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CORONA/HEXAGON

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(b)(3) 10 USC ⊥ 424
(b)(3) 50 USC ⊥ 3024(i)
(b)(3) 50 USC ⊥ 3507

BYE-7545-69
Cy 14
28 JUL 1969

MEMORANDUM FOR: Director, CIA Reconnaissance Programs

SUBJECT : OSP's NRO Quarterly Report on NRP Satellite Systems

Attached for your consolidation into an overall CIA Reconnaissance Report is OSP's NRO Quarterly Progress Report. Two additional copies are attached for Dr. McLucas and General Berg, and one copy each of CORONA and HEXAGON is attached for forwarding to SAFSP.

JOHN J. CROWLEY
Director of Special Projects

Attachments: a/s

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SUBJECT: OSP's NRO Quarterly Report on NRP Satellite Systems

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QUARTERLY PROGRESS REPORT

SATELLITE SYSTEMS

1 April 1969 through 30 June 1969

I. CORONA PROGRAM

A. General

Maintenance of system reliability is of continuing concern during the phase down period, as experienced industry personnel are being assigned out of the program. Positive steps are being taken to attempt to reduce or hopefully eliminate technical anomalies which have occurred with increased frequency during recent missions. Discussions have been initiated with contractors to establish a more conservative personnel reduction rate and to enhance quality control procedures. A special report on these efforts will be submitted under separate cover.

B. Open Items From Last Quarter

Digital Shift Register (DSR) - CR-6 Anomalies

It has been determined that the DSR malfunction which occurred during Mission 1106 on Rev 9 COOK and Rev 22 POGO is not a design deficiency. The contractor analysis indicates no circuit changes are required, and no hardware changes are being made. The DSR assigned to Mission 1107 was subjected to special tests to recognize the anomaly if it occurred and to establish flight ready confidence. Over 800 command loads were initiated successfully during these tests. Software changes were made so that in-flight command loads would be generated with other than a "200" word in the first position, to identify the anomaly more easily if it should occur. Retransmission of the load can then be accomplished to obtain correct operations. A further software and procedural change has been found necessary as a result of Mission 1107 to prevent occurrence of cases which can shift the "200" word into the first position and preclude the desired TM verification.

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C. J-1 System Status

J-44 Flight Summary

1. On 2 May 1969 J-44 (Mission 1051) was successfully launched. This mission was only the second in the CORONA series that was flown using a low inclination orbit and permitting ascending and descending photography. This type of orbit provided saturation type coverage of specific denied areas.

2. The Mission lasted a total of 17 days (one day longer than nominal). This extra day was available due to an unexpected bonus from the Agena batteries. During the Mission the only hardware anomaly which occurred was that the Horizon Optics failed to operate for 20 frames during Rev 7. It is believed that a particle of dirt caused a relay to fail for this short period--no action is recommended.

3. Photographically, this system did not produce the results that were expected. The PEIR reported that the photography

> "exhibits extreme image variability with overall quality of forward camera being poorer than an average J-1 Mission. The overall image quality of the aft-looking camera is somewhat better than the forward and exhibits examples of imagery comparable to an average J-1 Mission. In general, the imagery of both pan cameras is soft and lacks crispness and overall edge sharpness.
>
> The PI comment on suitability of 1051-1 ranges from good to poor with the majority in the fair to poor category. The suitability of 1051-2 ranges from good to poor with the majority in the fair category. Weather is considered a major degrading factor, hindering the readout."

Efforts have been directed to test and evaluation of the dynamic film behavior of J-46, the single remaining J-1 system. This, it is believed, will reduce the probability of similar results from J-46.

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D. Ultra Thin Base Film - Testing

1. Since CR-5 (Mission 1105) Itek has conducted studies of UTB handling characteristics. A brief description of these tests and results is given below:

a. Random flatness errors appear similar for 3404 and SO-380 films;

b. Average lift increases in vacuum from ambient levels, and SO-380 has a larger increase;

c. The increase in average lift seems to be larger the first two days, when the moisture content of the film is highest;

d. No definite relation of magnitude of random flatness errors is observed between ambient and vacuum conditions;

e. Average lift is characteristic of a particular instrument;

f. Higher tensions tend to stabilize the SO-380 film during the first two days while drying is occurring.

