PRO-A 62

~~TOP SECRET~~

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS UNITED STATES AIR FORCE
WASHINGTON, D.C.

10 JAN 1969

REPLY TO ATTN OF: AFNIN

SUBJECT: Proposed DoD Policy on the Development of Data Reduction Equipment For Use With KH-9 Materials

TO: SAFSS

1. Reference Enclosure 1, "Policy on the Development of Data Reduction Equipment For Use With KH-9 Materials", to DIA Memorandum for the Director, Defense Research and Engineering, Subject: Technical Development Plans for the Reduction of KH-9 (New Search) Materials, December 10, 1968 (Atch 1).

2. The proposed Policy, which purports to bear upon the development of data reduction equipment, has implications which reach far beyond this field. This Policy, if implemented, will deny to the Air Force the capability of using the panoramic photography of the KH-9 system covering areas which are not also covered by the frame photography, to meet operational needs. The Air Force now has the capability to use the panoramic photography of the KH-4 system for this purpose.

3. The operational considerations upon which the proposed Policy is based, and, specifically, the inference that world-wide coverage by the frame camera of the KH-9 system will be accomplished very early in the operational life of the system appear to be extremely optimistic, when viewed in the light of our success in accomplishing comparable KH-4 coverage for MC&G purposes.

4. Because of the grave implications to the operational effectiveness of the Air Force implicit in the proposed Policy, request your verification of the Operational Considerations contained in paragraph 2 of reference 1, and, particularly, your estimate of the time frame in which world-wide coverage by the frame camera of the KH-9 system may be expected to have been accomplished.

Jack E. Thomas

JACK E. THOMAS, Major General, USAF
Assistant Chief of Staff, Intelligence

1 Atch
DIA Memo to DDR&E,
10 Dec 68

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DEPARTMENT OF THE AIR FORCE
HEADQUARTERS UNITED STATES AIR FORCE
WASHINGTON, D.C.

REPLY TO ATTN OF: AFNIN

1 AUG 1969

SUBJECT: Proposed DoD Policy on the Development of Data Reduction Equipment For Use With KH-9 Materials

TO: SAFSS

1. References:

a. AFNIN letter, subject as above, 10 Jan 1969.

b. (S)NRO MEMORANDUM FOR MAJOR GENERAL JACK E. THOMAS, USAF, SUBJECT: Planned Operation of the KH-9 System, 27 January 1969.

c. ACIC document, "Extracts from USAF KH-9 Utilization Study", 23 May 1969 (Atch 1 hereto).

2. In reference 1a, AFNIN requested your estimate of the time frame in which world-wide coverage by the frame camera of the KH-9 system may be expected to have been accomplished.

3. In reference 1b, it was estimated that world-wide coverage by the frame camera, except for cloud covered areas, could be achieved in 4 to 6 missions, this to include closure at the equator, again ignoring cloud interference. When cloud distribution is considered, it was expected that 8 to 12 missions with the frame camera would be required for essentially world-wide coverage.

4. In reference 1c, ACIC estimates that 25 to 55 missions will be required to achieve essentially world-wide coverage, and provides extensive data to support the estimate.

5. To some extent, the validity of an Air Force requirement for the development of a 60° half-scan rectifier for KH-9 pan photography may depend upon the time period in which KH-9 frame coverage may be expected to be available. Consequently, and in view of the disparity between the estimates cited in par 3 and par 4 above, your comments upon the conclusions drawn in reference 1c are requested.

ROCKLY TRIANTAFELLU, Major General, USAF
Deputy Asst Chief of Staff, Intelligence

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DEFENSE INTELLIGENCE AGENCY
WASHINGTON, D.C. 20301

DEC 19 1968

MEMORANDUM FOR THE DIRECTOR, DEFENSE RESEARCH AND ENGINEERING

SUBJECT: Technical Development Plans for the Data Reduction of KH-9 (New Search) Materials

1. Reference is made to our memorandum U-5329/MC-5 to your office, dated 22 October 1968, subject: Technical Development Plans.

