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THE KH-9 SEARCH AND MC&G PERFORMANCE STUDY

VOLUME II
HISTORICAL PERFORMANCE SUMMARY

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THE KH-9 SEARCH AND MC&G PERFORMANCE STUDY

VOLUME II

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FOREWORD

Presented in this volume is a review of the KH-9 performance against the standing search and MC&G requirements for the first twelve missions. Included are a brief description of the KH-9 satellite system, the evolution of the search and MC&G requirements, collection statistics, and some specific examples of the unique contributions made by the KH-9 system while performing the search mission. The majority of the data presented was extracted from existing reports and publications by the participating organizations.

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GLOSSARY

ACRES	Area Collection Requirements Evaluation System
APTC	Astro-Positioning Terrain Camera
COMIREX	Committee on Imagery Requirements and Exploitation
DMA	Defense Mapping Agency
GRD	Ground Resolved Distance
IDF	Installation Data File
MC&G	Mapping, Charting and Geodesy
MCS	Mapping Camera Subsystem
NAEF	National Area Exploitation File
NIIRS	National Imagery Interpretability Rating Scale
NRO	National Reconnaissance Office
NRP	National Reconnaissance Program
NTB	National Target Base
USIB	United States Intelligence Board
USGS	United States Geological Survey
WGS	World Geodetic System

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1.0 INTRODUCTION

This historical review was performed in response to Task 2 set forth in the Terms of Reference for the KH-9 Search and MC&G Performance Study and a companion [redacted]

1.1 Objectives

The objectives of this review were to establish in quantitative terms the KH-9 historical performance against the standing broad area search and MC&G requirements and to establish a reference against which new collection strategies, when applied to new collection requirements, could be judged.

1.2 Participants

The data presented in this volume was compiled by a working group chartered by the HOSS steering Group. Participating in the working group were representatives from a program element of the National Reconnaissance Office, COMIREX/IC Staff, Defense Mapping Agency, National Photographic Interpretation Center, and Defense Intelligence Agency. These organizations were responsible for compiling and collating the information in this report.

2.0 KH-9 SYSTEM DESCRIPTION OVERVIEW

The KH-9 System was developed to collect stereoscopic broad area imagery at a resolution adequate for both general search and surveillance. It collects imagery in the two to twenty-foot GRD range. The satellite vehicle contains two camera systems - a dual camera panoramic system and a stellar terrain camera system. Imagery collected by the panoramic system is used primarily for search and general surveillance, but it does have MC&G applications. The stellar terrain camera system, first flown in 1973 on satellite vehicle number 5, provides DMA with imagery at the required quality and metric accuracies for point positioning to establish a suitable data base for the production of MC&G products.

2.1 The Satellite System

The KH-9 satellite consists of three major sections - the forward, the mid, and the aft sections. The forward section contains the four reentry vehicles for recovery of film exposed by the panoramic cameras; the stellar terrain mapping camera and the fifth reentry vehicle for recovery of its film; [redacted].

The midsection contains the dual camera panoramic system, its film supply and the supporting electronics. The dual camera system provides for stereoscopic coverage within 60 degrees either side of nadir.

TABLE 2-3
KH-5 OPERATIONAL SUMMARY

MISSION NUMBER	ORBITAL PARAMETERS INCLINATION/PERIGEE/APOGEE	LAUNCH DATE	MISSION DURATION	FILM (FT)* CAMERA A	FILM (FT)* CAMERA B
1201	98.4°/93.3/165.1 n.m.	15 Jun 71	31	100,626	100,502
1202	97.0°/86.1/106.7 n.m.	26 Jan 72	30	110,845	110,236
1203	96.9°/95.6/137.3 n.m.	7 Jul 72	83	103,170	107,728
1204	96.8°/95.3/136.8 n.m.	19 Oct 72	84	107,588	110,009
1205	95.7°/85.3/158.5 n.m.	9 Mar 73	83	108,197	110,141
1206	96.2°/87.7/164.4 n.m.	17 Jul 73	74	106,780	102,792
1207	96.9°/88.7/154.4 n.m.	18 Nov 73	102	107,380	106,243
1208	94.5°/85.5/104.0 n.m.	18 Apr 74	100	106,881	106,712
1209	96.7°/85.3/155.7 n.m.	29 Oct 74	129	110,813	111,808
1210	96.4°/90.8/157.0 n.m.	1 Jun 75	126	110,188	110,562
1211	96.3°/90.0/138.3 n.m.	4 Dec 75	116	113,502	111,107
1212	97.0°/90.1/138.6 n.m.	9 Jul 76	154	120,621	110,806
1213	97.0°/90.5/138.1 n.m.	27 Jan 77	—	121,371	110,670

*Differences in film footage between Camera A and Camera B is due to special films (color and/or infrared) which are thicker than the normal black and white.

overlap, respectively. At 95 nautical miles,each frame covers an area of approximately 71 by 142 nautical miles. The terrain camera carries approximately 3,330 feet of film. This yields about 2,000 frames of photography.

The two stellar cameras provide a means for accurately determining the attitude of the terrain camera at the exact time of exposure. They are oriented in such a way that the star field is photographed simultaneously with the acquisition of terrain photography. The film format consists of two adjacent frames which are 70 mm by 110 mm. The stellar cameras together consume approximately 2,000 feet of film which yields about 2,000 pairs of stellar frames. See Table 2-3 for a summary of the MCS features and Table 2-4 for mission statistics.

A doppler transponder accompanies the MCS frame camera. The on-board transponder is tracked by a 42-station TRANET and GEOCEIVER network, resulting in a worldwide camera on-orbit position determination capability accurate to 27, 18 and 9 meters (one sigma) for in-track, cross-track and radial components, respectively.

3.0 REQUIREMENTS

3.1 Standing Search

3.1.1 Evolution of Search Requirements

The following paragraphs trace the evolutionary process responsible for the present structure and dimensions of the Intelligence Community's standing requirements for periodic broad area coverage of the Communist countries and regions of conflict in the Middle East.

3.1.1.1 Late 50's and Early 60's

To understand the initial requirements for satellite-borne broad area collection, it is necessary to recall the environment of the late 1950's. Although U-2's had been overflying the Communist countries for several years, a large fraction of the Eurasian landmass had yet to be photographed even once. The other sources of intelligence then available seemed to be unearthing new problems about as fast as they were solving old ones. The maps in our possession were old and/or unreliable. The weapon systems perceived to be the major threats embodied technology too new to support reliable assessments of just where and how they could be deployed. The quality of the imagery needed to detect the as-yet-unseen ICBM deployment sites could only be guessed at.

Under these circumstances, the initial requirement, issued in 1958, called for coverage of the entirety of the Eurasian communist countries every six months. A resolution of twenty feet was judged to be adequate unless the Soviets deployed mobile or transportable ICBMs, in which case resolutions of ten feet or better might be needed. In July 1960, shortly before the launch of the first successful imaging satellite mission, the need for 20-foot resolution was reaffirmed. The value of stereo coverage was not addressed, and that potential issue soon disappeared, as the camera system adopted was designed to operate in stereo.[1]

Although the initial standing requirements lacked specific guidance concerning collection priorities, the dominance of the threat posed by the Soviet ICBM program to a large extent controlled the pattern of collection during the early years of the imaging satellite program. Long before the summer of 1960 - indeed, as soon as the USSR began to deploy strategic missiles - the Intelligence Community singled out certain regions as the most promising for launch sites. These delineations fairly quickly became quite sophisticated and, as it turned out, accurate. Twenty-three of the 26 Soviet ICBM complexes are located in or very close to regions described as likely deployment areas.