2. Itek, West Coast, has also begun a series of film thermal/vacuum tests. The purpose of this test series is to study the tension--curl relationship, sensitivity, and moisture characteristics of certain types of film as a function of tension, temperature, and vacuum, using interferometry to measure the film distortion quantitatively. The second group of tests will study the effects of environment on film speed and granularity. The last test will study the change in moisture content of the film under specified environmental conditions, using a microwave detector to measure the moisture content. These tests are under way and are scheduled to be completed in early August.

3. CR-8 will be subjected to a Dr. "A" test during its environmental test in the HIVOS chamber. If results are acceptable, the system will fly with SO-380 in late October 1969.

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E. Proposals and Future Changes

1. Glass Filters - CR-14 and up will use glass filters.

2. Splices - Ultrasonic splices tested thus far have proved satisfactory. Testing will continue this summer with a decision to be made sometime this fall.

F. Itek has delivered the final J-3 systems and has shut down the manufacturing and test facility in Boston. The Program direction and engineering support will be located in the Palo Alto Directorate and A/P on the West Coast. The Photoscience Group will be maintained in Lexington providing support to the CORONA Program.

General Electric has delivered the final order of SRV's, with only 17 forebodies remaining to be manufactured and delivered to A/P. G. E. is maintaining engineering and management support in Philadelphia with two persons in the field at A/P.

G. Deliveries to A/P

Main Instrument Deliveries

330/331	-	20 May 1969
332/333	-	11 April 1969
300/301	-	9 May 1969

H. Mission Completed This Quarter

Mission No.	1051
Booster No.	69-037
Agena No.	1649
Payload No.	J-44
Instrument No.	212/213
SI No.	D-115/122
DRCG No.	617
Film Type	3404
Flight Date	2 May 1969
Feet Payload Flown	32,600 feet
Feet Payload Recovered	32,600 feet
Recovery Dates	9 May 1969
	18 May 1969

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I. Missions Planned for Next Quarter

Date	23 July 1969	17 September 1969
Mission	1107	1052
Payload	CR-7	J-46

J. Meetings and Briefings

1. Dr. McLucas was given a CORONA briefing and tour of A/P on 22 April.

2. Mission 1051 PET Meeting was held 4-6 June 1969.

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Approved for Release: 2017/03/22 C05100296

C02768369.
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QUARTERLY PROGRESS REPORT

SATELLITE SYSTEMS

1 April 1969 through 30 June 1969

II. HEXAGON PROGRAM

A. Programmatic

1. DD/NRO, assisted by Agency and SAFSP personnel, conducted a study of the HEXAGON cost and schedule status to determine the best plan to accomplish national reconnaissance objectives relative to the HEXAGON and CORONA programs. As a result of his study and recommendations made to the Executive Committee, it was decided that the CORONA launch schedule will be stretched out to five (5) launches in FY's 70 and 71 and two (2) in FY 72 and that both programs will be re-evaluated prior to December 1969.

2. The Project Office directed Perkin-Elmer to undertake a reprogramming effort to bring the FY 69 expenditures within authorized funding. This resulted in deferral of equipment purchases and some subcontract effort until FY 70. These deferrals impacted delivery schedules and caused a shift of first flight schedule from October 1970 to December 1970. The D/NRO authorized the schedule change, and a revised integrated master schedule was agreed to by SSPO and SPO. The initial Flight Model Sensor Subsystem is on schedule for delivery to LMSC in April 1970 and will support the first launch date.

3. Effort is under way with Perkin-Elmer to negotiate the costs associated with a number of changes principally associated with interfaces between the sensor and other system elements. Agreement has been reached on a substantial number of these changes. The remaining changes are expected to be negotiated during the month of July 1969.

