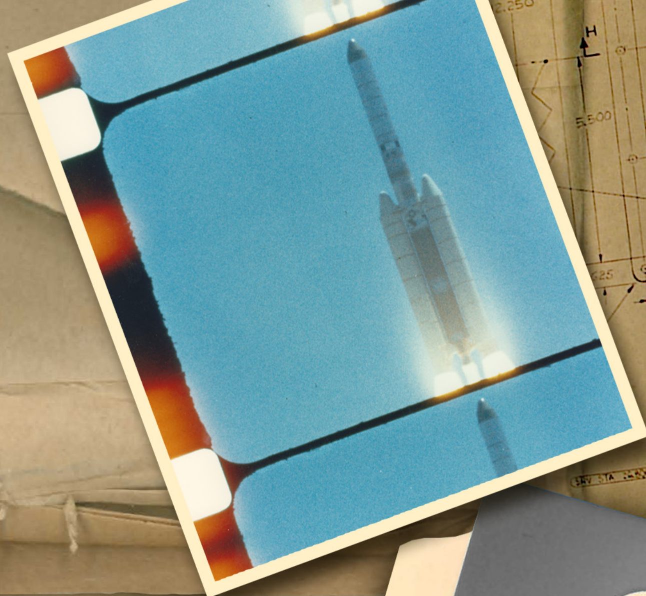

CRITICAL TO US SECURITY:
THE GAMBIT AND HEXAGON SATELLITE RECONNAISSANCE SYSTEMS COMPENDIUM

NATIONAL RECONNAISSANCE OFFICE
UNITED STATES OF AMERICA

CRITICAL TO US SECURITY:
THE GAMBIT AND HEXAGON SATELLITE
RECONNAISSANCE SYSTEMS COMPENDIUM

JANUARY 2012

CRITICAL TO US SECURITY:

THE GAMBIT AND HEXAGON SATELLITE RECONNAISSANCE SYSTEMS COMPENDIUM

EDITED BY JAMES OUTZEN, PH.D.

CENTER FOR THE STUDY OF
NATIONAL RECONNAISSANCE

JANUARY 2012

CENTER FOR THE STUDY OF NATIONAL RECONNAISSANCE

The Center for the Study of National Reconnaissance (CSNR) is an independent National Reconnaissance Office (NRO) research body reporting to the NRO Deputy Director, Business Plans and Operations. Its primary objective is to ensure that the NRO leadership has the analytic framework and historical context to make effective policy and programmatic decisions. The CSNR accomplishes its mission by promoting the study, dialogue, and understanding of the discipline, practice, and history of national reconnaissance. The Center studies the past, analyzes the present, and searches for lessons-learned.

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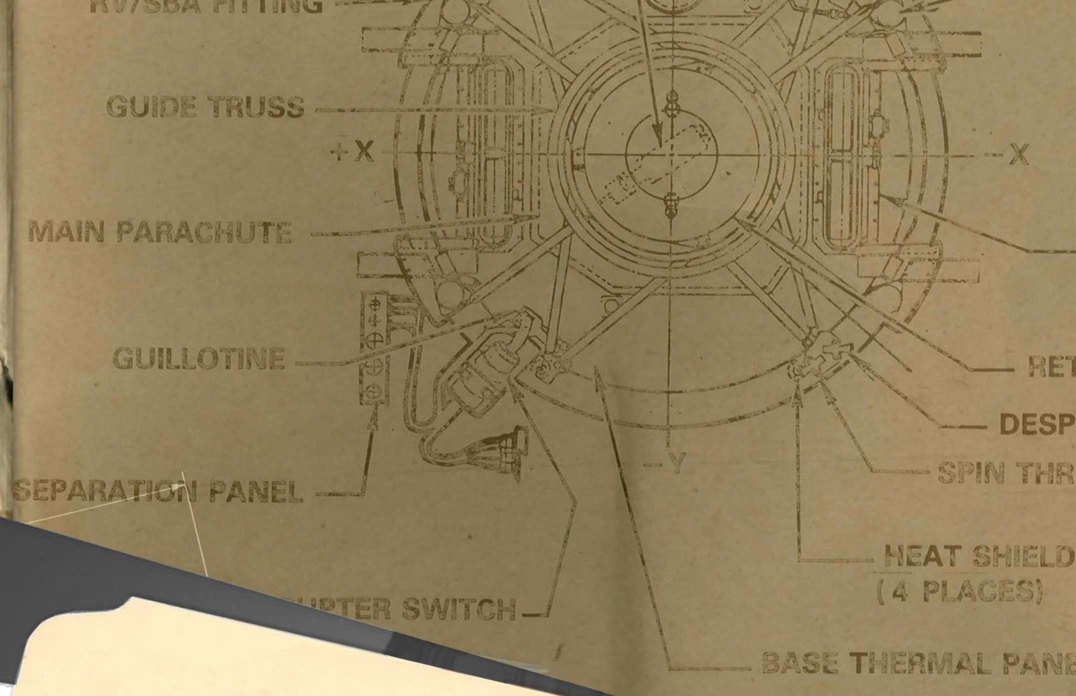

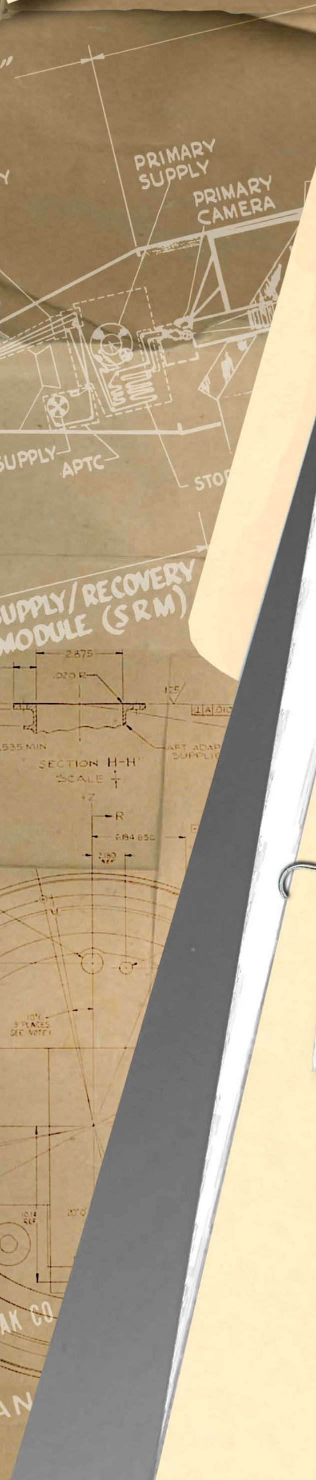

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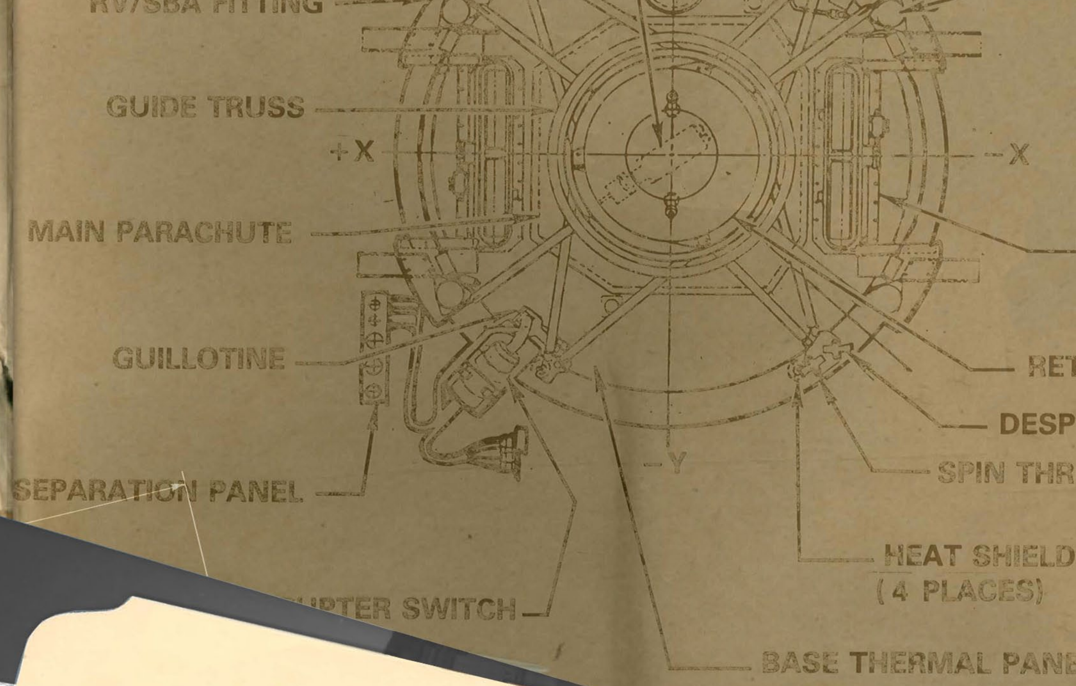

CRITICAL TO US SECURITY:

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FOREWORD

I am pleased that the Historical Documentation & Research (HDR) Section of the Center for the Study of National Reconnaissance (CSNR) has produced this collection of Gambit and Hexagon documents titled Critical to US Security: The Gambit and Hexagon Satellite Reconnaissance Systems Compendium. This will give researchers in the Intelligence Community and academic world an opportunity to preview some of the program documents that the National Reconnaissance Office (NRO) will be declassifying and an opportunity to study the history and background of these two phenomenal film-return satellite reconnaissance programs as reflected in these documents.

I personally have been involved in efforts to declassify the Gambit and Hexagon satellite programs for over a decade. The declassification process has been slow and deliberate because these two systems have represented state-of-the-art capabilities that even in 2011, on the occasion of the NRO's 50th Anniversary, remain impressive. The CSNR conducted a series of assessments of the risks of declassifying program details and consulted with experts across the Intelligence Community. There has been extended dialogue to ensure that the Intelligence Community continues to protect any capabilities, the disclosure of which might adversely impact on current operations. National reconnaissance is a much too valuable national treasure for its secrets to be lost to compromise.

During the past decade, I have come to understand the importance of these programs on a number of levels. First, the then newly established NRO developed these systems relatively early in its history, and that activity helped forge the way for the NRO to develop and operate satellite systems. Second, the systems provided essential data to intelligence users and valuable information to national security policymakers, thereby making the NRO an essential organization for succeeding in the intelligence battles of the Cold War. Third, the systems proved essential for teaching the NRO how to transition from successful programs to new programs that promised even greater capabilities. In short, these programs are cornerstones of the NRO's history and architects of its culture of success.

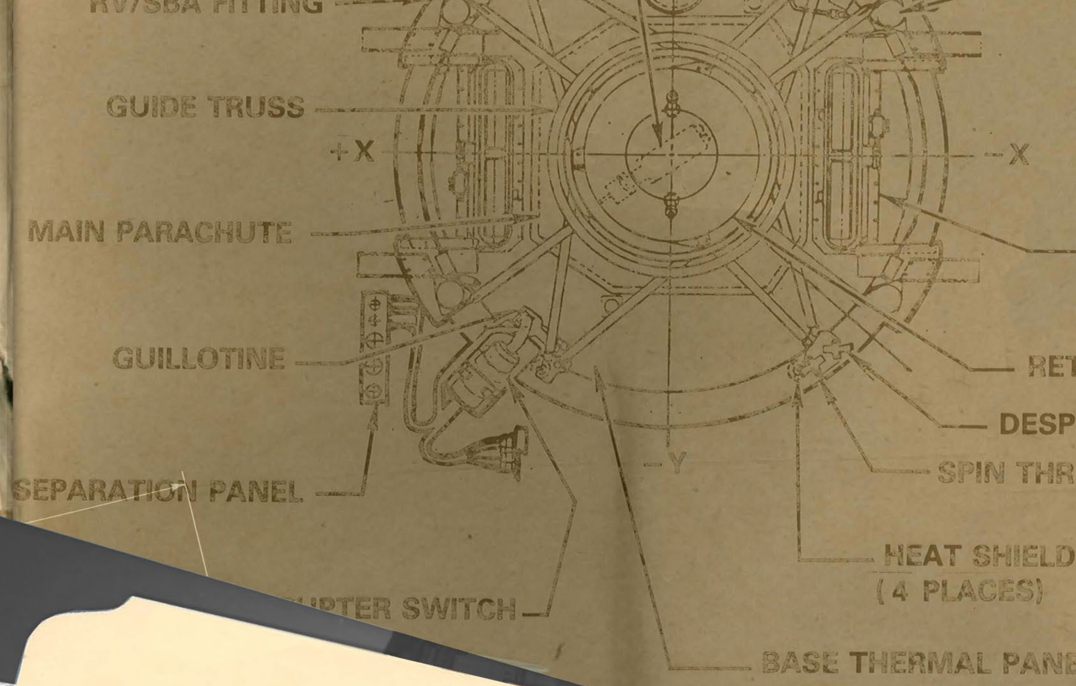
The NRO developed the Gambit and Hexagon satellite photoreconnaissance systems to satisfy intelligence requirements that date back to at least the mid 1950s. Dr. James Outzen, the NRO Historian, selected the documents contained in this compendium to provide the reader with information on the history, capabilities, and technical contributions of these programs.

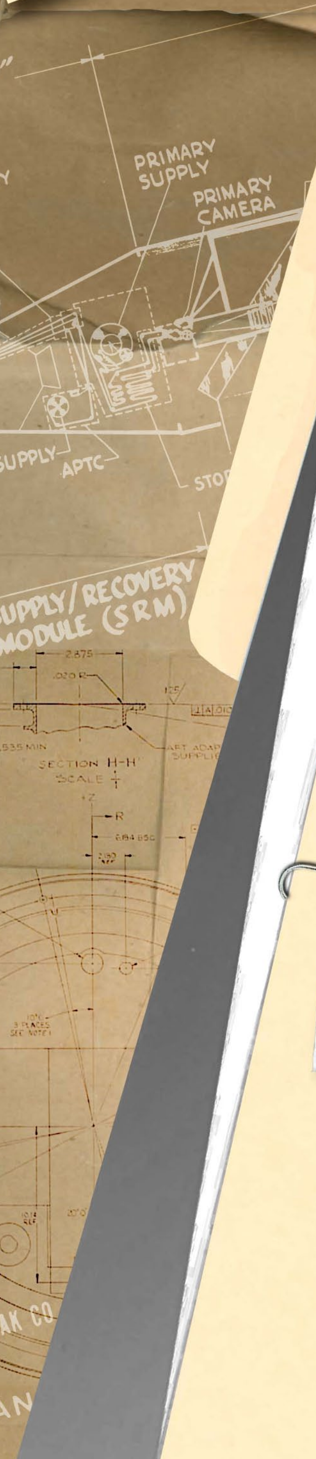
The first section of this volume is a short history of the Gambit and Hexagon programs prepared by the NRO's first historian, Dr. Gerald Haines. Dr. Outzen and I chose this history because Dr. Haines wrote it for the occasion of the declassification of the programs—something we had anticipated years earlier, but only became possible in 2011, the 50th Anniversary of the NRO. We have additional document sections in this compendium that contain primary source documents on the initilization of each of the systems, intelligence requirements for the systems, and capabilities and contributions of the Gambit and Hexagon systems, as well as the controversies surrounding the systems and recognition of the systems successes.

Based on the intelligence requirements for these programs and the information contained in the compendium, I anticipate the readers of this compendium will gain an appreciation of the roles Gambit and Hexagon played in the NRO's history. I also expect that the compendium will help readers understand the intelligence reasons for developing the programs, the challenges in meeting the intelligence imperatives, and the successes of the programs. The readers should come away from reviewing this volume with insight applicable to their own efforts to assure the United States' success in gathering intelligence by using satellites.

Although not exhaustive, the compendium will provide a hearty introduction to the dynamics surrounding the development, operation, and termination of these important overhead reconnaissance systems. This compendium is an opportunity to have an early look into a formerly highly classified world of national reconnaissance.

Robert A. McDonald, Ph.D.
Director, Center for the Study of National Reconnaissance
Business Plans and Operations
National Reconnaissance Office





CRITICAL TO US SECURITY:
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PREFACE

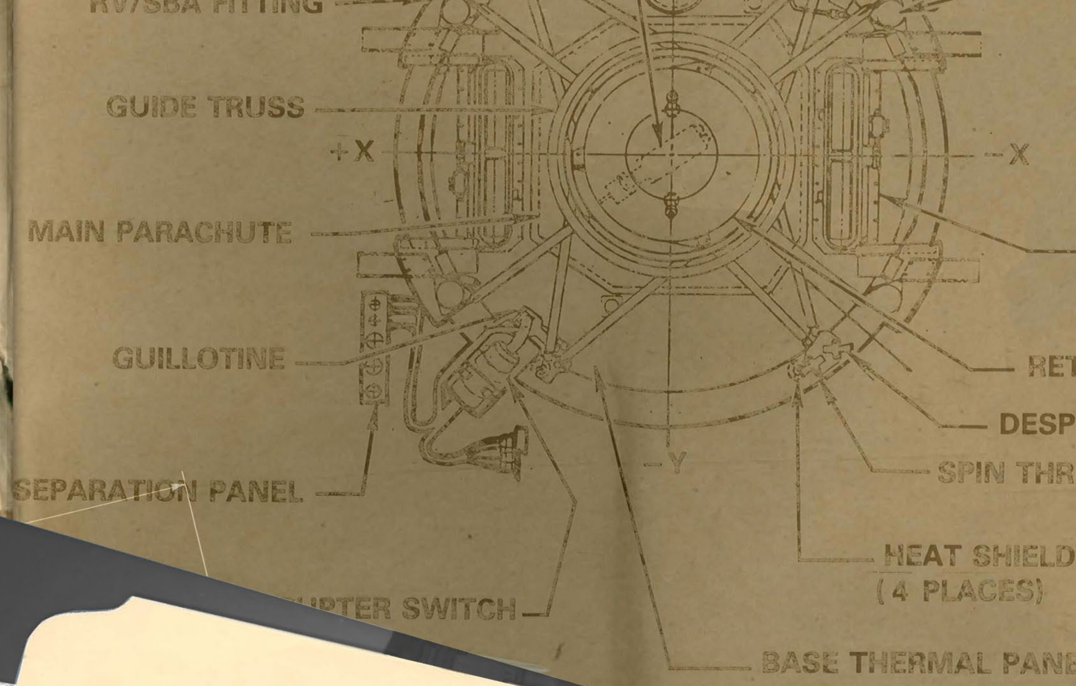
This compendium of documents related to the Gambit and Hexagon satellite programs was inspired by a practice initiated with the 1995 declassification of the Corona satellite reconnaissance program. A few months after the declassification announcement for the Corona program, the Central Intelligence Agency (CIA) published a similar volume edited by Kevin Ruffner. Like the CIA's Corona compendium, we wanted to include a basic history of the Gambit and Hexagon systems. Dr. Gerald Haines, the NRO's first historian wrote a history of the Gambit and Hexagon systems that was unpublished up to this point. Dr. Haines finished the history in 1997 in anticipation of the declassification of the Gambit and Hexagon programs. We are pleased to publish the history for the first time in conjunction with the 2011 Gambit and Hexagon declassification announcement. To enhance the history, we have also included photographs and graphic illustrations that were used to explain the capabilities of the two systems.

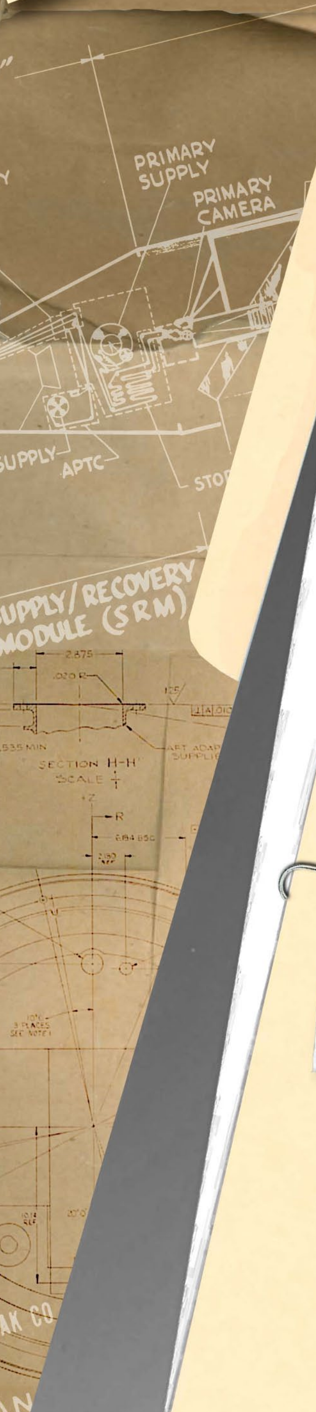
A much more challenging task was to identify documents to include in the compendium in order to explain the development, launch, and operation of the Gambit and Hexagon systems. The difficulty arose from an abundance of documentation for all of the systems. To determine which documents to include, I conducted document reviews at the CIA records center, the NRO records center, and NRO field sites where documentation still resided for the programs. I also reviewed a small number of Hexagon documents complied by the NRO's Public Affairs staff.

From these efforts, I identified some 4,000 pages of documentation for consideration to include in this volume. After this initial selection, I sorted the documents into main themes that characterize the histories of the Gambit and Hexagon systems. Those themes include program requirements, program initiation, system capabilities, technological contributions, controversies surrounding the programs, and recognition of program successes. The challenge then was to select documents representative of these themes. I made the selections that best described important elements relevant to each theme. Unlike the Corona volume, we are not able to include later Gambit or Hexagon panoramic imagery. This imagery remains classified at this writing.

As with any major publication, there are many individuals who are responsible for completing the project. I express appreciation to the NRO records center. Their staff provided outstanding help in locating dozens of boxes of records for me to review. Likewise, I express my appreciation to the staff at the CIA's record center who located many boxes for my review related to the CIA's development of what would become the KH-9 camera system for Hexagon. I express appreciation to the NRO's Public Affairs staff, for sharing documents located through part of their research process. During the summer of 2011, four interns for the Center for the Study of National Reconnaissance (CSNR) provided invaluable assistance with this effort. Steve Glenn and the records declassification staff for the NRO provided incredible support in reviewing several hundred pages of documents for release. Without their efforts, this project would never have been completed The Director of the CSNR, Dr. Robert A. McDonald, provided not only essential support, but valued wisdom in developing this volume. Finally, none of this would have been possible without the editing, layout, and graphic design work by the CSNR support staff.

James Outzen, Ph.D.
Chief, Historical Documentation and Research
Center for the Study of National Reconnaissance





CRITICAL TO US SECURITY:
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INTRODUCTION

After the 1960 success of the Corona program, users of imagery intelligence developed growing appetites for more space based photoreconnaissance. During the more than two and a half decades that followed, the United States operated three additional film-return satellites. They were named Gambit, Gambit-3, and Hexagon.

The introduction of the Gambit system in 1963 provided the United States with the ability to take higher resolution images of specific targets. This complimented Corona's wide area coverage. Gambit allowed the United States to carry out "surveillance," or ongoing tracking of known targets. Corona's wide area coverage allowed the United States to continue to "search" broad areas of the Soviet Union and China in order to locate the targets such as intercontinental ballistic missile sites, nuclear test sites and facilities, and other strategic and tactical land, air, and naval targets. Search and surveillance from space became a key strategic capability for the United States to fight the Cold War.

The National Reconnaissance Office (NRO) developed Gambit-3 to further improve resolution for surveillance of targets identified by Corona imagery or other sources of intelligence. First launched in 1966, Gambit-3 incorporated a number of technological changes to not only improve resolution, but also increase the length of time the system operated, the amount of coverage, and control of the system.

Hexagon was developed to improve resolution of wide-area search imagery captured by the Corona program. Hexagon's developers introduced a primary camera system that produced imagery of high enough resolution to fulfill some search requirements as well. Later Hexagon missions would also include a mapping camera system to aid possible Cold War military operations. The NRO launched the Hexagon system in June 1971, replacing the Corona program that developers originally only expected to last two years. Hexagon would be the last of the nation's four film return imagery systems that, together, provided insight into the U.S. adversaries' military capabilities.

Gambit and Hexagon moved the Intelligence Community closer to meeting the intelligence requirements that prompted the development of space imagery systems. The requirements can be traced back to as early as 1955 for what would become the Air Force's Samos program. First and foremost, the United States needed satellite imagery systems that could provide "instantaneous warning of ballistic missile attack(s)" by the Soviet Union. The requirements also included supporting U.S. war planning, understanding the intentions of possible U.S. adversaries, and determining the military capabilities of those enemies.

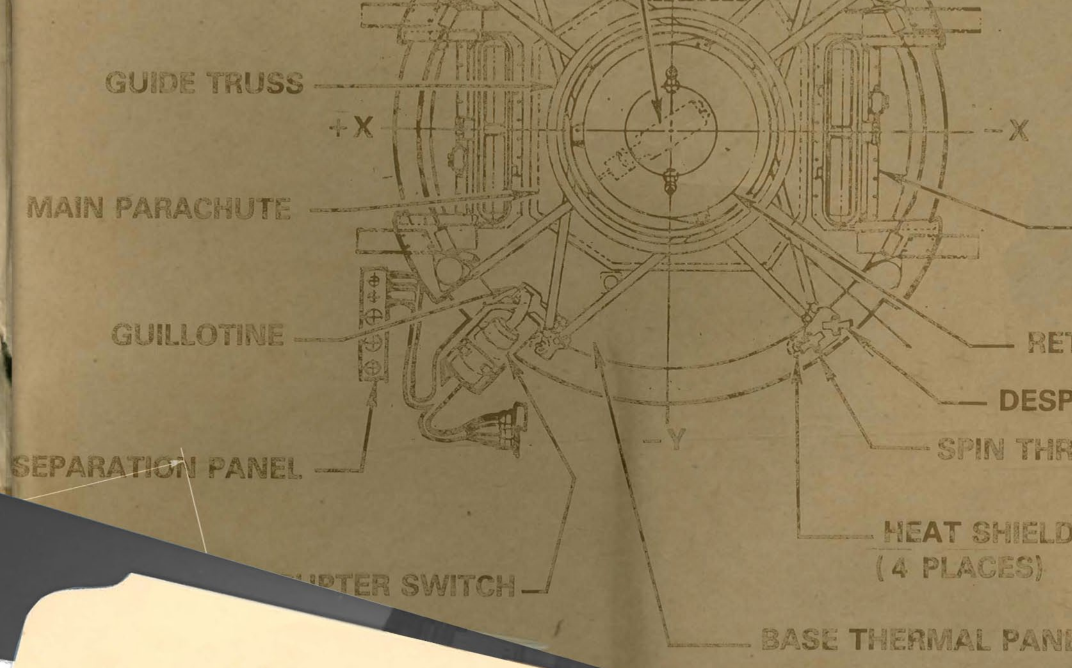
The historical record indicates that Corona and Gambit were essential for assessing the Soviet nuclear strike capabilities in the 1960s. The systems worked hand in hand, with Corona imagery first identifying nuclear facilities and then Gambit providing detailed information on those facilities. By the end of the 1960s, while U.S. concerns about the size of Soviet nuclear remained, the United States began to focus on curtailing those nuclear capabilities. Gambit and Hexagon would also become essential resources for helping achieve this end.

The United States and the Soviet Union entered the 1970s actively pursuing control of nuclear arms. The Strategic Arms and Limitations Talks (SALT) resulted in an agreement to control development of antiballistic missiles as well as an interim agreement on limitations on nuclear weapons development. By this time, the Hexagon system was operational and replaced Corona for wide area search requirements. Hexagon satellites joined later Gambit satellites in serving as a primary means for verifying Soviet compliance with the agreements reached through the SALT process.

As the systems neared the end of their lifespans in the mid-1980s, they remained a key resource for nuclear arms limitation verification. The systems also served as a means for gaining insight into other intelligence issues that would arise over their lifespans. Together, Gambit and Hexagon yielded intelligence information that assisted the President of the United States, as well as U.S. military, diplomatic, and intelligence officials to make better informed decisions on matters of national security.

Eventually the costs, both in terms of money and time, would lead to the replacement of Gambit and Hexagon by near-real-time imagery systems. Gambit and Hexagon would remain highly regarded for their technological innovations and invaluable contributions to the defense of the United States. The contents of this volume are intended to help the reader understand and appreciate this high regard for the Gambit and Hexagon imagery satellite systems.

James D. Outzen, Ph.D.
Compendium Editor



CRITICAL TO US SECURITY:

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SECTION I: HISTORY

WRITTEN BY GERALD HAINES, PH.D.

OVERVIEW

Since the early 1960s, U.S. policymakers have come to rely increasingly on photoreconnaissance satellite imagery for timely and accurate intelligence. Photoreconnaissance satellites and the information they provide have become virtually indispensable to the U.S. Intelligence Community and its intelligence assessments. Developed, operated, and managed by the National Reconnaissance Office (NRO), these satellite systems sparked a revolution in intelligence collection. Operating in a crisis atmosphere, the NRO forged a unique working partnership with U.S. private industry partners to design and build these new satellite systems. The NRO/industry partnership drove space reconnaissance technology beyond current limits. It made possible a new generation of photoreconnaissance technologies that resulted in the acquisition of never-before-seen, detailed intelligence data for U.S. officials.

Corona, the first U.S. reconnaissance satellite program ushered in this new era in intelligence. A stop gap film recovery system, Corona focused primarily on the Soviet Union and other denied areas. Corona imagery provided U.S. decisionmakers with vital information on Soviet weapons development, order-of-battle, and its nuclear program. During the 1960s, Corona satellites were this nation's primary search system. Covering wide swaths of the Soviet Union, Corona cameras swept the Soviet land mass for signs of missile development and nuclear testing activity. Although its contribution to U.S. intelligence was "virtually immeasurable," Corona imagery also had limitations. In 1961, for example, it could resolve no object smaller than 10 to 15 ft. U.S. photointerpreters and U.S. planners needed, and demanded, higher resolution imagery for their intelligence estimates relating to Soviet weapons systems and target identifications.

To fill this gap, Director, NRO (DNRO), Joseph Charyk, pushed the development of a high-resolution spotting satellite system, Gambit. Also known as the KH-7, Gambit was to provide resolution better than 2 ft. After overcoming a series of developmental problems, both technical and managerial, the first Gambit satellite flew in July 1963. The returned film product whetted the appetite of U.S. intelligence analysts for more. Although Gambit, a surveillance system, covered far less area than Corona, it produced photography with a much better resolution, for example, objects as small as 6 ft could now be located and observed.

An improved Gambit, known as Gambit-3 or the KH-8, flew in 1967. Capable of stereo photography, it proved highly successful replacing Gambit-1. The Gambit program eventually flew 54 missions over 20 years, concluding in 1984. It provided U.S. officials with unique, highly detailed imagery of sensitive targets, and became a major tool for photo analysts during the Cold War.

Film-recovery payloads culminated with the development of the Hexagon series of satellites. Approved for design and development by the United States Intelligence Board (USIB) in 1964, the Central Intelligence Agency (CIA) designed Hexagon as both a high resolution and wide area coverage system. It was one of the largest and most complex reconnaissance satellites ever built. Known to the American public as "Big Bird," it was 10 ft in diameter and 55 ft in length. It rivaled the National Aeronautics and Space Administration's (NASA's) Space Lab in size. Hexagon featured two panoramic counterrotating optical-bar cameras and four recovery capsules (later Corona and Gambit satellites carried two). Later Hexagons also contained a fifth capsule to return film from a separate mapping camera. Accompanying stellar and terrain cameras in Hexagon made it possible to extract mapping, charting, and geodetic data for the Defense Mapping Agency and other organizations of the Intelligence Community. The NRO launched twenty Hexagon's between June 1971 and April 1986. The only failure to mar this remarkable satellite program occurred on the twentieth and last flight when the launch booster exploded above Vandenberg Air Force Base, California on 18 April 1986.

In the 1980s, the next generation of U.S. photoreconnaissance satellites (which eliminated the need for film return) replaced both Gambit and Hexagon. During their years of operation, however, Gambit and Hexagon proved invaluable to U.S. policymakers. For much of the Cold War, these systems kept watch over the Soviet Union and other communist bloc areas. They proved critical to U.S. security by providing detailed intelligence on U.S. adversaries. Their search and surveillance capabilities also made possible arms limitation negotiations and the verification of nuclear reduction treaties.

This study traces the origins and development of the Gambit and Hexagon programs. It details the technological problems, breakthroughs, and accomplishments encountered as NRO, CIA, Air Force, and private industry engineers, designers, and program managers pushed the cutting edge of space reconnaissance technology. It outlines the evolving close partnership and working relationship between the NRO and industry in pursuing far-reaching scientific and technological goals. This study also describes the bureaucratic battles among the CIA, the NRO, and the Air Force over control and management of these systems. Finally, it places the development of these unique satellite systems squarely in the crisis atmosphere of the Cold War and the constant demands of U.S. officials for more and better pictures. It is a remarkable story.

BACKGROUND

Deeply concerned over Soviet boasts about the success of their missile program and the growing "missile gap," controversy, President Dwight D. Eisenhower, despite reservations, authorized a U-2 penetration flight of the Soviet Union for 1 May 1960. The Department of State and the CIA strongly supported the decision. The intelligence objective of gathering information on the Soviet missile program was overwhelming in spite of the dangers.

The most experienced U-2 pilot, Francis Gary Powers was selected to fly Operation Grand Slam. According to CIA analysts, this route offered the best chance of photographing suspected locations of Soviet Intercontinental Ballistic Missile (ICBM) sites. Powers' first target was the Tyuratam Missile Test Range; he was then to head for Chelyabinsk, just south of Sverdlovsk. Powers never made it past Sverdlovsk. Four and a half hours into the mission, a Soviet SA-2 Surface-to-Air Missile (SAM) disabled his aircraft 70,500 ft above the Sverdlovsk area. The Soviets had succeeded in downing the United States' most advanced reconnaissance aircraft. When Eisenhower finally admitted U.S. responsibility for the U-2 overflight, he suspended all future U-2 flights over the Soviet Union. The United States was now primarily blind regarding Soviet missile advancements.

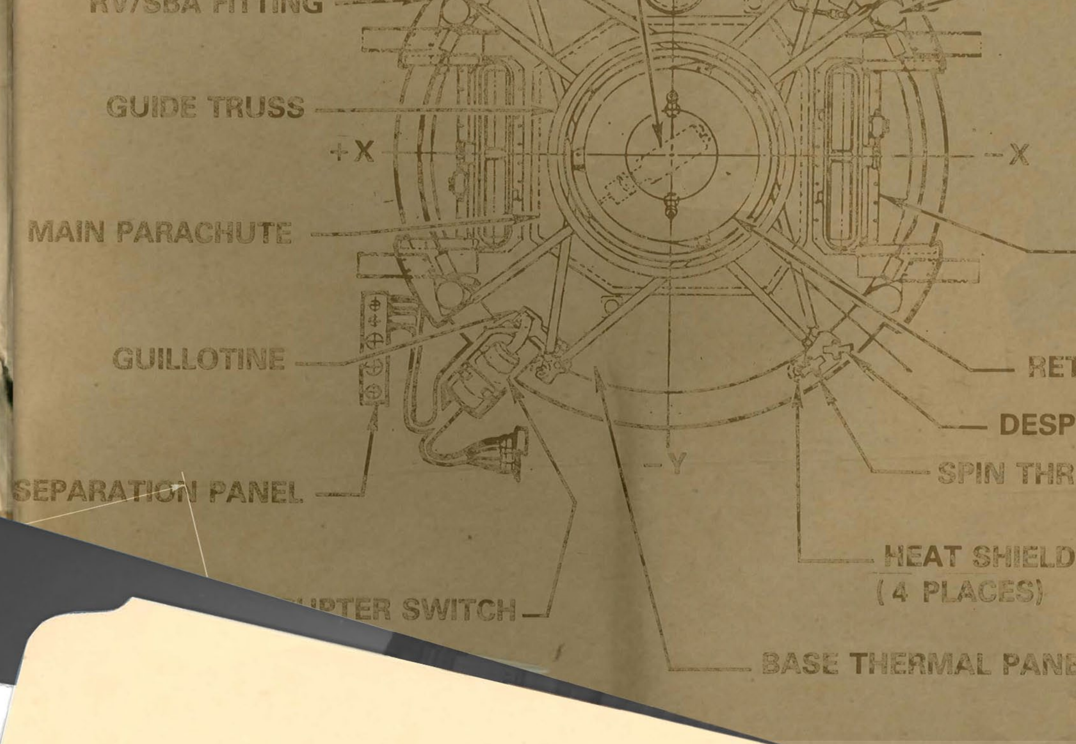
At the same time the U-2 was successfully overflying the Soviet Union, 1956 through 1960, and following the dramatic Soviet space successes in 1957 with Sputnik I and Sputnik II, President Eisenhower formally endorsed a stop-gap U.S. satellite program in February 1958. The new Corona project, managed jointly by the same CIA-Air Force team, which had built the U-2, was to produce a satellite imaging reconnaissance system that would take pictures from space and deorbit a capsule with film back to earth. Like the U-2, this was a bold initiative to counter the closed societies of the Sino-Soviet bloc.

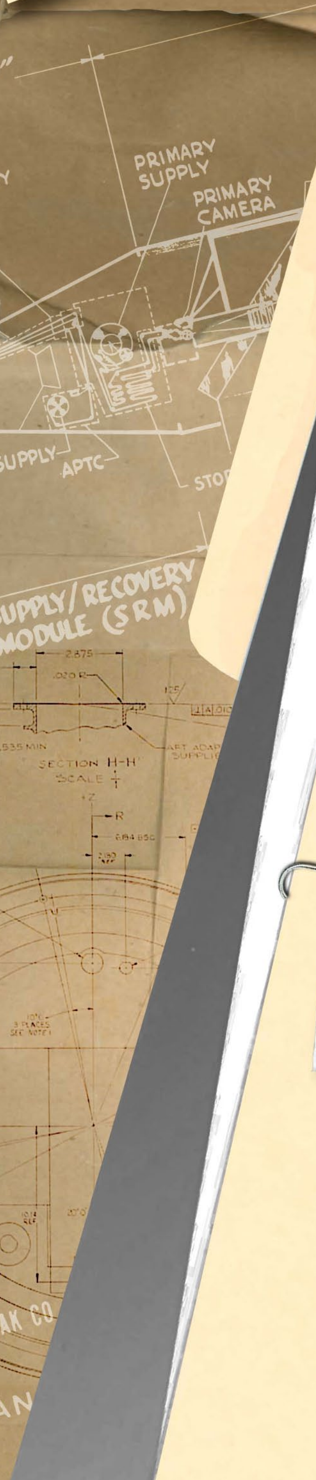
A string of twelve successive failures, however, threatened to end the Corona program before it even succeeded in returning a single film capsule from space. As the failures continued to mount, CIA Deputy Director for Plans, Richard Bissell and his Corona team became frustrated. It was not like the development of the U-2 where, if something failed, the pilot, unless it was a fatal error, could usually relate what happened. With satellites, according to Bissell, "they spun out of control, burned up in the atmosphere, crashed, hopelessly lost in the ocean, or exploded. Because the whole system was destroyed on reentry, it was often impossible to retrieve it and do an assessment."

Discouraged, on 10 August 1960, the Corona team launched a diagnostic payload in an attempt to determine what was going wrong. The launch from Vandenberg, AFB, California, was perfect, the Agena rocket sent the spacecraft into the proper orbit, and on its 17th revolution, it successfully returned to earth, the first payload from space.

Buoyed by this success, the CIA/U.S. Air Force team launched a camera-equipped Corona on 18 August. Like the earlier mission, Corona Mission 9009 worked perfectly and deorbited its film payload on Friday, 19 August 1960, exactly 100 days after the Soviets shot down Powers and his U-2. The two recoveries did not make a successful program, however. Of the next four launches, only three went into orbit and one of these suffered a camera failure.

Corona Mission 9013, recovered on 10 December 1960, revealed Soviet construction work on its SS-6 missile sites at Plesetsk and at Yurya. Photoreconnaissance was beginning to pay off. Corona photography obtained in June 1961 also revealed a new Soviet missile project around Leningrad. Some CIA analysts believed this new system was an Antiballistic Missile (ABM) system designed to counter U.S. intermediate-range missiles. The John F. Kennedy administration, anxious over this new development, turned to the CIA and the Corona program for more data. Corona, however, was not able to perform the required task. Even its newest camera, the stereo KH-4, known as Mural, was not good enough to provide technical data on the design of objects as small as a SAM. Moreover, Corona engineers were still grappling with keeping the satellite cameras in focus. According to the Satellite Intelligence Requirements Committee (SIRC), new U.S. satellite systems were needed that could resolve objects as small as 6, 1.5, and 0.3 m. Corona cameras called only for a resolution of 6 m. This was in accordance with its role of performing wide-area, low resolution "search" missions.





CRITICAL TO US SECURITY:
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GAMBIT

ORIGINS OF THE PROGRAM

The NRO Gambit satellite program evolved from the Air Force's larger developmental plans for building reconnaissance satellites—the WS-117L program in the mid-1950s. As originally envisioned, the Air Force sought to create a multifaceted satellite observation system. Little came of these efforts, however, as the Department of Defense (DoD) struggled to eliminate “non-critical” defense expenditures and the Eisenhower administration stressed a “space for peace” theme. Following the Soviet space successes of 1957, however, Defense Secretary Neil H. McElroy authorized the acceleration of WS-117L to proceed “at the maximum rate consistent with good management.”[7]

Upon the urging of his civilian scientific advisors, President Eisenhower in 1958 ordered a small part of the WS-117L program, a satellite with a returnable film capsule, be taken from the Air Force overall program and given to the same team that had built the U-2—the CIA's Richard Bissell and the Air Force's Brig Gen Osmond Ritland—for quick development. Corona was to be a stop-gap measure until the larger Air Force effort produced results.

In the aftermath of the U-2 shoot-down, the suspension of U-2 operations over the Soviet Union in May 1960, and the mounting failures of the Corona and Samos programs, U.S. officials urgently sought new sources of high resolution reconnaissance photography.[8] The imagery was critical to U.S. national security interests.

The U-2 shoot-down triggered a series of top level meetings on the status of the Air Force's Samos programs. The Eisenhower decision to stop all aircraft overflight operations meant the loss of high-resolution observation of the Soviet Union. Even if Corona achieved success, and at this point it had not, there was an immediate need for much better resolution than it could provide. George B. Kistiakowsky, who had succeeded James Killian as President Eisenhower's science advisor, was pessimistic about the Samos programs.

On 26 May 1960, Eisenhower directed Kistiakowsky to set up a group to advise, as quickly as possible, the best way to expand satellite reconnaissance options. Kistiakowsky turned to James Killian, Edwin H. Land, Carl Overhage of Lincoln Laboratories, Richard M. Bissell, Jr., and Air Force Under Secretary Joseph V. Charyk. They all echoed Kistiakowsky's concerns over Samos and suggested a DoD streamlined, super-Corona program. Charyk also argued strongly for keeping the program in the Air Force. If given the chance, Charyk believed he could create a successful covert satellite program within the Air Force.

On 25 August 1960, Eisenhower approved the recommendation of the Kistiakowsky Study Group. Charyk got his wish and Samos became part of a new Air Force organization known as the Air Force Project Office, which subsequently became the Secretary of the Air Force Special Project Office (SAFSP). The new Samos project office in Los Angeles was to be housed in the same building as the new Space System Division. It would have direct access to all Air Force resources: an Atlas booster; an Agena spacecraft; a launching site at Vandenberg AFB; tracking and control services at Sunnyvale, California; and recovery services at Oahu, Hawaii. Brig Gen Robert E. Greer became the first SAFSP director. He had previously been the Air Force's assistant chief of staff for guided missiles. At the same time, under a security strategy called “Raincoat,” Charyk hid the sensitive space program by forbidding any publicity releases on an Air Force space project.

Another factor that affected the Gambit program was the formal establishment of the NRO in September 1961. Now, all national collection requirements went through the NRO and its Satellite Operations Center (SOC) located in the basement of the Pentagon. Joseph Charyk and Richard Bissell, Jr. became the first co-DNROs and Gambit became the first full-scale venture of the new organization. Charyk assigned the Gambit Project to Program A (Air Force) at SAFSP. It proceeded independently from the Corona project and the CIA satellite effort (Program B).

GAMBIT DEVELOPMENT

In March 1960, Eastman Kodak submitted proposals to the Air Force and the CIA for the development of a 77-in (focal length) camera for satellite reconnaissance. Building on its development work for the CIA's Oxcart aircraft program, Kodak suggested that the new high performance catadioptric lens camera might be suitable for satellites.[9]

In June, Kodak proposed a 36-in camera system to provide convergent stereo coverage of Soviet territory. Termed “Blanket,” Kodak claimed the new system could be made operational in a short period of time because it was based on existing technology from the Oxcart program. Kodak officials, Arthur Simmons and Herman Waggershauser, showed the proposal to Edwin H. (Din) Land, one of Eisenhower's scientific advisors. Land enthusiastically brought the proposal to the attention of Air Force Under Secretary Joseph V. Charyk. Charyk, too, was interested. He liked the Kodak proposal, a film-only recovery scheme like Corona with a very high-acuity, long focal-length camera. In discussion with Charyk, Kodak officials confidently projected the feasibility of providing a surveillance camera with 2- to 3-ft around resolution with high-acuity stereo coverage.

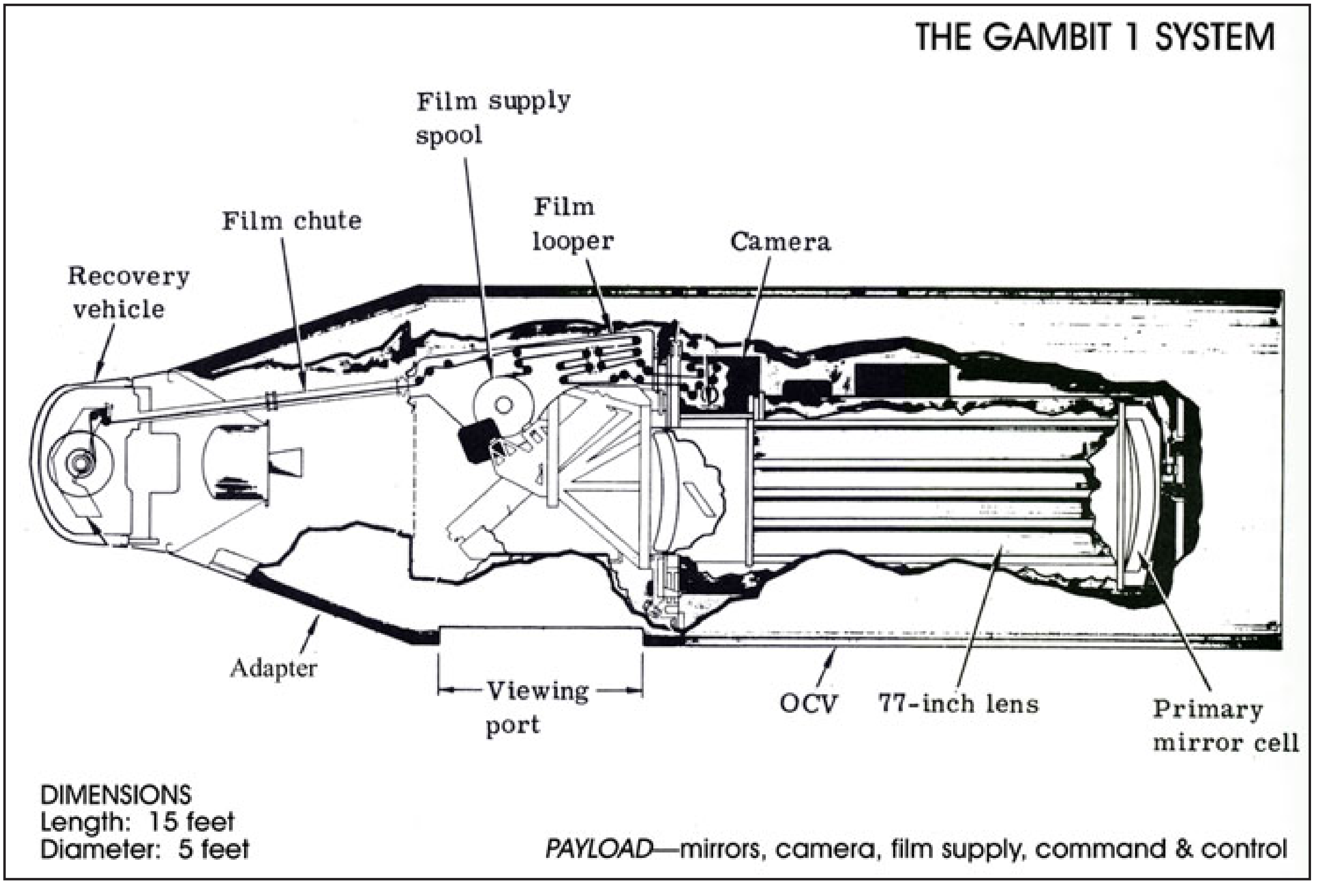
A month later, on 20 July, Kodak offered a modified proposal, which integrated the 77-in camera with the stereo features and film recovery techniques embodied in "Blanket." It termed the new proposal "Sunset Strip" after the popular television series. This was promising technology for new orbital reconnaissance systems.

In September 1960, Charyk met with Greer, Col Paul J. Heran (Chairman of the E-6 Source Selection Board) and Lt Col James Seay (Greer's procurement chief) to review proposed satellite programs. All agreed to proceed with both E-6 (which had the potential of being twice as good as Corona) and the Kodak "Sunset Strip" proposal. Charyk directed that "Sunset Strip" be developed on a cover basis, hidden in the E-6 program. He set initial funding for research and development study funds for the balance of FY 1961. Greer named the new "black" program Gambit. By keeping the physical and environmental limitations of E-6 and Gambit compatible, it seemed possible to develop and test Gambit without any outward indication that such a program existed.

At the same time Charyk moved to hide the Gambit project, he also shielded it from the overall Air Force Samos program, cutting out the Strategic Air Command, the Air Force Ballistic Missile Division, and the Air Force System Command. They all objected strongly to "losing" Samos. Charyk later reflected that it was extremely difficult limiting "need to know" especially when everyone believed they were working on a strategically important program. On the one hand he was telling them that Samos was extremely important and on the other that it would be drastically cut back.

Since the 77-in camera development program was well publicized, Charyk and Greer followed the earlier Corona precedent. They terminated the Kodak study contract for "Sunset Strip" as "no longer required" and simultaneously authorized Kodak to continue the development as a covert effort. As the "Sunset Strip" activity closed and Kodak personnel nominally shifted to other Kodak projects, they actually moved into a new facility in a different building and resumed their work. In establishing the Corona program, Bissell and Ritland followed much the same procedures.[10]

The complex, involved, security procedures for Gambit "cover and deception," in retrospect seem overdone. There were few challenges or threats to the system or the disclosure of Gambit.



Gambit-1 configuration

Samos Nose Cone

GETTING PICTURES

While putting the rather elaborate security system in place, both Charyk and Greer agreed that their real job was to “get pictures,” the objective of the national satellite reconnaissance program. Although Charyk initially balked at Eastman Kodak's demand for a 7-percent profit margin on camera development, by January 1961, he and Kodak had reached agreement.

Greer supported Kodak. According to Greer, the fee was not excessive. He based his judgment on the U-2 camera expenses and Kodak's “unique capability.” Moreover, the 25 August National Security Council directive ordered the Samos “take to be processed by the same agency that processed U-2 take”—Eastman Kodak. There were no alternatives. General Electric's (GE’s) Space Division was to build the orbital-control vehicle. By mid-1961, Gambit had evolved into a 15-ft long, 5 ft in diameter space vehicle.

The Gambit payload embodied a Maksutov f/4.0 lens (both reflecting and refracting elements) similar to an astronomical telescope with a 77-in focal length and a clean aperture of 19.5 in. This lens, when flown at a nominal 95 rim altitude was to produce an around resolution, at nadir, from 2 to 3 ft. Gambit was to carry 3,000 ft of 9.5-in diameter, thin-base film through a strip camera, which would provide image-motion compensation by moving the film across the image exposure slit at the same velocity that the projected image moved over the earth. The camera would image a strip on the earth 10.6 nm wide. It possessed the capability of photographing specific targets, which were off the immediate orbital track through oblique pointing. The planned weight of the total photographic system was 1,154 lbs.

The high resolution requirement for Gambit imposed a need for accurate orbit maintenance over a period of several days and for an ability to rotate the camera section about the vehicle's roll axis. The GE Orbital Control Vehicle (OCV) was to be capable of varying the roll attitude from 0 to 45 degrees and of performing 350 roll maneuvers at an average role of one per second. The command system was to receive, accept or reject, and execute both real-time or stored commands.

The attitude control system was a two-axis gimballed platform on which were mounted infrared horizon scanners and an integrating gyroscope. The horizon sensors measured pitch and roll error; the gyro measured yaw error. Control movements were dependent on several jet-nozzle apertures. A set of four rocket engines, each capable of producing 50 lbs of thrust, would provide orbit maintenance.

The initial Gambit launch vehicle was an Atlas Agena-D. The Atlas used 123 tons of liquid oxygen and refined kerosene (RP-1) to power the booster engines—each generating 154,500 lbs of thrust and a 57,200-lb thrust sustainer engine. The Agena-D upper stage used 13,234 lbs of fuel to power its 16,000-lb thrust engines.

After exposure, the camera's film was wound up in the Recovery Vehicle (RV). At the end of the mission, the RV was separated from the OCV, spun up on its axis of symmetry by a cold-gas system, and then deboosted from orbit. Parachute deployment was to occur at 55,000 ft. The initial recovery vehicle was intended for land recovery. In fact, in October 1961, Charyk approved the use of the Wendover AFB in Utah for Gambit land recovery operations. At this point, both Kodak and GE appeared to be ahead of schedule in completion of their design concept. By 1 August 1961, a Gambit launch date in January 1963 appeared possible.

Even with progress in the Gambit program, by January 1962, the need for an on-orbit, high-resolution, photographic reconnaissance system was even more critical. The Samos E-5 program had been cancelled after a series of failures and Corona was experiencing operational difficulties. DNRO Charyk, under constant pressure to get quick and effective results from the satellite reconnaissance program, wanted to accelerate the pace of Gambit development and improve its product. In discussions with Greer and Quentin A. Riepe, the program director for Gambit, however, it soon became clear that serious problems remained and any quick fixes would seriously degrade the photography. There was general agreement that the earliest possible date for the initial launch would be May rather than February 1963.

PROBLEMS

The National Security Council (NSC) program directive in 1960 approving Gambit specified the development of a land recovery program. In the climate of the early Corona program, land recovery appeared to be a useful option, less risky, more reliable, and less costly than the ocean recovery used by Corona. Moreover, the projected weight of the Gambit RV would exceed the capability of the C-119 recovery aircraft. By July 1962, however, the reasons for distrusting air-sea recovery methods seemed less valid. The improving capability of the Corona RV and the good performance of the overwater recovery system convinced Greer of the feasibility of using a Corona-like RV on Gambit.

The Gambit RV was then 500 lbs over design weight and most of the overweight derived from complications introduced by the land recovery requirement. Overwater recovery, as developed in the Corona program, seemed to Greer a very simple process when compared to the planned land recovery scheme. In its descent toward the ocean, a Corona reentry vehicle could safely shed all sorts of accessories—hatch covers and ablative cones, for example. They simply fell into the ocean and sank. A land recovery vehicle could shed nothing, lest it became a lethal projectile. Greer asked GE to do a quiet study of "gluing the Discoverer capsule on the front end of Gambit."

Greer was attracted to the concept by the potential of major savings on weight, cost, and launch schedule. More than 600 lbs of orbital weight could be saved by going to an overwater recovery mode. Facility funds for the Wendover range could be cut from the budget. Most importantly, with a modified Corona RV, Gambit could maintain its launch schedule. After listening to the various arguments, including the Gambit program office, which felt that the land recovery approach was still the better option, on 18 September Charyk authorized Greer to begin immediate development of a Corona-type recovery system for Gambit in preparation for a June 1963 first flight date.

The switch to a Corona-type water recovery vehicle markedly simplified the entire Gambit system and probably saved the program. It did not, however, eliminate all problems. While work on the camera payload at Eastman Kodak continued to progress, major problems threatened the launch date schedule. The optics for Gambit were to be larger and lighter than any previously built for space including the primary and stereo mirrors. Using large boules of very pure fused silica glass, engineers joined the sections. The fusion operation was extremely delicate: heated too long or at too high a temperature, the structure became a molten blob, too low a temperature or too short a time prevented the parts from fusing properly. Engineers shipped the large, lightweight blanks to Kodak for figuring and polishing at its special facility.[11]

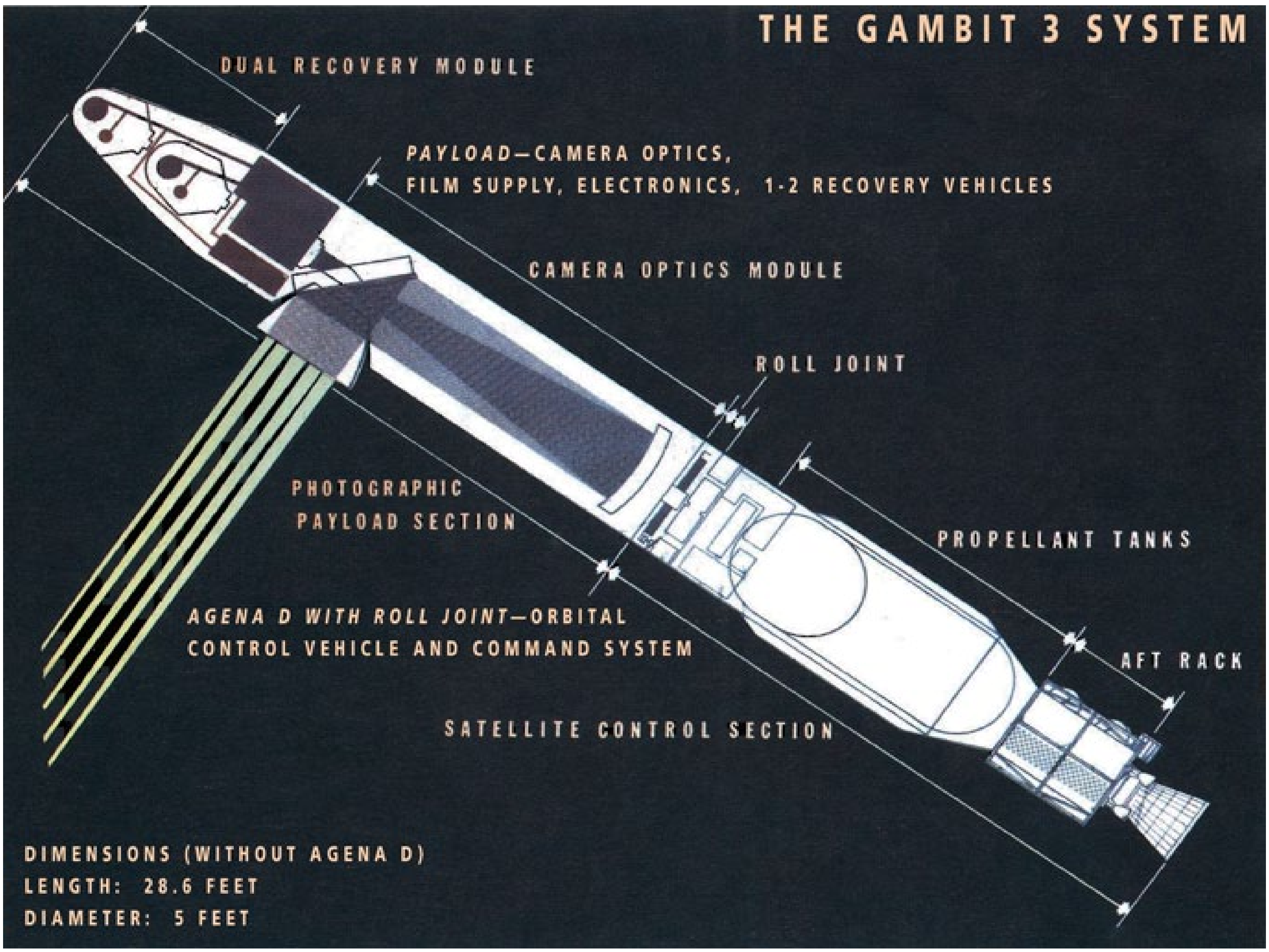
Frederic Oder, director of Special Projects at Kodak and familiar with the Corona RV from his previous work on WS-117L, favored the use of Corona technology on Gambit. Kodak had originally planned to keep the film path pressurized including the film chute and take-up cassettes. Using his Corona background, Oder urged the adoption of a nonpressurized film path. This simplified the process and allowed the Gambit film load to be accommodated in a Corona-like RV without serious modifications.

Kodak was also having problems attaching or cementing the silica mirrors to their metal case and with the platen drive, which caused the film to move irregularly over the exposure slit. Although the problems were not considered major, they added to existing pressure on delivery time and flight schedules.

The OCV development by GE, in its Valley Forge, Pennsylvania facility, was another story. Repeated failures in such varied experiments as the harnesses, power supplies, batteries, command systems, horizon sensors, rate gyros, environmental doors, and pyro devices, caused major cost overruns and severely threatened delivery schedules.

The prevalence of cost overruns, particularly at GE, the threat of new schedule slippage, and the increasing cost of the Gambit program greatly concerned Charyk. At the same time, pressures continued to increase for hard intelligence on the Soviet Union. The Cuban Missile Crisis of October 1962 added to the sense of urgency.

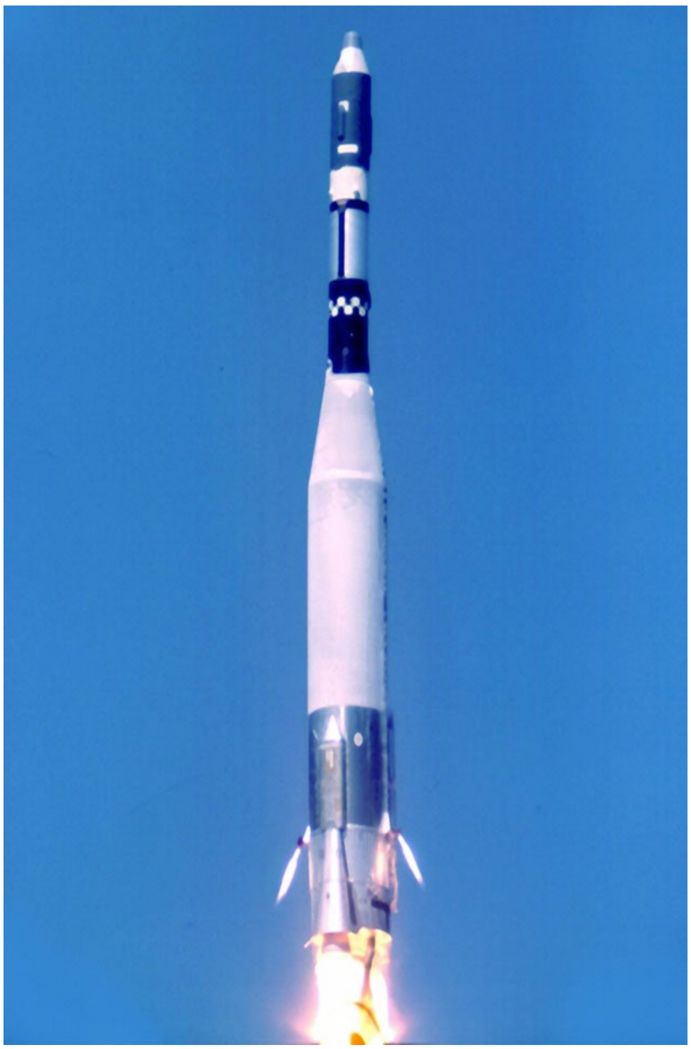
At a meeting with the President's Foreign Intelligence Advisory Board and the “special group” of the National Security Council, Charyk characterized Gambit as “imperative” and urged that the program be pressed with a “maximum sense of urgency.” “No reasonable steps,” Charyk argued, “should be omitted to guarantee its success at the earliest possible time.” According to Charyk, Gambit offered the most promising approach to discovering whether or not the Soviet Union was actively preparing for war.[12]



Gambit-3 Agena Vehicle

Discouraged about the rate of Gambit progress, Charyk suggested to Greer a management change. He wanted an exhaustive technical review of the program to locate any remaining problems. Greer was reluctant to relieve Col Riepe, the original program manager. Nevertheless, on 30 October 1962, Greer replaced Riepe with Col William G. King. King had a long experience with satellite reconnaissance. He had been Samos program director in the late 1950s and was one of the first to recognize the advantages of film recovery techniques over the technically more difficult readout systems. At the time of his appointment to head the Gambit program, he was serving as Greer's special plans officer.[13]

Immediately upon taking over the Gambit program, King discovered that the GE adaptation of the Corona capsule to Gambit was seriously off course. Greer's original intent, confirmed by Charyk, was to “glue on” the Corona recovery vehicle. Elaborate or extensive modification of the capsule was neither intended nor desired. In the course of changing over from land recovery to air-sea recovery, however,



Gambit launch

Gambit officials had authorized GE to develop a recovery vehicle capable of accepting the original pressurized Gambit take-up cassette and film chute.[14] Responding to the request to convert Gambit to a Corona recovery vehicle, GE scaled up the Corona capsule, making it deeper and increasing its base diameter. The result was a completely new capsule which required an extensive test program. The cost also escalated.

King suggested that the original intent of the Corona modification be reinstated and that the rapidly expanding GE development effort be stopped. Greer, who had originally ordered that changes to the Corona capsule should be minimal, agreed. King imposed an “absolute minimum” change policy in his instructions to GE on adopting the Corona recovery system to Gambit.

At the same time, King was sorting out the technical problems with Gambit, Charyk and Greer decided to strengthen Gambit management further by transferring the program from the Space Systems Division to SAFSP. Such a move would give Gambit the prestige and authority of the office of the Secretary of the Air Force. This set off a fire storm in the Air Force Systems Command (AFSC). General Bernard Schriever, commander of AFSC, had been a major force in establishing the Air Force space program. Schriever believed strongly that all Air Force space activity should be under AFSC management. He made several determined but ultimately unsuccessful attempts to regain “ownership.” High priority space programs would from now on report directly to the Office of the Secretary of the Air Force.

King continued his technical review of the Gambit program by questioning GE's untested OCV and its attitude-control subsystem. In order to improve the probability of early Gambit flight successes, King and Greer suggested that the Agena, at least for the first three flights, remain connected to the OCV. The reliable Agena, while not as precise as the Gambit system, could provide a stabilization and control mechanism to stabilize the Gambit camera long enough to secure operating experience and proof of system feasibility. Flying in this “hitch-up” configuration would not allow the demonstration of Gambit's full capability and it would only permit near-nadir photography, but King and Greer were determined that the first Gambit should return at least “one good picture.”

King and Greer also envisioned using a roll-joint coupling (invented for an interim high resolution satellite developed by the CIA, known as Project Lanyard and its KH-6 camera) between the spacecraft (Agena) and the camera system. Should the GE OCV prove unreliable, the introduction of the Lanyard roll-joint could stabilize and control the vehicle.

As was the case with the Corona reentry capsule, the roll-joint technology was unknown to most Gambit people.

Because of the high degree of security compartmentation in the reconnaissance Program structure, CIA security officials were reluctant to disclose even the existence of Lanyard to Gambit personnel. Charyk got around this problem by “suggesting” to Greer (Greer actually drafted the suggestion) that he contact Lockheed Corporation about the roll joint as “...he (Charyk) believed a similar idea was once proposed and possibly designed in connection with another space program.” Lockheed thus delivered the finished roll joints to the Gambit program as though they were new items with no relationship to any other reconnaissance program.

On 14 December 1962 Greer and King proposed yet another technical innovation. The latest change advocated incorporating “Lifeboat” provisions into Gambit. “Lifeboat” was another Corona originated technique. It involved providing independent reentry command circuitry (including a receiver), a separate magnetometer, and its own stabilization gas supply. All were independent of the main systems. If the primary reentry systems became inoperative, “Lifeboat” could be separately activated.

“Lifeboat” had proven its value on several occasions with Corona. Charyk formally approved adding “Lifeboat,” “hitchup,” and “roll joint” to Gambit on 19 December. “Lifeboat” was to be a permanent part of Gambit, “hitchup” was to be used on just the first four vehicles and then on a flight-by-flight basis. “Roll joint” was to be developed as an operational substitute for the OCV roll system. At the same time, in order to maintain the launch schedule, Greer and King deleted a substantial portion of the test program for Gambit. There was no alternative if Gambit was to meet its proposed schedule of June. Both knew the risk, but additional overruns or schedule slippage could put the program in danger of being cancelled.[15] U.S. policymakers demanded useful intelligence images of Soviet targets.

When Charyk resigned as DNRO on 1 March 1963, Brockway McMillan of Bell Telephone Laboratories replaced him. All seemed to be proceeding well with Gambit. By May, Gambit was in its first flight checkout sequence. On the afternoon of 11 May, however, a faulty valve and a deficient fuel loading sequence caused a loss of internal pressure on the Atlas 190D. The booster collapsed on the pad, dumping both the GE orbital vehicle and the Agena on the concrete slab. The GE vehicle was severely damaged, the Agena to a lesser degree. Surprisingly, there was no explosion or fire, although 13,000 gallons of liquid oxygen and a full load of fuel sloshed over the pad. The camera system was damaged beyond repair, a large part of the optics demolished. The Gambit project team worked furiously to repair the damage and keep the pre-flight checkout on schedule. Despite their efforts the original 27 June launch date slipped back to July.[16]

FIRST LAUNCHES

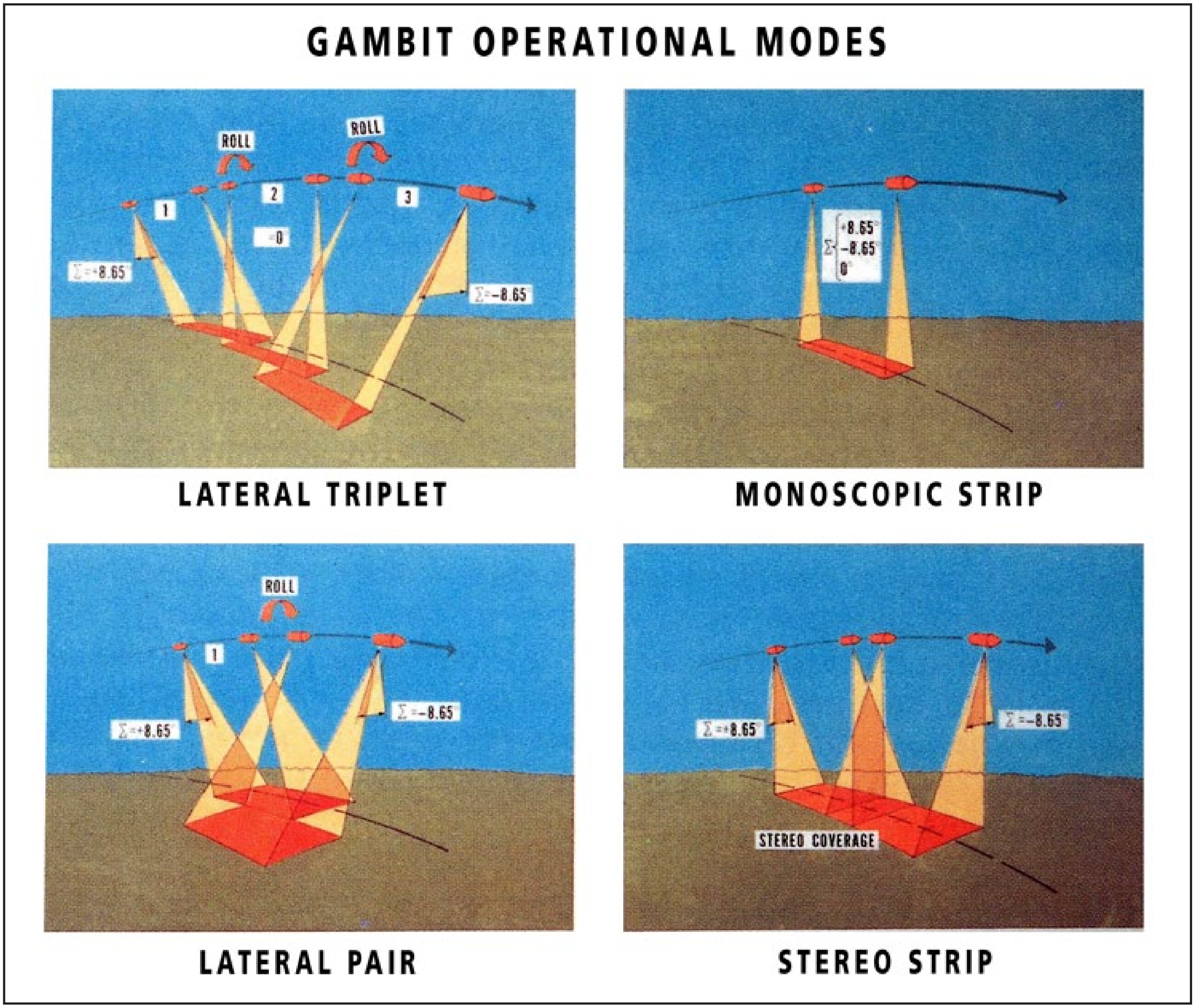
Twenty-two months and 17 days after the National Security Council decision to proceed with a covert high-resolution satellite, Gambit flight vehicle No. 1 lifted off from its Vandenberg launching pad on 12 July 1963 at 1344, Pacific Daylight Time (PDT). For an instant during the launch, most observers experienced the horrified sense that disaster had come again to the NRO/Air Force satellite reconnaissance program. The splashing rocket exhaust of the Atlas knocked out all electrical connections to telemetry and cameras. It gave the impression of a major launch start explosion. Seconds later, however, the Atlas could be seen climbing steadily towards its launch window. Climbout, separation, and orbital injection went smoothly. Greer and King knew, however, it would be another 90 minutes before they would have proof that the bird was in a proper polar orbit. It would take another five orbits before the Gambit payload came to life. After another nine “working” passes, a recovery attempt would be made. There would be another wait as the capsule re-entered the earth's atmosphere, hopefully survived its passage through the upper atmosphere, arrested its descent by parachute, and was recovered.

On the fifth orbital revolution, command controllers turned on the camera for light strip exposures of 20 seconds each. On orbits eight and nine, two stereo pairs, and five, 2-second strips were exposed. A premature exhaustion of Agena stabilization gas then forced the discontinuance of camera operations. With the Agena out of fuel, “Lifeboat” became the only means of recovering the film capsule. On the eighteenth orbit, a ground station commanded “Lifeboat” and Gambit back toward earth. A C-119 aircraft waiting near Hawaii swept the parachuting reentry capsule out of the sky. The first Gambit was a success, but what about the film?

Evaluation of the recovered film, only 198 ft was exposed, indicated an out-of-focus condition for most of the flight caused apparently by uncompensated temperature changes that affected the face of the primary mirror and by faulty image motion compensation settings. Nevertheless, the best resolution was close to 3.5 ft, the average resolution about 10 ft. It was the best photographic return ever obtained from a reconnaissance satellite.

Greer, gratified by the success of the first flight, informed King that he very much wanted “two in a row.” The very success of the first flight raised Intelligence Community expectations for subsequent flights.

The second Gambit flight took place on 6 September 1963. All went well. During 51 hours on orbit, the hitched vehicle completed 34 orbits and exposed 1,930 ft of film. On the 34th revolution, the reentry vehicle was detached



Gambit Operational Modes

and successfully recovered by air catch. An analysis of the photographs recovered from the second Gambit showed consistently high quality until the 31st orbit. The resolution achieved during the initial portion of the fight meant the photointerpreters could distinguish such detail as aircraft engine nacelles, small vehicles, and even maintenance equipment. For the first time, a satellite reconnaissance camera had returned detail at levels previously obtained only from reconnaissance aircraft. Only three years after Eisenhower ordered manned reconnaissance flights over the Soviet Union discontinued, U.S. satellites had filled the intelligence gap. First, Corona had returned coverage of areas most U-2s could not reach or safely overfly, and now Gambit had returned detail not greatly inferior to that produced by U-2 cameras. Gambit imagery, however, was limited to 1,930 ft of film from Gambit's second flight. Although Gambit's achievements were remarkable, it did not yet provide recurring coverage of the Soviet Union. Such coverage, at resolutions much better than Corona could provide, was still an urgent national goal.

McMillan, under constant pressure for more pictures, wanted future Gambit missions to concentrate on obtaining the best possible ground resolution over larger numbers of "denied area" targets. McMillan informed Greer, "... the name of the game is specific coverage of specific, known targets with stereo photography of the best possible quality." Greer was increasingly confident Gambit could produce the desired results.

On 25 October 1963, Gambit's third flight produced photography "better and more consistent than that of either of the first two missions." Imagery was the first to show identifiable figures of people on the ground—from a distance of 90 miles. The scene was a football field in Great Falls, Montana. In one photo, a place kicker could be seen putting the football in place while the other players moved into position. In a second photo, the players had lined up, ready for the kickoff.

Despite the superb resolution, however, the first three Gambit flights produced little intelligence. They did, however, whet the appetite of the U.S. Intelligence Community for more and better satellite imagery.

Gambit No. 6, launched on 11 March 1964, seemed to bring the program to maturity. Despite some continuing problems, Gambit No. 6 returned substantial quantities of highly useful intelligence data on targets.

CONTINUING PROBLEMS

The year 1964, however, brought serious problems to the program. From May through October 1964, half of six flights produced no coverage whatsoever. The best resolution degraded to 7 ft. Despite some successes in early 1965, the Gambit program was seriously ill.

Maj Gen Robert Greer retired on 30 June. He was replaced by Brig Gen John L. Martin who had been chief of the NRO Staff in the Pentagon and deputy to Greer. The summer of 1965 brought key personnel changes as well. Dr. Alexander H. Flax, Assistant Secretary of the Air Force for Research and Development replaced McMillan as DNRO on 1 October. Only Col King continued in place as project director for Gambit.

As Greer's deputy, Martin had a detailed knowledge of Gambit. He had witnessed the agonies of the early Gambit operations and years later recalled the emotion of "watching a bird go dead." "You simply cannot imagine," he said, "the frustration you feel when a healthy-looking Gambit suddenly became a zombie."

Shortly after assuming command, Martin faced the issue of whether or not Gambit No. 20 should hold to its early July flight date. Martin decided to go ahead with the previous schedule. On 12 July Martin witnessed a comprehensive failure, the Atlas booster shut down prematurely and Gambit No. 20 flew a 682-mile arc into the Pacific Ocean. Martin demanded immediate changes. He and King set about tightening quality control and the incentive contracting system. They subjected the Gambit system to new and more stringent test and inspection procedures. Despite their efforts, Gambit No. 21 became the third successive Gambit to experience catastrophic failure when the AC/DC power converter in the OCV failed, resulting in the loss of stability. The Intelligence Community, increasingly dependent on high-resolution photography to determine Soviet ICBM activity expressed its major concern with the gap in detailed coverage of the Soviet program.[17]

Martin, although under pressure to produce detailed imagery, delayed the next scheduled Gambit launch. He turned his attention to GE's OCV, which had, on balance, provided most of the program difficulties. Traveling to GE Philadelphia, he and King mystified GE management by requiring exclusive use of a dining room, ten tables, ten white tablecloths, and ten completed Gambit electronic boxes. With GE management looking on, Martin produced his own screwdriver and removed the cover-plates from the first box. He raised the box above the cloth-covered table and shook it hard. He paused to inventory the native and foreign items which fell on the table. He and King moved from table to table repeating the operation with each box. Martin concluded by stating that someone or someones had to be responsible for the debris on the table. GE management responded by revamping its organization and production and testing procedures. They were determined that GE hardware would become a quality member of the Gambit components family.

GE was not the only errant contractor King and Martin took to task. Lockheed and Kodak were both criticized for shipping unfinished products to Vandenberg and then attempting to complete their work in Vandenberg's Missile Assembly Building (MAE). Determined to guarantee hardware integrity, King even threatened to close the MAB, forcing all contractors to deliver flight-ready hardware to the launch site.

Martin also made an exhaustive study of the incentive contracting in effect for the Gambit program. He was amazed to find that the system of rewards paid more for under-cost, on-time delivery than for high quality performance on orbit. He observed, for example, that such a set of values placed GE in position to collect a healthy bonus for providing the OCV under cost and on time despite the failure rate on orbit. To the contractor, the arrangement stressed the cost factor far more than the performance factor. The result was that GE was motivated to delete as many control and test procedures as possible in order to save money and time in producing the OCV. Taken to its logical extreme, the incentive formula could result in the delivery of a minimum cost vehicle which failed catastrophically, but, nonetheless, earned a premium for the contractors. Martin shifted the focus of the incentive system from cost to performance. Martin's new system placed the emphasis on orbital performance and provided large bonuses for on-orbit success.

Gambit No. 23, launched on 8 November 1965, was the first satellite to have full benefit of the new test and inspection regime. Unfortunately, it too quickly succumbed to flaws and during its 18-revolution lifetime photographed limited targets. The Martin-King plan for improvement in the Gambit program, however, continued unrelenting. It finally paid off. The next 10 flights were all qualified successes. From January to October 1966, the NRO launched Gambit satellites at a rate of about one per month. They routinely returned photographic intelligence of high quality, covering more targets in each flight. "Best resolution" averaged about 2 ft. By the third anniversary of the Gambit flight program, 12 July 1966, Gambit had extended its longevity from one to eight days on orbit; had increased the number of targets and had improved resolution from 3.5 to 2 ft. The last Gambit mission, No. 38 (KH-7), flew on 4 June 1967. It was replaced by the highly successful Gambit-3 Program.[18]

GAMBIT-1 SUMMARY

Gambit was the first operational U.S. satellite system to return high resolution photography consistently. An Atlas-Agena booster combination launched the Gambit into orbit. GE built the orbital control vehicle which housed the camera system. Eastman Kodak developed and manufactured the camera system itself which was originally designed around a lens of 77-in focal length, producing photographs with a ground resolution of 2 to 3 ft. GE built the recovery capsule, which was adapted from the Corona program. The first Gambit was launched in 12 July 1963 and flights continued until 4 June 1967 when Gambit-3 replaced the Gambit-1 system.

THE DEVELOPMENT OF GAMBIT-3[19]

Even before the launch of the first of the Gambit reconnaissance satellites in July 1963, U.S. planners discussed the need for an even greater capability system. Gambit, with its 2 to 3-ft resolution, (three to five times better than anything Corona produced) could produce significant operational and technical details on Soviet weaponry. But, they believed, even greater intelligence on the Soviets could be obtained if the United States developed an imaging system that could return better ground details. Intelligence Community analysts wanted "more."

In the early 1960s, the dominant factor in obtaining higher resolution tended to be focal length and pointing accuracy. Long lens systems created enlarged images of relatively small areas. Eastman Kodak worked on such a system with its Valley program. By August 1963, Valley research and Gambit-1 experience convinced many NRO officials that long focal lengths were feasible for satellite operations. In December 1963, Kodak employees, Charles P. Spoelhof and James H. Mahar, presented their ideas for an advanced Gambit system to DNRO Brockway McMillan and Gen. Robert Greer. Following the presentation, McMillan approved the development of an improved, higher resolution, Gambit program.

The crux of Kodak's proposal was a system that would exploit the pointing accuracy of Gambit-1 with a new camera. Kodak engineers believed that better resolution could be obtained, assuming imagery from an orbital altitude of 90 miles. Spoelhof and Mahar also proposed that the new system incorporate a "factory to pad" concept to provide greater modularity, instead of an orbital control vehicle enveloping the camera system (Gambit-1). They proposed using two modules, one containing the camera and the recovery vehicle, the other housing propulsion and the on-orbit initial subsystems. Kodak also incorporated the Lockheed roll-joint concept between the forward photographic payload/recovery vehicle section and the satellite-control section.

Kodak also planned to use a special, very-low-coefficient-of-thermal-expansion Invar (an iron-nickel alloy) for both the optical barrel and related assemblies, and a new thin-base (1.5 mile) high-resolution film with an exposure index of 6.0. (The film was roughly three times more sensitive than the film then in use on Gambit-1.)

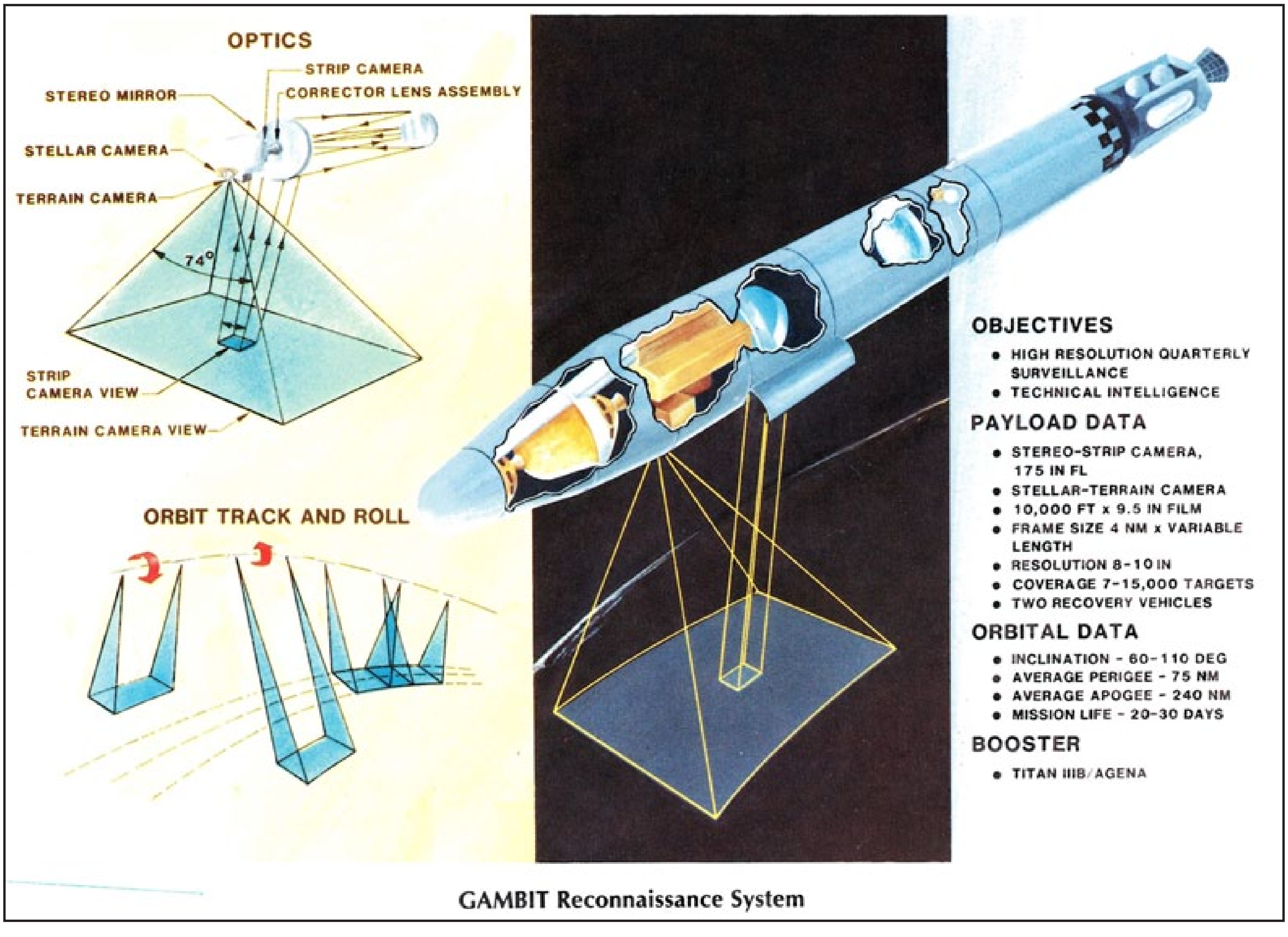
Concerned that the new program might have major problems in producing the larger optics and that the improved film could not be delivered on schedule, DNRO McMillan sponsored a host of alternative technologies. This caution was also evident in the selection of the booster. Although King and Greer favored using the Atlas and Agena booster combination, McMillan wanted an option of using the new Titan-III booster which would provide for a greater payload weight.

King and Greer worked out the remaining major elements of the Gambit-3 concept in January 1964. Their plan called for the entire Gambit-3 program to operate under the purview of the SAFSP. They called for an initial flight in July 1966. The Gambit-1 system would continue until Gambit-3 became operational.

Because of DNRO McMillan's strong interest in the Titan as a possible booster for Gambit-3, Greer and King tasked Lockheed in July 1964 to study Agena compatibility with the Titan-III. In October 1964, on the basis of the Titan III-Agena study carried out by Lockheed, Greer's staff prepared cost estimates for switching from the Atlas-Agena. Consideration for making the change included the desire to use the Titan III family of boosters for other Air Force space missions, the potential versatility and on-orbit weight-growth capability, and the likelihood that a new search system replacing Corona would rely on Titan III boosters. Despite the fact that the Atlas was considered the standard launching vehicle for the Air Force, DNRO McMillan officially approved the switch to Titan in October 1964. Although this increased cost and caused a slippage in the initial launch date, the choice of the Titan, in hindsight, was a major improvement. It allowed future system changes with less consideration of the limited lift capacity of the Atlas.

At Lockheed, the Gambit-3 program came under the direction of the Space Systems Division. The program manager was Harold Huntley who reported directly to James W. Plummer, assistant general manager for Special Programs (Plummer would become DNRO in 1974). While Lockheed's work on the Agena modifications proceeded and never seriously threatened the planned launch date of July 1966, payload development by Eastman Kodak was behind schedule by the fall of 1964. The major problem for Kodak centered on the manufacture and mounting of the two large mirrors of Gambit-3 optics. These optics were larger than those of many earth telescopes, but needed to be much lighter to operate in space. Kodak experienced several failures in attempting to manufacture the mirrors. In addition, the figuring and polishing processes were far more difficult than originally anticipated. Kodak originally estimated that each of the two mirrors would require around 800 hrs of grinding, polishing, testing, and coating to finish. The early mirrors took 3,000 hrs per mirror. Because of mirror-fabrication problems, Kodak was three months behind schedule. Kodak's problem was compounded by its underestimation of the needed engineering manpower. The company experienced a major shortage of technical people, apparently from an overcommitment of resources. Kodak was working simultaneously on Gambit-1, Gambit-3, a lunar camera for NASA, and a proposed new search system that later became the Hexagon program.

The final determination for fabrication fused silica, for the primary aspheric mirror substrate and the return to conventional polishing techniques, pushed the production schedule ahead. By January 1966, there still existed considerable doubt that the high-speed, high resolution film on which Gambit-3 depended would be ready for use in initial flights. If it was not ready, the fall-back film, with an index of 3.6 and a resolution capability of 110 lines per millimeter, as against the 130 lines ASA (American National



Gambit system and optics swath

Standards Institute, formerly known as American Standards Association) 6.0 film would be used. It would build a certain amount of smear but there was no alternative. In fact, the new film did not become available until June 1968.

Given their experience with Gambit-1, Greer and King also introduced another innovative management technique. In contrast to the extensive testing at the launch site that characterized Gambit-1, testing that frequently brought substantial repair work in the Missile Assembly Building, Greer and King initiated a command system for Gambit-3, featuring an automated checkout system that allowed telemetry readout of functions. These readouts directly indicated whether or not various subsystems and components operated within acceptable limits. This automated checkout was normally performed during final assembly at Kodak and Lockheed, the principal manufacturers. The components, therefore, went directly from factory to launch pad.

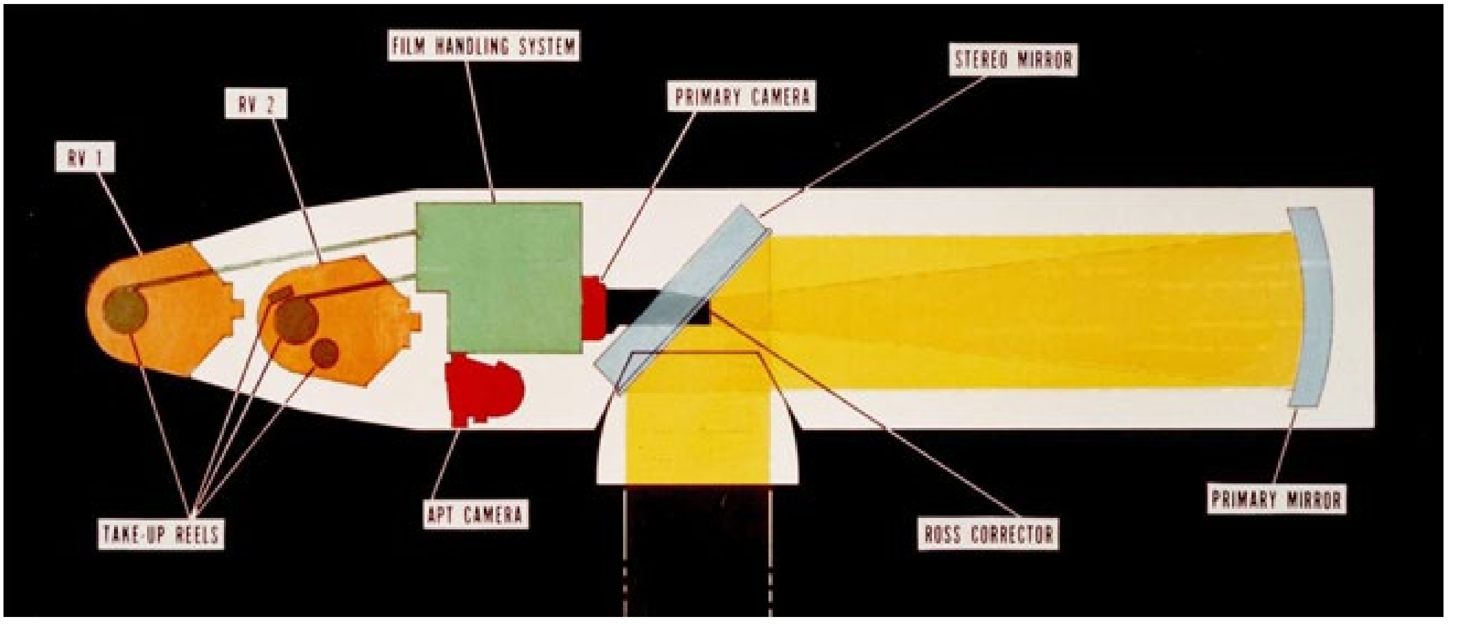
NRO planners took no chance with the success of the first launch of Gambit-3. By the time of the launch, recovery operations had become rather routine, using Air Force C-130 aircraft and Navy range ships. An NRO agreement with the U.S. Navy provided for the Navy to support these recoveries with two such range ships. As the first Gambit-3 launch approached, the Navy, however, had only one ship on duty station. NRO program officers requested additional Navy support through the Office of the Commander-in-Chief, Pacific Forces (CINCPAC), which controlled all DoD assets in the Pacific. CINCPAC responded that because of the Vietnam conflict, the usual recovery support could not be provided. Col King took the issue to DNRO John McLucas. This was a serious threat to the successful completion of the mission. McLucas took up the matter with the Chief of Naval Operations (CNO), ADM David L. McDonald, who, in turn, sent a flash precedence message to CINPAC ordering the support. CINCPAC signaled back to SAFSP, “We don't know whom you know, but how many battleships do you want and where do you want them delivered?”

GAMBIT-3 BECOMES OPERATIONAL

On 29 July 1966 at 1130 PDT, the first Gambit-3 roared off the launch pad at Vandenberg (the initial launch had been projected nearly three years earlier for 1 July 1966). Two hours later, Sunnyvale reported, “All systems appear normal.” The first Gambit-3 performed exceptionally well. The satellite achieved a near-nominal orbit. Its mission lasted five days during which it acquired targets that were successfully “read out.”[20]

The overall quality of the imagery from the first Gambit-3 mission was better than that obtained from any Gambit-1 mission. Although the primary optics fell short of the design goal, the intelligence provided by this mission was the highest of any reconnaissance satellite to date.

The fate of Gambit-1 was now sealed, although DNRO Alexander Flax was extremely reluctant to cancel any planned Gambit-1 launches until Gambit-3 actually demonstrated a consistent level of capability. Director of Central Intelligence (DCI) Richard Helms, however, felt strongly that the success of Gambit-3 warranted cutting back Gambit-1 launches. The United States Intelligence Board's (USIB) Committee on Overhead Reconnaissance (COMOR) proposed, after listening to the arguments, that



Gambit photographic payload section

nine Gambit-1s and eight Gambit-3s be approved for the FY 1967 flight schedule. Contemporary launch schedules called for the launch of Gambit-1s at the rate of one per month. The decision to proceed with a mix of Gambit-1 and Gambit-3 was based on the perceived greater cost of the new system (Gambit-3), and the concern that success in all of the scheduled missions would cause the exploitation and analytical elements to be inundated with high resolution imagery. The concern was real.

During the 11-month period, July 1966 to June 1967, the success of Gambit-3 created a new problem for U.S. officials by returning huge quantities of surveillance-quality photography. The sheer volume overwhelmed U.S. photointerpreters. The United States now had three successful satellite systems routinely returning large quantities of imagery: Corona, Gambit-1, and Gambit-3. The Satellite Operations Center (SOC) in the Pentagon was also feeling deluged. It was barely able to cope with Gambit and Corona.

Despite the success, DNRO Flax was less than euphoric. A best resolution fell well short of the planned resolution. He, nevertheless, cancelled the final five Gambit-1 missions on 30 June 1967. Gambit-3 was to be the main surveillance satellite system. Unlike Flax, DCI Helms characterized the take from Gambit-3 in November 1967 as providing “extremely important intelligence.” He saw it as a striking success. Flax's more cautious optimism proved prophetic.

By late 1967 the inadequacy of the Gambit-3 camera system remained an unsolved problem. Despite the fact that it was better than that of Gambit-1, it did not obtain the resolution originally specified. Some at NRO believed Gambit-3 would never achieve the resolution for which it had been designed, much less the long coveted resolution desired by photointerpreters. However, improvements were on the way as Kodak continued its work on improving the mirror substitute materials and the high-speed emulsion on its ultra-thin base film. Kodak introduced its new film on the 14th Gambit-3 flight on 5 June 1968. By the 27th flight it exceeded all expectations.[21]

A CHANCE ENCOUNTER

Gambit program officials strongly believed that neither the Soviets, nor anyone else, knew the capability of the Gambit program. In 1969, however, officials held their breath as a Soviet satellite, Cosmos 264, began to make orbital adjustments that U.S. engineers calculated would bring it within 70 miles of Gambit-3. Eventually the two satellites passed within 15 miles of each other as NRO controllers held their breath, wondering if Cosmos was a “killer satellite.”

THE BLOCK II PROGRAM

One of the major innovations in the Gambit-3 program was the introduction of a second recovery vehicle. It eventually became known as the Block II program. Growing national interest during the period of Gambit-3 development in creating a satellite capability of quick reaction to world-wide crisis situations drove concepts for improving Gambit-3. As early as January 1965, DNRO McMillan informed Secretary of Defense, Robert McNamara, of studies underway for providing Gambit-3 with such a capability. The Corona program had demonstrated the feasibility and utility of using two recovery buckets. The premise behind the change was that a long-life, multiple capsule, film return system, could provide urgently required images that would be taken and returned to earth for evaluation, while at the same time continuing the satellite's routine surveillance duties.

Fortunately, owing mostly to McMillan's foresight, the Titan booster used for Gambit-3 had excess lift capability. The addition of a second reentry vehicle and more film capacity, while they greatly increased Gambit-3's weight, did not exceed the Titan lift capacity. Work began on the Block II series of Gambit-3 in late 1966. The double-bucket Gambit was ready by the fall of 1969. The first Block II vehicle (Gambit-3, no. 23) flew on 23 August 1969. After this first successful Block II flight, the program suffered a series of annoying problems, from poor orbits, to failed parachutes, to program malfunctions, which kept it from reaching its full potential.

Despite the nagging problems, the resolution of Gambit-3 cameras continued to increase. Operational longevity also increased from 10 days to 27 days. A new lens, under development by Kodak for several years, was finally introduced in 1971. It brought an immediate performance improvement in the camera system. With a different focal length, the new lens permitted Gambit resolution to surpass even the previous best. Target coverage also increased.

A FULLY MATURE SYSTEM

By August 1977 Gambit-3, with 48 vehicles flown, was a fully mature, successful satellite program. During the next seven years, Gambit-3 continued to steadily improve its performance. Time-on-orbit lengthened to three to four months for each flight. Target coverage also increased significantly. By the time of the last Gambit-3 flight in April 1984, Gambit-3 was still producing the high quality imagery, which maintained its preeminence in technical collection.[22]

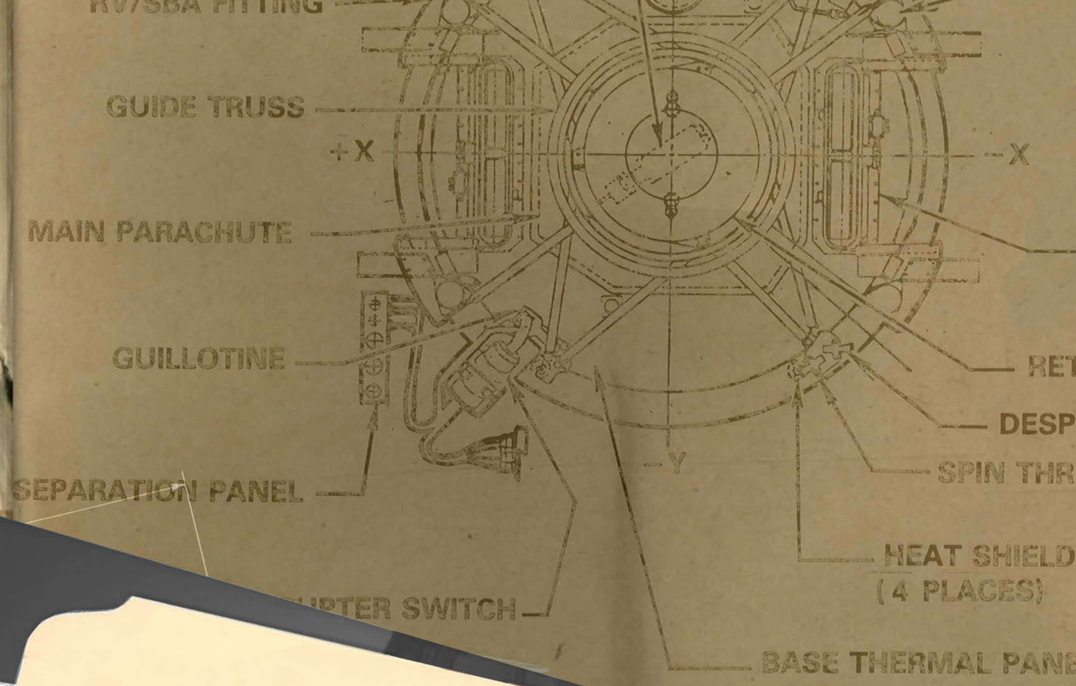
SUMMARY

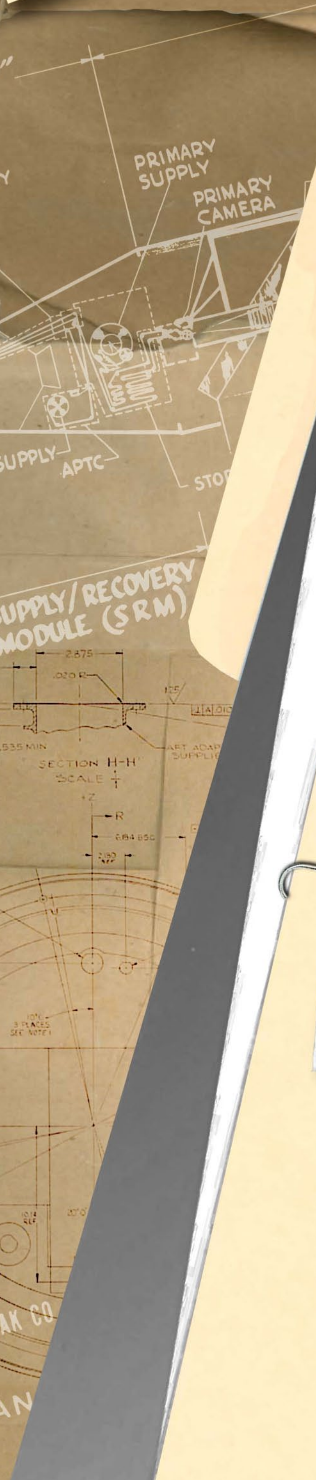
The Corona program provided U.S. policymakers, for the first time, a capability to monitor military and industrial developments over vast areas of the Soviet Union and other denied areas of the world. Although Corona provided immeasurable contributions to national security, its resolution was not good enough to answer numerous critical intelligence questions regarding Soviet weapons development. Nor could it provide the image quality needed to provide true science and technology analysis. Gambit filled this gap. By the end of the program, Gambit routinely collected high-resolution imagery.

Gambit imagery closely monitored the Soviet Union. Gambit also provided insight on China. This information was vital to U.S. strategic planners, photointerpreters, and U.S. policymakers and defense planners. The Gambit system proved to be an invaluable intelligence collection tool during the Cold War.

In August 1984 President Ronald Reagan emphasized Gambit's contribution to U.S. intelligence in a message to DNRO Pete Aldridge:

> When the Gambit Program commenced we were in the dawn of the space age. Technologies we now take for granted had to be invented, adapted, and refined to meet the Nation's highest intelligence information needs while exploiting the unknown and hostile medium of space. Through the years you and your team have systematically produced improved satellites providing major increases in both quantity and quality of space photography.
>
> The technology of acquiring high quality pictures from space was perfected by the Gambit Program engineers; .... Through the years, intelligence gained from these photographs has been essential to myself, my predecessors, and others involved with international policy decisions. These photographs have greatly assisted our arms monitoring initiatives. They have also provided vital knowledge about Soviet and Communist Bloc scientific and technological military developments, which is of paramount importance in determining our defense posture.
>
> A generation of this Nation's youth has grown up unaware that, in large measure, their security was ensured by the dedicated work of your employees. National security interests prohibit me from rewarding you with public recognition which you so richly deserve. However, rest assured that your accomplishments and contributions are well known and appreciated at the highest levels of our Nation's government.





CRITICAL TO US SECURITY:

THE GAMBIT AND HEXAGON SATELLITE RECONNAISSANCE SYSTEMS COMPENDIUM

HEXAGON

INTRODUCTION

Gambit was primarily a National Reconnaissance Office (NRO)/Air Force program to develop a high-resolution "spotter-type" satellite. It caused few bureaucratic turf battles and became highly successful. Proposals for and the development of a second-generation search satellite to follow Corona, however, became embroiled in major bureaucratic conflicts between the NRO and the Central Intelligence Agency (CIA).

Despite the bureaucratic in-fighting, the development and operation of the Hexagon photoreconnaissance satellite system provided U.S. policymakers and planners with a unique collection capability. Hexagon's ability to cover thousands of square nautical miles with contiguous, cloud-free, high resolution imagery in a single operation, provided U.S. intelligence users with vast amounts of intelligence information on the Soviet Union and other denied areas. It also collected large-scale contiguous imagery within specific geometric accuracies and unique mapping, charting, and geodesic data. Used in combination with the Gambit program, Hexagon was of paramount importance in confirming or denying Soviet strategic weapons development and deployment. Its ability to detect quickly any new Soviet intercontinental ballistic missile (ICBM) complex or mobile missile placement became invaluable to U.S. negotiators working on arms-limitation treaties and agreements.

ORIGINS

In May 1963, Director of Central Intelligence (DCI) John A. McCone convened a Scientific Advisory Panel under the chairmanship of Edwin Purcell, Nobel laureate and professor of physics at Harvard University, "to determine the future role and posture of the United States Reconnaissance Program." The Purcell Panel recommended a Corona improvement program rather than an entirely new satellite system:

> We believe that an attempt to make a completely new (search) system, which would provide equally wide coverage (as Corona) with a modest improvement in resolution (5-feet, say, instead of 10-feet around resolution) would not be a wise investment of resources.

Not entirely satisfied with the Purcell Panel recommendation, in the fall of 1963, McCone directed his Deputy Director of Science and Technology (DDS&T), Albert D. (Bud) Wheelon, to explore the requirements and possible configuration for a second generation search satellite to replace Corona. One of the major questions confronting Wheelon and his staff was the degree of resolution needed to fulfill the various requirements of the Intelligence Community. Wheelon directed his newly created Systems Analysis Staff, headed by Jackson D. Maxey, to review the types and characteristics of United States Intelligence Board (USIB) targets to determine the kinds of coverage needed. A detailed experiment, which included 25 National Photographic Intelligence Center (NPIC) photointerpreters, concluded that the majority of USIB targets could be properly identified using imagery with a resolution in the 0.6 to 1.2 m (2 to 4 ft) range. Due to the cost of booster rockets, Wheelon concluded that an entirely new camera system with a longer focal length covering a large swath would have to be developed to meet such target requirements.

While Wheelon and Maxey continued to work on their study, Corona's Performance Evaluation Team (PET) also looked at the problem. The PET investigation effort examined the possibility of "scaling up" the Corona camera from the existing 610-mm (24-in) lens to a 1-m (40-in) lens while maintaining the same "acuity." According to the PET report, "scaling up" could improve Corona's resolution without having to design an entirely new camera and satellite.[23]

Director, NRO (DNRO) Brockway McMillan and his NRO staff strongly supported the Purcell Panel and PET recommendations. This sparked a growing debate between the NRO and the CIA over the development of a follow-on system to Corona.[24]

Critical of the NRO position, McCone asked for a meeting with Deputy Defense Secretary, Roswell L. Gilpatric, to discuss the issue. On 22 October 1963, McCone and Gilpatric agreed to form a separate CIA-NRO/Air Force sponsored research group of the nation's leading optical experts to explore the issue of improving satellite photography. Chaired by Sidney Drell of Stanford University, the group met on 13 November 1963 to study image quality. The Drell group findings basically supported the CIA contention that the United States needed a new system, which would provide Corona-type coverage with consistent Gambit-type resolution. At the same time, in order to augment these studies, Wheelon asked for additional reports from Itek and Space Technology Laboratories (STL) of the Thompson Ramo-Wooldridge (TRW) Corporation. All seemed to be in agreement. A new system was needed to meet the growing requirements of the Intelligence Community for high quality imagery and expanded coverage.

PROJECT FULCRUM

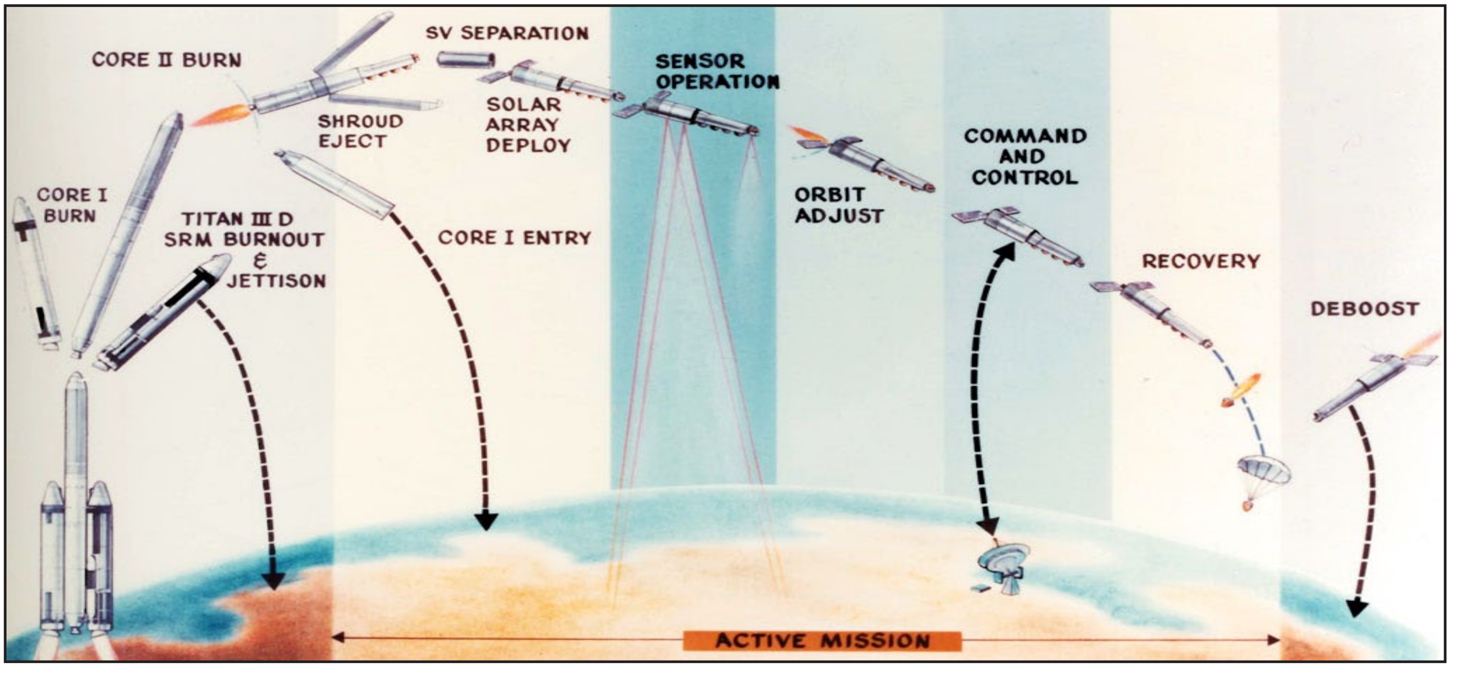
Following up these studies, in May 1964, Wheelon directed Itek and STL to prepare a joint proposal for a satellite system that could replace both Corona and Gambit. The Itek-STL proposal recommended a 2,495-kg (5,500-lb) payload containing two, counter-rotating Itek cameras in an STL three-axis stabilized spacecraft with a simple recovery system. A modified Titan II booster with no second stage would place it directly in orbit. The camera was to be a dual Maksutov reflective system with f/3.0 lenses having a 1.5-m (60-in) focal length employing a corrective lens, beryllium mirror, and eggerate quartz main plate. The cameras would provide a nadir resolution from 0.8 to 1.2 m (2.7 to 4 ft) at an altitude of 185 km (100 miles). In his memorandum recommending NRO/CIA funding for Project Fulcrum, Wheelon suggested the program could be developed within 24 months. He also stressed the cost savings. According Wheelon, by replacing the Corona and Gambit programs, the government could save money by the end of FY 1969.[25]

McMillan was furious. Wheelon and the CIA were contracting for satellite systems and subsystems studies without even informing the NRO, which theoretically had responsibility for all reconnaissance satellite development. Deputy Director, Research and Engineering (DDR&E), Eugene Fubini, sympathetic to McMillan's position, questioned the entire Fulcrum proposal. Fubini reported that the recent Corona missions seemed to confirm the Purcell Panel recommendations that substantial improvement in the Corona camera results could be obtained. Over the strong objections of McMillan and Fubini, DCI McCone asked Gilpatric to direct the DNRO to establish Fulcrum as an NRO development project and assign responsibility for research, development, and operation to the CIA.

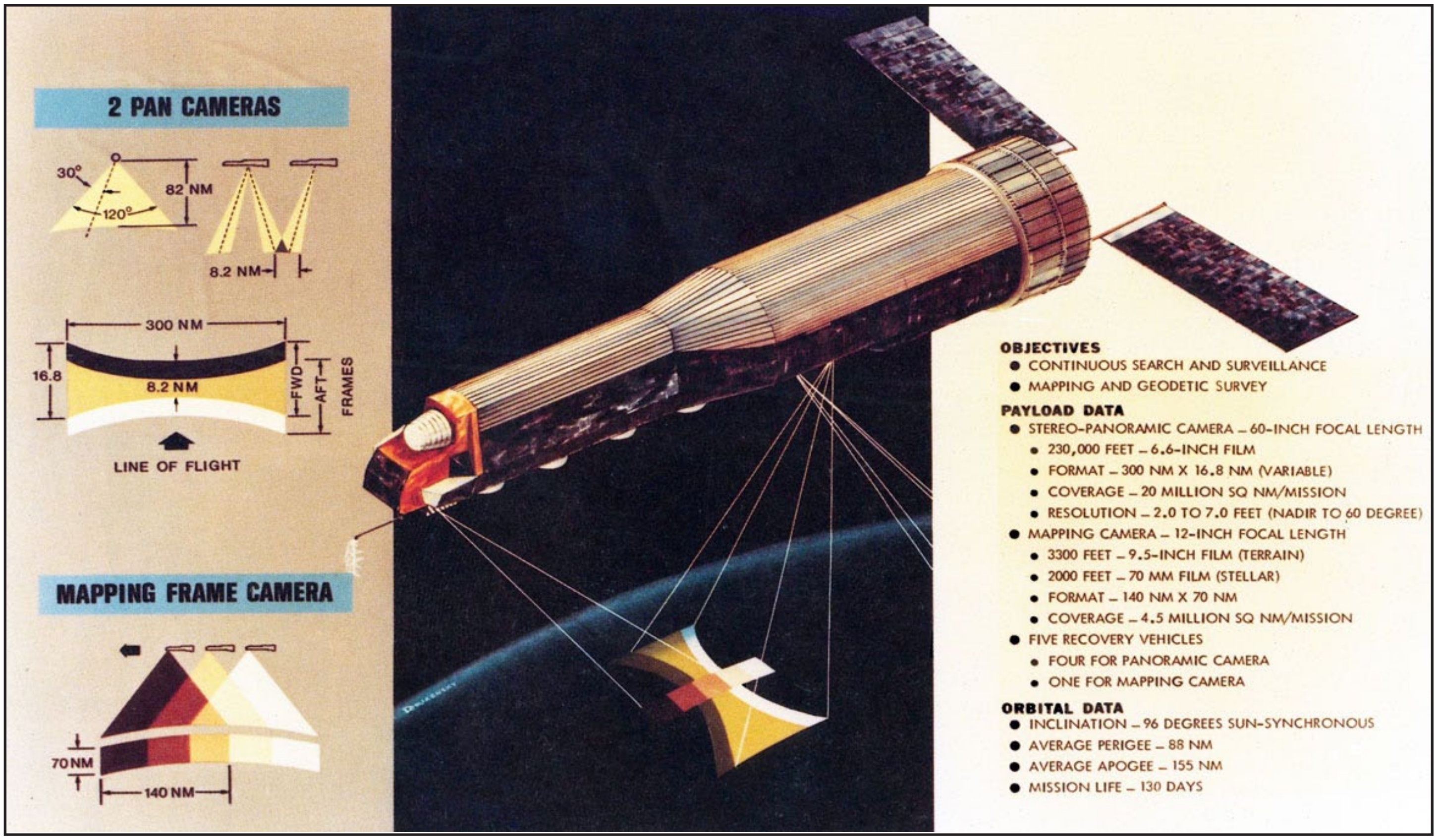
Looking for further support, McCone also asked Polaroid's Edwin H. (Din) Land to convene a panel of experts to consider the technical feasibility of the Fulcrum proposal. The group met on 26 June 1964 and issued its recommendations the same day. Land called the proposed system "extremely attractive," and "praised the ingenuity of the idea." The Land Panel also noted several problem areas but added that the system looked good enough to fund study efforts.

Armed with the Land Panel recommendation, Wheelon, on 2 July 1964, formally presented a plan to McMillan for initiating Fulcrum. After conferring with McMillan, on 8 July, Deputy Secretary of Defense, Cyrus Vance, cautiously suggested that the DNRO complete comparative studies and explore all possible alternatives before committing to the new system. He, nevertheless, authorized the CIA to pursue "design tests necessary to establish the feasibility of the proposed Fulcrum camera concept."

McCone's and Wheelon's plan went far beyond design studies. They wanted to build a strong CIA space system development and management capability. Wheelon and McCone received the backing of the USIB on 27 July 1964. The Board approved the recommendation of its Committee on Overhead Reconnaissance (COMOR) that there was an urgent need for a search and surveillance system capable of Corona coverage and Gambit resolution. This echoed Wheelon's justification for Fulcrum. In August 1964, Wheelon created a Special Projects Group (SPG) within DS&T to handle all CIA satellite reconnaissance programs. He named Jackson D. Maxey Fulcrum Project Manager. (Maxey was one of several senior engineers Wheelon hired



Hexagon sequence of events diagram



Hexagon system concept

from industry.) He also brought in Leslie Dirks as project engineer. In addition, Wheelon proposed to McCone that the CIA sponsor two competitive design efforts for the film-handling system for the Fulcrum camera. At the same time, Wheelon initiated spacecraft and recovery vehicle competitions. Itek won the camera competition. General Electric (GE) became the spacecraft contractor and Avco the reentry vehicle designer. These CIA efforts touched off a bureaucratic donnybrook with the NRO and Department of Defense (DoD) that threatened the very fabric of the U.S. National Reconnaissance Program (NRP).

McMillan and the NRO believed Wheelon and the CIA had exceeded their authority and gone far beyond preliminary design concepts. McMillan took sharp exception to CIA's development of a spacecraft and a Satellite Recovery Vehicle (SRV). Such development, McMillan believed, was contrary to the Third NRP Agreement that gave the NRO specific responsibility for the spacecraft and SRV. McMillan protested that the CIA should limit its activity to developing the sensors carried by the satellites. McMillan requested a suspension of further CIA efforts until the situation could be considered by the ExCom.[26]

Meanwhile, CIA officials learned that DNRO McMillan had authorized Secretary of the Air Force/Special Projects Office (SAFSP) to begin preliminary designs for a photographic payload that would include an optimal search and broad-coverage satellite system. McMillan authorized this SAFSP study in early 1964, even before the CIA's Fulcrum Project. These efforts became known as S-2. Eastman Kodak and Itek completed S-2 preliminary designs by September 1964. Even after the formal approval of the CIA's Fulcrum project, McMillan approved further camera studies at Fairchild Camera and initiated studies for a new orbiting vehicle at both Lockheed and GE in support of S-2.

Relations between the NRO and the CIA continued to deteriorate. Even before Deputy Secretary Vance established a steering group to evaluate the most promising search and/or surveillance satellite and the CIA agreed to participate, cooperation between the CIA and the NRO became virtually nonexistent. When McMillan asked Wheelon to furnish a Fulcrum briefing to the steering group for “the new NRO Search/Surveillance Satellite system,” Wheelon refused. He replied that “he would have to await instructions from ‘his boss’ before agreeing to brief the steering group as requested.” Wheelon added that, “his organization was not persuaded that the steering group was a proper or good idea.” Given this attitude, the steering group accomplished little.

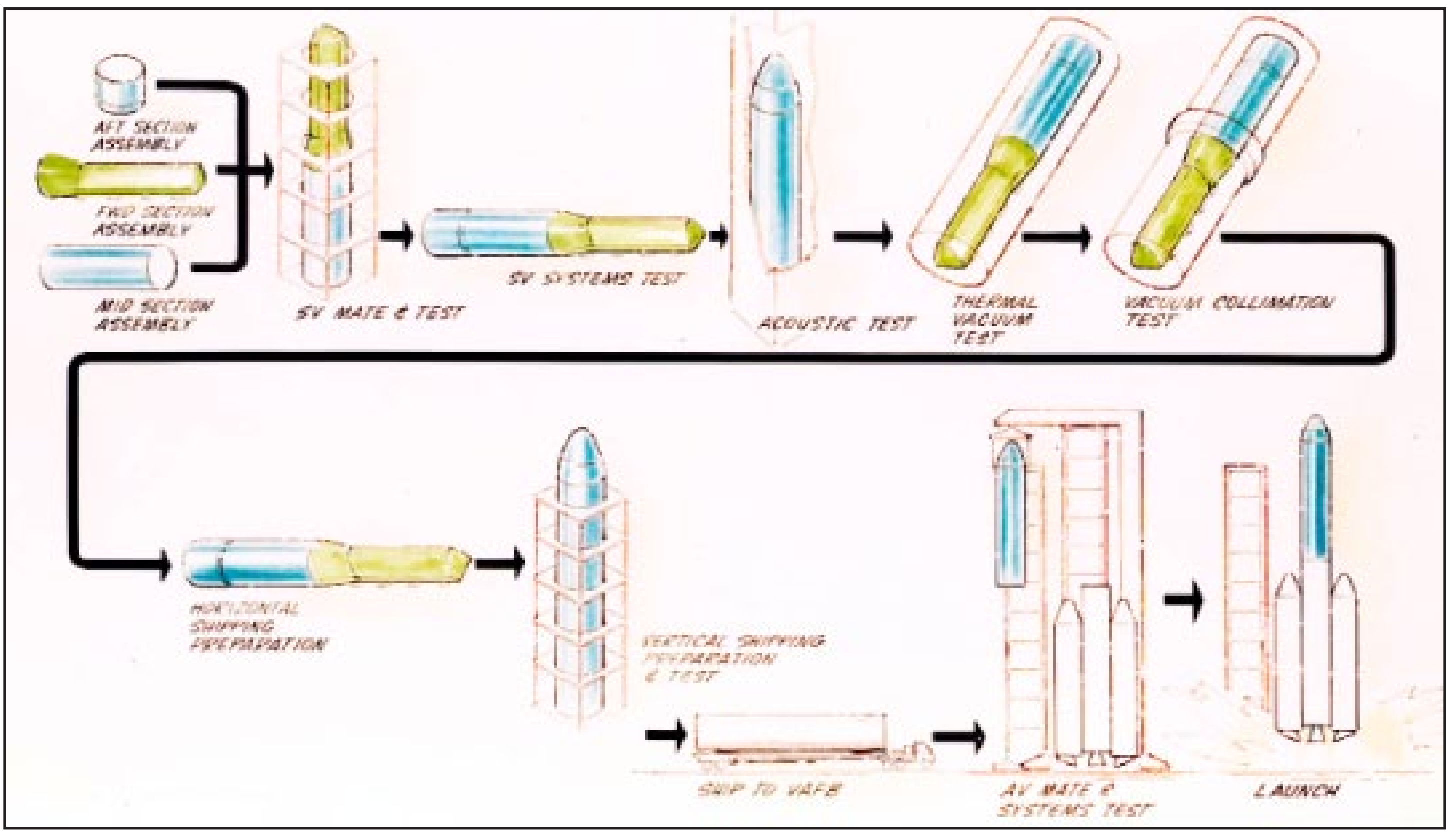
In this fight, McMillan and his NRO staff stood virtually alone in attempting to defend the authorities of the NRO. Secretary of Defense McNamara and most of the DoD were preoccupied with Vietnam. The regular Air Force, or White Air Force, totally ignored space activities. The Air Force Space Systems and Air Staff were still smarting from being excluded from most satellite developments. Even SAFSP took a limited interest. Located in Los Angeles, California, SAFSP officers concerned themselves solely with operations. They saw their role as strictly "birding" (launching and operating satellites). Future systems were not their concern, nor was politics. They saw politics as strictly a function of their "Washington branch." Moreover, coming from Bell Laboratories, McMillan had few inside connections either in Congress, the White House, or the Department of State.

To get around the DoD's steering group, McCone turned to Din Land and his Panel of experts to evaluate Fulcrum.[27] Convening at Itek headquarters in Boston on 23 February 1965, the panel heard presentations on Fulcrum as well as the other search system studies funded by the NRO (S-2) by Eastman Kodak, Itek, and Fairchild Camera. Itek officials startled CIA officials when they announced to Land that Itek was withdrawing its support from the Fulcrum program because of disagreements with the CIA over systems specifications.[28]

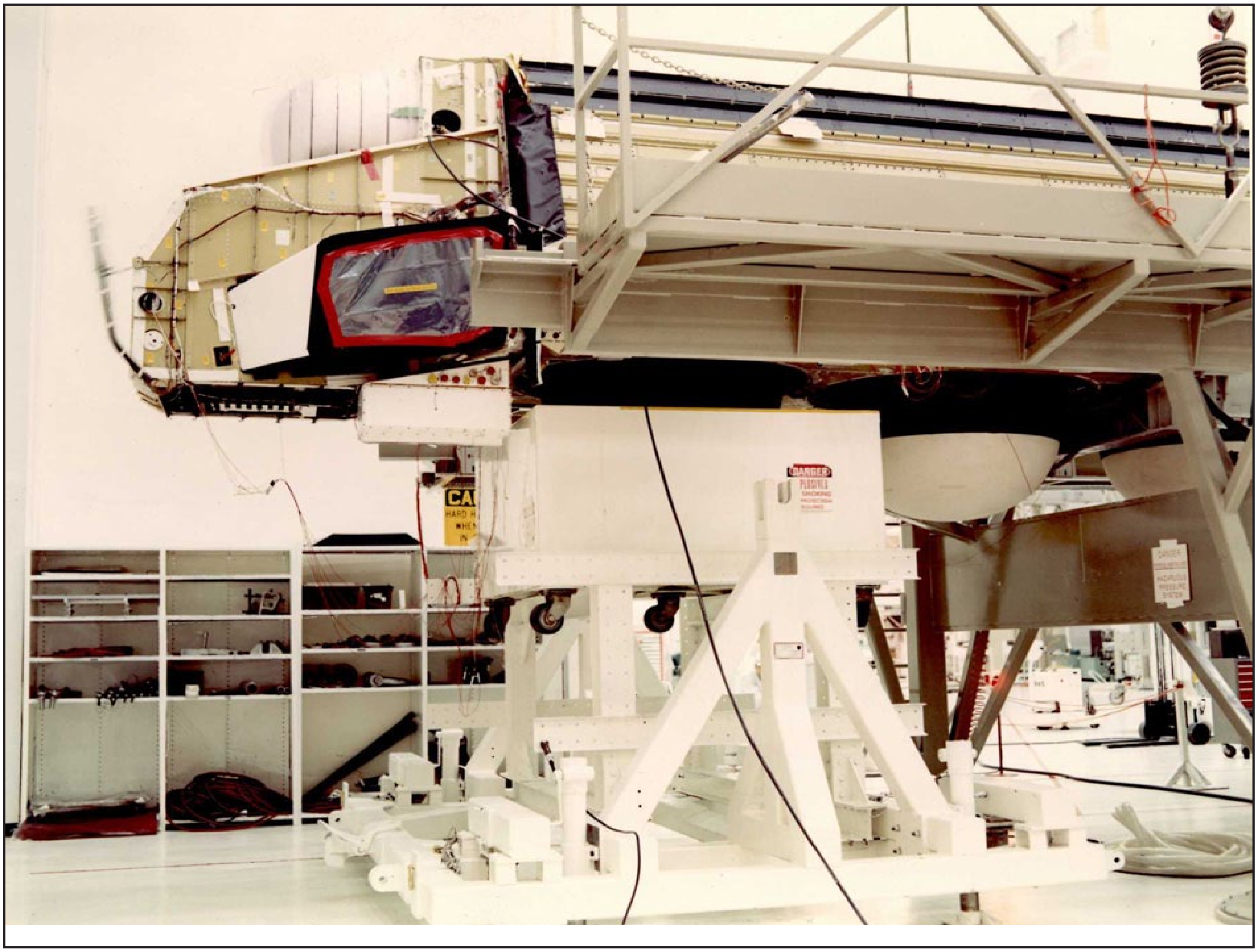
McCone and Wheelon had hoped and expected that the Land Panel findings would be the basis for early approval of Fulcrum by the ExCom.[29] In order to preserve Fulcrum sensor work and the momentum of the project, Wheelon quickly arranged to transfer Itek's government-funded Itek-design plans for the Fulcrum camera system to Perkin-Elmer of Norwalk, Connecticut. Perkin-Elmer had been working on a smaller back-up design for the CIA since June 1964.

The steadily growing hostility between the NRO and the CIA and the constant battles between Wheelon and McMillan brought the program to a near standstill. On 13 July 1965, in a report to Vance and new DCI VADM William F. Raborn, Jr., McMillan indicated he intended to select the S-2 system for a new search satellite. Upon the advice of Wheelon, Raborn countered by asking Vance to delay any decision pending the Land Panel's report. On 26 July 1965, the Land Panel finally issued its recommendation. It satisfied no one. The Panel recommended that all three camera system studies (the CIA effort at Perkin-Elmer and the NRO S-2 programs at Itek and Kodak) be funded for an additional three months.

At this point work on Fulcrum virtually came to a standstill as DCI Raborn and Deputy Secretary of Defense Vance worked out a new NRP Agreement—the fourth. Signed on 13 August 1965, the new agreement gave the CIA



Hexagon factory to launch sequence



Hexagon SV-5 forward section with mapping camera module

responsibility for developing the optical sensor subsystem of the advanced general-search satellite (Fulcrum) and the engineering development of the spacecraft, reentry vehicles, and booster to the NRO and the Air Force. Both sides hoped this carefully crafted agreement would provide the incoming DNRO, Alexander Flax, with the authorities and leverage to resolve the bitter, divisive debate between the NRO and the CIA over roles and responsibilities for the new satellite system. It did not.

McMillan departed the NRO on 30 September 1965, disappointed that the new agreement was less explicit in stating the authorities of the DNRO than the old agreement had been. The new agreement did not please many in the CIA either. Maxey, who headed the Fulcrum effort and was chief of the Special Projects Staff (SPS), resigned because he felt strongly that the new NRP pact was too restrictive on the CIA.[31]

HEXAGON DEVELOPMENT

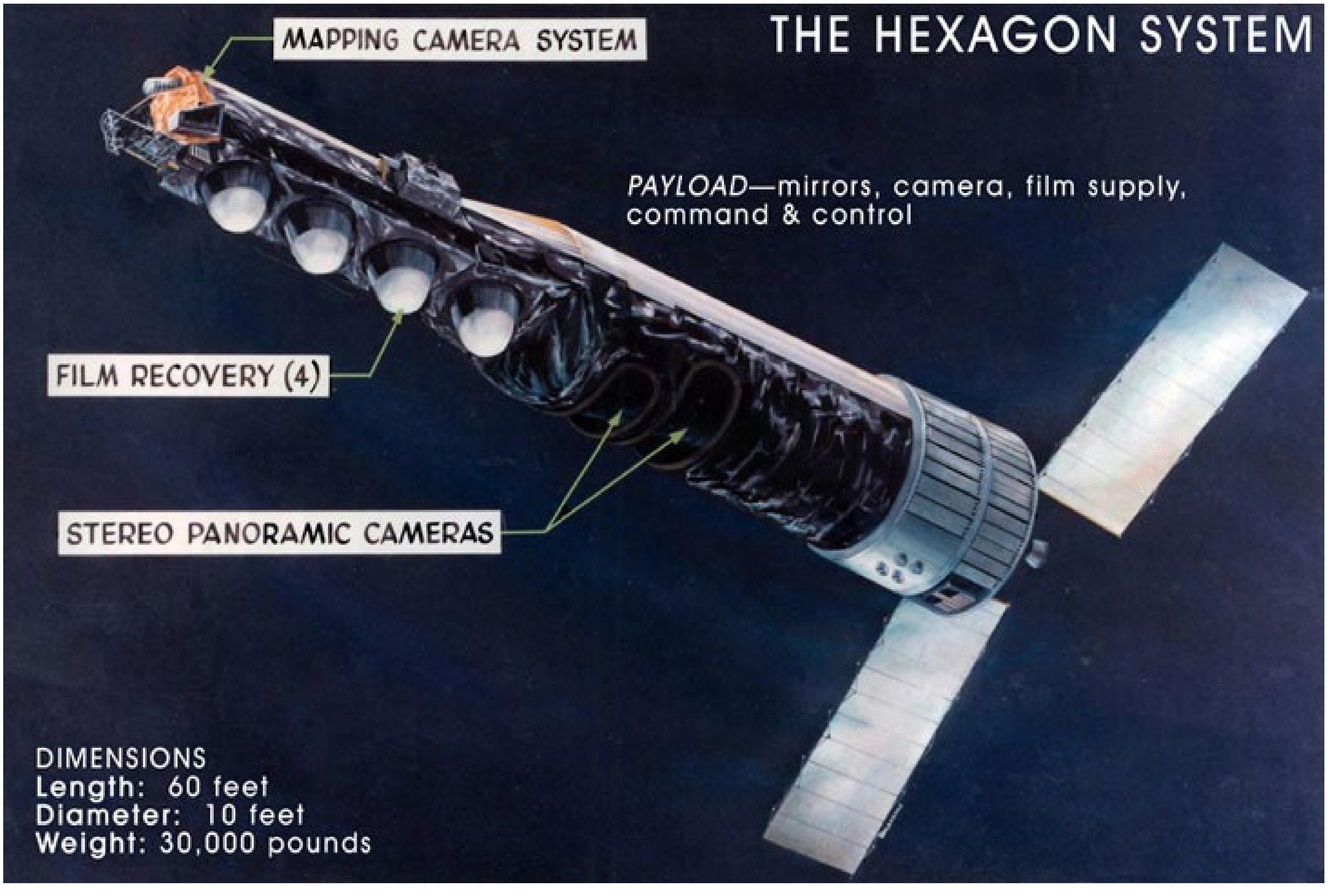
Flax moved quickly to get the new system on track and mend relations with the CIA. Deputy Director, Central Intelligence (DDCI) Richard Helms also moved to develop a more cooperative relationship between the Agency and DoD. He wrote to Flax that the CIA was consolidating all CIA elements supporting the NRO into an organization headed by Huntington Sheldon, the Director of CIA Reconnaissance, and that all CIA satellite activities would be placed in a new Office of Special Projects (OSP) under John Crowley. Aiding the situation was the fact that Crowley, the new chief, and Flax got along well. Flax, in turn, established a Technical Task Group and a Project Management Task Group to study the various forms of program development and program partnership. Nevertheless, the bickering continued.

Faced with a lack of consensus on the “right” way to do the project, Flax devised his own plan for the management and technical development of Fulcrum. On 22 April 1966, Flax submitted his plan to the ExCom for consideration and approval. Now called the HELIX program, Flax recommended a management approach that would make the CIA OSP responsible for the entire sensor subsystem and SAFSP responsible for the remaining system elements. He proposed making the Director, SAFSP, the project director for the entire system, stating that SAFSP was "the only NRP component possessing the personnel, facilities, operational resources, experience, and technical competence to be designated Special Project Director (SPD) for the new general search and surveillance satellite system." CIA officials countered that the CIA's in-house technical personnel and its relationship with the contractors built up over the years, gave it the capability of program management commensurate with that of SAFSP.

Despite continuing CIA protests, the ExCom, meeting in executive session on 26 April 1966, approved Flax's HELIX/Hexagon program proposal as submitted.[31] Finally, more than two years after the original Fulcrum planning, the ExCom gave formal authority for developing a new search and surveillance satellite system—Hexagon. Flax's compromises did not resolve all issues between the CIA and the NRO but they did reduce the "turf battles" and allowed development of Hexagon to proceed.

THE SENSOR SUBSYSTEM

The CIA awarded Perkin-Elmer the contract for the design, development, and fabrication of the camera system for Hexagon in October 1966, in a cost-plus-fixed-fee contract. Realizing that the Hexagon contract was the largest single program ever undertaken by Perkin-Elmer, OSP chief, Crowley, traveled to Perkin-Elmer headquarters to urge the company's executives to use a new System Engineering/Technical Support (SETS) System developed by the TRW Corporation.[32] Despite Crowley's concern and special effort to warn Perkin-Elmer of the immense size of the Hexagon project, by the end of 1966, work at Perkin-Elmer was already several weeks behind schedule. Just manning the program was a major problem. Perkin-Elmer's original proposal called for growth from 150 to 600 people within four months and to 700 by the eighth month. This rate proved impossible to achieve, especially



Hexagon vehicle on orbit

given the long delays in security and clearance approvals. Perkin-Elmer's lack of extensive electronic-design experience and shortage of electronic engineers also created serious problems. In addition, the general Perkin-Elmer management structure was simply inadequate for the magnitude of the Hexagon program. In January 1967, Crowley decided the situation required drastic action. He invited the key Perkin-Elmer managers, including company president, RADM Chester W. Nimitz, Jr., USN (Ret) to CIA headquarters for a management planning session. Crowley told the Perkin-Elmer officials that he was "deeply distressed and vitally concerned" about the lack of progress and even more concerned about Perkin-Elmer's attitude toward deficiencies that had surfaced in both management and technology. Crowley's frank talk resulted in a management overhaul at Perkin-Elmer.

The Hexagon sensor subsystem developed by Perkin-Elmer consisted of a two camera assembly, the film supply, and four take-ups. Located in the Hexagon satellite mid-section, the camera assembly contained a pair of panoramic cameras mounted in a frame. One camera looked forward on the satellite vehicle (camera A, port side) and the other looked aft (camera B, starboard side). Each camera had a 60-in focal length, f/ 3.0 folded Wright optical system. This optical system, which contained both reflection and refracting optical elements, was mounted in an optical bar.

Perkin-Elmer's optical bar involved two, 1-m diameter tubes each containing a 75-cm (30-in) optically flat mirror. This was mounted at a 45-degree angle to reflect the ground images passing beneath the satellite and through a corrector plate into a 91-cm (36-in) concave main mirror at one end of the tube. Images collected in the main mirror were then focused through a hole in the flat mirror and into a compound lens, located behind the flat mirror. The compound lens then projected the images onto the film platen at the opposite end of the optical tube. As the satellite moved through space, each optical bar tube rotated about its longitudinal axis in opposite directions. This provided a panoramic image, up to 120 in wide. Each optical bar was longer than the payload part of Corona. Just to test the tubes, Perkin-Elmer built an entirely new facility at Danbury, Connecticut.

Early on, Perkin Elmer had difficulties with the 91-cm (36-in) main mirror. Initially, the West German firm supplied the mirror blanks, which were quartz optical surfaces fused to ceramic cores. The first blanks exhibited faults in the bonding of the face plates to the cores. These first, fused quartz, blanks were also very heavy and brittle for use in space. CIA and Perkin-Elmer engineers searched for a different material that was lighter weight, with a lower coefficient of expansion.

Beryllium, a relatively rare and lightweight metal, met all their requirements. It was one third as heavy as aluminum, had a very low coefficient of linear expansion, resisted oxidation, and was capable of being polished to a very high degree of reflectance. Its reflectivity extended beyond the visible spectrum into the infrared area, where many other mirrors failed. Unfortunately, beryllium was toxic. Inhalation of beryllium salts caused a reaction similar to chlorine poisoning.

Despite the hazards, Perkin-Elmer undertook a program to develop a beryllium folding mirror for the twin-60 cameras. It soon abandoned the project as too expensive and dangerous. Eventually, Perkin-Elmer decided to use a heavier but less expensive and less dangerous product that had several advantages. It was of lightweight, almost 100 lbs less per mirror blank then fused quartz, and it had a much lower coefficient of expansion. Its cost, however, was 20 percent greater than the German blanks. Hexagon managers reverted to the West German product.

THE MAPPING CAMERA MODULE

In order for imagery to be useful for measurement purposes (measuring distance and determining the size of objects on the ground), satellite altitude and position information needed to be recorded at the exact moment a picture was taken. In the Corona system, this was accomplished by using a stellar-index camera, a separate unit, which took pictures of both the star fields and the ground, thus allowing analysts to determine vehicle altitude and position accurately. This made it possible to prepare maps from Corona imagery. The Defense Mapping Agency also desired a map making capability from Hexagon imagery. In July 1968 Itek became the prime contractor for the stellar-terrain camera and GE for the RV. This was nearly 20 months after Perkin-Elmer won the contract for the main Hexagon cameras. First launch date was projected for April 1970.

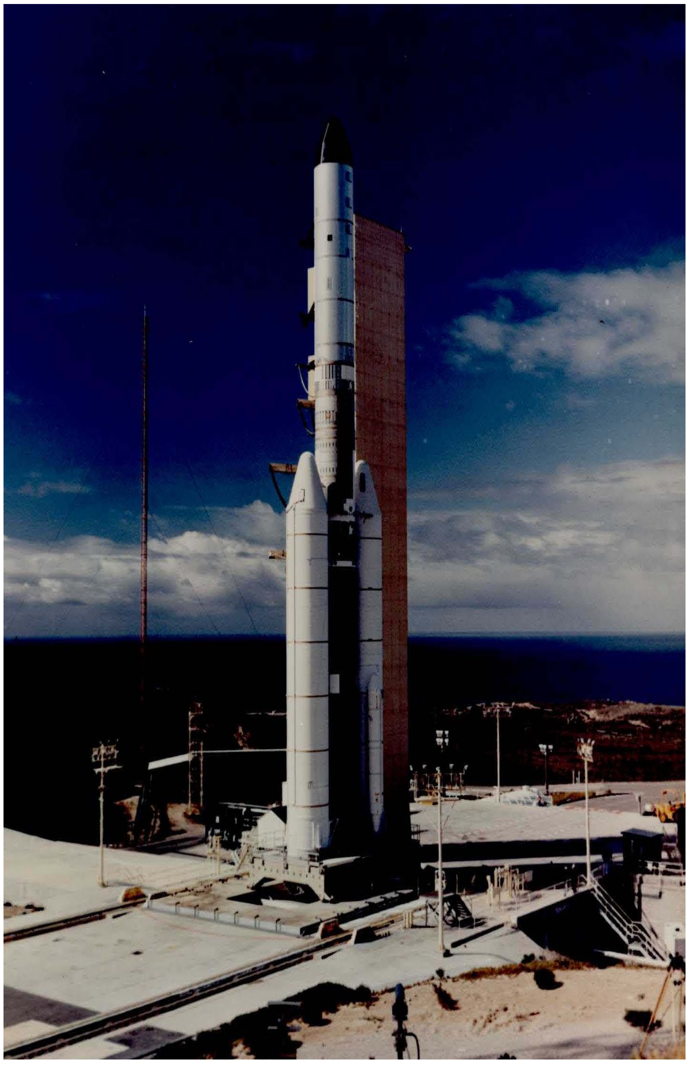
The Itek Corporation had far less trouble with the mapping camera module than Perkin-Elmer had with the main camera. Itek developed and built a mapping camera module that contained a stellar-terrain camera with a 12-in f/6.0 metric lens with eight elements. It used 9.5-in film. The stellar camera, which imaged stars above sixth magnitude, had two 10-in f/ 20 systems—one looking out each side of the module. It used 70-mm film. The GE RV was simply an improved version of the vehicle originally developed for the Corona program, modified to accommodate the 9.5-in and 70-mm film take-ups.

THE SATELLITE VEHICLE

It was not until 20 July 1967 that DNRO Flax finally approved a contractor, Lockheed, for the spacecraft.

Under the leadership of program manager, Stanley I. Weiss, the general vehicle configuration for Hexagon soon began to emerge. Hexagon would be a satellite vehicle 10 ft in diameter and with an overall length of nearly 47 ft. One section would be devoted to the satellite control unit (the brains of Hexagon), one to the sensor subsystem (the cameras), and a recovery section of four RVs. To grasp the sheer size of Hexagon, the spacecraft weighed five times more than the Corona payload—22,500 lbs compared to 4,280 lbs. It was designed to be well within the lift capabilities of the Titan III-D booster.

The spacecraft design and development experienced few major problems. In early 1971, however, Lockheed itself became involved in a serious financial imbroglio, which nearly brought about the collapse of the company. Rolls-Royce Motors Ltd. of Great Britain was under contract to provide the jet engines for Lockheed's new widebody TriStar airliner. Rolls-Royce’s financial collapse threatened Lockheed's promised delivery of its TriStars to several airlines. This in turn created a cash-flow problem for Lockheed (Lockheed was already claiming heavy losses connected with its Air Force C-5A Galaxy aircraft).



Hexagon SV on Titan III D booster

In order not to delay the highly classified work then being performed by Lockheed for Corona and Hexagon, the firm spun off its missiles and space division. It became Lockheed Missiles and Space Company, a wholly owned subsidiary. It was, however, now protected if Lockheed found it necessary to declare bankruptcy. Eventually, the U.S. Government provided a $210 million loan to help Lockheed avoid bankruptcy. It, nevertheless, was a close call for some of the United States' most closely held programs.

Although progress on the various Hexagon components continued, mounting cost overruns and delays brought slippage to the projected launch schedule. By late 1967, Flax and the entire Intelligence Community began to fear that further slips in the Hexagon launch schedule might result in a period during which there would be no photo coverage of the Soviet Union.[33]

Bickering between NRO officials and the CIA continued as well as CIA and SAFSP fighting over the development of on-orbit operational control software for the system. CIA officials wanted to control the satellite from the Satellite Operations Center (SOC) in Washington, sending specific commands to the Satellite Test Center in California for re-transmission to the satellite. This was the system used for the Corona program. SAFSP maintained that the complexity of the new system required that all control of the satellite be done by the Satellite Control Center (SCC) at Sunnyvale, California. In a compromise, Flax finally decided that the SOC in Washington would send a list of requirements with their priorities to the SCC where the actual target selection for a particular revolution would be made, given weather conditions and vehicle health. Although the CIA was not entirely happy with the decision, it was, nevertheless, a semi-victory for the Agency since the CIA now controlled the requirements, which drove the system.

ATTEMPTS TO CANCEL HEXAGON

From the origins of the Hexagon (Fulcrum) program, critics maintained that system requirements could be satisfied less expensively by improving Corona or by using some other less sophisticated system. When the cost of Hexagon at Perkin-Elmer alone rose dramatically in February 1968 and other contractors began showing similar cost increases, the critics intensified their efforts. In 1968, new Deputy Secretary of Defense Paul Nitze questioned the need for Hexagon. Echoing Nitze's concerns and confronted with escalating Vietnam costs, the Bureau of the Budget (BoB) recommended that Hexagon be cancelled in early 1968. Hexagon was the single most expensive item in the 1968 through 1970 NRP. As an alternative to Hexagon, DNRO

Flax, asked the CIA for cost estimates for developing an Improved Corona system. The CIA reported that an improved Corona, without a complete redesign, (with costs estimated to be equal to those of completing Hexagon) could never provide the search resolutions needed for verification of arms limitation agreements (resolutions of 3 ft or better). After reviewing the CIA cost estimates for 20 Improved Corona satellites, an NRO study group recommended to the ExCom that Hexagon be continued. The ExCom agreed and nothing came of the BoB's recommendation.[34]

The Presidential election in November 1968 and the inauguration of Richard M. Nixon as President in January 1969 brought a series of personnel changes and another look at the Hexagon program. Melvin Laird became Secretary of Defense and John L. McLucas, a former DDR&E and head of the Mitre Corporation, replaced Flax as DNRO. In the spring of 1969, the BoB renewed its recommendation to cancel Hexagon.[35]

As Perkin-Elmer began to lay off employees in response to the BoB recommendation, DCI Richard Helms mounted a major effort to have Hexagon reinstated. He called upon Roland Inlow, who had been deeply involved in planning for the Strategic Arms Limitation Treaty (SALT) to study the impact of the loss of Hexagon on arms limitations negotiations. Inlow found that all SALT proposals being made by U.S. officials were predicated on the availability of large-scale search photography from Hexagon satellites. Helms urged Inlow to brief James R. Schlesinger, the BoB's Director for International Relations, on his findings. Inlow did. Helms and Inlow also invited Schlesinger, Vice President Spiro Agnew, and DNRO McLucas for a briefing at NPIC on the Hexagon project. After hearing the briefing, Schlesinger and Agnew recommended to President Nixon that the Hexagon program be reinstated. On 15 June 1969, the BoB reversed its decision and reinstituted Project Hexagon. Full-scale work resumed on the camera system at Perkin-Elmer, but the cost continued to escalate.

