~~TOP SECRET~~
GAMBIT/HEXAGON

HANDLE VIA BYEMAN/TALENT-KEYHOLE COMINT CONTROL SYSTEMS JOINTLY

Copy No. 31 of 90
BYE No. 111152-75

USIB-D-46.2/38
(COMIREX-D-2.2/10)
15 April 1975
Limited Distribution

UNITED STATES INTELLIGENCE BOARD

MEMORANDUM FOR THE UNITED STATES INTELLIGENCE BOARD

SUBJECT : COMIREX Review of TALENT-KEYHOLE Decompartmentation Criteria

REFERENCES :
a. Memorandum for Holders of USIB-D-46.2/31, 14 March 1974, Limited Distribution
b. Memorandum for Holders of USIB-D-46.2/31, 1 March 1974, Limited Distribution
c. USIB-D-46.2/31, 1 February 1974, Limited Distribution

DISTRIBUTION		
	A	I
SAFSS		
SAFOS		XX
DD		XXX
SS-1		
SS-2		
SS-3		
SS-4	X	
SS-5		X
SS-6		
SS-7		X
COMP		
SS-1/RF		X
RF-TI		
FILE		

1. Pursuant to Board discussion at the 14 March 1974 USIB meeting (reference a.) the attached memorandum from the Chairman, Committee on Imagery Requirements and Exploitation and its Annex are circulated for Board consideration of the COMIREX recommendations in paragraph 22.

2. Mr. Inlow advises that, in the course of extensive review and evaluation, COMIREX has not been able to achieve a unanimous view on the criteria to be applied in determining the eligibility for release of KH-8 photography for use outside the T-KH compartment without prior review.

3. It is planned to schedule this item on an agenda for USIB consideration at an early date, probably 1 May 1975.

25X1

[redacted]
Executive Secretary

Attachment

WORKING COPY

Classified by BYE-1
Exempt from general declassification schedule of E.O. 11652 exemption category 58(1),(2),(3)
Automatically declassified on Date Impossible to Determine

GAMBIT/HEXAGON
~~TOP SECRET~~

Attachment
USIB-D-46.2/38
(COMIREX-D-2.2/10)
15 April 1975
Limited Distribution

MEMORANDUM FOR: United States Intelligence Board

SUBJECT : COMIREX Review of TALENT-KEYHOLE Decompartmentation Criteria

REFERENCE :
a. Memorandum for Holders of USIB-D-46.2/31, 14 March 1974, Limited Distribution

b. Memorandum for Holders of USIB-D-46.2/31, 1 March 1974, Limited Distribution

c. USIB-D-46.2/31, 1 February 1974, Limited Distribution

1. This memorandum reports activities and findings pursuant to the Board's discussion (reference a.) of the criteria to be applied in determining the eligibility for release of KH-8 photography for use outside the T-KH compartment without prior review.

a. The extant USIB interim guidelines on this issue (reference b.) provide that KH-8 photographs which have been assigned a National Imagery Interpretability Rating Scale (NIIRS) value 1 through 5 may be decompartmented without further review and issued at the appropriate TOP SECRET or SECRET classification.

b. They stipulate further that KH-8 photographs with a NIIRS rating of 6, 7, 8, or 9 will, under normal circumstances, not be eligible for use outside the TALENT-KEYHOLE compartment.

BYE-111152-75

In relation to the present action the Board instructed COMIREX to review the feasibility of including KH-8 photography having a NIIRS rating 6 in the category to be eligible for decompartmented use without recourse to special request.

2. The foregoing guidelines apply solely to photographs, and do not apply to the handling and control of intelligence information derived from the photography. Derived information is broadly eligible for use outside the TALENT-KEYHOLE compartment under other provisions of the T-KH modification program (reference c.). An exception is the restriction -- designed to protect the KH-8 high-resolution capabilities -- on the decompartmentation of textual or graphic information which indicates a satellite capability of detecting objects smaller than two feet (reference c., paragraph VI C1d(1)).

3. In the course of extensive review and evaluation COMIREX has been unable to achieve a unanimous view for Board and Director of Central Intelligence consideration. The Central Intelligence Agency, National Security Agency, Departments of State and the Army, and the Energy Research and Development Administration COMIREX members, the National Photographic Interpretation Center and National Reconnaissance Office representatives, and I recommend retention of NIIRS 5 as the qualitative threshold for automatic eligibility as in the current interim guidelines, but with decentralized and more flexible procedures for exceptions. The Defense Intelligence Agency and Departments of the Navy and Air Force COMIREX members recommend inclusion of NIIRS 6 photography in the category automatically eligible for decompartmented use.

4. A summary of these viewpoints and considerations follows. Paragraph 22 below, contains my recommendations.

Discussion

5. Pursuant to the Board's instructions, the COMIREX T-KH Modification Working Group carried out an extensive review and consolidation of data bearing on the question of sensitive parameters in US

photosatellite systems. The Working Group prepared a summary report, "Sensitive Parameters of Photosatellite Systems" which is attached at Annex to this memorandum. This review was aimed specifically at developing objective criteria for judging the intelligence sensitivity of collection system characteristics. The review activity drew upon data and analytical assets throughout the community and included specialized support from the NRO and NPIC.

6. The Working Group also conducted a number of additional investigations in an attempt to measure objectively the potential source sensitivity of photography in the NIIRS ratings 6, 7, and 8 for GAMBIT and NIIRS 6 for HEXAGON. Tab A to this memorandum contains a listing of the various investigations and experiments which were undertaken. A review was also made of the various applications which would be affected by a limitation on automatic eligibility for release of NIIRS 6 photography for use outside the T-KH compartment. Additional data have also been acquired on the amount of photography which falls within various NIIRS categories. To provide background on the scope of imagery materials involved, a NIIRS distribution profile for the most recent satellite missions is provided in Tab B of this memorandum.

