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CRITICAL TO US SECURITY:

THE DEVELOPMENT OF THE GAMBIT AND HEXAGON SATELLITE RECONNAISSANCE SYSTEMS

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NRO HISTORIAN

1997

Handle Via BYEMAN
Control System

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TABLE OF CONTENTS

NRO APPROVED FOR
RELEASE 17 September 2011

NRO APPROVED FOR
RELEASE 17 September 2011

Critical to US Security: The Development of the GAMBIT and HEXAGON Satellite Reconnaissance Systems

Introduction

Since the early 1960s, US policymakers have come to rely increasingly on photo-reconnaissance satellite imagery for timely and accurate intelligence. Photo-reconnaissance satellites and the information they provide have become virtually indispensable to the US 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 US private industry 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 photo-reconnaissance technologies that resulted in the acquisition of never-before-seen, detailed intelligence data for US officials.

CORONA, the first US 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

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RELEASE 17 September 2011

areas. CORONA imagery provided US decision makers 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.[1] 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 US intelligence was "virtually immeasurable," CORONA imagery also had limitations. In 1961, for example, it could resolve no object smaller than 10-15 feet. US photointerpreters and US planners needed, and demanded, higher resolution imagery for their intelligence estimates relating to Soviet weapons systems and target identifications.

To fill this gap, 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 of [redacted] two feet. After overcoming a series of developmental problems, both technical and managerial, the first GAMBIT satellite flew in July

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[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.

1963. The returned film product whetted the appetite of US intelligence analysts for more. Although GAMBIT, a surveillance system, covered far less area than CORONA, it produced photography with a much better resolution. Objects as small as six feet could now be located and observed.

An improved GAMBIT, known as GAMBIT-3 or the KH-8, flew in 1967. Capable of stereo photography and [redacted] resolution, it proved highly successful replacing GAMBIT-1. The GAMBIT program eventually flew 54 missions over 20 years, concluding in 1984. It provided US 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 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 feet in diameter and 55 feet in length. It rivaled 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 on 18 April 1986.

In the 1980s, the next generation of US photo-reconnaissance 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 US policymakers. For much of the Cold War, these systems kept watch over the Soviet Union and other communist bloc areas. They proved critical to US security by providing detailed intelligence on US 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 they encountered as NRO, CIA,

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RELEASE 17 September 2011

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 developed between the NRO and industry in pursuing far-reaching scientific and technological goals. It 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 US 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.[2]

The most experienced U-2 pilot, Francis Gary Powers was selected to fly Operation GRAND SLAM from [redacted] to [redacted]. According to CIA analysts, this route offered the

[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 US 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.

NRO APPROVED FOR
RELEASE 17 September 2011

best chance of photographing suspected locations of Soviet 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 disabled his aircraft 70,500 feet above the Sverdlovsk area. The Soviets had succeeded in downing the United States' most advanced reconnaissance aircraft. When Eisenhower finally admitted US 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.[3]

At the same time the U-2 was successfully overflying the Soviet Union, 1956-1960, and following the dramatic Soviet space successes in 1957 with Sputnik I and Sputnik II, President Eisenhower formally endorsed a stop-gap US 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

[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.

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RELEASE 17 September 2011

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.[4]

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, Bissell and the 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."[5]

Discouraged, on 10 August 1960, the CORONA team launched a diagnostic payload in an attempt to determine what was going

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[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.

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RELEASE 17 September 2011

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/USAF 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.[6]

CORONA Mission 9013, recovered on 10 December 1960, revealed Soviet construction work on its SS-6 missile sites at Plesetsk and at Yurya. Photo reconnaissance 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 anti-ballistic missile (ABM) system designed to counter US intermediate-range missiles. The John F. Kennedy administration, anxious over this new development, turned to the CIA and the CORONA program for more

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RELEASE 17 September 2011

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 the surface-to-air missile. Moreover, CORONA engineers were still grappling with keeping the satellite cameras in focus. According to the Satellite Intelligence Requirements Committee (SIRC), new US satellite systems were needed that could resolve objects as small as 6, 1.5, and 0.3 meters. CORONA cameras called only for a resolution of 6 meters. This was in accordance with its role of performing wide-area, low resolution "search" missions.[7]

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

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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 multi-faceted satellite observation system. Little came of these efforts, however, as the Department of Defense 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."[8]

Upon the urging of his civilian scientific advisors,

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[8]See *. 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). See * and William M. Leary, ed., *The Central Intelligence Agency, History and Documents* (Birmingham, Alabama: University of Alabama Press, 1984).