ONE MORE CHALLENGE FOR PERKIN-ELMER

One of the most difficult engineering problems confronting Perkin-Elmer and CIA engineers was the challenge of moving film at very high velocities over many rollers and around sharp bends to deliver it to the focal-plane platen and then transfer it to the take-up reels in the film buckets. The high speeds and shiny surfaces created many problems, including the familiar Van de Graaff effect which had plagued Corona. Another problem was the heat generated by the friction of the film as it rubbed over rubber rollers or on shiny metallic bearing surfaces. In prototype models, the film heated up, became gummy, and stuck to these surfaces.

Hexagon launch

Perkin-Elmer engineers, headed by Rod Scott, attacked the film transport problem by adapting a unique air-bag (a gas-cushioned bearing surface) approach Scott had designed for the Oxcart (SR-71) cameras. This method permitted moving the film through the spacecraft without it touching either rubber or metal until it reached the focal-plane platen, and then not again until it reached the take-up reel. The 168-mm film, traveling at 6.6 m (21.6 ft) per second, left the supply spool, entered the film channel, traveled nearly 4 m to the focal-plane platen, stopped to accent images from the optical-bar lenses, and moved along another 6 m to the take-up reel. In between the film-supply reel and the platen and between the platen and the take-up reel, the film was allowed to go slack in a buffer chamber known as a “looper” so that the torque of starting and stopping would not stretch or tear it.

LAUNCH

Despite the setbacks, all appeared ready for a first launch on 15 June 1971. One final glitch appeared when Lockheed attempted to move the flight vehicle from Sunnyvale to Vandenberg Air Force Base for launch preparation. The State of California restricted use of the vehicle transporter (a mammoth vehicle some 14 ft high, 14 ft wide, and 70 ft long) to daylight, weekday, and non-rush hours. It was 28 May, the start of the Memorial Day weekend. The satellite could not be moved to Vandenberg until after the holiday.

The Hexagon spacecraft itself was as big as a locomotive and 16.7 m (55 ft) long, almost as large as NASA's Spacelab, and weighed several metric tons. It contained two giant, rotating optical-bar tubes, each with a 91-cm mirror and a camera. There were also four Satellite Recovery Vehicles (SRVs) for returning film to earth and a 208,000-ft film supply. At 1141 Pacific Daylight Time (PDT) 15 June 1971, the first Hexagon, sitting atop a Titan III-D missile, roared over the launch pad. The Lompoc, California Record reported the launch and nicknamed the satellite “Big Bird.”

On 20 June 1971, during orbital revolution 82, the first film bucket separated from the satellite and reentered the earth's atmosphere in the Hawaiian recovery area. Recovery teams sighted the capsule and its badly damaged parachute. It hit the ocean but the recovery teams got to it before it sank. The film was immediately flown to Eastman Kodak in Rochester, New York for processing. An NPIC representative at Eastman Kodak remarked after reviewing the film, “My God, we never dreamed there would be this much, this good! We'll have to revamp our entire operation to handle the stuff.”

The second film bucket was brought back to earth on 26 June and recovery teams successfully snatched it in midair. Both the first two buckets provided extensive coverage of Soviet missile sites and other sensitive targets. The U.S. Intelligence Community greeted the

Hexagon re-entry chute

product enthusiastically. Unfortunately, when the third RV deorbited on 10 July, its main parachute failed completely and the bucket made a high-speed impact into the Pacific Ocean. It sank in several thousand meters of water before the recovery team could reach it. A recovery team snatched the fourth film bucket without incident on 16 July.

Approximately 75 percent of the photography in the three recovered film buckets was free of clouds, a considerable improvement over earlier satellite photography. This was due to a revolutionary new system named the Hexagon Targeting Program (HTP). The HTP effort was a computer-based method for determining, prior to launch, the accessibility on the intended targets for each mission as well as the likelihood of their being cloud-free. The major features of the HTP included: the use of World Aeronautical Chart (WAC) divisions known as World Aeronautical Grid (WAG) cells, which were a uniform 12 by 18 nm, computer routines for forecasting cloud cover, and maintaining a WAC cell climatological history. Eventually, HTP became part of a much larger NRO effort known as TUNITY. It was used in coordination with the Air Force's advanced Defense Meteorological Satellite Program and increased the efficiency of Hexagon cameras to 90 percent.

During its 52-day mission (31 days active phase) this first Hexagon conducted 430 photo operations and produced an average ground resolution of 3.5 ft and a best resolution of 2.3 ft. It used 175,601 ft (1,350 lbs) of film. Of this 123,601 ft (930 lbs) was recovered. In comparison, the first successful Corona recovery (August 1960) carried 20 lbs of film. Later, Corona flights carried 40 lbs, the two-capsule version, 80 lbs. In the Gambit program, Gambit-1 carried 45 lbs of film and 3,000 ft of film. Gambit-3 carried multiple types of film with differing weights that ranged in length from 7,500 to 10,000 ft of film. It also included two film return capsules, increasing the duration of Gambit-3 missions.

The first Hexagon mission was an outstanding success. For example, the first return capsule contained coverage of more than two thirds of Soviet missile sites alone. The first mission was not without complications, however. Batteries on the first Hexagon overheated, reducing camera operations. Additionally, only the fourth return capsule was free of parachute malfunctions. The first and second capsules were captured despite limited parachute malfunctions. The third return capsule’s parachute failed completely and the capsule hit the ocean surface with such force that flotation devices also failed. The capsule quickly sank to the ocean floor, nearly 3 miles below the surface, before surface ships could retrieve the capsule.

The second Hexagon mission, no. 1202, was originally scheduled to launch three months after the return of the final capsule from the first Hexagon mission. The problems with batteries and parachute malfunctions resulted in a longer delay, and the second mission was launched on 20 January 1972. The first two return capsules were retrieved uneventfully. A film tracking malfunction of the aft camera left only the forward camera available for the final two capsules. Both were retrieved uneventfully in February, 1972.

The third Hexagon mission, no. 1203, was launched 7 July 1972. A modified parachute design for the return capsule was incorporated into this mission as well as some additional modifications based on the previous two Hexagon missions. Similar to the second mission, both of the first two return capsules were de-orbited and retrieved without difficulty. During imaging operations for the third capsule, an altitude control problem developed as well as film tracking problems again with the aft camera. Both problems limited successful imagery operations for the third and fourth return capsules, despite their successful retrieval.

The fourth Hexagon mission, no. 1204, launched on 10 October 1972, involved an extraordinary effort by CIA and NRO officials to test color film and analyze camera focus. This exercise deployed targets throughout the Southwest United States to evaluate Hexagon camera operations with color film. A 28-man team cleared sites and erected and dismantled various configurations along the ground trace of the Hexagon satellite so they were photographable as the Hexagon passed overhead. Known as ground-truthing, CIA and NRO engineers used the photographs of these targets to analyze the focus accuracy of the Hexagon optical system. NRO and CIA officials considered this 68-day mission highly successful.

The fifth Hexagon flight, mission no. 1205, launched on 9 March 1973, was the first to carry the separate Mapping Camera System. Both the stellar and the terrain cameras functioned well during the mission. Defense Mapping Agency analysts rated the results “outstanding.” Numerous small man-made features were easily detected and often identifiable; a baseball diamond, a small aircraft on a taxiway, individual homes with driveways and automobiles. This was quite remarkable for a 12-in focal-length lens at a 92-mile altitude. The stellar photography also provided adequate star images in both magnitude and quality.

A CHANGE IN MANAGEMENT

When President Nixon approved the CIA proposal for a follow-on imaging system as the next photo reconnaissance system in September 1971, Carl Duckett, DDS&T, and other CIA officials, began to look for ways to ensure that the new program was properly staffed. They asked DNRO John McLucas to consolidate all aspects of the Hexagon program under Program A (SAFSP) so that Program B (CIA) could concentrate on the new revolutionary system.

McLucas agreed and transferred Program B responsibilities for Hexagon to Program A. The transfer went smoothly and on 1 July 1973, Gen David D. Bradburn, Director SAFSP, formally assumed all responsibility for management of the Hexagon system, wiring the CIA “we will do our very best to continue the proud record.” The CIA’s Office of Special Projects was now free to focus on the next generation of imagery satellites.

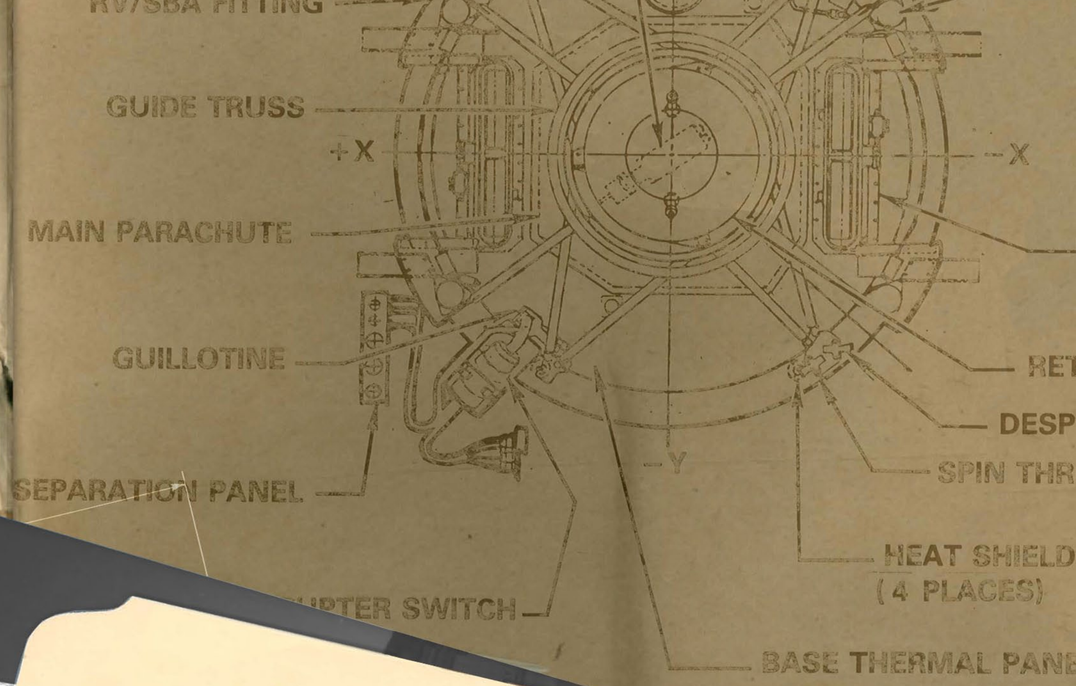
The Hexagon program continued to fly with ever-improving results after the transfer. Unfortunately, the Hexagon program ended on 18 April 1986. A catastrophic Titan 34D failure, nine seconds after lift-off, terminated the 20th and final Hexagon mission. Nevertheless, during its 13 year-life, Hexagon proved to be an invaluable intelligence collection tool.

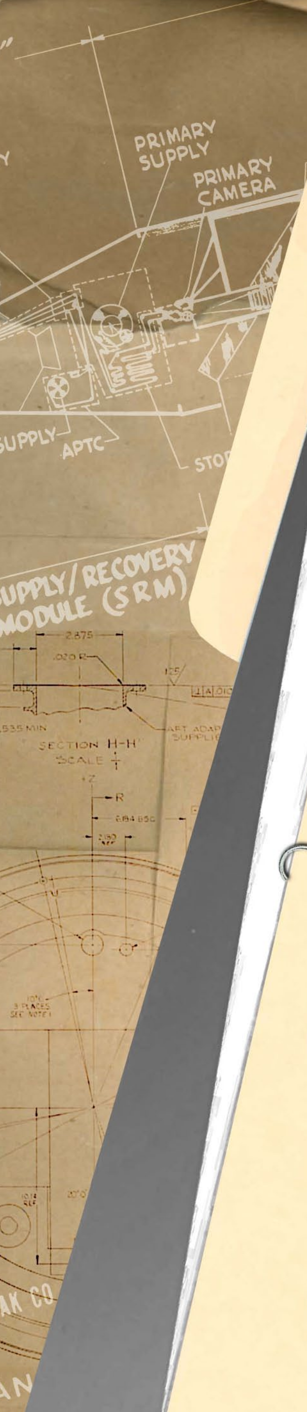
SUMMARY

Despite numerous delays and large cost over-runs, Hexagon met 70 to 80 percent of all the U.S. Intelligence Community’s surveillance requirements. Considering that the Soviet Union encompassed an area of almost 7 million square nautical miles, the mature Hexagon system would image about 80 percent of this area, cloud-free, on a typical mission. During its lifetime, Hexagon played a key role in monitoring Soviet research and development, production, and deployment of strategic offensive and defensive weapons systems. It made possible the first SALT in 1972. Hexagon's broad area coverage capability provided U.S. officials a high degree of confidence, that the United States could detect any new Soviet installations or activities early in the construction phase. The ability of Hexagon to furnish high quality imagery of military installations also allowed U.S. intelligence analysts to develop and maintain very accurate, order-of-battle information on Soviet and Chinese forces.[36] Entire Soviet military districts, for example, could, at times, be imaged on a single mission. These images provided current and accurate force-structure assessments. Hexagon's broad area coverage provided the U.S. analysts opportunities to monitor large-scale Soviet military exercises. In March 1979, for example, when the Soviets staged a major military exercise in Mongolia, in response to the Chinese attack on Vietnam, Hexagon captured the Soviet mobilization.

Hexagon was also tasked to provide coverage of Soviet and Chinese nuclear test sites; often providing complete coverage of these test sites often in a single image. This allowed U.S. officials to closely monitor test preparations and assemble data on the tests themselves. Hexagon also played a key contributing role in U.S. economic forecasts and projections regarding the Soviet economy. During its lifetime, Hexagon provided economic intelligence on Soviet heavy metal production, oil and natural gas exploitation, nuclear production, and conventional electrical power capacity. It also photographed Soviet grain-growing regions allowing accurate U.S. predictions on Soviet grain production.

In addition to its coverage of the Soviet Union and China, Hexagon produced more detailed knowledge of third world development than any system before or since. Moreover, the Defense Mapping Agency and other government agencies that produced maps and charts were almost solely dependent on Hexagon for mapping source materials. Not a bad job for an over-sized “Big Bird.”





CRITICAL TO US SECURITY:
THE GAMBIT AND HEXAGON SATELLITE RECONNAISSANCE SYSTEMS COMPENDIUM

CONCLUSION

During the heart of the Cold War, the National Reconnaissance Office (NRO), with its Central Intelligence Agency (CIA) and Air Force components and their industry partners, designed, developed, built, and operated the Gambit and Hexagon photoreconnaissance satellite systems. The growing reality of a Soviet nuclear arsenal, the development of Soviet nuclear-tipped intercontinental ballistic missiles (ICBMs), and a vigorous Soviet nuclear weapons program, combined with an increasingly complex and divisive Vietnam conflict, created a global crisis atmosphere for U.S. policymakers during the 1960s and 1970s. A sense of extraordinary urgency swept over Washington as U.S. officials searched for intelligence on the Soviet Union and its allies.

This crisis atmosphere drove the NRO effort to develop the next generation of search and surveillance satellites and to provide U.S. decisionmakers with ever more detailed imagery. Building on the pioneer efforts and accomplishments of the Corona program, U.S. designers, engineers, scientists, and managers pushed photoreconnaissance and space flight technologies to their limit in order to meet the demand for more and better photographs from space of Soviet activities.
Most program officials felt the security of the United States depended upon their success.

The years of Gambit and Hexagon program development were marked by great vision, repeated disappointment and failure, and finally by extraordinary triumphs. Gambit, an NRO/Air Force/private industry effort strove to capture clear details of Soviet weapons activity. Under constant pressure to achieve results quickly and operating almost totally in a "black" environment, the Gambit program suffered from excessive compartmentation and secrecy. Corona program development, with its successes and failures, for example, remained virtually unknown to Gambit officials. This resulted in duplication of effort and long delays in design and testing time. Only the introduction of Corona technologies such as the stabilizing Agena second stage "hitchup," the state-of-the-art roll-joint, the Lockheed developed "Lifeboat," and Corona recovery techniques saved the early Gambit program from cancellation and catastrophic failure. Frustrated time and again with system problems, the Gambit team finally reached its goal of routinely providing U.S. intelligence analysts with high resolution imagery. It was a giant step from the fuzzy, 20- to 30-ft resolution imagery provided by the early Corona cameras. This imagery was even better than manned reconnaissance photography. It amazed U.S. photointerpreters.

Overcoming technical uncertainty, Gambit scientists and engineers not only brought a revolution to space photography but they made major improvements in satellite command and control systems, time on orbit, and target coverage. Its impact on U.S. intelligence capabilities was enormous. Combined with the imagery data from Corona and Hexagon, Gambit provided the U.S. Intelligence Community with over 90 percent of its hard data on the Soviet Union. For the first time, using Gambit imagery, U.S. officials had detailed factual information and accurate mensuration data to actually develop engineering drawings on Soviet weapons capabilities. This helped U.S. officials save billions of dollars in U.S. weapons development alone. President Lyndon Johnson expressed his appreciation for these satellites when in early 1967, he informed a meeting of American educators that these satellites "justified spending ten times what the nation had already spent on space." "Because of this reconnaissance," the President confided to the group, "I know how many missiles the enemy has." President Johnson also knew, because of Gambit, the approximate capabilities and state of readiness of Soviet ICBMs.

Hexagon, like Gambit, was a daring technological challenge. An NRO/CIA/industry program, Hexagon became the ultimate film-return photoreconnaissance satellite system. It, like Gambit, suffered hard times during its development stages. Not only were there technological problems to overcome—camera and film design, reflective and refractive mirror construction, and film movement—but Hexagon also suffered from constant bureaucratic struggles over who would control the program. The often bitter debates between the NRO and the CIA caused major delays in design and development time. This resulted in serious launch slippages and major cost overruns. Originally proposed as a cost-saving system to replace Corona and Gambit, Hexagon became the most expensive system yet built. Nevertheless, Hexagon proved to be an extraordinary success. It had the capability of providing stereoscopic, cloud-free photography over 80 to 90 percent of the Sino-Soviet landmass on each mission. In addition, Hexagon had the unique ability to satisfy surveillance and mapping, charting, and geodetic data requirements. Hexagon imagery, by providing continuous direct evidence of Soviet activities, helped eliminate the surprise element for U.S. officials and increased the Intelligence Community's and U.S. policymakers confidence in the overall intelligence product. It provided the hard data for analysis. It also provided assurance to U.S. leaders negotiating arms limitation agreements with the Soviets.

Gambit and Hexagon proved to be of paramount importance to U.S. policymakers. With these systems, U.S. officials had detailed information on Soviet strategic weapons development and deployment. Any new Soviet ICBM complex or development, such as mobile missile deployment, was quickly detected. Soviet construction of antiballistic (ABM) sites, nuclear submarines, aircraft, and naval vessels, and Soviet ballistic missile launchings were all carefully monitored by Gambit and Hexagon. Conceived and built under a crisis situation, these systems stretched space technologies and ultimately performed well beyond their initial expectations. They were truly, "Critical to U.S. Security."

CRITICAL TO US SECURITY:

THE GAMBIT AND HEXAGON SATELLITE RECONNAISSANCE SYSTEMS COMPENDIUM

ENDNOTES

1. Traditionally, photointerpreters divided reconnaissance photography into two categories. One was "search." It was dedicated to finding something. Corona was a search system. Its cameras were designed to photograph large contiguous areas in a single frame of film. The second observation function was "surveillance." Once it was determined there was something of interest there, the surveillance system provided detailed information on the particular target.

2. For a review of the missile gap controversy see Roy E. Licklides, "The Missile Gap Controversy," *Political Science Quarterly* 85 (1970): 600-615. For a detailed review of the U-2 program see Gregory W. Pedlow and Ronald E. Welzenbach, *The Central Intelligence Agency and Overhead Reconnaissance: The U-2 and Oxcart Programs 1954-1974* (CIA, 1992) (S). In August 1957, the Soviets launched a long-range ballistic missile. On 4 October 1957, they rocked U.S. policymakers by orbiting Sputnik I (the first artificial earth satellite; it weighed 84 kg or 185 pounds) and in November 1957 the Soviet Union announced the launching of another earth satellite weighing 900 kg or 1,980 pounds. See Gerald K. Haines, *The National Reconnaissance Office, Its Origins, Creation, and Early Years* (NRO, 1997), pp. 12-13, Cargill Hall "Post-War Strategic Reconnaissance and the Genesis of Project Corona," and Robert A. McDonald, ed., *Corona: Between the Sun and the Earth, The First NRO Reconnaissance Eye in Space* (American Society for Photogrammetry and Remote Sensing, 1997), pp. 25-58. No U-2 operations were to be carried out after 1 May because the President did not want anything to disrupt the Paris Summit scheduled to begin 16 May 1960.

3. For a discussion of the shoot-down and the aftermath of the U-2 downing, see Pedlow and Welzenbach, pp. 177-187. The Soviets prepared an elaborate show trial for Powers which began on 17 August 1960. The Soviets sentenced him to 10 years in prison. On 10 February 1962, the Soviet exchanged Powers for captured Soviet spy Rudolf Abel.

4. Corona was to be a stop-gap effort until the much larger and complex Air Force W117L Samos Satellite became operational. See Hall, pp. 42-51; Haines, pp. 14-15; and McDonald, pp. 61-74. At the same time, Eisenhower approved plans for the CIA to develop a follow-on plane for the U-2.

5. Richard M. Bissell, Jr., with Jonathan E. Lewis and Frances T. Pudlo, *Reflections of a Cold Warrior: From Yalta to the Bay of Pigs*, (New Haven: Yale University Press, 1996) p. 137.

6. The Air Force had the task of developing a high-resolution "spotting" satellite.

7. In early 1958 President Eisenhower set up a Satellite Intelligence Requirements Committee (SIRC) within the Intelligence Advisory Committee (IAC) to establish requirements for satellite reconnaissance. In July 1960, the United States Intelligence Board (USIB) (The IAC was the predecessor body to the USIB.) merged the Ad Hoc Requirements Committee (ARC), originally established by Richard Bissell as an intragovernmental unit to oversee the tasking requirements for the U-2, with SIRC to form a new unit, the Committee on Overhead Reconnaissance (COMOR). William M. Leary, ed., *The Central Intelligence Agency, History and Documents* (Birmingham, Alabama: University of Alabama Press, 1984).

8. Samos originally had two planned photographic capabilities E-1 and E-2. These involved the on-orbit exposure and processing of film, translation of that imagery into an electrical signal by means of a flying-spot scanner, and transmission of the signal to earth for recomposition as a picture. E-3 was the designator for a system which substituted photosensitive electrostatic tape for film; E-4 was used to identify a proposed mapping/geodetic photographic system; E-5 was a recoverable satellite with a large recovery vehicle; and E-6 was a recoverable-film search system with several times the capability of Corona. E-1, E-2, and E-3 were readout systems, E-5 and E-6 were film-recovery systems. Only E1, E-2, and E-6 ever flew.

9. Oxcart was the next generation of manned reconnaissance aircraft. Although originally developed to overfly the Soviet Union, it never did. Improvements in Soviet radar and the SAM missile made such overflights impossible. The Air Force version of Oxcart was known as the SR-71 or Blackbird.

10. Kevin C.Ruffner, ed., *Corona: America's First Satellite Program*, (Washington, DC: CIA History Staff, 1995).

11. Kodak set up a special unit to deal with Gambit. Dr. Frank Hicks directed the program at Kodak. He reported to the director of Special Projects, Dr. Frederic C. E. Oder. The Special Projects organization reported to Arthur Simmons, director of research and engineering of the Apparatus and Optical Division. The Gambit project received the highest priority within Kodak because of its national priority. Earlier, as an Air Force officer, Oder was the original WS-117L project officer and was witting of the entire Corona effort.

12. Most of the Samos program's photo-oriented reconnaissance had been canceled and the E-6 program was experiencing grave technical problems—four failures in four tries.

13. Greer's instruction to King emphasized these goals: 1) stay within budget; 2) stay on schedule; and 3) obtain one good picture.

14. Because of rigid compartmentation of programs, only Col Riepe in the Gambit program office had a working knowledge of the Corona program. Lacking any indication that unpressurized operation was possible, (The Corona experience with unpressurized operation had been employed successfully for two years.) Gambit officials assumed that the pressurization of the film cassette would have to be continued in the new recovery capsule.

15. The CIA program Lanyard at this point had some prospect of filling the proposed Gambit role.

16. Charyk resigned to become president of the newly formed Communications Satellite (Comsat) Corporation.

17. Corona operation continued reasonably successfully during the summer of 1965, only one major mission failure in three flights, but Corona did not return the detail that intelligence analysts needed to interpret Soviet force status.

18. See later discussion of Gambit-3.

19. When first considered, Gambit-3 was informally referred to as Advanced Gambit, and G3, or G-Cubed. G-3 eventually became the accepted designator for the successor program, although upon the completion of the original Gambit program and the start of Gambit-3 operations that suffix was dropped and it became simply the Gambit program. For the sake of clarity, this study will continue to distinguish between the two systems using Gambit-1 for the first program and Gambit-3 for the follow-on.

20. The dominant cause for differences between targets programmed and targets readout in the entire Gambit-3 program was cloud cover. The introduction of weather satellites helped, but the problem persisted as long as cloud cover data was delayed.

21. The dominant cause for differences between targets programmed and targets readout in the entire Gambit-3 program was cloud cover. The introduction of weather satellites helped, but the problem persisted as long as cloud cover data was delayed.

22. The development of near-real time imagery systems made the Gambit-3 film return system obsolete.

23. 0ne way of obtaining greater resolution is to use a longer focal-length lens. The other is to improve "acuity" of the existing system by enlarging and enhancing the imagery. In the beginning of the Corona program there were finite limitations on the size of the lens because of the weight restraints of the booster vehicle. The optimum focal length was a 610 mm refracting lens. Throughout the 14-year Corona program, the focal length of the system never changed—it was 610 mm for the KH-1, KH-2, KH3, KH-4, KH-4A, and KH-4B cameras. Any increase in the focal length would have required a spacecraft with a larger diameter and greater payload capacity. It would have meant abandoning the heavy refracting-type lenses and developing reflecting-type systems that used mirrors and smaller lens cells. Given the limitations of the launch vehicles, the Corona team concentrated on improving the acuity of the 610 mm system.

24. McMillan was at odds with McCone and Wheelon over a host of NRO/CIA issues. He wrote to Secretary of Defense, Robert McNamara, on 12 December 1963, that "the final price of peace with the CIA 'considering the temperament of its leaders' was at least to give the CIA *carte blanche* for development of a new search system." McMillan believed that unless something like this was done, or the CIA management changed, there would be continued obstruction to the NRO and its activity.

25. Wheelon estimated that a single Fulcrum launch could return as much film as the Corona and Gambit programs and cost less.

26. The ExCom was made up of the DCI, John McCone, the Secretary of Defense Robert McNamara, and the President's Scientific Advisor.

27. The Panel consisted of Land, chairman, Dr. Sidney Drell, Dr. Donald Ling, Dr. James Baker, Dr. Allen Puckett, Dr. Edwin Purcell, and Dr. Joseph Shea.

28. CIA and Itek squabbled over the angle through which the camera system would scan. The CIA demanded a 120-degree scan. Itek officials felt this angle was too large and would seriously prejudice the Fulcrum design.

29. In fact, the Land Panel had made no recommendation on the new camera system by the time McCone resigned as DCI in April 1965. President Lyndon Johnson replaced McCone with Vice Admiral William F. Raborn, Jr.

30. Wheelon recruited a new Fulcrum program chief and John J. Crowley as Chief SPS. Crowley was, at the time, heading the Corona project.

31. The ExCom consisted of DCI Raborn, Deputy Secretary of Defense Vance and Presidential Scientific Advisor, Dr. Donald Horning.

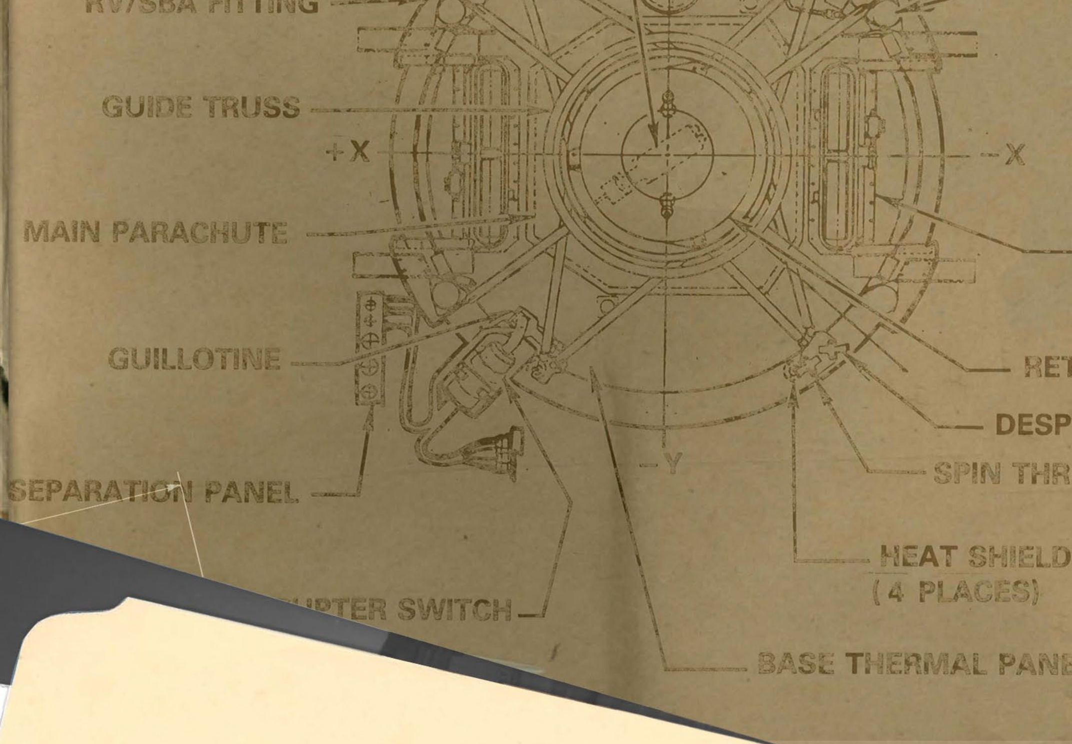
32. Total Perkin-Elmer employment in the Norwalk, Connecticut, area was 2,800 (1,350 of these in the Optical Group, of which 150 were involved with Hexagon).

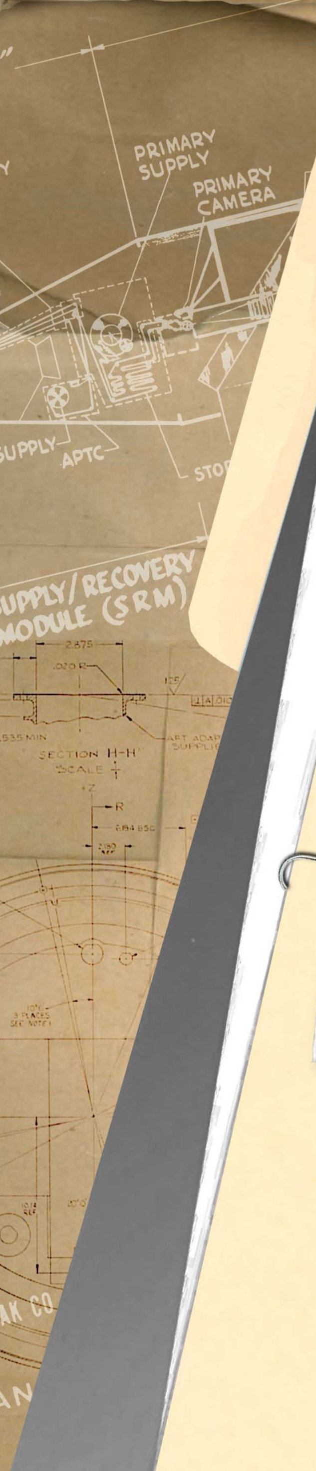
33. The number of Corona vehicles was now severely limited. There were only 11 left in the barn. They could only be stretched out so far.

34. The CIA reported that even an Improved Corona could never provide search resolutions much better than 4.5 ft. The Budget Bureau questioned whether a 1.5 ft difference in resolution could possibly be worth the major cost it estimated it would take to complete the Hexagon program. The decision was already made, however.

35. The Bureau of the Budget was simply dismayed at the size of the satellite programs underway in the CIA, Air Force, and NRO.

36. The high quality of Hexagon imagery is often overlooked because the Gambit program, which produced imagery of the very highest quality, overlapped Hexagon. Nevertheless, Hexagon was capable of meeting most Intelligence Community requirements.





CRITICAL TO US SECURITY:
THE GAMBIT AND HEXAGON SATELLITE RECONNAISSANCE SYSTEMS COMPENDIUM

SECTION II: SYSTEMS REQUIREMENTS

The United States' call for imagery from space can be traced back to efforts to identify technological means for preserving the hard won peace achieved by winning World War II. The forerunner to today's Rand Corporation produced the first study to identify how technology could be leveraged to obtain images from space. For nearly a decade, Rand continued to refine their analysis, leading the US Air Force to begin a formal satellite reconnaissance program in 1956 known as WS117L, and later as Sentry and then Satellite and Missile Observation System (Samos). Corona, Gambit, and Hexagon find their origins in this program.

As important as technical innovation was to development of space-based imagery, the purposes for the systems—or requirements as they are often known—were as important. The Air Force established requirements as early as 1955 in the General Operational Requirements for a Reconnaissance Satellite Weapon System. We have included in this volume the 1958 version of the report which provides the earliest requirements for imagery from space. Some of those requirements include: warnings of ballistic missile attacks, assessment of adversaries' military capabilities, support of US war plans, and identification of adversaries' intentions. The document also describes desired technical requirements for such a system including visual, electronic, infrared, and mapping capabilities. These requirements would significantly influence both the Gambit and Hexagon programs.

We included a 1958 Air Force memorandum outlining the requirements for the Sentry—later known as Samos—photoreconnaissance satellite. In this memorandum, the Air Force identifies specific kinds of strategic targets. The memorandum also includes technical requirements for gaining insight into the specified strategic targets.

By July 1960, the United States Intelligence Board (USIB), chaired by the Director of Central Intelligence, Allen Dulles, fully endorsed a photoreconnaissance satellite. The USIB issued a report that uses the proposed Samos program to explain how satellite reconnaissance will meet requirements to better understand long standing strategic targets. The report emphasizes the unique contributions that an imagery satellite can make to reveal insight into the Soviet Union and other denied areas.

The Eisenhower Whitehouse played a very prominent role in the development of photoreconnaissance satellites. In August 1960, James Killian, Eisenhower's Science and Technology Advisor, issued a report that affirmed the need for imagery satellites. The report supported developing film return systems rather than film readout systems. Most importantly for Gambit, the report affirmed the need for a high resolution satellite in conjunction with Corona's broad area search capabilities.

By 1963 Corona had established a record of returning wide-area imagery. Gambit was poised to offer high resolution imagery. The defense and intelligence communities explored the question of whether or not to develop a new system to replace Corona—one with high resolution, but wide-area capability. Edward Purcell led a panel of experts to explore this question. Although they concluded that pursuing a new system to replace Corona was premature at the time, the CIA was not dissuaded from developing the Fulcrum system that would eventually become the Hexagon system. This early report lays out the parameters of the debate that followed concerning wide-area imagery capabilities.

The USIB tasked the Committee on Overhead Reconnaissance (COMOR) to make a recommendation on developing a new satellite system with Gambit-like resolution and Corona-like coverage. The USIB reviewed the COMOR's recommendation in a 29 July 1964 meeting based on an analysis of long-range requirements for photoreconnaissance. We have included the COMOR's recommendations along with the decision memorandum from the meeting. The USIB agreed with the COMOR conclusion to continue the Gambit system improvements, but also pursue CIA's efforts in developing a new search system. The USIB's recommendations would serve as a strong basis of support for what would become the Hexagon program.

LIST OF SYSTEMS REQUIREMENTS DOCUMENTS

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS UNITED STATES AIR FORCE
DIRECTORATE OF REQUIREMENTS

GOR NO. 80

DATE 15 March 1955

REVISED Sep 26, 1958

~~(S)~~ GENERAL OPERATIONAL REQUIREMENT
FOR
A RECONNAISSANCE STELLITE WEAPON SYSTEM

This GOR supersedes GOR No. 80, dated 15 March 1955, for ~~(S)~~ A Strategic Reconnaissance Satellite Weapon System which should be removed from the file and destroyed.

I. PURPOSE.

This General Operational Requirement is in support of the Intelligence and Reconnaissance Development Planning Objective 1960-1970, and the National Intelligence Objectives of the United States. It is desired that development action following this requirement result in a satellite weapon system capable of providing reconnaissance of the earth. ~~(S)~~

II. OPERATIONAL MISSION.

A. The operational mission of this weapon system is to provide aerial reconnaissance world wide and/or of preselected areas of the earth for:

1. Instantaneous warning of ballistic missile attack.

2. Collection of intelligence data to satisfy national intelligence objectives.

3. Support of U.S. emergency war plans.

4. An aid in determining the intentions of a potential enemy and the status of his warmaking capabilities.

B. Aerial reconnaissance will be performed by photographic, ferret, infrared, and other sensor systems as necessary to collect data on intelligence objectives which will be designated on the basis of priority requirements.

III. ENEMY EFFECTIVENESS ESTIMATES.

Enemy capabilities are contained in the "GOR Intelligence Annex." (U)

DS 58-4746 A2

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~~Secret~~

IV. FRIENDLY ENVIRONMENT.

A. General

It is desired that satellites be launched from the continental limits of the United States and monitored from ground stations in the Western Hemisphere. ~~(S)~~

B. Ground Based Facilities

1. A satellite computation and control center is required.

2. Acquisition and tracking sites are required to receive collected data from the satellite and to relay command messages to the orbiting vehicle. The facilities will be designed and located to receive the data from satellites with minimum delay or degradation and to minimize enemy interception of or interference with the space to ground transmission.

3. A data processing subsystem is required for effective operational control, and for processing, screening, storing and transmission to other agencies via the USAF Communications Support System 456L (GOR 129) to the USAF Intelligence Data Handling System 438L (GOR 149 and 149-1).

V. OPERATIONAL EMPLOYMENT.

A. Satellites will be employed to acquire or confirm data concerning locations, capabilities and vulnerability of manned and unmanned strike forces, defense systems, technological developments, meteorology, topography and geography. They will be employed singly or in numbers to insure desired coverage of a selected area in a given period of time. The frequency or density of coverage required will be determined by correlation of data acquired from a variety of sensors. Separate or combined configurations of the photographic, electronic, infrared or other sensors will be employed to provide the desired coverage.

B. These sensors will be employed to acquire broad coverage within which areas or subjects of critical interest will be identified. When a specific objective that merits scrutiny is identified, frequent, or perhaps for brief periods, continuous coverage on the relatively confined specific objective may be directed.

C. Each satellite may require the capability of in-flight processing of the data collected and transmission to the appropriate ground receiving stations. ~~(S)~~

VI. LIMITATIONS OF PRESENT SYSTEMS.

Present reconnaissance systems are limited as follows:

A. Inability to provide continuous surveillance. ~~(C)~~

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B. Vulnerability to detection. ~~(C)~~

C. Vulnerability to countermeasures. ~~(C)~~

VII. OPERATIONAL PERFORMANCE.

A. Airframe and Propulsion Subsystems

1. The satellite airframe should be designed to insure compatibility with the load carrying capability of ICBM boosters. ~~(S)~~

2. The propulsion system visualized will use the ICBM boosters for the first stage propulsion, and a second stage engine to furnish additional thrust to achieve orbital speeds. ~~(S)~~

B. Auxiliary Power Subsystem

1. An auxiliary power subsystem is required in the satellite to supply electrical power to the various airborne components from just prior to launch until the end of the satellite's reconnaissance lifetime. These components must be compatible with available ground power during warm-up, testing and check-out on the launch stand. (S)

C. Guidance and Control Subsystem

1. This subsystem will be designed to provide guidance and control necessary to place the satellite on the required orbit. ~~(S)~~

2. A method of self-stabilization in attitude must be provided when this vehicle is on orbit. ~~(S)~~

3. Appropriate items of ground support equipment necessary to service, test and calibrate the elements of this sub-system are required. ~~(S)~~

D. Choice of Orbit and Inclination Angle

1. The altitude and inclination angle of the satellite should be selective, depending upon the intelligence requirements of the specific mission. ~~(S)~~

E. Launch Facilities

1. The satellite launching facility will normally be a fixed, permanent type installation. ~~(S)~~

2. Satellite launching facilities should utilize to the maxium extent, ground support equipments designed for current ballistic missiles. ~~(S)~~

F. Communications Network

1. A ground-space communications link is required to transmit collected data from the orbiting satellite, and to transmit command instructions from the acquisition and tracking station to the satellite.

~~Secret~~

2. A point-to-point link is required to relay data from the acquisition and tracking station to the data processing center, and to relay command instructions from the control center to the acquisition and tracking station.

G. Data Processing Facilities

1. Development of a suitable data handling subsystem is required by this weapon system and must be available by the time a potential exists for the actual collection of intelligence information.

2. In order to facilitate dissemination of the processed intelligence information from the intelligence center to other using agencies, the data handling subsystem developed for this weapon system should be as compatible as possible with system 438L - Intelligence Data Handling System.

H. Self-Destruction

Provisions for self-destruction, to the extent that the satellite is removed from orbit, will be incorporated into each satellite. Incorporation of this feature should not delay attainment of an early operational capability.

I. Reconnaissance Sensing Systems Requirements

The reconnaissance sub-systems performance requirements are detailed in addenda to this General Operational Requirement according to the following numbering system.

a. Visual - GOR NO. 80-1
b. Electronic - GOR NO. 80-2
c. Infrared - GOR NO. 80-3
d. Mapping & Charting - GOR NO. 80-4 ~~(C)~~

VIII. GENERAL CONSIDERATIONS.

1. Development of this system will be on an expedited basis to provide an operational capability at the earliest possible date. ~~(S)~~

2. Consideration should be given to the use of a recoverable satellite in order to achieve maximum accuracy, information content, reliability of receipt of collected data, and reuse where economically feasible.

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3. Consideration should be given to the security against enemy interrogation of the orbiting satellite and the survivability of long life satellites.

IX. AVAILABILITY.

The earliest versions of this system should be available by mid 1960 and a full operational capability must be available by 1965.

JAMES FERGUSON
Major General, USAF
Director of Requirements
DCS, Development

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10 November 1958

MEMORANDUM FOR THE DIRECTOR, Advanced Research Project Agency

SUBJECT: Intelligence Requirements for SENTRY

1. Reference is made to your memorandum, subject as above, dated 30 September 1958.

2. The attached statements of electronic and photographic intelligence requirements for SENTRY represent the requirements of the Department of Air Force, Department of Army, Department of Navy, Central Intelligence Agency, and National Security Agency.

3. These requirements were developed by the Ad Hoc Satellite Intelligence Requirements Committee with a representative of your staff acting as an observer. In general, they are an expansion of those expressed in the Department of Air Force, General Operational Requirements for a Reconnaissance Satellite System, dated 26 September 1958. The only significant difference between the statement of requirements in the Air Force GOR and those contained in this memorandum concern specifications for communications intelligence. The requirement for coverage of the frequency spectrum expressed in this memo is 20 mcs lower and 10 kmcs higher than that expressed in the GOR.

4. In regard to ARPA's participation in the Ad Hoc Satellite Intelligence Requirements Committee, it is recommended that an ARPA representative continue to work with the committee in the role of observer as Mr. John S. Patton did during development of the attached requirements.

5. The AFCIN staff and, when appropriate, the Ad Hoc Satellite Intelligence Requirements Committee, will be available at your request to assist you in solving any problems related to intelligence requirements and specifically, as these requirements relate to the development of collection sensors for space reconnaissance systems.

2 Incls
1. Electronic Rqmts (Tab A)
2. Photo Rqmts (Tab B)

/s/
JAMES H. WALSH
Major General, USAF
Assistant Chief of Staff,
Intelligence

~~DS 60-4720 A1~~
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TAB "B"
29 October 1958

REQUIREMENTS FOR PHOTOGRAPHIC INTELLIGENCE CAPABILITY OF SENTRY

1. At this time, there is available a tabulation of approximately 3,000 specific objectives in order of national priorities for reconnaissance. The reconnaissance objectives designated in this list require a photographic ground resolution of approximately 20 feet or better. Photography from systems limited by the state-of-the-art to a ground resolution of approximately 100 feet will be used by the Intelligence Community to develop a photographic or cartographic base into which photography with better resolution can be integrated.

2. The tabulation of reconnaissance objectives known as "The National Priority Reconnaissance Requirements List" is divided into interest categories which are:

a. Soviet Air Force installations associated with the long range bomber program.

b. Soviet capabilities for defense against air attack.

c. Atomic Energy installations.

d. Guided Missile installations.

e. Naval bases, shipyard and port facilities.

f. Industrial complexes.

g. Strategic positioning and capabilities of the Soviet military forces.

The interest categories divided by priority consist of:

a. 32 objectives covering guided missile installations, heavy bomber bases, naval bases, and nuclear production facilities of highest priority interest and constituting the known hard core of Soviet capability for nuclear attack on the United States. It is imperative that current, indisputable information be available on these to accurately assess Soviet capabilities and intentions and to enable effective retaliatory strike planning.

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b. 446 objectives of high priority which are directly related to Soviet war making capabilities.

c. 2564 objectives of priority interest which represent other Soviet capabilities that relate to the various elements of power.

d. Objectives which represent requirements for technical intelligence are included in the priority listing.

e. In addition to these specific requirements which have been identified, information is required on areas that are inaccessible to other collection methods. It is anticipated that such information will reveal the existence of important installations previously unknown.

3. The following essential elements of information concerning the Soviet military strength have been used as a basis for selecting the above specific requirements and establishing priorities:

a. Missile objectives include location and activity of launch sites, operational capability, vulnerability and force inventory. Also, detailed technical information on individual missiles, launchers, propellants, site facilities, guidance systems, production sites, storage sites and launch sites.

b. Long range Air Force objectives include location and activity of airfields, types, disposition, configuration and numbers of aircraft, plus other elements of strike capability. Also included are detailed and technical information on aircraft, special weapons, special weapons storage, loading and handling, defense facilities, runway surface and parking facilities, aircraft production facilities and activities.

c. Air defense objectives include detailed and technical information on surface-to-air missiles, air-to-air missiles, aircraft, special weapons storage and handling, early warning radar, anti-missiles capability, alert procedures and composition, location and status of defense facilities.

d. Atomic energy objectives include detailed and technical information on ore production and processing facilities, fission and fusion products, feed material products production, R&D and programmed weapon systems utilizing atomic or nuclear materials, and weapon fabrication and nuclear propulsion facilities.

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e. Soviet research and development objectives are related but not limited to space travel and exploration, biological and chemical warfare, electronic warfare, nuclear propulsion and aircraft.

f. Complexes, ports and general military objectives include detailed information on locations, types of industries, capacities and facilities of ports, capacities and facilities of military installations, storage depots and air logistics installations.

4. The National Priority Reconnaissance Requirements List represents a current statement of photographic requirements. Based on past experience, it can be anticipated that the general validity of this list will carry into the 1960 - 1965 time period. The individual reconnaissance objectives within the various priorities could change based on new intelligence. Under current procedures within the intelligence community, a National Reconnaissance List will be maintained on a current basis. This list will be applied by the Ad Hoc Satellite Intelligence Requirements Committee to form the basis for the initial operational guidance for the SENTRY program.

5. During development and operational employment, the photography with a ground resolution of objects approximately 100 feet on a side will be used by AFCIN, USAF Aeronautical Chart and Information Center, Army Map Service, Army Photo Interpretation Center, Navy Photo Interpretation Center, Navy Hydrographic Office, Strategic Air Command, and Central Intelligence Agency for production of air navigation charts, topographic maps, geodetic data, target graphics, special purpose maps, and P. I. Reports. This quality of photography will provide an initial complete base of photo coverage. After the first base is completed, the frequency of subsequent coverage will be governed by the schedule for revision of maps and charts at a scale of approximately 1/1,000,000, or not more than annually.

6. The Photography with a ground resolution of objects approximately 10 to 20 feet on a side will be used by Strategic Air Command, Aeronautical Chart and Information Center, Army Map Service, Navy Photo Interpretation Center, AFCIN and Central Intelligence Agency for the production of many intelligence end products. Coverage with a ground resolution of 10 to 20 feet of selected targets such as active missile test sites, research and development centers, or other targets specified as highest priority interest on the National Priority Reconnaissance Requirements List is required on the average of once a week. From time to time during very short periods, daily photographic coverage of a few targets may be required.

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7. Photography with a ground resolution of objects approximately 1 to 5 feet on a side will be used by Central Intelligence Agency, Department of the Air Force, Department of the Army, and Department of the Navy for the most critical intelligence end products in the fields of guided missiles, nuclear energy, aircraft production and development, electronics, electronic installations, biological-chemical-radiological warfare, and other technical intelligence.

8. The probability of acquiring intelligence from photography is dependent on many factors, one of which is resolution. An evaluation of the probable intelligence to be derived from photography with various ground resolutions is sub-divided for discussion into increments of 100, 20, 10, 5 and 1 feet on a side. This evaluation is considered valid provided the targets are not concealed by deception or camouflage.

a. Photography with a ground resolution of objects 100 feet on a side should provide information for identification and location of cities, forests, large bodies of water, industrial complexes, major military complexes, air bases and large Naval and port facilities. Indications of industrial growth should be detected. Large ships (300 feet in length or more) should be detected at anchor or at sea and naval formations at sea identified. The extent of complexes, installations and sea formations should be approximately measured and some geodetic and topographic information should be available. It should be noted that geodetic data derived from this photography will be limited to extension of existing control networks.

b. Photography with a ground resolution of objects 20 feet on a side should provide all the information available from that with a ground resolution of 100 feet on a side, plus intelligence information concerning components of installations or complexes. Some air base runways, submarine bases, drydocks, piers and supporting facilities, major or isolated Moscow-type surface-to-air missile sites, atomic energy installations, ballistic missile sites, and industrial installations should be detected, located, identified by type and approximately measured. Large vessels including surfaced submarines, large aircraft and missile launch pads, should be counted. Military support facilities should be identified by type. The identification and disposition of major Soviet naval forces should be determined.

c. Photography with a ground resolution of objects 10 feet on a side should provide a capability to identify large aircraft and known missile carrying submarine and ship types, determine base utilization,

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locate special weapons facilities and analyze base support facilities. A general functional analysis of industrial, military and transportation facilities should be completed. Above ground fixed ICBM facilities such as launch pads, stands and some support equipment should be accurately measured. The capacity of military storage facilities, the general level of military activity, military transportation capabilities and indications of security should be determined. Naval ships and units should be identified by type.

d. Photography with a ground resolution of objects 5 feet on a side should provide detailed intelligence information concerning most military and industrial installations. All aircraft, except model improvements, some large missiles, early warning sites, AAA sites, atomic energy materials production, except weapons, structural shipboard configurations for missile handling, and special weapons storage, loading and handling should be identified, measured and analysed. A level of military activity and type of training should be discernable.

e. Photography with a ground resolution of objects 1 foot on a side should provide detailed technical intelligence concerning air, naval or ground force equipment and industrial production processes.

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~~S E C R E T~~

The Honorable Thomas S. Gates
The Secretary of Defense
Department of Defense
Washington, D. C.

Dear Mr. Secretary:

The United States Intelligence Board has considered two major areas relating to the development and employment of the SAMOS reconnaissance system. The first of these areas is the consolidation of the general intelligence requirements of the various departments, services and agencies of the United States to serve as the overall basis for the SAMOS system development. The second of these areas is to establish priorities for the system developers and for the employment of the SAMOS system in the development stage during the 1961-1962 time period. These requirements and priorities are set forth in the attached paper entitled: "Intelligence Requirements for Satellite Reconnaissance Systems of which SAMOS is an Example".

The fulfillment of these requirements as expressed is considered critical to the security of the United States, this is also evidenced by the national priority established for SAMOS.

Sincerely,

Allen W. Dulles
Chairman

~~S E C R E T~~

~~SECRET~~ USIB-D-33.6/8
(FINAL - USIB APPROVED)
5 July 1960

INTELLIGENCE REQUIREMENTS FOR SATELLITE RECONNAISSANCE SYSTEMS OF WHICH SAMOS IS AN EXAMPLE

Previous reference
G. O. R. I, II
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1. The United States has, and will continue to have for the foreseeable future, a high priority requirement for photographic and electronic reconnaissance of the Soviet Union and other denied areas. In theory, it is feasible to conduct a large amount of this reconnaissance in a number of different ways, but this feasibility will be affected from time to time by technical and political considerations that might make it difficult or impossible to use all of the theoretically feasible means. Although a satellite reconnaissance system has not yet been operationally demonstrated and is not likely in the near term to produce the quality of information that can be obtained by other systems, on balance, it should be able to perform a number of reconnaissance tasks better than other systems and should be able to produce useful information on the great majority of intelligence questions against which reconnaissance systems might be employed. A satellite reconnaissance system might also be less affected by some of the political considerations affecting other reconnaissance systems. The U. S. Intelligence Board considers it essential, therefore, that the United States develop and maintain an operational satellite reconnaissance system with a wide range of capabilities.

G. O. R. 80
Ops Requirement

2. The intelligence situation facing the United States will continue to be highly dynamic, influenced both by changes in Soviet capabilities and

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5 July 1960

our own intelligence assets, making it impossible to specify at any one time the precise nature of the satellite reconnaissance system that will be required in the distant future. As stated in paragraph 1 above, however, we are sure that there will exist an urgent requirement for a satellite reconnaissance system throughout the foreseeable future.

G. O. R. 80-1
2. ops characteristics

Letter 10 Nov 58
Tab B, par 1 and 5

3. The photographic system must be capable of obtaining coverage of denied areas at object resolutions of approximately 20 feet, 5 feet, and ultimately 1 foot on a side. However, the 100 feet on a side programmed for R&D design objectives will be utilized and exploited for intelligence purposes to the maximum extent possible. (See Annex "A" for examples of objects that can be identified at these resolutions.) 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. The anticipated frequency can be predicted more precisely as the intelligence situation develops.

G. O. R. 80
V ops employment

4. It is essential that the U. S. have access to information derived from electronic emissions inside of denied areas that, in the present state of the art, can be collected only by electronic reconnaissance over those denied areas. A satellite electronic reconnaissance vehicle is likely to be of great value in this reconnaissance. It is essential that such an electronic reconnaissance vehicle have a wide range of capabilities in order that it may fulfill the requirements expressed in the

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5 July 1960

National ELINT Requirements List that are appropriate to collection by a satellite. The characteristics required of these vehicles are described in Annex "B". Unfortunately, however, in the present state of the art electronic art, these capabilities are likely to be obtained only after a considerable R&D effort. We feel that the information derived from photographic reconnaissance is now, and is likely to be, of greater value and priority than that obtained by any foreseeable electronic reconnaissance system. Even in these circumstances, however, we feel that the information likely to be obtained by electronic reconnaissance would be of such value that the R&D effort to achieve this capability should be carried forward with the highest priority short of interfering with the photographic tasks outlined elsewhere in this paper. In the absence of a fully developed electronic reconnaissance system, and in view of the uncertainties as to what can be collected with interim systems, we are reluctant to specify detailed requirements for the short term that might cause serious disruptions in the R&D effort leading toward the fully developed system. There are important problems, however, toward which electronic reconnaissance could contribute critical information during the R&D phase without serious disruption to that effort. One of the most important of these is the search for emissions associated with an Anti-Ballistic Missile system. These problems are outlined in greater detail in Appendix I to Annex "B". It is probable that from time to time the intelligence situation will require that additional tasks be levied on

Photo over Ferret

Search for missile emissions

- 3 -

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(FINAL - USIB APPROVED)
5 July 1960

the satellite electronic reconnaissance system during the R&D phase. These will be communicated to the proper authorities as they arise.

Letter from ARPD to BMD
3 Dec 58

5. In order for the system to move in a realistic direction and provide the maximum amount of intelligence to the country, it is essential that the R&D phase of the system be guided by and devoted to the intelligence tasks outlined below and to such additional high priority intelligence tasks as may arise from time to time. The intelligence community will review these requirements at frequent intervals as the intelligence situation develops in order that new tasks may be identified and brought to the attention of the R&D authorities at the earliest possible time.

Letter 10 Nov 58
Tab B Par 3

6. At the present time, the U. S. intelligence community maintains a National Priority Reconnaissance Requirements List which identifies those specific targets in the Soviet Union against which photographic reconnaissance should be employed. This list is concerned with Soviet offensive capabilities including installations associated with the Soviet Long Range Bomber program, the Soviet Guided Missile program, the Soviet Navy especially with regard to nuclear-propelled and guided missile configured vessels and Soviet Tank, Motorized and Artillery Forces. Other targets on the list are concerned with the capabilities and strategic positioning of Soviet military forces, Soviet capabilities for defense against air and missile attack, and the Soviet power base in the form of atomic energy installations and industrial complexes. The National Priority Reconnaissance Requirements List is broken down into various categories of priority interest.

- 4 -

At the present time, approximately 35 objectives are considered to be of the highest priority interest. Approximately 500 objectives are of high priority interest and approximately 3,000 additional objectives are of priority interest. In addition to these specific objectives, information is required on areas that have been inaccessible to other collection systems. It is anticipated that reconnaissance of these areas may reveal the existence of important installations previously unknown.

Letter 10 Nov 58
Tab B, Par 1a

7. The specific composition of the National Priority Reconnaissance Requirements List will change from time to time as new information is acquired from all sources and as the important intelligence problems facing the United States change. It is anticipated, however, that at any given time within the foreseeable future, our requirements for photographic reconnaissance will approximate the present list in size and variety. Complete and simultaneous coverage of the Soviet Union would not eliminate such a list, even if it were possible to achieve, because the elements of power in the Soviet Union are dynamic and new developments and additions are occurring constantly. Repeat coverage of many of the target areas in the Soviet Union will remain a requirement, therefore, although the number and periodicity of this repeat coverage will vary, depending on the nature of the target and the intelligence situation existing at the time. 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

G. O. E. 80 V
Letter 8 Dec 58
Par 2a

Letter 10 Nov 58
Tab B, Par 5 & 6

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(FINAL-USIB APPROVED)
5 July 1960

sufficient flexibility to permit the coverage to be timed to meet the needs of the specific intelligence situation as it develops.

8. The information obtained by the satellite reconnaissance system would be of maximum use in providing strategic intelligence information. In addition to this primary mission, it should provide important by-products in the form of information bearing on indications of Soviet intentions.

9. At the present time, the U. S. Intelligence Board is faced with several outstanding problems which should be considered on a priority basis for system development and employment of the photographic satellite vehicles during the 1961-1962 time period as follows:

Letter 10 Dec 58

a. Our first and most urgent priority requirement is for a photographic reconnaissance system capable of locating suspect ICBM launch sites. It is estimated that many sites for the launching of operational Soviet ICBM's will be completed between now and the end of 1962. It is our strong belief that our best and possibly our only chance to detect these sites will be during the construction phase; once these sites are completed, we will have considerably less opportunity to detect them. It is important, therefore, that a maximum effort be made to find the Soviet operational ICBM launch sites before the end of 1962. Once any ICBM site is located, a satellite reconnaissance system with adequate ground resolution should be able to maintain surveillance and report changes in its status, but if these sites are not located before the end of the construction phase almost any reconnaissance system would be of considerably less value

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(FINAL-USIB APPROVED)
5 July 1960

against such a target. We believe that if we are to find the Soviet operational ICBM launch sites, our highest priority effort should be directed to a general search of a substantial portion of that part of the USSR covered by the rail net. Photographic resolution to accomplish this search mission would need to approach 20 feet on a side. Repetition of this general search at the rate of approximately once each month initially would give us a relatively high degree of assurance of providing the information required. Read-out of the photography on this frequency would establish trends and priorities for the programming of subsequent search missions. It is expected that the photography will also be used to supplement that obtained by other means for the improvement of mapping and more precise location of targets in the Soviet Union in response to the Emergency War Plans of the Armed Services.

G.O.R. 80 Par V B
G.O.R. 80-1 Par 2a
Letter 10 Nov 58 Par 6

G.O.R. 80 Par V A.

b. If suspicious locations are identified which might be possible ICBM launch sites, these locations will be added to the highest priority category of the National Priority Reconnaissance Requirements List. Our second priority requirement, therefore, is for photographic coverage of the highest priority target category in the USSR, with a photographic system of sufficient resolution to supply us with descriptive information on those targets. It is believed that resolution approaching 5 feet on a side is necessary for this requirement. There should be a capability to launch and/or control these missions on-call at short notice to meet the needs of the intelligence situation as it develops.

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c. Our third priority requirement is for a photographic system of sufficient resolution to supply us with the technical characteristics of the highest priority targets before the end of 1962. This will require a resolution of better than 5 feet on a side.

d. If technological development barriers preclude the design objectives for resolutions described above, the USIB will designate resolutions which are acceptable from an intelligence standpoint.

2 Atchs
1. Photo (Annex "A")
2. ELINT/COMINT (Annex "B")

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5 July 1960
Annex "A"

Letter 10 Nov 58 Par 8

EXAMPLES OF INTELLIGENCE TARGETS THAT MIGHT BE IDENTIFIED AT VARIOUS RESOLUTIONS

1. The following categories, although not intended to be definitive or comprehensive, are presented for the purpose of giving some idea of object size in the intelligence spectrum which might be identified at the limiting resolutions indicated. This evaluation is considered valid provided the targets are not concealed by deception or camouflage.

a. Photography with a ground resolution of objects 100 feet on a side should provide information for identification and location of cities, forests, large bodies of water, changes in rail alignments and transportation patterns, industrial complexes, CBR and nuclear R&D test facilities, major military complexes, possibly including large missile sites or related electronic facilities and patterns, air bases and large Naval and port facilities. Indications of industrial growth should be detected. Large ships (300 feet in length or more) should be detected at anchor or at sea and naval formations at sea identified. The extent of complexes, installations and sea formations should be approximately measured and some locational and topographic information should be available.

b. Photography with a ground resolution of objects 20 feet on a side should provide all the information available from that with a ground resolution of 100 feet on a side, plus intelligence information concerning

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components of installations or complexes. Some air base runways, submarine bases, drydocks, piers and supporting facilities, ground forces barracks areas, equipment parks, and training centers, major or isolated surface-to-air missile sites, atomic energy installations, ballistic missile sites, and industrial installations should be detected, located, identified by type and approximately measured. Large vessels including surfaced submarines, large aircraft and missile launch pads, should be counted. Military support facilities should be identified by type. The identification and disposition of major Soviet naval forces should be determined.

c. Photography with a ground resolution of objects 10 feet on a side should provide a capability to identify large aircraft and known missile carrying submarine and ship types, determine base utilization, locate special weapons and CBR facilities, limited map and chart revision could be accomplished, and analyze base support facilities. A general functional analysis of industrial, military and transportation facilities should be completed. Above ground ICBM and IRBM facilities such as launch pads, stands and some support equipment should be accurately measured. The capacity of military storage facilities, the general level of military activity, military transportation capabilities and indications of security should be determined. Naval ships and units should be identified by type.

d. Photography with a ground resolution of objects 5 feet on a side should provide relatively detailed intelligence information concerning

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most military and industrial installations. All aircraft, except model improvements, ground forces disposition and equipment to include tanks and artillery, some large missiles, early warning sites, AAA sites, atomic energy materials production, except weapons, structural shipboard configurations for missile handling, and special weapons storage, loading and handling should be identified, measured and analyzed. A level of military activity and type of training should be discernible.

e. Photography with a ground resolution of objects 1 foot on a side should provide detailed technical intelligence concerning air, naval or ground force equipment and industrial production processes.

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5 July 1960
Annex "B"

REQUIREMENTS FOR ELINT/COMINT CAPABILITY

G.O.R. 80-2 Par 1 a
Letter 10 Nov 58 Tab A 1 a

1. GENERAL

a. The ELINT/COMINT reconnaissance system must provide the ability to intercept electromagnetic emissions from the Sino-Soviet Bloc, to return the intercepted information in a secure manner to appropriate locations, and to record against an accurate time base this information in a form suitable for other processing.

G.O.R. 80-2 Par 1 B
Letter 10 Nov 58 Par 1b.

b. Development of electronic reconnaissance satellites will involve maximum equipment progression, utilizing state-of-the-art equipment without inhibitions of past techniques and custom in intercept, recording and processing. The most advanced equipment possible must be employed as early in the program as is permissible within operational considerations and equipment availability. No individual vehicle will necessarily have all of the characteristics and capabilities required for the sub-system as a whole.

c. As SAMOS reaches the operational stage, intelligence information received from the project or other sources may indicate the need for additional types of directed intercept systems capable of receiving, recognizing and recording specific types of signals. As more is learned of the technical capabilities of the system, operational requirements will be revised. Provisions should be made to procure

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such equipment as might be required by Quick Reaction Capabilities. A close working relationship between the R&D organization and the intelligence community is required.

d. The ELINT targets for the system will be drawn from the National ELINT Requirements List and the COMINT targets from the National COMINT Requirements List. It is not intended that collection by satellites will replace other means of ELINT/COMINT collection. It is important that the effort be concentrated on obtaining signals inaccessible by other means of collection.

e. Facilities should be provided to allow programming of the collection systems from the ground for specific targets, by changing the system directivity, radio frequency and bandwidth vs time.

f. The read-out and data processing capability for intercepted signals must be as effective as the capability for collection so as to provide a means of rapid processing and dissemination of the products to producers and users. Every effort should be made to insure that any machineable output of the system be in a form compatible with the input capabilities of the users.

g. The objective is to have an operational system as soon as possible. However, during the R&D phase, flights are required for R&D purposes, during which time it is recognized that intelligence priorities may be of a secondary consideration.

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2. OPERATIONAL CHARACTERISTICS: The following characteristics represent the ultimate in the system. Appendix "I" to this Annex which shows the specific requirements for selected priority targets demonstrates that not all of the operational characteristics given below are needed for each requirement.

G.O.R. 80-2 Par 1c-a
Letter 10 Nov 58 Par 2

a. The system should provide receiving and recording equipment capable of intercepting land based, shipborne and airborne electronic emissions between 10 mcs and 50 kmcs and at lower and higher frequencies, if propagation will permit. Equipments covering specific bands within this range should be in easily substituted modular form.

b. The receiving and recording equipment should be of high sensitivity, low noise, high fidelity and most modern design in keeping with the latest developments within the state-of-the-art.

G.O.R. 80-2 Par 1c-b

c. Receivers covering specific RF bands should be capable of receiving, recognizing, and providing outputs for the recording of all known types of modulation within their specified bands.

G.O.R. 80-2 Par 1c. d

d. The system should be capable of recognizing and recording new and unusual signals. The original modulation of intercepted signals should be preserved to the greatest degree possible.

e. The system should incorporate a direction finding capability that will permit location of electronic emitters within a five mile CEP; however, achieving this capability should not preclude attaining a high order technical collection capability within the system.

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G.O.R. 80-2 Par 1c-G

f. If feasible, receiver outputs are required that will allow determination of scan rate and polarization of intercepted signals.

g. The system should be capable of storing and discriminating between intercepted data from several orbits, at least until readout has been accomplished.

h. The system should also provide calibration data to the ground-space communications and to the data processing sub-systems adequate for the production of the most reliable intelligence information.

Letter 10 Nov 58 Par 3

3. GENERAL TECHNICAL CHARACTERISTICS:

a. The receiver dynamic range requirements should be maximized to preserve pulse amplitude modulations that occur in telemetry, missile guidance, etc.

b. Receiver sensitivities should be a maximum consistent with intercept requirement. RF accuracy should be the best attainable.

c. Rapid automatic spectrum coverage is required with a high probability of intercept.

d. Image and spurious response interference should be a minimum.

e. The system should be capable of determining the synchronization of several different signals simultaneously.

Letter 10 Nov 58 Par 4 a. & a.

4. SPECIFIC ELINT COLLECTION: The foregoing characteristics represent the ultimate in the system as we now see it. Specific requirements will change during the development phase and will be subject to

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continuing revision by the Intelligence Community in accordance with the priorities established by the National ELINT Requirements List. Examples of targets of current importance and considered to be obtainable by the system are listed in Appendix "I", Section A. The technical parameters desired and the accuracies needed are added. Section B lists examples of specific targets which will become progressively attainable with development of the system. These will be moved to Section A when appropriate.

Letter 10 Nov 58 Par 5

5. COMINT COLLECTION:

a. COMINT requirements for SAMOS are of lower priority than the ELINT requirements. Development of COMINT collection devices will be dependent upon empirical data acquired by the ELINT system.

b. The frequency spectrum of interest ranges from below ten megacycles per second to ten thousand megacycles per second.

c. The estimated radiated power of the transmitters to be intercepted is tabulated below:

FREQUENCY	MINIMUM POWER	SIGNAL BANDWIDTH
HF	1.0 watts	1 kc min to 10 kc max
VHF	10 watts	5 kc min to 100 kc max
UHF	3 watts	30 kc min to 1 megacycle

d. The recorder will provide for storage of video signals and will have a bandwidth capability of one megacycle.

e. The minimum sub-system (antenna, receiver, recording and playback) signal to noise ratio should be of the order of ten decibels.

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Appendix I

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5 July 1960
Appendix I

SPECIFIC ELINT REQUIREMENTS FOR SAMOS

Letter 10 Nov 58 Par 4

SECTION A

TYPE	FREQ.	DESIRED ACCURACIES
ABM Radar	130 - 225 mc 375 - 425 mc 800 - 900 mc 1200 - 1300 mc	RF 1% - PRF 1% - PW 5% and scan rate 5% DF 25 nm CEP
Missile Telemetry (against VTMTR)	60 - 80 mc	Analog Recording 1 mc DF 25 nm CEP
Earth to Satellite TX and Command TX	130 - 1000 mc	RF 1% - PRF 5% - scan rate 5% DF 25 nm CEP

SECTION B

GCI Radar	560 - 575 mc 2700 - 3200 mc	See SPECOR or superseding document.
HF Radar	2600 - 2640 mc	"
EW Radar	80 - 95 mc	"
GCA Radar	9300 - 9400 mc	"
SHORAN	200 - 350 mc	"
Shell Tracker	9300 - 9450 mc	"
Tactical AAA	2700 - 2800 mc	"
Tactical Acquisition	2700 - 2800 mc	"
Beacon Interrogator and Tracking Radars	2600 - 2800 mc	"
SAM Radars	2900 - 3100 mc	"
AAA	2600 - 2800 mc	"
SAM	2950 - 3100 mc	"
AAA Acq.	150 - 160 mc	"
Eq operating outside normal freq bands	900 - 2500 mc 3500 - 9000 mc 9500 - up	" " "

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DEPARTMENT OF THE AIR FORCE
HEADQUARTERS UNITED STATES AIR FORCE
WASHINGTON 25, D.C.

REPLY TO ATTN OF: AFCIN-P2

SUBJECT: Intelligence Requirements for SAMOS

TO: Undersecretary of the Air Force

1. The following is submitted in response to your question about the difference between the statement of intelligence requirements for satellite reconnaissance by the USIB, 5 July 1960, and previous statements on which SAMOS development was based.

2. There is no change in the intelligence requirement. However, the 5 July statement is complete; the previous statements dated 10 November and 8 December 1958 were supplements to GOR 80. The main editorial changes pertain to the operational employment of the system. This is evident by comparing the USIB statement, 5 July 1960, paragraphs 3, 7 and 9b (Atch 1) with GOR 80, page 2, paragraph 5 (Atch 2), letter, 10 November 1958, Tab B, page 3, paragraphs 5 and 6 (Atch 3), and letter, 8 December 1958, paragraph 2a (Atch 4).

3. For your convenience a copy of the USIB statement with the references for comparison typed in the margin is attached.

J H Walsh

JAMES H. WALSH
Major General, USAF
ACS/Intelligence

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a/s

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OFFICE OF THE SPECIAL ASSISTANT TO THE
PRESIDENT FOR SCIENCE & TECHNOLOGY

REPORT OF A SPECIAL PANEL ON
SATELLITE RECONNAISSANCE

August 25, 1960

The concept of an artificial satellite orbiting around the earth has been associated, from the outset, with the thought that such a vehicle could be used to maintain a continuous reconnaissance and surveillance over any desired part of the globe. The original plan was to install a kind of television camera in the satellite and to transmit its images by radio techniques to a ground station where the signals would be reassembled into a photograph. With such equipment, a systematic search was to be made of the Eurasian land mass for airfields and other military installations large enough to be detected with the limited resolving power of such a system. By repeated observations it was hoped that changes would be detected with sufficient reliability to provide warning of imminent attack.

The appeal of this fundamentally straightforward approach lies in its relative political unobtrusiveness; in the apparent power of television techniques for making observations almost instantly available; in the prolonged utilization of satellites in their orbits; and in the freedom from the logistic intricacies of recovery techniques. At first sight, this "electronic readout" appears to be the fully modern approach to reconnaissance. It has deserved, and indeed has had the most careful study. As a result, we have now arrived at a clear understanding of the technological problems which remain to be solved. The initial SAMOS development project was aimed at the electronic solution of these problems; we shall shortly discuss the difficulties.

Several years ago, it was realized that orbiting satellites might be used for the detection of ballistic missile attack in a much simpler and more direct method than television or photographic observation. While the hostile missile is being launched, its

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engine is a very powerful source of infrared radiation, and this radiation can be detected, above the atmosphere, from satellites many hundred miles away. The exploitation of this early-warning scheme is going forward as Project MIDAS; it has been separated from the reconnaissance project (SAMOS) and will not be discussed further in this paper. As a consequence of this separate development, the warning function is no longer a primary requirement for SAMOS.

Meanwhile, a much more urgent reconnaissance need has been pointed out by the U. S. Intelligence Board. The overriding intelligence requirement at the present time is information on the operational status of Soviet missile launch sites. This requires photographs of very high resolution--high enough to enable a skilled photo-interpreter to recognize and identify the objects of interest in a missile launch site.

The exact resolution performance required for this purpose need not be discussed here. Its technical specification is complicated and often controversial. One must realize, for example, that a system which will resolve 20 feet on the ground will not permit a photo-interpreter to describe an object 20 feet in length.

Up to now, there has been only one source for high-resolution photographs of the Soviet missile installations, and that source has been eliminated with the grounding of the U-2 aircraft. Can we substitute a satellite as the observing vehicle and obtain comparable results? More specifically, can we look to SAMOS to yield results of the necessary quality within a short time?

Unfortunately, as far as electronic readout is concerned, the answer is NO.

The essence of the problem is that a photograph which contains the amount of detail that is required to know the state of readiness and kind of activity at a missile site must be made up of a fantastically large number of bits of information--a number so large that there is not time enough to transmit all of these bits of information from satellites to earth while the

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satellite is over our own or friendly territory. It is to be expected during the next ten years that the elaboration of satellite technology, the ease of keeping many satellites in orbit, and improvements in our electronic arts, will ultimately make it feasible electrically to transmit detailed information about a given point on the earth. But what we must emphasize here today is that it is not feasible now, and it is not likely to be feasible in time to give our country the kind of reconnaissance it needs at once. Therefore, while we recommend continued research on those electronic readout programs, and the occasional orbital flights which are now planned, we must warn that we cannot rely on the electronic readout approach for military purposes and urge that higher operational priority be given to other Air Force developments which we are about to discuss.

Physical recovery, in the air or in the sea, of a satellite that has completed a number of revolutions in orbit has become feasible. The improvement of recovery techniques is going forward in the DISCOVERER project. One can therefore consider the possibility of using advanced photographic techniques which are capable of very high resolution, and of recovering the exposed photographic film on or near the surface of the earth. The subsequent processing and evaluation of the film can then be performed under the same favorable conditions that are used in the best aerial photography.

While this approach may superficially appear clumsy and pedestrian when compared with electronic readout, a detailed analysis will show its performance to be distinctly superior in providing the kind of detailed information that is required for the study of operational missile sites. In fact, we are convinced that this primary objective of satellite reconnaissance can be realized most promptly and most effectively by the physical recovery of film exposed in a high-resolution convergent stereo camera system. The principles and techniques of this kind of photography are now well understood. Therefore, if timely action is taken, we can expect to have an adequate photographic payload by the time we have mastered the techniques for recovery.

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Time is short. We should acquire information on Soviet missile launch sites while they are under construction, in order to counter the deception and concealment that can be used in a completed site. It will take a year and a half at best to fill the present gap in our reconnaissance ability. And we can expect useful performance in 1962 only if we clearly establish high resolution photography as the first goal of the U. S. satellite reconnaissance program.

We are not unmindful of other objectives associated with SAMOS. Photographic surveys of broad areas, in which extensive coverage is obtained at the expense of reduced resolving power, have important uses. The detection and recording of electromagnetic transmissions by means of the proposed "F" payloads will provide valuable information, especially in areas of technical intelligence, of new aspects in communication links, in missile defense systems, in navigational aids.

But we do not consider these objectives comparable in importance to the task of getting, at the earliest possible date, high-resolution photographs that will provide information about the operational status of missile sites, with detail nearly as good as that from the U-2. We therefore recommend a carefully planned program, with simplified management, and with primary emphasis on:

(a) High-resolution stereo photography

(b) Recovery techniques

Mindful of the urgency of this need for detailed photography, the Air Force has greatly modified the initial SAMOS development plan. A number of well conceived photographic recovery systems are now under study and evaluation. These designs fall into two distinct categories:

1. A system to achieve maximum coverage with ground resolution adequate to identify missile sites under construction, and

2. A system capable of photographing a large number of selected installations with the higher resolution required for evaluation of the operational status of a missile site.

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We are convinced that with straightforward good management in the utilization of components and technology now potentially available, the first of these systems could be placed in operation by late 1962; the higher resolution system becoming operational about one year later. We therefore urge a resolute concentration of effort on these two systems and a clear decision to assign to this task a higher priority than to all other aspects together of the SAMOS program.

Since we must now rely upon the physical retrieval of satellite photographs it is necessary that increased efforts be made to improve the reliability of recovery techniques. Recent achievements in the DISCOVERER program are most encouraging. An alternative procedure, unproven operationally, but most appealing in concept, involves the use of a drag brake mechanism to effect reentry. The applicability of this technique to the SAMOS recovery operation should receive serious consideration.

Until recently, the operational aspects of recovery have been greatly complicated by the obvious requirement for safety to restrict these activities to the ocean areas. As a result of our increased confidence in the precision of the recovery operation, the Air Force is now studying the feasibility of effecting recovery over land. Since this would significantly increase the probability of success of the recovery operation, we heartily recommend the support of AirForce efforts in this area.

PROCESSING AND EVALUATION

The reconnaissance "take" of the proposed systems is recovered as a set of latent images on photographic film. The intelligence yield that will be extracted from these latent images is critically dependent on quality factors in the chemical processing of the film and in the subsequent analysis and interpretation of the finished photographs. We cannot emphasize too strongly that much of the detailed information captured in the latent image can be irretrievably lost unless first-rate work is done in the processing laboratory and in the interpretation center.

In the purely technical domain, we must point out that the achievement of optimum image-quality calls for the closest possible interaction between individuals concerned with emulsion design and manufacture and individuals concerned with processing techniques. If these two activities were to be organized as separate and independent enterprises it is most unlikely, in our view, that the results would be the best obtainable.

A full awareness of these factors led to the special organization of processing and evaluation that was used in the handling of the U-2 films. Our experience with the superior results obtained under that arrangement leads us to recommend firmly that the same pattern be followed in preparing the output of the proposed satellite reconnaissance systems. We further recommend that this output be distributed by a centralized community laboratory.

WEATHER

In aerial photo-reconnaissance operations, the state of the weather over the target has long been a primary consideration. For satellite reconnaissance operations, the sensitivity to weather is in some respects even worse. If the target is obscured by clouds on the first pass, the satellite may have later opportunities to observe the target. But the times of subsequent passes over the target are fixed by the orbit parameters, and the situation is less flexible than the scheduling of aircraft. Moreover, the weather over the great majority of Soviet targets is very bad indeed, and the opportunities for good photography are scarce.

The program outlined in this discussion can succeed only if it is closely integrated with the weather services that will be associated with the TIROS project, with the Air Force's 433-L system, and with other sources of weather data that may come into existence. Because of the short reaction intervals that are necessary here, these arrangements will be difficult to establish, and we recommend early attention to planning.

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RECOMMENDATIONS

Our analysis of the investigations already carried out by the Air Force leads us to the conclusion that from the array of important studies a few can now be extracted and integrated into a single simple and powerful program to give us the reconnaissance we need. Therefore, our recommendation is that the following selected components of the AirForce satellite reconnaissance program be now assembled into a program of very high priority.

1. A recoverable satellite-payload for high resolution convergent stereo photography.

2. To be recovered for the time being at sea.

3. To be recovered as soon as feasible on land.

4. To carry in some of the satellites camera and film competent to identify with certainty missile sites both in construction and after completion.

5. To carry in other satellites camera and film competent to study the state of readiness, type of activity, and type of missiles.

We recommend emphasis on the development of more advanced recovery techniques, particularly for land recovery.

We recommend that electronic readout techniques be given lower priority but be continued as a research project and that the extensive program for a ground-based electronic readout system be cut back very substantially and promptly.

Also, the so-called "F" payloads for gathering electro-magnetic intelligence should be given lower priority than that assigned to photography.

We further recommend that this program be managed with the directness that the Air Force has used on occasion, with great success, for projects of overriding priority. We suggest that

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this can best be accomplished by a direct line of command from the Secretary of the Air Force to the general officer in operational charge of the whole program, with appropriate boards of scientific advisors to both the secretarial level and to the operational level. The general officer in command would look to associated military boards for support in the execution of his plans. We recommend this extraordinary type of organization to execute the program because we are convinced that the situation presents an unusual combination of urgency and inherent amenability to a direct approach.

In addition, we recommend that the same organization as was used in the handling of the U-2 films be used for chemical processing of the recovered film and that the output be distributed by a central community facility.

We also recommend that this program be closely integrated with the weather services that will be associated with the TIROS project, with USAF's 433-L system and other sources of weather data.

PANEL ON SATELLITE RECONNAISSANCE

Dr. J. R. Killian, Jr.) Co-Chairmen
Dr. Edwin H. Land)
Dr. William O. Baker
Mr. Richard Bissell
Dr. Carl F. J. Overhage
Dr. Edward M. Purcell

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3 July 1963

BYE-2869/63

MEMORANDUM FOR: The Director of Central Intelligence

SUBJECT : Panel for Future Satellite Reconnaissance Operations

1. The Panel which you appointed to consider questions related to the future satellite reconnaissance program has concluded its study, and I am transmitting herewith our Report. May I say at the outset that the group of Panel members and consultants over which you asked me to preside was an extremely well-informed, thoughtful, and conscientious group. I want to express my personal gratitude to the Panel members and consultants, and also my appreciation for the excellent staff support with which we were provided.

2. I know that you appreciate that time was a severely limiting factor. Because our study had to be compressed into so short a period, we had to limit the number of questions we could come to grips with. Within these limitations, however, I think the Panel has examined carefully and objectively the major questions you set before us.

3. The Panel had two full day meetings on 4 and 5 June which were preceded by special briefings of some of the members. Our Report has gone through several stages of drafting in the course of which the Panel members were consulted, individually or in small groups. Except for very minor editorial changes our Report, as submitted herewith, has been reviewed by all Panel members, who concur substantially in its findings except where specifically noted to the contrary in the Report itself.

4. In behalf of the Panel members and consultants, I wish to express our appreciation of the privilege and responsibility you have

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assigned to us in calling on us to serve in this way. It is our sincere hope that our counsel, in some way, will benefit the work of the Intelligence Community.

SIGNED

EDWARD M. PURCELL
Chairman
Reconnaissance Panel

Dr. Purcell
Dept of Physics
Harvard
Cambridge, Mass.

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ATTACHMENT TO
BYE-2869-63

PURCELL PANEL

REPORT

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ATTACHMENT TO
BYE-2869-63

MEMBERSHIP

Dr. Edward M. Purcell, Chairman
Dr. Allen F. Donovan
Dr. Eugene G. Fubini
Dr. Richard L. Garwin
Dr. Edwin H. Land
Dr. Donald P. Ling
Dr. Arthur C. Lundahl

CONSULTANTS

Dr. James G. Baker
Dr. Henry C. Yutzy

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ATTACHMENT TO
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PURCELL PANEL REPORT

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c. Fully Covert Satellite

d. Night Photography

e. Balloons

10. A-12 DRONE

11. SUMMARY OF OUR MAIN CONCLUSIONS

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ATTACHMENT TO
BYE-2869-63

1. INTRODUCTION

In response to a request from the Director of Central Intelligence, the Panel was assembled to examine some broad problems in satellite reconnaissance. The Panel addressed itself to the following questions:

a. What is the capability of existing and programmed systems to provide photographic coverage of the quantity and quality required to meet future intelligence requirements?

b. What are the technical possibilities for the future development of satellite photography, and how should these affect systems planning and research?

c. What should be the technical goals in the next phase of development?

d. What is the vulnerability of our systems to countermeasures; how serious is the threat, and what steps should be planned to meet it?

In addition to these central questions, the Panel considered a number of proposals and ideas for special systems. Finally, although the Panel did not undertake a study of the A-12 airborne system as such, its importance in the whole picture was very much in our minds. The capabilities and the complementary roles of airborne and satellite systems were compared at relevant points.

To state our problem even more briefly, we tried to look into the future to see how far satellite reconnaissance may reasonably be expected to develop in the service of our intelligence needs, and what work needs to be done to insure that it develops as rapidly as possible in the right directions. It is obvious that so short a study had to leave many important problems untouched.

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ATTACHMENT TO
BYE-2869-63

2. GENERAL OBSERVATIONS ON COVERAGE AND RESOLUTION

The remarkably successful development of photographic reconnaissance from satellites, represented by our currently operating systems, has brought the technology to a point where future progress can be made in two rather different directions. Naturally, high resolution and full coverage are both desirable. In any single program, however, some choice will have to be made. The excellence of resolution now foreseeable, if we strive for resolution alone, is so high that full search coverage at that same resolution would produce a volume of information substantially exceeding the capacity of our present resources for interpretation and exploitation. This argument is hardly a decisive one. Ways could be found to cope with such an embarassment of riches. What is more important is that the development of systems required to provide full search coverage is not the speediest way to attain the resolution capability which the state of the art permits. In other words, the natural incompatibility of wide coverage and high resolution, within a given payload, is becoming more acute, rather than less, as the art advances. The attempt to obtain both simultaneously is likely to prevent the achievement of either one.

On the other hand, the ground resolution achieved under the best conditions by the M system now operating appears to be adequate to meet a large fraction of those intelligence requirements which depend on general coverage. We believe, therefore, that an attempt to make a completely new system which would provide equally wide coverage with only a modest improvement in resolution (5 foot, say, instead of 10 foot ground resolution) would not be a wise investment of resources. Instead, as we proceed beyond the current system, we ought to aim primarily at high resolution accepting the coverage limitation that will be entailed, at least at the beginning. Coverage capability can evolve after the resolution has been obtained. We believe that very substantial improvements in ground resolution are obtainable and that in the foreseeable future there will always be very important uses for spot coverage at the very highest possible resolution.

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3. CURRENT PROGRAMS

The M system operates at its ultimate photographic capability only about 10% of the time or less. Some of the degradation is due to causes which are understood - inaccurate image motion compensation, yaw, exposure inappropriate for the light conditions at a particular time, etc. It seems entirely feasible to bring most of these factors under control so that one could count on peak resolution performance from the M system on 90% of the exposed film. This would represent an enormous gain in information acquisition, and the information would still be in the form which our interpretation and handling facilities are designed to match. On the operational side, it has the merit of keeping things moving in the pattern already established with obvious advantages in reliability. It may be good for political security too; what could be less provocative than to keep doing, without visible change, what one has been inconspicuously doing already?

We believe that improvement in the operation of the M system is the most promising way to make an immediate and substantial gain in photographic reconnaissance. Our first recommendation is simply: Make the M system work well all the time. Some of the important steps in effecting the desired product improvement will be:

a. Better V/H determination and IMC.

b. Yaw detection and control.

c. Exposure control.

d. Automatic focus.

Some carefully designed experiments should be carried out with the operating system to separate and assess the factors contributing to loss of resolution, and to evaluate the remedies.

We need, even now, a standardized objective test of resolution quality in the final M negative; for the programs recommended above, such a test is absolutely indispensable. The test need not be applicable

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to all films and cameras; nor need it measure any precisely defined theoretical parameters. It need not even relate closely to the military specification involving bar targets, but it must be applicable routinely and simply to any segment of useful M negative. Possibly a simple measurement of something related only to the cut-off of the spatial-frequency power spectrum in the final negative can be devised. If it can be diagnostic, so much the better, but the overriding need is for an unambiguous quality control test.

This "product improvement" program for M presents a really golden opportunity, not a thankless chore. If carried through in that spirit, with determination, its quantitative yield in intelligence information may surpass that of any single more advanced system we could now design.

The G and L programs are moving in the right direction and if successful will be very significant steps toward higher resolution. In addition to the actual intelligence we can expect from G system reconnaissance, the performance of this system will teach us a great deal about the opportunities of higher resolution photography - that is, its performance should and will have a decisive influence on our choice and design of future systems. For this reason, we recommend that special attention be given early in the G operations to acquiring some photography with the G camera under ideal photographic conditions. In other words, the urgency of collecting intelligence should not prevent us entirely from ascertaining exactly what this kind of system can do under ideal conditions. The L system is a valuable backup for G, and, at the same time, its parameters are different enough so that any additional experience with L will significantly advance our understanding of the problem of higher resolution photography.

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4. PLANNING BEYOND CURRENTLY PROGRAMMED SYSTEMS

The VALLEY program is an example of a bold step in what we would think is generally the right direction, that is, in pushing resolution to the limit even at some expense in coverage. Actually, as now conceived, the VALLEY system with its considerable flexibility would offer substantial coverage in some modes. We feel, however, that it is a little too early to freeze the concept of the next advanced system. The reasons for this are the following: in the current state of the art, as was convincingly demonstrated by the excellent parametric studies presented to us, the controlling parameters of film speed, film resolution, vehicle attitude stability, and the laws of wave optics, lead one to a compromise in which size, weight and complexity of the instrument are affected by even a modest change in a basic parameter. One can almost say that a modest factor in film speed could mean the difference between a thrust-augmented THOR and a TITAN for the transporting vehicle. In other words, in the next generation of reconnaissance cameras it will be even more important than before, if that is imaginable, to take the utmost advantage of every advance in optical materials and techniques. In the following section, we discuss some possibilities for technological advances which can probably be evaluated soon enough so that one can estimate their importance for the coming generation of systems. In a few months' time, it may be possible to see much more clearly than now what kind of system we ought to go for.

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5. TECHNOLOGICAL ADVANCES

a. Emulsion Properties

Current camera designs, when optimized, turn out to be an expression of the properties of the SO-132 emulsion. Within limits at a given state of the emulsion art, there is a trade off between sensitivity and resolution which can be manipulated to get better results in a particular context. On the other hand, it appears not unreasonable to hope for some absolute improvement in emulsion properties which would yield a faster film at the same resolution or its equivalent. Probably a factor of 4 in speed for a given resolution is too much to hope for, but we have some confidence that a factor of 2 may be obtainable. This would be an extremely significant gain, which would of course be welcome in our current systems. It could be immediately exploited in the design of new systems to alter materially the weight-size-stabilization requirements in the next generation of instruments. Within a few months one may know whether such an improvement in emulsions can indeed be anticipated. We think it extremely important that this question be pursued.

b. Image Intensifiers

The electronic image intensifier is a device which is now being developed vigorously in a number of forms. It may possibly present an opportunity for a major breakthrough in satellite photography. In the image intensifier, light from the original scene falls on a photo-cathode rather than on the film directly. The electrons ejected from the photo-cathode are accelerated to bombard the phosphor, where they make more light. This light can then expose a photographic film or the process can be cascaded to make more electrons, more light, etc., until at some stage photographic recording occurs. It remains to be seen whether the required resolution in lines per millimeter can be maintained. There is no fundamental reason why it cannot be. Some preliminary calculations suggest that several hundred lines/mm is not out of the question. Indeed, in the application to satellite cameras, we appear to have a situation peculiarly favorable to the application of the image-intensifier technique. In most of the current and future designs the light is

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recorded at any given instant along a narrow strip or slit, a geometry highly advantageous for control of the electron trajectories. This technique may permit the further flexibility of recording photographically at a scale different from that of the primary image. We recommend that the possibilities of image-intensifier techniques be immediately investigated. If closer investigation corroborates our present optimism, a vigorous program of development should be started. Here, too, we expect that a few months' study could give us a very much clearer picture of the implications for planning of our future systems.

c. Very Large Optics

Advances in the design of very large optical systems are continuing to be made. These include not only new geometrical arrangements of reflecting surfaces, correcting plates and lenses, but also new techniques for constructing large mirrors that are accurate but not enormously heavy. It is reasonable to contemplate apertures at least as large as 60" diameter operating, so far as their intrinsic optical performance is concerned, close to the "diffraction limit" set by the wave length of light. To be more specific, it appears that a 60" diameter f/2 system forming a good image on a 10" slit is entirely feasible, as is a 40" diameter, f/1.5 with a 6" slit. If and when we move into larger vehicles, it is these larger systems we should be thinking about. It is not too early to support research and development on components, in view of the fact that the lead time on the very large optical elements involved may be as much as two or three years. (Of course we must not forget that the lead time on launching facilities may be another critical element in the utilization of larger vehicles.)

The impression gained from our discussions of these large optical systems is that bulk is likely to be a more stringent limitation than weight, especially if the development of large beryllium mirrors continues to proceed as successfully as it has to date.

d. Stabilization

The problem of vehicle stabilization is likely to remain with us in spite of all optical inventions and will grow more acute rather than

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less. Hence, there will be a conti[illegible]ing need for innovation and ingenuity in the development of vehicle stabilization techniques appropriate to the camera platform. Some degree of image stabilization (as contrasted with vehicle stabilization) may be possible in some of the new optical systems, including the hypothetical image-intensifier system just mentioned.

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6. EVENTUAL LIMITS OF RESOLUTION

There is no evidence that our present systems are running into any fundamental limitations on ground resolution. Of course, the inexorable relation between angular resolution and lens diameter does impose an ultimate lower limit on the size of our instrument. It takes a [redacted] if everything else is perfect. Probably one can push as far as [redacted] ground resolution without severe trouble from the atmospheric medium. The question remains as to where the inhomogeneity of the atmosphere will make itself evident, preventing any further useful advances. On this question we have no conclusive experimental evidence. The astronomers are familiar with the inverse problem of seeing up through the atmosphere, but their experience does not necessarily provide the answer. We are also unable to predict at present whether this eventual limitation will be relatively more or less serious for the satellite borne camera than for an airborne camera. As we advance into a new domain of performance this fundamental question will deserve serious research attention. In advance of empirical tests, we may well be able to draw useful conclusions from calculations for various models of a turbulent atmosphere.

Satellite systems are completely free from one problem which may eventually limit the resolution of airborne cameras, the optical irregularities in the airstream adjacent to the vehicle. Where this limit will set in, for airborne systems, is an open question at the moment, but tests in the actual environment which are now scheduled should provide a reliable answer, at least for ground resolution of the order of [redacted] two foot. This problem, if it ever becomes serious, is perhaps not entirely beyond remedy.

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7. SATELLITE VULNERABILITY

The Panel was given a detailed briefing on satellite vulnerability and on the current program aimed at the planning of counter countermeasures and protection of reconnaissance satellites. On the whole, the facts, as presented to us, were reassuring, in the following limited sense: a) It appears that if the Soviets were to mount an attack employing their existing radar capability with a medium-range ballistic missile as the attacking vehicle, the problem the attacker would face in predicting the satellite trajectory accurately enough is so severe that relatively modest counter countermeasures on our part would defeat such an attack. The main reason for this is that the missile has to be committed to its trajectory before the satellite appears over the horizon; thus it has to be committed on the basis of extrapolation from a previous pass; b) the analysis of pellet attack pretty convincingly shows that our present satellite configurations, shielded as they are anyway by the AGENA stage forward, would be quite difficult to hit with pellets and that a very moderate amount of judiciously placed shielding can protect them very effectively. In short, it looks from this analysis, as though the attacker will have to employ a nuclear burst. How severely this will inhibit him from resorting to attack is, of course, a question that involves much more than technical considerations.

It seems probable, however, that the Nike Zeus Target Track Radar at Kwajalein (and therefore perhaps also the 54-foot dish at Sary Shagan) could acquire the satellite as it came over the horizon. This might be done on the basis of SPASUR-like data accummulated over a period of a couple of days. A Thor could thus be launched when the satellite is about 600 miles away (about 45 seconds after radar detection) and could intercept approximately overhead. The recent MUDFLAP experiment, in which Zeus was sent against a small satellite, gave a miss distance of about 200 meters, at which distance 3,000 pounds of pellets spread in a 600 foot radius pattern would give about 1.5 grams of pellets per square foot. It is clear that reliable information is required concerning the effectiveness of the proposed shielding against pellets in the few-gram range. Such an intercept could not be made so readily against satellites whose ground tracks pass more than about 100 miles from the launch site.

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However one may feel about these estimates, it is certainly wise to take all reasonable steps to meet such a threat, in particular the studies of methods for reducing radar detectability and for adding some capability for maneuver deserve continuing support. It seems that even more could be done than was indicated to us in the way of radar cross-section reduction. We raise the question whether all the advances of technique and measurement which have been developed in similar work on other programs are being taken advantage of effectively in this project. As concerns reduction of radar cross-section, it would probably be too optimistic to hope that the cross-section could be reduced to the point where it would be undetectable by radars of a class designed for AICBM acquisition. Nevertheless, reduction of radar cross-section makes decoying easier, and it can hardly be anything but beneficial to make our targets less conspicuous.

It will probably ease the situation if there are more satellites other than reconnaissance satellites in polar orbit. We must hope for and, where possible, foster a proliferation of space activity in polar orbit. Meteorological satellites, among others, can provide welcome company. There are many scientific objectives, and they are probably growing more numerous, which could benefit from instruments in polar orbit. With enough of this going on, the work on modification of radar signature might have the specific aim of making the reconnaissance satellite look like a certain class of open satellites.

In the long run our greatest hope may well lie in the gradual establishment of public recognition of the freedom of space for passive transit. The strength of our present position derives from the past conduct of our space program and our official policy with respect to freedom of space. We should be alert to every opportunity to reinforce this position.

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8. READ-OUT SYSTEMS

The Panel considered rather briefly the current status of developments in read-out systems. This technique has, of course, had a long history of development. The original technical objectives were met; we know that read-out can work, but there has been no practical application to reconnaissance. The basic limitation of present read-out systems is still imposed by the radio frequency channel capacity and the read-out time available, and this handicap has grown, if anything, relatively more discouraging in comparison with photographic recording and recovery. A constant which pretty well characterized read-out systems was stated in the following form: one or two square inches of picture per megacycle band, per minute, for a picture with 100 lines per millimeter resolution. One can perhaps invent missions aimed at quick recovery of 1 or 2 pictures of a few small targets which would make a read-out system attractive, but these would have to be compared with what we might do by a [redacted]. On the whole, we can generate very little enthusiasm for the read-out technique. Some research in this area might reasonably be kept going. In particular, new means should be sought to expand the capacity of the over-all film-to-ground channels by ultra-fast scanning techniques and very wide band communications. But we conclude that there are no evident opportunities in read-out systems which ought to affect our major plans for further development and use of photographic systems with recovery.

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9. SOME SPECIAL SYSTEMS AND MISSIONS

The Panel considered briefly a number of special systems; some are already under study, others may warrant examination.

a. Quick Reaction Satellite. Clearly our present capability for prompt acquisition of important photographic intelligence is limited, not so much by the recovery cycle, as by the lead time involved in the launching of a previously unscheduled flight. The Panel shares the rather obvious view that something ought to be done about this and that in addition to the general streamlining of the launching operations, which is a problem already being attacked on other fronts, the possibility of a specially planned quick reaction vehicle should be studied. Whether this is feasible or not will have an important bearing on the relative utility of such other means as readout satellites and drones.

b. Storage in Orbit. The so-called zombie mode of operation offers a variant of the quick reaction satellite. [redacted] We see no obvious difficulty in storage of the photographic material, although the radiation exposure would, of course, need to be assessed. What is needed is a small system study of such an operation to evaluate its general promise. The problem of observing at will any point on earth a short time after an order is given should not be minimized. Program computations, in-orbit trajectory corrections, engines with accurate multiburn capabilities need to be examined; the total number of satellites required may, in some cases become so high that a quick reaction device may be more desirable.

c. Fully Covert Satellite. The Panel feels that the time is not ripe to take a definitive position on the usefulness or feasibility of the covert satellite and recommends that the current preliminary study proceed as planned. It is our impression that an air launch may prove to be the most practicable means, and we hope that this aspect will be carefully investigated. Under the concept of "graduated deterrents" a situation can be described where both the Atlantic Missile Range and the Pacific Missile Range have been rendered inoperable just when reconnaissance is most necessary. Then certainly a mobile, if not truly covert satellite, would be needed. The idea of a covert satellite should not be abandoned if one cannot now establish the feasibility of truly covert operation in all respects. A covert launch capability is a more limited but still attractive objective.

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d. Night Photography. There may be some attractive possibilities in night photography from a satellite. In its least ambitious form the objective would be to record simply artificial lights on the ground. There are some known intelligence targets for which this kind of information might be extremely interesting and significant. It may even lie within the capabilities of the present M system to do this; the G and L systems would be even better. Accepting a sacrifice in ground resolution, which would not be serious in this application, one would switch to the fastest emulsion available and lengthen the exposure time. The latter change could be tolerated because at lower resolution the image motion problem is somewhat eased. In any case, there is enough information available to decide whether the M camera could meet this objective technically. Looking ahead to a more ambitious goal it is possible one can imagine an extremely fast optical system which could produce ground pictures in moonlight. In northern latitudes in the winter, snow cover, moonlight, and the aurora provides a good photographic combination. We suggest that it would at least be worthwhile to encourage a theoretical study of the technical requirements and possibilities.

e. Balloons. The question of the possible utility of balloons was raised during our discussions, but for lack of time and background material, the Panel was unable to examine this problem.

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10. A-12 DRONE

The possible role of the A-12 drone was discussed by the Panel from various points of view. It is not our place to assess the political advantage of an unmanned as opposed to a manned reconnaissance vehicle. To the extent that we had intuitive opinions on this, they were probably not unanimous. Some members of the Panel expressed a concern that the TAGBOARD project, whatever its intrinsic merits might be, is diverting some of the effort which is necessary to make the A-12 itself a complete success. (Perhaps an even more serious threat to progress with the A-12 is the simultaneous emergency R-12 and AF-12 programs). This question, too, involves other than purely technical considerations. As for the technical capability of the drone to collect intelligence in the special situations for which it might be deemed the appropriate instrument, we would point out that the photographic performance of the TAGBOARD camera, as now planned, will be inferior to the capability of the A-12 system itself. Therefore in evaluating the utility of the TAGBOARD, it may be as important to compare it with the performance of the G system as with the performance of the A-12. Indeed, the G system which will be operating soon should achieve a ground resolution not much inferior to what the TAGBOARD camera may do, and this without any of the political risks which still surround the drone operation even with the pilot absent. The drone, of course, does have the advantage in certain operational situations of being able to get quickly to a particular target or area. It involves, however, a rather complicated and inflexible overall operation; certainly less flexible than the use of the A-12 itself. It will take a careful analysis of an entire operation to establish its real usefulness.

One member of the Panel, Dr. Fubini, feels that the TAGBOARD matter was not dealt with in sufficient depth and he does not wish to be recorded as concurring with section ten (10).

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II. SUMMARY OF OUR MAIN CONCLUSIONS

Returning to the central questions from which we began, we find emerging from our discussions a few important conclusions. First, the M system itself, successful as it has been, still holds great potential for better work and more return. We cannot emphasize too strongly the importance of this opportunity. Second, the technological possibilities for growth in the direction of higher resolution systems are extremely promising. The eventual goal of ground resolution approaching [redacted] is not too high for optical photography to aim at. Third, there is a good chance that a new technique developed around the electronic image intensifier can greatly widen the technical possibilities for photography from satellites. With these prospects before us, we may clearly look forward to an extremely active enterprise in this area.

The compact and competent management organization, under which the present operational systems were developed, we believe has contributed largely to the past success of the program. The Panel did not consider at this time the effect of recent changes in the management structure. It recommends, however, that this subject be continuously reviewed to ensure that the clearness of focus and purpose, originally achieved, has not been diffused.

Requirement for a X system

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USIB-D-41.13/11
(COMOR-D-13/16)
27 July 1964
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UNITED STATES INTELLIGENCE BOARD

MEMORANDUM FOR THE UNITED STATES INTELLIGENCE BOARD

SUBJECT : Long-Range Requirements for Satellite Photographic Collection

REFERENCE : USIB-D-41.13/10 (COMOR-D-13/14) 24 July 1964, Limited Distribution

1. The enclosed report on the subject from the Committee on Overhead Reconnaissance (COMOR), in response to USIB action in Executive Session at its 22 July meeting as recorded in the reference, is transmitted herewith for consideration by the Board of the COMOR Conclusions and Recommendations contained in Tab B hereto, pages 6 through 10.

2. The National Photographic Interpretation Center (NPIC) study attached as Tab c hereto is being distributed in a limited number of copies primarily to USIB Members and Observers.

3. The enclosed COMOR report is scheduled for consideration by the USIB at its meeting on 29 July 1964.

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

Attachment with
Tab A
Tab B
Tab C (TCS-7473-64)

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UNITED STATES INTELLIGENCE BOARD

MEMORANDUM FOR THE UNITED STATES INTELLIGENCE BOARD

SUBJECT: Long-Range Requirements for Satellite Photographic Collection

REFERENCE: USIB-D-41. 13/10 (COMOR-D-13/14)

1. This report is in response to the assignment by the Board at its Executive Session, meeting of 22 July, and seeks to respond directly to the Chairman's directive to COMOR set forth as an attachment to the referenced document. For the convenience of the Board in studying this report, that attachment is set forth as Tab A.

2. In pursuing its assignment, COMOR took into account its knowledge of the nature and mode of operation of the present KH-4 and KH-7 systems and the results obtained therefrom, comments of the NRO on the prospects of improvements to these systems, a briefing by CIA on a proposal for a search system with area coverage approximating KH-4 and resolution approximating KH-7, and a briefing by the NRO on

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G-3 and LANYARD. It had available, of course, the papers on the same subject submitted to the Board in April 1963 but on which there had not been a conclusion by the Board. NRO and the NPIC representatives participated fully in the discussions.

3. In direct response to the Board's assignment, the COMOR specified to NPIC the essential elements of information on major problems with a request that the NPIC, using the resources of all of the agencies participating in NPIC, advise on the extent to which the EEI could be met by photography with a capability of resolution to permit interpretation of objects ten feet, three feet, [redacted] The results of this study are submitted at Tab C.

4. The conclusions which COMOR has reached as a result of its examination of the problems presented in our assignment are expressed in Tab B.

James Q. Reber

James Q. Reber
Chairman
Committee on Overhead Reconnaissance

Attachments (3)
Tab A
Tab B
Tab C

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Tab A

Directive to COMOR Regarding Long-Term Intelligence Requirements for Satellite Photographic Reconnaissance

1. COMOR is directed to provide for the Board's consideration at its 29 July meeting recommendations for future intelligence requirements for satellite photographic reconnaissance from the standpoint of required input to the intelligence inventory. In preparing its report, COMOR should take into account the experience achieved thus far through the use of the KH-7 and KH-4 configurations and an analysis by NPIC on the extent to which specified Essential Elements of Information can be met by improved resolution and quality of photography.

2. The COMOR deliberations and report should be concerned with the needs from an intelligence viewpoint of improved resolution in the GAMBIT spotting system, the advantages and disadvantages of a very much higher resolution in the spotting system even though the area coverage is reduced, the ability of the present and contemplated spotting systems to cover targets of interest with due consideration to accuracy of pointing and the ability to cover successive targets because of time involved in the roll and pointing of the camera.

3. Recommendations will be expected on the advantages of improvements to the present GAMBIT system considered feasible with further research and development and also advantages to be gained from further improvement in the existing CORONA system.

4. The importance of the development of a search system with area coverage approximating the CORONA (KH-4) but with resolution equaling the GAMBIT (KH-7) should be examined from the standpoint of the value of the input of Essential Elements of Information to the intelligence inventory resulting from such a development.

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Tab A Contd

5. Finally, consideration should be given to the need for an interim search system built around the LANYARD cameras which might produce resolution considerably better than the KH-4 but not as good as the KH-7 and which could be available long in advance of any of the proposed systems.

6. Although there is no indication that budget restrictions or technical or physical resources would necessarily foreclose concurrent action in several of the areas mentioned above, USIB would be interested in COMOR's views on the relative importance and hence the priorities which might be attached to the several courses of action indicated.

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Tab B

CONCLUSIONS

1. Intelligence requirements for search and surveillance necessitate a satellite photographic capability or capabilities for complete area coverage of the Sino-Soviet Bloc with a resolution which will permit interpretation of objects between three and four feet on a side.

2. There is also a requirement for photography which will permit interpretation of details on the order of [redacted] on a side on a number of targets.

3. There are many advantages and we believe no disadvantages from the point of view of photo interpretation or analytic usefulness in a satellite photographic system which would have continuous stereoscopic ground coverage equivalent to KH-4 and resolution equivalent to KH-7.

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4. There would also be advantages in a system with the capability to permit interpretation of details [redacted] on a side even with a swath width approximately half that of KH-7. Such resolution would provide valuable increments to our intelligence inventory. Although the number of targets for which such a system would be required in terms of vital importance is relatively small, the ability of such a system to also provide additional information on less critical targets could be an over-all important bonus.

5. Improvements are perhaps possible in KH-4 and KH-7 resolution--at best a reduction in the KH-4 from ten to nine feet and in the KH-7 from three to two feet. Improvement should be made in these systems, as well as in their reliability, without impeding development of the systems discussed in paragraph 7.

6. Because of its relatively narrow swath width (about 50 miles) and non-contiguous stereo coverage, the LANYARD System

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(KH-6), of which there are five packages available, could not be usefully employed as a substitute for KH-4; nor, since it has an estimated five-foot on a side resolution, could it be employed as a substitute for KH-7. COMOR has concluded that the KH-7 should be used in lieu of the KH-4 as a crisis satellite. However, before submitting its recommendation to the Board, COMOR has requested comments from the NRO and the NIC. In view of the fact that we are advised that the five LANYARD packages can be reinstituted and placed on standby as a crisis satellite without interference with the developments recommended in paragraph 7 below, we recommend the consideration of LANYARD for this purpose. In that case, there might eventually be on standby for a crisis both a KH-7 and a LANYARD, which in certain circumstances would be extremely desirable.

7. Recommendations on New Systems:

a. That developmental work should proceed urgently toward the achievement of

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(1) A single capability for search and surveillance with a continuous stereoscopic ground coverage equivalent to KH-4 and a resolution equivalent to KH-7; and

(2) A capability which will permit interpretation of details on the order [redacted] on a side even with a swath width approximately half that of KH-7.

b. That, if a priority of development must be established, the second should have first priority. (COMOR believes that in view of the existence today of a search and surveillance capability in the form of KH-4 and KH-7, the most urgent need is to develop a collection capability to fill the coverage gap in the high-resolution area, [redacted]

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*The CIA recommends that the first capability should have priority over the second. For the following reasons: a., A high-resolution system

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(three feet at nadir) which gives continuous, stereoptic coverage of a strip some 300 miles wide would appear to have substantially greater advantages from an over-all intelligence point of view over a very high resolution system [redacted] which CIA believes is seriously limited by the very narrow swath width and by the difficulty of achieving the necessary, extremely high pointing accuracy; and

b., Based on CIA's analysis of several major weapons systems and nuclear materials installations, photographs with a ground resolution of about three feet are adequate to determine existence and identity, and to provide in most cases the data upon which capacity/capability can be estimated.

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Tab C

Ground Resolution Comparison by NPIC
(see attached)

1. The Board requested that COMOR's study take into account an analysis by NPIC on the extent to which the specified Essential Elements of Information (EEI) can be met by improved resolution and quality of photography. COMOR accordingly arranged for a CIA study on this question to be subjected to amplification of the EEIs by DIA and evaluation of target data at three different ground resolutions by joint teams of DIA and CIA photo interpreters. Within the limits of the time permitted, such amplification of the EEI was made and the above task force at NPIC sought to complete its evaluation. Pages 1 through 9 have been fully coordinated insofar as these evaluations are concerned. Pages 10 through 17 have not for lack of time been fully coordinated.

2. The Director, NPIC has given as his opinion that differences between the CIA study and the joint evaluation are probably not significant. He observes that for the most part, they are differences in precise interpretation or small variances in probability. This judgment was presumably based on pages 1 through 9.

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3. It was the consensus of COMOR that the column headed "Alternative, Possibly Better, Sources," should be omitted at this time. It was agreed that this column as presented is incomplete, particularly as to SIGINT contributions, and would nevertheless be thoroughly meaningful only if it contained alternative sources which could be weighed against a "yes" or "partially" in the [redacted] column. It would also only be important should the answers in the ten-foot column and three-foot column have been "no" or "partially." It would be necessary to specify that such obvious alternatives as obtaining the article in question, obtaining an operations manual, or suborning a technical expert involved in the design of the article must be ruled out. Furthermore, to permit a proper weighting of the need for such detailed photography, the entry in the "Alternative Source" column should be specific as to the type and value of the various elements of information which could be obtained on the one hand by high-resolution photography and on the other by the alternative source.

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Legend

Yes - Task can be accomplished
Partially - Task partially accomplished
? - Some possibility task can be accomplished
No - Task impossible
* - Elements of information added by DIAAP-1

General Indication of Intelligence Information Obtainable Relative to Ground Resolution of Camera Systems

	Information Sought	10'	3'	[redacted]	Alternative, possibly better sources	Remarks
A.	ICBM-MRBM/IRBM System					
	Identify launch complex	yes				
	* Area search	yes				
	* Identify launch & support facility	yes				
	Basing					
	Hard or soft launch	yes				
	If soft - how missile prepared and erected for launch	?	?	?		If gross features are to be considered Dependant upon amount of detail requested
	If hard - determination of hardness based on:					
	- Thickness of silo door			partially		
	- Thickness of walls			partially		
	- Extent "rattle space"			partially		

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Information Sought	10'	3'	[redacted]	Alternative, possibly better sources	Remarks
- Suspension system			?		Depends on timing and angle of photography
Type launch (fly out or lift out)			partially		"
*Periodic phases of site construction	partially	yes			General stages of construction (early, mid, late) identifiable on 10'
* Identification of ambiguous support facilities (i.e., missile/space)	partially	?	?		Complete answer requires other information
· Identification of weapons system employed	partially	partially	partially		
* Refire capability- Quantity of support facilities and additional missile storage on or near launch sites		?	?		
Location of nuclear warhead storage	partially	yes	yes		

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Information Sought	10'	3'	[redacted]	Alternative possibly better sources	Remarks
Technical Characteristics of Missile					
Liquid or solid fuel	partially	partially	partially		
If liquid, types of propellent		no	?		
Number of engines			?		
Guidance, whether all-inertial or radio-inertial	partially	partially	partially		
If radio-inertial, how functions		no	?		
Dimensions of missile:					
- Length		partially	yes		
Diameter at base			partially		
Number of stages			partially		If defined on missile
- Sizing of nose cone (RV)			?		"

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Information Sought	10'	3'	[redacted]	Alternative, possibly Better sources	Remarks
B. ABM/SAM Systems					
Locate/identify ABM facility/ complex *and security measures	yes			Ground photography	If signature is known. Security measures provide problems at 10'
pport areas & facilities & equipment ABM & SAM	partially	yes			Equipt. may not be seen at 10'
Electronics					
- Frequency of radar	no	no	?		
- Dimensions of associated radars and other sensors	?	partially	yes		Depends on size of radar associated with system
- Dimensions of wave guide	no	no	?		
- Interrelationships between element facilities of ABM complex *testing areas and oprnl. sites	partially	yes	yes		
- Power input to major radars	partially	partially	partially		Externally supplied power to site only
Weapons					
- Launcher mechanism/mode of launch	no	partially	yes		Mode of launch partially on 10'
Characteristics ABM/SAM					
- Dimensions	?	partia[illegible]	yes		Dependent [illegible]

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Information Sought	10'	3'	[redacted]	Alternative, possibly better sources	Remarks
Characteristics ABM (continued)					
Fuel	?	?	?		
Type guidance	no	partially	partially		
* Missile Ranges (Facilities					
* Layout and Transportation	yes	yes	yes		
* Support Buildings	yes	yes	yes		
* Pad Configuration	yes	yes	yes		
* Missile Configuration	no	partially	yes		This will not permit detailed S&T analysis
Launch Systems	partially	yes	yes		
Type Guidance	no	no	?		
* Electronics Instrumentation Layout	yes	yes	yes		
* Electronic Instrumentation Components	no	no	partially		Uncertain meaning

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Information Sought	10'	3'	[redacted]	Alternative, possibly better sources	Remarks
. Submarines					
- Sub base location	yes	yes	yes		
* Sub base function	?	yes			
Sub deployment dispersed	?			COMINT	
- Sub type identification	?	partially	yes		Under optimum conditions
- Length	?	yes			
- Width	?	yes			
- Dimension of sail	no	?	yes		
* Missile Dimensions (Hatch)	no	partially	yes	Low altitude aerial photography	
* Hull Construction	no	?	yes	Ground photography	
* Communications Facilities	no	no	yes	"	Only under optimum conditions at [redacted]
* Naval Missile Support Facilities					
* Location	yes				
* Function (i.e., ballistic or cruise missile support)	no	?	yes	Low altitude aerial photography	Pass at 3' if missile or handling equip. observed

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Information Sought	10'	3'	[redacted]	Alternative, possibly better sources	Remarks
D. Nuclear Energy Production					
- Identification of major production facility	yes	yes	yes		
- Production layout	partially	yes	yes		
- Overall power consumption	partially	yes	yes		
- Power consumption by section	no	no	?		
- Chemical processing facilities	?	partially	yes		
- Hot water effluence	partially	partially	partially		
- Metal and similar production	partially	partially	yes		
- Number of reactors	partially	partially	partially		
- Production rate of weapons	?	?	?		
- Stockpile procedures	partially	partially	partially		
- Storage capacity	partially	partially	partially		
Nuclear Testing					
- Test site identification	partially	partially	partially		

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Information Sought	10'	3'	[redacted]	Alternative, possibly better sources	Remarks
- Activity levels	yes	yes	yes		
- Weapon yields	partially	partially	partially		
- Test objectives	partially	partially	partially		

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Information Sought	10'	3'	[redacted]	Alternative, possibly better sources	Remarks
E. Other Systems					
1. Aircraft					
Bases					
- Location/presence of aircraft	yes	yes			
- Fueling capacity	yes				If large storage tanks above ground
Identification of Aircraft					
-By Class (Fighter Bomber)	yes				
-By type (Beagle Badger)	?	yes			Large aircraft
-By model	no	?	partially		
Characteristics of Aircraft					
-Range based on size	no	no	?		
-Speed based on engine sizing and design	no	no	?		Give optimum conditions at [redacted]

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Information Sought	10'	3'	[redacted]	Alternative	Remarks
* Weapon Storage					
* Nuclear - Location	yes				
Capacity	no	yes		If observed during construction	
Hardness	no	yes	yes		
* ASM - Location	yes				
Number and Type	no	yes			
* AAM - Location	yes				
Capacity	no	yes			
Type	no	no	yes	If observed during construction	
* Conventional - Location	yes				
Capacity	no	yes		"	
* Maintenance Support Facilities					
Location	yes				
Function & Capacity	partially	yes			
* Communication and Navigation Facilities	partially	yes		Major Facilities only	

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Information Sought	10'	3'	[redacted]	Alternative, possibly better sources	Remarks
F. Electronic and Communications					
Radar and Commo locations	yes				
Radar Design Determination	?	partially	yes		
Commo type identification	?	?	?		
Mobility Status	yes				
G. Missile Production					
* Identification of Production Facility	partially	partially	yes		Can be ident., but product must be seen to ident as missile production
* Production Layout	partially	yes			
* Product Identification	?	?	yes		Depends on size and type of missile
* Assoc. Test Facilities	partially	partially	yes		Large vert. stands visible at 10'
* Testing Activity	partially	partially	yes		Blast marks visible at 10'
*Research and Development Facilities	partially	partially	partially		
* Testing Activity	partially	partially	yes		

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Information Sought	10'	3'	[redacted]	Alternative	Remarks
H. *Aircraft Production					
*Identification of Production Facility	Yes				
*Production Layout	Yes				
*Product Identification	Yes				If product is engines only 3' req.
*Testing Facilities (Static)	Yes				
*Flight Test Facilities (ident)	Yes				
*Test Vehicle	Yes				If product is engines only 3' req.
*Research & Development Facilities	?	?	?	Other collateral.	Can look any other engineering bldg
*Test Cells (Engines)	Yes				
*Test Cells (environment)	?	?	?	Other collateral	Poss assoc features could assist ident.
I. *CW Production					
*Production Facilities	No	No	No	Other collateral	
*Storage	No	?	Partially	Other collateral	
*Test Ranges	?	Partially	Partially		
J. *BW Production					
*Production	No	No	No	Other collateral	Assoc features may allow "suspect" ident.
*Storage	No	No	No		
*Test Ranges	?	Partially	Partially		

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Information Sought	10'	3'	[redacted]	Alternative	Remarks
Ground Forces					
Locations of Installations	Yes				
*Mensuration of Bldgs	Yes				
*Location of Training Areas	Yes				
*Mensuration of Firing Ranges	Yes	Yes			
Type of Major Equipment	No	Yes			
O/B Identification of Unit by Type and Echelon	No	Yes	Yes		
*Level of Activity in Installations	Partially	Partially	Yes		
*Level of Activity in Training Areas	Partially	Partially	Yes		
Locations of Reserves & Support	No	Yes			
*Major Material Depots					
*Identification of Installation	No	?	Yes		
Facility Layout	Yes				
*Product Identification	No	Partially	Yes		

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Inf·rmation Sought	10'	3'	[redacted]	Alternative	Remarks
M. *Submarine and Other Naval Ship Production					
*Identification of Prod. Facility	Yes				
*Production Layout	Yes				
*Production Identification	Yes				
*Propulsion Equip. Prod.	?	?	?		
*Product I·entification	?	?	?		
N. *Ground & Naval Armament Prod.					
*Identification of Prod. Facility	?	?	Partially		
*Production Layout	?	Yes	Yes		
*Product Identification	No	?	?		
*Research & Development Facilities	Yes				
*Testing Activity	Partially	Yes			

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Information Sought	10'	3'	[redacted]	Alternative	Remarks
9. *Inland Waterways					
*Locks	Partially	Yes			Gate dimensions
*Dams	Yes				
*Craft	Partially	Yes			
*Wharves	Yes				
*Storage (Open & Covered)	Partially	Yes			
*POL	Partially	Yes			
*Overpasses	Partially	Yes			
*Chanals & Channels	Partially	Partially	Yes		
*Mechanical Handling Facilities	No	Yes			
*Clearance (Rail & Road)	Yes				
*Ship Repair Facilities	Partially	Yes			

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Information Sought	10'	3'	[redacted]	Alternative	Remarks
P. *Ports					
*Wharves	Yes				
*Warehouses	Partially	Yes			
*POL Storage Facilities	Partially	Yes			
*Ship Repair Facilities	Partially	Yes			
*Mechanical Handling Facilities	No	Yes			
*Rail & Road Clearance from Wharves	Partially	Yes			
*Harbor Craft	Partially	Yes			
*Breakwaters and Jetties	Yes				
Q. *Railways					
*Bridges	Partially	Yes			
*Yards	Partially	Yes			
*Shops	Partially	Yes			
*Passing Track	No	Yes			
*Trackage	Partially	Yes			
*Motive Power	No	Yes			
*Freight Cars	No	Yes			
*Passenger Cars	No	Yes			
*Tunnels	Partial	Yes			

Information Sought	10'	3'	[redacted]	Alternative	Remarks
R. *Highways					
*Roadway Surface (Including shoulders)	No	?	Yes		
*Drainage Facilities (Ditches, culverts, etc.)	No	Partial	Yes		
*Bridges	Partially	Yes	Yes		Structural dimensions for capacity and vulnerability
*Defiles	Yes				
*Ferrys	Partially	Yes			
*Tunnels	Partially	Yes			

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31 July 1964
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UNITED STATES INTELLIGENCE BOARD

MEMORANDUM FOR THE UNITED STATES INTELLIGENCE BOARD

SUBJECT : Long-Range Requirements for Satellite Photographic Collection

REFERENCE : USIB-D-41.13/11 (COMOR-D-13/16), 27 July 1964, Limited Distribution

1. At the United States Intelligence Board (USIB) meeting on 29 July, in restricted session with Dr. McMillan, Director, National Reconnaissance Office (D/NRO) present, the Chairman, Committee on Overhead Reconnaissanc (COMOR) opened this subject by explaining that in the recommendation in paragraph 7.a.(1) of the reference, COMOR did not presume to judge the suitability of any particular system in meeting USIB requirements for an advanced satellite search system. Likewise in paragraph 7.a.(2), although the specifications appeared to point to the G-3, Mr. Reber stated COMOR was not endorsing any system, but was looking for a resolution of [redacted] or better, and if feasible, a swath width as wide as possible, accuracy in pointing the camera and continuous coverage stereo. He noted that in paragraph 5, COMOR had also concluded that those improvements in resolution and reliability that could be made in the KH-4 and KH-7 without impending development of the two systems mentioned above should be effected. The Chairman, COMOR, also stated that although COMOR had not yet made a formal recommendation to the Board, his Committee preferred the KH-7 to the KH-4 as a crisis standby and that the KH-6 might serve as a supplement thereto.

2. The DIA member, referring to paragraph 6 of the COMOR Conclusions and Recommendations, stated he did not think COMOR had given adequate

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consideration to the USIB directive regarding the need for an interim search system like the LANYARD. General Carroll noted that there was a requirement for coverage of targets KH-4 could not detect and for which the swath width of KH-7 was too narrow, and urged USIB not to drop consideration of the KH-6 (LANYARD) as an intelligence collection system against certain targets. The Chairman agreed that this was an important point and stated he would like NRO and COMOR to study the feasibility of running one or two KH-6 missions with orbits worked out to give maximum coverage of China near the end of this year when the weather will improve. Mr. McCone said he felt this might prove to be a useful input to our intelligence inventory. The D/NRO stated that after the last Board meeting he had initiated a technica and cost study, as well as an informal targeting study on how many KH-6 missions would be required to obtain coverage of South China. While he had nothing at present to report on the targeting study, Dr. McMillan reported that it appeared the first flight with the existing payload could be ready about 4 months after the decision was made to go ahead. The D/NRO added that he had not yet looked into all factors involved, and there would be some costs directly associated with the project. He said that THOR and AGENA boosters already in the program as standbys could be used to orbit the KH-6s but noted that this would deplete the reserve of standby vehicles. Dr. McMillan stated that we have 5 complete KH-6 payloads in storage and the removal from storage and utilization did not present severe technical problems. In respons to a question by the Chairman regarding how many missions would be requirec [redacted] of the NRO Staff, stated that the number required would depend primarily on the weather. Although the study was not yet completed, [redacted] estimated it would probably take 3 or 4 missions at the time of the year proposed. The D/NRO stated the study would be completed by next week. In response to questions by Admiral Taylor as to the possibility of R&D conflict between the improved search system and the high resolution system, and the timing involved, the D/NRO replied that there was no conflict in priorities, there was no problem as to "state of the art" in developing the search system as recommended by COMOR, and the development cycle for the high resolution system which would be about 2 1/4 years after initiation of

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payload design, or the latter part of 1966. Mr. McCone suggested that in view of Dr. Fubini's statements last week regarding availability of funds, it appeared questionable whether priorities for the development stage were important. The D/NRO replied that he felt it was a matter of convincing Secretary McNamara of the requirement, as the Secretary of Defense had told him repeatedly not to stint on this program.

3. The Chairman stated that after considerable thought on the matter, he believed the positions developed by COMOR were logical and understandable. He said he understood and was fully sympathetic to the Defense Department responsibilities and desire for the highest possible resolution in order to produce the best technical estimates on Soviet weapons systems. On the other hand, Mr. McCone said he recognized the high priority placed by CIA analysts on the broad view of Soviet progress which could better be answered by broad coverage. The Chairman stated he was not going to try to resolve this apparent problem as he believed we needed both capabilities. Although new heavier boosters may help, Mr. McCone recognized serious problems incident to development of both systems. He said consultants had pointed out areas of serious doubt in the new CIA-proposed search system. G-3 also has development problems, including those surrounding the use of the largest (48 inches) mirror employed to date. The Chairman pointed out that only when research and development is completed can we prove or disprove their capabilities and approve a "go ahead" on either or both of these systems.

4. Mr. McCone then reviewed the substance of a letter he had written to Deputy Secretary of Defense Vance on 23 July in which he had recommended certain steps be taken to improve or develop GAMBIT, GAMBIT-3, the CIA concept for a higher resolution search system, and alternative high resolution spotting and search systems in anticipation of the availability of the TITAN III booster. Specifically, Mr. McCone had recommended research and development work on G-3 and the CIA concept over the next six months as a basis for further decisions. The Chairman stated that if the Board generally agreed to

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this procedure, he would meet with the Secretary of Defense and arrive at definite decisions on how to proceed. Mr. McCone said he was particularly interested in the effect TITAN III might have on future satellite reconnaissance systems. He then requested the D/NRO to make a study regarding the potential of TITAN III in improvement of satellite reconnaissance systems currently under consideration. The DIA member said he subscribed to the Chairman's proposal as he believed it necessary and appropriate that the Board state firm requirements for collection systems. Mr. McCone noted that having stated intelligence requirements, the problem of how to fulfill it was beyond the province and competence of USIB.

5. The D/NRO stated that it was very helpful to have firm statements of current USIB requirements. He agreed that study was needed on the use of TITAN III, and noted that a fair amount of analysis had already been done on its use. Dr. McMillan pointed out, however, that the information on the use of TITAN III for general search is not up to date, while studies on its use in connection with a high resolution pointing system are more current. In this connection he said that at the present state of the art [redacted] resolution pointing system would not require the full weight carrying capacity of TITAN III. The D/NRO emphasized that there were critical technical problems involved in the development of such a very high resolution system and mentioned two:

a. The large (100 inch) mirror, which would require extremely fine finishing, and which would experience to a higher degree, all of the problems the Chairman had pointed out in discussing the 48 inch mirror in G-3.

b. Much development needed for a suitable target tracking device not based on a timed flight schedule. He noted that this second problem is technically easier than the mirror problem mentioned above.

The D/NRO said that although he was not prepared to discuss development

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CORONA/GAMBIT/LANYARD

~~TOP SECRET~~

HANDLE VIA BYEMAN-TALENT/
KEYHOLE CONTROL SYSTEMS
JOINTLY

BYE 4594-64
USIB-D441.13/12
(COMOR-D-13/17
31 July 1964
Limited Distributi

problems incident to the general search requirements which incorporate resolution [redacted] with a broad swath, he believed such a system would require the full payload capacity of TITAN III.

6. The CIA member, in connection with the discussion of the weight carrying capacity of the TITAN, raised the possibility of eventually using a man to point the camera, Dr. McMillan said studies along this line were being conducted by NRO. It appeared that a man could do the job, but the unmanned system should do almost as well and did not require the 8,000 pound additional capacity required to support manned flight and was not involved with manned recovery problems.

7. The Deputy Director, Science and Technology, CIA, asked whether, in view of Board interest in high resolution, our requirements should stop at [redacted] The Chairman suggested that an effort be made to find out what this improvement would cost before we go further, as he was becoming increasingly allergic to expressions of requirements which did not bear a price tag. Mr. McCone indicated there may be a lower limit to resolution [redacted] beyond which atmospheric phenomena may be a controlling factor. Dr. Wheelon explained that the CIA general search propo: which was pegged to the use of TITAN II had the problem of moving film fast enough. He said that faster films being worked on by Eastman for G-3 might help the problem by cutting down exposure time.

8. In response to a question from the Chairman regarding the status of N efforts to resolve G-3 problems, the D/NRO stated that specific efforts were currently being made to bring the resolution down to that requested, through a design contract to Eastman for the system which includes the structure to be orbited. He said that the present schedule calls for the fabrication of full siz mirrors from two sets of materials by February 1965. Smaller mirrors to te materials were expected this fall. Dr. McMillan said that environmental test of the mirrors would be less complicated than similar tests for the complete camera, and that money was included in the Eastman contract for the constru tion of a test facility.

~~TOP SECRET~~

CORONA/GAMBIT/LANYARD

HANDLE VIA BYEMAN-TALENT/
KEYHOLE CONTROL SYSTEMS
JOINTLY

BYE 4594-64
USIB-D-41.13/12
(COMOR-D-13/17)
31 July 1964
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7. After further discussion USIB:

a. Approved as guidance to NRO the COMOR Conclusions and Recommendations contained in Tab B of USIB-D-41.13/11, subject to the deletion of the priority statement in subparagraph 7.b., and the reservations expressed by the Chairman and the DIA member concerning the COMOR Conclusions regarding LANYARD in paragraph 6.

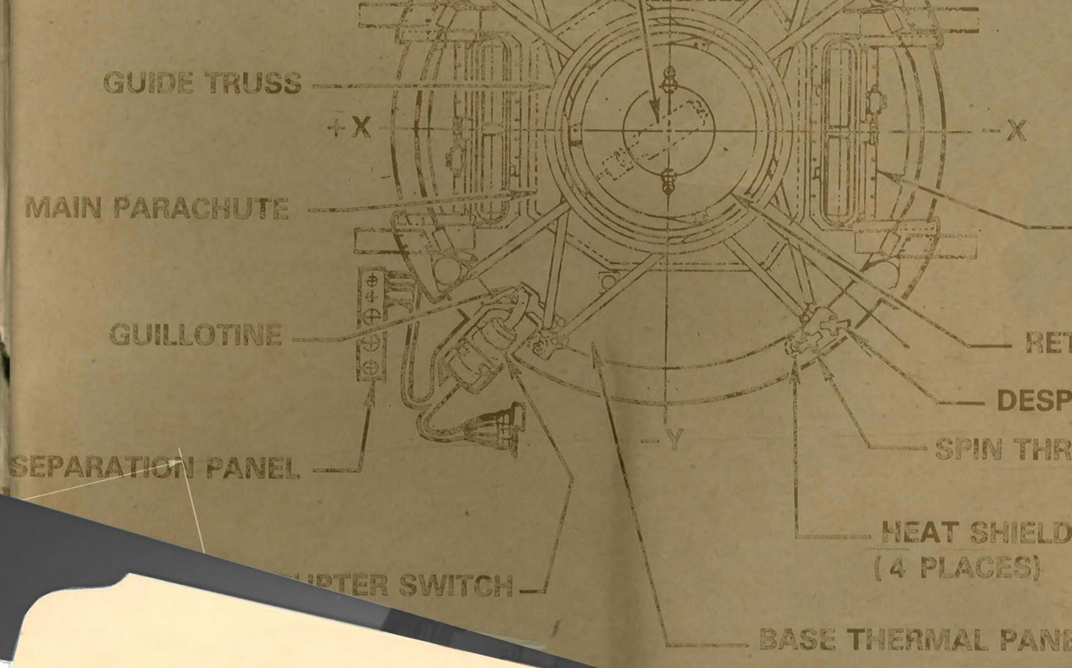
b. Noted the DCI's review of the substance of a letter to Secretary Vance recommending certain steps to improve or develop GAMBIT, GAMBIT-the CIA concept for a new and improved search system, and alternative high resolution spotting and search systems in anticipation of the availability of TITAN III, with which USIB expressed general agreement.

c. Requested that NRO report at the next regular USIB meeting on the results of the NRO feasibility study to conduct one or two KH-6 mission giving maximum coverage over China near the end of this year.

d. Noted that the D/NRO would have studies on the use of TITAN I for both general search and pointing systems brought up to date and presented to USIB.

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

- 6 -
CORONA/GAMBIT/LANYARD
~~TOP SECRET~~



CRITICAL TO US SECURITY:
THE GAMBIT AND HEXAGON SATELLITE RECONNAISSANCE SYSTEMS COMPENDIUM

SECTION III: PROGRAM INITIALIZATION

The Air Force was responsible for initiating Gambit as part of the Satellite and Missile Observation System (Samos) program. Samos was mostly an overt program with several components including film retrieval and film readout systems. The film retrieval elements would fully mature in the form of the Corona and Gambit programs. The film readout elements, beset by multiple difficulties, would eventually wither. The only exception was National Aeronautics and Space Administration's (NASA's) use of Samos technology for lunar imaging to support the Apollo program. Hexagon initialization really began in the Central Intelligence Agency's (CIA's) Directorate of Science and Technology. There, CIA scientists worked with Itek and later Perkin-Elmer to develop the Fulcrum imaging system. CIA development efforts caused significant tension with the National Reconnaissance Office (NRO). Eventually CIA and NRO leadership reached a mutually acceptable accommodation where the CIA developed the optics and camera system and the Air Force was responsible for the development of the other major system components, with overall responsibility assigned to CIA's Program B housed at the NRO.

Since the Gambit systems can trace their origins directly back to the Samos program, we have included the Operational Order for Samos. The Order includes the assignment of Brigadier General Robert Greer as Director of the Samos Project Office. Greer would also oversee the early development of the Gambit system. The document also includes the structure and responsibilities of the Samos program and relationship to other Air Force elements.

By the end of 1960, the policies for the Samos program office were well developed. We have included a memorandum with a classified attachment that summarizes the governance structure for the Samos program as well as the integration of the Gambit program. The document provides early and concise insight into the efforts and systems that comprised the Samos program.

Security has always been a significant concern for national reconnaissance satellites. The Security Guidance of an Unclassified Nature Relating to SAMOS describes the unclassified purposes of the Samos program, basic configuration and other technical details, and the uses of military assets supporting the program. More importantly, the document reveals how the Samos program was presented to the public, allowing Gambit to hide in plain sight as an element of that program.

Gambit traces its origins to early camera system proposals from Eastman Kodak known as Blanket and Sunset Strip. We included early company correspondence that confirms initial contact with what would become the Air Force's Program A housed in the NRO. Eastman Kodak would eventually supply the Gambit Camera systems as well as provide film processing for all US intelligence community film return satellite imagery systems.

In other correspondence, Eastman Kodak identifies preliminary schedules for the Blanket and Sunset Strip programs as well as budget estimates and capabilities estimates. The package also includes recommendations for organizational and management structures to support the development of the then challenging space reconnaissance systems.

By late 1961, Blanket and Sunset Strip had evolved to Project Cue Ball. We include a project summary that provides significant details of the program that would eventually become Gambit. It includes an overview of the program, the program management approach, schedule estimates, as well as cost estimates. The document includes descriptions of the industrial contractors supporting the project and the facilities used in the project. The document was released shortly after the formation of the NRO in September 1961.

Gambit would be succeeded by the Gambit-3 program. The original Gambit program provided high resolution imagery that became critical to intelligence analysis on a host of issues. NRO's Program A developed the Gambit-3 to achieve even higher resolution and longer mission duration. We include an early program management plan that contains an overview of the program, technical aspects of the program, as well as schedule and finance information.

By the mid 1960's Corona's successful capture of wide-area imagery allowed the United States significant advantages in searching for threats in the broad expanses of the Soviet Union and other denied areas. The Corona success also led to development efforts for wide-area search capabilities with even higher resolution than Corona could provide. We include a CIA program document that details CIA's early efforts to test such a system known then as Fulcrum. The CIA's effort in the first phase tasking would eventually lead to the Hexagon system and some significant tension with the Air Force in getting there. The phase one testing would assess Fulcrum's film handling capabilities, camera system and optics, facilities needed to support the system, and design and engineering requirements.

CIA's Fulcrum project caused tension with the NRO, despite the agreed upon approach for testing Fulcrum described in the previous document. We include a program memorandum to the DCI that describes an earlier memorandum from the Director of National Reconnaissance who raised concerns about Fulcrum to the CIA's Deputy Director for Science and Technology. The CIA and NRO disagreed over whether or not the phase one testing was for design purposes or for development purposes. This document provides the CIA's internal response to the NRO concerns.

When Alexander Flax became Director of the NRO in the fall of 1965 he inherited an impasse between the NRO and the CIA over the Fulcrum system. In his 29 April 1966 memorandum to Air Force and CIA program leaders, Flax describes the resolution of the impasse where the CIA would assume responsibility for the optics and camera system and the Air Force would assume responsibility for the remaining elements of the program. This document provides significant details on the anticipated technical capabilities of the new system.

In a 21 July 1966 cover letter for the Perkin-Elmer Hexagon optical sensor design proposal, Perkin-Elmer President Chester Nimitz, Jr. highlighted significant elements of his company's proposal. Those highlights include: establishing a separate optical technology division, acquiring a new facility committed to the Hexagon program, and recruitment of an additional professional personnel to support the effort. Nimitz also highlights characteristics of the system including: 2.7 foot resolution from 95 miles above the earth, a thermal design that yielded a favorable environment for optics, and an optical design that provided for a generous focus tolerance. Perkin-Elmer would provide the system to the CIA and successfully contribute to the overall success of the Hexagon program.

LIST OF PROGRAM INITIALIZATION DOCUMENTS

* Pages including full-page redactions and blank pages have been removed from this document.

~~CONFIDENTIAL~~

HEADQUARTERS
AIR RESEARCH AND DEVELOPMENT COMMAND
UNITED STATES AIR FORCE
Andrews Air Force Base
Washington 25, D.C.

REPLY TO
ATTN OF: RDRDS

SUBJECT: Operational Order for Satellite and Missile Observation System (SAMOS) Serial No. 60-1

TO:

1. You are directed to take immediate action to implement the subject Operations Order (copy attached).

B. A. Schriever

B. A. SCHRIEVER
Lieutenant General, USAF
Commander

1 Atch
Operations Order

IF INCLOSURES ARE WITHDRAWN (OR NOT ATTACHED) THE CLASSIFICATION OF THIS CORRESPONDENCE WILL BE CANCELLED IN ACCORDANCE WITH PAR 25B, AFR 205-1.

~~CONFIDENTIAL~~

CO-92240

~~CONFIDENTIAL~~

HEADQUARTERS
AIR RESEARCH AND DEVELOPMENT COMMAND
WASHINGTON 23, DC

OPERATIONS ORDER FOR SATELLITE AND MISSILE OBSERVATION SYSTEM (SAMOS)
SERIAL NO. 60-1

~~CONFIDENTIAL~~

TABLE OF CONTENTS

THIS OPERATIONS ORDER IS CLASSIFIED IN ACCORDANCE WITH THE REQUIREMENTS OF PARAGRAPH 23 OF AFR 205-1

CONFIDENTIAL OPERATIONS ORDER NO. 60-1 ~~CONFIDENTIAL~~ CO-

~~CONFIDENTIAL~~

HEADQUARTERS
AIR RESEARCH AND DEVELOPMENT COMMAND
WASHINGTON 25, DC

OPERATIONS ORDER NO.

TASK ORGANIZATION:

The Satellite and Missile Observation System (SAMOS) Project Office, field extension of the Office of the Secretary of the Air Force, has been established at 2400 East El Segundo Blvd, El Segundo, California, per SAF Order No. 115.1, 31 August 60. (See Annex A) Brigadier General Robert E. Greer has been designated Director of the SAMOS Project Office, with additional duty as Vice Commander for Satellite Systems, AFBMD, ARDC. As Director of the SAMOS Project, General Greer is responsible to, and will report directly to the Secretary of the Air Force. In his dual capacity as Director of the SAMOS project and Vice Commander, AFBMD, he will exercise authority and control of the field management of the SAMOS program. Manpower and all necessary resources will be made available by AFBMD to support this office on the highest national priority. The resources and assistance of all ARDC Divisions and Centers will be made available as required.

1. GENERAL SITUATION:

The Deputy Secretary of Defense has directed the Secretary of the Air Force to assume direct responsibility for the reconnaissance satellite program (SAMOS), and to report for review and approval of the program directly to the Deputy Secretary of Defense. To assist in discharging his responsibilities for direction, supervision, and control of the SAMOS Project, the Secretary of the Air Force has established the SAMOS Project Office at AFBMD and the Office of Missile and Satellite Systems in the Office of the Secretary of the Air Force. He will appoint, as appropriate, a Satellite Reconnaissance Technical Advisory Group and has appointed a Satellite Reconnaissance Advisory Council. The SAMOS Program has been accorded the highest national priority, with the objective to obtain an operational capability for the United States at the earliest possible date.

2. MISSION:

Headquarters ARDC will, within existing capabilities, support to the maximum extent possible the development of the SAMOS Program. This support will include all functions normally considered operational and performed by other Commands and activities.

3. TASKS:

A. Headquarters ARDC will in accordance with appropriate directives provide the necessary support to the SAMOS development program. An office, Assistant for Satellite Systems (RDRB-1) has been established for this purpose. The functions of this office will include the following responsibilities:

(1) Informs the Commander on all aspects of SAMOS development program.

HQ ARDC
OPERATIONS ORDER NO. 60-1 ~~CONFIDENTIAL~~ CO-922

~~CONFIDENTIAL~~

(2) Monitors the program to insure consistency between its assigned priority and the resources applied against the program.

(3) Maintains cognizance of the activities of ARDC Divisions and Centers to include effecting coordination as requested by the Commander, AFBMD.

(4) Maintains a knowledge of the activities of the staff, Hq ARDC, to assist in accomplishing staff actions expeditiously.

B. Hq AFBMD will support the SAMOS development program to the extent possible from within existing resources. Such resources will not be at the expense of programs having equal national priority. Hq ARDC will be advised of any requirements beyond existing capability to provide. Maximum use will be made of the technical resources of the Aerospace Corporation and Associate Contractors. Subordinate units will be augmented wherever necessary by the employment of competent civilian scientific and technical talent. The programming and status reporting facilities of the AFBMD will be augmented as necessary to support this program.

C. Each ARDC Division and Center having an assigned responsibility in connection with the SAMOS development program will establish a single point of contact office, reporting directly to the Division/Center Commander, and will support the program in accordance with its national priority. The Assistant for Satellite Systems, Directorate of Ballistic Missiles & Space Systems (RDRB-1) is designated as the SAMOS point of contact within Hq ARDC and will report directly to the Commander, ARDC, on SAMOS matters.

D. Headquarters USAF has directed that the Air Force provide the necessary resources and assistance to assure the timely attainment of the SAMOS objectives.

E. The urgency of this program will require lowest safe security classification to permit expeditious accomplishment. Extreme care will be exercised by all concerned, however, to ensure the strictest "need to know" in order to protect the sensitive political nature of this program.

F. Specific supporting requirements are outlined in the attached Annexes.

B. A. Schriever

B. A. SCHRIEVER
Lieutenant General, USAF
Commander

ANNEXES:
A - Implementing Directives
B - Comptroller
C - Facilities
D - Logistics
E - Not used
F - Communications-Electronics
G - Personnel, Manpower & Organization
H - Aircraft Support
I - Security & Inspection Services
J - Legal
K - Information & Historical Services
L - Administrative Services

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ANNEXES: (Continued)

M - Medical Services

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1 - DCS/C

Headquarters ARDC:

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1 - RDGV
1 - RDGE
1 - RDA
1 - RDE
1 - RDI
1 - RDJ
1 - RDC
2 - RDY
3 - RDM
2 - RDP
1 - RDL
3 - RDR
5 - RDRB

ARDC Commands:

5 - Each ARDC Division
3 - Each ARDC Center

HQ ARDC
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ANNEX "A"
TO
OPERATIONS ORDER
SERIAL NO.
IMPLEMENTING DIRECTIVES

HEADQUARTERS
AIR RESEARCH AND DEVELOPMENT COMMAND
WASHINGTON 25, DC

COPY

THE SECRETARY OF DEFENSE
WASHINGTON

Sep 15, 1960

MEMORANDUM FOR THE SECRETARY OF THE AIR FORCE

SUBJECT: Reconnaissance Satellite Program

The Secretary of the Air Force will assume direct responsibility for the reconnaissance satellite program and will report for review and approval on the program directly to the Deputy Secretary of Defense. A project management structure will be established within the Department of the Air Force which will ensure that the USAF director of the program will report directly to the Secretary of the Air Force.

The principal staff agency to assist the Deputy Secretary of Defense on the program is the Office of the Director of Defense Research and Engineering (ODDR&E). The USAF project management office will keep the ODD&E fully informed, on a timely basis, concerning all matters pertaining to the program.

/signed/
JAMES H. DOUGLAS
ACTING

HQ ARDC
OPERATIONS ORDER NO. 60-1

COPY

NO: 115.1

DATE: August 31, 1960

SECRETARY OF THE AIR FORCE

ORDER

SUBJECT: Organization and Functions of the Office of Missile and Satellite Systems

1. There is hereby established the Office of Missile and Satellite Systems in the Office of the Secretary of the Air Force.

2. The Director of the Office of Missile and Satellite Systems is primarily responsible for assisting the Secretary in discharging his responsibility for the direction, supervision and control of the SAMOS Project. He is responsible for maintaining liaison with the Office, Secretary of Defense, and other interested Governmental agencies on matters relative to his assigned responsibilities. He may be assigned additional duties as deemed appropriate by the Secretary of the Air Force.