2. The subject TDPs have been evaluated by DIAMC. Enclosure 1 gives the overall DIAMC position on general exploitation of the KH-9 materials. This general position is related to proposed instrumentation by the Military Departments in Evaluation of the Army SDP (TDP) (enclosure 2) and Evaluation of the Air Force TDP (enclosure 3).

3. The operational assumptions on which the DIA position is based are stated in the background part of enclosure 1. Within these overriding assumptions the following recommendations are made relative to the proposed Army and Air Force funding:

a. The Air Force TDP be approved with the following exceptions:

(1) Disapprove the requested 60° half scan angle panoramic photography rectifier. In lieu thereof, the Army and Air Force should be directed to jointly develop a GAMMA type rectifier with a half scan angle capability of 25°. It is recommended that Air Force be designated as the lead agency in this joint development.

(2) Disapprove the proposed Precision Photographic Enlarger-Reductor. In lieu thereof, Army and Air Force should be directed to jointly develop a series of special purpose, single ratio, enlargers and reductors for each required scale change in the production process. It is recommended the Army be designated the lead agency in this joint development.

b. The Army SDP (TDP) be approved with the following exceptions:

(1) The 6.3 Phase II funding should be delayed pending the outcome of the 6.2 Phase II study effort and subsequent revisions of the TDP.

(2) The proposed rectifier, enlarger and reductor developments should involve joint Army-Air Force effort as stated in paragraph 3.a. above.

TCS-657959-68 USAF

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4. The above approvals are based on the current status of operational concepts and proposed instrumentation as reflected in the referenced Army and Air Force TDPs. Changes in concepts, technology or requirements may result in submission of revised TDPs for DIA/DDR&E review.

5. It is recommended that DDR&E approve the DoD policy on the Development of Data Reduction Equipment for Use With KH-9 Materials (enclosure 1) and provide the approved DoD policy statement to the Assistant Secretary of the Army (R&D) and the Assistant Secretary of the Air Force (R&D) with direction that it be followed in use of these materials. Further, that the cited TDPs (SDP) be approved insofar as they are in agreement with the DoD policy with the exception noted in paragraph 4, above.

6. DIAMC will continue to monitor the progress of the TDPs and coordinate the joint efforts between the Military Departments in order to establish a timely capability to exploit the materials from the KH-9 satellite collection system.

FOR THE DIRECTOR:

[redacted]
COLONEL, USAF
ASSIST DIR FOR MAPPING, CHARTING AND GEODESY

3 Enclosures a/s

cc: Army
Air Force

TCS-65750-83

DOD POLICY ON THE DEVELOPMENT OF DATA REDUCTION EQUIPMENT FOR USE WITH KH-9 MATERIALS

DEC 2 1968

1. Background

The KH-9 satellite collection system was scheduled to become fully operational in the third quarter of FY 71 and DIA is attempting to have this date held. The improved sensors of this system (a 12" frame camera and convergent 60" pan camera) will for the first time provide photographic materials which are capable of meeting DoD requirements for military maps and charts at all standard military scales. The selection of the KH-9 SI was predicated on its ability to accomplish large scale mapping. In order to prepare for the effective use of these materials, DIA requested that Army and Air Force submit Technical Development Plans for the development of new data reduction equipment. The TDPs indicate that equipment requirements are related directly to map and chart products and the production procedure used to arrive at the finished product. As new information on the KH-9 system becomes available and exploitation concepts evolve, the TDPs should be revised and resubmitted for DIA/DDR&E review.

2. Operational Considerations

This paper establishes DoD policy on the basic data reduction procedures anticipated to be utilized by the DoD production agencies in accomplishing the MC&G mission using KH-9 materials. The DoD policy is based on the following operational considerations:

a. The USIB approved worldwide MC&G requirement for simultaneous frame and pan coverage is 19-28 million square miles over a three-year period (NRO estimates 15 million square miles per year of gross coverage). Normally, for the MC&G mission, the pan swath will be 60° (30° on each side of nadir compared to 21° for each side of nadir for frame coverage). Coverage in persistent cloud cover areas may require wider or oblique pan swaths.

b. The normal mode of operation for the pan camera in the search portion of the mission, which is anticipated to comprise seventy-five percent of film usage, will be a swath of 90° centered on nadir. The outer 30° of the total 120° scan swath (15° portion on either side) will be used only in contingency intelligence situations where the high scan angle will be accepted due to the urgency of obtaining coverage.

c. On a 34-day mission, all the earth's surface (exclusive of clouded areas), above and below 20° latitude should be covered by the frame. If the mission is extended to 45 days, as planned, there should be very few gaps in frame coverage in the equatorial latitudes.

