be assigned to this project.

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STATEMENTS OF QUALIFICATIONS

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A. FACILITY STATEMENT

1. General

[redacted] founded in 1957, was acquired by [redacted] in 1962. Today, [redacted] specializes in research, development and operations relating to data collection and reduction systems for reconnaissance, mapping, geodesy, intelligence, and associated activities, as well as industrial applications of photogrammetry. In addition, [redacted] designs and develops prototypes for a variety of complex data reduction equipments, relying upon the unexcelled resources of [redacted] for the manufacture of such equipment. 25X1
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[redacted] personnel include scientists and engineers, ably assisted by highly trained technicians. The professional stature of the people comprising [redacted] is reflected by the fact that 70 percent have college degrees and of these, 20 percent have either a Master degree or a Doctorate. This staff has been drawn from military, other government agencies, private industry and educational institutions. Many of these people are recognized internationally as authorities in their fields of specialization. 25X1
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2. Physical Facilities

In August 1964, [redacted] moved into new and modern quarters within the [redacted] This new building encompasses 33,000 square feet of air-conditioned floor space and houses comfortably 150 employees. Approximately half of the entire facility is devoted to laboratory space with offices for technical and administrative personnel accounting for the remaining area. Furthermore, there is ample property to expand the existing physical plant anytime in the future. 25X1
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Special facilities and laboratories within [redacted] Operation include: 25X1

a. Imagery and Data Exploitation Laboratory

The Imagery and Data Exploitation Laboratory, comprising approximately 4,000 square feet, is equipped with stereo and monoscopic imagery viewers, layout tables, secure vaults, imagery and data files, and special image matching, projection and mensuration equipment. The laboratory is arranged to accommodate a variety of separate interpretation and data processing projects and provides ideal space for analysis and evaluation tasks; plotting, indexing, mosaicking, screening and interpretation, conducting experiments and performing basic and applied research relating to reconnaissance or mapping programs.

b. Mensuration and Photogrammetric Facility

Mensuration tasks to within ± 1 micron are performed in the environmentally controlled areas housing precision measuring equipment, consisting of

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[redacted] monocular comparators with digital outputs, an automatic point coordinate reader and viewer with digital output, and a [redacted] PUG point transfer device. These equipments, supported by the high acuity output of the Photographic Laboratory, on film or glass, give [redacted] one of the outstanding mensuration facilities in the country.

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This facility also possesses a [redacted] photogrammetric plotter, automated with the STEREO-MAT image correlator. This unique equipment permits the automatic production of orthophotographs and automatic extraction of contour records, as well as the digital recording of X, Y and Z model coordinates from near vertical and super wide-angle aerial or terrestrial photography.

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c. Photographic Laboratory

This laboratory comprises nine rooms which are controlled carefully for temperature, humidity and dust. In addition to handling conventional photography tasks, this laboratory is geared for special services, such as: (1) the processing of various sensor records, i.e., infrared, side-looking radar and aerial camera records; (2) production of high acuity reproduction on glass in support of analytical photogrammetry and stellar plate measurements; and (3) continuous LogEtronic printing and continuous precision printing on formats varying from 70mm - 9½" to ± .005 weave, on special order. Some of the important capital equipment within this laboratory includes:

LogEtronic CR/18 Contact Printer, 14" x 18" format

LogEtronic Continuous Printer SP10/70, 9½" x 500'

Fluor-o-Dodge Contact Printer, 12" x 18" format

Durst Laborator V-185, 10" x 10" Negative format

Vacuum Back Process Camera, 24" x 30"

Kodak Versamat Film Processor

Ozalid 1000 Printmaster

Moviola for magnetic and optical sound reproduction

Film cold vault, 7' x 8' x 10'

Various processing rooms, sinks, washers, dryers, etc.

d. Computer Facility

The primary computer in this versatile assembly is a [redacted] This is a micro-second machine with a micro-programming logic which allows for maximum programming flexibility. The present 520 installation has 24,576 24 bit words of core memory and 256 words of rapid (200 nanosecond) biaxial memory. Peripheral equipment includes:

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- 300 character per second paper tape reader
- 110 character per second paper tape punch
- Console typewriter
- 4 magnetic tape units
- 800 card per minute card reader
- 250 card per minute card punch
- 600 line per minute printer

