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A History of Satellite Reconnaissance Volume I

PREPARED FOR

THE NATIONAL RECONNAISSANCE OFFICE

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*** NOTICE OF REMOVED VOLUMES ***

Volumes II,III and IV of "A HISTORY OF SATELLITE RECONNAISSANCE" are not provided because they do not contain CORONA, ARGON, LANYARD programmatic information.

A HISTORY OF SATELLITE RECONNAISSANCE

Volume I - CORONA

by

[redacted]

[redacted]

Revised October 1973
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1964, 1967, and 1972

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Preface to Volume I

This volume of A History of Satellite Reconnaissance is principally concerned with the Corona program, although it necessarily deals with predecessor reconnaissance satellite activities (Project Feedback, the Advanced Reconnaissance System, Weapon System 117L, "Samos," "Sentry," and several other short-lived activities), with concurrent and alternative programs (the several Samos E-series projects, Argon, Lanyard, and various Corona variants), and with successor programs (chiefly [redacted] and [redacted]. The Samos or WS 117L programs, under their several names, are treated in Volume II. Volume III contains the histories of the [redacted] and [redacted] programs to 1973, the date of this note. A fourth volume, concerned with non-photographic reconnaissance satellites, was also in preparation at that time. Volume V, intended to detail the policy issues and organizational activities of the National Reconnaissance Office, carries the treatment of those topics through 1965; as of 1973, no firm plans for additional coverage had been made.

The preparation of this and other volumes of this history began in 1963 at the suggestion and under the initial direction of [redacted] then head of the West Coast activities of the National Reconnaissance Office. It was carried on, though spasmodically rather than at a steady pace, under the sponsorship of his successors in that post, chiefly [redacted], [redacted] [redacted] and [redacted] [redacted] An early and constant supporter of the project was Colonel Paul E. Worthman, whose association with overflight reconnaissance extended from the original balloon-lofted Genetrix cameras of 1954 through the U-2, Corona, Oxcart, [redacted], [redacted], and the many lesser programs of the National Reconnaissance Program, until his retirement in 1969. A listing of the many other contributors to the history would occupy several pages. Their names appear in the citations that follow each chapter, an inadequate but necessary acknowledgement of advice, assistance, and information. I was from time to time assisted in research and writing by [redacted] formerly of the Rand Corporation, and by [redacted] of [redacted] [redacted] [redacted] of [redacted] detected and corrected a frighteningly large number of textual and substantive errors that escaped my notice and that of early reviewers. Notwithstanding such assistance, I remain wholly responsible for whatever errors of omission or commission that escaped the scrutiny of critics and associates. I am also responsible for a textual structure which assumes the reader's familiarity with many aspects of the United States space program that perhaps were memorable mostly to specialists and experts. This history is concerned with events that for the most part have not been otherwise discussed in any continuing narrative. The circumstances of its preparation did not allow for a full explanation of peripheral events described in generally available publications. Had it been otherwise, these volumes might have been many times bulkier and much less marked by assumptions of prior knowledge. In extenuation, I can but note that even Gibbon made such excuses.

[redacted]

March 1974

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* [redacted]

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Illustrations have been separately bound in an Appendix volume.

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Foreword to Volume I

Although largely concerned with Corona, this volume also includes discussions of the origins of satellite reconnaissance and of the interactions between the Corona program and various other of the overflight activities of the National Reconnaissance Program and its organizational predecessors, including the Central Intelligence Agency.

The antecedents of Corona and its adolescent years are treated in Chapters I and II, respectively. Chapter III opens with a cursory review of Corona activities before 1961, but is mostly concerned with the operations and subsequent evolution of the Corona system through its final mission in May 1972. Although they are interrelated, each of the three chapters can stand alone.

Some matters of considerable importance to Corona are dealt with inadequately or not at all in this volume. Each omission of that sort was deliberate. Issues of management policy, program proprietorship, and reconnaissance program organization were frequent intruders in the Corona program, but because they had a unity of their own, and because such issues generally involved far more than Corona, their treatment has mostly been relegated to Volume V. So with cover and security matters; although some incidents and events directly relevant

[redacted]

to concealment of Corona program activity have been described in this volume, those topics are not explicitly discussed. Such specialized aspects of satellite reconnaissance operations as vulnerability, countermeasures, and the exploitation of returned photography have also been considered only in passing. Technical matters like the carriage of "piggyback payloads," improvements in photochemistry and film, and the development of reentry and recovery machinery have been little mentioned. They require specialized historical coverage and are not integrals of Corona.

Some readers may wish to proceed directly to Chapter III, which covers Corona matters from the time of first successful operation to the end of the program. To ease that process, this foreword includes two specialized summaries, one dealing with program nomenclature (which proved in the end to be far more confusing than even the most dedicated obscurer of program reality could have wanted), and the second with complexities of program structure and conduct to 1966, after which they became much less confusing.

Nomenclature

Code names have been a fixture of the U.S. security system since the mid-1930s, when they were applied to contingency war plans. They proliferated during World War II, achieving levels of faddishness not surpassed until the 1960s, when every operation more complex than moving bookcases from one office to another acquired some exotic nickname. So many were the variants of Operation Bootstrap and Project Forecast that the important nicknames and codes could scarcely be distinguished from the wholly frivolous. Corona may be uniquely distinguished in that respect. It was never frivolous, and in an activity that lasted more than 14 years, counting from conception to final flight, the Corona system of 1972 continued to carry the name first formally applied to its ancestor of 1957. It had little more in common with that ancestor than its name, and even that was tampered with from time to time. Covert, classified, and unclassified names and designators for Corona appeared, were briefly used, and disappeared with disconcerting frequency. To moderate the confusion that would surely arise were names either introduced without explanation or explained as they occurred, it is advisable to begin with a review of program designators and titles.

All of the many model variations of Corona fell basically into three fundamental versions and two payload variants. The first Corona was a single-camera, single-recovery-capsule system; the second a single-capsule, dual-camera stereo system; and the third a dual-recovery capsule, dual-camera stereo system. With three exceptions, all versions and models carried the Corona name, either alone or as a prefix. Those exceptions were transitory; Mural, Argon, and Lanyard, each discussed below.

Between April 1961 and 24 January 1962, the name Mural was used to identify the original stereo-camera variant of Corona. During that brief period, program managers proceeded on the assumption that the follow-on to the original single-camera program would occupy its own security compartment and needed to be segregated from its predecessor. The possibility that Mural might be developed and operated by the Air Force, with only peripheral CIA participation, was a factor, but at the time there was considerable worry that association of Corona nomenclature with what was then represented to be the scientific-satellite "Discoverer" program would compromise U.S. credibility. The U-2 embarrassment of May 1960 could not be easily forgotten. In any event, as Mural moved toward operational readiness it became increasingly apparent that any effort to disguise its ancestry was certain to be futile, and in January 1962 Mural was merged into the existing Corona security package.

Before Mural appeared, three different camera configurations were flown under the Corona nomenclature: "C," "C'," and "C'''."

The names all derived from the informal but common practice of conversationally referring to Corona by its initial. The first improvement of the original camera, "C," was known as C' --"C-prime" in conversation. Proposals for C" and C''' ("C-double-prime" and "C-triple-prime") cameras appeared in 1959 and 1960, the first a Fairchild Camera and Instrument Corporation (FCIC) design,* the latter advocated by Itek (which had manufactured and done most of the design for the original C and the C' cameras). Itek's C''' proposal found acceptance; C" disappeared.

After Mural (which during 1962 and most of 1963 was called Corona-Mural and Corona-M to distinguish it from the predecessor C' and C''' models), there appeared proposals for a dual-recovery-capsule version of Corona. It first was known as Mural-J and was transiently called M^2 (for Mural-squared)--which led to some later confusion with the Mural-2 or M-2 nomenclature used to identify an early concept of what later became the Corona J-4 proposal.** Mural-J eventually became Corona-J. With the appearance but non-acceptance

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* Both Itek and Fairchild proposed C" designs; as noted later, Fairchild's design was more attractive. The C" proposal was also known, briefly, as C-61.

** In fact, virtually nobody active in the M-2 evaluation remembered the earlier appearance of M^2. Historians and file clerks were the principal victims of the confusion.

of a proposal for a modest improvement of Corona-J under the informal designator Corona J-2, the original of the dual-capsule systems was called Corona J-1, a designation that became meaningful rather than symbolic upon adoption of the modifications that distinguished the last operational Corona variant, Corona J-3. Corona J-4 proposals appeared in various guises and under several transitory identifiers at intervals between 1962 and 1969, but the term had no official standing.

One of the payload variants was the mapping camera program called Argon, but also sometimes identified as Corona-A. It was compartmented separately from Corona until 1965, nominally because it differed from the basic Corona reconnaissance satellite in detail and function, but also because it had Army rather than Air Force or CIA funds sponsorship.

In addition to the mono, stereo, and mapping camera systems flown under Corona bylines, yet another photographic instrument, known by the code name Lanyard, used Corona hardware as its foundation. Lanyard, an adaptation of a camera originally developed as part of the Samos E-5 program, was carried forward until its October 1963 cancellation partly as a backup for the [redacted] system and partly as a candidate replacement for Corona, although it would have ill-served either role. Sometimes identified as Corona-L, the Lanyard stereo system embodied an accommodation of various Corona camera subsystems to re-engineered Samos E-5 optics; it utilized a modification of the Thor-Agena booster-spacecraft combination developed for Corona and the Corona film recovery system.

Although codeword nomenclature was invariably used for Corona and its variants within what became the [redacted] security system, a great many classified and unclassified designators were employed over the years to identify the several Corona models and variants in dealing with people not cognizant of the program's real purpose. "Discoverer" was the first unclassified program designator; it disappeared from official use in 1962 but, like "Samos," remained a favorite of the press for several years thereafter. The pretense that Discoverer was either a scientific statellite or an engineering development satellite had been relatively easy to maintain while most missions ended in failure. But once the launch, orbit operations, and recovery techniques being nominally tested in Discoverer had been debugged and successful missions became the rule rather than the exception, it was increasingly difficult to maintain the credibility of such a fiction. Pacification of the scientific community became particularly awkward. Too many scientists wanted to know when Discoverer would begin carrying their various bulky and weighty scientific experiments, as had rather vaguely been suggested in 1958, or at least when they would begin receiving some of the biological and astrophysical data presumably being collected by way of Discoverer missions. By late 1962, the representation that Discoverer was a scientific and engineering research vehicle was rapidly losing its appeal as a cover story. It was therefore abandoned. Discoverer XXXVII, launched on 13 January 1962, was the last Corona to carry the name. It was also the last mono (C''') camera mission. All later Corona operations were casually announced as "Department of Defense satellite launches," as were all other military space operations, whatever their real nature. Fortunately for all concerned, NASA satellites which really were what they pretended to be began to return quantities of scientifically interesting data in the early 1960s, and that too tended to distract attention earlier focused on Discoverer.

Within the defense community generally, and to a lesser extent within the Corona program, the "white" designator used most often as a program identifier once Discoverer disappeared was "Program [redacted]." However, at various later times the numerical designators [redacted], [redacted], Program [redacted], and Program [redacted] were also applied to Corona. In 1959 and 1960, it was briefly known as "Program IIA," and Argon as "Program IA." In the separate TALENT-KEYHOLE security category (covering the product of satellite reconnaissance operations), the code KH-4 was used to identify Corona-Mural mission products. Other KH codes, including KH-1, KH-2, and KH-3,[1]* identified predecessor products of the C, C', and C''' cameras, respectively.**

Individual mission numbers were also used in series that readily identified Corona operations to most cognizant reconnaissance program participants. Mission numbers in one of four series identified all of the satellite reconnaissance operations that involved a Thor booster, an Agena spacecraft, and one or more Corona reentry capsules.

The first series began with 9001, (the mission publicly called Discoverer IV) and continued through 9066A (the last Argon flight). It included all Corona operations through the end of the Corona-M series as well as all flights with Argon cameras. The second mission number series ran from 1001, the first Corona-J (dual capsule) mission, through 1052, the final Corona J-1 operation. The third, which was used solely for Corona J-3 operations, began with 1101 and continued through 1117, the final Corona program flight of May 1972. Lanyard operations were numbered 8001, 8002, and 8003.

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* Numbered source citations are consolidated at the end of each section.

** KH-1 applied only to mission 9009, the only successful operation to use the original Fairchild-Itek camera system; KH-2 applied to the products of missions 9013, 9017, and 9019, all of the successful C' missions; the KH-3 designator covered the products of all Corona C''' operations; KH-4 applied to Corona-M mission products; KH-4A products resulted from Corona J-1 operations; and KH-4B terminology applied to the products of Corona J-3 missions.

The 9000, 1000, and 1100 mission numbers overlapped and within series were not necessarily used sequentially, by launch date. Some additional disorder in 9000-series program records occurred because of the irregular use of the suffix letter "A" to identify Argon operations, and because in formal program records some mission numbers appeared twice, both with and without the suffix. (The mission numbered 9014 in Corona program records was listed as an Argon operation, while the separately listed 9014A was not; 9066A was an Argon mission, and there was no separate 9066.)* In any case, the suffix designators were not consistently used in all Corona reporting documents even though the Argon program records listed all cartographic camera operations by mission number with suffix. Interspersed through the late 9000-series mission numbers and the early 1000-series numbers were the three Lanyard missions--8001 through 8003.

In the narrative that follows, the term Corona is used as a generic. Where necessary, the subset identifiers C, C', C''', Mural, Corona-M, Corona-J or Corona J-1, and Corona J-3 are used to single out specific elements of the overall program. As appropriate, missions are identified by mission number and date of launch. That practice has been followed in the interests of clarity even if the source documents

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* The mixup was in record keeping, not in real designation. There was only one mission 9014, and it did carry an Argon camera. It should have been entered, in all cases, as 9014A.

actually refer to "Program IIA," "Program [redacted]" or some other of the many transient identifiers used in 14 years of Corona activity.

