RA-R-13-16

HANDLE VIA
BYEMAN
CONTROL SYSTEM

~~TOP SECRET~~

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

14 00078034D

THE NRO STAFF

28 March 1968

MEMORANDUM FOR COLONEL WORTHMAN

SUBJECT: Resolution of DoD SACC members' comments on Volumes 6 and 8 of the NASA 1967 summer studies

The DoD SACC members' comments on the referenced volumes are at TAB A.

The only comment on Vol 6 addressed by Mr. Myron Kreuger and the undersigned is the comment concerning page 13. TAB B contains the proposed rephrased wording for this paragraph which we feel will overcome the earlier objections.

TAB C contains the modified paragraph to overcome the objection to Vol 8.

I feel that the above changes will release Vol 8; however, Vol 6 is still objectionable from the standpoint of comments 1 and 3 on Vol 6 and comment B.2. of the general comments.

William E. Williamson
Lt/Col, USA

Attachments

HANDLE VIA
BYEMAN
CONTROL SYSTEM

~~TOP SECRET~~
EXCLUDED FROM AUTOMATIC REGRADING
DOD DIRECTIVE 5200.10 DOES NOT APPLY

CONTROL NO________
COPY_____OF_____COPIES
PAGE_____OF_____PAGES

[redacted] (b)(1) (b)(3)

improvements in ship routing, is an undeveloped assertive concept. (If this "benefit" were truly achievable, it would properly be credited to meteorology, rather than oceanography).

The Panel's recommendation that a comprehensive research program precede any satellite hardware activity is commendable (see Section 6.1).

4. Forestry, Agriculture, and Geography (Volume #5)

This panel report is not compatible with the security guidelines established in the SACC charter. Specifically, the satellite sensor described in Section 3.5.2 assumes a ground resolution of 50 feet. Section 3.4.2 proposes a sensor which equates to a 12-inch camera in a 100-125 n.m. orbit, exceeding the restrictions imposed on NASA earth-sensors. [redacted] (b)(1) (b)(3)

Other comments are as follows:

a. On page 1, line 7. The word "reconnaissance" is valid, but unnecessarily provocative.

b. On page 3-10, the implication that satellite costs are much less than those of aircraft is assertive and erroneous.

c. On page 3-7, 3-8, and in Appendix B, the proposed use of active radar as a sensor creates unnecessary serious problems for our government, as mentioned above.

The inverse cost-savings relationship proposed by this Panel deserves attention. Should the United States spend $70 million per year (after an initial outlay of $124 million) in order to save $40 million?

WORKING PAPERS

5. Geology (Volume #6)

The sensor definition in this panel report is too vague for positive assessment in terms of SACC security guidelines. However, the 1:800,000 scale to be achieved from 100 n.m. altitude, as specified on page 11, calls for a 12-inch focal length. Since the resolution of color film is about one-half that of black-and-white, the lens system implicit in this camera is probably in violation of SACC security guidelines. Achieving the same scale with a 6-inch lens (see 2.i.i) will require a two times enlargement. Here, again, the use of color film will drive the camera design beyond the security limits.

On page 13, reference is made to "existing sensor hardware, a developed satellite." This statement, coupled with a characteristic of 9" x 9" format, is a clear reference to a BYEMAN classified system and must be deleted.

The estimated benefits of $2 billion, over a 40-year period "in terms of royalties" for gas, oil, and minerals, is a possible benefit to landowners, but hardly a benefit to the federal government, which is actually being asked to spend $42.5 million dollars for no foreseeable direct return.

6. Geodesy and Cartography (Volume 7)

This panel report has been reviewed separately in BYE 12634-68, which is attached to these comments.

7. Sensors and Data Systems (Volume 8)

This panel report is compatible with the security guidelines established in the SACC charter, with one exception: the first paragraph on page B-23 essentially describes a BYEMAN-classified system and must be deleted.

8. General Comments

This paper concludes the review of the reports generated by NASA's Summer Study at Woods Hole in the summer of 1967. Several additional comments of a general nature are offered in a constructive spirit.

a. The Summer Study Report is over-generalized. The report addresses very few specifics, it is essentially an assortment of

WORKING PAPERS

general indorsements for an earth-sensor program. The report represents very little progress, if any, over the situation in February 1967, when a Panel of the President's Science Advisory Committee stated that NASA had "not yet presented a convincing case that such survey programs can best be carried out by satellites."

b. The report does not achieve its goals. The Summer Study was chartered by NASA to make a search inquiry into three areas:

(1) "The feasibility and practicality of using space systems for meeting existing and foreseen needs on the Earth." The Study Committee did not do this. Rather, it appears to have been dazzled by the rapid advances of space technology; its ultimate reaction is expressed in a description of space technology as "such a great adventure." Charged with looking at feasibility and practicality, the Committee appears to have taken the easy road, judging all things feasible and, as indicated in the next paragraph, barely touching on practicality.

(2) "The economic tradeoffs of providing such needs with space systems, or of not providing them at all." Economic tradeoffs between different systems -- the "practicality" aspect -- were not addressed. Conventional earth-sensing techniques, like aircraft-borne sensors, do not appear in the body of any of the reports. The estimates of "cost" and "benefit" appears to have been done by two separate teams which never saw each other's work. How else could one explain the inverse cost-savings relationships in the Hydrology, Forestry, Geology, and Cartography panel reports?