---

[1] Memorandum from Ad Hoc Intelligence Requirements Committee to Director, ARPA, 8 December 1958 (Reprinted in USIB-D-33.6/6, 10 March 1960); USIB-D-33.6/8, 5 July 1960.

Many of the basic collection concepts employed today had been enunciated by the time of the first successful flight:

> "The photographing system must be capable of obtaining coverage of denied areas at object resolutions of approximately 20 feet, 5 feet [redacted] on a side."
>
> "The system must provide for repeat coverage of targets at these various resolutions, depending on the nature of the target and the intelligence problem involved."
>
> "The periodicity of this repeat coverage will also depend on the nature of the target and the intelligence situation, as well as on other sources that can be brought to bear on it."
>
> "From an ideal point of intelligence utility, many of the high priority and highest priority targets should be covered at intervals on the order of 1 to 6 months, but the reconnaissance system should have sufficient flexibility to permit the coverage to be timed to meet the needs of the specific intelligence situation as it develops."
>
> "The photo system should be capable of obtaining coverage and readout within 24 hours on selected objectives anywhere within Soviet territory ..."
>
> "It is imperative that current, indisputable information be available on (targets where Soviet strategic strike forces are located) to accurately assess Soviet capabilities and intentions and to enable effective retaliatory strike planning ..."

agreement that a swath width "on the order of 200 miles" was needed, and the Defense Department agencies stated that the six million square miles constituting the so-called built-up areas of the Communist countries should be covered every 45 days, and the remainder of these countries should be covered every 90 days. The "practical impossibility" of obtaining complete coverage of such large areas over such short time spans was noted, however.[5]

Following its discussion of the papers submitted by the requirements committee, the USIB instructed that they be forwarded to the NRO for study and comment. Then followed more than a year of intensive activity that bore fruit in July 1964 with the USIB's endorsement of a recommendation that work proceed rapidly toward achievement of

> "A single capability for search and surveillance with a continuous stereoscopic ground coverage equivalent to KH-4 and a resolution equivalent to KH-7 ..."

This guidance was the basis for the development of the KH-9 system.[6]

With the question of image quality out of the way, the Community next turned to reconsideration of frequency and distribution. In March 1965, the USIB forwarded to the NRO guidance intended to permit the launch rates of KH-4 satellites to be sized "for the next two years or so." This guidance, the first long-term standing search requirement sent to the NRO by the USIB in nearly five years, called for cloud-free coverage of the entire Sino-Soviet area semiannually, with priority to be given to built-up parts. The impossibility of achieving complete coverage was recognized, however, and the requirement was backed up with a recommendation that a program of ten successful launches per year be planned. Statistical evaluations by the NRO had indicated that such a rate would result in coverage of about 90 percent of the Sino-Soviet landmass semi-annually.[7]

In the summer of 1966 the USIB furnished amplification of the KH-9 guidance levied two years before. The need for a swath width "at least" equivalent to the KH-4's and a resolution equivalent to the KH-7's was reaffirmed. On the basis of "the results obtained and general satisfaction with search coverage acquired over the last 18 months with the KH-4" the frequency and distribution of the required coverage was modified as follows:

> "Search Mission. KH-9 should have the capability to provide stereoscopic, cloud-free (about 90 percent) photography of about 80-90 percent of the built-up areas of the Sino-Soviet bloc (approximately 6.8

[5] USIB-D-41.14/4, 28 January 1963; USIB-D-41.14/28, 19 April 1963. In USIB-D-41.14/28, also disseminated on 19 April, the built-up areas were identified as "the European Satellites, European and trans-Ural USSR, the area within 100 miles on either side of the Trans-Siberian railroad between Petropavlovsk and Kharbarovsk, the Soviet Far East, south central Asia, the provinces of "old" China, Manchuria, North Korea, North Vietnam, and the Arctic coast during the summer period."

[6] USIB-D-41.14/36, 25 April 1963; USIB-D-41.13/11, 31 July 1964. In USIB-D-41.14/294, 21 June 1966, the Board made clear that what it had in mind was a swath width of at least 150 miles and a resolution of "3-5 feet over the total format."

[7] USIB-D-41.14/229, 19 March 1965 and USIB-D-41.14/235, 26 March 1965.

> million sq. nm.) semiannually and should provide similar coverage of about 75 percent of the undeveloped areas (2.8 million sq. nm.) annually ... In addition to search of the Sino-Soviet bloc, KH-9 should provide the capability to acquire coverage of contingency areas in other parts of the world on demand."

This guidance possessed several new features. The call for complete coverage that previously had been specified was dropped in favor of levels that experience indicated were realizable. They were, in addition, levels the Community judged to be adequate to meet essential needs - subjective judgments that were, however, based on feel rather than on technical analysis. Then too, for the first time in official guidance, the distinction between built-up and undeveloped regions was delineated on a map (see Figure 3-1). Also new at the USIB level was the Community's acceptance of imagery less than completely cloud-free as adequate for search. And new for the KH-9 was the recognition of areas outside the Communist countries that might have to be acquired.*

Coverage needs for the non-Communist countries were not expected to exceed three million square nautical miles annually.

The requirement also described a non-search role to be performed by the system:

> "Surveillance Mission. In recognition of the capability of the KH-9 to obtain high resolution area coverage...we believe it appropriate to specify frequency of coverage in terms of surveillance of geographic areas representing target clusters ... Based on target distribution, we have identified about one hundred clusters ranging in size up to 120-mile by 120-mile areas in which approximately 70 percent of current targets are located."

Although potential cluster areas had been identified, no delineations were included in the USIB guidance, and the NRO was told that experience with KH-9 collection would have to precede confident identification of collection frequencies; until then, "for planning purposes" it should anticipate covering 80 percent of the cluster areas quarterly.

Later in 1966, the Community brought the standing requirements for KH-4 collection into line with those established for the KH-9. Although it found the principle of obtaining complete coverage of broad areas still attractive, the Community "had learned through experience that operational considerations make the fulfillment of such a requirement highly unlikely under normal circumstances." For this reason, it endorsed a program calling for approximately ten successful KH-4 launches annually, which it believed would yield stereoscopic, cloudfree coverage of:

- More than 80 percent of the built-up areas semiannually;
- More than 80 percent of the undeveloped areas annually;
- Approximately 2.5 million square miles outside the Bloc annually;

* USIB-D-41.14/294, 21 June 1966 and USIB-D-41.14/296, 20 July 1966. Use of the KH-4 for periodic search of non-Communist countries was specified in the 1965 guidance for that system.