Argon operations were not really part of the Corona program but generally were treated as such because of equipment and operational similarities. To perform its cartographic function, Argon flew much higher than Corona and used a much shorter (3-inches focal length) lens and a different camera mechanism, but in most outward respects it was indistinguishable from a Corona-C or C'. Between 1961 and the end of 1964, 13 Argon launches were attempted. Six missions were accounted successful in some degree, and the remainder failures. Notably, six of the first seven mission attempts failed, but only one failure occurred (on 26 April 1963) in six launches during the last two years of Argon operations. Mission numbers, included in the original Corona series, were 9014A, 9016A, 9018A, 9020A, 9034A, 9042A, 9046A, 9055A, 9058A, 9059A, 9065A, and 9066A.*

The several Samos photographic reconnaissance systems proposed or developed at intervals between 1955 and 1963 are discussed in Volume II. They are occasionally mentioned in connection with

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* These mission numbers were for Argon missions and should not be counted in any Corona accounting, although summaries written in 1968 and after frequently ignored that circumstance, most people having by then forgotten about Argon.

Corona development in the chapters that follow. In order to avoid confusion, it seems necessary to identify them here. All carried "E" designators followed by a number, as E-1 and E-5. (There were "A," "B," and other designators, but not in the photo satellite series.) E-1, E-2, and E-3 were readout satellites. E-1 was built and flew once; E-2 was constructed but cancelled before flying, and E-3 never passed the preliminary development stage. The appearance of Corona made them functionally obsolete. E-4 was a mapping camera alternative to Argon, built but never flown, and made obsolete with the development of a mapping capability in stellar-indexing cameras first flown with Corona. E-5 was to be a surveillance system and E-6 a search system complementing [redacted] both flew and both were technical failures, but in any case [redacted] and Corona successes made them valueless.

[redacted] was, of course, the only successful American photo-reconnaissance satellite development of the 1960s other than Corona. The development of the [redacted] weather reconnaissance satellite is described in Volume II. It had what could be technically described as photo-reconnaissance capability, but only in jest. So with NASA's weather satellites, chiefly Tiros.

References to other reconnaissance programs are self-explanatory.

Structure and Setting

Basic modes of conducting the Corona program were established by 1961 and did not change greatly thereafter. The Thor booster and Agena spacecraft used in all Corona operations were procured and launched "in the white" and were funded under ordinary Air Force budgets. (The Army funded most of Argon.) Thor and Agena research and development programs were funded and conducted "in the white," though occasionally classified as to design detail and operating capability. The reconnaissance payload and payload-peculiar equipment were developed and procured covertly, "in the black," mostly with special Central Intelligence Agency funds. "Piggyback" payloads were purchased by their several sponsors. Pre-launch mating of the payload, booster, and spacecraft was performed as a covert operation in a secure facility at Vandenberg Air Force Base. Mission control and recovery operations were covert. Obviously, complete concealment was impossible because missile launches, radio transmissions, and extensive aircraft operations could not be wholly curtained from public observation. Their purposes could be disguised, however, and for the most part were, for more than a decade.* Recovery operations received occasional and unwanted

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*[redacted] security procedures were developed as one of the offshoots of the Corona program. All the available evidence indicates that they were entirely adequate.

[redacted]

attention, but once U.S. satellite launches had become commonplace there was surprisingly slight public interest in the possible reconnaissance missions of those identified as "DoD launches."

Occasionally, of course, there were embarrassing trespasses on Corona security. In April 1961, for instance, the San Francisco Examiner, in commenting on some testimony before a Senate committee concerning the need for a B-70 strike reconnaissance aircraft, observed that "amazing intelligence work . . . by the cameras of the Discoverer satellite . . ." had not overcome the need for manned systems. Not quite a year later the London Daily Mirror credited Discoverer with having "recently" brought back reconnaissance photographs of Russia. But these were speculative items. Perhaps the most disturbing of early security leaks was a column by Joseph Alsop that appeared in the New York Herald-Tribune (and other papers) in December 1963. Alsop, who characterized himself as Richard Bissell's "oldest friend," briefly summarized much of the early history of Corona, mentioning Major General O. J. Ritland's involvement and identifying August 1960 as the date on which the U.S. first recovered photographic evidence that no Soviet intercontinental missiles were yet emplaced.* He

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* As detailed in Chapter I, Bissell and Ritland were indeed responsible for much of the program's success, and August 1960 was the key date.

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credited Bissell's enterprise with having led to a major change in the strategic posture of the United States.[3] But again there were no indications of lasting damage, and Corona went on much as before.

The management of the several phases and aspects of the Corona program varied from time to time. The original Corona program was managed almost entirely by Air Force officers, some officially assigned to the Central Intelligence Agency but most to the Air Force Ballistic Missile Center (of the Air Research and Development Command) or its organizational descendents. The CIA role was initially confined "almost exclusively" to "top-level general support, contracting services, and security factors." [redacted] With the appearance of Mural, the development and configuration selection aspects of the program became responsibilities of CIA field and headquarters representatives, many of whom were Air Force officers on detached service. Between 1963 and 1966 the question of Corona management responsibility was an open issue that frequently caused friction between the CIA and the Director of the National Reconnaissance Office. It did not become regularized again until the approval of [redacted] development in April 1966 finally relegated Corona to the status of a terminal system largely managed by the [redacted] Office in Los Angeles.*

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* The involved and disputive question of NRO authorities and responsibilities involved much more than Corona, of course. The matter is discussed elsewhere in this history.

Argon management generally resembled that of Corona except that the Director of Defense Research and Engineering (DDR&E) was a member of the configuration control board and exercised considerable authority in the decision process. Lanyard was managed by a program office reporting to the Directorate of [redacted] the West Coast operating arm of the National Reconnaissance Office.

Contractual arrangements were as varied, and frequently as controversial, as were program management responsibilities. The precursor Corona camera was designed by Professor Walter Levison of Boston University (later a founder of Itek), under contract to the CIA. Its technological antecedents stemmed from the earlier development of a camera for the U-2 and the still earlier Genetrix camera used in free balloon reconnaissance of the Soviet Union in the mid-1950s. The CIA originally expected Fairchild Camera to design and produce the C camera, but Bissell's judgment and USIB (United States Intelligence Board) and CIA preferences caused Itek to become the camera system designer, and Fairchild a subcomponent designer and manufacturing subcontractor (later an associate contractor). Fairchild participation largely vanished with the 1960 decision to adopt the Itek-designed C''' camera rather than the C'' version Fairchild favored. Lockheed performed the spacecraft-camera integration work under contract to the CIA.

With the appearance of Corona-Mural, the earlier and less formal arrangement became a tightly structured contractual relationship. Lockheed performed system engineering and technical direction functions under the nominal cognizance of the Directorate of [redacted] but under the contractual control of the CIA. Itek was an associate contractor rather than a subcontractor to Lockheed. So was General Electric, manufacturer of the reentry capsule and associated subsystems.* As late as March 1961 the CIA suggested that complete responsibility for Corona-Mural should be transferred from the CIA to the NRO. Dr. J. V. Charyk, then Director of the NRO, concluded that Corona would phase out shortly, being replaced by the Samos E-5 system, and that reorganization of existing relationships for so brief a period would be wasteful. However, complete responsibility for Lanyard was assigned to the NRO, to be exercised by the Directorate of [redacted]. The substitution of the [redacted] for Lockheed as system engineering and technical direction contractor for Corona was proposed as early as 1962 but remained an issue between the CIA and the NRO through 1965.[5]

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* Thor launch vehicles were purchased under an open contract between Douglas and the Air Force.

The 1966 resolution of Corona management controversies made the [redacted], NRO, system program director for Corona with authority over system and subsystem development and with authority to create a unitary System Program Office to manage details of the program. The Director of Reconnaissance, CIA, controlled and supervised development and production of the payload (then Corona-J) but reported directly to the Director, NRO (as did the [redacted] NRO).

NOTES ON SOURCES

1. NPIC Technical Publication [redacted] "Modification of KH-4 Keyhole Camera System," Feb 62; [redacted] "The KH-4A Camera Systems," Mar 67; [redacted] "...KH-4A..." 1 June 63.

2. [redacted]

3. San Francisco _Examiner_, 15 Apr 61, p 18; London _Daily Mirror_, 5 Mar 62; New York _Herald-Tribune_, 23 Dec 63, J. Alsop column.

4. [redacted]

5. The records on _Corona_ management and contracting are, to say the least, voluminous, particularly for the 1964-1965 period. Basic arrangements were variously specified. See: [redacted]

6. [redacted]

I BACKGROUND

As early as May 1946, Project RAND[*] had formally suggested to the Army Air Forces the advisability of developing a satellite and--in one application--using it for reconnaissance. Although nothing useful emerged from the resulting discussions--the Army and Navy differed sharply on who should have responsibility for space vehicles--RAND renewed the suggestion again in February 1947 and by the end of that year, following creation of an independent United States Air Force, service specialists at Wright Field had endorsed the general thesis. Principally because no money was available for such an undertaking, nothing more venturesome than a continuing study program was immediately authorized. However, at the urging of Wright Field's Engineering Division, which was concerned by the possibility that the Navy might actually construct and launch a small satellite, the Air Force early in January 1948 formally staked a token claim to responsibility for all space vehicles. Largely because they had no valid grounds for objecting, the other services let the dictate stand by default.

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[*] Progenitor of The Rand Corporation, but then a special element of the Douglas Aircraft Corporation.

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By early 1951, RAND was sponsoring design work on such components as a television system and an attitude sensing device, both vital to any later reconnaissance satellite. In April 1951, RAND officially defined the technical and engineering characteristics of such a satellite, proposing television transmission of photographs to ground stations. Over the next two years, six individual contractors conducted feasibility and design studies of reconnaissance satellite components and subsystems. Concurrently, the Atomic Energy Commission--at the urging of the Air Force--began work on small auxiliary power reactors capable of functioning in orbit.

In May 1953, Air Force headquarters made the Air Research and Development Command responsible for management of the reconnaissance satellite proposal, and five months later RAND formally urged that command to begin planning for the early start of system development. Receptive project officers in the command headquarters had by January 1954 succeeded in transforming RAND's "Project Feedback" proposal into a tentative development called the "Advanced Reconnaissance System--Weapon System 117L." In a final summary report of March 1954, RAND recommended that the Air Force undertake "the earliest possible completion and use of an efficient satellite

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reconnaissance vehicle" as a matter of "vital strategic interest to the United States." On 27 November 1954, ARDC headquarters published a system requirement which officially established a satellite development program.

System management responsibility was initially assigned to Wright Air Development Center but in October 1955, after preliminary design and development contracts had been let, ARDC transferred custody to its Western Development Division, created about a year earlier to manage the revitalized ballistic missile development. The close relationship between the satellite and its prospective booster, the Atlas missile, chiefly prompted the decision.

The first complete development plan for a reconnaissance satellite, proposing full operational capability by the third quarter of 1963, appeared on 2 April 1956. (A plan for an "interim" satellite with "scientific" applications had been prepared in January.) Exclusive of facilities, development cost was estimated at [redacted]. The first year of system work, fiscal 1957, would require [redacted] Over the preceding 10 years, [redacted] had been expended on the program, including RAND studies and all component developments. For obvious reasons, progress had been agonizingly slow. With

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approval of the development plan (24 July 1956) and issuance of a confirming development directive (3 August 1956), the financial stringency seemed to be passing, but the initial funds allocation for fiscal 1957, when it appeared, totaled only [redacted]

Nevertheless, Western Development Division on 29 October 1956 issued a letter contract to Lockheed Aircraft Corporation which made that firm the prime contractor for WS 117L. Design studies had originally been solicited in December 1954, when Wright Air Development Center moved to invite the participation of 18 individual contractors. The violent objections of RAND Corporation to such a shotgun approach caused a last-minute change of plans and the original invitations were suppressed. (Only one had actually been mailed and it was recovered, unopened.) On orders from Air Force headquarters (prompted by RAND's insistence that "unique and unusual" security was vital), the Air Research and Development Command directed that only Lockheed, Bell Telephone Laboratories, Glen L. Martin Company, and RCA receive bid invitations.

Bell declined to participate. The Air Force funded design studies by the other three, the trio of proposals being received by Western Development Division in March 1956, after transfer of program authority from Wright Field. A selection board (which included as members [redacted] and [redacted] both later to play very prominent roles in satellite reconnaissance) rated Lockheed's proposal highest and in a 20 March 1956 report urged use of a strip camera for the photography, favoring that over a panning camera because of simpler lens design, the relative ease of focusing, shutter simplicity, and a less complex film transport system. The delay from March to October in letting a contract had been caused by funds shortages; even after the award to Lockheed, work had to be conducted at about one-tenth the planned rate. [redacted]

For the next several months, desperate efforts to secure additional funds and to obtain a high-level endorsement that would permit increasing the pace of the program were consistently unavailing. Air Force Secretary D. L. Quarles responded to news of the contract award by ruling that neither mock-ups nor experimental vehicles should be built without his specific prior approval. The entire project seemed endangered by demonstrations of homage to the "space for peace" theme that had become a credo of United States policy in 1955 and by the concurrent emphasis on cutting all "non-critical" funds out of the defense budget.

After futilely attempting to re-interpret secretarial directives to the advantage of the WS 117L program, Major General B. A. Schriever, Western Development Division commander, concentrated on an effort to secure further increments of fiscal 1957 funds. The original [redacted] request was scaled down to [redacted] in August 1956; five months later, Air Force headquarters released enough money to bring the available fiscal 1957 funds total to [redacted].

Schriever then introduced the suggestion that WS 117L be employed as a "backup" to the faltering Vanguard scientific satellite. It brought no relief. Proposals for the use of the WS 117L satellite in the International Geophysical Year program had first been heard in 1955 but had been repeatedly rejected on the grounds that it was contrary to national policy to use military hardware in "peaceful" space programs. In April 1957, a final increment of [redacted] was released to the Western Development Division, raising the total available for fiscal 1957 to [redacted]. The prospect that no more than [redacted] would be provided for fiscal 1958, against a "minimum requirement" for [redacted] cast further gloom on the program.

The obstacles that Schriever faced were two: Quarles' attitude, and the quixotic "space for peace" homily that so facinated the national administration. Quarles was not actively hostile to the satellite program as such, but he had developed strong views about reliability and using low-risk technology and he took very seriously the administration's commitment to eliminate "non-critical" defense expenditures. The technology to be embodied in the 117L satellite was largely unproven, no satellite had ever been orbited, and little was known of problems that might arise in a weightless, airless environment. Nor was the need for satellite overflight generally acknowledged. To budget-conscious pragmatists, therefore, the entire thesis of satellite reconnaissance seemed shaky. In such reasoning Quarles found ample justification for his stubborn refusal to approve the start of a meaningful development program. He was more than willing to allow relatively low-cost studies to proceed--but further he would not go. The fact that the administration was wrestling with a growing financial crisis--which later that year would cause the government to postpone payments due on defense contracts in order to relieve pressure on the established national debt limit--gave additional weight to the arguments of the economy bloc.

