[redacted] CORONA

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6 DEC 1967

MEMORANDUM FOR: Director, National Reconnaissance Office

SUBJECT : Program for Study and Development of Systems for Denoting Atmospherically Obscured Photographed Areas

REFERENCES : a. [redacted] dated 31 January 1967
b. [redacted] dated 28 March 1967

1. In previous budget submissions to the NRO, such as reference a, the development of a cloud cover planimeter was proposed. Support was withheld pending verification, as was stated in reference b, of the utility of such a device to operational programs or exploitation agencies. Subsequently, this utility has been the subject of extensive consultations by our staff with NPIC, the AMS, members of the NRO Satellite Operations Center and with [redacted] of the NRO Staff. It is apparent that a strong need now exists for a simple feedback information loop which rapidly specifies the ground areas which have been successfully photographed through the atmosphere.

2. Specification of these areas for [redacted] with the procedure now used on CORONA would be extremely burdensome and time consuming, if possible at all. Not only would the results of the first quarter of a mission have no reprogramming impact on the final quarter of the same mission, but--as estimated in the attachment--the coverage evaluation of one mission would probably not be completed in time to be used in planning the next mission.

3. In recognition of these problems, the practicability and desired characteristics of suitable fully and partially mechanized evaluation systems have been examined. This has led to the definition of two programs which are described in some detail in the attachment. If the products

SUBJECT: Program for Study and Development of Systems for Denoting Atmospherically Obscured Photographed Areas

of these programs were applied to CORONA and [redacted], the film delivered in the first RV could hopefully be assessed in time to influence the reprogramming of some of the film to be delivered in the following RV in the same mission. Both programs will begin with a study and design definition phase with experimental support. The total cost of these initial phases will be [redacted] Of this amount [redacted] will be for two parallel [redacted] studies of a fully mechanized system; the balance of [redacted] will be used to support the study of a partially mechanized version.

4. It is recommended that this approach be approved and that a program approval for [redacted] be so granted. The first phase of these programs would be completed within nine to twelve months from the date of assignment of funds. Based on the results of this study phase, a final equipment development plan will be submitted for your consideration.

[redacted]
Director
CIA Reconnaissance Programs

Attachment: a/s

Distribution:
Cy [redacted]

101 (1 December 1967)

Attachment to:
[redacted]

SUBJECT: Timely Determination of which Ground Areas Photographed during a Satellite Mission were Obscured by Atmosphere Components

1. Summary

Procedures and devices currently used in the CORONA program to determine which photographed ground areas were obscured by atmospheric components, including clouds, would be inadequate for the [redacted] program.

Specification of these areas for CORONA is essentially a manual process which is completed for one mission in time to influence the programming of the next. It is not done so rapidly that the evaluation results for the first half of a particular mission can affect reprogramming of part of the second half of the same mission. However, if these same and only existing procedures were applied to [redacted] not only would the results of the first quarter of a mission have no programming impact on the final quarter of the same mission, but also the coverage evaluation of one mission would probably not be completed in time to be used in planning the next mission.

Differences in the quantity and type of photography evaluated account for the wide discrepancies between these two programs. For CORONA, 1,000 feet of essentially fixed scale terrain index photography covers what is recorded on 8,000 feet of variable scale panoramic photography and the former is examined to determine what was obscured in the latter. Terrain index photography having coverage compatible with the panoramic will not be produced in a [redacted] mission. Thus, 25,000 feet of panoramic photography having greater scale variability than CORONA must be directly evaluated for each [redacted] re-entry vehicle load.

The practicability and desired characteristics of new systems that would be suitable for [redacted] have been examined. This has led to the definition of two programs which are described in greater detail in the following sections.

One program has as an ultimate goal the development of a high speed, fully mechanized device that scans processed film at rates approximately comparable to film development speed (20fpm) and specifies in digital format which photographed ground areas were obscured by atmospheric components. This device is called SP-GOBAC System I. This program has two phases, the first being a study effort with experimental support to develop working concepts and prove design in tests against single frames of CORONA photography. Phase II would be for the development of a final higher speed model suitable for employment with CORONA and [redacted] original negatives and usable at the processing site. Because of the diversity of approaches proposed and the range of experience of candidate contractors, it is proposed that two parallel efforts be conducted to accomplish Phase I for System I. The cost for each effort has been estimated at [redacted] or a total of [redacted] for Phase I.

The second program involves the use of a human operator to indicate obscured areas as seen on the film, and mechanical devices to read out the location of these areas. This version is called SP-GOBAC System II. This program also has two phases: Phase I in which a brassboard model is built for demonstration against sample frames of CORONA photography, and Phase II for development of a final model capable of processing film as fast as a human operator can make suitable indications. A single contract of [redacted] is proposed for accomplishment of Phase I.