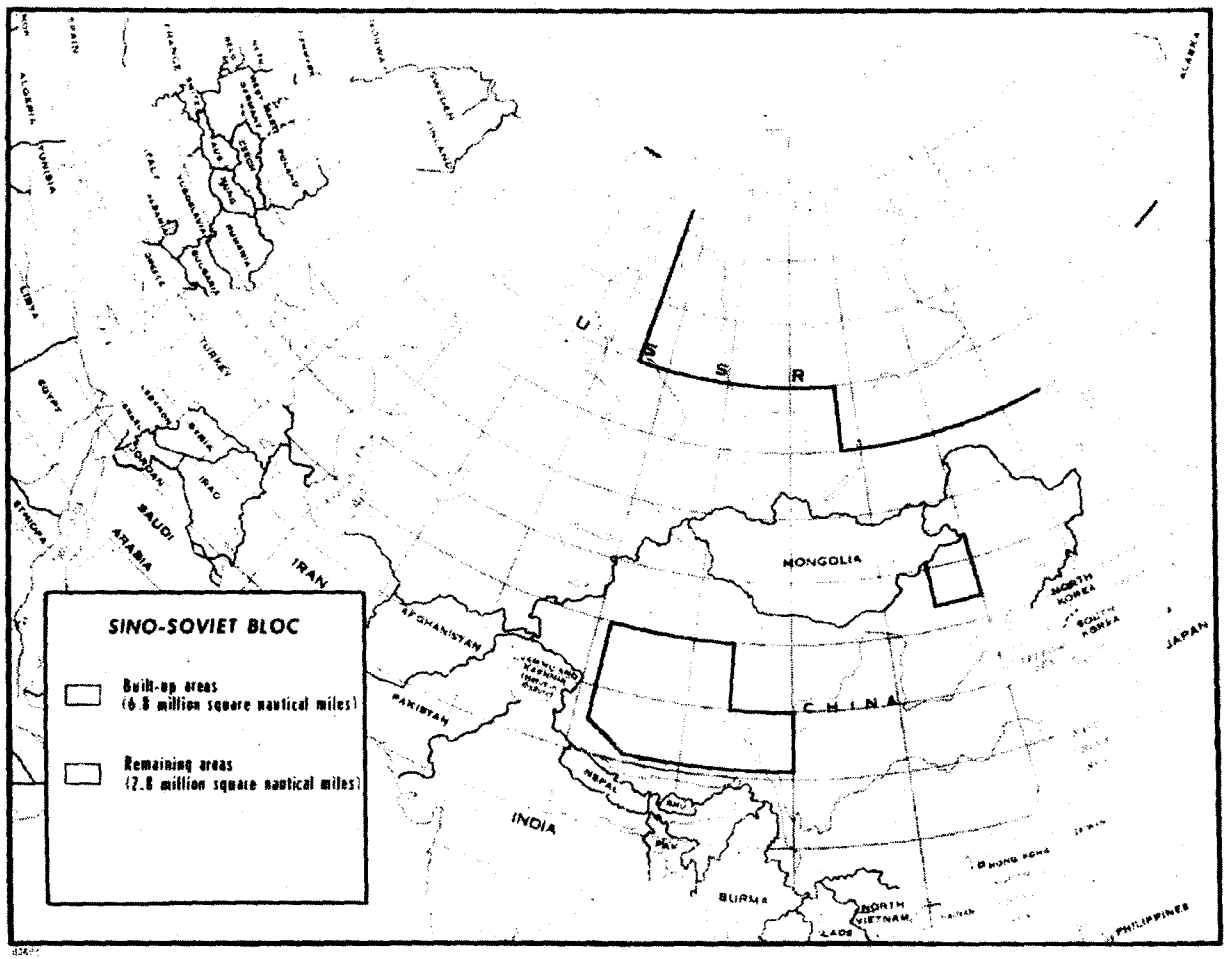

FIGURE 3-1. MAP WHICH SHOWS FIRST BREAKOUT OF BUILT-UP AND UNDEVELOPED REGIONS

KH-9 Area Coverage Objectives

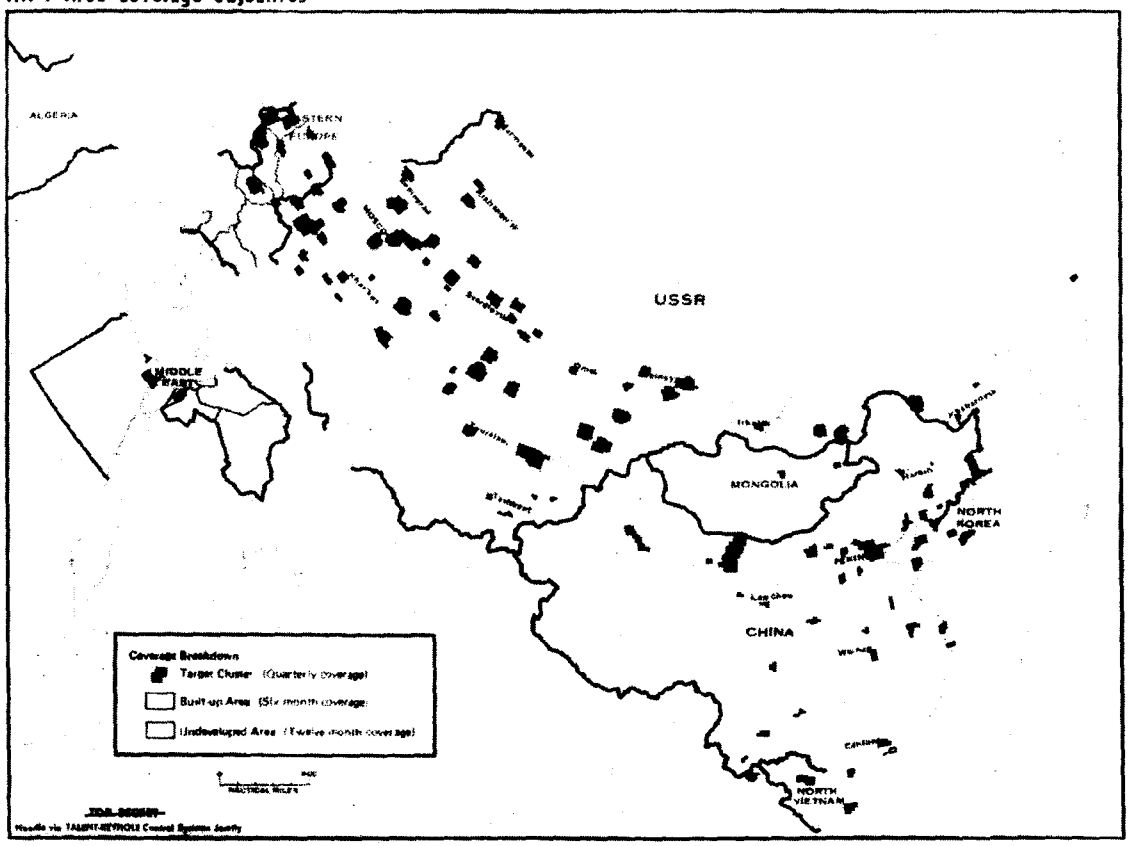

FIGURE 3-2. MAP SHOWING THE ADDITION OF TARGET CLUSTERS

air, ground, sea and space operations, and for intelligence and military planning. The geodetic data derived from satellite imagery provides the military with tens of thousands of accurate point locations needed for operation of strategic and tactical weapon systems.

Satellite imagery requirements to support these various military MC&G production activities have several different aspects. They include coverage of various areas of the world by imagery of varying degrees of resolution and metric fidelity, which includes: calibration, attitude determination (pitch, roll and yaw at instant of exposure), and accurate determination of camera location at time of exposure (latitude, longitude and elevation determined by means of a doppler device and timing marks on the film). Among the technical requirements that are satisfied in whole or in part by the current configuration of the NRP satellite systems is the derivation of specific levels of horizontal and vertical accuracy of targets and other positional data for maps and feature analysis - both on a World Geodetic System (WGS), as well as on a more localized regional datum basis.

Operational weapon systems including Minuteman II/III, Polaris, Poseidon, Lance, Pershing, B-52, and F-111 are dependent on this positional information and on maps and charts for navigation and target strike.