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Approved for Release: 2017/03/22 C05100296

C02768369
Approved for Release: 2017/03/22 C05100296

4. Agreement was reached between the SSPO and Perkin-Elmer that acceptance of the development model would be made after it had been assembled and operated as a complete system at Lockheed and that any design deficiencies discovered after system integration would be the responsibility of Perkin-Elmer to correct. On the first flight unit and succeeding flight units, the Government will accept various end items comprising the sensor subsystem at the contractor and subcontractor facilities, and the contractor will certify flight readiness in the field prior to shipment to VAFB and just prior to launch.

5. D/NRO directed that SPO had prime responsibility for operational software development. Subsequently, the Advisory Council and Evaluation Board for HEXAGON software met at SAFSP to review the documentation to be sent to contractors under the Request for Proposal. Agency personnel subsequently briefed the potential bidders relative to the technical details and the operational concept of the sensor subsystem. Agency personnel will participate in the proposal review and evaluation which is scheduled to begin 28 July 1969.

6. On 30 June, Perkin-Elmer presented a briefing to D/NRO on their concept of program schedule and cost control.

B. Technical

1. A major milestone was achieved during this period in completion of assembly and operation of the single-camera engineering model of the sensor subsystem. Evaluation of initial data from camera operation indicates that the system is operating well, with only minor problems. This provides increased confidence in the schedules for the development and flight systems. To date, the system has only been operated in air. It is scheduled to go into a thermal/vacuum environment for further testing, including complete optical tests, early in July.

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2. The development model is progressing on schedule to meet a ship date to Lockheed of 20 February 1970. The optical systems for the development model have completed optical testing with results in excess of specification requirements. Assembly and test techniques learned from the engineering model are being applied to the development model and producing reduced assembly and test times.

3. The mass model mounted in an SBA mid-section was shipped by Perkin-Elmer to Lockheed in April 1969. Prior to shipping, the mass model in the mid-section was subjected to a resonance search vibration test at Perkin-Elmer throughout the frequency range of 5 to 200 cps at levels from .1G to .5G. No breakage or damage was found.

4. The sensor subsystem electrical simulator was delivered to Lockheed in May and the take-up mass model was shipped to McDonnell-Douglas in June. The former equipment will be retrofitted in the field by Perkin-Elmer prior to the Lockheed required date.

5. One of the optical bars for the first flight article is being disassembled to determine why the color correction is out of specification. Optical bars from the second flight article are being expedited for use on flight article number one. It appears that there will be little if any schedule impact.

C. Facilities

The Perkin-Elmer facilities, including the various test stations, are virtually complete. Pending items are Government technical concurrence on test stations A, B and D (thermal vacuum test stations) and contractor demonstration of compatibility of these stations, plus the electromagnetic interference test station, with the flight-configured sensor subsystem.

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QUARTERLY PROGRESS REPORT

SATELLITE SYSTEMS

1 April 1969 Through 30 June 1969

III. ELECTRO-OPTICAL IMAGING TECHNOLOGY

A. Program Planning

The EOI Technology Program was modified to reflect FY 69 funding changes including the reprogrammed Vulnerability funding and the supplemental funding of [redacted] These funds were used to broaden solid state transducer development activities. (b)(1) (b)(3) 10 USC 424

The FY 70 Financial Program/FY 71 Budget Recommendations, with estimates through FY 75, were submitted to the NRO 7 May 1969. They provide for EOI initial operational capability (IOC) in a five year period. A revised FY 70 funding request and EOI Program Plan for a four-year period to IOC were in preparation at Quarter's end. The preliminary plan and cost breakdowns were discussed with D/NRO on 16 May 1969.

Preliminary configuration studies of the imaging satellite and the key subsysterns were completed as requested by the Land Panel. Detailed discussions were conducted with contractors concerning system definition and total program costs and schedules. Major system elements were examined, and schedule and cost estimates were developed for each item.