Also available is a [redacted] computer, a small micro-second machine, which is used for peripheral computing for the [redacted] when paper tape is involved. Within this facility there is also a [redacted] computer used primarily for the solution of "engineering-type" problems. The [redacted] has a drum memory of 4096 40-bit words with a rather extensive repertoire of instructions. 25X1

e. Engineering and Manufacturing Facility

This facility is fully equipped for activities associated with the design, development, fabrication, manufacture and testing of breadboard, engineering and production models of electro-mechanical devices. In addition to the electronic assembly area, and mechanical assembly and test area, there is a well equipped machine shop and drafting room. The large manufacturing facilities of the [redacted] are also available to the [redacted] Operation if size-able quantities of instruments or component hardware are required. 25X1

f. [redacted] 25X1

[redacted] office is located at [redacted] and is within one mile of the [redacted]. This facility, comprising approximately 490 square feet, is staffed and equipped to accommodate a variety of imagery interpretation and data exploitation tasks. It provides ideal space for analysis and evaluation efforts, interpretation, experimentation, and reconnaissance research. 25X1

3. Facility Clearance

[redacted] facility has a TOP SECRET clearance (TOP SECRET Final Clearance granted by [redacted] 27 August 1964). Courier service, utilizing [redacted] personnel, can be arranged up to and including TOP SECRET. [redacted] office has a SECRET clearance, granted by [redacted] on 4 October 1965. 25X1

B. ORGANIZATION

[redacted] is one of the Engineering Operations of [redacted]. The Operation is organized along departmental lines, each being responsible for a broad area of technical or administrative operation. (Note Organization Chart appearing on the following page.) 25X1

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The primary roles and missions of the operating departments are as follows:

1. Mapping Sciences Department

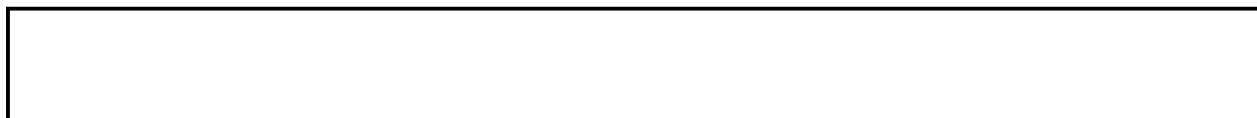
This department is concerned principally with the design and analysis of data acquisition and data reduction systems applied to space navigation, mapping, geodesy and resources surveys of the Earth, Moon and, eventually, other bodies within the solar system. Such undertakings include the development of design parameters and performance characteristics of sensors, employment of classical and non-classical techniques in data reduction, calibration of unusual sensor configurations, formulation and analysis of mathematical models in support of analytical photogrammetry and geodetic position determinations, and the application of statistical theory in the performance of error analysis of whole or partial data collection and reduction systems. In addition, this department offers consultation services for industrial applications of photogrammetry. Many solutions to the problem areas cited above are determined through computer programs developed by the scientific programming staff within this department and run on [redacted] or customer computers. This staff has considerable experience in both FORTRAN and machine language coding for various computers. Although the programming staff is primarily scientifically oriented, it has considerable experience in developing large scale, computer oriented, data processing systems. 25X1

2. Intelligence and Interpretation Department

This department is concerned with the design, analysis and test of advanced reconnaissance data processing subsystems, including assemblies for the utilization of returns from side-looking radar, infrared, conventional and special purpose photography and other special sensing devices. This department has assembled a large staff of reconnaissance system analysts and imagery interpreters capable of extracting and processing information from the multi-sensor records cited above. In fact, staff members have pioneered in the application of: (1) multiple sensors to tactical and strategic intelligence problems; (2) side-looking radar to area geology, geomorphology and land utilization, and (3) special data reduction and interpretation subsystems for the exploitation of single or multi-sensor reconnaissance imagery and data.

This department is accustomed to planning and managing reconnaissance operations. Capabilities include the providing of statistically valid field samples, acquisition of ground truth, interpreter testing, proper supporting utilization of digital and analog computers and devising storage and data retrieval systems to support dynamic reconnaissance operations.

Professional capabilities of the personnel of this department range from land sciences, such as geology, forestry and geography to engineering, military science, physics and psychology.



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4. Applied Engineering Department

This department designs, develops and manufactures new equipment either in response to unique equipment requirements disclosed as the result of data acquisition and reduction systems studies performed by other [redacted] departments, or in response to other customer needs. It is also responsible for the manufacture of [redacted] STEREO-MAT product line, an electronic stereo image correlator designed for the [redacted] photogrammetric plotter which, together, constitute the only automatic mapping equipment commercially available today.

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This department has made significant contributions in the development of image matchers, zenith cameras, automatic length and position measuring equipment, image filters and automatic rectifiers. For any equipment manufacturing requirement calling for sizeable quantities of items, the unexcelled manufacturing facilities of other [redacted] organizations can be tasked by [redacted]

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The professional staff includes electronic and mechanical engineers ably assisted by competent technicians and draftsmen.