3. The Director will provide the Secretariat for the Air Force Ballistic Missile Committee.

DUDLEY C. SHARP
Secretary of the Air Force

HQ ARDC
OPERATIONS ORDER NO. 60-1

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COPY

NO: 116.1

DATE: August 31, 1960

SECRETARY OF THE AIR FORCE

ORDER

SUBJECT: The Director of the SAMOS Project

1. Effective this date, Brigadier General Robert E. Greer, Assistant Chief of Staff for Guided Missiles, is designated as Director of the SAMOS Project, with additional duty as Vice Commander for Satellite Systems, AFBMD, ARDC, with duty station at 2400 East El Segundo Boulevard, El Segundo, California.

2. The Director will organize an office to manage the SAMOS Project. Manpower to staff the office will be drawn from manpower available to him as Vice Commander for Satellite Systems. The SAMOS Project Office will be a field extension of the Office of the Secretary of the Air Force.

3. The Director is responsible to and will report directly to the Secretary of the Air Force.

4. Additional duties may be assigned to the Director as deemed appropriate by the Secretary of the Air Force.

DUDLEY C. SHARP
Secretary of the Air Force

COPY

31 Aug 60

OFFICE OF THE SECRETARY

MEMORANDUM FOR THE CHIEF OF STAFF

1. In implementation of SAFO 115.1, it is requested that orders be issued assigning Brigadier General Richard D. Curtin as Director of the Office of Missile and Satellite Systems. Personnel listed in the attachment should be assigned coincident with General Curtin's assignment.

2. Necessary adjustment to the authorized manning of OSAF will be made to accommodate the transfer of the personnel indicated.

3. Physical office space should be in the area presently occupied by the Assistant Chief of Staff for Guided Missiles, if feasible.

1 Incl
Attach

/signed/
DUDLEY C. SHARP

HQ ARDC
OPERATIONS ORDER NO. 60-1

7

COPY

12 Sep 60

ORGANIZATION AND FUNCTIONS OF THE

OFFICE OF MISSILE AND SATELLITE SYSTEMS

1. Secretary of the Air Force Order No. 116.1, dated 31 August 1960, designated Brigadier General Robert E. Greer as Director of the SAMOS Project, with additional duty as Vice Commander for Satellite Systems, AFBM, ARDC, with duty station at AFBMD. It directs him to organize a SAMOS Project Office at AFBMD as a field edtension of the Office of the Secretary of the Air Force. It specifies that Director of the SAMOS Project is responsible to and will report directly to the Secretary of the Air Force.

2. Secretary of the Air Force Order No. 115.1, dated 31 August 1960, established the Office of Missile and Satellite Systems in the Office of the Secretary of the Air Force. It provides that the Director of the Office of Missile and Satellite Systems is primarily responsible for assisting the Secretary in discharging his responsibility for the direction, supervision and control of the SAMOS Project. He is responsible for maintaining liaison with the Office, Secretary of Defense and other interested governmental agencies on matters relative to his assigned responsibilities. He may be assigned additional duties as deemed appropriate by the Secretary of the Air Force, and he will provide the Secretariat for the Air Force Ballistic Missile Committee.

3. The general management structure for the SAMOS Project is outlined in figure 1, attached. The Satellite Reconnaissance Technical Advisory Group will be appointed by the Secretary of the Air Force and will provide the means of obtaining the services of recognized experts from the scientific and applied engineering fields in the furtherance of the technical program. The Satellite Reconnaissance Advisory Council will be appointed by the Secretary of the Air Force to provide advice and counsel to him in the discharge of his overall responsibilities.

4. The internal organization and personnel assignment of the Office of Missile and Satellite Systems is outlined in Figure 2, attached. Following is a brief description of the principal duties of SAFMS officers:

OFFICE OF THE DIRECTOR

DIRECTOR	Responsible for conducting all actions of SAFMS in accordance with policy of and delegated authority from the Secretary of the Air Force.
DEPUTY DIRECTOR	Principal assistant to the Director, acts with full authority of the Director on all affairs of SAFMS. Responsible for overall direction, guidance, supervision, and co-ordination of the activities of the office.
EXECUTIVE OFFICE	Executive Officer, and Chief of the Executive

HQ ARDC
OPERATIONS ORDER NO. 60-1

Executive Asst Executive	Office responsible for the general administration of SAFMS, including mail, security, records, inspections, personnel, travel, and overall office management.

EXECUTIVE SECRETARIAT OF AFBMC

Secretary Asst Secretary	Executive Secretariat of the Air Force Ballistic Missile Commitee for Missile and Space Systems. Handles all matters related to Committee Actions.

SATELLITE RECONNAISSANCE

Asst for Programs	Responsible for SAFMS duties concerning programming, funding, and schedules. Monitors, briefs and reports on all SAMOS launches. Maintains an active, working SAMOS control room for daily use. Responsible for actions incident to revising, processing, and maintaining the SAMOS development plan. Responsible for general briefings on the entire overall SAMOS Project, and for the preparation and maintenance of complete briefing material, aids and information on the overall project.
Asst for Electronics	Responsible for SAFMC duties concerning electronic payloads, ELINT, and related matters; weather aspects of the SAMOS Project, technical compatibility of electronic aspects of subsystem I, Space-Ground Communications. Responsible for NSA liaison and coordination. Responsible for maintaining current knowledge of booster and vehicle capabilities. Alternate to the Assistant for Instrumentation.
Asst for Photography	Responsible for SAFMS duties concerning photographic equipment and payloads and related coordination with other services and agencies. Responsible for photographic compatibility aspects of Subsystem I. Alternate to Assistant for System Engineering.
Asst for Instrumentation	Responsible for SAFMS duties concerning Subsystem I, its overall development, schedules, locations, tests, and overall technical design, overall data processing and handling of all SAMOS outputs. Also responsible for SAMOS recovery program, SAMOS command and control aspects, including centers and stations. Also responsible for MIDAS and DISCOVERER coordination. Alternate to Assistant for Electronics.

Asst for System Engineering	Responsible for overall system engineering aspects including interchangeability of payloads, system performance capabilities, mission variations, system growth possibilities, and relative priorities within the project. Responsible for necessary coordination with related and supporting R&D programs. Also responsible for special projects as assigned by the Director. Alternate to the Assistant for Photography.

COPY

SATELLITE RECONNAISSANCE
TECHNICAL ADVISORY GROUP

1. The services of recognized experts from the scientific and applied engineering communities shall be solicited as appropriate in the furtherance of the SAMOS technical program. Such services shall be rendered through the functioning of the Satellite Reconnaissance Technical Advisory Group.

2. The Satellite Reconnaissance Technical Advisory Group shall be composed of:

a. A permanent Standing Committee of four, which shall include recognized experts in the fields of electronics, photography, and data handling. The membership of the Standing Committee will be appointed by the Secretary of the Air Force.

b. Assemblies of technical experts representing pertinent scientific and engineering fields convened as occasions arise necessitating competent technical evaluation and advice in the prosecution of the Satellite Reconnaissance Program. Participation of such individuals in assemblies of the Satellite Reconnaissance Technical Advisory Group shall be by invitation from the Secretary of the Air Force. The Standing Committee shall preside at assemblies of the Technical Advisory Group.

3. Each assembly of the Satellite Reconnaissance Technical Advisory Group shall be chartered to consider specifically designated matters. Individuals invited to participate in Technical Advisory Group assemblies may vary for each assembly according to the nature of the matters under consideration.

4. Reports and findings of the Satellite Reconnaissance Technical Advisory Group shall be prepared for and submitted to the Secretary of the Air Force by the Standing Committee.

5. The Secretary of the Air Force shall, upon request from other government agencies in matters of national interest involving resolution of technical differences, direct the permanent Standing Committee to convene a special assembly of competent persons as determined by the Standing Committee, to consider the matter under request and to recommend appropriate resolution.

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SATELLITE RECONNAISSANCE
ADVISORY COUNCIL

1. Recent changes in the SAMOS management structure have resulted in the establishment of a Director of the SAMOS Project at AFBMD as a field extension of the Office of the Secretary of the Air Force, and an Office of Missile and Satellite Systems within the Secretary's staff to assist him in the discharge of his responsibilities. The SAMOS Project will be managed within this structure, with no intermediate review or approval channels between the SAMOS Project Director and the Secretary of the Air Force.

2. In order to assist the Secretary in the discharge of his responsibilities, there is a need for an advisory agency to provide assistance, advice and recommendations as required. This agency will be the Satellite Reconnaissance Advisory Council.

THE SATELLITE RECONNAISSANCE ADVISORY COUNCIL:

Under Secretary of the Air Force, Chairman
Assistant Secretary (Research and Development)
Assistant Secretary (Financial Management)
Assistant Secretary (Materiel)
Vice Chief of Staff
Deputy Chief of Staff, Development
Assistant Chief of Staff, Intelligence
Director, Office of Missile and Satellite Systems

3. The Office of Missile and Satellite Systems will provide the Secretariat for the Council.

4. No alternates will be designated. Attendance will be limited to the members of the Council and such other individuals as may be invited to attend by the Chairman.

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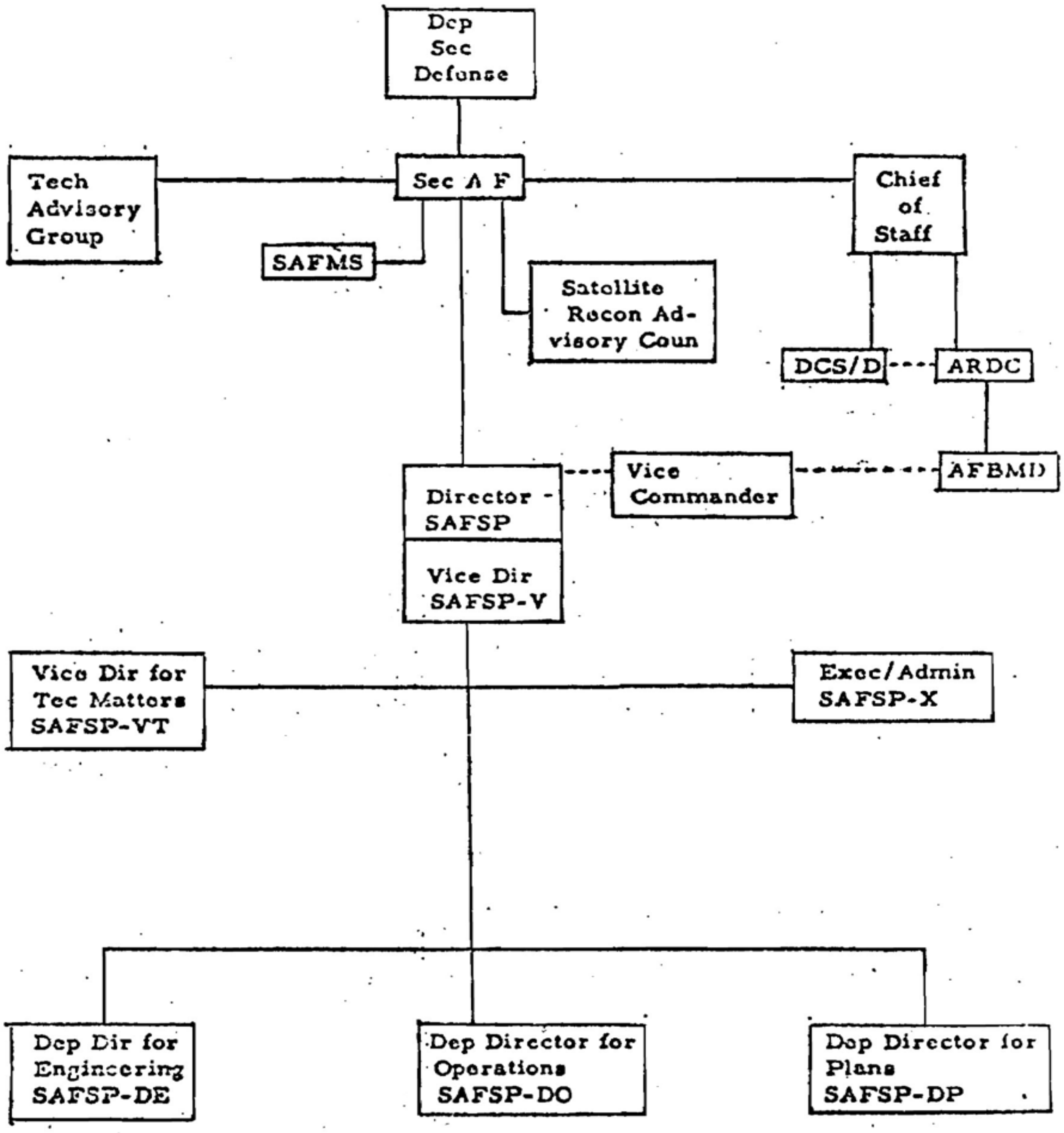

Figure 1

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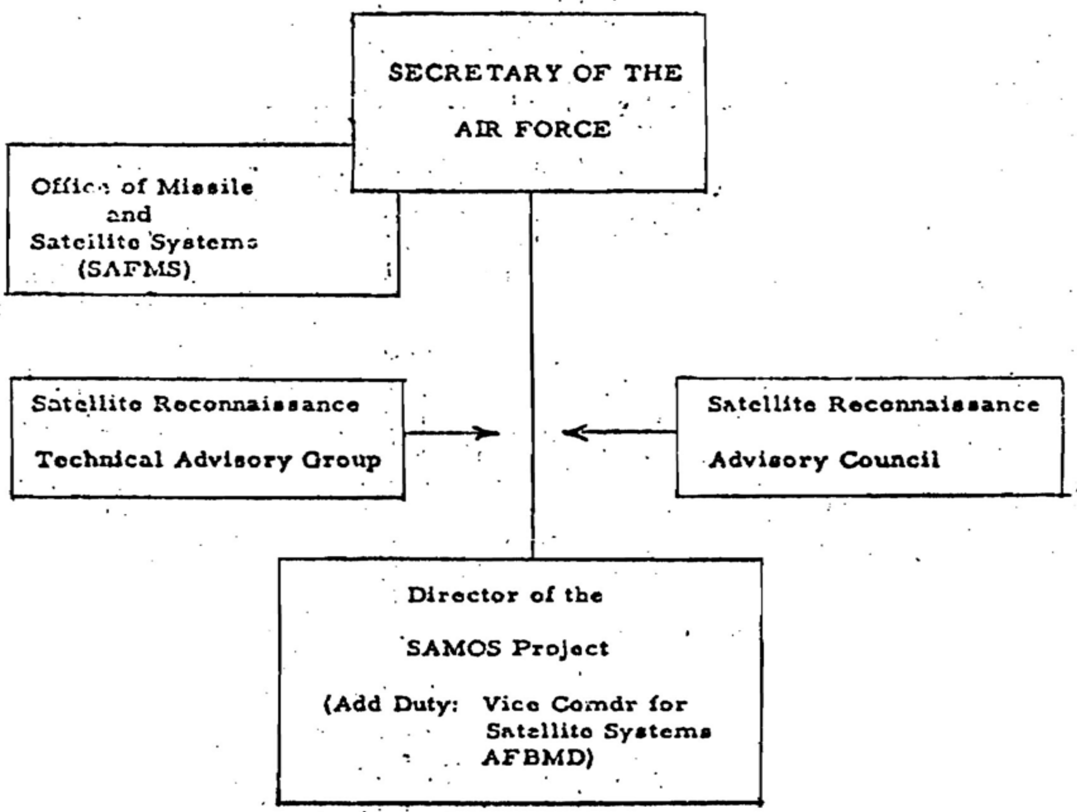

Figure 2

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COPY

DEPARTMENT OF THE AIR FORCE
Office of the Secretary of the Air Force
12 September 1960

OFFICE OF
MISSILE AND SATELLITE SYSTEMS

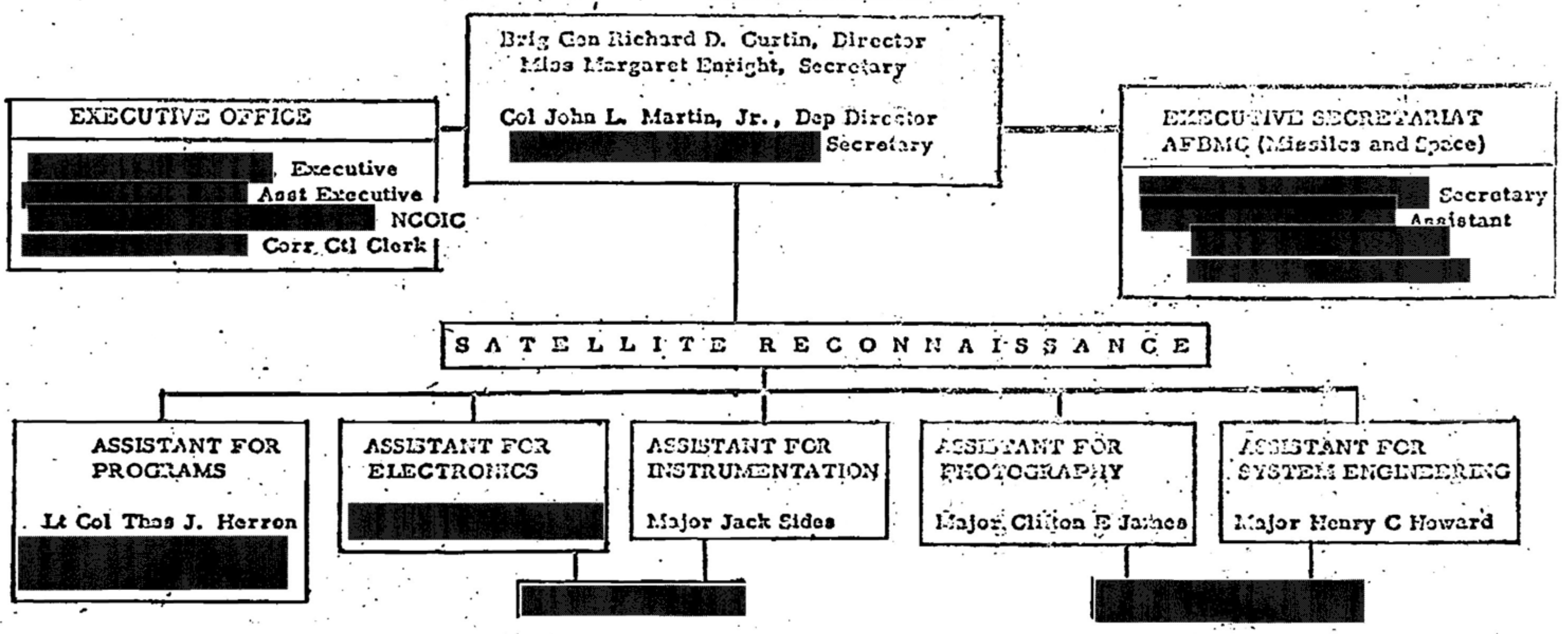

Figure 3

HQ ARDC
OPERATIONS ORDER NO. 60-1

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1 October 1960

Special Order A-1790, dated 27 September 1960:

1. The verbal orders of the Secretary of the Air Force on 6 September 1960 as follows are confirmed:

"Brigadier General Robert E. Greer, 1672A, is relieved from Hq AFBMD (ARDC) Los Angeles, California, from duty as Vice Commander for Satellite Systems, AFBMD: Assigned OSAF, Hq USAF, Washington, D. C., with duty station 2400 East El Segundo Boulevard, El Segundo, California for duty as Director of the Satellite and Missile Observation System Project with additional duty as Vice Commander for Satellite Systems, AFBMD (ARDC). EDCSA 1 October. No travel involved."

HQ ARDC
OPERATIONS ORDER NO. 60-1

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DEPARTMENT OF THE AIR FORCE
HEADQUARTERS UNITED STATES AIR FORCE
WASHINGTON 25, DC

AFCSS

Missile and Satellite Systems 14 October 1960

AAC	CAIRC	USAFE	ADC	HqC	AFAFC
ARDC	PACAF	AU	CONAC	ATC	TAC
USAFSS	MATS	USAFA	AMC.	SAC	

1. The Secretary of the Air Force has established:

a. An Office of Missile and Satellite Systems (SAFMC) in the Office of the Secretary of the Air Force to assist him in discharging his responsibility for the direct supervision and control of the SAMOS Project. The Director will provide the Executive Secretariat for the Air Force Ballistic Missile Committee. The Director, SAFMS, is responsible for maintaining liaison with the Office of the Secretary of Defense and other interested government agencies on matters relative to his assigned responsibilities. He may be assigned additional duties as deemed appropriate by the Secretary of the Air Force. Brigadier General Richard D. Curtin has been designated as Director of this office.

b. A Directorate of the SAMOS Project (SAFSP) at AFBMD as a field extension of the Office of the Secretary of the Air Force responsible to and reporting directly to the Secretary for management of the SAMOS Project. Brigadier General Robert E. Greer has been designated as Director with additional duty as Vice Commander for Satellite Systems, AFBMD, ARDC, with duty station at 2400 East El Segundo Blvd., El Segundo, California.

c. A Satellite Reconnaissance Technical Advisory Group and a Satellite Reconnaissance Advisory Council.

2. Effective immediately, the satellite reconnaissance program will be managed within the above structure. Further:

a. There will be no review or approval channels between the Director of the SAMOS Project and the Secretary of the Air Force. However, in order to maintain general project knowledge within those command or staff offices where such knowledge is necessary for program support or coordination of related matters, need-to-know briefings will be given on a periodic basis. Briefings will be given by SAFMS without request and not as a part of project management actions. Requests for briefings will be directed to the Secretary of the Air Force and will be approved on a strict need-to-know basis.

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b. Visits to the SAMOS Project Office, El Segundo, California, will be for official business only. Requests for visits by other than specifically accredited contractors and agencies of the government whose business requires regular and frequent visits will be directed to the Secretary of the Air Force for approval.

c. The Director of the SAMOS Project is authorized direct contact with major commands to request support.

d. The Director, Office of Missile and Satellite Systems, is authorized direct contact with the Air Staff and other staffs and agencies to request support as required.

3. The Executive Secretariat of the Air Force Ballistic Missile Committee will be the responsibility of the Director of Missile and Satellite Systems. Pending resolution and clarification of Air Staff participation in the direction of Ballistic Missile and Space Programs, the Secretariat will continue to provide the Air Force Ballistic Missile Committee with a direct channel to the Inglewood Complex, Air Materiel Command, and the Air Staff. This will include the necessary arrangements for meetings and follow-on implementing actions. The Air Staff will keep this office fully advised on missile and space matters so as to insure maximum effectiveness for the Secretary of the Air Force and the Air Force Ballistic Missile Commitee. Until more detailed operating instructions are issued, the Air Staff will continue to assist the Office of Missile and Satellite Systems in every way possible.

4. The high national importance accorded the SAMOS Project requires complete support and immediate response from all elements of the Air Force. All individuals and organizations of the Air Force are urged to provide the necessary resources and assistance to these offices to assure the timely attainment of missile and satellite objectives.

/signed/
ROBERT R. ROWLAND
Colonel, USAF
Secretary of the Air Staff

~~FOR OFFICIAL USE ONLY~~

HQ ARDC
OPERATIONS ORDER NO. 60-1

ANNEX "D"
TO
OPERATIONS ORDER
SERIAL NO.
COMPTROLLER

HEADQUARTERS
AIR RESEARCH AND DEVELOPMENT COMMAND
WASHINGTON 25, DC

1. BUDGET:

a. The Budget Annex of the Development Plan will provide the basis for justifying the program fund requirements through all levels of review. It will include prior year funding, current year fund requirements, and one future year estimated fund requirements unless otherwise directed by the Secretary of the Air Force. The Development Plan will not contain support-type fund requirements. These will be included in normal Budget Estimates and Financial Plans submitted by supporting Centers, Divisions, and Commands.

b. After appropriation of funds by the Congress, the Financial Plan as approved by the Secretary of the Air Force will constitute the authority for all funding actions by Hq USAF. Funds allocated to the Commander, ARDC, will be sub-allocated to appropriate Division and Center Commander. Military Construction funds will be allocated by Hq USAF directly to the Air Force Construction Agent, as designated by the Secretary of the Air Force.

c. Each Division/Center having a responsibility in this program will state support fund requirements to Hq ARDC. This will normally be accomplished in the Division/Center Budget Estimates and Financial Plans and revisions thereto. Fund requirements stated by each Division/Center in support of this program will be separately identified. In the event unprogrammed items requiring funding arise, and the Division/Center cannot absorb the funding within existing resources, the Division/Center involved will advise Hq ARDC of the additional fund requirement.

d. The AFBMD Budget Directorate will provide Budget Services to the Director, SAMOS Project, as required.

2. ACCOUNTING AND FINANCE:

a. The AFBMD Accounting and Finance Directorate will perform accounting operations for this program as prescribed in current directives.

b. The AFBMD Accounting and Finance Directorate will provide the same finance service to this program and assigned personnel as provided other programs and personnel assigned to AFBMD.

c. Each Division/Center will perform accounting operations as prescribed in current directives for funds received in support of this program.

Hq ARDC
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3. STATISTICAL SERVICES:

a. Each Division/Center will provide normal statistical services in support of this program.

4. MANAGEMENT ANALYSIS:

a. The AFBMD Financial Analysis Directorate will provide the Commander AFBMD and the Director, SAMOS Project financial analysis services as required.

b. Each Division/Center Commander will insure that appropriate analysis is performed to provide him data to insure smooth implementation and accomplishment of his portion of the program.

ANNEX "C"
TO
OPERATIONS ORDER
SERIAL NO.
FACILITIES

HEADQUARTERS
AIR RESEARCH AND DEVELOPMENT COMMAND
WASHINGTON 25, DC

I. POLICY: The Air Research and Development Command, through the Air Force Ballistic Missile Division, Los Angeles 45, California, will provide facility support for the SAMOS Program worldwide and for the SAMOS Project Office, El Segundo, California.

II. SAMOS PROGRAM SUPPORT: The Deputy Commander for Facilities, Air Force Ballistic Missile Division, will provide the Civil Engineering support required for implementation of the SAMOS PROGRAM including, but not limited to:

a. Development of worldwide facility requirements.

b. Programming of requirements.

c. Design of all facilities. Design responsibility includes architect-engineer selection, supervision, review and approval of design concepts, preliminary and final design; design interpretation during construction and review and approval of design change orders during construction.

d. Construction surveillance.

e. Fiscal management of design and construction.

f. Acceptance of completed facilities.

III. SAMOS PROJECT OFFICE SUPPORT: The Civil Engineering Division of the 6592nd Support Group, AFBMD, will support the SAMOS Project Office, El Segundo, California, as follows:

a. Provide for the maintenance, operation and accountability of all Air Force Real Property utilized in support of the SAMOS PROGRAM.

b. In conjunction with Aerospace Corporation, provide necessary office space, fixed facilities and parking space.

c. Analyze, review and process requests for modification and alterations of facility requirements submitted in accordance with AFBMD Regulation 85-1, "Work Order Request".

HQ ARDC
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ANNEX "D"
TO
OPERATIONS ORDER
SERIAL NO. ______
LOGISTICS

HEADQUARTERS
AIR RESEARCH AND DEVELOPMENT COMMAND
WASHINGTON 25, DC

1. GENERAL:

a. A priority and precedence rating of 1-1 and a DOD rating of Brickbat .01 is assigned to the SAMOS Program.

b. AFBMD is responsible for insuring that timely Logistics Support is available to meet the requirements of the SAMOS Project Office. This includes both support of Military Organizations and Contractors engaged in Research and Development of the SAMOS system in both the Los Angeles area and at operational sites.

2. SUPPORT SOURCES:

a. Support will be provided from three major sources - AF host commands (host Air Force bases), other DOD agencies and/or AFBMD. Support agreements with host agencies will be negotiated by AFBMD.

b. In the event site location makes it impossible to provide support from Air Force or interservice sources, AFB MD will take the necessary action to contract for the required support.

3. TRANSPORTATION:

a. Transportation for equipment and supplies for the SAMOS Program will be arranged for by AFBMD (WDMT) in accordance with applicable directives and agreements between the AMC (LSM).

b. Vehicles in support of the SAMOS Program will be arranged for by AFBMD. SAMOS organizations are responsible for proper use of vehicles in accordance with AFBMDR 77-1.

4. MAINTENANCE:

a. AFBMD will process modifications for aircraft used to support the SAMOS Program in accordance with AFR 57-4 and will arrange for accomplishment of modifications.

b. Calibration, chemical laboratories, liquid oxygen cleaning and other highly specialized technical facilities will be arranged for by AFBMD making maximum use of existing facilities.

c. Technical Order Libraries will be provided by AFBMD.

HQ ARDC
OPERATIONS ORDER NO. 60-1

d. AFBMD will prepare and consolidate budget estimates and financial plans for contract maintenance and equipment modification in support of the SAMOS Program.

5. SUPPLY:

a. General. AFBMD will render supply assistance to the SAMOS Program on an as required basis, and insure that required items are procured and delivered by established need dates.

b. Equipment Authorizations. AFBMD will be responsible for equipment review and authorization functions as prescribed by Air Force Directives.

c. Budget. AFBMD will prepare and consolidate financial plans and budget estimates for GFE equipment and supplies required by the SAMOS Program.

d. Propellants. Liquid propellants, fuels and chemicals required for the SAMOS Program will be programmed and/or budgeted for by AFBMD in accordance with USAF procedures.

ANNEX "F"
TO
OPERATIONS ORDER
SERIAL NO.
COMMUNICATIONS-ELECTRONICS

HEADQUARTERS
AIR RESEARCH AND DEVELOPMENT COMMAND
WASHINGTON 25, DC

1. GENERAL

a. AFBMD is responsible for providing suitable and timely Communications-Electronics support of the SAMOS Program Office.

b. Communications-Electronic support includes that of military organizations, prime and sub-contractors, and commercial carriers in both the Los Angeles area and at operational bases.

2. PROCUREMENT AND INSTALLATION

a. The intra-station and inter-station ground-support communications requirements will be procured and installed through lease from commercial carriers whenever possible. Government owned ground-support communications systems will be procured and installed through a communications contractor.

b. Prime and sub-contractors will be responsible for providing the ground-space communication requirements and the necessary interface equipments with the ground-support communications system. Ground-space communications systems will be government owned whenever possible.

3. MAINTENANCE

a. Lease ground-support communications systems will be maintained by the commercial carrier. Government owned ground-support communications will be maintained by either a commercial contractor or military personnel.

b. Ground-space communications systems will be maintained by a communications contractor or military personnel.

NOTE: Complete details such as Wire Plan, Frequencies, etc will be included in this Annex as quickly as possible.

HQ ARDC
OPERATIONS ORDER NO. 60-1

ANNEX "G"
TO
OPERATIONS ORDER
SERIAL NO.
PERSONNEL, MANPOWER & ORGANIZATION

HEADQUARTERS
AIR RESEARCH AND DEVELOPMENT COMMAND
WASHINGTON 25, DC.

1. MILITARY PERSONNEL:

The AFBMD will provide all normal personnel support services to the Director, SAMOS Project, within its capabilities in accordance with current policies and procedures. Such support will include:

a. Personnel Accounting.

b. Military Pay.

c. Personnel Classification Action.

d. Manning of all authorized positions. Assistance in manning key positions will be provided by the Secretary of the Air Force.

2. CIVILIAN PERSONNEL:

The AFBMD will provide all Civilian Personnel support within its capability to the Director, SAMOS Project. Such support will include:

a. Direction and administration of the civilian personnel program.

b. Classification and pay administration.

c. Recruitment, employment, placement, and separation of civilian employees.

d. Employee-management relations and necessary employee services.

e. Training and development of civilian employees.

3. MANPOWER AND ORGANIZATION:

a. AFBMD has provided 39 officer and 15 civilian manpower spaces for the SAMOS Project Office. In addition, 10 officer and 10 civilian spaces have been provided by the Office of the Secretary of the Air Force, specifically for the SAMOS program. Any additional spaces required will be provided by Hq USAF. Additional requirements will be submitted to Hq AFBMD (WDPO) who will assist in the preparation of substantiating data for transmittal on an expedited basis to Hq USAF through ARDC.

b. Directorate of SAMOS Project Office is a field extension of the Office of the Secretary of the Air Force, by authority of SAF Order 116.1, dated 31 August 1960. The Director is responsible to, and will report directly to, the Secretary of the Air Force. As an additional duty, he will act as Vice Commander for Satellite Systems to the Commander of AFBMD in which capacity he may command such additional support as AFBMD has the capability to provide. Organizational structure of the Directorate of SAMOS Project will be consistent with proper Air Force management procedures and will be functionally aligned to fulfill its mission. Organization changes desired by the Director of SAMOS project will be submitted to Hq AFBMD (WDPO) for transmittal to USAF through ARDC.

ANNEX "H"
TO
OPERATIONS ORDER
SERIAL NO.
AIRCRAFT SUPPORT

HEADQUARTERS
AIR RESEARCH AND DEVELOPMENT COMMAND
WASHINGTON 25, DC

I. POLICY:

The Air Research and Development Command through the Air Force Ballistic Missile Division, Los Angeles 45, California, will provide all aircraft requirements (assigned or bailed) in direct support of the SAMOS Program.

II. PROCEDURE:

The Support Operations Division (WDQO) of the 6592d Support Group, AFBMD, will support the SAMOS Program as follows:

a. Bailment requests will be processed in accordance with AFBMDIR 70-7 and ARDC Regulation 55-3.

b. Requests for assignment of aircraft will be processed through WDQO in accordance with ARDC Regulation 55-3.

c. WDQO will assist in validating aircraft requirements when required.

ANNEX "I"
TO
OPERATIONS ORDER
SERIAL NO.
SECURITY AND INSPECTION SERVICES

HEADQUARTERS
AIR RESEARCH AND DEVELOPMENT COMMAND
WASHINGTON 25, DC

1. SECURITY:

The AFBMD will provide those security services normal to a host/tenant relationship. Services provided will include:

a. Guard services to meet physical security requirements within the AFBMD Complex.

b. Personnel Security Clearance actions as required.

c. Visitor Control Services.

d. Classification guidance and assistance as required.

e. Such other requested services as are within the capability of the AFBMD.

2. INSPECTION SERVICES:

The Inspector General, AFBMD, will provide:

a. Inspection Services required by AFR 123-1.

b. Quarterly Security Inspection Check Lists in compliance with AFR 205-1.

c. Such other requested services and assistance as are within the capability of the AFBMD.

HQ ARDC
OPERATIONS ORDER NO. 60-1

ANNEX "J"
TO
OPERATIONS ORDER
SERIAL NO.
LEGAL

HEADQUARTERS
AIR RESEARCH AND DEVELOPMENT
WASHINGTON 25, DC

1. The Staff Judge Advocate, Headquarters, ARDC, will provide assistance to and will exercise surveillance over all legal activities of the Ballistic Missile Division in support of the SAMOS Project, Office of the Secretary of the Air Force.

2. The Staff Judge Advocate, Headquarters AFBMD, as required, will:

a. Act as advisor to the Director of the SAMOS Project and his staff on legal problems pertaining to the SAMOS Project.

b. Provide legal review of all contracts written in support of the SAMOS Project.

c. Render advice, assistance and act on all patent, copyright and royalty and other proprietary right matters including infringement claims arising out of or incident to SAMOS project activities.

d. Monitor and coordinate all actions dealing with the Reports Clause of all contracts written for the SAMOS project including evaluations and clearances for payment.

e. Direct the administration and processing of claims in favor of and against the United States Government.

f. Provide legal assistance for all eligible personnel assigned or attached to the SAMOS Directorate.

g. Provide advice and assistance to the Director on disciplinary problems.

HQ ARDC
OPERATIONS ORDER NO. 60-1

ANNEX "K"
TO
OPERATIONS ORDER
SERIAL NO.
INFORMATION AND HISTORICAL SERVICES

HEADQUARTERS
AIR RESEARCH AND DEVELOPMENT COMMAND
WASHINGTON 25, DC

1. INFORMATION SERVICES:

a. Within the procedures prescribed by the Public Affairs Plan for SAMOS SATELLITE PROJECT (PA 13/1), dated 22 September 1960, AFBMD is responsible for developing detailed Information plans and initiating programs for all Information aspects of the SAMOS program in direct support to the SAMOS Project Director, Office of the Secretary of the Air Force.

b. AFBMD will establish procedures and channels for the control of SAMOS Program information, including that information generated by participating ARDC Divisions and Centers, Major Air Commands, and Air Force contractors, subcontractors, and suppliers; to provide a central coordinating agency for the review and processing of material intended for public dissemination. SAMOS Program progress will be closely monitored by AFBMD so that technical secrets are protected while general progressive information can be recommended for publication in order to serve public interest.

c. AFBMD will initiate and supervise actions affecting local and national acceptance of the SAMOS Program. This will include preparation and coordination of press plans for significant events in the SAMOS Program including making available to news media, pre-launch, launch, and post-launch information; routine handling of press queries regarding SAMOS, inputs to speeches by key SAMOS Program officials, photographic support, both still and motion, and the normal internal (Air Force wide) information activities. Other ARDC Divisions and Centers will cooperate and participate in this program as required.

d. AFBMD will submit through established Information channels to the Office of Security Review, OASD(PA), all handout material, statements, fact sheets, etc for release to news media, for coordination and final approval not less than ten days in advance of the planned date of launch.

e. Hq ARDC Office of Information will be continually advised of all public information aspects of the SAMOS Program.

2. HISTORICAL SERVICES:

a. Upon request, the AFBMD Historian will provide guidance to the staff of the SAMOS Project Director, Office of the Secretary of the Air Force, in the preparation of any historical reports required under AFR 210-3, 12 August 1960.

HQ ARDC
OPERATIONS ORDER NO. 60-1

27

ANNEX "L"
TO
OPERATIONS ORDER
SERIAL NO.
ADMINISTRATIVE SERVICES

HEADQUARTERS
AIR RESEARCH AND DEVELOPMENT COMMAND
WASHINGTON 25, DC

1. GENERAL:

The Director, SAMOS Project, will receive administrative support from Hq AFBMD in the same manner and extent as is received by other organizations located on the AFBMD installation. Details of support requirements will be arranged and changed as necessary by mutual agreement between the Director of Administrative Service, Hq AFBMD (WDA), and the Executive Officer, SAMOS Project Office (SAFSP-X).

2. MAIL, MESSAGE, & COURIER SERVICE:

The Director of Administrative Services (WDA), Hq AFBMD, will provide normal message center, mail room, and courier services to the SAMOS Project Office. Maintenance of internal accountability records for classified material is the responsibility of the SAMOS Project Office.

3. ADMINISTRATIVE ORDERS:

Travel performed by the Director, SAMOS Project, in his capacity as a representative of the Secretary of the Air Force and in support of the SAMOS Project, will be covered by blanket orders from the Office of the Secretary of the Air Force. All other travel by the Director, SAMOS Project, and all travel by members of his staff will be performed under orders issued by Hq AFBMD upon request of designated officials assigned to duty in the SAMOS Project Office. As qualified above, Hq AFBMD will provide complete orders-issuing service to include travel, leave, personnel actions, board appointments and any other action requiring issuance of a special order. Hq AFBMD Regulations shall apply.

4. PRINTING, DUPLICATING, & ART SERVICES:

Printing, duplicating, and art services will be provided by Hq AFBMD. Hq AFBMD Regulations shall apply.

5. PUBLICATIONS AND FORMS:

Hq AFBMD will furnish departmental, ARDC, and AFBMD publications and forms necessary to operate the SAMOS Project Office. AFBMD Regulations governing issuance of publications and forms shall apply. Directives issued by the Secretary of the Air Force will be received directly in the SAMOS Project Office in accordance with procedures to be established by the SAMOS Project Office.

b. RECORDS MANAGEMENT.

Files of current records will be maintained in accordance with AFM 181-4. Assistance in preparing Records Control Schedules will be furnished by the Records Management Officer, Hq AFBMD.

ANNEX "M"
TO
OPERATIONS ORDER
SERIAL NO.
MEDICAL SERVICES

HEADQUARTERS
AIR RESEARCH AND DEVELOPMENT COMMAND
WASHINGTON 25, DC

The Air Force Ballistic Missile Division will provide all medical support within its capabilities to personnel of the SAMOS Project Directorate, in accordance with ARDC directives and existing procedures. Such support will include professional medical services and appropriate medical services as required.

HQ ARDC
OPERATIONS ORDER NO. 60-1

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DEPARTMENT OF THE AIR FORCE
OFFICE OF THE CHIEF OF STAFF
UNITED STATES AIR FORCE
WASHINGTON, D.C.

REPLY TO ATTN OF: AFCCS

SUBJECT: (Uncl) Basic Policy Concerning SAMOS

29 December 1960
(Expires 29 March 1961)

TO: DEPUTIES, DIRECTORS, AND CHIEFS OF COMPARABLE OFFICES (NO. 25)

1. Reference is made to: (U)

a. Secretary of the Air Force Order No. 115.1, 31 August 1960.

b. Secretary of the Air Force Order No. 116.1, 31 August 1960.

c. AFCSS letter, subject "Missile and Satellite Systems", 14 October 1960.

d. SAFOI-3c message, 1506/60, 15 December 1960.

2. Secretary of the Air Force Order No. 115.1, dated 31 August 1960, established the Office of Missile and Satellite Systems in the Office of the Secretary of the Air Force. It provides that the Director of the Office of Missile and Satellite Systems is primarily responsible for assisting the Secretary in discharging his responsibility for the direction, supervision and control of the SAMOS project. (U)

3. Secretary of the Air Force Order No. 116.1, dated 31 August 1960, directed the organization of a SAMOS Project Office as a field extension of the Office of the Secretary of the Air Force. It specifies that the Director of the SAMOS Project is responsible to and will report directly to the Secretary of the Air Force. (U)

4. In recognition of the special management procedures and the necessity of achieving the program objectives at the earliest date, the following policy is established for the SAMOS program: (U)

a. No information concerning this program will be initiated by Air Force organizations. (C)

b. This program is an R&D effort aimed at the development of various promising reconnaissance techniques. (U)

c. The R&D program will include all the necessary elements to insure that the data which is obtained can be efficiently and promptly exploited. (S)

d. The nature and character of an ultimate operational system is completely conditional upon the success of the methods which will be exploited in the R&D program. Accordingly, progress to date in the R&D program does not warrant operational planning. However, as

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soon as sufficient R&D progress is made to justify effective operational planning, specific instructions will be issued to insure timely integration of this system in Air Force operational inventory. (S)

5. The following actions will be taken by the appropriate Air Staff agency which are consistent with the established SAMOS management procedures and policy outlined above. (U)

a. SAMOS for the time being will not be included in the Program Documents (example: PG, PD) described in AFM 27-1. (U)

b. SAMOS project information will be furnished as necessary for legislative matters and for the Chief of Staff Policy Book by the Director of the Office of Missile and Satellite Systems. (U)

c. The Director of the Office of Missile and Satellite Systems will keep the key elements of the Air Staff and the commands informed, as necessary, regarding this program. Normal monitoring by the Weapons Board system is unnecessary, and no reviews or analyses will be undertaken by the various groups, panels, boards and committees. (U)

d. Documents reflecting Air Force requirements for reconnaissance will continue to be preapred and should be forwarded through normal channels to the USIB for consideration in SAMOS project requirements. (S)

e. The SAMOS Working Group will be dissolved. (U)

f. Air Force Regulation 375 series will not apply to this program. (U)

R. M. Montgomery

R. M. MONTGOMERY
Major General, U. S. Air Force
Assistant Vice Chief of Staff

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~~SECRET~~

~~TOP SECRET~~
SPECIAL HANDLING

SAMOS

The Under Secretary of the Air Force has been delegated responsibility for the SAMOS project. The SAMOS project consists of both overt and covert programs. The overt projects are numbered, the covert projects are given code word names.

The Secretary has established a field extension of his office located with the Air Force Space Systems Division at El Segundo, California, under the Director of Special Projects. The Director of Special Projects also serves, as additional duty, as Vice Commander, Air Force Space Systems Division, AFSC. He also has a small special staff in the Pentagon under the Director, Office of Missile and Satellite Systems. Other project staffing and support is provided by the Air Force Systems Command.

The programs and their purposes are as follows:

I. OVERT

a. Program 101 B - Atlas/Agena vehicle with E-5 photographic payload.

b. Program 102 - Thor/Agena vehicle with digital and analogue ferret payloads.

c. Program 201 - Atlas/Agena with E-6 photographic payload.

d. Program 202 - Design study of maneuverable re-entry vehicle.

II. COVERT

a. GAMBIT - Atlas/Agena with high acuity photographic payload.

[redacted]

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Page 2 of 6 pages
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~~TOP SECRET~~
SPECIAL HANDLING

NRO APPROVED FOR
RELEASE 17 September 2011

SPECIAL HANDLING

SAMOS (continued)

Technical Management

Technical management of all SAMOS programs is the responsibility of the Under Secretary with delegation to the Director of Special Projects and to the program directors.

The contractor structure varies with each program:

101 B - Lockheed is the prime contractor and does the SETD. Itek builds the payload as a subcontractor.

102 - Lockheed is the prime contractor and does the SETD. Airborne Instrument Laboratories builds the payloads as a subcontractor.

201 - General Electric, Eastman Kodak, and Lockheed are associate contractors for the payload vehicle, the payload, and the orbiting vehicle respectively. Aerospace Corporation does the SETD.

202 - Martin is the design contractor. Aerospace does the SETD.

GAMBIT - The overt aspects of this operation previously have been covered by 201. However, a new cover project is being established which will show a program office structure in the Space Systems Division. This program will overtly report to the Director under his additional duty as Vice Commander, Air Force Space Systems Division, AFSC. The contract structure is the same as 201.

[redacted]

Financial Management

The financial management of the project is by the Under Secretary. He has an individual in the Headquarters USAF, Directorate of Budget, to assist him. Overt contracting is handled by AF SSD. Covert contracting is done directly by the Director of Special Projects under a special delegation of authority. Covert administrative contracting officers are stationed with the major covert contractors.

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SPECIAL HANDLING

SPECIAL HANDLING

SAMOS (continued)

Operational Management

The operational target programming function is done at the Satellite Test Center based on COMAR target priority lists. All operational and engineering decisions are made by the Director of Special Projects or his delegate.

Security

The security of the overt projects is handled in accordance with DOD and Air Force security procedures with determination of need-to-know reserved to the Under Secretary. This has resulted in an extremely tight security system for the project. Covert security is handled within the project with code word security procedures and clearance standards higher than TOP SECRET standards.

The major portion of all project communications are on a private TWX system. Normal Air Force and other channels are used infrequently and only when absolutely necessary to pass information to other agencies on overt projects. All covert communications are handled by a small group within the project.

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Page 4 of 6 pages
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SPECIAL HANDLING

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DEPARTMENT OF THE AIR FORCE
SAMOS PROJECT OFFICE
Air Force Unit Post Office, Los Angeles 45, California

REPLY TO ATTN OF: SAFSP-X/LtCol [redacted]/3575

SUBJECT: Security Guidance of An Unclassified Nature Relating to SAMOS

TO: All SAFSP and LBX Personnel

1. There has been some misunderstanding as to the general classification of SAMOS information. To alleviate some of the misconceptions, I have attached to this memorandum the SAMOS Fact Sheet that is used in Public Affairs Plan for SAMOS Satellites.

2. The only unclassified information available on the purpose of SAMOS is:

"The SAMOS Project is a Research and Development Program to determine the capabilities for making observations of space, the atmosphere and the globe from a satellite."

This definition of the purpose of SAMOS will be used for all unclassified discussions; and will also be used, wherever possible, in classified briefings.

Harry L. Evans

HARRY L. EVANS
Colonel, USAF
Vice Director
SAMOS Project

SAMOS II FACT SHEET

I. GENERAL INFORMATION

Project SAMOS is a research and development program to determine the capabilities for making observations of space, the atmosphere and the nature of the globe from satellites. The program is under the executive management of the Secretary of the Air Force.

II. TEST OBJECTIVE

SAMOS II was launched into the Pacific Missile Range from an Air Force launch pad at the Naval Missile Facility, Point Arguello, California, to place the vehicle in a near circular polar orbit. The purpose of the research and development SAMOS flights is component testing bearing on the engineering feasibility of obtaining an observation capability from an orbiting satellite.

III. CONFIGURATION

SAMOS employs the AGENA as its second stage. It is boosted out of the atmosphere by a modified Air Force ATLAS, and placed into orbit by the AGENA.

First Stage

Booster: An Air Force ATLAS modified for the SAMOS II.

Height: Approximately 77 feet. (With adapter section).

Launch Weight: Approximately 262,000 pounds.

Propulsion: Rocketdyne liquid propellant engine. 356,000 pounds thrust.

Guidance and Control: The ATLAS booster is equipped with the GE/Burroughs radio command guidance system. The guidance system can detect position and rate, compare this information with the predetermined projectory data and command flight correction.

Satellite Vehicle

The entire Lockheed AGENA second stage becomes the orbiting satellite vehicle.

Height: About 22 feet.

Weight: Approximately 11,000 pounds at launch. Orbital weight after fuel exhaustion will be approximately 4,100 pounds.

Propulsion: Following coast period after ATLAS Burnout, a Bell liquid fuel rocket engine, developing 15,000 pounds of thrust, will propel the second stage into orbit.

Instrument Package: Test photographic and related equipment.

IV. TRACKING, TELEMETRY AND COMMAND

a. Primary tracking, telemetry and command during orbit will be performed by:

Vandenberg Tracking Station, Vandenberg AFB, California

Hawaiian Tracking Station, Kaena, Oahu, Hawaii

Kodiak Tracking Station, Kodiak, Alaska

b. Ascent Guidance (booster)

GE MOD II, Vandenberg AFB, California

c. Ascent Tracking and Telemetry

Vandenberg Tracking Station, Vandenberg, California

d. Downrange Telemetry and Tracking Ship

Pvt. Joe E. Mann

e. Ascent Radar and/or Optical Tracking (PMR)

Point Arguello, California

Point Mugu, California

St. Nicholas Island, California

f. USAF Satellite Test Center, Sunnyvale, California

(Control Center receiving all orbital data and exercising command control of SAMOS)

Address reply to:
M. E. Anderson
P.O. Box 1071
Rochester 3, New York

The Honorable Joseph V. Charyk
Assistant Secretary of the Air Force,
Research and Development
The Pentagon
Washington 25, D.C.

Dear Doctor Charyk:

Doctors E. H. Land and H. Waters have told us of your interest in receiving and reviewing our "Technical Proposal for Recoverable Reconnaissance System" dated 17 June 1960. We are pleased to be able to transmit Copy No. 8 for your attention. This proposal includes a considerable amount of information which is of a proprietary nature; therefore, its contents should be treated in a manner commensurate with this condition. The name by which this particular camera system is known to the very few people in our organization who have knowledge of its existence is "Blanket".

On the assumption that you will have interest in a camera design which yields finer ground resolution, we are including data regarding a system known to us as "Sunset Strip". Its characteristics are listed on a separate sheet.

If it is your opinion that either or both of these reconnaissance systems would be of value to the Air Force we would be pleased to discuss with you or your representative the appropriate details of the research and development and fabrication of the equipments and submit for your consideration our estimates of the time of delivery and the cost of such work.

Should you have questions regarding this information or want additional information, you may get in touch with me by calling COgress 6-2049, Rochester, N.Y., or by the post office box indicated above with an inner envelope addressed to me personally. If you are unable to reach me, please contact Mr. J. L. Boon, LOcust 2-8573, Rochester, N.Y.

Yours very truly,

Arthur B. Simmons

Arthur B. Simmons

ABS:aku
Enclosures

SC 400088 13-2 5-106

July 1, 1960

SIMULATIONS OF GROUND RESOLUTIONS

The attached transparencies in stereo pairs have been prepared from actual aerial negatives having a scale reduction of 22,000 to 1 and a ground resolution in the region of [redacted] feet. The various "degradations" which represent several steps of poorer ground resolutions have been made by various degrees of "out-of-contact" contact printing. In each case resolution charts were used as guides to determine the maximum resolution possible which could be printed with clear film base in between the charts and the raw stock to create the desired out-of-focus condition. It is felt that this method of simulation will give examples which are only slightly poorer than would be obtained by the photography they represent.

JLBoon:aku

Preliminary Schedules
for Blanket and Sunset Strip

The equipment visualized herein and on which the attached schedule is predicated, is not only complex within itself but poses complex interface problems requiring extensive coordination with other contractors. Such coordination largely must precede any detail design and engineering work. We anticipate that we would perform as much as possible of this coordination, team organization, etc., prior to formalization of the contract.

As discussed elsewhere, we believe that a modification of the normal organizational concept is necessary if such a schedule is to be feasible.

July 22, 1960

#11

NRO APPROVED FOR
RELEASE 17 September 2011

Address reply to:

M. E. Anderson
Post Office Box 1071
Rochester 3, New York
July 22, 1960

The Honorable Joseph V. Charyk
Under Secretary of the Air Force
The Pentagon
Washington 25, D. C.

Dear Dr. Charyk:

As we agreed in your office on July 5, I am hand carrying to you further and more complete information on several of the items that we discussed at that time. We have prepared more accurate examples of the output photography for E-1 and E-2 of the Samos project and for the Blanket and Sunset Strip proposals. There are two sets of these simulations. One of them shows the expected end results with the scale factor relatively correct for the four systems. The other shows the expected results with a varying scale factor such that the image size is held constant. These examples were prepared using more accurate photographic techniques than for those that I left with you. They more closely simulate the expected photography, and I would suggest that you destroy the original set in favor of these now being delivered. All of the above examples are of a scene at Edwards Air Force Base. Inasmuch as the E-1 Samos program does not include stereo capability, the examples of E-1 are not in stereo, although there are duplicates of the same frame so that the view can be seen with both eyes.

For your further information we have also enclosed certain other examples of the expected output of both the E-1 and E-2 Samos projects which we will describe to you verbally.

You may recall that I was quite conservative in my statements in regard to the Sunset Strip proposal at the time of our meeting because we had not had the proper amount of time to be really sure of our predictions. Since then our people have more carefully studied the possibilities of this system, and we have assured ourselves that the concept is indeed technically possible as described in Technical Proposal for Recoverable Reconnaissance System, Volume II, Copy #1 which is enclosed.

Dr. Charyk -2- July 22, 1960

We have also attached to this letter budgetary estimates of cost and delivery for both the Blanket and Sunset Strip projects. As we discussed, we have premised these on certain modifications of normal Air Force procurement and management practices. We are prepared to discuss the details of this with you in your office.

We have also rearranged and assembled data comparing certain characteristics of several current reconnaissance projects including those of Blanket and Sunset Strip. You may recall that I showed you a rough copy of some of this information during my visit with you. If, after we have described it to you, you wish a copy, we are prepared to leave it with you.

Very truly yours,

Arthur B. Simmons

Arthur B. Simmons

ABS/MDG
Enclosures

NRO APPROVED FOR
RELEASE 17 September 2011

Preliminary Schedule

25 July 1960

		CY 1960												CY 1961												CY 1962												CY					
								FY												FY												FY											
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J
1	Months after authorization								1		3			6			9			12			15			18			21			24			27			30			33		
2																																											
3	PROJECT BLANKET																																										
4																																											
5	Preliminary Contractor Coordi-								X	X	X																																
6	nation																																										
7	Mock-Up Model:																																										
8	Structural																				1																						
9																																											
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11	Deliver to EK																							1																			
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13	Flight Test Models:																																										
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NOTE: The quantities shown are only suggested values and have been assumed for the purpose of a preliminary budgetary estimate.

SUGGESTED
ORGANIZATION
FOR A
SATELLITE SYSTEM

Satellite Systems are most complex undertakings - perhaps the most complex that man has seriously contemplated at the present time. With the exception of systems for purely scientific purposes, the urgency is such that all must be entered upon on a crash basis.

The Systems Manager-Prime Contractor-Sub method of organizing a program has certain disadvantages that are reasonably obvious and hence will not be discussed here. For those interested, a more detailed examination of such concepts is attached.

It is the purpose of this paper to propose an organizational concept which, it is hoped, avoids the deficiencies of the Systems Manager-Prime-Sub organization while utilizing the advantages. At least one crash program was carried to a successful completion on schedule by such an unconventional approach. This is the "team" concept of contractors in which the providers of important assemblies or subassemblies are so imbued with the imperative need for a successful program that they work together to solve their and each others problems and prevent interface interferences so that there is no need to establish one as "boss" or "prime". This is not to imply that each supplier of a nut or a bolt is a "prime" contractor. We envision three to six "associates" on the team each of whom is primarily responsible for an essential assembly or group of assemblies. These, in turn, can be relied on to pick subcontractors and suppliers in their field to provide the necessary components for their assemblies.

We envision the entire operation headed by a Project Director. This would be a very senior individual from the Government or on loan from Industry with broad managerial experience and a background of vision and success. His caliber must be sufficient to justify the confidence placed in him by the Secretary and the President.

A Coordinating Committee composed of a senior member of the Management of each contractor or associate should be formed to assist the Project Director to establish broad policies and coordinate intercompany relationships. They would adjudicate such infrequent clashes as might be expected occasionally from a group of dedicated people. Such a committee would operate both as a whole and by parts as required by specific problems.

Reporting directly to the Project Director would be a Project Control Group composed as necessary or desired of Civil Service, Military or of Civilians on loan from Industry. This

-2-

group would not necessarily attempt to provide technical guidance - in fact, it might be better if they did not. They would, however, provide contractual, legal, security, materiel and administrative advice and control. They would act as liaison in obtaining information on the status and problems of the program and would keep the Project Director knowledgeable so that he, in turn, could keep the President and others informed through such channels as may be set up.

In addition to the associated contractors, another "associate" would be a team from the Military. This group would provide liaison with the Services, spell out operational needs, perform operational planning, arrange for such service personnel or facilities as may be required such as those to fire, track and recover.

Another team would be provided by the group or groups designated to exploit the information expected from the satellite system and who would be expected to provide the final product - intelligence.

Still another group that might be considered as part of the team is an organization already provided with the background material and studies to provide data without the need for individual team members recompiling it. Such an organization might come from one of the "Systems Manager (Non Profit)" type but would be used as consultants rather than in a managerial capacity.

Free communication on technical matters should be encouraged at all levels among members having mutual interests or interface problems. In addition, it is desirable to have liaison personnel resident at each company to provide contact in both directions, follow up on interface problems, etc.

It is believed that such an organization with the responsibility and authority to work toward an objective rather than to a set of established rules or restrictive and possibly unworkable specifications will encourage the best application of efforts and will result in the maximum accomplishment in the least time.

July 22, 1960

Advantages and Disadvantages
of Systems Manager-Prime-Sub
Organizations

The organizational concept of a prime contractor together with other manufacturers or suppliers as subcontractors has certain disadvantages. The prime contractor is most often selected on the basis of ratio of expenditures. This implies, and rightly, that his share of the undertaking is complex and requires unique or profound knowledge in his field. Nevertheless, there are other facets of the system which can be equally or more complex and which are essential to successful performance but which may cost only a few percent of the total cost of a system.

Furthermore, the skills and talents required for the production of successful components of a system very often require the giants of their respective industries. To subordinate one giant to another may not achieve cooperation on the part of the management of the subordinated company.

Where a crash program is involved, there is a tendency for a prime contractor to require unrealistic schedules on the part of his subs in order to make certain that all of the assemblies or subassemblies are available to him well in advance of the actual need for them. It can be argued that prime contractors require this extra lead time to make certain all items mate and that performance is as specified or required. But how much of this can be charged to lack of ability or to lack of performance on the part of the subcontractor, and how much to being penalized by inadequate instructions or supervision from the prime contractor? A satellite system is somewhat the reverse of the one horse shay - it should go together all at once.

Another weak point in the prime-sub relationship is that the prime may provide the only communication link between the customer and the sub. This can result in erroneous interpretation of what he is to do by the sub and an equally erroneous impression of what he is to receive on the part of the customer. In an effort to bridge this gap, the prime gathers into his fold various "experts" in the fields of his subcontractors. These experts usually do not have as much knowledge of the specialized fields of the subs they are "directing" in the name of the prime. We repeat - a satellite system is a most complex undertaking.

Normally, there is added to the prime-sub relationship a "Systems Manager". This Systems Manager is all things to all people. He represents the customer to the prime and the prime to the customer. He controls, audits, contracts, schedules, investigates, explains and fixes blame but mostly he produces paper work or, and worse, he requires paper work from others. Because he must be omnipotent, the Systems Manager must collect a complete staff of "experts" in all fields related to the system under consideration. These, of course, are in addition to the corps of report writers, report readers and the like that are necessary to support the Systems Manager concept. Some of these concerns have, without question, accumulated enormous amounts of technical data bearing on broad aspects of the problem and providing extensive background valuable in analysis of the problems. But satellite systems are composed of screws that stay tight, motors that run, relays that operate and interfaces that mate. The problems can be solved only by contractors, although they can be greatly assisted by data on such things as environment.

The Systems Manager concept can be provided in three ways:

1. Utilizing the prime as a systems manager.

2. Utilizing a service organization.

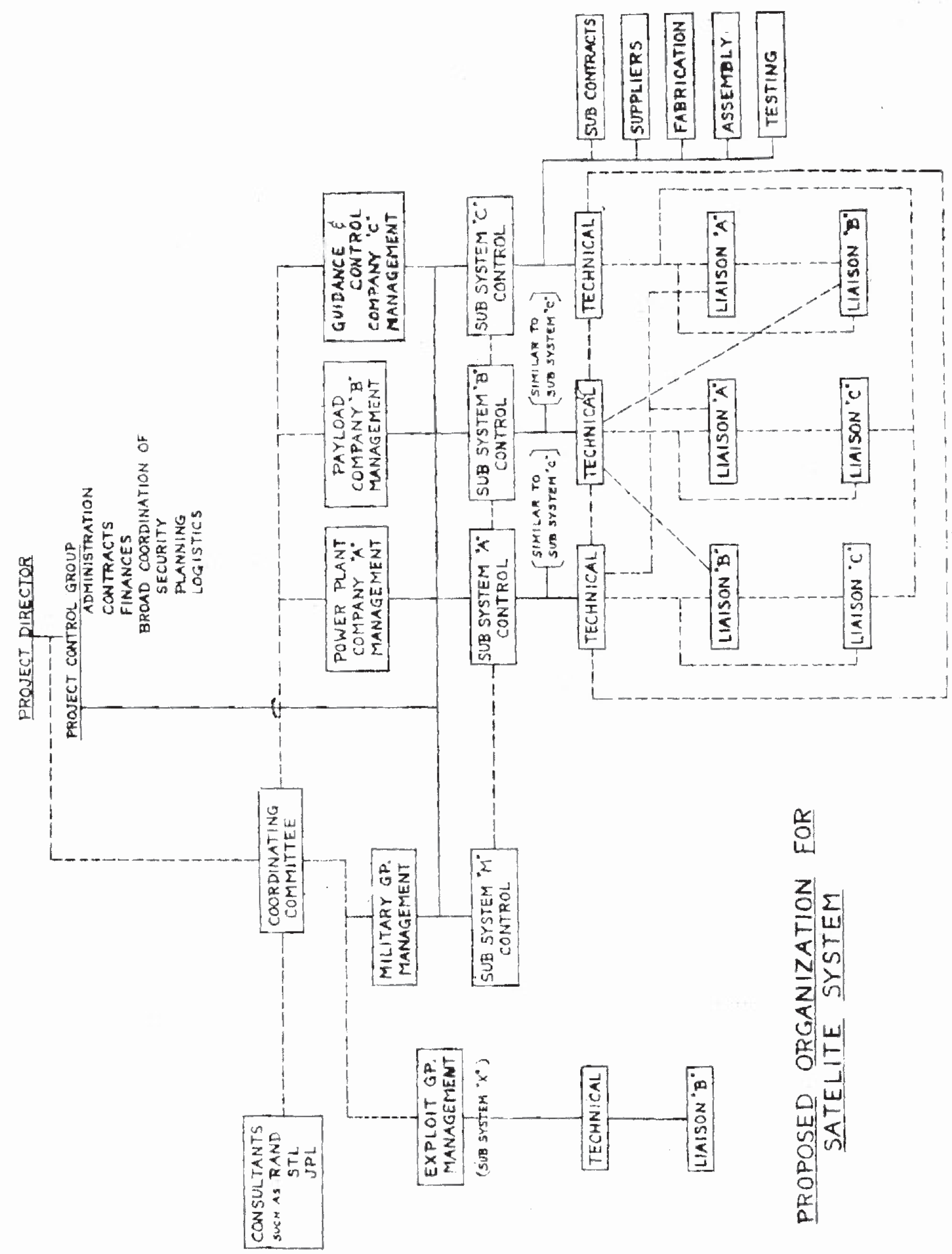
3. Utilizing a "non-profit" concern.

Utilizing the prime contractor as a Systems Manager may be hazardous because it gives the same man or men two hats to wear. He is at the same time a public servant and a member of a profit making organization. He is too close to one set of explanations and too far from another. There is the further danger that, in endeavoring to fill two jobs, his talents may be spread too thin to be successful at either.

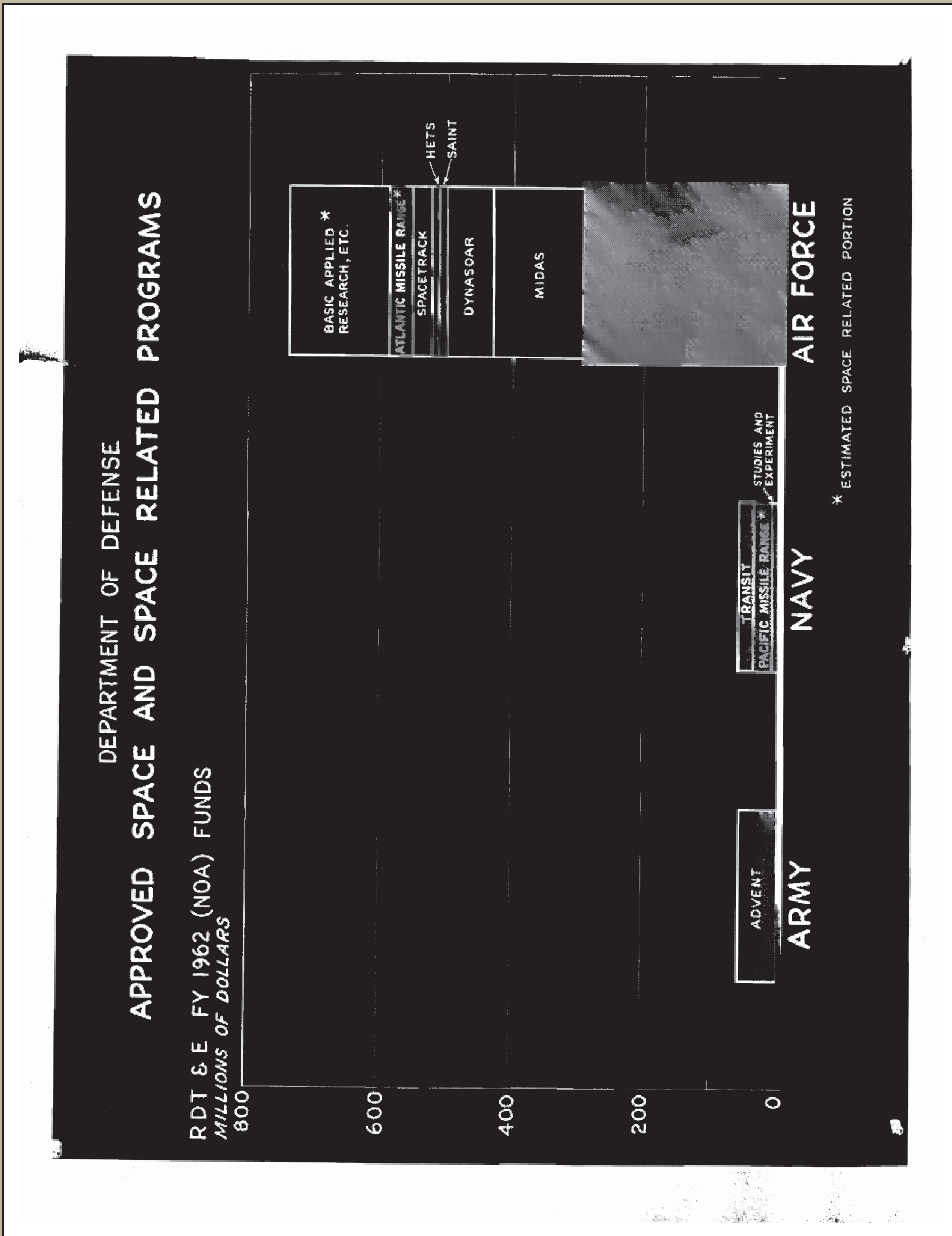
A service organization acting as Systems Manager has an even more difficult role to fill and, usually, with less talent. Since the ultimate customer of a satellite system is normally one of the Services - the Air Force - a Systems Manager from the Service could reasonably be expected to know the customer's needs and requirements. He may also have an exceptional array of talent in the field most open to him - the engine. But the Service Organization cannot have nor hope to have the required technical skills for understanding and controlling all of the many technical minutiae required in a system. As a result there may be a tendency to solve by edict or sheer weight of manpower or money, problems which will bow only to technical competence or to tedious trial, experimentation and development. There may be an impatience which evolves an unrealistic schedule. A crash program with an unrealistic schedule will crash.

The third approach, that of a non-profit organization serving as Systems Manager, has the least to condemn it. This is true particularly if the concern is of reasonably long standing and has accumulated a background of data on what has happened, what environments can be expected and has studied the past attempts or failures for their lessons. But in the final analysis what can they be expected to contribute except this guidance information that cannot come equally as well or better from specialist contractors?

July 22, 1960



PROPOSED ORGANIZATION FOR SATELLITE SYSTEM


DEPARTMENT OF DEFENSE
APPROVED SPACE AND SPACE RELATED PROGRAMS
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BASIC APPLIED RESEARCH, ETC. *
ATLANTIC MISSILE RANGE *
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P[illegible] BALL

November 1961

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SPACE SYSTEMS DIVISION

AIR FORCE SYSTEMS COMMAND

9 November 1961

FOREWORD

This Outline Development Plan presents the elements of Project CUE BALL which is AFSC support for a classified priority Space Program. This document has been prepared in response to Hq USAF Secret Message AFCVC 54852, 25 September 1961. Achievement of the tasks outlined in this plan will meet initial requirements for a program of space launches, satellite control, and re-entry operations.

The directed phase of this effort includes four shots at sixty-day intervals. An alternate program of ten shots at forty-day intervals is also presented in order to provide more adequate demonstration of CUE BALL performance and reliability.

This document further describes the technical tasks, management approach, schedule of activities, and resources required to accomplish the proposed programs.

O. J. Ritland

O. J. RITLAND
Major General, USAF
Commander

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PART I - PROGRAM SUMMARY

1.0 BACKGROUND INFORMATION

a. Project CUE BALL has been established by Hq USAF to carry out AFSC support for a classified Space Program. (See Annex A, "Hq USAF Program Message"). Space Systems Division, AFSC, has been assigned responsibility for Project CUE BALL which includes boosters, satellite vehicles, and associated services for launch, on-orbit control, and re-entry operations.

b. In accordance with current policy, information on Project CUE BALL will be supplied on a strict need-to-know basis. Therefore, technical information has been minimized in this outline development and funding plan.

c. The presently directed program for Project CUE BALL, referenced herein as the Program A, consists of four launches from PMR at 60-day intervals beginning in February 1963. However, the level of confidence of success associated with Program A is low. Therefore, an alternate Program B of ten launches at 40-day intervals is also presented using the same starting date.

d. Project CUE BALL has potentially serious problems with hardware and facilities lead time. These are discussed in appropriate detail in various sections of this document.

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1.1 APPROACH

a. Program Concepts.

Project CUE BALL includes system engineering, procurement, and test operations.

(1) The principal engineering problems concern the definition and integration of a suitable satellite vehicle within the very stringent time schedule.

(2) In order to meet procurement schedules, maximum use is being made of existing hardware, facilities, and support equipment.

(3) Maximum assurance of mission success in the operational test phases will be achieved through use of existing launch and on-orbit tracking and control sites and stations.

b. Mission Concept

(1) A two-stage Atlas/Agena booster configuration will provide primary propulsive power to launch and inject the satellite vehicle into the selected orbit.

(2) After separation of the boosters, the satellite vehicle maintains orientation and attitude using internal controls. The principal on-orbit requirement is for the satellite to be responsive to ground based commands in order that accurate de-boost and re-entry can be effected at any point along the trajectory.

(3) The re-entry operation is still under study.

1.2 PROGRAM SCOPE

a. Number of Flights - The testing organization has planned three mission configurations, each with an identical vehicle interface.

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One successful flight with each configuration is required to demonstrate the required system versatility. It is assumed that the urgency of Project CUE BALL warrants at least 90% confidence that three flights will be successful.

Figure I - 1 shows that the proper number of shots (r) is a function of the probability of success of a single shot (p). For Category I tests of the multi-stage CUE BALL System, a maximum value of (p=.5) seems appropriate. Therefore, a ten-shot launch series, the so-called Program B, has also been exercised and presented.

b. Program Tasks - The principal tasks and responsible organizations for Project CUE BALL are:

(1) Overall program management: Hq SSD SPO (SSZX)

(2) General system engineering and technical direction: Aerospace Corporation.

(3) Satellite control engineering and technical direction: Hq SSD (SSZC)

(4) Atlas Booster: General Dynamics/Astronautics.

(5) Agena Booster: Lockheed Missile and Space Company.

(6) Satellite Vehicle: (Associate to be selected).

(7) National range support: Pacific Missile Range.

(8) Launch operation: 6565th Test Wg (VAFB)

(9) On-orbit operation: 6594th Test Wg (Sunnyvale)

(10) Re-entry operation: (To be determined).

(11) Launch site facilities: Vandenberg AFB.

(12) Up-Range TT&C station facilities: (Under study)

(13) Impact Range facilities: (Under study)

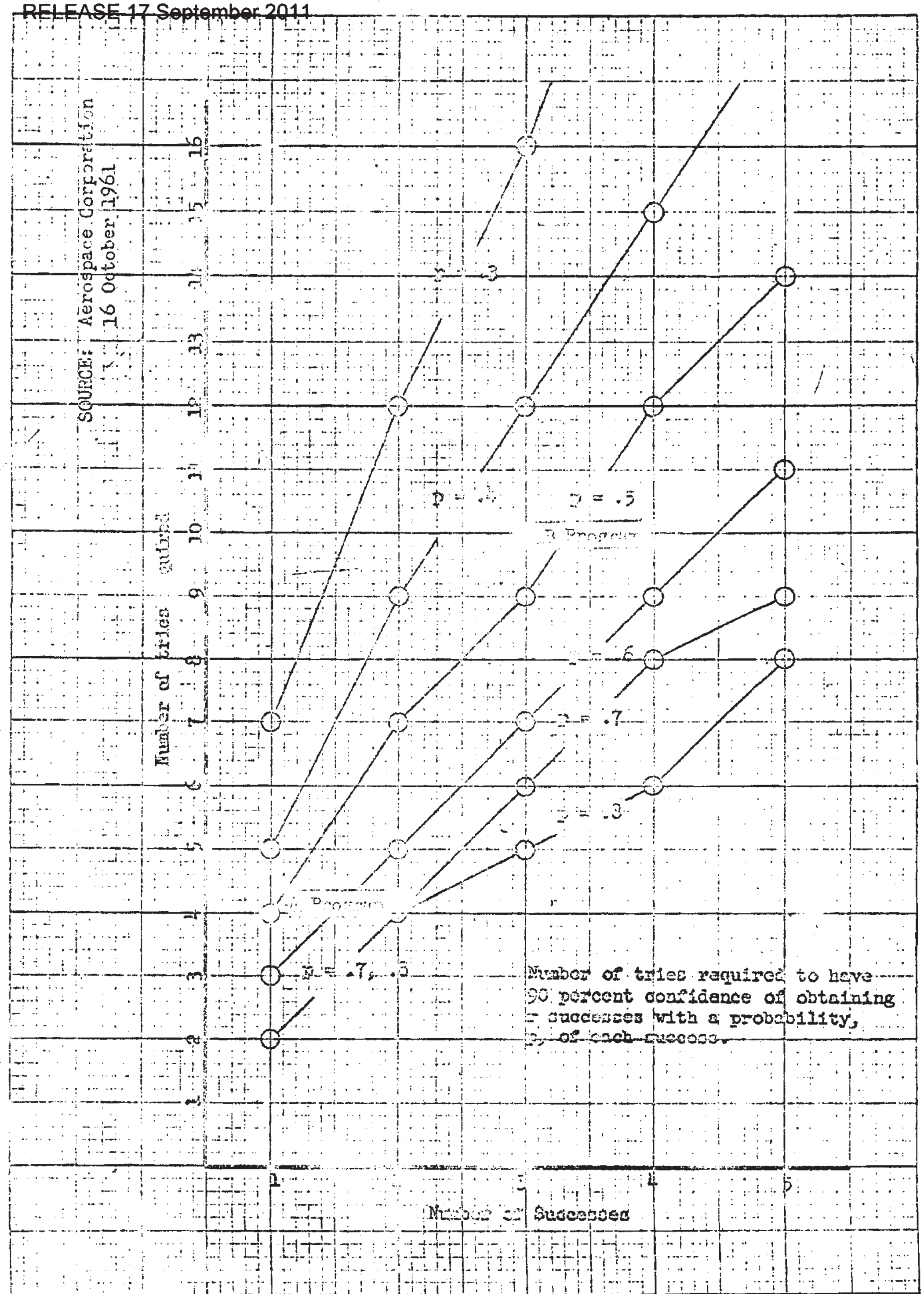

FIGURE I - 1

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PART II - PROGRAM MANAGEMENT

2.0 SUMMARY

a. CUE BALL SPO. The CUE BALL SPO, Space Systems Division (SSD), AFSC, is the responsible management agency for Project CUE BALL. This responsibility includes the preparation of development, funding, and testing plans, and the direction of engineering, production, and field operations of the CUE BALL program, as approved by higher authority. The SPO will establish and maintain overall milestones and schedules (See Section III), make interpretations as required, and coordinate the participation of non-Air Force support agencies. SPO organization and manning requirements are included in Annex B.

b. Contractors. Definitive contracts will be negotiated by SSD for specific portions of the CUE BALL System effort. This will include Associates for:

- General Systems Engineering and Technical Direction (GSE&TD)
- First Stage Booster (ATLAS)
- Second Stage Booster (AGENA)
- Satellite Vehicle (To be determined)

Each Associate will be responsible to the SPO for the necessary planning and programming required to carry out his portion of the effort. This will include task definition, management organization, interior schedules, and subcontracted responsibilities.

c. AFSC Support. The SPO will define, coordinate, integrate, and establish priorities for the participation required of all USAF agencies.

It is anticipated that AFSC organizations will provide the principal support required for launch, on-orbit, and re-entry operation.

2.1 MANAGEMENT RELATIONSHIPS.

The Director, CUE BALL SPO, is responsible for overall direction of USAF elements. Management relationships of participating organizations are indicated in Figure II-1.

2.2 CONTRACTOR STATUS. (As of 1 November) A class D & F pursuant to 10 U.S.C. 2304(a)(11) to negotiate CUE BALL contracts is needed immediately to initiate the following procurements:

a. Aerospace Corporation(GSE&TD). New funding is required immediately so that SSD can contract with Aerospace Corporation for the establishment of a CUE BALL Program Office. The proposed build-up of Aerospace support (in MTS - Members of the Technical Staff) is as follows:

Month	Nov 61	Dec 61	Jan 62	Feb 62	Mar 62
Total MTS	[redacted]				

b. General Dynamics/Astronautics (ATLAS). Six ATLAS first stage boosters were placed on order by SSD using reimbursable funds. This has protected Program A lead times and covered Program B through December 1961. Initial CUE BALL funding is required immediately to pay for these six boosters. Additional funding for four more ATLAS boosters will be required if the ten-shot Program B is approved.

c. Lockheed Missile and Space Co. (AGENA). Four AGENA vehicles have been ordered for CUE BALL using reimbursable funds. This has protected Program A lead times and covered Program B through December 1961. Initial FY62 funding is required immediately to pay for these AGENAs.

MANAGEMENT RELATIONSHIPS: Project CUE BALL.

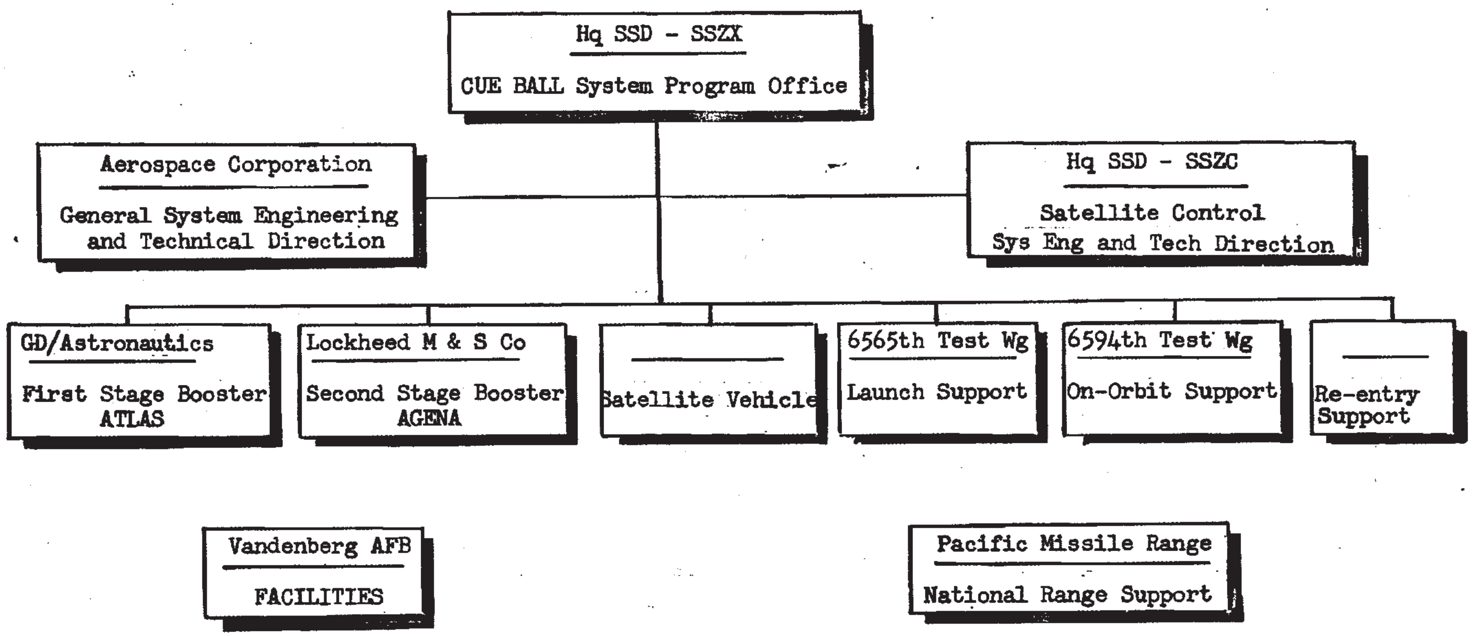

FIGURE II - 1

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Additional FY62 funds for six more AGENAs will be required for Program B.

d. Contractor for Satellite Vehicle.

(1) Design Study. A study is being completed by SSD/Aerospace to define the design requirements of the Satellite Vehicle. Availability, performance, and reliability are primary criteria for this effort which will provide procurement data in November 1961.

(2) Contractor Selection. Immediate funding is required to permit solicitation and evaluation of proposals for the Satellite Vehicle. Source Selection and initiation of contractual coverage in December 1961 is mandatory to maintain CUE BALL launch dates.

2.3 TEST SUPPORT STATUS

a. Range Support. A support commitment has been obtained from the Commander, PMR, for either Program A or B of CUE BALL. No CUE BALL funding is required by PMR.

b. Launch Support. The 6565th Development Test Wing will provide launch support for both CUE BALL programs within presently programmed funding.

c. On-Orbit Support. The 6594th Satellite Test Wing will provide on-orbit support (telemetry, tracking, and control) for both CUE BALL programs. Funding estimates are shown on pages V - 2 and V - 3.

d. Re-entry Support.

SSD/Aerospace Study. During October, a study of CUE BALL re-entry operations was initiated within SSD/Aerospace. This study will define facilities, sites, and forces necessary to support the CUE BALL mission. Definitive results (including lead times, funding requirements, and equipment) are expected in December 1961.

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3.0 BASIC LAUNCH SCHEDULES

a. Definitions -- This section presents procurement and launch schedules for two programs:

(1) "Program A" is the four-shot/sixty-day interval effort directed by Hq USAF. The vehicles associated with this program are identified by the "-A" suffix, e.g., 1-A, 2-A, etc.

(2) "Program B" is the ten-shot/forty-day interval effort recommended for Project CUE BALL by AFSC. The vehicles associated with this program are identified by the "-B" suffix, e.g., 1-B, 2-B, etc.

b. Launch Schedules.

Launch Dates	Program A	Program B
1 February1963	#1-A	#1-B
2 April 1963	#2-A	#2-B
12 May 1963		#3-B
2 June 1963	#3-A	
21 June 1963		#4-B
31 July 1963	#4-A	#5-B
9 September 1963		#6-B
19 October 1963		#7-B
28 November 1963		#8-B
7 January 1964		#9-B
16 February 1964		#10-B

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3.1 PROCUREMENT LEAD TIMES

a. Definitions - Normal procurement lead times for the principal hardware elements of Project CUE BALL are:

- o ATLAS 1st Stage Booster: 21 months
- o AGENA 2nd Stage Booster: 18 months
- o SATELLITE VEHICLES: 15 months (approx)

These times are based on the interval from initial contractual coverage to completion of launch operations. Under premium overtime conditions, these lead times can be reduced; they can also be cut back by pre-empting similar hardware already under procurement for other, low priority programs. In order to minimize such undesirable measures, Project CUE BALL funding should be made available at the earliest possible time.

b. Interim SSD Actions

(1) Aerospace Studies. Action has been taken under an existing SSD/Aerospace support contract to conduct urgent CUE BALL studies at a level of 10 MTS (Members of the Technical Staff) man-months during October/November 1961.

(2) GSE&TD. Aerospace GSE&TD support cannot be provided without new funds and new contractual coverage.

(3) ATLAS. Six ATLAS vehicles have been placed on order by SSD using reimbursable funds.

(4) AGENA. Four AGENA vehicles have been placed on order by SSD using reimbursable funds.

(5) SATELLITE VEHICLE. SSD/Aerospace studies are in progress in order to develop procurement data (vehicle specifications and a technical statement of work) during November 1961.

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c. Procurement Lead Time - The desirable procurement schedule for the various CUE BALL vehicles, using the launch schedules and normal procurement lead times (paragraphs 3.0.b and 3.1.a, respectively) are approximately as follows:

LAUNCH NUMBER	BUY ATLAS	BUY AGENA	BUY SATELLITE VEHICLE
#1-A/1-B	Six ATLAS Boosters on order - Normal lead times protected using reimbursable funds	Four AGENA Boosters on order - Normal lead times protected using reimbursable funds	1 Nov1961
#2-A/2-B			2 Jan 1962
#3-B			12 Feb 1962
#3-A			2 Mar 1962
#4-B			21 Mar 1962
#4-A			30 April 1962
#5-B		31 Jan 1962	30 Apr 1962
#6-B		9 Mar 62	9 Jun 1962
#7-B	19 Jan 1962	19 Apr 1962	19 Jul 1962
#8-B	28 Feb 1962	28 May 1962	28 Aug 1962
#9-B	7 Apr 1962	7 Jul 1962	7 Oct 1962
#10-B	16 May 1962	16 Aug 1962	16 Nov 1962

d. Funding Requirements.

(1) Program A. Immediate funding requirements (through 31 March 1962) were forwarded to Hq AFSC by SSD Secret Message SSZX-26-10-1, 26 October 1961. Estimated FY62 requirements are summarized in Part V, Fund Estimate.

(2) Program B. Estimated FY62 requirements are summarized in Part V, Fund Estimate.

3.2 LAUNCH PROGRAM

a. Test Support Plans - Support by Pacific Missile Range, 6565th Development Test Wing, and 6594th Satellite Test Wing has been scheduled.

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The principal gap in the test program is definition of the re-entry operation. An SSD/Aerospace study of the re-entry phase will be complete late in November 1961.

b. MAB Facility. CUE BALL schedules require the assignment of space in MAB-3 at Vandenberg AFB about 1 August 1962. All modification of the facility and checkout of associated equipment must be completed so that CUE BALL MAB operations can begin on 1 November 1962. MAB-3 is presently occupied by other programs. This situation is now under study to determine the cost and extent of the adjustments required.

3.3 MASTER SCHEDULES.

Figures III-1 and III-2 summarize the schedules of Programs A and B for CUE BALL, respectively.

NRO APPROVED FOR
RELEASE 17 September 2011

PROGRAM S[illegible]DULE C.Y.I.O.

Project CUE BALL

FY 1962 | FY 1963 | FY 1964 | FY
CY61 | CY 62 | CY 63 | CY | CY

A PROGRAM

1 PROGRAM INITIATION
2 USAF Program Message
3 System Project Office Established
4 Outline Development Plan
5 USAF Program Directive
6
7 PROCUREMENT PROGRAM
8 GSE & TD (Aerospace Corp)
9 FY62 Funds (Initial and Final Release)
10 Contract Coverage
11 ATLAS (General Dynamics/Astronautics)
12 FY62 Funds (Initial and Final Release)
13 Contract Coverage
14 Vehicle Delivery at VAFB
15 AGENA (Lockheed Missile and Space Co)
16 FY62 Funds (Initial and Final Release)
17 Contract Coverage
18 Vehicle Delivery at VAFB
19 SATELLITE VEHICLE (Source to be Selected)
20 Procurement Data (SSD/Aerospace Study)
21 Source Determination
22 FY62 Funds (Initial and Final Release)
23 Contract Coverage
24 Vehicle Delivery at VAFB
25
26 LAUNCH PROGRAM
27 LAUNCH SCHEDULE
28 TEST SUPPORT PLANS
29 Range Support (PMR)
30 Launch Support (6565th Test Wg)
31 On-Orbit Support (6594th Test Wg)
32 Re-Entry Support (Orgn to be selected)
33 FACILITIES
34 MAB #3 (Space Assigned)
35 (Modification and Checkout)
36 (CUE BALL Operations)
37 Up-Range Tracking Station
38 (SSD/Aerospace Study Completed)
39 Re-entry Operations
40 (SSD/Aerospace Study Completed)

SDZK-1
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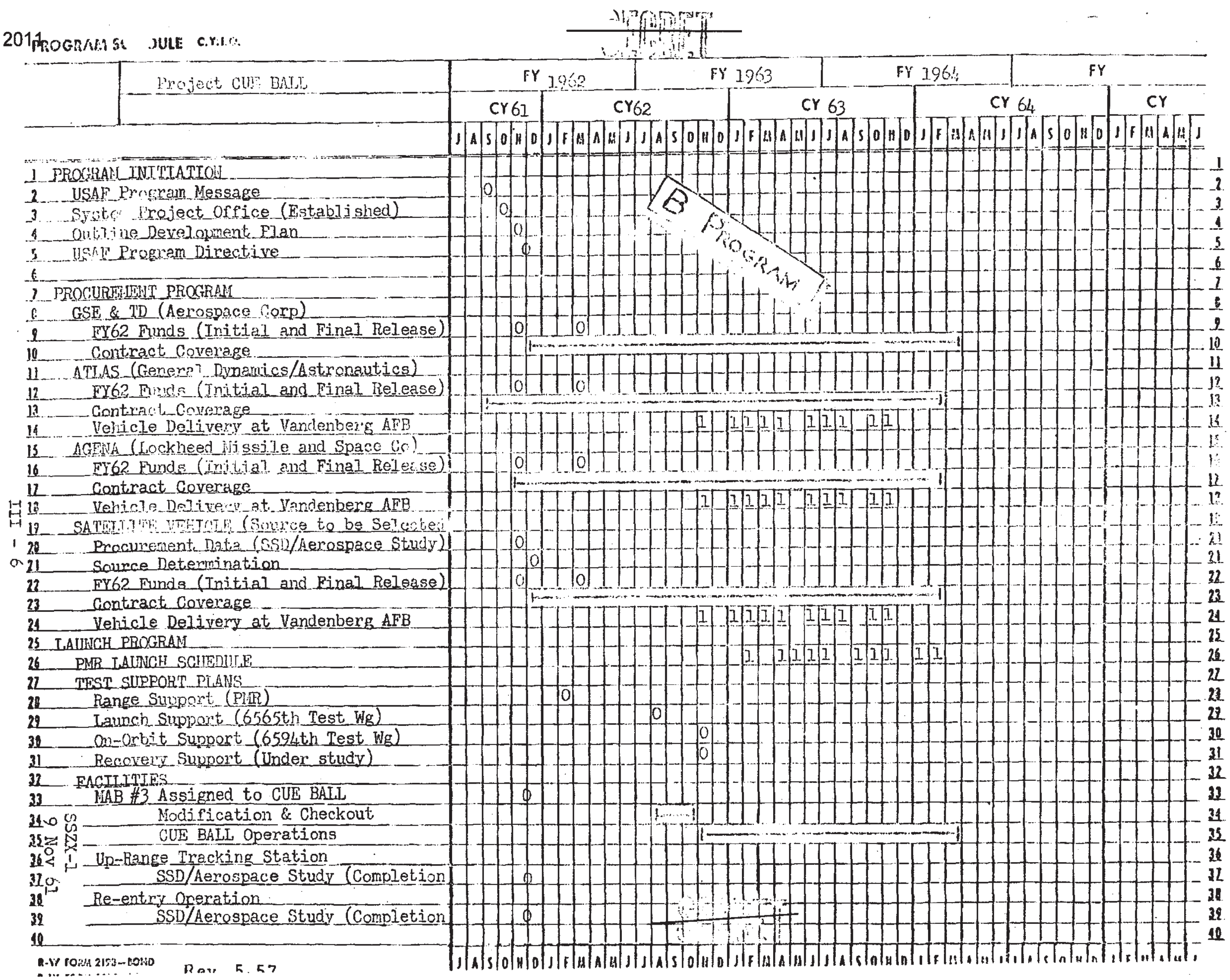
R-W FORM 2158-FOND
Rev 5-57



PROGRAM SC DULE C.Y.I.G.

Project CUE BALL

FY 1962 — FY 1963 — FY 1964 — FY
CY 61 — CY62 — CY 63 — CY 64 — CY

1 PROGRAM INITIATION
2 USAF Program Message
3 System Project Office (Established)
4 Outline Development Plan
5 USAF Program Directive
6
7 PROCUREMENT PROGRAM
8 GSE & TD (Aerospace Corp)
9 FY62 Funds (Initial and Final Release)
10 Contract Coverage
11 ATLAS (General Dynamics/Astronautics)
12 FY62 Funds (Initial and Final Release)
13 Contract Coverage
14 Vehicle Delivery at Vandenberg AFB
15 AGENA (Lockheed Missile and Space Co)
16 FY62 Funds (Initial and Final Release)
17 Contract Coverage
18 Vehicle Delivery at Vandenberg AFB
19 SATELLITE VEHICLE (Source to be Selected)
20 Procurement Data (SSD/Aerospace Study)
21 Source Determination
22 FY62 Funds (Initial and Final Release)
23 Contract Coverage
24 Vehicle Delivery at Vandenberg AFB
25 LAUNCH PROGRAM
26 PMR LAUNCH SCHEDULE
27 TEST SUPPORT PLANS
28 Range Support (PMR)
29 Launch Support (6565th Test Wg)
30 On-Orbit Support (6594th Test Wg)
31 Recovery Support (Under study)
32 FACILITIES
33 MAB #3 Assigned to CUE BALL
34 Modification & Checkout
35 CUE BALL Operations
36 Up-Range Tracking Station
37 SSD/Aerospace Study (Completion
38 Re-entry Operation
39 SSD/Aerospace Study (Completion
40

B PROGRAM

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Rev 5-57

4.0 GENERAL

a. Scope. Project CUE BALL facilities requirements have been examined in four areas:

- Contractor production and test facilities
- Vandenberg AFB
- On-orbit TT&C Stations
- Re-entry Operations

b. Status.

(1) No contractor facilities requirements have been identified at Aerospace, LMSC, GD/A, or Philco. It is doubtful that the selected SATELLITE VEHICLE contractor would require new facilities.

(2) A requirement has been identified at Vandenberg AFB for modifications to a Missile Assembly Building (MAB #3). An estimate on the FY62 and/or FY63 facilities funds is being prepared by the appropriate CE organization.

(3) Existing on-orbit TT&C Stations are adequate for support of Project CUE BALL from a facilities funding position. However, additional TT&C requirements are now under study by SSD/Aerospace. It is probable that a new up-range station and a down-range ship will be required. It is expected that some FY63 facilities funds will be associated with the up-range installation and that PMR will meet requirements for facilities funding related to shipborne stations. Definitive funding information is not expected to be available until December 1961.

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4.1 MISSILE ASSEMBLY BUILDING (MAB #3, VAFB).

a. Requirement. Vandenberg AFB facilities are required for the assembly and checkout of CUE BALL Satellite Vehicles. Current investigations indicate that a portion of MAB #3, currently occupied by elements of the ATLAS booster program, is the most suitable location for CUE BALL operations. Minor facilities funds (e.g., approximately [redacted] are required to adapt MAB #3.

b. Schedule. Approximately three months lead time will be required to relocate ATLAS and install/checkout CUE BALL facilities. Since CUE BALL operations must start 1 November 1962, MAB #3 modifications must be initiated by 1 August 1962.

PART V - FUND ESTIMATE

5.0 FUND ESTIMATE

a. Scope. Estimates based on the incremental funding concept are presented separately for Program A (USAF directed) and Program B (AFSC recommended) for Fiscal Years 62, 63 and 64. These estimates are incomplete concerning re-entry operations and facilities pending completion of studies now in progress. In addition, costs for the Up-Range Tracking Station have been roughly estimated and may require substantial revision during December 1961.

b. FY62 Funding. Because of immediate requirements for CUE BALL program initiation, FY62 funding has been identified by TWX to AFSC on 26 October in two increments as follows:

(1) First. Funds needed to initiate long lead time procurement and contract performance through 31 March 1962. Release of Initial FY62 funds is required during November 1961 in the amount of [redacted] for either Program A or B.

(2) Balance. Funds required to complete FY62 commitments. Release of balance of FY62 funds is required before the end of March 1962.

5.1 PREVIOUS FUNDING REQUEST

Previously, FY62 funding requirements, for the CUE BALL Program A only, were forwarded through Command channels by SSD Secret Message SSZX-26-10-1, 26 October 1961. This message summarized FY62 requirements, exclusive of funds for re-entry operations and facilities, as follows:

Initial Increment: [redacted]
Balance Increment:
Total FY62

5.2 FUNDING SUMMARY:

See pages V-2 (Program A) and V-3 (Program B).

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INITIAL FUND ESTIMATE PROGRAM "A", PROJECT CUE BALL

[redacted]

Category	Contractor	FY62	FY63	FY64	Total
TECHNICAL SERVICES		[redacted]			
General Systems Engineering and Technical Direction	Aerospace				
FLIGHT PROGRAM					
4 ATLAS Boosters and Launch Serv.	GD/Astro, NAA, others				
4 AGENA Boosters and Launch Serv.	LMSC				
4 SATELLITE VEHICLES and Services	Unknown				
SUPPORT PROGRAM					
Telemetry, Tracking and Command (TT&C)	LMSC & Philco				
Additional Up-Range TT&C Station	Unknown				
Re-entry Operations	Unknown				
SUB-TOTALS					
GENERAL SUPPORT					
TOTAL P-6399					

FACILITIES (P-300)	Location	
MAB #3	VAFB	Estimates available in December 61
Up-Range TT&C Station	Unknown	Estimates available in December 1961
Re-entry Operations	Unknown	(Under Study)

V-2 SECRET SSZX-1
9 Nov 61

INITIAL FUND ESTIMATE PROGRAM "B", PROJECT CUE BALL

Category	Contractor	FY62	FY63	FY64	TOTAL
TECHNICAL SERVICES		[redacted]			
General Systems Engineering and Technical Direction	Aerospace				
FLIGHT PROGRAM					
10 ATLAS Boosters and Launch Serv	GD/Astro, NAA, others				
10 AGENA Boosters and Launch Serv.	LMSC				
10 SATELLITE VEHICLES and Services	Unknown				
SUPPORT PROGRAM					
Telemetry, Tracking and Command (TT&C)	LMSC and Philco				
Additional Up-Range TT&C Station	Unknown				
Re-entry Operations	Unknown				
SUB-TOTALS					
GENERAL SUPPORT					
TOTAL P-6399					

FACILITIES (P-300)	Location	
MAB #3	VAFB	Estimates available in Dec 61
Up-Range TT&C Station	Unknown	Estimates available in Dec 61
Re-entry Operations	Unknown	(Under study)

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SSLPP

AFBMD
ACTION SSZC

1961 SEP 26 AM 8:42

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INFO SSG
SSV - SSR
SSL SSZ
SSRBA
SSZE
SSLP
SSLPP

ZQA626TFD016
PP RJUZBK
DE RJEZFF 23C
P 261457Z
FM HQ AFSC ANDREWS
FB MD
TO SSD LOS ANGELES CALIF
BT
~~S E C R E T~~ SCGN 26-9-5Ø. FOR SSG. THIS MESSAGE IN TWO PARTS.
PART I. THE FOLLOWING MESSAGE RECEIVED FROM AFCVC IS
RETRANSMITTED AS FOLLOWS: QUOTE. SECRET FROM AFCVC 64852.
THIS MESSAGE CONFIRMS OUR RECENT DISCUSSION. PROJECT
EXEMPLAR HAS BEEN ESTABLISHED BY HIGHER AUTHORITY. THE
CODEWORD EXEMPLAR IS CLASSIFIED CONFIDENTIAL. PAYLOAD AND
MISSION ASSOCIATED WITH EXEMPLAR ARE TOP SECRET. THE AIR
FORCE HAS BEEN ASSIGNED THE RESPONSIBILITY FOR BOOSTERS,
SPACE VEHICLES, LAUNCH AND COMMAND AND CONTROL SERVICES
ASSOCIATED WITH THIS SATELLITE SYSTEM. THE PROGRAM SHOULD

11605

PAGE TWO RJEZFF 23C
BE PLANNED FOR FOUR LAUNCHES FROM PMR AT SIXTY-DAY
INTERVALS BEGINNING IN FEBRUARY 1963. SECAF HAS BY SEPARATE
ACTION ORDERED THE PROCUREMENT OF AGENA AND ATLAS
BOOSTERS ON AN UNASSIGNED BASIS. THESE VEHICLES ARE HEREBY
ASSIGNED TO EXEMPLAR. YOU ARE REQUESTED TO SUBMIT AN
OUTLINE DEVELOPMENT PLAN NO LATER THAN 15 NOVEMBER 1961.
COST ESTIMATES SHOULD BE BASED ON THE FOLLOWING CRITERIA:
(1) ATLAS/AGENA COSTS FOR THE ABOVE REFERENCED "UNASSIGNED"
VEHICLES WILL BE INCLUDED IN THE PLAN. (2) EXISTING LAUNCH,
CHECKOUT AND COMMUNICATION FACILITIES WILL BE USED. (3)
PAYLOAD COSTS ARE EXCLUDED. (4) TERMINAL VEHICLE AND
ENGINEERING MANAGEMENT COSTS WILL BE INCLUDED. PROJECT
EXEMPLAR WILL BE HANDLED ON A STRICT NEED-TO-KNOW BASIS.
UNQUOTE. PART II. SSD IS DIRECTED TO TAKE THE NECESSARY
ACTION INDICATED IN PART I. SCP-3
BT
26/15ØØZ SEP RJEZFF

DOWNGR
INTERVALS;
DECLASSIFIE

SSZX-1
9 Nov 61

SECRET

To: SSZX

HEADQUARTERS
OFFICE OF THE DEPUTY COMMANDER AFSC
FOR AEROSPACE SYSTEMS
UNITED STATES AIR FORCE
Air Force Unit Post Office, Los Angeles 45, California

REPLY TO ATTN OF: DCAPO-1

SUBJECT: CUE BALL Program

17 OCT 1961

TO: Hq AFSC (SCPOM)
Andrews AFB
Wash 25, DC

1. Reference your secret message nr. SCGN-26-9-50, dated 26 September 1961, our secret message nr. SSZ-27-9-3, dated 27 September 1961, and your secret message nr. SCGN-10-10-14, dated 10 October 1961, concerning the CUE BALL Program.

2. Your headquarters has placed this program in a high importance category. As a result, an ad hoc group has been established under the Deputy for Satellite Systems, SSD, to manage the function pending approval of a recommended organization. The initial launch date will be difficult to meet; therefore, we assume, for planning purposes, that a very high priority will be assigned to the program.

3. Attached are a proposed listing of manpower requirements, organization chart, and functional responsibilities for each branch. This requirement is submitted based on knowledge available to this organization and should be considered within this parameter. In the event that you have additional information concerning CUE BALL that has not been released to DCAS, request this requirement be adjusted accordingly.

4. You will note that we have requested a Lt Colonel position, AFSC 2716, for duty as Deputy Director. This position is necessary due to the fact the Director and/or Deputy will be required to engage in TDY to manage the program more than fifty per cent of their time. Additionally, it is essential that one of these individuals be present at his duty station at all times.

5. AFR 26-3 has not been applied on a functional basis to identify manpower spaces for this program. There is no reprogramming capability within DCAS to satisfy this requirement. Dependent on the priority assigned, a program or programs of lesser priority will of necessity be eliminated if we must reprogram from within DCAS.

6. Expeditious processing of this requirement is requested.

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1-SSL
1-SSZX

FOR THE COMMANDER

Ralph Eames

RALPH EAMES
Colonel, USAF
Chief, Personnel & Manpower

3 Atchs
1. List of Manpower Rqmts
2. Proposed Orgn Chart
3. CUE BALL Functional Stmts

DOWNGRADED AT 12 YEAR INTERVALS; NOT AUTOMATICALLY DECLASSIFIED. DOD DIR 5200.10

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CUE BALL DIRECTORATE

FUNCTION TITLE	OFFICE SYMBOL	SEQUENCE CODE
Cue Ball Directorate	SSZX	1085

[redacted]

Responsible for management and direction of the CUE BALL Program. Specifically, this responsibility includes: Formulating, documenting, and continually updating development plans, implementing directives, and technical, resource, and financial requirements; presenting and justifying those requirements and gaining formal approvals therefor; integrating and coordinating the efforts of participating local offices and external agencies, furnishing direction and guidance to such participants, and monitoring their progress; regulating the commitment of authorized funds and otherwise exercising program financial control; initiating, negotiating, directing, and monitoring contractual efforts for general systems engineering, vehicle and component development, and supporting functions as required; supervising technical direction by the engineering management contractor; approving key technical decisions, and insuring adequate review and approval of specifications and other detailed technical data.

Procurement & Programming Branch

[redacted]

Responsible for over-all administration and management of non-technical phases of the program. Effects procurement and contractual actions. Acquires, maintains, prepares, and processes procurement data. Negotiates, authenticates, and issues contracts and contractual changes. Prepares financial analyses, financial status reports, and budget estimates. Controls expenditures to insure their most advantageous application against program objectives. Establishes and maintains master schedules, program milestones, manpower and financial charts, and other management tools for use in periodic reviews for the Director. Assembles and arranges other data for inclusion in program briefings. Supervises the preparation, review, coordination, publication, updating, amending, and distribution of development plans, work statements, special reports, and other program documentation as required. Gathers inputs from contributors and prepares portions of such documents. Handles general administrative functions for the Program Directorate including security and personnel matters.

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Engineering Branch

[redacted]

Responsible for the final stage vehicle, for integration of subsystems within it, and for integration of the total vehicle system. Directs the engineering management contractor in exercising its systems engineering and technical direction function for the over-all program and in the design, development, fabrication and testing of final stage vehicle, including resolution of unique electrical, thermal, and radiation interface problems introduced by the incorporation of the payload. Reviews, revises, and approves work statements, specifications, test plans, development plans, cost proposals, CCN's, ECP's, ATPM's and other technical and administrative contractual documents. Evaluates the necessity and adequacy of contractor's current and proposed technical efforts, relates to manpower and financial resources applied, and directs changes in accordance with findings. In the booster and communications and control areas, represents the CUE BALL Directorate in all matters concerning configuration, modification, component design and development, testing, and delivery schedules.

Test Operations & Support Branch

[redacted]

Responsible for aerospace ground equipment, facilities, range activities, test operations, and general support. Insures that program requirements in these areas are properly formulated, updated, and documented, and that they are issued to, understood by, and acted upon by responsible offices and agencies. Receives, in turn, funding, resource, and other requirements from participating organizations and acts to fulfill commitments to them. Pursues directly those mission-peculiar portions of the areas cited which are not within the responsibility of existing groups. In the aerospace ground equipment area, represents the CUE BALL Directorate in all matters concerning configuration, modification, component design and development, testing, and delivery schedules.

DOWNGRADED AT 12 YEAR
INTERVALS; NOT AUTOMATICALLY
DECLASSIFIED. DOD DIR 5200.10

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9 Nov 61

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DEPARTMENT OF THE AIR FORCE
DIRECTORATE OF SPECIAL PROJECTS (OSAF)
AF UNIT POST OFFICE, LOS ANGELES, CALIFORNIA 90045

REPLY TO ATTN OF: [redacted]

1 FEB 1966

SUBJECT: Program Management Plan, Project G-3

TO: SP-1 (Gen Martin)

Submitted herewith is a Program Management Plan for the Advanced GAMBIT System, Project G-3. It is intended for local use in implementing the Preliminary Development Plan, dated 4 Feb 1964.

WILLIAM G. KING, JR., Colonel, USAF
Deputy Director

SP-1

2 FEB 1966

SUBJECT: Project Approval

TO: [redacted] (Col King)

1. Pursuant to authority contained in Secretary of the Air Force Order 116.1, dated 19 July 1962, the attached Program Management Plan for Project G-3 is approved.

2. This Plan will be used as a guide for over-all objectives, delivery and launch schedules, contracting and financial planning.

3. You will submit change requests for approval when any of the project elements require revision.

JOHN L. MARTIN, JR., Brig General, USAF
Director

DISTRIBUTION:

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SAFSP	1 Cy
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OFFICE OF THE SECRETARY OF THE AIR FORCE

PROJECT G-3
(ADVANCED GAMBIT SYSTEM)

PROGRAM MANAGEMENT PLAN

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GAMBIT CUBED (G^3)

GENERAL DESCRIPTION OF

MISSION, SYSTEM CHARACTERISTICS AND OPERATIONS

SECTION I

GENERAL

A. MISSION

The mission of the GAMBIT-Cubed system is to conduct high resolution, satellite reconnaissance missions to cover specified high priority targets and to recover the photographic record. Ground resolutions will be [redacted]

B. GENERAL

1. The project is covert and has the covert code name of GAMBIT-Cubed (G^3). This name indicates that the system is an advanced version of the G or GAMBIT system. The overt identifier is Project 206-II, which is conducted as a classified (strict need-to-know) R&D space effort.

2. The project was approved by DNRO in message [redacted] 3 January 1964.

C. SYSTEM CHARACTERISTICS

1. The first stage booster will be the Titan IIIB, with the injection stage to be an adaption of the Agena D, which is identified as a part of the Satellite Control Section.

2. The Satellite Vehicle will have two sections: a Photographic Payload Section (PPS) and a Satellite Control Section (SCS). In covert documentation, the SCS actually includes the Payload Adapter Section (PAS) which is commonly called the "roll joint," which provides the obliquity pointing capability.

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3. The payload employs a catadioptric optical system having a focal length of approximately 160 inches. The payload will be an integral part of the Photographic Payload Section (PPS) structure, as opposed to the GAMBIT system method of separate fabrication of the payload and orbital control vehicle and their mating in the field prior to launch.

4. The PPS contains the following elements as described in the Development Plan:

Supply and Looper Assembly

Satellite Re-entry Vehicle (SRV)

Supply Recovery Module (SRM)

Camera Optics Module (COM)

Adapter Section Assembly (ASA)

External Structure (sub-contracted to LMSC)

5. The SCS is an adaption of the Agena D vehicle and contains the following elements:

a. Spaceframe Subsystem. Mounts and supports all vehicle system equipments and provides environmental shelter to the extent necessary to achieve mission objectives. This includes a program peculiar booster adapter section.

b. Propulsion Subsystem. The primary propulsion system is a dual burn liquid rocket engine with its propellant pressurization, loading and feed system and is used for initial orbit injection, as well as for post-mission de-boost. The secondary propulsion system is a fixed thrust, pressure fed, storable hypergolic liquid propellant rocket engine system and is used for orbit correction and change, as well as for de-boost.

c. Back-Up Stabilization System (BUSS). Controls the vehicle during terminal maneuvering in the event the primary attitude control system fails.

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d. Electrical Power Subsystem. Provides primary power for the SCS and the PPS and also includes the pyrotechnics and the power and distribution system for the vehicle.'

e. Tracking, Telemetry and Command (T, T&C). Provides for these required functions.

f. Command Subsystem. Consists of an Extended Command Subsystem (ECS) and a Minimal Command Subsystem (MCS) for both normal (ECS) operation and emergency (MCS) operation.

g. Guidance and Control Subsystem. Provides necessary attitude, time, velocity references and flight programming to attain orbit; control attitude on-orbit; and control during normal recovery and de-boost operation.

6. Major Specifications:

a. Detail Specification, Model 58205 Vehicle, Program 206-II - LMSC/1417190A, 23 July 1965 (~~C~~).

b. Detail Model Specification for the PAS/SCS - LMSC/ 1417539B, 1 November 1965 (~~S~~-SH).

c. Program 206-II General Systems Specification - Aerospace 65-0000-05261, Reissue C, 20 December 1965 (~~S~~).

d. Photographic Subsystem Specification No. 1402-215- Eastman Kodak Company Document No. K-006490-DH-001, 2 April 1965 (~~S~~-SH).

D. OPERATIONS

1. Launch. The PPS is shipped by covert means directly to Pad 3 at Vandenberg AFB, where it is mated with the SCS, and integrated pre-launch tests are accomplished. Vandenberg AFB assembly, test and launch operations are under the over-all supervision of the 6595th ATW.

2. On-orbit Operation. Computer programming is prepared in advance by various software contractors [redacted] GE, STL, [redacted] to

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provide ephemeris determination, command generation and mission optimization. The data processing and computation procedures provide the capability of generating a new vehicle program in 90 minutes.

On-orbit operations utilize the existing Air Force Satellite Control Facility. Various tracking stations track the vehicle for establishment of the ephemeris and for transmission of command loadings to the satellite. Commands are stored and equated through the on-board command subsystem to conduct the on-orbit function of the SCS and PPS. Telemetry data are recorded and transmitted to the SCF at station contacts for monitoring of vehicle health. Vehicle health evaluation and on-orbit operational decision are the responsibility of the Director, Special Projects, and his technical staff. The 6594th Support Group has over-all responsibility for conducting the operation of the Satellite Control Facility, including the recovery.

a. The orbit has the following general characteristics:

Injection altitude - 65 to 160 n. mi.

Orbit inclination - 60° to 145°

Nominal period - 90 min.

b. The nominal mission life is five days for early flights with eight to 12 days as objectives for follow-on flights.

3. <u>Record Handling.</u> Same as the G Program.

SECTION II

PROGRAM DIRECTION CORRESPONDENCE

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TSCF032/102218Z ZEA 10 FEB 1964
BT
XXXXX ZEA

~~S E C R E T~~ 102218Z

PRIORITY [redacted] CITE [redacted]

FOR GENERAL GREER FROM GENERAL MARTIN.

REFERENCE YOUR BRIEFING ON G-CUBE ON 5 FEBRUARY. DR.MCMILLAN APPROVES PROCEEDING WITH RFP AND THE SPECIFICATIONS AS PROPOSED IN THE BRIEFING.

~~S E C R E T~~

CFN GENERAL GREER GENERAL MARTIN G-CUBE 5 FEBRUARY DR. MCMILLAN RFP
BT

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~~S E C R E T~~ 031604Z [redacted] 3 JAN 1964
PRIORITY [redacted] CITE [redacted]

FOR GENERAL GREER FROM GEN MARTIN AND [redacted]

REFERENCE [redacted]

DNRO APPROVES INITIATION OF THE G3 EFFORT ALONG THE LINES IN REFERENCED MESSAGE. AUTHORITY TO USE PRESENTLY-PROGRAMMED GAMBIT FUNDS FOR THIS PURPOSE IS GRANTED. REQUEST G3 FUND ACCOUNTABILITY BE ESTABLISHED AND MAINTAINED SEPARATELY FROM GAMBIT. IT IS EXPECTED THAT OSD EMERGENCY FUNDS WILL BE MADE AVAILABLE WHEN NEEDED TO CONTINUE THE FY 1964 EFFORT. HOWEVER, MORE DEFINITIVE COST DATA WILL BE REQUIRED BEFORE A REQUEST TO OSD CAN BE MADE. ACCORDINGLY, AT THE POINT WHERE THE FY 1964 COSTS ARE REASONABLY FIRM, SUPPORTING DETAIL SHOULD BE FURNISHED, WITH AN INDICATION AS TO HOW MUCH CAN BE ABSORBED WITHIN THE PRESENT GAMBIT PROGRAM, AND THE ADDITIONAL COSTS. ALSO REQUEST THAT REVISED BLACK AND WHITE FUNDING UNDER GAMBIT AND G3 BE FURNISHED AS EXPEDITIOUSLY AS DETERMINATIONS CAN BE MADE, WITHIN PRESENT GAMBIT TOTALS.

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SP-1

2 Jan 64

MEMO FOR COL KING

SUBJECT: G^3

1. Per verbal KY-9 direction of Dr. McMillan, we may proceed as of this date on the G^3 program as outlined in message [redacted] dated 27 Dec 63.

2. Dr. McMillan desires to keep open the choice of booster at this time, examining further the alternatives of Titan I or Titan III core as substitutes for Atlas/Agena. You should probably study and make recommendations to me on this element prior to finalizing the space vehicle RFP's.

3. Advise me on the latest date we need to fix on the booster decision; move out immediately on the payload contract.

ROBERT E. GREER
Major General, USAF
Director, Special Projects

cy to: [redacted]

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~~S E C R E T~~ 271942Z 27 DEC 1963

[redacted] CITE [redacted]

SUBJECT: FOLLOW ON GAMBIT PROGRAM - G3. REFERENCE IS MADE TO 5 DEC 63 BRIEFING TO DR. MCMILLAN BY EKC.

PART I. GENERAL PLANS HAVE BEEN FORMULATED TO PURSUE THE G3 DEVELOPMENT AS FOLLOWS: (A) MANAGEMENT - DEVELOPMENT WILL BE CARRIED OUT UNDER GAMBIT PROGRAM MANAGEMENT, EXCEPT THAT A SPECIFIC AEROSPACE GSE/TD DIRECTOR AND GROUP WILL STEER THE G3 EFFORT. (B) TIME PHASING - INITIAL FLIGHT TESTS OF G3 WILL BE SCHEDULED FOR THE 2D QUARTER OF CY 66. AT SOME POINT DOWNSTREAM IN CY 66, G3 WILL PHASE IN AND G OUT. CONTROLLED ENTRY INTO THE DEVELOPMENT PROGRAM FOR BOTH THE PAYLOAD CONTRACTOR AND VEHICLE CONTRACTOR WILL COMMENCE IN FY 64. IT IS EMPHASIZED THAT BOTH A PAYLOAD AND VEHICLE CONTRACTOR MUST BE DEFINED AND INTERFACES ESTABLISHED WHICH WILL ALLOW EITHER CONTRACTOR TO WORK EFFECTIVELY IN SUPPORT OF INITIAL LAUNCHES IN CY 66. THE GAP BETWEEN THE CURRENT 22 VEHICLE G PROGRAM AND THE EFFECTIVITY OF G3 WILL BE FILLED WITH ADDITIONAL G PROCUREMENT. REASONABLE G IMPROVEMENTS WILL BE EFFECTED, BUT MAJOR CHANGES SUCH AS FOCAL LENGTH, APERATURE, ETC., WILL NOT BE INCLUDED. (C) PROCUREMENT SCHEDULE - PAYLOAD - EK HAS BEEN REQUESTED TO SUBMIT TECHNICAL PROPOSAL; A DRAFT OF WHICH HAS BEEN RECEIVED. THIS DRAFT PROPOSAL IS BEING USED IN THE PREPARATION OF A WORK STATEMENT. THIS WORK STATEMENT WILL PROVIDE FOR CONTROLLED ENTRY INTO DEVELOPMENT DURING THIS FISCAL YEAR AND WILL PROVIDE FOR MILESTONES AT WHICH FEASIBILITY CAN BE ASSESSED FOR DECISION INTO FULL SCALE DEVELOPMENT. EKC WORK STATEMENT SHOULD BE COMPLETED AND COORDINATED BY EARLY JANUARY 1964. VEHICLES - IN ORDER TO SELECT A MOST OPTIMUM APPROACH FOR A VEHICLE CONFIGURATION, AN RFP WILL BE PREPARED AND SUBMITTED TO LMSC AND GE. IT IS ANTICIPATED THAT THIS COMPETITIVE APPROACH WILL GIVE US A LOOK ON TWO DIFFERENT VEHICLE ARRANGEMENTS, I.E., PROBABLY (1) AN AGENA - ROLL JOINT APPROACH AND (2) AN OCV WITH AN ASCENT CAPABILITY APPROACH. RFP'S WILL BE SUBMITTED MID FEB '64 WITH PROPOSALS BEING RECEIVED MID APRIL; EVALUATION OF PROPOSAL COMPLETED IN EARLY MAY '64; DEFINITIVE CONTRACT IN JUNE '64.

PART II. PRINCIPAL G3 EFFORT WILL BE APPLIED TO A VEHICLE UTILIZING THE ATLAS WITH INJECTION BY THE AGENA OR COMPARABLE VEHICLE. A SEPARATE EFFORT TO ENHANCE INVULVERABILITY WILL BE STUDIED AS PART OF G3 WITH THE PROVISION THAT TITAN III OR FLOX ATLAS MAY BE REQUIRED TO MEET ORBITAL REQUIREMENTS.

PART III. IT IS ESTIMATED THAT THE FY 1964 COSTS WILL BE APPROXIMATELY [redacted] OF WHICH [redacted] WILL BE BLACK. I BELIEVE THAT BY CAREFUL MANAGEMENT I CAN GET [redacted] OF THE REQUIRED [redacted] FROM THE CURRENT GAMBIT BUDGET IN ORDER TO GET THE G3 PROJECT STARTED. THIS WOULD REQUIRE AN ADDITIONAL [redacted] FROM YOU ABOUT MARCH. SOME ADJUSTMENT BETWEEN BLACK AND WHITE IN THE CURRENT BUDGET MAY BE NECESSARY.

SIGNED, R. GREER. GP-1

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SECTION III

CONTRACT STRUCTURE

NRO APPROVED FOR
RELEASE 17 September 2011

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SPECIAL HANDLING

CONTRACT STRUCTURE

CONTRACT	TYPE	FOR	LIFE	FACE VALUE
AF 04(695)-619 LMSC Admin: [redacted]	WHITE	Satellite Control Section: Development and 6 Vehicles, Non-Payload Related Effort	21 Jul 1964 - 30 Apr 1967	[redacted]
AF 04(695)-896 LMSC Admin: [redacted]	WHITE	Satellite Control Section: 16 Vehicle Follow-on to Above Contract -619	1 Dec 65 - 31 Aug 68	
[redacted] LMSC Admin: [redacted]	BLACK	Satellite Control Section: Development and 6 Vehicles, Payload Related Effort	21 Jul 1964 - 30 Apr 1967	
[redacted] LMSC Admin: [redacted]	BLACK	Satellite Control Section: 16 Vehicle Follow-on to Above Contract -2709	To be Determined	To be Determined
[redacted] Eastman Kodak Company Admin: [redacted]	BLACK	Photographic Payload Section: Development and 6 Vehicles	22 Jan 1964 - 31 Mar 1967	[redacted]
[redacted] Eastman Kodak Company Admin: [redacted]	BLACK	Photographic Payload Section: 16 Vehicle Follow-on to Above Contract -2108	1 Nov 1965 - 3 Jul 1968	
AF 04(695)-594 GE-LMED Admin: [redacted]	WHITE	Command Programmers: Development and 6 Vehicles	25 May 1964 - 15 Jul 1966	
AF 04(695)-897 GE-LMED Admin: [redacted]	WHITE	Command Programmers: 16 Vehicle Follow-on to Above Contract -594	5 Nov 65 - 7 Aug 68	st)

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CONTRACT	TYPE	FOR	LIFE	FACE VALUE
AF 04(695)-636 GE-Spacecraft Dept. Admin: [redacted]	WHITE	Parallel Study Effort on SCS	27 Jul 1964 - 31 May 1965	[redacted]
AF 04(695)-693 GE-Spacecraft Dept. Admin: [redacted]	WHITE	Command and Control Computer Effort (Software) in Support of SCS	8 Sep 1964 - 15 Feb 1967	
[redacted] GE-RSD Admin: [redacted]	BLACK	Satellite Re-entry Vehicles: 16 Vehicle Follow-on (Original 6 Procured Under Subcontract to -2108)	8 Dec 1965 - 31 Mar 1968	
Various Admin: SSHK	WHITE	Titan IIIB Booster Hardware and Launch Services	—	FY 66 Program (GAMBIT^3 funds only): [redacted]
Various LMSC Admin: SSVAK	WHITE	Standard Agena (SS-01B) Hardware	—	FY 66 Program (GAMBIT^3 funds only): [redacted]
AF 04(695)-669 Aerospace Corp. Admin: SSYK	WHITE	Systems Engineering/Technical Direction Support	1 Jul 1965 - 30 Jun 1966	FY 66 Program (GAMBIT^3 funds only): [redacted]

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SECTION IV

DELIVERY AND LAUNCH SCHEDULES

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CONTRACT DELIVERY AND LAUNCH SCHEDULES

TIIIB		PPS		SCS		Launch Date
	Date	FMT	15 Jan 66		Date	
1	24 May 66	FM-1	13 Jul 66	4751	8 Jul 66	28 Jul 66
2	16 Aug 66	FM-2	10 Sep 66	4752	25 Aug 66	15 Sep 66
3	15 Sep 66	FM-3	26 Oct 66	4753	12 Oct 66	1 Nov 66
4	14 Oct 66	FM-4	25 Nov 66	4754	9 Nov 66	1 Dec 66
5	15 Nov 66	FM-5	29 Dec 66	4755	9 Dec 66	3 Jan 67
6	16 Dec 66	FM-6 (Formerly FMT)	26 Jan 67	4756	12 Jan 67	1 Feb 67
1/Mo. thereafter thru 24		1/Mo. thereafter thru 22		1/Mo. thereafter thru 22		1/Mo. thereafter

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1 July 1964

Preliminary Project FULCRUM Phase I Tasking

1. Phase I of Project FULCRUM is intended to demonstrate clearly and decisively the feasibility of the FULCRUM Photo Satellite Reconnaissance System. The duration of Phase I will be approximately six months with all final reports delivered to the contracting agency by 31 December 1965. At this time the results of Phase I will be carefully reviewed by all agencies and committees concerned, and a decision will be made to commit funds for hardware or to terminate the program.

2. During the course of Phase I there will be substantial participation by personnel of the contracting agency, and therefore, the five tasks outlined below should not be regarded as final and all inclusive.

Task I: <u>Film Handling Feasibility Studies</u>

Detailed engineering study of alternative approaches to the FULCRUM film handling problem. This will include examination of both the constant film velocity approach as well as the accelerated film approach.

The most promising constant velocity and the most promising accelerated film approach will be built in prototype and instrumented so as to provide a feasibility demonstration and performance evaluation. The prototypes will include the film drum rotation and translation mechanizations for matching v/h over a 120 degree scan angle. The prototypes will be designed for v/h ranging from .06 rad./sec. to .035 rad./sec.

In the case of the constant velocity approach requiring film indexing, the various methods of indexing should be experimentally evaluated and a preferred method selected. A careful study should be made of the reliability and practicality of the film reversing operation. Careful attention should be payed to minimizing film wastage and the trade off between startup

Preliminary Project FULCRUM Phase I Tasking

power and minimum time for an off-on cycle.

In the case of the accelerated film approach, an evaluation of wasted film due to degraded imagery should be made. Also, the feasibility of using an interrupted scan mode of operation should be studies. The problem of additional programmer complexity should also be examined in this context.

At the conclusion of the six month program, a detailed evaluation report on each of the two prototypes will be delivered. This report will include the following:

a. The results of experiments designed to measure the film velocity errors.

b. A statistical estimate of image degradation due to film velocity error.

c. The results of environment chamber tests designed to examine high speed film handling problems (such as corona discharge) at operational gas pressures.

d. The results of experiments with Kodak Type 4404 7" film designed to test the two prototypes for film damage (scratching, etc.).

e. A summary comparison of the two prototypes including operational considerations and estimated reliability.

Task II: Camera Dynamics Studies and Engineering Test Mock-Up

A detailed analytical study of the camera dynamics. Particular emphasis should be placed on:

a. Bearing, loading, and gas requirements during both prelaunch testing and in flight operation.

Preliminary Project FULCRUM Phase I Tasking

b. The perturbations to camera rotation caused by spacecraft torquing.

c. Effects of start-up transients - - - particularly film supply and takeup spools.

d. Effects of c. g. shifts due to film movement.

In addition to the above analytical studies, a full scale single camera mock-up will be designed and built. The design effort should include a survey of past experience with large air bearings of this type, particularly under near vacuum environmental conditions. The primary purposes of this mock-up will be to test air bearing operation under operational environmental conditions, and to test and evaluate the performance of the slip rings that provide electrical coupling between the optical bar and the space craft. These tests will include start-up and stopping as well as steady-state operation. To this end, the weights and balances of the mock-up should be as realistic as possible, consistant with the prevailing stage of the camera design.

A secondary purpose of the mock-up tests will be to instrument for vibration measurements insofar as they are deemed useful and feasible.

The product of this six month effort will be a detailed report covering the analytical studies outlined above, and a second report covering the mock-up design and experimental results. This second report should include an extrapolation of the test results to free fall conditions, as well as an examination of the launch loads problem. The mock-up experiments should be sufficiently detailed and definitive to permit immediate engineering design of a high confidence bearing and slip ring configuration.

One of the reports should include a summary section discussing the estimated effects on image quality due to gross camera dynamics (not including film velocity air effects).

Preliminary Project FULCRUM Phase I Testing

Task III: Optical Design

A two to three month effort leading to a final FULCRUM optical system design. The design should be carried to preparation of fabrication specifications.

In addition to the engineering specifications, a report will be prepared discussing the essentials of the design and the reasons for image degradation, both on and off axis. This report will include an optical element weight estimate.

If particular elements of the optical system appear to present basic feasibility problems, this study may phase into a three to four month critical component fabrication and test phase. In any case, this task must be completed and reported on by the end of Phase I.

Task IV: Facilities Study

A five month study to identify additional facilities required for the support of the FULCRUM program. Detailed specifications for these facilities will be developed so that, on release of funds, procurement of equipment and facility construction can proceed without delay. This planning should include facilities for dynamic performance measurement of the completed camera system under operational environment conditions. By the end of the five month period, a summary document should be prepared outlining the justifying arguments for the various recommended facilities, including cost and scheduling information.

Task V: Design and Engineering

A detailed camera design effort to be coordinated with the film handling and engineering test mock-up tasks. This is a six month program, involving detailed component and sub-system engineering with the following major goals:

a. Support of the film handling prototype and camera mock-up tasks.

Preliminary Project FULCRUM Phase I Tasking

b. Preparation by the end of month two of an interface document to be used by companies involved in the space vehicle competition.

c. A six month report summarizing the engineering effort to that date emphasizing weight, power, and thermal considerations.

While the main purpose of this task is to arrive at firm weight and power numbers, the work should be organized so as to minimize additional design and engineering effort required when funds are released for camera procurement. To this end a full scale design mock-up should be built with all sub-systems in place. This mock-up is intended both to demonstrate packing feasibility and to aid in final design and fabrication.

This task will also include some additional study of alternative camera configurations. This work will be concentrated during the first month of Phase I and may include preliminary weights and power estimates. Work will proceed in close coordination with the contracting agency. Specific reporting requirements will be worked out as necessary.

Task VI - Program Analysis

A continuing analysis of the Phase II program from the point of view schedules and lead times. This effort will lead to a ~~[illegible]~~ definitive program schedule for Phase II by the end of Phase I. During the course of Phase I any long lead items that may ~~[illegible]~~ pace phase II should be identified as ~~they emerge~~ emerge.

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BYE-0282-64

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30 Sept. 1964

MEMORANDUM FOR: Director of Central Intelligence

SUBJECT : Project FULCRUM

1. In a memorandum, dated 29 September 1964, the Director of the National Reconnaissance Office advised the Deputy Director for Science and Technology that he could not agree in the course of action which the Agency had taken in the FULCRUM Program by engaging in spacecraft and recovery vehicle competitions at this time. The D/NRO stated that he felt this action was premature and contrary to an agreement allegedly reached on 11 August, which agreement stipulated that a single contractor would be selected competitively to conduct a systems design study and that, moreover, the D/NRO would approve the work statements before hand. The D/NRO went on to request that further efforts be suspended, pending discussion of the matter in a meeting of the NRO Executive Committee (BYE-22318-64).

2. The D/NRO's expressed opinion regarding FULCRUM is a surprise to the DD/S&T and certainly not in concert with the many discussions and memoranda which had gone before.

3. On 2 July 1964, Dr. Wheelon handcarried a memorandum to the Director, NRO which stipulated the actions in which the Agency would engage during Phase I of the FULCRUM Program and the corresponding cost estimate for each effort. In this memorandum the Agency identified the various efforts in which it would engage during Phase I in response to the recommendations of the Land Panel called by the DCI on 25 June. Dr. Wheelon's memorandum of 2 July stated that the weight budget and dynamic balance problem would be studied in a funded proposal for space craft and recovery vehicle systems with follow-up design and development efforts by those companies awarded the contracts.

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BYE-0282-64

4. On 13 August Dr. Wheelon and Mr. Maxey met with Dr. McMillan to discuss the status of Phase I efforts of FULCRUM. In that meeting, Dr. McMillan related what he felt was the agreement with the DCI concerning FULCRUM. He allowed that he would try to reiterate the understanding as Dr. Fubini also saw it. Dr. McMillan stated that he contemplated FULCRUM Phase I efforts as really a period of systems design study. In addition to study efforts regarding the camera design and fast film transport, the Agency would also consider the housing for the payload such as the spacecraft.

5. Additionally, Dr. McMillan suggested that, wherever possible, we use existing hardware or hardware under development. He went on to suggest that such words could also apply to the recovery vehicle, and he stated that the National Reconnaissance Program was ripe for a new recovery vehicle, and possibly two. He recommended that we scrutinize the recovery vehicle requirements even to the point of suggesting a land recovery with a small recovery vehicle. He further recommended that we select a single contractor to do the systems design study and that this contractor, and possibly a competitor, be responsible for producing the entire FULCRUM system including getting a recovery vehicle contractor as a sub.

6. Dr. Wheelon retorted that he thought it was desirable and necessary to obtain separate R/V studies and select the Assembly, Integration, and Checkout contractor and give him the systems engineering function while the program got underway.

7. On 14 August the DCI issued the following instructions regarding contractual procedures in FULCRUM:

(1) There shall be no commitment, contractual or implied, that we are to proceed past the authorized R & D work on the film handling mechanism and the camera, which includes developmental mock-ups built in sufficient detail to answer or to disprove all questions or doubts concerning feasibility and, with respect to the spacecraft and re-entry vehicle, conceptual designs and sufficient detailed engineering to present accurate determinations as to weight of the total assembly and compatability with the launcher.

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(2) You will employ engineers and contractors to the fullest possible extent, reserving as "in-house activities" responsibilities for supervision and guidance of the engineers and contractors. I wish you to avoid as far as possible unnecessarily building an in-house capability, restricting the expansion of your staff, if any is required, to such additions as are necessary to adequately supervise the work of the engineers and the contractors.

This memorandum specifically suggested competitive contract for the design of the spacecraft. The Director indicated that the instructions were entirely consistent with the understanding reached at the Executive Committee meeting on 11 August.

8. On 18 August the DCI recommended in a Memorandum for the Record on the Executive Committee meeting of 18 August that the decision was made to proceed in accordance with his memorandum of 14 August.

9. On 27 August in a Memorandum for the Record by the DDCI regarding the Executive Committee meeting of 26 August, General Carter indicated that Secretary Vance had registered his agreement that the FULCRUM Program was all agreed and squared away, and he thought that this was a great step forward.

10. On 27 August the DDCI advised the DD/S&T that the DCI had approved the following additional guidelines for overall organization and direction of the FULCRUM Program. The FULCRUM Program is a CIA program under NRO aegis. Command, control, supervision and direction of the entire FULCRUM Phase I program is assigned to the DD/S&T. Additionally, he instructed the DD/S&T to keep the NRO fully and completely informed of its progress and to provide information copies of contractual work statements to the NRO.

11. On 31 August Dr. Wheelon prepared a memorandum on the conduct of the FULCRUM Program and the terms of reference which the DD/S&T would employ in the management of Phase I. This memorandum was approved by General Carter, and notation was made that the DCI had read and orally approved it. In the terms of reference of this memorandum it was specified

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that there would be a competitive selection of a spacecraft design study contractor as well as one for the recovery vehicle.

12. On 1 September the DCI directed a memorandum to Secretary Vance, which included as attachments not only the memorandum prepared by Dr. Wheelon specifying the terms of reference and basic management plan for Project FULCRUM, but also the directive to Dr. Wheelon from General Carter which placed FULCRUM under the direction of the DD/S&T and specified that the DD/S&T should provide the NRO information copies of work statements.

13. On 8 September Dr. Wheelon advised the D/NRO by memorandum that the Agency planned to release the funded design competition contracts for the re-entry vehicle. Dr. Wheelon requested that the results of other R/V design studies conducted by the Air Force or NRO be made available to the Agency.

14. On 11 September the DD/S&T forwarded to the D/NRO information copies of the spacecraft and recovery vehicle work statements.

15. On 17 September the D/NRO, acceding to Dr. Wheelon's request, directed the Director, Program A, to provide Dr. Wheelon with information derived from the R/V design studies.

16. In response to a query from D/NRO on 21 September as to the status of the FULCRUM Project, the DD/S&T replied on 23 September appraising the D/NRO as to the work efforts presently underway in FULCRUM and assuring him that as definitized work statements were prepared they would be forwarded to the NRO as had been done with the R/V and spacecraft contracts.

ALBERT D. WHEELON
Deputy Director
for
Science and Technology

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

OFFICE OF THE DIRECTOR

29 APR 1966

MEMORANDUM FOR: DIRECTOR OF SPECIAL PROJECTS, SAF
DIRECTOR OF RECONNAISSANCE, CIA

SUBJECT: System Operational Requirements for the New Search and Surveillance System

The approved System Operational Requirement for the New Search and Surveillance System is attached for your information and guidance.

In this regard, if desired, appropriate project personnel may be given the opportunity to familiarize themselves with the supplementary rationale contained in Attachments 4-1, 4-2, 4-3, and 4-4 to my April 23 memorandum to the Executive Committee.

Alexander H. Flax
Alexander H. Flax

Attachment

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SYSTEM OPERATIONAL REQUIREMENT FOR A NEW PHOTOGRAPHIC GENERAL SEARCH AND SURVEILLANCE SATELLITE SYSTEM

March 1966

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GENERAL SYSTEM OPERATIONAL REQUIREMENTS

The stated intelligence requirements for a new photographic general search and surveillance satellite system are reflected in the following general system operational requirements. A description of the system, and the specific technical and operational criteria which this system must meet, are contained in the following sections of this report.

A continued requirement will exist for the United States to acquire satellite photographic reconnaissance of any designated part of the earth's surface as a primary source of information on the status, capability and threat posed by potentially hostile nations to the peace of the free world.

The new General Search and Surveillance System will be designed to provide an optimum capability for fulfilling the national search and surveillance objectives specified for the time period beginning in 1969 by the United States Intelligence Board through the Committee on Overhead Reconnaissance. These search and surveillance activities will be conducted in an environment similar to the current world situation ranging from a "normal" or cold war, through crisis situations during periods of international tension.

Priority will be given to photography of built-up areas of the USSR and China. The capability to cover other designated areas of the world is also required.

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Systematic search of some 12 million square nautical miles may be required semi-annually, to detect activities associated with possible threats against the United States. Periodic surveillance is required of previously known specific objective targets at a ground resolution sufficient to detect and analyze changes in the status or capability of a target. Repetitive coverage of certain types of targets and target complexes is vitally important to permit a definitive analysis and to detect changes in status. Numerically, coverage approaching a total of [redacted] specific targets may be required, with coverages of various numbers required at intervals of two months, quarterly, semi-annually, and annually. Most primary targets are expected to be distributed throughout the Sino-Soviet land mass.

During periods of crisis, photographic coverage of any selected area of the world is desired. Crisis situation targets will be similar in character and require about the same ground resolution as those identified under search and surveillance. However, to prove effective, the satellite reconnaissance capability used for crisis situations must be flexible, i.e., capable of prolonged "standby" periods prior to launch, rapid response after the decision to launch is received, and responsive to on-orbit command and control. In addition, the overall system must be designed for minimal time between launch, recovery and delivery of photography to the user.

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In meeting these requirements, the new system must be capable of providing a ground resolution from design perigee altitude of 2.7 feet or better at nadir. In addition, symmetrical stereo photography at appropriate convergent angles is required.

With a regard to anti-satellite defensive protection, the initial system design should consider precautionary features such as "passive" operation over area of interest, secure "activate-deactivate" and recovery command sequences, etc. Reasonable provisions will be included during design for volume, structural strength, power, etc., necessary for possible later incorporation of vulnerability reduction devices such as radiation shielding, shielding against pellet attack, decoys, electronic counter-measures (ECM), etc. These provisions may also be used [redacted] instead of the vulnerability reduction devices as appropriate. Since most of these vulnerability-reducing measures are threat dependent, initiation of development of specific devices should be deferred to as late in the system development period as possible to allow maximum use of timely threat intelligence.

Optimum use of existing or planned launching and on-orbit control equipments and facilities is desired with minimal modification where necessary, and the new system will be as nearly compatible with existing or planned command and control equipments and facilities as is practicable. Established recovery system equipments and methods will be utilized with minimal modification as necessary. The primary recovery zone will be the present Hawaiian recovery area. A contingency land recovery capability may be considered with no compromise to the primary mission or recovery method.

Existing photographic processing and data handling support facilities with equipment updated to the operational time period (and other modifications if required) will be used in exploitation of photography acquired by this new system.

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SYSTEM DESCRIPTION

This section provides a general description, together with key operational constraints and requirements, of the new General Search and Surveillance System. A more detailed definition of the specific technical and operational criteria applicable to the various subsystems follows in the next section of this document.

The outboard profile of the entire aerospace vehicle is shown in Figure 1.

Launch Vehicle. The launch vehicle which has been selected for this system is the TITAN IIID. The TITAN IIID consists of stages 1 and 2 of the TITAN III, with two 120-inch diameter three-segment solid-propellant motors strapped on the sides of the first stage. This booster uses BTL radio guidance during powered flight and accomplishes a direct injection of the space vehicle into the desired orbit. The TITAN IIID is capable of placing a payload in excess of 16,000 pounds into a 100 NM circular 96° orbit from PMR and is capable of orbital inclinations from 75° to 140°. (Current range safety restrictions require a waiver below 83°). The TITAN IIID is capable of holding for launch at T-1 hour or less for 30 days.

No orbit control requirements are imposed on the booster. After stage 2 engine cut-off, the space vehicle is separated from the stage and a retro velocity is imparted to the stage.

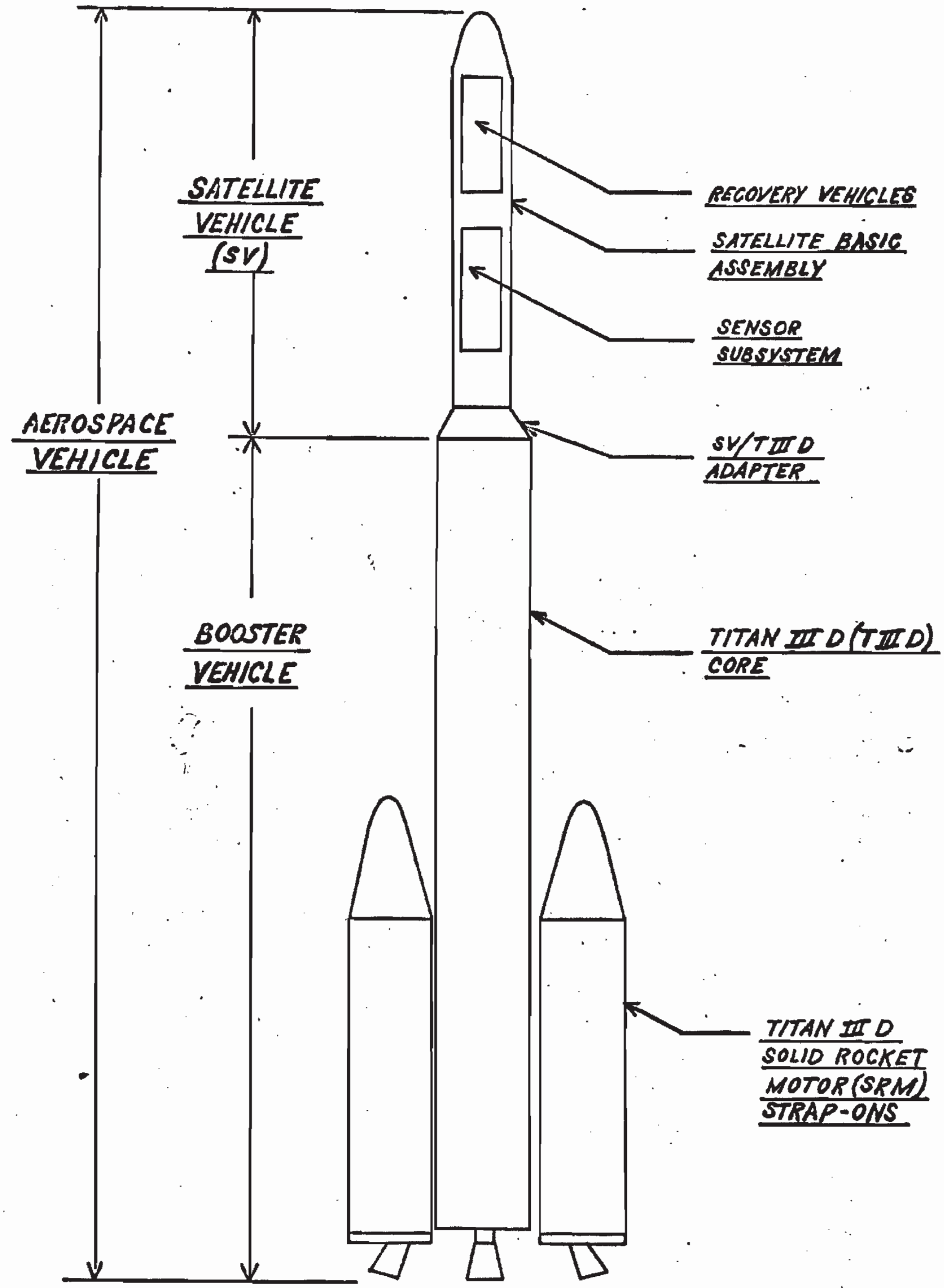

FIG. 1 - AEROSPACE VEHICLE OUTBOARD PROFILE

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Satellite Vehicle. The Satellite Vehicle is the entire assemblage placed into orbit by the launch vehicle. It includes a Sensor Subsystem, a Satellite Basic Assembly, and the necessary Recovery Vehicles.

Sensor Subsystem: The Sensor Subsystem provides two panoramic cameras mounted for stereo imagery and includes all elements of the film path; all camera-peculiar electronics, and/or pneumatics necessary for operation of these elements in response to commands; power conversion components peculiar to the sensor subsystem; and a housing which establishes and controls the internal environment for the sensor and provides the structural support for all internal elements of the sensor subsystem.

Satellite Basic Assembly (SBA): The Satellite Basic Assembly provides the basic structure to support, house and protect all elements of the Satellite Vehicle and includes equipment necessary for on-orbit control, vehicle attitude control, orbit period control, and telemetry, tracking, command functions, all general electric power, and de-orbit control. It provides the controlled environment necessary for the proper operation of all subsystems and elements of the satellite vehicle during launch and in orbit. The Satellite Basic Assembly includes the Stellar Index and Terrain Frame Cameras (SI) and associated structure and power.

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Recovery Vehicles: The Recovery Vehicles are mounted along the vehicle longitudinal axis and supported structurally by the SV. The primary recovery vehicles are identical in all respects except for the differences in film path imposed by the requirement to take-up of film sequentially. Each recovery vehicle consists of a heat shield; a spin-deboost-despin system, a parachute system; a watertight canister containing two film take-up reels (the reels are part of the film path); an events sequencer with appropriate electric power; and necessary telemetry, recovery aids, and security aids.

The spacecraft structure must be designed to accommodate the anticipated loads for either two or four Primary RV's. However, before final design is released, the system implications of each will be studied in detail and a specific configuration designated.

A separate recovery vehicle for the SI film will be provided and mounted appropriately within the Satellite Basic Assembly, or if more advantageous, one of the multiple RV's will be used for this purpose.

Operational Support. Launches will be conducted by the 6595th Test Wing from a launch pad such as PALC II Pad 4 at the Vandenberg Air Force Base complex. The system must meet all range safety requirements of the Air Force Western Test Range.

On-orbit operations will be controlled through the Satellite Test Center in response to direction from the Satellite Operations Center.

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Recovery will be accomplished by air catch over the Pacific Ocean in the general area of Hawaii. RV dispersions, velocities, weights and diameters will be compatible with the capabilities of the USAF 6594th Recovery Wing operating with C-130 type aircraft.

Operational Constraints. The search and surveillance mission will be accomplished by relatively long-life vehicles (at least 25 days mission duration) launched at intervals of approximately 60 days. The Satellite Vehicle will include the option of increasing expendables to obtain increased life.