3.2.1 Evolution of MC&G Requirements

Military MC&G has employed satellite photography since 1960. With the aid of this photography, DMA and its predecessor organizations have produced over 50,000 different maps and charts out of a current requirement which exceeds 80,000 worldwide, levied by the Unified and Specified Commands, the Military Services and the Intelligence Community.

Photographic coverage of metric accuracy (currently provided by the KH-9 MCS) and medium to medium-high resolution (2 to 10 feet , such as that provided by the KH-9 panoramic camera) is indispensable at present, and will continue to be into the 1980s, for the production and updating of these MC&G products to support operational needs.

The satellite systems of earlier NRP projects were limited by evolving system design and state-of-the-art improvements for hardware/software components from which optimum on-orbit performance could be generated. The three-inch focal length frame cameras of the KH-4, KH-5, and KH-8 APTC (Astro-Positioning Terrain Camera) were initially employed to provide the early 1960 era worldwide MC&G coverage. This coverage has some of the features needed for metric fidelity. Much of the coverage included the stellar index camera coverage for attitude determination, but much of it does not permit positioning of points to accuracies sufficient for a significant number of MC&G products.

Only five of the KH-4 Dual Improved Stellar Index Camera (DISIC) missions had the doppler transponder which provided good positional data. About 20 million square nautical miles of KH-4 DISIC frame was collected worldwide between 1962 and 1972, and 16 million square nautical miles of KH-4 DISIC with doppler was collected worldwide between 1970 and 1971. Nearly all of the Eurasian Communist countries were covered. The KH-4 DISIC frame coverage with doppler provides accuracy of 76 meters for horizontal positioning.

Standing Requirements

Area Redelineation

[redacted] Clusters

[redacted] Built-up area

[redacted] Undeveloped area

[redacted] Remote area

[redacted] Topographically unuseable area

[redacted]

Limited Area Directed Search

	No. of Target Clusters	Total Area (in thousand nm²)
USSR	[redacted]	213
China		70
[redacted]		7
		16
		306

Broad Area Strategic Search (in thousands nm²)

	Built-up Area	Undeveloped Area	Remote Area	Topographically Unsuitable Area	Total Search Area**
USSR	2,218	2,105	2,083	327	6,866
[redacted]	302	102	0	0	404
China	1,116	922	566	143	2,817
[redacted]	48	255	153	0	456
	39	0	0	0	46
	37	21	0	0	58
	147	62	22	0	247
	3,907	3,467	2,744	470	10,894

[redacted]

**Includes total of Limited Area Directed Search

KH-5 was a frame camera system which provided MC&G coverage of more than 43 million square nautical miles from 1962 through 1964, primarily for geodetic positioning. This system had a three-inch focal length terrain frame camera and a stellar camera. Since it did not include a doppler geodetic package, this photography gives a best accuracy of only 230 meters horizontal. This material temporarily satisfied some of the early accuracy requirements for positioning, but for the 1970 time period the KH-5 coverage cannot be relied upon for production of Class A maps at scales of 1:250,000 and larger because 1:250,000 maps require a horizontal accuracy of 127 meters.

The KH-8 APTC system included a three-inch focal length frame terrain camera, which provided imagery from Mission 4301, August 1966, until the end of Mission 4340, November 1973. Since the APTC did not include a doppler geodetic package, this coverage cannot be used for accurate point positioning. APTC ground resolution was estimated to be about 180 feet compared with 120 feet for the KH-4 DISIC, and 20-50 feet for the KH-9 MCS. The APTC generally has provided an additional source of photographic coverage in areas not otherwise covered. However, this imagery source will only be used in particularly low priority areas with high cloudiness, where only small scale mapping is scheduled.

Most of the three-inch focal length photography is now out of date and cannot, therefore, be used for revising maps whose cultural information is out of date. Utilization of the three-inch coverage is more costly than is the use of the KH-9 MCS coverage. It is also questionable whether the uncontrolled three-inch frame coverage has significantly enhanced MC&G production unless controlled KH-9 MCS coverage is available.

3.2.1.1 Non-Metric Requirements

Area requirements for panoramic imagery include the entirety of the Eurasian Communist countries and approximately 22.4 million square nautical miles of the remaining land areas of the world for a total of 32.8 million square nautical miles. The collection parameters are for 90% cloud-free coverage: stereoscopic for original compilation and monoscopic for revisions and map updates. This requirement was not subdivided into priority areas; however, the compilation of panoramic requirements submitted for each KH-9 mission are prioritized. Standing search requirement areas are not tasked for MC&G collection since MC&G needs in this area are generally satisfied by panoramic imagery collected in response to Intelligence Community requirements.

Of the more than 10 million square miles in the Communist countries, roughly 1.3 million square nautical miles for original compilation remain to be covered in quality adequate for MC&G. See Figure 3-5. Approximately 2.5 million square nautical miles outside the Eurasian Communist countries required for MC&G are in tropical areas that traditionally experience extremely heavy cloud cover. Charts and maps of these areas are required but because of the poor weather resources are generally not programmed to collect these areas.

In general, original compilation coverage or recoverage of the 22.4 million square nautical miles (outside the Eurasian Communist countries) is needed to form a data bank of pan-

