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~~(S//BYE)~~ The Dual-Mode Gambit Mission 4352: An Illustration of Risk in National Reconnaissance Operations[1]

B[redacted]

~~(S//BYE)~~ In 1982 the National Reconnaissance Office (NRO) faced an intelligence collection problem that led to a decision to employ a creative approach to an operational challenge. The intelligence collection problem involved a gap in search imagery capability. After developing and debating a number of potential solutions, the decision was made to employ the Gambit imaging reconnaissance satellite for a purpose other than that for which it had been designed. Specifically, in March 1982 this high-resolution "point target" surveillance imaging system was employed for a broad-area search mission, referred to as Mission 4352 (M4352). Unfortunately, part of the mission was unsuccessful, and a film-return recovery bucket remained in space for over twenty years until it made a fiery return to Earth on 28 September 2002.

~~(S//BYE)~~ Although this mission was only partially successful, it provided valuable lessons in risk management for both the NRO and a mission partner at the time, the DCI Committee on Imagery Requirements and Exploitation (COMIREX) that may continue to be applicable to current national reconnaissance planning and operations.[2] Specific risks associated with this mission included: the search imagery gap; system and operational challenges from using Gambit in

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[1] ~~(S//BYE)~~ The history of Gambit mission 4352-1 and the status of the film-return bucket came to the NRO's attention during the course of assessing the feasibility of declassifying large portions of the Gambit and Hexagon programs in 2002[redacted]was involved in these declassification assessments on behalf of the NRO Office of Policy, Center for the Study of National Reconnaissance[redacted]served as chairman of the Imagery Collection Requirements Subcommittee (ICRS) of the Committee on Imagery Requirements and Exploitation (COMIREX) at the time of Gambit Mission 4352. In June 2002, he brought the film bucket issue to the attention o[redacted]USAF, who represented the NRO Office of Policy as co-chair of the NRO Flight Safety Working Group.

[2] (U) COMIREX was a DCI committee to advise and assist the U.S. Intelligence Board on matters involving overhead reconnaissance and imagery exploitation. The former functions of COMIREX are among the legacy activities that are now incorporated into the responsibilities of the National Geospatial-Intelligence Agency (NGA).

dual-mode; unplanned, untested film bucket re-entry plan; and the uncontrolled re-entry of a film bucket twenty years after the mission. This article reviews the factors that contributed to the decision to attempt this novel approach to filling an intelligence collection gap.

(U) Background

~~(S//BYE/TK)~~ During the early 1980s, the Imagery Collection Requirements Subcommittee (ICRS) of COMIREX identified a significant imagery intelligence (IMINT) collection gap with regard to broad-area search (BAS).[3] There would be a gap of approximately one year in BAS coverage, the longest BAS collection gap in ten years. The resulting intelligence gap presented challenges to national policymakers and military planners, who required accurate and timely intelligence on Soviet strategic systems, particularly mobile intercontinental ballistic missiles (ICBMs). Locating, identifying, and tracking these mobile ICBMs was a high priority for U.S. national reconnaissance. At the time, national-level BAS imagery was collected entirely by the KH-9 cameras flown on the Hexagon film-return photoreconnaissance system, but no Hexagon vehicles were available at that time to satisfy these national intelligence requirements.

(U) This intelligence gap occurred during a heightened period of tension in the Cold War and in American-Soviet relations. The U.S. and USSR, usually through their respective clients and proxies, were confronting each other militarily in Southeast Asia, the Middle East, Africa, and Central America. In terms of the strategic balance, the Soviets were deploying a new generation of mobile ICBMs, and the U.S. was deploying a new generation of ICBMs (the MX or "Peacekeeper") in the U.S. and medium-range ballistic missiles (MRBM – Pershing II) in Europe. This deployment occurred amid significant European public dissent. The international political climate was quite heated, as illustrated by President Ronald Reagan's now-famous public reference to the Soviet Union as an "evil empire."