B. Transducer Development

1. Thermoplastic Recording

a. Screened Thermoplastic Xerography (STX) - Fourth Quarter efforts were devoted

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primarily to measuring the sensitivity-resolution performance of the first plates produced under clean room conditions. Samples screened at 250 cycles per millimeter and exposed to sine wave targets were examined with a Zeiss Ultraphot microscope equipped with a Zeiss microphotometer and precision scanning stage. The samples were examined under bright field illumination and in a laser-illuminated Suzuki readout mode. Resolutions of 117 cycles per millimeter were measured under bright field conditions (with the image parallel to screen). Samples demodulated in the Suzuki system had a large noise component which precluded the accurate measurement of higher frequencies (40 cyc/mm and above). It is suspected that the primary noise source is due to micro-defects within the sample; samples produced late in this Quarter, when fabrication parameters were under better control, were greatly improved in this respect. The latter samples, Suzuki demodulated with images exposed orthogonal to the screen, had resolutions on the order of 90 cycles per millimeter and an MTF greater than 0.2. Absolute sensitivity measurements show a threshold response of 2 to 8 x 10^{10} photons/ cm^2. One sample has been cycled 111 times without noticeable deterioration of any of the component layers and without significant change in its imaging or development characteristics.

b. Readout Studies - The ability to produce hard copy from phase images by direct spot scanning was demonstrated during this Quarter. Relief targets containing deformation amplitudes of 90-1500°A were prepared on Kodak 70 mm Mini-Card film; a carrier frequency of 100 cycles per millimeter was used, and images consisted of step wedges, tri-bar targets and continuous

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C02768369.

Approved for Release: 2017/03/22 C05100296

tone scenes. The scanning beam was a 25 micron diameter spot generated from a 5 mw He-Ne gas laser source. The mirror scan speed of the prototype system was 30 rpm. A photomultiplier tube was used to detect the second diffraction order from the simulated STX surface, and the output from the PMT was fed to a KDP modulator and amplifier stage which in turn modulated a second laser beam used to "write" on silver halide film. The target was scanned at a vertical (translation) speed of 0.1 inch per minute. This demonstration achieves the current program goal of demonstrating the feasibility of the direct spot scanning system and has provided a base line for the point-design of a system capable of operational performance.

2. Quasi-Linear Array

Fairchild Camera and Instrument Corporation continues on a program to fabricate and test a phototransistor array. The program goal is to build and to determine the sensitivity, resolution, and related performance parameters of the current chip design. The testing program to measure device performance has been nearly completed. Results from the test program to date are encouraging in most respects. The program is in an overrun status in both schedule and cost. The program has not been accelerated pending management and technical review.

3. Phototransistor Array

TRW Systems has started an accelerated program to fabricate and test a modification improving their original design. Sensor chips and switching chips have been made separately, and preliminary testing has been performed. The results of the tests of sensitivity and geometrical response were encouraging. Uniformity and yield may become problems. A new chip design has been completed, and masking and test fabrication runs have been made. This new design combines

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Approved for Release: 2017/03/22 C05100296

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sensor elements and switching circuitry on the same silicon chip. If the proposed chip edge forming techniques are successful, the sensor elements will be in nearly the ideal geometrical arrangement. If the edge cannot be shaped as proposed, the fall back position is still better than any current device. The feasibility of the new design should be known by the end of the first Quarter.

4. Photodiode Array

Westinghouse is continuing work on photodiode arrays. Both sensor and switch chips have been fabricated. Electrical wire-bond interconnection patterns have been made and shown to be feasible. Beam-lead fabrication testing is under way to ease the interconnection problem. The proposed design calls for a deviation from true linear configuration of about ten times pitch. This seems to be a useful value. A photocathode-coupled array design has been completed. Tests on photocathode properties under the influence of high surface electric fields are under way. Also, tests have been started to determine the compatibility of silicon devices in the presence of photocathode materials, and results of these tests will be available in the first Quarter.

5. Solid State Array Circuit Design Study

During the Quarter, Stanford Research Institute started a study of the fundamental aspects of solid state array circuitry. Each of the three array contractors makes use of a different electrical circuit arrangement to transform the minute photon-induced electrical current into a usable electrical signal. In general, these circuit designs have evolved more from attempts to find the easiest arrangement to fabricate than from more fundamental reasons. The study will examine the designs to see that they are making the best use of available technology to derive maximum performance.