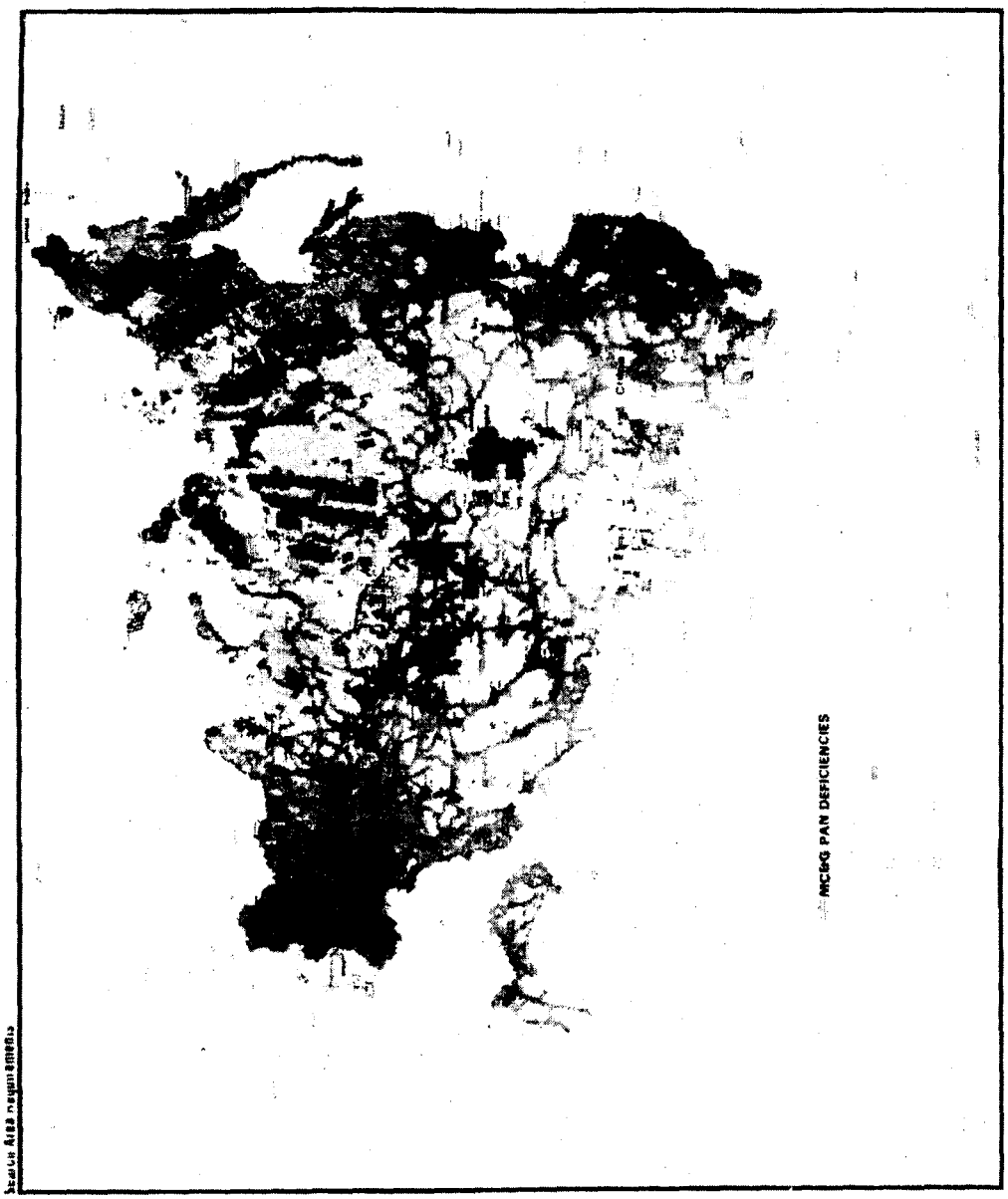

FIGURE 3-5.

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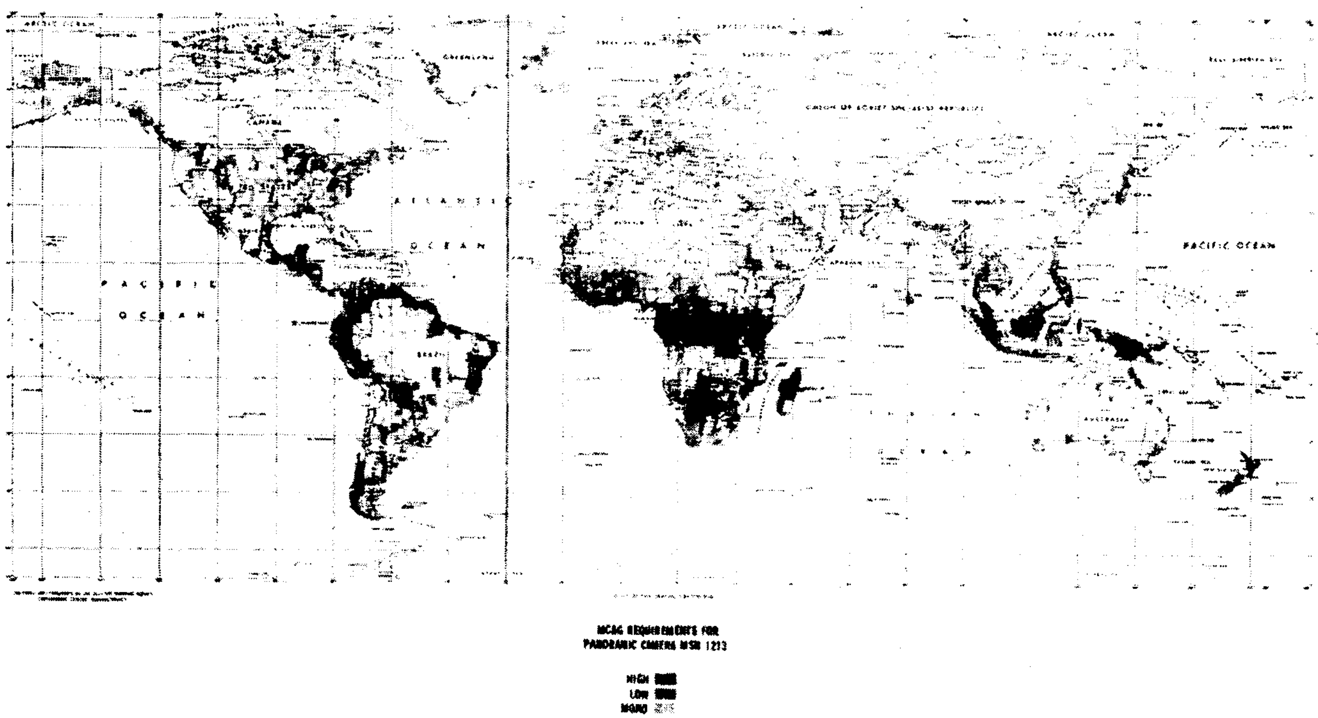

FIGURE 3-6.

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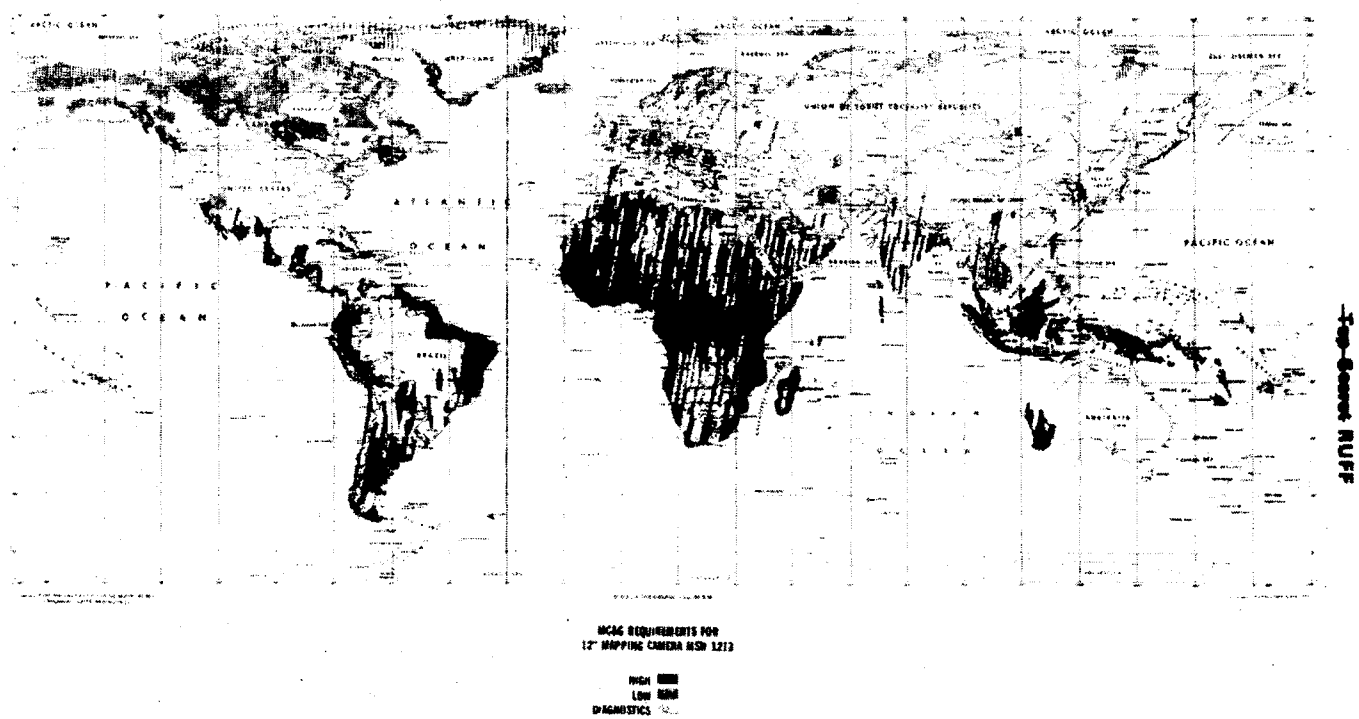


FIGURE 3-7.