~~(S//BYE)~~ It was within this framework that the National Reconnaissance Office, specifically the former Air Force Program A, developed and implemented a novel approach to address the problem of the intelligence collection gap. The program office turned to Gambit, a satellite system that had been highly successful in its mission of high-resolution photography of point targets, to solve the problem. The proposed approach was to employ Gambit in a novel dual-mode in which it would perform both broad-area search and point target imagery collection functions.

(U) Satellite Reconnaissance Capabilities

~~(S//BYE)~~ During the 1970s and early 1980s, the NRO was flying two film-return imaging satellite programs: a surveillance system (Gambit) and a search system (Hexagon).[4] Search denotes

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[3] (U) The ICRS was responsible for establishing and prioritizing imagery requirements for all national imaging reconnaissance systems. This included working with the NRO in the selection of imagery system phasing to optimize satisfaction of the highest-priority national and departmental imagery requirements.

[4] ~~(S)~~ The first generation of electro-optical (EO) near real-time satellites, known as th[redacted]as also flying as early as December 1976.

[redacted]

(S//BYE) Gambit high-resolution image of the U.S. Capitol, Washington, DC.

the ability to provide imagery coverage of large geographic areas. A search system's design provides large area coverage at the expense of very high spatial resolution. The early Corona photoreconnaissance satellite, with its KH-4 camera, was a search system. In comparison, surveillance denotes the acquisition of very high-resolution imagery of selected targets within relatively small geographic areas. These conceptual and design differences provide the framework to understand the decisions made to use Gambit as a dual-mode (i.e., search and surveillance) system.

(S//BYE) The Gambit surveillance system was designed to acquire high-resolution imagery of point targets. By 1981, the Gambit program had evolved from its early KH-7 camera to the higher-resolution KH-8 camera. The KH-7 operated from 1963 to 1967, and produced a ground resolution nominally in the two-to three-feet range. The KH-8 camera operated from 1966 to 1984 and had a nominal best resolution o[redacted] The KH-8 camera is the Gambit sensor of this story.

(S//BYE) Acquiring imagery of scientific and technical targets was the primary mission for Gambit, and the Soviet Union and China were the primary areas of interest at the time. Development and emergence of the Soviet mobile ICBMs (SS-24) and locating where they were being deployed was a particularly vexing challenge.

(U) The Imagery Collection Gap

(S//BYE) In 1966, the Hexagon/KH-9 program (designed to replace Corona/KH-4 as a broad-area search system) started its acquisition phase. By the end of the 1960s, concern as to when Hexagon would be ready and how well it would perform prompted a number of gap-filler actions. One of these involved the Gambit program and was called variously "highboy," "higherboy," and, ultimately, "dual-mode."

(S//BYE) During the early 1980s, there was a major gap in search imagery coverage. By the time M4352 Gambit was launched, there had been no satellite search imagery for about ten months, the largest gap in search imagery for the previous ten years (DCI, 1981). A number of factors contributed to this gap in imagery intelligence: development and acquisition problems, launch pad conflicts, and other system-related issues. A brief look at the satellite operations of that period illustrates the problem. Hexagon Mission 1216 was launched on 18 June 1980. Its fourth and last film-return bucket was recovered in March 1981. COMIREX recommended to the DCI in October 1981 that the next Hexagon mission (M1217) be launched between late April 1982 and mid-May 1982.[5]

~~(S//BYE)~~ There were concerns related to military mobilization issues in various countries. The lack of imagery search coverage caused great concern to the Intelligence Community by reducing its ability to provide comprehensive, timely intelligence support to national and military leaders and other intelligence consumers. The NRO presented the analytical work done by Program A to COMIREX, and proposed an interim solution for the critical loss of search coverage. Specifically, the NRO proposed launching and operating the next Gambit as a dual-mode mission.[6]

~~(S//BYE)~~ Dual-Mode Gambit

~~(S//BYE)~~ The purpose of dual-mode Gambit mission was to allow the vehicle to operate for 90 days at much higher altitudes—perigees of approximately 300-350 miles (high-mode), and then to return to a lower, more normal perigee of 78 miles for the balance of the mission. In high-mode, the system would be capable of broad area coverage that would mitigate the search gap until launch of the next Hexagon vehicle.[7] Design modifications were required for this approach to be successful. For dual-mode operations, changes were necessary to both the photographic payload section (PPS) and the satellite control section (SCS).