Perhaps equally critical to the future of the WS 117L program was the intransigence of administration advisors on the "space for peace" policy. In April 1957, Schriever faced squarely up to this question, instructing his 117L program chief--Colonel F. C. Oder--to conduct an exhaustive study of the basic problem.

The difficulty was not a simple one. In many respects it stemmed from the mid-1955 decision that the United States would

[redacted]

participate in the International Geophysical Year satellite activity but that such participation would be limited to non-military "hardware." Whatever its merits, and the administration judged that the public relations benefits would be considerable, the policy effectively eliminated ballistic missiles from consideration as boosters and caused independent development of what became the Vanguard.

Although not clearly drawn, the issue ultimately stemmed from uncertainty about the legality of satellite operations under international law. So long as policy makers in the national military establishment doubted the technical feasibility of satellite operations, there was no point to considering how space vehicles were affected by passage over national borders. Even when technical feasibility was conceded, the absence of a realistic, funded development program made such discussions academic. It is not surprising, therefore, that concern for the jurisdictional complications that might arise from satellite operations was largely confined to a small circle of space flight devotees and to a few specialists in international law. With minor exceptions, most secretariat-level policy makers considered the entire subject to be a preposterous waste of time and money. Nevertheless, the introduction of paramilitary vehicles into space, particularly if they were to have a known reconnaissance capability, ran counter to the instincts of the State Department and hence of the administration.

Both the RAND Corporation and the Air Force had researched the question of space flight and international law between 1947 and 1954, but there was no evidence that such findings as emerged influenced decisions on either the Advanced Reconnaissance System development or on the International Geophysical Year satellite program. When WS 117L was finally approved for development in 1955, the problem was again glossed over, since it seemed probable that at least six years would elapse before the first operational vehicle was launched.

In July 1955, as part of a determined United States effort to arrive at a technique of arms control acceptable to the Soviet Union, the President proposed "mutual air reconnaissance" as a means of policing international disarmament. A somewhat similar concept had been embodied in the 1946 "Baruch Plan" for international control of nuclear weapons. Predictably, the Soviet Union endorsed the idea "in principle" and found excellent reasons for opposing its application. The traditional Soviet deference to "airspace sovereignty" was unquestionably a factor. Yet three months earlier, in April 1955, the Soviets had openly announced their intention of orbiting various scientific satellites--and had identified "photographic equipment" as a portion of the proposed cargo. The United States followed suit, in July 1955, with an announcement of its own scientific satellite. Apart from an inconspicuous mention of American interest in military satellites in a 1948 report by the Secretary of the Air Force and a considerable volume of speculative writing about potential satellite applications, nothing much had been said on either side about the implications of reconnaissance overflights by orbiting vehicles. Probably because the "mutual air reconnaissance" scheme stalled at the platitude stage, specific vehicles were never discussed. (Both the U-2 and a high-altitude modification of the RB-57 were in development, however.)

One of the background figures responsible for the "aerial inspection" ploy was Richard S. Leghorn, an Eastman Kodak official recently returned to civilian life after active duty service as an Air Force colonel during the Korean call-up. As early as January 1955, he had publicly, if indirectly, suggested that satellite reconnaissance techniques might make inspected disarmament feasible. In October 1955 he prepared and privately circulated a specific proposal that satellite reconnaissance become the "inspection mode" in arms control. Both because of his work with Kodak and through his Pentagon connections--he had served under Schriever in the Advanced Plans Section of the Air Force headquarters--he was familiar with WS 117L technology.

Russia's obvious mistrust of the original Eisenhower inspection proposal convinced Leghorn that negotiating a mutually acceptable inspection agreement with the Soviets would be "virtually impossible." Assuming that WS 117L would be funded at a respectable level and thus would lead to an operationally eligible reconnaissance satellite by 1959-1960, Leghorn suggested that the WS 117L or a similar vehicle be used for <u>covert</u> overflights of the Soviet land mass. In July 1956 he updated his earlier paper and sent a copy to Schriever, by then the commander of the Western Development Division.

Overflight, whether covert, overt in the face of Soviet protests, or openly conducted under the sponsorship of some international agency, was by 1955 very nearly an essential of national security for the United States. Like espionage, overflight was a customary, if seldom acknowledged, instrument of peacetime military activity. Literally hundreds of instances had been recorded starting with French and German penetrations of border defense zones in the pre-1914 period. Aircraft violations of international boundaries were among the most frequent causes of ambassadorial protests and apologies during the late 1930s. Incidents involving both Russian and American aircraft were common to the fringes of both the iron and bamboo curtains during the late 1940s. Neither side ever admitted a deliberate policy of aerial espionage, but its existence was indisputable.

[redacted]

The near impossibility that the United States could ever mount a surprise attack made that nation more dependent than the Soviet Union on overflight-derived information for warning of possibly hostile concentrations. The Soviets did not accept the validity of that reasoning, but it nonetheless remained an element of United States military readiness. The principal advantage of overflight, of course, would be to provide targeting information nowhere else obtainable and, under favorable conditions, to furnish at least a low-grade warning of Soviet preparations for attack.

Aircraft range limitations and their vulnerability to conventional air defense measures made deep penetrations of Soviet air space infrequent and dangerous. The enormous breadth of the Soviet Union diluted the worth of shallow penetrations. Some indication of the value of border-to-border passes was provided by a succession of balloon overflights that finally ended in February 1956 after four years of surprising success. The program (Genetrix) had been conducted under cover of an upper-atmosphere research project nominally managed by the Air Force Cambridge Research Center. Over the several years of its existence, Genetrix employed a variety of cameras and produced a wealth of information on such diverse subjects as precise altitude control of balloons during long periods and techniques of recovering

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parachuted camera capsules by air catch. Although the United States consistently denied an overflight intention, the effort was ostensibly canceled because of the violence of Russian protests (which were heightened by use of similar balloons to release propaganda materials deep behind the iron curtain).

In actuality there were more practical reasons for halting the balloon operations. One factor was that about as much information had been gathered as seemed feasible without risking a violent response. Another was that by late 1955 Soviet air defense forces were routinely destroying <u>Genetrix</u> balloons. Although by then the launch group could have successfully operated the balloons at altitudes above the reach of contemporary Soviet weapons, that option was discarded because of the danger that it might motivate the Soviets to develop weapons effective against U-2 aircraft which were scheduled to begin their high-altitude penetrations shortly thereafter.

A determined effort to create an aircraft-mode reconnaissance capability with a potential for greater selectivity and accuracy than the random-path balloon operations had begun in 1954. It included the "big wing" B-57 aircraft and the still-embryonic U-2 as well as more ambitious ultra-high-altitude winged vehicles, both manned and unmanned. Satellite reconnaissance was not included, mostly because of contemporary defense department opinion that it was only theoretically feasible and at best could not be of practical use before the mid-1960s.

Leghorn's endorsement of satellite reconnaissance was based on the thesis that an orbiting camera would be more difficult to disable than cameras carried in balloons and aircraft. He suggested also that an unpublicized series of successful satellite reconnaissance flights might reasonably be followed by a discreet diplomatic approach to the Soviet Union, the presentation of copies of the reconnaissance "take," and a private agreement that the Soviets were free to reap any propaganda credit they chose if they would but propose interference-free satellite inspections as an international modus vivendi.

Although Leghorn's ideas were well known to both Schriever and his WS 117L chief, Colonel Oder, they were of little more than academic interest until the spring of 1957. Then the funds crisis, the increasing frustrations of the "space for peace" catchphrase, Quarles' insistence on more studies and less hardware, and general defense department hostility to "space research"* drove Schriever

* During the immediate pre-Sputnik months of 1957, a considerable quantity of Air Force time was devoted to reprogramming all space-associated projects to obscure any connotation of space flight interest. Stubborn project officers and staff planners carefully constructed

and Oder to consider all conceivable alternatives to the "normal" development cycle they had been pursuing.

In that milieu, Schriever in April 1957 instructed Oder to devise a policy approach that would improve the status of the Air Force satellite program. Colonel Oder promptly began an analysis of national policy considerations affecting the actual use of satellite reconnaissance, an examination of security factors that would have to be accommodated in announcing the Air Force program to the public, and a consideration of possible scientific applications of the WS 117L vehicle.

Convinced of the desperate need for a device that would permit acceleration of the satellite program--at least to the pace originally proposed--Schriever also discussed his quandary in some detail with Colonel W. A. Sheppard, [redacted] and Leghorn. They were generally agreed on the seriousness of the situation, but for the moment were unable to suggest an approach that would overbear stubborn administration objections to an adequately-funded satellite program.

"high altitude research" camouflage around all that could be preserved. The alternative, precisely defined by defense department statements on "useless activity," was cancellation. A corresponding amount of reprogramming effort was necessary in the immediate post-Sputnik period, when "space" suddenly became a respectable word once again.

While such deliberations were continuing, General Schriever made yet another effort to secure needed funds through established channels. The first annual revision of the WS 117L development plan went forward in April, but within a matter of weeks it had become apparent that in fiscal 1958 as in previous years the program would probably be funded at a level well below that considered acceptable by program managers. Discussions of money and of possible schedule adjustments marked May and early June. The existent development plan then called for initial launches during 1960 and full operational status five years later, but that schedule was totally dependent on finding money to support accelerated development during fiscal 1958.

In mid-June, General Schriever met with the President's Board of Consultants on Foreign Intelligence Activities to re-justify the status of the satellite reconnaissance program, the critical need for satellite-obtained intelligence, the advantages of a military over a civilian-managed approach, and the rationale for continued Air Force conduct of the program. Shortly thereafter, the increasingly grave financial crisis obliged the project office to submit a revised development plan that incorporated an "austere" as well as a "desirable" budget request. By late July, spending ceilings had been imposed which limited Lockheed to a maximum of [redacted] for the first half of the fiscal year and to a possible total of [redacted] the entire year. Colonel Oder had earlier defined a [redacted] requirement as the minimum needed to maintain hopes for a first launch by 1960.[redacted]

Well in advance of official notification that program funds would be virtually nonexistent during fiscal 1958, Colonel Oder had informally proposed an alternate approach to General Schriever. Concluding that in some degree the persistent funding difficulty was tied to the administration's determination not to undertake an expensive new program that, if it became publicly known, might ultimately lessen chances of arriving at a satisfactory settlement with the Soviet Union, Schriever quietly endorsed the alternate proposal, which he called "Second Story."*

The "Second Story" concept was built around three preconditions: covert overflight, participation of the Central Intelligence Agency, and program acceleration. It involved an announced cancellation of the WS 117L program, overt establishment of a "heavyweight" Air Force scientific satellite project as a follow-on to the marginal Vanguard, and covert re-establishment of the reconnaissance program under

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* Colonel Oder's secretary invented the name to identify the file of working papers which had to be kept apart from other WS 117L documents. "Second Story" implied a cover legend rather than an upper floor, although it was occasionally written "Second Storey."

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cognizance of the Central Intelligence Agency--but with the Western Development Division retaining technical management responsibilities.

By the time of Schriever's June meeting with the President's intelligence board he had privately informed Lieutenant General D. L. Putt (Air Force Deputy Chief of Staff, Development) and Air Force Assistant Secretary R. E. Horner of the "Second Story" concept. Concurrently, Leghorn secured an expression of interest from Dr. J. R. Killian, the President's Science Advisor. Schriever and Dr. Edwin Land (an Intelligence Board associate) broached the scheme to R. M. Bissell, assistant to CIA Director Allen W. Dulles. Schriever and Oder had become well acquainted with Bissell during Oder's 1952 assignment to CIA.

Early in August 1957, when such discussions were going forward, it was generally believed that the Soviets would orbit a scientific satellite somewhat larger than Vanguard but probably smaller than the WS 117L vehicle. If that assumption were accepted, adoption of the "Second Story" approach would leave undisturbed the official "space for peace" motif, would permit the eventual accumulation of significantly more scientific data than Vanguard could collect, would demonstrate the continuing technical superiority of the United States, and still would permit the collection of highly useful intelligence information.[redacted] It seemed to have some attraction for everybody concerned.

Effort was not entirely diverted to "Second Story" during the late summer of 1957, but sporadic attempts to obtain relief from the WS 117L expenditures ceiling were repetitiously unsuccessful. Early in September, General Putt secured permission for the start of work on mock-up of the Lockheed upper stage vehicle and for fabrication of hardware items that had to be purchased well in advance if an experimental satellite were to be flown during 1960, but restatements of the fiscal 1958 funding requirements--and their endorsement by the Air Council--had no effect. The purse remained closed.

The satellite program was not alone in that situation. Virtually every major development effort, including ballistic missiles, was affected. Expenditure limitations were imposed on all major military programs so that the administration would not be forced to ask Congress for a higher ceiling on the national debt, an expedient which the Treasury Department viewed with considerable distaste, particularly in an election year.

In such circumstances, "Second Story" offered perhaps the only realistic hope. Its key was ostensible conversion of the existent WS 117L effort into a scientific satellite program. General Schriever tentatively approved an action schedule which called for General Putt to "request" and BMD to submit a new scientific satellite proposal before 1 September. Assuming unimpeded flow of the subsequent actions, the covert CIA program would come into being several weeks later, side-by-side with the "scientific satellite" that had "replaced" the WS 117L.*

The arguments supporting such a course were impressive--at least to those who felt, with Schriever and Oder, that the technical feasibility of a reconnaissance satellite had been clearly established by more than a decade of study and experimentation. All of the key technical ingredients were available from the current program. The United States had conducted covert reconnaissance in the past and was planning more for the future. It certainly should be possible, therefore, to begin covert satellite reconnaissance by 1960 and to maintain continuous surveillance of the Soviet Union thereafter. Schriever and Oder were confident that the group which had so skillfully managed the intercontinental ballistic missile program could successfully administer the "Second Story" effort.

Conceding that covert operation of a photographic satellite could not be indefinitely sustained, Oder suggested that the basic vehicle be publicly identified as a weather surveillance satellite to

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* CIA records are largely silent on these matters. They were mostly handled by personal contact among Bissell, Land, Schriever, and Oder.

follow the Vanguard. Initially, extremely tight security over reconnaissance components would be maintained. If at some later date the arms control efforts of the United States were successful, the reconnaissance components could be surfaced as newly devised "improvements" and applied to an international arms control system.