The typical mission will be conducted near the sun synchronous orbit inclination (orbit plane inclined slightly more than 96 degrees to the earth's equator). A sun synchronous orbit with period determined by perigee altitude for design camera performance and system resolution requirements will be identified as the reference orbit. In general, the reference orbit is defined as the least elliptic orbit which meets all these constraints at perigee altitudes not less than 80 NM. The mission duration must be satisfied specifically for the reference orbit conditions.

In order to provide flexibility, the system must be capable of being operated in a wide spectrum of orbits in addition to the reference orbit, although it is not a firm requirement that maximum duration requirements be met for those off reference orbits. It is required that the system be capable of operation (photography) at all orbital altitudes between 80 and

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240 nautical miles and at synchronous periods of three days and greater. (A three-day synchronous period repeats ground traces beginning on the fourth day.) Orbits with earth synchronous periods of three days or greater and sun-synchronous inclination are shown by the cross-hatched portion of Figure 2. The additional orbits shown in Figure 2 would provide the added flexibility of a family of orbits with ground tracks on successive days lying west of the preceding day's.

Although no firm criteria for selecting an inclination other than sun-synchronous can be stated at this time, the capability to launch and operate in orbits with inclination from 75 to 140 degrees is required.

The overall system design must provide the capability to launch at any time commensurate with the desired latitude of photography, orbital inclinations, and environmental constraints as described herein.

There is no requirement to incorporate specific provisions in the initial operational system configuration to enhance survivability in a counter-measures environment. It is a requirement, however, to evaluate the potential threat and to define configuration options which could be employed in response to countermeasures activity. It is permissible to consider reduced mission life if required in order to employ these options, but it shall be an objective that provisions to incorporate them do not degrade the other capabilities of the operational configuration.

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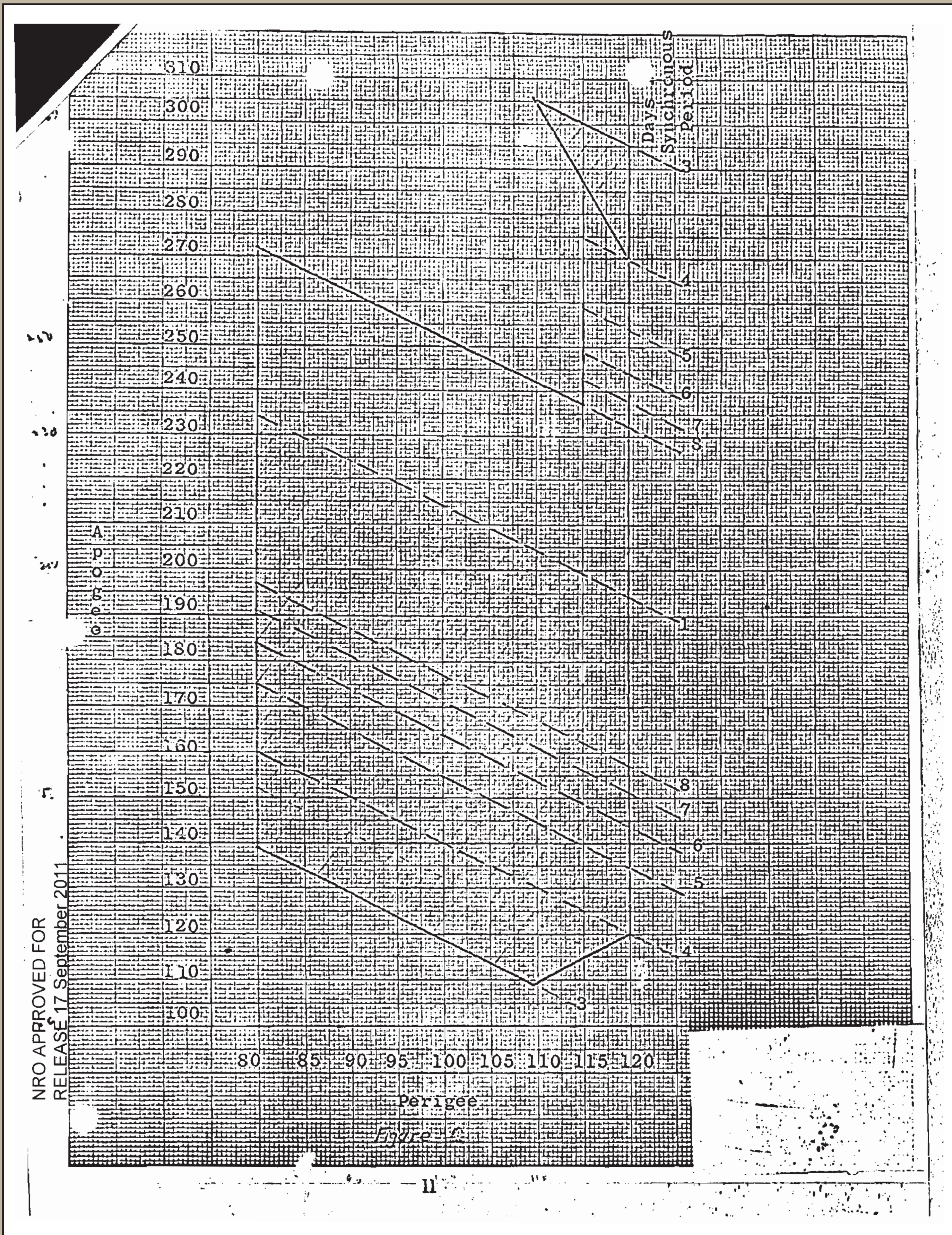
Days
Synchronous
Period
3
4
5
6
7
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1
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5
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3
Apogee
310
300
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190
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170
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130
120
110
100
80
85
90
95
100
105
110
115
120
Perigee
11

In normal operations, the booster will be targeted to accomplish a direct injection into orbit at perigee, thus fixing perigee initially at about 20 degrees North Latitude. Perigee location will move north as a result of the apsidal motion caused by oblateness of the earth. When perigee reaches 55 degrees North Latitude, the orbit adjust capability will be used to stabilize the apsidal orientation. For these perigee constraints, the camera must be capable of photography at true anomalies within $\leq$ 100 degrees. A capability is required to obtain photography on both south to north and north to south elements of the orbit.

Preliminary orbit determination will be based upon telemetered guidance conditions at separation of the space vehicle. More precise determination will be accomplished as tracking contacts are made by the Satellite Control Facility. The capability of the SV orbit adjust system will be used to establish the proper period. During the mission life, the orbit adjust system must also provide a period adjust capability to counteract the effects of atmospheric drag, and/or to adjust or maintain location of perigee and to deorbit the satellite vehicle after the mission is completed.

Recovery of the first RV will be accomplished when the nominal film weight has been loaded on the take-up reels. Camera operating decisions will normally be programmed to use the film throughout the nominal mission duration, so that recovery of subsequent RV's will

NRO APPROVED FOR
RELEASE 17 September 2011

be at specific times throughout the mission. In the event of a critical on-orbit failure, a back-up capability will be provided to recover any RV into which film has been spooled.

Subsequent to the recovery of the final RV, the space vehicle will be deorbited to impact in a water area.

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TECHNICAL AND OPERATIONAL CRITERIA

SYSTEM PERFORMANCE REQUIREMENTS

Resolution - The required ground resolution for the system from design perigee altitude shall be 2.7 feet or better at scan nadir.

Ground resolution is to be stated as the geometric mean from design altitude for a Mil Std 150A three-bar target with 2:1 contrast at the entrance pupil and with 30 degrees sun angle. This resolution shall include the effects of manufacturing tolerances and is to be stated for dynamic conditions at 2 sigma focus and smear.

For purposes of standardization, resolution off nadir will be degraded with the scan angle by the secant of the scan angle to the 3/2 power and will be degraded further by any change in manufacturing tolerances, smear, focus, and other factors associated with the scan angle.

Stereo Coverage - Equal-scale convergent stereo coverage with an included angle of at least 20 degrees symmetrical to the vertical shall be provided. A capability to furnish monoscopic coverage with each camera shall also be provided.

Viewing Obliquity - The solution used for cross-track scanning shall produce a viewing obliquity of at least 45 degrees and shall not exceed 60 degrees. A capability to program total scan angle in 15^{o} increments and to select any increment within the scan for photography is desired. However, the provision for varying scan angle or selecting any increment within the scan should not cause substantial degradation in system reliability or increase in system cost. If programmable scan angle is not provided then the amount of film required will be adjusted in accordance with the stipulations in paragraph 4, Coverage Requirements.

Coverage Requirements - The system must produce enough imagery to insure repeated coverage of the Sino-Soviet Bloc [redacted]

The imagery acquired depends upon the swath width (scan angle) provided by the system. This system shall carry sufficient film per day per camera to photograph

$$\frac{730{,}000 \text{ (design scan angle)}}{\text{scan angle to achieve 140 NM swath from design perigee}} \ NM^2.$$

This formula takes account of the effects of cloud cover, season of the year, typical target spread for search, surveillance, mapping and charting, and engineering test missions and duplicative frame to frame coverage. If programmable and selectable scan is provided, the constant in this formula may be decreased from 730,000 to 680,000.

Continuity - The overall system design shall provide a capability for continuous in-track coverage during system operation, and shall provide 3% overlap in-track at nadir.

Mensuration - A design goal for the GSS shall be the determination of the location of the nadir point of any frame relative to an established earth-datum within an error of 450 feet horizontally and 300 feet vertically, and determination of the relative position of points separated by not more than 20 miles ground distance to 40 feet horizontally and 10 feet vertically. The Sensor Subsystem should include provision for calibration with the other elements of the Satellite Vehicle as required to achieve this goal.

SATELLITE VEHICLE

General Definition - The Satellite Vehicle is the entire on-orbit configuration. It consists of the Sensor Subsystem (SS), the Satellite Basic Assembly (SBA), and the Recovery Vehicles (RV's). Figure 3 identifies the major components and functions of each subsystem.

The general design goal for the space vehicle shall be minimum weight consistent with the required performance and reliability specifications. The outside diameter of the entire space vehicle will not exceed 120 inches.

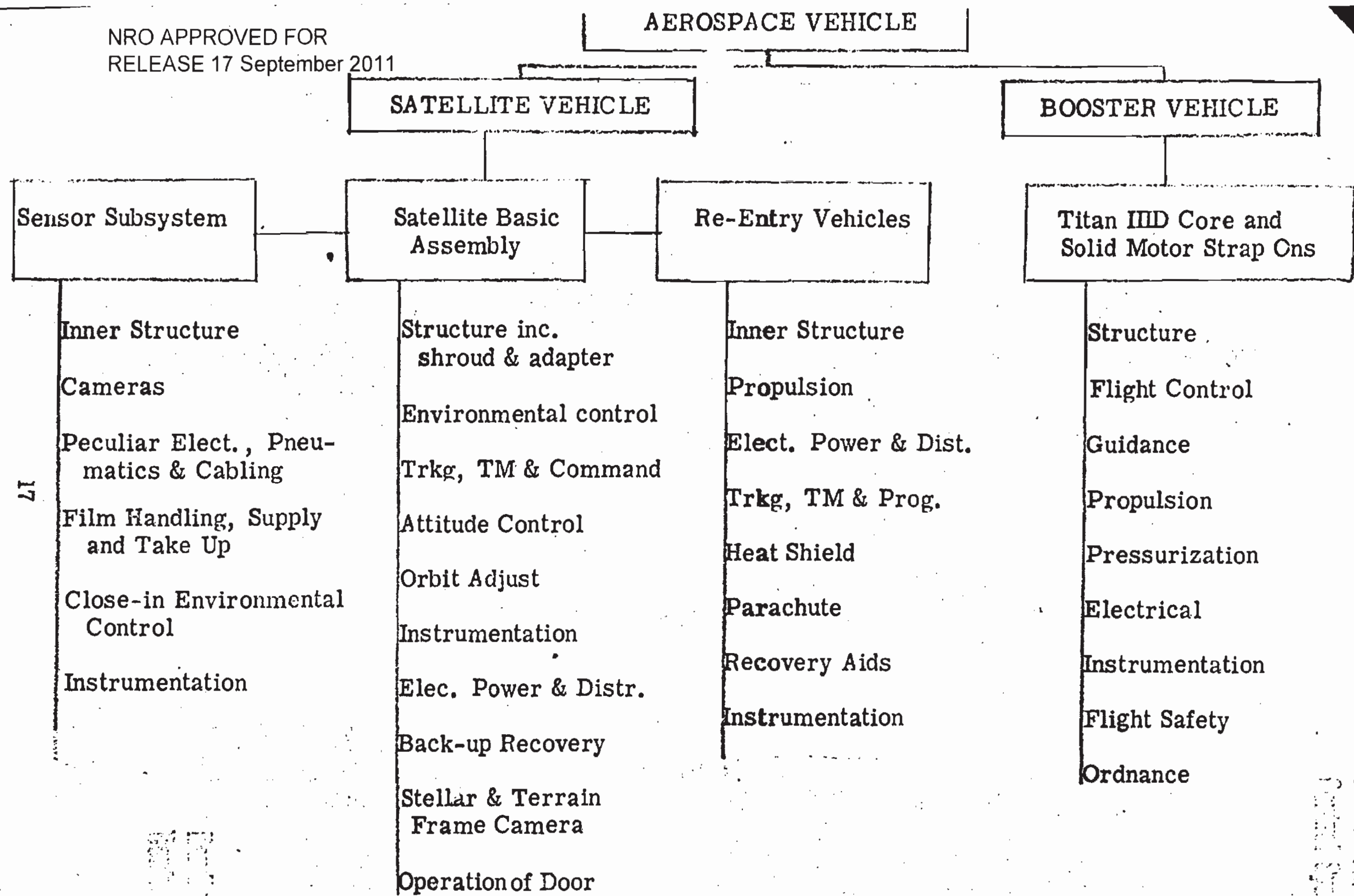
AEROSPACE VEHICLE
SATELLITE VEHICLE
BOOSTER VEHICLE
Sensor Subsystem
Satellite Basic Assembly
Re-Entry Vehicles
Titan IIID Core and Solid Motor Strap Ons
Inner Structure
Cameras
Peculiar Elect., Pneumatics & Cabling
Film Handling, Supply and Take Up
Close-in Environmental Control
Instrumentation
Structure inc. shroud & adapter
Environmental control
Trkg, TM & Command
Attitude Control
Orbit Adjust
Instrumentation
Elec. Power & Distr.
Back-up Recovery
Stellar & Terrain Frame Camera
Operation of Door
Inner Structure
Propulsion
Elect. Power & Dist.
Trkg, TM & Prog.
Heat Shield
Parachute
Recovery Aids
Instrumentation
Structure
Flight Control
Guidance
Propulsion
Pressurization
Electrical
Instrumentation
Flight Safety
Ordnance

Figure 3

Sensor Subsystem (SS)

Technical criteria for the major components of the sensor subsystem are as follows:

Panoramic Cameras: The SS will contain two panoramic cameras. Each camera includes an optical system and a film transport system for controlling the movement of film within the camera. The cameras will be mounted for stereo viewing at equal scale and equal angle. Maximum film width will be 9 1/2 inches.

Sensor Subsystem Electronics and Pneumatics: All electronic and pneumatic components required for the operation of the sensor subsystem maybe mounted with the sensor subsystem.

Environmental Control: The Sensor Subsystem will provide the environment dictated by the requirements of the panoramic cameras and film. This environment will include controlled temperature, pressure, and humidity. The Sensor Subsystem will operate within the environment provided by the Satellite Vehicle. The Satellite Vehicle must provide an environment acceptable to the Sensor Subsystem over the range of angles between the orbit plane and the earth sun line angles of $\leq$ 60 degrees.

Sensor Peculiar Power Supply Components: Any power supply conversion components which are required solely for the operation of the panoramic cameras, and associated instrumentation maybe mounted with the Sensor Subsystem.

Film Handling System: The film handling system consists of the supply cassettes, the take-up cassettes, and provisions for cut or splice and wrap, and all other components which have to do with the guiding or supporting of the film path and its light-tight integrity external to the panoramic camera. With the exception of the take-up cassettes and their associated drives, all components of the film handling system may be mounted with the sensor subsystem. The take-up cassettes will be mounted internal to the RV's.

Satellite Basic Assembly (SBA)

The general function of the SBA is to provide the structure to mount and protect all elements of the satellite vehicle and to provide stabilization, propulsion, command and control, and power for the satellite vehicle. Provision shall be made to control the orbital decay and re-entry of the space vehicle upon completion of the mission so that the probability of land impact of any part of the space vehicle is less than 0.01. Technical criteria for the major components of the SBA are as follows:

Attitude Control: The attitude control system will provide 3 axis earth oriented stabilization for the entire space vehicle. The stability requirements must be consistent with the overall resolution performance goals of the system. Minimum tolerable attitude accuracies during photographic operations are:

Roll Error	0.7 degrees
Pitch Error	0.7 degrees
Yaw Error	0.8 degrees

The instantaneous SV rates about each of the three principal axes at any time during photographic operation will not exceed the following:

Roll	0.012 degrees/sec
Pitch	0.008 degrees/sec
Yaw	0.008 degrees/sec

A back-up stabilization capability to continue the mission will be provided at a reduced attitude accuracy if required.

Command and Control: The command and control system consists of a programmer and associated encoders, and an RF link with the Satellite Control Facility. Its main function is to provide discrete commands and other necessary data to the spacecraft. The command and control system must be compatible with the configuration of the Satellite Control Facility and include a capability for updating and revising the operating program on-orbit. Secure commands will be provided for those functions which could abort the mission. A back-up command and control capability to continue the mission will be provided at reduced capacity if required.

Tracking Transponder: The transponder is a beacon to assist tracking by the Satellite Control Facility and must be compatible with the requirements of this facility.

Telemetry: The telemetry system must meet the requirements of all equipment aboard the Satellite Vehicle. The telemetry system does not include transducers and signal conditioners peculiar to the Sensor Subsystem. A capability must be provided to store for later playback certain critical data relative to Sensor Subsystem operation, the Satellite Basic Assembly performance, and general health data of the Satellite

Vehicle. The telemetry system must be compatible with the Satellite Control Facility equipments.

Orbit Adjust: The orbit adjust system is a propulsion system integral with the Satellite Basic Assembly designed to insure that the required orbit is maintained for the duration of the mission. In particular, the orbit adjust system must be capable of adjusting and maintaining the desired period and location of perigee.

Power Supply: The power supply for the entire Satellite Vehicle will be an integral part of the Satellite Basic Assembly except for power conversion equipment peculiar to the Sensor Subsystem, and for the RV power requirements.

[redacted]

Back-Up Recovery: The Satellite Basic Assembly must include an independent subsystem to enable recovery in the event of a primary system failure. This back-up recovery system must provide a high probability of successful recovery in the primary recovery area in the event of a failure of the primary attitude control system, the command system, or the on-board programmer.

Structure: The Satellite Basic Assembly will provide the primary load carrying structure for the entire Satellite Vehicle and will be adequate to carry the acceleration and wind loads during powered flight. The Satellite Basic Assembly structure will also provide a mechanical interface with the RV's.

Stellar Index and Terrain Frame Camera: The Satellite Basic Assembly will contain a subsystem to record that data necessary for timely and accurate post-flight determination of the orientation of the panoramic camera optical axis during camera operations, and the calibration of the panoramic imagery with an accuracy consistent with the system performance requirements for mensuration.

Re-Entry Vehicles (RV's)

The Satellite Vehicle configuration will provide for mounting and protecting Recovery Vehicles. The RV's will be separated sequentially by command during the orbital operation. The RV's will be essentially identical. Each Recovery Vehicle will contain two take-up cassettes - one for each main panoramic camera. The re-entry vehicle design must permit a successful recovery in the primary recovery zone from all orbits described in the System Description Section of this document. In addition, the recovery vehicles must be capable of successful re-entry over the range of payload weights from both take-up cassettes empty to both full, and with any weight distribution between the two cassettes. A separate recovery vehicle will be carried for the SI film or one of the primary RV's may be used if found more advantageous. Technical criteria for the major components of the recovery vehicles are as follows:

Heat Shield: The ablative or other appropriate heat shield will provide for the protection of the film cassettes and other RV subsystems during the re-entry phase of the operation. The heat shield and its associated thermal coatings and insulation must be designed so that the internal time/temperature profile does not exceed the constraints specified for protecting the physical and chemical properties of the exposed film.

Retro Rocket: The retro rocket will provide for a Δ V large enough to insure that the re-entry dispersions do not exceed the requirements of the recovery force.

Spin-Despin System: The spin-despin system will impart a controlled angular velocity to the Recovery Vehicle after separation from the space vehicle. After firing the retro rocket, the RV will be despun to an accuracy as required by the re-entry dynamics of the vehicle.

Parachute System: The parachute system will insure that the sink rate of the package to be recovered does not exceed a specified velocity/ altitude profile as determined by the capability of the recovery force.

The parachute configuration must also be consistent with the air-borne catch gear deployed with the recovery force.

Re-Entry Vehicle Electronics: The RV will contain electronic subsystems as required for sequencing events, tracking, and telemetry. The RV will also contain its own power supply for operation of these subsystems after separation from the Satellite Vehicle.

Structure: Each RV will contain a load carrying structure to integrate all RV components and to provide an internal mechanical interface for the take-up cassettes and associated components as well as an external mechanical interface for mating to the space vehicle. This structure will be adequate to carry the powered flight loads of the empty RV's and the re-entry loads of the RV's with both take-up cassettes full. The structure shall also guarantee structural integrity upon water impact and insure flotation. Provision will be made for destructive sinking after 48 hours as a security precaution.

Launch Vehicle

The Launch Vehicle for this system is the TITAN IIID. A capability to achieve a range of operational orbits from 75 to 140 degrees is required. Applicable specifications for this Launch Vehicle shall be used during system design and development.

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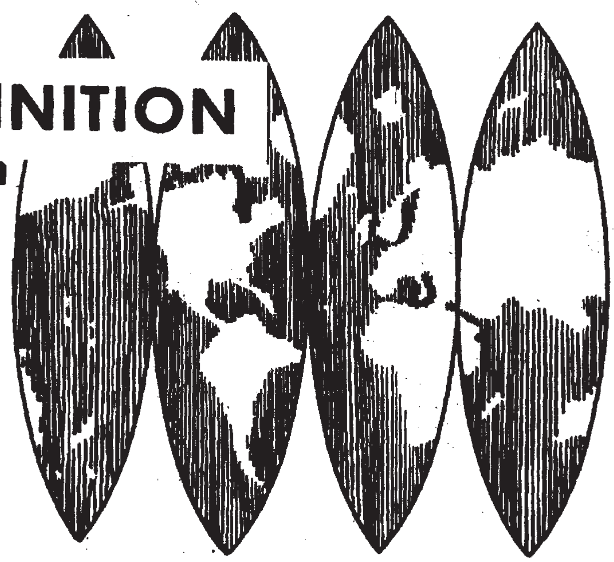
VOLUME I (PART 1)

DESIGN DEFINITION
sensor subsystem



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THE PERKIN-ELMER CORPORATION NORWALK, CONNECTICUT, U.S.A.

CHESTER W. NIMITZ, JR. PRESIDENT

21 July 1966

Gentlemen:

We are pleased to make this submission in response to requirements defined in your 23 May 1966 Request for Proposal for the sensor subsystem on the Hexagon Program. The proposal is responsive in all aspects to that request.

The Perkin-Elmer Corporation considers itself uniquely qualified to accomplish the objectives of the Program. The Corporation has a record of significant accomplishment in the design, development, and production of advanced scientific instrumentation with emphasis in the technical disciplines particular to Hexagon. We are prepared to commit the personnel, facilities, and financial resources necessary to assure satisfaction of that Program's performance, delivery, and cost goals.

As evidence of our confidence in satisfying such goals, we have undertaken a series of actions aimed at timely implementation of a full program on date of award. These include -

Preparations for the establishment of a separate Optical Technology Division specifically charged with management and technical performance responsibilities for the Hexagon Program.

Purchase of a facility committed solely to this program with A & E studies (partially funded at company risk) now in progress to provide for expansion as is necessary.

Commitments of funds at company risk to procure critical long lead-time materials and services.

Evaluation of a series of potential major subcontractors in order that vendor commitments can be triggered coincident with contract award.

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Initiation, months ago, of a program for recruitment of professional personnel which has produced tangible results to date, and which continues.

As noted above, to better assure a successful Program, it is our plan to establish a separate Optical Technology Division. Personnel presently assigned to the Program will be augmented according to plan by identifiable personnel presently within the Corporation, and by recruitment as required. This combination of identifiable people will represent a cross-section of the technical excellence, and management and administrative capability drawn from all facets of the Corporation.

A conscientious effort has been made as a part of this Program to anticipate the principal technical problems to be encountered, and specific conclusions in regard to such problems are documented in the proposal. Our extensive analysis, design, and experimentation have led us to full confidence that the technical approach which we propose will meet or exceed the requirements of the Hexagon mission for the following reasons:

The ability of our design to resolve 2.7 feet from a perigee altitude of 95 nautical miles, thereby achieving operational flexibility between the increased coverage capability at this altitude and an even better resolution of 2.2 feet at the minimum altitude of 80 nautical miles.

A passive thermal design that yields a favorable environment for the optics, and which is both significantly lighter and more reliable than an active thermal system.

An optical design that provides for a generous focus tolerance (14μ, 2σ), yields high resolution, is enclosed in a single structure for maintaining alignment integrity during launch as well as uncoupling from vehicle distortions in orbit, and provides an additional measure of thermal protection.

The use of proven components and techniques in the film transport system including: air bars, edge-guidance sensors and steerers, focal-plane

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THE PERKIN-ELMER CORPORATION

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defining rollers, tension sensors and controls, a twister mechanism, phase-lock synchronization to the scanners, and adaptive loop control of all drives.

Additional operational flexibility in the ability to operate in the surveillance mode with efficient use of film by mixed scan, short scan, and patch mode operation.

The successful implementation of an advanced optical fabrication technique which utilizes machine processing to produce precision optical parts on a reliable and repeatable basis in a much shorter time than can be accomplished by conventional techniques.

In consonance with our past record, we advocate a balanced and thorough approach in evaluating technical solutions. Conclusions are the responsibility of cognizant engineering managers, and such conclusions have been, and will continue to be, reviewed and approved by the Corporate Technical Advisory Board made up of Perkin-Elmer's most experienced scientific and engineering personnel.

We recognize that our acceptance of technical direction from the Procuring Agency is an essential element in accomplishing this program. We believe that our record on previous procurements with this Agency and other Government Agencies is the best endorsement that can be made to support this statement.

Of critical importance in meeting Program goals is our ability to add personnel consistent with the proposed plan. Our plan calls for the sensible coordination of transfers from within the company, recruitment of new personnel, assignment of consultants, judicious sub-contracting, and selective use of purchased technical services. The plan, as detailed in the proposal, will permit accomplishment of Program goals.

Perkin-Elmer submits this proposal on the basis that it possesses the management, scientific, technical, fabrication, and administrative skills necessary to the accomplishment of the Hexagon Program. The Corporate managerial record for stability, integrity, performance, and service underwrites this conviction,

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as does our specific history in serving the Procuring Agency on previous programs whose accomplishments lend credit to both contracting parties.

This undertaking has the enthusiastic support of Corporate management and its employees. On behalf of the Corporation, I commit the technical, administrative, and financial resources of Perkin-Elmer to the success of the Hexagon Program.

Yours truly,

C. W. Nimitz, Jr.
President

mb
Attachments:

Volume I, Design Definition
Volume II, Program Plan
Volume III, Cost Proposal

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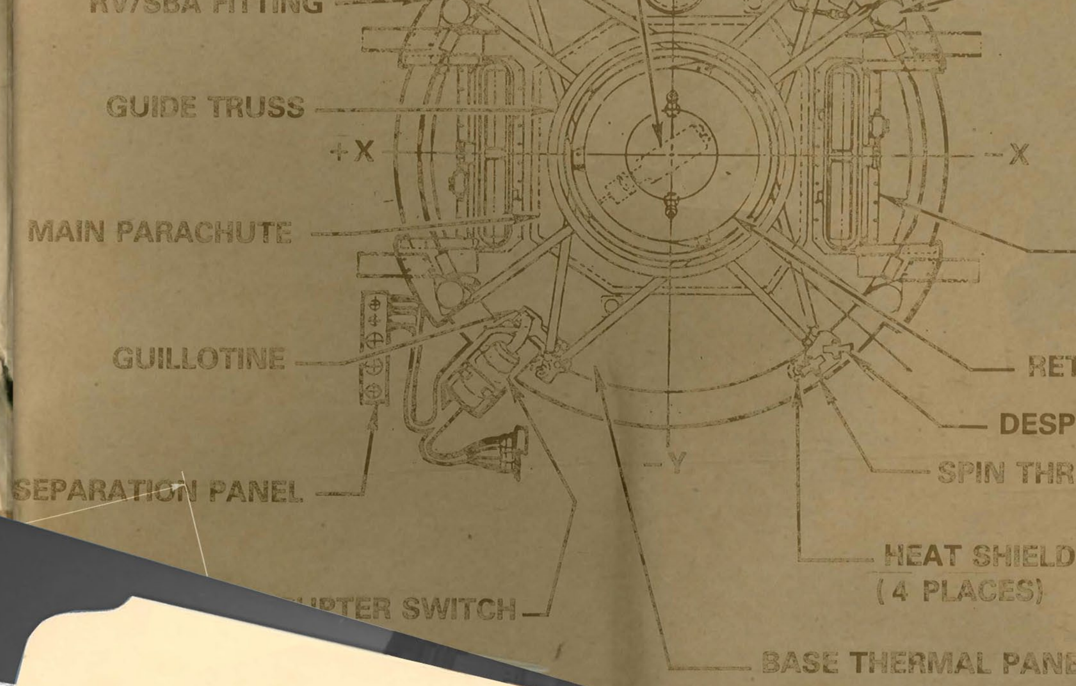

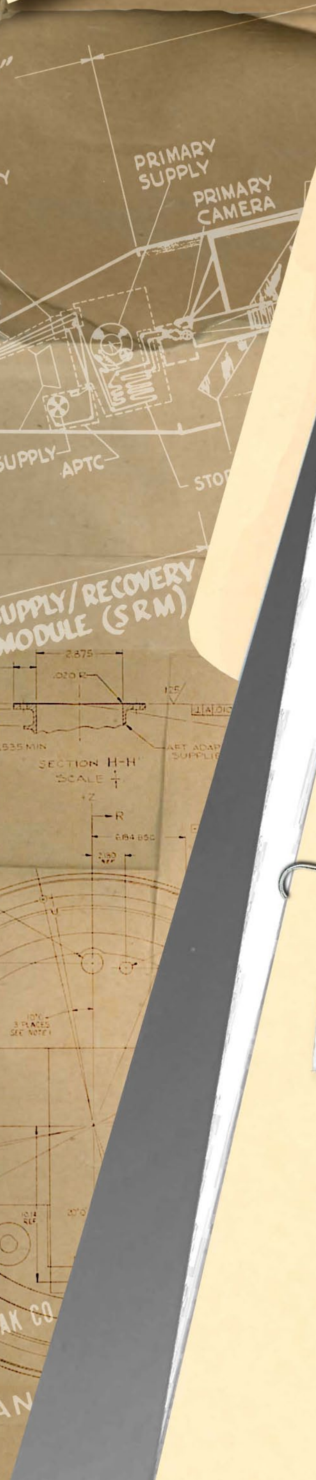

CRITICAL TO US SECURITY:
THE GAMBIT AND HEXAGON SATELLITE RECONNAISSANCE SYSTEMS COMPENDIUM

SECTION IV: SYSTEMS CAPABILITIES

We have selected the documents for this section to highlight the capabilities of the newly declassified Gambit, Gambit-3, and Hexagon systems. The documents describe the individual camera systems and were developed to help producers and consumers of imagery intelligence understand the camera systems' capabilities.

We included the National Photographic Interpretation Center's KH-7 Camera System Part I because this document presents general technical information for early exploitation of photography from KH-7. The document provides details on the strip, stellar, and index cameras that composed the integrated KH-7 camera system and flew on the Gambit system. The document highlights measurement capabilities as well.

The NRO and NPIC collaborated on a very similar document for Gambit-3. The KH-8B Camera System contains detailed information on the main strip camera as well as the cameras used to position the satellite—the terrain and stellar cameras. A comparison of the KH-7 and KH-8 camera system books reveal the significant advances that were made with the operation of the Gambit-3 system.

We opted to include the NRO's Project Hexagon Overview because it contains a very thorough description of Hexagon acquisition, operations, and search capability. The document contains descriptive diagrams explaining functions of Hexagon camera systems and is one of the single best documents we found in our review for explaining the overall Hexagon system.

LIST OF SYSTEMS CAPABILITIES DOCUMENTS

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NPIC/TP-18/63

July 1963

TECHNICAL PUBLICATION

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KH-7 CAMERA SYSTEM

PART I

CIA

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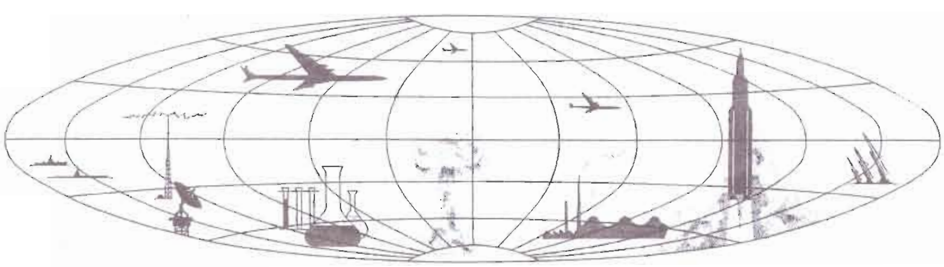
NATIONAL PHOTOGRAPHIC INTERPRETATION CENTER



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TECHNICAL PUBLICATION

KH-7 CAMERA SYSTEM
PART I

NPIC/TP-18/63
July 1963

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PREFACE

This publication presents general technical information for the early exploitation of photography obtained by the KH-7 camera system. The scales, tables, charts, and graphs presented are for the photo-interpreter's use in determining approximate sizes, scales, and relative orientation of objects or images and is not meant to take the place of the more precise mensuration parameters.

Technical information with complete mathematical analysis for reduction of quantitative data will be published as Part II of this manual.

The following data will be made available for each mission on a timely basis:

1. Camera Data: Operational focal length, lens distortions, ramp informations, film velocity, image motion data, film type, filters, exposures, slit width, and expected resolution.
2. Stellar/Index Unit Data: Calibrated focal lengths, distortions, grid intersections, exposures, etc.
3. Orbital Data: A one second orbital ephemeris for each second of camera operation, including velocity, altitude, geographic position, time of operation, etc.
4. Vehicle Attitude: Pitch, roll, and yaw, and rates of each when available.

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INTRODUCTION

The KH-7 camera system consists of a single strip camera, a stellar camera, and an index camera.

The strip camera utilized in the KH-7 system will provide relatively large-scale, high-acuity photography of selected target areas in either monoscopic or stereo modes. It is designed to provide the photo-interpreter with an image considerably larger and with better ground resolution than that provided by the present KH-4 surveillance system. The strip camera can roll about its longitudinal axis to either side of the ground track in increments of 0.709 degrees to a maximum of plus or minus 44 degrees 40 minutes. This allows centering of the target area in the format of the strip frame. Also the camera is yawed around its vertical axis to eliminate coriolis force.

The strip camera consists of a rotating mirror, a 77-inch focal length folded lens system, and a cylindrical platen. (See Figure 1 for details.) The camera system may be operated in several modes: monoscopic strip, stereoscopic superimposed strips, or lateral pairs of strips. Any of these modes are available in any of the roll positions. (See Table No 1.)

Table No 1. Roll Positions Available In Degrees (Left or Right)

0 Vertical	11.344	22.688	34.032
0.709	12.053	23.397	34.741
1.418	12.762	24.106	35.450
2.127	13.471	24.815	36.159
2.836	14.180	25.524	36.868
3.545	14.889	26.233	37.577
4.254	15.598	26.942	38.286
4.963	16.307	27.651	38.995
5.672	17.016	28.361	39.704
6.381	17.725	29.060	40.413
7.090	18.434	29.778	41.122
7.799	19.143	30.487	41.831
8.508	19.852	31.196	42.540
9.217	20.561	31.905	43.249
9.926	21.270	32.614	43.958
10.685	21.979	33.323	44.667

The film width is 9.460 inches with variable length to each strip depending on operation parameters. This system will produce an image at a nominal scale of about 1:90,000, and the nominal strip will be about 12 nautical miles (nm) in width.

The lens film resolution will be approximately 2.5 feet with proper camera operation.

Two time tracks are recorded on the film with a binary time word recorded on each track every .8 second.

Yaw slits are exposed on both sides of the film as an aid in attitude analysis.

THE STRIP CAMERA

DESCRIPTION OF THE STRIP CAMERA

The strip camera is a 77-inch focal length folded lens system consisting of a primary rotating mirror, a meniscus lens, a stationary primary mirror, a diagonal mirror, field flatteners, a slit plate, and a rotating platen.

The rotating mirror moves to forward and aft positions to produce 30 degree convergent photography for the stereo and lateral pair operating modes. In the mono strip mode the mirror is stationary at 45 degrees from the axis of the lens system. This is a narrow angle lens system since the angle of coverage is only 6.4 degrees with a half angle of 3.2 degrees across ground track. The primary mirror and diagonal mirror focus the image through the slit onto the rotating platen.

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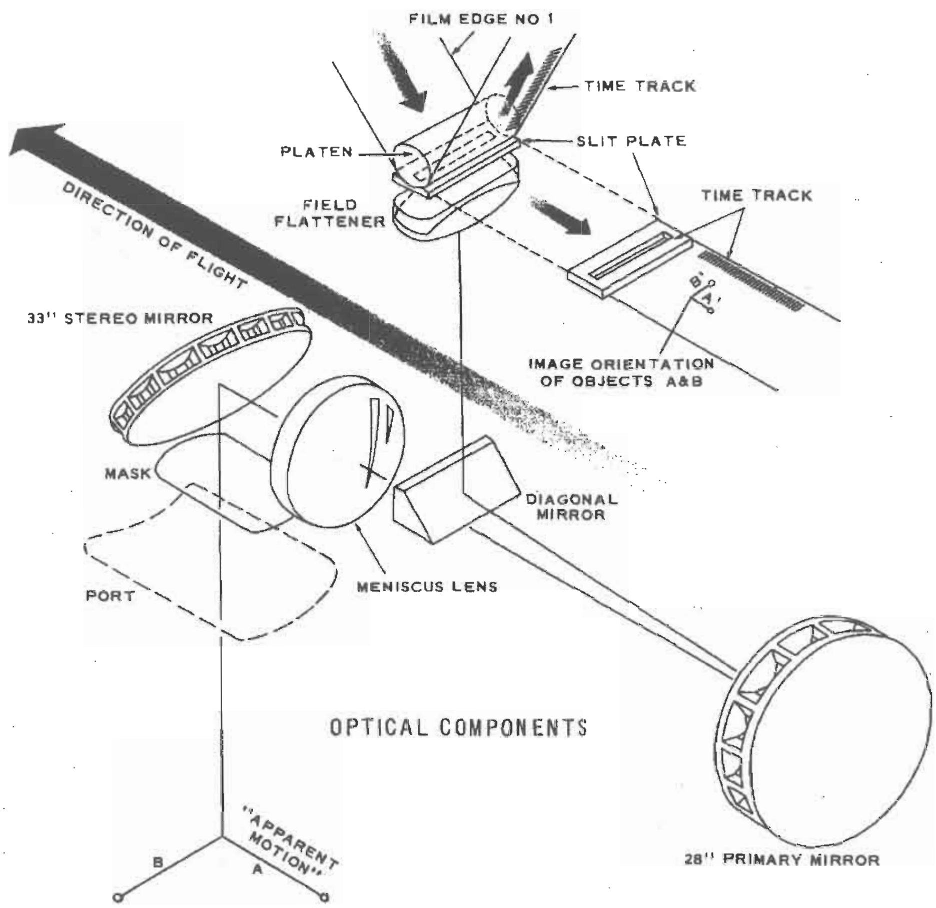

NPIC H-3530 (7/63)

FIGURE 1. KH-7 CAMERA LENS SCHEMATIC.

The speed of the rotating platen is the controlling factor in production of sharp, distortion-free images and therefore is of utmost importance to the intelligence community. (See "Discussion of Strip Camera".) This cylindrical platen moves at variable speeds and carries the film past the image forming slit at a speed compatible with the movement of ground images past the slit. When operating at the proper speed, this platen will enable the camera to produce sharp images with high resolution. (See Table No 2.)

A pair of fiducial lines will be on the film, one on each edge, rather than fiducial marks. These lines will be the same distance apart at all times, since they are being exposed at the same time that the image is exposed, and will be one controlling factor in mensuration and determination of coverage and size of objects. In addition to these two

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Table No 2. Lengths of Film Strips in Inches With Varying Film Speeds and Lengths of Operations

Film Speed Inches Per Second										
2.022	4.04	6.07	8.09	10.11	13.35	18.20	24.87	50.55	101.10	207.05
2.132	4.26	6.40	8.52	10.66	14.07	19.19	26.22	53.30	106.60	218.32
2.242	4.48	6.73	8.97	11.21	14.80	20.18	27.58	56.05	112.10	229.58
2.352	4.70	7.06	9.41	11.76	15.52	21.17	28.93	58.80	117.60	240.85
2.462	4.92	7.39	9.85	12.31	16.25	22.16	30.29	61.55	123.10	252.11
2.572	5.14	7.72	10.29	12.86	16.98	23.15	31.64	64.30	128.60	263.38
2.682	5.36	8.05	10.73	13.41	17.70	24.14	33.00	67.05	134.10	274.64
2.793	5.59	8.38	11.17	13.97	18.43	25.13	34.35	69.83	139.65	286.00
2.903	5.81	8.71	11.61	14.52	19.15	26.12	35.70	72.58	145.15	297.27
3.013	6.03	9.04	12.05	15.07	19.88	27.11	37.06	75.33	150.65	308.53
3.123	6.25	9.37	12.49	15.62	20.61	28.10	38.41	78.08	156.15	319.80
3.233	6.47	9.70	12.93	16.17	21.33	29.09	39.76	80.83	161.65	331.06
3.343	6.69	10.03	13.37	16.72	22.06	30.08	41.12	83.58	167.15	342.22
3.453	6.91	10.36	13.82	17.27	22.79	31.08	42.48	86.33	172.65	353.59
3.564	7.13	10.69	14.26	17.82	23.52	32.07	43.83	89.10	178.15	364.95
3.674	7.35	11.02	14.70	18.37	24.25	33.06	45.19	91.85	183.70	376.22
3.784	7.57	11.35	15.14	18.92	24.98	34.06	46.54	94.60	189.20	387.48
	2.0	3.0	4.0	5.0	6.6	9.0	12.3	25.0	50.0	102.4

Length of Operation in Seconds

lines, there will be four yaw slits, two on each edge of the film. Each pair of slits is offset from the image slit, one on either side, so that the same image is exposed at two different times. By analyzing the image displacement from slit to slit, roll and yaw can be determined.

STRIP CAMERA FEATURES

Lens: Meniscus Maksutov, Concave-Convex Type.

Rotating Mirror: Plano Surface Mirror 33 Inch Diameter.

Focal Length: 77 Inches.

Slit Plate: Three Slit Widths Available (not changeable during operation).

Primary Mirror: 1st Surface Spherical Mirror (focusing mirror).

Diagonal Mirror: Rectangular Flat Mirror.

Field Flattener: Two Lens Elements (Chromatic Aberration Corrector).

Film Load: 3,000 Feet, 9.460 Inch Width.

Format Size: 8.718 Inches (variable length).

DISCUSSION OF STRIP CAMERA

A strip camera is primarily a motion recording device which stabilizes an image in the focal plane by moving the film past a stationary slit at the same speed as the image moves past the slit. When these two motions are in synchronization, a high resolution image is recorded on the film. Since the film speed and image speed are difficult to establish in an orbiting vehicle, a discussion of variations caused by changes in speed is necessary.

Assuming a stable vehicle, the camera can be operated at near the proper speed, and images formed are very close to precise scale; however, as the speed of the film image combination varies away from the synchronous position, distortion will occur along the line of flight. This distortion or smearing of images is a direct result of film-image speeds, and with the speed available in the KH-7 camera system, smear of 130% is possible along the flight path.

Smear is not the only type distortion apparent in strip photography since a mismatch of film-image speed can also cause compression of images along the flight path. If film speed is too fast for the image, elongation occurs, and if the film speed is too slow for the image, compression occurs.

Any change of film speed will cause elongation or compression of images along the flight path, and because of this, it is very difficult to determine sizes of objects in that direction. A high order of elongation or compression is readily apparent to the trained eye; however, a small order of elongation or compression will make distortion of the size and shape of objects difficult to detect. If the speed of the film changes during exposure, a differential distortion pattern will result in trapezoidal shapes of rectangular objects and curving lines that should be straight.

Since the speed of the film is applicable in only one direction, there is no distortion across the film with a stable vehicle, and all distortions caused by incorrect film speed are in the longitudinal direction of the film (parallel to flight path). Since the vehicle is not a stable platform, it is possible to have distortions caused by vehicle motion in the pitch, roll and yaw planes. There are two separate motions, static and dynamic conditions, in each of the planes. The static condition is when the vehicle is rolled, pitched, or yawed from its nominal position and remains in this position throughout the exposure. The dynamic condition is when the vehicle is pitching, rolling, or yawing during the exposure. For the static condition, pitch and roll are altitude sensitive because any change in vehicle attitude in these planes will alter the image speed at the center of the lens; since image speed is the one that controls film speed, distortions will occur in the direction parallel to the flight path. In the dynamic condition where movement is occuring during exposure, the motion is translated to the images being recorded, and distortions will occur in either direction, parallel to the flight path or perpendicular to it.

Yaw is not altitude sensitive, but the rotational motion in the dynamic condition is translated to the image the same as the pitch and roll motions are. Under static yaw conditions only small amounts of distortions are evident unless the yaw is excessive.

All of the distortions or smear of images discussed may occur at the same time and on the same exposure; therefore, determination of the exact cause of image distortion is not possible. Part II of this manual will discuss the mathematical approach to the problem of determination of image size and shape with multiple image motion problems.

OPERATING MODES

The KH-7 camera system can produce single strips of photography over a wide range of sizes from a minimum of 4 to a maximum of 387 inches in length; however, normal operations will fall in a much narrower range of 13 to 46 inches in length. (See Table No 2.) The film speeds available are from 2.022 inches per second up to 3.784 inches per second in 64 separate speeds; this allows operation in various portions of the orbit to produce distortion-free photography. (See "Discussion of Strip Cameras".)

When operating in either the stereo mode or in the lateral pair mode, the lengths of strips are controlled by speed of the vehicle and its altitude. The stereo pairs are programmed to produce 100% forward lap, and the lateral pairs are programmed to produce parallel strips with minimum side lap. (See Figures 2 and 3.) In the stereo mode, the rotating mirror is moved to the forward-looking position (15 degrees from the vertical along the flight path or parallel to the flight path); a strip of photography is ex-

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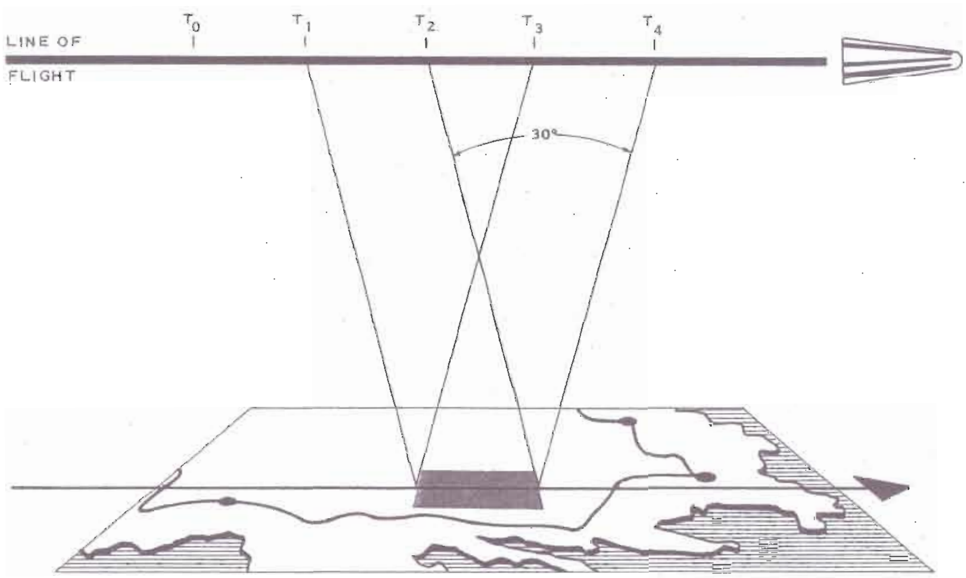

FIGURE 2. STEREO OPERATION SCHEMATIC.

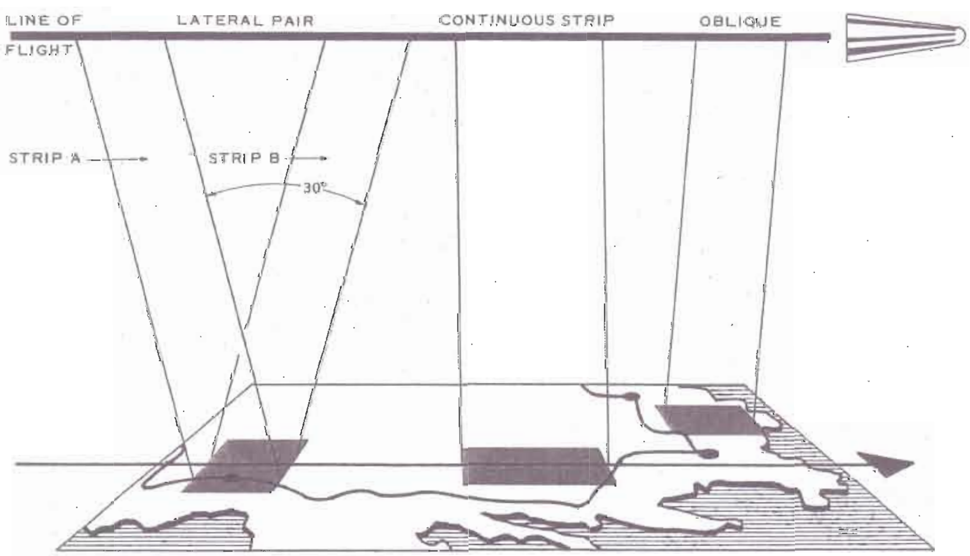

FIGURE 3. OPERATING MODES KH-7 CAMERA SYSTEM

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posed; then the mirror is rotated to its aft position (15 degrees), and the second exposure is made. Some roll is required to produce 100% stereo coverage due to coriolis; therefore, the vehicle rolls to the correct position between exposures. For the lateral pairs, the same 15 degree forward and aft positions are occupied, but the roll position is changed between frames to produce parallel photographs, rather than stereo.

The camera will produce photography over a wide range of coverage area by producing strip, pair, or stereo coverage any place within the 89 degree angular roll coverage available. Any mode may be operated in any roll position, and therefore, a high accuracy pointing camera is available. (See Figures 4 and 5.)

FORMAT AND TITLING

The KH-7 camera format provides a photographic strip of variable length, with a scene width of 8.514 inches as measured between the fiducial lines and excluding the yaw slits. This represents the usable image width. The scene width, if yaw slits are included, is 8.718 inches. (See Figure 6.)

At nominal altitude, the ground coverage width is approximately 12.25 nm. It is not anticipated that altitudes will vary to the extent that width of ground coverage will be less than 10 nm or appreciably more than 20 nm under normal oribtal conditions. (Refer to Table No 3 for altitude/coverage computations.)

The maximum obtainable strip length is approximately 32 feet if film speed and operational time are set to their limits. Strip length, therefore, will vary as film speed and length of camera operation are varied. A total of 64 speed steps are available, from a minimum of 2.022 inches to a maximum of 3.784 inches per second. The length of camera operation may range from 2 seconds to 102.4 seconds. Refer to Table No 2 for the pertinent data. The end of each frame will be denoted by an overexposed section of film, with a small area of distorted imagery caused by film speed acceleration and deceleration in this area. (See Figure 2.) The titling is imprinted in 10-point type on the film edge opposite the edge that contains the time track and is right-reading with the emulsion ~~up~~ down on film positives. Titles are started 1.5 inches in from the leading edge of the photographic format and are repeated to provide two complete title blocks within every 18 linear inches of film. Explanation of the title increments follows, in order of appearance:

1. Pass Direction Designator ("A" or "D", as appropriate)
2. Pass Number
4 ~~3.~~ Engineering Pass Designator ("E"), if applicable
3 ~~4.~~ Frame Number - The sequence begins with 001 on each photographic pass
5. Mission Number
6. Day-Month-Year (The day is the Z Date of each frame, and the components in this increment are separated by spaces)
7. Security Classification
8. Special Designations (Codeword)

FOCUS

The KH-7 camera system is designed to minimize spontaneous changes in focal length (FL = 77 inches) generated by mechanical or thermal factors beyond the system's control. However, it is recognized that slight shifts in excess of acceptable tolerances may be induced in the image plane by environmental conditions during launch or orbit. Consequently, a focus control assembly is provided for determination

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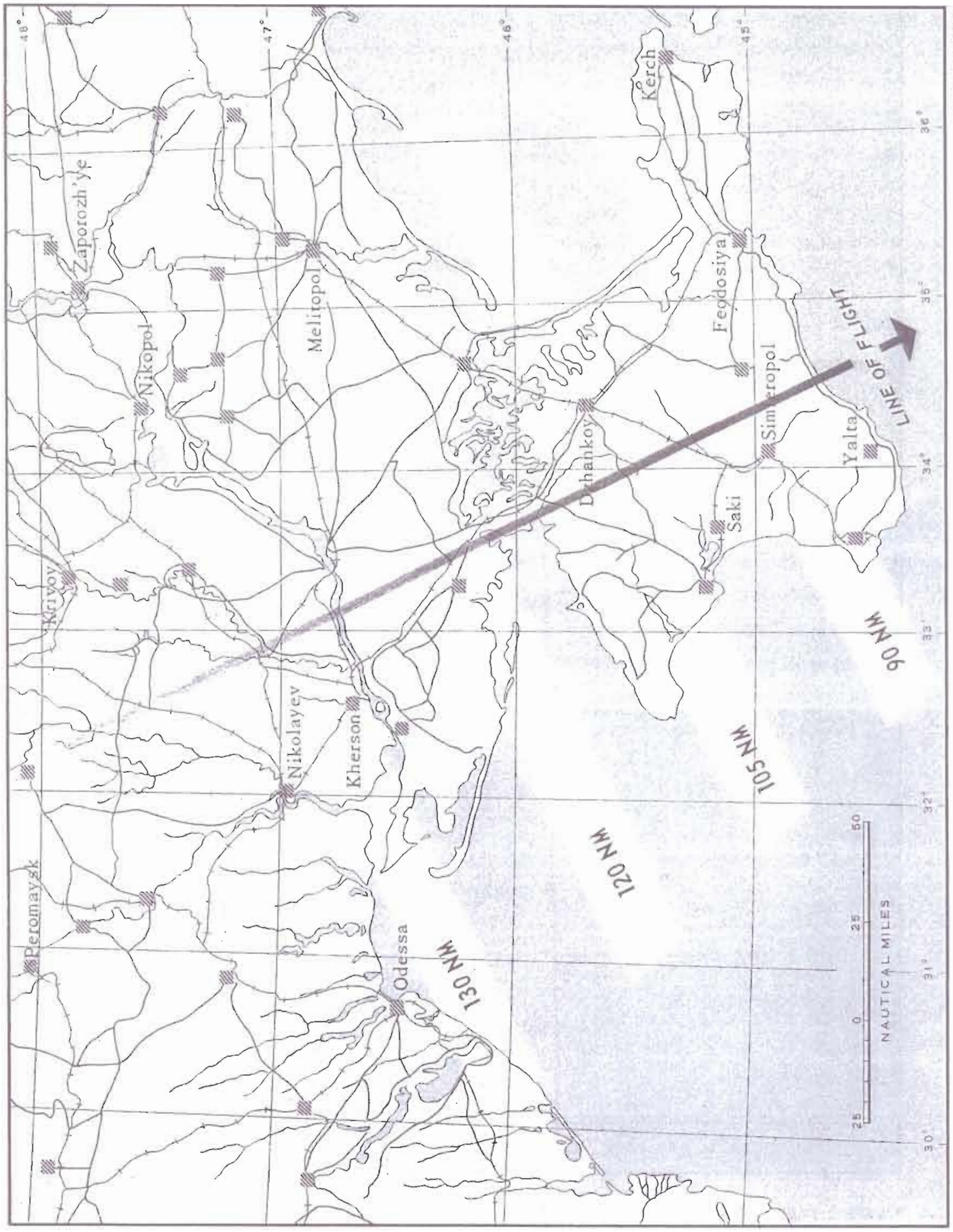

FIGURE 4. POSSIBLE SEARCH AREA FOR VARIOUS ALTITUDES OF KH-7 PROVIDED BY ROLL CAPABILITY.

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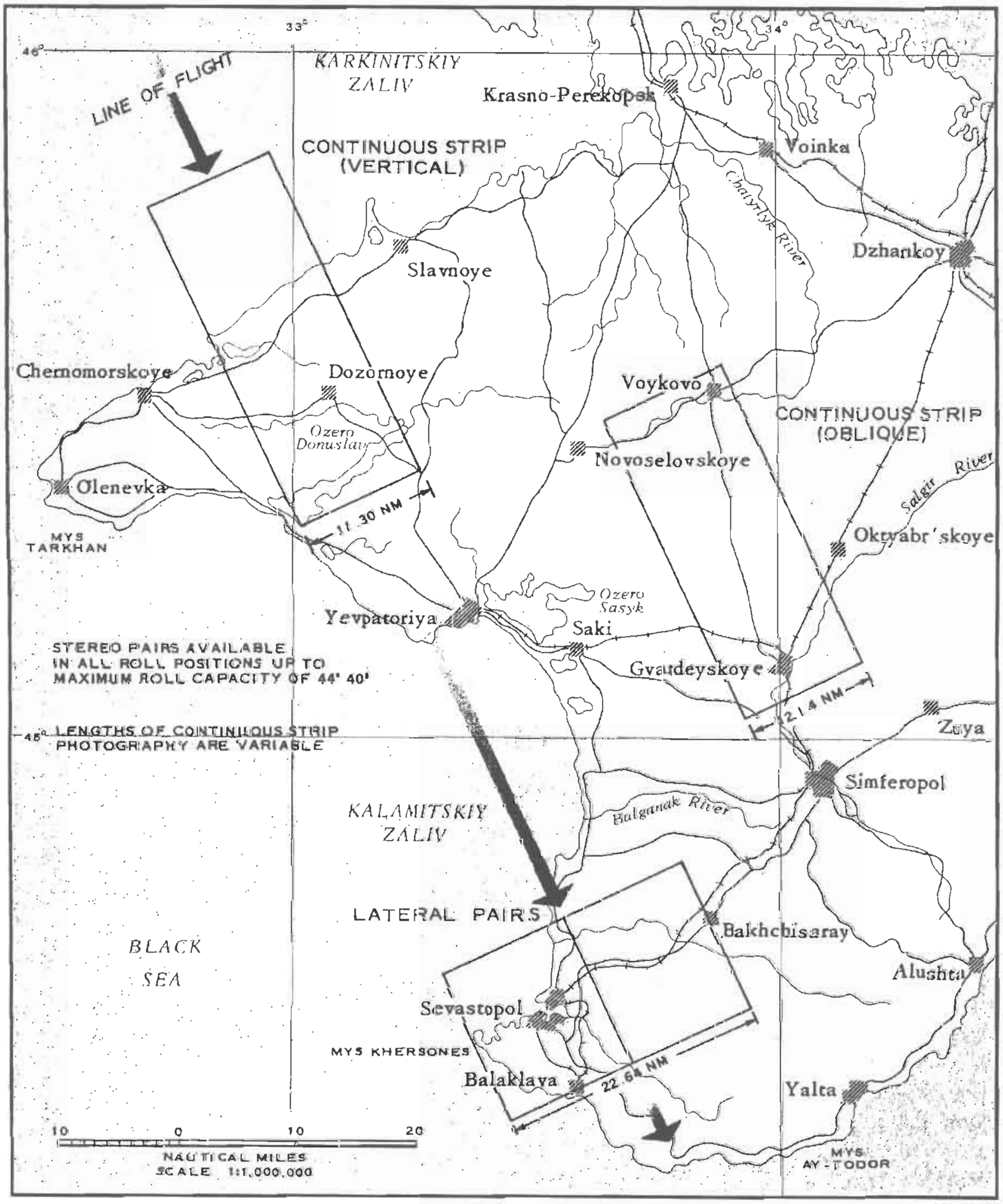

FIGURE 5. TYPICAL EXAMPLES OF CONTINOUS STRIP AND LATERAL PAIR FRAME COVERAGE AT NOMINAL 95 NM ALTITUDE.

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Table No 3. Vertical Coverage Table

ALTITUDE NAUTICAL MILES	ALTITUDE FEET	WIDTH COVERAGE NAUTICAL MILES	SCALES	WIDTH COVERAGE IN FEET
90	547,200	10.06	85,275	61,186
90.46	550,000	10.12	85,712	61,500
95	577,600	10.62	90,013	64,586
98.68	600,000	11.03	93,504	67,090
100	608,000	11.18	94,750	67,984
100.33	610,000	11.22	95,062	68,200
102.80	625,000	11.50	97,400	69,886
104.44	635,000	11.68	98,958	71,004
105	638,400	11.74	99,488	71,384
106.91	650,000	11.95	101,296	72,680
110	668,800	12.30	104,225	74,784
111.84	680,000	12.51	105,970	76,036
113.49	690,000	12.69	107,530	77,154
115	699,200	12.86	108,965	78,182
115.13	700,000	12.89	109,088	78,372
116.78	710,000	13.06	110,646	79,390
118.42	720,000	13.24	112,205	80,508
120	729,600	13.42	113,700	81,582
120.89	735,000	13.51	114,540	82,186
123.35	750,000	13.80	116,880	83,864
125	760,000	13.98	118,438	84,980
125.82	765,000	14.07	119,218	85,540
127.46	775,000	14.25	120,776	86,660
129.93	790,000	14.53	123,115	88,340
130	790,400	14.54	123,175	88,380
131.58	800,000	14.71	124,672	89,454
135	820,800	15.10	127,913	91,780
139.80	850,000	15.63	132,464	95,044
140	851,200	15.65	132,651	95,180
143.91	875,000	16.09	136,360	97,840
145	881,600	16.21	137,389	98,578
148.02	900,000	16.55	140,256	100,636
150	912,000	16.77	142,216	101,978
152.13	925,000	17.01	144,152	103,430
155	942,400	17.33	146,864	105,376
156.25	950,000	17.48	148,048	106,226
160	972,800	17.89	151,601	108,776
160.36	975,000	17.93	151,944	109,020
164.47	1,000,000	18.40	155,840	111,818
165	1,003,200	18.45	156,340	112,176
168.58	1,025,000	18.85	159,736	114,612
170	1,033,600	19.00	161,076	115,574
172.69	1,050,000	19.31	163,632	117,408
175	1,064,000	19.57	165,814	118,974
176.81	1,075,000	19.77	167,528	120,204
180	1,094,400	20.13	170,551	122,372
180.92	1,100,000	20.25	171,424	123,000

of the optimal lens-image plane--film-surface plane relationship. The range of focus adjustment is ± 0.010 inches.

In general terms, the focus control assembly evaluates the conditions of focus. When departure from the limits of best focus is detected, the focus output signals (generated by the detector) indicate that an adjustment of focus is required. The focus drive motor, upon command, then shifts the film platen a controlled distance, returning the plane of best focus to coincidence with the film surface plane.

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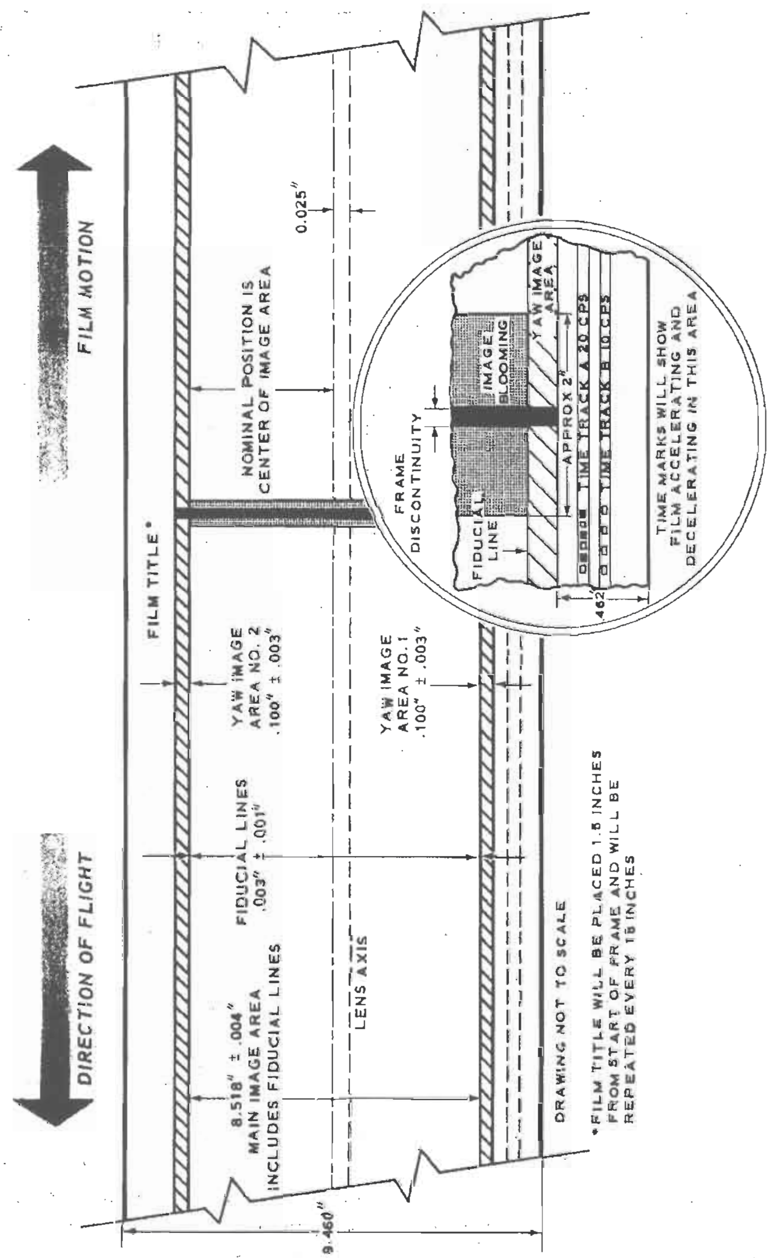

FIGURE 6. KH-7 FILM FORMAT.

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TIME MARKS

A time track will be exposed on the film from which correlative data may be extracted. This time track is composed of two separate time tracks, one operating at 10 cycles per second (cps) and one operating at 20 cps. Binary time is recorded in both time tracks for redundancy checks, with the index marks for each track appearing at different intervals (50 milliseconds apart for the 20 cps track and 100 milliseconds apart for the 10 cps track). (See Inset, Figure 6.)

The binary time word is recorded in 23 bits to an accuracy of .1 second and is repeated every .8 second.

The size and variability of this time word and time track precludes early and easy access to the information. The variability of the time track and time word are controlled by the speed of the film moving past the slit; since this is a variable speed, the recording of the time track is variable also. (See "Discussion of Strip Cameras".) The size of the time track is so small that it is difficult to distinguish individual data bits at less than 10-time magnification, and a 25- or 30-time magnification is necessary to adequately read the time track.

STELLAR/INDEX CAMERA

The stellar/index camera system to be employed in the KH-7 system is the same one used in previous KH-4 and KH-6 systems. (See Figure 7.) These S/I units may be operated at varying intervals to produce adequate exposures for attitude determination during the main strip camera operation. A greater film supply than has been available in the KH-4 S/I units will allow more flexibility in the number of exposures and therefore attitude determination.

STELLAR CAMERA

The stellar camera produces photography of the stellar field over a format area 0.9375 inches diameter. A reseau grid is superimposed on the image plane to produce four fiducial marks at certain intersections of the grid and also to produce a grid on the exposure. The orientation of the reseau grid will vary from mission to mission. Calibration data for the camera and its reseau grid will be supplied with other camera data for each mission.

Frame correlation marks will appear on random frames for correlations of stellar frame and index frame.

Only the frame number will be titled on each frame. Frames will be numbered consecutively throughout the mission. Titling information consisting of mission number, date, classification, codeword, and a chart correlating frames to passes will be affixed to the head leader.

Stellar Camera Data

Lens: Cannon f/1.9.

Focal Length: 85 mm.

Cone Angle: 16 degrees.

Shutter Speed: 0.5 second to 6 seconds.

Filter: None.

Film Load: Variable 35 mm by 75 to 250 feet.

Format Size: 0.9375 inches diameter.

Reseau Grid: 2.5 mm calibrated grid.

In the roll positions available, the stellar camera will be photographing a changing star field since the entire package is rolled to these positions. In the case of a negative roll condition, the stellar unit will be pointing at or near the earth's surface; therefore, attitude may not always be available from this source.

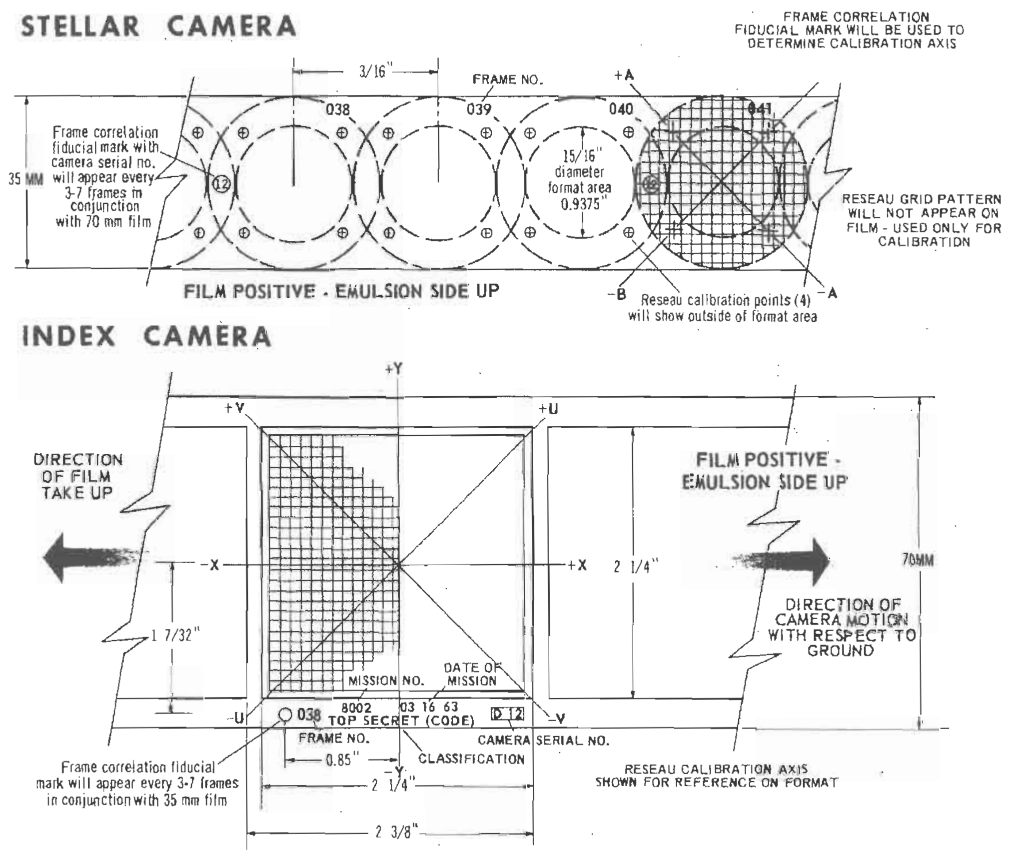

FIGURE 7. STELLAR AND INDEX CAMERA FORMAT AND TITLING.

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INDEX CAMERA

The index camera used is the same as the one in use on other systems, and has a format size of 2.25 inches square with a 2.5 mm reseau grid superimposed on the image. Calibration will be provided for each index camera, and the camera serial number will be recorded on each frame. A frame correlation mark, on a random frame basis, will be imaged for correlation of the stellar camera on one edge of the frame. Titling data will include the frame number, mission number, date, classification, and codeword. Frames will be numbered consecutively throughout the mission, and a chart correlating frames to passes will be attached to the leader.

INDEX CAMERA DATA

Lens: Zeiss Biogon f/4.5.

Focal Length: 38 mm.

Field Angle: 72 x 72 degrees.

Shutter Speeds: 1/125 second, 1/250 second & 1/500 seconds.

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Filter: Wratten 21.

Film Load: 70 mm by 125 to 500 feet.

Format Size: 2.25 inches square.

Reseau: 2.5 mm calibrated grid.

Scale: Approximately 1:4,400,000.

The index camera will photograph the portion of the earth directly in line with the roll position of the vehicle since the index camera will be rolled the same amount as the main camera system. This will preclude yaw analysis and stereo coverage between frames taken at different roll positions.

GLOSSARY

The possible degradation of photography by image smearing is inherent in any aerial photographic system. (See Figures 8, 9, and 10.) Hence, one of the major requirements of a system is the capability of reducing or compensating for the various smear-inducing factors. The following are technical terms most commonly encountered with relation to this problem:

IMAGE SMEAR: The degradation or distortion of terrestrial images, usually evidenced by edge-smearing in a direction parallel to the line of flight or approximately perpendicular to it, depending on the factors involved. Elongation or compression of images results, and circular objects may be recorded as elliptical forms.

ALONG-TRACK SMEAR: Image smear parallel to the forward motion or flight path of the camera vehicle.

CROSS-TRACK SMEAR: Image smear perpendicular to the forward motion or flight path of the camera vehicle.

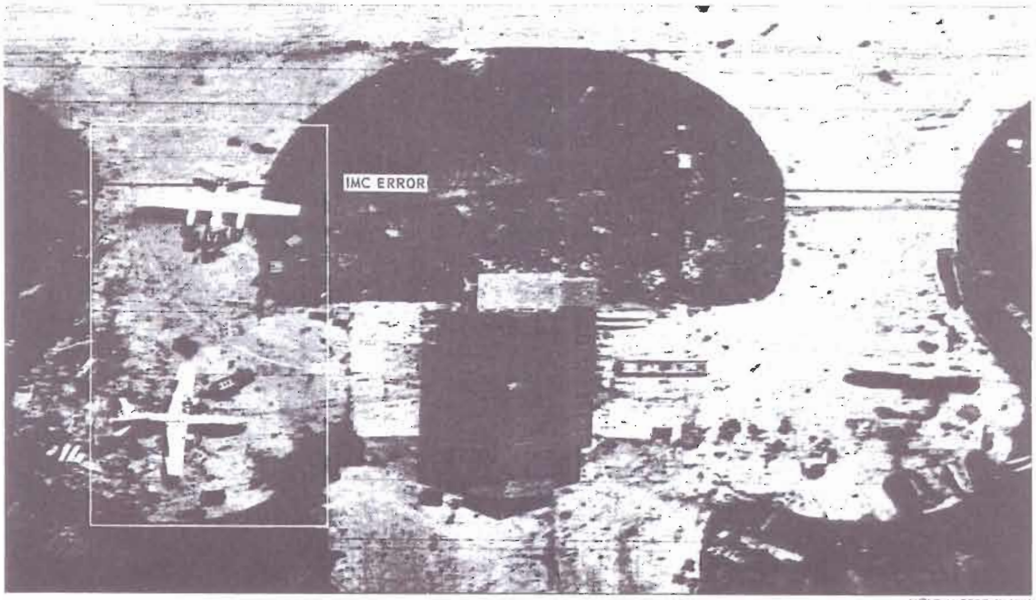

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FIGURE 8. DISTORTION IN STRIP PHOTOGRAPHY.

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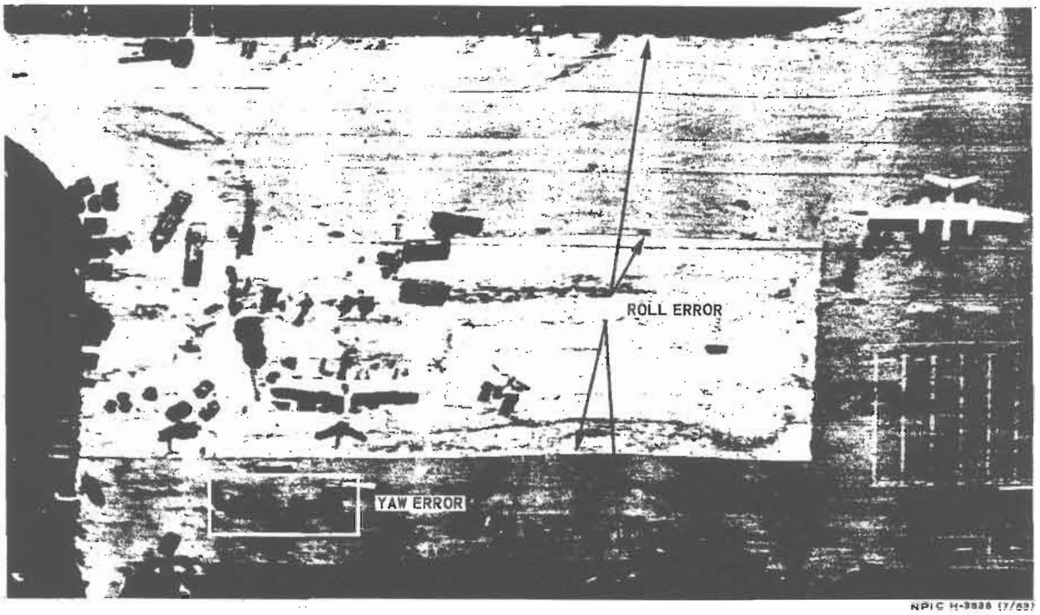

FIGURE 9. DISTORTION IN STRIP PHOTOGRAPHY.

FILM SPEED: The rate at which the film is advanced in the camera as a means of compensation for the relative motion between terrestrial images and the camera. If too slow, images of ground objects will be compressed; if too fast, images will be elongated.

PITCH: Movement of the vehicle about its lateral axis. Pitch deviations may be negative or positive with relation to the nominal reference angle and alter the camera altitude over ground objects.

PITCH RATE: Motion during exposure, not to be confused with pitch, per se. However, pitch rate is similarly altitude-sensitive and therefore causes along-track image smearing.

ROLL: Movement of the vehicle about its longitudinal axis. This results in a change in attitude that alters the height of the camera over ground images; hence, it is an along-track error. However, note carefully the distinction between roll and roll rate with relation to image smear effect.

ROLL RATE: Motion during exposure. Since the actual movement leading to roll change in vehicle attitude is perpendicular to the line of flight, it is so recorded by the film, resulting in cross-track image smears.

YAW: Rotation from the line of flight of the longitudinal axis of the vehicle about its vertical axis.

YAW RATE: Motion during exposure. Since yaw and yaw rate are not altitude-sensitive, the resultant displacement of ground imagery is solely in a lateral direction and induces cross-track smearing.

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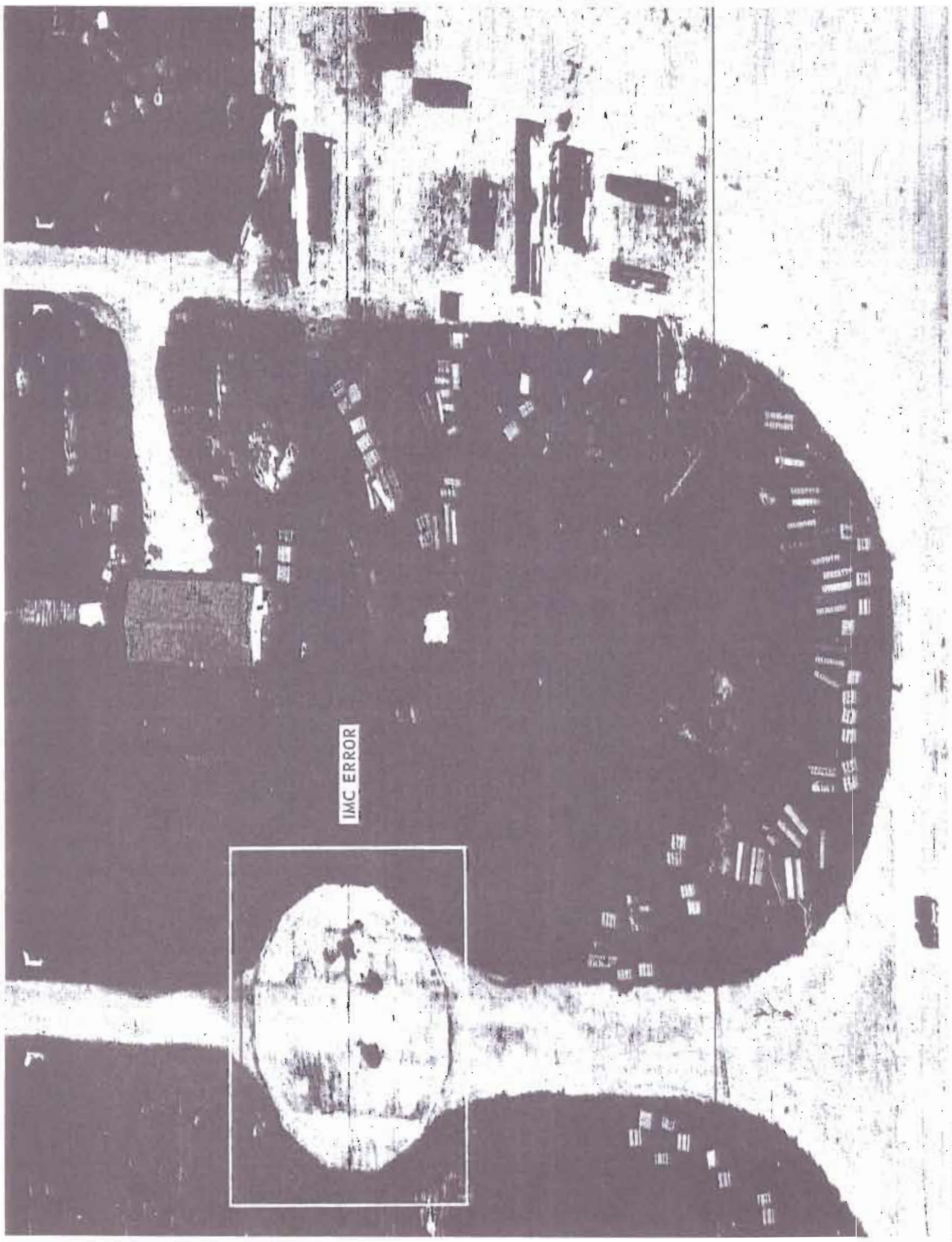

FIGURE 10. DISTORTION IN STRIP PHOTOGRAPHY.

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THE KH-8B CAMERA SYSTEM

THIRD EDITION

PUBLISHED BY
NATIONAL PHOTOGRAPHIC INTERPRETATION CENTER
OCTOBER 1970

Group I Excluded from Automatic
Downgrading and Declassification

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PREFACE

This data book has been prepared by the National Reconnaissance Office with the assistance of the National Photographic Interpretation Center to facilitate the use of the photography from the KH-8B camera system. This book revises and updates previous releases concerning this system.

Third Edition

October 1970

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

INTRODUCTION

The KH-8B camera system (Figure 1) consists of four cameras and two recovery buckets. Various improvements are designed to increase the primary camera resolution by about 30% and increase the lifetime of the vehicle by an additional 6 days over the next 10 missions (starting with 27). The Primary camera is designed to produce high-resolution, large-scale photography of selected target areas.

A separate unit, the Astro-Position Terrain Camera (APTC), contains the other 3 cameras, one 75mm focal length terrain frame camera and dual 90mm focal length stellar cameras. The terrain camera is designed to point in the direction of the principal ray of the main camera. It provides mapping coverage and images for relative orientation. The stellar cameras are pointed 180 degrees apart, one to the port (left) side of the vehicle and one to the starboard (right) side. These provide at least one reduceable stellar frame with each main camera frame. The APTC will also be improved by providing a larger film load.

MAIN CAMERA

Strip Cameras

A strip camera is a device which stabilizes an image in the focal plane of the camera by moving film past a stationary slit at the same speed that the image is moving past the slit. When these two motions are synchronized, an unsmeared image is recorded on the film.

If these motions are not synchronized, the images are distorted by either compression or elongation in the direction of film movement.

Mensuration techniques allow for these variations in film speed and permit determination of changes in film speed with a high degree of accuracy.

When the camera is operating normally, the film speed should be within 0.6 mm/sec of the speed desired, except during looper action and start up transients. Image distortion will also occur if the film speed drive malfunctions or is commanded to operate at the wrong speed. However, this compression or elongation will not be discernible to the photointerpreter, and proper mensuration techniques still permit accurate mensuration of images on the film.

Optics

The optical part of the main camera consists of a flat stereo mirror, an aspheric mirror used as a converging lens, a corrector lens assembly, a slit, and a platen.

Film Drive

The film-drive mechanism is designed to maintain highly accurate and consistent film speeds throughout camera operation and through the following range of possible image motion: altitude from 65 to 135 nautical miles (nm) and obliquity angles from 0 to 45 degrees.

The film load can be either 10,000 feet of black and white 1414 ultra-thin-base (UTB) film; 7,500 feet of SO-242 UTB color film; or a combination of both film types which results in a variable film load. The film-drive mechanism prevents motion, except rotation of the platen, during normal exposure.

Accurate determinations of film speed can be made by measuring the time-track recordings on the edge of the film. These aid greatly in determining the mensuration capability for missions (See Recorded Data, p. 9).

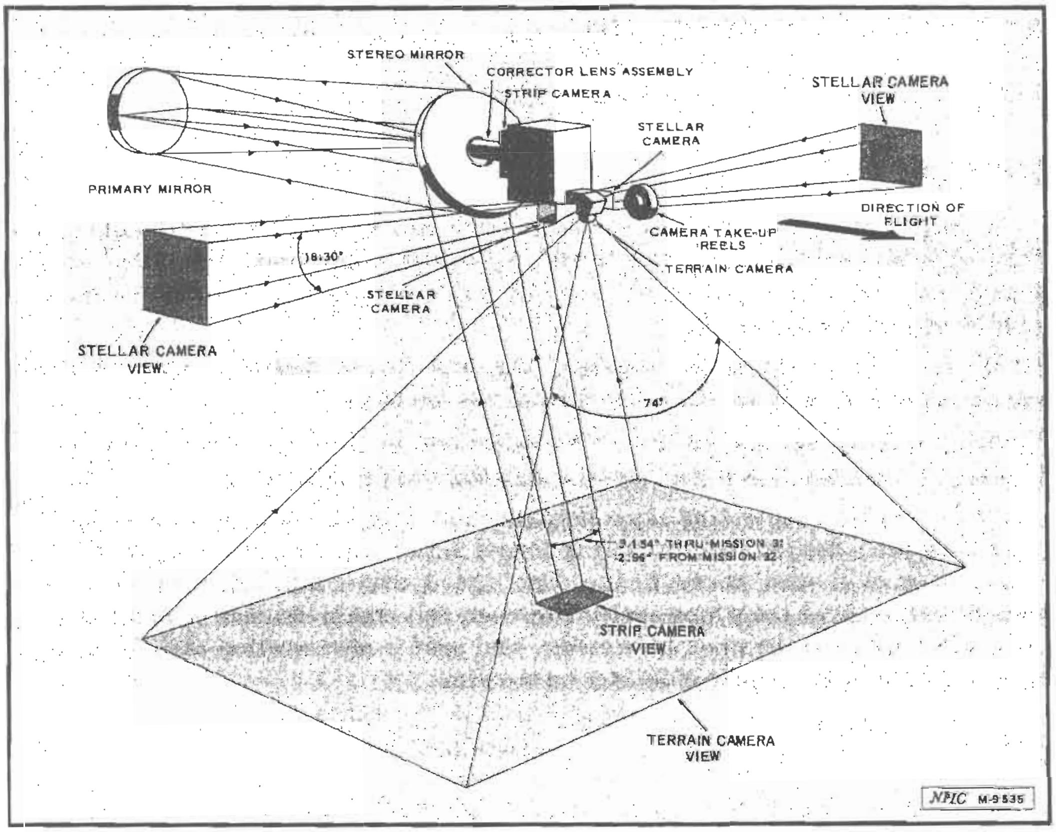

FIGURE 1. KH-8B CAMERA SYSTEM

Exposure

Film speed, slit size, and sun angle determine the exposure of images on the film. Since the film speed is determined by the speed of images in the focal plane, variation in film speed cannot be used for exposure control. Several slits have been supplied so that exposure can be controlled from sun angles of from 2 to 90 degrees and throughout the range of film speeds available (Figure 3).

Faster film speeds shorten and wider slits lengthen the exposure time. The film speed is determined by the image speed, and then the sun angle (and predicted snow cover) are viewed to find the best possible exposure. With these two parameters determined, the slit with the nearest exposure time for this combination can then be programmed.

Exposure may be determined by this formula:

$$T = W/VF$$

Where:

T = Exposure time in seconds

W = Slit width in inches

VF = Film velocity in inches per second

Unpredicted snow cover, desert scenes, and heavily wooded areas present special exposure problems. Consequently, some frames on each mission will not have the best possible exposure. These individual frames can be enhanced through printing techniques.

Control

The vehicle control system is designed to allow accurate pointing of a main camera system to the area of interest. The stereo mirror is rotated in the pitch plane of the vehicle to give the necessary angular relationship for stereoscopic coverage. The mirror can be stopped in any one of 3 positions. The effective lines of sight are 8.65 degrees forward from the vertical, vertical, and 8.65 degrees aft. Normal stereo is obtained in the forward and aft positions, but may be acquired in other modes.

The mirror is crabbed in the roll plane to compensate for the Earth's rotation.

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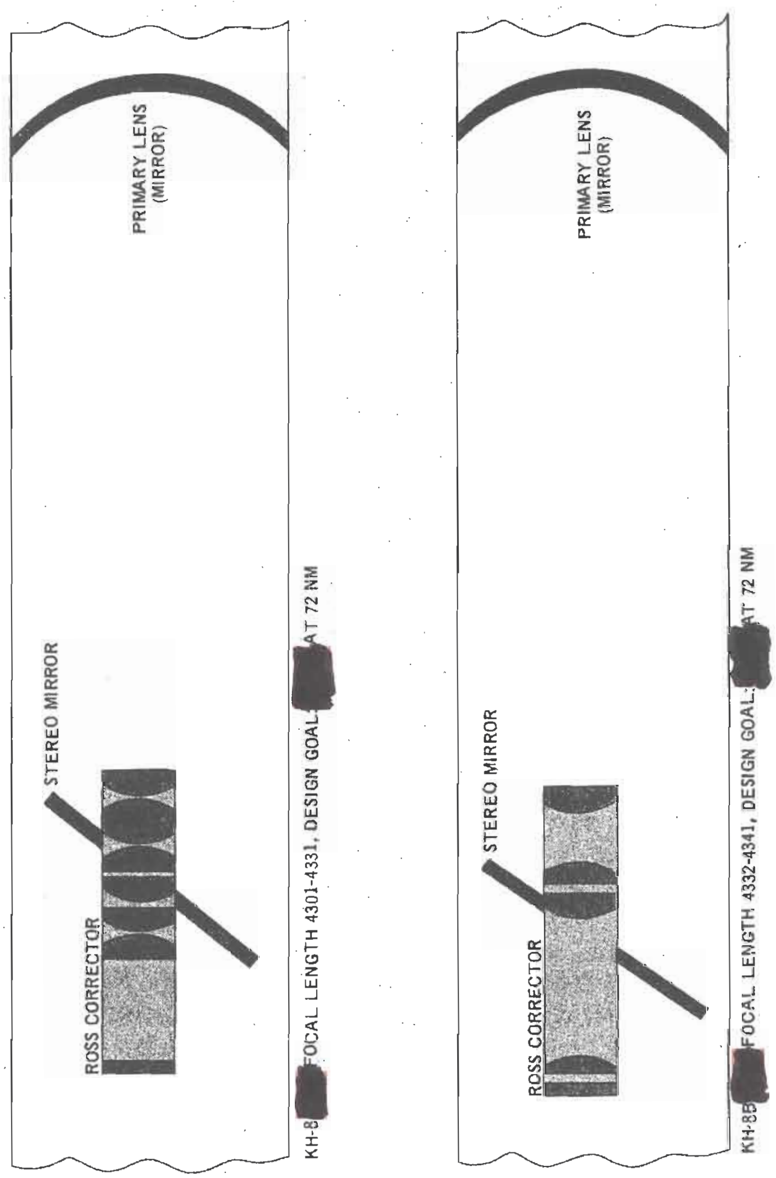

FIGURE 2. KH-8B LENS IMPROVEMENT PROGRAM

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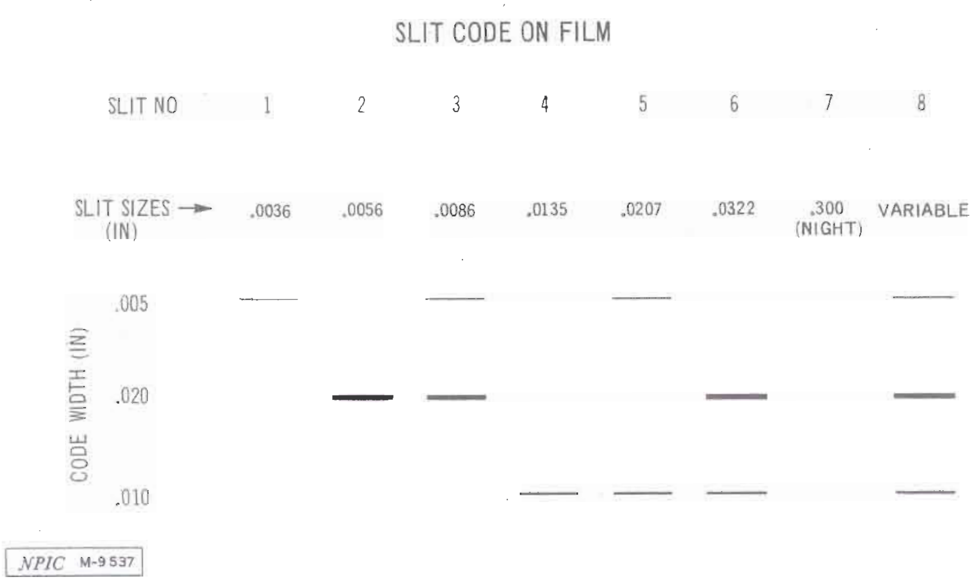

FIGURE 3. SLIT CODE ON FILM

Modes of Operation

The main camera can be used in various ways to provide the best views and selection of targets. These include:

Stereo: Fwd-aft, fwd-vertical, vertical-aft, fwd-vertical with aft mono, fwd-aft with vertical mono, fwd mono with vertical-aft.

Stereo: Double stereo fwd-aft of target with fwd-aft of second target interspersed.

Mono: Forward, vertical, aft, lateral pair, lateral triplet, end to end, and strip.

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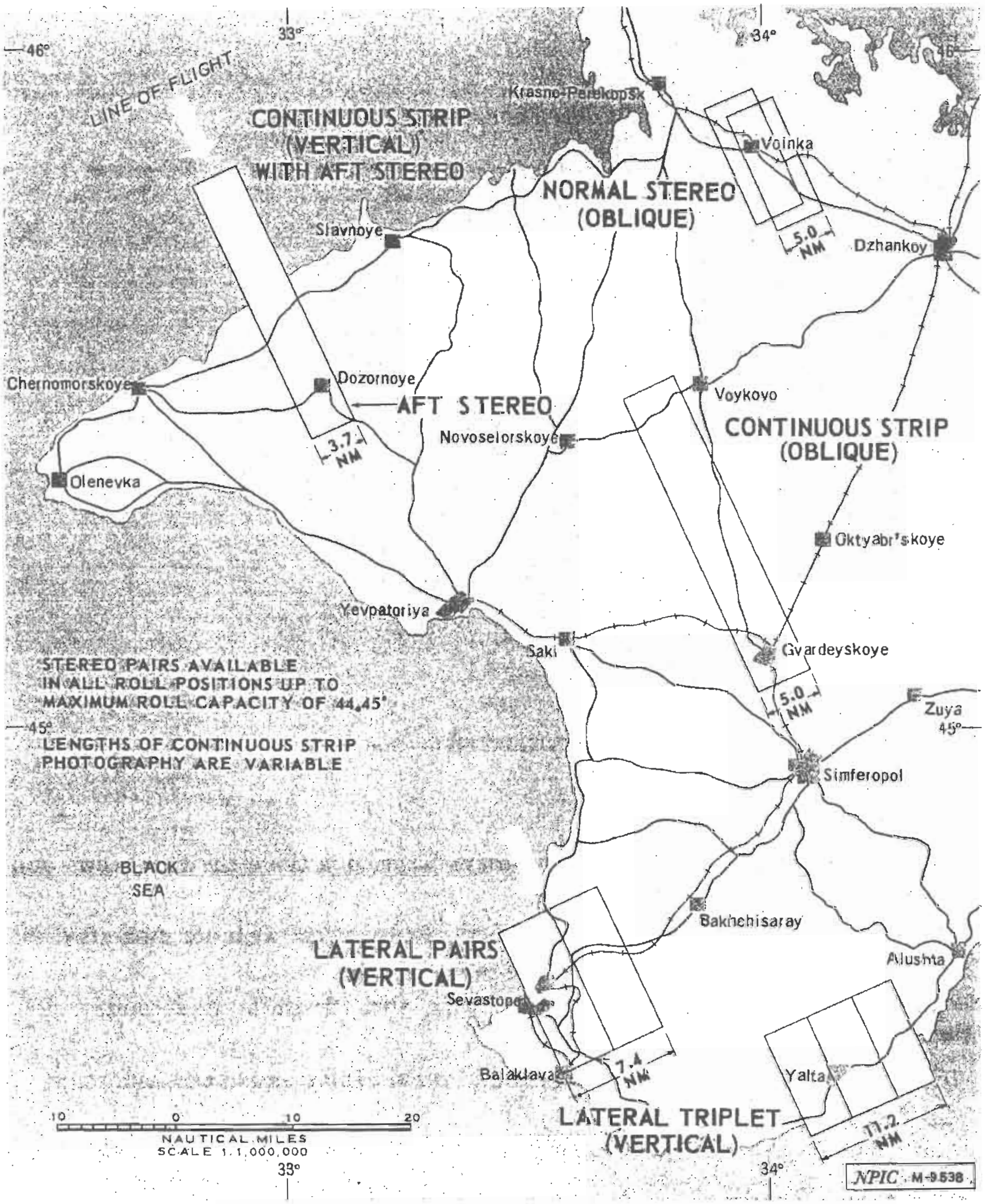

FIGURE 4. FRAME COVERAGE WITH 160" FOCAL LENGTH LENS

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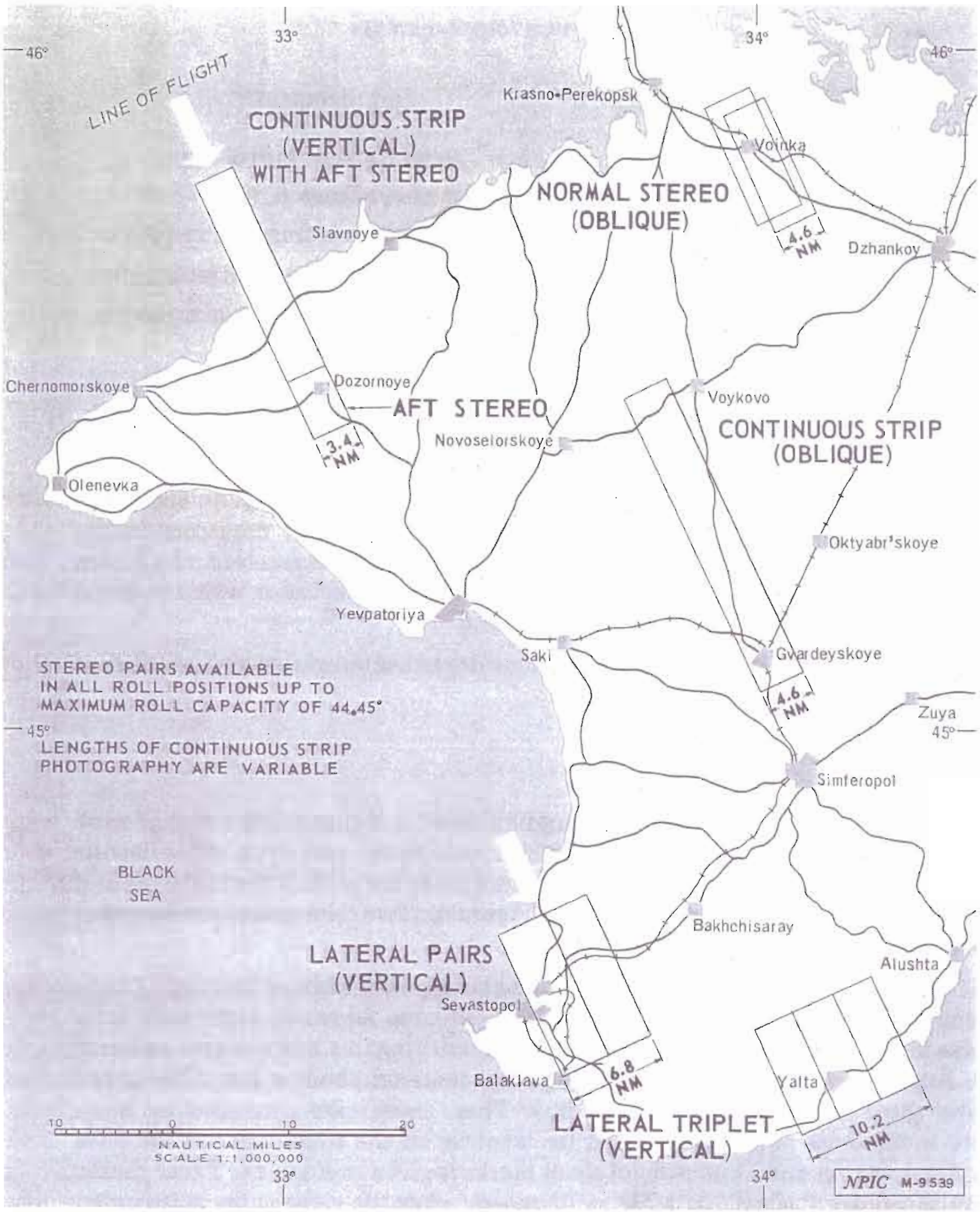

FIGURE 5. FRAME COVERAGE WITH 175.6" FOCAL LENGTH LENS

Table 1. Main Camera Improvements

Mission	Improvement
27	Low coefficient stereo mirror
29-31 (only)	Minus red filter coated on lens
32	Focal length increase from [redacted]
32	Flatter field & color corrected lens
26-32	Approach lower end of altitude range

Start-up Times and Film Coast

This system utilizes film moving on the platen face to record imagery; and, since this is a dynamic motion, a 0.25-second start-up transient time is necessary for the film to gain the proper speed. Also, when the command to stop is received, the platen and film coast to a stationary position. This coasting distance varies with the speed of the platen, but it is between 0.3 and 1.35 inches.

These two areas of the film may record some degraded imagery which should not be used for interpretation mensuration.

Format

The main camera records the image and all data on a film roll 9.5 inches wide (Figures 6 and 7). The image area is 8.810 inches wide with a yaw slit 0.100 inch wide on both sides of the film. The yaw slits record images at the ends of the main slit and provide some checks on vehicle motion (see Figure 6). Two data tracks are recorded outside the yaw slit on one side of the film.

The end-of-frame markers are recorded on the opposite edge of the film. At the beginning of each exposure or frame, the film will have remained stationary for a period far in excess of any normal exposure time, resulting in a burn-in area or burn-in line. A pair of frame-line position marks are centered about a line 2.25 inches preceding the burn-in area or burn-in line. These marks are produced by lamp exposure in the area normally reserved for labeling on the edge opposite the data tracks. The location and dimension of these marks is given in Figure 4. These marks are simultaneously flashed 700 $\pm$ 50 milliseconds after the camera is commanded off.

Titling Information

Titling information is on the base side of the original negative along the edge opposite the time track. It includes:

	SAMPLE
a. Revolution number (Pass)	196
b. Frame number	27
c. Mission - bucket number.	4332-2
d. Date of actual photography	Jan 4, 1970
e. Classification	TOP SECRET RUFF
f. Index number	+33

This information is repeated on long frames within each 18 inches of film. The frame numbers remain constant within each frame, but the index numbers advance sequentially with each title. Frames are numbered sequentially within each pass, beginning with 001. Index numbers on each pass also begin with 001.

Recorded Data

The data tracks are located near the left-hand edge of the primary film (see Figure 6). These data tracks record as photographic code marks such pertinent data as vehicle time, time of terrain camera shutter actuation and roll position.

A time label is recorded on data track A at 200 millisecond intervals. Each positive bit in the time code causes a lamp to produce a 1-millisecond exposure. The first bit in the code is always positive (binary one) and serves as synchronization pulse. The synchronization pulse is followed by a 22 bit time word with least significant bit first. For example, Figure 8 reads:

binary	1	010	010	111	111	111	100	100	10
octal		2	2	7	7	7	1	0	1

or, reading from most to least significant bit, 10177722.

A slit identifier code is also recorded on the same edge of the frame as the time track. This recording identifies the slit that is being used by continuously recording a code in three channels on the film edge (Figure 3).

Data track B is a 500 pulse-per-second timing signal containing the complement time label of data track A and the terrain camera shutter actuation indicator.

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Control System Only

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TCS-20292/70

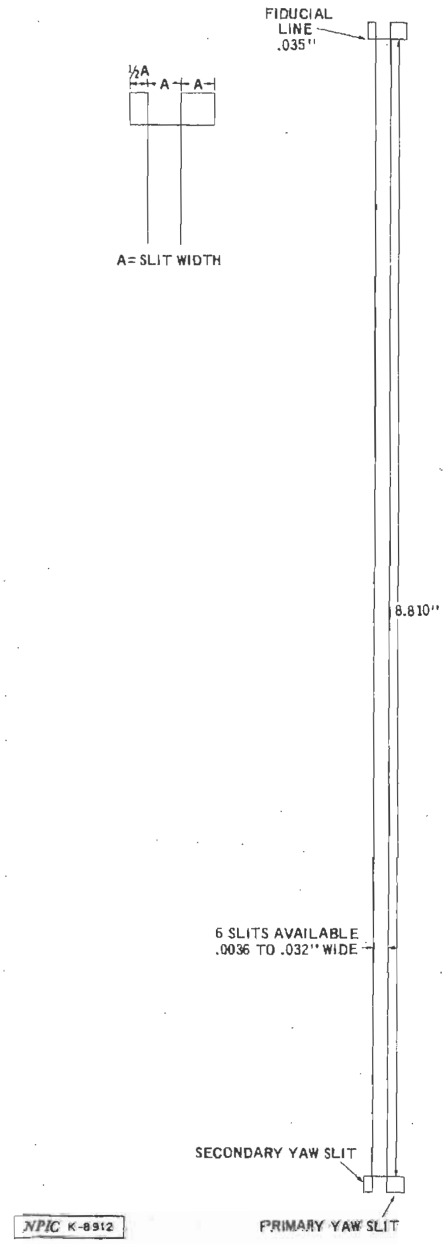

FIGURE 6. PRIMARY CAMERA SLIT

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Handle Via
TALENT-KEYHOLE
Control System Only

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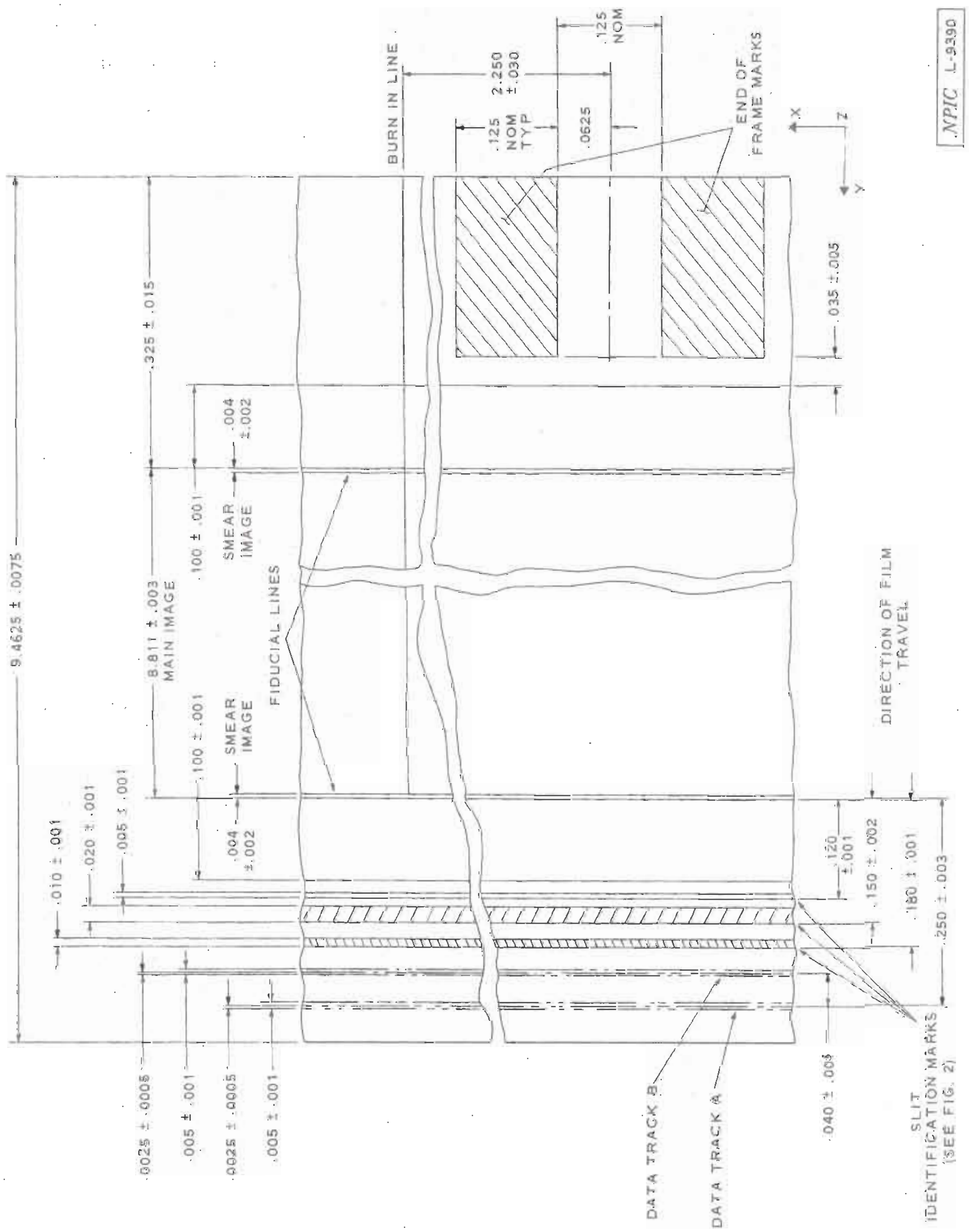

FIGURE 7. PRIMARY CAMERA FILM FORMAT, FILM NEGATIVE EMULSION SIDE DOWN

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In addition to the data recorded in the camera system, there are other sources of information available such as telemetry, command lists, calibration manuals, computer sources, and the mission correlation data (MCD), an outline of which is given below.

Mission Correlation Data

A. Data Output at Beginning of each Run

1. Earth constants
2. Vehicle Payload Constants:

a. Primary:

(1) Slit calibrations
(2) Focal length
(3) Field angles
(4) Mirror pitch angles (calibrated)
(5) Skew angle

b. APTC:

(1) Focal lengths (3 cameras)
(2) Field angles (3 cameras)
(3) Calibration angles (3 cameras)

B. Data Output at the Beginning of Each Rev Which Has Camera Operations

1. Start of new rev indicators:

a. Rev & mission number
b. GMT date of new rev
c. GMT time & longitude of ascending node

2. Ephemeris Data:

a. Vehicle inertial position (X, Y, Z)
b. Vehicle inertial velocity (XD, YD, ZD)
c. Vehicle inertial acceleration (XDD, YDD, ZDD)

C. Data Output for Primary Camera Operations

1. Event data:

a. Rev number
b. Frame number
c. Duration of event (camera exposure time)
d. Mode:

(1) One-half of a stereo pair
(2) Strip
(3) One-half of a lateral pair
(4) F = mirror fwd
(5) V = mirror vertical
(6) A = mirror aft

e. Aperture designator (slit size)
f. Cone angle (angle between nadir and principal ray)
g. Camera roll
h. Film velocity (theoretical & commanded) in inches/second
i. Camera crab angle
j. Effective shutter speed
k. Intrack-crosstrack scale
l. Frame altitude
m. Skew angle
n. Frame length in inches

2. Target Data:

a. Programmed (Target ID)
b. Actual target ID, priority and X and Y coordinates on frame for target location
c. Marginal targets
d. Frame corners latitude and longitude

3. Ephemeris and Positioning Data:

a. System time referenced to GMT
b. Geodetic position of vehicle nadir
c. Geodetic position of intersection of camera principal ray with the earth.
d. Vehicle altitude
e. Inertial velocity & azimuth of vehicle
f. Flight path angle of vehicle
g. Sun elevation & azimuth
h. V/H (Velocity/Height) ratio in radians/second
i. Payload clock time (OCTAL)

4. Programmed blank frame event & corresponding data:

D. <u>APTC Camera Data</u>

1. Dependent operation
2. Independent operation

3. Frame number
4. Time of exposure GMT & OCTAL
5. Shutter speed
6. Geodetic Latitude & Longitude of Principal Ray
7. Altitude & radial distance
8. Inertial velocity & azimuth
9. Right ascension
10. Camera roll
11. Velocity/height ratio
12. Right ascension & declination
13. Solar azimuth & elevation
14. Flight path angle
15. Swing angle

E. Film Summary Data

1. Primary Camera Data:

   (a) Rev number
   (b) Exposed frames & footage
   (c) Unexposed frames & footage
   (d) R&D exposed frames & footage
   (e) Total footage for rev
   (f) Total footage for mission

2. APTC:

   a. Independent & dependent frames
   b. Blank frames
   c. Rev and mission total footages

ASTRO-POSITION TERRAIN CAMERA

The Astro-Position Terrain Camera (APTC) system is used to produce: 1) terrain photographs for image correlation, mapping, geodetic, and relative orientation purposes, and 2) stellar photographs for attitude determinations and rate computations (Figures 9, 10, and 11).

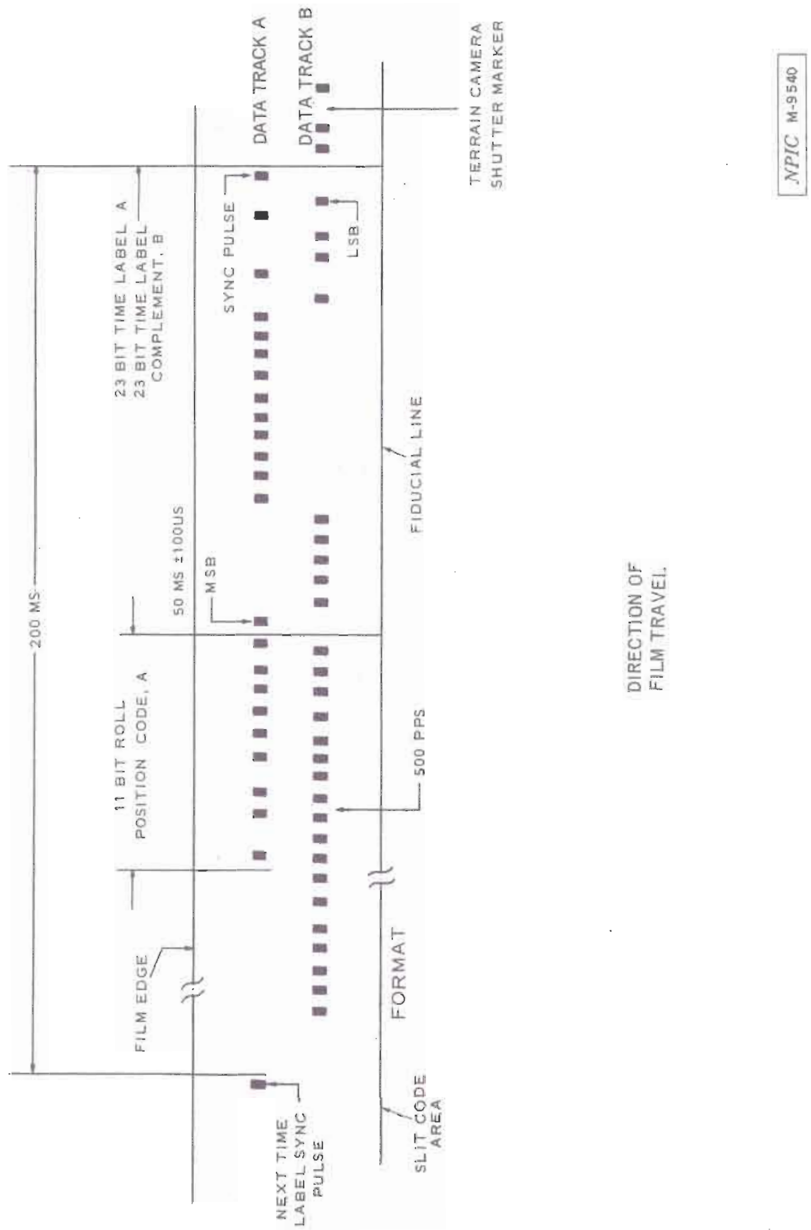

FIGURE 8. PRIMARY FILM DATA TRACKS, NEGATIVE EMULSION DOWN

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NPIC M-9541

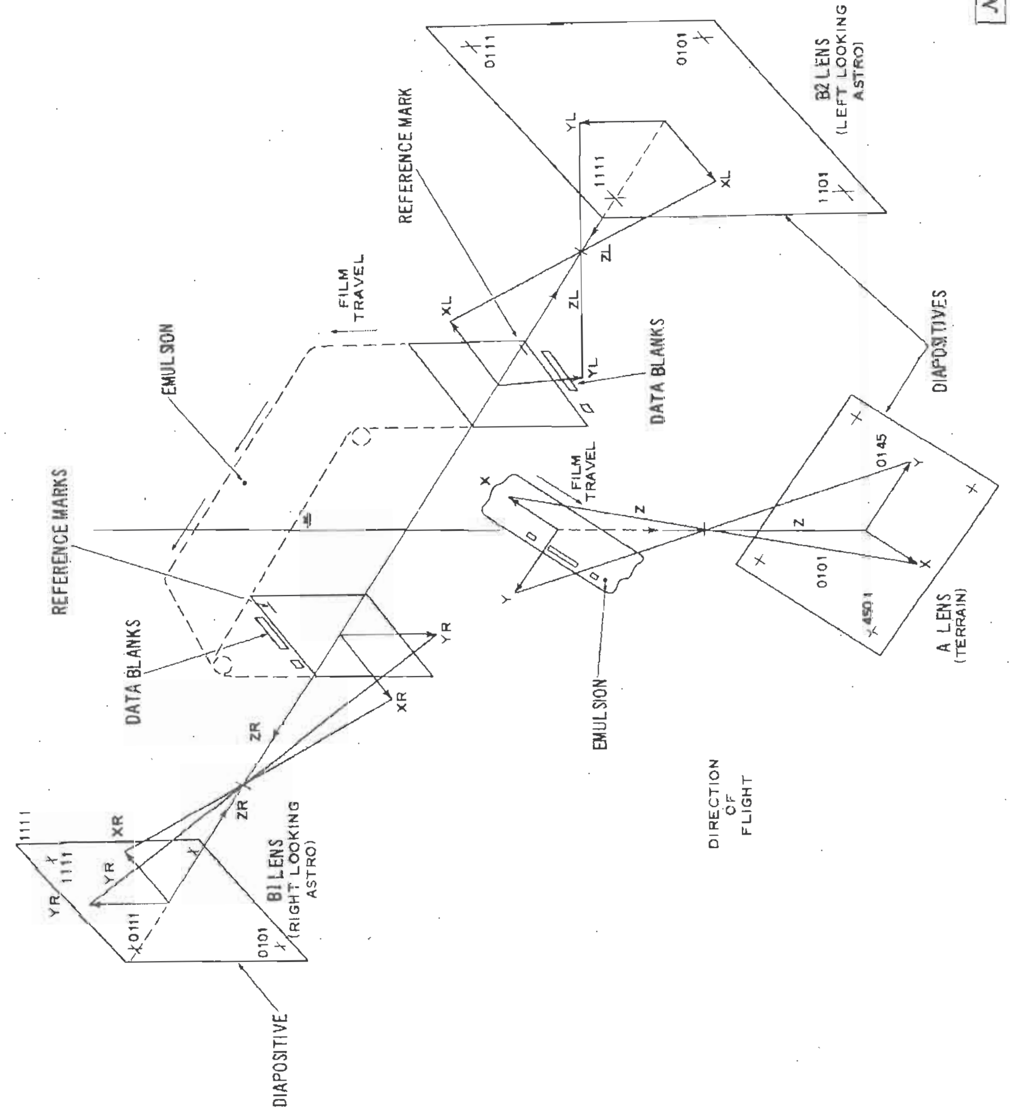

FIGURE 9. THE ASTRO-POSITION TERRAIN CAMERA COORDINATE SYSTEM

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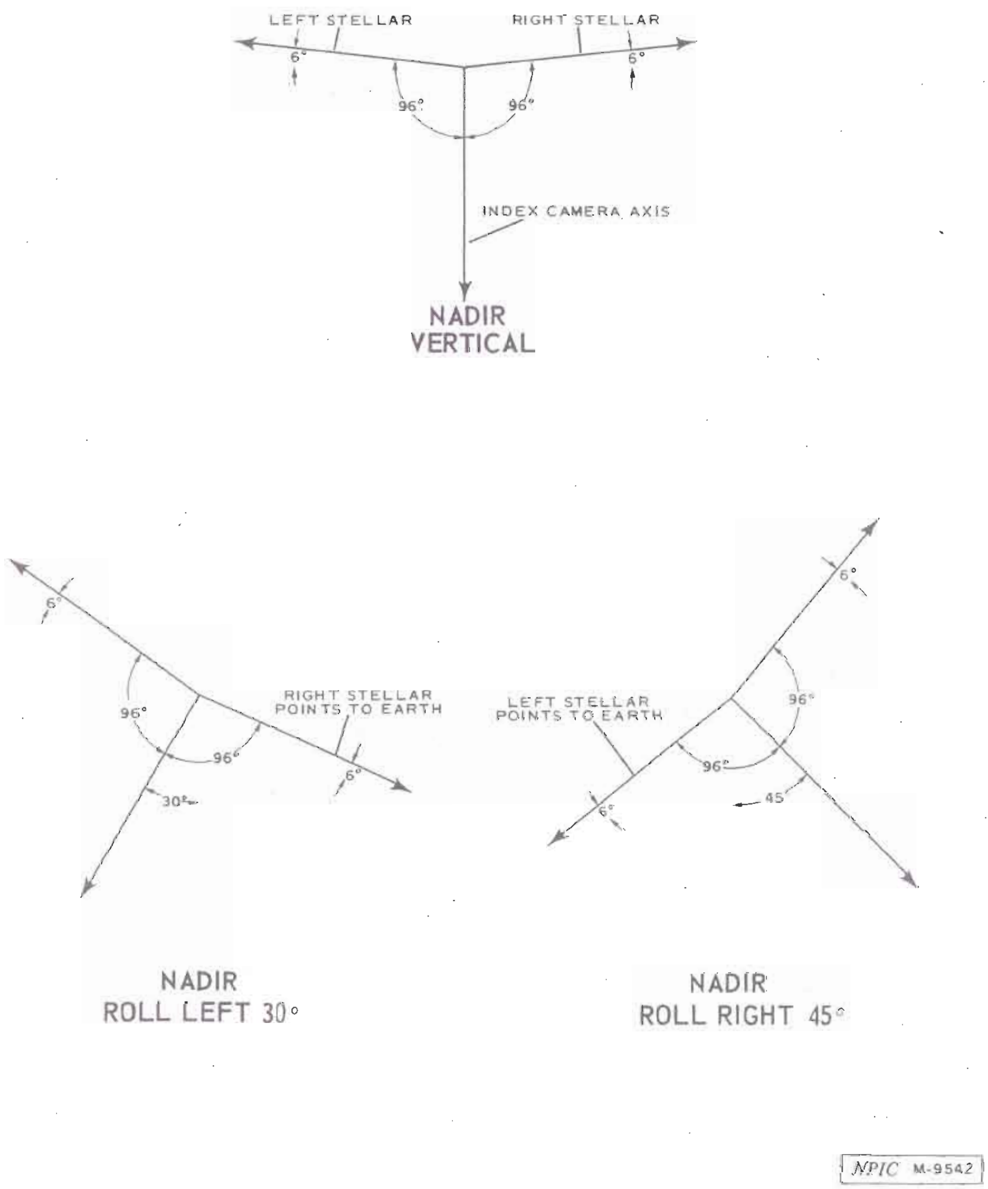


FIGURE 10. APTC ORIENTATION

Terrain Camera

The terrain camera is an f/5.0 frame camera with a 75 mm focal length. The camera uses an Aptcagon lens with a 74-degree field angle and produces frames 4.5 x 4.5 inches on 5-inch film. The camera contains sufficient ultra-thin-base (UTB) 5-inch film to photograph approximately 3,190 frames per mission. The film load will be increased with Mission 4330 to match the new APC capacity of 4,150 frames per mission.

The primary purpose of the terrain camera is to provide input to relative orientation computations for an accurate determination of the attitudes of the main frame. The terrain camera and the stellar cameras are accurately calibrated. The terrain camera is also used independently for mapping and geodetic purposes to obtain photography of poorly mapped or controlled areas of the world.

Titling Information

The titling information for the terrain camera is placed on the base side of original negatives. The information is along the edge of the film, opposite the binary time word. It includes:

- Pass number
- Frame number
- Mission number
- Date of photography
- Classification

Pass numbers are titled in the blank frame at the beginning and end of each pass. Frames are numbered sequentially throughout each pass, beginning with 001. The terrain format is shown in Figure 12.

Data

Table 3. Terrain Camera Data

Focal length	75mm
f number	5.0
Half field angle	47 deg diagonal
Full field angle	94 deg
Film format	4.5 x 4.5 in
Film type	1414
Exposure	1/200 sec, 1/300 sec, and 1/500 sec (changeable on orbit)
Film supply	3,190 to 4,150 frames
Reseau	2.5-mm grid

Stellar Camera

The stellar cameras, pointed out opposite sides of the vehicle, are used to match main camera frames with useable stellar frames. These cameras point with the main camera. Therefore when the main camera rolls the APTC rolls to the same place. Since high roll angles would cause a single stellar camera to be pointing at the ground half the time, two stellar cameras are required to get full coverage. They are mounted to point six degrees above the horizontal line through the vehicle to eliminate albedo light. Therefore, in the vertical and near vertical positions, two useable photographs will be taken.

The stellar cameras are f/2.0 cameras with a 90-mm focal length, a 25.6-degree field angle, and a 29 x 29mm square film format (Figure 13).

A 2.5-mm reseau grid superimposed on the format of both the stellar and terrain cameras aids in calibration and data reduction.

The stellar cameras produce two exposures with each index frame, and, since these two cameras are physically separated, the same left and right exposures are two frames apart on the film.

The exposure time selected for the stellar cameras is 0.4 seconds. However, if this should prove inadequate, it can be changed to .8, 1.2, 1.6, or 2.0 seconds as necessary on future missions.

Titling Information

The original negative on the stellar camera is not titled except for the beginning and end of each pass. The duplicate negatives are titled on the base side, the duplicate positives are titled on the emulsion side.

The information carried on the duplicate negatives and duplicate positives includes the frame number (in sequence) and the left or right designator. The sequence of photographs in each stellar pass is as follows: 1 left, blank, 2 left, 1 right, 3 left, 2 right, 4 left, 3 right, etc. The leader contains the mission number and classification. The stellar format is shown in Figure 13.

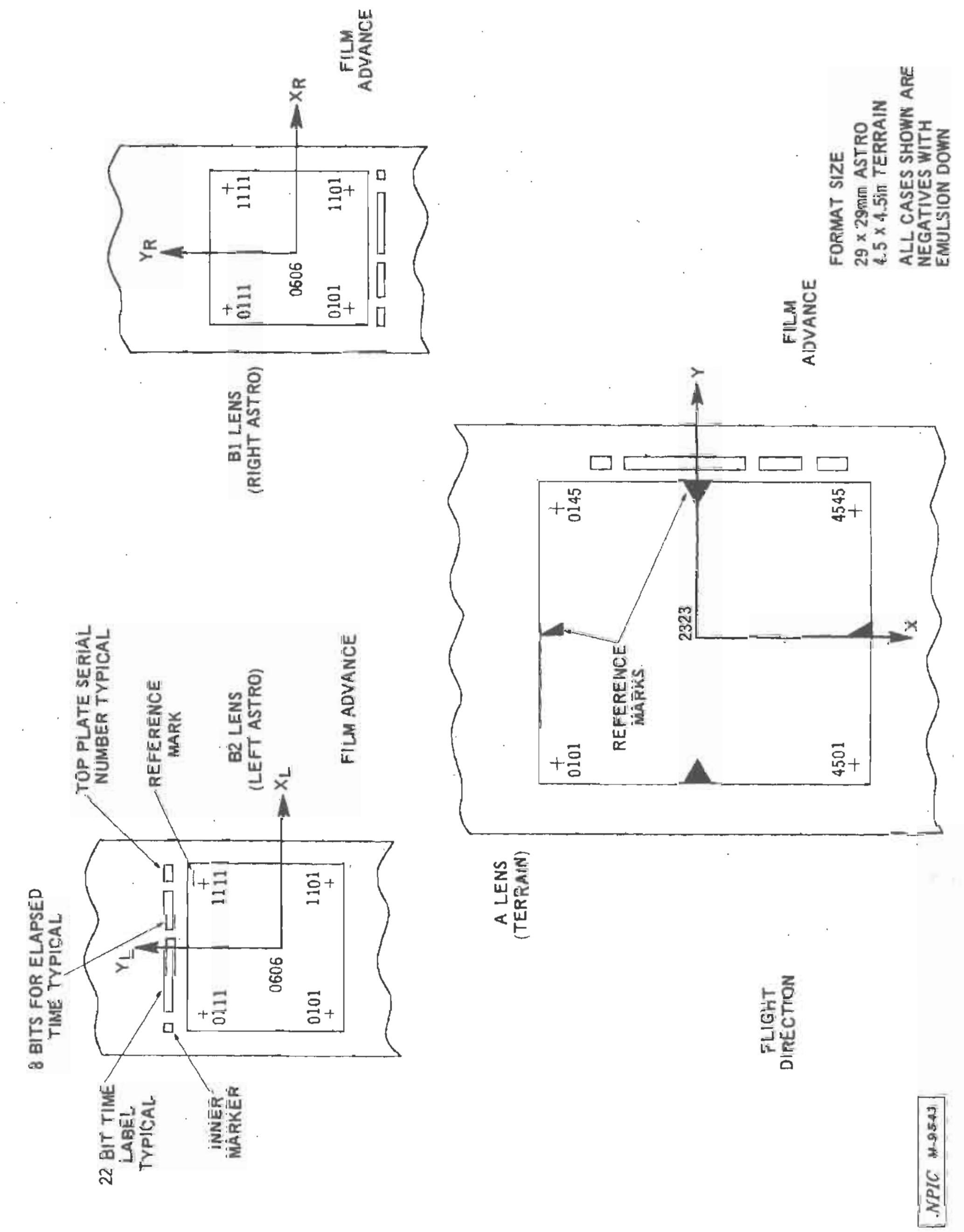
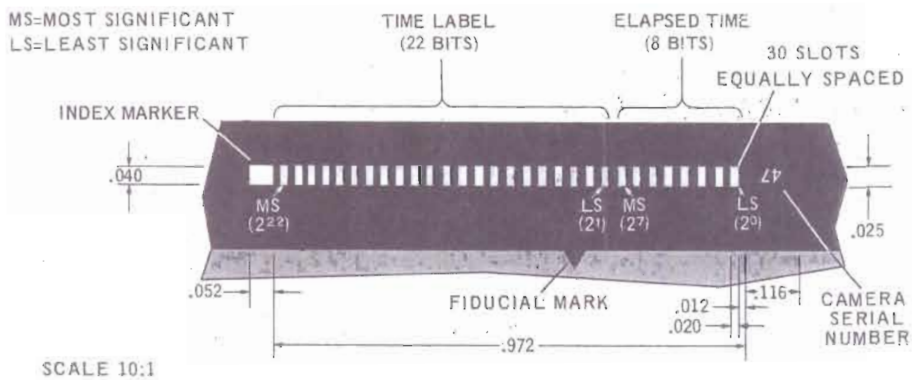


FIGURE 11. APTC FILM FORMAT AND IDENTIFICATION OF RESEAU INTERSECTIONS



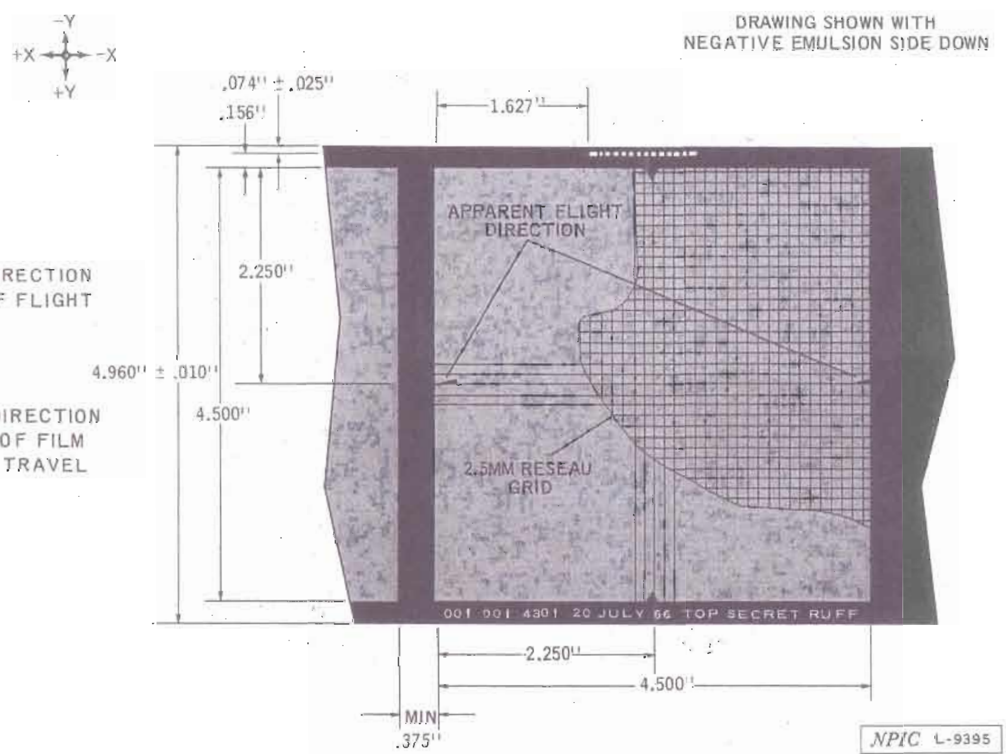


FIGURE 12. TERRAIN CAMERA FORMAT

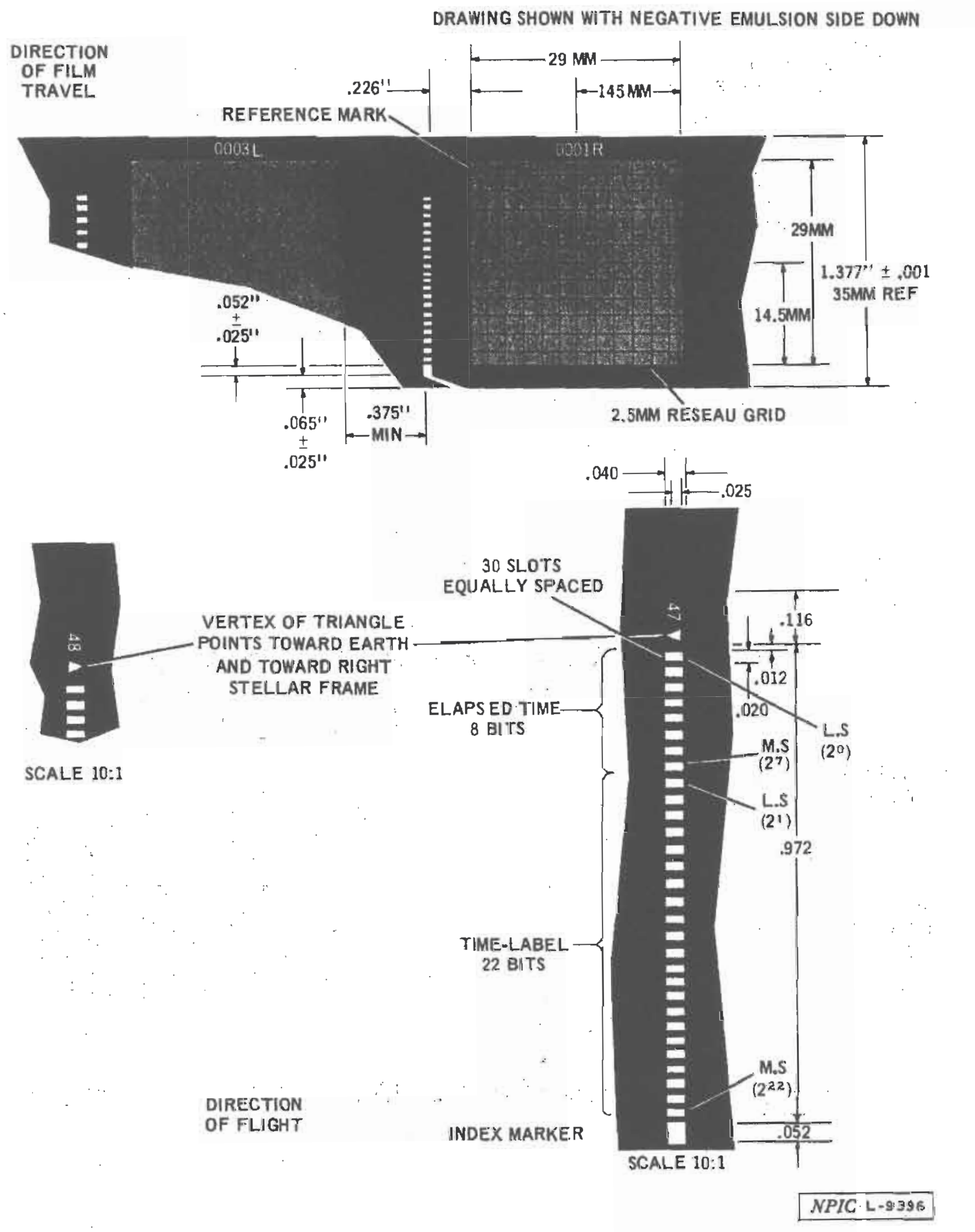


FIGURE 13. STELLAR CAMERA FORMAT

Data

Table 4. Stellar Camera Data

Focal length	90 mm
f number	2.0
Half angle	12.8 deg diagonal
Full angle	25.6 deg
Film format	29 x 29 mm
Film type	3401
Exposure	0.4 sec (standard), changeable at factory up to 2.0 sec
Film supply	3,190 and 4,150 frames
Reseau	2.5-mm grid

APTC Operation

The APTC can operate in either a dependent mode with the main camera or in an independent mode for mapping or geodetic purposes.

The independent mode is utilized exclusively for coverage of areas of the world that have inadequate maps or inadequate geodetic bases. The dependent mode is used to match the main camera frames with reduceable stellar frames. For strip photographs of long duration, one reduceable frame will be cycled each 10 seconds of operation.

Both the terrain camera and the stellar cameras record the time of exposure to an accuracy of .001 second in a 30-bit binary time word in the space outside the frame. The stellar cameras record the time word across the format and the terrain camera records along the format. Both units record a camera number or designator at the ends of the time words. The lower 8 bits are used to designate the milliseconds of elapsed time and the higher 22 bits record the actual clock time to .1 seconds.

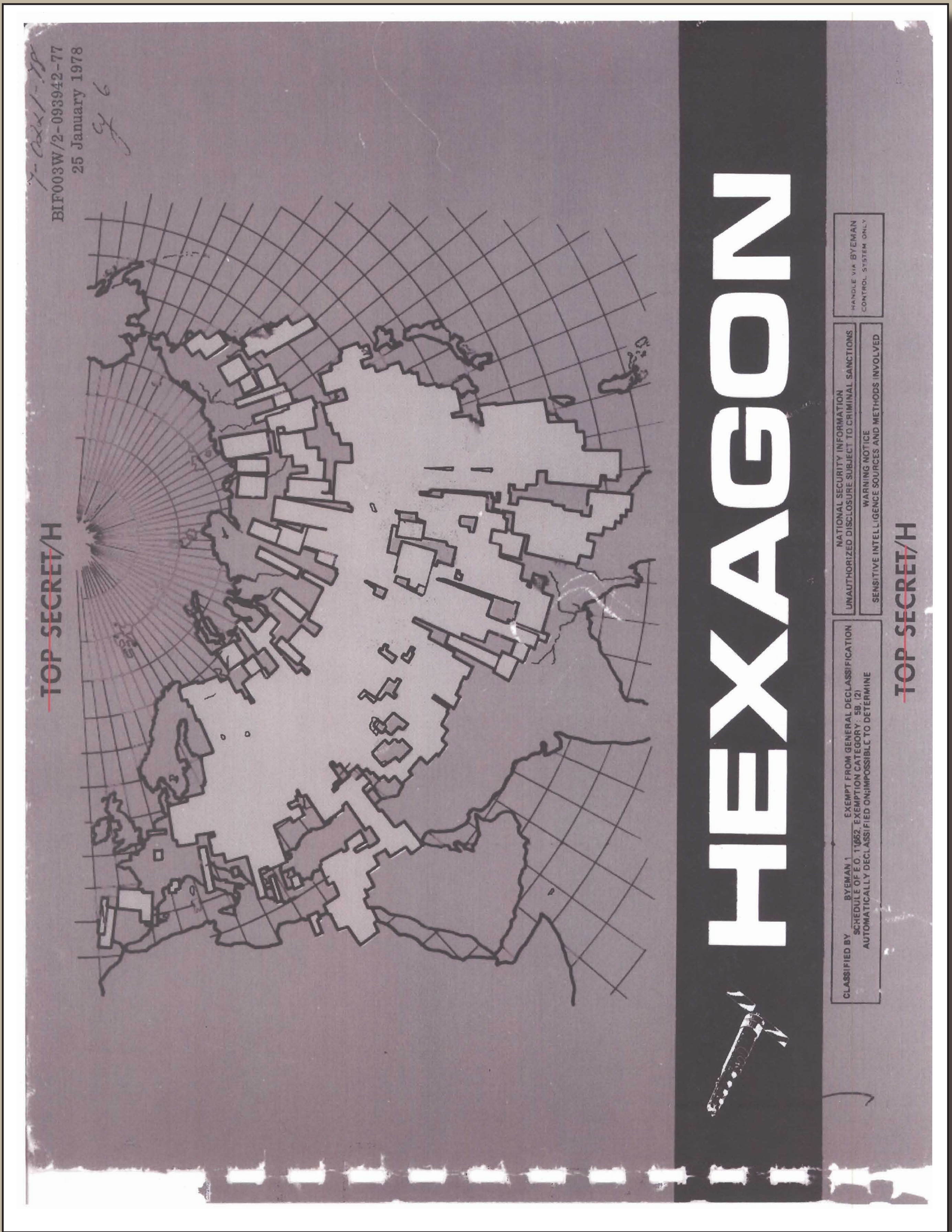
The stellars are presently inhibited in the near-vertical positions since attitude is not necessary in the lower roll positions. The inhibited portion of the flight is at approximately 16 degrees obliquity.

GLOSSARY

The possible degradation of photography by image smearing is inherent in any aerial photographic system. Hence, one of the major requirements of a system is the capability of reducing or compensating for the various smear-inducing factors. The following are technical terms most commonly encountered with relation to this problem.

IMAGE SMEAR:	The degradation or distortion of terrestrial images, usually evidenced by edge-smearing in a direction either parallel to the line of flight or approximately perpendicular to it, depending upon the factors involved. Elongation or compression of images results, and circular objects may be recorded as elliptical forms.
ALONG-TRACK SMEAR:	Image smear parallel to the forward motion or flight path of the vehicle.
ACROSS-TRACK SMEAR:	Image smear perpendicular to the forward motion or flight path of the vehicle.
FILM SPEED:	The rate at which the film is advanced in the camera as a means of compensation for the relative motion between terrestrial images and the camera. If the film is too slow, images of ground objects will be compressed; if it is too fast, images will be elongated.
PITCH:	Rotation of the vehicle about its lateral axis. Pitch deviations may be negative or positive with relation to the nominal reference angle, and may alter the camera's effective attitude over ground objects.
PITCH RATE:	Motion about the lateral axis--not to be confused with pitch, per se. Pitch rate causes along-track image smearing.
ROLL:	Rotation of the vehicle about its longitudinal axis. This results in a change in attitude that alters the slant range of the camera to ground images; hence, it is an along-track error. However, note carefully the distinction between roll and roll rate with relation to image-smear effect.

ROLL RATE:	Motion about the longitudinal axis. Since roll change is perpendicular to the line of flight, it is so recorded by film, resulting in across-track image smears.
YAW:	Rotation from the line of flight of the longitudinal axis of the vehicle about its vertical axis. The resultant displacement of ground imagery is solely in a lateral direction and induces cross-track smearing.
YAW RATE:	Motion about the verticle axis. Smearing caused by yaw rate is negligible.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25 January 1978
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HEXAGON
CLASSIFIED BY BYEMAN 1
EXEMPT FROM GENERAL DECLASSIFICATION SCHEDULE OF E.O. 11652, EXEMPTION CATEGORY: 5B, (2)
AUTOMATICALLY DECLASSIFIED ON: IMPOSSIBLE TO DETERMINE
NATIONAL SECURITY INFORMATION
UNAUTHORIZED DISCLOSURE SUBJECT TO CRIMINAL SANCTIONS
WARNING NOTICE
SENSITIVE INTELLIGENCE SOURCES AND METHODS INVOLVED
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HEXAGON CY 6
31 DECEMBER 1977
72 SHEETS

PROJECT HEXAGON OVERVIEW

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HEXAGON VEHICLE ON ORBIT

The Hexagon vehicle performs world-wide search and surveillance missions with two cameras that provide stereo panoramic photography. The film is recovered as each of four (4) large reentry vehicles (Mark 8) is filled. Each reentry vehicle is ejected from the Hexagon vehicle and is caught by USAF JC130 aircraft near the Hawaiian Islands. The film is then flown to Eastman Kodak at Rochester, N. Y., to be despooled, processed, and then copied for the using agencies.

The Hexagon vehicle also performs mapping and geodesy missions with stellar and terrain frame cameras. The film is retrieved via the small (Mark V) reentry vehicle mounted on the Hexagon vehicle nose. Accurate Hexagon vehicle location for the mapping mission is determined with the Doppler Beacon System and in the future via the Navigational Package.

The Hexagon vehicle flies in a near polar orbit (97 deg inclination) at a typical perigee/apogee of 88/155 NM, respectively. Mission durations of up to 180 days have been flown. In addition to the stereo panoramic cameras and the Mapping Camera System, the Hexagon vehicle [redacted]

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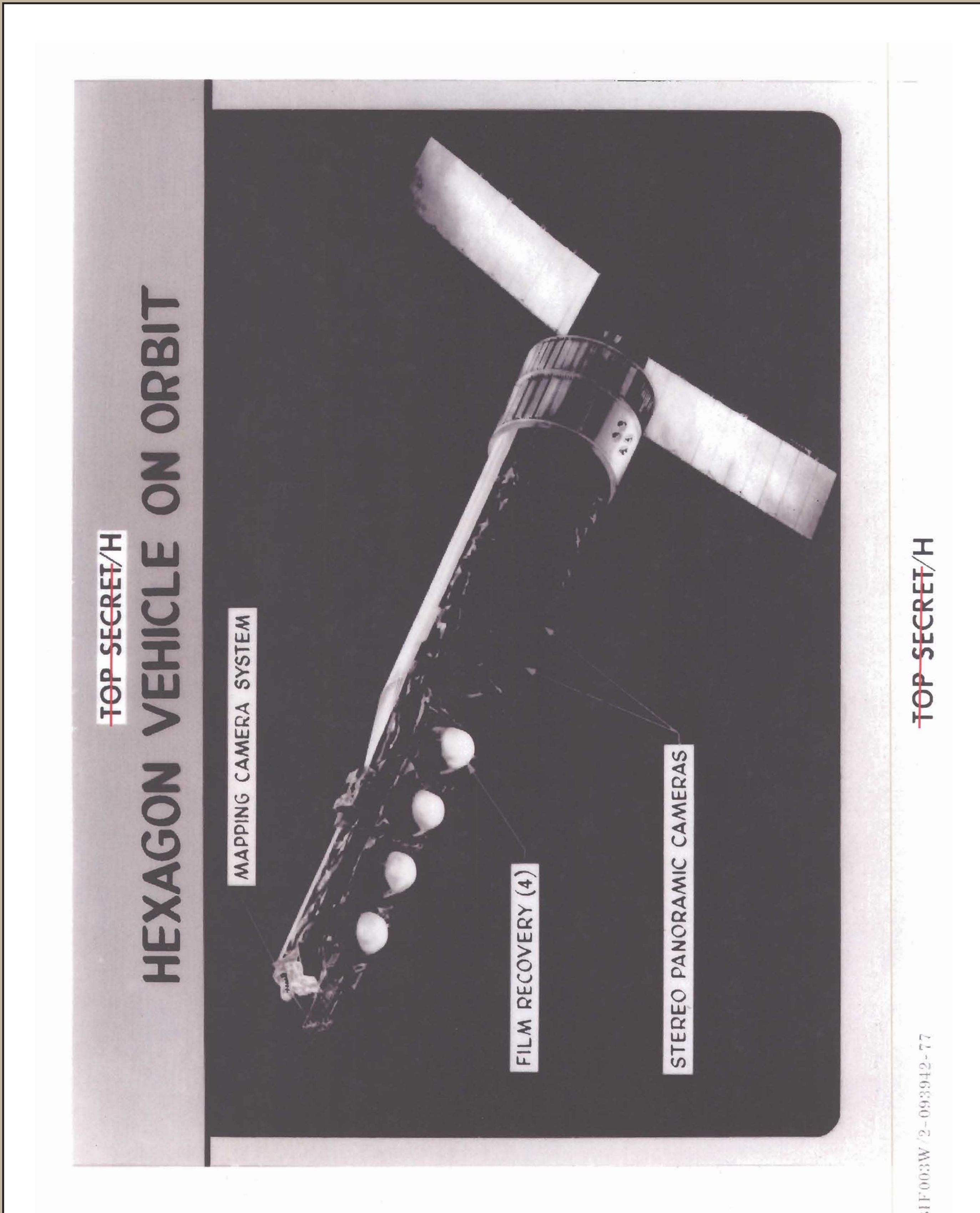
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HEXAGON VEHICLE ON ORBIT
MAPPING CAMERA SYSTEM
FILM RECOVERY (4)
STEREO PANORAMIC CAMERAS
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SATELLITE VEHICLE (SV) CONFIGURATION

The SV configuration incorporates overall mission success considerations as well as weight minimization and structural efficiency. Film supply, cameras, and RVs are arranged in line for film path simplicity; the two-camera assembly is relatively close to the attitude control system in the Aft Section to enhance pointing accuracy. Aft Section electronic/electric equipment, mounted on trays in a modular fashion, is accessible through removable panels during the factory and pad spans. Access is provided to the RVs, two camera assembly, and film supply for necessary servicing. Propulsion/control force elements are grouped in a module for testing efficiency and brazed plumbing is used to assure the integrity of the propellant system through handling, launch, and flight.