Study Conclusions

7. The summary report "Sensitive Parameters of Photosatellite Systems", at Annex, contains the following conclusions:

> "US photosatellite capabilities appear to be significantly superior to Soviet systems in terms of image quality (resolution), quantity (film capacity and area coverage), and sophistication of targeting techniques. Soviet estimates of these US capabilities are not known. If based solely on their own experience and technology, they would seriously underestimate US capabilities.
>
> "If they applied US-type analytical techniques to the full range of US data available to them through

various sources -- telemetry, documentary, commercial films, technical data -- they could make accurate deductions about the missions and general capabilities of the US photosatellite systems.

"The main parameters which could not be determined with high confidence from these data would be the best resolution for either GAMBIT or HEXAGON. Short of having direct evidence, we believe that Soviet analysts would probably conclude that the best resolution of the GAMBIT system is between one foot and two feet, and for HEXAGON, between three feet and five feet.

"The fact that the Soviets make a concerted effort to conceal their most sensitive installations and military equipment against the KH-8 system suggests that they may have underestimated the KH-9 actual resolution capability and provides an indicator of their sensitivity to coverage by high resolution systems. Soviet acquisition of high quality T-KH imagery -- or even derived lithographic prints -- would enable them to calculate resolution capability and overall quality parameters with a high degree of accuracy. Their confirmation of the true capabilities of the US systems poses an added risk to the US reconnaissance effort and might result in their expanding camouflage, concealment, and deception programs, or adopting other countermeasures."

Position of Various Organizations

8. In balancing the different judgments on the recommendation to be made in relation to whether NIIRS 6 quality imagery should be included or excluded from automatic eligibility for decompartmentation, COMIREX was unable to arrive at a unanimous view. There was agreement on factual points but differences in assessment of the trade-offs between security and breadth of utilization.

9. The study at Annex indicates that Soviet acquisition of high quality T-KH imagery would enable them to calculate resolution capability and overall quality parameters with a high degree of accuracy. All COMIREX members agree that the high-resolution capability of the KH-8 system is a valuable intelligence collection asset which must be accorded maximum security protection to maintain its viability and utility.

10. The interim guidelines, reference b., contain the following statements (paragraphs 2 and 3) as background:

> "The very high-resolution capability of the KH-8 imagery satellite system and the advanced technology it represents constitute uniquely valuable intelligence collection assets that must be accorded maximum security protection. To this end, it is deemed essential that KH-8 photography and derived data revealing the higher qualitative range of the system's performance must continue to be held within the TALENT-KEYHOLE compartment.
>
> "It is recognized that a number of factors and variants are involved in the qualitative equation and that these are not readily susceptible to arbitrary combinations rigidly and uniformly delineating the sensitivity thresholds. For any KH-8 photography, the extent to which the actual quality of the original imagery is reflected in photographic duplicates or prints is a function of the particular reproduction involved and use to be made."

11. Throughout the course of the Committee's many discussions on these issues there was full cognizance of the Board's intent at its restricted session on 10 September 1973 when the USIB agreed in principle to modification of T-KH controls as presented by [redacted] In part, that proposal called for: "Information and prints from current systems (KH-8 and KH-9) to be classified SECRET NOFORN or TOP SECRET NOFORN provided that prints and information do not reveal ground resolution of the KH-8 and swath width of the KH-9. It will exclude a small amount of information or

prints which are deemed especially sensitive on substantive ground. (Only actual film and a few sensitive substantive items from KH-8 and KH-9 would remain in the T-KH control system.)" The intent of the proposal was to expand the utility of information, increase the credibility of intelligence, and allow more expeditious use of films and prints, while continuing to provide special protection to the most sensitive capabilities of our photo-reconnaissance program.

12. There was also a uniform COMIREX understanding that the basic intent of the decompartmentation program has been to maximize the availability of photosatellite materials while retaining within the T-KH compartment only that which must be retained. During the 14 March 1974 USIB meeting (reference a.) the DCI expressed his hope that the COMIREX proposals for broadening the authority for release without further review, to include NIIRS 6, be as automatic as possible.

13. The summary view and recommendation of Chairman, COMIREX, and the Central Intelligence Agency, National Security Agency, Departments of State and Army, and Energy Research and Development Administration members and the National Photographic Interpretation Center and National Reconnaissance Office representatives are provided in Option 1, paragraphs 14 to 17 following. The views and recommendations of the Defense Intelligence Agency member, supported by the Departments of the Navy and the Air Force members are outlined verbatim in Option 2, paragraphs 18 to 21 below.

Option 1

14. Those recommending Option 1, which includes retention of the present threshold, gave principal weight to:

a. the uncertainties concerning Soviet and PRC knowledge;

b. the intelligence importance of the highest resolution materials;

c. their belief that effective procedures can be developed to broaden utilization and ease selective exception when necessary.

They recognize that there are legitimate differences of view as to the Soviet or Chinese estimates of best US capabilities and the potential consequences which could result from the removal of all uncertainties in this area through compromise. Because the security compromise of a single highest quality photograph would make it possible to determine the precise capabilities of the collection system, and in view of the uncertainties involved, they give major weight to maintaining the viability of the source.

15. Those recommending Option 1 also reached the conclusion that special protection should be given to NIIRS 6 quality photography from the KH-9 system as well, even though only about one percent of the KH-9 photography falls in that category. It was judged that if the Soviet Union or other nations were aware that the KH-9 system is capable of producing imagery of 24 to 30-inch ground resolved distance (high end of NIIRS 6) it could lead to implementation of more stringent security measures against that system.