The necessary ingredients, as Oder and Leghorn saw it, were Presidential confirmation of a high priority, followed by adequate funding; approval of the political approach; and, finally, cancellation of the WS 117L and substitution of either clandestine or a "very secure" Air Force reconnaissance satellite program.[redacted]

The schedule Colonel Oder had proposed early in August proved impossible to maintain, but before the end of that month Schriever had briefed Dr. Killian and had exposed the total scheme to Major General A. J. Goodpaster, the President's military aide, and others at the White House level. The Schriever group also made informal contact with the Department of State and renewed discussions with Bissell and his associates in the Central Intelligence Agency.[redacted]

The "Second Story" proposal had been entirely concocted within Schriever's own division and had not thus far been introduced into "normal" channels. General Putt and his immediate aides had been the principal contacts in Air Force headquarters. Through Putt, Schriever scheduled a formal meeting with State and CIA for late September, by which time he planned to have the "Second Story" proposal in a form suitable for line-of-command submission.

While in the Pentagon on 10 September, General Schriever prepared an official letter to Lieutenant General S. E. Anderson, Air Research and Development Command chief, recommending conversion of WS 117L to a scientific satellite. Colonel Oder personally took it to General Anderson that afternoon, seizing the opportunity of its delivery to brief him on the background of the proposal and its real purpose. Unfortunately for the schedule earlier mapped out, General Anderson instructed his headquarters staff to prepare and coordinate an endorsement to Air Force headquarters. For several days the ARDC group debated the merits of various responses and then produced an unenthusiastic comment letter which, in the later view of at least one "Second Story" supporter, was worse than no response at all.* Consequently, the "formal" proposal Schriever had wanted Anderson to send to the Air Force chief of staff proved both late and ineffective.

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* The possibility that the Anderson "endorsement" was composed by officers who were unaware of its actual motivation cannot be dismissed, but neither can it be satisfactorily explained. It is far more likely that Anderson's staff acted out of native dislike for a scheme that would have removed yet another major program from ARDC control--as had happened with the whole of the ballistic missile effort.

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By late September, the complications inherent in "coordinating" the proposal with all the authorities involved in scientific and military satellite programs had thoroughly impeded progress toward Schriever's goal. Early that month, he had learned of a Department of Defense decision to re-activate the "Stewart Committee" which had recommended the original Vanguard program and had later rejected Army and Air Force back-up proposals. It appeared that the Stewart Committee was to be the chief executive agency in selection of an advanced scientific satellite. In its turn, the revived Stewart Committee planned to call on the services to submit proposals of such advanced satellites. The invitation was to be issued between November 1957 and January 1958. [redacted]

General Schriever also learned that "an influential DoD consultant" was preparing a memorandum for [redacted] the Defense Department's Director of Guided Missiles, calling for establishment of a national policy on space exploration and unfavorably analyzing the feasibility of a WS 117L scientific satellite. Arguments against the "scientific 117L" included the lack of agreement within the Air Force on the value of such a satellite, the security complications inherent in a scientific satellite using military hardware, and possible interference of a scientific satellite program with the military satellite effort.

[redacted]

Of course, the "Second Story" as refined summarily disposed of such objections by transforming the WS 117L reconnaissance activity into a covert project, but advice of such a course obviously had not reached the "influential consultant." Moreover, the tenor of the pending memorandum was in agreement with existent administration policy.

In order to secure acceptance of the "Second Story" approach, it would be necessary for the Ballistic Missile Division (renamed in August 1957) to prepare a detailed scientific satellite proposal which the Air Secretariat could present to the Defense Department (thus demonstrating Air Force unity on its desirability), to plan an acceptable information release policy, and to prove to all concerned (including the Stewart Committee) that a scientific variant of the WS 117L satellite would benefit the military program. It seemed unlikely that all those steps could be taken before 1 November.

On 4 October 1957, the appearance of Sputnik I cancelled much of the rationale of the "Second Story" approach. Almost immediately thereafter, General T. D. White, Air Force Chief of Staff, told the Air Staff to drop consideration of a scientific satellite and to concentrate on accelerating the basic WS 117L program. Defense Secretary C. E. Wilson, notoriously anti-satellite in his outlook, was retiring from office and his replacement, Neil McElroy, was expected to approve a substantial program expansion. Essential funds, long delayed by dissension over the feasibility of and the real requirement for a reconnaissance satellite, could be expected shortly. However, a subsequent attempt to convince the Deputy Secretary of Defense, D. A. Quarles, that WS 117L should be accelerated was generally unsuccessful, and under pressure from Quarles, Air Force Secretary J. H. Douglas hedged his earlier approval of program acceleration. Putt, working desperately to overcome secretarial inertia, secured permission from Douglas to present the issue directly to McElroy for resolution and simultaneously urged General Anderson to submit a plan for an early Air Force "space spectacular" which would enhance the possibility of securing appropriate WS 117L funding. At the same time, General White, disregarding command channels in the interest of speed, instructed BMD to propose a new ballistic missile and space program at a funding level of [redacted] above the current fiscal 1959 ceiling, thus increasing the level of effort to ". . . the maximum possible in terms of technical and operational capabilities."

The optimism of the Air Staff and of General White proved justified. On 29 October, after Putt briefed him on the WS 117L program, Defense Secretary McElroy reversed the Quarles decision of 16 October and asked to be advised on how the satellite program could be accelerated. Three days later he authorized the Air Force to proceed "at the maximum rate consistent with good management."

For the moment, "Second Story" was submerged in a welter of proposals, acceleration plans, and suggestions for "interim" satellites, both scientific and military. In part because of the consternation caused by Sputnik and by immediately subsequent failures in several hasty and overpublicized attempts to orbit "something" made in the United States, WS 117L acquired the support so long withheld. But, beneath the surface there flowed an undercurrent of reluctance to sponsor an "open" reconnaissance satellite program which, by antagonizing the Soviets, would weaken the prospect of relaxing world tensions and reaching agreement on other points at issue. Additionally, there were psychological obstacles to securing uninhibited approval of a major space program. The President resented inferences that his administration had been lax in supporting earlier space and missile proposals, so there was continued reluctance to approve program accelerations which indicated that "crash efforts" were necessary to overcome earlier lapses. Finally, notwithstanding the evidence at hand, the conviction persisted at high levels that the entire space program was more a matter of public relations than of engineering, that nothing useful could come of an investment in satellite development.[20]

Even though WS 117L had finally been approved and funded, it was apparent that much remained to be done before the United States acquired a satellite reconnaissance capability.

***** NOTICE OF REMOVED PAGES *****

Pages 28 through 30 of CORONA, ARGON, LANYARD programmatic information are not provided because their full text remains classified.

20. See New York Times, Oct 10, 17, 21, for articles reflecting the viewpoints of key administration officials on Sputnik and the need for an expanded United States space program. See also John Emmet Hughes, The Ordeal of Power, for a first-hand account of White House reaction to the Sputnik furor. Ltr, Putt to Anderson, 17 Oct 57, is the best surviving record of executive reluctance to abandon pre-Sputnik attitudes concerning space enterprise.

21. [redacted]

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II CORONA--PHASE I

Trailing after Sputnik I and Sputnik II came a succession of proposals for accelerating the WS 117L program and for "regaining" the "pre-eminence" of the United States in space. Perhaps because the disaster-haunted Vanguard program absorbed public attention almost to the exclusion of concern for military programs, Congressional inquiries into the American space effort did not focus on WS 117L. Attempts to fix responsibility for the "space gap" became so entangled with partisan politics, interservice rivalries, and the fecundity of the Defense Department in creating new committees, czars, councils, boards, and agencies to deal with the "space program" that they were meaningless.

While the Navy was desperately attempting to overcome the effects of three years of pennypinching in Vanguard and the Army vainly sought permission to orbit satellites earlier built in violation of secretarial directives, the Air Force was the recipient of suggestions from several quarters that the Thor intermediate range ballistic missile, scheduled for availability sooner than the Atlas, be used to boost a satellite into orbit.

The earliest formal proposal of that sort emerged in the report of a special ARDC committee in October 1957. On the day following issuance of the Quarles' "go slow" directive, Lieutenant General D. L. Putt directed Lieutenant General S. E. Anderson to assemble an _ad hoc_ group to consider possible USAF space contributions that would counter the effects of Sputnik I on world opinion. Headed by the noted nuclear physicist, Edward Teller, the group submitted a report which included in its recommendations for a series of space probes and moon shots a suggestion that Thor boosters and makeshift second stages be used to orbit 200-300 pound satellites at an early date.[redacted] The recommendation stemmed from Rand Corporation studies summarized for presentation to the Teller Committee.

Presentation of the Teller Committee findings and related Air Force recommendations to the Armed Forces Policy Council on 5 November 1957 stimulated a lively discussion within that body. Rand's proposal to use Thor as an interim booster evoked considerable enthusiasm. Air Force Assistant Secretary R. E. Horner, encouraged by the optimism of the meeting, submitted a formal memorandum to the Secretary of Defense one week later, on 12 November, elaborating on the Thor-boosted satellite scheme. Horner emphasized that a Thor-boosted interim reconnaissance vehicle could be operational by April 1959, whereas the Atlas-WS 117L program had been so affected by earlier funds shortages that late 1959 or early 1960 seemed to be its earliest possible launch date. (Neither the Atlas nor the WS 117L reconnaissance subsystem could be ready before 1960.) Horner reported, on the strength of the Policy Council discussions and presentations to the Council, that a combination of Thor with a modified WS 117L upper stage could place a 300-pound reconnaissance device in a 150-mile orbit.

Concurrent with the Horner recommendation, Rand circulated the first written discussion of its proposal for an interim reconnaissance system based on a combination of the Thor booster with the Aerobee-derived upper stage used in the Vanguard program. Advance copies were distributed on 12 November 1957, the day of the Horner memorandum. In addition to use of Thor as a booster, Rand urged a technique of spin stabilization for a third-stage, camera-carrying element of the system. (The concept had been invented by Merton Davies, one of several Rand scientists who contributed to the study.) Rand also suggested abandoning the WS 117L readout concept for the interim system, urging a mode of payload deboost and water landing to permit recovery of the entire third stage.

Even though the Rand proposal was new to many who first heard it in late 1957, it embodied elements of several earlier suggestions, each prompted either by desperation at the inadequacy of the financial support for the satellite program or by misgivings about some of the technical details. The basic notion of combining a ballistic missile with an Aerobee upper stage had originated at Wright Field in 1955, when it was proposed as the Air Force alternative to Vanguard. In that instance a combination of Atlas with an Aerobee upper stage had been suggested as the best means of boosting a relatively large scientific satellite into orbit. The use of recovery rather than readout techniques had been suggested, and studied, at least as early as December 1956, when the Ballistic Missiles Division had asked [redacted] to analyze the technical aspects of such an option. Rand researchers had examined the prospects in some detail through the summer of 1957; the revised version of Rand's 12 November study eventually suggested a complete family of recoverable satellites.[redacted]

Apparently quite independent of the Rand and Teller recommendations, General Electric on 29 October suggested to headquarters of the Air Research and Development Command (and very possibly, through other channels, to the Central Intelligence Agency) that a "pioneer" system could be put together using the Thor booster, a General Electric Hermes rocket (for a second stage), and a third stage built around a horizon-stabilized recoverable satellite. One month later, on 27

November, General Electric followed up the initial suggestion with a more detailed proposal which outlined a camera subsystem, a recoverable capsule subsystem, propulsion, command and control, program planning, and a management approach. The original camera concept embodying an eight-inch lens capable of resolving 350-foot objects had, by November, become an f3.5, 18-inch lens used with Microfile film to provide resolution of 75-foot objects. The capsule design, bearing an obvious likeness to General Electric ballistic missile reentry bodies then in development, was intended to free-fall into the ocean, at which point the ablative shell would crack and the recovered elements would remain afloat encased in a foam rubber ball.

Although the General Electric scheme was further elaborated in a 4 January 1958 brochure, it apparently had little influence on the program then being considered on the West Coast. Colonel W. A. Sheppard, intimately concerned with satellite proposals, later said he had absolutely no recollection of having encountered the General Electric brochure. A high General Electric official insisted that the idea had been submitted to BMD in October 1957. In the frenzy of the first 100 days following Sputnik many such proposals could have been received, filed or mis-routed, and forgotten. Additionally, the

BMD group was by mid-November rather firmly committed to its own approach.●

That approach, undoubtedly influenced by the Teller Report, the Horner memorandum, and the Rand study, appeared as a BMD-Lockheed plan for the acceleration of the entire WS 117L program. Discussions between Lockheed and BMD officials preceded the dispatch of an informal Lockheed proposal on 26 November. It was considered in some detail immediately thereafter, particularly in the course of a 5 December meeting at BMD. Lockheed urged the adaptation of the WS 117L upper stage to the Thor missile as the first step in a program acceleration. Taking issue with Teller Report and Rand conclusions that the Aerobee upper stage promised earlier availability than the WS 117L upper stage, Lockheed proposed a "more realistic" system embodying elements of the Rand-proposed camera technique, the Horner vehicle concept, and Teller committee suggestions for schedule acceleration. On 23 December, General Schriever asked Lockheed to prepare a formal proposal along such lines, and on 6 January 1958 Lockheed actually completed and forwarded a rather comprehensive development plan.●

One aspect of the Lockheed proposal was particularly applicable to a clandestine satellite reconnaissance program, an approach revived at BMD early in December. General Schriever's November correspondence with Lockheed had included some mention of the highly sensitive U-2 program and Lockheed's success in pushing that reconnaissance aircraft system to early completion. Lockheed had also called attention to its relatively recent experience in the development of a covert reconnaissance vehicle. Brigadier General O. J. Ritland, BMD's Vice Commander and a key figure in the U-2 development, was, like Schriever and Oder, on familiar terms with R. M. Bissell and other officials of the Central Intelligence Agency who were most concerned in reconnaissance overflight operations. (Ritland had managed U-2 development under Bissell's direction.) Thus Ritland was a principal in early December discussions between Schriever and important policy figures in Washington: Bissell of the Central Intelligence Agency, Dr. Edwin Land of Polaroid Corporation and the Boston University optical research laboratory (Land had also been a member of the Technological Capabilities Panel of the Office of Defense Mobilization), Dr. J. R. Killian, and Major General A. J. Goodpaster. That group quietly considered the political and technical aspects of the satellite reconnaissance problem and concluded that the best course for the nation was to sponsor a covert program employing the Thor-WS 117L vehicle. The combination was generally described

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as the Thor-Hustler, the rocket in the WS 117L upper stage being derived from the XRM-81 motor originally designed for the "powered pod" missile of the B-58 Hustler bomber. Much later, the upper stage acquired the more lasting name "Agena."