In the factory the SV is brought to flight readiness by acoustic and thermal vacuum testing of the assembled vehicle; vehicle instrumentation is designed for such system level testing with RF command and data links.

The SV is shipped flight-ready to the launch base, with validation prior to launch. When required, equipment is replaced on a module/box basis to preserve factory verifications.

Provision has been made for alignment of critical elements during assembly and for verifying the alignment of the Attitude Reference Module with the two-camera assembly at the launch pad.

The SV configuration permits modification to meet specific mission requirements. The Mapping Camera System, [redacted] can be omitted, and propellant and RVs can be off-loaded at the base.

The overall length in orbit of the SV illustrated is 52 feet. At launch, with shroud and booster adapter, the length is 58.75 feet. The shroud, which protects all but the Aft Section, is 52 feet long. The solar arrays, when deployed, extend 17 feet outboard on each side of the vehicle. Injection weight for the SV illustrated is approximately 24,000 pounds.

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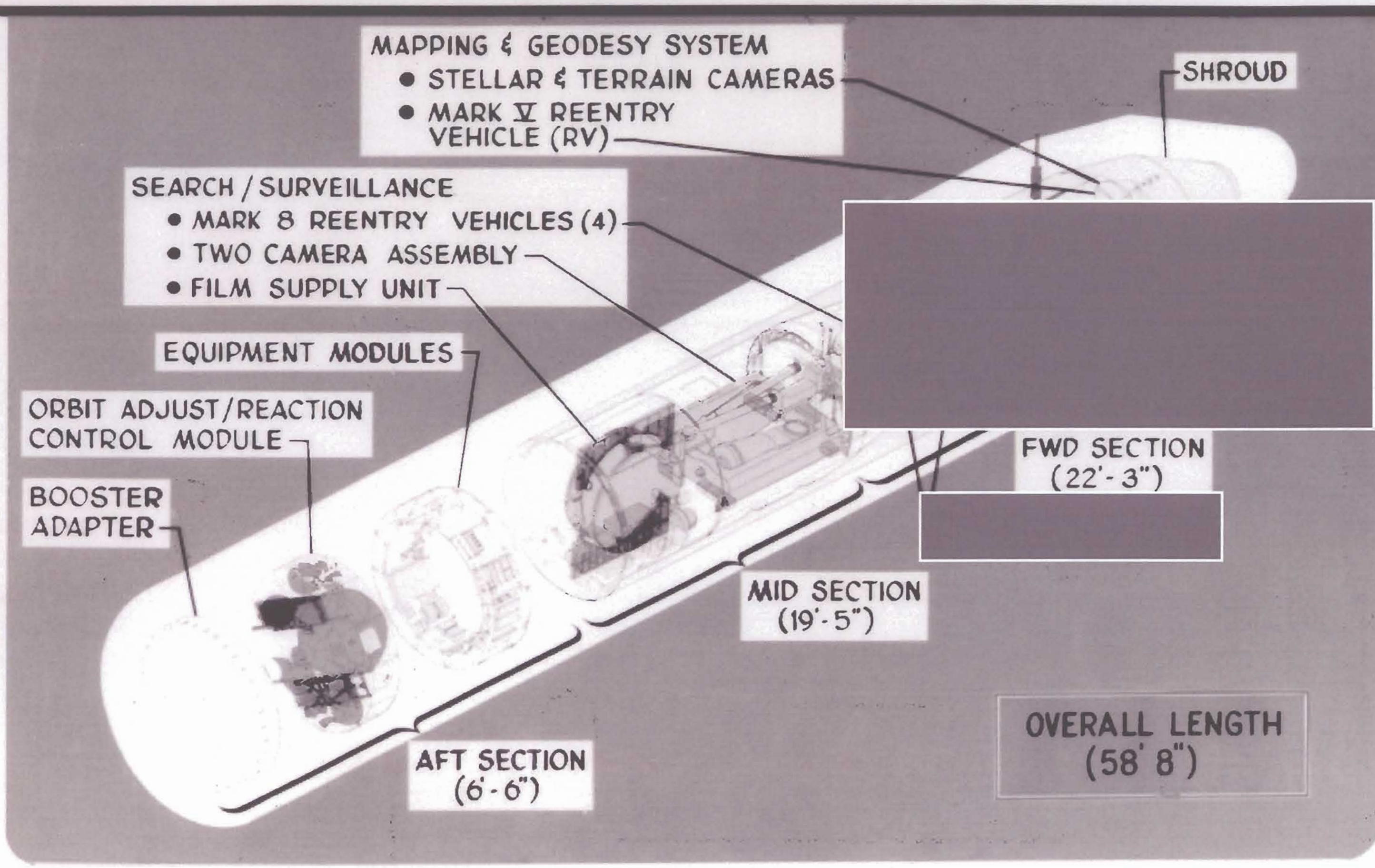
SATELLITE VEHICLE CONFIGURATION



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ASSOCIATE CONTRACTORS

Project HEXAGON is a team effort consisting of nine major contractors throughout the United States. These contractors provide a coordinated effort by using Interface Control Documents as binding technical agreement on responsibilities and performance of their respective equipments. The project HEXAGON team consists of:

Search/Surveillance (Stereo Panoramic)

- Two Camera Assembly – Perkin-Elmer, Danbury
- Film supply and take-up units – Perkin-Elmer, Danbury
- Shroud, Mid and Forward Section structure – Lockheed, Sunnyvale
- Reentry vehicles (Mark 8) – McDonnell Douglas, St. Louis
- Film – Eastman Kodak, Rochester

Mapping and Geodesy System

- Stellar and terrain cameras – Itek, Burlington
- Reentry vehicle (Mark V) – General Electric, Philadelphia
- Structure – Lockheed, Sunnyvale
- Film – Eastman Kodak, Rochester

Satellite Control Section

- Telemetry, power, and pyros – Lockheed, Sunnyvale
- Command system – General Electric, Utica
- Attitude control and orbit adjust – Lockheed, Sunnyvale
- Structure and booster adapter – Lockheed, Sunnyvale

Booster Vehicle – Titan IIID

- Stage O solid propellant – United Technologies Chemical System Division, Sunnyvale
- Stage I and II liquid propellant – Martin Marietta Corporation, Denver

The photographs were taken via the search and surveillance camera and magnified 40 times.

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OPERATIONS

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AEROSPACE VEHICLE

The HEXAGON Satellite Vehicle is launched by the Titan IIID Booster Vehicle. When mated together, the entire assembly is termed the Aerospace Vehicle.

The Aerospace Vehicle is launched from Space Launch Complex -4 East, Vandenberg Air Force Base. The Solid Rocket Motor, Stage I and Stage II are stacked at the launch site and functionally tested. The complete SV including the shroud is mated to the booster vehicle fourteen (14) days prior to launch. The Aerospace Vehicle is then functionally checked and all propellants and gases are loaded.

The booster vehicle can place 24,800 pounds into an 82 x 144 nm (perigee x apogee) orbit with an inclination (~ 97 degrees) that provides the nearly sun synchronous condition needed for long life missions.

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AEROSPACE VEHICLE

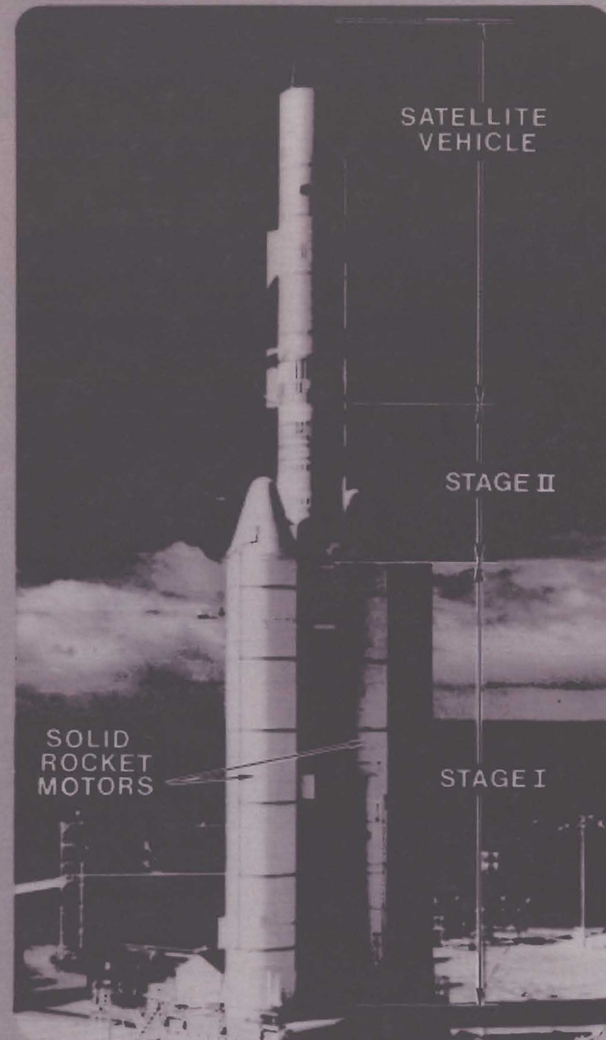
- -1.4 MILLION POUNDS LIFT-OFF WEIGHT
- -LAUNCH HEIGHT: 160 FT
- -VANDENBERG AIR FORCE BASE LAUNCH SITE

BOOSTER VEHICLE - TITAN III D

- -STAGE O SOLID ROCKET MOTOR
  - 2.3 MILLION LBS INITIAL THRUST
  - INITIAL WEIGHT: 1.01 MILLION LBS
- -STAGE I
  - TWO AJ-[illegible] ROCKET ENGINES
  - 0.53 [illegible] LBS THRUST
  - INITIAL [illegible] MILLION LBS
- -STAGE II
  - ONE AJ-[illegible] ENGINE
  - 0.1 [illegible]
  - INITIAL [illegible] MILLION LBS

SATELLITE VEHICLE

- -27,000 LB LAUNCH WEIGHT
- -2,800 LB SHROUD EJECTED DURING ASCENT



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TITAN IIID BOOSTER VEHICLE

The Titan IIID booster vehicle is a three-stage booster consisting of the standard liquid core for Stages I and II plus two solid rocket motors (SRMs) as Stage 0.

Each SRM is 10 feet in diameter and 85 feet long. It consists of five identical interchangeable segments, a six-degree canted nozzle, a gas generator type igniter, staging rockets, and an externally mounted thrust vector control (TVC) injectant tank. The TVC provides steering during Stage 0 burn by injecting nitrogen tetroxide ($N_2 0_4$) through 24 proportional valves around the SRM nozzle. Jettison is provided by pyrotechnic separation of the interconnecting structure between each SRM and the Titan core vehicle, followed by ignition of four solid staging rockets at each end of each SRM.

Stage I liquid core is 10 feet in diameter and 71.5 feet long. It is aluminum skin-stringer construction with propellant tanks arranged in tandem. The two turbo pump feed Aerojet LR87-AJ-11 engines burn a 50-50 blend of hydrazine/UDMH (Aerozine) as the fuel and nitrogen textroxide as the oxidizer. Each engine subassembly contains a regeneratively cooled gimballed thrust chamber combined with an ablative skirt extension giving a 15:1 expansion ratio.

The Stage II propulsion system is similar to that of Stage I. It is also 10 ft in diameter but only 31 feet long. The single engine thrust chamber is also regeneratively cooled and has an ablative skirt extension that provides an overall expansion ratio of 49:1.

The flight control system stabilizes the vehicle from launch to SV separation in response to (1) attitude data, (2) rate data, (3) command data – issued by flight control computer and/or the radio guidance system via ground tracking station.

Electrical power for the flight control system, instrumentation, flight safety, and electrical sequencing system is provided via silver-zinc primary batteries.

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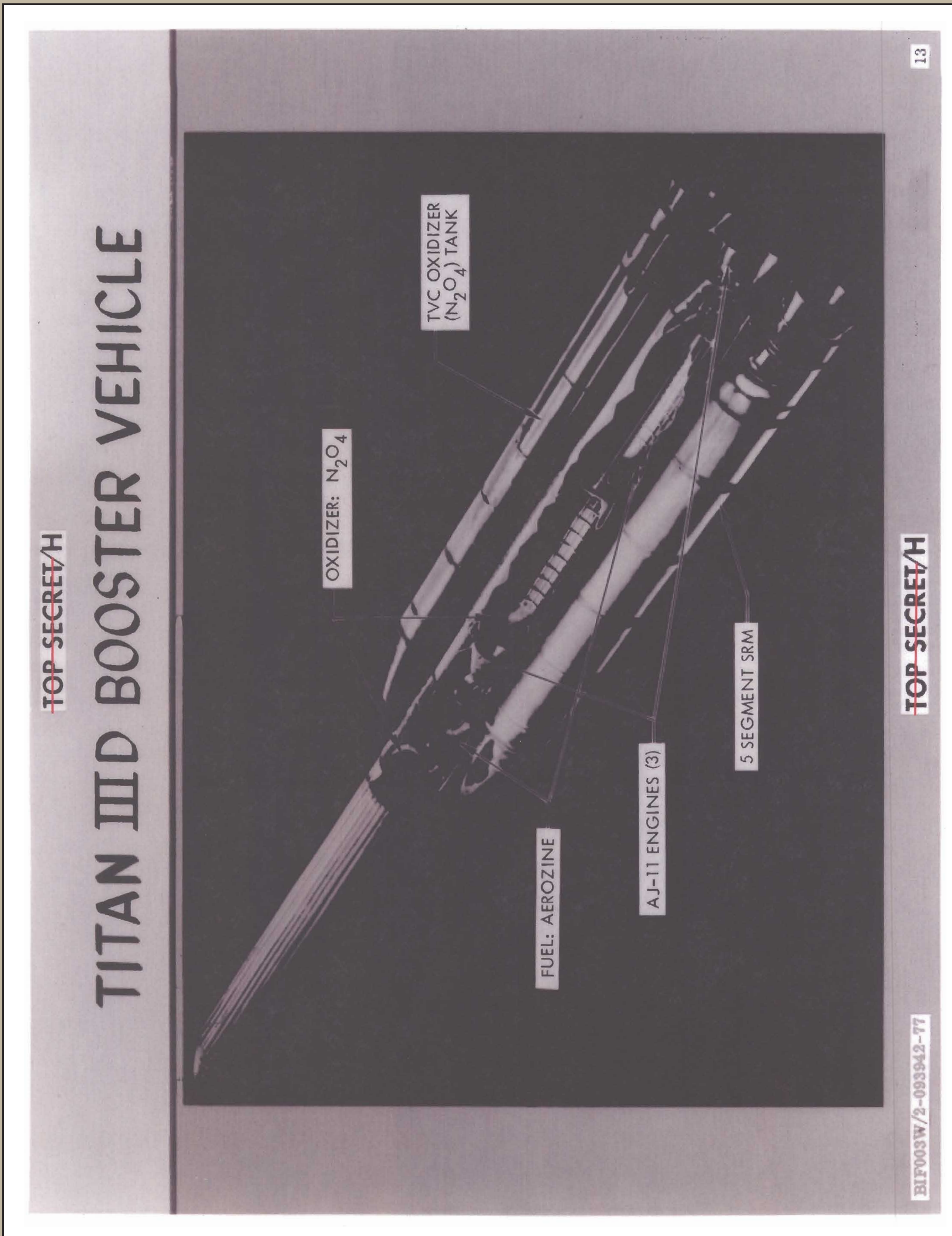
TOP SECRET/H
TITAN IIID BOOSTER VEHICLE
OXIDIZER: N_2O_4
TVC OXIDIZER (N_2O_4) TANK
FUEL: AEROZINE
AJ-11 ENGINES (3)
5 SEGMENT SRM
TOP SECRET/H
13
BIF003W/2-0939412-77

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OPERATIONAL EVENTS

The major operational events are launch, orbit maintenance/payload operations, and RV recovery/SV deboost. Sequence of launch events:

0.0 sec	SRM Ignition
0.2	Lift-off
40.0	Transonic passage
54.0	Maximum dynamic pressure
113.9	Core I start burn
125.3	SRM separation
262.0	Core I shutdown and Core II start burn
262.7	Core I separation
276.0	Shroud separation
460.6	Core II shutdown
472.6	Core II separation (injection)

The solar arrays are deployed after SV stabilization on Rev 1 with payload operations starting on Rev 5. Orbit adjusts to correct period, altitude and perigee location occur every two to four days. All control of the SV and telemetry data is processed through the Air Force Satellite Control Facilities and associated remote tracking stations.

The SV is pitched down to a specified angle for each RV ejection. The SV is deboosted for ocean impact after the last RV is ejected.

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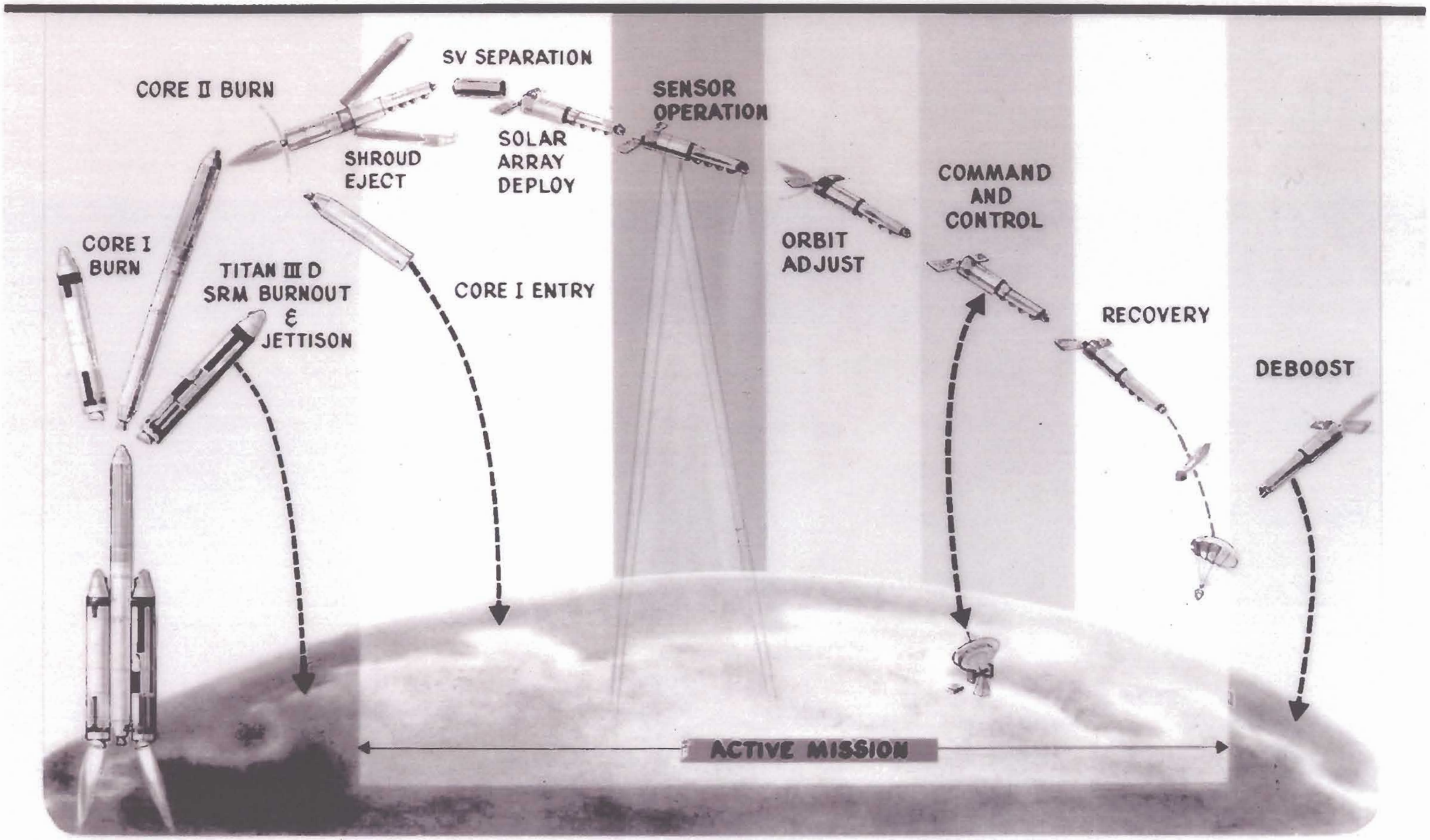
OPERATIONAL EVENTS



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USAF TRACKING NETWORK

The Sunnyvale Satellite Test Center (STC), part of the SAMSO Satellite Control Facilities, is organized to provide operational control of on-orbit satellites and does this function for project HEXAGON. The center directs the tracking and commanding of these satellites through a net of remote tracking stations (RTS). The STC also coordinates the aerial and surface recovery operations for reentry vehicles (RV). Launch activities are a coordinated effort between the Vandenberg AFB Test Wing and the STC.

Servicing the HEXAGON vehicle requires skin and beacon tracking, recording and displaying telemetry data, and commanding that often needs more than one RTS each revolution. Because the STC supports several programs, the Mission Control Center (MCC) within the STC is used to direct the effort of each tracking station in support of each program. The SV real time telemetry data incoming to the RTS are processed and displayed in real time via 1200 bit lines or relay satellites to the STC. The SV real time and recorded data are recorded at the RTS for later playback to the STC. Complete RTS recorded tapes are flown to the STC as permanent records. Display and analysis of these data provides SV health and status information to the Technical Advisor (TA) staff on a continuous basis throughout the mission. The TA staff, located at the STC, includes operational specialist teams for each major contractor.

The remote tracking stations acronyms and locations are as follows:

- Vandenberg Tracking Station (VTS) or COOK at Vandenberg Air Force Base, California
- Guam Tracking Station (GTS) or GUAM on Guam Island
- Hawaii Tracking Station (HTS) or HULA at Kaena Point on the island of Oahu
- Indian Ocean Station (IOS) or INDI in Seychelles Island group on Mahe' Island
- New Hampshire Station (NHS) or BOSS near New Boston, New Hampshire
- Thule Tracking Station (TTS) or POGO at Thule Air Force Base, Greenland

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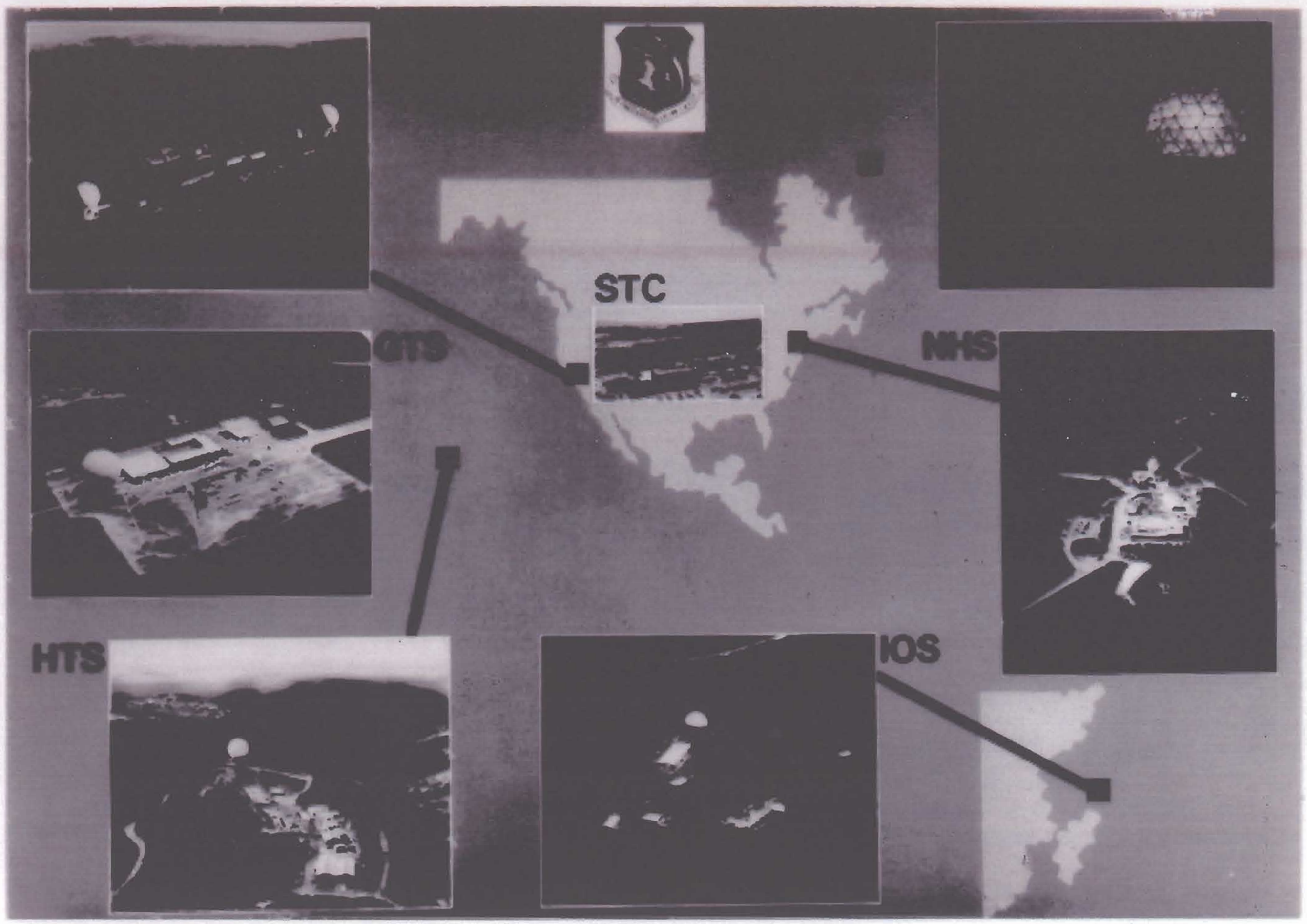
USAF TRACKING NETWORK



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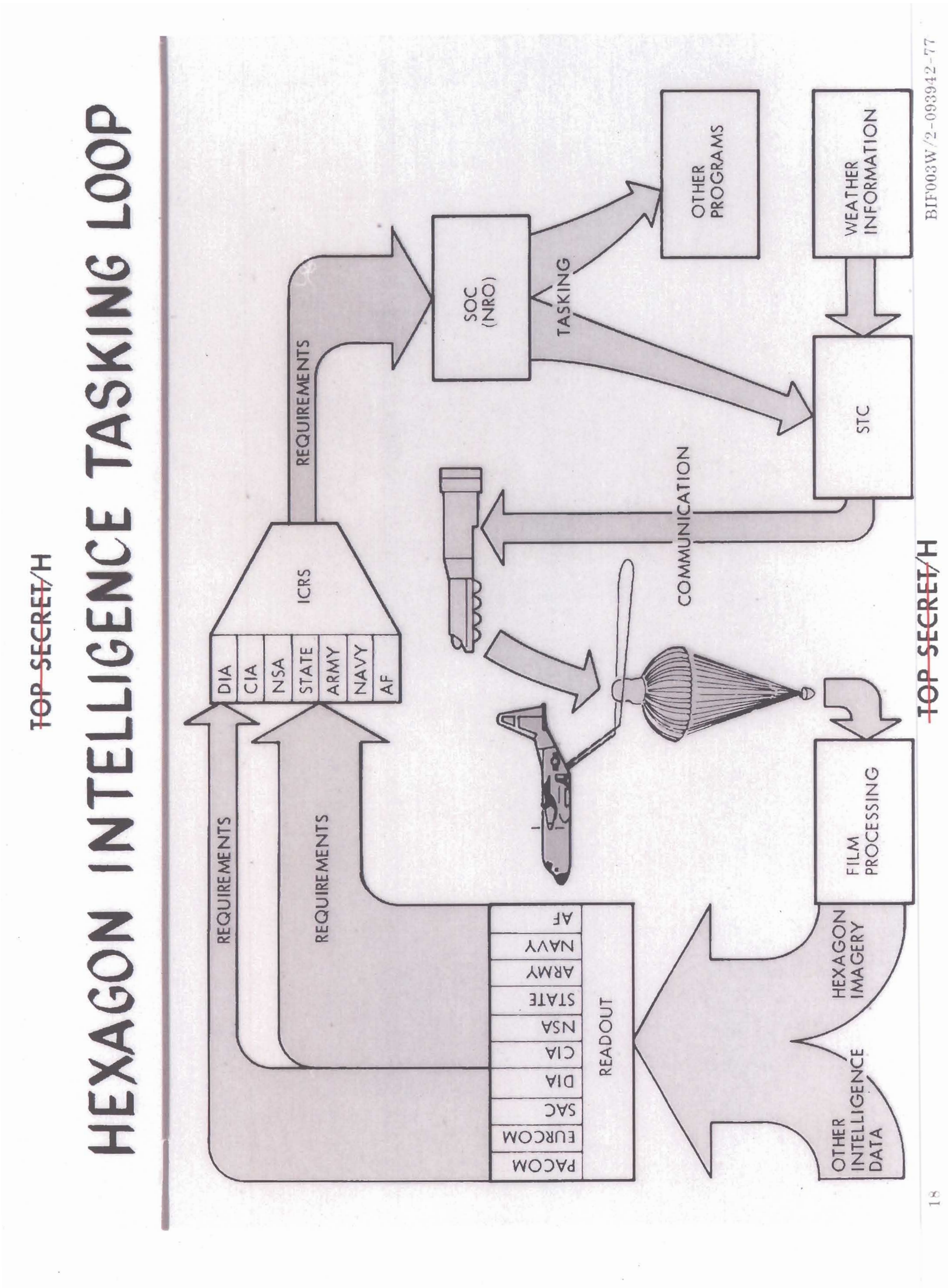
17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HEXAGON INTELLIGENCE TASKING LOOP
DIA
CIA
NSA
STATE
ARMY
NAVY
AF
ICRS
REQUIREMENTS
SOC (NRO)
TASKING
OTHER PROGRAMS
WEATHER INFORMATION
STC
COMMUNICATION
FILM PROCESSING
HEXAGON IMAGERY
OTHER INTELLIGENCE DATA
READOUT
PACOM
EURCOM
SAC
REQUIREMENTS
REQUIREMENTS
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SEARCH/SURVEILLANCE CAMERAS

SEARCH/SURVEILLANCE CAMERAS

The search/surveillance cameras provide high-resolution stereoscopic coverage of selected areas on the earth's surface by using two independently controllable panoramic cameras. The system provides a target resolution of 2.7 ft or better at nadir when operating at primary mission orbital altitudes with an apparent target contrast of 2:1, sun angles greater than 30 degrees and using *S0-208 film.

The search/surveillance system has been designed with the following characteristics:

Optics	60-in. focal length, f/3 Folded Wright (Modified Schmidt) System
Film	6.6-in. wide film – Type 1414 or S0-208 (B & W), S0255 (Color), and S0130 (Infrared)
Film Load	123,000 ft Type 1414 or 144,000 ft S0-208 per camera (1950 lb total)
Film Resolution (2:1 Contrast)	Center of format ≥ 155 l/mm, elsewhere in format ≥ 94 l/mm
Field Angle	±2.85 Degrees
Scan Modes	30, 60, 90, and 120 degrees
Center of Scan	0, ±15, ±30, and ±45 degrees
Maximum Scan Angle	±60 degrees
Stereo Convergence Angle	20 degrees
Frame format (120 degree scan)	6-in. by 125-in.
Film Velocity	200 in./sec (maximum) at focal plane
Image Motion Compensation Range	0.018 rad/sec to 0.054 rad/sec for Vx/H ±0.0033 rad/sec for Vy/H
Weight (less film)	5375 pounds

*S0-208 is a thinner base equivalent to Type 1414 film used extensively for the first 13 missions.

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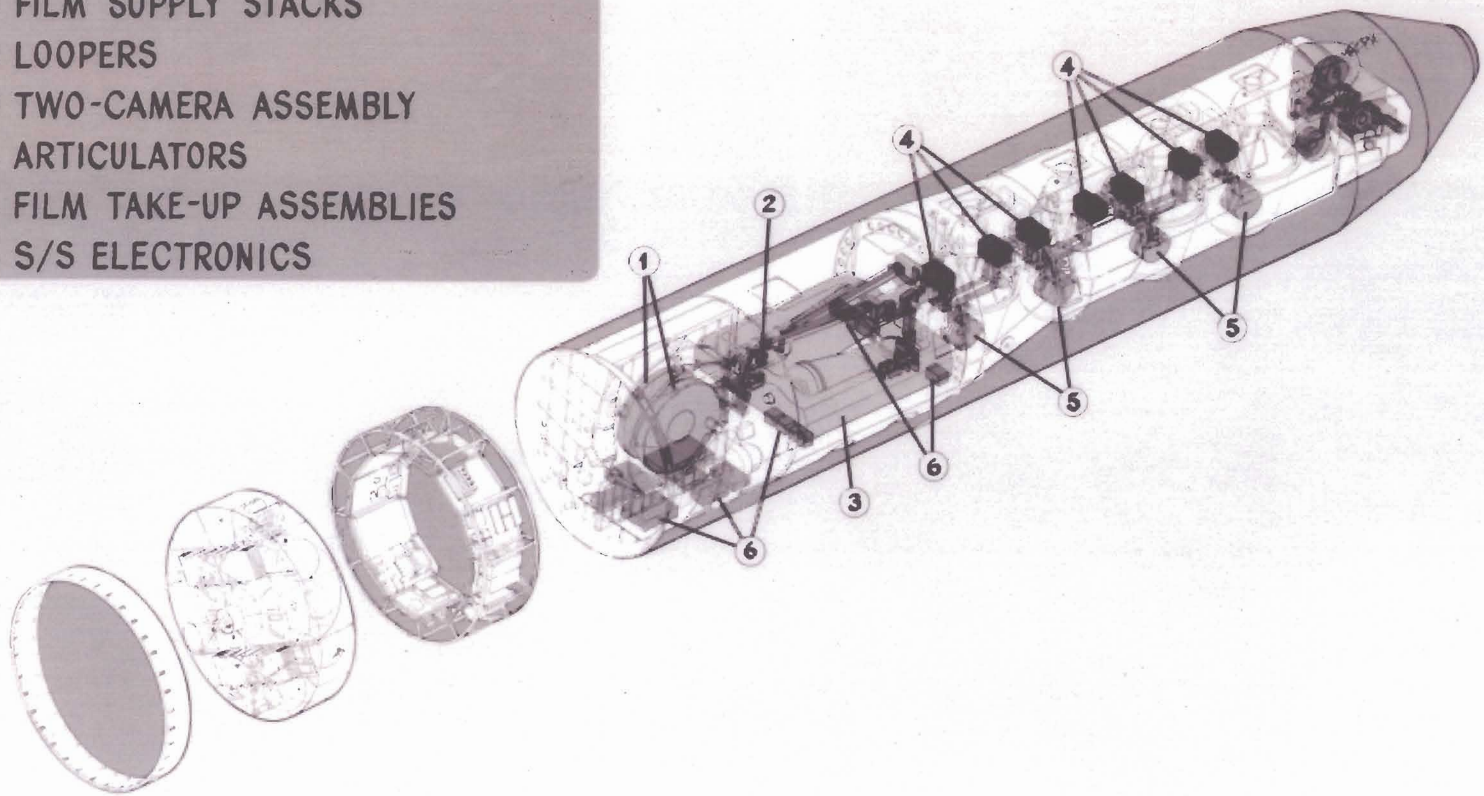
SEARCH/SURVEILLANCE CAMERAS

1. FILM SUPPLY STACKS
2. LOOPERS
3. TWO-CAMERA ASSEMBLY
4. ARTICULATORS
5. FILM TAKE-UP ASSEMBLIES
6. S/S ELECTRONICS



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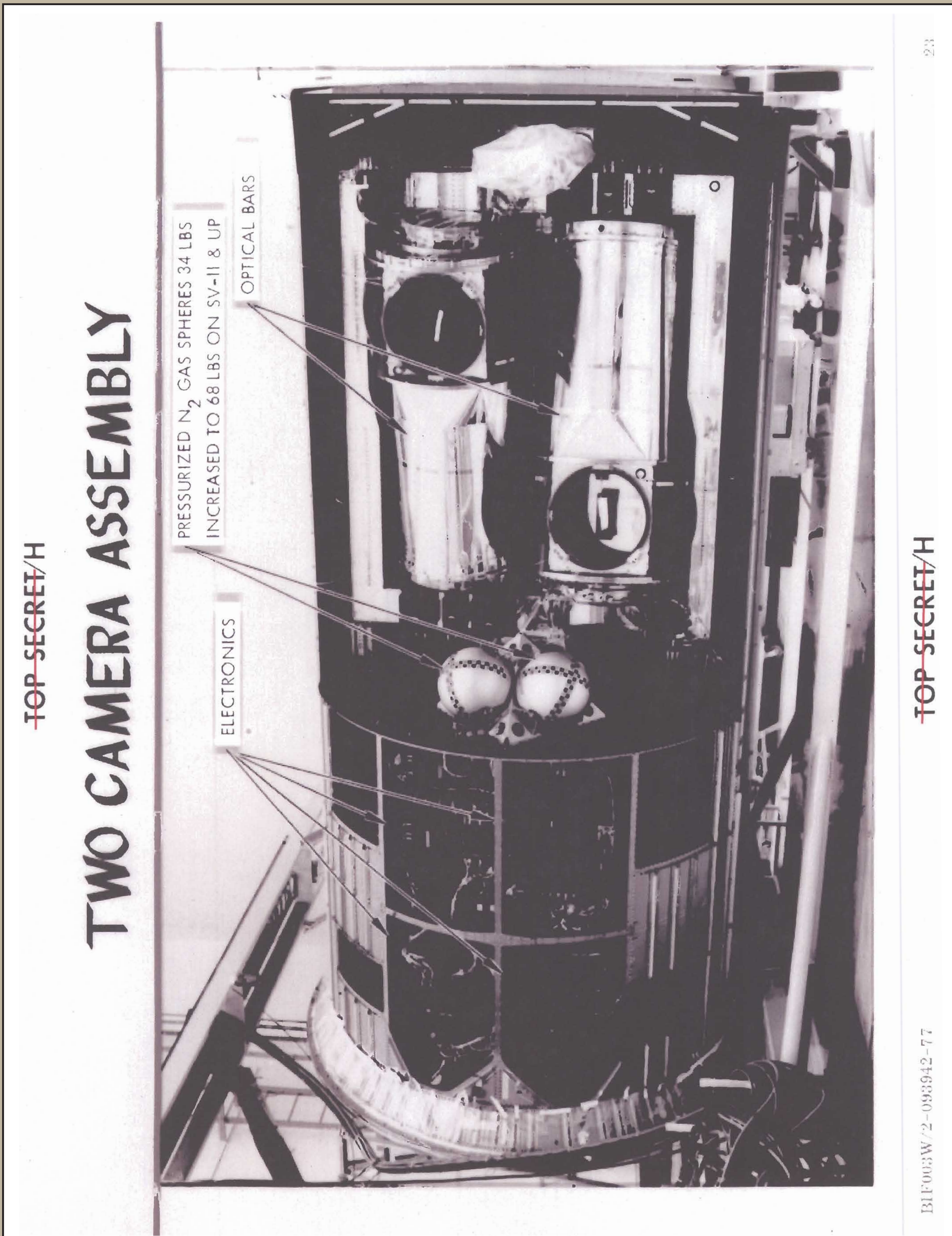
TWO CAMERA ASSEMBLY

The Mid Section has been rotated to show the side that looks toward the earth with the two Camera Assembly (TCA) exposed. In flight, a black fiberglass baffle and a multilayer insulation covers the gas spheres and optical bars except for view ports. Doors cover the electronics and then multilayer insulation blankets are installed. Not shown are the film take-up reentry vehicles in the Forward Section.

The two optical bars rotate in opposite directions indicated by the arrows adjacent to the lenses. The light is conducted along a folded path to the film platen where the film motion is matched to the image motion by the commands generated in the electronics.

Normally both optical bars are commanded on simultaneously to reduce vehicle roll torques. However, each camera can be commanded individually, and either may be operated alone, if desired.


23
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TWO CAMERA ASSEMBLY
PRESSURIZED N2 GAS SPHERES 34 LBS
INCREASED TO 68 LBS ON SV-II & UP
OPTICAL BARS
ELECTRONICS
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SYSTEM FILM PATH

The coarse film transport includes all components that operate at nominally constant speed during photography and recycle, as well as the looper carriage which operates at the recycle frequency. The supply and take-up control system maintains a steady flow of film into and out of the loopers at precisely the average rate at which film moves through the platen. The loopers serve as an interface between the coarse and fine film transport system. Total film in the looper is constant but relative lengths in supply and take-up sides vary with looper carriage position.

The control of film tracking is by active and passive articulators. The film path of the forward camera functionally includes component assemblies in the following order:

a. Supply "B"	g. Platen	m. Take-up 4
b. Seal Door/Exit Vestibule	h. Metering Capstan	n. Articulator
c. Articulator Steerer	i. Output Drive Capstan	o. Takeup 3
d. Looper	j. Crossover	p. Articulator
e. Crossover	k. Looper	q. Takeup 2
f. Input Drive Capstan	l. Articulator Steerer	r. Articulator
		s. Takeup 1

The film supply spools rotate in opposite directions, and the respective take-up spools rotate opposite to the supply spools in order to reduce vehicle torques. The start-up disturbances are minimized by accelerating the film path to the required coarse velocity before photographic operations are begun.

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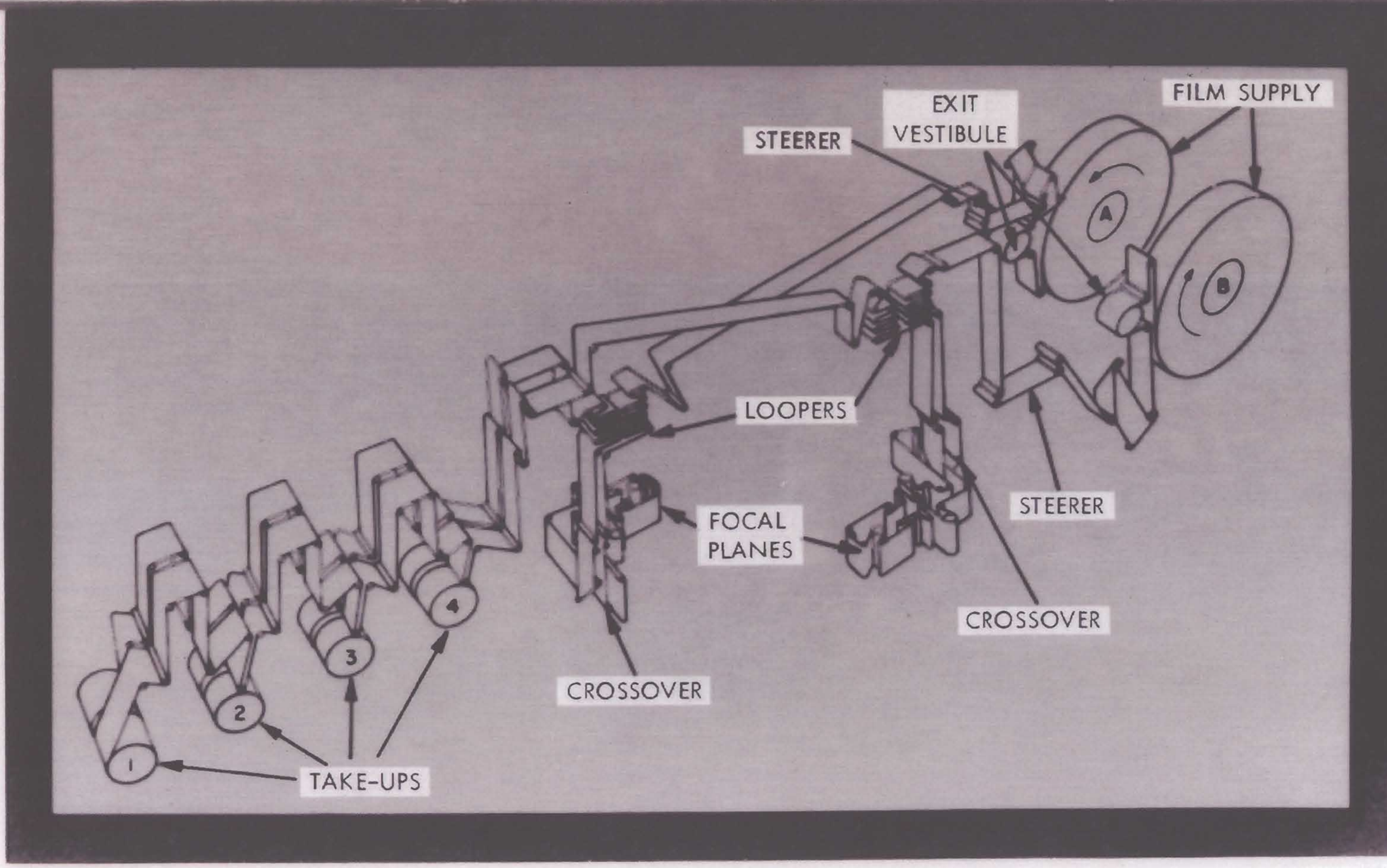
SYSTEM FILM PATH



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OPTICAL BAR ASSEMBLY

The two cameras mounted in a frame make up a two-camera assembly with each camera having a folded Wright optical system mounted in a rotating optical bar. Structurally the bar consists of two rigid end bulkheads separated by a cylindrical tube with housings and hollow shafts at each end on which bearings are mounted. The platen end bulkhead is the member to which the optical components are referenced. The optics consist of the corrector plate as the aperture, a folding flat mirror, a concave primary mirror and a field group of refracting elements and a filter. The optics wavefront errors spec values are shown as a fraction of the wavelength. All values are root mean square (RMS).

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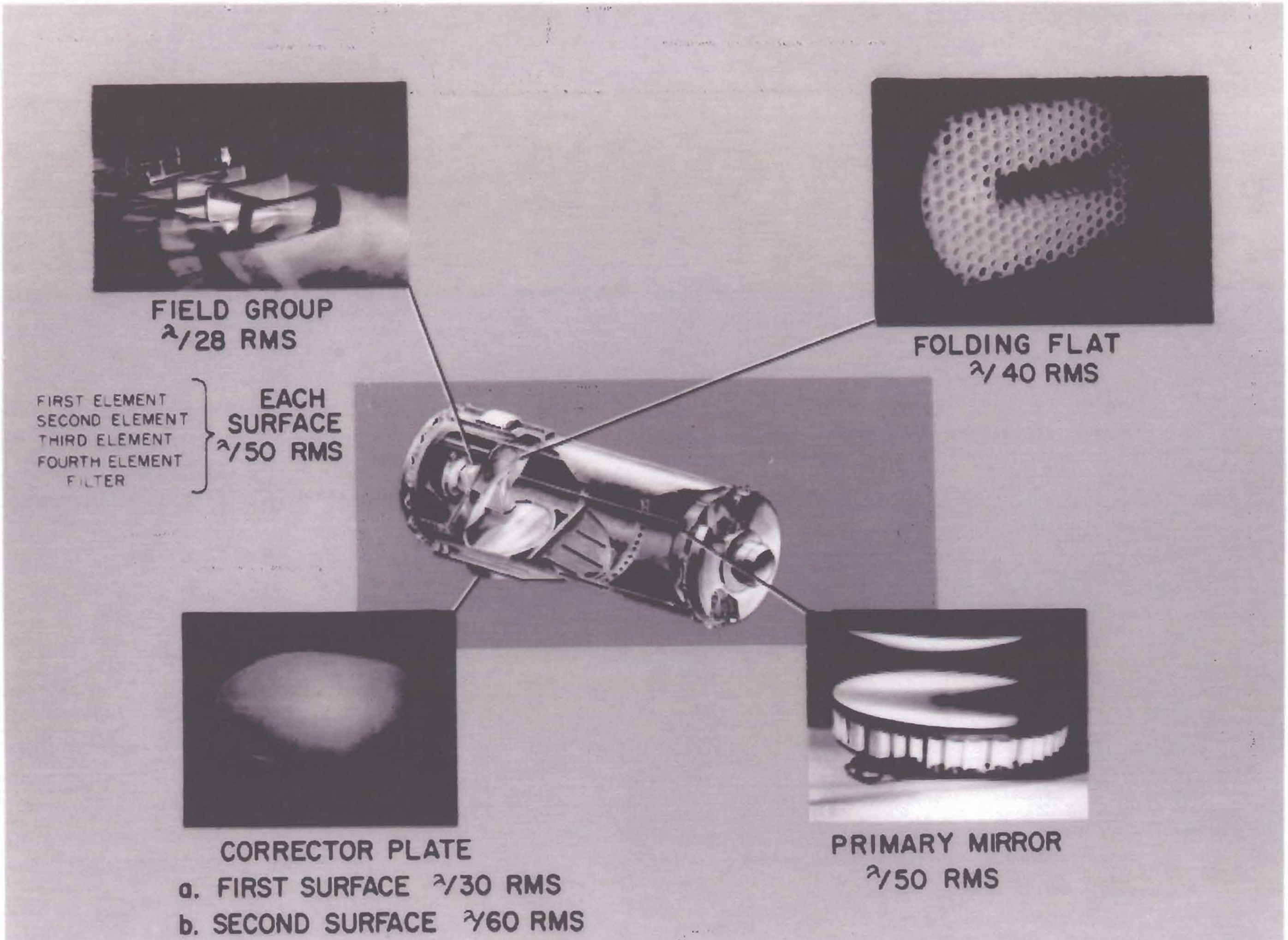
OPTICAL BAR ASSEMBLY



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OPTICAL PATH

The optics for each camera are mounted in an optical bar (OB). The system is a f/3 folded Wright. The aperture is formed by an aspheric corrector plate that corrects for spherical aberration. Light entering the aperture is folded 90° by the folding flat and reflected onto the primary mirror at the far end of the OB. The primary mirror focuses the light back through the field group mounted in a center hole in the folding flat. The field group includes four refracting elements and a filter. The refracting elements provide correction for the field curvature and residual chromatic aberration characteristics of optical systems using a concave primary mirror.

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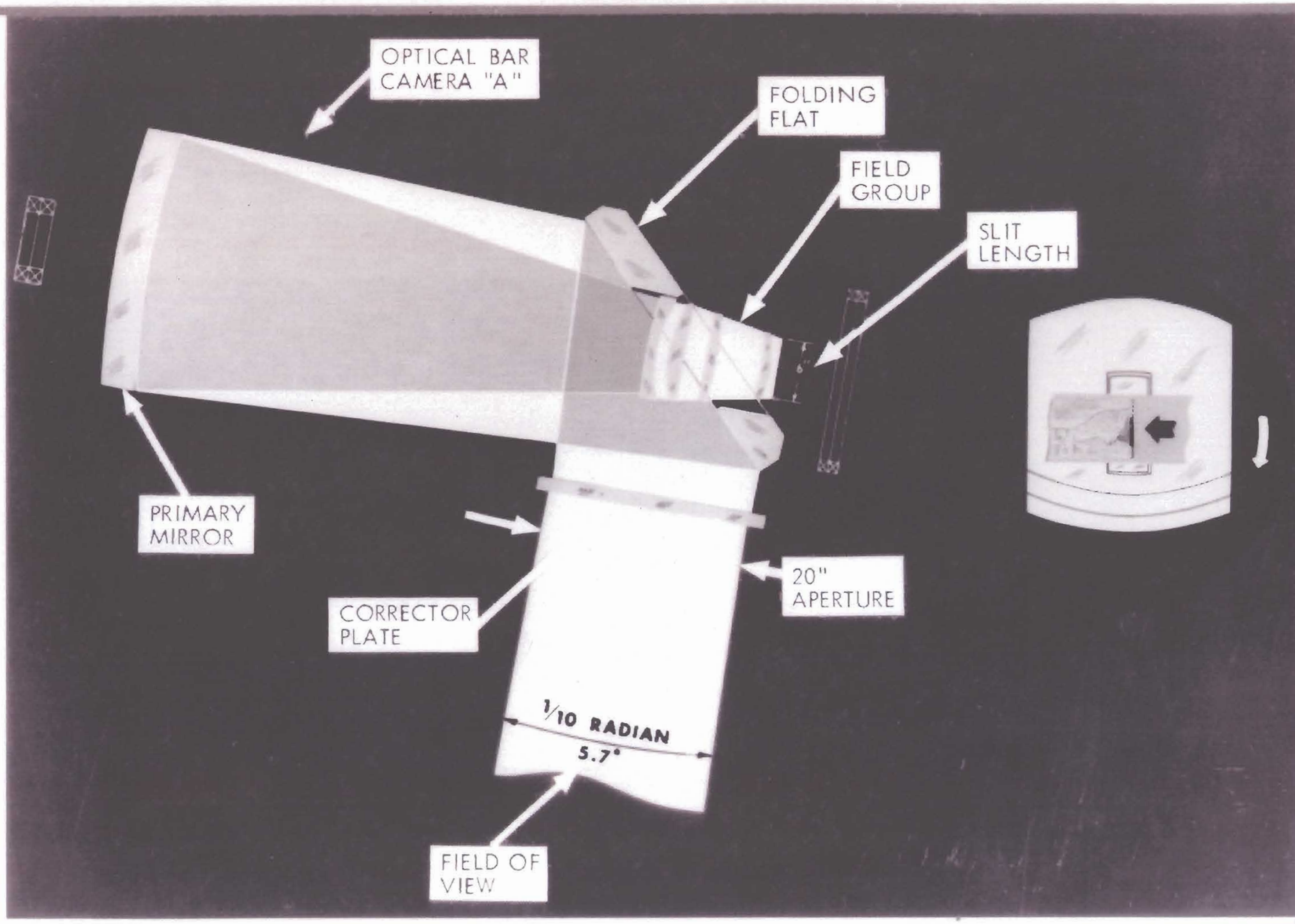
OPTICAL PATH



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PLATEN AND FILM DRIVE

The platen is mounted at the focal plane end of the optical bar (OB). The platen assembly is mounted on the OB's inner housing to support the film in the camera focal plane, and to rotate on its own bearings independently of the OB. While the OB is rotating continuously on its end bearings, the platen assembly is free to oscillate through its 130-degree operational arc. The fine film drive assembly encloses the outer end of the platen assembly and is stationary. A twister assembly, included in the fine film drive assembly, accommodates the twisting of the film path at the interface between the stationary film drive assembly and the oscillating platen assembly. The twister assembly consists of a twin air-bar assembly and a housing that incorporates a manifold through which nitrogen gas is supplied to the bars. The use of air bars in the twister, rather than rollers, permits the film to translate along the length of the bars without damage as the film path twists.

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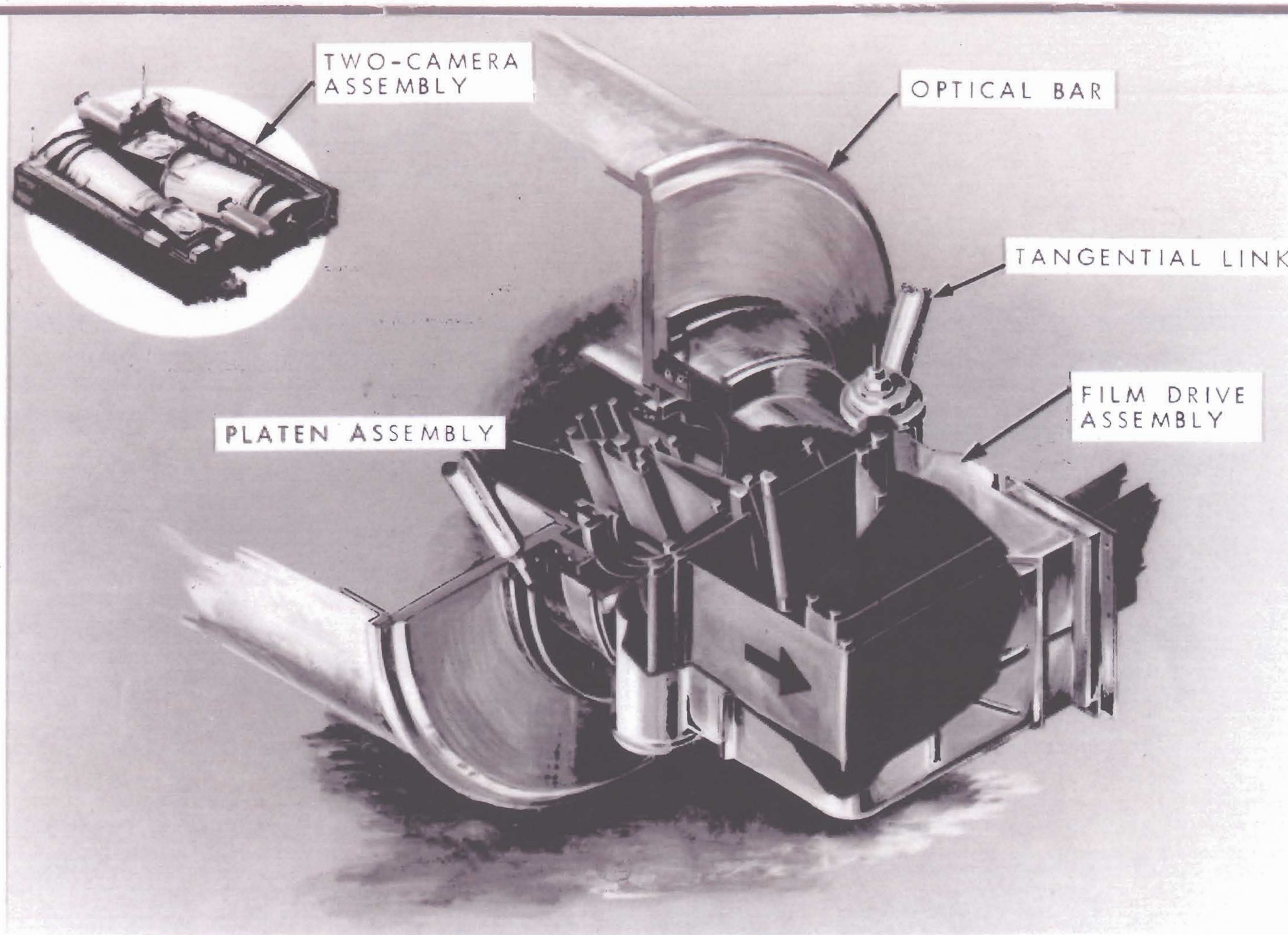
PLATEN AND FILM DRIVE



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PNEUMATICS SYSTEM

Dry nitrogen gas is supplied to the film path air bars at specified flow rates and pressures. Air bars are located in the twister, TCA cross-over, and the supply cross-overs. These bars are D-shaped in cross-section and hollow with small holes in their curved portion through which nitrogen is forced by the pneumatic system. This provides a practically frictionless bearing for the film, permitting both lateral film movement and film transport across the bar. The nitrogen supply is two spherical tanks with a combined storage capacity of 68 pounds of which 62 pounds are usable.

Pressure enclosures seal the entire film path including the film supply and the take-ups, maintaining the required relative humidity for film moisture content stabilization. The film path gaseous environment includes the 50 pounds of water in the film as outgassing water vapor plus the 62 pounds of nitrogen coming through the orifices of the gas bars. During non-operating periods the film supply unit is isolated from the rest of the film path by a commandable seal door to minimize leakage and moisture loss.

In test and during ascent the sealed film path accommodates atmospheric pressure changes through relief and pressurizing valves. When film is being transported, a lower pressure relief setting in the film path compared to that in the supply allows a system pressure bleed-off through vents on the forward steerer enclosure.

The pneumatics supply module is a self-contained unit consisting of high pressure storage spheres, regulators, and valves. The system is designed with individual paths from a supply sphere to a camera with cross-overs at the high pressure and low pressure portions of the system. The high pressure cross-over valve between the nitrogen tanks is normally closed. It is used to transfer gas from one tank to the other. To isolate a flow path, on external command or in response to a feedback signal of over-pressure downstream of the regulator, a solenoid latching valve in the high pressure portion is closed. Normally, a uniform simultaneous flow through both sides is maintained by the open low pressure cross-over valve, which is commanded closed only because of any failure requiring isolation. The shut-off valves in the low pressure paths are commandable, controlling on/off requirements of gas flow.

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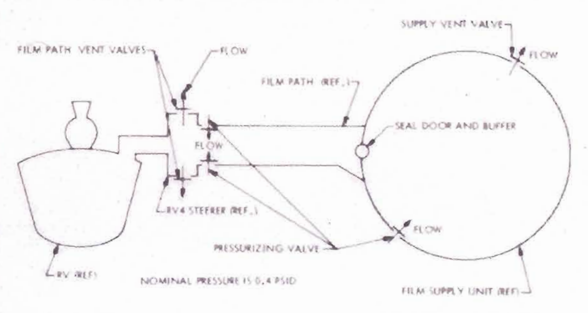
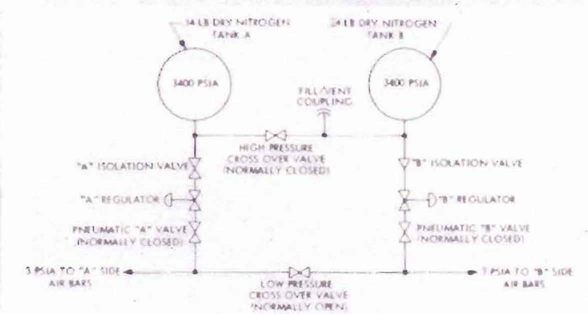
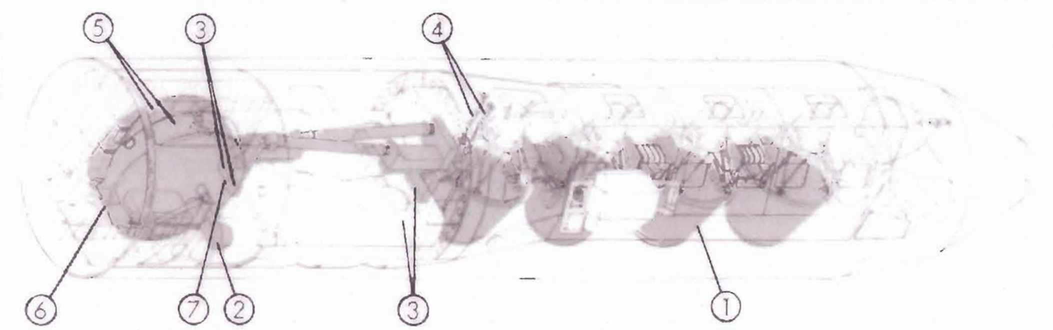
PNEUMATICS SYSTEM



FILM PATH VENTING SCHEMATIC



PNEUMATICS SUPPLY MODULE



PRESSURIZED REGIONS - SHADED

1. REENTRY VEHICLES
2. PNEUMATIC SUPPLY MODULE
3. AIR BAR PAIRS
4. FILM PATH VENT VALVES
5. SUPPLY VENT VALVES
6. PRESSURIZING VALVE
7. SUPPLY SEAL DOOR

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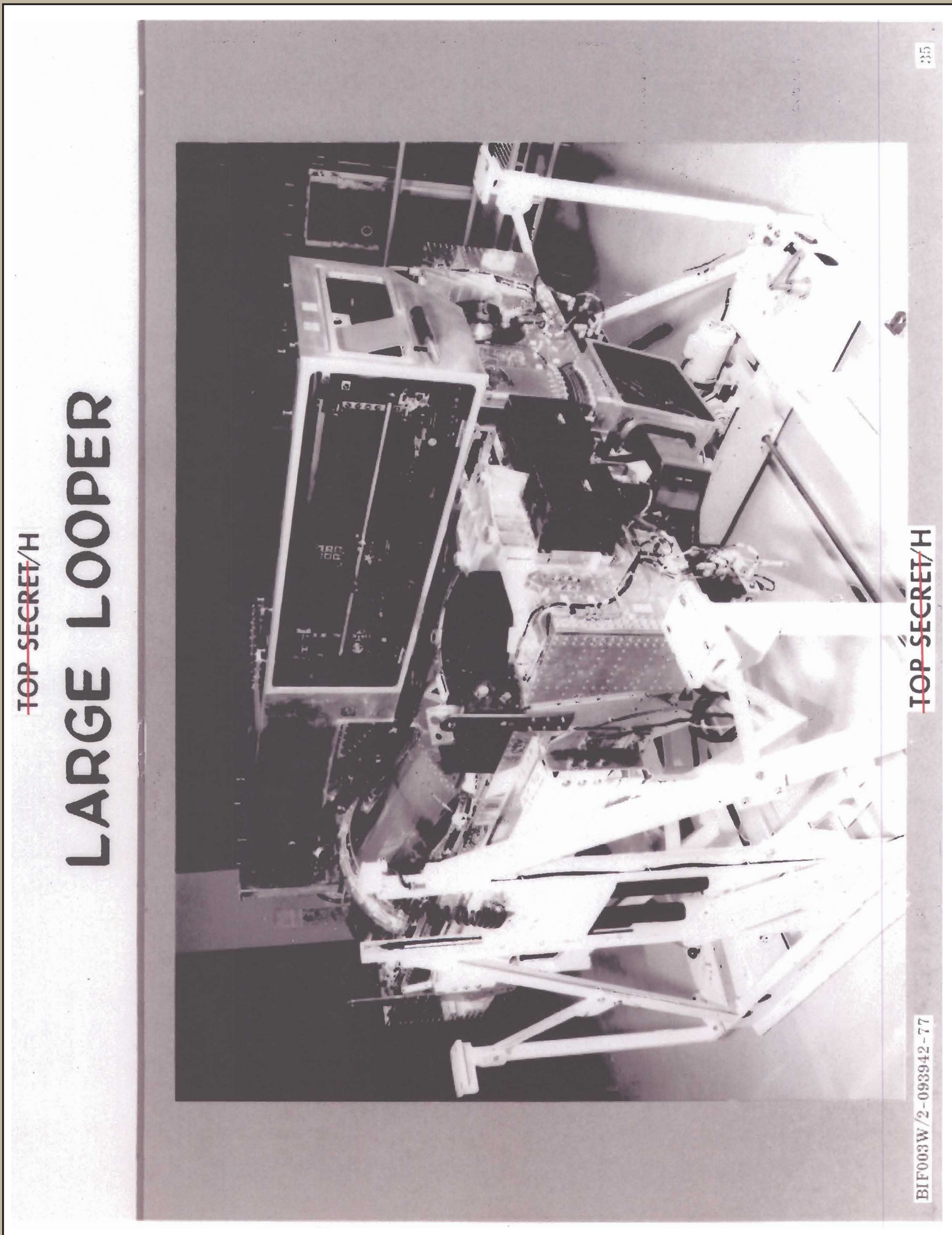
LARGE LOOPER

The accompanying illustration shows a Two Camera Assembly (TCA) incorporating the large looper which will become operational with SV-17. The increased film capacity (45 feet versus the 13 feet on the original design) enables the platen to be fed film at the desired rate during the time the coarse transport system is accelerating and to be stopped while the coarse film transport system is decelerating. Film management is greatly simplified since all the film is used in sequence. The present delay in the start of photography until the coarse film transport has accelerated to the average rate and the rewind of unexposed film passed through the platen is eliminated. This removes rewind as a possible source of contamination or as a wastage of film when rewind could not be accomplished between nested operations. Because this major change is being accomplished in-line, full provisions are retained to operate the coarse transport system in the original mode.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LARGE LOOPER
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MARK 8 REENTRY VEHICLE

When the take-ups in the RV are filled, the next in-line RV is enabled and the full RV is ejected from the optimized pitched down SV at a 3 ft/second rate. The spin-up to 10 radians per second is accomplished via hot gas generator to stabilize the RV during the retro rocket motor burn. The retro rocket provides a 1623 pound thrust to slow the RV for reentry. The despin system then slows the spin rate to 1.4 radians per second, which provides the needed stability during the coast period and still permits the aerodynamic torques to align the RV angle-of-attack with the flight path early in the reentry period. The drogue parachute is deployed upon closure of an acceleration switch at approximately 60,000 ft altitude. The drogue parachute is released and main parachute deployed upon closure of a barometric pressure switch at about 50,000 feet.

At 15,000 feet, the rate of descent is from 1200 to 1650 feet per minute, which is suitable for aerial recovery by USAF JC130 aircraft.

Each RV has a base diameter of 57-1/2 inches and is 85 inches from the heatshield nose to the retro motor nozzle. Maximum total weight of the RV and film is 1695 pounds. This consists of 956 pounds of RV and equipment, 239 pounds for film take-ups, and 500 pounds of film.

The heatshield when removed shows the gold tape covered canister which is part of a passive on-orbit thermal control system which, together with electrical heaters, maintains the desired canister temperature. The propulsion truss assembly and SV attachment fittings are shown.

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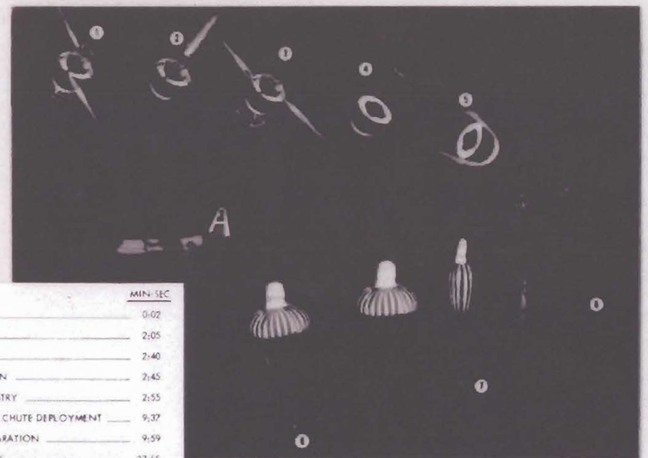
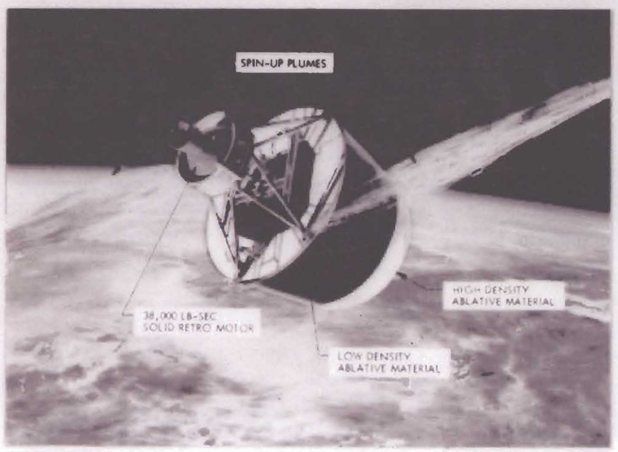
MARK 8 REENTRY VEHICLE

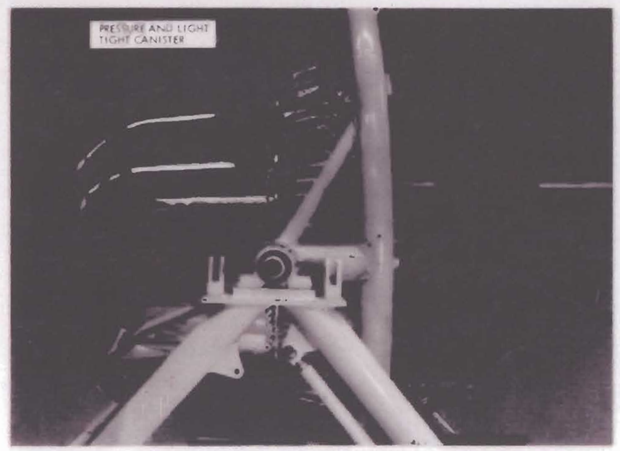
RECOVERY SEQUENCE



		MIN-SEC
1	SPIN-UP	0:02
2	RETROGRADE	2:05
3	SPIN-DOWN	2:40
4	TRUSS SEPARATION	2:45
5	ATMOSPHERIC ENTRY	2:55
6	DROGUE & MAIN CHUTE DEPLOYMENT	9:37
7	HEAT SHIELD SEPARATION	9:59
8	AERIAL RECOVERY	27:55



SPIN-UP EVENT



RV WITHOUT HEAT SHIELD

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DATA RECOVERY OPERATIONS

The target cone is 10 feet in diameter and 15 feet high. It contains the nylon load lines which are engaged by hooks on the retrieval line loops deployed by the retrieval aircraft.

The minimum dispersal impact area applies to all normal film load with the maximum dispersal area applicable to a maximum unbalanced film load. In an emergency, recoveries may be required outside this designated area toward Midway Island or the California Coast.

If aerial retrieval is not accomplished, water recovery becomes a backup phase. When sea water contacts a sensor, a relay closes the film canister vent valve and transfers vehicle power to the water recovery beacon. A salt water corrosion plug will sink the recovery capsule in 48 to 60 hours after water impact. This allows a reasonable time for location and pickup by Air Force and Navy forces.

If the RV significantly overshoots the specified impact point, it will be destroyed. This is accomplished by ejecting the heatshield and deploying the drogue chute if aero drag has not produced 0.003 g by a given time after RV separation. This results in the RV burning up when the atmosphere is encountered. This provision has not been utilized on the HEXAGON program to date.

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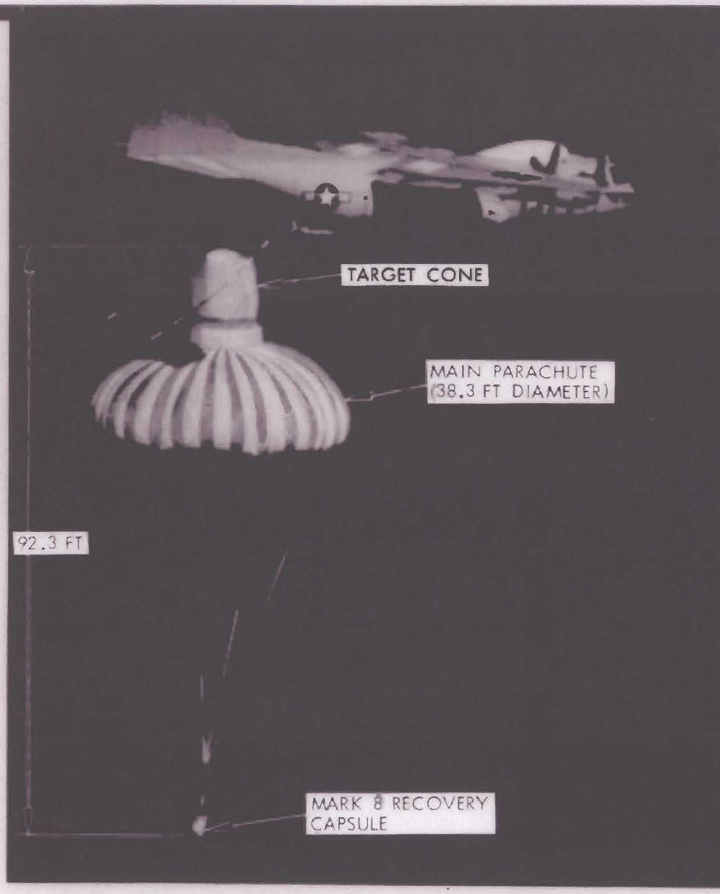
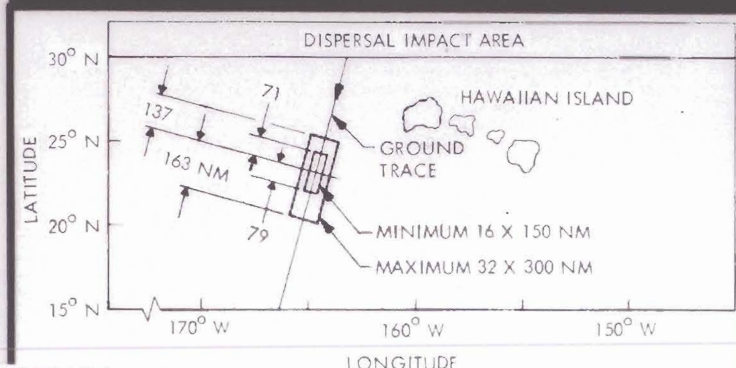
DATA RECOVERY OPERATIONS





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MARK 8 EQUIPMENT

The film is shown passing through the RV. Transfer of film to this RV consists of transferring take-up power, wrapping film on this take-up, cutting and sealing the film path on the exit side, followed by cutting and sealing the inlet film path on the forward RV.

The RV base ablative cover consists of panels of ultra low density material. The base panel structures are of fiberglass honeycomb sandwich construction. A laminate of graphite blankets over glass fiber blankets covers the main parachute compartment. The circuit interrupter switch and wire bundles are mechanically separated near the ablative surface by a guillotine prior to physical separation of the RV from the SV.

The bottom view shows the film on take-up A and B. The take-up drive motor and control electronics are contained mainly within the take-up hub. The canister is shown removed for access to the take-up and the RV equipment. This access greatly enhances film tracking alignments and testing during SV factory testing.

The RV assembly shows the structural frames within the RV which provide mechanical support for the take-up assembly and RV equipment. Of the encapsulated volume inside the RV, 18 ft^3 is for the take-up assembly and 13 ft^3 is used by the RV equipment. The film stack diameter can be up to 35 inches. RV power distribution and event sequence control is provided by relays. Time delay relays are used to control sequence timing. Instrumentation is provided for monitoring the deorbit-reentry events and temperature. This data is processed through the PCM commutator to the tracking and telemetry transmitter.

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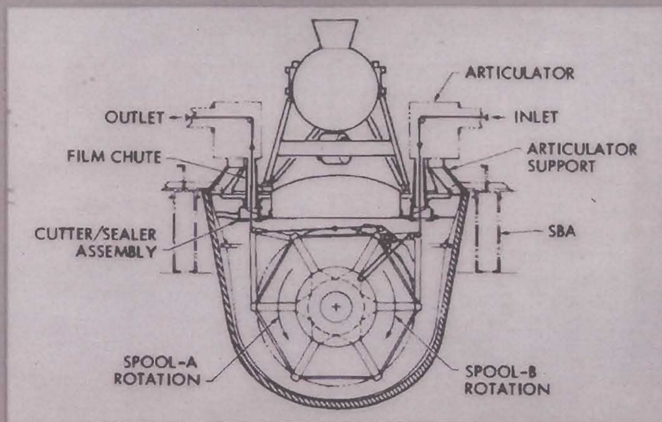
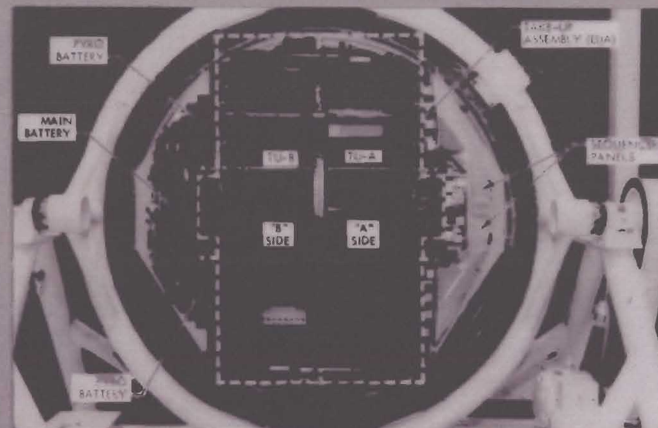
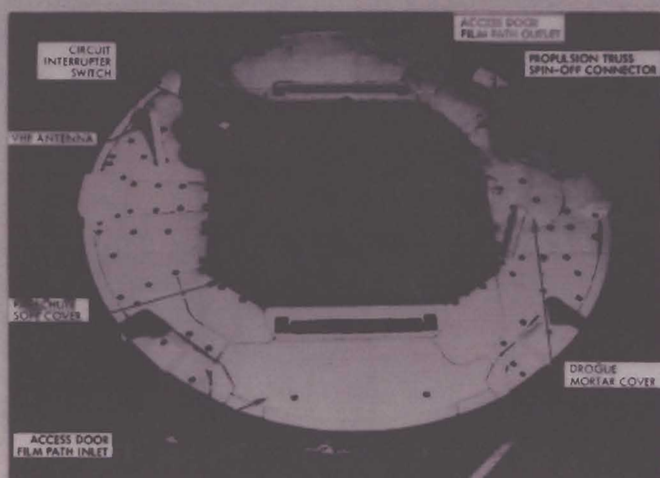
MARK 8 RV EQUIPMENT



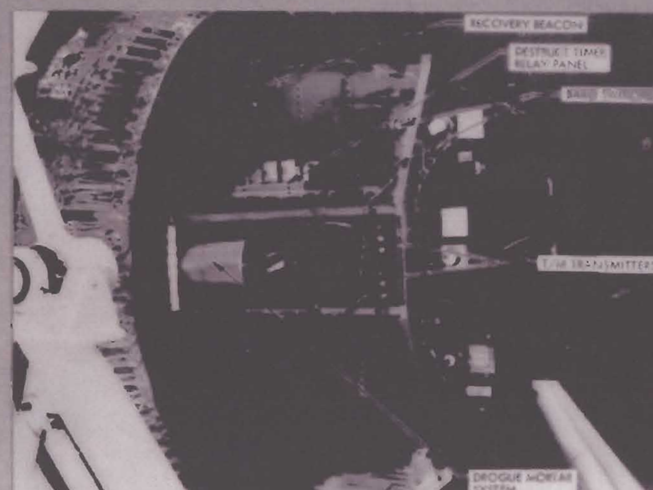
FILM THROUGH RV



FILM ON RV TAKE UPS



RV BASE ABLATIVE COVER



RV ASSEMBLY

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SEARCH CAPABILITY

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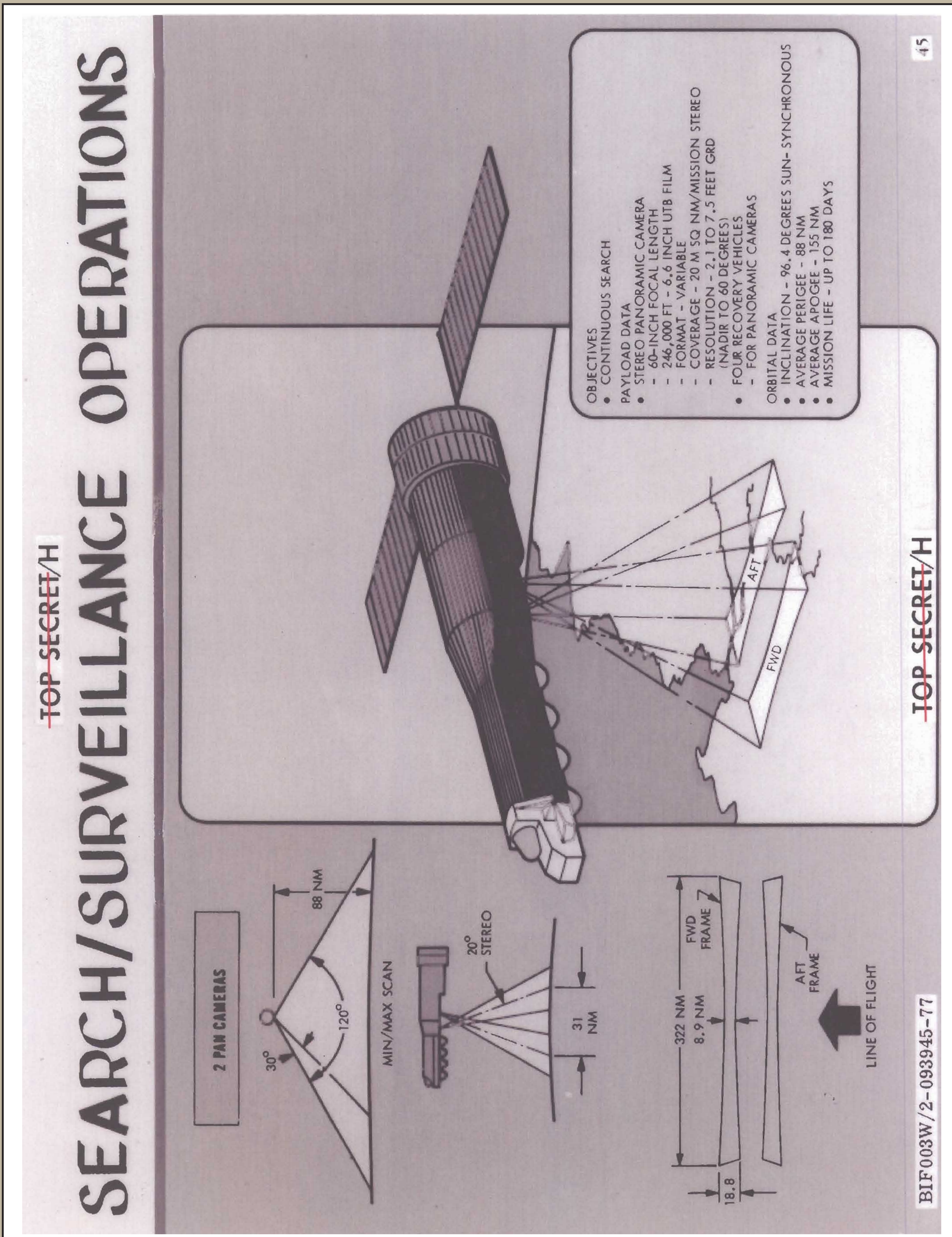
SEARCH/SURVEILLANCE OPERATIONS

Scanning is accomplished by continuous rotation of the optical bars at a rate to produce a nominal three percent frame-to-frame overlap allowance at nadir. The minimum scan sector is 30 degrees, the maximum 120 degrees. To achieve stereoscopic coverage the port camera (camera-A) looks forward 10 degrees and the starboard camera (camera-B) looks aft 10 degrees. At 88 nm altitude the interval of the forward to the aft frame is 31 nm. Since camera-B lags camera-A with respect to ground cover at nadir, the shutter of camera-B is inhibited for the first three frames and camera-A for the last three frames of each operation. Either camera can be operated separately in a mono mode.

The ground format varies with altitude, scan sector, and scan center. With the optical bars counter-rotating the ground formats for the two camera are not the same. The area of coverage per mission also varies with the average scan sector of acquisitions. At ±45 degrees average scan with the maximum supply of 1414 black and white film, gross stereo coverage of 20 million square nautical miles (M sq. nm) can be achieved at an average acquisition altitude of 88 nm with the current film transport system. At an average scan of ±30 degrees, this coverage would be reduced to 16 M sq. nm.



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SEARCH/SURVEILLANCE OPERATIONS
2 PAN CAMERAS
30°
120°
88 NM
MIN/MAX SCAN
20° STEREO
31 NM
322 NM
8.9 NM
FWD FRAME
AFT FRAME
18.8
LINE OF FLIGHT
FWD
AFT
OBJECTIVES
• CONTINUOUS SEARCH
PAYLOAD DATA
• STEREO PANORAMIC CAMERA
- 60-INCH FOCAL LENGTH
- 246,000 FT - 6.6 INCH UTB FILM
- FORMAT - VARIABLE
- COVERAGE - 20 M SQ NM/MISSION STEREO
- RESOLUTION - 2.1 TO 7.5 FEET GRD (NADIR TO 60 DEGREES)
• FOUR RECOVERY VEHICLES
- FOR PANORAMIC CAMERAS
ORBITAL DATA
• INCLINATION - 96.4 DEGREES SUN-SYNCHRONOUS
• AVERAGE PERIGEE - 88 NM
• AVERAGE APOGEE - 155 NM
• MISSION LIFE - UP TO 180 DAYS
45
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THE CAPITOL

Conditions for this photograph are: Mission 1212-3, op 723, frame 002 forward, 002 aft, -24^{o} scan, 15 October 1976, stereo, 20X magnification of the Capital, Washington, D. C.

The ability of the HEXAGON camera to photograph targets in stereo greatly increase its capability as an intelligence gathering tool. All subjects reveal more information in three dimensions because they assume all the spatial dimension we are used to seeing. This allows determination of structure height, seeing the real shape of unusual objects and separation of items from confusing background.

The item at (A) is the press box for the last presidential inauguration. It was still under construction. The relief of the trees at (B) shows how cover for troops and vehicles can be interpreted and targets located.

During the time between exposures, vehicles (C) moved to new locations. The scale of the photograph and time interval are known so their speed can be calculated.

Stereo imagery generally increases the information content of a target area and provides for a more complete and accurate intelligence reporting.

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PANORAMIC SYSTEM FLEXIBILITY

HEXAGON has considerable flexibility in area search because of the selectability of scan sectors, scan centers, mono/stereo modes, and the number of frames for contiguous area acquisition. Using the United States as a familiar target objective, the four operations shown in the accompanying illustration range from a ±30 degree scan sector with 6 frames totaling 5300 sq nm mono to a ±60 degree scan sector with 18 frames totaling 51,680 sq nm mono. The example illustrates acquisitions along the flight path and on either side of it in a variety of modes, all during a single orbit rev. Acquisitions could be either mono or stereo operations.

Data return at Hawaii is available in [redacted] from this particular pass if timeliness is a factor. In its capability to perform world-wide search, data return of any acquisition is achievable within a one-day period.

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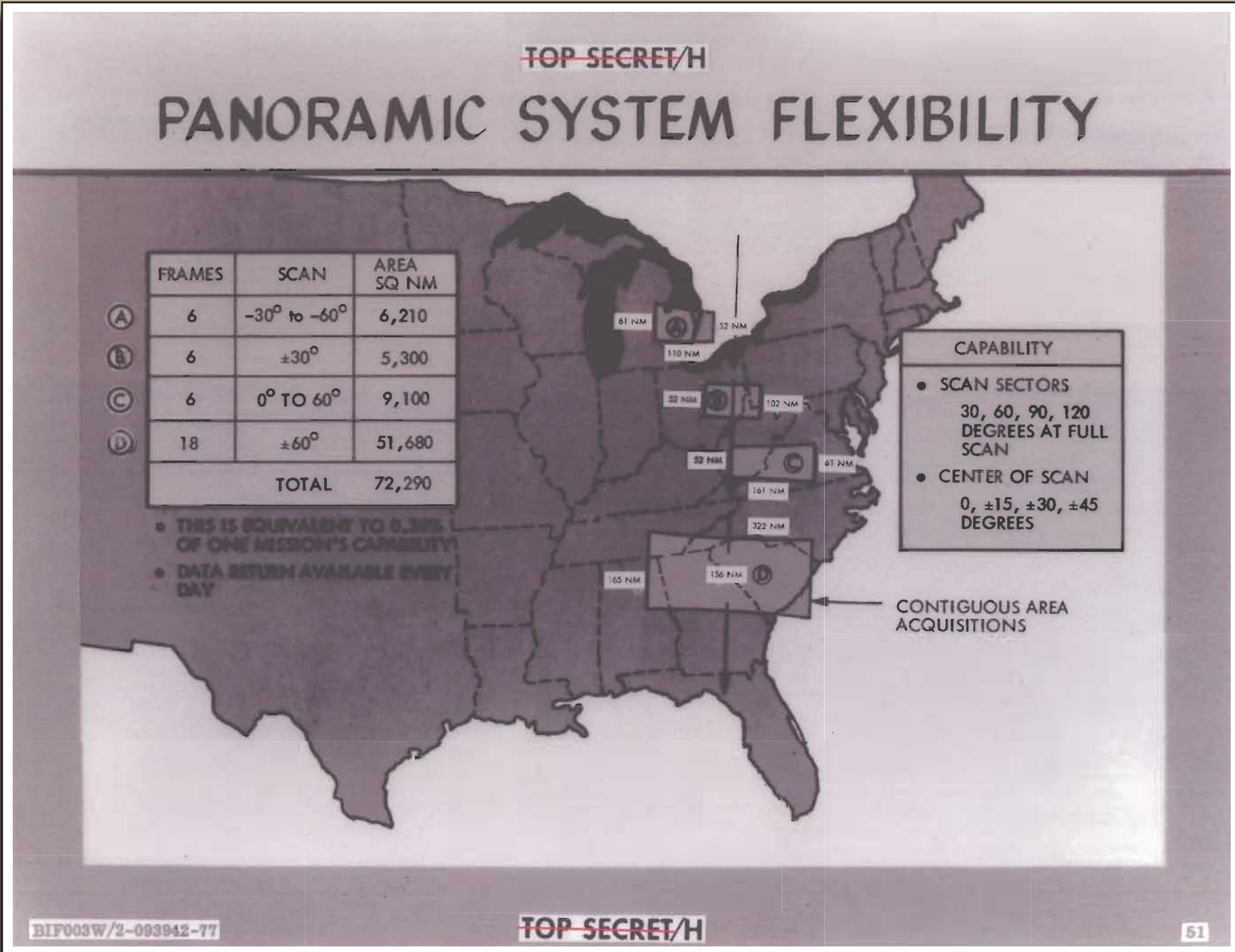
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PANORAMIC SYSTEM FLEXIBILITY
FRAMES | SCAN | AREA SQ NM
A 6 | -30° to -60° | 6,210
B 6 | ±30° | 5,300
C 6 | 0° TO 60° | 9,100
D 18 | ±60° | 51,680
TOTAL 72,290
• DATA RETURN AVAILABLE EVERY DAY
61 NM
52 NM
110 NM
102 NM
61 NM
161 NM
322 NM
156 NM
165 NM
CAPABILITY
• SCAN SECTORS
30, 60, 90, 120 DEGREES AT FULL SCAN
• CENTER OF SCAN
0, ±15, ±30, ±45 DEGREES
CONTIGUOUS AREA ACQUISITIONS
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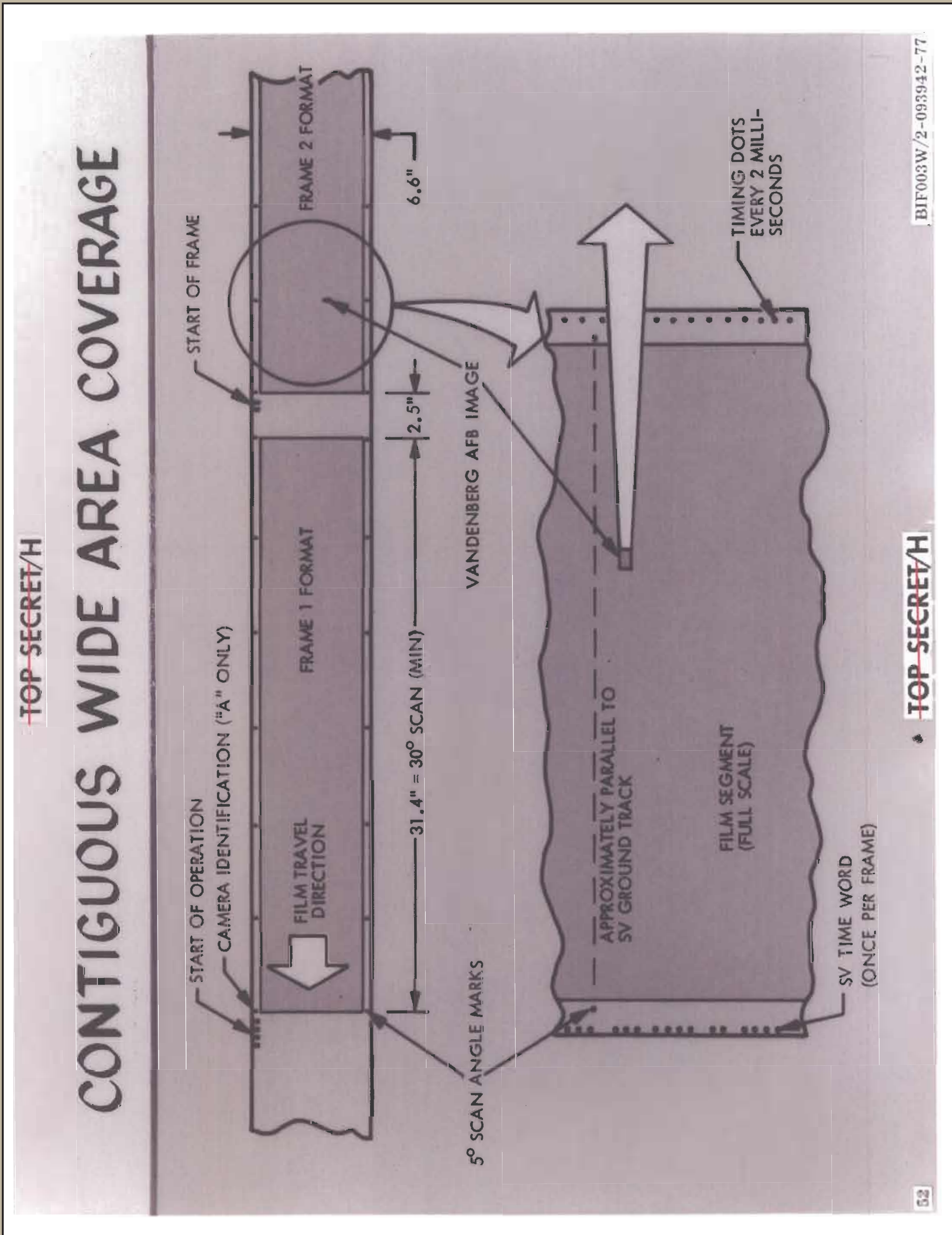
TOP ~~SECRET~~/H
CONTIGUOUS WIDE AREA COVERAGE
START OF OPERATION
CAMERA IDENTIFICATION ("A" ONLY)
START OF FRAME
FILM TRAVEL DIRECTION
FRAME 1 FORMAT
FRAME 2 FORMAT
31.4" = 30° SCAN (MIN)
2.5"
6.6"
5° SCAN ANGLE MARKS
VANDENBERG AFB IMAGE
APPROXIMATELY PARALLEL TO SV GROUND TRACK
FILM SEGMENT (FULL SCALE)
SV TIME WORD (ONCE PER FRAME)
TIMING DOTS EVERY 2 MILLI-SECONDS
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CONTIGUOUS WIDE AREA COVERAGE

VANDENBERG AFB (HEXAGON LAUNCH SITE ON RIGHT)
VIA MISSION 1209-1 AT 40 TIMES MAGNIFICATION

THE KEY UNIQUE FEATURE OF HEXAGON IS ITS ABILITY TO CAPTURE LARGE AREAS ON FILM WITHIN A FEW MINUTES. A "FREEZING" OF THE ENTIRE AREA ALLOWS FOR IDENTIFICATION AND ENLARGEMENT OF ANY POINT OF POSSIBLE INTEREST AS ILLUSTRATED ABOVE. THIS IS A VALUABLE CAPABILITY WHEN CONDUCTING SEARCH FOR SPECIFIC TARGETS OF UNCERTAIN LOCATIONS.

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MID EAST COVERAGE

A typical area search acquisition by HEXAGON is the coverage of the Eastern Mediterranean. This is a single two-minute stereo operation. At 90 nm altitude and a cross track scan of ±45 degrees, the primary areas of interest in Western Syria, Lebanon, Israel, Western Jordan, part of the Sinai Peninsula, and part of Cyprus are acquired as a contiguous area. At ±60 degrees scan, the additional width permits a greater tolerance in the longitudinal position of the flight path in addition to a wider area searched. In an extreme crisis, through the control of the orbit, a daily report of the acquisition of these areas is achievable.

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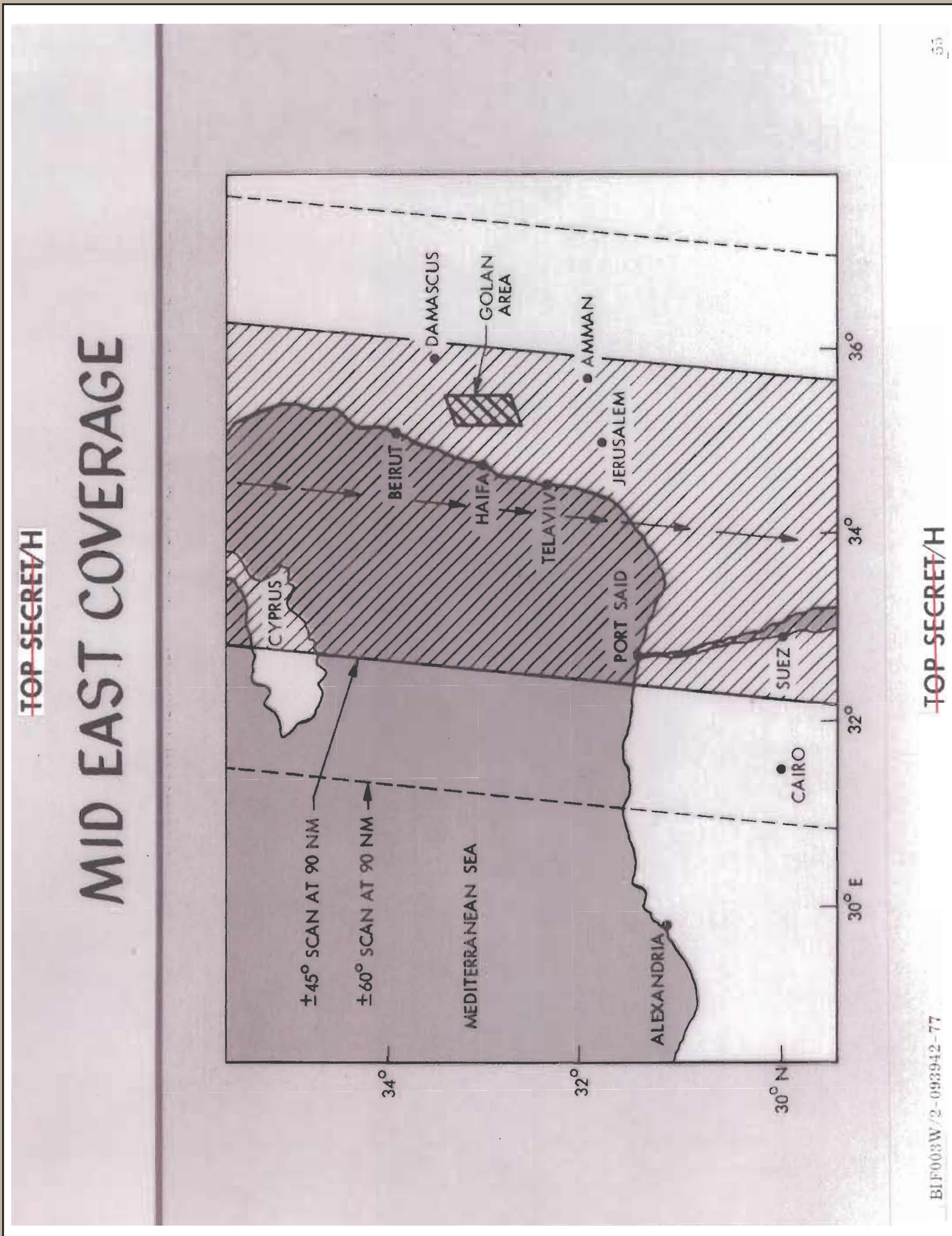
TOP ~~SECRET~~/H
MID EAST COVERAGE
±45° SCAN AT 90 NM
±60° SCAN AT 90 NM
MEDITERRANEAN SEA
ALEXANDRIA
CAIRO
SUEZ
PORT SAID
CYPRUS
TEL AVIV
HAIFA
BEIRUT
JERUSALEM
AMMAN
DAMASCUS
GOLAN AREA
34°
32°
30° N
30° E
32°
34°
36°
TOP ~~SECRET~~/H
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BROAD AREA ACQUISITION

The HEXAGON system can provide broad area acquisition with a contiguous area acquisition of considerable magnitude along the line of flight using any of the selectable scan sector and scan center combinations. The maximum 120 degree swath width is illustrated for a 20 minute contiguous operation acquiring a 4800 nm long area, 322 nm wide, extending from Western Russia, through the Eastern Mediterranean, down into Southern Africa. The total area approximates 1.54 M sq nm with an average altitude of 88 nm.

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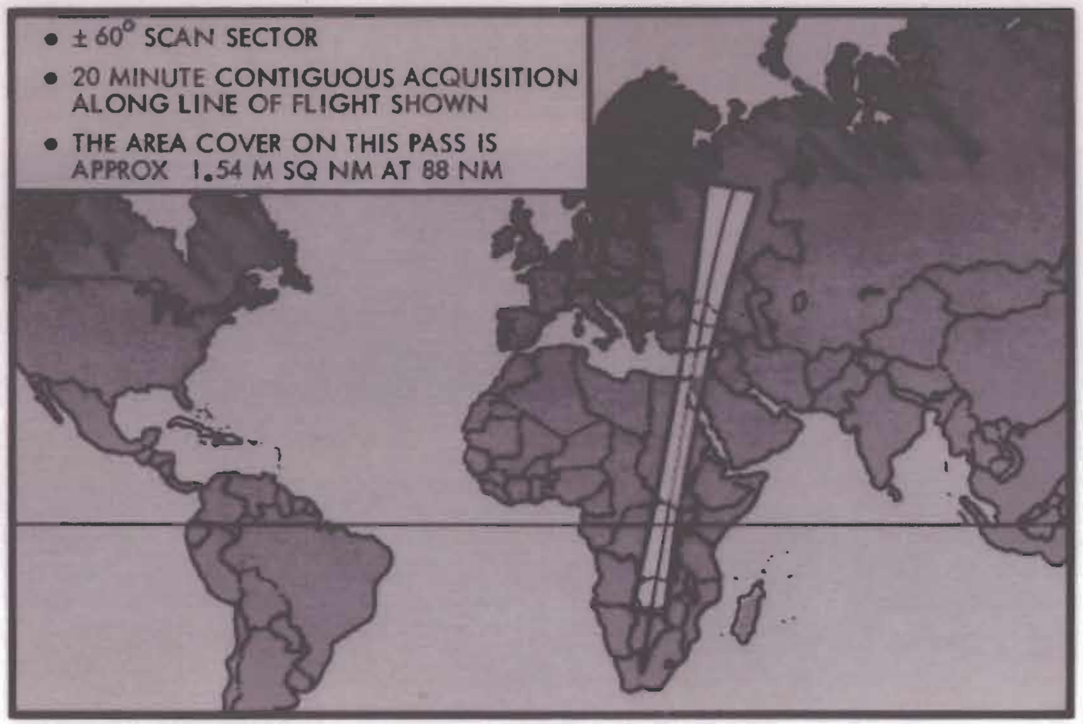
BROAD AREA ACQUISITION



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COVERAGE ACHIEVEMENTS

The magnitude of the total world-wide imagery accomplished by HEXAGON can be compared with a familiar geographic area equivalent. As examples, the cloud-free total worldwide imagery of the fourth mission is equivalent to sixty acquisitions of Texas, or mission three equivalent to eight times the United States. The total area of Communist and free-world is 52.2 million square nautical miles which could be covered within two to three missions. The reduced coverage on mission 1201 was due to the loss of RV-3.

The percent of cloud-free acquisitions are dependent on several factors. The geographic locations of selected targets, the time of year, the time of day, and satellite weather information determine basic weather expectancy. The probability of cloud-free acquisitions is improved by longer missions, permitting more selectivity of operations within longer intervals of time between RV returns. The need to acquire certain high priority targets on every access reduces the probability of cloud-free acquisitions. The cloud-free unique imagery from mission 1212 consisted of: USSR [redacted] square nautical miles, Eastern Europe [redacted] China [redacted] other [redacted] and Middle East [redacted] Egypt, Syria, Jordan, Iraq, Lebanon and Israel) for a total of [redacted] square nautical miles.

The unique COMIREX targets shown in the table for each mission were read out by NPIC out of a total COMIREX target population that has ranged from about [redacted] in the earlier missions to about [redacted] on the most recent missions.

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COVERAGE ACHIEVEMENTS

MISSION NUMBER	AREA COVERAGE (MILLION SQUARE NAUTICAL MILES)					UNIQUE COMIREX TARGETS IMAGED
	WORLD-WIDE		COMMUNIST COUNTRIES AND MIDDLE EAST			
	TOTAL IMAGERY	PERCENT CLOUD FREE	TOTAL IMAGERY	CLOUD-FREE GROSS	CLOUD-FREE UNIQUE	
1201	15.9	[redacted]	11.2	[redacted]	[redacted]	[redacted]
1202	21.1	[redacted]	16.1	[redacted]	[redacted]	[redacted]
1203	26.4	[redacted]	22.5	[redacted]	[redacted]	[redacted]
1204	18.8	[redacted]	14.2	[redacted]	[redacted]	[redacted]
1205	17.5	[redacted]	12.7	[redacted]	[redacted]	[redacted]
1206	18.9	[redacted]	15.1	[redacted]	[redacted]	[redacted]
1207	18.0	[redacted]	13.9	[redacted]	[redacted]	[redacted]
1208	16.6	[redacted]	13.0	[redacted]	[redacted]	[redacted]
1209	18.6	[redacted]	14.1	[redacted]	[redacted]	[redacted]
1210	17.4	[redacted]	13.6	[redacted]	[redacted]	[redacted]
1211	23.1	[redacted]	17.6	[redacted]	[redacted]	[redacted]
1212	17.9	[redacted]	12.6	[redacted]	[redacted]	[redacted]
1213	14.2 (1)	[redacted]				

(1) THROUGH RV #3

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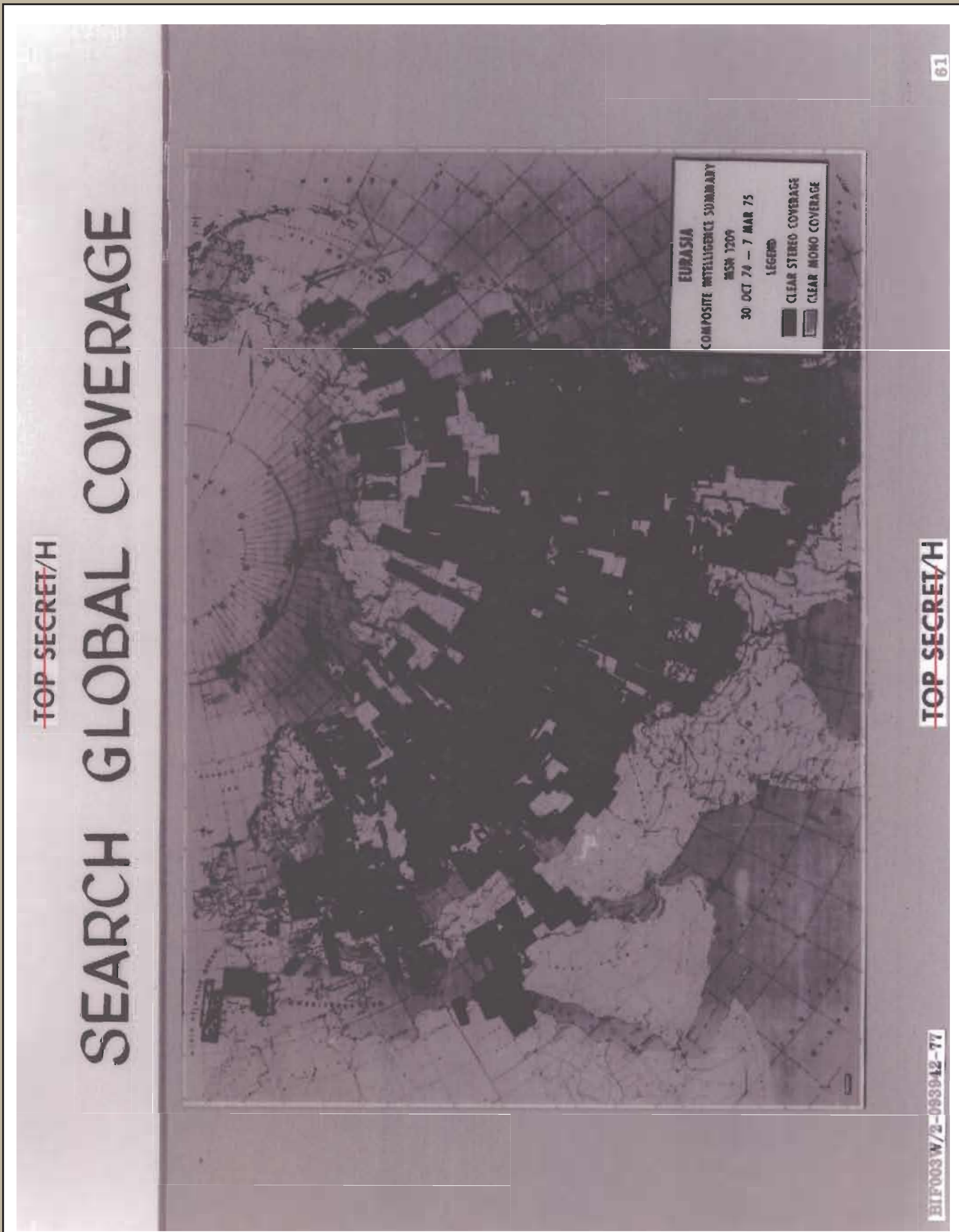
SEARCH GLOBAL COVERAGE

This is a representative coverage of the Europe, Asia, and surrounding countries. The enclosed block or cell areas taken but not cloud-free are also shown. High priority targets were taken several times to ensure a cloud-free take and to note ground activity changes throughout the four-month life of Mission 1209.

These geographic areas of interest total 10.9 million square nautical miles and consist of: USSR 6.87, Eastern Europe 0.4, China 2.82, other Communist countries 0.56, and Middle East 0.25. The free-world area, including the United States, comprises a total of 41.3 million square nautical miles.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SEARCH GLOBAL COVERAGE
EURASIA
COMPOSITE INTELLIGENCE SUMMARY
MSN 1209
30 OCT 74 – 7 MAR 75
LEGEND
CLEAR STEREO COVERAGE
CLEAR MONO COVERAGE
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COVERAGE HISTORY

The initial contract for HEXAGON was to fly each vehicle for thirty days every 60 days for a 50% search coverage. The highly successful on-orbit performance, higher altitude, and design improvements of HEXAGON has allowed longer mission durations. This has resulted in extending search and surveillance operations up to 176 days.

The gap in continuity (RV #4 recovery to next vehicle launch) of HEXAGON coverage has varied widely. These gaps for the 13 flights to date have ranged from a low of 39 days to a high of more than 200 days. Under the accomplished schedule of the 13 launches, operational coverage with the acquisition and subsequent return of imagery data was available approximately half the time.

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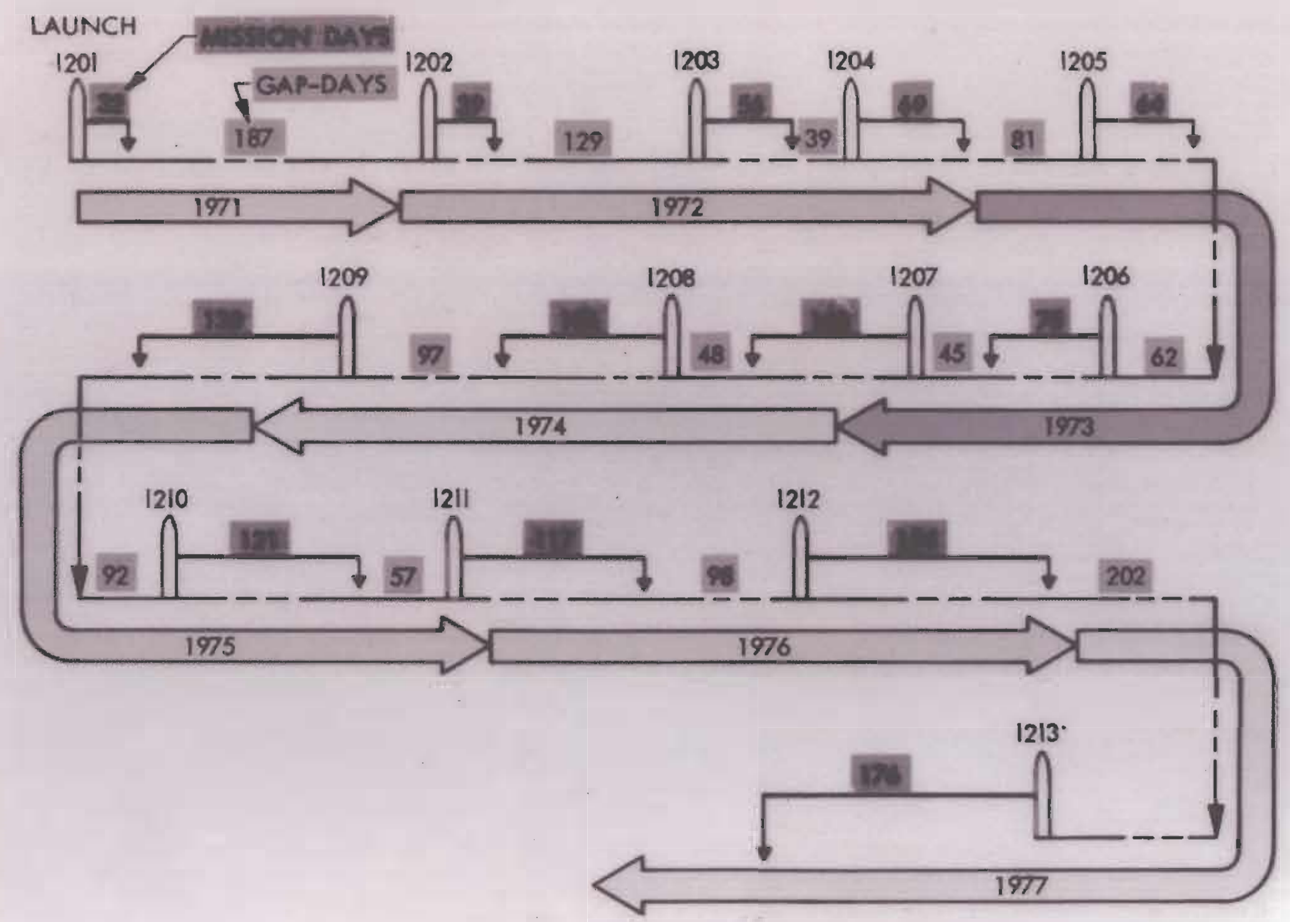
COVERAGE HISTORY



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INCREASING DURATION BETWEEN RECOVERIES

Since the first launch on 15 June 1971 the increasing mission life (from 32 to 176 days) has resulted in an increasing number of operating days between recoveries. Starting with a low of 5 days, it has increased to intervals of 36, 34, 60, and 46 days on the thirteenth flight. On each of 11 flights, the shortest operating days per RV preceded the recovery of RV-1. On each of eight flights the longest time period preceded RV-4 recovery. Future increases in mission life to utilize the potential of the SV will produce on the average as many as 60 days of operations preceding the recovery of each RV.

Under crisis condition it is [redacted]possible to make a non-full RV recovery after the critical target is photographed; however, this option has not been selected to date.

Solo operations have been used to exploit the SV capabilities without risk to RV recovery. Solo tests have been instrumental in successfully increasing mission durations.

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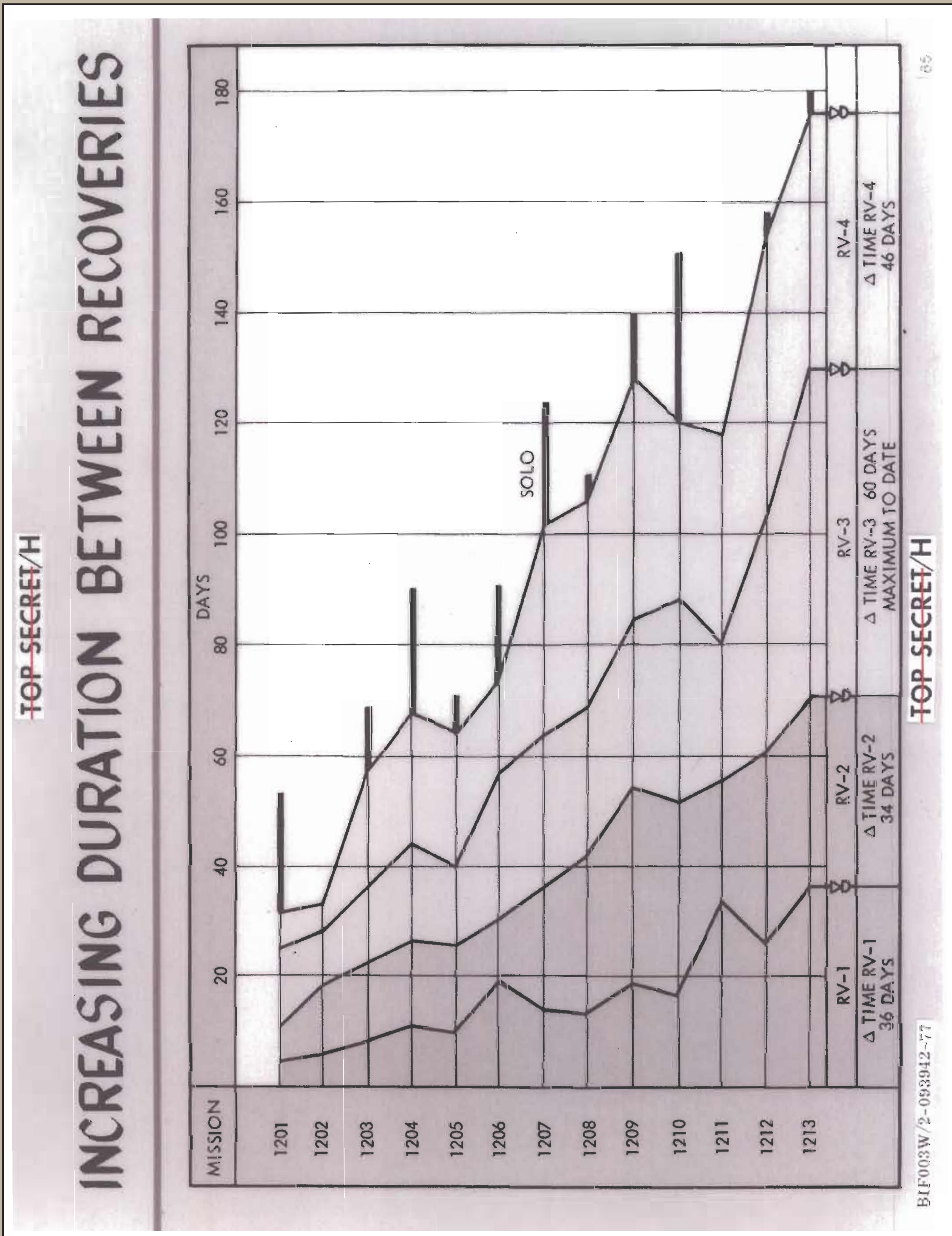
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INCREASING DURATION BETWEEN RECOVERIES
MISSION
1201
1202
1203
1204
1205
1206
1207
1208
1209
1210
1211
1212
1213
DAYS
20
40
60
80
100
120
140
160
180
SOLO
RV-1
Δ TIME RV-1 36 DAYS
RV-2
Δ TIME RV-2 34 DAYS
RV-3
Δ TIME RV-3 60 DAYS MAXIMUM TO DATE
RV-4
Δ TIME RV-4 46 DAYS
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SO-255 COLOR FILM

Conditions for this photo are: Mission 1208-4, OP 733, Frame 006, Aft, Scan Angle -2°, 15 July 1974, 40X magnification of San Francisco, California.

Color photography contributes an additional dimension to search and surveillance photography. It removes the image from the abstraction of black-and-white and places it in a context we understand more readily.

We see the world as a collection of shapes with size, texture, and color. A photograph lacking color is lacking one element in relation to reality.

This scene is photographed in natural color and many items are readily identifiable because of color cues. The school buses at (A) could be interpreted as such in black-and-white by their proximity to the school complex. However, the distinctive yellow hue that we associate with school buses signals their use immediately.

The blue color traditionally found in swimming pools is easily located in several residential areas (B). Black and white coverage would require a detailed search because their geometric shapes would be lost among the buildings. The competition pool at (C) shows varying depth by the transition from lighter to darker blue as the water deepens. This same signature is seen at (D) indicating an expensive, in-ground pool. Numerous other items will be apparent to the viewer because of its association with object color in everyday experience.

Military, industrial, and transportation items also have distinctive color coding signatures and are separated from the enormous amount of photo detail in the same manner as the items cited above.

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SO-130 INFRARED COLOR FILM

Conditions for this photo are: Mission 1213-3, OP 713, Frame 006, aft, scan angle 0^{o}, Oct 14, 1976, 5X magnification near Santa Fe, New Mexico.

Infrared color films were originally designed as a camouflage detection film. They have the capability of separating man-made, hidden objects from natural vegetation because of special characteristics of infrared radiation. Resolution is quite low compared to the black-and-white films used as the primary payload.

Vegetation containing living chlorophyl reflects a large percentage of the infra-red component of natural sunlight. Plants under stress (having insufficient water, diseased, etc.) will have a breakdown in their chlorophyl structure and consequently reflect less infrared. This type of color film shows infrared reflectance as a magenta colored image. Healthy vegetation will appear as bright magenta and will change in either color or brightness as the plants degrade.

As a result of this characteristic, SO-130 is an ideal film for monitoring crop vigor and potential yield giving very basic intelligence data on the food supply and import/export requirements of a country.

In the accompanying photo varying degrees of vegetation vigor and distribution are indicated. The plantings at (A) are well advanced and show local irregularities in water supply and/or soil capability. Pasture land is seen as healthy at (B) and fallow fields are obvious at (C). The natural ground cover for the area is indicated as arid area, low chlorophyl cover by the response indicated by (D).

There are also notable color differences in the ponds that cross the format diagonally. As suspended sediments increase in volume, the color shifts toward the light blue and into the green portion of the spectrum. This is an indicator of the erosion and retention of valuable soils. Though marginally useful as a comouflage detection film at this scale, SO-130 is outstanding as a crop monitoring tool.

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FILM TYPES FLOWN

CONVENTIONAL BLACK AND WHITE FILMS ARE:

- 1414 – The standard fine grain high resolution B & W film flown on HEXAGON Missions through Mission 1213. This film has an extended red sensitivity, is approximately 2 mils thick (0.5 mil emulsion coated on a 1.5 mil base), and has an Aerial Film Speed (AFS) of 15.0.
- SO-208 – This film is identical to 1414 except that it is coated on an ultra-thin 1.2 mil base. This will allow approximately 20,000 additional feet of film to be utilized in the HEXAGON system and is the standard material for missions 1214 and up.

HIGHER RESOLUTION BLACK AND WHITE FILMS ARE:

- SO-124 – A panchromatic B & W film flown experimentally on Mission 1210. This film has higher low-contrast resolution than the conventional B & W films. It is coated on a 1.5 mil base and has an AFS of 6.0 requiring longer exposure times than the conventional B & W films.
- SO-460 – This film is essentially identical to SO-124 except that it is coated on the ultra-thin 1.2 mil base. The AFS is 6.0.
- SO-464 – This film is essentially SO-460 with the yellow AH dye removed. This results in an increase of emulsion speed to an AFS of 10.0. This emulsion is also coated on the ultra-thin 1.2 mil base.
- Aerial 15 – This is one of the new "Mono Dispersed Cubic" emulsions sometimes also referred to as "J" coatings. These emulsions exhibit extremely fine grain, high resolution, and very slow emulsion speeds. This film has an AFS of 6.6 and is coated on the ultra-thin 1.2 mil base.

COLOR FILMS ARE:

- SO-255 – This is a conventionally sensitized, fine grain, high-definition color reversal film. The emulsion is coated on a 1.5 mil base with the film having an AFS of 9.5.
- SO-130 – This is a "False Color" infrared sensitive color reversal film on a 1.5 mil base with an AFS of 7.5. This film is used extensively for economic intelligence evaluation.

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FILM TYPES FLOWN

MISSION	FILM TYPES							
	1414	SO-255	SO-130	SO-208	SO-124	SO-460	SO-464	AERIAL 15
	Film Footage - Feet							
1201	172,640							
1202	156,115							
1203	185,325							
1204	208,454	10,000						
1205	216,010	2,000						
1206	191,017	21,000	500					
1207	207,832	4,984	500					
1208	210,069	2,588	3,000					
1209	217,338	8,150	3,400					
1210	210,156	9,150	3,150		3,750			
1211	153,942	4,500	4,500	4,500				
1212	231,450	4,500	4,500					
1213	198,536	3,500	5,500	20,000		7,000	8,000	2,000
TOTALS	2,558,884	70,372	25,050	24,500	3,750	7,000	8,000	2,000

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MAPPING SYSTEM

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MAPPING CAMERA OPERATION

The mapping camera system (MCS) is utilized to provide cartographic control for compilation of 1:50,000 scale maps. Photogrametric data is achieved by simultaneously acquiring overlapping terrain and star field photographs through three precisely calibrated lens systems. Control points are established by measurements of prominent imagery on overlapping pairs of terrain photography. Measurements of star image locations on stellar frames provide an accurate orientation of the terrain camera axis in space at the time of each photograph. Stereo photography, necessary for vertical measurements of terrain imagery, is acquired in two stereo modes providing 70% or 55% overlap. A third mode is used to provide mono photography with 10% overlap. The high resolution and wide coverage (70 X 140 nm) of the terrain camera provide a useful tool in searching for primary targets of interest and earth survey objectives. On completion of the MCS mission, the terrain and stellar films are returned in a single Mark V recovery vehicle. The doppler beacon system and NAVPAC system provides ephemeral information which accurately establishes camera/vehicle position in space. These data are needed to support mensuration of MCS imagery.

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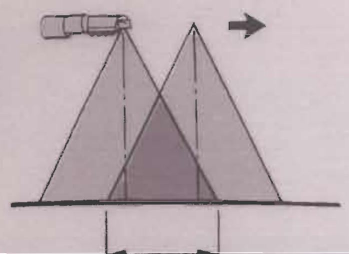
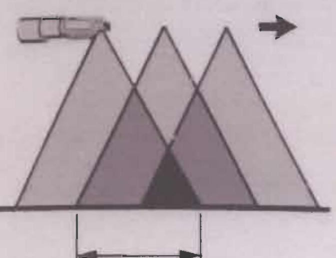
MAPPING CAMERA OPERATIONS

TERRAIN MAPPING CAMERA
BILAP PHOTOGRAPHY



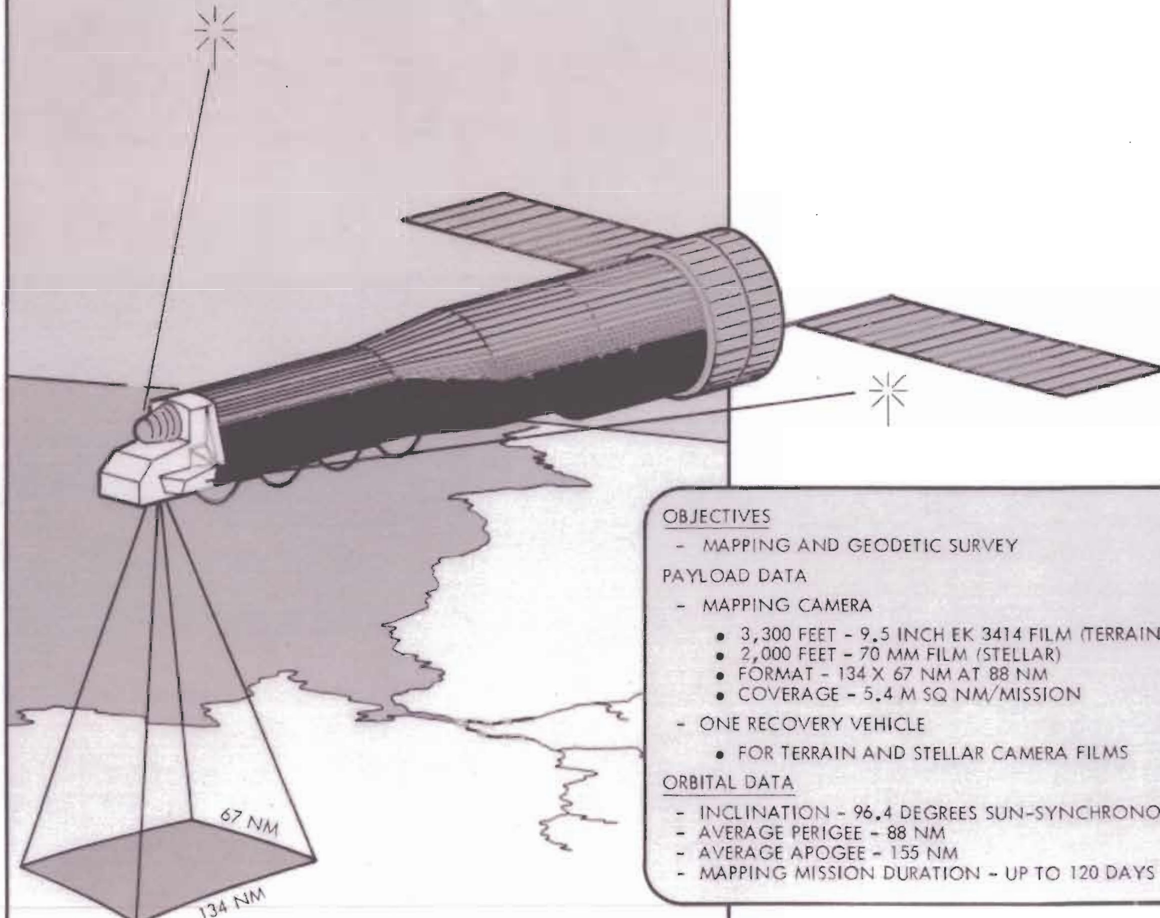
55% OVERLAP

TERRAIN MAPPING CAMERA
TRILAP PHOTOGRAPHY



70% OVERLAP

AT 88 NM. ALTITUDE



OBJECTIVES

- MAPPING AND GEODETIC SURVEY

PAYLOAD DATA

- MAPPING CAMERA
  - 3,300 FEET - 9.5 INCH EK 3414 FILM (TERRAIN)
  - 2,000 FEET - 70 MM FILM (STELLAR)
  - FORMAT - 134 X 67 NM AT 88 NM
  - COVERAGE - 5.4 M SQ NM/MISSION
- ONE RECOVERY VEHICLE
  - FOR TERRAIN AND STELLAR CAMERA FILMS

ORBITAL DATA

- INCLINATION - 96.4 DEGREES SUN-SYNCHRONOUS
- AVERAGE PERIGEE - 88 NM
- AVERAGE APOGEE - 155 NM
- MAPPING MISSION DURATION - UP TO 120 DAYS

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MAPPING CAMERA SYSTEM

The Mapping Camera System (MCS) structure supports and positions the individual subsystems with respect to each other and within the space constraints of the SV shroud. The loads are transmitted to six structural attach points on the vehicle bulkhead. Pitch and yaw alignment of the structure to the SV attitude reference module is achieved by shimming the attach points.

Temperature control is achieved by passive means (paint, tape, multilayer blankets and thin metal sheets, i.e., cocoons) for all but the precise temperature requirements of the lens system, which employs heaters for their accurate control.

Electrical interfaces between the SV and the MCS are at the bulkhead. All command, telemetry, timing and power are provided by the SV.