3.2.2.1 Point Target Requirement

High content monoscopic satellite materials are used to update airfield features, produce large-scale city maps and generate port/harbor charts. The total validated requirement (as of FY 76) for point target coverage is 45,900 which is made up of 42,500 airfields, 1,600 city graphics, and 1,800 ports/harbors. An active target file for collection containing 3,000 prioritized point targets is maintained operationally. This file is continuously monitored and updated as point targets are accessed by satellite systems. KH-9 film is not allocated against these unique targets; however, the targets are included in the collection file to add emphasis for imaging in conjunction with MC&G and intelligence requirements. At least 2,300 targets are required per year, based on the specified sample rates.

3.2.2.2 Broad Area Non-Metric Requirements

The Broad Area MC&G coverage requirements are for both monoscopic and stereoscopic panoramic imagery to satisfy original compilation and product revision. The current KH-9 requirement is for 9.6 million square miles outside the Eurasian Communist countries. The MC&G Broad Area coverage requirement is divided into two collection categories: stereoscopic coverage which is divided into two priorities (high and low) and monoscopic coverage (see Figure 3-6, Table 3-1 and Table 3-2).

~~TABLE 3-1~~*
~~ANNUAL MC&G RECOVERAGE REQUIREMENTS FOR KH-9 PANORAMIC COVERAGE~~
FY 1972-78 USIB-Approved Non-Communist Areas*
(Stereo, 90% Cloud-Free, Millions of Square Nautical Miles)

~~Fiscal Year~~	~~Stereo~~		~~Mono~~	~~Total~~
	~~High Pri~~	~~Low Pri~~	~~Low Pri~~	
1972	1.5	0.5	0.3	2.3
~~1973~~	~~2.0~~	~~3.0~~	~~0.3~~	~~5.3~~
1974	1.5	2.5	0.3	4.3
~~1975~~	~~1.0~~	~~2.0~~	~~0.3~~	~~3.3~~
1976	0.5	2.0	0.3	2.8
~~1977~~	~~0.3~~	~~1.6~~	~~0.3~~	~~3.1~~
1978	0.0	2.0	0.3	2.3
~~Total~~	~~6.8~~	~~13.5~~**	~~2.1~~	~~22.4~~

*Excludes the Sino-Soviet Area and important areas of the Middle East, on which pan coverage is provided in response to intelligence requirements. Also incudes the U.S. Geological Survey requirement for coverage of 0.3 million square nautical miles of the U.S. annually.

**Military recoverage requirements for non-Communist areas extend beyond FY 1978 at an annual rate of 2.0 million square nautical miles. This requirement is a continuing one, to satisfy requirements for periodic updating of MC&G products.

TABLE 3-4

[illegible]

(Stereo, 80% Cloud-Free Millions of Square Nautical Miles)

Region	USIB Approved	Total DMA WAG Cell Area Requirements	Remaining Requirement
Sino-Soviet Area	10.2	10.4	1.9
Eurasia	5.2	6.4	2.1
Africa plus Sinai	8.8	8.8	6.2
North America	5.2[1]	5.7[1]	4.7
South America	5.4	5.5	4.8
Other	2.2[2]	4.0	3.5
Total	37.0	39.8[3]	23.2

[1] USIB-approved requirements excludes 1.2 million square nautical miles of the US.
[2] Australia only.
[3] The USIB-approved requirements converts to 39.4 million square nautical miles in the DMA ACRES file which uses WAG cells for area delineation. Recent mission requirements have totaled 39.8 million square nautical miles which include the USGS Antarctica request of 0.4 million square nautical miles.

As indicated in Table 3-4, a technical objective to support advanced weapon systems with 23 meters (CE 90% probability) with reference to the WGS is the driving future requirement for the horizontal accuracy portion of the military MC&G products. This technical objective, which would be in direct support of both the Advanced MX-ICBM and the new Cruise Missiles, would require repositioning all of the targets in the National Target Base (NTB).

The NTB currently consists of approximately 42,000 targets used by strategic forces in the implementation of the Single Integrated Operations Plan (SIOP). The accuracy requirement for positioning targets in the NTB has become incrementally more stringent, as weapon systems have improved, from over 300 meters in the mid-60's to a current requirement of 62 meters horizontally.

Stringent vertical WGS accuracies related to the NTB, Short-Range Attack Missiles (SRAM) radar reference points and mini-bloc data for B-52 penetration route planning are concentrated in the Sino-Soviet areas. Present validated requirements call for 29 meters LE at 90% probability vertical accuracy in positioning of the NTB targets. The technical objective for the Advanced MX-ICBM is 17 meters at 90% probability for the NTB targets. Other vertical requirements are shown in Table 3-4.

Measuring KH-9 performance against MC&G collection requirements is, to a large extent, more straightforward given that the system delivers the required image quality and mode (mono or stereo), and the necessary data for point positioning at the required accuracies. The most significant evaluation criteria is the gross cloud-free square nautical miles returned by mission.

4.1 Coverage Statistics

Three types of coverage statistics are presented in this section - gross coverage, age distributions, and NIIRS distributions.[1] Gross coverage statistics are presented for both area search and point target surveillance. These statistics show area attempted, area cloud-free, and film used. Age distributions are graphical ways of viewing KH-9 effectiveness in meeting the standing search collection objectives. NIIRS distributions provide a means for assessing the interpretability of the imagery.

Two types of NIIRS distributions are presented in this section - point ratings and area ratings. The point ratings are ratings assigned to point targets by the photointerpreter during the exploitation process. These ratings are generally applied while viewing the imagery in stereo and are maintained in the Installation Data File (IDF) by NPIC.

The area ratings are applied during the search exploitation process. Unlike the point ratings, they are applied to large areas. They are assigned to film segments. For film exposed within 30 degrees of obliquity, the ratings are assigned for every 15 degrees of obliquity and for every 7-1/2 degrees of obliquity for film exposed outside 30 degrees. Area ratings are assigned while viewing the imagery monoscopically. The ratings are maintained in the National Area Exploitation File (NAEF). Most of the KH-9 imagery receives an area NIIRS rating.

The ratings contained in both files represent a single photointerpreter's assessment of the imagery. For large samples, the difference in mean rating between point ratings and area ratings is about .4 NIIRS units with the point ratings being higher. This is due primarily to the fact that the point ratings are assigned while viewing the imagery in stereo at higher magnifications and the mono ratings are assigned at lower magnification while viewing the image monoscopically.

4.1.1 Performance Summaries for Broad Area Search

4.1.1.1 Gross Coverage Achievements

Table 4-1 summarizes the gross coverage achievements of all past KH-9 missions. It shows also the number of unique COMIREX targets imaged by each mission. The total imaging capacity of the KH-9 system has averaged about 19 million square nautical miles per mission. The first three KH-9 missions were flown at higher altitudes and employed higher

[1] The NIIRS rating system became operational in 1974. Until its advent there was no systematic way of assessing the overall interpretability of imagery produced by satellites. It was designed for application to point targets, but soon after its development it was applied to search imagery. The first KH-9 mission to be NIIRS rated was 1207.