Phase I for both programs would be completed within nine to twelve months of assignment of funds and would cost a total of [redacted]

2. Current Procedures

Only manual methods now exist for determining from satellite photography of the ground which surface areas were obscured by atmospheric components. The current procedure is divided into three steps:

a. each frame is examined and the obscured portions are noted;

b. the true geographical position of these portions are outlined on a map (thus far panoramic frames have not been used for this purpose and hence complicated rectification processes have not been required); and,

c. these outline contours are traced by a human operator guiding a plotting machine which reads out plotting points in digital format.

For the CORONA program, the Army Map Service performs steps (a) and (b), adding mapping and charting requirements to the maps. The OSP performs step (c) and sends the results to the SOC.

3. The Effect of Current Procedures on the Time Required to Provide the SOC with a List of which Photographed Areas were Obscured by Atmospheric Components Including Clouds

Table I shows the major functions performed and times involved in evaluating coverage achieved in a CORONA mission. Table II indicates the effect of applying the same procedures to a [redacted] mission.

4. The Effect of Mechanizing the Process of Specifying Obscured Areas

Various approaches to reducing the coverage evaluation and reporting time have been studied and two have been selected as the most promising. One such is to mechanize the equivalent of all three steps

listed in section two. This is called SP-GOBAC System I. The acronym is formed from "Specification of Photographed Ground Areas that were Obscured by Atmospheric Components." The alternative involves the use of a human operator to perform step (a) and the use of a mechanical device to perform the equivalent of steps (b) and (c); this is called SP-GOBAC System II. Neither of these devices will perform the equivalent of step (b) completely as they will output area locations in frame grid elements or frame coordinates and frame identification number. A computer program will be utilized to make the conversion of these parameters to true geographical coordinates.

The effects of applying SP-GOBAC Systems I and II to CORONA and [redacted] are shown in Table III. The rate at which System I would evaluate film is assumed to be equal to the developing and printing rate. The time to process a supply of film by System II is taken to be 16 hours for a CORONA RV load and 17 days for a [redacted] RV load (see Table II).

Comparison of Table I to Table III shows that if either System I or II were used on CORONA the SOC would be informed of coverage achieved by RV-1 photography while RV-2 was still in operation. Without either system, SOC would not receive this information until RV-2 would be due for recovery except for the [redacted] first look messages. With these systems the launch schedule of CORONA missions could be compressed markedly while still providing the SOC with sufficiently timely coverage evaluation information.

The very significant impact Systems I or II would have on [redacted] is appreciated by comparing Tables II and III. With the support of these systems the SOC would be able to utilize the capability to reprogram the coverage assignments of the balance of an on-going mission. In fact using System I the information acquired from one RV can be used to reprogram use of some of the film to be delivered in the following RV.

Without the support of either of these systems the coverage information recorded on the film recovered during one mission probably could not impact the programming of the following [redacted] mission.

5. A Program for Developing SP-GOBAC System I

The Office of Special Projects has been studying techniques and systems for automated assessment of coverage by [redacted] panoramic photography. Representatives of NPIC, NRO and appropriately cleared individuals in industry with broad experience in the field have been consulted. It has been concluded that there is a need first to examine a variety of approaches, analytically and experimentally, in order to identify the most suitable system to accomplish the task, before embarking on the construction of comprehensive operating hardware.

It is suggested that such studies have the following objectives:

a. Search for, propose and analytically and experimentally test against samples of real photography, various concepts or principles of operation for a device that scans frames of low-altitude satellite photography of surface areas ranging from 10 miles by approximately 80 miles to 10 miles by approximately 325 miles and specifies, in grid elements or in a frame coordinate system, the portions of the frame that do not show the surface because of obscuration by intervening atmospheric components, including clouds.

b. Compare these concepts and evaluate in terms of film reading speed, technological feasibility, certainty of meeting performance requirements, development cost and other criteria deemed significant by the contractor.

c. Select from these concepts the combination offering the greatest promise for the final system. Write the detailed optical, mechanical and electronic specifications for a system which would be able to scan film at speeds comparable to the film processing speed.

It is expected that contractors working on these studies would take a variety of approaches in the context of the following.

a. The search for concepts of operation should include, unless experience contraindicates, various tests for correlation between surface obscuration and brightness profiles or between descriptors such as general brightness signatures of the surface and clouds versus position. The exploitation of the information acquired by stereo photographs may also be considered toward the end of distinguishing between surface and airborne objects. Pattern descriptors may also be systematically examined as well as various pattern recognition schemes. Combinations of techniques may also be tried and found necessary. Edge analysis techniques, although a class of brightness profile exploitation, are sufficiently developed to warrant separate mention and consideration.