(3) "The direction and priority of existing, planned and recommended U.S. research, development and operational activities in the field." This very complex assignment was handled summarily by the Committee: it simply recommended a doubled budget for NASA.

c. The report ignores the formidable international policy problems associated with earth-sensing. A tacit reference is made to "certain delicate and complicated international problems." Elsewhere the following statement appears, "Although technically it would not be necessary, politically the full cooperation of developing countries to be mapped should be sought." The scientists participating in the Summer Study deserved the facts -- which could have been given to them in unclassified form -- concerning the risks and difficulties inherent in carrying out announced observational overflights of denied territories.

WORKING PAPERS

more information than just topography resides in the imagery.

(4) Time Scale for GEROS I

Since the proposed system will use existing SENSORS DERIVED FROM AIRCRAFT PROGRAM [redacted] EXISTING SPACECRAFT TECHNOLOGY [redacted], existing aircraft and existing methods for interpretation of the data, the following represent the only constraints on completion of the initial program:

	Time Required (Years)
Aircraft-radar coverage (2 aircraft)	2.2
Satellite construction, launch and recovery of date	2.0
Data indexing and distribution	0.8

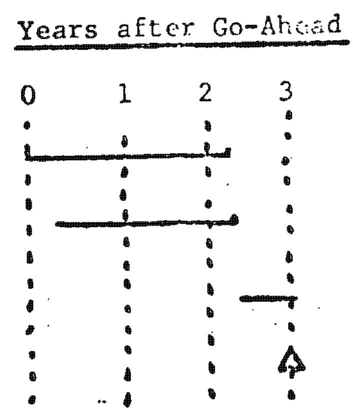
The schedule is as follows:

Aircraft radar coverage

Satellite construction, launch and recovery

Data indexing and distribution

Release date



Vol 8

One important aspect of traditional data-handling is dissemination. If copies of color IR photographs are to be handed out, very good duplication techniques will be required to minimize the inevitable tonal and resolution losses. This may be an argument for a facsimile type of reproduction, putting the data of the original picture on tape, at least for some areas, as soon as it is available. Since it is to be expected that the photographic data retrieved by satellite cameras will be useful to many different disciplines, there is scope for research to find the most efficient duplication and dissemination methods.

4.5 Weight and Volume vs Performance

The areas of film required is obviously proportional to the area of ground to be covered. As expressed by Katz:

$$\text{Film area } (\text{ft}^2) = \frac{2.8 \times 10^7 \text{ Ground area } (\text{mi.}^2)}{S^2}$$

where S is the scale number.

$$\text{Film area } (\text{ft}^2) = \frac{300 \text{ Ground area } (\text{mi.}^2)}{R^2 G^2}$$

where R is resolution in lines per mm. on the film and G is ground resolution required.

For the low resolutions specified for most Earth Resources applications the area of film required is very small. Thus for one million square miles at a ground resolution of 100 feet and a film resolution of 30 lines per mm. (6" lens at 100 miles) the required area of film is 30 square feet - say 200 feet of 70 mm. film. The weight would be less than two pounds, even for thick base IR color film. The corresponding camera would occupy 2-4 cubic feet with mounting of controls and would weight around 300 pounds. Film ejection devices would add weight and bulk, but this need not be excessive. Power requirement would be about 100 watts, intermittent.

The area and volume of both film and camera increase rapidly with resolution. ~~Though not of direct interest to the Earth Resources program, the figures for a ten-foot ground-resolution system covering one million square miles provide a useful illustration.~~

One conceivable system would use about 20 pounds of film per million square miles and this ~~a 24" lens at 80 lines/mm. This would require about 70 square feet of film per million square miles, say 3000 feet of 70-mm. or 1500 feet of 5" film. This film weight would be about 20 pounds.~~ ~~This~~ camera would occupy about ten cubic feet and weight on the order of 200 pounds. ~~Total information stored would be on the order of 10^{12} bits, say 10^{10} bits per pound of apparatus, or 10^{11} bits per pound of film.~~

4.6 Dynamic Range

Photography's dynamic range is conventionally specified in terms of the H and D curve, density versus log exposure. While this refers to the negative, it is implicit that anything recorded on a negative can be reproduced on a positive transparency. In principle it is also possible to obtain satisfactory positive prints on paper, because the luminance range of a good bromide or chloride paper (say 5 to 1) is much greater than the typical luminance range (say 6 to 1) of a view seen through the whole atmosphere in the clearest air. However, the common practice of working to a gamma of 2 or more, and the complications of the non-linearities of negative and positive emulsions, result in paper prints which are less linear than transparencies.

The straight-line part of the H and D curve in aerial films covers a log luminance range of 1.0 (10 to 1 range). In practice, exposure cannot be controlled with sufficient accuracy to locate the image invariably on the straight line. Moreover, the premium on exposure tends to push the densities down to the toe more often than not. This is even beneficial, since a gamma of 2.0 is too high for vertical photography on clear days. The working dynamic range is thus greater than 10 to 1, say 32 to 1 in practice.

So far, we have considered the range on large film areas, i.e., large relative to the resolving power. Obviously, at the resolution limit there is no dynamic range, and for intermediate sizes it must fall off more or less