Concurrently, on the strength of detailed instructions from General Schriever, Colonel F. C. E. Oder began drawing up a revised "Second Story" cover plan based on staging an "open" Thor-Hustler scientific satellite program to cloak reconnaissance over-flights. In the sense that Killian and Goodpaster were spokesmen for the White House and would undoubtedly be able to commit the administration to support such an effort, their acceptance of this scheme shortly before Christmas of 1957 constituted an unofficial but highly significant endorsement. Bissell's agreement, and acceptance by the Central Intelligence Agency of the covert program approach, closed the loop.

Oder's modified "Second Story" proposal involved the creation of an interdepartmental reconnaissance system coordinating committee which would secure approval of a complete covert operation, prepare a political action plan, define a comprehensive security system, and decide how to handle public information aspects of the activity. The Central Intelligence Agency, Department of State, and Department of

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the Air Force were obvious participants. The key element was to be a very tight security wrap around the reconnaissance phase and a concurrent, highly-publicized scientific satellite effort based on the Thor-Hustler combination.

The BMD-Lockheed proposal of an "open" Thor-Hustler reconnaissance satellite reached the "official channels" stage late in January, after the covert approach had been approved in principle but before any special measures had been taken to put it into effect. Lockheed's 6 January submission, somewhat refined, was transformed into a formal request for amendment of the basic WS 117L development plan and sent forward to ARDC and USAF Headquarters on 23 January. It had the highly enthusiastic support of several of the most brilliant junior members of the BMD staff, who considered it a logical--even obvious--means of accelerating the reconnaissance satellite program and therefore vigorously lobbied for its acceptance.

Thus both an "open" and a covert program were being considered, in different channels, by late December 1957, and a month later both had been "approved" at the lower echelons. They were obviously incompatible, and one of the difficulties faced by sponsors of the covert approach during January was subduing the "open" plan. For practical purposes, only the covert program had a real chance

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of final acceptance. The political climate was such that no open attempt to orbit a reconnaissance satellite in the near future could secure support, and experience had demonstrated that the objectives of major programs generally became known to the public even if protected by strict normal security measures.

There was no important technical distinction between the Thor-Hustler system being considered openly and that proposed covertly. (Lockheed's 6 January presentation had listed the Thor-boost version as "Program IIA," the title by which the open program was thereafter generally known.) Both incorporated the Rand-originated concept of a spin stabilized panoramic camera, though the Lockheed modifications were significant.

Both the Program IIA advocates and the "covert approach" group spent most of January 1958 in working out details of their proposed programs and in settling on financial, management, and technical recommendations. Additionally, the covert operation supporters continued their search for a cover story that would explain why the perfectly feasible Program IIA proposal should not be approved precisely as submitted. (At that point the Program IIA option involved launching five engineering test satellites and five spin-stabilized photographic-payload satellites, actual test operations being scheduled to start in October 1958.)

On 1 February, the Secretary of the Air Force again asked the Secretary of Defense to approve the Thor-Hustler program originally suggested the previous November and now formalized as Program IIA. Two days later, President Eisenhower directed that satellite, ballistic missile, and ballistic missile defense programs be mutually accorded the "highest national priority." If the covert plan was to go into effect before an "open" program received approval, action would have to be rapid and effective.

Although the details still were not firm, General Schriever was by then convinced that the concept of concealing a Central Intelligence Agency activity under a scientific-satellite Thor-Hustler program was entirely valid. He felt that the best way out of the existent impasse was to disapprove Program IIA on some plausible grounds and to authorize development of a recovery capsule as a "first step" toward manned space flight, actually carrying on with "Program IIA" under cover of the recovery capsule program. The missing elements then included Defense Department approval, agreements with the Central Intelligence Agency on participating and support arrangements, and formal Presidential endorsement. Lesser but nevertheless important uncertainties included an appropriate management scheme, security measures, and personnel arrangements.

The pieces began to fall into place by late February 1958. On the 26th of that month, Schriever informed Oder and [redacted] [redacted] of Lockheed that a forthcoming directive from Defense Secretary McElroy would disapprove Program IIA, but would concurrently authorize use of Thor with the WS 117L upper stage to test airframe components and to conduct a recoverable capsule biomedical program. (The memorandum had actually been written by Bissell, Ritland, and Sheppard.) [redacted]

On the basis of such advance information, Schriever instructed [redacted] to assemble "black" estimates on system specifications and costs, made Oder responsible for coordination with the Central Intelligence Agency, and ordered transfer of payload contract costs from BMD to the Central Intelligence Agency. (General Electric and Fairchild Camera had earlier begun working, under Lockheed, on the Program IIA spin-stabilized payload.) The cover story was to be a Lockheed contract to develop the "biomedical" capsule. [redacted]

An unrehearsed complication was the injection of the Advanced Research Projects Agency (ARPA) into the scheme. ARPA had been proposed the previous December as a "super agency" which by controlling the various military space system developments would eliminate interservice rivalries. On 24 February, McElroy formally approved the WS 117L program acceleration recommended in November but also specified that it would be conducted under ARPA direction. ARPA, although theoretically functional, actually possessed neither personnel nor facilities at that point. Nevertheless, on 28 February the newly named director of ARPA, R. W. Johnson, signed the key WS 117L directive that Bissell, Ritland, and Sheppard had written. The paper disapproved development of the proposed interim WS 117L recoverable system (Program IIA), but authorized the Air Force to use Thor boosters for test firings of the second stage WS 117L vehicle for engineering tests and for biomedical experiments in support of manned space flight objectives.

Some confusion characterized proceedings during the latter part of February and the first two weeks of March. Of considerable importance was the fact that Oder and Sheppard had gradually developed reservations about the wisdom of a spin-stabilized reconnaissance vehicle. As early as 18 February Oder had urged General Schriever to fund a preliminary stable-body approach, suggesting that both the stable body design and a camera configuration proposed by Itek Corporation were improvements over the spin stabilization and the Fairchild camera then being supported as part of Program IIA. Additionally, Air Force headquarters in early March advised BMD that the

Thor-boosted "reconnaissance test vehicle" approach had been endorsed by the Department of Defense and that formal development plans for an operation called "Nightshift"--the proposed nickname for early Thor-boosted WS 117L launches--should be drawn up for early submission to the Air Force Ballistic Missile Committee. The "Nightshift" proposal had been devised within the Air Staff as a means of obtaining early Air Force entry into a "satellite club" that still was limited to the Navy Vanguard and the Army Explorer. Unaware of the scheduled covert program, Air Staff officials were intent on securing permission for launching something developed by the Air Force; whether it had a reconnaissance function or was a "scientific" satellite carrying odds and ends of instrumentation seemed of little consequence.

Once circulated, the Johnson directive had the effect desired by General Schriever; it made "Program IIA" a system designed for covert development and covert operation. Johnson's letter had other effects as well. The BMD specialists who had enthusiastically adopted the scheme of "interim satellite reconnaissance" based on the use of Thor boosters and WS 117L upper stages were completely taken aback. Innocent of knowledge that the "cancellation" was but the first and most critical step in what was to be an accelerated

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Handle via [redacted] ~~Talent-Keyhole~~ Controls Only covert program, and convinced by logic that "Program IIA" was the most sensible approach to an early reconnaissance satellite, they were appalled by Johnson's ruling and by the unprotesting acquiescence of responsible Air Force officials. One or two had an inkling of what had actually happened, but not until they were inducted into the covert operation as much as 18 months later were they sure of the rationale. For the moment, they had no outlet for their distress.

Schriever and Oder were meeting with Central Intelligence Agency and Lockheed representatives on the afternoon of 28 February 1958, when a copy of the Johnson directive first reached BMD. They completed arrangements to inform General Electric and Fairchild of what was afoot and reviewed the preliminary BMD analysis of proposals for camera and vehicle subsystems earlier submitted under "Program IIA" auspices. Both the technical approach and the management pattern were gradually taking shape.

Four distinct proposals for vehicle-reconnaissance system development had emerged from the Program IIA considerations. Lockheed and Rand both favored spin stabilization employing a Fairchild transverse panoramic camera with film drive synchronized to vehicle rotation rate. Lockheed, however, urged that only a ballistic-missile type nose cone be recovered, while Rand favored recovery of the entire orbital vehicle. Both proposals assumed use of Fairchild cameras capable of resolving 60-foot objects.

General Electric and Itek* proposed stable-body vehicles carrying panoramic cameras. General Electric thought ground resolution of 25 feet could be obtained; Itek, that seven-foot resolution was possible. General Electric paralleled Lockheed in favoring data capsule recovery, while Itek supported the total-vehicle recovery concept originated by Rand.**

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* Itek had come into being in 1957, principally through the efforts of Richard Leghorn, Professor Duncan McDonald (Boston University's Physics Research Laboratory), and [redacted]. On 1 January 1958, Itek acquired the personnel and facilities of the Physics Research Laboratory with funding support provided by the Rockefeller interests. Boston University had long been uneasy at the transition occurring in the Physics Research Lab, which had become more of an industrial research facility than a campus establishment through the instrumentation of contracts largely with the government. The resignation of Professor McDonald, who had been the chief figure in laboratory activities for some years, decided the University to withdraw from the field. The resulting arrangement, by which Itek acquired the laboratory, equipment, contracts, and personnel, made Itek a very strong contender for new research and development contract awards, the company having assimilated (in Colonel Oder's judgment) "some of the nation's best camera people." Itek personnel had directly participated in the development of the balloon reconnaissance cameras as well as in the U-2 camera program.

** That basic disagreement extended into the design of the first recoverable WS 117L (Samos) vehicles; the eventual Samos E-5 recoverable payload included the camera, the E-6 included provisions for film-only recovery.

In the opinion of the BMD analysts, the choice between spin stabilization and stable body configurations should be based on earliest availability, and spin stabilization appeared to have the advantage. Either the General Electric or the Itek system was adaptable to the WS 117L upper stage if the entire stage were stabilized. Of the lot, the Itek 24-inch focal length camera design seemed most promising in terms of ground resolution and growth potential. Itek also appeared to have the most attractive research facilities, the former Boston University Physics Research Laboratory. [redacted]

Before a final decision could be taken in technical matters, certain critical management items required disposal. Most were satisfactorily arranged in a series of meetings between 26 February and 15 March. The Central Intelligence Agency was charged with security control, and thus with principal conduct of covert activity as such. Bissell, as the responsible official in the intelligence agency, was obviously in need of a "very knowledgeable WS 117L man" to assist him; Schriever and Oder made available Oder's assistant, [redacted] (United States Navy), under cover of a [redacted] assignment to ARPA. The intelligence agency agreed to brief both General Electric and Fairchild on the covert program in advance of formal notice to Fairchild that the IIA program had been "cancelled."

In order to establish the proper "black" environment, it would be necessary to overtly cancel the Fairchild agreement and to re-orient the General Electric effort toward development of a "biomedical" capsule.

With receipt of the Johnson directive, one other step became possible: the Central Intelligence Agency on 10 March 1958 assigned the code title Corona to the covert program.

Bissell arranged with the proper Washington authorities to delay circulation of the Johnson directive until Fairchild and General Electric could be advised of the background factors. BMD had agreed to pay Lockheed the basic costs of the "cancelled" IIA program as they involved these contractors. Officially, BMD would pay "under protest," since all three firms had proceeded on Program IIA on the strength of informal agreement only.

A 15 March meeting between Bissell and Ritland, in Washington, confirmed the earlier BMD decision to use the "Hustler" (Agena) upper stage for Corona rather than the Aerobee stage from Vanguard. It was also agreed that Bissell's interest in WS 117L would be authenticated by a formal assignment to keep CIA Chief Allen Dulles briefed on the progress of that "major collection system." Even within the Central Intelligence Agency, Corona was to be a closely held secret.

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The choice both of a technical approach and of specific contractors, during March 1958, was not without a degree of further confusion. The starting point was the Program IIA arrangement. As a result of preliminary actions during that January, Lockheed's verbal commitments to Fairchild (camera subsystem) and General Electric (reentry body) were along the lines of the Rand proposals and the prevailing CIA opinion. But continued expressions of BMD unease plus advice from Central Intelligence Agency technical specialists who had their own copies of all the proposals apparently caused Bissell to have second thoughts. On 15 March, Bissell told Ritland that special meetings were scheduled for 17 and 18 March to discuss the advisability of funding a "back-up" alternate to the primary Fairchild-General Electric approach.

The group that met at Cambridge, Massachusetts, on 18 March included three members of the President's Science Advisory Committee, two Central Intelligence Agency officials (including Bissell), three BMD officers (Ritland, Oder, and [redacted], and Dr. Herbert F. York of ARPA. Its task--decided only one day earlier--was to select a "back-up" contractor. After hearing detailed presentations from Itek, General Electric, Fairchild, and Eastman Kodak, the panel concluded that Itek was best qualified to develop an alternate camera system for

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Corona. Going further, the group recommended that Itek and Lockheed, with assistance from General Electric, if needed, should develop a gas-jet-stabilized vehicle with Lockheed having systems engineering and technical direction responsibilities.

The differences between the Itek proposal and the "primary" Fairchild camera subsystem compelled attention. Essentially, Itek was proposing a 24-inch camera with theoretical resolution on the order of 15 feet, while Fairchild was urging a camera with 60- to 100-foot resolution. Principally because of that difference, the Central Intelligence Agency in late March began to look more favorably on the Itek than the Fairchild proposal but continued to advocate concurrent development of spin stabilized and stable-body techniques. The first formal project plan prepared by the CIA (on 9 April) contemplated development of the Fairchild camera in the Rand-conceived spin stabilized orbital body, with a stable-body Itek camera following on somewhat later. [redacted] reflecting Oder's notions, and with the support of several CIA technical specialists now engaged in the program, urged reversing those priorities. The 9 April draft was revised two days later, but did not merely propose allocating major emphasis to Itek and the stable-body configuration; rather, it provided for dropping the spin-stabilized configuration and the Fairchild camera altogether.