5. Technical Services Department

This department is equipped to undertake operational assignments as a customer service, as well as provide technical service support to other [redacted] departments. These services are associated with (1) photography, such as production of high resolution microfilm photography in black-and-white and color, rapid film processing of sensor records, high definition printing on film and glass, precision formatting and photo-quality manipulation; (2) mensuration, in conjunction with aerial and terrestrial photography, zenith and ballistic cameras, industrial and architectural photography; (3) numerical computations, in support of camera calibration, analytical aero-triangulation, coordinate transformations, ground survey computations, industrial dimensioning and earth-work calculations; (4) photogrammetric computations, such as orthophotographs, digital profiles and cross-sections, topographic, planimetric and special purpose maps and mosaics.

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The staff of this department includes mathematicians, programmers, photogrammetric and mensuration equipment operators and photographic technicians in sufficient number to permit two and three shift operations, thus providing a quick-reaction capability for these numerous technical services.

6. Systems Management

The Systems Management staff is responsible for the development and management of complete systems in the reconnaissance and intelligence areas. Program Offices for individual programs are established within this group and are responsible directly to the Manager of the [redacted] Operation through the Manager of the Systems Group. This type of control is designed to best

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apply [redacted] systems experience and allow for direct action which successful completion of systems programs requires. 25X1

The Systems Management structure allows for the established Program Offices to effectively coordinate and direct the various inter-department, inter-division and subcontracting organizations which make major contributions to a program and serve as the principal point of contact for customer liaison.

In general, program management is accomplished by the Systems Management staff through assignment of work packages to the functional organizations which will represent the source of best capability to perform the work package task by virtue of prior experience and available capacity. Individual project leaders and task supervisors are assigned by the cognizant functional organizations.

The Systems Management staff is composed of highly qualified personnel who possess not only a technical competence in the various phases of reconnaissance and intelligence, but also administrative experience and ability for management of projects from the conception through successful completion.

C. EXPERIENCE

There follows a selected list of current and past [redacted] contracts, as well as a selected list of internally funded study subjects and research and development efforts. 25X1

For this particular submission, pertinent contracts are flagged on these lists, and project summaries of these flagged items are to be found on the pages which follow.

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SELECTED INVESTIGATIONS

INTERNALLY FUNDED

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Among the areas investigated by [redacted] with the help of internal funding are the following:

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1. Analytical photogrammetry
2. Arms control
3. Computer programming
4. Design and automation of mensuration equipment
5. Economic development/terrain analyses
6. Electronic image correlation
7. Systems error analyses
8. Geodesy
9. Lunar studies
10. Mapping systems
11. Mensuration services
12. Multi-sensor interpretation
13. Numerical computations
14. Photogrammetric compilations
15. Photo services (including photo chemistry)
16. Psychometric aspects of photo-interpretation
17. Storage & retrieval of mapping data
18. Tactical reconnaissance
19. Industrial photogrammetry

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[REDACTED] researched, developed and successfully demonstrated a data handling system designed to obtain positional data utilizing airborne radar recordings and limited ground control. The system was designed to process and reduce mass statistical data to stringent accuracies at high speed. The data handling system involved a radar correlation technique to obtain ground measurements, which in turn were operated upon by both digital and analog computers to yield a consistent set of positional information within the constraints of the available control. Specific tasks involved included the development of electronic matching devices, high precision optical measuring procedures, a least-square analog computer, and high speed film handling methods as well as new interpretation techniques. Concepts and equipment developed for this project were successfully utilized during large scale Strategic Air Command exercises. 25X1



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High Resolution Radar Interpretation Manual



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This 343-page manual has become a standard reference for radar interpreters. It was the first of its kind, and has been republished as a Technical Documentary Report by the Air Force. It provides basic information regarding the theories and characteristics which are essential to understanding the side-looking radar scope display. The manual provides considerable high altitude, high resolution, side-looking radar imagery; pertinent interpretation and mensuration techniques; and many illustrations of targets of strategic military interest. All imagery is from the AN/APQ-56 radar, which recently has been declassified.

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A Metrical Analysis of Panoramic Photography

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Under this contract the formulation for obtaining dimensional information from panoramic photography was derived and analyzed. The effects of ignoring various physical and geometrical conditions affecting panoramic photography and of imposing errors upon various parameters for a number of configurations were presented. Finally, the results of some measurements of actual panoramic photographs were shown.

[Redacted] 25x1

Data Reduction and Analysis for Airborne Target Location Tests

[Redacted]

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[Redacted] responsibility under this contract was to reduce, analyze and evaluate data derived from an Army low altitude target location test system. The contract involved the use of low altitude side-looking airborne radar in coordination with a ground radar tracking system, and the preparation of computer programs to evaluate different target location systems. It also involved the rectification and use of KC-1 photographic coverage for control purposes.