16. In the course of the COMIREX review a number of special military planning needs and applications for decompartmented imagery were considered which afford limited and closely controlled non-T-KH access to such photography. For example, Army provided a detailed examination and assessment of its requirements and uses for decompartmented imagery, particularly KH-8 photography of NIIRS 6 quality, for tactical and field command purposes. In reviewing the security aspects of these applications it was found that they are conducted against sharply defined objectives and under closely controlled circumstances. Those favoring Option 1 believe it is feasible to establish, under the existing guidelines, specific exemption procedures that will readily allow these types of needs to be met.

17. Based on the foregoing and related considerations, those supporting Option 1 submit the following recommendations.

a. As modified to include the KH-9, the interim guidance (reference b.) governing decompartmentation of KH-8 photography should be reissued as the standing guidelines for this process.

b. Paragraph 5d. of reference b. is to be replaced by the following subparagraph:

"5d. Photography of KH-8 or KH-9 targets with NIIRS rating of 6, 7, or 8 will not be eligible for use outside the TALENT-KEYHOLE compartment except as provided below.

(1) Supplemental guidelines will be developed, in consultation with the Defense Intelligence Agency and concerned Department of Defense components, and issued by COMIREX that will identify specific categories of military planning and field activities conducted in a controlled environment for which general authorization will be given to decompartment KH-8 or KH-9 imagery of NIIRS 6 quality without further review.

(2) In addition, the Senior Intelligence Officer of each USIB agency, including military departments, is authorized to approve exceptions on a case-by-case basis consistent with the policy outlined in paragraphs 2 and 3 above. This responsibility may be further delegated, as necessary, to the SIO's of other agencies and commands participating in the TALENT-KEYHOLE program."

c. The procedures and policies enumerated under this option should be evaluated by the USIB one year after

approval and, based on experience gained in their application, a further determination made as to authorization for the decompartmentation of NIIRS 6 imagery without recourse to special request.

Option 2

18. Those recommending Option 2 gave principal weight to the intent of the 10 September 1973 USIB proposal to expand the utility of information, increase the credibility of intelligence, and to allow more expeditious use of film and prints while continuing to provide special protection to the most sensitive capabilities of our photoreconnaissance program.

19. The study at Annex concludes that the evidence indicates the Soviets credit the US, under optimum conditions, with the potential for one foot resolution with GAMBIT. Current guidelines permit decompartmentation of information and imagery which would reveal US capability to detect objects down to two feet in size. The two-foot threshold was established as an interim measure while gaining experience to refine the specific cut off and while maintaining the momentum toward greater utilization of T-KH materials outside the compartmented control system. The Department of Defense decompartmentation experience to date indicates that whereas the present easements have improved utilization and product credibility they have fallen far short of meeting the full scope of Defense Department requirements.

20. The continued compartmentation of NIIRS 6 imagery is of considerable concern to the Defense Department as it will significantly inhibit the use of KH-8 imagery in the tactical environment and severely restrict the application of the many non-T-KH cleared imagery interpretation resources. For example, under the current threshold level of NIIRS 5, approximately half of the targets reported on KH-8 missions are ineligible for use at the SECRET level. Targets of prime concern to field commanders are those which are most adversely affected by this threshold. The Imagery Resolution Requirements Study conducted by a COMIREX panel in 1970

indicated that the precise identification of missiles (SSM and SAM), aircraft, communications/electronics/radar, and air base and ground force facilities all require resolutions of one to two feet. Precise identification therefore depends upon availability of NIIRS 6 quality. Precise identification of specific weapons systems is critical in a multitude of tasks performed at tactical level including penetration analysis, vulnerability analysis, weapon selection, order of battle development, and verification/fusion of tactical ELINT. Decompartmentation of NIIRS 6 imagery would permit greater utilization of imagery by tactical commanders who are responsible for the tasks indicated above and who do not currently have facilities for processing and handling T-KH material. Authority to decompartment the additional 40 percent of KH-8 imagery which presently falls within the NIIRS 6 category without recourse to a "case-by-case" review would facilitate and enhance contingency planning and improve operations in crisis situations.

21. Based on the foregoing, the Defense Intelligence Agency and the Departments of the Navy and the Air Force COMIREX members recommend the following.

a. The current guidelines (reference b.) be amended to include NIIRS 6 imagery in the category eligible for decompartmentation without recourse to special request.

b. No reference be made to extend guidelines to cover best quality KH-9 photography (NIIRS 6).

Recommendations

22. Resolution of this issue is a matter of judgment. I believe that there are feasible steps which can be taken to expand substantially the decompartmented use of the highest resolution photography. In my judgment the uncertainties involved in this issue require the final emphasis to be placed on maintaining the viability of the collection resources. Consequently I recommend that:

a. the USIB note this memorandum and its supporting Annex and data;

b. the Director of Central Intelligence, in consultation with the Board, approve the Option 1 recommendations given in paragraph 17 above.

Roland S. Inlow

Roland S. Inlow
Chairman
Committee on Imagery Requirements and Exploitation

STUDY ON
SENSITIVE PARAMETERS OF PHOTOSATELLITE SYSTEMS

Special Investigations
(January - November 1974)

1. Sanitization of Photographic Materials (Memorandum for the Record, DIA/Directorate for Collection and Surveillance (DC-6), dated 21 January 1974.
DIA study addressing what information can be derived from sample film and what methods can be used to restrict information in photographic images.

2. Determination of KH-9 System Parameters from Telemetry Intercepts (BYE-7613-74, dated 11 March 1974).
OD&E estimate of Soviet capability to determine KH-9 System Parameters from telemetry intercepts.

3. Effects of Enlargement and Screening (TCS-10425/74, 18 March 1974).
NPIC examples of the effects of halftone screening on imagery magnified 25X.

4. Decompartmentation of NIIRS 6 Rated Imagery (TCS-10040/74, 28 March 1974).
NPIC study showing resolution loss of second generation Duplicate Positive (DP) film, fourth generation paper print and sixth generation lithographic print in enlargement halftone format.