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C. Optical System Design

A specific preliminary design was generated for an optical subsystem intended for operation with a quasi-linear semiconductor array. Preliminary analysis of system performance and thermal, structural, and optical element fabrication error budgets was performed to assure that performance specifications will be met by the system, as well as to define critical technology areas in an overall system development plan. This design work was presented in a final report concluding the preliminary phase of the optical system design effort. Subsequent work in this area will involve generation of a detailed design on the basis of new test data on the semiconductor arrays, as well as generation of detailed plans for optical system design and fabrication compatible with the overall system development schedule.

D. Image Data Processing

RCA initiated an examination of methods to be used for RF data reception and recording, retransmission, initial processing for viewing, storage, and potential enhancement requirements. Program planning was started for system definition and system development activities. Philco-Ford completed one solid state array data processor analysis and conducted studies of V-band RF requirements as well as estimates of relay satellite functional characteristics.

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Approved for Release: 2017/03/22 C05100296

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QUARTERLY PROGRESS REPORT

SATELLITE SYSTEMS

1 April 1969 Through 30 June 1969

IV. GENERAL RESEARCH AND DEVELOPMENT IN SUPPORT OF RECONNAISSANCE SATELLITE PROGRAMS

A. Sensing Techniques and Devices

No contractual effort in this category was performed this Quarter.

B. Optical Fabrication and Evaluation Technique Development

1. Selective Vacuum Deposition for Figuring Large Optics

Chamber instrumentation for a manually controlled demonstration was completed, and the entire process line was made operational through the use of some temporary equipment modifications. Several correction masks, derived from interferometric data taken from the 30-inch CerVit test piece were made, and evaporant distribution experiments were run in the large chamber.

The operational status of the chamber, its instrumentation, and the entire mask-making process line represent a marked improvement over anticipated program progress for the Quarter. This is a consequence of the program acceleration instituted during this Quarter in order to provide an early demonstration correction. Initial correction depositions have been made on the demonstration piece.

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Approved for Release: 2017/03/22 C05100296

C02768369 Approved for Release: 2017/03/22 C05100296

2. The Development of a Hologram Interferometer

The emulsion study designed to determine the extent of errors due to dimensional changes in film and processing techniques for minimizing these effects was begun. Data from initial phases of the study indicate that the accuracy in holographic testing is not as emulsion-limited as was previously believed.

Conversion of computer programs for use with the new optical head and plotter was completed, and synthetic holograms were generated using the scribing technique. The synthetic holograms will be evaluated to determine plotter positioning accuracy and its effect on ultimate testing capability.

3. Fiber Optics Technology

Improvements were made in the transmission efficiency of the double-core fiber configuration, which was designed to provide an effective input-to-output controlled separation. Further optimization is believed possible through the selection of glasses with different indices of refraction than those presently used. Initial samples of the alternative, separated monofiber configuration, were made. These showed promise, but more work on this approach is required to determine its feasibility.

4. Low-Scatter Coatings

Work during this Quarter has been primarily directed toward equipment procurement, modification, and testing. In order to differentiate between substrate scattering and coating scattering, the roughness of all substrates must be examined interferometrically prior to experimentation. Some preliminary work was begun on the classification and grouping of substrate samples on the basis of surface condition.

TOP SECRET

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Approved for Release: 2017/03/22 C05100296

C02768369 Approved for Release: 2017/03/22 C05100296

C. Optical Material Development and Evaluation

1. Beryllium-Based Material Development

Fabrication of the final set of test samples was completed by SRI. These samples will be sent to Perkin-Elmer for evaluation and comparison with similar samples fabricated by other processes. Preliminary results indicate that samples fabricated by the SRI pressureless sintering process are superior in all respects to those made by competing processes.

Work has begun on the fabrication of one sample of approximately 12 inches in diameter. SRI has prepared the powders for this piece and has located a hydrostatic press in Oregon for this single pressing. Subsequent fabrication and testing of this sample will supply much needed data regarding the scale-up characteristics of the process.

D. Mechanical/Optical Structures

No contractual effort in this category was performed during this Quarter.