Shadow analysis schemes might also be considered. The geometry of shadows (or their absence) from high altitude entities such as well defined clouds may be quite distinct from even tall or large surface features. (Unfortunately, color or multi-wavelength photography is not used precluding any spectrally based schemes.)

b. The contractors would be expected to analytically and experimentally test against samples of real panoramic photography these concepts singly and in whatever combinations are attractive. The results of such testing would be statements about the feasibility of ultimately accomplishing the basic objective.

c. The contractor would then be expected to make preliminary designs of the model systems found to be most promising by the sponsor as a result of step (b).

d. From these preliminary designs detailed optical, mechanical and electronic specifications for a final high speed system would be developed.

6. A Program for Developing SP-GOBAC System II

Studies by OSP and consultations with industry have also led to the recognition of a need for a separate development program involving an alternate lesser level of complexity. This modification in approach would be based on the assumption that a human operator would physically or otherwise indicate the portions of the print displaying areas obscured by atmospheric conditions. This program also has two phases: Phase I in which a brassboard model is built for demonstration against sample frames of CORONA photography and Phase II development of a final model capable of processing film as fast as a human operator can make suitable indications. This device would read out the obscured areas in frame coordinates or grid cells in digital form on a paper or magnetic tape.

The outputs of both the automatic and partially automated systems would be made compatible with CORONA and [redacted] coverage assignment and mission control software to insure optimum utilization. On completion of Phase I of either or both programs a separate study would be initiated to develop the software for conversion of frame coordinates or grid elements to true earth coordinates.

7. Implementation of the Program for SP-GOBAC System I

The development of SP-GOBAC System I appears to be best accomplished in two phases. Phase I would be a study program with experimental support in which steps (a), (b) and (c) of section 5 would be accomplished. The overall goal of Phase I would be the selection of the best combination of evaluation descriptors and the demonstration of success in evaluating single frames of sample photography such as that produced by CORONA.

Because of the diversity of proposed approaches and the wide range of experience among potential contractors, two parallel efforts

are contemplated. The cost of each is estimated at [redacted] The total cost of Phase I would, therefore, be [redacted]

Phase II would be the development of a final working system capable of handling film at a speed comparable to the speed of film development.

8. Implementation of the Program for SP-GOBAC System II

Since existing technology should be directly applicable, only one contracted study demonstration effort is planned for accomplishment of Phase I. The cost for this is estimated to be [redacted] As for System I, the cost of the final development phase will be determined in the course of completing the Phase I.

9. Implementation Time

In recognition of the development and operational schedules for [redacted] and the potential value of a rapid area coverage evaluation capability to other programs including CORONA, it is recommended that the subject studies be initiated at an early date. It is estimated that Phase I of both programs would be completed in nine to twelve months from the date of assignment of funds. The last month would be set aside for demonstrations and report writing.

[redacted] CORONA

Attachment to: [redacted]

# TABLE I CONDENSED MISSION PROFILE FOR CORONA

| Function | Time Required to Perform Function In Days | Mission Day, Since Launch, When Function Was Completed | |
|---|---|---|---|
| | | RV-1 | RV-2 |
| Launch $C_n$ | | 0 | |
| Recover RVs | | 7th day | 14 |
| Deliver Film | 0.5 | 7.5 | 14.5 |
| Process Film | 0.5 | 8 | 15 |
| NPIC Scan, [redacted] Report to SOC | 1 | 9 | 16 |
| AMS Receives Processed Film | | 9.5 | 16.5 |
| Using Terrain Index Photography, About 1000 feet per RV load, AMS Identifies *Maps Obscured Areas, Inserts Charting and Mapping Requirement | 2 | 11.5 | 18.5 |
| Tracing AMS Map, Output Digital Form to SOC | 3 | 14.5 | 21.5 |

*Notification not necessary in this use of terrain index photography

[redacted] CORONA

HANDLE VIA [redacted] CONTROL SYSTEM ONLY

Attachment to: [redacted]

TABLE II CONDENSED MISSION PROFILE FOR [redacted]

| Function | Time Required To Perform Function in Days | Mission Day, Since Launch, When Function Was Completed |
|---|---|---|
| [redacted] | | |

[redacted]CORONA

Attachment to:
[redacted]

TABLE III COMPARISON OF EVALUATION TIMES

| Function | Time Required to Perform Function - in Days | | | |
|---|---|---|---|---|
| | Current Procedures CORONA | [redacted] | SP-GOBAC System I | SP-GOBAC System II |
| Delivery of Processed Film to AMS | 2 | [redacted] | | |
| AMS Identify, Map Obscured Areas | 2 | [redacted] | Operates at Rate that Film is Developed and Printed | 1 (CORONA 17 [redacted] |
| [illegible] AMS [illegible] Output Digital [illegible] Send to SOC | 3 | [redacted] | | |

[redacted]CORONA

HANDLE VIA [redacted]
CONTROL SYSTEM ONLY