~~(S//BYE)~~ The NRO planned to operate the Gambit vehicle in a way that had not been previously attempted. There were significant risks associated with using the system in a mode other than that for which it was designed, but the potential risks had to be balanced against the potential gain in satisfying a difficult high-priority customer requirement. The Intelligence Community had many competing collection requirements, chiefly collecting very high-resolution imagery of key targets versus mitigating a critical shortfall in search coverage. Both requirement sets could not be fully achieved, and difficult choices had to be made, each with associated risks and costs.

~~(S//BYE/TK)~~ For COMIREX, the risk management assessment was to determine the potential losses of critical imagery intelligence in attempting to perform both search and surveillance on the same mission, recognizing that there could be unacceptable intelligence shortfalls if something went wrong. The Chairman of ICRS had the NRO present this proposal (i.e., operating in dual-mode) at the next scheduled ICRS meeting. There was a contentious debate. Some

[5] ~~(S//BYE)~~ The mid-May "no later than" limitation was "...a function of both climate and the technical certification requirements of a system prepared for a 15 April launch." DCI William Casey approved the COMIREX recommendations on 5 November 1981.

[6] ~~(S//BYE)~~ The COMIREX recommendation as documented in this memo states that all but one member supported the dual-mode, high-low mission. Only the Navy member expressed an objection, and he favored the standard all low-altitude, high-resolution collection mode. Navy's concern was that the recommendation would substantially reduce the opportunities to satisfy S&T intelligence needs.

[7] ~~(S//BYE)~~ In normal operations at ~70 nm perigee, Gambit's swath width was on the order of 4 nm. Raising the altitude to 350 nm would increase swath width to about 20 nm if no other operational changes were made. In nominal operations, Hexagon could easily collect a 300-nm swath width.

Intelligence Community members wanted the whole mission to be in the high-altitude search mode, while others, primarily in the Science & Technology (S&T) community, desired an all very high-resolution Gambit mission. The final decision was to go dual-mode with high-altitude search imagery collected first, followed by low-altitude, high-resolution imagery (SAF, 1984a, SAF, 1984b).[8]

~~(S//BYE)~~ Recovery Failure—Film-Return Bucket M4352-1 Stranded in Space

~~(TS//BYE/TK)~~ On 21 January 1982, Gambit Mission 4352 was launched. The primary flight objective was a 120-day reconnaissance mission to obtain both search and high-resolution photography in the dual-mode configuration. As agreed in COMIREX, the first 90 days of the mission were to be flown at a perigee altitude of 300-350 nm (high-mode) and the last 30 days at 78 nm (low-mode) (Fitzpatrick, 1991). However, the mission profile and orbit schedule were subsequently modified to take advantage of optimum weather conditions over China, Southeast Asia [redacted] and parts of Africa, and to maximize coverage of broad area search mission requirements. The high-mode was extended to 97 days, and the low-mode was shortened to 23 days. Mission 4352 completed 1,125 revolutions of photographic activity. Film from the first 500 revolutions was stored aboard bucket 1 (4352-1), and film from the last 625 revolutions was stored aboard bucket 2 (4352-2).

~~(S//BYE)~~ A major problem occurred during operations to recover the first Satellite Re-entry Vehicle (SRV).[9] SRV-1 (commonly referred to as a "film bucket"), which contained imagery from the high-mode, did not de-orbit as planned on 20 March 1982. An electro-explosive device on an in-flight disconnect (IFD) unit failed to operate, which prevented clean separation of the SRV from the imaging vehicle. There were several backup devices and activities intended to ensure destruction of the bucket and its film payload in case of abnormal re-entry. However, the nature of the initial malfunction prevented the backups from functioning as originally envisioned.

