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USIB-D-41. 14/295
(COMOR-D-13/65)
11 July 1966
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UNITED STATES INTELLIGENCE BOARD

MEMORANDUM FOR THE UNITED STATES INTELLIGENCE BOARD

SUBJECT : Mapping, Charting and Geodesy Requirements
for Image Forming Satellites

REFERENCE : USIB-D-41. 14/229 (COMOR-D-13/43)
19 March 1965, and Memorandum for Holders,
15 April 1965, Limited Distribution

1. The attached memorandum on the subject from the Chairman, Committee on Overhead Reconnaissance (COMOR), is circulated for United States Intelligence Board (USIB) consideration of the Recommendations in paragraph 11. thereof.
2. The attached statement of requirements is designed to update and expand upon the previously approved statements on the subject in paragraphs 8 through 11 of the Enclosure to the reference document.
3. The Attachment is scheduled on the agenda for the Board meeting on Thursday, 14 July 1966.

James S. Lay, Jr.
JAMES S. LAY, JR.
Executive Secretary

Attachment

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MEMORANDUM FOR: United States Intelligence Board

SUBJECT: Mapping, Charting, and Geodesy Requirements
for Image Forming Satellites

Introduction

1. Mapping, charting, and geodesy disciplines are currently being revolutionized as a result of:

- a. Increasing U.S. Needs for mapping, charting, and geodetic information in support of both existing and new weapons systems and other changing national requirements.
- b. The receipt of large quantities of data from the DAFF, KH-4, and KH-7 satellite programs that can be applied against these increasing requirements.
- c. The potential for achieving a significantly improved world-wide geodetic control system by use of overt geodetic satellite programs in combination with the material produced by covert programs.
- d. Technological advances which achieved expanded production capability in the use of data derived from satellite programs.
- e. Substantially complete coverage of the Sino-Soviet bloc and approximately 9.4 million square miles outside this area that has been obtained by present panoramic satellite collection programs. (Although this coverage is very useful in the production of maps and charts, it does not meet all mapping and charting accuracy requirements).

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Requirements

2. Against this background of both extensive and changing needs and the fact that we have acquired and expect to acquire large volumes of data useful in meeting many of our anticipated requirements, it is necessary to set forth a new statement of current and future requirements for mapping, charting, and geodesy to be fulfilled by covert satellite collection systems. These requirements which relate directly to U. S. needs insofar as they can be predicted through 1972 fall into two classes as follows:

a. Global Geodetic Requirements. Long range missile systems that will be added to our inventory require that targets be accurately positioned world-wide to 450 feet on the horizontal with 90 per cent assurance relative to the World Geodetic System. In the Sino-Soviet bloc this must be accomplished by 1970. Furthermore, since these missiles will employ low-angle re-entry warheads, target elevations throughout the Sino-Soviet bloc must be accurate to 300 feet with 90 per cent assurance, again relative to the World Geodetic System. It is currently estimated that data derived from DAFF materials, which cover 44 million square miles of the 56 million required, when integrated with existing geodetic measurements will provide geodetic accuracy to within 750 feet by 1968. It is further estimated that by 1970, refined horizontal accuracies of 450 feet and vertical accuracies of 300 feet will probably be achieved but cannot be assured. These accuracies will accrue through mathematical refinement combining the covert DAFF products with applicable data from overt U. S. geodetic satellite programs, with the world primary triangulation network and the five year gravity plan, plus necessary filling in of gaps in DAFF coverage by bridging photography from existing covert systems (such as the freewheeling stellar index camera presently incorporated in the KH-7 system which yields a product

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similar to DAFF). Thus we expect that our geodetic requirements relative to the World Geodetic System will probably be satisfied without further development of covert satellite systems specifically for geodetic purposes. It may be possible, however, when conducting research and development leading to new covert photography systems, to achieve further improvement of geodetic accuracies. Consideration of these improvements should be encouraged in that they may permit savings in other geodetic and geophysical programs.

b. Mapping and Charting Requirements.

Horizontal and vertical control accuracies with 90 per cent assurance for maps and charts at various scales are set forth below:

	<u>Local Horizontal Accuracy</u>	<u>Vertical Accuracy (Including Datum Degradation)</u>
Large Scale Topo Maps at 1:50,000	85 ft over a distance of 25 statute miles.	16-33 ft over 10-20 statute miles.*
Medium Scale Maps at 1:250,000	415 ft over a distance of 125 miles	82 ft over 20 miles.*
Medium Scale Charts at 1:200,000	333 ft over a distance of 100 miles	50-75 ft over 20-30 miles.*
Significant Features		20-50 ft over 10 miles

* These are contour accuracies indicating that 90 per cent of the points on a contour must fall within the accuracies indicated.

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Within a region extending 500 miles in any direction, a photogrammetric control network is required to permit the orderly production of maps and charts to the accuracy requirements set forth above. The error limits for such a control network are:

(1) The relative error of horizontal control points will not exceed 40 feet over distances up to 20 miles and 400 feet over distance up to 500 miles within the region.

(2) The relative error of vertical control points will not exceed 10-20 feet over distances up to 20 miles nor exceed 80 feet over distances up to 100 miles.