5. Decompartmentation of Materials Exhibiting Camouflage, Concealment, or Deception (TCS-10225/74, March 1974).
NPIC study on imagery exhibiting foreign camouflage, concealment, and deception techniques.

6. Possible Effect of Decompartmentation on Soviet Camouflage, Concealment, and Deception Efforts (TCS-11140/74, 5 August 1974).
NPIC study covering actions by Soviets against KH-8 and KH-9 satellite systems and US ability to penetrate cover.

7. "NIIRS" Decompartmentation Level for KH-8 Imagery (TCS-101081/74, 12 September 1974).
Army study detailing Army interest in ground equipments and levels of NIIRS ratings required to Detect, Classify, and Identify said equipments.

8. Systems Performance Evaluation from Sample Photographic Products (TCS-864133/74, 5 November 1974).
USGS study of 9 halftone reproductions. Examples of satellite imagery already decompartmented and published in lithographic form were subjected to evaluation by appropriately cleared USGS personnel to determine the collection systems characteristics derivable from such photographs by technically-trained personnel who did not have access to specific systems data. The objective of the study was to evaluate the halftones, assign a corresponding NIIRS rating and then attempt to determine estimates of the collection system's capability.

9. Photographic Downgrading Study (BYE-13444-74, 11 November 1974).
NRO/EK study which developed a matrix showing what critical satellite parameters can be determined from the Original Negative (ON) film and from second and third generation Duplicate Negative (DN) and Duplicate Positive (DP) film.

DISTRIBUTION OF NIIRS FOR RECENT KH-8 AND KH-9 MISSIONS

MISSIONS
(1974)

NIIRS Rating	4341 13 Feb-15 Mar Tgts	%	1207 10 Nov 73-20 Feb Tgts	%	4342 6 Jun-22 Jul Tgts	%	1208 11 Apr-24 Jul Tgts	%	4343 14 Aug-28 Sep Tgts	%
1	13	-	30	-	8	-	18	-	5	-
2	65	1	707	7	54	1	357	5	36	1
3	248	5	3,408	36	262	6	2,228	30	182	4
4	844	18	4,230	44	718	16	3,290	45	656	13
5	1,541	34	1,136	12	1,409	32	1,367	19	1,504	31
6	1,492	33	48	-	1,547	35	88	1	1,926	40
7	333	7	0	0	416	9	0	0	519	11
8	29	-	0	0	17	-	0	0	28	-
9	0	0	0	0	0	0	0	0	0	0
TOTALS	4,565		9,560		4,431		7,348		4,856	

UNITED STATES INTELLIGENCE BOARD

COMMITTEE ON IMAGERY REQUIREMENTS AND EXPLOITATION

STUDY

ON

SENSITIVE PARAMETERS OF PHOTOSATELLITE SYSTEMS

14 NOVEMBER 1974

TABLE OF CONTENTS

FOREWORD

This document summarizes the results of an extensive review and consolidation of data bearing on the question of sensitive parameters of U.S. photosatellite systems conducted under aegis of the COMIREX T-KH Modification Working Group during the period March-November 1974. The study was undertaken by COMIREX pursuant to USIB instructions of 14 March 1974[1] and incorporates available data and draws upon judgments from pertinent analytic assets throughout the community. Specialized support was provided by the NRO, NPIC, and other technical analytic elements.

A series of supporting investigations and technical evaluations also were conducted to determine the sensitivity of photographs made from the best quality GAMBIT (NIIRS 6, 7, and 8) and HEXAGON products and to assess the collection system characteristics derivable from various forms of photographic reproduction. The detailed supporting data related to these efforts is available in the Office of the Chairman, COMIREX.

[1] *Memorandum for Holders of USIB-D-46.2/31, 14 March 1974, paragraph 3.*

SENSITIVE PARAMETERS OF PHOTOSATELLITE SYSTEMS

Introduction

1. This study focuses on and summarizes the extent of knowledge which exists or might be available to the Soviets on the capabilities of the United States satellite photo reconnaissance program. The study brings much of the limited available data to bear on the problem. Its purpose is to identify those aspects pertinent to the USIB deliberations on the criteria which are to be employed for decompartmentation and classification of satellite imagery and derived intelligence.

2. The study first compares Soviet and U.S. hardware capabilities and identifies those features of the U.S. program which can be considered to be unique and perhaps critical, particularly resolution or image quality. An estimate is then made of how the Soviets might either be already cognizant of or could uncover the most significant features of the U.S. program, and an assessment is given of the potential implications of this knowledge.

Conclusions

3. U.S. photosatellite capabilities appear to be significantly superior to Soviet systems in terms of image quality (resolution), quantity (film capacity and area coverage), and sophistication of targeting techniques. Soviet estimates of these U.S. capabilities are not known. If based solely on their own experience and technology, they would seriously underestimate U.S. capabilities.

a. If they applied U.S.-type analytical techniques to the full range of U.S. data available to them through various sources -- telemetry, documentary, commercial films, technical data -- they could make accurate deductions about the missions and general capabilities of the U.S. photosatellite systems.

b. The main parameters which could not be determined with high confidence from these data would be the best resolution for either GAMBIT or HEXAGON. Short of having direct evidence, we believe that Soviet analysts would probably conclude that the best resolution of the GAMBIT system is between one foot and two feet, and for HEXAGON, between three feet and five feet.

4. The fact that the Soviets make a concerted effort to conceal their most sensitive installations and military equipment against the KH-8 system suggests that they may have underestimated the KH-9 actual resolution capability and provides an indicator of their sensitivity to coverage by high resolution systems. Soviet acquisition of high quality T-KH imagery -- or even derived lithographic prints -- would enable them to calculate resolution capability and overall quality parameters with a high degree of accuracy. Their confirmation of the true capabilities of the U.S. systems poses an added risk to the U.S. reconnaissance effort and might result in their expanding camouflage, concealment, and deception programs, or adopting other countermeasures.