That decision, which surprised Oder and Ritland (who had reservations about the wisdom of concentrating all effort on a single line of approach), was the product of a subdued but intense three-week debate that followed the 18 March meeting and was not ended until a second revision of the 11 April draft program directive passed Bissell's scrutiny and was forwarded to General Goodpaster on 16 April. The debate had two facets. One was a question of technical policy: was it wise to abandon spin stabilization while there remained considerable uncertainty about the achievability of a stable-body photographic satellite? There was no real doubt about the feasibility of using spin stabilization, although the quality of the resulting photography was far from certain. The second issue was whether spin stabilization might not provide a good cover for the development of a stable-body satellite, concealing the potential of the latter. Colonel Oder held to the view that pursuit of the more conservative Fairchild approach was ". . . worth a limited effort."[redacted] But Oder, one of the original proponents of the Itek approach, was not inclined to press the issue unduly. There was general agreement between BMD and CIA technical specialists that the Itek proposal had greater technical appeal, that Itek had better facilities than Fairchild (or General Electric), and that spin stabilization had inherent disadvantages when compared to body stabilization. Bissell felt that the Itek approach would cost less, and he was particularly impressed by the greater resolution potential and performance growth potential of the Itek camera. There is little doubt that reliance of the Itek approach on the availability of the Lockheed upper stage for WS 117L had considerable influence on Oder's (and Schriever's) ready acceptance of Bissell's judgment; continued development of what was to become the Agena was essential to the eventual appearance of the WS 117L, on which Air Force space hopes still were concentrated. The factors that caused a complete reversal of judgment between 18 March and 18 April, when President Eisenhower verbally approved Bissell's 16 April proposal, were far more complex than most of those who reviewed and approved the decision ever realized.

By early April, therefore, a technical approach, cost estimates, and an operating plan were in existence. CIA Director Allen W. Dulles, Defense Secretary Neil McElroy, and Presidential Science Advisor J. R. Killian then presented the matter to President Eisenhower personally for final approval. Their sponsorship was convincing, and Corona received the President's endorsement.* The rationale was

* However, only 10 launches were initially funded, as against the 12 proposed in the 16 April Corona development plan.

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that reconnaissance was vital to national security, that the U-2 program could not be expected to continue indefinitely, and that the Soviet Union would not countenance an "open" reconnaissance satellite operation. A covert operation concealed under a cloak of scientific research would permit the United States to deny the actuality with sufficient plausibility to satisfy sensitive neutrals and timid allies. At worst, clandestine reconnaissance would be feasible until the WS 117L system began initial flight trials, and by that time it might be possible to confront the Soviets with a fait accompli, thus nullifying political action to prevent WS 117L operations.

Early Problems

Management of Corona proved complicated if only because it involved so many agencies and contractors. ARPA reviewed and funded the overt effort, insured adequate support, arranged for sea recovery (a Navy operation), and kept the Defense Department advised. BMD developed and provided all hardware that could be related to a cover or supporting program and provided facilities and personnel for launch and track operations. The Central Intelligence Agency defined covert program objectives, established and policed security policy, maintained liaison with the Department of State, developed the covert hardware items, and insured that covert and overt technologies were compatible. Lockheed Missile Systems Division (under contract to both the intelligence agency and BMD) served as techical director of all equipment but the camera, capsule, and support equipment; developed the orbiting upper stage; and checked out everything but the booster, camera and recovery system. Itek developed the camera under subcontract to Lockheed, and General Electric subcontracted for the recovery capsule. Douglas furnished the Thor boosters.

BMD was satisfied that the technical evaluation had been adequate and that the program was sound. The next step was to issue proper letter contracts to Lockheed as quickly as possible so that

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launch schedules (tentatively approved on 18 April) could have some expectation of validity. The principal tasks connected with this aspect of the Corona program were completed by 9 May, with Lockheed's issuance of summary work statements to both General Electric and Itek. (Itek promptly subcontracted with Fairchild for the manufacture of the camera itself.)

Another critical requirement, the provision of working space where Lockheed personnel could actually assemble the "black" hardware into operationally ready satellite vehicles, was also satisfied between April and July. The agreed operational procedure--ostensible engineering flights followed by "biomedical" flights followed by "advanced engineering tests"--afforded a legal and plausible requirement for tight security, particularly in stabilization technology. Much of the cost, moreover, could be concealed in such items, and many of the basic components could be manufactured and tested "openly." For the remainder, Lockheed decided to conduct operations in a leased [redacted] plant which was in close proximity to the main Lockheed facility. Lockheed explained to [redacted] that the work to be carried on in the [redacted] buildings was company proprietary and thus was not to be disclosed to anyone--including other sections of Lockheed. Some [redacted] people were hired, but most of the population of what came to be known as the "Skunk Works" was transferred from the Lockheed payroll, although all employees were actually paid by [redacted]

Conscientious Air Force plant representatives and Lockheed supply personnel presented an early problem, derived from the need for moving expensive equipment and materials to a place that had no legal existence, but the <u>Corona</u> people devised "secondary" cover stories which satisfied inquiries. There was no real need for elaborate deceit, chiefly because no one would expect Lockheed to be doing work in the [redacted] plant, and no connection linked [redacted] with any space projects. The "company proprietary" explanation satisfied others who were curious. Within the company itself, prolonged absences of personnel were explained by references to a "company program." Itek, General Electric, and Air Force people who were known by Lockheed personnel to be associated with reconnaissance programs made only the most circumspect visits to the "Skunk Works." Even the wives of the Lockheed employees did not know where their husbands actually worked. A further step was the compartmentation of assembly work at Lockheed; most workers engaged in but a single, segmented phase of the vehicle assembly process. [redacted]

In July, Lockheed officials issued an "inhouse" statement that the recoverable payload for Thor-WS 117L flights would include "in addition to normal instrumentation, recording devices for the advanced engineering tests." Responsibility for these devices was assigned to a special department with the explanation that ". . . the existing shortages of space at the Palo Alto plant and . . . the sensitive nature of the experiments" made it necessary to expand into new facilities. "Instrumentation development" and the assembly and checkout of nose cones and payloads would be concentrated in the "additional facilities." Lockheed officials cautioned that extreme project secrecy was essential to prevent an anti-vivisectionist outcry over the scheduled biomedical experiments. Fully cognizant project personnel also understood that the phrase "recording devices" could be used to explain the presence of camera equipment in a "biomedical capsule" if an explanation became necessary.

A special cryptographic teletypewriter network linked BMD to the Lockheed "Skunk Works" and those facilities to CIA's Washington headquarters. [redacted]

[redacted] It shortly became apparent, however, that both ARPA and ARDC headquarters staffs contained more knowledgeable people than were authorized there, principally because high-ranking officials had yielded to the compulsion to inform their immediate superiors and their immediate staff assistants. [redacted]

Confirmation and approval of the 10-vehicle flight schedule by mid-June and general distribution of the "scientific payload" cover story brought a new complication. Biomedical specialists, overjoyed at the possibility of stuffing various organic samples into recoverable satellite capsules, developed an overpowering interest in the Thor-WS 117L. Even though Brigadier General Don Flickinger, the Command's biomedical chief, was cognizant of <u>Corona</u> he could not forcibly fend off those of his people who insisted on participating in program management without provoking undesirable curiosity. By June, flights number 3, 4, 6, 8, and 10 had nominally been scheduled for biological specimens, flights 1 and 2 for engineering tests, and flights 5, 7, and 9 for "advanced engineering tests." Actually, cameras were to be carried in all of the "advanced engineering" satellites and some of the "biomedical" test vehicles. Both Air Force and Lockheed personnel appreciated that new problems might arise when it became apparent that all of the "biomedical" flights were not actually returning biomedical specimens.

One of the basic difficulties in the program was that well-meaning people convinced they were advancing the interests of the Air Force insisted on tinkering with one or another aspect of the "open" Discoverer program. Generally, the Corona managers at BMD were able to limit the ill effects by calling on the Central Intelligence Agency to apply quiet pressure to the danger spots. Sometimes it proved necessary to brief one or more people who had no role to play in Corona itself but whose influence was necessary to keep events from unfolding in undesired directions. A case in point was the July 1958 Department of Defense suggestion of deploying all Thor missiles and using all of the Army-developed Jupiters as satellite boosters. Since Jupiter was essentially incompatible with the WS 117L upper stage, the danger to Corona was obvious: at least a nine-month delay in schedules, re-engineering of payloads, reduction in orbital weights, and reliance on non-standard boosters. In this instance, Colonel Sheppard* immediately contacted Bissell with a request that the CIA official take action "at the highest possible level" to insure that the suggestion was withdrawn before it could become a matter of debate. Apparently the maneuver was effective, for no more was heard of that particular gem.

Sometimes it was difficult to decide whether to stifle such undesired assistance or to draw secondary benefits from it. Such was the affair of the highly respected reconnaissance expert who, as Colonel Sheppard put it, was complicating matters by "going around convincing people we should be doing the things we in fact are doing in the [Corona] program." The affair had its useful aspect, however, since it was inconceivable that one so highly placed could be unaware of actual reconnaissance programs, and his ill-timed propaganda must also have served to convince many that the Air Force was indeed concentrating on WS 117L rather than the Thor-boosted satellite.

Another interesting problem Colonel Sheppard encountered was that the program director for the Thor-WS 117L "experimental and biomedical" satellite vehicle kept "insisting that the overt part of the system be designed rationally to support the overt missions." In this

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* On 8 April, General Schriever made Sheppard the Air Force Corona chief. Oder, associated with the WS 117L reconnaissance program, had to be removed from direct participation because of the danger that his association with reconnaissance would weaken the Corona cover plan.

instance there was no alternative to making him aware of the covert plan. How else could one explain designing the satellite vehicle for horizontal rather than vertical flight attitudes which were logical for biomedical experiments but impossible for film recovery purposes, or why it was undesirable to air-condition a specimen chamber when the truthful reason was that the chamber in question must covertly be made light tight.

The technical decisions which largely determined the future of the program for the next two years were made in the period from April through October 1958. The key contracts were in being, at least in letter form, by the end of May: CIA with Lockheed, and Lockheed with General Electric, Itek, and Fairchild. At that point, it appeared that reentry stability was the only major technical uncertainty, although engine tests, vehicle control, and guidance still were matters of concern. The recovery method had been selected (air catch, with water recovery following if the air catch failed for any reason), and a test and training program covering recovery aspects was taking shape.

In actuality, the process of selecting a recovery technique, assembling capable personnel, and locating equipment was much less difficult than it might have been. The basic methodology had been perfected four years earlier in the course of the <u>Genetrix</u> program, the balloon reconnaissance operation that ended in February 1956. Colonel Paul Worthman, who later became the Air Force director for Corona, had been instrumental in devising the 119L capsule recovery process and with others who had experience in that operation was able to assist in reactivation of the flight organization. The equipment had gone into storage after the cessation of activity in 1956 and essentially required no more than refurbishing to qualify it for re-use. The difference between hooking and reeling in a package parachuted from a high-altitude balloon and performing a similar operation for a package descending by parachute after reentry from orbit was not enormous.

In the case of Corona it would be most difficult to conceal the fact of a capsule recovery, particularly if, as seemed probable, several hundred people were involved in interlocked shore, sea, and air operations. Briefing such vast numbers on Corona seemed rather impractical, so the air-sea recovery portion of Corona became an overt element. The fact that some publicity on the more newsworthy aspects of such a recovery activity would provide additional cover for Corona--assuming that the "package" itself could be adequately protected--was another attraction.

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Through "normal" channels--though with a fair amount of under-the-table pre-planning--BMD secured the authority to operate a recovery squadron without hindrance from any other command. A contingent of C-119J aircraft equipped for air recovery was drawn from the Tactical Air Command, essentially complete with air and ground crews at least in part familiar with the requirements of the original Genetrix operation. General Orders activating the contingent as the 6593d Test Squadron (Special) took effect on 1 August. Initially, the squadron moved to Edwards Air Force Base to begin intensive training and practice. Both balloons and high-altitude aircraft were used to release "training capsules" for C-119 retrieval. Within a few months, in time to meet the schedules for first capsule recovery, the squadron was to move to Hawaii, the center of the planned recovery area. Other essentials, including tracking stations in [redacted] and [redacted] as well as that at [redacted] the sea-borne task force to provide an optional recovery mode if air catch failed, and a plan for returning a recovered capsule to "black" channels after its "white" recovery, were arranged relatively early. The matter of who should operate the tracking stations, particularly that at [redacted] and the question of how to stage a "shell game" that would let the real capsule vanish enroute to the mainland caused some later difficulty, but during the summer of 1958 nothing of the sort was accurately foreseen.[redacted]

Of more immediate concern was a serious controversy between Lockheed and General Electric which threatened the stability of program management.[redacted] The apparent difficulty was inability of the two to agree on a work statement for General Electric, although the real problem was more deep-seated. During the early weeks of April, General Electric had urged upon Lockheed and the Air Force its own proposals for a separate third stage--which General Electric would design and build. The proposal, much like that submitted in the October-November-January brochures, proved unacceptable because of design misconceptions and the difficulty of mating the General Electric-proposed third stage to the Lockheed second stage. Although an Air Force-Central Intelligence Agency ruling on the final design presumably resolved the issue in May, again in June the two customers found their contractors at odds. To the Corona managers at BMD it appeared that they were jockeying for position, each company attempting to insure a favorable position for future programs. In a sense, General Electric held that Lockheed wanted General Electric to deliver basic hardware which Lockheed would thereafter engineer, modify and install; while Lockheed maintained that General

Electric wanted to deliver a sealed package for Lockheed to load and launch without question. Rather bitterly, each contractor pressed his viewpoint on the agency and the missile division. Not until late June was the issue satisfactorily resolved and the respective roles of the prime and the subcontractor defined in work statements acceptable to both.[redacted]

Lockheed, General Electric, and Itek designed their systems and subsystems basically in conformance with a philosophy jointly agreed upon by the agency and the Air Force. Of the available technical approaches, that which offered the best potential for success during the period of prospective operation was almost always adopted. Reliance on existing techniques or relatively simple extensions of the current state-of-the-art was universal. Reliability through simple design rather than an attempt to derive "the last few percentage points in perfection of product" was a consistent policy. Proceeding on this basis, Lockheed was able to report the total system design ready for initial review on 14 May, design freeze on 26 July, and release of engineering drawings on 23 October.[redacted] By all indications, the technical program was proceeding at a reasonable pace and without unanticipated difficulty.