Enclosure 1

TCS-6870-68

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3. Stereo Compilation of Large Scale Products

a. The stereo compilation of large scale maps should be accomplished directly from frame materials with rectified pan photography used only for detail intensification. AMS and ACIC should normally employ this method for all large scale mapping.

b. Stereo compilation from unrectified pan materials or other procedures may be authorized by DIA if it is demonstrated that direct compilation from frame is inadequate.

4. Stereo Compilation of Medium and Small Scale Products

a. Medium and small scale stereo compilation will be accomplished directly from the frame material with medium scale detail intensification accomplished with rectified pan photography.

b. Adequate medium scale detail intensification will be achieved by rectification of pan material using existing techniques, procedures and equipments.*

5. Medium and Small Scale Photogrammetric Revision

a. Medium scale photogrammetric revision will be accomplished with pan photography utilizing present techniques, procedures and equipment.*

b. Small scale photogrammetric revision will be accomplished directly from frame material.

6. Orthopictomap and Pictomap Production

The production of orthopictomaps and pictomaps and similar products utilizing KH-9 materials requires further study.

*This does not provide a quick response production capability to rectify KH-9 pan photography beyond a 70° swath on those few occasions when such rectified photography may be required and concurrent frame and pan coverage is not available.

ARMY TDP (SDP)

Evaluation of the Army Technical Development Plan (TDP) on the Data Reduction System for KH-9 (New Search) Photography

A. Background

This evaluation contains the rationale used by DIAMC in the recommendations made to DDR&E concerning project funding. To perform the evaluation, each production operation is isolated by type and scale, and the various options are identified. Next, the options are discussed and the most feasible is selected as a basis for the recommendations made to DDR&E. Hardware implications of the recommended option are also presented.

B. Medium Scale Compilation (1:250,000)

OPTIONS

I. Army TDP - Stereo compilation with frame, planimetric detail intensification with rectified pan.

II. Total compilation with frame.

DISCUSSION

I. The frame photography characteristics have the inherent capability, when suitably exploited, to provide products meeting the stated medium scale requirements, but will not provide all planimetric detail content. The lacking content must be obtained from the panoramic materials.

II. The option is a marginal one at best, because frame material lacks the required ground resolution (15 ft.) for medium scale planimetric detail.

RECOMMENDATION

Option I be accepted with rectified pan materials being used only for medium scale planimetric detail.

HARDWARE IMPLICATION

A rectifier with 15-foot ground resolution output and a scan angle covering the frame swath (45°) will meet the medium scale compilation requirement. Reducing the KH-9 pan materials 2 1/2 times and then using the GAMMA for rectification will prove an adequate solution with only a 2 1/2 times precision reductor needed in new equipment.

C. Medium Scale Revision (1:250,000)

OPTIONS

I. Use full swath rectified panoramic photography.

II. Use frame photography only.

III. Use 70° swath of pan.

DISCUSSION

I. The use of full swath rectified pan photography for medium scale revision would require a rectifier with full swath capability and implies that the pan camera will be used in a full swath collection mode. SAFSS has indicated that 70 percent of the time the swath width will be limited to 90° centered at nadir.

II. Use of frame photography alone for medium scale revision is not practical since the resolution (35-40 ft.) is not adequate.

III. Use of the 70° swath of the pan for revision of medium scale maps will enable rectification to be done on the existing GAMMA rectifier after 2 1/2 times reduction with the retention of adequate ground resolution. The approach will, of course, save the rectifier development.