Justification for Accuracies and the Degree to Which
Present Collection Systems are Meeting Requirements

3. The accuracies stated for large scale topographic maps are required in order to achieve at least minimum acceptable (30 per cent kill) first round effectiveness for tube artillery. Present reconnaissance systems are not meeting either the horizontal or vertical accuracy criteria.

4. The accuracy requirements for medium scale maps are based on their use as a substitute for large scale topographic maps. Although medium scale maps are employed in many different ways, none of their uses is as demanding in accuracy as the part they play as substitutes for large scale maps. The increased accuracy for medium scale aeronautical charts as compared with topographic maps, is needed to prepare radar predictions for all-weather, low level penetration of tactical and strategic aircraft. Present covert satellite reconnaissance is meeting the medium scale horizontal accuracy but not providing sufficient contour accuracy.

5. Requirements for accuracies of photogrammetric control points relative to regional and local control have been established in order to permit the orderly production of contiguous maps and charts to the accuracies stated above. Present systems are meeting the horizontal accuracy requirement, for medium scale, but not large scale maps and charts.

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Photographic Resolution and Accuracy of Significant Features

6. In addition to the requirements for horizontal and vertical accuracies listed above, map and chart production also requires that certain details, especially those relating to the height and shape of significant features, be portrayed accurately. Furthermore, it has been determined that a ground resolution of five feet is sufficient for these details. Neither the requirements for vertical accuracy nor for five-foot resolution are being met.

Timeliness of Photographic Collection

7. Since map and chart production is a time-consuming process, it is essential that an adequate data bank of photographic coverage and regional and local photogrammetric positioning information be obtained well in advance of military contingencies that may arise anywhere in the world and could require the production of medium and large scale maps and charts on an emergency basis. These emergencies may require a capability to collect photography on short notice and/or a capability to acquire non-photographic imagery under all-weather conditions.

8. We are presently employing both the KH-4 and KH-7 to acquire photography for the data bank and we expect this program to continue by including better quality photography as improvements are made in collection systems. In addition to performing their primary mission of obtaining search and surveillance photography over denied areas, advanced reconnaissance systems should provide the capability to obtain world-wide mapping and charting photography including approximately 7-10 million square miles a year of areas outside the Sino-Soviet bloc.

New Systems Design

9. Opportunities to enhance efficiencies and ease in using data from satellite reconnaissance systems for mapping have been discussed with NRO representatives. Horizontal accuracies required for medium scale maps and charts and for relative point position for local map control at these scales are being met by present satellite

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systems. The NRO has advised that it believes that it is feasible to meet mapping and charting requirements with the NEW SEARCH system and that it intends to have the system designed to meet the vertical accuracy requirements for medium scale maps and charts and the vertical, horizontal, and photogrammetric control and position accuracies required for local map control on large scale maps. The design criteria for NEW SEARCH also provides the five-foot resolution required for certain details of significant features to be portrayed on both medium and large scale maps.

Conclusions

10. It is concluded that:

a. Global geodetic requirements will probably be satisfied by mathematical refinements accomplished by combining DAFF materials with the data from overt U.S. geodetic satellite programs plus bridging photography from covert systems.

b. Although some accuracy requirements for maps and charts are satisfied by present systems, the NEW SEARCH satellite system could be designed to satisfy all accuracy requirements stated above.

c. There are possible improvements requiring further study which, if added to existing systems or incorporated into advanced systems on a cost-effectiveness basis, may make map production more efficient and would provide easier methods for rapid satellite data reduction in the production of maps and charts.

Recommendations.

11. It is recommended that:

a. Technical characteristics of NEW SEARCH be designed to meet the requirements for medium and large scale maps and charts set forth above; however, if meeting these

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requirements is likely to result in significant adverse effects on intelligence collection, the problem should be brought to the attention of COMOR; NRO be requested to provide COMOR with information on those specific requirements that could be exceeded appreciably at negligible cost increase and on those specific requirements which, if reduced, would result in substantial program savings or in substantial improvements in other requirement areas.

b. NEW SEARCH have the capability to obtain world-wide mapping and charting photography including approximately 7-10 million square miles a year of areas outside the Sino-Soviet bloc.

c. Present efforts to obtain photographic material of non-denied areas for the mapping and charting data bank be continued with the present KH-4 and with the improved KH-4 when it becomes operational.

d. The NRO, in conjunction with COMOR, continue to study the problem of improving the cost-effectiveness of photographic satellite systems for the production of maps and charts and through consultation with the technical representatives of the COMOR Mapping, Charting, and Geodesy Working Group develop improvements, responsive to COMOR's recommendations, in systems designs that are compatible with the primary intelligence mission performed by covert satellite reconnaissance.

e. Even though the current world-wide geodetic requirement will probably be fulfilled by DoD combining the results of overt and programmed covert systems, the NRO should continue consideration of major

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advances in the application of satellites to the solution of world-wide geodetic problems and should inform COMOR of possible improvements in covert satellite systems when these might achieve greater accuracies or economies in the future conduct of world-wide geodetic programs.

~~W. A. Tidwell~~

William A. Tidwell
Chairman
Committee on Overhead Reconnaissance