As much could not be said for all the program management aspects of Corona. Starting about September 1958, a succession of difficulties and uncertainties began to plague Corona managers. In part they were the natural but nonetheless unwelcome offshoots of a tightly scheduled program with unusually important objectives. Another portion, however, derived from the peculiar alignment of technical and managerial responsibilities which saw BMD, ARPA, CIA, and several high officials in the Administration sharing authority. In particular, the ill-defined role of ARPA in the Corona program proved troublesome.

As ARPA had assumed control of the entire military space effort during the summer of 1958, the tendency of that agency to redirect space programs toward objectives which frequently had not been those of the military served to complicate management. Moreover, as the National Aeronautics and Space Administration (NASA) gradually acquired control of the obviously "scientific" and "research" aspects of the national space effort during the summer of 1958, ARPA both resisted that trend and attempted to create an alternate program which would give the agency a significant and lasting role in space operations. WS 117L funds provided the largest portion of fiscal 1958 ARPA resources and constituted the most valid justification for a large fiscal 1959 ARPA budget, and the Thor-Hustler (Corona) program nominally fell under the aegis of WS 117L. ARPA's tendency to redirect WS 117L toward new objectives indirectly affected the immediate conduct of Corona itself, but ARPA's attempt to exercise direct control over portions of the Corona program, largely by manipulating the purse strings, was considerably more critical. Finally, as the fiscal 1960 budget cycle entered its closing phases, the matter of continuing a form of Corona into calendar 1960 became of increasing concern. If Corona proved successful, a matter which could not be judged until the first satellite reconnaissance photographs were actually examined, its continuation was logical. The question of its continuance as a covert operation--the matter of whether cover could be successfully maintained past the period of "engineering" and "biomedical" flights--versus its reincarnation as a highly secure but overt activity, had to be faced eventually.

The original Corona approval of April 1958 had been based on 10 vehicles funded by ARPA from WS 117L program money. The Air Force-CIA plan, however, called for a minimum of 12 shots on the assumption of one-third successes and the need for a minimum of four successful reconnaissance flights to provide adequate coverage of the Soviet Union. In June, Colonel Sheppard had convinced Air Force Secretary James A. Douglas of the need to provide enough additional money (through ARPA) to keep ahead of the "lead time problem" and to insure a continuing flow of Thor boosters and Lockheed second stages. On 2 July, Douglas responded with an open directive to BMD which expanded procurement authority as Sheppard had urged.

The 14-vehicle program thus constructed accommodated the 12 scheduled Corona flights and two engineering or biomedical tests. It lasted only until 6 August, when BMD learned of ARPA instructions that the "Thor-WS 117L" program was to be expanded by 9 vehicles additional to the 10 officially authorized. (Biomedical payloads were specified in the ARPA directive, though with the proviso that "special payloads . . . to investigate and measure certain suspected space phenomena" might later be substituted.) The new addition essentially provided for seven real biomedical payloads in addition to the 12 Corona packages. Its timing and the fact that ARPA was then attempting to retain control of the "Man in Space" program that subsequently went to NASA, indicated that ARPA intended to use the Thor-WS 117L program, if possible, as a counterweight to the announced NASA biomedical program.

By virtue of these and related changes, the total WS 117L program had risen by September 1958 from a budget level (for fiscal 1959) of [redacted] to a total of [redacted] Of this total, [redacted] was shown in the current proposed development plan for WS 117L and the remainder was required for purchase of additional Thor and Atlas boosters. ARPA apparently intended at least [redacted] to go for biomedical research and [redacted] to long-lead items. Another [redacted] not shown in the "open" totals, was CIA money supporting "black" Corona procurements.*

In this maze of figures, which one participant flatly called "chaotic," ARPA Director Johnson in August identified [redacted] as "open" Corona money, concluding that an additional [redacted] in fiscal 1960 would see to the purchase of the 19 scheduled vehicles as well as programmed engineering changes. He also suggested that CIA bear a larger portion of the cost, arguing that the Corona effort was principally for CIA benefit.

On 1 October, revised Corona program costs reached Bissell. The total there shown was [redacted] the bulk of the increase arising from the re-estimates by Lockheed and its subcontractors.

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* The 18 April plan approved by the President had contemplated expenditures of $7 million for "black" hardware and R&D, plus [redacted] for Thor and Agena development and procurement. That [redacted] total reflected an increase of [redacted] over the first (9 April) cost estimates.

ARPA had questioned the validity of the cost increase, protested its size, and passed the matter to the CIA. Bissell, in his turn, was startled into a violent protest. Citing the fact that the funding estimates of April, used in obtaining approval for <u>Corona</u>, had totaled [redacted] he told General Ritland that if McElroy, Dulles, and Killian had been aware of the prospective costs in April they would never have recommended the program to Eisenhower. Displaying the effects of having just been scored by Killian, Bissell told Ritland that "Corona [is] simply not worth [redacted] [in] ARPA funds plus [redacted] [in] CIA funds." Dulles, Killian, and McElroy were slated to discuss the entire affair with the President in the immediate future, he added, and it seemed probable that " . . . complete cancellation of Corona will be considered."

Bissell concluded that <u>Corona</u> was being charged for undefinable development costs that actually belonged to the remainder of WS 117L, urged that the two programs be disengaged for funding purposes, and made some rather unflattering references to "rubbery accounting systems" and "juggling costs." In a separate message to Colonel Sheppard later that day, Bissell--somewhat less emotional than had earlier been the case--said sadly that "all of us concerned with <u>Corona</u> have some embarrassing explaining to do."

Apart from being thoroughly accustomed to substantial differences between early estimates and actual program costs, Ritland and Sheppard were less alarmed than Bissell because they were closer to and more aware of the remarkable convolutions of the program during the preceding six months. To explain the situation to their CIA counterparts, they detailed program fluctuations and broke down the cost totals to show that changes in the level of engineering effort and in the scope of the program had caused price increases. Sensitive to the implications of reprogramming and aware of the potential for mischief implicit in such funds juggling as ARPA was then practicing, they added the caution that a covert program could not be conducted under requirements for constant rejustification and that it would be advisable to keep program matters in the hands of program participants. In their reply they also included a resume of Corona potential and a further explanation of the worth of the basic Thor-WS 117L program as a major contribution to the national space effort.[redacted]

Before the end of October the problem had largely been resolved by the personal intervention of Schriever, Ritland, and Sheppard with key CIA and White House officials. The complicity of ARPA in the funds crisis and the cancellation threat received implicit confirmation through a subsequent agreement between Schriever, Killian and Bissell

[redacted]

that the funding totals provided by the Air Force were reasonable and that henceforth the role of ARPA should be as a "utility intermediate" without authority "to steer or affect CORONA."[redacted] But the basic suggestion earlier endorsed by Bissell, that it would be advisable to separate Corona from the balance of WS 117L, continued to receive attention.

ARPA had taken a preliminary step in this direction early in September. All reaction was not favorable. Colonel Oder, for instance, contended that program segmentation would draw too much attention to Corona, since the rationale for the Thor-WS 117L program was partly based on "engineering tests" of WS 117L upper stages. Oder also emphasized that once the Thor-boosted vehicle was recognized as a separate "scientific" program, scientists would come to expect the recovery of data which it would be quite impossible to fake. A counter argument, of course, was that continued association of Thor-boosted satellite with the Atlas-WS 117L effort would lead inevitably to the conclusion that Corona flights were reconnaissance oriented. The fact that efforts to improve the image of the United States space "program" had caused WS 117L to be openly identified with reconnaissance--and even glorified in that role--tended to color all aspects of the original program. The name "Sentry" given the WS 117L program in September 1958 was compromising in itself.[redacted]

Early in November, Bissell went around both the Air Force and ARPA to reach General Goodpaster, responsible for liaison between CIA and the White House, with a strong suggestion that the Corona flights be completely separated from the balance of the "Sentry" program and covered by a scientific satellite mission assignment. Almost concurrently, a special scientific committee examining the status of the entire reconnaissance program encountered again the problem of ARPA interference. Dr. Edwin Land made it clear to R. W. Johnson and [redacted] of ARPA that Corona was considered "an operating program to achieve a limited objective" and was not to be "subjected to or perturbed by R&D tinkering; and that the actions of all must be primarily governed by security since exposure of the program must be avoided at all costs."

There was slight indication that the ARPA officials were impressed. They promptly proposed the deletion of three of the scheduled biomedical shots and the addition of a "Super-Corona" satellite, essentially an Atlas-boosted Corona with an "improved" recoverable payload. In other channels ARPA people also suggested that Corona be reoriented toward an electronic readout system rather than a recovery payload system. (Electrostatic tape systems were great favorites with ARPA that fall; the basic WS 117L program suffered through the same syndrome.) On the whole, however, such notions had a cool reception. Dr. Land, influential in both CIA and administration circles, was particularly insistent that the nation take advantage of what was available rather than plan grandiose substitute programs.[redacted]

Notwithstanding the reaction, ARPA on 25 November officially notified ARDC that two of the scheduled biomedical tests in the Thor-Hustler series were to be cancelled. No change in the total number of vehicles was immediately provided, however.[redacted] That followed roughly a week later, upon Johnson's receipt of an official recommendation from several ARPA specialists assigned to study reorientation of the entire WS 117L program.

Although the reasoning behind the ARPA maneuvering was not entirely clear, it began to appear to those in Corona that the coincidence of rescheduled biomedical flights with the proposal for an Atlas-Corona, including a large recoverable capsule, might be an ARPA attempt to justify development of a man-size satellite. The original ARPA proposal of this sort, based on BMD's "Man in Space Soonest" (MISS) program of June 1958, had been effectively overtaken by transfer of manned space flight responsibilities to NASA. (MISS, not much changed, became Project Mercury.)[redacted]

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The 1 December 1958 memorandum report forwarded to Johnson was largely motivated by new funding strictures directed from the Office of the Secretary of Defense. Instead of the [redacted] earlier recommended for WS 117L in fiscal year 1960, the program would receive [redacted] from ARPA. In order to stay within the funding limit, ARPA proposed cancelling all newly proposed Thor-boosted shots and reducing the approved total from 19 to 15 shots. Two of the 15--the cancelled biomedical tests--were to be further abstracted for transfer to "other" ARPA programs. In the remainder, the first two were to be vehicle development tests, the next two were to carry mice, eight were to be in the Corona configuration, and the 13th was to carry a small monkey. All were to be fired from a single Pacific Missile Range launcher.

More significantly, the report stated a new ARPA philosophy: ". . . ARPA's program responsibility ends when a system has been brought through its Research and Development. At this point it is available for users." And most significantly, thereafter the "user" would have to fund the program.

When word of the ARPA deliberations had first reached BMD, late in November 1958, the WS 117L office had concluded that ARPA meant to support 15 of the scheduled 19 flights and that the Air Force would have to find the money for the remainder. The fact that no ARPA money would be available for Corona after fiscal 1960, and that the Air Force presumably would have to carry on the program from its own resources, prompted thought for a completely new program approach based on the transition of Corona to an "open" but highly classified Air Force program managed under the WS 117L aegis. Toward this end, there was renewed discussion of separating the Thor-boosted satellite program from Sentry.[redacted]

A succession of meetings in Washington took up the several critical issues arising from the latest ARPA actions. Late on the afternoon of 4 December, Air Force Undersecretary Marvin A. MacIntyre wrote a memorandum to himself, had Johnson's signature block typed at its foot, took it to Johnson, and obtained the signature. The directive formally created a separate Thor-WS 117L program, under the nickname "Discoverer," to include "a number of systems and techniques which will be employed in the operation of space vehicles."[redacted]

Uncertainties concerning what ARPA would fund were eliminated in the course of a 15 December meeting during which the participants decided that eight Corona firings would complete the ARPA development effort and that the remaining four Corona flights would require Air

Force funding. By a memorandum to the Air Force Under Secretary two days later, Johnson confirmed the agreement and formally specified the research agency's intention of sponsoring only 13 Discoverer flights; two vehicle tests, three biomedical flights, and eight Corona launches. The settlement was not reached easily, however, since first Air Force and CIA officials had to convince ARPA that a readout program was not available to substitute for Corona recovery techniques. And there were interesting sidelights: on the afternoon of Johnson's directive, Colonel Sheppard discovered a Pentagon staff officer busily attempting to rejoin Sentry and Discoverer as a Top Secret program. The officer was convinced that ARPA had just succeeded in stealing an Air Force satellite program.

With the establishment of the Discoverer project as a formal, autonomous activity and with the open identification of Sentry as a reconnaissance satellite, the conditions for conducting Corona were somewhat altered. The first scheduled Discoverer launch was but a month distant in December 1958, and this also impelled thought for improving the cover story.

In a sense the disclosure that Sentry was a reconnaissance program tainted all aspects of the earlier development effort, including what was now Discoverer. Additionally, the international political climate was even more hostile to overflight than formerly. Indeed, in the opinion of Corona personnel "this hostility has manifested itself to the point where high government officials might cancel the CORONA program should it continue to be identified with such efforts."

Cover requirements were straightforward. ARPA participation had to be logically explained: if Discoverer was not a military program, why was ARPA involved? Any intelligence community interest in or association with Discoverer had to be concealed, as did any military reconnaissance implications. Finally, it would be essential to obscure any direct connection between Corona (as Discoverer) and a later Sentry vehicle with similar equipment. By the same token, a logical explanation for use of a polar orbit was needed. Finally, cover efforts should satisfy professional curiosity by insuring "a logical sequence of technical effort and the production of a product having military application."

The proper approach appeared to be to release enough information to discourage untidy speculation and to dispel any air of mystery. It also seemed useful to offer "consistent but much more complete technical explanations (. . . at least in part classified) to the considerable number of persons who do not need to know the true purpose of C [Corona] but are in a position to guess what it involves unless they are provided with a convincing alternate explanation." Military and contractor personnel at the launch site, in the recovery force, and in related military and corporate organizations fell into the latter category.

Inasmuch as the Corona configuration and the Discoverer biomedical configuration would be outwardly indistinguishable, there need be no great concern for unauthorized observation and no real need for "closed" launchings. Press releases, by emphasizing hardware tests rather than scientific probes, would help to prevent interference from "the vast number of scientists who claim a right to such data."