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MAPPING CAMERA SYSTEM
RECOVERY VEHICLE
MULTILAYER BLANKETS
STELLAR CAMERA LIGHT BAFFLE
DOPPLER BEACON ANTENNA
TOP SECRET/H
77

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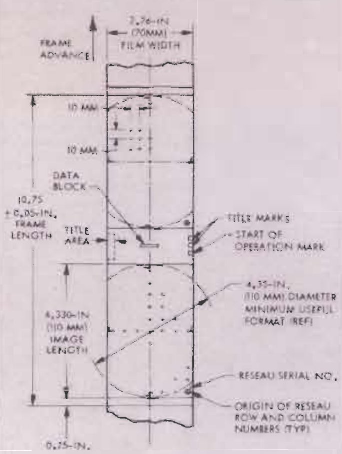
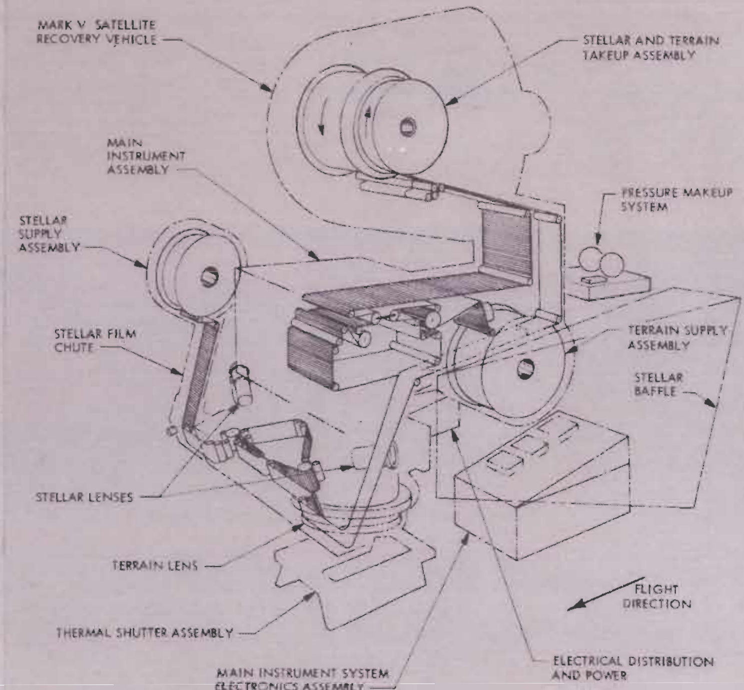
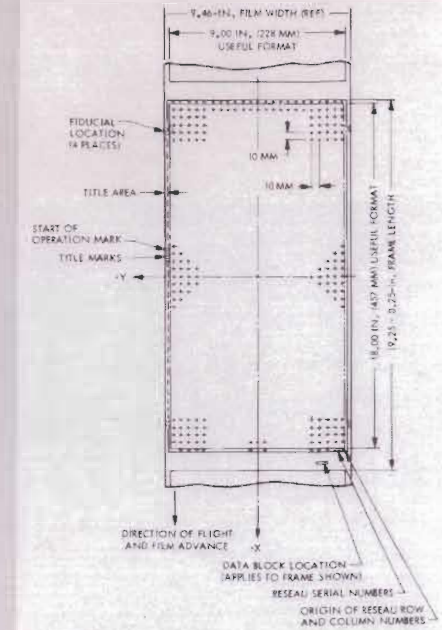
MAPPING CAMERA DESCRIPTION



STELLAR FORMAT





TERRAIN FORMAT

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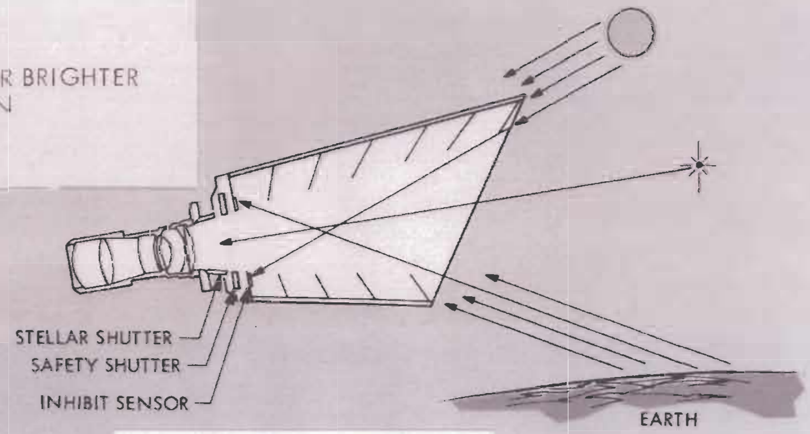
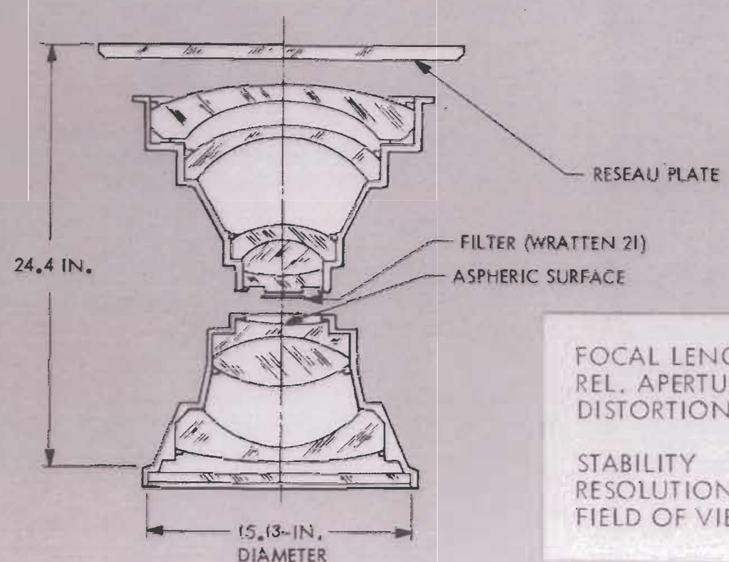
MAPPING CAMERA LENSES

LENS FOCAL LENGTH	10.0 INCHES
RELATIVE APERTURE	f/2.0
SENSITIVITY	6th MAGNITUDE STARS OR BRIGHTER
BORESIGHT STABILITY	2 ARC-SEC IN OPERATION
FIELD OF VIEW	16 BY 25 DEGREES



STELLAR LENS AND BAFFLE



TERRAIN LENS

FOCAL LENGTH	12.0 IN.
REL. APERTURE	f/6, T/14
DISTORTION	100 MICRONS MAX RADIAL
	20 MICRONS MAX TANGENTIAL
STABILITY	2 MICRONS IN OPERATION
RESOLUTION	95 L/MM AWAR (VEM ON 3414 FILM)
FIELD OF VIEW	38 BY 72 DEGREES

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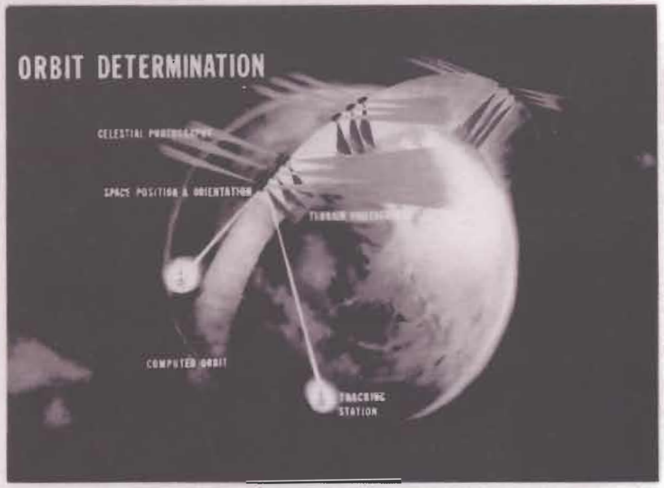
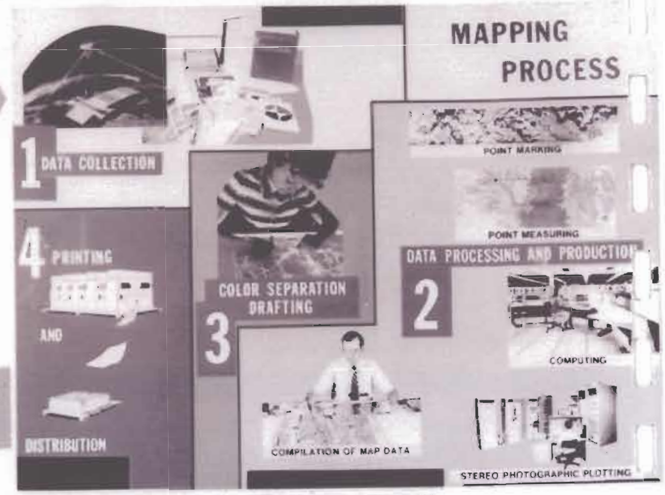
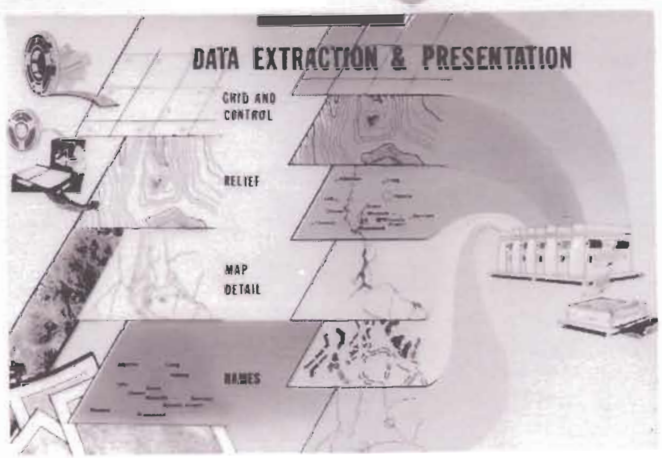
MAPPING PROCESS



ACQUISITION



EXPLOITATION



PUBLICATION

80

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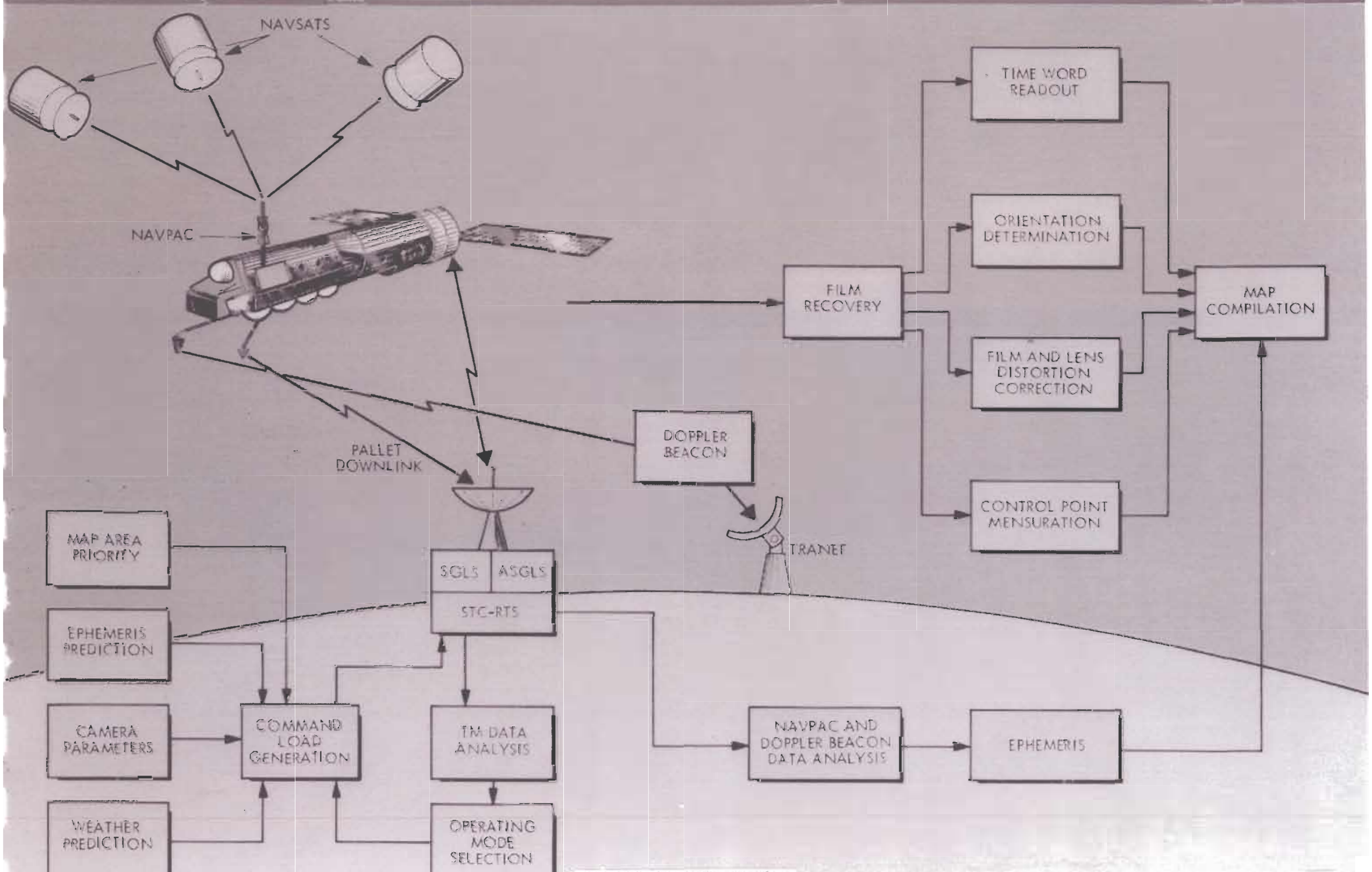
MAPPING CAMERA DATA FLOW



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81

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TERRAIN FRAME

50% REDUCTION OF FULL (9 × 18 INCH) TERRAIN FRAME

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IDENTIFICATION OF FULL FRAME COVERAGE

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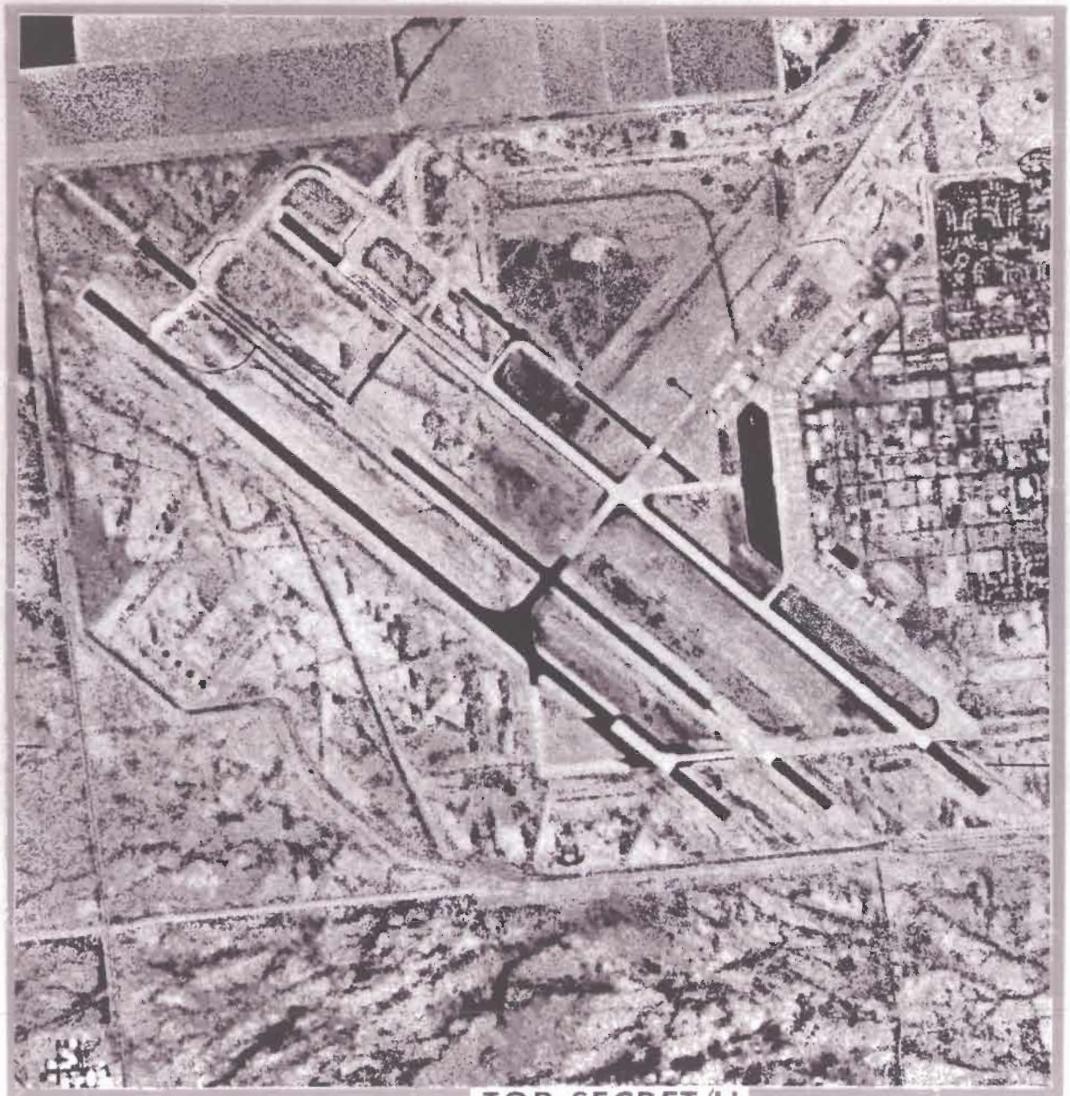
ORIGINAL DESIGN PHOTO



- WILLIAMS AFB (20 X)
- EK 3400 FILM (MISSIONS 1205 – 1208)

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PRODUCT IMPROVEMENT

- MIDLAND TEXAS AIR TERMINAL (20 X)
- EK 3414 FILM (MISSIONS 1209 AND UP)

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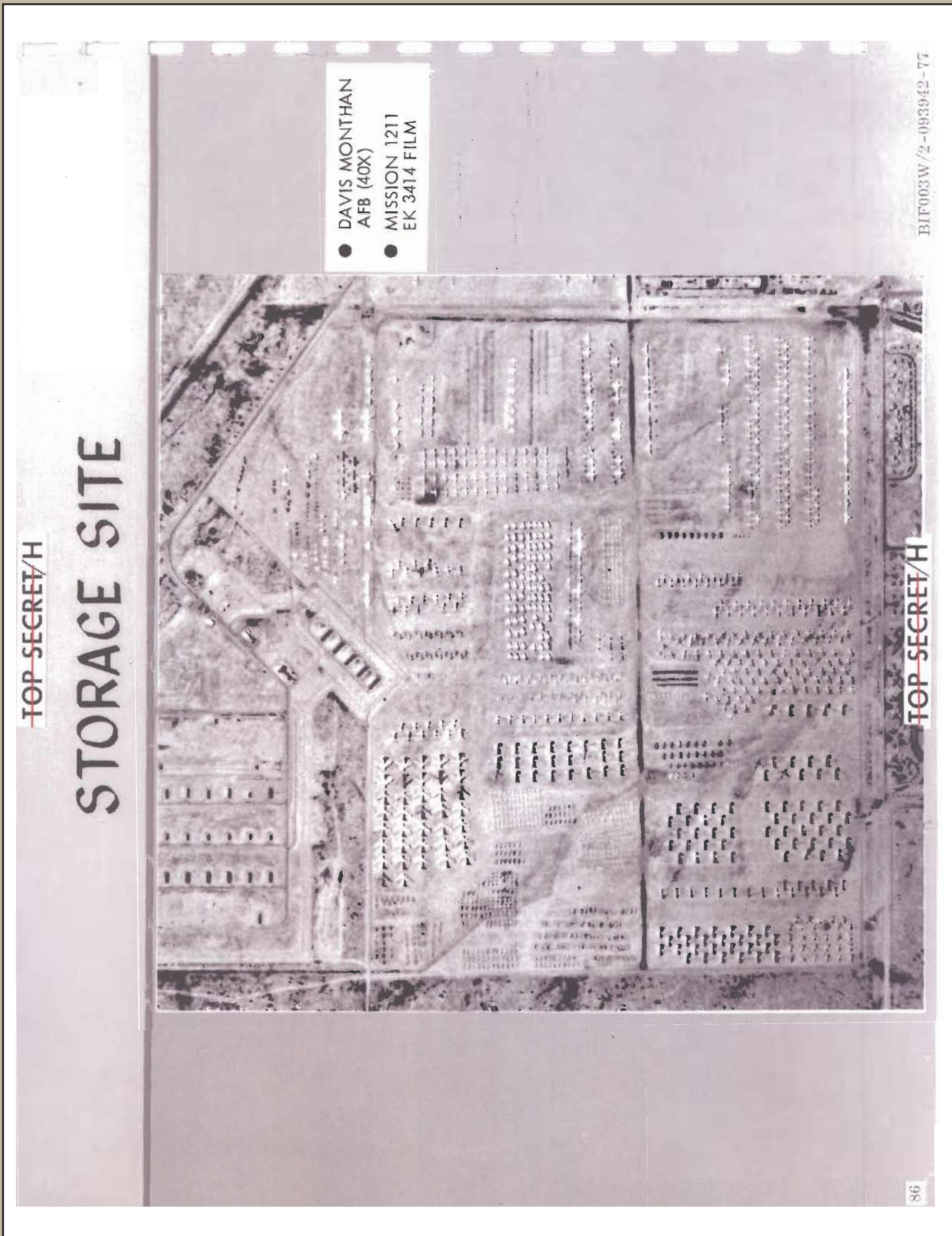
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STORAGE SITE
DAVIS MONTHAN AFB (40X)
MISSION 1211 EK 3414 FILM
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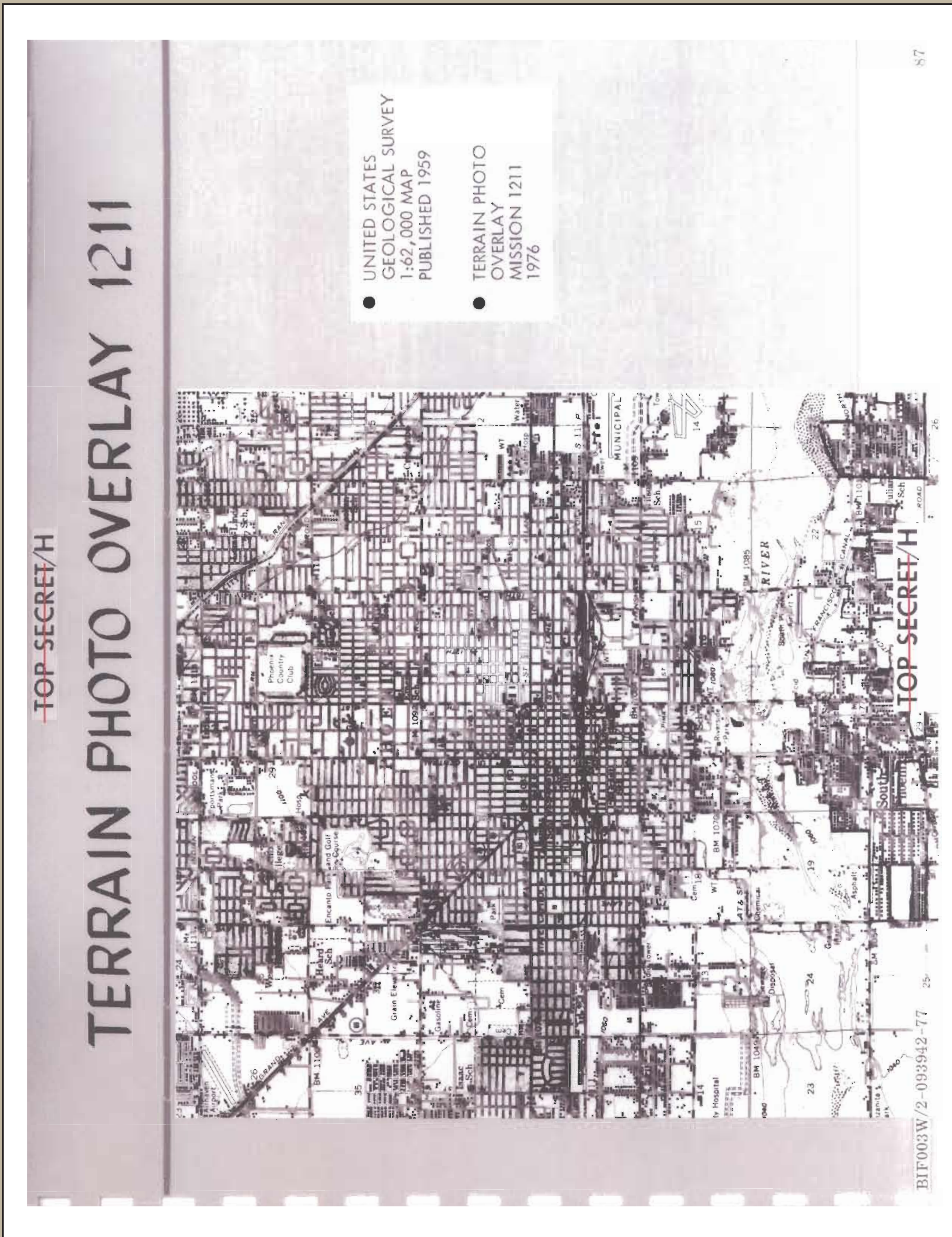
BIF003W/2-093942-77
86


TOP SECRET/H
TERRAIN PHOTO OVERLAY 1211
UNITED STATES GEOLOGICAL SURVEY 1:62,000 MAP PUBLISHED 1959
TERRAIN PHOTO OVERLAY MISSION 1211 1976
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87

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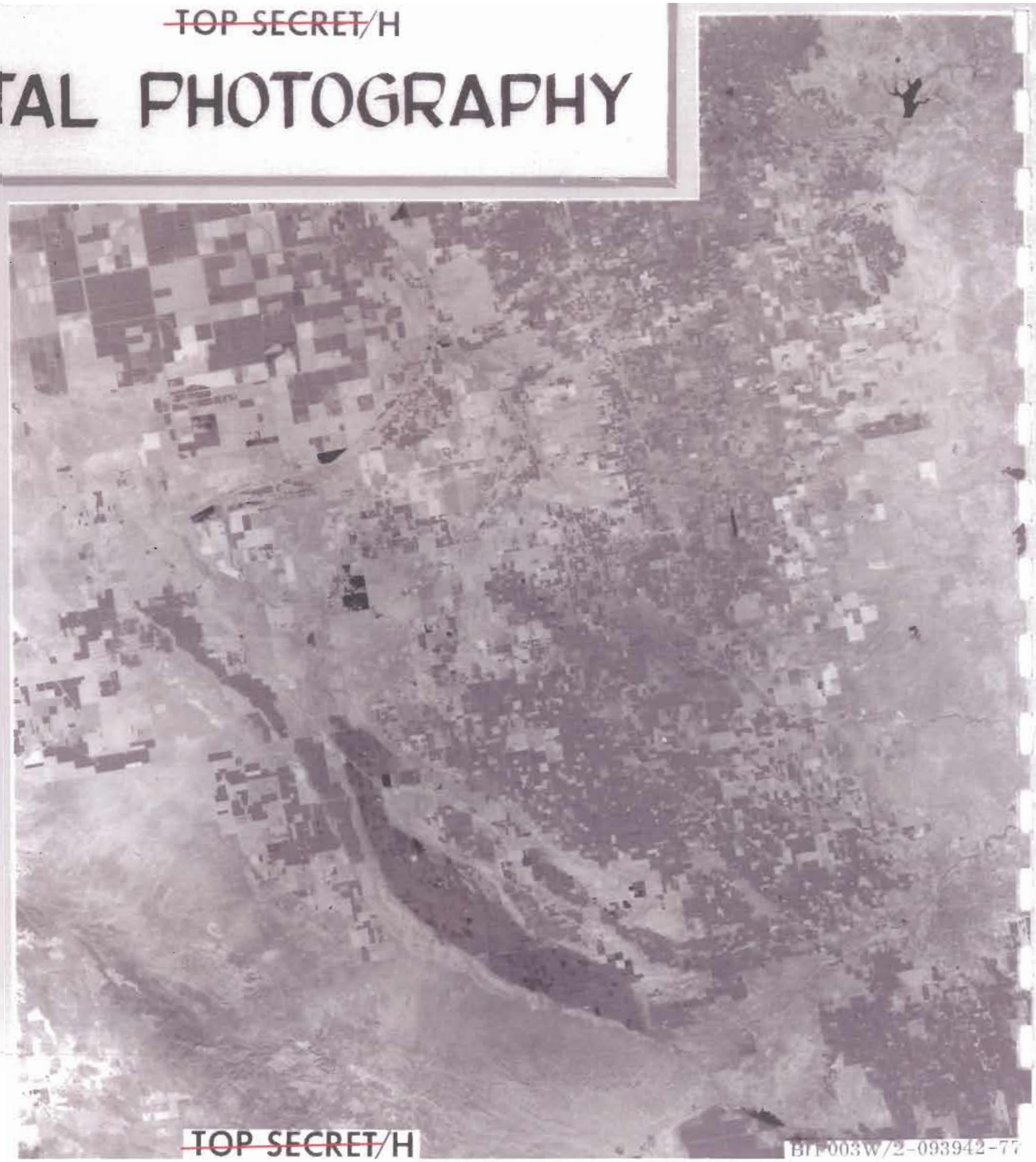
EXPERIMENTAL PHOTOGRAPHY

- SAN JOAQUIN VALLEY
- MISSION 1206
  CONTACT PRINT
  S0131 FILM
  (IR FALSE COLOR)



88

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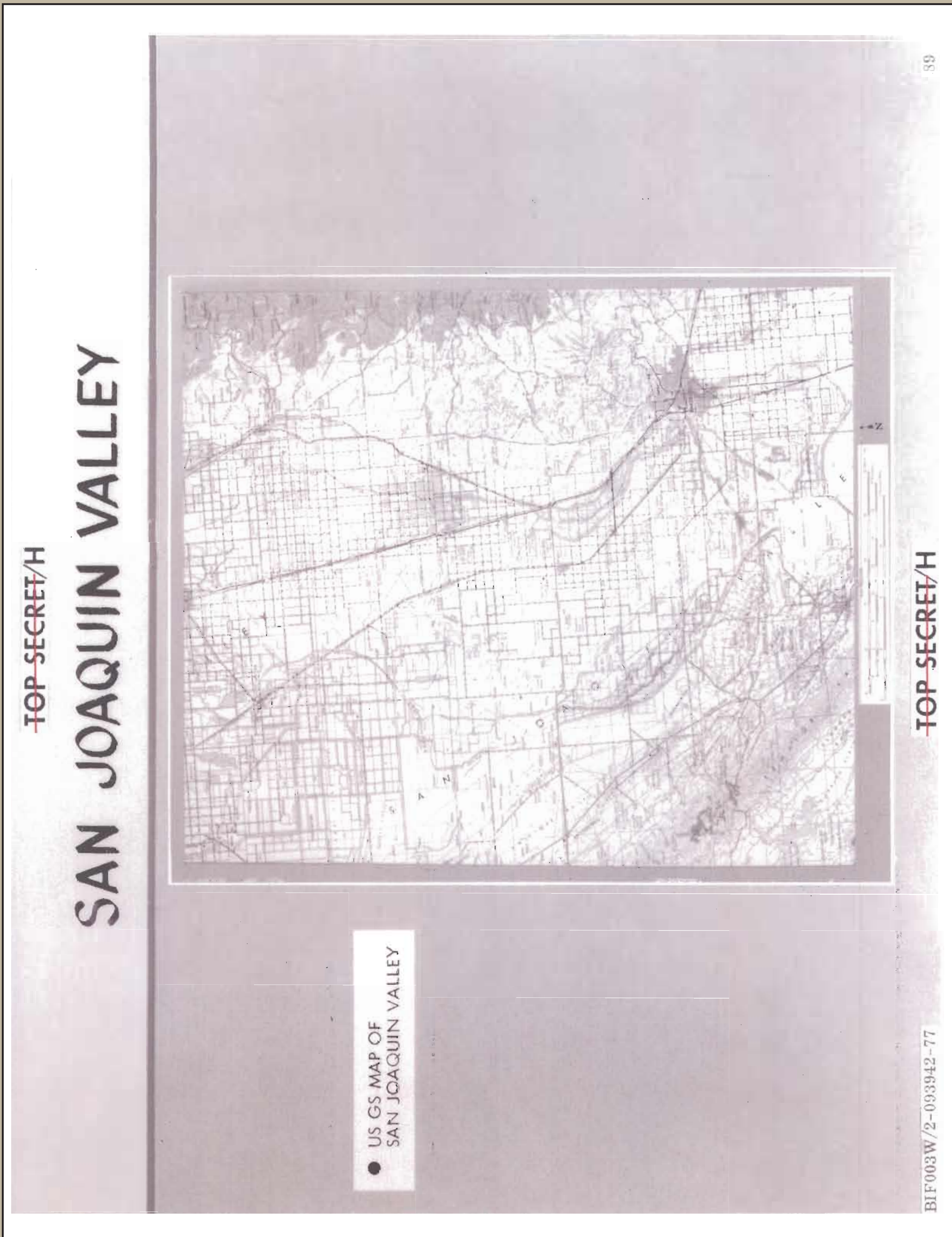
~~TOP SECRET~~/H
SAN JOAQUIN VALLEY
US GS MAP OF SAN JOAQUIN VALLEY
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AREA ACCESSED PER MISSION

ACTUAL TERRAIN COVERAGE

MISSION (NUMBER)	MISSION LENGTH (DAYS)	TOTAL AREA ACCESSED (THOUSAND SQ NM)	EQUIVALENT AREA ACCESSED (SQ NM)		
			CONUS (2.26 M)	S. AMERICA (5.20 M)	AFRICA (8.95 M)
1205	40	5894	2.6 X	1.1 X	0.6 X
1206	42	6282	2.8 X	1.2 X	0.7 X
1207	58	6671	3.0 X	1.3 X	0.7 X
1208	60	6487	2.9 X	1.3 X	0.7 X
1209	59	6773	3.0 X	1.3 X	0.8 X
1210	52	6668	3.0 X	1.3 X	0.7 X
1211	60	6919	3.1 X	1.3 X	0.8 X
1212	62	7363	3.3 X	1.4 X	0.8 X
1213	112	8099	3.6 X	1.6 X	0.9 X

90

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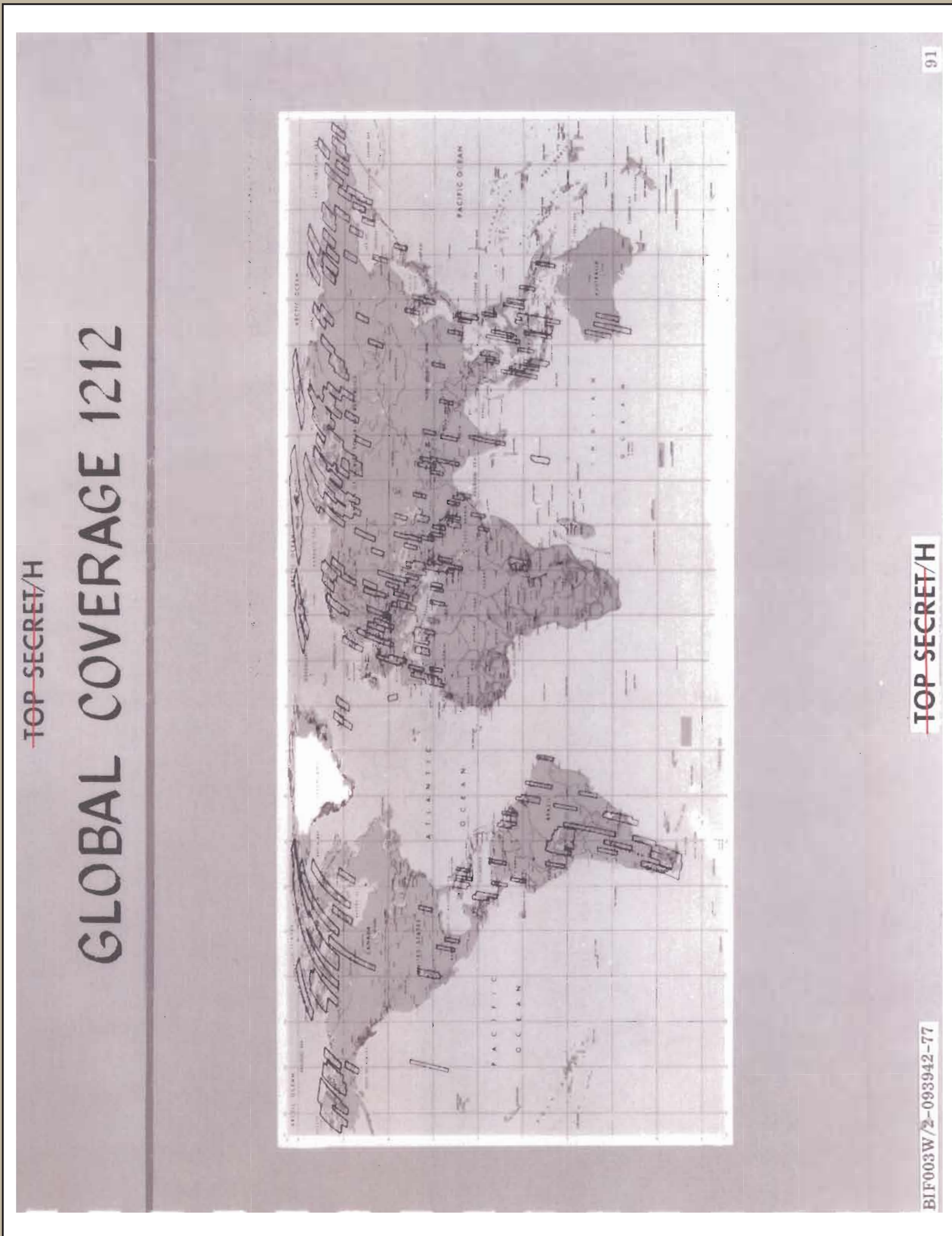
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GLOBAL COVERAGE 1212
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METRIC PAN CAMERA SYSTEM-ATTITUDE DETERMINATION

The metric pan camera attitude determination provides accurate coordinates of selected geographic points to be used as control points for compiling maps. It derives image space angles from measured space coordinates and requires auxiliary data to establish absolute coordinates and base distances; e.g., accurate ephemeris data and time of exposure, the angular orientation of the stellar relative to the pan terrain camera (interlock). the stellar angular orientation and camera angular motion history are the required data.

Stellar orientation data is acquired by a solid state electronic camera system accurate enough to determine pan camera line-of-sight pointing to within 5 arc seconds (1 σ). Two stellar cameras will be mounted on the TCA frame, one on each side of the SV, with line-of-sight elevation of 10 degrees up from horizontal and 55 degrees aft in azimuth. Data of star image detections will be processed and stored in existing on-board recorder. This data will be read out to supporting tracking stations and will be processed off-line. Film markings will be provided correlating stellar camera star image detections and pan photography time.

SV rigid body motion history during photography is obtained from the current ARM rate gyros through the existing telemetry system. Vibration and thermal distortion motions are accounted for in on-ground data processing. Implementation is scheduled for SV-17 and up superseding the Mapping Camera System (MCS) previously described.

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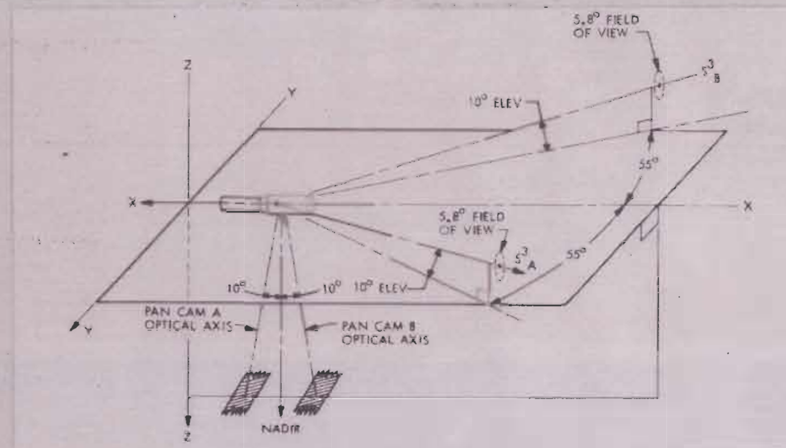
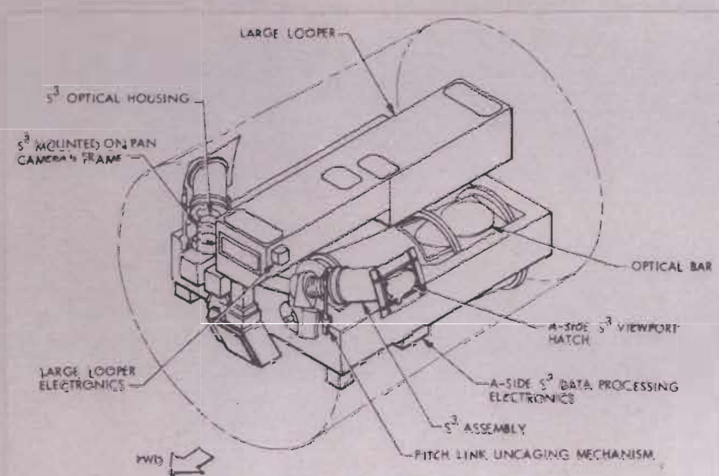
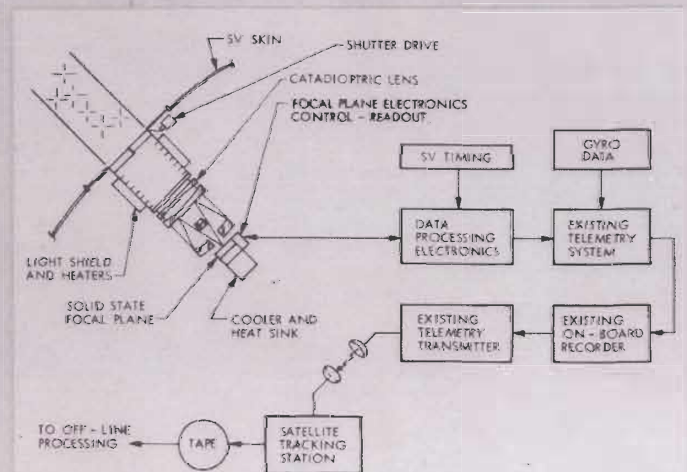
METRIC PAN CAMERA SYSTEM

ATTITUDE DETERMINATION





STELLAR SOLID STATE (S^3) CAMERA ASSEMBLY



STELLAR CAMERA DATA FLOW

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METRIC PAN CAMERA SYSTEM-LOCATION DETERMINATION

The primary tracking system for the reconstruction of an accurate ephemeris has been the Doppler Beacon System (DBS) using a worldwide network of geoceivers. This subsystem is a dual oscillator of ultra high stability which provides a method for the accurate tracking of the Satellite Vehicle by the supporting station network. The electronics and the antenna are currently mounted on the mapping camera system. The plan is to install the antenna on the forward bulkhead starting with SV-17, which will be configured without a mapping camera system.

The DBS will be redundant to the Navigational Package (NAVPAC), which will be the primary means by which a precision ephemeris can be reconstructed for mapping. NAVPAC consists of two sensing systems plus associated control and data processing hardware. The antenna/receiver system can acquire up to three Navy Navigation Satellites (NAVSATS) simultaneously and track the doppler and refraction frequencies. The miniature electrostatic accelerometer (MESA) provides data on all non-gravitational accelerations sensed. The delta processing unit collects, sorts, and time annotates all the data, recording NAVPAC times at which NAVSAT time marks are received, thus calibrating the NAVPAC clock. Timing accuracy is expected to be 1-2 microseconds.

NAVPAC is mounted on the -Y pallet with the antenna erected vertically above.

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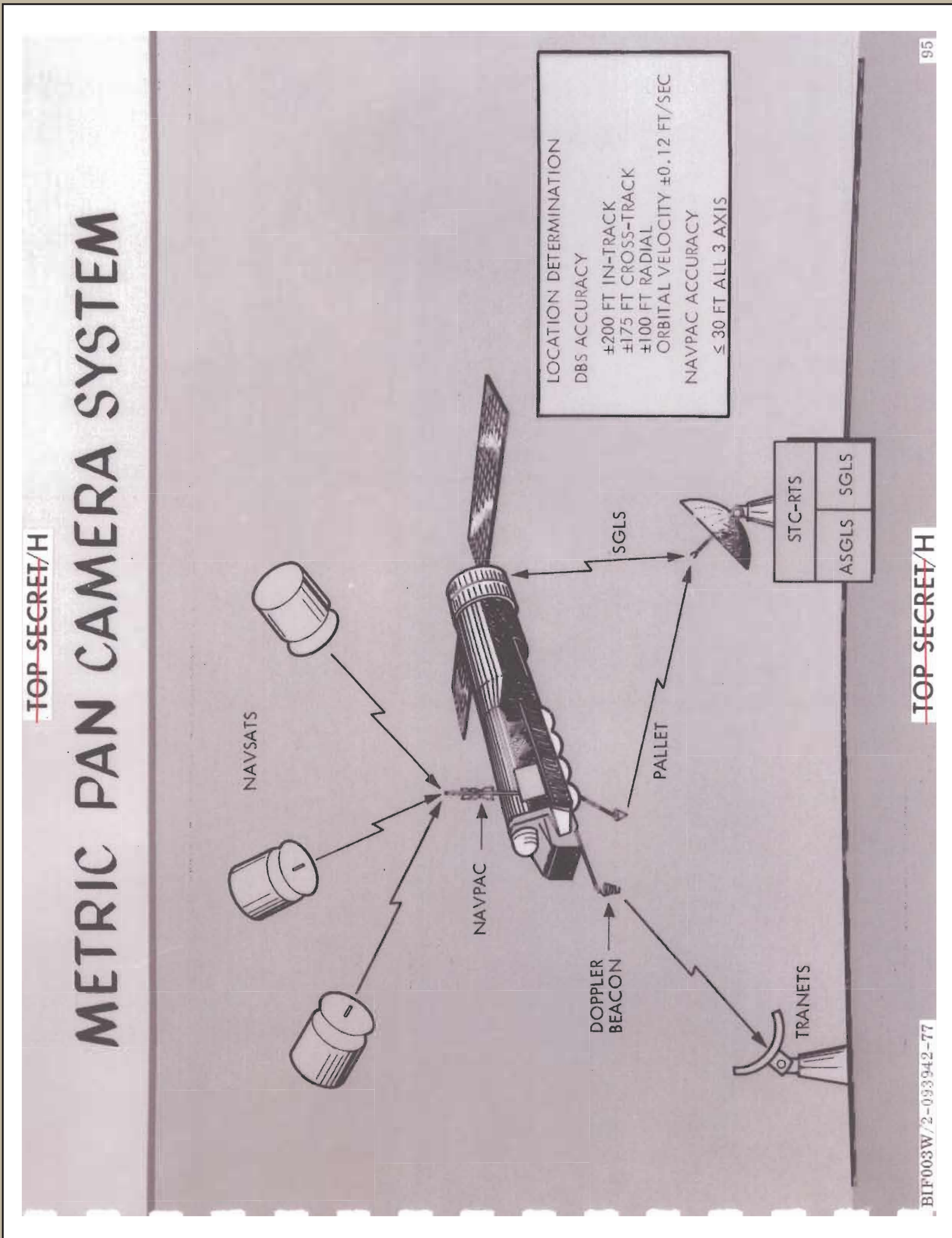
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METRIC PAN CAMERA SYSTEM
NAVSATS
NAVPAC
DOPPLER
BEACON
TRANETS
PALLET
SGLS
STC-RTS
ASGLS
SGLS
LOCATION DETERMINATION
DBS ACCURACY
±200 FT IN-TRACK
±175 FT CROSS-TRACK
±100 FT RADIAL
ORBITAL VELOCITY ±0.12 FT/SEC
NAVPAC ACCURACY
≤ 30 FT ALL 3 AXIS
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SATELLITE BASIC ASSEMBLY

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SHROUD CONFIGURATION

The shroud provides a protective enclosure for the payload on the launch pad and during ascent. It is a corrugated monocoque aluminum cylinder 52 ft long and 10 ft in diameter. Through air conditioning umbilicals and ducting the temperature and humidity are maintained at the desired values while on the launch pad.

Twenty-four removable doors provide access for servicing reentry vehicle igniters, sub-satellite trickle charge and arming, alignment checks of attitude reference to two-camera assembly reference axes, shroud thruster spring cocking, and shroud final pyro arming.

The shroud separates from the Satellite Vehicle after the pyrotechnic agent, Mild Detonating Fuse (MDF), breaks the magnesium longitudinal and beryllium circumferential breakstrips. Springs initiate the shell separation and then the acceleration from the booster Stage II cause the halves to fall away from the SV. No single failure in the pyrotechnic or electrical system will prevent shroud separation.

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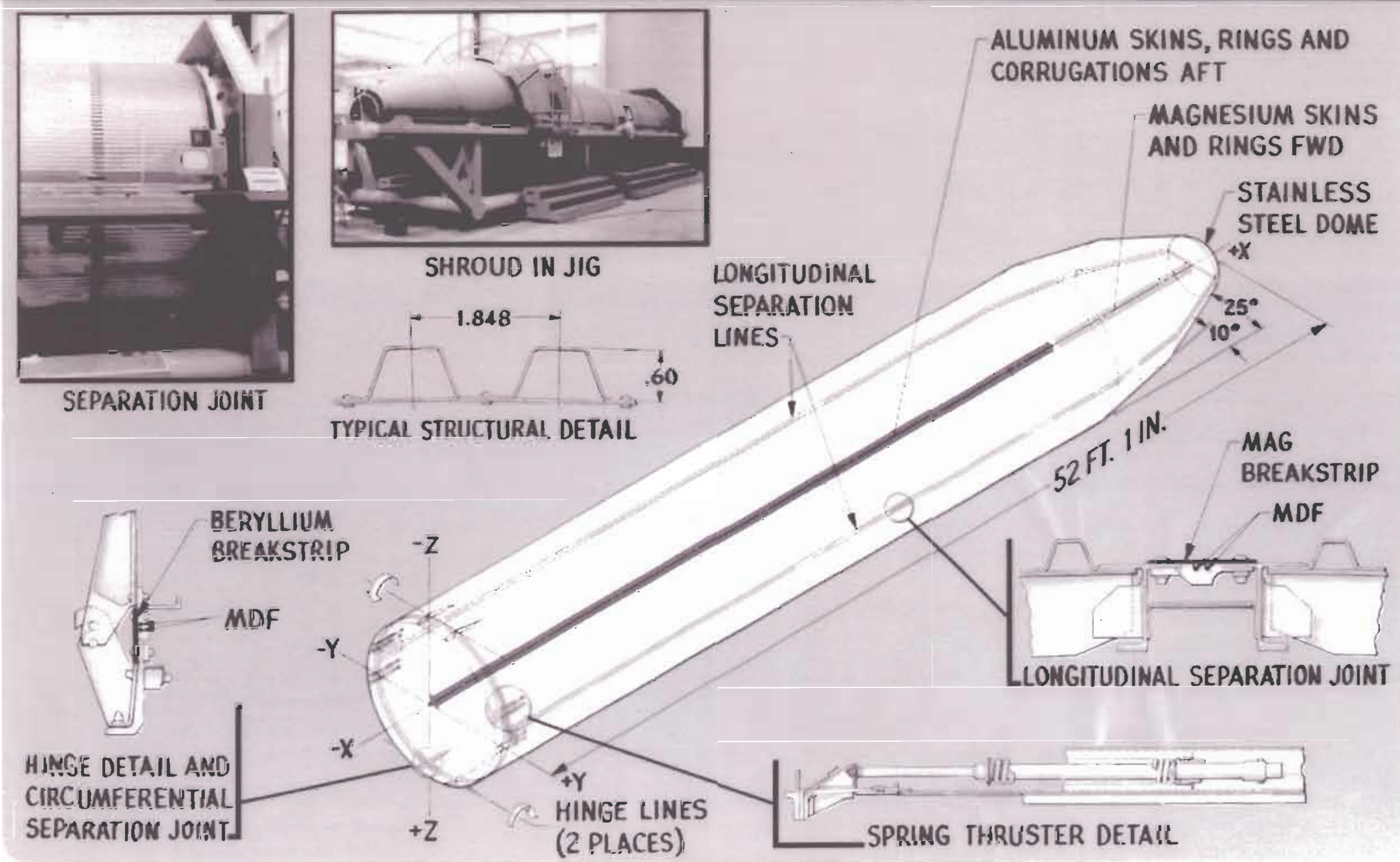
SHROUD CONFIGURATION



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THERMAL CONTROL

Temperature control is maintained primarily by passive design techniques, with augmentation by electric heaters as required for special control and thermal uncertainties. The two-camera assembly is passively maintained within 70 $\pm 23^{o}$F and the film supply within 70 $\pm 30^{o}$F by isolating them from the earth-facing environment and coupling to the upper-vehicle surfaces (cocoons). The temperature gradient requirement along the film path is 5^{o}F or less and cannot be met with a passive design; temperature sensors, heaters and control logic are required.

In the Aft Section, the conflicting requirements of keeping the electronic equipment temperature down and the propellant and thruster temperatures up cannot be met passively. Heaters are provided to keep the OAS propellant above 70^{o}F, to heat the OAS engine to 70^{o}F before starting, to keep the RCS engines above 100^{o}F, and to prevent hydrazine from freezing in the RCS tanks and OAS valves. However, these heaters are usually not required for nominal conditions.

Rechargeable (type-40) batteries are provided with heaters because the 30^{o}F to 70^{o}F temperature limits are tighter than the passive design uncertainties allow. The Lifeboat tanks can be heated to increase their impulse capacity.

The thermal design provides required temperature control over a beta angle range of -8 to +60 degrees for the complete range of vehicle activity level and resulting power dissipation with a single paint pattern. Larger negative beta angles are not permitted since the contamination of the thermal control surface by the booster causes the batteries to run at too high a temperature. When [redacted] metric pan camera stellar sensors are flown, the beta angle is limited to +30 degrees.

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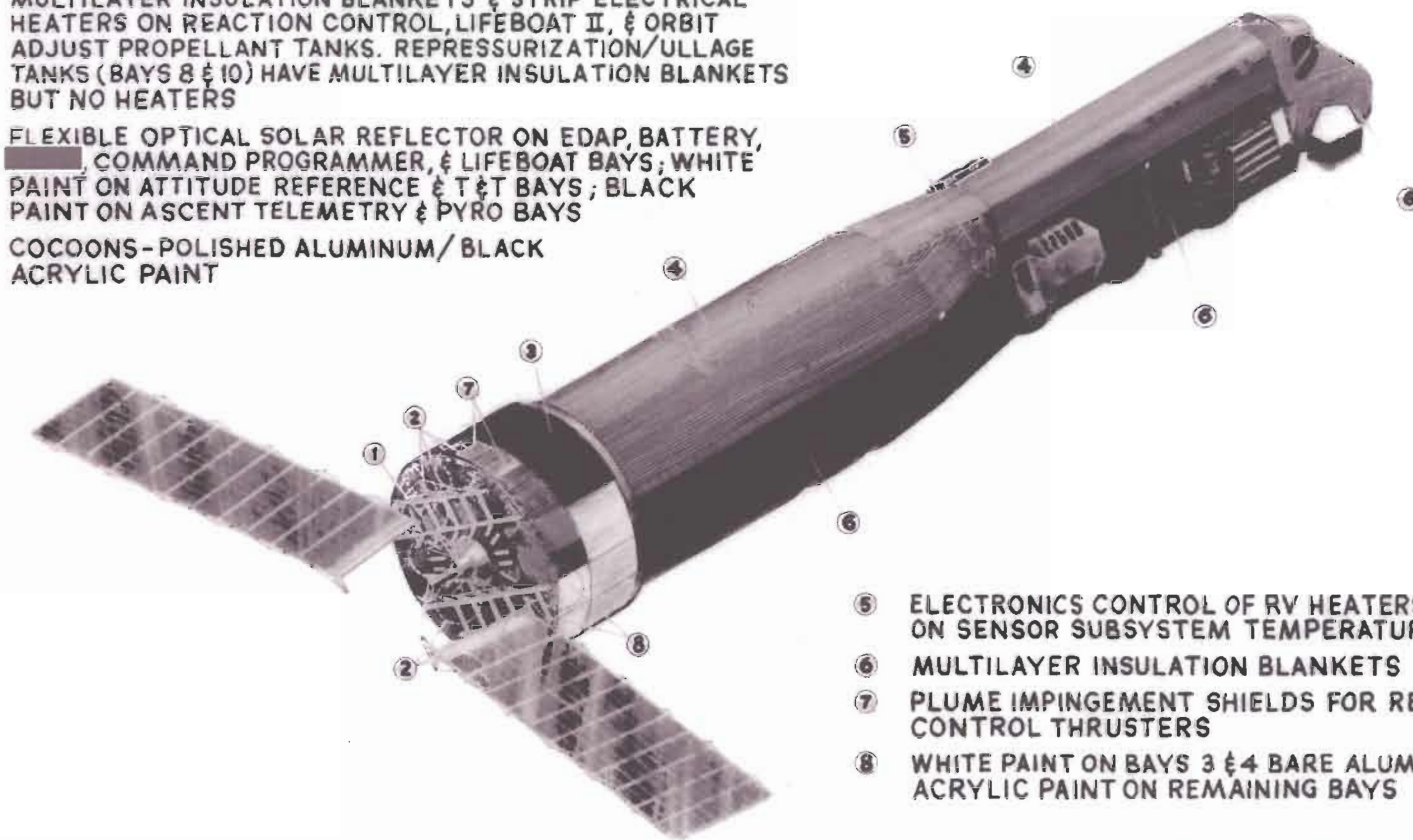
THERMAL CONTROL

1. ORBIT ADJUST VALVE SHIELD & HEATER
2. MULTILAYER INSULATION BLANKETS & STRIP ELECTRICAL HEATERS ON REACTION CONTROL, LIFEBOAT II, & ORBIT ADJUST PROPELLANT TANKS. REPRESSURIZATION/ULLAGE TANKS (BAYS 8 & 10) HAVE MULTILAYER INSULATION BLANKETS BUT NO HEATERS
3. FLEXIBLE OPTICAL SOLAR REFLECTOR ON EDAP, BATTERY, [redacted], COMMAND PROGRAMMER, & LIFEBOAT BAYS; WHITE PAINT ON ATTITUDE REFERENCE & T&T BAYS; BLACK PAINT ON ASCENT TELEMETRY & PYRO BAYS
4. COCOONS-POLISHED ALUMINUM/ BLACK ACRYLIC PAINT



5. ELECTRONICS CONTROL OF RV HEATERS-BASED ON SENSOR SUBSYSTEM TEMPERATURE
6. MULTILAYER INSULATION BLANKETS
7. PLUME IMPINGEMENT SHIELDS FOR REACTION CONTROL THRUSTERS
8. WHITE PAINT ON BAYS 3 & 4 BARE ALUMINUM/BLACK ACRYLIC PAINT ON REMAINING BAYS

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SATELLITE BASIC ASSEMBLY STRUCTURE

The SBA structure, shown in the cut-away drawing, is of semimonocoque construction. The booster adapter section has aluminum skin, rings, and stringers. This section contains the booster separation joint, which uses 2-1/2 grain/ft of mild detonating fuse to break a circumferential beryllium strip.

The OAM/RCM section has corrugation-reinforced aluminum skin with aluminum and magnesium internal structure. This section contains the propulsion elements and the solar array modules.

The equipment section has twelve removable corrugation reinforced aluminum skin panels bolted to an aluminum tubular internal structure which supports honeycomb equipment panels. Guidance, communication, command, and power components are mounted on these panels as subsystem modules.

The Mid-Section has a short titanium conical section and a cylindrical section of magnesium skin, with magnesium hat-section longitudinal stiffeners. Magnesium and titanium internal structure supports the primary payload.

The Forward Section has aluminum and magnesium skin with magnesium hat-section longitudinal stiffeners. The internal magnesium and aluminum structure with titanium fittings supports the four (4) reentry vehicles. The Mapping Camera System, [redacted] are supported on the external surfaces of the Forward Section.

The Mapping Camera System is supported in the Auxiliary Payload Structure Assembly (APSA).

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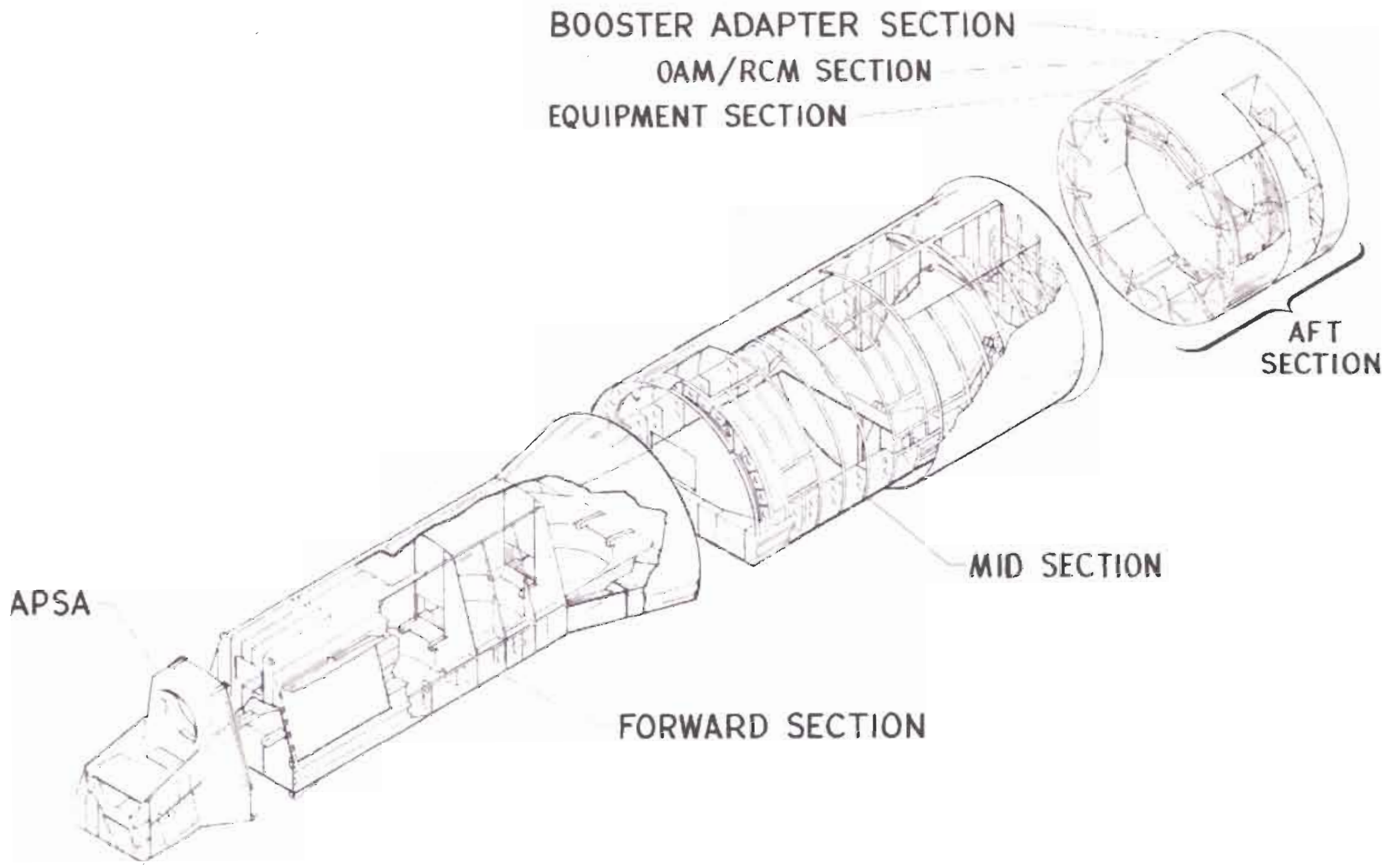
SATELLITE BASIC ASSEMBLY STRUCTURE



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SATELLITE BASIC ASSEMBLY-AFT SECTION

The Aft Section consists of an equipment module, a booster adapter section, and an Orbit Adjust Module/Reaction Control Module (OAM/RCM). It is 10 ft in diameter and 5 ft long. This section is a semimonocoque structure with a corrugated aluminum external skin. It weighs approximately 3500 pounds, including all equipment, less expendables. The Aft Section provides environmental protection and thermal control during ground, ascent, and orbital operations. The structure is capable of withstanding the dynamic and static conditions imposed during all phases of ground handling, launch, ascent, and orbit. The Aft Section interfaces with the booster, Mid Section, ground AGE, main electrical umbilical, pressurization and propellant loading lines, and the battery cooling lines.

The booster adapter section mates the Satellite Vehicle to the Titan IIID booster. The adapter is equipped with 70 square inches of vent area. The separation joint with a redundant pyrotechnic system is a part of this section.

The OAM/RCM section houses and supports the OAS/RCS hydrazine systems which provide orbit and attitude control, the independent lifeboat freon gas system which provides emergency attitude control, and the solar array modules which generate power. This section interfaces with ground pressurization and propellant loading lines. The solar array modules which mount on the aft bulkhead adjacent to the OA engine nozzle are not shown in the photograph.

The equipment section consists of 12 equally spaced, equally sized bays, each capable of supporting up to 500 pounds of equipment on individual trays. Two bays are presently unused and are available for growth items. Each equipment bay provides sufficient access to allow complete module installation and removal at the factory and pad as shown in the lower completely open bay. The other bays as shown have non-flight panels with ground access doors used in factory assembly and test. This section interfaces with the main electrical umbilical and the Mid Section.

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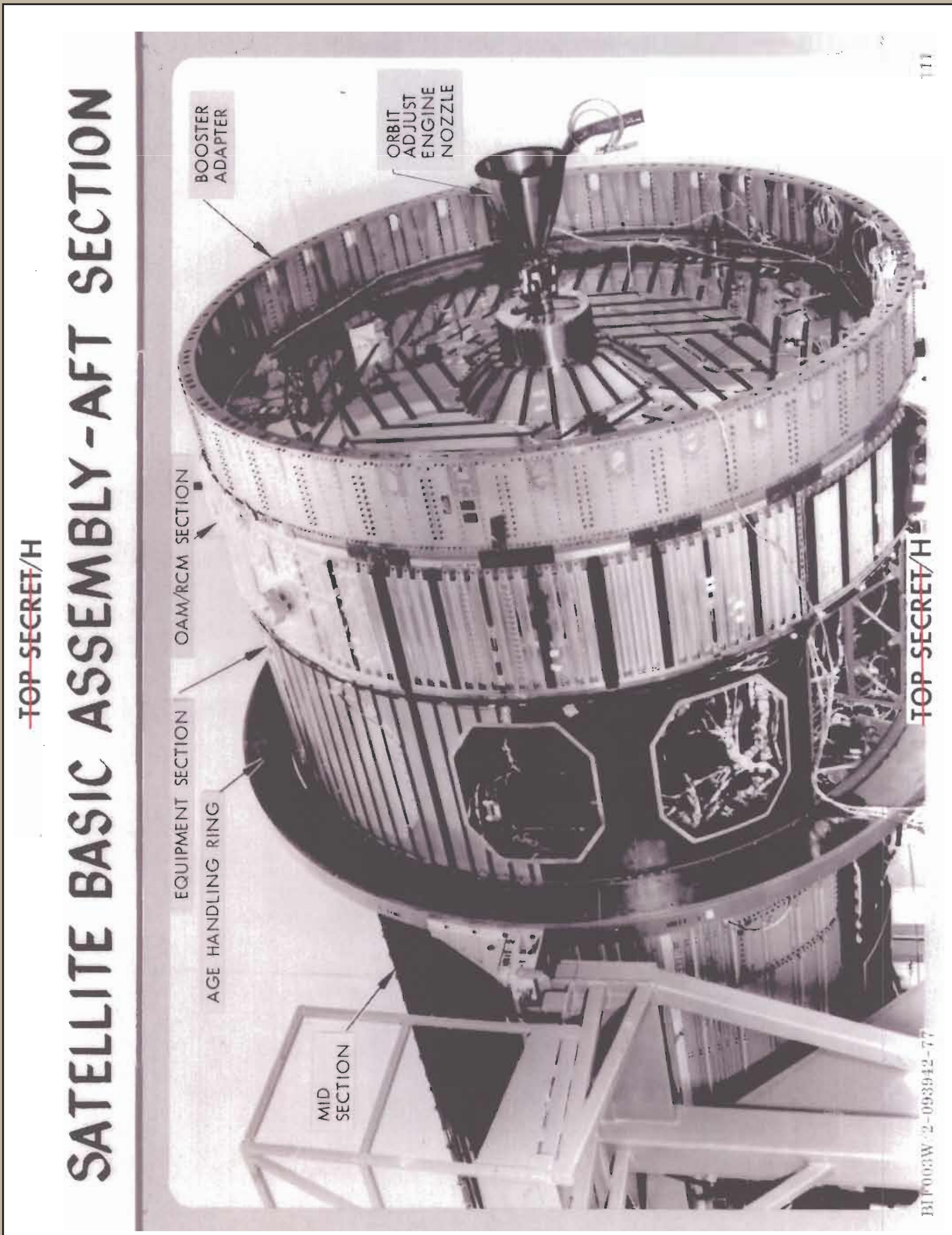
TOP ~~SECRET~~/H
SATELLITE BASIC ASSEMBLY - AFT SECTION
BOOSTER ADAPTER
ORBIT ADJUST ENGINE NOZZLE
OAM/RCM SECTION
EQUIPMENT SECTION
AGE HANDLING RING
MID SECTION
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ATTITUDE CONTROL

The Attitude Control System (ACS) provides earth-oriented attitude reference and rate sensing. It develops RCS thruster firing signals to bring the vehicle to a commanded attitude and to maintain attitude and rate within the accuracies shown below. The ACS also provides measurements of vehicle attitude and rate during search/surveillance operation to the accuracy shown.

The ACS is a three-axis rate gyro-integrator system with updating in pitch and roll by horizon sensor and in yaw by gyro-compassing. Error signals generated by the gyros and horizon sensor are combined in the flight control electronics, and modulated by pseudo-rate circuits in each axis to provide thruster firing commands with the impulse bit control necessary to meet the tight rate control and short settling-time requirements.

All elements are redundant for malfunction correction. Cross-strapping between redundant and primary ACS components (horizon sensors, gyros, flight control electronics assembly) is possible to permit selection of non-failed components to drive the RCS thruster.

	Control Requirements			Measurement Requirements		
	Pitch	Roll	Yaw	Pitch	Roll	Yaw
For search/surveillance operations						
Attitude accuracy (deg)	0.7	0.7	0.64	0.4	0.4	0.5
Rate accuracy (deg/sec)	0.014	0.021	0.014	0.001	0.001	0.001
During non-horizontal operations						
Attitude accuracy (deg)	3	1	1			
Rate accuracy (deg/sec)	0.15	0.15	0.15			

Setting time from search/surveillance disturbances: Stereo 0.2 seconds, Mono 6 seconds

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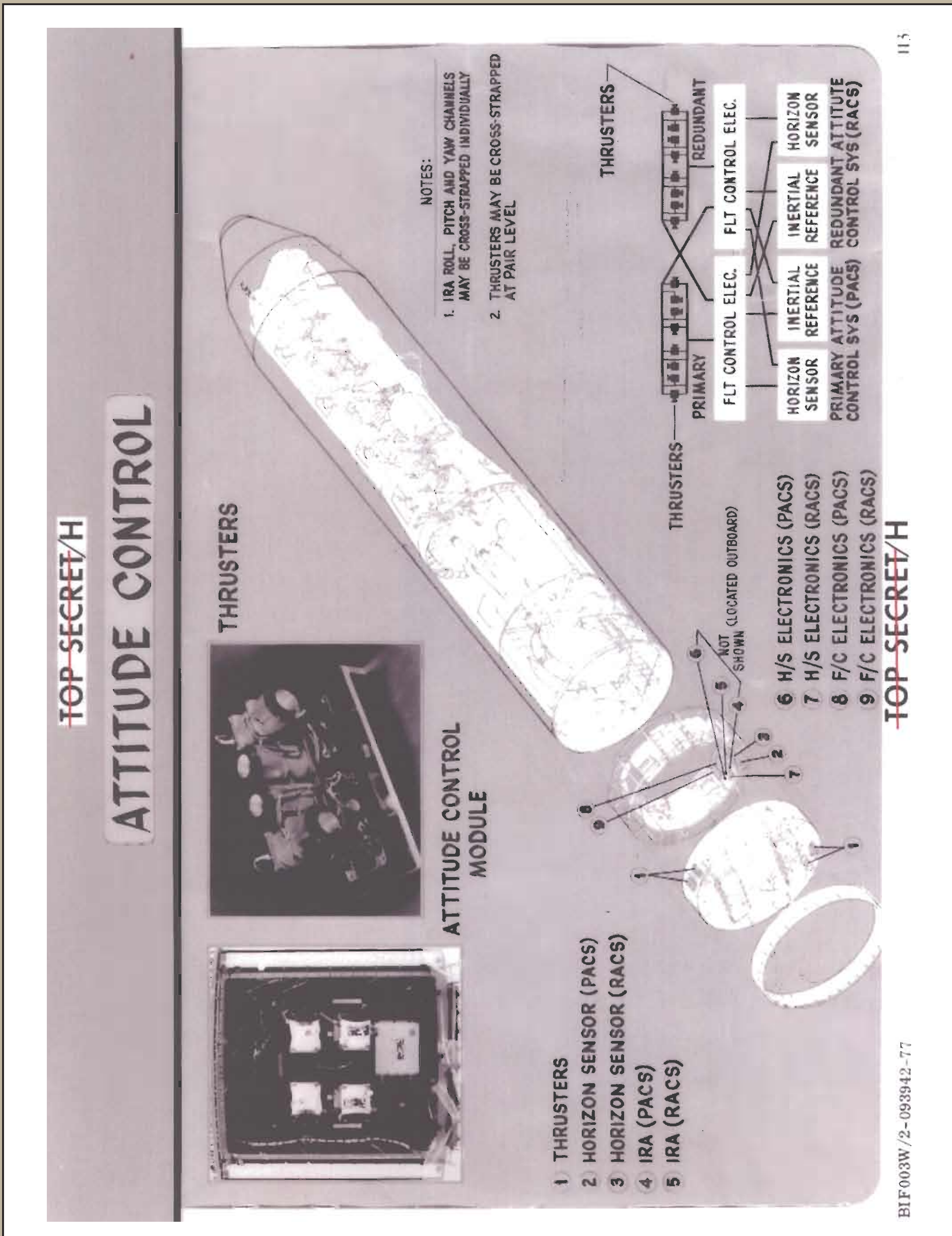
~~TOP SECRET~~/H
ATTITUDE CONTROL
THRUSTERS
ATTITUDE CONTROL MODULE
NOTES:
1. IRA ROLL, PITCH AND YAW CHANNELS MAY BE CROSS-STRAPPED INDIVIDUALLY
2. THRUSTERS MAY BE CROSS-STRAPPED AT PAIR LEVEL
THRUSTERS
PRIMARY
REDUNDANT
THRUSTERS
FLT CONTROL ELEC.
FLT CONTROL ELEC.
HORIZON SENSOR
INERTIAL REFERENCE
INERTIAL REFERENCE
HORIZON SENSOR
PRIMARY ATTITUDE CONTROL SYS (PACS)
REDUNDANT ATTITUDE CONTROL SYS (RACS)
THRUSTERS
NOT SHOWN (LOCATED OUTBOARD)
1 THRUSTERS
2 HORIZON SENSOR (PACS)
3 HORIZON SENSOR (RACS)
4 IRA (PACS)
5 IRA (RACS)
6 H/S ELECTRONICS (PACS)
7 H/S ELECTRONICS (RACS)
8 F/C ELECTRONICS (PACS)
9 F/C ELECTRONICS (RACS)
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ORBIT ADJUST AND REACTION CONTROL

An Orbit Adjust System (OAS) and Reaction Control System (RCS) provide the forces necessary to control the vehicle orbit and the vehicle attitude in orbit, respectively. The OAS provides injection error correction (if required), drag and perigee rotation makeup, and deorbit of the Satellite Vehicle at the end of the mission. The RCS provides pitch, yaw, and roll control via 8 thrusters.

OAS and RCS both use catalytic decomposition of monopropellant hydrazine to generate thrust. For reliability, the systems are pressure-fed, with the pressurizing gas enclosed in the propellant tank with the hydrazine. This results in declining or blowdown pressure characteristics; the thrust level of the OAS engine declines from 250 to 100 pounds and that of the RCS engines from 6 to 2 pounds. A quad-redundant valve operated by the command system controls flow to the OAS engine. The ACS generates signals that control the firing of the RCS engines.

On SV-15 the 62-inch diameter OAS tank can be loaded with up to 4000 pounds of propellant with two spheres containing high pressure nitrogen (isolated by pyro valves and admitted into the OA tank at times selected during the mission) to maintain the pressure within the desired operating range. This propellant can be utilized in OA burns to provide velocity increments of 2 ft/sec to 400 ft/sec. A passive (surface tension) propellant management device maintains propellant at the tank outlet at all times, permitting engine firings in any attitude.

On Vehicles SV-13 and SV-14 the two nitrogen tanks are manifolded directly with the OA tank and provide enough ullage space to permit 3700 pounds of propellant to be loaded within the operating pressure range.

The four 22-in. diameter RCS tanks provided capacity for 450 to 540 pounds of propellant. Propellant orientation is maintained by diaphragms. The thruster impulse bit (0.15 lb-sec or less, depending on blowdown status) is compatible with the tight rate-control requirements. A complete redundant set of thrusters is provided for malfunction protection; either set can be supplied by the four tanks and each pair of thrusters can be driven by the primary or redundant ACS valve drivers.

A transfer line is provided between the OAS and RCS tanks to permit propellant exchange to optimize the use of on-board propellant for each mission.


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ORBIT ADJUST & REACTION CONTROL
VIEW LOOKING AFT
VIEW LOOKING FORWARD
1 OAS FILL VALVE
2 RCS GAS FILL VALVES (2)
3 RCS PROPELLANT FILL VALVE
4 ISOLATION VALVES (6)
5 RCS GAS/PROP TANK (4)
6 RCS THRUSTERS (16)
7 OAS ULLAGE TANKS (2)
8 62" DIA. ORBIT ADJUST TANK
9 OA/RCM J-BOX
10 ORBIT ADJUST ENGINE
OAS ULLAGE TANKS (2)
NITROGEN FILL VALVE
CAPILLARY GALLERY
62" DIA ORBIT ADJUST TANK
QUAD PROPELLANT VALVE
CATALYST BED
NITROGEN FILL VALVES (2)
NITROGEN
HYDRAZINE
OAS & RCS FILL & DRAIN
ISOLATION VALVES (6)
PRIMARY
REDUNDANT
RCS THRUSTERS
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ELECTRICAL DISTRIBUTION AND POWER

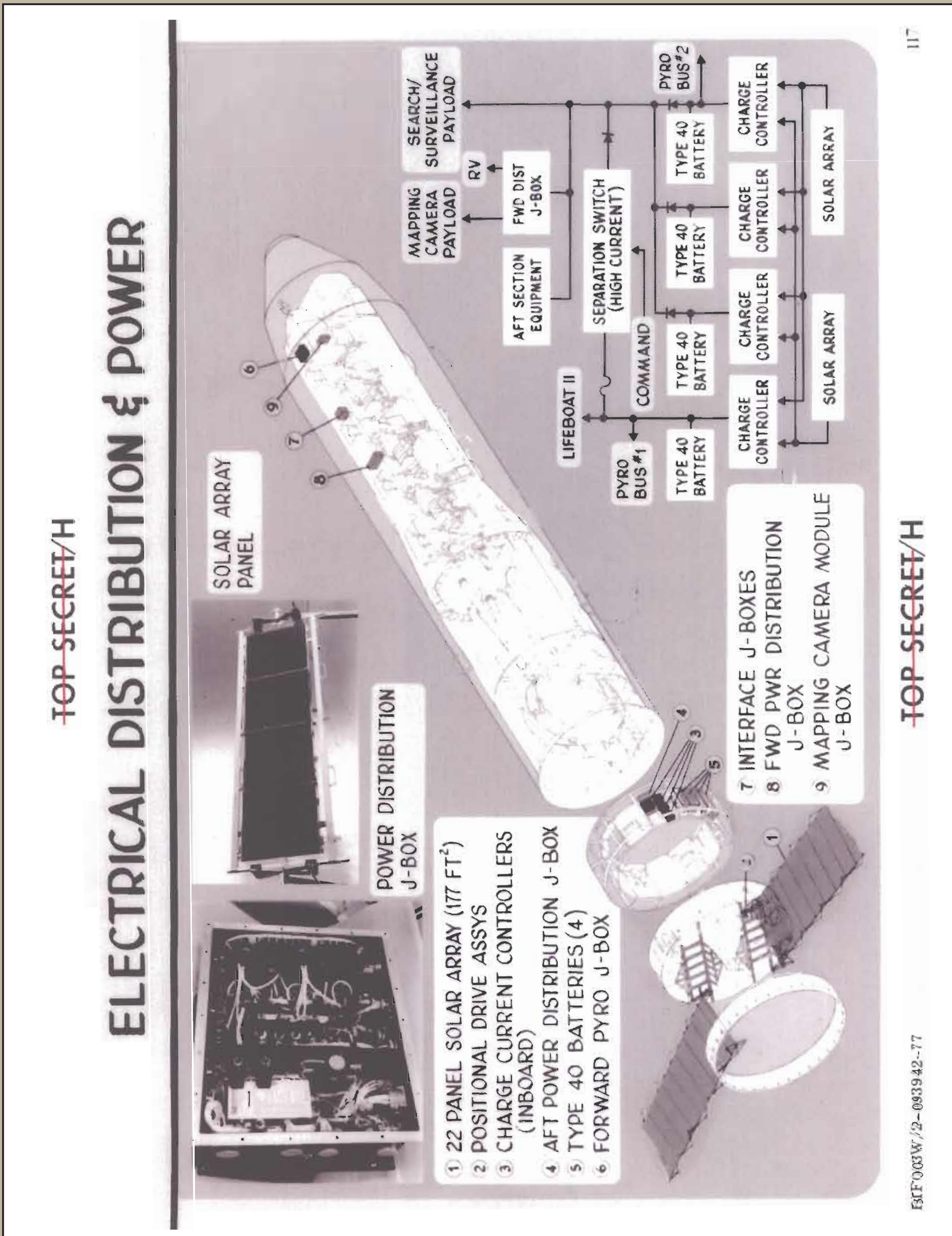
Power to operate the Satellite Vehicle is provided by solar arrays deployed from the Aft Section following separation from the booster. Rechargeable NiCd batteries (type-40) provide energy storage to meet dark-side-earth and peak power requirements. Unregulated power is distributed throughout the vehicle to using equipment within a 24 to 33 vdc range.

The power generation and storage system comprises four parallel segments, with an array section, charge controller, and battery in each to reduce the effect of a failure; a single malfunction will not terminate the mission. Fusing of equipment, limiting minimum wire size, and isolating voltage-critical circuits add to the reliability.

The power system is capable of providing approximately 11,000 watt-hours/day of usable power over a beta angle range of -8 to +60 deg by adjusting the array angle about the vehicle roll axis. This will support at least 52 minutes per day of search/surveillance and mapping camera system operation.

Power for the lifeboat system is provided by one type-40 battery from the main power system. Equipment necessary for recovery vehicle and Satellite Vehicle deorbit can be switched to this battery for emergency operations. Depletion of the batteries below 55 percent or an excessive load on the main power system will automatically isolate the lifeboat system and its battery. This assures adequate power for the emergency operations. The lifeboat system can be re-connected to the main system by command if the anomaly can be corrected.

Pyro power is provided by either of two type-40 batteries from the main power system and distributed by redundant circuits.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ELECTRICAL DISTRIBUTION & POWER
SOLAR ARRAY PANEL
POWER DISTRIBUTION J-BOX
MAPPING CAMERA PAYLOAD
SEARCH/ SURVEILLANCE PAYLOAD
RV
FWD DIST J-BOX
AFT SECTION EQUIPMENT
SEPARATION SWITCH (HIGH CURRENT)
COMMAND
LIFEBOAT II
PYRO BUS#1
PYRO BUS#2
TYPE 40 BATTERY
CHARGE CONTROLLER
SOLAR ARRAY
1 22 PANEL SOLAR ARRAY (177 FT²)
2 POSITIONAL DRIVE ASSYS
3 CHARGE CURRENT CONTROLLERS (INBOARD)
4 AFT POWER DISTRIBUTION J-BOX
5 TYPE 40 BATTERIES (4)
6 FORWARD PYRO J-BOX
7 INTERFACE J-BOXES
8 FWD PWR DISTRIBUTION J-BOX
9 MAPPING CAMERA MODULE J-BOX
TOP SECRET/H
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TELEMETRY AND TRACKING

The SGLS-compatible telemetry subsystem provides PCM real-time data (ascent at 48 kbps, engineering analysis at 128 kbps, and orbit at 64 kbps), and PCM tape recorded data (48 kbps played back at 256 kbps). The PCM telemeter provides status data for normal mission operation, test operations and evaluation, command acceptance confirmation, and postflight evaluation. Each tape recorder storage allows the monitoring of the SV temperature profile by periodic sampling. Over 1500 data sources are monitored – some at up to 500 samples per second.

The SGLS-compatible tracking subsystem provides range measurement information, including slant range (50 ft maximum 1σ bias error and 60 ft rms maximum noise error), range rate (0.2 ft/sec maximum 1σ error), and angle-of-arrival (1.0 milliradian maximum 1σ bias error and 1.0 milliradian rms maximum noise error).

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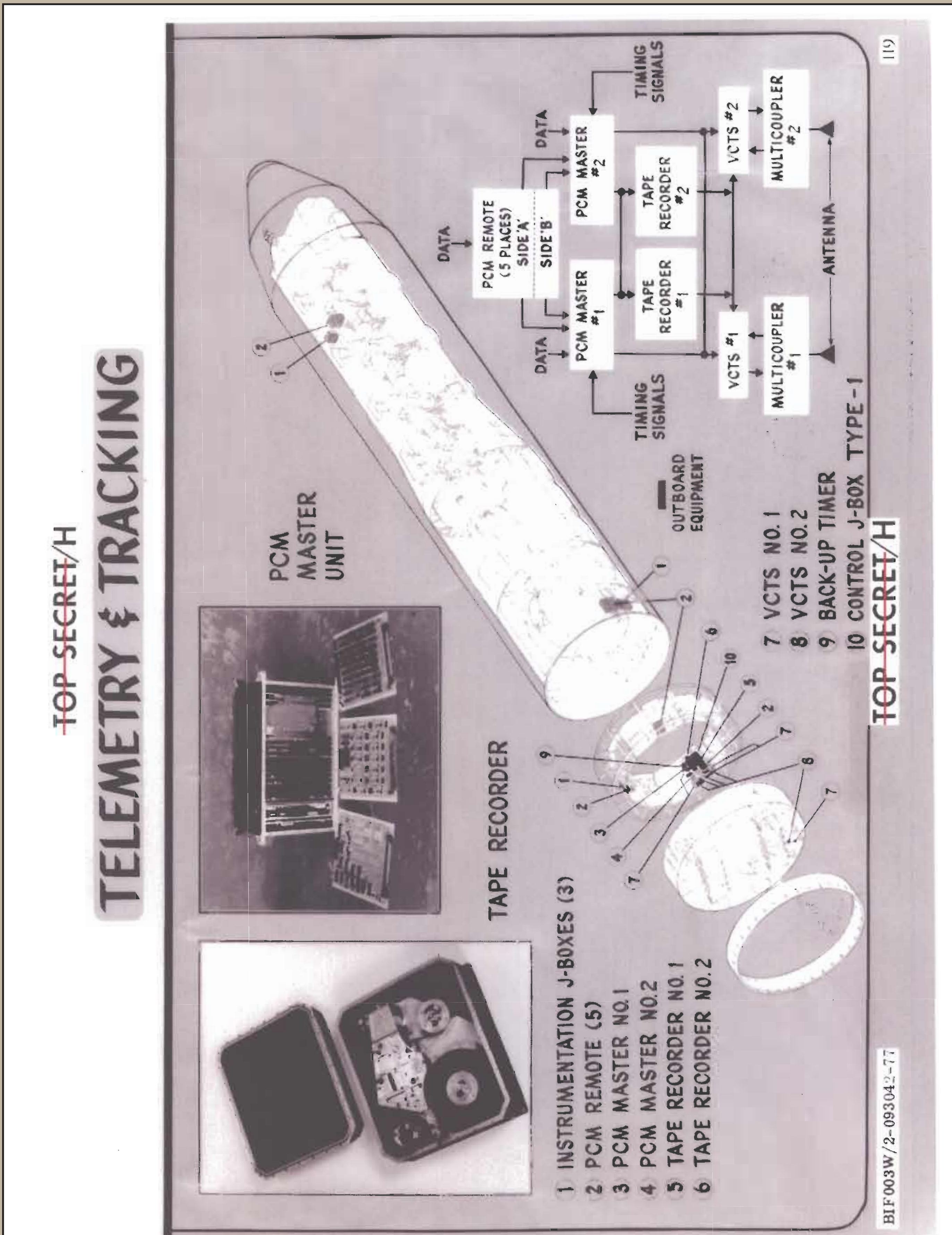
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TELEMETRY & TRACKING
TAPE RECORDER
PCM MASTER UNIT
1 INSTRUMENTATION J-BOXES (3)
2 PCM REMOTE (5)
3 PCM MASTER NO.1
4 PCM MASTER NO.2
5 TAPE RECORDER NO.1
6 TAPE RECORDER NO.2
7 VCTS NO.1
8 VCTS NO.2
9 BACK-UP TIMER
10 CONTROL J-BOX TYPE-1
OUTBOARD EQUIPMENT
DATA
PCM REMOTE (5 PLACES)
SIDE 'A'
SIDE 'B'
PCM MASTER #1
PCM MASTER #2
TAPE RECORDER #1
TAPE RECORDER #2
VCTS #1
VCTS #2
MULTICOUPLER #1
MULTICOUPLER #2
TIMING SIGNALS
ANTENNA
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COMMAND AND TIMING

The Extended Command System (ECS) provides real-time and stored-program command capability. The SGLS compatible ECS system with complete redundancy provides 64 real-time and 626 stored-program commands with a memory capability of 1152 commands. Ninety-six secure command operations are possible. On SV-15 and up the number of secure command operations will be increased to 192. The ECS provides operational commands to perform primary and secondary missions, the capability to configure the vehicle into various operational modes, a pre-flight test and checkout capability, security for critical functions, and a time signal to the PCM and the payload.

The Minimal Command System (MCS) provides 28 real-time and 66 stored-program commands with a memory capability of 53 commands. Ten secure command operations are available. The MCS provides lifeboat commands for an independent capability of recovery RVs and initiating SV deboost and the capability to obtain real-time and recorded telemetry data.

The Data Interface Unit (DIU) provides for the generation, storage and transfer of time information to the search/surveillance camera, mapping camera, telemetry, [redacted] The DIU also provides the mapping camera system and pan camera time request pulse to the NAVPAC experiment.

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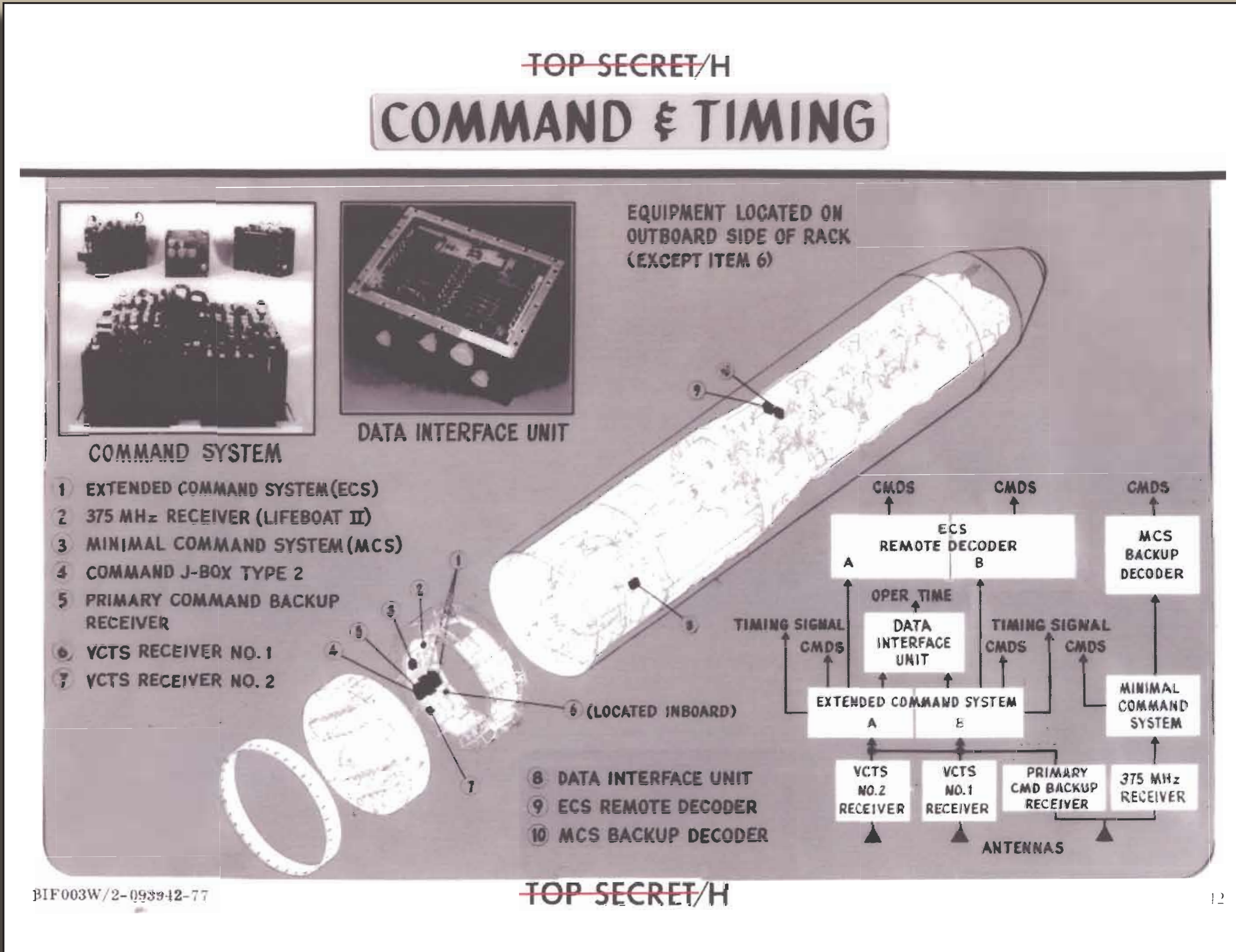
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COMMAND & TIMING
COMMAND SYSTEM
DATA INTERFACE UNIT
EQUIPMENT LOCATED ON OUTBOARD SIDE OF RACK (EXCEPT ITEM 6)
1 EXTENDED COMMAND SYSTEM (ECS)
2 375 MHz RECEIVER (LIFEBOAT II)
3 MINIMAL COMMAND SYSTEM (MCS)
4 COMMAND J-BOX TYPE 2
5 PRIMARY COMMAND BACKUP RECEIVER
6 VCTS RECEIVER NO. 1
7 VCTS RECEIVER NO. 2
6 (LOCATED INBOARD)
8 DATA INTERFACE UNIT
9 ECS REMOTE DECODER
10 MCS BACKUP DECODER
CMDS
CMDS
CMDS
ECS REMOTE DECODER
A
B
MCS BACKUP DECODER
OPER TIME
DATA INTERFACE UNIT
TIMING SIGNAL
CMDS
TIMING SIGNAL
CMDS
CMDS
EXTENDED COMMAND SYSTEM
A
B
MINIMAL COMMAND SYSTEM
VCTS NO.2 RECEIVER
VCTS NO.1 RECEIVER
PRIMARY CMD BACKUP RECEIVER
375 MHz RECEIVER
ANTENNAS
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LIFEBOAT II

The lifeboat system provides emergency capability to initiate separation of two Reentry Vehicles (RV) and to deorbit the Satellite Vehicle in the event of a complete failure of the main power system. the attitude control system, or the extended command system.

Emergency operational control is provided by the 375 MHz receiver and minimal command system, with capability for real-time, stored-program, and secure commands.

Attitude control for RV releases and SV deorbit is provided by earth-field sensing magnetometers, rate gyros, and a cold gas (freon 14) control force system. Lifeboat is capable of RV releases and SV deorbit operations on both south-to-north and north-to-south passes.

Power to keep the system ready for use, and for the emergency operations is provided by a type-40 battery and 1/4 of the solar arrays from the main power system. The OAS engine and the redundant SGLS, PCM, tape recorder, and other equipment necessary for RV release, SV deorbit, and recovery of vehicle diagnostic data are switched from the main power system to the lifeboat bus for the emergency operations. In a nominal tumbling mode, enough power is generated to keep this emergency mode operating until the vehicle reenters.

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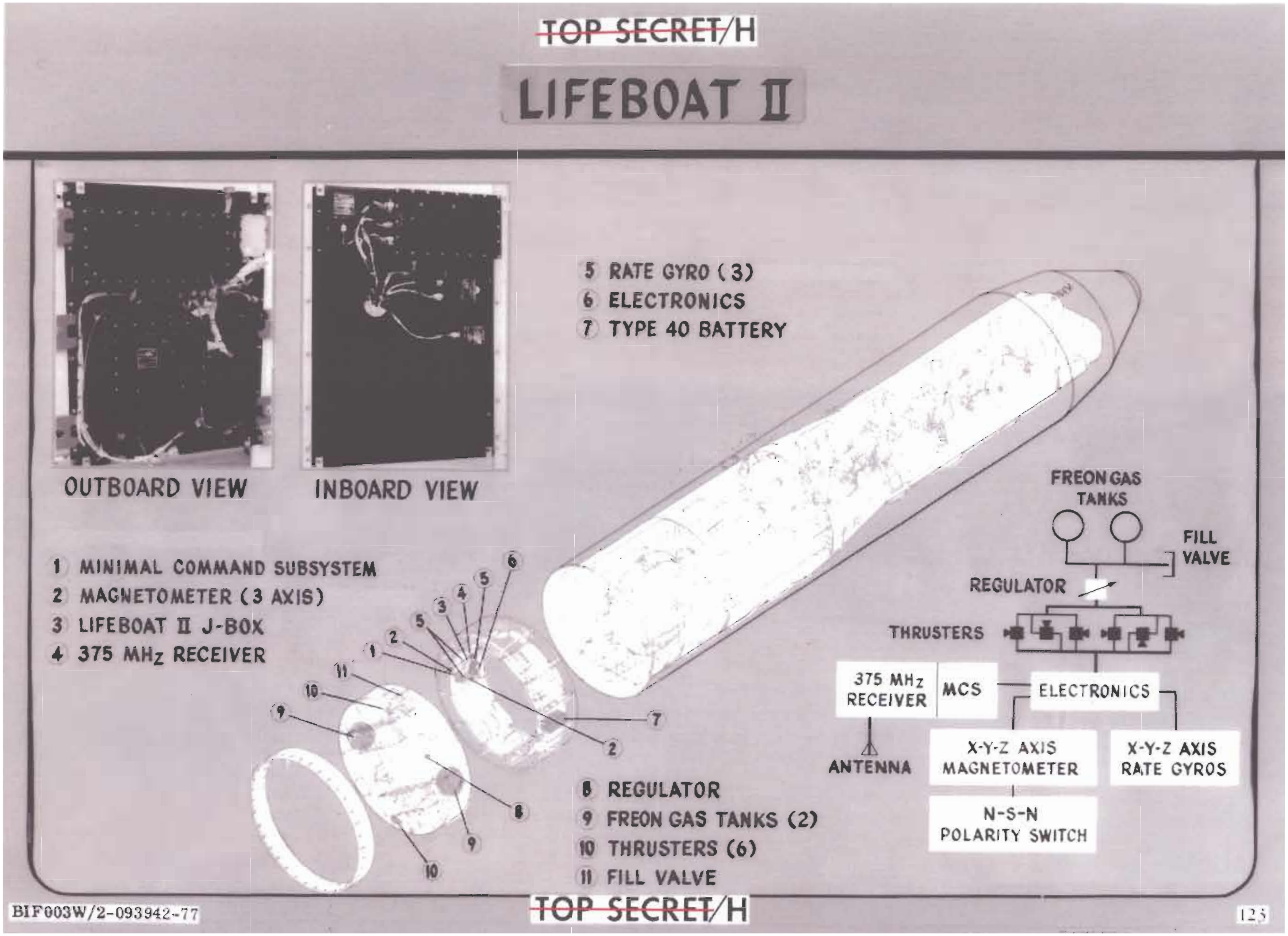
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LIFEBOAT II
OUTBOARD VIEW
INBOARD VIEW
1 MINIMAL COMMAND SUBSYSTEM
2 MAGNETOMETER (3 AXIS)
3 LIFEBOAT II J-BOX
4 375 MHz RECEIVER
5 RATE GYRO (3)
6 ELECTRONICS
7 TYPE 40 BATTERY
8 REGULATOR
9 FREON GAS TANKS (2)
10 THRUSTERS (6)
11 FILL VALVE
FREON GAS TANKS
FILL VALVE
REGULATOR
THRUSTERS
375 MHz RECEIVER
MCS
ELECTRONICS
ANTENNA
X-Y-Z AXIS MAGNETOMETER
X-Y-Z AXIS RATE GYROS
N-S-N POLARITY SWITCH
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HARDWARE FLOW

The HEXAGON integrated test program begins at the piece-part level and continues through component, module and vehicle levels of assembly. Testing at progressive levels of assembly permits workmanship faults to be identified and eliminated early in the test program.

The SBA piece-parts are subjected to electrical and environmental stress and visual inspection tests to verify piece-part specification. The SBA components are subjected to ambient, random vibration, temperature-vacuum and burn-in acceptance tests for early detection and correction of design, parts and manufacturing defects. The components are then assembled into the aft section modules or installed in the forward and mid-sections. The aft section electronic modules are subjected to ambient, acoustic and thermal vacuum tests. The propulsion module and solar array modules are subjected to ambient and acoustic tests.

The sections are then mated to form the Satellite Vehicle which is then ready for the system level tests prior to VAFB shipment.

The nomenclature shown on the accompanying illustration indicates the contractor where manufacturing or testing occurs:

SBAC – Satellite Basic Assembly Contractor (Lockheed)
MWC – Midwest Contractor (McDonnell Douglas)
NEC – Northeast Contractor (Itek)
OPC – Our Philadelphia Contractor (General Electric)
SSC – Sensor Subsystem Contractor (Perkin-Elmer)

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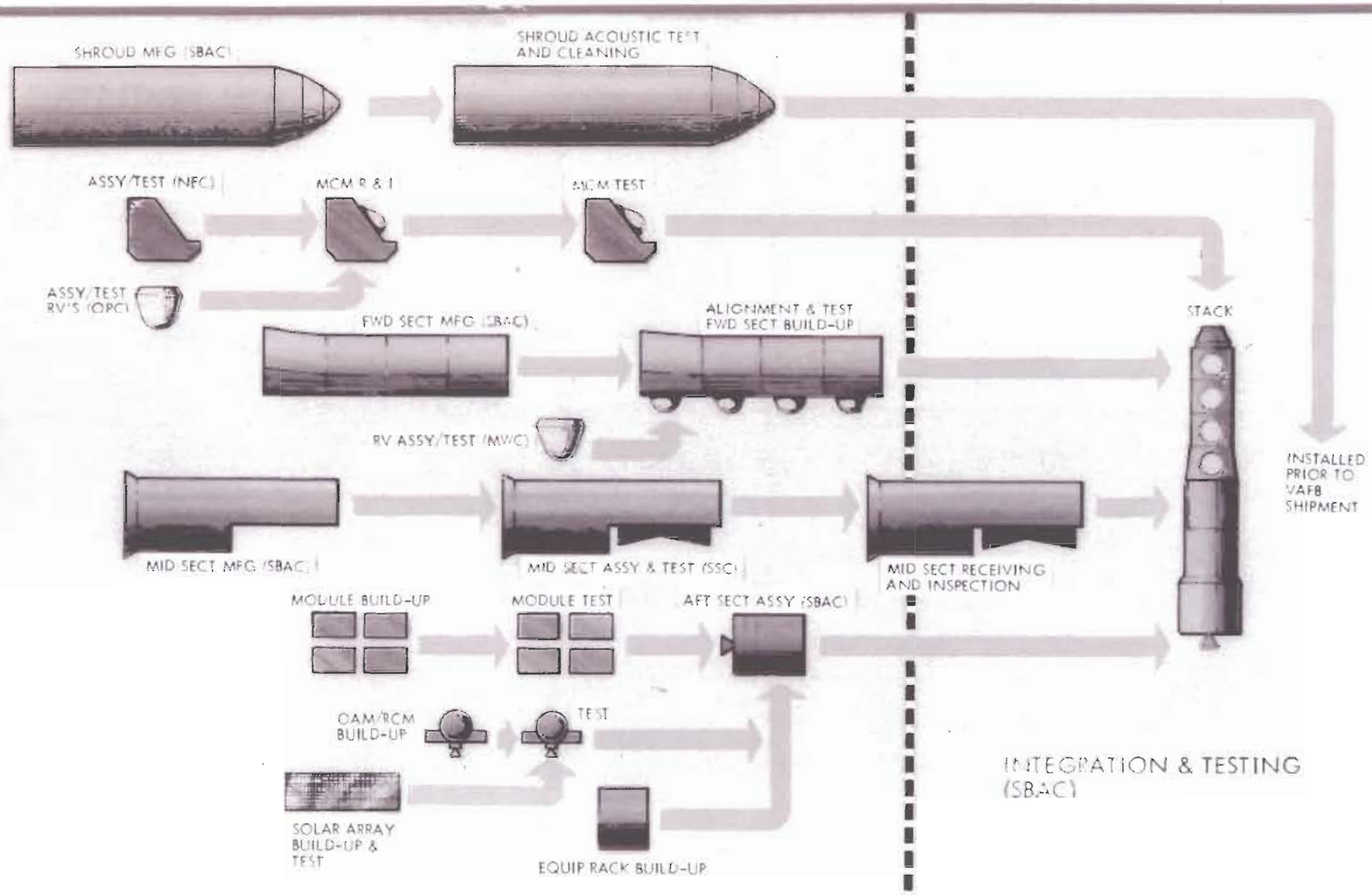
HARDWARE FLOW



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HARDWARE FLOW

The objective of the factory-to-pad test program is to demonstrate flight readiness of each vehicle at the factory and to perform vehicle checkout and launch preparations at the launch complex.

The assembled vehicle is tested as a system with payload electrical simulators to verify compatibility of the SBA equipment with the payload interfaces. The payloads are then electrically connected to the Satellite Basic Assembly (SBA) and the vehicle is tested to verify performance and compatibility.

The vehicle is subjected to an acoustic test and is monitored during the exposure to verify proper SV health and status. The vehicle is then tested to verify that it survived the acoustic environment. The vehicle is next subjected to a thermal vacuum test with the aft section subjected to two thermal cycles and the payloads subjected to one thermal cycle. Aft section performance tests are conducted at low and high temperatures and typical mission profile tests are performed on the payloads including film transfers to each reentry vehicle.

A collimation test of the Two Camera Assembly (TCA) is performed at vacuum to verify optical performance and to determine the flight focus setting for the camera system. The mapping camera flatness is verified and the flight setting for the film path pressure makeup is determined.

The vehicle is then prepared for shipment which includes flight film loading [redacted] A systems test is then performed to verify systems performance. Final shipping preparations are performed and the shroud is installed. The vehicle is then transported to the launch base.

The vehicle is mated to the booster and an Aerospace Vehicle (AV) systems test is performed to verify that the SV operates properly and to verify compatibility between the AV and the Vandenberg tracking station and the Satellite Test Center. Final flight preparations consisting of propellant loading and pyrotechnic installation is performed. The countdown is initiated and consists of the final SV functional test and launch configuring for lift-off, roll back of the Mobile Service Tower, flight command loading, performing terminal count and launching the Aerospace Vehicle.

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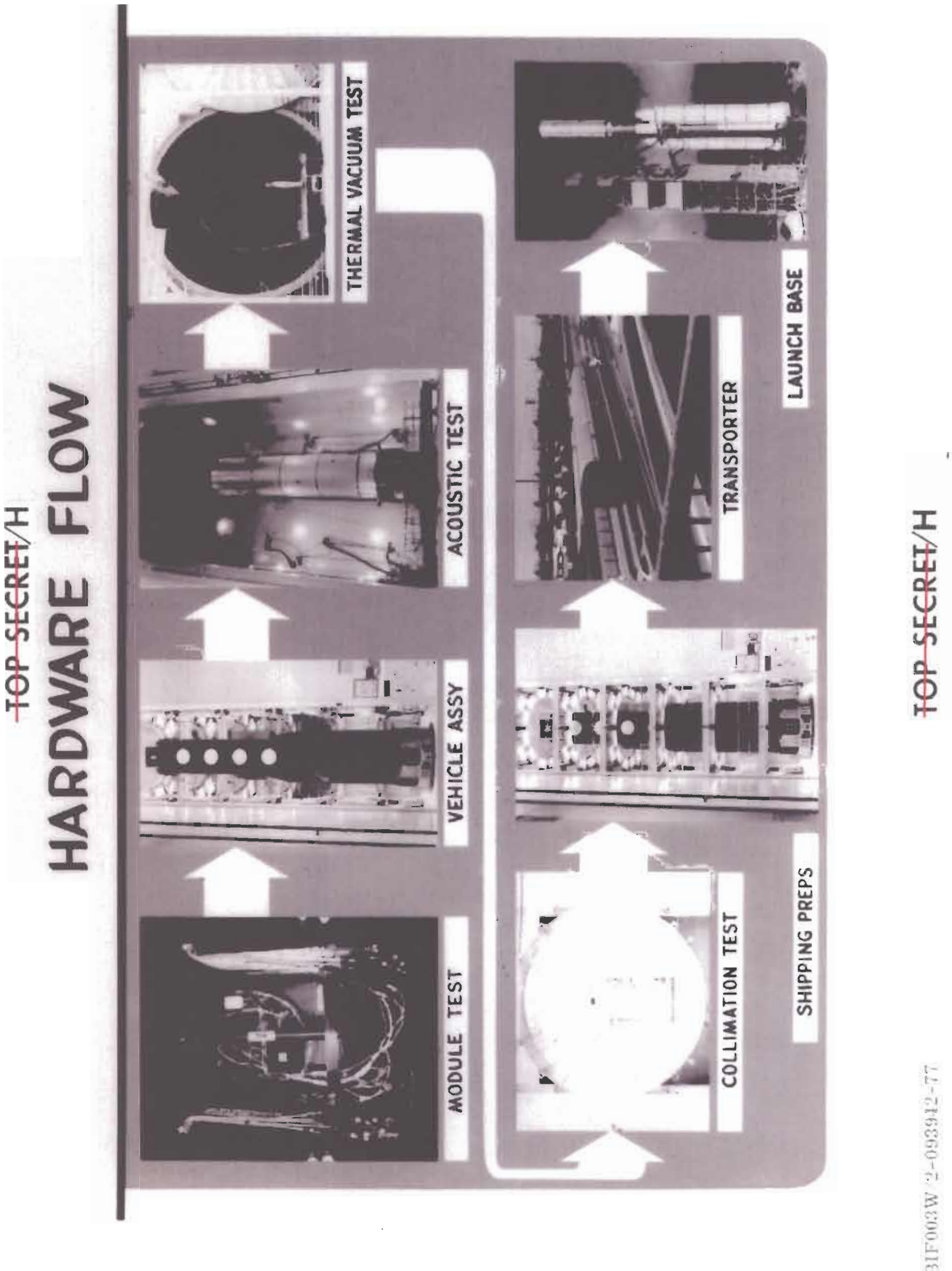
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HARDWARE FLOW
MODULE TEST
VEHICLE ASSY
ACOUSTIC TEST
THERMAL VACUUM TEST
COLLIMATION TEST
SHIPPING PREPS
TRANSPORTER
LAUNCH BASE
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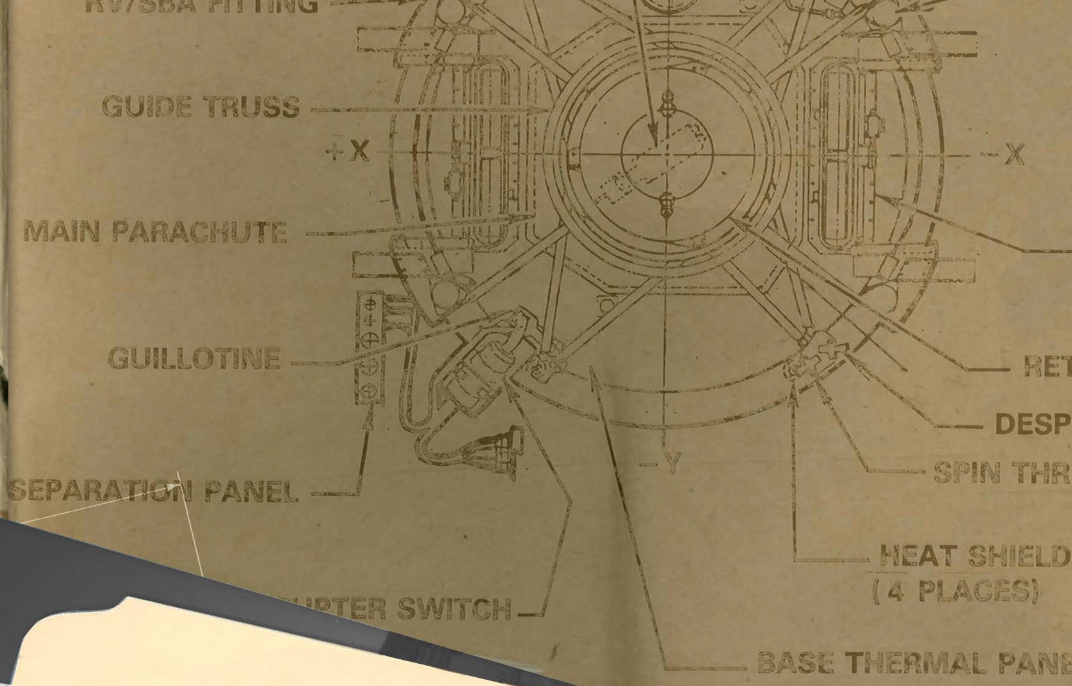

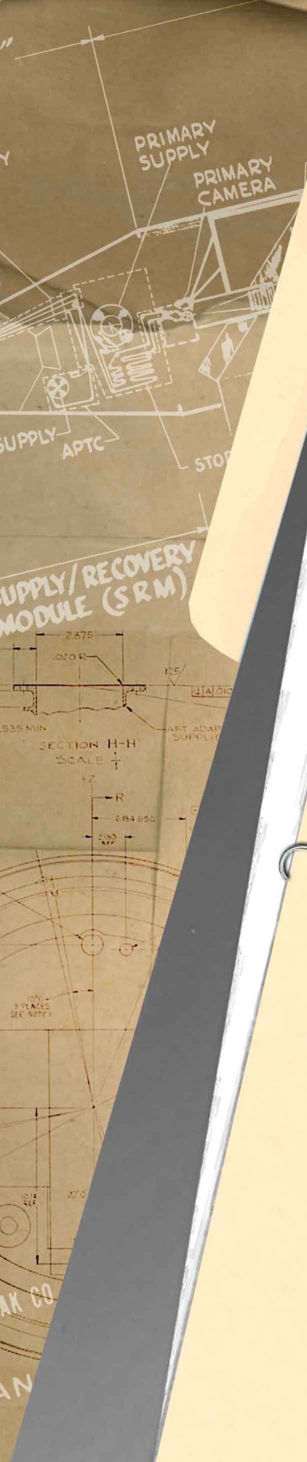

CRITICAL TO US SECURITY:
THE GAMBIT AND HEXAGON SATELLITE RECONNAISSANCE SYSTEMS COMPENDIUM

SECTION V: SYSTEMS CONTRIBUTIONS

This set of documents describes the intelligence capabilities of the systems as well as their successes. Gambit and Hexagon were each designed for specific intelligence purposes. However, they worked together by providing more flexible and persistent imagery coverage for countering the threats posed by U.S. adversaries including China and the Soviet Union.

The first document in this section is a 1967 report prepared for then Director of the National Reconnaissance Office (DNRO), Alexander Flax, which summarizes the Gambit program. The report is rich in historical details, system capabilities, and management approaches. The report summarizes the growth in capabilities as the system matured, the technical problems encountered, and procurement aspects such as the incentive fee structure and costs.

DNRO John McLucus requested a similar report for Gambit-3, also known as program 110. Although the report was prepared early in the life of the Gambit-3 program, we included it in this compendium because it was modeled after the earlier Gambit report. The two together provide a unique opportunity to compare the systems at this point in time. Like the Gambit report, we also find rich details of the programs uses and early successes. The report also addresses intelligence value, satellite operations, technical issues, and procurement costs.

American space companies were essential partners in the NRO's successful satellite programs. We have included two corporate documents from Lockheed Missiles and Space Company. The documents describe the successful launch of late Gambit vehicles. In a letter from Lockheed's Reginald R. Kearton to DNRO Flax, Kearton identifies intangible reasons for the Gambit including cooperation and management harmony between the military and contractors. He identifies tangible factors of success including effective design, effective launch preparations, and realistic cost estimation.

In an interesting memo concerning Hexagon, a National Photographic Interpretation Center (NPIC) manager describes the innovations that Hexagon prompted in the exploitation of imagery. The memo identifies innovations in equipment, management, and personnel management. The memo also identifies how Hexagon influenced consideration and analysis of intelligence targets.

Finally, we included the second volume of The KH-9 Search and MC&G Performance Study. The study reviews KH-9 performance and briefly summarizes the satellite system, the evolution of search requirements, and names specific examples of contributions made by KH-9 to the mission. The study concludes that Hexagon, in general, satisfied the most important intelligence requirements.

LIST OF SYSTEMS CONTRIBUTIONS DOCUMENTS

* Pages including full-page redactions and blank pages have been removed from these documents.

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BYE-70792-67

Cy 1

DEPARTMENT OF THE AIR FORCE
DIRECTORATE OF SPECIAL PROJECTS (OSAF)
AF UNIT POST OFFICE, LOS ANGELES, CALIFORNIA 90045

29 August 1967

REPLY TO ATTN OF: SP-1

SUBJECT: Summary Analysis of Program 206 (GAMBIT)

TO: Director, NRO (Dr. Flax)

1. On completion of Program 206 (GAMBIT), I asked [redacted] to undertake a summary analysis of the overall program. This report is his work. I believe that you will find it interesting, including all of the appendices as well as the summary discussion.

2. With the exception of one Agena failure and one Atlas failure, both of which resulted in no orbit being attained, all of the mission catastrophic failures and most of the other serious failures were in GE equipment. Some payload difficulties existed throughout the program lifetime but no payload difficulty seriously affected the accomplishment of the primary objectives of any mission. Note that, although only four payloads clearly exceeded (bettered) the specification on resolution, 11 more were at the very threshold of bettering it, as may be seen from the graph on resolution versus flight number in Attachment 2.

3. On an overall basis, considering all SAFSP contracts on the program, including our estimate of final figures as explained in the report, the principal contractors earned the following fee as a percent of actual cost (obviously a higher percent of the original target costs where actuals exceeded target, lower where actuals were under target):

GE	5.6%
LMSC........	7.4%
EK..........	7.7%

4. The new incentive applied to 19 of the last 20 vehicles of the GE-580 contract; 15 of these vehicles were flown, of which 14 were generally successful, with an average performance score of 86.3%.

5. The difficulties encountered in this program are not necessary characteristics of this business. As an illustration, we have drawn

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heavily on this experience in laying out and proceeding with Program 110 (GAMBIT-3). It is a much more complex system, and the comparison of the first seven flights with the GAMBIT experience illustrates the degree to which we have been successful in this regard.

JOHN L. MARTIN, JR
Brigadier General, USAF
Director

1 Atch
Analysis of Gambit Project
24 Aug 67 w/5 Atch

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CONTROL SYSTEM ONLY

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DEPARTMENT OF THE AIR FORCE
DIRECTORATE OF SPECIAL PROJECTS (OSAF)
AF UNIT POST OFFICE, LOS ANGELES, CALIFORNIA 90045

BYE-70792-67

Cy 1

2 4 AUG 1967

REPLY TO ATTN OF: SP-2

SUBJECT: Analysis of GAMBIT Project

TO: SP-1 (Gen Martin)

1. Purpose and Scope

a. This paper analyzes the effectiveness of the recently completed GAMBIT (206) project, which launched 38 missions, all but two of which achieved orbit. One of the 36 orbiting missions was not recovered.

b. The following parameters are addressed: intelligence, operations, technical, procurement, and cost.

c. The Quarterly Program Review as of 31 Dec 1966 (BYE 66207-67) contained a summary comparison of GAMBIT operations in calendar years 1965 and 1966. Portions of the data on which that comparison was based were in error, and are superseded by correct data in this analysis.

d. This basic paper summarizes the results of the analysis. The attachments contain details in narrative, tabular and chart form.

2. Intelligence

a. Photographs of [redacted] intelligence targets were recovered during the life of the GAMBIT project. Not all of these were useable because of cloud cover or degraded resolution. The total number of targets photographed as used in this analysis does not distinguish between target priorities, mono versus stereo, or resolution obtained.

b. GAMBIT provided the intelligence community with the first high resolution (2-3 ft) satellite photography of denied areas. The community has stated that the intelligence value of this photography was extremely high.

c. There was steady growth in the capability of the GAMBIT system to obtain photography, as seen in the following table of calendar year averages.

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Targets Photographed

CY	Per Flight	Per Day	Per Rev
63	[redacted]		
64			
65			
66			
67			

d. The contract specification for GAMBIT ground resolution was 2 to 3 ft (135 lines/mm). The total take of any single mission contained photographs with a variety of resolutions because of flight and ground conditions. Considering only the best resolution obtained on any flights, the results of the 36 missions achieving orbit may be tabulated as follows:

Resolution	Number of Flights	%
[redacted]	4	11.1
2 to 3 ft	21	58.3
3 to 10 ft	3	8.3
Worse than 10 ft	7	19.5
Not recovered	1	2.8
TOTAL	36	100%

e. Thus, 69.4% of all flights obtained some photography that was within specification, 27.8% obtained photography worse than specification and 2.8% obtained no photography.

3. Operations

a. The system was originally designed for a nominal 5-day life,

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but operations began with shorter planned orbital lifetimes. The first 5-day mission was No. 17, nearly two years after No. 1. Lifetimes were extended to 6 days by mission No. 26 and to 8 days by mission No. 30. The 36 flights achieving orbit had the following orbital lives:

Days	Number of Flights
8	7
7	2
6	4
5	4
4	8
3	1
2	5
1	5
Total	36

b. Of 36 recovery attempts, 35 capsules were successfully recovered by air. On mission No. 13, which had flown 4 days (67 revs), the recovery vehicle separated but there was no retrofire. The capsule impacted in the ocean and was lost.

c. The 36 orbiting vehicles accomplished a total of 2,716 operational revs (before RV separation) or a total of 169.745 operational days. Of these, 136.445 operational days (80.4%) were acceptable, i.e., days in which the satellite operated so as to permit a mission which could achieve 75% of the planned reconnaissance. On the other 19.6% of the days, system anomalies degraded performance.

d. The first three flights were planned in the "hitch-up" mode, wherein the Agena stage did not separate from the OCV. Only nadir photography was possible.

4. Technical

a. Major problems encountered in development, test, production and operation can be categorized into the following divisions:

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(1) Deficient handling, selection, testing and quality control of parts and components.

(2) Inadequate design

b. Changes in procedures, 100% selection of piece parts, additional testing and emphasis on quality control solved most of the deficiencies in parts and component failures. Some of the most significant of these were

(1) Redesign of harness connections and potting procedures eliminated a rash of early electrical problems where connecting pins were bent or pulled loose.

(2) In analyzing a DC powe r supply problem several black boxes were opened which disclosed faulty wiring, contamination and lack of thorough inspection. This disclosure resulted in increased emphasis on quality control, but also prompted a new series of thermal vacuum and shake tests in order to identify possible failures prior to launch. In addition identical tests were instituted at the factory and at Vandenberg to disclose failures occurring during shipment.

(3) A serious battery problem occurred which was traced to a change in design not accompanied by a necessary change in procedure. The battery exploded damaging critical flight components. A vent line to the vehicle's exterior was added to minimize recurrence, and battery checkout and fill procedures were updated.

(4) A series of servo failures on the crab and stereo systems were traced to improper handling of parts; lead screws were cut down to fit without reanodizing, allowing contaminants to build up when operated on orbit.

c. The possibility of the command system issuing false commands when triggered by voltage transients was never completely solved. Logic circuits were "hardwired" into the vehicles that prevented the operation of simultaneous commands which together would be catastrophic.

(1) The inability of the horizon sensor to discriminate between sky and very cold earth areas resulted in loss of stability. This started

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a development cycle on a new sensor, some models of which were flown on the Agena for testing. However, because of cost and long lead times, a procedure was adopted to turn off the sensors and go inertial over those cold earth masses. Further development was discontinued.

(2) Impingement of cold gas from the roll nozzles resulted in a forward thrust to the vehicle destroying accurate position knowledge. The nozzles were moved back for one flight and studies were made as to moving them outward from the vehicle. Instead, we were able to calculate the added thrust for each roll accurately enough to discontinue further development.

(3) One capsule loss because of anomaly in ejection programmer led to a design of redundant wiring within the recovery vehicle.

(4) Electro-magnetic interference throughout the vehicle resulted in a series of changes. A power amplifier was removed from the telemetry transmitters, but signal strength remained sufficient for operation. The 6-volt power supply was filtered and refiltered many times to reduce interference with the command system. This problem was never really solved. Interference in the horizon sensor system from the Rate Attitude Gyros and the stabilization amplifiers started a study in elimination of the RAGS. This turned out to be too difficult and a replacement system was not available, so the gain was reduced along with a reduction in sensitivity of the sensors.

(5) Beginning with the second flight, failures persisted with the environmental door. The original pneumatic actuator was eventually backed up by an electric motor. Then the pneumatic system was discarded in favor of an all-electric system with a pyro backup to guarantee a fail-open condition. The first flight of the electric system failed because of a switch relay - which was then changed to a magnetic type.

(6) An outer shield separation failure because of a buildup of tolerances and a change in design of a pyro by the vendor resulted in a new, stronger pyro and some design changes in the separation mechanism.

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(7) Polystyrene capacitors were eliminated from the primary camera drive system and from the supply torque motor after a number of failures. The wrong type of lubricant resulted in variable running rates for the platen drive motor.

(8) Degradation in results was traced to thermal effects on the primary and stereo mirrors. A new design resulted in segmented potting of the mirrors to the casing. Also the temperature specifications were changed during optical testing at the factory and at the launch base.

(9) Some servo failures were caused by arcing between relay contacts and case. This was corrected by modifying the design, purchasing new relays, and reinspecting decoders.

d. Although it is believed (erroneously) in some quarters that once a space project becomes operational, the quantity of technical changes decreases significantly, the GAMBIT experience was to the contrary, and in this respect was typical of all reconnaissance satellite effort. It was necessary to introduce technical changes throughout the entire life of the GAMBIT project for two reasons: to correct design deficiencies which usually resulted in on-orbit anomalies and to improve the operational effectiveness of the system. As an illustration of these changes, Atch 6 shows the Contract Change Notifications (CCN) history of GE-580, the contract on which the last 20 OCVs were procured. The originally negotiated price of [redacted] was increased by the technical changes (and also to a slight degree by a cost overrun) to [redacted] a growth of 73% over the three year period of performance. These changes were all necessary, and in fact were the means by which the operational performance was improved significantly during the later stages of the project.

5. <u>Procurement</u>

a. Of the total dollar cost of the GAMBIT project, nearly [redacted] was incurred on SAFSP contracts and the remaining [redacted] on SSD and CIA contracts.

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b. The SAFSP contracts were of the following types:

	Total	White	Black
CPFF	10	8	2
CPIF	14	12	2
FFP	5	4	1
L/C (terminated)	1	1	0
	30	25	5

c. The most significant procurement development on the GAMBIT project was the introduction of a new incentive structure devised by Gen Martin. Previous structures, written at a time when cost was the principal concern and the effect of GE workmanship problems on flight performance was not yet apparent, had emphasized cost at the expense of performance. Under the new structure, the only way the contractor could earn fee was by successful in-flight performance. There were only negative incentives on cost and schedule, to insure responsible financial and production effort by the contractor. (Atch 4 describes the structure.)

d. Cost experience on the major contracts was:

(1) Eastman:

While CPFF, over-ran [redacted] (6.7%)

While CPIF, under-ran (4.2%)

(2) GE:

-76	(CPFF)	over-ran	[redacted]	(7.3%)
-155	(CPIF)	over-ran		(3.8%)
-432	(CPIF)	over-ran		(7.1%)
-580	(CPIF	over-ran		(26.2%)
-7705	(CPFF)	over-ran		(.9%)
-2106	(CPIF)	broke even		

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(3) LMSC:

-92	(CPFF)	Over-ran	[redacted]	(2.8%)
-506	(CPIF)	under-ran		(3.9%)
-670	(CPIF)	under-ran		(7.3%)

e. Schedule experience showed that GE consistently lost fee on schedule, and only [redacted] gained fee in this parameter. Since the OCV was the pacing component in the system, GE schedule delays impacted on the launch dates.

f. Performance experience showed fee gain by all contractors except on GE -155 (smallest GE contract for 4 OCVs) which lost [redacted] on performance. Contracts having the old performance incentive showed small fee gains for performance. The only contract with the new performance incentive (GE-580) showed a fee gain of [redacted] for the performance parameter (of a possible gain of [redacted]; however, cost and schedule penalties resulted in a net fee loss.

g. Of all the GAMBIT contractors, GE posed the greatest workload by far in contract administration. Agreements reached at top management level were disseminated to lower levels slowly and/or with varying accuracies of interpretation. Positions taken during negotiations were more often intractable, resulting in discontinuance of negotiations. There were frequent disputes concerning whether directed work was within contract scope, and a growing tendency to request new contractual coverage for all minor directions from the SAFSP project office. These, combined with other examples too numerous to mention here, reflected unfavorably on GE's capability to manage the project. This is confirmed by Gen Martin's letters to DNRO in 1965 (BYE 40317-65 and BYE 40329-65) in which the poor GE performance was documented.

6. Cost

a. As of 30 June 1967 the GAMBIT project had cost [redacted] Final contract settlements over the next few years will cause minor changes in this amount.

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b. The [redacted] includes the [redacted] cost of hardware purchased for GAMBIT but reallocated by DNRO without reimbursement to other SAFSP projects. [redacted]

c. The non-recurring costs for development, industrial facilities, and one-time support totalled [redacted] or 24.3% of the total program cost. Two-thirds of the development cost was for development of the satellite vehicle by GE, and 18% was for development of the payload by EKC.

d. Determination of unit costs is difficult because of overlapping contract periods and fiscal year accounting. It is possible to make a fairly accurate division of the recurring costs into two groups: those associated with the first 10 flights and those associated with the last 28 flights. On this basis the unit costs of a GAMBIT flight averaged [redacted] for the first 10 and [redacted] for the last 28.

e. On a more arbitrary basis, the recurring costs were allocated to the vehicles flown in each calendar year, i.e., the cost of the four flights in CY 1963 was determined to be [redacted], etc. This allocation gives the following comparisons [redacted]

	63	64	65	66	67
Average Cost per flight	[redacted]				
Average Cost per day in orbit					
Average Cost per target photographed					

f. It is perhaps more meaningful after a project is completed to lump all costs (recurring and non-recurring) into one total and then determine the above averages. This gives [redacted]

Average Cost per flight	[redacted]
Average Cost per day in orbit	
Average Cost per target photographed	

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7. Summary

The GAMBIT project can be said to have been highly successful in that:

a. It produced the first high resolution satellite photography and thus filled the gap created by the cessation of U-2 flights following the Powers incident.

b. Its record of successful launches, orbits and recoveries far surpassed the records of earlier systems, especially during comparable periods of the initial four years.

c. It advanced the state of the art to the point where a follow-on larger system could be developed and flown so successfully that GAMBIT could be phased out.

d. The record of cost control showed a steady decrease in cost of days in orbit and cost of targets photographed.

e. Specific technical, procurement and cost problems successfully resolved during the GAMBIT project improved the capability of SAFSP, and indeed the NRO, to prosecute other satellite projects.

[redacted]

[redacted] Colonel, USAF
Vice Director

5 Atch
1. Proj history and list of flts
2. Graphs
3. Flt anomalies
4. Procurement Data
5. Cost Data

10

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Cy 1

Attachment 1

Project History

1. A detailed historical record of the GAMBIT project is contained in the official SAFSP history being compiled by Mr Robert Perry. Volumes completed to date are on file in SP-3. Following is a summary of a few key points.

2. GAMBIT was the first NRO satellite project to produce reconnaissance photographs with high (2-3 ft) ground resolution. (The CORONA project, which began earlier and is still operating, produces photography of 8-15 ft resolution. In the SAMOS series, the one E-1 flight achieved about 100 ft resolution, the one E-5 camera flight (LANYARD) achieved 7-12 ft resolution, and no photography was recovered from the five E-6 flights.)

3. The photography produced by GAMBIT has been extremely valuable to the intelligence community.

4. GAMBIT has been managed entirely by SAFSP, which office had complete responsibility for development, production and operation of all system components. This contrasts with CORONA, where the CIA has responsibility for the sensor subsystem. For cover purposes, GAMBIT was overtly placed under ostensible SSD management until Dec 1962, when the overt assignment was changed to SAFSP; however, SAFSP covertly had the complete management responsibility from the outset.

5. There were a number of overt designators used throughout the life of the GAMBIT project:

Sep 1961	Exemplar
Dec 1961	Cue Ball and 483A
Feb 1962	698AL
Aug 1962	206

6. After earlier SAFSP parametric work had established feasibility, official GAMBIT go-ahead was given in Sep 1961. The first flight was launched 12 Jul 1963 and the thirty-eighth and final flight was launched

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4 June 1967. The first three flights were flown in the "Hitch-up" mode, wherein the Agena stage was not separated, but orbited attached to the Orbital Control Vehicle (OCV). In the remaining thirty-five flights, the Agena was programmed to separate and the OCV was the orbiting vehicle.

7. Principal components and their manufacturers were:

Payload	EKC
OCV	GE
RV	GE
Agena Stage	LMSC
Atlas Booster	GDA
S/I Camera	Itek
Horizon Sensor	Barnes

8. During the life of the project there were these changes in key personnel:

a. DNRO:

Sep 1961 - Mar 1963	Dr J V Charyk	(Initial Development)
Mar 1963 - Sep 1965	Dr B McMillan	(Final Dev and 22 Flights)
Sep 1965 - Jun 1967	Dr A H Flax	(16 Flights)

b. Director of Special Projects:

Sep 1961 - Jun 1965	Gen R E Greer	(Dev and 19 Flights)
Jul 1965 - Jun 1967	Gen J L Martin Jr	(19 Flights)

c. Project Director:

Sep 1961 - Dec 1962	Col Q Riepe	(Initial Development)
Dec 1962 - Aug 1966	Col W G King Jr	(Final Dev and 31 Flights)
Sep 1966 - Jun 1967	[redacted]	(7 Flights)

9. The following pages contain a list of the thirty-eight GAMBIT launches.

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SPECIAL HANDLING

List of GAMBIT Flights

Sequence	OCV#	Launch Date	Orbit	Orbital Revs	Days on Orbit Total	Days on Orbit Acceptable	Targets Photographed	Best Ground Resolution (ft)	Recovery
1	951	12 Jul 63	Yes	18	1.125	.50	[redacted]	3.5	Yes
2	952	6 Sep 63	Yes	34	2.125	2.125	[redacted]	2.5	Yes
3	953	25 Oct 63	Yes	34	2.125	2.125	[redacted]	3.0	Yes
4	954	18 Dec 63	Yes	18	1.125	0	[redacted]	N/A	Yes
5	955	25 Feb 64	Yes	34	2.125	0	[redacted]	N/A	Yes
6	956	11 Mar 64	Yes	51	3.188	3.188	[redacted]	3.0	Yes
7	957	23 Apr 64	Yes	66	4.125	4.125	[redacted]	2.5	Yes
8	958	19 May 64	Yes	34	2.125	1.0	[redacted]	2.0	Yes
9	959	6 Jul 64	Yes	34	2.125	0	[redacted]	50.0	Yes
10	960	14 Aug 64	Yes	66	4.125	1.0	[redacted]	7.0	Yes
11	962	23 Sep 64	Yes	67	4.188	4.188	[redacted]	7.0	Yes
12	961	8 Oct 64	No	0	0	0	[redacted]	N/A	N/A
13	963	23 Oct 64	Yes	67	4.188	0	[redacted]	N/A	No
14	964	4 Dec 64	Yes	16	1.0	.5	[redacted]	2.1	Yes
15	965	23 Jan 65	Yes	67	4.188	4.188	[redacted]	2.0 (b)	Yes
16	966	12 Mar 65	Yes	67	4.188	4.188	[redacted]	2.4	Yes
17	967	28 Apr 65	Yes	83	5.188	5.188	[redacted]	2.0	Yes
18	968	27 May 65	Yes	83	5.188	5.188	[redacted]	2.0	Yes

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SPECIAL HANDLING

List of GAMBIT Flights
(cont'd)

Sequence	OCV#	Launch Date	Orbit	Orbital Revs	Days on Orbit: Total	Days on Orbit: Acceptable	Targets Photographed	Best Ground Resolution (ft)	Recovery
19	969	25 Jun 65	Yes	18	1.125	0	[redacted]	N/A	Yes
20	970	12 Jul 65	No	0	0	0		N/A	N/A
21	971	3 Aug 65	Yes	67	4.188	0		N/A	Yes
22	972	30 Sep 65	Yes	67	4.188	4.188		[redacted]	Yes
23	973	8 Nov 65	Yes	18	1.125	.25		N/A (c)	Yes
24	974	19 Jan 66	Yes	83	5.188	5.188		2.0	Yes
25	975	15 Feb 66	Yes	84	5.250	5.250		2.0	Yes
26	976	18 Mar 66	Yes	99	6.188	5.250		2.0	Yes
27	977	19 Apr 66	Yes	98	6.125	6.125		2.0	Yes
28	978	14 May 66	Yes	99	6.188	6.188		2.0	Yes
29	979	3 Jun 66	Yes	99	6.188	6.188		2.3	Yes
30	980	12 Jul 66	Yes	131	8.188	5.50		2.5	Yes
31	981	16 Aug 66	Yes	130	8.125	6.75		2.0	Yes
32	982	16 Sep 66	Yes	115	7.188	7.188		2.0	Yes
33	983	12 Oct 66	Yes	131	8.188	8.188		[redacted]	Yes
34	984	2 Nov 66	Yes	115	7.188	0		N/A	Yes
35	985	5 Dec 66	Yes	131	8.188	8.188		2.5	Yes

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List of GAMBIT Flights
(cont'd)

Sequence	OCV#	Launch Date	Orbit	Orbital Revs	Days on Orbit Total	Days on Orbit Acceptable	Targets Photographed	Best Ground Resolution (ft)	Recovery
36	986	2 Feb 67	Yes	131	8.188	8.188	[redacted]	2.2	Yes
37	987	22 May 67	Yes	131	8.188	8.188		[redacted]	Yes
38	988	4 Jun 67	Yes	130	8.125	8.125			Yes
	TOTALS			2,716	169.745	136.445			

Notes:

(a) Targets shown for flights 1 and 14 are cloud free targets photographed and do not include other targets photographed.

(b) Resolution on flight 15 was 2.0 ft on day 1 but degraded to 10 ft on day 4.

(c) Resolution on flight 23 was so poor it was not measurable.

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Attachment #2

Graphs

1. Total targets photographed, by mission.
2. Average targets photographed, by calendar year.
3. Orbital Life by mission, actual vs planned.
4. Acceptable Life by mission, actual vs planned.
5. Ground Resolution, actual (best) vs specified.
6. Costs, per flight, per day and per target.

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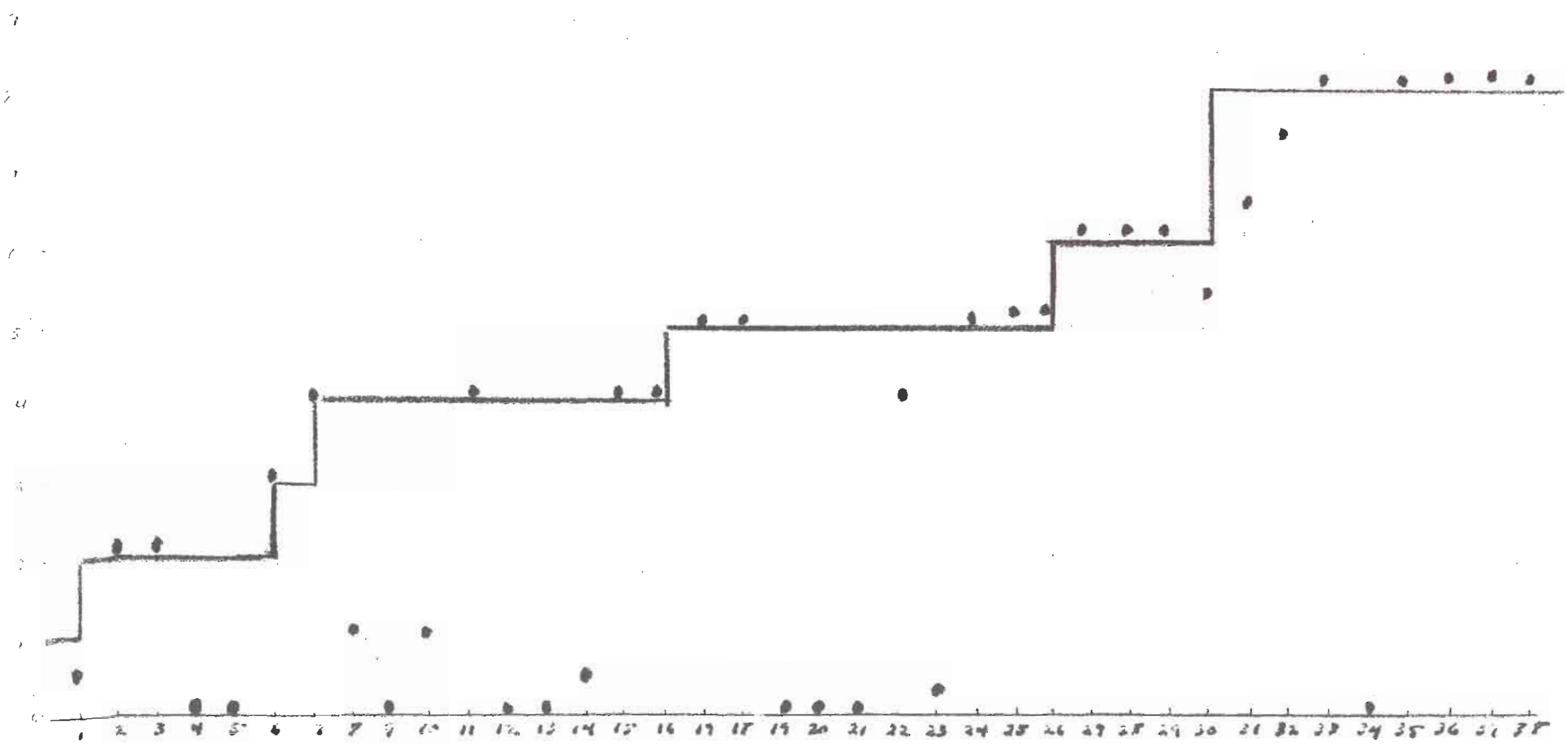
■ ACTUAL ACCEPTABLE DAYS ON ORBIT
VS
■ PLANNED DAYS



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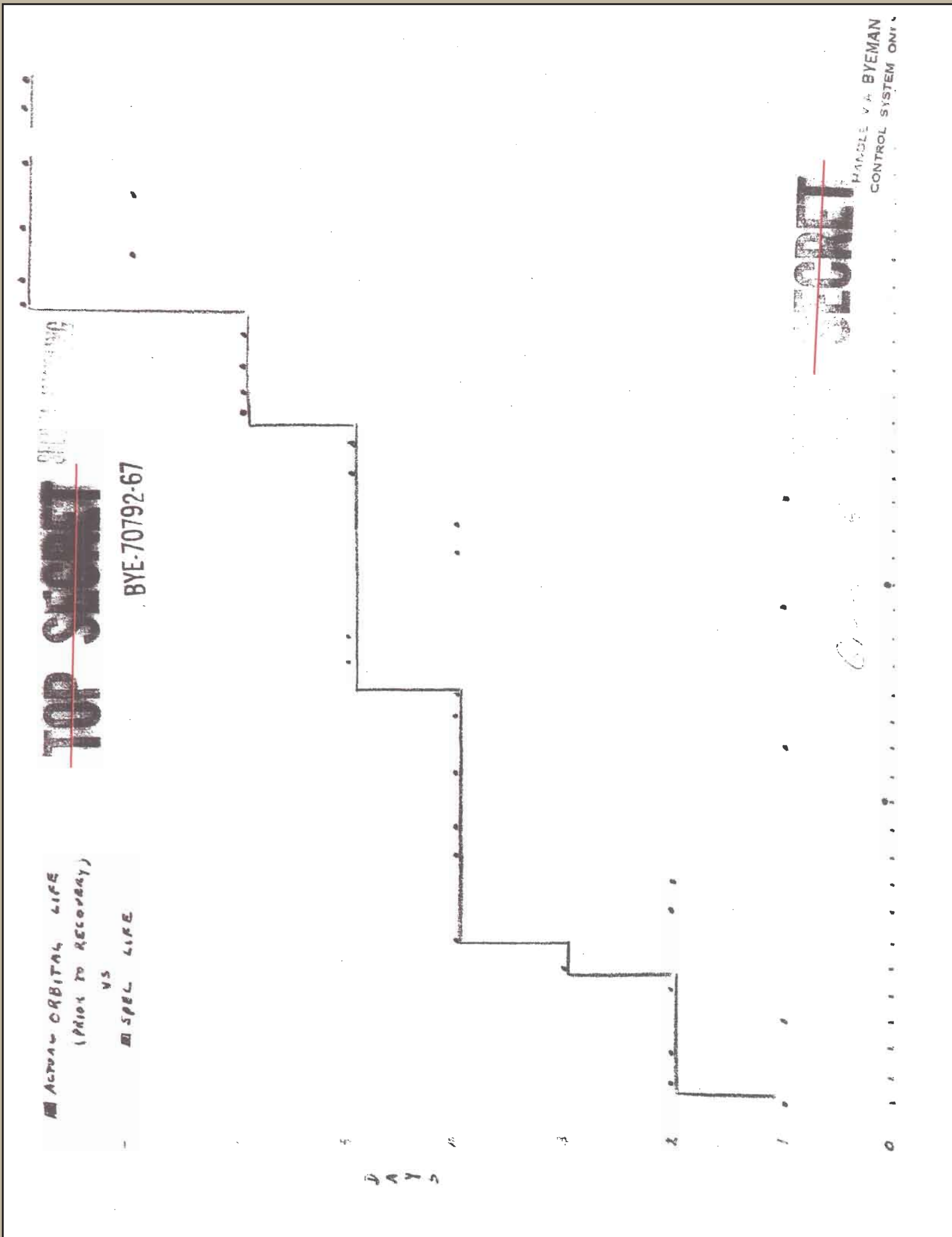
ACTUAL ORBITAL LIFE
(PRIOR TO RECOVERY)
VS
SPEL LIFE
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DAYS
0
1
2
3
5
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Cy 1

Attachment #3

GAMBIT Flight Anomalies

Vehicle	Days on Orbit Total	Days on Orbit Acceptable	Principal Anomalies
951	1.1	.5	Agena gas depletion, vehicle unstable.
952	2.1	2.1	Same
953	2.1	2.1	None
954	1.1	0	RAGS package overheat and loss of rate. Vehicle unstable. OCV did not deboost.
955	2.1	0	Excessive yaw through rev 16. Environmental door did not open on rev 22.
956	3.1	3.1	Excessive settling times
957	4.1	4.1	Bad component in horizon sensor mixer box caused pitch bias equal to 4 miles in-track error beginning rev 42.
958	2.1	1.0	Unstable in all three axes from rev 16. Horizon sensor could not discriminate over Antarctic.
959	2.1	0	Same
960	4.1	0	Slit misalignment and improper temperature correction caused out-of-focus condition. Unable to load programmer after rev 19.
962	4.1	4.1	Improper temperature correction caused out-of-focus condition.
961	0	0	No orbit. Agena engine failure.
963	4.1	0	No retrofire on RV. Capsule lost.
964	1.0	.5	Loss of power to stabilization system on rev 9. Vehicle unstable.

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GAMBIT Flight Anomalies
(cont'd)

	Days on Orbit		
Vehicle	Total	Acceptable	Principal Anomalies
965	4.1	4.1	Payload temperature anomalies. Stereo mirror stuck forward.
966	4.1	4.1	Stereo mirror stuck in 0 degree on rev 16. Mono photography only.
967	5.1	5.1	Primary door actuator.
968	5.1	5.1	Same
969	1.1	0	Power supply malfunction during ascent.
970	0	0	No orbit. Booster failure.
971	4.1	0	DC/DC power converter failed. Vehicle unstable.
972	4.1	4.1	High gas consumption. Roll maneuvers restricted on day 4.
973	1.1	.25	High gas consumption caused early mission termination.
974	5.1	5.1	Stereo mirror failed to drive to proper angle beginning rev 25.
975	5.2	5.2	Crab servo mechanism failed to move from zero. Stellar shutter malfunctioned.
976	6.1	5.2	S/I camera intermittent between revs 40 and 59. No commanding attempted after rev 71.
977	6.1	6.1	Slit position commanding anomaly. Slow platen drive motor.
978	6.1	6.1	Torque motor failure
979	6.1	6.1	Stabilization system performed improperly.
980	8.1	5.5	Vehicle clock malfunctioned, resulted in 58 degree pitch down, pressurization of the orbit propellant tanks and driving platen to full forward position.

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GAMBIT Flight Anomalies
(cont'd)

	Days on Orbit		
Vehicle	Total	Acceptable	Principal Anomalies
981	8.1	6.7	Stereo mirror stuck 0 degrees on rev 9, resulting in mono only
982	7.1	7.1	High gas consumption
983	8.1	8.1	Low thrust roll control valve leaked intermittently.
984	7.1	0	Outside hatch failed to jettison, preventing main camera photography.
985	8.1	8.1	Excessive time for roll at low rate.
986	8.1	8.1	Software selected wrong slit on revs 7 through 25. Primary stored command system inoperative on rev 126.
987 *	8.1	8.1	None
988 *	8.1	8.1	None

* Although both of these flights achieved planned performance, GE did not earn the maximum fee on the performance portion of the incentive structure [redacted] per flight) for the following reasons. Prior to these flights, GE completed an analysis of component vibration data obtained on previous flights, from which they concluded that some components on these two vehicles would probably exceed the vibration levels for which they had been qualified originally. Accordingly, GE considered that some adjustment should be made in the fee structure for these two vehicles. The government contracting officer proposed to score each of these two flights at the average performance score awarded on the previous 13 flights [redacted] per flight), or to fly them under the full incentive provisions, with the provision that the same option would have to apply to both flights and would have to be elected prior to the first of these two flights. GE accepted the option of the average performance score, with the result

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that these two flights earned a total performance fee of [redacted] as opposed to [redacted] that would have otherwise been earned by the actual performance of the vehicles. The government contracting officer's rationale in accepting the apparent risk of guaranteeing GE a performance fee prior to flying either of these vehicles was based on the following considerations:

a. Both vehicles at the time of the settlement on the average performance option had already been completely manufactured and shipped to the launch base, this manufacturing cycle having been carried out under the full terms of the incentive contract. Thus, the incentive had already had all possible effect on the quality of these two vehicles, except for the actual launch activities, all of which were under detailed supervision of experienced Air Force personnel at Vandenberg AFB.

b. These two vehicles had had all previously established improvements carried out completely in the above manufacturing process. Therefore, they had a higher probability of successful operation than any of the preceding 13 flights.

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Attachment 4

Procurement Data

GENERAL

1. SAFSP contracted for the payloads, Orbital Control Vehicles (OCVs), Agena peculiars, Recovery Vehicles (RVs), horizon sensors, mission planning and miscellaneous support effort.

2. SSD contracted for the Atlas boosters and launch service, standard Agena and launch services, satellite control, aerospace MTS and miscellaneous support effort. Funds for these items were released to SSD by SAFSP.

3. CIA contracted for the S/I cameras, film, roll joints, and certain RV parts. Funds for these items were released to CIA by the NRO comptroller at SAFSP request.

4. The SAFSP contracting was accomplished by an [redacted] procurement division collocated with the GAMBIT project office. Division chiefs were:

[redacted]	Sep 1961 - May 1965
	Jun 1965 - Jun 1967

INCENTIVES

5. Several types of incentive structure were used. Following is a narrative description of them, showing actual results obtained:

General Electric

a. Contract -76 (white) and [redacted] (black) covered development and production of the first six OCVs and RVs.

(1) -76 began as CPFF, but a performance incentive was introduced on the last two flights. Under this incentive, 100 possible points could be

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earned during orbit and recovery and 70 points was par. At par the contractor received target fee, at above par he earned additional fee up to a maximum increase of [redacted] per flight, and below par he lost fee up to the same maximum. Of the two flights, one earned maximum fee and one lost maximum fee, thus canceling each other. The cost overrun was 7.5%, but since there was no cost incentive, this did not penalize GE. Final fee situation was (% is of actual cost):

Target fee
Maximum possible fee
Actual fee

[redacted]

(2) [redacted] was CPFF throughout, with a fixed fee of [redacted] (6.4%). There was a small overrun of less than 1%.

b. There followed a series of four follow-on white contracts and one black contract with a life covering the lives of all four white contracts.

(1) -155 (white) produced four OCVs. It had the same performance incentive as -76, but added a negative schedule incentive penalizing GE [redacted] per week up to a maximum penalty of [redacted] as well as a cost incentive under which GE could earn or lose 7.871% respectively of underruns or overruns up to a maximum gain/loss of [redacted]. Actual results were losses on all three parameters:

Performance
Schedule
Cost

Total

[redacted]

Final fee situation was (% is of actual cost)

Target fee
Maximum possible fee
Actual fee

[redacted]

(2) -432 (white) produced 12 OCVs. It had the same general performance incentive, except that the par was higher and the maximum gain/loss per flight was [redacted] The negative schedule incentive was [redacted]

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per week penalty up to a maximum penalty of [redacted] The cost incentive had graduated sharing ratios with maximum gain/loss of [redacted] Actual results were:

Performance	[redacted]	gain
Schedule		loss
Cost		loss
Net		loss

Final fee situation was (% is of actual cost):

Target fee	[redacted]
Maximum possible fee	
Actual fee	

(3) -580 (white) produced 20 OCVs, of which 16 were flown. The incentive structure was changed significantly effective with the second of these 20 OCVs.

(a) For the first OCV, the performance incentive was generally the same as -432, except that the par was higher and the maximum gain/loss per flight was [redacted] There was a savings clause that where final score was lower than par the score would be adjusted to equal the average of previous flights on this contract but not lower than par. The negative schedule incentive was [redacted] per week penalty up to a maximum penalty of [redacted] The cost incentive was generally the same as on -432 except that the maximum gain/loss was [redacted]

(b) Effective with the second of the 20 OCVs, the incentive structure changed. The performance incentive was based on a list of critical events and on the ratio of the number of revs until the first critical event occurs to the number of planned revs. GE could earn an additional 7.5% above target fee of 7.5% for having no critical events during all the planned revs, and lose fee progressively because of critical events down to the point where there was no fee if a critical event occurred at 50% of the planned revs. There was a savings clause under which SAFSP could unilaterally award a higher fee if the intelligence obtained indicated a higher % of mission achievement. Maximum gain/loss per flight on performance was [redacted] for OCVs 2 through 11 and [redacted] for OCVs 12

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through 20 (8-day birds). (The last four birds were not flown and were awarded average performance fees of [redacted] each.) Schedule incentive was negative only, with penalties of [redacted] per day up to a maximum penalty of [redacted]. Cost incentives were negative only, with sharing ratio of 80/20 up to [redacted] overrun and 70/30 thereafter, up to a maximum penalty of [redacted]

(c) Pending completion of contract termination, we estimate the following results:

Performance	[redacted]
Schedule	
Cost	
Net	

(d) Final fee situation is estimated to be (% is of actual cost):

Target fee	[redacted]
Maximum possible fee	
Actual fee	

(4) [redacted] was to have produced three OCVs. This was issued as a letter contract which was negotiated but terminated before the definitive contract was executed. The OCVs were in various stages of completion at the time of termination. [redacted] was to have had the same incentive structure as [redacted], but since it was terminated from letter contract status there was no incentive operation. Actual fee paid was [redacted] as set by the terminating contracting officer. This is 7.6% of actual cost.

(5) [redacted] was a black contract covering mission - revealing aspects of the production of all but the first six OCVs and RVs. It had incentives on two elements:

(a) Performance. The incentive was on how well GE integrated the CIA-furnished S/I cameras. GE could earn points on the following formula:

$$\frac{100 \times \text{no. pairs of acceptable photos obtained}}{95\% \text{ of no. pairs available at liftoff}}$$

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The maximum fee gain/loss per flight was [redacted] Pending completion of contract termination, we estimate the contractor will earn about [redacted] on performance.

(b) Cost. The contractor could lose or earn 20% of overruns or underruns up to a maximum gain/loss of [redacted] Pending completion of contract termination, we estimate no gain or loss on cost.

(c) Estimated final fee position (% of actual cost):

Target fee	[redacted]	(7.5%)
Maximum possible fee		(12.5%)
Actual fee		(7.6%)

Eastman Kodak

(6) All the GAMBIT payload development and the production of 45 payloads [redacted] was done on black contract [redacted].

(a) The contract began as CPFF in Oct 1960 and was converted to CPIF in May 1964 effective with the 23d payload. At the time of conversion we recognized a cost overrun of [redacted] (6.7%) and in effect started over again from scratch on the CPIF basis.

(b) From payload no. 23 on, the incentive was on cost only, with fee gain/loss of 3% of target cost without dollar limit (up to 15% of cost). Pending completion of contract termination, we estimate EKC will earn a fee gain of [redacted]

(c) Final fee situation will thus be (% is of actual cost):

Target fee	[redacted]	(7.3%)
Maximum possible fee		(15%)
Actual fee		(7.8%)

Lockheed

(7) White contract -92 called out development work and the peculiarization of 10 Agenas as GAMBIT stages. It was CPFF, with a fixed fee of [redacted]

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(8) White contract -506 was a CPIF follow-on for peculiarization of 12 Agenas, with incentives on cost only. LMSC earned a fee gain of [redacted] Final fee situation was (% is of actual cost):

Target fee	[redacted]	(7.0%)
Maximum possible fee		(8.8%)
Actual fee		(7.4%)

(9) White contract -670 was a CPIF follow-on for peculiarization of 13 Agenas, with incentives on performance and cost. LMSC earned fee gains of [redacted] on performance and [redacted] on cost for a total gain of [redacted]. Final fee situation was (% is of actual cost):

Target fee	[redacted]	(4.9%)
Maximum possible fee		(11.2%)
Actual fee		(7.8%)

(10) White contract -874 was a CPIF follow-on for peculiarization of 6 Agenas, with incentives on performance and cost. Pending completion of contract termination, we estimate LMSC will earn a fee gain of [redacted] on performance and break even on cost, with the following final fee situation (% is of actual cost):

Target fee	[redacted]	(5.2%)
Maximum possible fee		(11.2%)
Actual fee		(7.8%)

(11) None of the above LMSC CPIF contracts contained the new incentive structure described for GE [redacted].

<u>Barnes</u>

(12) White contract -666 was a CPIF contract for production of 17 model 155 sensors, with incentives on schedule and cost. The contract was terminated, and there was no fee gain/loss because of the incentives. Actual fee paid was [redacted] as set by the terminating contracting officer.

(13) White contract -840 was a CPIF contract for production of 20 model 151 sensors, with incentives on cost and schedule. Pending

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completion of contract termination, we estimate the following results:

Schedule	[redacted]	gain
Cost		gain
Total		gain

Final fee position will thus be (% is of actual cost):

Target fee	[redacted]	(3.5%)
Maximum possible fee		(8.4%)
Actual fee		(7.6%)

TRW

(14) White contract -841 was a CPIF contract for mission planning software, with incentive on cost only. This was a follow-on to earlier CPFF and FFP contracts. The contractor broke even on cost. The actual fee was thus the target fee of [redacted] which was 8.2% of actual cost.

(15) White contract -1014 was a CPIF follow-on contract to -841, but provided mission planning for both GAMBIT and G-3. The contract is still active. We estimate the GAMBIT portion of the work will break even on cost, and that the actual fee for GAMBIT will be the target fee of [redacted] which is 4.5% of cost.

6. **Listings**

The following pages contain listings of SAFSP contracts for GAMBIT and a summary of results of those which had incentive features.

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List of SAFSP GAMBIT Contracts

Number	Type	Secur	With	For	Life	Final Price	Fee Earned (% of actual cost)
PAYLOAD							
[redacted]	CPFF for 22 then CPIF	Black	EKC	Dev and Production of 45 payloads	Oct 60-Jul 67	[redacted]	(7.8%)
OCV							
-76	CPFF	White	GE	Dev, Prod and Launch of 6 OCV	Dec 61-May 64	[redacted]	(6.3%)
-155	CPIF	White	GE	Prod and Launch of 5 OCV	May 62-Sep 64	[redacted]	(5.8%)
-432	CPIF	White	GE	Prod and Launch of 11 OCV	Apr 63-Sep 65	[redacted]	(7.1%)
-580	CPIF	White	GE	Prod and Lnch of 20 OCV(part.term)	Mar 64-Jun 67	[redacted]	(2.7%)
-988	L/C	White	GE	Prod and Lnch of 3 OCV (term)	Mar 66-Mar 67	[redacted]	(7.6%)
[redacted]	CPFF	Black	GE	Mission Revealing work on 10 SVs	Dec 60-Sep 64	[redacted]	(6.4%)
	CPIF	Black	GE	Same, plus Incentives on Integration of 32 GFE S/I Cameras	Oct 63-Jun 67	[redacted]	(7.6%)
AGENA PECULIARS							
-92	CPFF	White	LMSC	10 Vehicles	Mar 62-Jun 64	[redacted]	(7.0%)
-506	CPIF	White	LMSC	12 Vehicles	Feb 64-Jun 65	[redacted]	(7.4%)
-670	CPIF	White	LMSC	13 Vehicles	Apr 65-Oct 66	[redacted]	(7.8%)
-874	CPIF	White	LMSC	6 Vehicles	Apr 66-Jun 67	[redacted]	(7.8%)
HORIZON SENSOR							
-503	CPFF	White	Barnes	Sensor Development	Nov 63-Apr 64	[redacted]	(7.6%)
-666	CPIF	White	Barnes	17 Model 155 Sensors	Sep 64-Nov 65	[redacted]	(7.0%)
-840	CPIF	White	Barnes	20 Model 151 Sensors	Apr 65-May 66	[redacted]	(7.6%)
-160	CPFF	White	EKC	1 Prototype and 4 Flight Models	May 62-Dec 64	[redacted]	(5.8%)

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List of SAFSP GAMBIT Contracts (Cont)

Number	Type	Secur	With	For	Life	Final Price	Fee Earned (% of actual cost)
SOFTWARE							
-145	CPFF	White	STL	Mission Planning	Apr 62-Jun 64	[redacted]	(7.2%)
-622	FFP	White	STL	Mission Planning	Jul 64-Jun 65	[redacted]	
-841	CPIF	White	TRW	Mission Planning	Jul 65-Apr 66	[redacted]	(8.2%)
-1014	CPIF	White	TRW	Mission Planning	Apr 66-Apr 67	[redacted]	(10.9%)
MISCELLANEOUS							
-438	CPFF	White	GE	Pad Modification	Aug 63-Oct 63(	[redacted]	
-749	FFP	White	AVCO	Angle Detector	Feb 65-Nov 65	[redacted]	
-757	FFP	White	Philco	Spiral Decay Study	Feb 65-Jan 66	[redacted]	
-895	FFP	White	[redacted]	D C Power Supply Failure Analysis	Sep 65-Nov 65	[redacted]	
-0014	CPFF	White	GE	Command Gen and Software	Dec 66-current	[redacted]	(8.2%)
[redacted]	FFP	Black	LMSC	Cutter/Sealer and Parts	Oct 64-Nov 65	[redacted]	
[redacted]	CPFF	Black	GE	Command Generation	Jul 65-Dec 66	[redacted]	(7.3%)
-533	CPIF	White	GE	Engineering Study	Jan 64-Jun 64	[redacted]	(7.0%)
-665	CPFF	White	EKC	VAFB support	12 Oct 64-curr	[redacted]	(8.4%)
RELATED WORK (Funded by GAMBIT)							
-790	CPIF	White	STL	Mission Optimization	20 Apr 65-20 Apr 66	[redacted]	(8.2%)
-573	CPFF	White	[redacted]	Low Altitude Study	9 Mar 64-27 Jul 64	[redacted]	(7.1%)

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Overall Fee Earnings

Principal SAFSP Contractors on Total GAMBIT Work

Contractor	No. of Contracts	Actual Cost ($ mil)	Actual Fee ($ mil)	Actual Fee (% of Actual Cost)
GE	10	[redacted]	[redacted]	5.6
EKC	3	[redacted]	[redacted]	7.7
LMSC	4	[redacted]	[redacted]	7.4
STL/TRW	4	[redacted]	[redacted]	9.2
Barnes	3	[redacted]	[redacted]	7.1
[redacted]	1	[redacted]	[redacted]	7.1
	26	[redacted]	[redacted]	6.1 (average)

Note: Above dollar figures represent all SAFSP GAMBIT contracts except five small FFP contracts.