~~(S//BYE)~~ Collectively, the leadership of NRO Program A and Gambit program managers and engineers concluded that the bucket could not be successfully recovered. At this point, the primary objective was to conclude the remainder of Mission 4352, specifically the remaining high-mode collection, transition to low-mode, collection of low-mode imagery, and the successful return of the remaining film bucket (SRV-2). In order to continue with the mission, SRV-1 had to be disconnected from the satellite vehicle.

~~(S//BYE)~~ The bucket was separated from its thrust cone and its heat shield. This allowed the bucket to separate from the satellite vehicle, which left the bucket and enclosed film abandoned in orbit. This action was viewed as a fail-safe measure in the expectation that the film would decay in space and the film bucket likely would burn up on its eventual re-entry to Earth.

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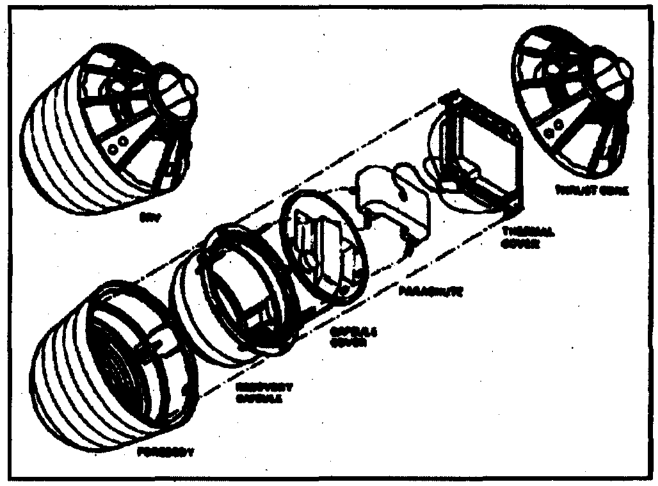
[8] ~~(S//BYE)~~ The original plan was that high-mode was to be collected for recovery on both buckets 1 and 2. The first bucket was filled with high-altitude imagery, 500 revs worth. The second bucket collected imagery from 125 high-mode revs and 248 low-mode imaging revs.

[9] ~~(S//BYE)~~ The Gambit satellite contained two film return buckets, which were identified by mission number (e.g., 4352-1 and 4352-2).

Because of the high altitude of the film bucket, initial estimates were that it could be up to thirty years before the bucket's orbit decayed to a point where it would re-enter the Earth's atmosphere. The lost bucket was characterized, and subsequently tracked, as M4352-related space debris.



~~(S//BYE)~~ Gambit Space Recovery Vehicle schematic diagram.

~~(S//BYE)~~ An innovative backup recovery procedure was implemented to prevent a similar malfunction from causing the loss of M4352 SRV-2. As a result of the SRV-1 IFD failure, a special recovery/de-boost plan was used to maximize the probability of SRV-2 recovery. The procedure consisted of a normal recovery sequence and a backup sequence using the satellite vehicle de-boost in conjunction with the backup SRV separate command. Although the SRV-2 in-flight disconnect also failed to function, a backup/recovery de-boost was employed using the satellite-control sections to re-enter the entire vehicle, whereupon SRV-2 separated. The remaining SRV-2 recovery events functioned nominally, and the SRV was successfully air recovered on 23 May 1982.

~~(S//BYE)~~ The quality of the imagery recovered from SRV-2 was degraded by nearly fifty percent from photo scientists' expectations. Despite months of investigation by a team representing many elements of the program, plus independent outside assistance, the exact cause of the degraded performance on Gambit mission 4352 could not be identified. It was noted that the device that initiated separation was a new design on this vehicle, and this component was never tested on the ground under conditions that approximated those encountered during the high-altitude operations of M4352.

~~(S//BYE)~~ The Gambit program came to an end in 1984, and there were only two Gambit KH-8 missions subsequent to 4352. Gambit Mission 4353 was launched on 15 April 1983 and operated successfully for 129 days, the longest-duration mission ever. The last Gambit KH-8 mission was 4354, which successfully launched on 17 April 1984.[10] Hexagon KH-9 Mission 1217 was launched successfully on 11 May 1982, restoring the much-needed broad-area imagery coverage.