U.S. Estimate of Soviet Capabilities

5. There are several reports which have assessed the Soviet satellite programs. The present study drew upon the system analysis of the factors bounding Soviet photo reconnaissance capabilities in the DIA study Reconnaissance Space Systems - USSR (ST-CX-12-23-74), and its supporting annex Supplement to Reconnaissance Space Systems - USSR (SAO/ST-SS-12-23-74) which were coordinated with the USIB Guided

Missiles and Astronautics Intelligence Committee (GMAIC). Factors considered include spacecraft size, film and optics technology, satellite altitude, field of view and roll angle step size, image motion compensation, attitude control accuracy, and resolution targets. Every effort has been made to elicit comments from the community at large on all aspects of this study.

6. The Soviet photo reconnaissance spacecraft is believed to be sized identically to the Vostok. A deduction is made that the inner diameter of the cabin is probably no larger than 85 inches, thus restricting the size and camera configurations. Both low and high resolution systems employ the same spacecraft.

7. Much operational data are detectable from telemetry as well as from observable orbital characteristics. Film capacities of the primary and indexing cameras can be estimated for both high and low resolution systems to plus or minus 8-15 percent. It is estimated that the low resolution system employs five cameras: three for the primary mission; one for indexing or cartography; and one with an unknown function. The high resolution system is believed to employ three cameras -- one of which is for indexing.

8. Telemetry analyses indicate that framing cameras are used for both high and low resolution systems instead of panoramic cameras. The observation that the Soviet high resolution spacecraft employs a roll maneuver during its operations strengthens the conclusion that a panoramic camera is not used. The indications in telemetry of camera pulsing also supports the estimate that a framing format is used instead of a stripping format.

9. The Soviet low resolution system apparently has its cameras aligned cross-track of the vehicle axis in order to obtain wide swath coverage. Analyses of the orbital characteristics suggest that a 115 (105-115) nm swath at 49-53° total field of view is achievable at a 100 mile

altitude. This is supported by telemetric evidence of the differing speeds of operations of the three cameras, e.g. the cameras pointed off nadir operate more slowly than the one pointing to nadir. It does not appear likely that they have a capability for the separate operation of each camera.

10. The high resolution system apparently employs one camera pointing forward along the ground track; a second one pointing aft. This assumption is based on a premise that the Soviets desire high resolution stereoscopic coverage. Operating rates indicate that both cameras are pointing at the same angle from nadir. The operational sequence indicated by telemetry suggests also that stereoscopic coverage is attainable.

11. Soviet commercial films available for analysis and exploitation by the U.S. have proven to be of good resolving quality but poorer than U.S. films. It is believed that they produce film equivalent to those produced by the U.S. in the late 1960's for reconnaissance purposes. Factors such as base quality and emulsion uniformity probably lag U.S. standards. Soviet reconnaissance camera optics may be produced at the State Optical Institute (GOI) in Leningrad. The best Soviet optics openly available are catadioptric (lens-mirror), based on design by D. D. Maksutov. There has been a strong association between Maksutov and the GOI. Exploitation of these lenses result in resolving power of .7 of theoretical (diffraction limiting) capability. It is assumed that the Soviets can scale up to larger format cameras and retain .7 of theoretical resolution. Another practical consideration in camera design is the optics size and frame size (film format). The volume of the spacecraft and the constraint of having two cameras which look in generally the same direction are believed to constrain aperture size to no more than 0.5 meters.

12. Other factors used in assessing Soviet resolution capabilities are the field of view and image motion compensation (IMC). A roll angle increment of three degrees and the framing frequency, both detectable from telemetry, point to a view angle of 7-9 degrees for the high resolution cameras. This is consistent with spacecraft size and typical Soviet

film formats. The 16 step-in-track IMC capability indicates the Soviets are willing to accept from this source an image smear equivalent to about one foot of resolution. From the lack of any apparent cross-track IMC flexibility one must presume a preset in the cameras for ascending pass photography.

13. The Soviets have deployed a variety of resolution targets in the USSR, starting in 1967. The earlier deployed targets were apparently designed for an optimum resolution of two meters (6.5 ft). In the last two or three years, resolution targets designed for one meter, .5 meter, .4 meter, and smaller have appeared. Most recently, a tri-bar resolution target array that is computed to go down to one foot, with a possible design resolution of three feet, has been seen at Tyuratam. There is no tangible evidence, however, that these resolution targets are satellite connected.

14. The various foregoing factors, assumptions, and bounds have been put through two types of analysis, and both result in estimates of a best ground resolution of about three feet (GRD) for the Soviet high resolution reconnaissance spacecraft from 100 nm altitude. Because of the various bounds (spacecraft volume, aperture limit, field of view, film quality, image motion compensation) this estimated resolution is independent of the focal length. The actual (versus theoretical) resolution is degraded in photography obtained under operational conditions because of factors such as target contrast, atmosphere, smear, etc. Consideration of the many factors that contribute to the degradation of operational coverage leads to the conclusion that most of the Soviet high resolution imagery obtained under good lighting and atmospheric conditions (1.6 to one contrast ratio) would have resolutions ranging from about three to five feet. A small fraction of the coverage may show resolution of three feet or better. Similarly, the design resolution of the low resolution system probably is no worse than 12-15 feet, but no better than about 7-8 feet.

15. In general, the high resolution photographic satellites have gone through normal evolutionary changes which can be identified in

telemetry -- attitude control, possibly the cameras, the batteries and the roll maneuver system -- all of which have contributed to gradually improved capabilities. The Soviets are believed, however, to be developing higher resolution photo reconnaissance systems. Some evidence points to Salyut type manned space stations as participating in such developments. It is estimated by the intelligence community that the Soviets will attempt to achieve 1-2 foot resolution by the late 1970's.