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Attachment #5

COST DATA

1. The total program of [redacted] includes the following:

a. Thirty-eight satellite vehicles launched plus two complete for storage and two complete except for systems test. Additional parts for three systems are included. The cost does not include the long term storage of the excess hardware.

b. Forty payloads excluding a possible underrun of [redacted] recoverable in FY 1968 or 1969.

c. Forty-five Atlas boosters and launch services for thirty-eight launches. Five boosters have been reallocated to [redacted] but costed against GAMBIT. These have been removed from the unit cost recapitulation shown on the page referred to in paragraph 2.b., below. The launch services cost includes maintenance of capability at WTR until 30 June 1967.

d. Forty-five Agenas and launch services for thirty-eight launches. Five Agenas have been allocated to [redacted] and the costs have been treated the same as the Atlas costs, above. Forty sets of Agena peculiar equipment were procured.

e. Aerospace, mission planning, and general support costs include effort through 30 June 1967.

2. The following pages show:

a. GAMBIT cost summary by FY with line items as in monthly Financial Status Reports.

b. Non-recurring investment summary, unit cost for the development phase of 10 launches, and unit cost for the remaining units. Each line item shows the inclusive equivalent units.

c. Development cost by fiscal year. This information relates directly to that referred to in 2.a., above.

d. Flight cost per calendar year. This summary shows the cost in the calendar year of the flight and does not consider long lead funding.

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Attachment #6

CCN History of GE Contract [redacted]

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~~(S)~~ NATIONAL RECONNAISSANCE OFFICE

WASHINGTON, D.C.

[redacted]

THE NRO STAFF

— I think you will find this interesting ALF

19 September 1967

Yes. Jd

MEMORANDUM FOR DR. FLAX

SUBJECT: Summary Report of GAMBIT Program

STATEMENT OF THE PROBLEM

General Martin has submitted a summary of the GAMBIT program.

DISCUSSION

The highlights of the report are as follows:

General Martin's cover letter points out that:

(1) Most of the serious failures were associated with the GE equipment.

(2) The overall fee of 5.6% for GE versus the LMSC and EK fees of 7.4% and 7.7% reflects the GE problems.

(3) Four missions had ground resolutions [redacted] and 11 had resolutions approaching or equal to 2 feet.

[redacted] analysis summarizes the growth in capability as the system matured, the technical problems encountered, and the procurement aspects such as the incentive fee structure and costs.

Attachment #1 consists of a short project history.

Attachment #2 consists of 6 graphs:

Graph 1 - Targets per mission

Graph 2 - Average targets per mission by calendar year

Graph 3 - Acceptable versus planned days on orbit

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Graph 4 - Days prior to recovery versus planned days on orbit

Graph 5 - Actual (best) ground resolution by flight

Graph 6 - Costs per flight, per day, and per target

Attachment #3 is a summary of flight anomalies. A footnote concerning the last two missions explains that even though the missions had no major problems, GE did not get the maximum performance incentive for these flights because prior to the flights GE accepted the Government contracting officer's offer to score the flights at the average score awarded on the previous 13 flights.

Attachment #4 is primarily an analysis of the effect of the incentive contracts.

Attachment #5 tabulates the total costs.

Attachment #6 is the CCN history of GE Contract [redacted] which illustrates [redacted] comment (in paragraph 4d of his report) that the quantity of technical changes do not decrease as a space project becomes operational.

<u>RECOMMENDATION</u>

That you take note of this report.

Albert Johnson
ALBERT W. JOHNSON
Major, USAF

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DEPARTMENT OF THE AIR FORCE
OFFICE OF SPECIAL PROJECTS (OSAF)
AF UNIT POST OFFICE, LOS ANGELES, CALIFORNIA 90045

28 April 1970

REPLY TO ATTN OF: SP-1

SUBJECT: Analysis of Gambit (110) Project

TO: DNRO (Dr McLucas)

1. As you requested, the subject report is submitted as an analysis of Gambit (110), Flights 1 through 22, covering the same aspects as a previous report of Gambit (206).

2. I think you will consider the success this program has had with obtaining higher resolution photography and in reducing cost per target as quite acceptable. With the further increase in primary film capacity, dual recovery units and projected use of increased battery power and [redacted] you can expect some further improvements in these areas for the follow-on systems.

/S/

WILLIAM G KING, JR
BrigGeneral, USAF
Director

1 Atch
[redacted] Letter, subject as above, w/5 Atchs

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28 April 1970

FROM: [redacted]

SUBJ: Analysis of Gambit (110) Project

TO: SP-1

1. Purpose and Scope:

a. This paper analyzes the effectiveness of the recently completed Gambit (110) Project, Flights 1 through 22. The following parameters are addressed: Intelligence, Operations, Technical, Procurement and Costs.

2. Intelligence:

a. As for the missions associated with the 20 successful recoveries, [redacted] intelligence targets were programmed into the flight vehicles. Only 56.5%, [redacted], of the programmed targets were processed and readout into clear usable intelligence photography. The difference between targets programmed and targets readout was a result in some cases of operational problems causing pointing errors or degraded resolution, but most significantly, a result of target cloud cover.

b. As can be seen from Attachment 2 (Figures 1 and 2), the number of programmed and readout targets steadily increased. This was attributed to: (1) an increase in mission lifetime; (2) choosing launch times so as to take advantage of summer high sun angles to permit ascending, as well as decending photography; (3) a more accurate orbit drag prediction, thus decreasing the photography burst time and film used; (4) an increase in film quantity with the use of ultra-thin base film; (5) an increase in desired targets; and (6) improvements in software used for target selection.

c. In addition to the increase in target acquisition, there was also a trend of improvement in best ground resolution as shown in Attachment 2 (Figure 5). The increase in resolution was mostly a result of better optic materials, better optics polishing controls and better optics alignment and focusing procedures at the Eastman Kodak Company factory. A specification goal was set to achieve [redacted] resolution, while at 90 nm altitude, of a target with a two to one contrast ratio. This goal was achieved and slightly surpassed with the final mission, Flight 22, which had a best ground resolution of [redacted] determination.

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3. Operations:

a. Of the 22 missions attempted, 2 flights (Flights 5 and 11) were complete failures. Flight 5 did not reach orbit because the Titan IIIB Second Stage failed 16 seconds after start. The Flight 11 re-entry vehicle parachute deployment system failed during re-entry causing all of its filmed targets to be lost in the water.

b. Two systems were injected into orbit with far higher energy than planned. A ground guidance station problem at Vandenberg AFB resulted in a termination of ground guidance commands and permitted the Flight 18 Titan IIIB Second Stage to burn to depletion even after desired velocity had been reached. The Agena added its planned increase in velocity leaving the injection velocity and the apogee altitude far too high. Flight 18 had a later orbit adjust problem which caused an early mission termination on Day 7. Flight 19 injection velocity meter under-measured the change in velocity produced by the Agena main engine. The Agena burned to depletion. Apogee altitude was 598 nm. The specified maximum apogee altitude of 270 nm was more than doubled.

c. Other than the complete failures of Flights 5 and 11, and the early termination of Flight 18, the other flights were considered very successful. Although most of the 19 successful flights did have some flight hardware problems and operational constraints, Operations personnel were able to use redundant systems and change operating procedures to continue the missions until successfully completed.

d. The most significant operational details for each flight are given in Attachment 3. Some important flight data are given in Attachment 1, Table 1.

4. Technical:

a. Photographic Payload Section

(1) Camera-Optics Module

(a) During the conceptual phase of the Gambit (110) system, it was recognized that the large optics which provided the main performance improvement over the previous Gambit (206) program would provide the most serious manufacturing and testing challenge. Initial attempts to introduce unconventional manufacturing techniques and substrates for the large reflectors failed, resulting in dependence on conventionally polished [redacted] fused silica reflectors. Two important developments resulted in the successful employment of the conventional techniques: interferometer testing and selectro-plating. By using the interferometry to draw a map of the surface errors in the reflective pieces, and the selectro-plating to fill in the surface where indicated by the interferometry, the overall surface irregularities could be reduced to specified value. System assembly and testing showed steady improvement

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from the first unit on. By Flight 18, both the optical components and the assembled camera-optics module were being produced at or very near specification quality.

(b) A persistent problem with primary camera drive smoothness was present on all units in the form of fine corduroy banding at 250 Hz on the primary photography. Performance loss due to this lack of smoothness was calculated to vary from none to 30% loss of resolution. A satisfactory fix has not been determined.

(2) Satellite Re-entry Vehicle (SRV)

(a) The SRV employed on Flight 11 failed to deploy its main parachute and was lost in the recovery zone near Hawaii. Failure investigation did not pinpoint the failure cause, but weaknesses in design were discovered and corrected in the area of the thermal cover bridle and its deployment system. (A similar failure on Flight 25 second SRV in the subsequent double bucket series indicated that the true failure may have been inadequate design of the thermal cover ejection system for the flight environment encountered. It appears that the solution is to deploy the thermal cover earlier.) The SRV was essentially the same as the Gambit (206) model, and except for the catastrophic failure on Flight 11, the SRV operated well.

(3) Electromechanical Hardware

(a) Except for minor random failures, the electromechanical (non-optical) portions of the photographic payload section performed reliably. No major problems were encountered in deployment.

(4) Post Flight Evaluation of System Performance

(a) While post flight measures of photographic quality showed a parallel improvement with the improvements in optical quality shown by factory test, a performance, or resolution, gap appeared to exist between the levels of the two. On some flights, this gap was as much as 60% of the factory predicted resolution. Two possible causes of the resolution gap were investigated: hardware malfunction between factory test and flight and inadequate analytical modeling of system performance. These two possibilities were explored in parallel, with no firm conclusions reached at the end of the series.

b. Satellite Control Section (SCS)

There were no major technical problems associated with the SCS in the Gambit (110) program. The hardware was essentially a continued production to that used on the Gambit (206) program. The inadequate design and quality control problems which were corrected on Gambit (206) were successfully carried through on Gambit (110). Most of the technical effort on this program was directed to enhancing the reliability of the hardware and adding a Redundant Attitude Control System (RACS) on

Vehicle 16. This improvement had the capability of providing redundancy to the Primary Attitude Control System (PACS) for on-orbit vehicle attitude control only. The availability of RACS proved extremely fortunate: on Flight 17 PACS failed and RACS was activated on Rev 40 and operated successfully for the remainder of the flight; on Flight 20 PACS failed and RACS was activated on Rev 52 and operated successfully for the remainder of the flight.

c. Roll Joint (RJ)

The original RJ used on Vehicles 1 through 11 used a belt drive with a brushless motor for the primary servo system. Redundancy was provided by a second brush-type motor which could be irreversibly engaged but which would also drive the primary motor and belt if used. Capability of the RJ was 1,250 rolls at a roll rate of [redacted] degrees/second. For Vehicles 12 through 15 the servo systems were changed to two brush-type motors with friction drive. To provide a fully reversible dual system, the friction drive engage mechanism was changed from a spring loaded pyro activated device to spring loaded, electrical linear actuators. Capability was extended to 2,250 total rolls with an average roll rate of [redacted] degrees/second. For Vehicles 16 through 22 the redundant drive motor was replaced with a new design "long-life" motor. With a new Servo Electronics Assembly, including an inverter, the redundant system could now operate on unregulated power. The primary purpose for these changes to the redundant system on Vehicle 16 was to gain flight experience on one of the two "long-life" (7,000 roll capability) servo systems which would be effective on Vehicle 23.

5. <u>Procurement</u>:

a. Of the approximate total of [redacted] cost for Gambit (110) [redacted], was contracted directly by Special Projects for the satellite system and related support. Procurement of the remainder was handled by Space and Missile Systems Organization (SAMSO) for the booster system and related support. Funds were provided to SAMSO by SAFSP.

b. Five of the program's major contracts implemented a novel incentive fee arrangement personally developed by Major General John Martin, Jr for use on satellite systems. His paper entitled, "A Specialized Incentive Contract Structure for Satellite Projects" has become the established incentive guide for satellite programs. His approach emphasizes vehicle system performance, with cost and schedule trade-offs.

c. Details of the program contractual arrangements are contained in Attachment 4.

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6. Cost:

a. As of 1 April 1970, the Gambit (110) project, Flights 1 through 22, had cost [redacted]. Final contract settlements over the next few years may cause minor changes in this amount.

b. Of the [redacted] was determined as recurring cost for the 22 flights. An estimate of individual flight recurring cost by calendar year was made in an effort to show the trend of decrease in cost per mission day flown and also the decrease cost per clear target readout. Because of long lead funding, the recurring cost attributed to a calendar year of flights may not have been funded during the calendar year in which the launches occurred. Because of overlapping contract periods, recurring costs were divided between those associated with the first six flights and those associated with the last sixteen flights. Recurring cost of the [redacted], Redundant Roll Joint System and Redundant Attitude Control System were not effective until Flights 10, 12 and 16 respectively. Recurring cost by calendar year then followed by adding recurring cost of those flights launched during a calendar year.

c. From the supporting attachments the following data of Table C-1 was gathered so as to determine the succeeding data of Table C-2.

TABLE C-1

Calendar Year	No. of Flights	No. of Primary Mission Days Flown	Clear Targets Readout	Recurring Cost	Total Cost
1966	3	20	[redacted]	[redacted]	
1967	6 + 1*	59			
1968	7 + 1*	67			
1969	4	40			
Total	22	186			[redacted]

All costs are in [redacted]
* Mission Failures

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TABLE C-2

Calendar Year	Cost per Flight	Cost per Mission Day	Cost per Clear Target Readout
1966*	[redacted]		
1967*			
1968*			
1969*			
22 Launch Average**			

All costs are in [redacted] dollars

* Recurring cost only
**Total Cost

Most significant from the above data is that the cost per target was constantly going down to an average in calendar year 1969 of about [redacted] per clear target readout. Fortunately, costs per target of Gambit (110) were far more favorable than for Gambit (206) which considered for the majority of cases, targets recovered rather than cloud free targets. (Reference report to SP-1, "Analysis of Gambit Project" dated 24 August 1967.)

d. More detailed recurring and non-recurring cost data are included in Attachment 5. Costs per flight, per mission day and per clear target readout by calendar year are charted on Attachment 2, Figure 6.

7. Summary:

The Gambit (110) project, Flights 1 through 22, was highly successful in that:

a. Its capability of obtaining high resolution photography was good from its beginning and was continually bettered until its conclusion to the point only considered possible at its onset.

b. With the cost inflation of wages and materials, its cost per mission day and cost per filmed target continued to decrease.

c. The record of successful missions completed even if not perfect, was outstanding.

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d. Action was taken to add features to increase reliability such as the Redundant Attitude Control System which proved to be required on Flights 17, 18 and 20. Action was taken to increase capability as in the case of technical improvements with the optics system.

[redacted]

5 Atchs
1. Project History
2. Graphs
3. Flight Brief
4. Procurement Data
5. Cost Data

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Following is a narrative description of each contract and the results thereof:

Lockheed Missiles and Space Company

a. AF-619 (White) Covered the design, development test and production of the peculiarization of the first six SS-01B Standard Agena vehicles into GAMBIT Satellite Control Section (SCS) vehicles. Originally negotiated as a conventional cost-plus-incentive-fee contract, it was changed to incorporate the above "Specialized Incentive" structure prior to the first launch. Target fee was [redacted] equal to 13.8 percent of target cost. (The target fee was reduced from 15 percent due to non-vehicle related changes I.E. AGE and STE) No schedule incentive was used. Cost incentive was negative only, shared at a ratio of 85/15 up to 9 percent of target cost. All six of the vehicles were scored at 100 percent success. The contract experienced a cost penalty of [redacted] due to an overrun of [redacted] (equal to 6.8 percent of target cost). As a result the contract final fee is [redacted] equal to 13.0 percent of target cost.

b. [redacted] covered design development test and production of the first six roll joints (PAS) and was also originally negotiated as a conventional cost-plus-incentive-fee contract with conventional cost, schedule and performance arrangements. However, concurrent with the change in AF-619 the "Specialized Incentive Contract Structure" was implemented. The same performance and cost parameters as those on AF-619 were used. Vehicle performance was identical to AF-619. The contract experienced an overrun of 17.6%. As a result the final adjusted fee rate was 10.44 percent. Final fee is as follows:

Target fee [redacted]
Actual fee

c. Contracts AF-896 (white) and [redacted] (black) were originally negotiated as sustaining follow-on effort for peculiarization of sixteen additional SS01B Standard Agena vehicles into GAMBIT SCS vehicles and roll joints (PAS's), respectively. However, the contracts were amended to include the development (non-recurring) effort associated with longer life, redundant capability vehicles to be flown on subsequent contracts.

(1) AF-896 originally covered engineering, manufacturing, test and launch support of sixteen SCS vehicles. Later the changes were added for long life development, SGLS, RACS & DACS. The same incentive structure as AF-619 was used, with the addition of a schedule incentive penalty of one-half percent of target cost up to a maximum [redacted] applied at [redacted] per day. Cost incentive penalties applied over a range up to 9% of target cost. Cost sharing ratios of 90/10 from 9%-15% over target cost, 80/20 from 16%-30% and 70/30 from 31 to 45% were applied. Actual results were 100% vehicle performance, schedule penalties of [redacted] and a cost penalty of [redacted] actual results were:

Target fee [redacted]
Final fee

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(2) [redacted] produced sixteen PAS's (roll joints) and all development and non-recurring effort for the long life redundant capability. The identical incentive fee parameters as AF-896 were employed. An overrun of 1% was incurred. All vehicles were on schedule and 100% successful performance was scored. Actuals were:

Target fee
Final fee
[redacted]

General Electric Light Military Electronics Department, Later: Aerospace Electronics Department

a. Contracts AF-594 and AF-897 (both white) covered the development and production efforts of the vehicle Command Subsystems including STE, AGE and facilities.

(1) AF-594 was negotiated as a CPIF with cost and schedule parameters. Under this incentive arrangement the contractor shared cost variances from target cost up to plus or minus 5% at the ratios of 85/15. Target fee was 8.0%. The contractor could earn as much as 13% or lose down to 3%, respectively, for underruns or overruns to a maximum gain/loss of [redacted]. Schedule incentive was a penalty of [redacted] for the first unit and [redacted] for each subsequent flight unit up to a maximum of [redacted]. All six flights were flown at 100% success. Pending completion of determination of final costs the following are the estimated fee results:

Target fee
Cost Penalty
Schedule Penalty
Net loss
Net fee
[redacted]

(2) AF-897 was negotiated as a CPIF-P contract utilizing the "Specialized Incentive Contract Structure" of 15% for performance and covered flight units 10 through 25. Of the sixteen flights flown, fourteen were scored at 100% success. Of the two units flown with anomalies, Flight 7 was scored at [redacted] penalty points and Flight 16 at [redacted] penalty points resulting in a total fee loss of [redacted]. Cost incentives were negative only and had sharing ratios of 90/10 up to 15% over target cost, 80/20 from 16 to 30% and in excess of 30% to a maximum of [redacted]. Schedule and combined system test penalties of minus 1% respectively were applied to each unit to a maximum of [redacted] for each parameter. Flight unit 13 experienced a system test failure of [redacted]. No schedule penalties were experienced. Pending completion of final cost, the following are the final results: ($ earned)

Target fee
Par Performance
Adjusted Performance
C/ST Failure (loss)
Cost (loss)
Net fee
[redacted]

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General Electric - Re-Entry Systems Department

a. Black contract [redacted] covered the production of SRV's 6 thru 22. (All development work and flight models 1 through 5 was accomplished on a subcontract basis under prime contract AF-2108 with Eastman Kodak.) The contract was a FPIF contract with cost and delivery incentives. Cost ceiling was 11.7% with sharing of 70/30. Schedule incentive was 1% of target cost over 4 weeks, shared at the rate of 10% for the week 1, 25% for week 2, 30% for week 3 and 35% for week 4. The contractor experienced an overrun of [redacted] and all deliveries were on time. Final results are:

Cost
Fee
Price [redacted] (fee loss of [redacted])

General Electric - Spacecraft Department

a. White contract AF-693 was a CPIF contract for mission planning software. Cost share ratio was 85/15. The contract target fee was [redacted] 8.5% of target cost. Final fee was increased to [redacted] due to an underrun.

b. White contract [redacted] was a CPFF contract for mission planning software with a fixed fee of [redacted] equivalent to 8.3% of final estimated cost.

c. White contract [redacted] is a CPFF follow-on contract to [redacted] to provide continuing software support. The contract is still active. The fixed fee is [redacted] 8.6% of estimated cost.

d. White contract AF-636 was a CPIF contract with target cost of [redacted] and cost incentives only at a sharing ratio of 86/14. The effort was for a SCS parallel study. The target fee was increased by an underrun and the final fee amount was [redacted] to 8.2%.

TRW, Inc.

a. White contract [redacted] was a CPIF contract, with cost incentives only and a sharing ratio of 75/25, to provide mission planning software for earlier versions of GAMBIT vehicles. The contract remained active over the transition from the earlier versions. Target fee was [redacted]. The final adjusted fee is expected to be [redacted] as a result of reduction due to an overrun.

b. White contract [redacted] was a CPIF follow on to [redacted]. Cost incentives only were applied at the ratio of 75/25. Target fee was [redacted]. Actual fee is expected to be [redacted] when final rates are established and the contractors underrun computed.

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Eastman Kodak

Contract [redacted] covered development, test production and launch support for Photographic Payload Section vehicles number one through twenty-two including facilities, STE, AGE and launch support. The first five SRVs were included in this contract on a subcontract basis with GE-RSD. The contract effort also included design, development and test of the follow-on Dual-Recovery version PPS. A CPFF contract was negotiated at a fixed-fee rate of 7.7%. Final fee is expected to be [redacted], equivalent to 6.18% of final estimated cost.

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LIST OF SAFSP GAMBIT CONTRACTS

NUMBER	TYPE	SECURITY	WITH	FOR	LIFE	FINAL PRICE	FEE EARNED (% OF ACTUALS)
AF-619	CPIF-P	(White)	LMSC	Des. Dev. & Prod 6 SCS	Jul 64-Aug 67	[redacted]	13.0
[redacted]	CPIF-P	(Black)	LMSC	Des. Dev. & Prod 6 PAS	Jul 64-Aug 67	[redacted]	10.4
AF-896	CPIF-P	(White)	LMSC	Des. Dev. & Prod 16 SCS (includes: SGLS, DRM, FACS, RACS.)	Jan 66-Dec 69	[redacted]	13.9
[redacted]	CPIF-P	(Black)	LMSC	Des. Dev. & Prod 16 PAS	Jan 66-Jul 69	[redacted]	14.5
AF-594	CPIF-PV	(White)	GE-LMED	Des. Dev. & Prod 9 C/SS	May 64-Aug 67	[redacted]	4.4
AF-897	CPIF-P	(White)	GE-AED	Des. Dev. & Prod 22 C/SS	Nov 65-Aug 68	[redacted]	13.3
[redacted]	FPIF	(Black)	GE-RSD	Recurring 17 RSVs	Dec 65-Jul 69	[redacted]	10.4
[redacted]	CPFF	(Black)	EKC	Des. Dev. & Prod 22 PPS	Mar 64-Dec 69	[redacted]	6.2
[redacted]	CPIF	(White)	TRW	Software	Apr 66-Dec 67	[redacted]	10.8
[redacted]	CPIF-V	(White)	TRW	Software	Jan 68-Nov 69	[redacted]	10.9
AF-693	CPIF-V	(White)	GE-Spacecraft	Software	Sep 64-Feb 67	[redacted]	9.2
[redacted]	CPFF	(White)	GE-Spacecraft	Software	Jul 68-Current	[redacted]	8.6
AF-0014	CPFF	(White)	GE-Spacecraft	Software	Dec 66-Jul 68	[redacted]	

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LIST OF SAFSP GAMBIT CONTRACTS (Con't)

NUMBER	TYPE	SECURITY	WITH	FOR	LIFE	FINAL PRICE	FEE EARNED (% of ACTUALS)
MISCELLANEOUS							
AF-636	CPIF	(White)	GE-ASPD	SCS Parallel Study	Jul 64-May 65	[redacted]	8.2
[redacted]	CPFF	(Black)	Perkin-Elmer	Glass Polishing	Oct 66-Sep 68	[redacted]	7.8
Related Work:							
[redacted]	CR	(Black)	[redacted]		Jul 66-Current	[redacted]	0
[redacted]	CPFF	(Black)	LMSC	[redacted]	Aug 66-May 69	[redacted]	8.2
[redacted]	FFP	(Black)	Sylvania Corp	[redacted]	Apr 67-Sep 69	[redacted]	N/A
[redacted]	FFP	(Black)	Sylvania Corp	[redacted]	Aug 66-Current	[redacted]	N/A

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OVERALL FEE EARNING

PRINCIPAL SAFSP CONTRACTORS ON TOTAL GAMBIT WORK

CONTRACTOR	NO. OF CONTRACTS	ACTUAL COST	[redacted]	ACTUAL FEE (% OF ACTUAL COST)
LMSC	5	[redacted]	[redacted]	12.3
GE	7			8.3
EKC	1			6.2
TRW	2			9.8
OTHERS	4			.02
	19			8.84 (average)

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ATTACHMENT 1

PROJECT HISTORY

1. As was the Gambit (206) project, Gambit (110) was managed entirely by SAFSP, which had responsibility for development, production and operation of all system components. With this span of responsibility, SAFSP was able to coordinate efforts towards obtaining increasingly better resolution photography. The final Gambit (110) mission obtained a best ground resolution by [redacted] target determination of [redacted]. Gambit (110) initial development began in March 1964, approximately 28 months before the first Gambit (110) flight of July 1966. The success of Gambit (110) project brought about the termination of Gambit (206) project which had its thirty-eighth and last flight in June 1967.

2. The launch system configuration of the Gambit (110) project differed considerably from that of the Gambit (206) project. Major launch system changes incorporated at the onset of Gambit (110) were:

a. The two-stage Titan IIIB was the booster for ascent from the pad.

b. A roll joint was used between the payload and the Agena stage. In this configuration, the payload and Agena orbited together throughout the mission with roll joint movements as required for photographs in track or either side of track. The Agena was the orbit control vehicle or Satellite Control Section, as well as the orbit injection booster.

c. The Gambit (110) Photographic Payload became a separate section which adapted to the Agena (Satellite Control Section). This configuration differed very much from the earlier Gambit arrangement in which the payload fit within the orbital control vehicle. The Gambit (110) optics were arranged to achieve a focal length of 160 inches, a change from 77 inches for the Gambit (206) system.

d. The "factory-to-pad" concept became a reality with Gambit (110). The Titan IIIB booster, Agena with roll joint, and photographic payload section were shipped separately to Vandenberg AFB and assembled on the launch pad. This required more thorough testing at the "factory" before shipment and reduced the testing and hardware changes required at Vandenberg AFB.

3. Two important changes made during the deployment of Gambit (110) were:

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a. The primary film was changed from a thin base to an ultra-thin base which increased the film capacity from about 3,000 feet to about 5,000 feet. Ultra-thin base film was used on Flights 3 through 22.

b. A Redundant Attitude Control System (RACS) was first flown and tested during solo flight or Flight 16. Fortunately, the RACS was included on all subsequent Agena vehicles and was necessarily used during the primary portion of Flights 17, 18 and 20.

4. Principal components and their manufacturers were:

Payload	EKC
Re-entry Vehicle	GE/RESD
Agena Stage	LMSC
Command Subsystem	GE/AE
Titan IIIB	Martin Marietta

5. During the life of the project, these were the key personnel:

a. DNRO:

Mar 64 - Sep 65	Dr B. McMillan	Initial Development
Sep 65 - Mar 69	Dr A. H. Flax	Development, Flights 1 through 20
Mar 69 - Conclusion	Dr J. McLucas	Flights 21 and 22

b. Director of Special Projects

Mar 64 - Jul 65	MajGen R. Greer	Initial Development
Jul 65 - Conclusion	MajGen J. Martin, Jr	Development, All Flights

c. Program Director

Mar 64 - Sep 66	Col W. King, Jr	Initial Development, Flight 1
Sep 66 - Jun 68	Col [redacted]	Flights 2 through 14
Jun 68 - Conclusion	Col [redacted]	Flights 15 through 22

6. The following Table 1 contains some important data about each of the 22 Gambit (110) flights.

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ATTACHMENT 2

GRAPHS

Figure	Title
1	Programmed Targets by Mission
2	Average Targets per Mission by Calendar Year
3	Actual vs. Planned Orbital Lifetime by Mission
4	Acceptable vs. Planned Orbital Lifetime by Mission
5	Best Ground Resolution [redacted] by Mission
6	Costs per Flight, Day and Target by Calendar Year

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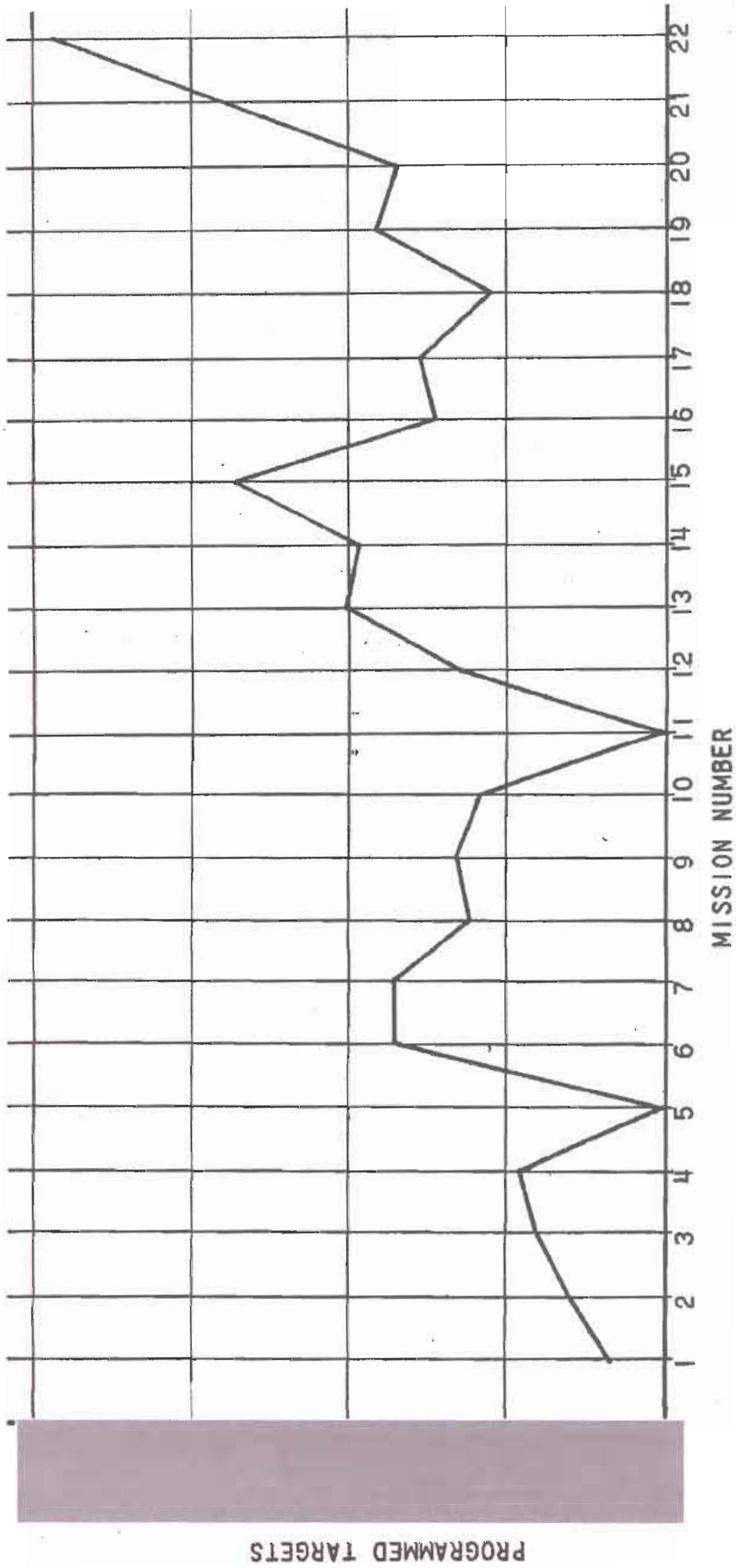

Figure 1 TOTAL PROGRAMMED TARGETS BY MISSION

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ATTACHMENT 5

GAMBIT (110) COST DATA - VEHICLES 1-22

1. The total program of [redacted] includes the following:

a. Twenty-two satellite vehicles, boosters, Agenas, payloads, and recovery vehicles launched. Some vehicles are configured with RACS [redacted] and Redundant Roll Joints with effectivities as indicated.

b. Titan IIIB costs include the [redacted] allocated directly to the Titan SPO for development of the booster, required pad modifications, and payment for the first booster/Agena and their associated launch costs.

c. Command Subsystem costs include twenty-two flight systems and nine spares.

d. Aerospace, Mission Planning and General Support costs include effort through the final launch of Vehicle 22 (June 1969).

e. Although non-recurring investment costs are segregated in total on the contracts, they are not segregated by fiscal year. The allocation shown is based on the best judgment of the Program Office.

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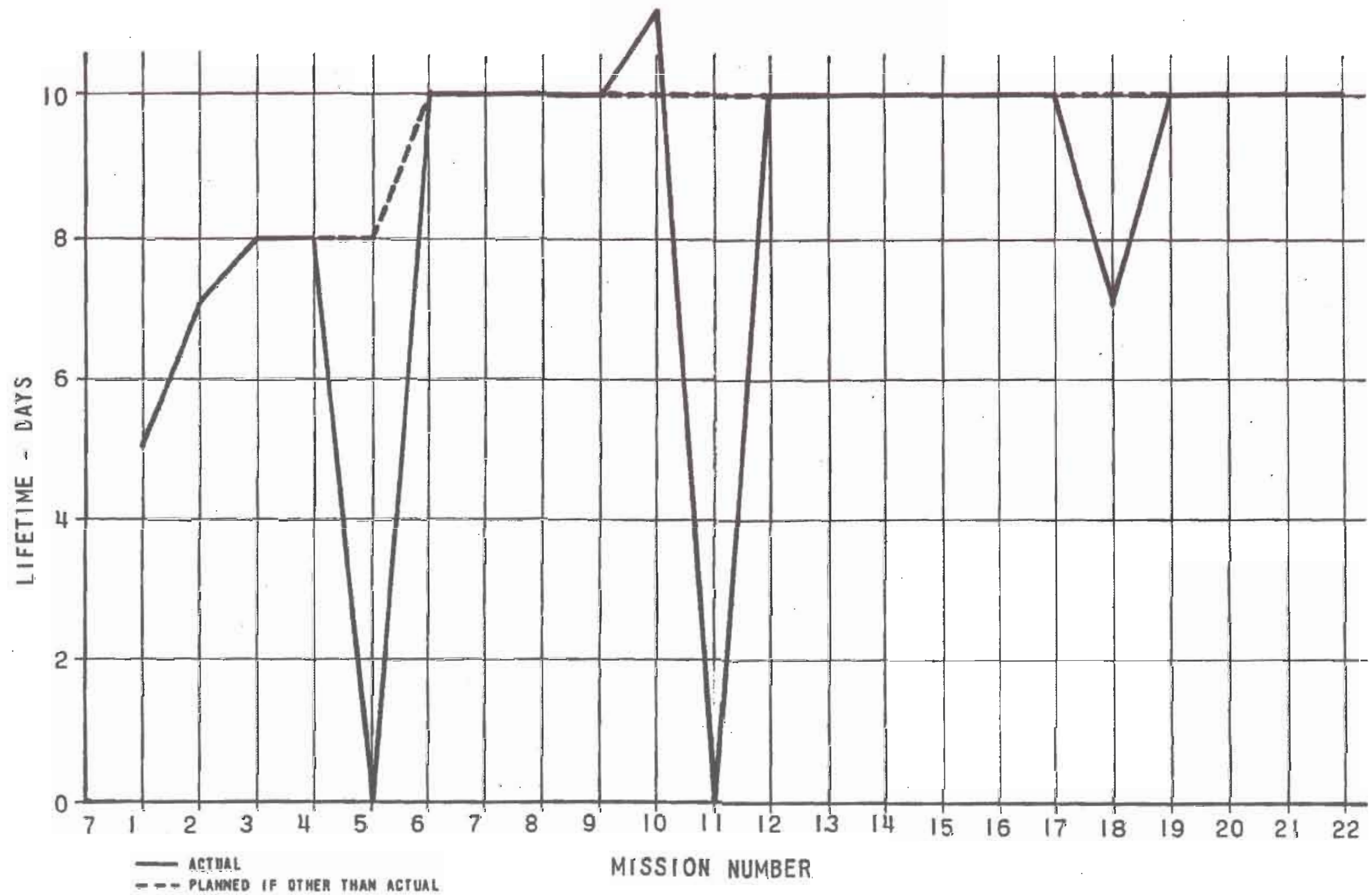

Figure 3 ACTUAL vs PLANNED ORBITAL LIFETIME BY MISSION (SOLO MISSION NOT INCLUDED)

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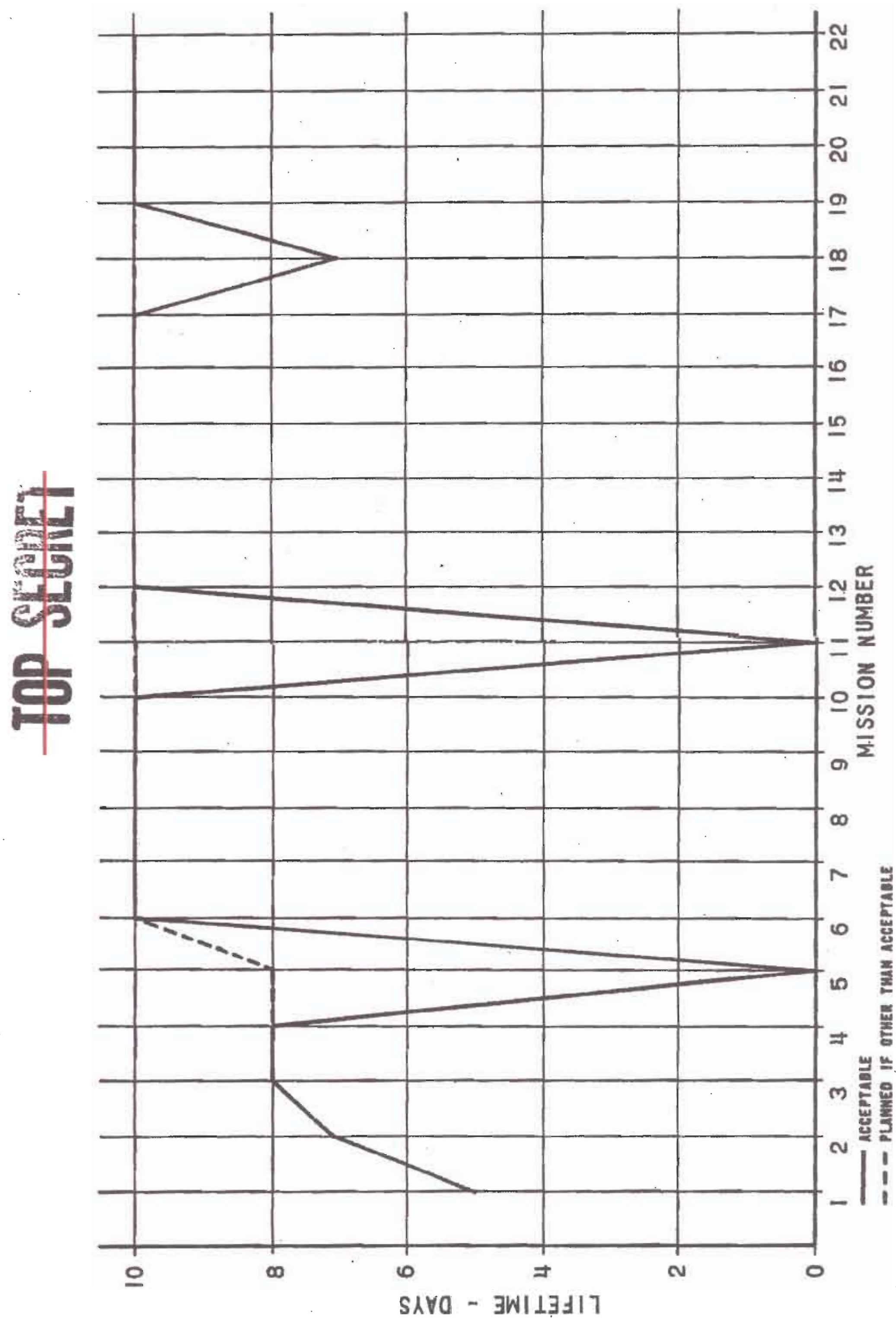

Figure 4 ACCEPTABLE vs PLANNED ORBITAL LIFETIME BY MISSION
(SOLO MISSION NOT INCLUDED)

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TABLE 1

GAMBIT (110) FLIGHT DATA

FLIGHT NO.	LAUNCH DATE	LAUNCH TIME (GMT)	INCLINATION (DEGREES)	APOGEE/PERIGEE AFTER INJECTION (NM)	RECOVERY REV	RECOVERED	DEBOOST REV	TARGETS PROGRAMMED	TARGETS READOUT	BEST RESOLUTION (INCHES)	PRINCIPAL PROBLEMS DURING OPERATION
1	29 Jul 66	1830	94.15	150.33/84.43	83	Yes	130	[redacted]	[redacted]	[redacted]	APTC shutter malfunction (APC intermittent); Slit position fixed (No. 4); RJ constrained, ± 35°
2	28 Sep 66	1907	94.0	176.07/83.93	115	Yes	147	[redacted]	[redacted]	36	APTC disable prior to flight (erratic behavior of advance mechanism)
3	14 Dec 66	1814	109.5	221.95/82.64	131	Yes	162	[redacted]	[redacted]	[redacted]	ECS command system problem, memory channel 22, Revs 28-31; APTC (APC shutter, intermittently stuck open)
4	24 Feb 67	1959	107.0	231.2/76.90	131	Yes	163	[redacted]	[redacted]	27	APTC (APC shutter failed in open position, Rev 46)
5	26 Apr 67	1800	-	-	-	No	-	[redacted]	[redacted]	-	Titan IIIB Second Stage failure (Δ V 8,000 fps low); Failed to obtain orbit
6	20 Jun 67	1615	111.42	196.15/75.21	164	Yes	165	[redacted]	[redacted]	[redacted]	Titan IIIB Second Stage skirt failure (Δ V of 88 fps low); RJ positioning error, Rev 64, certain angles were unattainable to end of flight
7	16 Aug 67	1707	111.58	252.91/79.95	163	Yes	195	[redacted]	[redacted]	[redacted]	Primary RJ release failed (B/U system functioned properly); ECS failure (delay line 12, Rev 39; delay line 11 intermittent, Revs 62-65)
8	19 Sep 67	1837	106.12	241.97/70.93	163	Yes	164	[redacted]	[redacted]	[redacted]	None
9	25 Oct 67	1915	111.56	243.70/74.21	163	Yes	164	[redacted]	[redacted]	[redacted]	Film handling system stalled (primary, Rev 155, Loss 200')
10	5 Dec 67	1845	109.57	248.90/77.09	178	Yes	179	[redacted]	[redacted]	[redacted]	SCS pitch valve intermittent failure to fire, Rev 103; ECS Decoder 2 failure, Rev 163; TC failure, Rev 37

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TABLE 1
Page 2

GAMBIT (110) FLIGHT DATA (Con't)

FLIGHT NO.	LAUNCH DATE	TIME (GMT)	INCLINATION (DEGREES)	APOGEE/PERIGEE AFTER INJECTION (NM)	RECOVERY REV	RECOVERED	DEBOOST REV	TARGETS PROGRAMMED	TARGETS READOUT	BEST RESOLUTION (INCHES)	PRINCIPAL PROBLEMS DURING OPERATION
11	18 Jan 68	1904	111.54	241.12/70.90	163	No	274	[redacted]	[redacted]	-	SRV parachute deployment system failed
12	13 Mar 68	1951	99.87	235.94/73.26	163	Yes	164	[redacted]	[redacted]	[redacted]	TC failed, Rev 4
13	17 Apr 68	1700	111.50	246.25/73.84	163	Yes	196	[redacted]	[redacted]	[redacted]	None
14	5 Jun 68	1733	110.55	251.11/69.89	163	Yes	196	[redacted]	[redacted]	[redacted]	Tape recorder failed, Rev 66
15	6 Aug 68	1630	110.0	250.60/69.36	162	Yes	163	[redacted]	[redacted]	[redacted]	TLM Ch 10 and 11 failed. Rev 9; [redacted] Rev 76; TC shutter failure
16	10 Sep 68	1830	106.0	235.81/70.77	163	Yes	238	[redacted]	[redacted]	[redacted]	Extended Command System failed on Rev 124
17	6 Nov 68	1910	106.0	224.32/72.71	163	Yes	212	[redacted]	[redacted]	[redacted]	PACS right head horizon sensor failed, Rev 38; RACS took over on Rev 41
18	4 Dec 68	1923	106.20	405.97/75.47	111	Yes	127	[redacted]	[redacted]	[redacted]	Ground guidance problem, Titan IIIB Second Stage burn to depletion; SPS single engine burn, Rev 93
19	22 Jan 69	1910	106.153	597.08/74.76	161	Yes	181	[redacted]	[redacted]	[redacted]	V/M failed, Agena burned to depletion; ECS Decoder 2 failed to execute PSPC's
20	4 Mar 69	1930	92.027	253.68/73.62	161	Yes	224	[redacted]	[redacted]	[redacted]	PACS failure, Rev 52 (Thrust valve); APC failure, Rev 24
21	15 Apr 69	1730	108.78	261.55/74.76	163	Yes	244	[redacted]	[redacted]	[redacted]	Ground guidance problem, slight inclination error; ECS Decoder 2 relay driver failed open; RACS failure, Rev 217
22	3 Jun 69	1649	110.03	239.07/75.36	163	Yes	179	[redacted]	[redacted]	[redacted]	None

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LMSC/B115417

SECTION 1

SYSTEM PERFORMANCE

A. MISSION OBJECTIVES

The first flight vehicle of Program 206-II consisted of the booster SLV-5B/66-8131, satellite control section (SCS) 58205/4751, and a forward satellite vehicle section (FSVS). The forward section included a recovery capsule.

The planned mission was as follows:

a. Five days of stable orbit operation with recovery on orbit 83.

b. Three days of solo operation to exercise the SCS, including yaw around maneuvers, secondary propulsion system (SPS), main engine deboost, and orientation via the backup stabilization system (BUSS).

B. FLIGHT RESULTS

The mission was accomplished according to plan, and all objectives associated with the SCS were met.

The vehicle was launched from PALC-2 Pad 3 at the Western Test Range on 29 July 1966 at 1130:19.81 PDT on the second countdown. The initial countdown on 28 July 1966 was aborted at T-1 minute because of a test fault indication at the WECO ground guidance station.

The velocity at Stage II shutdown was low by 8.8 ft/sec., due to a slightly early shutdown command from the WECO guidance system. The Agena velocity gained was 8634.53 ft/sec., 0.9 ft/sec. higher than the velocity meter setting. Attitude discrepancies existed in the SLV-5B and in the SS-01B, but the cumulative result gave a near-nominal trajectory.

All telemetry channels displayed two short data loss periods during Stage II ignition, one loss for 450 milliseconds and another for 105 milliseconds, separated by 85 milliseconds of data. Two unexplained data dropouts occurred at 318.46 seconds and 325.13 seconds from liftoff.

The tracking and S-band commanding was satisfactory with the exception of lower than normal signal strength after two days on orbit and some intermittent break-up of the S-band beacon pulses as received by the ground radar. These anomalies did not affect tracking or commanding.

An aerial recovery of the capsule was made on orbit 83.

During the three days of solo operations, three yaw-around maneuvers were made, and three SPS burns were accomplished.

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LMSC/B115417

On orbit 130 deboost was accomplished with the main engine.

Following deboost, orientation via the BUSS to the local magnetic vector was successfully accomplished.

C. CONCLUSIONS

The operation was conducted according to plan and all objectives were accomplished. The problems encountered did not degrade the mission.

D. RECOMMENDATIONS

1. Full advantage should be taken on future flights of the opportunity to accumulate additional data on performance of the Secondary Propulsion System during solo flight.
2. Conduct a study and test program on the susceptibility of the S-band RF cable assemblies to define the leakage mechanism.
3. Monitor future operations closely to obtain good time correlation of any S-band anomalies regarding signal strength and beacon characteristics.
4. Record vehicle time along with other recorded data by the vehicle tape recorder.
5. Efforts should continue to evaluate the possible cause and analyze the effects of the vehicle motion during the period between SECO and Stage II-Agena separation.

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Lockheed
MISSILES
& SPACE
COMPANY

REGINALD R. KEARTON
VICE PRESIDENT

November 13, 1966

Dear Al:

The attached paper is the result of our hindsight look at Program 206-II which we recently discussed. For your information, I have discussed this paper with John Martin and have given him a copy of same.

I hope it will be of some use to you, as I am sure it will help us.

Sincerely,

The Honorable A. H. Flax
Assistant Secretary of the Air Force
(Research and Development)
The Pentagon
Washington 25, D. C.

(Attach.)

1997 00 76 B-1 E-11

A GROUP DIVISION OF LOCKHEED AIRCRAFT CORPORATION

SUNNYVALE, CALIFORNIA

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MAJOR FACTORS CONTRIBUTING TO PROGRAM 206-II SUCCESS

It was believed that a useful purpose might be served in a hindsight review of the factors which contributed to the early success of the Program 206-II.

Preliminary examination indicated two broad categories of influence, i.e., intangible and tangible factors. It should be noted that the term intangible might be defined as discernible but hard to quantify factors which represented the subjective judgment of the contractor. The tangible, on the other hand, were those elements which would be easy to quantify and which any viewer would be unlikely to refute.

First of the intangibles were:

- The amount and nature of the cooperation between the Air Force System Program Office (SPO), including the Aerospace Corporation support, and the LMSC Program Organization.
- The contractor program office which had made available to it an abundance of appropriately experienced personnel, together with a degree of projectization which was effective through the delegation of necessary authority.
- A carefully devised incentive contract biased toward technical performance which resulted in a powerful management tool for motivation of all employees associated with the program to promote early and continued success.

A discussion of these factors follows:

1. From the beginning of the program there has existed a stable and tight SPO/LMSC relationship which has led to a very high level of mutual trust and confidence in the technical administration of this program. Effectiveness of the relationship has been aided by the tight change control on the general systems specification which had no significant changes after the first six months of the program. Problems, when first identified, have been given prompt attention by the Air Force/Aerospace/LMSC team, thus allowing timely resolution. Examples are such problem areas as the Command Programmer and the SCF software. These represented significant program features which were GFE to LMSC, which required and got decisive Air Force/Aerospace action.

2. This whole environment was aided by the LMSC choice of experienced key personnel who were given adequate authority to perform their job. As a result of the LMSC management trainee concept on programs extant at the initiation of 206-II, such as Standard Agena, 206-I, 241, and others, properly trained people were provided at no detriment to the existing programs. The physical co-location of all concerned LMSC elements led to de facto total projectization in all parts of the program. These circumstances were further aided by the LMSC program management concept of delegating cost, schedule, and technical responsibility for end-item segments.

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In this approach, all system and subsystem personnel were given extensive training early in the program on the total system technical approach as well as the contractual incentive provisions. In addition, techniques were developed to measure the individual's cost, schedule, and technical performance on a weekly basis. This technique, together with comprehensive design reviews and hardware audit programs, permitted program motivation to extend from the Group Engineers to the supporting organizations such as Manufacturing and Product Assurance.

3. The incentive contract which featured vehicle performance had the desired result. It was of particular importance that all performance was to be measured as a negative from optimum. In other words, any performance less than perfection represented a loss to the company rather than a more classic approach which provided a potential gain. The contract will experience a cost overrun of 5% or less. This did not result from irresponsible fiscal management, but rather many program decisions which were believed to contribute to better reliability. These actions were broadly within the scope of the contract but not foreseen. They did not represent difficult trade-off decisions, since it was believed that vehicle performance would offset the penalty to the company.

Turning now to the tangible factors:

Endorsement of CDP philosophy

- A timely, carefully reviewed, effective design. This included minimum technical risks with emphasis on those which were considered of a higher risk.

- A novel spacecraft testing concept embracing factory readiness before shipment to the launch pad, with least possible testing needed at that point.

- Realistic costs with an underlying philosophy of both Air Force and company management of allowing only what was necessary, but at the same time that which was essential to ensure mission success.

A discussion of these factors follows:

1. The program was able to draw upon the existence of a well thought out preliminary design. It is to be noted that the final design is almost identical to the design originally proposed by LMSC with the exception of changes in the Command Subsystem and the addition of certain redundant features. The willingness of the Air Force to accept LMSC's proposal permitted an extremely orderly program. This was further aided by the existence and execution of a detailed and logical development program which allowed six months for design, six months for component fabrication and development, six months for systems qualification, and six months for manufacturing flight hardware and preparing for launch. This program plan, combined with the Development Test Vehicle, permitted the inevitable problems to be absorbed in almost one year of detailed systems testing.

- 2 -

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Also noteworthy was the highly coordinated and cooperative management of the significant interfaces, particularly that between the LMSC hardware and that of the payload contractor. It should be noted that the higher risk areas (many of which were based on prior proven hardware of similar functional purpose) received special attention in all areas from systems analysis through the intervening steps such as concept, design, interface analysis, manufacture, etc., to the final factory systems test.

2. Implementation of the factory to pad concept with the firm backing of the SPO created the situation wherein flight hardware after being thoroughly tested at the factory was delivered to the launch pad in such condition that no anomalies existed. Corollary to this has been the implementation of computer programmed checkout using the RF linkage which permitted the accurate testing of flight hardware to a much greater depth than which has been possible before by manual means with hard wire connections. The value of this test method was further strengthened by requiring that the confidence tests at the launch pad be functionally identical to those executed at the factory during final Systems Test.

3. The extensive preparations by both the Government and the Contractor, both before and after contract award, resulted in an agreed upon and well understood work statement. This, in turn, made possible credible detailed cost agreements which, as the program evolved, were easy for both the SPO and Contractor to relate to work yet to be accomplished. In all of this operation, the Contractor operated upon the philosophy that the most effective program was one which provided an adequate emphasis on those areas which allowed the now demonstrated early success.

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TCS-6884/73
20 March 1973

Copy 2

MEMORANDUM FOR : Chairman, EXSUBCOM

THROUGH : Acting Chief, Imagery Exploitation Group, NPIC

SUBJECT : Innovations and Trends in Exploitation in the Western Geographic Division, IEG Caused by the KH-9 System

1. The advent of the KH-9 system caused some innovations over and above those normally expected when a new system becomes operational. We were prepared, in WGD, for the basic differences and advantages of the KH-9 and anticipated that the system would be of great benefit in satisfying our geographic area search requirements. The KH-9 has proven its value in the search; the innovations caused by the system have been accepted and absorbed; and some trends in exploitation due to the advent of the KH-9 have surfaced.

2. The innovations involved the subjects listed below:

a. New equipment:
Optics; light tables; film storage shelves

b. New film handling procedure:
Film separated by geographic areas.

c. Target readout:

Four bucket time-span (45-70 days) permitted more likelihood of changes occurring at targets during the mission; more targets covered by photography of better interpretability; increased probability of covering targets in normally cloudy regions (E. Europe).

d. Personnel:

Training and familiarity with the KH-9; need for some augmentation to handle increased workload.

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EXEMPT FROM GENERAL DECLASSIFICATION SCHEDULE OF E. O. 11652, EXEMPTION CATEGORY: § 5B(1), (2), (3) or (4) (circle one or more)
AUTOMATICALLY DECLASSIFIED ON
Date Impossible to Determine
(unless impossible, insert date or event)

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TCS-6884/73
20 March 1973

SUBJECT : Innovations and Trends in Exploitation in the Western Geographic Division, IEG Caused by the KH-9 System

e. Management:

Increased problems of PI motivation to search the large quantity of film; more awareness of interrelated intelligence items due to increased frequency and number of targets covered; need to organize so as to provide both in-depth geographic area knowledge and flexibility of PI strength.

3. Trends in exploitation based upon our KH-9 experience include:

a. More emphasis on the dynamic targets and less on those that have remained relatively static.

b. Increased emphasis on searching for new targets.

c. An increasing need for the PI to know the current situation in a geographic area so that his analyses will more directly address the intelligence problem, he can more accurately assess what he sees, and anticipate and look for new developments.

[redacted]
Deputy Chief
Western Geographic Division, IEG/NPIC

Distribution:
Cy 1 - Chairman, EXSUBCOM
2 - NPIC/IEG
3&4 - NPIC/IEG/WGD

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THE KH-9 SEARCH AND MC&G PERFORMANCE STUDY

VOLUME II

HISTORICAL PERFORMANCE SUMMARY

OCTOBER 1977

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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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TABLE OF CONTENTS (Continued)

NRO Approved for Release
17 September 2011
UPDATED: 14 December 2011

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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.

The aft section contains all of the equipment for control of the satellite vehicle in orbit. An orbit adjust subsystem provides propulsion for correction of velocity errors, drag makeup, and vehicle de-orbit at mission completion. An attitude control subsystem provides earth-oriented control and stabilization about all three vehicle axes - yaw, pitch and roll. The electrical distribution and power subsystem generates, controls, and distributes electrical power. The tracking, telemetry and command subsystem provides vehicle tracking, telemetry and command function capabilities .

2.1.1 Operational Characteristics of the Dual Camera Panoramic System

The panoramic cameras have 60-inch focal lengths and are mounted side-by-side. The port or forward-looking camera (Camera A) is pitched 10 degrees forward from vertical and the starboard, or aft-looking camera (Camera B) is pitched 10 degrees aft from the vertical. Operated together, the two cameras yield a 20-degree stereoscopic convergence angle at nadir. At 60 degrees obliquity, the convergence angle is 10 degrees. Camera A scans the surface of the earth from right to left, while the Camera B scans from left to right. There is a half frame overlap between Camera A and Camera B frames. The system can be operated in any of 16 different photographic modes. A mode is defined by a selection of scan width and scan center. There are four selectable scan widths, 30, 60, 90, or 120 degrees and seven selectable scan center placements, 0, ±15, ±30, or ±45. Table 2-1 summarizes the characteristics of panoramic camera system.

The amount of film carried for each camera varies. Earlier missions carried from 100 to 110 thousand feet. Mission 1212 carried 120 thousand feet on Camera A and 117 thousand feet on Camera B. The film is exposed on a frame-by-frame basis. The frame width is 6.6 inches and length varies from about 2.6 feet for a 30-degree scan width operation to about 10.5 feet for a 120-degree operation. Ground coverage at 90 nautical miles is approximately 9 nautical miles in-track at nadir and up to 315 nautical miles cross-track depending on selected mode.[1]

Image quality and scale vary across the film format depending on the altitude of the satellite and the viewing angle (scan angle) used. While flying at altitudes of 80 to 90 nautical miles, the system nominally produces imagery in the 2-foot to 20-foot GRD range when allowed to operate across the full range of scan angles. At extremely high scan angles, the usefulness of the imagery is degraded considerably due to high distortion. To eliminate this problem, recent KH-9 missions have not been allowed to operate outside a 45-degree obliquity angle. When such restrictions are imposed, the GRD range is usually between 2 and 10 feet producing imagery which range in NIIRS of 2 to 6 of which the majority is NIIRS 4 or better.

[1] These statistics are based on exposed film footage. For each operation taken and for each frame exposed, there is an associated unexposed footage. Due to hardware problems experienced on early KH-9 missions, the camera systems have not been allowed to operate in the film rewind mode, a capability designed to reduce the amount of unexposed film due to start-up and shutdown of the camera systems. This operational restriction results in some twenty to twenty-five percent of the film being returned unexposed. The percentages vary from mission-to-mission as it is dependent on the combination of modes of operations taken.

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TABLE 2-1

KH-9 SUMMARY OF PANORAMIC CAMERA SYSTEM FEATURES

Camera Type	2 panoramic
Focal Length	60 inches
Field Coverage	5.73 degrees in-track
Field of View	Selectable 30, 60, 90, 120 degrees cross-track
Modes	Mono or stereo
Nadir Field of View per Frame	9 X (up to 312 n.m.) at 90 n.m. vehicle altitude
Stereo Convergence Angle	20 degrees
Nadir Resolution	Approximately 2 ft*
Film	
Width	6 inches
Type	Type 1414
Capacity	Up to 120,000 feet per camera**
Data Return	4 reentry vehicles

*Technically, the resolution is roughly 170 line pairs/mm at 2:1 contrast in the film plane.
**Future missions will carry up to 142,000 feet per camera.

The system was designed to have an operational mission life of 30 days with a potential to grow to a 45-day life. The initial launch schedule called for four launches per year. Since the first vehicle was launched in June 1971, on-orbit mission life has steadily increased while the launches per year has decreased. The maximum number of launches in any one calendar year has been three, occurring in 1972 and 1973.

The shortest mission was Mission 1201 which operated for 31 days and the longest was Mission 1212 which operated for 154 days. See Table 2-2.

The camera system is capable of operating at altitudes ranging from approximately 80 to 200 nautical miles.

2.1.2 Operational Characteristics of the Stellar Terrain Camera System

The stellar terrain camera system is known as the Mapping Camera Subsystem (MCS) and consists of a vertical terrain camera and dual stellar cameras. The terrain camera has a 12-inch focal length that provides a resolution of approximately 50 line pairs/mm. There are three commandable modes - single, triple or quadruple overlap. Single overlap gives a 10% frame-to-frame overlap. Triple and quadruple modes give 70 and 78 percent frame-to-frame

TABLE 2-2

KH-9 OPERATIONAL SUMMARY

MISSION NUMBER	ORBITAL PARAMETERS INCLINATION/PERIGEE/APOGEE	LAUNCH DATE	MISSION DURATION	FILM (FT)*	
				CAMERA A	CAMERA B
1201	96.4°/95.3/165.1 nm	15 Jun 71	31	100,825	100,502
1202	97.0°/86.1/180.7 nm	20 Jan 72	39	110,945	110,298
1203	96.9°/95.5/137.3 nm	7 Jul 72	57	103,170	107,728
1204	96.5°/85.3/160.0 nm	10 Oct 72	68	107,508	110,004
1205	95.7°/85.3/158.5 nm	9 Mar 73	63	108,197	110,141
1206	96.2°/87.7/154.4 nm	13 Jul 73	74	109,700	102,732
1207	96.9°/88.7/154.4 nm	10 Nov 73	102	107,390	108,243
1208	94.5°/85.5/184.0 nm	10 Apr 74	105	100,891	100,712
1209	98.7°/85.3/155.7 nm	29 Oct 74	129	116,813	111,808
1210	96.4°/88.8/157.0 nm	8 Jun 75	120	110,189	110,602
1211	96.3°/90.0/118.3 nm	4 Dec 75	116	113,502	111,107
1212	97.0°/90.1/138.0 nm	8 Jul 76	154	120,621	116,984
1213	97.0°/90.5/139.1 nm	27 Jun 77		121,371	118,570

*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.

TABLE 2-3

SUMMARY OF MAPPING CAMERA SUBSYSTEM FEATURES

	TERRAIN	STELLAR
Camera Type	Frame	Frame
Focal Length	12 inches	10 inches
Format Size	9 x 18 inches	2.8 x 4 inches
Field of View		25 x 16 degrees
In Track	73.7 degrees	—
Cross-Track	41.1 degrees	—
Modes	10, 70 and 78 percent, frame-to-frame overlap	—
Nadir Field of View	71 x 142 n.m.	
Resolution	20 to 30 feet*	6th magnitude stars
Film		
Type	3414	3401
Width	9.5 inches	2.8 inches
Capacity	Approximately 3,300 feet	Approximately 2,000 feet
Data Return	1 reentry vehicle**	

*In technical terms, this means 50 cycles/mm at 2:1 contrast.
**The stellar film is returned with the terrain film.

TABLE 2-4

SUMMARY OF MAPPING CAMERA MISSIONS

MISSION NUMBER	MISSION DURATION (DAYS)	FILM (FT)	
		TERRAIN	STELLAR
1205	42	3200	1960
1206	42	3197	1995
1207	58	3355	2000
1208	60	3301	1966
1209	59	3243	1945
1210	53	3150	2092
1211	60	3253	2135
1212	62	3068	2102

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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.[2]

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.

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[2] 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 ..."

As soon as broad area photography began to be received in quantity, the United States Intelligence Board called for the development of a procedure through which the Community might assess its significance "with respect to confirming the presence or absence of ICBM deployment in areas which have been covered. In addressing this need, the Director of NPIC pointed out that

> 'There are essentially three basic parts to the problem: establishment of definitions for rating photography on a qualitative basis; determining the significance of varying levels of cloud cover; and developing mechanical procedures for recording and reporting the desired information.'

Beginning in mid-1961 and continuing for a number of years, the status of coverage of the Soviet rail net was reported out regularly, but the procedures employed had serious shortcomings. Not until the early 1970's, when the National Imagery Interpretability Rating Scale was developed, did there become available a workable system for recording photographic quality. And the 'mechanical procedures for recording and reporting' became operational only within the past few years."[3]

As a practical matter, some of the film frames returned by a broad area mission will be free of clouds, while others will be completely filled with them. In some cases the ground will be partially obscured, at times by randomly scattered clouds and at times by solid formations that are the borders of broad weather fronts. Where transportation arteries are present, some of the cloud-free photography will be limited to the ground on one side of the line. Consequently, in accounting for coverage of transportation routes, the minimum area to be recorded must be defined. In the procedure adopted for recording coverage of the Soviet rail net, the minimum cloud-free segment counted was a rectangle showing at least eight miles of line and the ground on both sides of it to a depth of at least fifteen nautical miles. The selection of eight and fifteen miles was arbitrary and was not based on any objective analysis. Indeed, at the time the criteria was established, hardly any coverage existed on which to make an analysis.[4]

3.1.1.2 The Mid-Sixties

In early 1963, the USIB asked the committee then responsible for imagery requirements development to furnish updated guidance. The subsequent effort uncovered a split opinion as regards the quality requirement. The Department of Defense agencies judged that a capability "to permit recognition of low-contrast objects 10 feet on a side" would be satisfactory, while CIA believed there was a need to see objects five feet on a side. There was general

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[3] The USIB Directive quoted and the NPIC response both can be found in USIB-D-33.11/3, 14 November 1961. The "good," "fair," and "poor" ratings used for so many years to describe the quality of imagery were first defined in this document. Notice that the wording of the USIB Directive shows recognition of the potential that imagery possesses for confirming the absence of activities.

[4] For evidence of the early use of these criteria, see NPIC/IM16/61, 25 August 1961 and CIA/RR GP 61-141, 18 October 1961.

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

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[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.[8]

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;

[8] 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.

- Approximately eight million square miles of mapping coverage annually;
- And "A residual of approximately five percent of the film per mission for unique, one-time search or surveillance tasks."[9]

3.1.1.3 The 1969 Amplification

The requirement sent to the NRO in late 1969 reaffirmed the concept and basic structure outlined in 1966, amplified major elements within it, and introduced several new features. One major innovation was the adoption of the 1:50,000 World Area Grid (WAG) cell, an area averaging about 12 by 18 nautical miles, as a unit of account for categorizing and arraying area coverage requirements. The WAG system, which already had been adopted by the NRO as a tool for use in the management of collection, permitted the Community to delineate and differentiate areas much more finely than was possible theretofore.[10]

The built-up areas were defined in terms of their proximity to transportation. In the absence of possessing any technique for defining "proximity" scientifically, the Community stuck with the figure adopted in 1961 - 15 miles. If any portion of a WAG cell fell within 15 miles of a transportation artery, the entire cell should be counted as part of the built-up area. At least 80 percent of these built-up area cells should be kept covered with cloud-free and interpretable photography not older than six months.

Another feature was the precise delineation of 108 target clusters and the specification that quarterly coverage of each be obtained - to at least the 85-percent level in the case of a fourth of them and to at least the 70-percent level in the case of the remainder. The objective of this coverage was search as well as surveillance, for the clusters were recognized as the most likely areas for new targets to appear since "new installations of military importance are frequently located near or within facilities of similar nature ..."

These more precise delineations of the cluster and built-up regions, depicted in Figure 3-2, led to their combined sizes being reduced from 6.8 million square miles to about 5.1.[11]

Further, the standing requirements areas were expanded to include Mongolia and the regions of conflict in the Middle East, and then were divided into seven geographical categories: USSR, China, North Korea, Mongolia, Eastern Europe, Middle East, and North Vietnam. The basis for this differentiation was recognition that the intelligence problems connected with one part of the world frequently are distinct from those connected with others, and the satisfaction of requirements for coverage of one part does not necessarily influence the requirement for coverage of another.

The guidance pointed out that special requirements associated both with search and with surveillance would be levied prior to and during each KH-9 mission. The quantity of

[9] USIB-D-41.15/79, 16 September 1966.

[10] USIB-D-46.4/32, 10 November 1969.

[11] The delineation of the cluster and built-up regions on the basis called for in the requirements was a large and complex task performed by the Office of Basic and Geographic Intelligence in CIA. COMIREX's request that OBGI undertake the responsibility is discussed in COMIREX-D-13.3/1, 20 January 1970.

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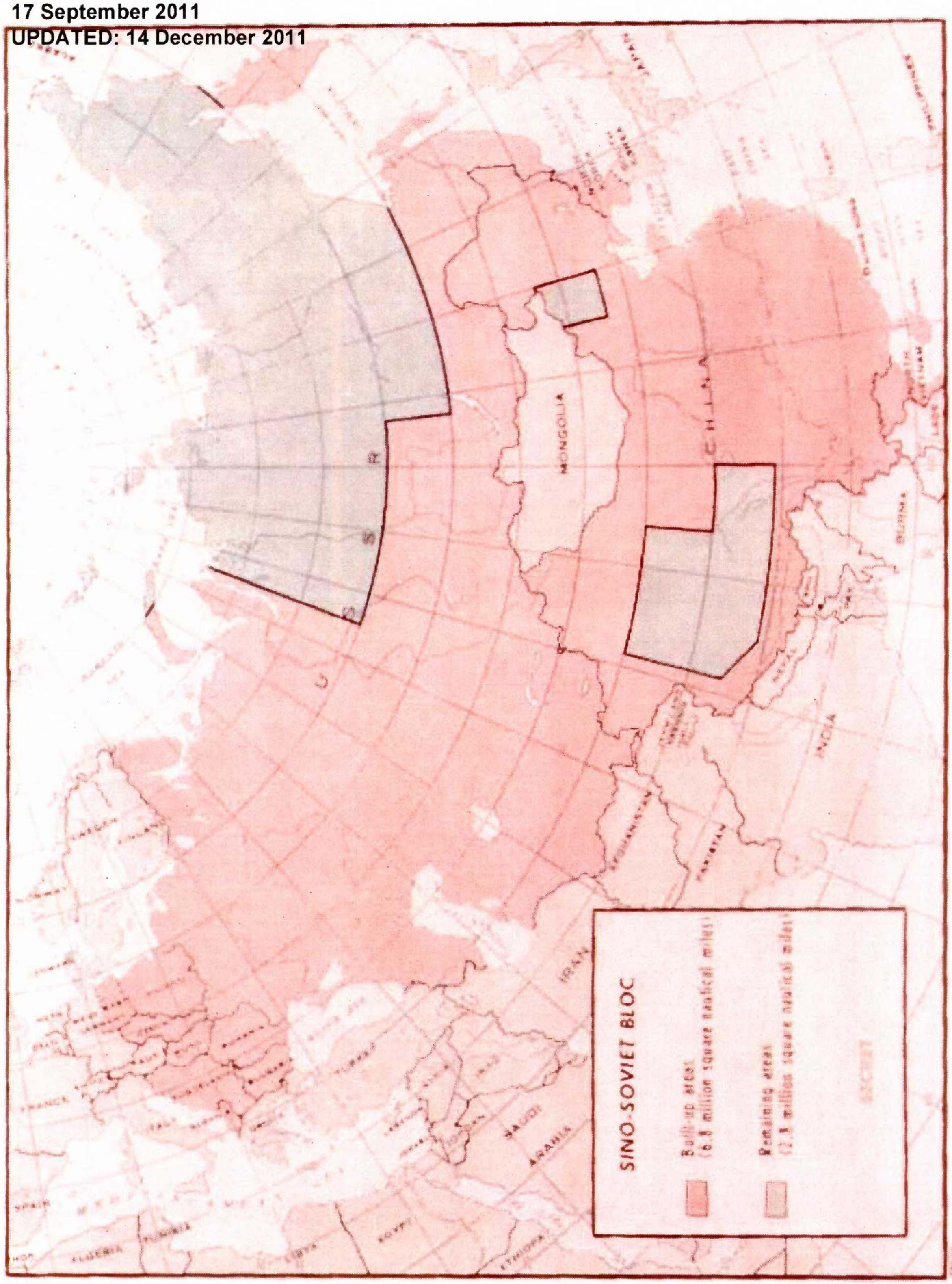

FIGURE 3-1 MAP WHICH SHOWS FIRST BREAKOUT OF BUILT-UP AND UNDEVELOPED REGIONS

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UPDATED: 14 December 2011

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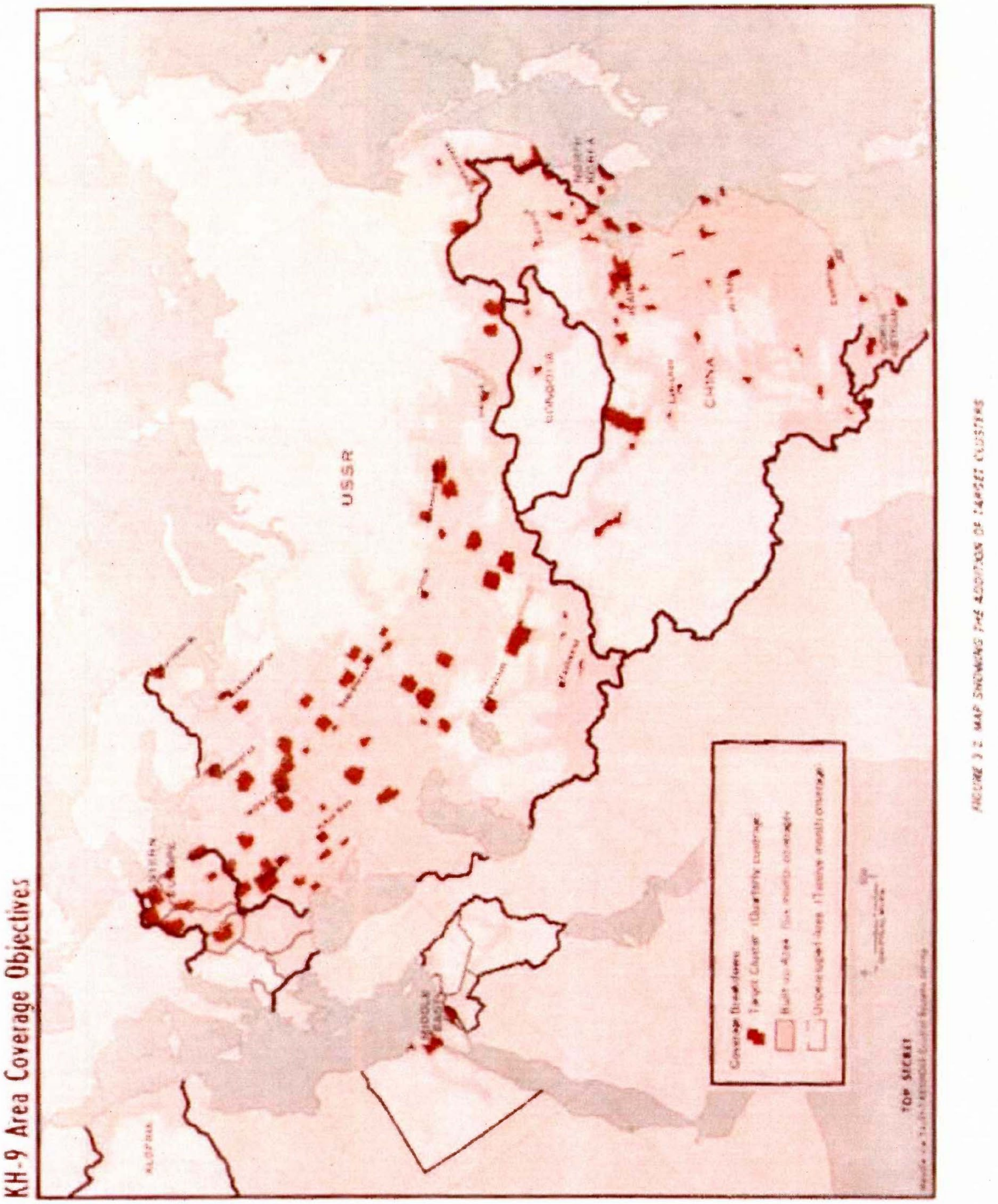

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film required to satisfy these ad hoc tasks were expected to vary greatly from mission to mission and could not be estimated with confidence. The COMIREX agreed that, to the extent possible, it would provide its ad hoc requirements in time for them to be evaluated during the pre-mission planning phase of each flight, so that a forecast could be made of their effect on the satisfaction of standing requirements.

3.1.2 Current Standing Search Requirements

The initial delineation of WAG cells for the various target clusters, built-up regions, and undeveloped areas called for in the 1969 amplification of the KH-9 requirement was completed in early 1970. In 1973, nearly 1.5 million square miles of the most inhospitable of the undeveloped areas was split off and designated as remote regions. At least 80 percent of each of the three remote categories identified USSR, China, and Mongolia - was to be kept covered by imagery no older than 18 months.[12]

During late 1974 and early 1975, in support of the Search Performance Study then under way, the Intelligence Community produced an area delineation much finer than any completed previously. This new delineation embraced an eight-level breakdown and used WAG subcells as the unit of accounting for differentiating among the eight, with the results shown in Figure 3-3. This new categorization was not usable as a standing broad area coverage requirement, however, because the computer software programs then available for managing collection operations could handle only four levels of frequency and could not accept accounting units smaller than a WAG cell. By late 1975, a methodology for aggregating the eight levels of subcells into four levels of cells had been worked out, allowing a four-level redelineation that permitted the combined cluster and built-up regions to be reduced from 5.5 million square miles to 4.2. In mid-1976, after certain software modifications had been completed, a fifth coverage category, topographically unusable, was created through the subdivision of the regions previously designated as remote. The topographically unusable regions, shown in Figure 3-4, have a two-year frequency of coverage.[13] These are the standing search requirements against which the KH-9 system is currently being tasked.

3.2 MC&G Requirements

The Defense Mapping Agency (DMA) has a world-wide mission to produce a wide variety of MC&G products for DoD Military and Intelligence Community users. An overwhelming majority of MC&G products are dependent on the resources available to DMA through the National Reconnaissance Program (NRP) in the form of covert satellite imagery. Almost 95 percent of the DMA products require some form of NRP satellite imagery to satisfy levied requirements. In general, products are generated at various scales for

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[12] COMIREX-D-15.2/15, 11 and 19 February 1970; COMIREX-D-15.2/20, 8 June 1971; COMIREX-D-15.2/25, 27 October 1972.

[13] Details about the eight regions are furnished in the Search Performance Study, BYE 2249-75, July 1975; how the delineation was accomplished is described in COMIREX-D-13.3/8, 23 September 1975; the four-fold delineation that followed is contained in COMIREX-D15.2/33, 15 December 1975, and COMIREX-D-15.2/34, 28 June 1976, provides the WAG cell delineation of the topographically unusable regions.

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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

- Clusters
- Built-up area
- Undeveloped area
- Remote area
- Topographically unusable area

[illegible]

Limited Area Directed Search

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

Broad Area Stragetic Search (in thousands nm²)

	Built-up Area	Undeveloped Area	Remote Area	Topographically Unusable Area	Total Search Area**
USSR	2,270	2,105	2,0[illegible]	227	6,[illegible]
[redacted]	302	102	0	0	404
China	1,118	922	596	143	2,817
[redacted]	48	255	153	0	456
	39	0	0	0	46
	37	21	-0	0	58
	147	62	22	0	867
	3,907	3,667	2,744	470	10,[illegible]

[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 panoramic imagery for overall preparedness and major MC&G production activities in priority areas. The world map in Figure 3-6 shows by red, blue and green the MC&G collection priorities that were established for panoramic collection for KH-9 Mission 1213. Red and blue are high and low priorities and green denotes those recoverage areas to be acquired with monoscopic imagery.

The recoverage is required for periodically updating MC&G products - maps, charts, point positioning and digital data bases in those parts of the world where culture is changing. Areas excluded from the 22.4 million square nautical miles MC&G required panoramic coverage are the extreme desert areas, large portions of the Amazon jungle and undeveloped, unpopulated regions such as: northern Canada, the interior of Greenland and major portions of Antarctica. The total land area excluded is approximately 8 million square nautical miles.

3.2.1.2 Metric Requirements

The USIB-approved MC&G requirement for KH-9 MCS frame coverage is for once over coverage of the entire world, except for certain ice-covered areas such as the interior of Greenland and Antarctica, and 1.2 million square nautical miles of the U.S. which are well surveyed and mapped (Figure 3-7). The 37 million square nautical miles (39.8 in ACRES which uses WAG cell areas) include a requirement for 1.6 million square nautical miles of poorly surveyed areas of the U.S., which satisfies both U.S. Geological Survey (USGS) and the DoD military. This material will form the metric data bank from which the point positioning products may be supported. The most stringent areas requiring metric coverage are the Eurasian Communist countries, Western Europe, Korea, Cuba and the Middle East. These areas contain over 90% of the total strategic and tactical point positioning requirements.

The original MCS frame requirement was for stereoscopic trilap coverage, 90-100% cloud-free. This has been modified (in areas where panoramic imagery exists or is programmed) to 50-100% cloud-free, effective with mission 1212. The weather threshold change (from 90% to 50% cloud-free) is the result of establishing a Continental Control Network (CCN). The CCN is a photogrammetric adjustment technique which will provide the required control from MCS frame imagery for MC&G production with panoramic imagery. Also, all previous MCS frame imagery that meets the new criteria will be counted toward overall MC&G requirement satisfaction.

The 39.8 million square nautical miles initially were subdivided into four general priority categories. However, the accomplishments of Missions 1205-1212 have reduced and subdivided these areas to where it is unrealistic to program against four priority categories. The new priority categories are high and low priority; lumping priority categories 1 and 2 in high and priority categories 3 and 4 in low priority.

3.2.2 Summary of Current MC&G Requirements

The MC&G requirements can be divided into three categories; point target requirements used to update information files, broad area coverage (non-metric) for original map compilation and revision, and broad area coverage metric requirements for original compilation requiring accurate point positioning.

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Search Area Requirements

FIGURE 3-5

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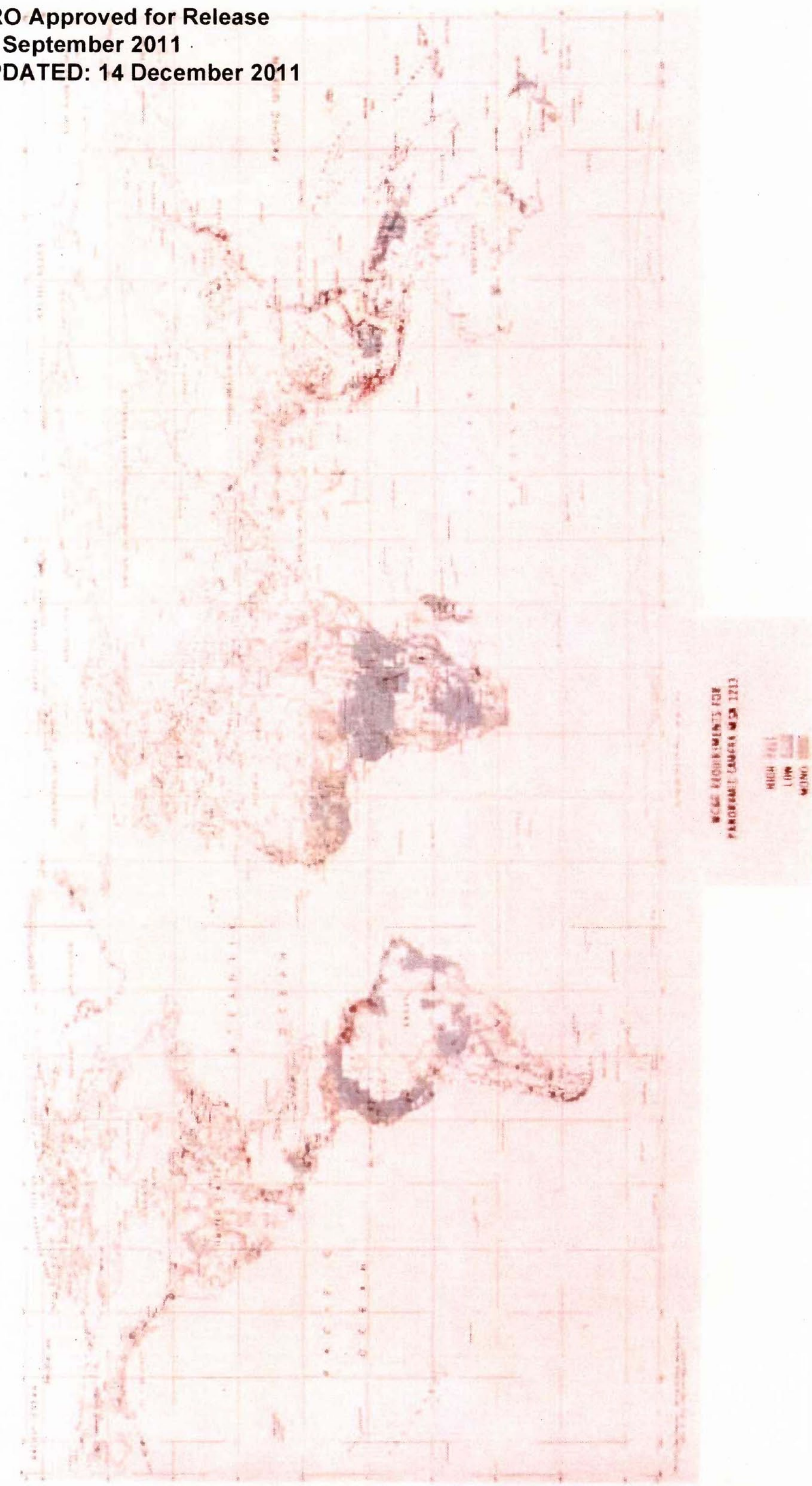

FIGURE 3-6

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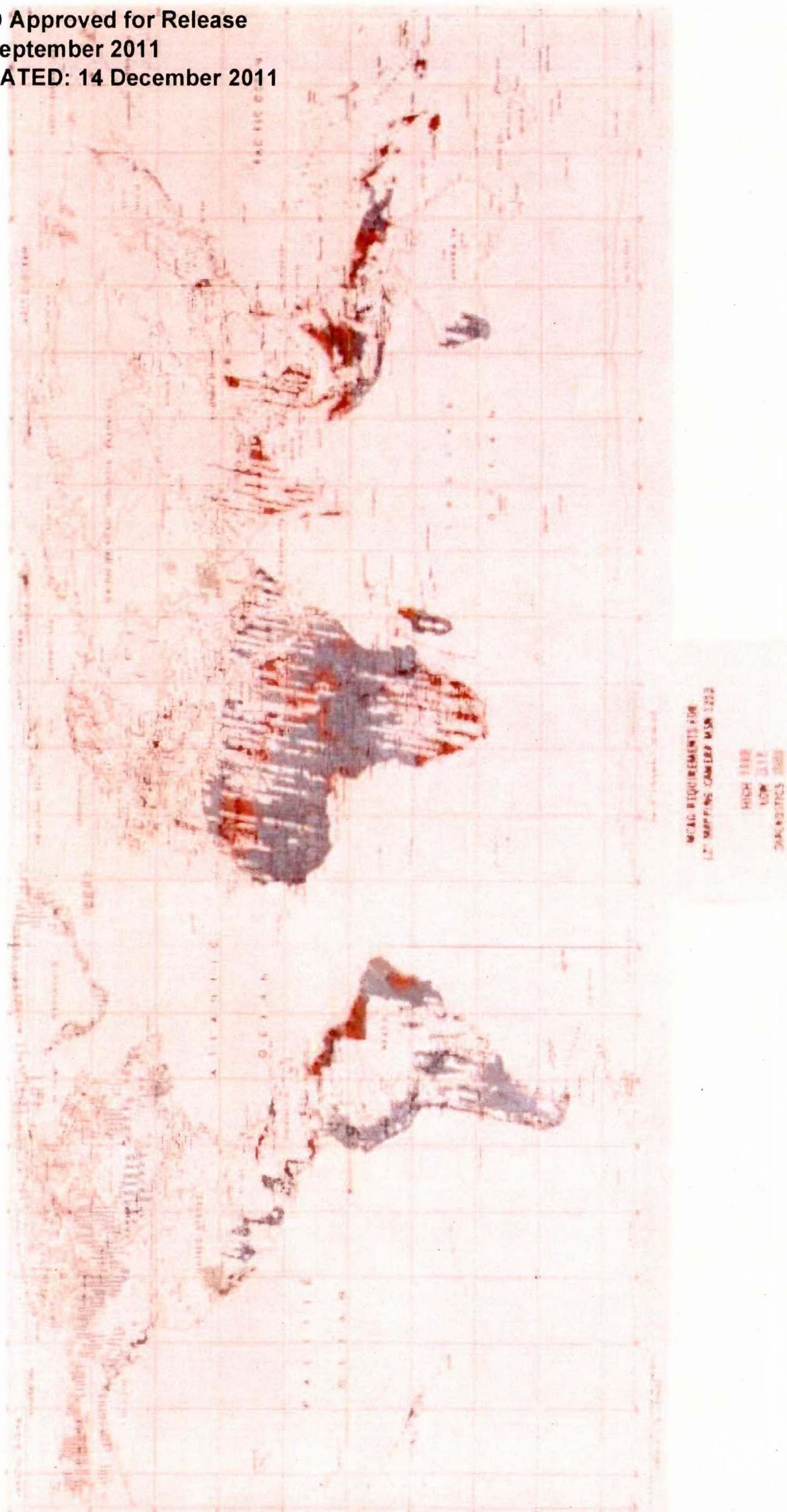

FIGURE 3-7

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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 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	Military		Civil	Total
	First Time	Recoverage	First Time	
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	1.5	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 3-2

MC&G REQUIREMENT FOR KH-9 PAN COVERAGE BY MAJOR GEOGRAPHIC REGIONS

REGION	USIB APPROVED	TOTAL DMA WAG CELL AREA REQUIREMENTS (Millions of Square Nautical Miles)	REMAINING REQUIREMENT
Sino-Soviet Area	10.2[1]	10.4[1]	1.3[2]
Eurasia	5.0	5.2	1.5
Africa plus Sinai	5.9	6.2	3.7
North America	4.2	4.4	2.0
South America	3.6	3.8	2.0
Other	2.6	2.8	2.2
Total[3]	21.3	22.4[3]	11.4

[1] DMA requirements in the Sino-Soviet area are satisfied by Intelligence collection activities. They are included in this table to show the scope of the requirements. Sino-Soviet area collection is not included in the totals.

[2] This shortfall has been identified to ICRS.

[3] The USIB-approved requirement of 21.5 million square nautical miles converts to 22.4 million square nautical miles in the DMA ACRES file which uses WAG cells for accounting.

3.2.2.3 Metric Requirements

The MC&G metric requirements are for both monoscopic and stereoscopic frame imagery to satisfy original compilation, point positioning, and island positioning. The current KH-9 requirement is for 18.5 million square miles throughout the world, including the Eurasian Communist countries. The mission objective for vehicle 13 is to collect 1.8 million square miles. The MC&G metric requirement is divided into two collection categories: stereoscopic and monoscopic coverage, which are divided into two priorities (high and low), see Figure 3-7 and Table 3-3 for a summary of the current MCS requirements.

With respect to positioning accuracy required for MC&G products, they are either relative or absolute. Relative accuracy refers to the relationship of features on a map grid or local reference datum. The accuracy required for relative relationship currently does not exceed areas larger than 300 x 300 square nautical miles. Absolute accuracy is worldwide and refers to relationship to the WGS.

The metric accuracy requirements are related to target horizontal position error and vertical position error. The horizontal position error is termed circular error (CE) which is defined as the radius of the circle in the horizontal plane centered at the estimated target location in which the true position of the target lies with a given probability. The vertical position error is termed linear error (LE).

TABLE 3-3
MC&G REQUIREMENTS FOR KH-9
MCS COVERAGE BY MAJOR GEOGRAPHIC REGION
(Stereo, 50% 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	5.4	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 U.S.

[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.

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TABLE 3-4

MC&G PRODUCT ACCURACY AND RESOLUTION REQUIREMENTS

Product	Horizontal (CE 90%)			Vertical (LE 90%)			Contour Interval	Elevation Accuracy	Ground Resolution
	WGS	MSL/LD	Pt to Pt	WGS	MSL/LD	Pt to Pt			
Line Maps & Charts									
[illegible]		[illegible]			[illegible]		[illegible]	[illegible]	[illegible]
[illegible]		[illegible]			[illegible]		[illegible]	[illegible]	[illegible]
[illegible]		[illegible]			[illegible]		[illegible]	[illegible]	[illegible]
Point Positioning									
Strategic									
[illegible]	[illegible]			[illegible]					[illegible]
[illegible]	[illegible]			[illegible]					[illegible]
[illegible]			80-40m						[illegible]
[illegible]	[illegible]		[illegible]	[illegible]					[illegible]
Tactical									
[illegible]		[illegible]			[illegible]	[illegible]			[illegible]
[illegible]			[illegible]						[illegible]
[illegible]		[illegible]	[illegible]		[illegible]	[illegible]			[illegible]
[illegible]		[illegible]	[illegible]						[illegible]
[illegible]		[illegible]	[illegible]						[illegible]
Digital Data									
[illegible]				[illegible]					[illegible]
[illegible]				[illegible]					[illegible]
[illegible]		[illegible]			[illegible]			[illegible]	[illegible]
[illegible]		[illegible]			[illegible]			[illegible]	[illegible]
[illegible]	[illegible]		[illegible]		[illegible]	[illegible]			[illegible]

[illegible]

[illegible]

[illegible]

4.0 PERFORMANCE EVALUATION

KH-9 photography routinely provides unique intelligence critical to maintenance of current order of battle, agreement monitoring, weapons system deployment, and industrial and agricultural developments. It is indeed a very difficult task to measure the "real" intelligence output of the system. With only a KH-9 mission on orbit, it generally represented the totality of the available U.S. satellite imagery capability, and therefore, its application was directed toward any and all important new requirements. For example, a significant portion of the target coverage obtained by KH-9 resulted from directed collection against special intelligence problems or was the outgrowth of standing requirements for search purposes. The classic means of measuring the performance against standing search requirements is in terms of gross coverage statistics, age distributions, and, recently, quality distributions in terms of NIIRS.

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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.[14] 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

[14] 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 4-1

KH-9 Coverage Achievements

KH-9 Mission			Coverage Accomplishments (Million sq. NM)					
			World-Wide		Communist Countries & Middle East			
Mission Number	Launch-Recovery Dates	Mission Days*	Total Imagery	Stereo Cloud-Free	Total Imagery	Cloud-Free Stereo	Cloud-Free Mono	Unique Targets Imaged***
1201	15 Jun 71 - 16 Jul 71	31**	15.9	8.3	11.2	3.6	3.2	6,932
1202	20 Jan 72 - 28 Feb 72	39	21.1	15.4	16.1	12.7	11.0	10,488
1203	7 Jul 72 - 2 Sep 72	57	28.4	16.4	22.6	13.8	11.6	11,813
1204	10 Oct 72 - 17 Dec 72	68	18.8	12.0	14.2	9.1	6.8	10,158
1205	9 Mar 73 - 11 May 73	63	17.5	12.7	12.7	9.4	6.3	11,074
1206	13 Jul 73 - 25 Sep 73	74	18.9	12.4	15.1	9.6	6.2	12,011
1207	10 Nov 73 - 20 Feb 74	102	18.0	14.3	13.9	11.4	7.3	12,852
1208	10 Apr 74 - 24 Jul 74	105	16.6	11.9	13.0	9.3	6.3	12,101
1209	29 Oct 74 - 7 Mar 75	129	18.6	14.4	14.1	11.2	7.6	13,696
1210	8 Jun 75 - 6 Oct 75	120	17.4	13.5	13.6	10.7	5.6	13,664
1211	4 Dec 75 - 29 Mar 76	116	23.1	17.3	17.6	14.1	8.2	14,275
1212	8 Jul 76 - 9 Dec 76	154	17.9	12.5	12.8	8.9	6.2	14,827

*Imaging days on orbit, not counting days of launch as an actual day on orbit.

**RV-3 was lost on 1201

***COMIREX target population has ranged from about 15,000 in the earlier missions to about 17,000 on the most recent missions.

obliquity scan sectors than present KH-9 missions. These factors resulted in larger amounts of coverage, but at a lower average quality than current missions. Due to operational problems, mission 1211 operated mostly in the mono mode. This resulted in an unusually high amount of coverage, but at reduced quality.

Tables 4-2 through 4-5 provide a more detailed breakout of the imaging capacity by mission and by primary area of interest to missions 1209 through 1212. A KH-9 system typically images cloud-free about 13 million square nautical miles. In general terms, about 45-50 percent of an average mission's film is used against the USSR (emphasis on SALT); about 15-20 percent is used against China (emphasis on missile search); 5-10 percent against Eastern Europe (emphasis on MBFR baseline); and about 3-5 percent against other Communist countries. Overall, about 75 percent of the coverage attempted is against Communist countries. Another 15-20 percent is used against the Middle East and Third World requirements. The remaining 7-8 percent of the film is used in the U.S. for satellite engineering tests, prelaunch film testing, and for mapping and other support, including U.S. civil applications.

4.1.1.2 Age Distributions

Age distributions or status curves are a graphical way of viewing KH-9 effectiveness in meeting the standing search collection objectives. Generally speaking, the requirement has been to collect eighty percent of each of the delineated search areas within the specified coverage period.

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TABLE 4-2

KH-9 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	Cloud-Free Imagery Acquired Unique
Primary Intelligence					
USSR	6 7	46 7	8 9	6 8	4 9
Eastern Europe	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
	1	2 2	4	2	1
Middle East*	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

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TABLE 4-3

KH-9 Coverage—Mission 1210

(6 Jun 75 - 6 Oct 75)

Collection Category	Size of Area (million sq nm)	Percent Film Used	Coverage (Million Square Nautical Miles)		
			Attempted Scenes	Cloud-Free Imagery Acquired	
				Gross	Unique
Primary Intelligence					
USSR	6.87	44.1	8.61	6.79	3.74
Eastern Europe	.40	9.1	1.50	1.16	.37
China	2.82	16.6	2.54	1.88	1.28
Other	.56	5.0	.22	.18	.14
Total Communist Countries	10.65	74.8	12.87	10.01	5.53
Middle East	.25	6.1	.73	.67	.22
Free World	38.50	12.2	3.04	2.29	1.86
Subtotal	49.50	18.3	3.77	2.96	2.08
Other					
United States	2.8	6.9	.76	.67	.50
TOTAL	52.70	100.0	17.4	13.64	8.11

Figures 4-1, 4-2 and 4-3 illustrate the status of search coverage satisfaction of primary requirements in relation to the 50, 80, and 90 percent satisfaction levels. It should be noted that the data in these figures are shown in terms of the area delineations which have been used in KH-9 requirements to date.

In spite of some interruptions to continuity of coverage at the desired rates, the KH-9 program has, in general, satisfied the most important of the non-time-sensitive requirements in terms of quality, quantity, and continuity of imagery flow. There have been short periods since KH-9 has been operational when important intelligence situations could not be monitored. These gaps were due to such factors as launch delays and extended periods of bad weather.

4.1.1.3 NAEF NIIRS Distributions

NIIRS distributions and cumulative distributions for search coverage rated from KH-9 missions 1209 through 1212 are provided in Figures 4-4 through 4-7. These distributions are single photo-interpreter ratings extracted from the National Area Exploitation File. Generally speaking, 55 to 65 percent of the unique images rated are rated NIIRS 4 or better. For the gross area rated, mission 1211 received significantly poorer area ratings than any of the other missions. This fact is not completely understood. The fact that Mission 1211 was predominantly a monoscopic mission should not affect the ratings significantly since all area ratings are assigned while viewing the imagery monoscopically.

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TABLE 4-4

KH-9 COVERAGE
MISSION 1211******

(4 December 1975 - 29 March 1976)

Collection Category	Size Million Sq. NM.	% Film Used	Coverage (Million Sq. NM)		
			Attempts	Cloud-Free	
			(Gross)	(Gross)	(Unique)
Primary Intelligence					
USSR	6.87	47 2	10 83	8 91	5 00
Eastern Europe	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
Middle East*	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 (inc 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

*Middle East includes the countries o[redacted]

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

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

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TABLE 4-5

KH-9 COVERAGE
MISSION 1212

(8 July 1976 - 9 December 1976)

Collection Category	Size Million Sq. NM.	% Film Used	Coverage (Million Sq. NM)		
			Attempts (Gross)	Cloud-Free (Gross)	Cloud-Free (Unique)
Primary Intelligence					
USSR	6.87	45.7	7.45	5.14	3.59
Eastern Europe	.40	4.3	.77	.47	.30
China	2.82	18.6	3.32	2.52	1.80
Other	.56	3.1	.56	.34	.26
Total Communist Countries	10.65	71.7	12.10	8.48	5.95
Middle East*	.25	2.6	.46	.41	.22
Free World	38.50	19.1	4.49	2.97	2.40
Subtotal	49.40	93.4	17.05	11.86	8.57
Other					
U.S.	2.84	6.6	.82	.63	.57
MC&G (incl Military)**		1.7	.29	.21	.19
Test/Engineering		2.7	.42	.33	.30
Pre-launch Film Tests		1.5			
Special Intell. Support		.4	.06	.05	.04
Direct Civil Applications		.3	.05	.04	.04
Grand Totals	52.24	100.0	17.87	12.49	9.14

*Middle East includes the [redacted]

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

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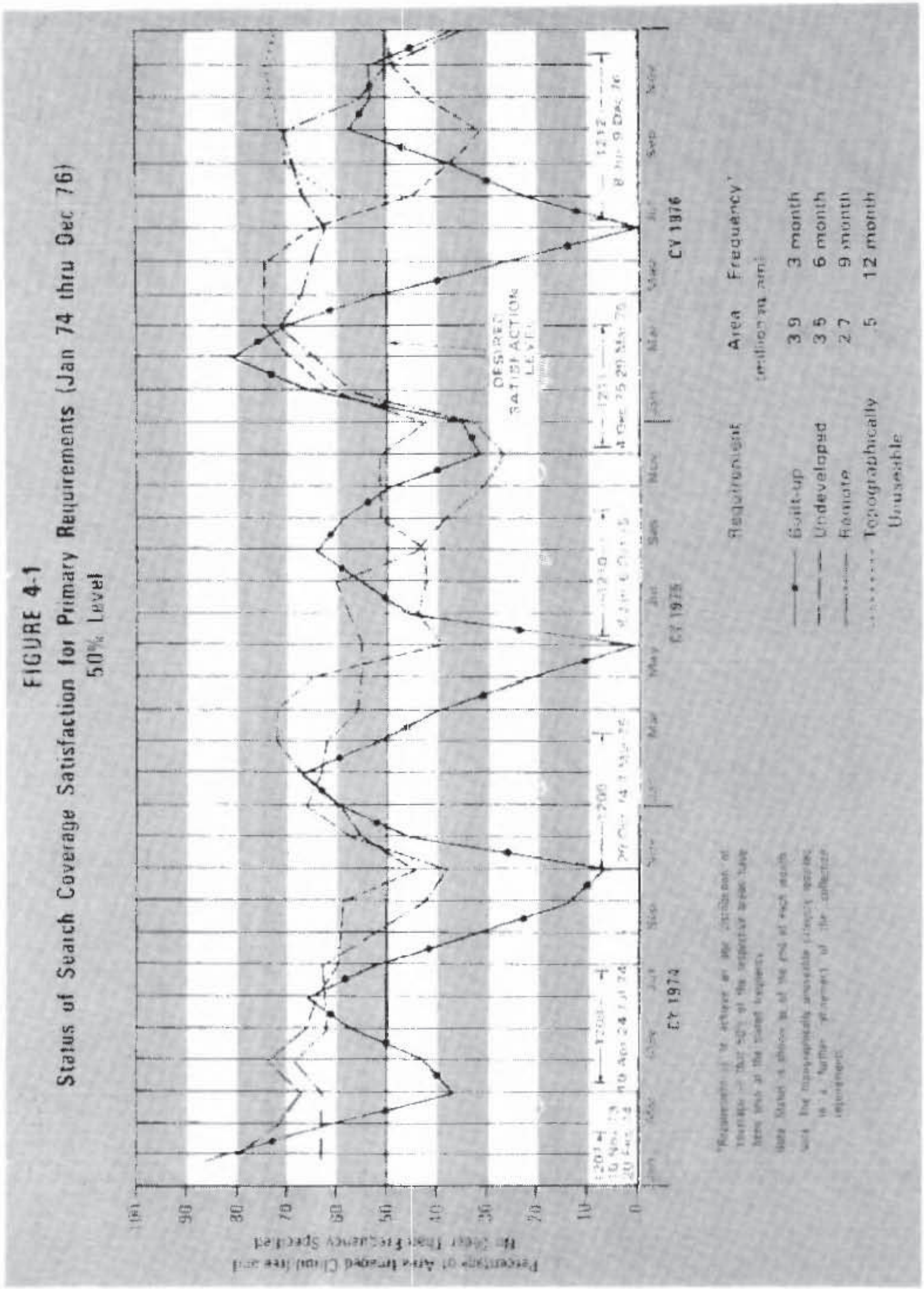

FIGURE 4-1
Status of Search Coverage Satisfaction for Primary Requirements (Jan 74 thru Dec 76)
50% Level

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FIGURE 4-2
Status of Search Coverage Satisfaction for Primary Requirements (Jan 74 thru Dec 76)
80% Level

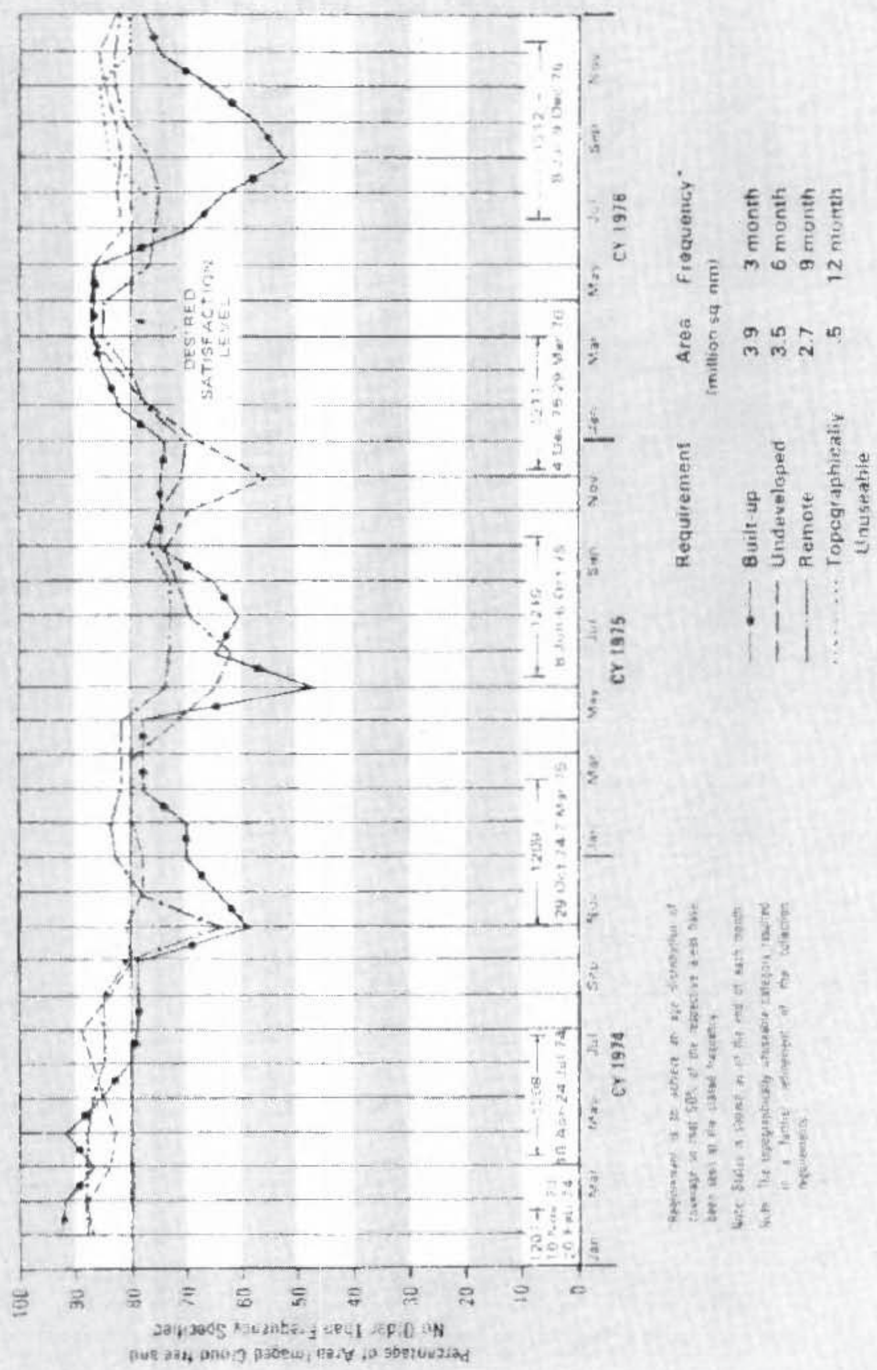

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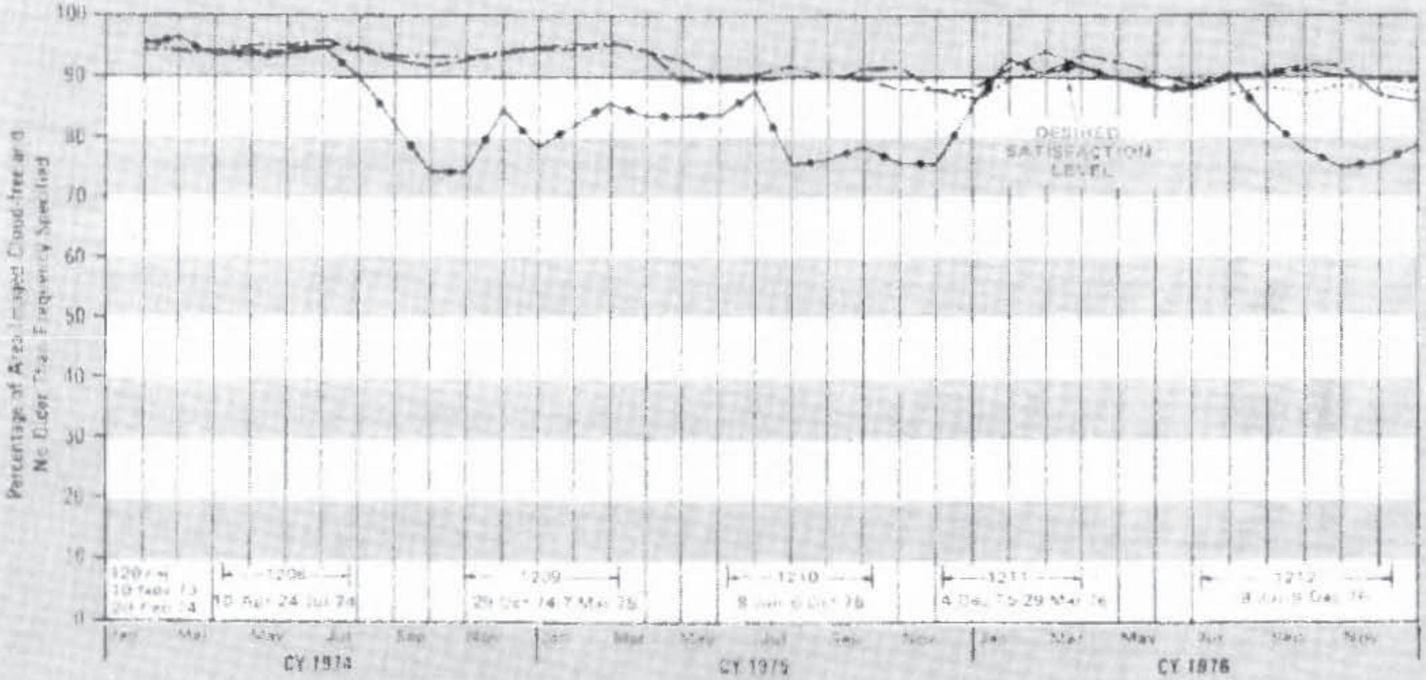
FIGURE 4-3

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

90% Level



Requirement	Area (million sq. nm)	Frequency*
Built-up	3.9	3 month
Undeveloped	3.5	6 month
Remote	2.7	9 month
Topographically Unuseable	5	12 month

FIGURE 4-4

NAEF NIIRS DISTRIBUTION AND CUMULATIVE DISTRIBUTION FOR KH-9 MISSION 1209

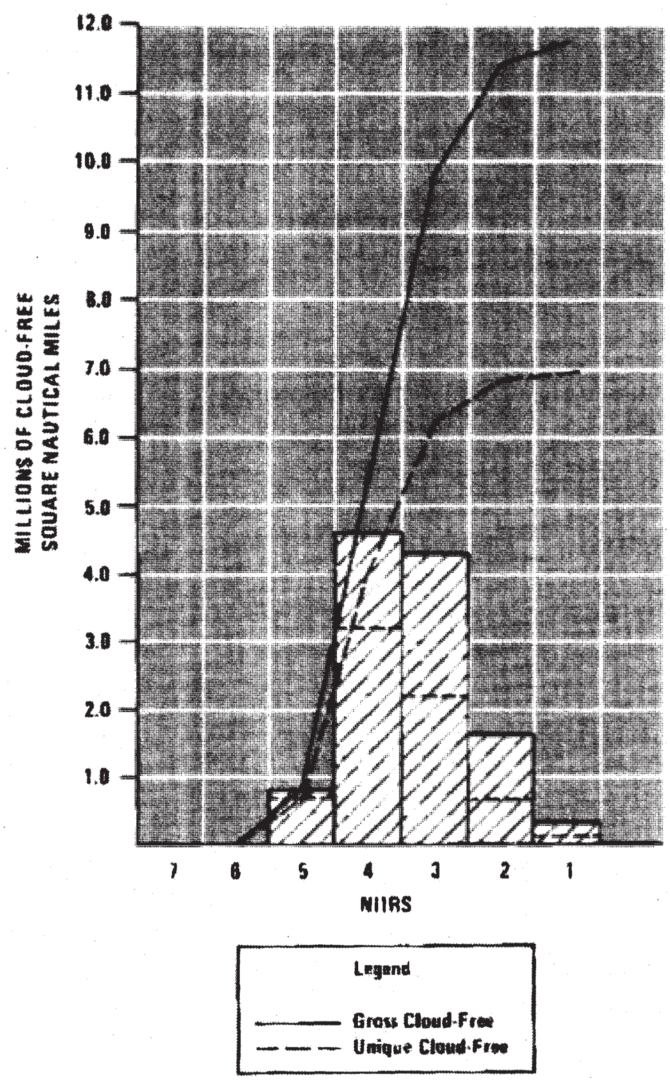


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FIGURE 4-5

NAEF NIIRS DISTRIBUTION AND CUMULATIVE DISTRIBUTION
FOR KH-9 MISSION 1210

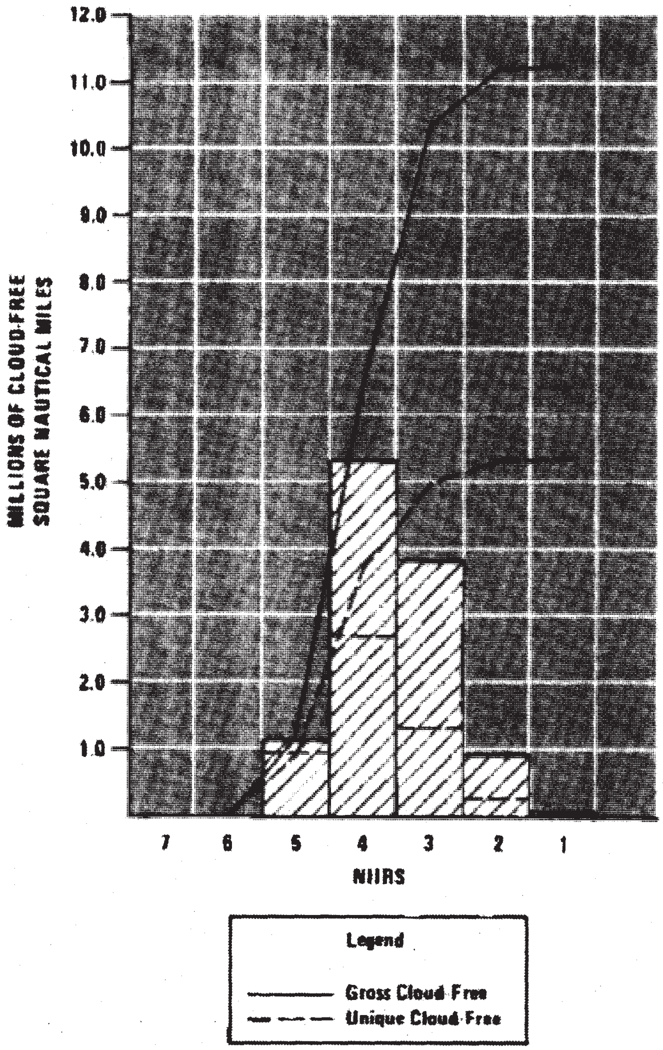

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FIGURE 4-6

NAEF NIIRS DISTRIBUTION AND CUMULATIVE DISTRIBUTION FOR KH-9 MISSION 1211

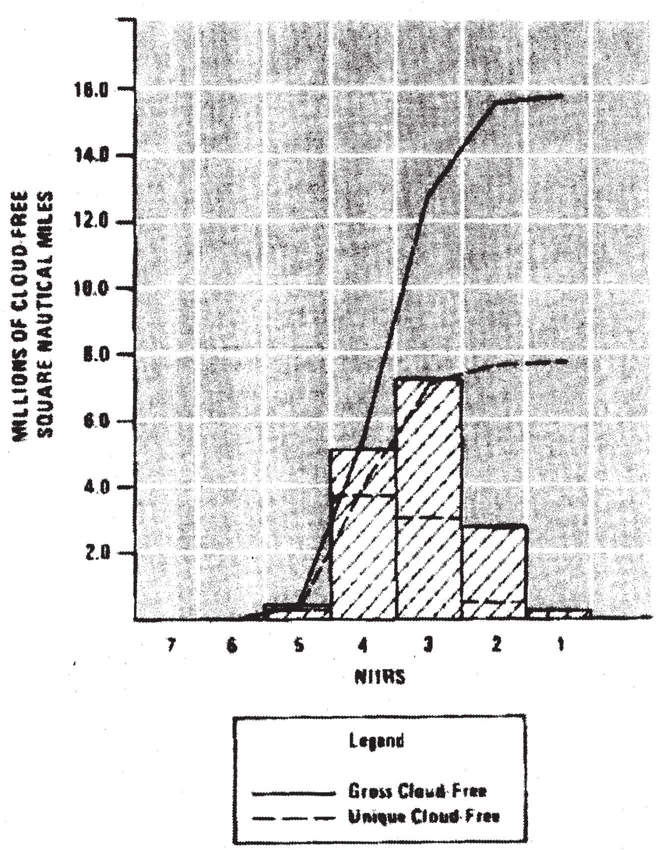

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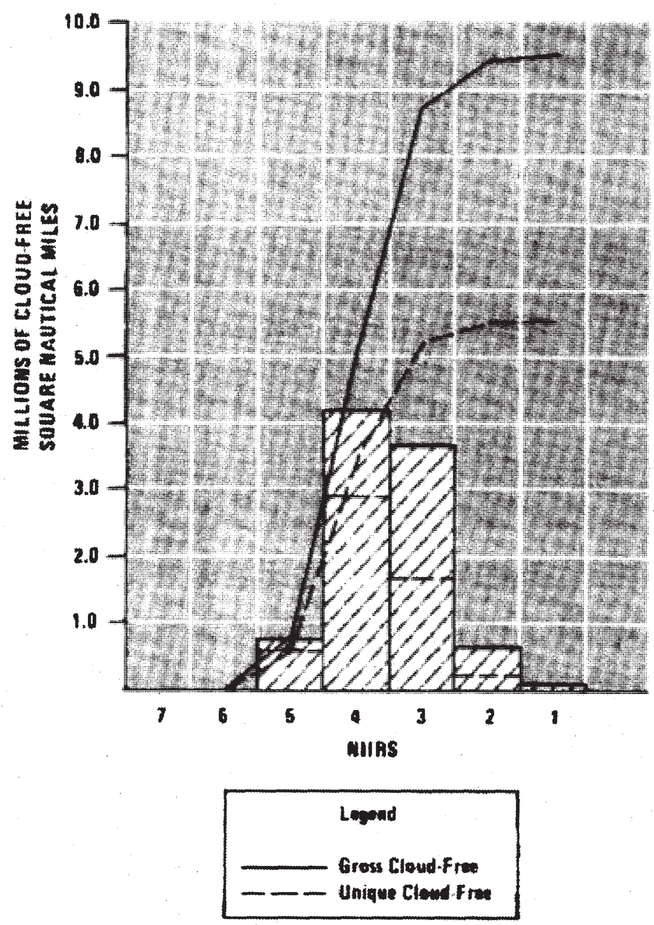
FIGURE 4-7

NAEF NIIRS DISTRIBUTION AND CUMULATIVE DISTRIBUTION
FOR KH-9 MISSION 1212



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4.1.2 Target Surveillance Coverage

The single most unique characteristic of the KH-9 system is its ability to provide photographic coverage of large geographic areas at a quality adequate for general point target surveillance. In the course of collecting search imagery, it typically covers 40 to 60 thousand point targets (COMIREX and non-COMIREX targets) per mission. If the surveillance requirement is non-time critical and the quality requirement for these targets is for NIIRS 4 imagery or less, there is an extremely high probability that the KH-9 coverage will periodically satisfy the surveillance needs.

Target coverage statistics for COMIREX targets are presented for missions 1210, 1211, and 1212. For each mission Tables 4-6, 4-7 and 4-8 give a breakout by country of the unique target and Figures 4-8, 4-9 and 4-10 provide NIIRS overall cumulative and distributions. The NIIRS distributions are based on the Installation Data File and reflect a single photointerpreter point target NIIRS rating. The KH-9 system typically covers about 80 percent of the COMIREX target deck per mission. Of this coverage, 70 to 80 percent is NIIRS 4 or better.

TABLE 4-6
UNIQUE
KH-9 COMIREX TARGET COVERAGE
FOR MISSION 1210

Geographic Area	Total Targets*	UNIQUE CLOUD-FREE Targets Photographed	
		Number	Percent
USSR	8,014	7,533	94
[redacted]			
China	3,460	2,294	66
[redacted]			
TOTAL	[redacted]		

*The figures given here are all of the active COMIREX targets as of November 1975.

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TABLE 4-7

UNIQUE
KH-9 COMIREX TARGET COVERAGE
FOR MISSION 1211

Geographic Area	Total Targets	UNIQUE Cloud-Free Targets Photographed	
		Number	Percent
USSR	8,595	7,625	88
[redacted]			
China	3,477	3,123	89
[redacted]			
TOTAL	[redacted]		

4.2 Unique Contributions of KH-9 to Intelligence

The unique contributions of KH-9 are of two types: system unique contributions and function-unique contributions. System-unique contributions can be provided by no other operational or proposed system. These contributions are due to KH 9's unique ability to collect stereo, broad area synoptic coverage at NIIRS 4 or better quality. Function-unique contributions are those contributions that have historically been provided only by KH-9, partly because of at least one of KH 9's capabilities (quality, broad area, or stereo) and partly because of KH 9's function of satisfying standing and special search requirements.

4.2.1 System-Unique Contributions

Exploitation that requires synoptic coverage of large areas of ground to show the relationship between several targets or activities (rather than detailed analysis of a single target or activity) is possible only through imagery returned from KH 9.

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TABLE 4-8

UNIQUE
KH-8 COMIREX TARGET COVERAGE
FOR MISSION 1212

Geographic Area	Total Targets	UNIQUE Cloud-Free Targets Photographed	
		Number	Percent
USSR	9,017	8,244	91
[redacted]			
China	4,052	3,772	93
[redacted]			
TOTAL	[redacted]		

[redacted]

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FIGURE 4-8
NIIRS DISTRIBUTION AND CUMULATIVE DISTRIBUTION OF UNIQUE COMIREX TARGETS COVERED ON KH-9 MISSION 1210

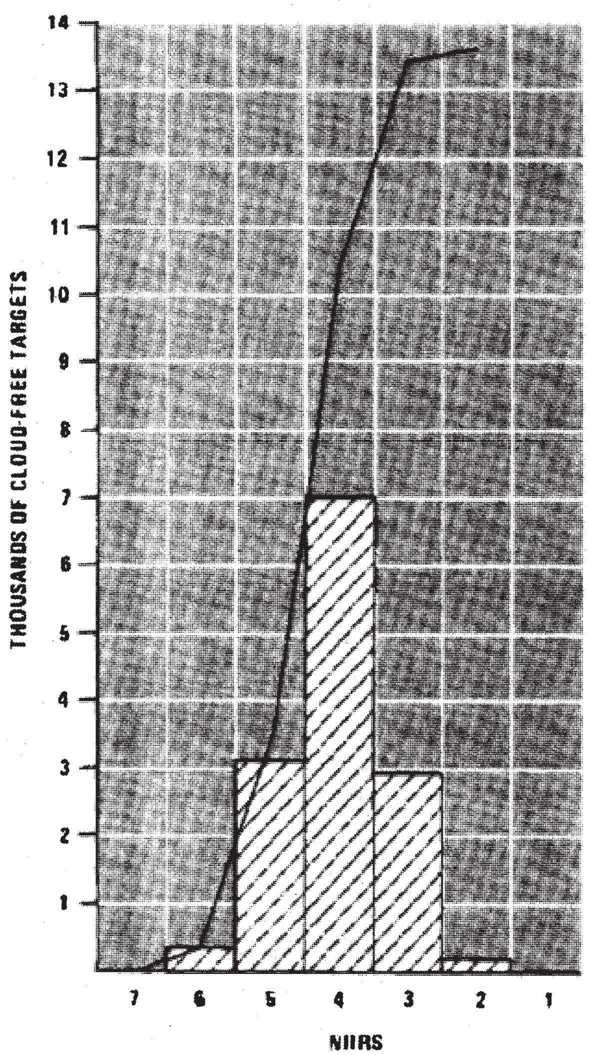

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FIGURE 4-9

NIIRS DISTRIBUTION AND CUMULATIVE DISTRIBUTION OF UNIQUE COMIREX TARGETS COVERED ON KH-9 MISSION 1211

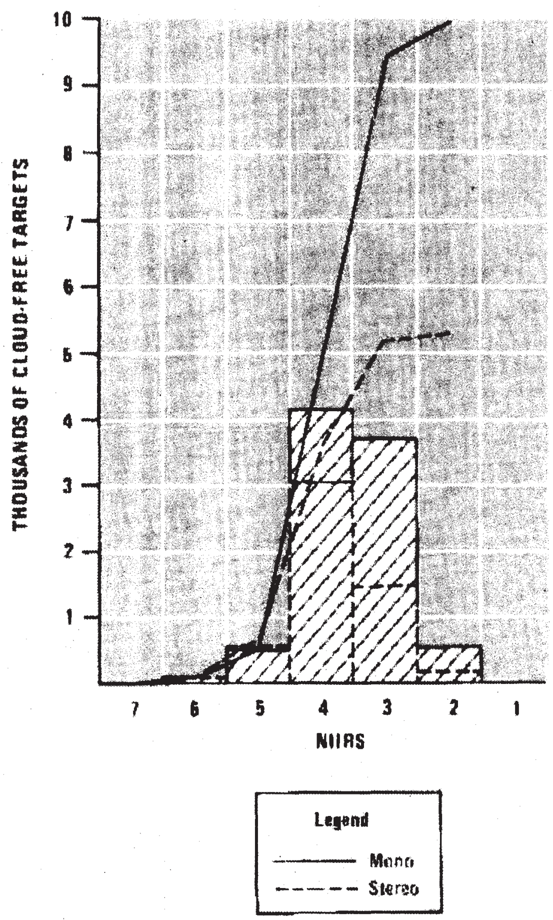

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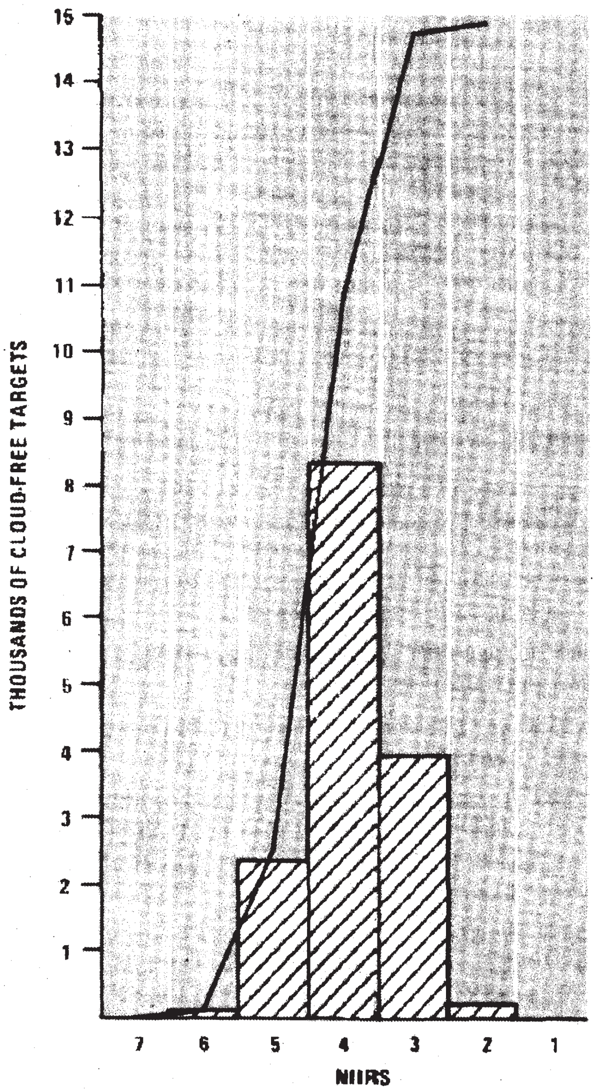
FIGURE 4-10

NIIRS DISTRIBUTION AND CUMULATIVE DISTRIBUTION OF
UNIQUE COMIREX TARGETS COVERED ON
KH-9 MISSION 1212



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4.2.2 Function-Unique Contributions

Function-unique contributions are provided by KH-9 because of its function of satisfying the standing and special search requirements. The contributions are unique because to date no other system has been able to provide them to the degree shown by the KH-9. It is reasonable to assume that other search systems, which satisfy the standing and special search requirements, might provide some or all of these contributions.

4.2.2.1 Standing Search

Millions of square miles of ground are covered each KH-9 mission to satisfy the standing search requirements. Imagery analysts then systematically examine the imagery to report significant changes and to negate the presence of items of military significance. In addition, tens of thousands of targets are necessarily imaged in the process of collecting such a large area of ground. Since these targets must then be exploited, good quality stereo is essential for providing reliable target readouts. Most of the targets now imaged by targeting systems were discovered during search, and new targets are constantly being found.

And if new targets or activities are detected, previous KH-9 coverage usually provides the only images of the earlier stages of construction where cable and foundation configurations can be analyzed.

4.2.2.1.1 Transient or Unexpected Activity

The purpose of the search phase of exploitation is to find significant changes and to negate the presence of items of intelligence significance. Millions of square nautical miles of ground must be systematically examined in order to find changes or to assure that there are none. KH-9's ability to image vast areas at good quality has made the detection of small, often camouflaged, and often mobile equipment successful.

While no attempt has been made to show the breadth of search finds, a few of the more significant recently discovered activities are:

(1) Chinese SSM fixed field sites. These sites are in mountainous ravines and some lack permanent identifying features (Figure 4-13).

[redacted]

(3) New SAM Sites. A new complex at Norilsk will directly affect SIOP penetration routes through the northern USSR, an SA-5 complex under construction at Gremika significantly upgrades air defense of a major operating base for SSBN's, and a chain of 18 new SA-2 and SA-3 sites and two SAM support facilities were found from Zavitinsk to Lesozavodsk in the far eastern Soviet Union.

[redacted]

[redacted]

4.2.2.1.2 Lower Priority Targets

KH-9 provides the only coverage of thousands of installations which are not individually important enough to merit national intelligence collection, but which collectively are worthwhile to the intelligence community for economic studies and production estimates. These targets include hundreds of each of the following kinds of activities:

(1) Petrochemical industry.
(2) Coke iron and steel plants.
(3) Fertilizer plants.
(4) AAA sites throughout the world.
(5) Regimental size military installations in China.
(6) Lesser airfields and naval facilities.
(7) POL storage facilities throughout the world.
(8) Dispersed storage areas.
(9) Agricultural monitoring.

4.2.2.2 Special Search

A significant fraction of KH-9's imagery is tasked against special search requirements. While the imagery is also examined to find the more general "anything of significance," special search imagery is taken to find something in particular. The following are some examples of the exploitation of special search imagery.

4.2.2.2.1 Mobile Missile Search

The search for the SS-X-16/SS-20 mobile missile has been hampered by the necessity to search large areas of ground, by the lack of equipment at launch sites, by the extensive use of netting and by the fact that certain structures are toned to blend with the surrounding scenery.

KH-9 has contributed to piecing together mobile missile equipment and deployment in the following ways:

(1) July 1974: A TEL and a resupply vehicle were detected north of Volograd (Figure 4-14). High resolution photography then provided good estimates of TEL and resupply configuration.

(2) February 1976: Detected field activity of SS-20. Detected movement of SS-20 launch site from Kapustin Yar to Gladkaya. The search area was extended from 30-nautical-mile to 50-nautical-mile radius about ICBM complexes.

(3) February 1976: Similarity noted between Scaleboard and SS-20 exercises and track activity.

(4) October 1976: Detected sliding-roof buildings as possible launch sites in time of heightened alert.

4.2.2.2.2 Directed Search

KH-9 has proved invaluable when the general location of a target or activity is known, but the location is not known precisely enough for acquisition by a targeting system. Typical examples:

- Nuclear Tests. After a Chinese nuclear test at Lop Nor, or a peaceful Soviet test, interpreters are generally required to locate the site in an effort to determine the type and purpose of the test. Seismic locations are not accurate enough for the site to be pinpointed in most cases without broad area coverage (Figure 4-15).

- Missile Failures. After a failure, missile components can impact in an ever-widening triangle downrange from missile test centers. Their discovery must rely on broad area coverage. Once located, the debris of the impacts may necessitate retargeting for higher resolution coverage for identification and mensuration of debris or sections of the missile which survived the crash.

- Civil Defense. A general search has been conducted to determine the extent of the civil defense program in the Soviet Union. Thousands of personnel shelters have been constructed, and many are not near known military targets and have therefore not been covered by KH-8 or KH-11 imagery. KH-9 stereo coverage is used for conducting this kind of search.

4.2.2.2.3 Historical Studies

Past KH-9 missions are regularly used to provide historical information on newly identified targets or activities. Once the Imagery Analyst identifies a new activity (usually as a result of good collateral information or of a find on higher quality imagery), he examines past KH-9 coverages to answer such questions as: When did the activity begin? What did the activity look like in its earlier stages? How widespread is the activity? And what events prompted the activity at that particular time? Once certain patterns or signatures have been established on higher quality targeting imagery, activities can be identified even on lower quality search imagery. For example, KH-8 imagery showed that certain motorized rifle regiments (MRRS) had added field artillery in a certain pattern. Analysts could then go back to KH-9 coverages, and armed with this information, could identify other upgraded MRRS.

Some other results provided by historical studies:

(1) Newly identified stockpiles of bridging equipment had been present for years so they did not represent a sudden change in Soviet practices, subduing rumors of impending hostilities.

(2) A motorized rifle regiment in the Leningrad Military District was trained in air mobile tactics, allowing for more mobility than was previously expected. Previous coverages showed this capability to be common throughout the district.

(3) Collateral information showed that previously unidentified storage bunkers could be used to protect reserve grain from nuclear fallout as a civil defense measure. Reexamination of previous KH-9 coverages identified some 30 more bunkers, provided approximate dates of construction, and so allowed analysts to speculate what national events prompted the construction of the storage bunkers.

4.3 MC&G Collection Summary

The criteria for evaluating KH-9 imagery collection against MC&G requirements are contained in Table 4-9. One of the more significant parameters is the gross cloud-free square nautical miles returned by missions against validated MC&G requirements. Cloud-free assessment reports are generated on World Area Grid (WAG) cell (12 x 18 square nautical miles) and WAG subcell (3 x 3 square nautical miles) basis. Even though the information on individual cloud-free subcells is available,the size of the area reported is smaller than the minimum area required. Satellite image resolution requirements for MC&G purposes vary with the scale and type of the product. The most stringent requirements for ground resolution to meet image content needs of military MC&G products is 2 feet for 1:50,000 line maps and for DLMS Level II digital culture and terrain data. This is more important for the panoramic imagery than for the stellar terrain imagery. The KH-9 panoramic imagery taken at altitudes of 82-132 nautical miles (the range of altitudes for missions 1201 through 1212) meets and in many cases exceeds the MC&G requirements for ground resolution distance (GRD) or NIIRS. Similarly, KH-9 MCS frame imagery taken at 84-156 nautical miles (the range of altitudes for MCS operations on missions 1205 through 1212) will, for certain products, provide the required GRD. The remainder of this section presents coverage satisfaction statistics for the panoramic and stellar terrain camera systems in terms of cloud-free imagery.

4.3.1 Panoramic Collection Summaries for MC&G

The current USIB-approved KH-9 panoramic imagery requirements are for 22.4 million square nautical miles, shown in Table 3-1. Current satisfaction levels against these requirements are shown in Table 4-10. This table is based primarily on the actual KH-9 collection and excludes the Sino-Soviet area and most of the important search or point target areas in the Middle East, for which MC&G requirements are generally met.

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TABLE 4-9

MC&G COLLECTION EVALUATION CRITERIA

CRITERIA		PAN	MCS
Cloud Freeness		90-100%	50-100%
Image Quality		2-13 Feet (5-2 NIIRS)	20-50 Feet GRD NO NIIRS
Image Quantity		10% of Film Load	97% of Film Load
Minimum Area		15° 30° Sector	TRILAP Model
Attitude	Pitch	15°	5°
	Roll	5°	5°
	Yaw	15°	5°
Elevation Angle		30° Min	—
Obliquity		0° - 45°	—
Stellar Exposures		—	One Pair Per Each Frame
Special Constraints		Free of Glare, Haze, and Heavy Snow	Same as Pan

The total panoramic imagery from the KH-9 sensors collected against the 22.4 million square nautical miles military and civil requirement is 8.9 million square nautical miles (see Table 4-11). Figure 4-16 shows graphically the MC&G priority panoramic collection versus the film allocation. Also depicted is the first-time and total panoramic imagery collection for MC&G priorities from the first 12 KH-9 missions. This figure confirms the below par performance against the total MC&G priority panoramic imagery requirement. Table 4-12 summarizes panoramic coverage by major geographical region.

4.3.2 MCS Collection Summary

Status of collection efforts for the Mapping Camera Subsystem is summarized in Table 4-13 and Figure 4-17 for MC&G metric requirements. Table 4-13 shows in detail the current requirement status by major world areas. There remains 23.2 million square nautical miles to be collected against the original 37 million approved requirement.

Relative to the positioning requirements, present KH-9 MCS imagery together with other calibration data provides 41 meters absolute horizontal and 23 meters absolute vertical point positioning accuracy. More than 21,000 NTB points have already been positioned to this accuracy and the remainder are positioned to accuracies from 300 to 62 meters horizontally and from 200 to 29 meters vertically.

TABLE 4-10

SUMMARY OF KH-9 PANORAMIC MC&G COVERAGE
FOR NON-COMMUNIST AREAS
(Stereo, 90% Cloud Free)

	(Millions of Cloud-Free Square N.M.)		
	Original Requirement	Area Collected By Dec 1976	Remaining Requirement
Military			
First Time (FY 72-77)	6.8	3.2	3.6
Recoverage (FY 72-78)	13.5	6.9	6.6
Subtotal	20.3	10.1	10.2
Civil			
First Time (FY 72-78 @ 0.3 msnm per year)	2.1	0.9	1.2
Total	22.4	11.0[1]	11.4

[1] Includes KH-4 coverage of 2.1 million square nautical miles collected in FY 1972. This figure includes 0.5 million square nautical miles of first-time coverage and 1.6 million square nautical miles of recoverage.

4.3.3 Exploitation

An overview of the DMA production process is portrayed in Figure 4-18. These processes are built on the assumption of the continued availability of both panoramic (wide area coverage) and frame imagery (high metric accuracy) as basic input. The output is a complete spectrum of DMA products, many of which are currently in a digital form. Advances in autocartography, for example, have made possible the extraction of mapping data from film imagery in digital form, and the subsequent generation of maps and charts from this digital data base. Proven reductions in project pipeline time and consequent cost savings have led to an increasing use of autocartography in DMA mapping activities; this trend is confidently predicted to continue. Similarly, requirements for MC&G products to support cruise missile

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TABLE 4-11

KH-9 PANORAMIC COVERAGE
MILITARY AND CIVIL ACQUISITION
(Millions of Square Nautical Miles)

Mission	First Time		Recoverage		Total		Combined
	Military	Civil	Military	Civil	Military	Civil	Total
1201	100	141	055	213	245	354	599
1202	078	028	139	088	217	116	333
1203	298	084	752	021	1 050	085	1 135
1204	326	059	280	022	606	081	687
1205	166	126	567	116	742	242	984
1206	452	051	442	004	894	055	949
1207	208	067	345	074	553	131	684
1208	202	050	521	017	723	067	790
1209	281	121	433	017	714	138	852
1210	246	127	220	085	466	212	678
1211	251	001	172	344	223	050	273
1212	176	086	464	172	640	258	898
Total	2 674	911	4 398	376	7 073	1 798	8 832

ANNUAL PAN COVERAGE
(Millions of Square Nautical Miles)

Mission	First Time		Recoverage		Total		Combined
	Military	Civil	Military	Civil	Military	Civil	Total
1971	190	141	055	213	245	354	599
1972	202	151	1 170	131	1 872	282	2 155
1973	826	234	1 362	194	2 189	428	2 617
1974	483	171	954	034	1 437	205	1 642
1975	297	126	392	134	689	262	951
1976	176	086	464	172	640	258	898
Total	2 674	911	4 393	876	7 073	1 785	8 862

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FIGURE 4-16
FIRST TIME MC&G PAN COVERAGE
AND FILM USED FOR
KH-9 MISSIONS 1201-1212

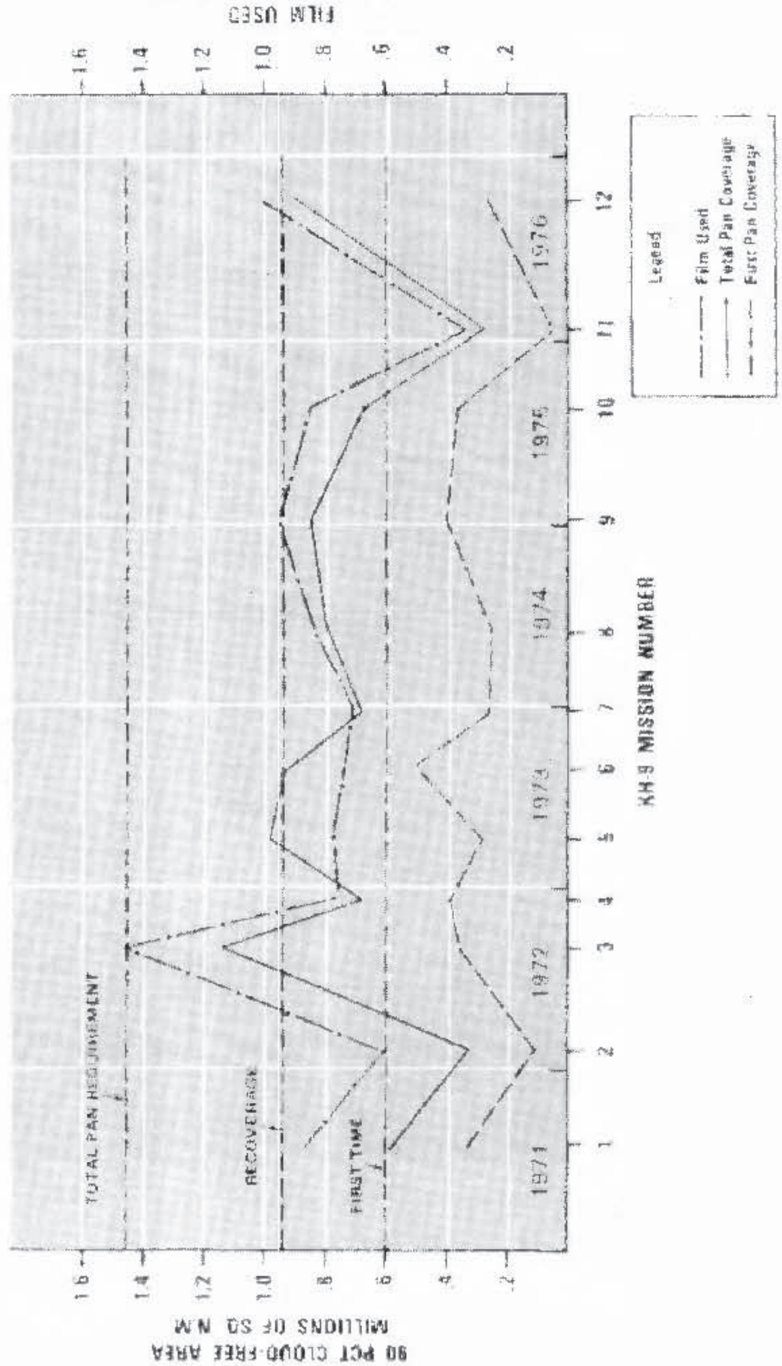

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TABLE 4-12

MILITARY AND CIVIL MC&G
PANORAMIC COVERAGE BY MAJOR GEOGRAPHICAL REGION

Worldwide, Including Sino-Soviet Area
(Stereo, 90% Cloud-Free)

	(Millions of Square Nautical Miles)						
	Sino-Soviet Area	Eurasia	Africa Plus Sinai	North America	South America	Other	total
USIB-Approved Requirements	10.2[1]	5.0	5.9	4.2	3.6	7.6	21.3
Total Requirements DMA WAG Cell Area	10.4	5.2	6.2	4.4	3.8	2.8	22.4[3]
Collected by End of December 1976 (Missions 1201-1212)[4]	9.1[1]	3.7	2.5	2.4	1.8	0.6	11.0
Balance Current Requirement	1.3[1]	1.5	3.6	2.0	2.0	2.2	11.4

[1] DMA requirements in the Sino-Soviet area are satisfied by intelligence community collection activities. They are included to show the scope of the requirements. Sino-Soviet area collection is not included in the totals.

[2] This shortfall has been identified to ICRS.

[3] The USIB approved requirement of 21.5 million square nautical miles converts to 22.4 million square nautical miles in the DMA ACRES file, which uses WAG cell areas.

[4] All statistics of coverage are given in terms of 12 x 18 nm WAG cells.