RECOMMENDATION

Option III be adopted as meeting all requirements in the most economical way.

HARDWARE IMPLICATION

The GAMMA rectifier on hand is adequate for rectification and a new, precision, high resolution 2 1/2 times reductor is needed. The conversion of the rectified material to compilation scale can be accomplished with a copy camera.

D. Large Scale Stereo Compilation (1:50,000 Scale Class "A" and 1:25,000 Class "B")

OPTIONS

I. Army TDP - Stereo compilation with frame material providing major planimetry and topography with planimetric detail densification using rectified pan material.

II., Stereo compilation with unrectified pan materials with control imposed from frame material through transfer of control points.

DISCUSSION

I. Analyses made on the KH-9 SI subsystem during the contract evaluation stage and the OSD Morrison Study clearly state that stereo compilation with frame materials alone will meet large scale mapping requirements with the exception of planimetric detail densification. This option is desirable because it eliminates the point transfer step and provides a larger area model size. (Even at 2X enlargement the scale factor alone provides a 6:1 advantage in model area.) However, it is recognized that even at the 2X enlargement proposed by Army there is little safety margin in meeting the vertical accuracy limitations with this approach. Hence, certain areas of low relief may require the Option II technique. The pan rectifier required needs only a 25° half scan angle to cover the frame swath and can tolerate a 2X degradation in ground resolution.

II. This method of stereo compilation with KH-4 materials has proved to be time consuming and costly. The point transfer operation and the small area of the pan model are factors which add to the cost. The higher resolution of the pan materials enables contouring at a closer interval than the frame.

RECOMMENDATION

That Option I be adopted as the standard large scale compilation method with a limited Option II capability for flat areas.

HARDWARE IMPLICATIONS

A rectifier with a half scan angle capability of 25° with allowable ground resolution degradation of 2X is required. With these limitations imposed on the rectifier parameters Army and Air Force should be able to agree on a joint specification and a GAMMA type rectifier should be adequate. Precision 1.5X and 2X enlargers are required to provide pan material and frame material respectively for stereo compilation: A 1:1 projection printer is required to provide M-4 plates for stereo compilation.

E. Large Scale Picto/Photomap Compilation (1:50,000 and 1:25,000)

OPTIONS

I. Preparation with frame material only.

II. Preparation from rectified pan material panelled to a best fit of available control.

DISCUSSION

I. This would be a quick response product, made by reducing or enlarging the photography to the desired scale, panelled to control and photographically processed to produce the pictomap effect. However, the frame photography resolution (35-40 ft.) will not be sufficient for the large scale application.

II. Use of the rectified pan photography will easily meet large scale resolution requirements; however, current security restrictions require the product to be retained under codeword control. Since maintaining geom[illegible] is not a requirement, the pan material may be broken into two [illegible]ore segments for rectification.

RECOMMENDATION

Option II be adopted to meet large scale quick response picto/photomap resolution requirements.

HARDWARE IMPLICATIONS

The GAMMA type rectifier recommended for processing for large scale compilation will easily meet resolution requirements for large scale picto/photomaps. Permitting the pan photography to be segmented will allow the recommended half scan angle capability of 25° to meet requirements.

F. Large Scale Orthophotomaps (1:50,000 and 1:25,000)

OPTIONS

I. Preparation with rectified pan materials superimposed on frame material for control purposes.

II. Preparation with unrectified pan material painted on the frame material.

DISCUSSION

I. The resolution of the frame material (35-40 ft.) will not provide the required orthophoto resolution. Additional study should be conducted to relate the resolution of the orthophoto input material to the resolution of the final printed orthophoto. At the present time, use of the instrumentation to produce compilation materials as well as orthophotos somewhat determines the basic orthophoto procedure. Similar rationale on the swath width also applies.

II. This approach is feasible if enough data on the pan photography characteristics is determined so that the instrumentation can compensate for the deformations present. Additional study in this area and also on potential instrumentation appears warranted before this option could be selected.

RECOMMENDATION

Option I be adopted as currently compatible with recommended large scale stereo compilation procedures and instrumentation.