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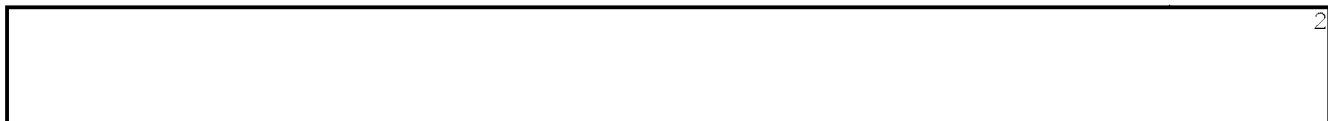
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Multi-Sensor Data Interpretation Task



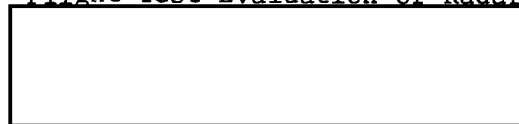
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This study provided a critical appraisal of the relative capabilities and limitations for target detection and identification of various sensors, used singly and in combination. The sensors studied were side-looking airborne radar, infrared, panoramic camera and ELINT. The experimental portion of the task was carried out under controlled human-factor conditions, using qualified multi-sensor interpreters on high altitude imagery collected by the QUICK CHECK program aircraft.




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Flight Test Evaluation of Radar AN/APQ-97 (XE-1)



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This program provided  with detailed and concise test-program results for the evaluation of its new developmental side-looking radar, APQ-97. Primary concern of the test program was the determination of slant-range accuracies and resolution, both along-track and across-track. Tasks included:

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- (1) selection of flight test areas
- (2) determination of on-board sensors and instrumentation
- (3) development of calibration procedures for the sensors
- (4) planning of operational flights
- (5) preparation of procedures for data validation
- (6) organization of data handling techniques
- (7) presentation of reduced data

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Compilation of Representative Sensor Imagery

[Redacted]

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The object of these two contracts has been to plan and develop a multi-sensor data base at the [Redacted] In the course of compiling the data base [Redacted]

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- (1) planning for data collection, including compilation of a master target list and target-coding system
- (2) designing and maintaining a storage and retrieval system for imagery and other data, including editing and updating all data-recording formats
- (3) reducing data and analyzing imagery on all data-base materials as required. In addition, [Redacted] compiles and produces multi-sensor imagery and data packages, and provides interpreters for the controlled interpreter testing relating to specific field exercises such as ROAD, ARRAY, SNOWFLEX, RODEO, and SILVER HAND.

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Course in Analytical Photogrammetry
Given to various U.S. Agencies

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Under this project, [REDACTED] developed two courses in Elementary and Advanced Analytical Photogrammetry. Subject matter included: 25X1

- (1) Vector and matrix algebra, and least squares
- (2) Image-space and object-space coordinate systems
- (3) Interior and exterior orientation
- (4) Collinearity, coplanarity, and scale equations
- (5) Single oblique photogrammetry and rectification
- (6) Panoramic photography
- (7) Space resection, orientation, and intersection
- (8) One-and two-station relative orientation
- (9) Stellar coordinate systems and camera calibration
- (10) Systems of analytical aerotriangulation
- (11) Adjustment of analytical aerotriangulation

Lecture notes, class problems and exercises were developed, and each course presented to several groups of students.

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Reconnaissance Color Evaluation

[REDACTED]

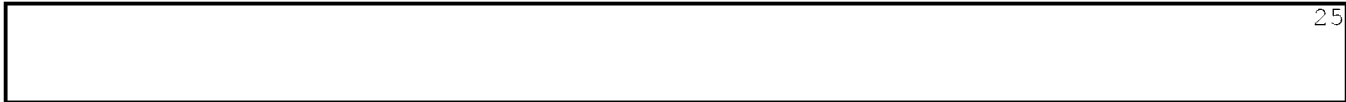
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The purpose of this current program is to explore the effect of color on reconnaissance imagery interpretation.

In the course of the effort, [REDACTED] with consultation from the [REDACTED] [REDACTED] will design, conduct and evaluate tests which will compare interpreter performance in standard analytic tasks using comparable panchromatic and [REDACTED]

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Ship Key Features and Interpretability of Sensor Imagery
Naval Radiological Defense Laboratory




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This contract was a follow-on to previous work in the multi-sensor ship interpretation area which is aiding the Navy in establishing requirements for future ship surveillance systems. Decision matrices were provided indicating a systematic methodology for performing the ship identification process as well as depicting key features and ground resolutions necessary for identification on different sensor recordings at various levels of target specificity.



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D. RESUMES OF KEY PERSONNEL

Resumes of key  personnel, appropriate to this particular submission, are attached.

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