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TABLE 4-13

STATUS OF MILITARY AND CIVIL MC&G
MCS COVERAGE

(Stereo, 50% Cloud-Free)

	Millions of Square Nautical Miles						
	Sino-Soviet Area	Eurasia	Africa Plus Sinai	North America	South America	Other	Total
USIB Approved Requirements	10.2	5.2	8.8	5.2[1]	5.4	2.2[2]	37.0
Total Requirements DMA WAG Cell Area	10.4	5.4	8.8	5.7[1]	5.5	4.0	39.8[3]
Collected by End of of Dec 1976 (Msns 1205-1212)[4]	8.5	3.3	2.6	1.0	0.7	0.5	16.6
Balance Current Requirement	1.9	2.1	6.2	4.7	4.8	3.5	23.2

[1] USIB-approved requirement excludes 1.2 million snm of the U.S.

[2] Australia only

[3] The USIB-approved requirement of 37.0 million snm converts to 39.4 million snm in the DMA ACRES file, which uses WAG cell areas. Recent mission requirements have totaled 39.8 million snm which include the USGS Antarctica request, 0.4 million snm.

[4] All statistics of coverage are given in terms of 12 x 18 nm WAG cells

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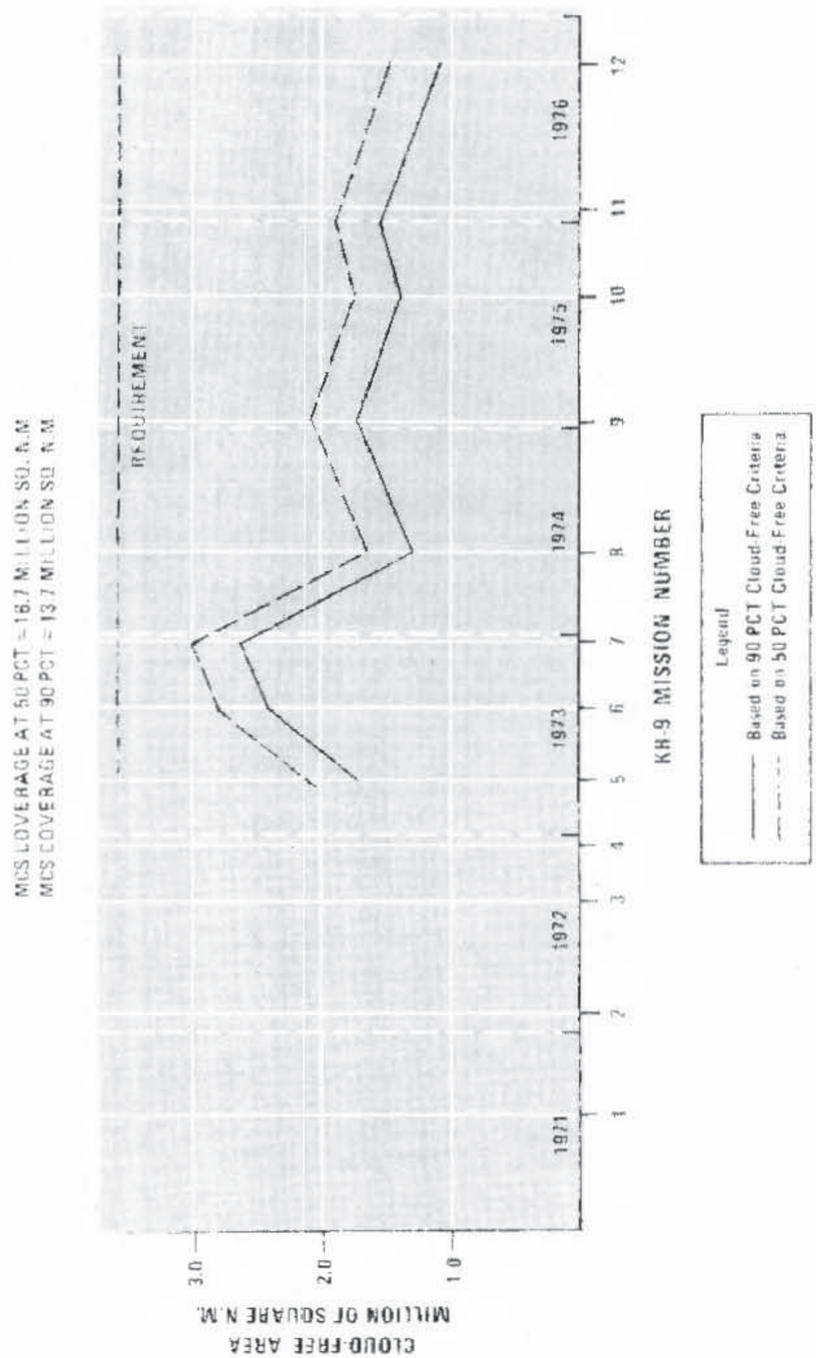
FIGURE 4-17

MC&G MCS COVERAGE
FOR KH-9 MISSIONS 1205 - 1212



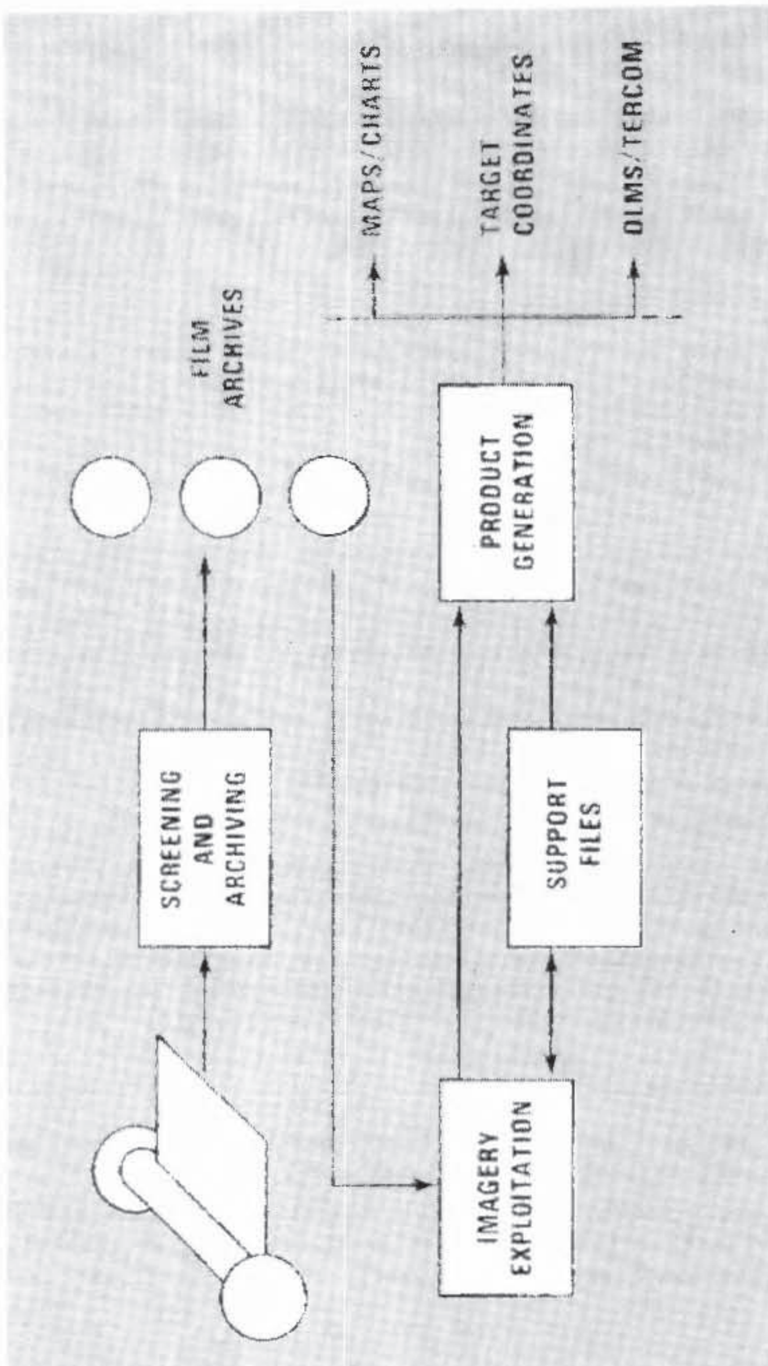


Figure 4-18. DMA MC&G Production Overview

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applications, precision guided reentry vehicle targeting, and low-level attack aircraft penetration missions dictate increasing demand for such digital products as terrain height matrices and radar reflectivity profiles.

Between the raw imagery and the final products are the various image processing operations, typified by rectification, registration, orthophoto generation, mosaicking, planimetry extraction, and feature extraction. These operations are carried out by a combination of manual, optical and hybrid optical/digital techniques, and currently constitute the bulk of DMA project pipeline time requirements and costs.

4.3.3.1 MC&G Product Description

Mapping, Charting and Geodesy exploitation of satellite imagery is a direct result of military and intelligence users' worldwide requirements for MC&G products and services. These products and services currently consist of some 230 different items which can generally be categorized as follows:

Compilation and revision of standard topographic maps and charts.

Generation of aeronautical data for chart overlays.

Generation and maintenance of information files and publications: Automated Airfield Information File, Notices to Mariners, and Flight Information Publications.

Development of digital data bases for storage and retrieval of extracted data.

Generation of data bases, such as DLMS, to simulate and operationally support aerospace terrain sensors.

Development of photogrammetric data bases.

Determination of point target coordinates.

The principal source for the generation of these products is satellite photography. To be useful for accurate map production, these photographic materials must possess qualities exhibiting sufficient resolution and metric stability. Currently, satellite imagery from the KH-9 sensors is the most economical form of imagery for application against the various MC&G requirements. It is the only system which provides imagery satisfactory for the production of MC&G products where synoptic coverage of denied areas is required.

Line Maps and Charts

Maps are a graphic representation, usually on a plane surface and at an established scale, of natural and manmade features on the surface of the earth.

Charts are special purpose maps, generally designed for navigation, in which essential map information is combined with various other data critical to the intended use, such as aeronautical information for aeronautical charts.

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The DMA family of maps and charts has developed over a number of years in a variety of scales and specialized formats designed to support different requirements, specifications and weapon systems. In general, cartographic products depend on the operation supported - land, sea, air, or combination. The intended use of a product also dictates such factors as scale, datum, grid and the nature and extent of features portrayed (planimetry, topography, radar return, intelligence, etc.). Table 4-14 summarizes representative cartographic products produced by DMA.

TABLE 4-14
SUMMARY OF SELECTED DMA CARTOGRAPHIC PRODUCTS

Approximate Map/Chart Scale	Optimum Accuracy (90% Probability)		Reference System Particulars				Representative Product(s)
	Horizontal (m)	Vertical (m)	Hori. Datum	Vert. Datum	Projection	Military Grid	
1:3,000,000	1500	—	Unsp	MSL	M	—	Naval Warfare Planning Chart
1:2,000,000	1000	150	Unsp	MSL	LCC/PS	GEOREF	Jet Navigation, LORAN and OMEGA Charts
1:1,000,000	500	75	Unsp	MSL	LCC/PS	GEOREF/ ACLANT	Operational Navigation, Bottom Contour Charts
1:600,000	300	45	Unsp	Local	M	UTM/UPS	Coastal Nautical Charts
1:500,000	250	38	Unsp	MSL	LCC/PS	GEOREF	Tactical Pilotage Charts
1:250,000	127	25	Pref	MSL	TM	UTM/UPS	Joint Operations Graphics
1:200,000	101	25	Pref	MSL	LCC/PS	UTM/UPS	Air Target Charts
1:100,000	50	15	Pref	MSL	TM	UTM/UPS	Topographical Line Maps
1:75,000	38	13	Local	Local	M	UTM/UPS	Harbor and Approach Charts
1:50,000	25	10	Local	MSL	TM	UTM/UPS	Large Scale Topo Line Maps and Combat Charts
1:25,000	13	3	Local	MSL	TM	UTM/UPS	Large Scale Topo Line Maps

Unsp - Unspecified
Pref - Preferred
MSL - Mean Sea Level
M - Mercator
LCC - Lambert Conformal Conic
PS - Polar Stereographic
TM - Transverse Mercator
GEOREF - World Geographic Reference System
ACLANT - Allied Command Atlantic
UTM - Universal Transverse Mercator
UPS - Universal Polar Stereographic

The scale of a map or chart depends on its intended purpose. A measure on the graphic represents an increasingly greater distance on the ground as the scale decreases. As shown in Table 4-14, large scale maps are applicable for ground and sea operations. The scale determines the amount and generalization of detail portrayed and limits the potential accuracy of horizontal and vertical information.

The accuracy of a cartographic product depends on the basic source material and the compilation/reproduction processes. The optimum horizontal accuracy for a cartographic product (Class A) is expressed in the meter equivalence of 0.5 millimeters at map scale (90% probability), and the vertical accuracy at one-half the contour interval (90% probability). The combination of scale and accuracy can subsequently affect the significance of the horizontal and vertical datum of the graphic.

Information Files

Various types of non-metric point/area targets are collected within KH-9 imaging operations that meet the requirements established to update airfield features, produce large-scale city maps and generate port/harbor charts.

Point Position Data Bases (PPDB)

The photogrammetrically controlled point positioning data base concept developed by DMA is defined as a set of controlled photographs, accompanying data, computer programs, and hardware enabling personnel to derive coordinates for any feature that may be located on the photography. This procedure was initiated to eliminate gross errors caused by inadequate positional data derived from maps which contributed to unacceptable mission results.

A photogrammetric process called analytical triangulation is employed to prepare PPDBs. An adjustment program on a large computer is used to assemble all individual photographs into a single homogeneous solution relative to available control. This final solution comprises the geodetically controlled PPDB which is a composition of the best geodetic and photogrammetric data for that area. Without further refinement, the PPDB can be used to provide target navigation point positions which meet current weapon system accuracy requirements.

Digital Data Base

Advanced aerospace navigation, training and mission planning systems are currently being developed, which will be dependent on the availability of digital data over large areas. These systems include the digital radar simulators for F-111, A-6, B-52, B-1, F-4, C-130 and C-141 aircraft; radar prediction devices for rapid and accurate generation of radar predictions for inclusion in operational and training mission folders; and hardware/software for automated SIOP mission planning. Correlation systems such as TERCOM and radar being developed for cruise missile, RPV, and other aircraft and missile navigation systems also require digital data derived from satellite imagery.

Strategic Target Data

The strategic point targets, predominantly in the Sino-Soviet area, are precise geodetic positional target coordinates in support of the SIOP of the Joint Strategic Target Planning Staff (JSTPS) with absolute accuracies on the WGS. The data base consists of Offset Aiming Points (OAP), Radar Fix Points (RFP) and the National Target Base (NTB); which total over 60,000 points. The Short-Range Attack Missile (SRAM) RFPs and the NTB have the same positioning requirement - 62 meters horizontally and 29 meters vertically, whereas the OAPs have a 46 meter point-to-point relative accuracy (LE 50%) within a target island. The NTB consisting of over 42,000 targets, is used by strategic forces in the implementation of the SIOP. The current technical objective for target positioning has been developed in conjunction with the development of the MX-ICBM. This improvement in the overall range of CEP's for the MX-ICBM is shown in Table 4-15.

TABLE 4-15

CURRENT AND FUTURE MC&G CONTRIBUTION TO IMPROVING MISSILE CEP FOR NTB TARGETS

	Current - To Be Completed FY 1980 (Meters)		Potential Future - MX Post-FY 1980 (Meters)	
Missile CEP (50% Probability)	230		90-150	
Total Geodetic and Geophysical (G&G) Contribution to Missile CEP (50% Probability)	78		30-46	
	Horizontal	Vertical	Horizontal	Vertical
Target Error Contribution to G&G (90% Probability)				
Circular Error	62	—	23-41	—
Linear Error	—	29	—	17-23
Orbital Contribution to Target Error (1 sigma) Horizontal Error				
In-Track	27	—	9	—
Cross-Track	16	—	9	—
Linear Error	—	9	—	9

4.3.3.2 Application of KH-9 Photography

Photography of the KH-9 MCS has very low resolution (20-50 feet) and small scale (between about 1:550,000 and 1:900,000). Therefore, intelligence requirements are not normally levied on the MCS. MCS photos are used for those MC&G applications which require precise geometric fidelity of the imagery, for products such as data bases and for horizontal and vertical control of new positions of points needed for precise location of strategic missile targets.

The MCS can act as a stand-alone system for both new and revised maps with small and medium scales (as large as 1:200,000) but cannot be used for products which depict radar return. The MCS has insufficient resolution for map revision at scales larger than 1:200,000 for which KH-9 panoramic photography is used.

When ground survey data are lacking, the KH-9 MCS can establish target positions on the WGS with accuracies better than 62m horizontal, Circular Error, and 29m vertical, Linear Error (both 90 percent probability). This is made possible by the availability of precise camera calibration data, the stellar cameras and timing data on the film, all part of the KH-9 MCS, together with the doppler transmitter and associated worldwide satellite tracking network. The camera calibration data are used to analytically remove effects of lens distortions and film shrinkage from the MCS terrain camera image. The stellar cameras are used to determine the attitude of the MCS terrain camera at the instant of exposure. The doppler transmitter and tracking network are used to develop a more accurate ephemeris of the MCS camera's position, and the timing data on the film permit determination of the camera's location at the instant of exposure, to provide accuracies of at least 18 meters in-track, 12 meters cross-track, and 6 meters vertical (one sigma values).

KH-9 panoramic photos are employed in those MC&G applications that require medium-high to medium resolution (2 to 20 feet). KH-9 panoramic photos provide medium-scale (about 1:110,000 to 1:180,000) coverage of large areas.

Uncertainties in the calibration, attitude, and orbit of the panoramic camera prevent the use of panoramic imagery as a single stand-alone system for compiling new maps. The compilation of new maps requires either KH-9 MCS photography or geodetic ground survey data for establishing a control network. Stereoscopic panoramic models are then fitted to this network to develop contour lines and fill in cultural details. Panoramic photos provide detail adequate for compiling or revising cultural features on maps, particularly at large scales but also at medium scales. It may also be used for revising small-scale maps in culturally developed areas. For revision of metrically accurate but culturally out-of-date maps, the panoramic photos are rectified and fitted to the map.

Imagery of 2 to 10 feet resolution provided by the KH-9 panoramic camera is also essential for determining radar reflectivity for 1:200,000 and 1:250,000 charts, and as a source of data for input into the Digital Radar Landmass Simulator.

4.3.3.3 DMA's Manpower and Equipment Review

The DMA is composed of a small headquarters consisting of 189 highly skilled professional and clerical people who direct the activities of about 7,500 people in three production centers. In addition, DMA is program manager for about 3,000 people assigned to the Military Departments but not under its direct control. To accomplish the DMA mission requires approximately a half billion dollars worth of resources. The total MC&G resources allocations are shown in Table 4-16.

TABLE 4-16

MC&G RESOURCE ALLOCATION

	Millions of Dollars
Facilities	105
Equipment	160
Annual Budget	246
Subtotal	506
Non-DMA	58
Total	564

The work force composition of the three production centers is shown in Table 4-17.

MC&G technology is extremely complex and requires the use of very precise and highly sophisticated equipment. Many processes require the application of automated digital and analytical plotting equipment unique to mapping. Equipment used in support of DMA's primary mission includes:

Stereocomparators for photogrammetric derivation of positional data;
Analytical stereoplotters for compilation of graphic and digital data;
Automated cartographic systems;
Scientific computers for geodetic, photogrammetric, and cartographic computations,
Lithographic reproduction equipment, and Photographic reproduction equipment

TABLE 4-17

PRODUCTION CENTERS WORK FORCE COMPOSITION

SKILLS	COUNT
Professional/Scientific:	[redacted]
Cartographers	
Geodesists	
Mathematicians	
Aeronautical Information Specialists	
Physical Scientists	
Other	
Wage Board	
Other	

The total investment for equipment to exploit the panoramic and frame imagery is over 71 million dollars (Table 4-18). This investment has been made to insure that DMA could

TABLE 4-18

MAPPING, CHARTING AND GEODETIC EQUIPMENT INVENTORY DATA APRIL 1977

(MILLIONS OF DOLLARS)

CATEGORY	DMAAC	DMAHC	DMATC	TOTAL
Photogrammetic	[redacted]			
Photographic				
Cartographic				
Geodetic				
Lithographic				
Automatic Data Processing				
TOTAL				

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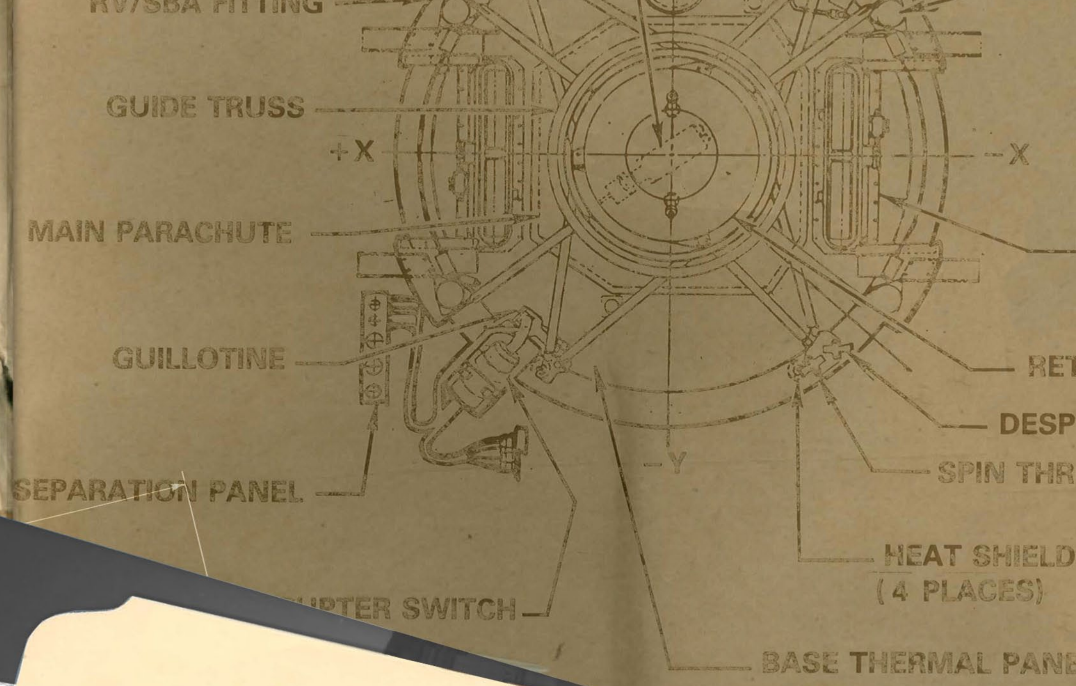
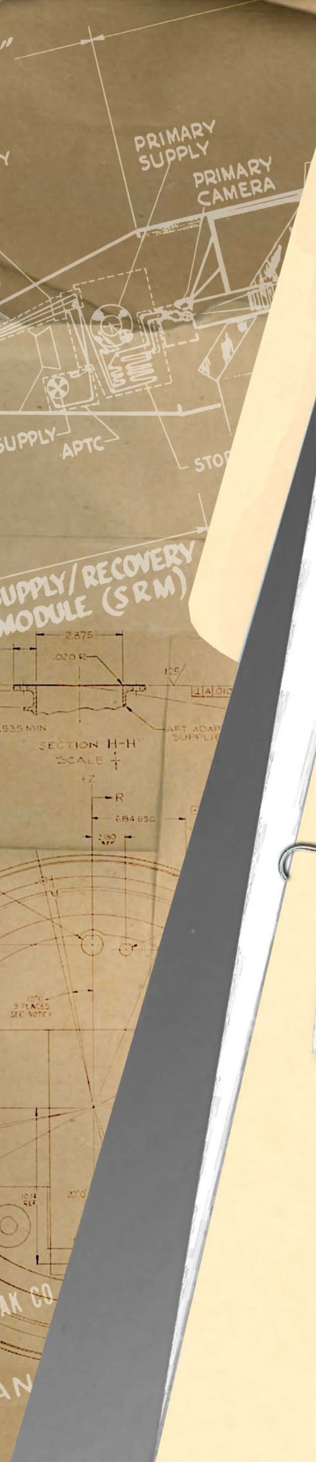
meet the MC&G requirements levied by DoD military and intelligence community users. Cost effective MC&G applications have been established during the life time of the KH-9 systems. Such application may well apply to other NRP imagery in the future; however, there will be additional cost associated with the necessary research and development for complete implementation.





CRITICAL TO US SECURITY:
THE GAMBIT AND HEXAGON SATELLITE RECONNAISSANCE SYSTEMS COMPENDIUM

SECTION VI: PROGRAM CONTROVERSIES

The Gambit and Hexagon imagery satellite systems offered the nation unparalleled capabilities at the time they were developed. They also resulted in a range of controversies in the very secret world in which they were born. The Air Force used the publically acknowledged Samos program to provide cover for Gambit. Samos was beset, however, with a number of problems that would eventually lead to the termination of the program. Various organizational elements wanted to gain some role in the Gambit program, resulting in additional tensions. The Hexagon program began as an independent effort in the Central Intelligence Agency (CIA) to develop a new generation of imagery search satellites. The CIA's independence caused concern and consternation within the National Reconnaissance Office (NRO) and the Air Force. The documents in this section represent some, but not all, of the concerns and conflicts that arose with the Gambit and Hexagon systems.

The Samos satellite program faced some very significant obstacles including development of new technology and new processes. By 1960, the Samos program was failing to meet program goals. On 1 July 1960 the Air Force Reconnaissance Panel and Samos Working Group met to discuss a revised Samos development plan. The minutes report from the meeting summarizes the urgency to address the difficulties encountered in the Samos program including significant attention from Dr. Joseph Charyk, Under Secretary of the Air Force, the Secretary of Defense, and the President of the United States. The concerns were magnified by a high level disagreement over the Air Forces' technical approach including doubts about the planned primary dependence upon readout photography. The minutes reflected that the overall problem was how "to get the Samos program off dead center." Samos would later be terminated by Under Secretary Charyk who was serving as the Director, NRO (DNRO). The Gambit program which was imbedded in the Samos program would be retained.

Plans for the Gambit program originally called for a land-based recovery of Gambit film. Program managers proposed this approach since it would permit recovery in the continental United States. The land based recovery approach introduced a number of technological challenges in order to protect the film upon landing. The protective mechanisms also added considerably more weight to the system. In a memorandum included here, Dr. Charyk discusses a land based recovery versus mid-air retrieval recovery. The memorandum affords insight into his decision-making processes. Dr. Charyk opts for the mid-air retrieval over the Pacific Ocean that had worked for Corona. This decision allowed significant weight reductions in the Gambit vehicle and proved to become a reliable means of recovery.

We have included a memorandum on efforts by the Military Air Transport Service to assume responsibility for the recovery of film return capsules. The Air Force Systems Command had demonstrated proficiency at mid-air retrieval by the time DNRO McMillan wrote this memorandum. In the memorandum he indicates that little would be gained by the proposed takeover, but much could be harmed. The mid-air recoveries required highly trained pilots and specially modified aircraft. McMillan explains that merger into a larger organization would do nothing to improve either crews or equipment.

DNRO McMillan became increasingly frustrated during his tenure with efforts outside the NRO to develop national reconnaissance systems. In an early letter to the CIA's Deputy Director for Science and Technology, Bud Wheelon, McMillan addresses the establishment by CIA of a joint working group for satellite photography efforts. Although cordial, McMillan requests that the CIA curtail efforts in meeting some of the working group objectives, especially with respect to the NRO's emerging Gambit and SR-71 programs. McMillan also seems to curtail access to Air Force facilities responsible for assembly and launch of the spacecraft. The letter serves as an exemplar of future conflicts between McMillan and CIA leadership where McMillan tries to rein in CIA space imagery efforts, especially with the Hexagon program.

Perhaps one of the most dramatic days in either the Gambit or Hexagon program was 24 February 1965. On that day, the leadership of Itek Corporation very surprisingly decided to discontinue their development efforts for the Fulcrum program follow-on. We have included three memorandums that describe the events on that day. The Itek leadership was able to meet with DNRO McMillan, and Polaroid Corporation President Din Land to explain their decision. McMillan happened to be attending a panel meeting nearby, chaired by Land to consider the options for pursuing a new wide area search satellite system. The memorandums for the record from McMillan and Paul Worthman capture the drama of the day. They also illustrate the level of animosity that had developed between NRO senior leadership and CIA's senior leadership over the Fulcrum program.

By the summer of 1965, the NRO and the CIA had agreed on "ground rules" for moving ahead with development of a new wide-area search satellite. Those ground rules are described in a memorandum from Fulcrum program manager, Jackson Maxey to the CIA's Deputy Director for Science and Technology. Both organizations agreed to fund, at approximately the same level, efforts to further develop concepts for the new system, but not purchase hardware. As noted earlier, the CIA was pursuing the Fulcrum program using a new camera system. The Air Force was examining modifications to Gambit that would allow it to perform wide-area search missions. The efforts would continue, pending a recommendation from the panel chaired by Din Land to decide the best approach for procuring the new wide-area search system.

Dr. Alexander Flax began serving as DNRO on 1 October 1965. By the middle of his first month as DNRO, Flax received a task group report on proposed management of the new wide-area search satellite. One of his first challenges was to settle the dispute over how the CIA and the Air Force should participate in the development of the new system. We have included three memos that address division of responsibility for system development and management. Dr. Flax received viewpoints at the beginning of November 1965 from CIA's program manager, the Air Force's program manager, and from the NRO staff director. Each offered assessments on how the labor could be divided most effectively to develop the new system. Flax carefully weighed the positions advocated by the NRO, Air Force, and CIA. By the spring of the following year he would recommend that CIA develop the sensor for the system and that the Air Force provide all other support for the new system, first known as Helix and then as Hexagon.

After resolving concerns about the management of the Hexagon system, the CIA and NRO would face questions about whether the cost of Hexagon was worth the additional capabilities offered by the system. In 1968 and 1969 there was a significant exchange of letters with the Bureau of the Budget (BoB) over this basic question. We have selected two letters to illustrate the basics of the arguments on both sides. Acting Director of Central Intelligence, Rufus Taylor, in his December 1968 letter explains the new capabilities that will be offered by Hexagon including higher resolution, time stamping, and the ability to verify Soviet forces as well as strategic nuclear capabilities. In his March 1969 letter responding to Director of Central Intelligence Richard Helms, the BoB's Robert Mayo, reviews the BoB assessment that Gambit and Corona have near sufficient capabilities for satisfying intelligence requirements. The argument would continue for the next several months until President Richard Nixon decided in June, 1969 to preserve Hexagon's funding.

While NRO and CIA leadership addressed Hexagon budget issues with the BoB, the leaders also faced questions about the Hexagon program schedule and likelihood of success. In 1969, DNRO, John McLucas asked his deputy, Robert Naka, to assess the likelihood that Hexagon would be on schedule and the likelihood of initial success. Naka's review panel would issue three reports before the first successful Hexagon launch in June 1971. We have included the first report where Naka concluded that the system would likely launch within six months of the planned December 1970 initial launch and that it would very likely succeed. Naka and his panel proved to be right on both accounts. The two additional reports can be found at NRO.gov.

The competition and tension between CIA and the Air Force continued into the 1970's. The final document included in this section highlights both. CIA program manager Robert Kohler provides reliability assessments of the Corona, Gambit, and Hexagon systems. In his assessment, Kohler determines reliability based on percentage of film returned rather than percentage of recovered capsules. Using this approach, he concludes that the Air Force's Gambit systems were less reliable than the CIA's Corona and Hexagon systems. The competition and tension between the Air Force and CIA programs at the NRO would continue until they were merged into functional organizations in the early 1990's.

LIST OF PROGRAM CONTROVERSIES DOCUMENTS

* Pages including full-page redactions and blank pages have been removed from this document.

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AFCRQ-PN/Panel

1 Jul 60

(U) Minutes of Joint Meeting of Reconnaissance Panel and SAMOS Working Group, 1 Jul 60

RECONNAISSANCE PANEL AND SAMOS WORKING GROUP MEMBERS

1. The Reconnaissance Panel and SAMOS Working Group of the Weapons Board met in room 5E377 on 1 Jul 60 at 0930 hours. The purpose was to hear a briefing on events of the past few weeks concerning the SAMOS system in an attempt to prepare for consideration of the revised SAMOS Development Plan which will be presented to a joint meeting on Wednesday, 6 July. The following briefing was presented by Col Shannon:

a. Recent events:

(1) 27 May 60, Dr. Charyk, Under Secretary of the Air Force, wrote Gen White a memorandum requesting preparation of a revised SAMOS Development Plan.

(2) 1 Jun 60, Gen Wilson signed a letter to ARDC, with info copies to SAC, ADC, AMC and AFBMD, directing the preparation of the revised Development Plan and quoting a guidance contained in memo from Dr. Charyk. A copy of this letter is inclosed as Atch 1. At the same time Gen Wilson signed this letter he requested Gen Strother to take the lead in developing an Air Staff position on four questions which were asked by Dr. Charyk and which are quoted in paragraph 4 of Atch 1. Gen Wilson stated that in his view these four questions had operational significance and, therefore, should be considered from an operational point of view.

(3) 7 Jun 60, Dr. York took note of the fact that the Air Force was attempting to resolve some of the controversial points surrounding SAMOS and requested that he be given a briefing at the earliest possible date.

(4) 10 Jun 60, the President wrote a memo to the Secretary of Defense stating that the SAMOS program needed to be carefully reevaluated and directed that a briefing covering the following

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points be presented to the National Security Council:

(a) What are the intelligence requirements for SAMOS?

(b) What is the technical feasibility of meeting these requirements?

(c) What are the Department of Defense plans for the system?

He assigned responsibility for the first and third questions to the Department of Defense and for the second question to his principal scientific advisor.

(5) Subsequent to the above exchange of memos, a three-man team was formed to conduct the NSC briefing, the team consisting of Dr. Charyk, Dr. Ruble and Dr. Kistiakowsky.

(6) Dr. Charyk requested that he be presented a briefing on the new Air Force plans on 5 July so that he could begin to prepare himself for the NSC briefing. Since this briefing must be presented by BMD before the Air Staff has an opportunity to evaluate the new plan, it has been agreed that the Department of Defense will attempt to delay the NSC briefing until after 12 July, thereby, giving the Staff a few days to evaluate the plan presented to Dr. Charyk and recommending any desired changes.

(7) On 29 June a letter to Gen Power was signed by Gen White stating his views and problems in connection with SAMOS and inclosing a copy of the supplemental guidance prepared by Gen Strother's staff in response to Gen Wilson's 1 June memo. Gen White's letter and supplemental guidance are attached as Atch 2 and 3. Subsequently this supplemental guidance was dispatched to ARDC, ADC, etc., with the statement that it had been approved by the Air Staff.

b. As a result of the above, the following schedules of briefings are now in effect:

5 July	Briefing for Dr. Charyk
6 "	Briefing to the SAMOS Working Gp and Recon Panel in a joint meeting
8 "	Presentation of the new Development Plan to the Weapons Board
11 " (AM)	Presentation of the new Development Plan to AFBMD
(PM)	Presentation to Dr. York

c. After explanation of the above events, the briefer presented a summation of the factors that had influenced the Staff in preparing the 1 June and 29 June guidance to ARDC and other agencies. The essence of this briefing is contained in Atch 4.

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2. After presentation of the briefing, considerable discussion ensued. Representatives from Plans discussed their problems in dealing with other agencies involved in approving the Air Force Operations Plan at JCS level and were given the benefit of the Panel thinking in this regard which, in summary, is that we should retain our operational concepts as expressed in preliminary operations plan and Gen White's 29 June letter but that within this framework we should assure all agencies that we are attempting to obtain no special advantage in exploitation of the "take" and further that technicians from other agencies would be welcome to participate in the processing and duplicating of the "take."

3. After this discussion, a discussion of Sub-system I was conducted. It was reported that possibly BMD would recommend that Sub-system I be separated from the SAMOS program as such and assigned to the Cambridge facility as a ground data handling system. In the consensus of the Panel, this action should be supported if recommended by BMD and ARDC, since it probably would result in closer coordination between the development of 438L and Sub-system I. The Panel, however, did not desire to propose this step unless it was recommended by the technical experts in ARDC/AFBMD.

[redacted] 1145 .

Colonel, USAF
Chairman, Reconnaissance Panel
[redacted]
Colonel, USAF
Chairman, SAMOS Working Group
Reconnaissance Panel, Weapons Board

5 Atch
1. Ltr fm Gen Wilson to ARDC, 1 Jun 60
2. Ltr fm Gen White to Gen Power, 29 Jun 60
3. Supplemental Guidance by Gen Strother
4. Factors considered in Guidance Preparation
5. Roster of Attendance

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THE PROBLEM

1. To get the Samos program off dead center.

FACTORS BEARING ON THE PROBLEM

2. Facts

a. 17 Nov 59 memorandum from Secretary Gates transferring Samos to the Air Force required:

(1) New development plan to emphasize physical recovery and provide for initial launch of recoverable payloads well in advance of the current schedule (early FY 62).

(2) Holding all steps beyond the current ARPA plan in abeyance pending specific approval from Office of Secretary of Defense.

b. New Development Plan, Development/Operations and Preliminary Operations Plans were submitted in February.

c. April 20 memo from Dr. York, replying to the 15 Feb Development Plan, stated:

(1) Samos program requires further adjustment: photo over ferret, recoverable photo over readout photo.

(2) Authorization to proceed on an interim basis with fund availability of 160.0 M in FY 60 and [redacted] in FY 61.

(3) Required AF to submit adjustments in accordance with paragraph a and b above.

d. The Under Secretary of the Air Force has withheld authority for the Air Force to spend [redacted] for "early fix" in the old Martin Bomber Plant at Omaha. Although he has never forwarded the directive, he has

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indicated that he has one from DDR&E requiring this action. As a result this headquarters has directed termination of the contract.

e. The development plan, per se, has progressed far enough to provide a substantial amount of concurrency for an initial operational capability. Facilities that will be available from the development program include:

(1) A control center at Sunnyvale.

(2) Two tracking and acquisition stations (Vandenberg AFB and New Boston).

(3) Launch pads (perhaps the most critical item)

f. The Air Force possesses a substantial capability to exploit reconnaissance photography in facilities that have been developed over the years and not specifically for Samos.

g. Substantial opposition to SAC control of the system exists. Following enumeration of apparent reasons for this opposition gives an indication of its scope:

(1) Lack of trust on the intentions and professional competence, in photographic intelligence matters, of SAC and the Air Force.

(2) Fear that SAC and the USAF want to become the national intelligence center.

(3) A predominant feeling that Samos is national, or even international, in character thereby mitigating against control by the major U. S. deterrent force.

(4) Belief by other agencies that the USAF does not freely and openly share its existing intelligence materials.

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(5) Jealousy of SAC.

h. Sub-system I is the subject of much criticism because:

(1) Its complexity is greatly increased by the ELINT requirement and serious questions exist about the state of the sensor art in this area.

(2) Its development has been based on estimates of the type of photographic take that will be received, but serious doubts exist as to the validity of these estimates (Readout vs Recovery).

i. The Air Force, so far, has not adequately responded to guidance from DOD on priorities in the development program.

j. The Air Staff is divided on the question of possible wartime survivability and utility of the system. This question must be treated by a separate study.

k. The Sunnyvale facility can control the operation for a fairly long time but is not adequate to exploit the photography nor to generate the Midas displays.

l. General White has instructed the staff to get a program that will sell rather than lose it.

m. Other recoverable payloads could possibly be developed faster than the E-5, and might have greater potential for solving the basic cover problem and detailed cover than either the E-1, E-2 or E-5.

n. The authority and funds to build the Martin Bomber Plant facility does not expire at the end of the fiscal year.

o. The operational nature of a readout photo system will require frequent coordination between the operators and the agency that makes first phase interpretation of the film.

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p. The operational nature of a recoverable photo system is such that frequent coordination between the operators and the agency that makes first phase interprotation of the film is not essential.

q. Photography of the USSR is of interest to many agencies, and since it is there are two separate and distinct steps in exploitation of any "take."

(1) Developing the primary film and providing duplicates to all authorized agencies.

(2) Interpretation and other uses of the duplicate copies by all agencies (SAC, ACIC, CIA, Army, Navy, AFIC, etc.)

3. Assumptions:

a. The operational photographic take from the first year's current readout R&D program will be inconsequential (SAC estimates 35 9x18 negatives per day of readout satellite operation).

b. No time phased estimates of take from recoverable packages is possible at this time because:

(1) The E-5, the only recoverable system in the current program, is not yet in the hardware stage and has serious technical problems facing it.

c. We cannot sell a facility in the Martin Bomber Plant for Samos at this time.

4. Criteria

a. Air Force plans for development and exploitation of Samos must be the very best that can be devised.

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b. The Air Force desires to retain its basic concepts for Samos operations. Specifically the preliminary operations plan currently under consideration by the JCS should not be violated.

c. It is necessary to break the political log jam that has consistently caused the Air Force's executive agents in this program to spend more time revising development plans than in actually supervising development of the system.

d. The Air Force must obtain and retain support and approval of its plans for development of Samos.

e. Any steps taken to reorient the Samos program must be carefully examined for impact on the Midas program and the Midas program must be adjusted to prohibit slippages in an operational Midas system.

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DISCUSSION

1. From the list of facts and assumptions it is apparent that Samos faces serious problems, both technical and political. The political problems have been magnified by high level disagreement on our technical approach. Further the Air Force has not been properly responsive to prior technical guidance.

2. Serious doubts of our planned primary dependence upon readout photography exist in the scientific community. Our operational system facilities were planned on the basis of the assumption that readout would prove satisfactory. Since this assumption is questioned most seriously, we are accused, perhaps justifiably, of leaping to conclusions supporting a grandiose operational program before we had any justification to do so.

3. The objections to SAC control has many facets. Since the first step in our plans for an operational system involve an interim data processing facility in the Martin Bomber Plant at Offutt, this step has been denied us. Our opposition can attack it on several grounds:

a. It is designed to expand into the center of our operational facilities, which are themselves questioned.

b. It will lead to complete SAC control of the system.

c. The R&D take foreseeable now will be too small to justify this action.

4. It must be recognized that the Air Force is not helpless in photo intelligence capabilities. So far as can be determined no complete study of existing SAC capability vs expected R&D take has been conducted, considering especially recent events. It appears that any attempt to obtain release of funds for an interim facility in the Martin Bomber Plant must clearly show that the entire command workload is such that purely SAC exploitation of reasonable R&D take cannot be conducted within existing capabilities.

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. . . .:

.. "Early fix" is recognized as the first step in establishment of a . SAC facility for control of the operational system;

. The plans for operational system facilities are based on the . . . tion that readout will be the primary operational mode; and

. The operational system required to operate and exploit readout . . . are more elaborate than those for recoverable systems, the . . tical and technical opposition to our present program is able to . . . on this seemingly minor issue (only [redacted] is involved). This . . sition is so formidable that we have been directed to withhold this . . ility, and from this one issue has stemmed most serious questions as to our technical and operational plans.

d. It is not vital to Air Force plans that the initial film processing and duplicating be conducted at the same location that SAC uses for exploitation of the photography. If subsequent studies of this problem indicate that other facilities can do the processing and duplicating job better, the Air Force should not object to their being utilized.

e. Colocation of data handling and Samos control centers is not essential if recoverable systems are the only ones used. However, readout systems probably will require this. This does not address the obvious requirement for exploitation facilities to be immediately available for . . Hqs. Since SAC Hqs does have a targeting problem requiring Samos . . ., a data handling capability must exist there. Therefore, one could . . . that if the control center is finally located at SAC, there is an urgent . . . irement for colocation of the data handling and control centers.

. . . SIONS

. The Air Force must be responsive to technical directives and develop . . . best possible program.

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2. An open-minded approach to the R&D program and the operational facilities required will be extremely difficult for the scientific community to challenge.

3. The Air Force should not insist on an interim facility in the Martin Bomber Plant at this time at the risk of further complication in the program, particularly until it is proven that current facilities are not adequate. This is especially true since it is politically unpalatable.

4. The following items are necessary before we can defend any firm position on additional exploitation facilities requirements:

a. Comprehensive review of current exploitation facilities available to the Strategic Air Command.

b. Current command workloads.

c. Best possible estimates of R&D take (these can be based only on a new development plan, not on existing schedules).

5. Questions of the utility of the Samos system in general war must first depend on the degree of survivability that can be provided. If survivability is possible, other operational factors must be considered — factors such as: reliability, flexibility, competing systems, etc.

6. Concurrency built into the development plan gives a substantial capability to exploit either a readout or recoverable system.

7. Any delay in the Martin Bomber Plant facility has serious implications in the Midas program since the Sunnyvale facility cannot handle the display generating equipment.

8. Interim facilities for processing and duplicating the primary record photography and supplying all users must be made available. Further study of the final answer for the processing and duplicating facilities must be conducted.

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RECOMMENDATIONS

1. That the Air Force support the directives that we have received requiring payload development in the following order: recoverable payload, readout payload, ferret payload.

2. That the Air Force adopt a completely open mind on the R&D program and the subsequent facilities required for an operational system.

3. That reconsideration of the hard vs soft problem begin with a technical study of the problem of giving the system survivability.

4. That the Air Force defer any move to establish an interim facility at Offutt until we have more facts on which to base our claims.

5. That consideration be given to the NORAD complex in Colorado as a strong possibility for location of the Midas display generating equipment.

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MEMORANDUM FOR THE RECORD 19 Sep 62

SUBJECT: Approval to Re-Orient Program 206 to Air Retrieval Over Pacific Area

A meeting was held in General Greer's Conference Room, 4th Floor of Bldg. A at the R&D Center, from 0830 to 1000 hours on 18 September 1962 with the following in attendance:

Pentagon	SSD	SSZX	Aerospace
Dr. J. Charyk	MajGen R. Greer	Col Q. Riepe	Dr. A. Donovan
[redacted]	Col R. Berg	[redacted]	Dr. W. Leverton
Col Martin	Col J. Ruebel		Mr. W. Sampson
Col Strand	Col Smith		
LtCol J. Sides	Capt Gorman, (USN)		

Purpose of Meeting:

1. To reaffirm the primary requirements of the program.

2. To determine the best design approach to meet these requirements.

3. To obtain approval of the fund requirements for the design approach selected.

Discussion:

Colonel Riepe gave the first part of the presentation outlined on Document V-2132 covering charts 1 through 8. On the questioned posed regarding the primary requirements of the program, the following comments were made:

Dr. Charyk: At the beginning of the program some of these requirements (precise land impact within a 3x10 area) presented here were objectives, not firm requirements that could not be relaxed regardless of cost and schedule.

Gen Greer: I agree but it has taken time to see which of the original objectives should be relaxed. Today, you will see the ultimate in relaxation of some of the original objectives.

Mr. Sampson then gave the second part of the presentation covering charts 9 through 43. On the point of longer mission life, these comments were made:

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Dr. Charyk: I am not sure why you want longer mission life.

Gen Greer: I thought I understood you to say two or three meetings ago that you were interested in this.

Dr. Charyk: Perhaps desirable for multiple mission flexibility.

Colonel Riepe then concluded the presentation covering charts 44 through 71. During this part, some of the more pertinent comments were:

Dr. Charyk: Do you have a column for complete program termination?

Col Riepe: No.

Dr. Charyk: I am ending up [redacted] to the good in FY 63 (by deciding on the H-30 over water retrieval design).

[redacted] You show [redacted] for GE for 698AL (land retrieval) and [redacted] for H-30, a simplier approach. Why is this?

Col Riepe: At this point in the program there are unrecoverable cost that have been expended on land retrieval. These costs are included in the [redacted] This figure is a 7% reduction of GE's estimate.

Gen Greer: We probably could negotiate these costs down but would most likely just be building in an overrun.

LtCol Sides: With the Discoverer schedule decreasing, I do not think it will be necessary to increase 6594th strength for Program 206. (H-30)

Dr. Charyk: We sent out a casual request for water retrieval and everyone grabs onto it like a drowning man to a life raft. This shakes our confidence in what we heard last August.

Gen Greer: I never really thought we would try for land impact on the first flight. What was the rationale of going for land in the first place?

Dr. Charyk: Operating cost, efficiency, security. If we are really going to get sophisticated in this space recovery business, we are going to have to learn to land these things in our backyard.

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Dr. Charyk: (Regarding recommendation to use H-30 water retrieval) We don't have much option, do we? What are your thoughts as where we go from here? Do we go on with this forever"

Gen Greer: Land recovery doesn't make much sense except in an emergency.

Dr. Charyk & [redacted] Ultimate economic approach may be land recovery. It is expensive to keep an air-sea recovery force in operation. The development of an acceptable land recovery capability may be 10 - 15 years away.

Dr. Charyk: If you are going to recover men, you are going to have to develop a land recovery capability.

Dr. Charyk: Cancel present program (land). Proceed with H-30 (air retrieval-water). Will deliberate between now and January 1963 regarding follow-on recognizing there is a 2 - 3 month Atlas lead time problem. ([redacted] indicated that the Atlas lead time problem would be taken care of by placing orders against unidentified space shots).

Dr. Charyk: The 40-day launch interval is not a bad schedule if it is realistic.

Gen Greer: We are confident this is a realistic schedule for the RV but we may have problems with the OCV.

Dr. Charyk: (Summarizing)
We can handle the Atlas lead time problem, so basically it means a decision in January on follow-on (based on GE follow-on lead time)

> Simplest design approach - H-30
> Next - some land capability
> Third - In-house study by Aerospace and AF on land recovery. What does land recovery ultimately buy you?

Dr. Leverton: Would you comment on kill probability? Are we in the ball park?

Dr. Charyk: I think the range you are working within is a good number (10^{-6})

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Dr. Charyk: (Summarizing again)
Use H-30 for initial ten (10) shots
Do this study between now and January to determine what course to take on the follow-on
Life of program - 63 to 65
You did not discuss the point but if you were starting over, would you use same payload or would you go panoramic?

Gen Greer: We have looked into panoramic.

Missed pertinent comments here.

Dr. Charyk: We are now enamored with this program (H-30). What are the problems with this one?

Gen Greer: It is not without problems. We still have some of the same ones such as stabilized platform, [redacted]

Dr. Charyk: What is the possibility that six months from now we will say we need panoramic camera?

Gen Greer: It is not zero but like 20%.

Dr. Charyk: You went to GE and said let's go Discoverer. They leaped on it. Now, if we went to EK and mentioned panoramic, would they leap on it?

Gen Greer: No. We have already done this.

[redacted] We have got to protect the budget for the follow-on.

Dr. Charyk: We will get some brilliant idea in January - have a program modification.

[redacted] That might be a little late.

Dr. Charyk: Call out H-30 all the way and in January I'll see if I want to change it. If changed in January, make some additions (to budget) at that time.

[redacted] What is FY63 requirement for H-30 follow-on?

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Col Riepe: [redacted]

Dr. Charyk: We will give consideration later on this year to land recovery. We will go with H-30 now.

Dr. Charyk: Let's get GE tied down on contract immediately (all contracts negotiated). Where do we stand now?

[redacted] We have two contracts negotiated - Phase A for design, development, testing, qualification;and Phase C, the corresponding "black" portion of Phase A. GE's proposal for Phase B - production of satellite vehicles - is due November 15.

There was a general discussion at this time regarding how to expedite the definitization of the outstanding letter contract (AF -155), the use of one white contract instead of two, and the desirability of using a CPFF contract for Phase A and a CPIF contract for Phase B.

Not much can be done at this time to expedite negotiation of AF-155 unless we can get GE to submit its proposal sooner than November 15, which is doubtful.

All right to use one contract instead of two. (Note: Apparently problem of having one contract for a large amount - like over [redacted] - is not considered a problem from a security standpoint anymore).

CPIF vs CPFF for Phase B.

Dr. Donovan, Dr. Leverton, and Mr. Sampson of Aerospace expressed reservations of being able to develop any meaningful performance incentives that could be reasonably measured during the design, development, testing and launch of the first ten SVs as the specifications are being developed during this period and are therefore subject to many changes. Dr. Donovan stated that about all you can do during this period is to measure QC.

Gen Greer and Col Riepe also expressed reservations on the appropriateness of writing performance incentives during this phase (first 10 shots).

Dr. Charyk: How many will you have to fly before you have realistic cost and performance data?

Dr. Donovan: May not have to fly any but will need to complete a considerable amount of testing.

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Dr. Charyk: What is our confidence for a June launch?

Col Riepe: Schedule calls for week 22 (1 June). May have problems.

Col Martin: Do you think the 4th flight will meet full spec on [redacted]

Col Riepe: Yes.

Gen Greer: Are you talking about camera changes within this scheme?

Dr. Charyk: Only in regards to reliability.

DECISIONS

1. First ten (10) SVs will be H-30.

2. Follow-on will be H-30 which will be subject to change in January to incorporate limited land capability, but we are to proceed with procurement action now.

3. Cancel what we have on ice (precise land impact)

4. AF and Aerospace will make in-house study between now and January regarding desirability of land recovery.

5. May write one (white) contract instead of two (white) for first ten SVs.

6. Write CPFF contract for first ten SVs or appropriate portion thereof. Consider CPIF for any balance SVs not on CPFF contract.

7. Write CPIF contract for follow-on.

Talk incentives after get cost.
Will not consider any letter contract but must start program with a definitive contract (Note: This is an extremely tight schedule to get CPIF definitive contract distributed by GE lead time for follow-on approximately 1 March 63.)

The above is from notes taken at meeting by [redacted]

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18 OCT 1963

MEMORANDUM FOR The Vice Chief of Staff, USAF

SUBJECT: Space Recovery Responsibility

Further to our recent discussion concerning programmed transfer of space recovery responsibilities and aircraft from the Air Force Systems Command to the Air Rescue Service of the Military Air Transport Service, I have reviewed this entire subject.

On close examination, it is evident that some of the apparent advantages of such a transfer will not be realizable in practice. Assigning the aircraft in question to a command having a larger fleet of the same basic aircraft will not provide better support to either the recovery operations or the other responsibilities of the command, since the aircraft in question must be specially modified with unique recovery gear to carry out the air catch recovery operation. Neither unmodified C-130 aircraft nor aircraft configured for ground recovery missions are interchangeable for use in the air catch mission. This special modification includes not only the installation of the recovery equipment within the fuselage but also includes special engine modifications which provide power for the recovery equipment. The modification cost for each aircraft is [redacted]

Programmed operations will preclude utilization of these air catch aircraft in other missions. These operations include, in addition to scheduled recovery operations, substantial requirements for the recovery fleet to hold in a ground alert status. In addition, there is a continuing training requirement, since it is necessary to maintain a very high degree of proficiency on the part of all pilots checked out in the air catch operations. This is imperative, since the entire cost of all equipment and operations which precede an individual recovery may easily be lost by lack of sufficient pilot skill at the crucial instant of recovery. In order to qualify as recovery pilot of these aircraft, current requirements are 25 successful training recoveries, requiring 70 hours flying time in training in the air catch

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aircraft. After initial qualification, a minimum of eight successful recoveries per month is required of all recovery pilots to maintain the qualification. These requirements not only affect the availability of the air catch aircraft for other missions, but preclude the substitution of other C-130 pilots into the air catch operations.

I also find that the aircraft utilization actually realized is outstanding, particularly in view of the limitations imposed by substantial ground alert requirements, and it is difficult to see how transfer could in any way improve this performance. The flying time during the last 12 months has averaged over 62 hours per aircraft per month, for the seven aircraft assigned.

I think we must consider the proposed transfer in the light of its effect on critical national effort associated with the mission of the air catch recovery unit. In this regard, I cannot see that the proposed transfer will make the job better, easier, or more responsive in any way. Neither can I see how such transfer can make any of these present resources available for any substantial employment on other missions. On the other hand, the involvement of an additional command with the present effort, will unavoidably introduce additional echelons of command and coordination.

It is my conclusion that the proposed transfer should be cancelled and the recovery unit retained in its present assignment. I will be happy to discuss this further if you desire.

Signed

Brockway McMillan

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DEPARTMENT OF THE AIR FORCE
WASHINGTON

OFFICE OF THE UNDER SECRETARY

November 18, 1963

Dr. Albert D. Wheelon
Deputy Director (Science & Technology)
Central Intelligence Agency
Washington, D. C., 20505

Dear Bud,

The establishment of the Satellite Photography Working Group, composed of qualified CIA, DOD and Industry representatives, affords an excellent opportunity to achieve a more basic understanding of the reasons for the variations in quality and resolution we have experienced to date with the CORONA system. The conduct of the initial session on 13 November was well thought out. I am sure that the motivation provided to the Group will have a definite influence over the course of the study efforts.

Your memorandum of 5 November outlining the organization, objectives, personnel selections, and working arrangements did not reach me in time for me to provide you with considered comments and recommendations prior to the initial meeting. I am in general agreement with the overall approach you have outlined, and in fact am looking forward to the benefits that should accrue to the NRP when the Group completes the study. There are however a number of points on which I should like to comment in more detail.

It seems to me important in the case of studies, such as this one, by outside groups to be sure that the task is well enough defined in content and scope that all parties recognize what is to be accomplished and can be confident of its accomplishment in a reasonable length of time. I feel therefore

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that the three month's duration suggested in your letter is appropriate, and that this should be made explicit in the planning of the Group's activities. We can of course review this decision as the Group's work continues; as noted again later, I suggest that this review certainly be made about mid-January.

In part to assist in delineating the task, and in part for another reason to be noted, I feel that objectives a, b, c, and d, as outlined in your memorandum should be undertaken specifically in reference to IDEALIST and CORONA. This limitation can be reviewed later. At the present time, however, I think it would be unwise to divert the Group into analysis of systems still under development until they have succeeded in their task as applied to our presently operational systems, for which both our data and our experience are more complete. In requesting this limitation, I do not mean to restrict access to the results of the GAMBIT and OXCART tests to date. In fact, I think that these results will help to separate external influences, such as that of the atmosphere, from factors internal to the CORONA and IDEALIST systems. If further tests are desirable with GAMBIT or OXCART for obtaining comparative data, these should be considered.

I concur with the objectives f, h, and i as described in your letter. These objectives occupy an area of study which, it seems to me, has been the subject of much casual conversation but very little definitive objective analysis. I believe that these three objectives should receive very serious consideration by the Working Group.

The objectives to which I have referred above represent important work which seems well suited for such a group as you have selected. The working arrangements also seem amenable to a serious attempt to reach them. I believe that the Group should be limited to these particular objectives, and every effort be made to reach them. In particular, I agree with the view that I believe you expressed at the opening meeting, that the objectives listed as e and g should not be specific responsibilities of this group. Although the results of the

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Working Group's efforts may well form the basis of specific product improvements, as well as design of newer systems, the task of determining the specific improvements to on-going systems is an NRO responsibility which should be assigned to the responsible NRO technical management unit, with contractor participation controlled by this unit, and personnel of competing contractors excluded. Similarly, the determination of the design of new systems is also a task for appropriate NRO technical personnel, although the results of the Working Group should be most helpful in this work.

The arrangements outlined in your letter seem well planned. I do however question any early need for visits of the Group to preparation, loading, and launching facilities, except perhaps for general orientation. If there is any adverse effect on the performance of the system exerted by the preparation, loading and launching activities, it must be exerted by influencing some element of the optical path or by disturbing the motion of vehicle or film. It seems to me a first task of the Group is to get a quantitative feel of the effects involved, and an understanding of what the sensitive elements of the optical and mechanical system really are.

As to staffing and organization, I think that the Working Group should be kept as small as possible, and confined to the very best qualified people. In my view, this is necessary, not only to be consistent with a basic NRO philosophy, which we continually enforce over strong objections within the Department of Defense, but even more fundamentally, to insure the accomplishment of something of real value. Consistant with my comments contained herein, the NRO will provide the requested personnel support and provide information necessary to the work of the Group.

I have selected Lt Colonel Henry Howard of the NRO Staff and Lt Colonel [redacted] of NRO Program A (SPPL) to serve as members of the Working Group. I consider both to be well qualified for this effort and am confident that they will contribute materially.

In regard to the funding of the Group effort, inasmuch as NRO is tasking DD/S&T to accomplish this project, I am agreeable

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to the use of the NRO funds for the costs associated with outside consultants only. Accordingly, I have instructed the Comptroller, NRO, to provide financing directions to Director of Program B.

I will appreciate your instructing the Group to direct its efforts to objectives a, b, c, d, f, h, and i as outlined in your letter and requested herein. I am interested in being kept informed of the progress being made. I suggest that by 15 January 1964 an interim status report be made to Gene Fubini, you, and me for determination of progress for subsequent orientation of the study.

Sincerely,

BROCKWAY McMILLAN
Director
National Reconnaissance Office

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24 February 1965

MEMORANDUM FOR RECORD

SUBJECT: Telephone Conversations with Representatives of the Itek Corporation

This afternoon, in the absence of General Stewart, I was seated in his office speaking to General Bleymaier when a telephone call came for me from Mr. Walt Levison, Itek Corporation. He asked me first if I would agree to keep silent on the information he was about to relate until such time as he would release me from the agreement. I told Walt that this was a difficult agreement to make "in the blind;" I needed some idea as to the content of what he was going to say and the probable duration of the secrecy to be imposed upon me. Furthermore, I could not agree to silence in any area which might adversely affect the organization of which I am a member. He assured me that the need for silence would not extend beyond several hours or perhaps a day and that it could not possibly harm the ~~(S)~~ NRO. He also advised me that Mr. John Wolfe was monitoring the telephone call. With these assurances, I agreed to preserve the Itek secret.

Walt then made the following remarkable announcement: "For a multitude of reasons, Itek has come to a corporate decision that it cannot accept the follow-on to FULCRUM, even if it is offered." He emphasized that this was a corporate decision; he also stated that there were no conditions which would change this attitude. At this point, Dick Philbrick spoke, confirming what Walt had told me.

It was an emotional moment; Levison's voice was shaking throughout the conversation. I told him that it was the most dramatic statement that I had ever heard and intellectually "shocking" from an industrial organization. I reassured him that I would not divulge any part of this information without his specific permission, but I was very much interested in what Itek proposed to do next, now that the decision had been made. Walt stated that the main reason for calling me was to request advice as to the proper scenario for handling the situation. I stated that the first thing Itek had to do was to advise its FULCRUM sponsor - Mr. McCone - of the decision. He said that Mr. Lindsay (President of Itek) was trying to get through to Mr. McCone by telephone

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to do just that. I urged him to move very quickly; specifically, I pointed out the danger of waiting several hours or perhaps a day until one could locate or gain access to Mr. McCone. If Mr. McCone were not immediately available it seemed to me Itek should convey its message to General Carter or to whoever was in charge of the Agency at the moment. I pointed out that the Land Committee was in executive session and that it would be most embarrassing to all participants if the Committee were to make a decision and then receive the Itek blockbuster. Levison and Philbrick agreed on the need for quick action. They informed me that they did not know where the Land Committee was meeting and asked if they could rely on me to arrange an assured audience with Dr. McMillan or Mr. Land on short notice. I agreed to do this.

About twenty minutes later Walt called again to say that Mr Lindsay was unable to reach Mr. McCone but had passed the corporate decision to Mr. Bross. Would I now arrange for a meeting with Mr. Land and Dr. McMillan? I promised to have them in telephone conversation with Dr. McMillan within five minutes.

I located Dr. McMillan at the Polaroid plant, called him to the telephone, and, without divulging the nature of the Itek announcement, urged him to call Walt Levison immediately at Volunteer 2-0419. He did so and seven minutes after Walt's second telephone conversation with me Walt had completed a conversation with Dr. McMillan and was on his way to a meeting at Polaroid.

I consider myself restricted by my agreement with Walt and have not divulged any of the information he has given me as of the close of business today.

PAUL E. WORTHMAN
Colonel, USAF

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25 February 1965

MEMORANDUM FOR RECORD

SUBJECT: Itek Discussions with Dr. McMillan and Mr. Land

Walt Levison called me at my home last night at about 2000 hrs to advise me that he had met with Dr. McMillan and Mr. Land in the Polaroid factory late in the afternoon to announce the Itek corporate decision regarding FULCRUM. He said he had stated categorically that under no condition would the Corporation accept a follow-on FULCRUM contract.

Both Dr. McMillan and Mr. Land were "stunned" by this announcement. Dr. McMillan reminded Walt immediately of his own technical preference for the EK proposal. Walt replied that he was aware of this preference, that Dr. McMillan had advised him of this reaction previously, and that the Itek decision was made with the full knowledge that it would cut the Corporation out of additional satellite camera development within the near-term future. He stated that Itek felt it could not survive under the "domination of the CIA." He also referred to the CIA as fostering an "immoral environment" which was becoming increasingly unacceptable to Itek. Walt stated that Mr. Land's response, after a long silence, was "what will I tell my Committee?"

I congratulated Walt on a brave and honorable action and asked him to pass my comment to the Corporation president, Mr. Lindsay.

For further events surrounding this situation one should consult a memorandum for record prepared by Lt Colonel Howard, who was at the scene of the meeting during this period.

PAUL E. WORTHMAN
Colonel, USAF

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FULCRUM

February 25, 1965

MEMORANDUM FOR RECORD

Recording events that took place on the afternoon of 24 February during the closing hours of the meeting chaired by Dr. Land. At approximately 5:00 P.M., I received a message from Colonel Worthman reporting that Mr. Levison of ITEK wished to talk to me at once. I called Mr. Levison. He said that the ITEK Corporation had made a Corporate decision that he thought might be of importance to the deliberations then going on with Dr. Land's Committee. He asked that he be given an opportunity to speak to me and to Dr. Land privately. I urged him to come to Dr. Land's office at once. Dr. Land's secretary arranged for the use of a private room and Dr. Land and I met Mr. Levison and Mr. John Wolf in this room at about 6:00 P.M. Mr. Levison stated that he had a Corporate decision to report to us and wished to make some preparatory remarks first. He said that he wished to make clear that the decision ITEK had made was a considered Corporate decision, that it was not politically motivated, that ITEK had no intention of seeking favor or special treatment of any kind as a result of this decision. He then said that that afternoon he, Mr. Lindsay, Mr. Philbrick and other members of the ITEK management, some of whom he named, had decided that they would not accept from the CIA any follow-on development contract to their present contract on FULCRUM. He said that he was not sure what the legal and moral obligations of ITEK were in respect to a proposal now before the CIA to continue the present FULCRUM effort for 30 days more.

He said that this decision had been arrived at at approximately 4:00 P.M., that Mr. Lindsay had immediately tried to telephone Mr. McCone. Mr. Lindsay had been unable to reach Mr. McCone by telephone, but had communicated the substance of this decision to Mr. Bross at the time of his call, i.e., approximately 4:00 P.M. He further said that Mr. Lindsay and Mr. Philbrick were already on their way to Washington with the hope of seeing Mr. McCone personally during the evening.

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Subsequent discussion brought out a number of circumstances surrounding the ITEK decision. Some of the significant points made by Mr. Levison and Mr. Wolf were the following.

1. ITEK felt that they could not maintain their "technical integrity" if they undertook a development project for FULCRUM with as little technical control over the project as they had been allowed during the work up to this time.

2. ITEK felt that the rotating optical bar technique to be used in FULCRUM could not be justified unless there was a firm requirement for scan angles of 120° or more. ITEK had on a number of occasions expressed this judgment to the CIA, at least once in writing in a letter from Mr. Levison to Dr. Wheelon, approximately 3 February. (This was the only specific citation of a written demur on this subject made in the conversation. The statement was made that other correspondence had also raised the same question.)

3. John Wolf stated that at a meeting at which all of the associate contractors were represented, he had pointed out that ITEK believed that the rotating optical bar could not be justified unless the CIA validated a firm requirement for 120° scan. In response, Dr. Wheelon had successively queried Mr. Maxey, Mr. Derks and one other member of the CIA staff whether "at any time, either verbally or in writing, they had stated to ITEK a requirement for 120° scan." All three of these people addressed individually with this question replied, "no". A fourth member of the CIA staff who entered the room during this conversation was also queried. He pointed out that the requirement for the 120° scan was stated in the ITEK contract.

4. Reference was also made to the fact that Mr. Derks, on the 23d of February, had specifically stated that the CIA was considering both 120° scan and 90° scan angles.

5. Mr. Levison stated that in June of 1964, Mr. Philbrick had asked Dr. Wheelon for permission to brief me on the FULCRUM project. He stated that this permission was denied protem and that several other requests during the summer were also denied. He said that in August, Dr. Wheelon had finally told Mr. Philbrick that Dr. Wheelon would be the point of contact between ITEK and me on the FULCRUM project.

6. It was brought out that ITEK had never been given any information from the associate contractors working on alternate film drives or alternate camera concepts. At this point I stated that I had never received any written technical information on the FULCRUM project except some copies of briefing charts that were used in Mr. Maxey's briefing to me in August 1964.

I pointed out at one time that in my judgment the NRO could never function effectively as long as people of the character, and sharing the attitudes, of some of those who had been promoting FULCRUM were in a position to interfere with the conduct of the National Reconnaissance Program.

I reminded Mr. Levison of the meeting that I had with him in my office during the preceding week, at which time I had told him that I felt that technically the Eastman Kodak general search proposal was more satisfactory than either of those being pursued by ITEK, but that I felt that it was important that the ITEK pancake idea be pursued further to be sure we were not overlooking important values and to be sure that we had a backup should any difficulties develop in the Eastman approach. Mr. Levison agreed that our conversation had covered these points and reminded me that he had disagreed with my technical judgment at the time and that he still disagreed. I noted that I had told him then, was repeating now, that it was precisely because I respected his disagreement that I felt the ITEK should continue. I pointed out, but not in connection of this exchange of remarks, that if ITEK did not continue work on FULCRUM a number of highly competent people could be made available to support a more vigorous effort on the ITEK pancake concept. I found on occasion during the meeting to state that I had always been impressed by the personal courage and integrity of Mr. Levison, Mr. Wolf, and that the events of the moment confirmed that impression.

Dr. Land raised a general question as to how we could be sure that the competence and resources of ITEK were preserved and made best use of by the Government. I said that I felt there were a number of things very important to do including further work on general search systems to which ITEK could contribute effectively, but no details were discussed. There

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was some discussion of the manner in which ITEK's announcement would be made available to Dr. Land's panel, one of the principal questions being whether Mr. Lindsay's call to John Bross should be considered adequate prior notice to the CIA, freeing Mr. Levison to report to Dr. Land and me and, in turn, freeing Dr. Land to speak to the panel. Mr. Levison stated that it was with the full knowledge of all of the Corporate Officers who participated in this decision, that he was coming to Dr. Land and me and that he personally felt and believed that Mr. Lindsay so felt also, that Mr. Lindsay's effort to reach Mr. McCone constituted adequate prior information to the CIA and that as far as Mr. Levison was concerned, we were further to use this information. The discussion closed at approximately 7:00 P.M.

At least twice during the discussions, Mr. Levison stated that it was ITEK's considered judgment that the decision to withdraw from FULCRUM was in their best Corporate interest and that it was his personal judgment that it was indeed in the Government's best interest. In elaborating on the Corporation interest, he noted that if ITEK were to undertake a development on FULCRUM, they, as a Corporation, would be held responsible for the outcome and that he did not feel that they could accept this responsibility without greater freedom for technical decisions than they had been given during the study phase.

Several technical difficulties that might develop in the FULCRUM system were discussed during the meeting. John Wolf emphasized the severe effects on vehicle motions that would result from even slight amounts of unbalance in the large rotating parts. In particular, he noted that an eccentricity of one inch in the balance of a reel of film would probably be catastrophic in the present design. Reference was made to details on this point provided during Tuesday's briefings. Mr. Wolf pointed out that the eccentricity of .003 inches, cited in the Tuesday briefing, was the result of one measurement of one reel of film.

Early in the discussions, Mr. Levison recited in some detail the dialogue between him and Mr. McCone that took place after he and Mr. Herther had briefed Mr. McCone and Mr. Vance on their pancake system on 2 February. He noted that at that time he had

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stated that the preference for FULCRUM or the pancake depended on exactly what requirements were levied and, in particular, he recalled that he had been cited a requirement for a 4-day search as being one of those that led to the FULCRUM configuration. He recalled further that Mr. McCone had emphasized ITEK's five-years experience with general search systems and had asked whether using this experience, irrespective of requirements, they would choose the FULCRUM approach. Mr. Levison noted that he had declined to answer that question, and identified it to Dr. Land and me as "a request for an oath of loyalty". He cited this conversation as the reason for the letter from him to Dr. Wheelon, noted earlier. He stated that no answer to that letter had been received. Mr. Wolf went on to say that he had, soon thereafter, had a conversation with Mr. Maxey in which the latter had denied that any requirement for search in 4-days had been levied upon ITEK.

Brockway McMillan
Director
National Reconnaissance Office

2 August 1965

MEMORANDUM FOR: Deputy Director for Science and Technology

SUBJECT: Ground Rules for the New Search System Competition

1. Herein are mentioned the key issues which must be faced in order that we have a reasonable context for the three month period suggested by the Land Panel:

a) Both the Agency and the Air Force must be prohibited from procurring system hardware, facilities and architect and engineering services - in other words, from using this three month period to buy a schedule advantage.

b) The funding available to both the Agency and the Air Force should be comparable and sufficient.

c) Both parties should be formally notified that a development decision has not been made, and that instructions to the contractors should be given accordingly.

d) Common ground rules should be adopted as to the booster choices available, as well as in the recovery techniques and limitations which can be assumed.

e) If the Land Panel has issued, or can be expected to issue, guidance on source selection criteria, an attempt should be made to insurethat that this information is available promptly to both parties.

2. We suggest that these ground rules should be the subject of discussion with senior levels of the DOD (presumably Secretary Vancy) with a small joint group established to furnish detailed guidance on the launch vehicle and recovery techniques/liminations questions.

JACKSON D. MAXEY

NRO APPROVED FOR
RELEASE 17 September 2011

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DEPARTMENT OF THE AIR FORCE
DIRECTORATE OF SPECIAL PROJECTS (OSAF)
AF UNIT POST OFFICE, LOS ANGELES, CALIFORNIA 90045

4 November 1965

REPLY TO
ATTN OF:

SUBJECT: Comments on Alternate Management Arrangements for the New Photographic Satellite Search and Surveillance System

TO: Director, NRO (Dr. Flax)

1. As requested by your 27 October memorandum on this subject, here are my comments and recommendations on the 15 October Task Group report on the above subject.

2. In any consideration of management arrangements for any projects of the National Reconnaissance Program, I believe that the overall objective should be, unequivocally, the strongest, most effective management structure possible. I cannot see how any avoidable degradation to this objective can be accepted responsibly, in the light of the national importance of these projects, nor the basis of any assignment be, instead, as has been proposed so often in past discussions on this subject, one of maximum utilization of resources, or the equitable distribution of projects or tasks, or the preservation of separate organizational identity and/or prerogatives of the participating agencies.

3. I believe that the following principles are mandatory requirements of any management plans under which the above objective can be met:

a. Overall project responsibility and corresponding authority, including responsibility and authority for overall system engineering and system integration, must be delegated to a single person who is organizationally and geographically located and appropriately chartered with respect to the resources involved, such that he can effectively control all such resources as necessary to carry out this overall responsibility.

b. This overall project management responsibility and authority must be delegated to the person referred to above, as head of his NRO element; no management responsibility or authority should be retained by the parent agency as such (as, for instance, the Air Force has no management responsibility or authority over NRO projects assigned to SAFSP).

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c. The person having this overall responsibility, and any (properly cleared) personnel he designates (from his office, his SE/TD contractor or his supporting resources) must have unrestricted access to all contractors and facilities participating in the project, and all information concerning all aspects of the project. He must have authority to determine need-to-know, for these personnel, for any information concerning the project, and authority to grant any project clearances necessary for this information, to personnel he determines to meet published BYEMAN clearability requirements.

d. For projects where divided management is directed, the person having this overall responsibility must be delegated corresponding authority over all participants in both agencies, established by specific directives in each agency, to all personnel who are, or may be, concerned.

4. In addition to the above basic considerations, there are three practical factors which bear on the question at hand:

a. Any management plan adopted should be considered capable of preventing the known difficulties which have periodically plagued the management of the CORONA project during the last several years. Although these problems have receded during periods of success, they have flared up sporadically, usually, but not always, at times of technical changes in the project, and when mission failures have occurred. These problems have been caused by inter-agency difficulties which are the direct result of the present management arrangement for this project. In this regard, even the most difficult of contractor interface problems can be less deleterious than an inter-agency impasse. The former can be solved at the working level, but the latter cannot, and the frequent escalation of working-level problems to higher echelons inevitably results in serious delibitation of the overall project management, and prevents the attainment of viable rapport which is essential to effective joint endeavor.

b. The CORONA project is a very poor management model for any new project. Both the circumstances which originally made split management of this project necessary and the factors which made the development eventually successful have long since vanished. The project survives under the present management arrangement only because it has gradually been developed into a high level of reliability, after considerable difficulties spread over a number of years. It has reached this point

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and survives in spite of, not because of, its present management structure. This project development was initiated with a very simple, single camera, and has very gradually evolved over more than five years of flight and numerous difficulties into the present two-camera payload, with an auxiliary indexing camera and a dual recovery capability. It is still extremely simple in comparison with, and not at all representative of, the proposed system for which a management plan is presently being sought. There is no overall systems engineering or overall system integration, aside from work performed, without overall supervision, by a common contractor.

c. It should be noted that the interfaces on existing satellite reconnaissance include several different variations. For instance, in GAMBIT, the OCV contractor is responsible for the environmental control of the camera, the camera is literally inserted into the OCV, and integrated by the OCV contractor, not the camera contractor; it is not integrated separately into an autonomous module structure, as in the case of CORONA (and, to date, we have never had a single GAMBIT camera failure or seriously degraded camera performance in 22 launches). Also, the recovery system is the responsibility of the OCV contractor in both CORONA and GAMBIT, but is the responsibility of the camera contractor in the case of GAMBIT-CUBE. The reasons that these interfaces were selected for these existing projects have no necessary connection with selection of the interface for new projects; what should govern this choice is how well the selected interface fits the type and complexity of the project in question; and whether it will permit the most effective overall system engineering and systems integration under the circumstances which must apply.

5. Before commenting on the alternate management plans, I have a few observations on the report as a whole: I agree that the Task Group identified alternatives that span the range of possibilities, and that their report can serve a useful purpose in the task of defining a workable management plan. However, the overall effort of the Group was marred by departing from its charter to consider its task as one of developing "management approaches applicable to any system undertaking * * *," as noted in par IIa, rather than concentrating on the specific project in question. In this, and other respects, the Group did not follow the 11 August Agreement, which clearly considers this particular project different from any other new project possibilities (in the latter case, among other points, it specifies determination of sensor responsibility by the Executive Committee; in the case of this project, it specifies that the CIA will be responsible for the optical sensor subsystem after certain events have transpired). The Task Group also considered arrangements which are excluded by the Agreement, and in other

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instances, read things into the Agreement which simply are not there. The Group also embraced wide extremes of arrangements which it considered workable, while dismissing what it "generally felt" to be the best way to manage a project with no more specific justification than "all things considered, despite its appeal, the Task Group does not recommend this management arrangement" (IIIb(4). Yet, other admittedly less desirable arrangements are treated in much greater detail and considered feasible and workable. More effort apparently was made to get agreement between the three Group members than to justify the matters agreed upon. The range of these excursions and the inconsistencies between the Group's stated conclusions and supporting rationale is such as to render the fact of Task Group agreement, and its recommendations, per se, of questionable value; the worth of its conclusions and recommendations must be determined by the validity of the stated supporting rationale, and not the fact of Group unanimity on any particular point.

6. My judgment on the relative strength and weakness of the alternate plans considered by the Task Group is summarized below (sub-paragraph titles refer to corresponding titles within the report):

a. "Overall System Responsibilities in the NRO" (i. e., DNRO and NRO Staff." I agree that this is totally unworkable and should receive no consideration.

b. "Fully Integrated System Project Office"

(1) I agree with the concept.

(2) I agree with the Task Group that this is the best way to manage a system project, and that there are no significant factors mitigating against such an arrangement.

(3) For reasons which I note in the last paragraph of this letter, I believe that in this concept, the total responsibility for the system should be assigned to SAFSP.

c. "Co-System Project Directors"

(1) I cannot agree with this concept. The only way that the DNRO can hold Co-SPD's "jointly and equally responsible" for overall system matters, such as system engineering and integration, is to do all overall jobs himself -- a patently impossible task. There is just no

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such thing as joint responsibility of different people in different agencies of the government concerning management of different aspects of a single project. This is not a responsible management arrangement -- it is a retreat from it. There must be some one in charge, with overall responsibility and commensurate authority over all aspects of the system, and this person must be organizationally and geographically located and chartered with the resources and time to carry out the task. For a new project, unencumbered with historical carry-over arrangements, I can see no rational basis for deliberate selection of this type of management. The relatively elaborate detail with which the Task Group presented this option only partially illustrates the complexity that would be involved in attempting to implement this scheme. And in spite of this involved arrangement, there still would not be a single authoritative project manager, and no effective overall system engineering and integration.

(2) In working out their proposed assignment of responsibilities under this plan, the Task Group oversimplified some important matters as, for instance, the proposed division of responsibilities at the STC in IIIc(6). The proposed division is obviously based upon consideration of relatively simple systems and interfaces; the on-orbit operation is not this clean-cut for new, more complex systems. There is too much interaction possible between payload, power, stabilization, programming, command and control, etc. And choosing a team chief by mutual agreement for each orbital operation, as proposed, is utterly absurd.

(3) One of the biggest and most significant "cons" was omitted entirely by the Task Group in par IIIc(9): There is simply no way in which responsible overall system engineering, system integration, and project direction can be done under this plan.

d. "<u>The Segregated System Project Office</u>"

(1) As described in the report, this plan is the same as the Co-SPD plan with two minor and two major modifications. The minor modifications are the re-naming of the Co-SPD of one agency as the APD, and the assignment to the SPD of a Deputy SPD by the agency which has the APD. The first major difference is the assignment of total responsibility for the system to the SPD. The second major difference is the assignment of responsibilities for specific sub-systems to separate organizations who are "held responsible to" the SPD. This sounds good, but the plan has a fatal flaw: there is simply no provision

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whereby it can be carried out in practice. The complete separation across the country, between the SPD and the APD is the same arrangement that presently exists in the CORONA project, which greatly accentuates any discordant tendencies by emphasizing organizational positions and organizational prerogatives, even on problems which should be simply solved. Even the designation of the SPD as having overall project management is similar; the DNRO previously designated SAFSP as having this overall responsibility, but the tremendous separation of the two groups, and the restrictions imposed by the CIA on access to payload data and contractors completely prevented the overall responsibility from being carried out in practice. There is nothing in the plan as described that would necessarily result in any difference in this case. If the DNRO cannot direct CORONA project level details, (such as making complete payload technical data available at the STC during on-orbit operations, as he tried but was unable to do except when he was personally present), how can the lower level SPD be expected to do it?

(2) I do not see any virtue in the DSPD arrangement described for this plan. The work which occasions his presence is being done elsewhere, at his parent agency under the control of the APD. He is at best a supernumerary liaison official, at worst just another echelon to go through; it would be much better for the SPD and his people to have direct access to the APD.

(3) The changes noted above do not solve the deficiencies of the Co-SPD plan: the assignment of overall responsibility has been stated, but in a way and under constraints which preclude it being effective. The Co-SPD plan admits that no one is in effective overall charge; this one claims that there is some one in charge, when, in actuality, he is not.

e. "Assignment of FOSS Responsibilities"

(1) The Task Group ignored some aspects of overall systems engineering and integration in recommending where the system interfaces should be established, and specifying that the camera sub-system should be integrated into a sensor module as a unit. For large, long lifetime vehicles, such as the ten-foot-diameter 24-day vehicle planned for this project, it may be desirable to integrate a number of other vehicle sub-system components within the same module. In any case, it should be noted that the sensor has not yet been selected from four

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contenders, with considerable variation between the designs, and the vehicle has not been selected, and essential overall systems engineering has not yet been accomplished. It is certainly not obvious that the camera module is the best interface approach; it is clear that it is not the only workable approach.

(2) I can see no reason why the camera sub-system cannot be treated as we do now on GAMBIT, where the camera contractor provides the camera, with fine environmental control, and the OCV contractor integrates it into the OCV, and provides coarse environmental control. This arrangement is exactly in accord with the 11 August Agreement, as well as successful current practice on a rather complex system; it is also the simplest inter-agency interface that is consistent with the Agreement.

(3) I, therefore, do not agree with any of the three "options" as written in par IVd of the report. CIA-OSP should be responsible for the camera sub-system. SAFSP should be responsible for the RV and OCV, and for integrating the camera sub-system and every thing else into the OCV.

(4) The new system will use programming, and command and control equipment which will be consistent with the existing GAMBIT and GAMBIT-CUBE equipment and associated STC resources. Clearly, SAFSP should have the responsibility for directing the operations at the STC.

f. "Summary-Conclusions"

(1) Of the plans described in the report, I believe that only the plan called "Fully Integrated System Project Office" can meet the fundamental objective of responsible, effective overall management. I do not agree with either of the two arrangements considered workable by the Task Group; neither can possibly provide really effective management, in my opinion.

(2) I do not agree with the Task Group on the responsibility for the camera module. The CIA should be assigned the camera sub-system only, with SAFSP responsible for RV, OCV, and the integration of all sub-systems, including integration of the camera sub-system, into the OCV. This is a workable technical interface, as proven on GAMBIT, and it is the simplest inter-agency interface since it avoids any requirement for common contractors serving both the Air Force

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and the CIA, which, while of benefit in the absence of effective overall system engineering and integration, has nevertheless contributed substantially to the inter-agency conflicts and impasse on the CORONA project. Moreover, it is the only arrangement fully consistent with the 11 August Agreement.

7. On balance, I think that there are only two managerial approaches to divided management of this project which have any chance of meeting the objective described in par 1 of this letter.

a. The first, which is described by the report as the "Fully Integrated System Project Office," involves assigning to SAFSP the CIA personnel who would be responsible (to SAFSP, not the CIA) for the optical sensor sub-system. These personnel would serve in the integrated project office at SAFSP on a normal inter-agency transfer basis; joint service in the same sense as joint service in the JCS. They would serve as individuals, fully and solely responsible to the supervisors in their duty office, who would rate their performance of duty exclusively.

b. The second approach is one which is not mentioned by the Task Group report, in spite of the Group's obvious concern with the preservation of organizational identity. This plan would be identical with that described in par 7a, above, with this difference: the CIA personnel would not be assigned to SAFSP, they would remain assigned to the CIA, but they all would be co-located at SAFSP, under a CIA supervisor, who would be responsible to the SPD. The co-located personnel would include all technical and contracting personnel who work on the CIA responsibilities for the system development and operation; all such CIA personnel located at contractor plants or other facilities concerned (except the NRO Staff) would be responsible exclusively to the senior CIA person in the SPD. This plan would require the complete delegation of the CIA responsibilities to their people referred to above, including specific direction that they are to respond to all direction received from the SPD. Periodic CIA-OSP review of the results of this management would be obtained by the inclusion of appropriate CIA officials in DNRO reviews of this project. Administrative matters only, such as audits, travel expenses, pay, etc., would be handled by CIA-OSP. This plan would not be as effective as that described in par 7a, but it is the only workable alternative that I can see. It would allow preservation of CIA organizational identity, if

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that is considered important enough to be worth some added complication in management. If actually implemented as I have described, it would do so in a manner which would preserve a single overall project manager. It permits assignment of responsibility for engineering development of the sensor sub-system to the CIA component located at SAFSP. This is unquestionably within the meaning of the 11 August Agreement, which uses the terms "the CIA or DOD components" in specifying sensor development responsibility in par Dd.

d. I recommend the plan described in par 7a. I believe the plan described in 7b is a less effective and less desirable alternative, but acceptable, provided that it is implemented fully as described, including full delegation of all technical and contracting responsibilities.

8. In addition to my views outlined above, I submit that the assignment of project management responsibilities should never be made on the basis of who thought of what idea first. It is not the identification of the historical birth of ideas that is at issue; it is the effective management of the development and operation of a new, complex, satellite reconnaissance system. Clearly, the only valid criteria are existing experience, competence and resources of the type required for this job. I agree completely with the 11 August Agreement's explicit stipulation that the allocation of development responsibilities will be made "with a view to ensuring that the development, testing and production of new systems is accomplished with maximum efficiency by the component of the government best equipped with facilities, experience and technical competence to undertake the assignment." SAFSP represents almost the total of such facilities, experience and technical competence that this government has in satellite reconnaissance, and is uniquely qualified under these criteria for assignment of overall project responsibility and the other tasks I have recommended herein.

JOHN L. MARTIN, JR
Brigadier General, USAF
Director

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CENTRAL INTELLIGENCE AGENCY

WASHINGTON 25, D. C.

4 NOV 1965

MEMORANDUM FOR: Director, National Reconnaissance Office

SUBJECT: CIA Comments Concerning Alternative Management Arrangements for the New Photographic Satellite Search and Surveillance System

REFERENCE: BYE-36887-65, dtd 27 October 1965

1. I have your request of 27 October for comments on the alternative management arrangements for the New Search and Surveillance System and welcome the opportunity to do so.

2. There are two basic choices before us, the first is how to divide the responsibilities for development of the payload and, secondly, the way in which the Air Force and CIA will collaborate in executing assigned responsibilities for the program. Should you decide upon a single project director to manage the new project then a third decision emerges, namely, whether the Agency or the Air Force should have primary responsibility for it.

3. The most important factor to be considered in carrying forth programs under the new National Reconnaissance Program is the desire of both the DOD and the CIA to insure that the full and creative participation of each organization is totally exercised as responsible contributors.

4. A review of the various NRP satellite reconnaissance projects readily demonstrates the magnitude of the Air Force's efforts since it remains totally responsible for GAMBIT, G-3, [redacted] QUILL,

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SUBJECT: CIA Comments Concerning Alternative Management Arrangements for the New Photographic Satellite Search and Surveillance System

structural view point the interface between the SM and the OCM is little different than the interface between the OCM and the booster, but it is clearly not essential that the OCM contract be given to the booster contractor. With respect to systems integration, it may well be more economical and expedient when the overall hardware flow is examined in detail to assign this function to the booster contractor. While we are not pleading any particular arrangement, we do recommend that these determinations be left, with Director, NRO concurrence, to the program management.

Huntington D. Sheldon

HUNTINGTON D. SHELDON
Director of Reconnaissance, CIA

cc: DD/NRO

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DEPARTMENT OF THE AIR FORCE
WASHINGTON

OFFICE OF THE ASSISTANT SECRETARY

November 5, 1965

MEMORANDUM FOR DR. FLAX

SUBJECT: Task Group Report (Alternative Management Arrangements For the New Photographic Search and Surveillance System)

In response to your October 27 request for an appraisal of the above report, comments are offered in two categories: the collective views of senior members of the NRO Staff (sans me); and my personal opinions on both NRO Staff views and the report itself.

I asked appropriate senior members of the Staff (Worthman, Carter, Howard, Buzard, and Koch) to give me their completely candid thoughts. A summary of their more pertinent views follows:

1. The casual discarding, in the report, of the fully integrated System Project Office because "...the Agreement reflects an obvious desire to maintain organizational identity and responsibility..." was "deplorable" and "distressing" to them. They felt this approach to management was the only valid one for a complex system development, and all alternatives proposed were, in effect, committee-management with all inherent weaknesses. They cited numerous examples of successes for the former, and failures for the latter, and felt the new search system was far more important than any organizational status or recognition.

2. In short, the Staff believes that you must have a single, authoritative, responsive System Project Director, and should establish a fully-integrated System Project Office (which co-locates all necessary CIA-DOD engineering, procurement, and security people in one office, and empowers these people to speak authoritatively for their "sponsors"). Although the Staff believes the overwhelming management capability to do the job is in SAFSP, they profess not to be anti-CIA, since they also assert that total system assignment to CIA

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would be vastly more effective than the "idealistic but impractical social ventures" proposed in the report.

Personally, I basically agree with the Staff on the desirability and effectiveness of a fully integrated SPO--the management alternatives to this approach are inherently weak, are potential trouble-makers, will require more of your attention, etc. However, I am not so positive as they that it is the "only" valid approach. Further, I am convinced the Agreement precludes a fully integrated SPO (as defined in the Report), since it repeatedly refers to "the CIA" and "the DOD" (or AF), not CIA-provided people, DOD-provided people, etc. In that vein, the Agreement specifically states "The CIA will develop the optical sensor sub-system." Therefore we must establish some compromise arrangement which assigns logical responsibilities for system tasks and specific sub-systems to SAFSP and CIA-OSP as organizational entities.

So much for the Staff views and my reactions thereto. Next, I should like to give you my personal views on the Report (as objectively as possible, but undoubtedly prejudiced by my role in its preparation):

1. I repeat my strong personal desire for the fully integrated SPO approach, but reluctantly must recommend against your selecting it in view of the apparent intent and the specifics of the Agreement.

2. I do recommend we try the so-called Segregated SPO approach, with overall system responsibility (and SPD) assigned to SAFSP. The Deputy SPD should be a CIA employee <u>assigned</u> to SAFSP (with no allegiance, per se, to CIA for the duration of such assignment) for this purpose. Additionally, an Assistant Project Director (APD) for CIA FOSS activities must be appointed. All CIA FOSS activities should be consolidated under this senior CIA representative who is responsible and responsive to appropriate project direction of the SPD. Both SAFSP and CIA-OSP must exercise considerable restraint in dealing with this individual.

3. I believe SAFSP is the only logical choice for overall system responsibility, and to provide the SPD, on the basis of personnel skills and experience, and personnel resources available to them. In the middle management field, CIA has virtually no one (other than Crowley and Ledford) with

system management experience and background. There are many such people in SAFSP or AFSC. If total system responsibility for FOSS should be assigned to CIA-OSP, then I recommend an experienced Air Force Colonel or Brigadier General be assigned to CIA as the SPD.

4. I have very firm convictions on the matter of co-location. There is no question about the necessity for co-locating a "line" DSPD, and I recommend the same for the APD (plus an appropriate portion of his office). Coordination and interface would, at best, be quite difficult if the SPD/DSPD and the APD were 2500 miles apart--particularly so, for the first year or so.

5. With regard to the responsibility of the APD, I believe CIA-OSP should be charged with the Sensor Module as defined in the Management Report. The prime reason for this is that it will enhance the Government's ability to hold the camera contractor responsible for the key factors associated with proper camera functioning (i.e., mounting and alignment, thermal control, critical film handling, peculiar electronics and pneumatics, etc).

6. The Technical Evaluation Group proposed that the sensor source selection include the camera sub-system and a combined Sensor/RV module (as one unit). Although this is a third option in the Management Report, I recommend against it for several reasons. First, these are in fact two separate modules (different types of structures--monocoque vs truss; different thermal requirements, etc) and will be built as such, in any event. The interface between the two modules--for example, in film path alignment--is not nearly as critical as the Technical Group imagines. Last, I do not wish to foster--unless there are overriding reasons--another CORONA "environment". Assigning CIA everything forward of the OCV would almost parallel the CORONA Program and encourage the same kinds of management problems we have today (only more serious, because concurrent sub-system development is involved in FOSS). Therefore, since the RV Module (see Management Report definition) is a separate element, its development responsibility should be assigned to SAFSP.

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7. I believe the Management Report recommendation that the OCV contractor also build the sensor module shell and RV module (in effect, the entire spacecraft sans payload), and be the system integrator, is most significant. Hopefully, despite split responsibilities among Government Agency/Department, this will facilitate system engineering, structural integrity, and simplify interface matters. This contractor should design and build the sensor module shell and deliver it to the camera contractor for camera sub-system integration and test.

8. Lastly, an early selection of the system engineer (whatever management approach is selected) is vital to the work of the three Source Selection Task Groups. I question that these groups could do an effective job in the absence of the overall detailed specifications which the SE must provide. I urge the designation of the organization responsible for the SE at the earliest possible date.

James T. Stewart
Brigadier General, USAF
Director, NRO Staff

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CENTRAL INTELLIGENCE AGENCY
WASHINGTON 25, D. C.

OFFICE OF THE DIRECTOR

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20 December 1968

The Honorable Charles J. Zwick
Director, Bureau of the Budget
Executive Office of the President
Washington, D. C. 20505

Dear Mr. Zwick:

I have considered carefully your memorandum, BYE-11695-68, dated 26 November 1968, discussing the Fiscal Year 1970 HEXAGON budget. Further, I have discussed this matter at length with Dick Helms whose views coincide with the considerations and conclusions expressed herein. You will recall that HEXAGON was an agenda item at the 13 November 1968 NRP Executive Committee (EXCOM) meeting wherein we considered the Bureau of the Budget's proposal to cancel HEXAGON, but concluded unanimously that the Program should be continued.

There is a continuing concern that neither the Bureau's 26 November paper nor its earlier position as presented to EXCOM takes sufficient account of the intelligence needs for the HEXAGON system. As you know, the question of the value of the HEXAGON capability has been reviewed extensively in the past six months by the United States Intelligence Board (USIB), the National Intelligence Resources Board, and independently by the Department of Defense. These reviews concluded that the value of intelligence expected from HEXAGON well justifies the costs associated with it.

While the Budget Bureau's 26 November paper contains no recommendations, the essence of the Bureau's position seems to be as follows:

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a. The current USIB requirements for satellite photography requirements are being adequately met by the GAMBIT-III and CORONA systems.

b. The only unique additional contribution that the HEXAGON system will make is in the area of ground forces.

Your memorandum raises the question as to whether the incremental additional contribution in the ground forces area is worth the additional costs as identified in the memorandum.

The Bureau's position on the intelligence contribution of the HEXAGON system is based on at least two misconceptions. First, although the current CORONA and GAMBIT-III systems do in general come close to meeting the USIB requirements set for those systems, this is so only because the USIB requirements referred to are tailored to the capabilities and limitations of those systems and thus do not represent a general statement of information needs. For example, in its 1 July 1968 "Assessment of the Intelligence Gain Provided by KH-9 over KH-4 and KH-8" (BYE-2265-68/1) COMIREX stated: "It is particularly important to emphasize that our current requirements have been developed on the basis of current capabilities and those problems within the range of these capabilities." It is not the general practice of USIB to generate detailed collection requirements for a system which that system cannot satisfy.

The second point of particular note is that the ground forces problem is only one of several major areas in which the HEXAGON system will make substantial additional contributions. The Bureau has somehow gotten the impression that the issue in this instance is limited solely to ground forces and solely to current requirements. The Intelligence Community and Department of Defense studies additionally place special emphasis on emerging problems foreseeable in the 1970's--an aspect generally overlooked in the Bureau paper.

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The HEXAGON system will make major contributions in at least four areas of high importance to the intelligence process, specifically:

a. It will provide the large area search coverage with a substantial image quality improvement over the present coverage capability in that regard.

b. It will provide the unique capability to discriminate between mobile forces of various types, categories and classes.

c. Because of its capability to cover large areas in high resolution imagery, the HEXAGON system will provide a time frame reference that will very materially assist in eliminating uncertainties arising out of time and distance factors as applied to mobile targets.

d. The HEXAGON system will represent a cogent source for verification of Soviet adherence to any future disarmament agreement owing to its capability to provide a solid base for establishing norms and to detect departures therefrom.

In summary, I do not believe the Bureau's memorandum on this subject takes into account many of the factors which compel me to regard HEXAGON as an intelligence tool of very high potential and one for which I perceive no substitute in the offing.

Sincerely,

/S/ Rufus Taylor

Rufus Taylor
Vice Admiral, U. S. Navy
Acting Director

cc: Deputy Secretary of Defense
Special Assistant to the President for Science and Technology
Director, National Reconnaissance Office

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HEXAGON CORONA GAMBIT

Signature Recommended:

Deputy Director for Science and Technology — 19 DEC 1968
Date

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3 - DepSecDef
4 - Sp. Asst. to Pres. for S&T
5 - D/NRO
6 - ADCI
7 - Exec. Reg.
8 - DD/S&T
9 - DD/S&T Registry
10 - D/OSP
11 - C/D&AD
12 - RB/OSP

DD/S&T/OSP/LCDirks/JJCrowley:bg/7905 (19 December 1968)

Rewritten:DDCI/as (20 Dec 68)

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HEXAGON CORONA GAMBIT

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Page Four

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RELEASE 17 September 2011

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Mr. [redacted]
Mr.
Mr. [redacted]

EXECUTIVE OFFICE OF THE PRESIDENT
BUREAU OF THE BUDGET
WASHINGTON, D.C. 20503

MAR 2 2 1969

Honorable Richard Helms
Director of Central Intelligence
Central Intelligence Agency
Washington, D. C.

Dear Dick:

Thank you very much for your letter of March 11. Let me start by emphasizing our area of agreement: it is our shared objective to cut away marginally productive intelligence activities. In this light, let me try to make clear why it is that we cannot now agree with your conclusion that the HEXAGON photography would provide additional intelligence information sufficient to justify its significant cost.

Let me address the question of the relative value of the HEXAGON system in terms of <u>need</u>, <u>cost</u> and <u>risks</u>. I have also attached a paper (Tab A) which discusses the six specific areas cited in your letter as examples of the special contribution which HEXAGON's performance could make to intelligence needs.

<u>Need</u>

1. <u>Initial Rationale and Present Situation</u>

- As you noted, the initial requirement for a system like the HEXAGON was set forth by USIB in 1964. Since 1964, both the CORONA (KH-4B) and the GAMBIT-3 (KH-8), although less expensive systems than the HEXAGON, have greatly improved. (The chart at Tab B shows this.) Consequently, the added marginal value of the HEXAGON, if it is used as a replacement

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for the CORONA and partial substitute for the GAMBIT-3, is now considerably less than it may reasonably have appeared in 1964.

- The GAMBIT-3 improved and improving performance against the surveillance requirement demonstrates there is no clear need for the more expensive HEXAGON system as a partial substitute in the surveillance role. The CORONA, too, as you know, has improved considerably since 1964. In recognition of such improvements in the present mix, the OSD study of November, 1968 concluded that the present and improving sampling capability of the GAMBIT-3/CORONA combination is adequate to meet our intelligence needs in the area of Soviet bloc and Chinese Communist capabilities in air and missile defense, aircraft systems, missile systems, and naval forces (page 5, par. 8, BYE-78416/68).

2. Performance and Capability of CORONA/GAMBIT-3 Mix

- The GAMBIT-3's performance for spotting now meets 99% of the annual target looks required against all [redacted] COMIREX targets (USIB D-46.9/16). This capability will further improve. All significant DIA targets are colocated with the COMIREX targets now covered.

-- The CORONA is adequate to meet the requirement of broad area search of the Soviet bloc and China. (In 1968, CORONA provided cloud-free search photography of 94% of mainland China.) When CORONA detects new targets or significant changes in previously identified targets, the GAMBIT-3 can be directed to provide high resolution spotting coverage.

Cost

1. NRO Cost Estimates vs. Probable Program Costs

- The cost savings resulting from a cancellation of the HEXAGON might well, I believe, exceed the FY 69-74 savings of [redacted] based upon the NRO estimates. Savings on the order of [redacted] are a more reasonable estimate. Although the NRO proposal indicates that the operating costs of the HEXAGON/GAMBIT-3 mix about equals that of the CORONA/GAMBIT-3 mix, it will actually be greater since

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- The HEXAGON mix will probably include 5 rather than 4 GAMBIT-3 and HEXAGON missions due to GAMBIT-3's advantage of [redacted] against HEXAGON's 30" best resolution and due to concerns for reliability and frequency of coverage.

- The CORONA mix will probably not require more than 6 CORONA's and 5 GAMBIT-3's as opposed to the 7 CORONA's and 7 GAMBIT-3's now in the NRO estimates.

- Tab C portrays detailed cost comparisons.

- As to potential additional costs for mapping satellites, the use of separate mapping satellites at a cost of [redacted] would never be seriously considered since the 3" system of the CORONA would be adequate. If the less complicated CORONA should continue, the bulk of the proposed out-year reductions could probably be retained.

Risks

1. HEXAGON program slippage of 3 to 6 months will probably occur due to technical and management complexities. This will drive costs up and a slip of more than 3 months will require the extension of CORONA production--now scheduled to phase out in the next 3 months.

2. HEXAGON launch rates of 4 per year now programmed may result in vehicle losses which would produce a significant gap in search coverage.

In summary, it does not seem that the arguments for the added value of the HEXAGON adequately reflect the growing capabilities of our present systems; the probable added cost over time of the HEXAGON system; and the related risk of probable technical difficulties with resulting delays which would increase HEXAGON costs and might necessitate further CORONA purchases in any event.

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In light of the factors in this letter and the attached materials, we feel that our original position is justified and my staff is available for more detailed discussions.

Sincerely,

Bob Mayo

Enclosures

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CORONA/GAMBIT-3 C abilities and HEXAGON/GAM I-3
Capabilities on Priority Intelligence Problems

This paper describes the quality of information available from the CORONA/GAMBIT-3 (G-3) systems mix against examples of intelligence problems where HEXAGON would make its greatest additional contribu ion, as provided in Mr. Helms' letter to the Bureau of the Budget, of March 11, 1969.

(1) Significantly better intelligence on Soviet and Chinese ground forces, including force composition, readiness, and redeployment.

Comment: For force composition and readiness, the GAMBIT-3 resolution, clearly superior to the HEXAGON's, does and would provide important details on the quality and quantity of Soviet and Chinese units that would not be discernible by the HEXAGON. Once GAMBIT-3 has established the signature or function (e.g., tank or motorized rifle division) of a ground force installation, then subsequent CORONA coverage along with occasional updates with GAMBIT-3 coverage is sufficient for high confidence estimates of force composition and readiness. See for example, studies of the Soviet Ground Force equipment holdings in the Byelorussian Military District (CIA, SR IR 67-2, Oct. '67) and Soviet Military Forces on the Sino-Soviet Border (CIA, SR IR 68-7, Sept. '68).

For redeployment, if it occurs over a period of months, the CORONA/G-3 can monitor such changes adequately. In the case of quick redeployment, the HEXAGON's broad swath would have an advantage in good weather. However, in rapid redeployment, any film recovery system is limited by the fact that the satellite must be over the target area during the redeployment under cloud-free and daylight conditions. Even then, the time delay from camera operation to film interpretation is measured in days. The gaps, with no crisis coverage, between the HEXAGON missions are longer than those between CORONA missions.

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(2) Better insight into the logistic support systems of Communist bloc countries.

Comment: G-3's high resolution is valuable in discerning some details of installations and equipment that could or do have a primary or substitute civilian use (e.g., trucks taken out of civilian use when large mobilization occurs). The Belorussian study, referred to above, based on the GAMBIT spotting system and the CORONA search systems, produced significant high confidence changes in our understanding of Soviet logistic support. While it is true that these studies were based in part upon low-level oblique aerial photography, the HEXAGON would be equally dependent on non-satellite data.

(3) A marked upgrading in our ability to detect and evaluate mobile missile forces in the USSR which we anticipate shortly (in this connection we must have the basis for confident judgments that deployments have not occurred, as well as the ability to detect once begun).

Comment: Given the long (e.g., 2 years) R & D phases associated with such a new missile, and given the high priority G-3 coverage targeted on missile test centers, the G-3 would be able to establish a signature of the missile and its support elements that could be used for later G-3 or CORONA identification of the systems in deployment phase. The G-3/CORONA mix was adequate to detect the deployment along the Sino-Soviet border of a tactical missile system (SCALEBOARD, SS-12), which is presumably smaller than a mobile missile system sufficiently large to pose a strategic threat to the U.S. (See CIA, SR IM 69-7, Feb. '69).

Because of the inherent serious disadvantages of mobile missiles, such as degraded accuracy, more difficult command and control problems, lower reliability, limited suitable rail or road network, etc., the Soviets are unlikely to introduce such a system on a wide scale (this is also discussed in the recent CIA-SR document referred to above).

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(4) Significantly improved intelligence on a wide range of othe targets, such as Communist bloc radar stations, and thus facilitating reduction in certain types of collection activity.

Comment. CORONA (KH-4B), as the 1968 OSD study and recent OAK Reports have indicated, is adequate to detect the deployment of all air defense radars and missiles, and is occasionally able to conclude that a SAM site is unoccupied. Moreover, SIGINT satellite coverage is targeted to update periodically SAM Order of Battle, and the [redacted] will be able to perform such a task in a [redacted]. Finally, we understand that the SIOP mission planning for air penetration of the Soviet Union either avoids known sites (available with present capabilities) or negates them with jamming or standoff missiles.

(5) Broad area and high resolution coverage of sensitive areas outside the USSR and China, such as the area of Israeli-Arab confrontation, the Czech borders, or the Sino-Indian border region.

Comment: In the case of the [redacted] confrontation, the CORONA is adequate for monitoring changes in air order of battle, and in other areas of the world where the weather is less favorable to overhead photography, all photographic satellite systems operate within noteworthy limitations. While it is true that the HEXAGON system will provide a better opportunity for sweeping up broad areas in good weather, the time delay in film recovery degrades timely responsiveness and therefore the value of any film recovery system, including the HEXAGON. We had good coverage of [redacted] but it was not available for use when it was needed.

(6) Substantial improvement of our capacity to monitor Soviet adherence to or violation of any future arms control agreement.

Comment: Soviet testing of any weapon in violation of arms control treaty prohibition would be monitored closely by the G-3 which is already targeted with highest priority against Soviet weapons R and D test centers. If the violation is detectable by photography, the higher resolution

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G-3 will be more able to detect subtle violations than the poorer resolution HEXAGON, and if it is not collectible by photography, but rather by SIGINT or HUMINT, the HEXAGON has no special advantage.

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EQUAL PERFORMANCE OPTIONS

System Mix Options Where Both Meet Current Requirements

Mix Option 1 below is currently approved to meet USIB requirements for both search and surveillance in FY 70. Mix Option 2 was that described by USIB (COMIREX) in April 1968, as that future combination that would also meet these requirements.

Mix Option 1		Launches	Successful Missions	Unit Cost	Annual Costs
[redacted] per yr.	CORONA	7	6	[redacted]	
	G-3	6	5		

Comments: (a) Nearly all surveillance with best available resolution; (b) Poorer (6'-10') resolution for search capability, but adequate to cover Sino-Soviet bloc; (c) More G-3 missions for technical intelligence; (d) Less risk; and (e) Lower 5-year costs (operating [redacted]; investment [redacted])

Mix Option 2				
[redacted]/per yr.	HEXAGON	5	4	[redacted]
	G-3	5	4	

Comments: (a) Better search resolution; (b) Less surveillance target looks with best available resolution; (c) More risk; and (d) Higher 5-year costs (see comment above: [redacted] more than mix option 1).

Note: The CORONA/G-3 mix would probably produce an even greater savings due to the following factors:

	Additional 5-year savings
- Surveillance requirements can be met with 4 G-3 missions per year in mix option #1	[redacted]
- HEXAGON would probably require 5 missions rather than 4 in each of the first 2 years in mix option #2 as the system is maturing	
- Additional HEXAGON development costs	

These three factors would produce a total cost differential of [redacted] over a 5-year period.

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

OFFICE OF THE DEPUTY DIRECTOR

September 4, 1969

Dr. McLucas,

The attached report of the HEXAGON Review Committee was used as the basis for the briefing given to the NRP Executive Committee on June 20, 1969. The report has been prepared for file to be available for later review.

~~F. Robert Naka~~
F. Robert Naka

Attachment
Report of the
HEXAGON Review Committee

HEXAGON CORONA GAMBIT

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REPORT OF THE HEXAGON REVIEW COMMITTEE

June 20, 1969

GENERAL

This survey of the HEXAGON Project responds to a DNRO request of June 4, 1969 to report to the NRP Executive Committee on June 20. The short but intensive review had the objectives of

Assessing the probability that an initial HEXAGON launch date of December 1970 can be met

Determining the confidence of mission success for initial HEXAGON launches

Recommending to the ExCom a plan to optimize existing collection capabilities while minimizing cost.

The Committee consisted of Dr. F. Robert Naka, DDNRO designee, Chairman; [redacted] CIA/OSP--the HEXAGON Sensor Subsystem Project Office (SSSPO); and Col. Lewis S. Norman, Jr., Vice Director of SAFSP.

It was clear that in the time available the Committee should not attempt an exhaustive technical review of either the HEXAGON Project or of other projects which could provide a capability for a time-phased collection overlap. The Committee concerned itself with comprehensive evaluation of those aspects of the HEXAGON and other projects which were directly relevant to the review objectives.

CONCLUSIONS AND RECOMMENDATIONS

Upon completion of its study, the HEXAGON Review Committee reached the following conclusions:

HEXAGON CORONA GAMBIT

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The probability that the date of the initial HEXAGON launch will not be delayed in excess of one month is 50 percent, that the delay will not exceed three months is 75 percent, and that the delay will not exceed six months is 95 percent.

The confidence of mission success for individual initial HEXAGON launches is 75 percent.

In view of these circumstances, adequate collection overlap could be provided if CORONA launches were rescheduled from the currently planned

6 in FY 1970
6 in FY 1971

to

5 in FY 1970
5 in FY 1971
2 in FY 1972.

No new CORONAs need be bought at this time.

Supported by these conclusions, the Committee recommends that:

The HEXAGON Project be funded to the minimum level necessary to meet the December 1970 initial launch date.

The CORONA launch schedule be revised to provide for

5 launches in FY 1970
5 launches in FY 1971
2 launches in FY 1972.

The need for a buy of additional CORONA vehicles be reviewed in December 1969.

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SATISFACTION OF COLLECTION REQUIREMENTS

The Committee first directed its attention to the United States Intelligence Board (USIB) collection requirements, specifically those for HEXAGON. In discussions with the NRO/SOC, it was noted that complete satisfaction of current USIB search requirements is not achieved by CORONA alone. Increased satisfaction could be provided by using a combination of CORONAs and GAMBITs; HEXAGON will provide near 100 percent satisfaction. It was not obvious, however, that the user community considered CORONA collection inadequate.

Most of the remaining CORONA vehicles in the inventory would have a mission lifetime approaching 20 days each compared with 15 now generally flown, therefore the mission lifetime of five of the remaining CORONAs is comparable to six or eight of the older CORONAs (approximately 100 mission days per fiscal? year). The Committee was convinced that their recommended change in the CORONA launch schedule (see page 2) would maintain the current level of search collection satisfaction and would extend the period of overlap with HEXAGON. The current HEXAGON and recommended revised CORONA schedules would then appear thus.

	CY 1970						CY 1971													
	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F
Current HEXAGON						Δ			Δ			Δ			Δ					
Revised CORONA		Δ	Δ				Δ		Δ			Δ		Δ			Δ			

The recommended overlap satisfies several contingent situations involving schedule slips and/or unsuccessful flights. As long as the first successful HEXAGON flight occurs by September 1971 (a 9-month delay from December 1970), the overlap with CORONA will maintain the current level of search collection satisfaction. Extending the CORONA schedule by six months into FY 1972 will require [redacted] of FY 1972 funding. However, these funds would not be required should successful HEXAGON flights occur before all CORONAs have been launched.

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The Committee also considered other steps to insure continuance of both search and surveillance collection:

A contingent buy of new CORONAs

Refurbishing and flying the remaining GAMBIT (KH-7) payloads

Buying one or two additional of the current GAMBIT (KH-8) series, flying them at high altitudes against the HEXAGON surveillance targets (with worst resolution equivalent to the best achievable with HEXAGON), and concentrating the remaining CORONAs against the most difficult to satisfy requirement--that of semiannual in-bloc search.

The latter alternative virtually fully satisfies collection requirements. It would cost an estimated [redacted] in FY 1971 for additional vehicles. The seven vehicles in the current program for FY 1970 are in part to provide a backup capability for the GAMBIT Vehicle 23 configuration. If Vehicle 23 is a success, one or more of the FY 1970 GAMBIT vehicles can be flown at high altitude. (No change in the GAMBIT camera is required if photos are taken at altitudes of 110 nautical miles or below. Flights above 110 nm would require a modest one-time change to the camera to extend the operating range of the slant range compensator and of the film drive speed. This cost is estimated at [redacted].) However, as GAMBIT was designed as a surveillance and technical intelligence collector, its camera is not suited to search as are the CORONA and HEXAGON pan cameras. To satisfy both search and surveillance requirements would require continuing CORONA. This option best satisfies a situation where HEXAGON is not used.

The second option, flying the older GAMBIT series payloads, would involve major costs and require at least 19 months' lead time. The Satellite Control Network would have to be reoutfitted to track and command such a vehicle. ~~New Age as and much out-of-production hardware would be~~ needed. This option was considered clearly uneconomical and would not satisfy search requirements.

The first option is closely allied with the Committee's recommendation to revise the CORONA schedule to insure overlap.

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If the revised schedule is adopted, reorder lead time for new CORONAs does not occur until December 1969. In the intervening time HEXAGON will have progressed through several major system level assemblies and tests, and we shall be in a much better position to determine whether a slip in HEXAGON will occur. Having had more testing time on the HEXAGON cameras, a better assessment of reliability could be made. The Committee urges that a decision to procure additional CORONAs be deferred until December 1969. Should a reorder be necessary, three units are estimated to cost a total of [redacted]; six units, [redacted]. [redacted] of FY 1970 funds would probably suffice to cover initial costs of either a three- or six-unit buy.

PROBABILITY OF MEETING A DECEMBER 1970 LAUNCH DATE

Sensor Subsystem (Perkin-Elmer)

The most critical, and indeed the pacing, HEXAGON component is the sensor subsystem. This Committee received detailed briefings at Perkin-Elmer, the sensor subsystem contractor, on progress in design, fabrication, and test. Of particular concern was the film transport system, the servo system, the thermal analysis of both the optical bars and the two-camera assembly, and the structural analysis. Perkin-Elmer has expended considerable effort in these critical areas. In particular, a thorough servo analysis, including the effects of structural and thermally induced disturbances, lends credence to Perkin-Elmer's conviction that successful operation of the sensor is highly probable. Thermal analyses were also exhaustive, resulting in a very good understanding of optical system performance. Work on the film transport system led to considerable refinement and simplification with consequent improved performance. The Committee also noted that in the six months since Dr. A. F. Donovan of Aerospace Corporation had conducted a systems engineering level audit of HEXAGON (at General Martin's request) informal assessment of HEXAGON sensor subsystem progress has been described as "remarkable." In general, the Committee was satisfied that the technical status of the sensor was indeed good.

The Committee also noted that, after considerable effort on the part of the SSSPO, Perkin-Elmer management had streamlined their internal functions to provide tighter and more effective technical management and cost control. The possible exception is in cost management of subcontractors.

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The Committee found no major known problems with the sensor subsystem. Reliability causes continued concern, largely because of the number of electro-mechanical components of which the sensor is composed--many of which cannot be made redundant. Since near perfection through exhaustive testing is the only real approach to high reliability, the Committee believes continued priority emphasis here, as well as with electronic components, is essential.

Important, but of lesser concern, is the question of film properties. Film base thickness variations and film relative humidity pose difficult but, in the Committee's view, solvable problems.

Satellite Basic Assembly (LMSC)

The next most critical HEXAGON system element, the satellite basic assembly (SBA), was then examined. The SBA contractor, Lockheed Missiles and Space Company (LMSC), has had much experience in spacecraft design, manufacture, and test; and few unknown problems are expected. In the case of the SBA, problems are largely engineering in nature and several solutions are available.

The Committee did not consider reliability a major problem, for the SBA is composed of many components that can be made functionally or otherwise redundant. Certain components, such as the orbit adjust engine and the propellant tankage, are not redundant; but they represent current state-of-the-art and can be made demonstrably quite reliable.

Not so obvious are the incipient problems of operating the spacecraft as an entity. Past experience points to the probability that system problems will arise. Time is necessary for their resolution. LMSC, as satellite integrating contractor, is aware of this situation. LMSC and Perkin-Elmer must exhibit close cooperation if major system problems are to be avoided. System level engineering analysis and audit are lagging; should this continue, some system problems may be discovered in terms of damaged hardware from sneak circuits and unsuspected transients rather than from errors on engineering drawings. These circumstances are the greatest cause of uncertainty about meeting the established December 1970 initial launch date.

After considering all factors, the Committee is confident that with adequate funding HEXAGON can meet the initial

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December 1970 launch date. As stated in the conclusions on page 2, the Committee agreed with the SSSPO evaluation of possible schedule delays. A lesser funding level would immediately produce a launch slip but no greater confidence in a firm initial launch date (for, though emerging problems might be solved during a schedule slip, there is no guarantee that the problems would reveal themselves in a timely fashion). However, only those aspects of the system associated with successful launch and operation of the basic sensor subsystem need be funded at levels necessary to achieve the December 1970 initial launch date. Other elements of the system (such as the terrain camera, associated integration costs, and its operational software costs) can be deferred without any effect on the basic HEXAGON vehicle.

CONFIDENCE OF MISSION SUCCESS

Factors assuring success of the first HEXAGON missions are wedded to those factors assuring achievement of a specified initial launch date. However, before a useful estimate of all-system success can be determined, it is necessary

To examine each major system element for its impact on probable mission success

To assess the critical technology

To evaluate expected launch and flight conditions.

Sensor Subsystem

The sensor subsystem represents the greatest advance in new technology. It is a complex redundant mechanism whose successful operation depends on excellence of functional design and thoroughness of testing. Its most critical components--those associated with the film transport and its allied servo system--are of new, untried designs. We believe the intensive attention given to these system aspects imparts a high confidence of successful operation. The Committee assesses the single shot probability as 88 percent that the sensor will survive the launch environment and operate for 30 days with acceptable optical performance--if not perfectly within specification.

Satellite Basic Assembly

The satellite basic assembly represents current state-of-the-art. However, it is an entirely new structure,

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containing some heretofore untried hardware--i.e., the propellant tankage with its gälleried fuel lines. The basic structure is very long and quite flexible, both in torsion and bending modes. The film supply mounting is statically indeterminate, which defeats rigid structural analysis. Hence, a thorough testing program of flight-quality hardware is essential to structural integrity and to determination of modes of structure movement which might be coupled into the sensor. Fortunately, guidance and control, telemetry, command, power (including solar arrays), and orbit adjust engine have had (or will have) considerable prior flight experience. These systems also are more amenable to functional redundancy. Based on these factors, the Committee assessed the single shot probability that the satellite basic assembly will survive the launch environment and operate acceptably for 30 days in orbit as 90 percent (probably conservative).

Launch Vehicle

The launch vehicle, Titan IIID, is a different configuration of the Titan booster family; its major difference is that the Titan transtage is not used. Other components of the Titan IIID have been thoroughly flight tested and proved. Because of past experience with the launch vehicle, the Committee assesses the single shot probability of successful Titan IIID operation throughout the launch phase as 95 percent (probably conservative).

Recovery Vehicle

The final essential element is the successful functioning and recovery of each recovery vehicle (RV). The HEXAGON RVs are new, but are a scaled up "DISCOVERER" shape. The parachute design has been flown on the PRIME Project and will be scaled for the HEXAGON recovery vehicles. An extensive test program is under way, including high altitude drop tests to simulate all recovery sequences occurring after initial re-entry. Again using experience as a basis, the Committee assesses as 98 percent the single shot probability that each individual recovery vehicle survives the launch environment, operates successfully in orbit for its particular specified lifetime (the last RV must operate 30 days in orbit), and is successfully recovered.

General Mission Success

The Committee calculates as 75 percent the single shot probability that each individual HEXAGON vehicle will survive

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launch, operate acceptably for 30 days on orbit, and have successful first RV recovery. The assessment for all four recovery vehicles places the probability of success closer to 70 percent. (This latter figure is not directly equatable to mission success in terms of product returned because the first recovery vehicles generally bring back the majority of critical targets as a consequence of target priorities.) The Committee finds that the 75 percent probability figure is for all intents identical with the HEXAGON Project specified probability requirement.

Initial HEXAGON Mission Success

For the initial HEXAGON launch, what is the probability of successfully recovering good photographs in the first RV? The first HEXAGON vehicle will be operated under conditions tending to improve probability of mission success and to provide for recovery of the most significant information; thus, a comprehensive grasp of vehicle performance can be gained. Specifically, the first vehicle will be placed in a "benign" orbit--one which will not task the thermal control system and which has a sufficiently high perigee so that no orbit-sustaining maneuver will be required prior to recovery of the first RV. The first RV itself will be fully instrumented so that its performance can be carefully measured. Under serious consideration is programming the cameras so that film is transported in the forward direction only (and not reversed as is normal between each photo operation). Although some film would not be exposed under these circumstances, there is less chance of a film transport malfunction. This technique would be added insurance that some exposed film would be returned so that actual camera performance on orbit can be measured. Once the first re-entry vehicle is recovered, the film transport system could be operated in the normal forward and reverse cycle and other operations, such as orbit adjust, could be begun. The first few flights will not carry the terrain camera, and the additional weight-carrying capacity will be utilized by the installation of extra batteries. This will help guard against solar array malfunctions and provide sufficient power to insure return of the first re-entry vehicle with its load of film.

The Committee assigned no percentage probability to these techniques, but it is quite clear that they enhance the likelihood of successful return of exposed film in the first recovery vehicle.

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EFFECT OF FUND LIMITATION

The Committee examined the situation which would arise should HEXAGON be funded in FY 1970 at a level less than that recommended. The sensitive element of the system is the sensor. If reduced [redacted] below the requested amount of [redacted], a six-month program slip would be expected. A [redacted] reduction would result in a twelve-month slip. Other elements of the system which are not pacing at this time appear to be as sensitive to reductions as does the sensor, but definitive figures were difficult to develop. However, the Committee agrees that a combined [redacted] reduction in satellite basic assembly and satellite integrating contractor funding (both LMSC) would result in a six-month slip. The amount of reduction leading to a twelve-month slip was not clearly identified, and considerable work on the part of the contractor would be necessary to develop credible figures. However, in the Committee's view, the launch date sensitivity to funding limitations had been tested enough to expose the problem adequately so no further exploration was conducted. It was evident that fund limitations would have an immediate, unfavorable effect on scheduling.

SUMMARY

Funding at the level required to achieve a December 1970 initial launch date is the preferable option. The probability of a successful HEXAGON flight by the third launch, June 1971, is close to 95 percent under these conditions. The pressure on the collection overlap can be relieved by stretching CORONA launches six months into FY 1972. This would entail expenditures of [redacted] in CORONA launch and operating costs in FY 1972, which may not actually be needed if HEXAGON flies successfully prior to our committing the last two CORONAs to flight. Immediate pressure on FY 1970 funds for a new CORONA buy can be relieved by deferring a decision until December 1969 at which time a more accurate assessment of the HEXAGON program can be made.

The Committee feels strongly that its recommendations are proper at this time. However, the Committee urges that the status of both CORONA and HEXAGON be carefully tracked in the next few months so that any departure from expected conditions can be quickly identified and a new course of action formulated. Such departures might take the form of

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a major technical problem in HEXAGON which would force a major slippage or any situation which would cause CORONA to be flown at more frequent intervals than those recommended. In any case, a clear determination should be made in December 1969 on whether to initiate a further CORONA buy.

F. Robert Naka

F. Robert Naka
Chairman

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GAMBIT HEXAGON [redacted]

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History

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20 February 1973

Wes:

1. Per our discussion, I provide the following data on the reliability of the various programs. As I said, "G" has been the most unreliable of the photo programs to date.

2. Attached are summary data on the programs that you might find interesting. Some summary statistics are more useful, however.

3. There are several ways to look at program reliability. The easiest (but not necessarily the most reliable) is to look at capsules (i.e. RV's) launched vs. capsules recovered. In this context, the following data is interesting:

Program	Capsules Launched	Capsules Recovered	% Recovered
CORONA	193	156	80
GAMBIT	90	80	88
HEXAGON	16	15	94
CORONA (1963 on)	147	132	90

4. The above is interesting in that HEXAGON, on this basis, is the most reliable to date. GAMBIT looks better than CORONA if you use all the CORONA data. This isn't really fair, however, since CORONA started the space age and had lots of booster problems that GAMBIT did not have. Comparing "C" and "G" on a more reasonable basis (i.e. 1963 on), "C" is slightly better than "G."

5. A more useful way to look at reliability, however, is in terms of how much film has been returned. Doing this for the three programs yields the data shown in Tables 1 and 2. Table 1 looks at the percentage of film either not returned or catastrophically imaged (i.e. useless) due directly to the camera system itself. On this basis, GAMBIT has been the more unreliable program. Table 2 looks at all failures (camera, booster, Agena, etc.) on the same basis. The only failures not included are lost film due to RV's being lost. That is, Table 2 is aimed at either launch or on-orbit failures. Again, GAMBIT is the worst of the three.

CIA

R. Kohler

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GAMBIT HEXAGON [redacted]

TABLE 1

Program Reliability Based on Film Return

(Camera Failures Only)

Program	Total Film Launched	Launches	Film Not Returned	% Not Returned
CORONA*	2,176,000	68	88,000	4
GAMBIT	445,000	75**	30,000	10
HEXAGON	880,000	4	12,000	1.4

* 1963 on.
**61 single-bucket, 14 dual-bucket.

TABLE 2

Program Reliability Based on Film Return

(All Failures Except RV's)

Program	Total Film Launched	Launches	Film Not Returned	% Not Returned
CORONA*	2,176,000	68	128,000	5.8
GAMBIT	445,000	75*	50,000	16.3
HEXAGON	880,000	4	62,000	7.0

* 1963 on.
**61 single-bucket, 14 dual-bucket.

GAMBIT HEXAGON [redacted]

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GAMBIT HEXAGON [redacted]

HEXAGON PERFORMANCE

	1971	1972
Launches	1	3
Capsules Launched	4	12
Capsules Recovered	3	12

ANOMALIES:

1202 HEXAGON Film break, one camera, mono RV-3 and RV-4 (1972)

1203 HEXAGON Film fold, one camera, RV-3 mono (1972)

GAMBIT HEXAGON [redacted]
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GAMBIT HEXAGON [redacted]RONA PERFORMANCE

	1959 C	1960 C&C'	1961 C&C'	1962 M	1963 MLA	1964 J-1	1965 J-1	1966 J-1	1967 J-1&3	1968 J-1&3	1969 J-1&3	1970 J-3	1971 J-3	1972 J-3
Launched	5	8	12	21	11	14	13	9	9	8	6	4	3	2
Capsules Launched	5	8	12	21	13	26	26	18	18	16	12	8	6	4
Capsules Orbited	3	5	11	20	11	24	26	16	18	16	12	8	4	4
Capsules Recovered	0	5	7	12	8	21	25	16	18	16	12	8	4	4

ANOMALIES: (Other than recovery or launch failure)

9012	C'	Film broke (1960)
9034	ARGON	Timer failure (1962)
9039	MURAL	Timer failure, 2-day mission (1962)
9046	ARGON	Shutter timer failure (1962)
8002	LANYARD	Decoder failure (1963)
1013	J-1	Both cameras failed Rev 52 (1964)
1021	J-1	One camera failed Rev 102, caused by film (1965)
1027	J-1	Timer failure, cameras not activated on bucket 2 (1965)
1031	J-1	One camera failed, bucket 2 (1966)
1048	J-1	Film tear, bucket 2 on one camera (1968)
1050	J-1	Vehicle unstable after Rev 22 (1969)
1107	J-3	One camera failed on Rev 1, all mono (1969)
1112	J-3	One camera failed during cut-and-wrap sequence (1970)

GAMBIT HEXAGON [redacted]

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GAMBIT HEXAGON [redacted]AMBIT PERFORMANCE

	1963 G	1964 G	1965 G	1966 G&G^3	1967 G&G^3	1968 G^3	1969 G^3	1970 G^3	1971 G^3	1972 G^3
Launched	4	10	9	15	10	8	6	5	4	4
Capsules Launched	4	10	9	15	10	8	8	10	8	8
Capsules Orbited	4	8	8	15	9	8	8	10	8	6
Capsules Recovered	4	7	8	15	9	7	8	8	8	6

ANOMALIES: (Other than recovery or launch failures)

4001	G	Distorted Image (1963)
4005	G	Unstable yaw, Rev 2 (1964)
4009	G	Severe warp (1964)
4014	G	Unstable after Rev 7 (1964)
4015	G	Stuck mirror (1965)
4019	G	Power failure (1965)
4021	G	Vehicle unstable (1965)
4023	G	Vehicle unstable--recovered Rev 18 (1965)
4302	G^3	Severe out-of-focus (1966)
4034	G	Outer shield failed to eject (1966)

GAMBIT HEXAGON [redacted]

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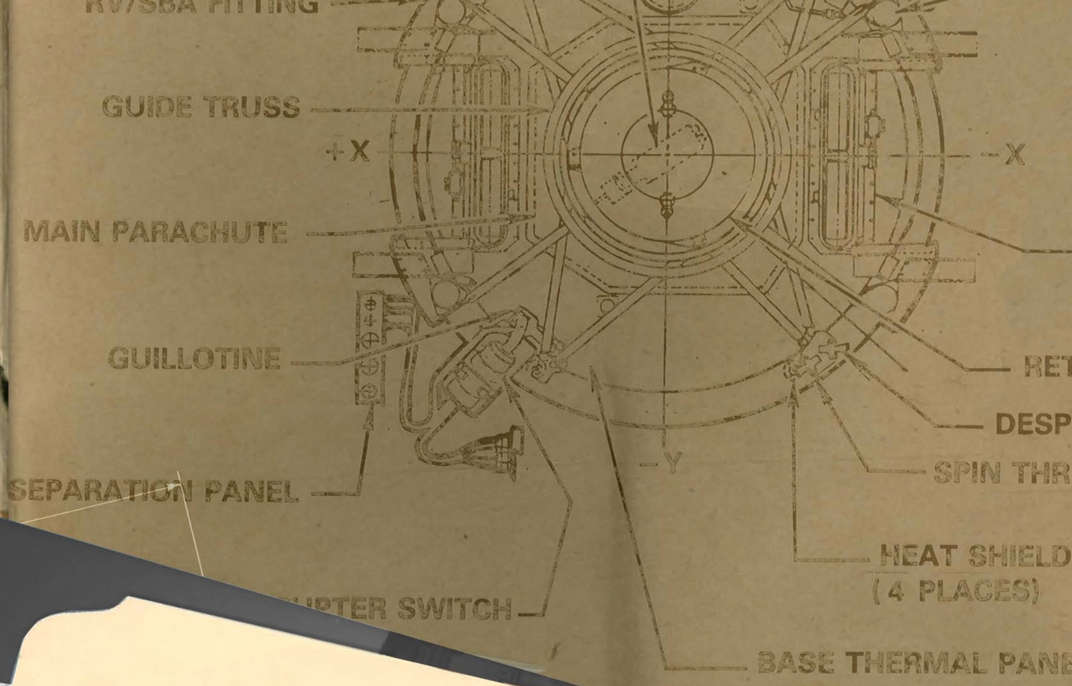

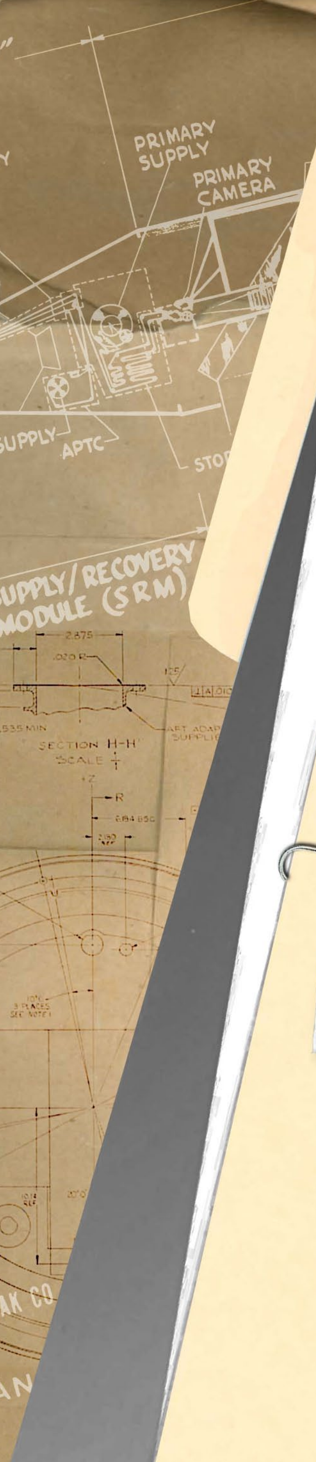

CRITICAL TO US SECURITY:
THE GAMBIT AND HEXAGON SATELLITE RECONNAISSANCE SYSTEMS COMPENDIUM

SECTION VII: PROGRAM CONGRATULATIONS

When the first imagery was reviewed from the Corona, Gambit, Gambit-3, and Hexagon film return imagery satellite systems, intelligence analysts, national reconnaissance, and policymakers praised each advance in piercing the iron curtain. There are numerous recorded compliments for these remarkable systems, and many more unrecorded comments.

We have selected four congratulatory documents for this compilation. The first is a letter of congratulations from Director of Central Intelligence, Richard Helms, for the first successful launch of the Gambit-3 system, which gave the nation high resolution satellite imagery capabilities. The next two memorandums are from Director of Central Intelligence William Casey and Director, National Reconnaissance Office (NRO) Pete Aldridge commending NRO teams responsible for the highly successful launch of the 17th Hexagon mission.

The final document might seem like an unusual choice, the transition plan for Hexagon from the Central Intelligence Agency (CIA) program at the NRO to the Air Force program at the NRO. It is a compliment in a way. First, it demonstrates that despite controversies and tensions, the elements of the NRO worked effectively to support the nation's intelligence and national security needs. Second, it represents an organizational accommodation to allow the reallocation of resources to focus on the next generation of imagery satellites that have proven, and continue to prove, a key asset for keeping the American people safe and secure in an unpredictable world.

LIST OF PROGRAM CONGRATULATIONS DOCUMENTS

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CENTRAL INTELLIGENCE AGENCY
WASHINGTON, D. C. 20505

OFFICE OF THE DIRECTOR

18 August 1966

BYE-0188-66 2A F

The Honorable Alexander Flax
Director, National Reconnaissance
Office
Department of Defense
Washington, D. C.

Dear Al:

Congratulations to you and your associates on the success of the first KH-8 mission.

This excellent photography will certainly be of great assistance in our attempts to solve some of our very difficult intelligence problems.

Cordially,

Dick

Richard Helms
Director

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HEXAGON

The Director of Central Intelligence

Washington, D.C. 20505

3 January 1983

MEMORANDUM FOR: E. C. Aldridge, Jr.
Director, National Reconnaissance Office (~~S~~/B)

SUBJECT: Commendation for the Operation of HEXAGON Mission 1217 (~~S~~/B-H)

1. The recent recovery of the final film increment of HEXAGON Mission 1217 brought to a conclusion the most successful mission of the HEXAGON Program. This mission achieved several firsts within the program. It had the longest active mission life; it was the first to employ the improved film looper which reduced considerably the amount of film wastage; and it provided the largest amount of cloud-free coverage ever achieved. (~~TS~~/B-H)

2. This mission filled a significant void by providing an excellent data base of broad area search coverage on Communist countries and Third World areas of major concern to the Intelligence Community. As you are aware, the Community had gone for sometime without adequate broad area search coverage. (~~S~~)

3. I commend you and your organization for the outstanding manner in which this mission's resources were managed and operated. I would, in particular, like to congratulate and thank Colonels Lester McChristian and [redacted] and their respective staffs for their professionalism, dedication, and overall efforts which made this such a successful mission. Please convey my appreciation to all involved in this effort. (~~S~~/B)

William Casey
William J. Casey

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

OFFICE OF THE DIRECTOR

January 7, 1983

MEMORANDUM FOR THE DIRECTOR, PROGRAM A

SUBJECT: Letter of Appreciation

Jack

Attached is a letter I received from Mr. William Casey, Director of Central Intelligence. His comments regarding HEXAGON Mission 1217 are especially gratifying, and I wanted to pass them on to you with my added congratulations and thanks for an exceptional effort.

I would like you to pass on my appreciation to both Les and Tom as well as to their staffs for their outstanding contribution. It is always extremely gratifying to have the outstanding professionalism and superior abilities of our personnel recognized by those with whom we deal.

Special activities such as ours place exceptional demands on the people and the complex systems they interact with. Successes, like HEXAGON Mission 1217, are a great tribute to the competence, professionalism, and dedication of all of the individuals involved. Please convey my heartfelt appreciation for their efforts.

Pete

E. C. Aldridge, Jr.

1 Attachment
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dtd 3 Jan 83 (BYE-2766-82)

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H E X A G O N

TRANSITION

PLAN

March 1972

Submitted by:

Donald L. Haas

Donald W. Patterson

Col. Robert H. Krumpe

Concur:

Harold L. Brownman

Approved:

B/G Lew Allen, Jr.

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HEXAGON TRANSITION PLAN

1.0 PURPOSE AND SCOPE

1.1 The purpose of this document is to identify and assign responsibilities for the actions necessary to insure an orderly transition of all CIA/OSP HEXAGON Program responsibilities (except those listed below) to the Director, SAFSP, in order to consolidate the responsibility for the HEXAGON Program under one manager. The CIA/OSP HEXAGON responsibilities that will not be transferred to SAFSP are:

1.1.1 The functions performed by the CIA/OSP in support of the SOC:

1.1.1.1 Operational supporting software.

1.1.1.2 Mission simulations.

1.1.1.3 Statistical prediction studies.

1.1.2 Procurement of sensor subsystems 1 through 6, and the associated post-flight effort.

1.1.3 Current CIA/OSP contracts for:

1.1.3.1 Visual edge matching.

1.1.3.2 Image evaluation devices.

1.1.3.3 Horizon free radical film.

1.2 Responsibilities are assigned to the CIA and SAFSP for contractual, budget and fiscal, engineering, and security matters. Schedules for the accomplishment of specific tasks

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are also contained in the plan. Details for the implementation of the plan will be developed jointly by CIA/OSP and SAFSP as required.

1.3 The plan assumes the sensor subsystem delivery and satellite vehicle launch dates shown in Figure 1, Schedules.

2.0 <u>AUTHORITY</u>

This plan has been developed in response to direction from the NRO (NRO message 1565, 29 November 1971, and NRO message 0251, 25 February 1972).

3.0 <u>CONTRACTS</u>

Formal transfer of all responsibility to SAFSP will be executed on 1 July 1973, with one exception; namely, the contract for Sensor Subsystems 1 through 6, Contract [redacted], as explained in Paragraph 3.1 below. The following paragraphs outline the contractual actions to be taken:

3.1 [redacted] <u>- Flight Sensor Subsystems 1 through 6</u>

CIA/OSP will retain full responsibility for the life of this contract. If present launch schedules are met, SV-6 will have flown in April and May of 1973, and only PFA reporting, fee determination, and contract close-out tasks will remain to be completed subsequent to the transfer time of 1 July 1973.

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HEXAGON

3.2 [redacted] - Flight Sensor Subsystems 7 through 12 and [redacted] - Facilities Contract

A tripartite agreement will be executed between the CIA/SAFSP/Perkin-Elmer which will substitute SAFSP for CIA/OSP as the customer effective 1 July 1973. This formal agreement will be signed by 1 September 1972. On or about 15 September 1972 the Director, CIA/OSP and the Director, SAFSP will meet to review the status of this agreement.

3.3 [redacted] - Field and Flight Operations, and [redacted] - Post-flight Analysis

The Field Operations contract will continue under the control of the CIA/OSP until 1 July 1973. The PFA contract will continue under the control of CIA/OSP until 1 July 1973 or the completion of Mission 1206 PFA activities, whichever is latest. SAFSP will contract independently for these efforts in sufficient time to insure continuity of these functions subsequent to 1 July 1973.

3.4 [redacted] - SETS

CIA/OSP will continue to contract for this support, as required, through 1 July 1973. SAFSP will determine the need for these services and will contract for them if necessary after 1 July 1973.

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3.5 Flight Sensor Subsystems 13 through 18

SAFSP will negotiate a new contract for Sensor Subsystems 13 through 18 and will assume complete responsibility for this and all subsequent procurements. CIA/OSP will provide financial and contractual advice, and technical support to SAFSP during the fact-finding and negotiation phases of the 13 through 18 procurement.

4.0 ENGINEERING MANAGEMENT

4.1 The CIA/OSP will provide engineering support to SAFSP during the transition period as required. There will be a free exchange of information between CIA/OSP and SAFSP on all elements of the HEXAGON Program to be transferred. Personnel from the program offices will meet frequently to discuss studies being conducted, plans for system changes, and any other subject which might affect the HEXAGON Program. SAFSP will assign personnel to work with and to observe CIA/OSP personnel in advance of the transfer date, especially in the area of hardware acceptance, flight readiness assessment, and post-flight analyses. Subsequent to the transfer date, CIA/DDS&T will maintain one individual as a permanent member of the PFA team.

4.2 The CIA/OSP will coordinate Class I engineering change proposals with SAFSP on contracts [redacted] prior to authorization to proceed. The CIA/OSP will submit those Class I engineering change proposals, which have a high probability

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of being approved, to SAFSP for coordination, comments and recommendations. SAFSP will coordinate by message to CIA/OSP.

4.3 CIA/OSP will provide SAFSP with a description of the current computer services and software used by CIA/OSP to support the HEXAGON Program. SAFSP will determine the need to continue these services and will make arrangements to provide the computer/software required.

5.0 SECURITY

This transition involves security - visit certification, program clearance approvals, plant physical security, courier support. No major problems are foreseen. Transfer details will be resolved jointly by CIA/USAF security personnel. SAFSP will be authorized to certify visitors into Perkin-Elmer on SAFSP related business beginning 1 April 1972. The CIA will continue to certify visitors on CIA related business until CIA/OSP contractual responsibilities with Perkin-Elmer are completed.

6.0 BUDGET AND FISCAL

6.1 Pursuant to NRO Fiscal Guidance (BYE-125881-72), CIA/OSP will derive budgetary funding requirements through Sensor Subsystem 12 and the post-flight evaluation. Funding requirements through FY 1978 for field support, spares, engineering changes, and facilities will be submitted by CIA/OSP. SAFSP will submit

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funding requirements for Sensor Subsystems 13 through 18.

6.2 SAFSP will be responsible for the May 1973 budget submission and will assume funding responsibility on 1 July 1973.

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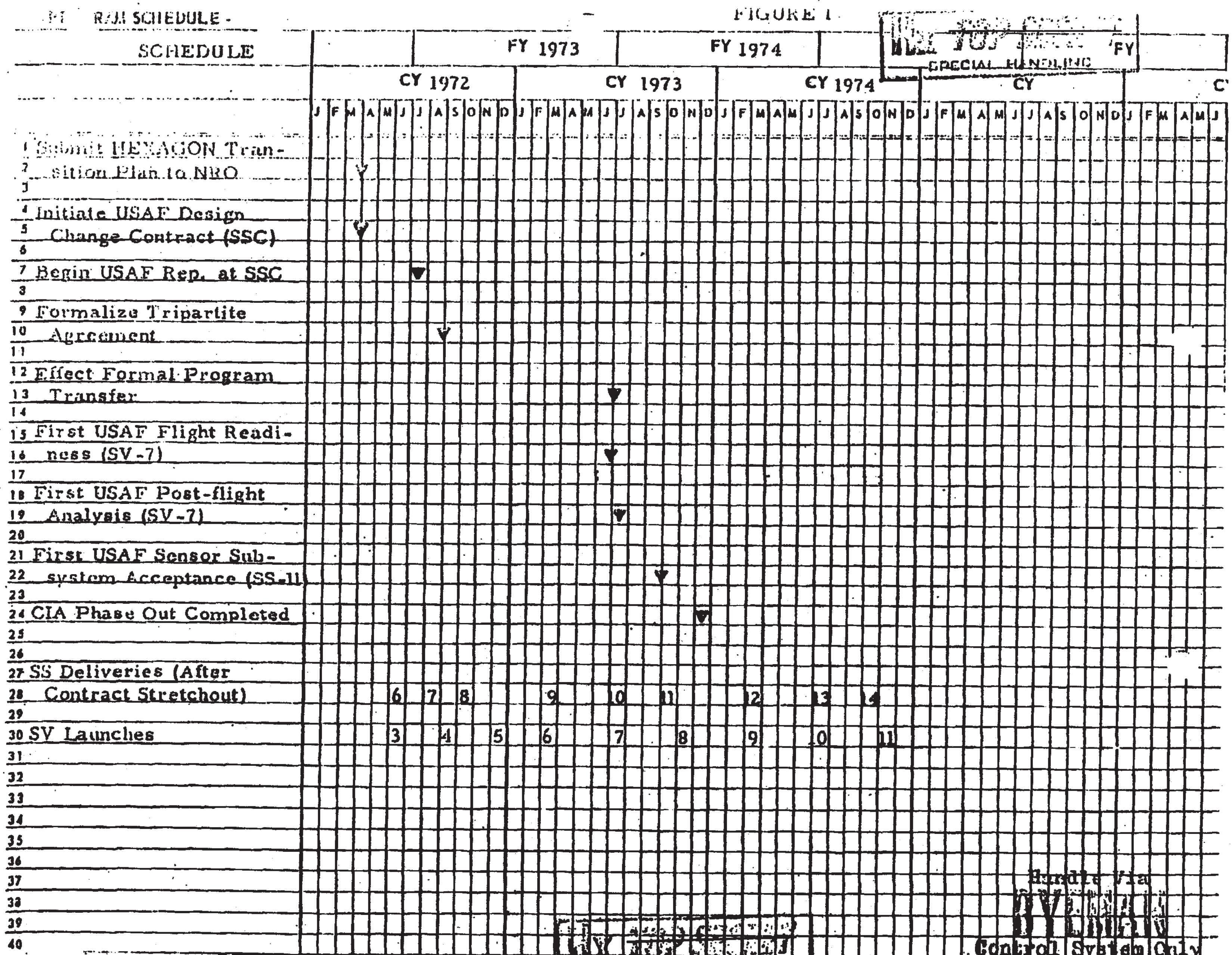
FIGURE 1


RAJI SCHEDULE -
SCHEDULE
FY 1973
FY 1974
FY
CY 1972
CY 1973
CY 1974
CY
J F M A M J J A S O N D
SPECIAL HANDLING
1 Submit HEXAGON Tran-
2 sition Plan to NRO
4 Initiate USAF Design
5 Change Contract (SSC)
7 Begin USAF Rep. at SSC
9 Formalize Tripartite
10 Agreement
12 Effect Formal Program
13 Transfer
15 First USAF Flight Readi-
16 ness (SV-7)
18 First USAF Post-flight
19 Analysis (SV-7)
21 First USAF Sensor Sub-
22 system Acceptance (SS-11)
24 CIA Phase Out Completed
27 SS Deliveries (After
28 Contract Stretchout)
6 7 8 9 10 11 12 13 14
30 SV Launches
3 4 5 6 7 8 9 10 11
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