HARDWARE IMPLICATIONS

The same GAMMA type rectifier with a 25° half scan angle capability recommended for large scale stereo compilation use is required.

C. Enlarger/Reductor Equipment

OPTIONS

I. Develop a universal instrument capable of a wide range of enlargement and reduction and a variety of input and output format sizes.

II. Use special purpose, single ratio, enlargers or reductors for each required scale or equivalent focal length change in the production processes.

DISCUSSION

I. Efforts to date to produce a universal, precision enlarger/reductor have been expensive and unsuccessful. Considering the expense of the proposed development (550K), the result would be only one piece of equipment for all scale changes that could prove to be a production bottleneck requiring multiple copies of this expensive instrument to meet production needs.

II. The requirements identified for precision enlargement/reduction are:

a. 2 1/2 time reduction for input to the GAMMA rectifier.

b. 2 time enlargement of frame materials for large scale stereo compilation.

c. 1.5 enlargement of pan photography for large scale stereo compilation and orthophotography.

d. 1:1 printer to change equivalent focal length for M-4 compilation.

e. 5 time reducer for pan materials for point transfer to frame for Option I large scale mapping.

All other scale changes can be handled by copy cameras. By developing these special purpose instruments, the total cost of approximately 50-100K each will be less than Option I and will result in five pieces of equipment which provide flexibility in operation and which can be used concurrently.

RECOMMENDATION

Option II be adopted as meeting production requirements in a far more economical way.

HARDWARE IMPLICATIONS

The following special purpose, precision enlargers and reductors are required:

a. 2 1/2 time reducer.

b. 2 time enlarger.

c. 1 1/2 time enlarger.

d. 1:1 printer changing equivalent focal length.

e. 5 time reducer.

TCS-657959-68

2 DEC 1968

AIR FORCE TDP

Evaluation of the Air Force Technical Development Plan (TDP) on the Data Reduction System for KH-9 (New Search) Photography

A. Background

This evaluation contains the rationale used by DIAMC in the recommendations made to DDR&E concerning project funding. To perform the evaluation, each production operation is isolated by type and scale, and the various options are identified. Next, the options are discussed and the most feasible is selected as a basis for the recommendations made to DDR&E. Hardware implications of the recommended option are also presented.

B. Medium and Small Scale Compilation

OPTIONS

I. AF TDP - Stereo compilation with frame, planimetric detail intensification with rectified pan.

II. Total compilation with frame.

DISCUSSION

I. All stereo compilation can be done for medium and small scale products to include major planimetry and topography. The frame material lacks the required ground resolution (15 ft.) for planimetric detail, therefore rectified pan material covering the frame area is required for detail at medium scale. All small scale requirements are met by the frame.

II. Frame materials do not have adequate ground resolution for medium scale detail.

RECOMMENDATION

Option I be accepted with rectified pan materials being used only for medium scale planimetric detail.

HARDWARE IMPLICATIONS

A rectifier with 15-foot ground resolution output and a scan angle covering the frame swath (45°) will meet the medium scale requirement. Reducing the KH-9 pan materials 2 1/2 times and then using the GAMMA for rectification will prove an adequate solution with only a 2 1/2 times precision reducer needed in new equipment.

Enclosure 3

C. Medium and Small Scale Cartographic Revision

OPTIONS

I. AF TDP - Use full swath rectified panoramic photography.

II. Use frame photography.

III. Use center 70° portion of pan swath for medium scale revision and use frame for small scale revision.

DISCUSSION

I. The use of full swath rectified pan photography for medium and small scale revision would require a rectifier with full swath capability and implies that the pan camera will be used in a full swath collection mode. SAFSS has indicated that 70 percent of the time the swath width will be limited to 90° centered at nadir. The special purpose rectifier requested is considered a high-risk, high-cost development that is not commensurate with the limited improvement in the capability to exploit the pan photography.

II. Use of frame photography alone for medium and small scale revision is not practical since the resolution (35-40 ft.) is not adequate for medium scale revision.