16. In summary, analyses of philosophy of operations, space vehicle size, telemetry, observable orbital characteristics, known film technology and known optical technology allow deductions and estimates to be made about the technical capabilities of Soviet photo reconnaissance satellite systems. These estimates are believed to provide a sound basis for judging the range of capability vis-a-vis resolution, although actual capability cannot be determined or proved. To date, Soviet reconnaissance satellite photography has not been available for evaluation by U.S. analysts.

17. Conclusion. Today, even with our advanced technology and analytical expertise, we are unable to precisely establish the best Soviet photosatellite resolution capability without benefit of imagery itself or detailed system description data.

Relative Soviet and U.S. Capabilities

18. The estimated values of the Soviet camera system parameters are as follows:

PARAMETER	LOW RESOLUTION SYSTEM	HIGH RESOLUTION SYSTEM	BASIS FOR ESTIMATE
Optical System	refractive or reflective	refractive or lens-mirror (possible folded mirror)	technology/ deduction
Camera Type	frame (3)	frame (2)	telemetry/deduction
Focal Length	500-750 mm (20-30 in)	1,800 refractive (71 in) or 2,500 lens-mirror (98 in) (2,500 mm folded mirror - 98 in)	technology/deduction
Resolution	seven feet best	three feet best	deduction/ calculation
Field of View	49-53 degrees	(7-9 degrees)	orbit/telemetry (technology)
Swath Width (at 100 mile altitude)	105-115 nm	12-16 nm	orbit/deduction
Film Capacity/ Total Mission	5,200 ± 150 feet	3,500 ± 100 feet	telemetry

19. The comparable U.S. capabilities for the low and high resolution systems are as follows:

PARAMETER	LOW RESOLUTION (HEXAGON)	HIGH RESOLUTION (GAMBIT)
Optical System	folded mirror	folded mirror
Camera Type	panoramic (2)	strip
Focal Length	60 inches (1,524 mm)	175 inches (4,345 mm)
Resolution*	1.75 feet best	
Scan Range/Roll Link	120^{o}	$\pm 45^{o}$
Swath Width	300 nm @ 90 alt	5 nm @ 70 alt
Film Capacity/Total Mission	229,000 feet	10,800

*3:1 Contrast, 30^{o} Solar Angle, at nadir. A reduction in contrast ratio would cause a reduction in resolution.

20. It becomes clear, not withstanding the differences in philosophy of operation and developmental thrusts, that the U.S. possesses superior capability in terms of film capacity and resolution.

What the Soviets May Already Know

21. There are two overt sources from which the Soviets could obtain data on U.S. photosatellites. These are from observables such as orbit and telemetry characteristics, and from open literature such as technical state-of-the-art descriptions and speculative trade journal and newspaper reports.

22. As in the case of U.S. estimates of Soviet capabilities there are very few ways for a Soviet observer to accurately estimate the capability of our systems. To the degree that the Soviets depend on their own capabilities and without exact data on most of the system parameters, they could underestimate the U.S. even with open U.S. literature. However, with the considerable data bearing on U.S. capabilities available for Soviet analysis they should be able to more closely estimate our capabilities. The state-of-the-art in both film and lens quality can be obtained in open literature. Camera technology sophistication can be acquired with minimal efforts. Although these bracket the system resolution capabilities, the actual focal length and the operational modes are needed to compute precise resolution (i.e., Ground Resolved Distance) and area coverage. Using the same criteria that were used to derive Soviet capabilities, some basic conclusions can be drawn. These criteria include vehicle size, film and optics technology, altitude, field of view, image motion compensation (IMC), attitude control accuracy, ground resolution targets.

23. Vehicle size. The sizes of both the GAMBIT and the HEXAGON systems at launch can be determined very accurately through photography and other data appearing in open literature. The approximate sizes and shapes of the vehicles on orbit can be determined from ground-based visual or radar imagery. The GAMBIT vehicle is clearly much longer than Soviet vehicles, and the fact that its diameter is small strongly implies a 45 degree mirror to achieve a long focal length. Sizing of the Agena and the two film recovery subsystems will allow a good estimate of maximum size of the optical bay and optics length. The HEXAGON vehicle is much larger in length and is larger in diameter than Soviet systems, which could give rise to overestimating its focal length.

24. Film and optics technology. Eastman Kodak is the recognized world leader in film technology and production. Film quality of 150 lines/mm has been suggested in open literature as a reasonable working value under average contrast conditions from space. The U.S. optics

technology has been clearly demonstrated by such openly available space efforts as the Lunar orbiter and the optical-bar camera on Apollo.

25. Altitude. It is clear that the U.S. achieves considerable resolution improvement in the case of GAMBIT by using perigee altitudes in the 67-72 nm range. Further, the low perigee indicates that the U.S. has highly advanced environmental control and attitude control systems to handle the heating and torquing problems the atmosphere creates at these lower altitudes. It appears that the Soviet system can only be used below 80 nm for short periods of time, and its nominal perigee altitude is about 100 miles.

26. Field of view. The GAMBIT field of view can be inferred, in part from the extremely small roll angle steps that are used (0.35^{o}) in comparison with Soviet steps of three degrees. (Roll angle steps can be computed from IMC factors and orbital geometry.) In addition, the photography of lateral pairs, as opposed to stereo pairs, yields further insight into cross-track field of view. The use of a strip camera has not only been described in the open literature but also would be evident from the reaction of satellite attitude control during periods of photography. The field of view is a major contributor to determining the focal length for the strip type GAMBIT camera system. The swath width of the HEXAGON imagery can be calculated from analysis of the telemetry internals and orbital data, as well as analytical extensions of detailed descriptions of the Apollo optical bar camera used for lunar photography.

27. Image motion compensation. GAMBIT uses over 30 times the number of in-track IMC steps that the Soviets use, and also incorporates cross-track IMC -- which has never been identified in Soviet reconnaissance spacecraft telemetry. Similar observations on the IMC control by HEXAGON could yield not only resolution limiting considerations but further data on likely coverage.