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RELEASE 17 September 2011

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 over-all 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. Osmund 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, US officials urgently sought new sources of high resolution reconnaissance photography.[9] The imagery was critical to US national security interests.

The U-2 shoot-down triggered a series of top level meetings

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[9]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 E-1, E-2, and E-6 ever flew. See *

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RELEASE 17 September 2011

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, on 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 Department of Defense 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

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RELEASE 17 September 2011

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: Atlas booster; Agena spacecraft; 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.[10]

Another factor that affected the GAMBIT program was the formal establishment of the National Reconnaissance Office 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 became the first Director, NRO 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

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RELEASE 17 September 2011

the CORONA project and the CIA satellite effort (Program B).

GAMBIT Development

Two months earlier in March 1960 Eastman Kodak submitted proposals to the Air Force and the CIA for the development of a 77-inch (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.[11]

In June, Kodak proposed a 36-inch 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

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[11]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.

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-foot ground resolution with high-acuity stereo coverage.

A month later, on 20 July, Kodak offered a modified proposal which integrated the 77-inch 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 at [redacted] for R&D 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

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RELEASE 17 September 2011

without any outward indication that such a program existed.[12]

At the same time Charyk moved to hide the GAMBIT project, he also shielded it from the over-all 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.[13]

Since the 77-inch 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

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much the same procedures.[14]

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.[15]

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 seven-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

[redacted]

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RELEASE 17 September 2011

Kodak. There were no alternatives.[16] General Electric's Space Division was to build the orbital-control vehicle. By mid-1961, GAMBIT had evolved into a 15-foot long, five-foot 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-inch focal length and a clean aperture of 19.5 inches. This lens, when flown at a nominal 95 nm altitude was to produce a ground resolution, at nadir, of from 2 to 3 feet. GAMBIT was to carry 3,000 feet of 9.50-inch 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 pounds.

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

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roll axis. The GE orbital control vehicle (OCV) was to be capable

of varying the roll attitude from 0° to 45° 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 pounds 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 pounds of thrust and a 57,200-pound thrust sustainer engine. The Agena-D upper stage used 13,234 pounds of fuel to power its 16,000-pound thrust engines.

After exposure, the cameras 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

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cold-gas system, and then deboosted from orbit. Parachute deployment was to occur at 55,000 feet. 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 and the State Department opened negotiations for an additional [redacted] for controlling the orbital vehicle and for safeguarding the proposed land recovery process.[17] 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 serious problems remained and that

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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 pounds over design weight and most of the overweight derived from complications introduced by the land recovery requirement. Over-water 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

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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."[18]

Greer was attracted to the concept by the potential of major savings on weight, cost, and launch schedule. More than 600 pounds of orbital weight could be saved by going to an overwater recovery mode. Over [redacted] in 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.[19]

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

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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. The [redacted] made the primary and stereo mirrors. Using large boules of very pure fused silica glass, [redacted] engineers joined the sections in an [redacted] fashion. 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. [redacted] shipped the large, lightweight blanks to Kodak for figuring and polishing at its special facility, [redacted]

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

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[20]Kodak set up a special unit to deal with GAMBIT. The entire project was located at [redacted]. 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.

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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.[21]

The Orbital Control Vehicle (OCV) development by General Electric, 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 over-runs and severely threatened delivery schedules.[22]

The prevalence of cost over-runs, particularly at General Electric, the threat of new schedule slippage, and the increasing cost of the GAMBIT program greatly concerned Charyk. At the same

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RELEASE 17 September 2011

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.[23]

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

[23]See*. 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.