E. Advanced Electromechanical Development

1. Sheet Film Transport

During this Quarter RCA completed the critical alignment of the film path through the rotating transfer drum as well as the testing and check-out of the control electronics. The pressure settings at the convoluted guides and the hold-down pads were tuned, and STB was successfully passed in both air and vacuum. In addition, the take-up was modified to allow lock at lower tension levels, and the output servo control loop was adjusted to insure loop stability at all values of reel/film diameter.

Two key goals in this program--the completion of the test and evaluation task and the 2500 sheet reliability run--were hampered this Quarter by problems during the initial attempt to run the system with large magazine loads of UTB material. It appears that the outgassing of the

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Approved for Release: 2017/03/22 C05100296

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upper stack sheets is giving rise to a yet undetermined amount of lateral shift in the stack. It is anticipated that this problem will be overcome during the next Quarter.

In addition, the contractor has completed a preliminary study of the interface requirements for the integration of the Sheet Film Transport into a HEXAGON-type system as a means of moving discrete film sheets past the focal plane of the Optical Bar. This study report is now under review by this Office.

F. Data Transmission, Processing, and Display Techniques

1. Photographic Coverage Assessment (Previously Area Coverage Program)

The test and evaluation program, initiated last Quarter through the facilities of NPIC, was completed. In addition, a number of minor hardware and software changes were made in order to facilitate operator usage. Also, the evaluation of Mission 1051 is continuing, and plots of the various levels of coverage are now being prepared for correlation with the previously acquired index readout.

A spares and replacement plan was formulated this Quarter, and steps were taken to acquire a number of encoders and circuit boards. These items represent the most probable sources of extended down-time for the digitizing table and control electronics.

2. Optical Processing for ELINT

During this Quarter the effort at KMS Industries, Inc., to assess the feasibility of utilizing coherent optical processing techniques for ELINT signal discrimination under noisy background conditions, progressed to the preliminary bread-board phase. An initial laboratory processor, consisting of four lenses, an ultrasonic water cell, an He Ne gas laser, and the necessary electronics was set up and exercised against a

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simulated input. Results to date have demonstrated that a one-microsecond pulse, buried at the input beneath a number of overriding interferers, can be readily detected. A new and more sophisticated cell was installed in the apparatus late this Quarter, and data is now being taken.

The analysis begun last quarter to determine the primary sources of error and/or degradation in the processor was continued. It is anticipated that this analysis will indicate those hardware problems which may be alleviated by only modest design modifications.

A final report will be prepared and submitted early in the next Quarter.

G. Collection System Evaluation

1. Sampled Imagery

During this Quarter the progress at Perkin-Elmer on the Sampled Imagery research program has been significant. The analysis and calculation of the preliminary EOI system transfer function based on the FCIC transducer and the Itek optical design data were completed, and the appropriate scanning spots were produced. These spot distributions, in turn, were electromechanically convolved with the linearized input transparency to generate a line-scanned image. In addition, two sets of output prints exhibiting a range of Gaussian white additive noise have been prepared and are now being evaluated.

Work on the optimal reconstruction spot has continued, and initial results indicate that this factor will have a significant impact on sampled image quality. A new software routine, which allows the rapid generation of both reading and writing spots as a function of the system spot transform, was prepared and is now being checked out.

Other imagery which was prepared this Quarter included variations in the sample spacing in one direction and in the noise distribution. In addition, preliminary examples of the effects of operating on a degraded image with a corrective spread function were prepared and reviewed.

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Approved for Release: 2017/03/22 C05100296

C02768369
Approved for Release: 2017/03/22 C05100296

QUARTERLY PROGRESS REPORT

SATELLITE SYSTEMS

1 April 1969 Through 30 June 1969

V. VULNERABILITY

Updating of GALOSH section of the threat notebook was completed, and it will be distributed shortly. In this Quarter priority was given to preparation of data for an Anti-Satellite Capabilities paper for General Berg. Preparation of additional notebook sections will be resumed during the next Quarter.