~~(S//BYE)~~ Personnel who worked on Gambit moved on to new assignments, and the memories of Mission 4352 gradually faded. Few had reason to remember the lost film bucket that remained on orbit for two decades.

[redacted]

[redacted]

~~(S//BYE)~~ Hexagon search image of the U.S. Capitol, Washington, DC.

~~(S//BYE)~~ Renewed Interest in Gambit Mission 4352

~~(S//BYE)~~ In the summer of 2002, the matter of the lost film bucket was brought to the attention of the NRO Flight Safety Working Group during the NRO assessment of the feasibility of declassifying elements of the Gambit program. The fact that the bucket would be returning to Earth in the foreseeable future, and contained over 6,800 feet of photoreconnaissance film presented security and safety concerns. It was generally believed that the re-entry process would cause a substantial degradation of the film, beyond the decaying effects of spending two decades in space. Nevertheless, the possibility of salvageable film surviving re-entry and landing in adversary territory or in a populated area represented security and safety concerns that could not be ignored.

~~(S//BYE)~~ Tracking Gambit's Stranded Bucket

~~(TS//BYE/TK//RSEN)~~ The NRO requested Air Force Space Command (AFSPC) attempt to identify the bucket among the M4352-related space debris ob[redacted] AFSPC identified an object they believed to be the film bucke[redacted] Using a variety of radars and other sensors, the NRO estimated where and when the bucket would re-enter the Earth's atmosphere and where it would impact. Given its orbital characteristics, it was predicted that the object would re-enter the atmosphere in about four to five weeks.

~~(S//BYE)~~ Once confirmation was made that the object was the M4352 film bucket, the National Reconnaissance Operations Center (NROC) initiated contingency support operations including procedures for monitoring the re-entry of an NRO payload. While estimates were made as to where the bucket was likely to come down, it was impossible to pinpoint an accurate re-entry time or location until almost four hours prior to re-entry. As the re-entry drew closer, the projected impact location converged on a South Atlantic-Antarctica regional impact. The Cheyenne Mountain Operations Center (CMOC) Space Vault tracked the bucket with its Space Surveillance Network radars, and the Aerospace Fusion Center captured [redacted] and provided a near-real-time assessment of impact location.

~~(S//BYE)~~ After nearly 21 years of orbiting in space, the bucket, or whatever was left of it, splashed down in the South Atlantic on 28 September 2002 at 0218Z (10:18 p.m. EST). The bucket landed in deep ocean waters, and it is believed it immediately sank. The NRO decided it was not necessary to conduct a recovery operation because of the remote location and depth of the ocean. This outcome represented good news for the NRO.

[redacted]

(U) Conclusion

~~(S//BYE)~~ Dual-mode Gambit operations demonstrated the ability of the NRO and the Intelligence Community to develop a creative approach to resolve a critical intelligence collection problem. Dual-mode operations were successful, and the space vehicle functioned through the entire mission. This effort would have been hailed as an innovative success if it were not for the malfunctions that occurred with the film buckets and resultant loss or degradation of photoreconnaissance imagery.

~~(S//BYE)~~ Several of the lessons learned from Gambit Mission 4352 remain relevant today. Specifically, space operations continue to be inherently risky; however, those risks did not deter Gambit program managers, mission planners, and engineers from pursuing an original and innovative concept. In a high-risk enterprise such as national reconnaissance, fear of failure should not inhibit creative thinking or attempts to push the boundaries of technical capability. As in the past, the NRO can continue to learn as much, if not more, from its failures as it can learn from its successes.

~~(S//BYE)~~ The return to Earth of Gambit film bucket 4352-1 in September 2002 proved to be a successful final chapter to this troubled mission. Multiple organizations within and outside of the NRO worked together to effectively employ [redacted] resources to identify, monitor, and track the bucket. To the extent that Mission 4352 returned imagery (representing over 50% of its operational passes) useful for intelligence purposes, the mission was successful. Also, to the extent that when film bucket 4352-1 finally re-entered, it hit nothing, hurt nothing, and gave away nothing, the tracking-recovery effort succeeded. ■

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[11] ~~(S//BYE)~~ [redacted]

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