28. Attitude control accuracy. The degree of motion the spacecraft are restricted to during periods of camera operations further support the IMC and resolution arguments. Soviet spacecraft are not as well controlled in yaw error or pitch/roll rate.

29. Telemetry. Soviet ELINT collection platforms are in position where they can actively monitor and collect telemetry from U.S. photosatellites. Refinement of this data into usable information, even with our advanced technology, can be defined as an effort of major proportions. It can be stated, with reasonable assurance, that telemetry alone will not provide the Soviets with an accurate assessment of the best U.S. photosatellite resolution capability.

30. Conclusion. It is clear from the sets of data above obtainable by the Soviets that the U.S. has under optimum conditions the potential for one foot resolution with GAMBIT. The multiple bucket recovery with HEXAGON is a strong indication of its film load and coverage. The far more detailed data available in open literature and in telemetry should give the Soviets the opportunity to compute more exactly U.S. capabilities than we can compute Soviet capabilities, and we must assume that they have attempted such analyses.

31. Literature. Considerable data, both factual and conjectural, has been published on U.S. photosatellite systems in various unclassified publications. These data, if correctly analyzed, could contribute to a more accurate Soviet assessment of the resolution of our satellites. Conversely, as discussions by the more knowledgeable sources also contain significant errors there is some probability of causing Soviet analysis to be predicated on some of the erroneous data. Some examples of the range of discussions which have appeared in unclassified publications include the following:

a. Article in Scientific American in February 1973 issue, "Reconnaissance and Arms Control" ". . .it seems

clear that U.S. photo reconnaissance satellites are close to achieving resolutions that are limited only by atmospheric effects" ". . .the Air Force selected the Lockheed Aircraft Corporation to develop a self-powered satellite vehicle, later named the Agena. This vehicle (along with several later models) was for many years the workhorse of the U.S. observation - satellite program." ". . .the ground resolution obtainable with the current generation of close-look reconnaissance satellites (roughly one foot from an altitude of 100 miles)." The article also links both Perkin-Elmer and Eastman Kodak with camera production.

b. Report No. TOR-0066 (5115-10)-1 "National Launch Vehicle Summary: Air Force Operational Boosters", April 1970 -- indicates the TITAN IIIB/Agena has a 21 foot Agena length with five foot diameter, and a payload fairing maximum length of 40 feet -- scaling of a TITAN IIID picture indicates a payload length of over 65 feet.

c. Comments by President Johnson that appeared in the Washington Post six years ago which indicated U.S. reconnaissance resolution capabilities

d. An article appearing in Aviation Week in the mid sixties included a photograph of an Agena/payload photograph in a Lockheed plant and the assessment that it was for high resolution reconnaissance with the focal length being along the roll axis of the spacecraft.

e. John Newhouse, Cold Dawn, the Story of SALT, 1973, which states: "Probably nothing the United States does is more closely held than the techniques and performance of its verification machinery. Even here, though, a fair amount of information finds its way into technical journals. We know

that accuracy expectation for optical photography is a ground resolution of [redacted]12 inches from an altitude of 60 miles; that the width of the strip photographed during a satellite transit may be up to 75 miles. We know that observations may be telemetered to earth in an hour; but, because this means an unacceptable loss of definition, we know that the CIA and the Air Force rely on five or six capsules of film (weighing a few hundred pounds each) ejected in sequence from each vehicle. These, we know, are recaptured by specially modified aircraft as they descend by parachute. Finally, we know that satellite photography is weather-dependent; Russian weather is more uncertain than American, with long periods of overcast."

32. Another interesting data point is a table on U.S. space systems extracted from a SECRET Polish document of 1967 vintage. Included in this table is a reference to SAMOS as a photosatellite with IOC of 1962, using orbits of 150 by 300 km and inclinations of 107 degrees. Spacecraft weight was given at 1860 kilograms and the best resolution of the system was .8 meters (31 inches). These parameters have many similarities to the KH-7. What is not clear is the source of this information and whether it represents Soviet thinking or cribbing from U.S. open literature. But of significance is the fact that a foreign government was willing to believe that the U.S. had a .8 meter resolution capability with photographic satellites back in 1967.

33. Technical experts have agreed that the Soviet acquisition of primary film (not necessarily a full format) -- or even high quality lithographic prints made from the T-KH photography -- would enable them to calculate resolution capability and overall quality parameters with a high degree of accuracy, provided the quality of the original imagery were not severely degraded by haze, poor lighting, or satellite malfunction. An NPIC study showed that other than the resolution loss between the original negative and the second generation duplicate positive enlargement, there

was no subsequent loss in ability to read the same measurements from resolution targets between the initial enlargement and a fourth generation paper print or even a sixth generation lithographic print.

34. For a number of reasons the odds of such Soviet acquisitions increase significantly as the materials are removed from the compartmental protection of the TALENT-KEYHOLE control system. Greater numbers of people are cleared for TOP SECRET -- and far greater numbers for SECRET -- than for access to T-KH materials. Furthermore, individuals approved for access to T-KH materials are investigated more fully, whereas SECRET clearance requires only a National Agency Check without any field investigation. Therefore, the mathematical probability of compromise is considerably greater at SECRET than at TOP SECRET or at T-KH. Physical security standards for the storage of SECRET materials are considerably less rigorous than for T-KH materials, which increases the risk of penetration and removal from some U.S. Government or contractor's premises. T-KH materials must be transmitted from one location to another by courier whereas SECRET materials may be sent Registered Mail within the continental limits of the U.S. -- with the consequent greater risk of accidental or intentional misrouting, and therefore compromise or loss.