III. The normal operation of the pan camera will be a 90° swath for the search mode, a 60° swath for concurrent frame coverage for HC&G, with the extreme outer 15° increment on either side being used only for coverage of high priority targets in contingency situations. Use of the center 70° portion of pan swath for revision of medium scale maps will enable rectification to be done on the existing GAMMA rectifier after 2 1/2 times reduction with the retention of adequate ground resolution. In the Sino-Soviet area it is anticipated that photography outside of the 70° portion will rarely be used due to the large amount of redundant coverage to be expected. This approach will, of course, negate the rectifier development. The frame material has adequate resolution for small scale revision and is also more economical since a frame photo covers four times more area than a full (120°) swath pan photo.

RECOMMENDATION

That Option III be adopted as meeting all requirements in the most economical way.

HARDWARE IMPLICATIONS

The GAMMA rectifier on hand is adequate for rectification and a new, precision, high resolution 2 1/2 times reductor is needed. The conversion of the rectified material to compilation scale can be accomplished with a copy camera.

D. Large Scale Stereo Compilation (1:50,000)

OPTIONS

I. Stereo compilation with unrectified pan materials with control imposed from frame material through transfer of control points.

II. Stereo compilation with frame material providing major planimetry and topography with planimetric detail densification using rectified pan material.

DISCUSSION

I. This method of stereo compilation currently employed for medium scale compilation with KH-4 materials has proved to be time consuming and costly. The higher resolution of the pan materials enables contouring at a closer interval than the frame. The point transfer operation and the small area of the pan model are factors which add to cost. Current practice in medium scale compilation at ACIC actually only extracts major planimetry and topography from the AS-11 and planimetry densification is done with rectified pan material.

II. Analyses made on the KH-9 SI subsystem during the contract evaluation stage and the OSD Morrison Study clearly state that stereo compilation with frame materials alone will meet large scale mapping requirements with the exception of planimetric detail densification. This method is desirable because it eliminates the point transfer step and provides a larger area model size. (Even at 2X enlargement the scale factor alone provides a 6:1 advantage in model area.) However, it is recognized that there is little safety margin in this approach and certain areas of low relief may require the Option I technique. The pan rectifier needs only a 25° half scan angle to cover the frame swath and can tolerate a 2X degradation in ground resolution.

RECOMMENDATION

It is recommended that Option II be adopted as the standard compilation method with a limited Option I capability for flat areas.

HARDWARE IMPLICATIONS

A rectifier with a half scan angle capability of 25° with allowable ground resolution degradation of 2X is required. With these limitations imposed on the rectifier parameters Army and Air Force should be able to agree on a joint specification and a GAMMA type rectifier should be adequate. All Air Force instrument modifications based on high scan angles are questionable. A precision 2X enlarger is required to provide input frame material for stereo compilation.

E. Enlarger/Reductor Equipment

OPTIONS

I. AF TDP - Develop a universal instrument capable of a wide range of enlargement and reduction and a variety of input and output format sizes.

II. Use special purpose, single ratio, enlargers or reductors for each required scale change in the production processes.

DISCUSSION

I. Efforts to date to produce a universal, precision enlarger/reductor have been expensive and unsuccessful. Considering the expense of the proposed development (550K), the result would be only one piece of equipment for all scale changes that could prove to be a production bottleneck requiring multiple copies of this expensive instrument to meet production needs.

II. The requirements identified for precision enlargement/reduction are:

a. 2 1/2 times reduction for input to the GAMMA rectifier.

b. 2 times enlargement of frame materials for large scale stereo compilation.

c. 5 times reducer for pan materials for point transfer to frame for Option I large scale mapping.

All other scale changes can be handled by copy cameras. By developing these special purpose instruments, the total cost of approximately 50-100K each will be less than Option I and will result in four pieces of equipment which provide flexibility in operation and which can be used concurrently.

RECOMMENDATION

Option II be adopted as meeting production requirements in a far more economical way.

HARDWARE IMPLICATIONS

The following special purpose, precision enlargers and reductors are required:

a. 2 1/2 times reducer.

b. 5 times reducer.

c. 2 times enlarger.