TABLE 4-2
KH-8 Coverage-Mission 1209
(29 October 1974—7 March 1975)

Collection Category	Size of Area (million sq nm)	Percent Film Used	Coverage (million sq nm)		
			Attempted Gross	Cloud-Free Imagery Acquired	
				Gross	Unique
Primary Intelligence					
USSR	6.7	46.7	8.9	6.8	4.9
[redacted]	.4	5.5	1.1	.7	.4
China	2.8	22.1	4.2	3.6	2.4
[redacted]	.5	2.2	.4	.4	.4
[redacted]	.1	2.2	.4	.2	.1
[redacted]	.5	5.1	1.0	.7	.4
Subtotal	11.0	83.8	16.0	12.4	8.6
Other					
Free World	35.9	10.6	2.0	1.6	1.4
United States**	2.8	5.6	.6	.5	.4
Total	49.7	100.0	18.6	14.5	10.4

*Includes portions of [redacted]

**US coverage includes MC&G (military and civilian) and Engineering Calibration.

TABLE 4-4

[redacted] COVERAGE

[redacted]

	[redacted] Sq. NM.	[redacted]	[redacted]	[redacted]	[redacted]
Primary Intelligence					
USSR	6.87	47.2	10.83	8.91	5.00
[redacted]	.40	4.8	1.14	.63	.33
China	2.82	19.8	4.36	3.63	2.25
Other	.56	3.3	.67	.55	.38
Total Communist Countries	10.65	75.1	17.00	13.72	7.96
[redacted]	.25	4.9	.61	.37	.20
Free World	38.50	13.8	4.61	3.14	2.34
Subtotal	49.40	93.8	22.22	17.23	10.50
Other					
U.S.	2.84	6.2	.87	.10	.09
MC&G (incl Military)**		2.0	.28	.06	.06
Test/Engineering		1.8	.08	.02	.01
Pre-launch Film Tests		1.0			
Special Intell. Support		0.4	.11	.01	.01
Direct Civil Applications		1.0	.40	.01	.01
Grand Totals	52.24	100.0	22.09	17.33	10.59

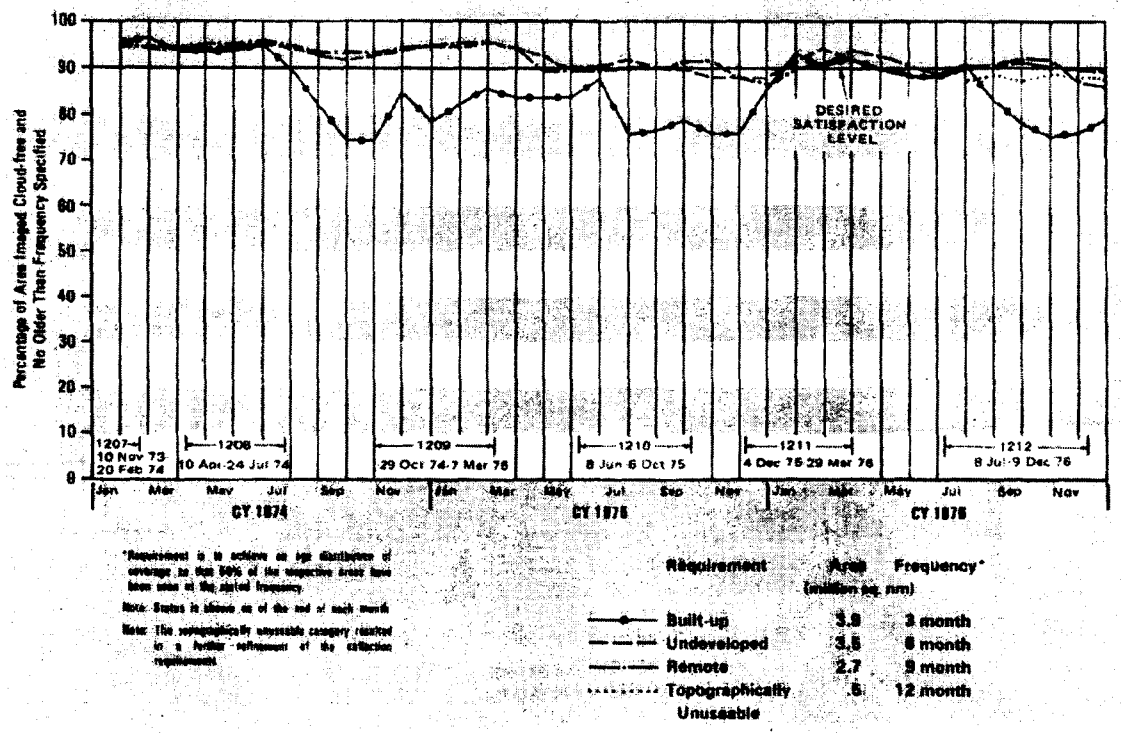
[redacted]

**The square nm of USGS coverage includes a portion that supports both the military and civilian mapping users

***High coverage levels resulted from necessity to operate mission primarily in the monoscopic mode

FIGURE 4-3

Status of Search Coverage Satisfaction for Primary Requirements (Jan 74 thru Dec 76)
90% Level

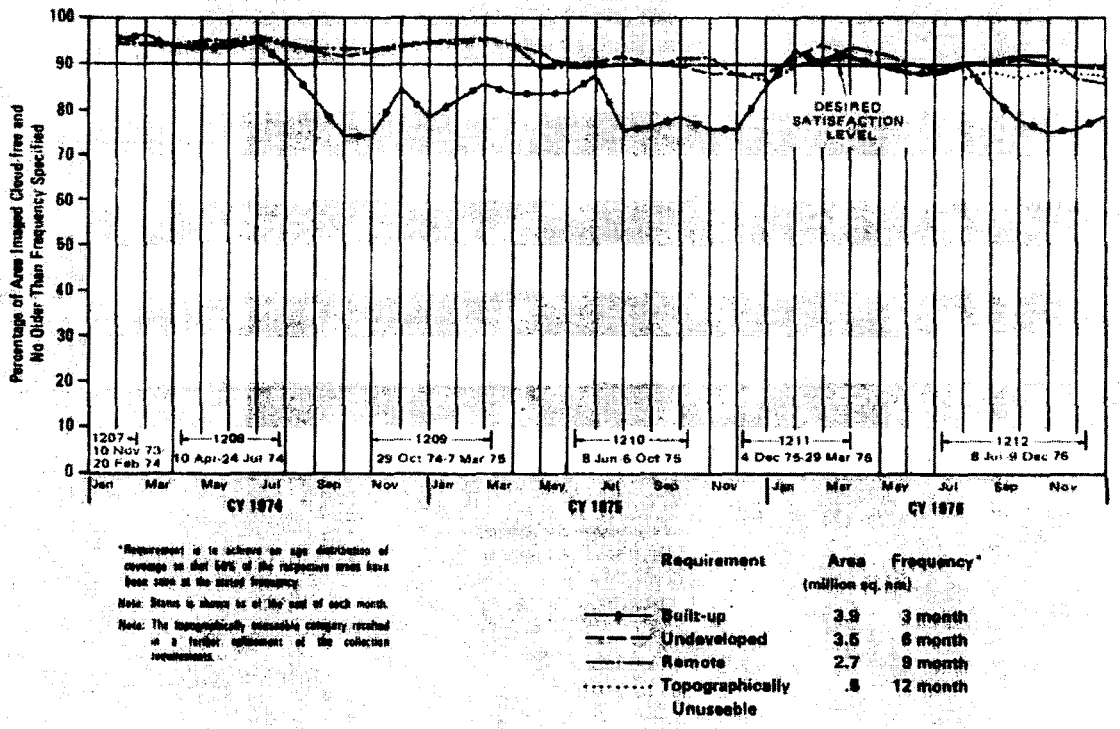


*Requirement is to achieve an age distribution of coverage so that 90% of the respective areas have been seen at the stated frequency.