35. To date, we possess no evidence that the Soviets have acquired any T-KH photography. On the other hand, there are numerous recorded instances of Soviet acquisition of highly classified U.S. documents and the opportunities for future acquisition are increasing. Previous to the present modification of T-KH security guidelines, prints of non-attributed "sanitized" KH-9 imagery was made available at the SECRET/NO FOREIGN DISSEM level. These materials were prepared in fairly large quantities -- but for highly specific purposes such as military targeting in preparation for contingency operations. Consequently, access to these sanitized materials was tightly controlled, and the possibilities of acquisition by the Soviets were considerably less than for prints of T-KH imagery that are now authorized for inclusion in current intelligence or general purposes publications at the SECRET/NO FOREIGN DISSEM level.

Implications of Potential Knowledge of the Soviets and Others

36. Should the Soviets confirm our precise capability from pictorial evidence, there are several impacts possible. These impacts fall into three categories -- Deception, Technological, and Other Countermeasures.

37. Deception. There is continuing evidence that the Soviets are actively pursuing Camouflage, Concealment, and Deception (CCD) programs.[1] These programs appear to fall into two categories: defensive and anti-reconnaissance. The defensive programs are passive thereby enhancing the protection of deployed military equipment and facilities during hostilities. The anti-reconnaissance programs are apparently aimed at deceiving U.S. photo analysts, at developing and perfecting techniques against overhead reconnaissance, or determining and evaluating their own ability to obtain foreign data and detect CCD efforts.

38. In support of the anti-reconnaissance program the Soviets have implemented an extensive program of systematically broadcasting warning messages detailing the passage of U.S. low-altitude SIGINT and photographic reconnaissance satellites for the purpose of electronic emitter control and, probably, concealment. This action, for example, apparently alerts the RAM-H (a large delta-wing aircraft) test crews as to the presence of both the U.S. high and low resolution photosatellite systems. Of significance is the fact that in two years the U.S. has been unable to obtain high resolution KH-8 coverage of the aircraft -- even after repeated attempts. The Soviets have, however, allowed for numerous photographs to be taken by the lower resolution KH-9 system. Dummy equipment has been seen at missile and electronic sites, naval bases, airfields, and industrial installations. Dummy missile submarines have been constructed at Severodvinsk and in the Far East. Elaborate camouflage and concealment measures have been employed at Plesetsk and

[1] NPIC Memorandum, Subject: "Decompartmentation of Materials Exhibiting Camouflage, Concealment or Deception," TCS-10225-74.

Votkinsk to deny the U.S. information on the suspected mobile version of the SS-X-16 missile. Resolution targets have been identified in conjunction with camouflage and deception efforts at a wide variety of targets in the Soviet Union. These efforts involve all of the Soviet armed services as well as industrial and R&D establishments. This suggests that a centrally directed CCD program exists and that tests and exercises are being conducted.

39. Technological. By itself, knowledge of U.S. resolution capabilities probably would not cause the Soviets to significantly alter their own reconnaissance development programs. They have growing S&T intelligence needs and are probably concerned about the U.S. living up to SAL agreements, particularly in advanced or new research areas supporting strategic offense/defense. Current Soviet photo reconnaissance satellites appear inadequate to collect much necessary S&T data. We believe they are upgrading resolution and coverage capabilities, with the Salyut space stations being plausible candidates as vehicles for carrying out such improved collection. Recently, the Soviets installed an improved set of resolution targets at Tyuratam that went down to one foot. We have noted them taking pictures of this target with an operational high resolution satellite very near the time that Salyut 3 passed over it.

40. Other Countermeasures. There are other countermeasures possible (short of attack of a satellite by the Soviet orbital intercept system) such as satellite degradation of U.S. photo capability through the use of lasers and electronic interference. We have, for the past several years, estimated that the Soviets are unlikely to take any direct action against U.S. satellites. This judgment was based upon a number of political and military considerations, including the U.S. reaction if it found this major source of intelligence information cut off.[2]

---

[2] Soviet Strategic Defense, NIE 11-3-72, 2 November 1972, TCS-889066-2; Soviet Forces for Intercontinental Conflict, NIE 11-3/8-74, 14 November 1974, TCS-889093-74/II.

A. GAMBIT

1. Technical Description

a. General Description

GAMBIT is a covert reconnaissance satellite program with a mission to obtain high resolution photography of selected targets of interest. Over the years, GAMBIT has pioneered the field of low altitude orbital flight while continually improving and returning photography of the highest quality. The current GAMBIT Program (110) was approved by DNRO on 3 January 1964 and is a follow-on to a previous GAMBIT Program (206) which launched 38 high resolution photographic systems during the period July 1963 to June 1967.

The first Program 110 GAMBIT vehicle, Mission 4301, was launched on 29 July 1966, carried 3,000 feet of film, conducted 5 days of photographic operations followed by 3 days of solo (post recovery) operations, and returned 640 frames of photography with a best resolution of 17 inches. The most recent GAMBIT vehicle, Mission 4343, was launched on 14 August 1974, carried 10,566 feet of film, conducted photographic operations for 45 days followed by one day of solo activity and returned 11,715 frames of photography with a best resolution [redacted]

The GAMBIT vehicle is launched from the Western Test Range (WTR), Vandenberg AFB, CA, and is injected into a low altitude, near polar orbit permitting photography of targets of interest in any part of the world. The exposed film is stored in the two recovery buckets and returned to earth in the Hawaii recovery area. Following the second recovery, a period of solo operations may be conducted for engineering and evaluation purposes. The GAMBIT mission is terminated upon de-orbit of the satellite vehicle into a broad ocean area.

The GAMBIT Launch Vehicle (LV), as shown in Figure 1, consists of two basic parts: the Titan IIIB Booster Vehicle and the Photographic Satellite Vehicle (PSV). The structural connection between the ten-foot diameter booster and the five-foot diameter Photographic Satellite Vehicle is identified as the Maximum Access Booster Adapter (MABA).