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QUARTERLY PROGRESS REPORT

SATELLITE SYSTEMS

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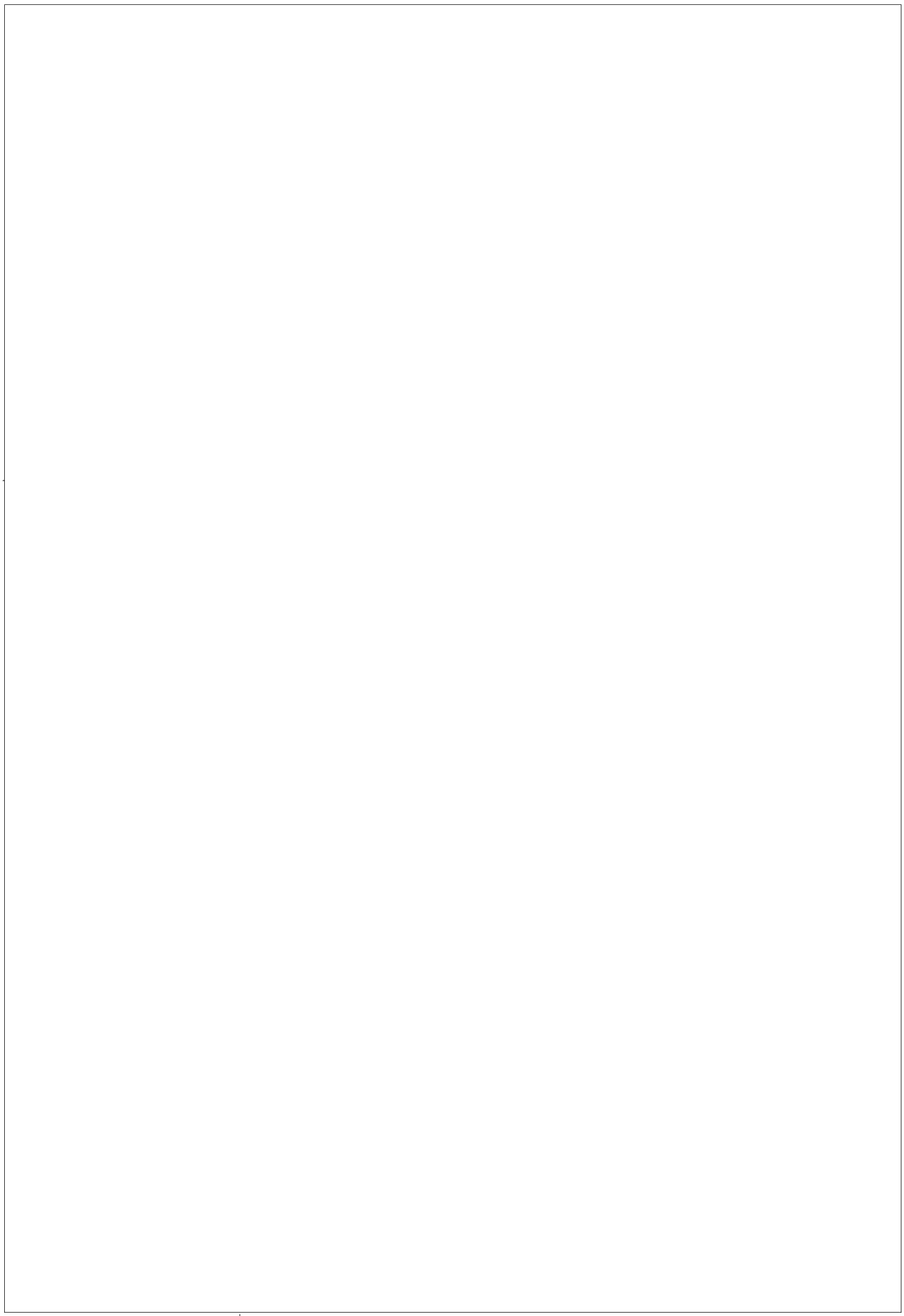