Note: Status is shown as of the end of each month

Note: The topographically unusable category resulted in a further refinement of the collection requirements

FIGURE 4-3
Status of Search Coverage Satisfaction for Primary Requirements (Jan 74 thru Dec 76)
90% Level



*Requirement is to achieve an age distribution of coverage so that 90% of the responsive areas have been seen at the stated frequency.

Note: Status is shown as of the end of each month.

Note: The topographically unseeable category resulted in a further refinement of the collection requirements.

Requirement	Area (million sq. nm)	Frequency*
Built-up	3.9	3 month
Undeveloped	3.5	6 month
Remote	2.7	9 month
Topographically Unseeable	.8	12 month

FIGURE 4-5
NAEF NIIRS DISTRIBUTION AND CUMULATIVE DISTRIBUTION FOR KH-9 MISSION 1210

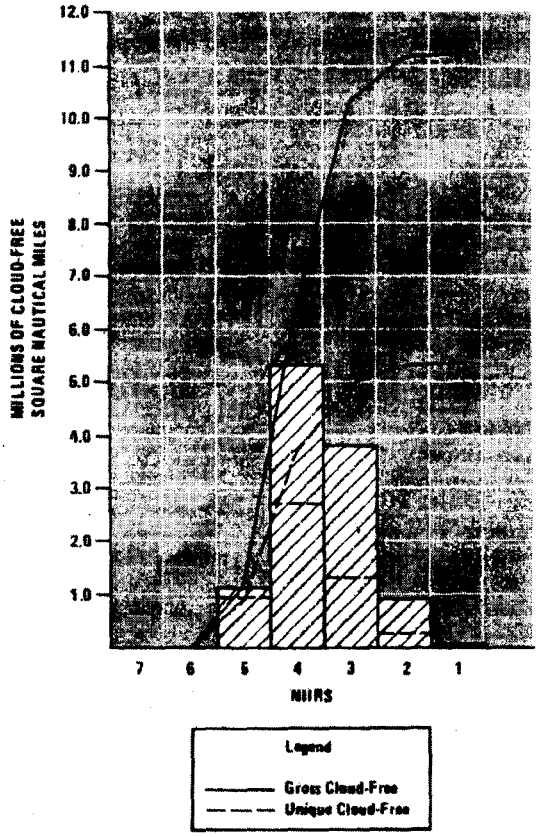


FIGURE 4-7
NAEF NIIRS DISTRIBUTION AND CUMULATIVE DISTRIBUTION
FOR KH-9 MISSION 1212

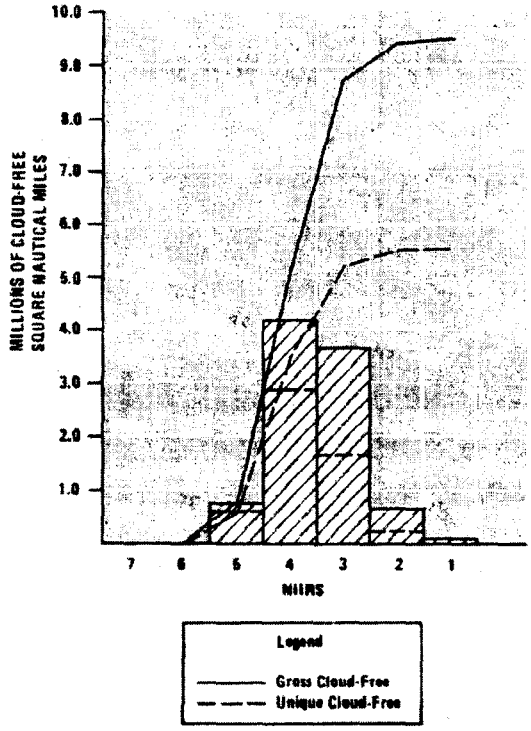


FIGURE 4-8

NIIRS DISTRIBUTION AND CUMULATIVE DISTRIBUTION OF UNIQUE [redacted] COVERED ON KH-9 MISSION 1210

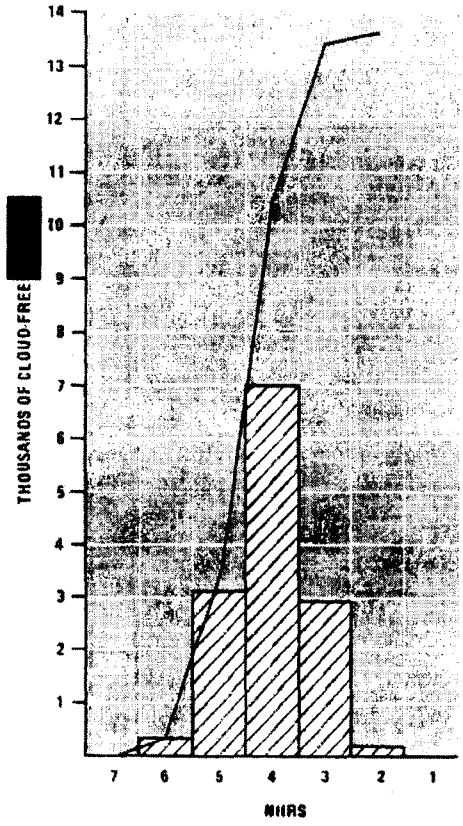


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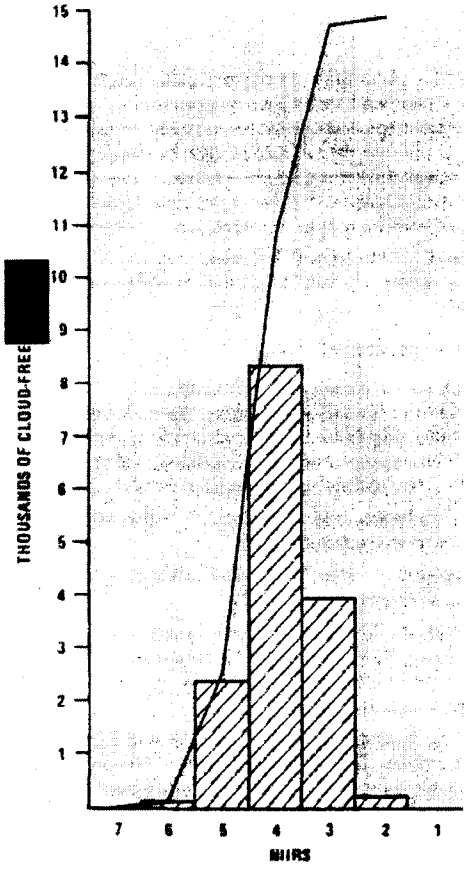
FIGURE 4-10

NIIRS DISTRIBUTION AND CUMULATIVE DISTRIBUTION OF UNIQUE [redacted] COVERED ON KH-8 MISSION 1212



[redacted]