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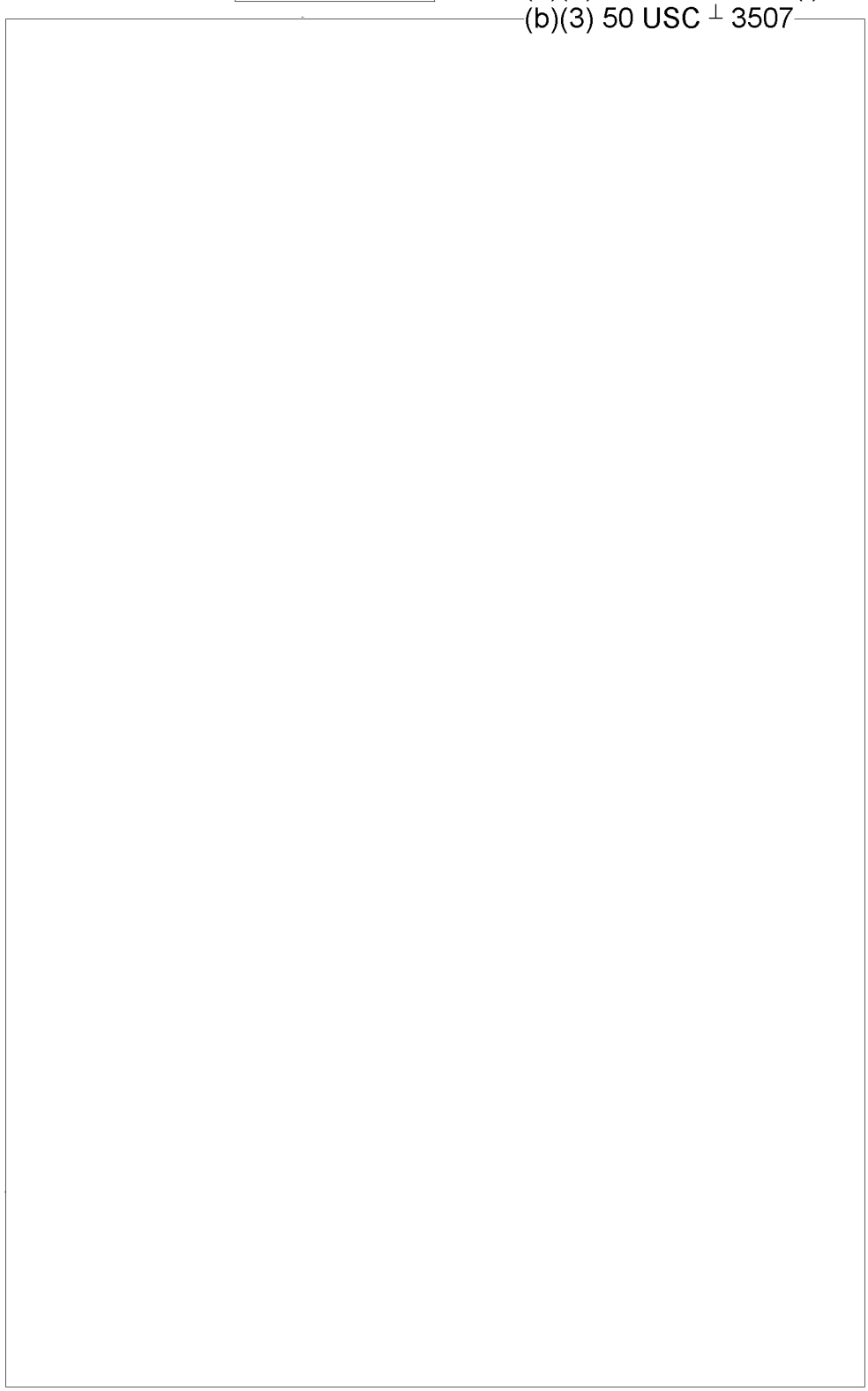

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(b)(3) 50 USC ⊥ 3024(i)
(b)(3) 50 USC ⊥ 3507

[redacted]

~~TOP SECRET~~

HANDLE VIA BYEMAN
CONTROL SYSTEM ONLY

Approved for Release: 2017/03/22 C05100296