[redacted]

The use of a recoverable capsule could be explained as the only means of insuring that recorded data were reserved for the

United States, that recovery was the only means of providing visual inspection of equipment returned from orbit, that it provided the most accurate data records, and that it enabled the re-use of costly equipment. Polar orbits (which were somewhat illogical in the light of the facilities available for equatorial orbit tests) were to be explained in terms of range safety requirements and the possible exercise of the missile warning net. Thus the explanation that Vandenberg Air Force Base was so located that only a polar launch was possible, that Air Force research vehicles had to be launched from Vandenberg because of limited facilities at Cape Canaveral, and the fact that the vehicle passed over the Soviet Union was incidental. The relatively low and scientifically undesirable orbit could be explained on the basis of limited United States ability and relatively small boosters.

Military and contractor personnel who became aware of the presence of Corona cameras could be told either that they were intended for astronomical observation and were not being publicized because of the possibility of misinterpretation or that they were used as part of the stability tests, to provide a continuous record of the attitude of the vehicle by photographing the horizon.

One major unresolved issue remained of those created by the ARPA-directed program alterations of November-December 1958. With the marked reduction in ARPA support, only eight Corona firings were covered by approved funds. The remaining four in the original series plus any follow-on firings had to be brought into the "open" program in some fashion. The choice was plain. Either the Air Force "surfaced" the reconnaissance capability of Discoverer and conducted all flights following the eighth Corona as a highly secure program but by means of a "normal" approach, or Corona would have to continue as a completely covert element of Discoverer.

As a hedge against the possibility that continuation of Corona might not be approved, the Discoverer office prepared a development plan providing for 20 open Discoverer-reconnaissance flights extending through the last months of 1960. By implication, 25 Discoverer launches were thus programmed, a number Bissell had recommended in December. The proposal, titled "Carrousel,"* went forward with Sentry and Midas development plans submitted to the Pentagon in January 1959. It was partly tied in with the current scheme re-elevating Sentry security to the Top Secret level and conducting the entire satellite reconnaissance effort in that environment.

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* The title was invented by a project officer who was rather cynically convinced that the merry-go-round was but making another turn.

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Initially, Air Force Undersecretary MacIntyre directed on 2 February that the Carrousel proposal be integrated with a revised and expanded Corona effort and funded within the total available to the Discoverer-Sentry program for fiscal 1959. However, the question of whether the Air Force or CIA should be the Corona-Carrousel program "sponsor" was held in abeyance.

The Central Intelligence Agency became quite uneasy at the prospect that some portion of Corona might come to light in the deliberations over Carrousel. Most of the Carrousel supporters, and a fair share of the planners, were entirely unaware of Corona, but it seemed apparent that a 1960 Discoverer-reconnaissance program could not appear, fully pregnant, without causing the virginity of the 1959 effort to be suspect. Sheppard and Bissell, in particular, were of two minds on the problem. In the one instance, approval of Carrousel seemed to invite disclosure of the CIA role in 1959 Discoverer flights. On the other hand, attempting to bury a reconnaissance program through all of 1960 and 1961 when, in Sheppard's words, "we could obviously accomplish one," might well have the same result. Adding to CIA's worry was the conclusion that Air Staff people were somewhat inept in designing "cover plans" for Carrousel and Sentry--although the customary scorn of a professional for an "amateur" perhaps explained much of the implied distrust.

By mid-February, the Corona managers were agreed that the least dangerous course was to continue the Discoverer cover for Corona and dispose of Carrousel as quietly as possible. The situation was almost precisely identical to that of the previous January, when Program IIA had been "competing" with what became Corona. And it was handled in similar fashion. Carrousel had not been too widely known, so arranging a demise for the development plans was not a major problem. The formal disapproval of Carrousel was not pronounced until April, however, As was inevitable, it justified the action by citing reasons similar to those used in "cancelling" Program IIA, more than a year earlier. High cost and technical risk coupled with the small potential gain over Sentry were listed as reasons for not developing a reconnaissance version of Discoverer.

A simple extension of the Discoverer program with provision for sufficient flights to cover 20 Corona operations was the most direct means of documenting the program and obtaining the necessary "white" funds. That course was complicated, however, by the ARPA's February action in cutting the program back to 13 vehicles and cancelling procurement authorizations for all additional Discoverers. Legally, under existing arrangements, funding had to come through ARPA.

Through the CIA, General Ritland arranged an unofficial but effective authorization to continue work on all of the 19 vehicles earlier scheduled. Bissell assured Sheppard that funds were available. On 1 April, [redacted] in "emergency funds" came to hand, drawn from the President's reserve. Of the total, [redacted] was diverted to the CIA to fund additional camera subsystems and [redacted] ARPA to finance re-expansion of "Discoverer." The Air Force scraped up an additional [redacted] by reprogramming, to cover the residual requirement.

A means of effectively throttling Carrousel had to be devised, and it had to be convincing because, as with Program IIA a year earlier, the entirely logical notion of using Discoverers to loft reconnaissance payloads had attracted a swarm of eager devotees. Sheppard concocted the antidote. He sent to Bissell a message which could be transformed into a directive from Air Force Assistant Secretary R. E. Horner to General Roscoe Wilson, on the Air Staff. Wilson would then shape it into a formal directive to BMD. It would (and ultimately did) say that Horner had been briefed on Carrousel early in February, that the cost and risk of Carrousel were incompatible with the gain over established projects (Sentry), and that Carrousel was therefore disapproved. But because of other attractions Discoverer was to be extended to include 25 flights lasting through 1960 and sufficient funds were available.

On 27 April, Air Force headquarters officially instructed BMD to undertake the 25-flight Discoverer program. The ARPA directive legally required to authenticate such an expansion was issued on 20 May, thus closing the circle.

The process had taken nearly six months and had been consistently marked by a high rate of program confusion. Although Corona schedules had since December provided for 20 flights, and thus for a total of 25 Discoverers, the official ARPA directives at various times from January through April authorized 12 Corona vehicles (only eight funded), either three or five biomedical flights, two unspecified payload satellites apparently intended for special ARPA assignments, and an indefinite number of proof-test vehicles. The Air Force knew it would have to pay for either four or six of the 19 "valid" Discoverers, but for several months was unable to learn what ARPA had in mind for the two "unassigned" birds.

The April 1959 program revision, however, effectively authorized the extension of Corona operations into 1960 and in a sense indicated that the covert activity would be a continuing program. And despite the near chaos of February and March, there was no

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indication that the Carrousel episode had compromised Corona security. Thus continuation was feasible.

A final installment in the restoration of complete cover for Corona was an interchange of letters between L. E. Root, Lockheed vice president, and General Schriever. The maneuver was planned in March as a means of satisfying curiosity that might have been aroused both in BMD and in Lockheed by the Carrousel proposal. The letters, classified Secret, handled through "normal" security channels and seen by any number of people at both sites, would in the normal course of events provide a "Secret" explanation for some of the peculiar aspects of the Carrousel episode.

Root's letter, dated 7 April, opened with a reference to "recent conversations" and the fact that the Sentry program was relatively well known in industry as a readout effort. Root remarked that he had been approached by several concerns proposing recoverable photographic payloads for Discoverer capsules for the 1959-1960 period, before Sentry became available. What, he asked, should be Lockheed's position?

By the time the BMD reply was ready, General Ritland had replaced General Schriever as commander. Ritland, in a letter that had been widely "coordinated" within BMD, said BMD had also

[redacted]

been approached, had arranged a quick reassessment of the Discoverer reconnaissance potential, and had learned that it would take too long to get results through Discoverer reconnaissance. He explained that available cameras were too heavy, that test schedules would not permit early introduction of photographic payloads, and that ". . . the Discoverer . . . already has too many complications of a sensitive nature without adding the probably unsolvable complication of a reconnaissance mission."

By all indications the letters served their intended purpose. (There was a last-minute scramble to advise Dr. Land of Polaroid, who had been listed as head of a nonexistent "re-evaluation committee," that his name was being used as the authority for the impracticality of Discoverer reconnaissance. Otherwise there were no important complications.)

By mid-1959, then, Corona had been established, its technology applied to actual equipment, its cover perfected, and its tenure extended into the future. The next task was to prove out the actual system through orbital operation, recovery, and utilization of the photographic product. That assignment, originally and optimistically scheduled for completion by mid-1959, occupied the attention of program managers for the next 18 months.

The Flight Program

The first attempt to launch a Discoverer satellite, on 21 January 1959, was aborted by the premature ignition of the accessory rockets on the upper stage. The second stage vehicle was severely damaged and the Thor so affected that it had to be withdrawn for major overhaul.

Discoverer I--actually the second scheduled flight vehicle--left the Vandenberg launch pad on 28 February 1959 and successfully established an orbit with an apogee of 605 miles and a perigee of 99 miles. Although somewhat more eccentric than planned, it represented success. No capsule was carried and no recovery attempted.

Discoverer II was also reasonably successful in establishing orbit following its 13 April launch. Unhappily, a malfunction in the satellite's timer caused the capsule to be ejected halfway around the earth from the planned recovery zone. It descended near Spitzbergen. Although the Air Attache in Norway (aided by an eager BMD officer who quickly flew into Oslo) made a thorough search of the probable descent area, no sign of the capsule could be found. The searchers did sight signs of ski traffic in the impact zone, however, and some of the more impressionistic program personnel concluded that the first capsule to reenter from orbit had been captured by a Russian mining party. (For several months, Discoverer personnel had haunting fears that the Soviets might "surface" the Discoverer II capsule in the midst of an American publicity campaign that featured a subsequent recovery.) If such had indeed been the fate of the Discoverer II capsule, it did not gravely disturb Corona managers; the missing capsule had carried "mechanical mice," electronic devices rigged to record biomedical effects data.

Discoverers III and IV, launched on 3 June and 25 June, failed to reach orbital velocities because Agena thrust did not meet expectations. The 3 June flight carried another biomedical payload, but the 25 June vehicle contained the first of the Corona cameras. Because of the failure to orbit, no data on camera operating characteristics were obtained.

Predictably, that succession of partial successes and failures touched off a flurry of alarm in CIA and White House quarters. Immediately after the 25 June failure, BMD advised CIA that no further launches would be attempted until a thorough evaluation of the upper stage difficulties had been completed. Special consultants from [redacted] were called in to assist.

By early August, the upper stage propulsion and control systems were slightly changed, as were computer settings. Concurrently, the Thor's fuel was altered. Later that month Discoverers V and VI were sent into orbit. In both instances (13 August and 19 August), the Agena upper stage functioned properly but the recovery sequence was in some fashion abnormal with the result that neither capsule was recovered. Discoverer V capsule was injected into high orbit because of improper positioning when reentry sequencing began. Nicknamed "Lonesome George," it circled the Earth in lonely splendor until 11 February 1961. For the purposes of the Corona program, the inability to recover was no more disappointing than the fact that telemetry clearly showed camera failure to have occurred on either the first or second revolution of the Earth in each instance.

At that point, BMD halted the launch program once again to permit a new analysis of the recovery capsule failures. A succession of exhaustive ground tests, involving both the capsule recovery subsystem and the camera subsystem, lasted well into October 1959, when it seemed feasible to resume launchings. The analyses had revealed several areas where technical weaknesses existed: (1) the reentry subsystem was being exposed to temperatures lower than those for which it had been designed; (2) insufficient electrical power was being provided to the re-injection squibs; (3) telemetered information was insufficient to establish the point of reentry system failure;

(4) it had been impossible to track the reentry vehicle until parachute deployment occurred; (5) data on the capsule separation sequence was imprecise; (6) the reentry capsule had marginal stability characteristics; and (7) telemetry did not adequately indicate the precise pitch angle of the Agena vehicle before capsule separation. The first flight items modified to correct such deficiencies left Lockheed for the launch area in late September. Subsequently, ground tests revealed that the spinup rockets had been deficient in quality, and those originally installed had to be replaced.

One additional change of significance resulted from the August 1959 failures. Conceding that Corona operations were being conducted in a high risk environment and under a high risk philosophy, BMD began a long-term instrumentation and analysis program as insurance against further failures. Although quick success would negate the usefulness of such a procedure, BMD felt it justified.[redacted]

Lockheed acted also to increase the electrical power output of the satellite batteries and to instrument the recovery capsule much more elaborately than had initially been thought necessary. In part, this was the consequence of the report by a special [redacted] study group which on 8 September seriously urged that the program be halted to permit additional engineering refinement of the Agena and the recovery capsule. It appeared both to the [redacted] specialists and to the BMD program managers that Lockheed had been overconfident and that the Agena-plus-capsule section was not instrumented adequately. Lockheed, in the words of one scientist, had not "instrumented for failures."[redacted]

The next two Discoverer flight trials, on 7 and 20 November, were as disappointing as their predecessors. Discoverers VII and VIII both experienced subsystem failures which prevented recovery of the capsule. And in neither instance did the camera system function properly. The Ballistic Missiles Division again suspended flight tests.[redacted]

Not until February 1960, after two months of intensive corrective engineering, were the launchings resumed. Unhappily, neither of the boosters used in the February flights (Discoverers IX and X, 4 and 19 February) functioned properly and in neither case did the Agena go into orbit. Some additional complications were provided when it proved necessary to destroy Discoverer X during its climbout, showering portions of Vandenberg Air Force Base with assorted residuals of the flight vehicle. Special security precautions were quickly enforced to protect the shards of the <u>Corona</u> camera section from compromise.[redacted]

[redacted]

Although there was little reason for optimism at that point, BMD nonetheless continued to insist that the program would eventually be successful. In January, the production and flight schedules had been expanded by four additional vehicles to accommodate the newly approved Argon mapping camera program, an Army-sponsored covert effort, raising the total of approved Discoverer launchings to 29. (Of these, 20 were to be Corona flights, four Argon flights, and the remainder biomedical and test vehicle flights.) CIA middle management, vastly discouraged both at the flight vehicle failures and the parallel camera subsystem failures, was by March again discussing the advisability of cancelling all Corona requirements in the Discoverer program. Colonel P. E. Worthman, the Air Force Corona manager, suggested that it was yet too early for a wake and reminded the agency that in their time the Atlas, Thor and Titan had all faced down demands for cancellation. BMD, said Worthman, had come to anticipate a panic response to development problems that probably were inevitable, at least in a program so rushed as was Corona.

On 15 April 1960, Discoverer XI went into orbit but the recovery system again malfunctioned. The failure was particularly disappointing because telemetry indicated that for the first time the camera had functioned perfectly, all 16 pounds of film passing through the subsystem into the recovery capsule. One product of the recovery failure was a personal message from the Air Force Vice Chief of Staff to Lockheed's president urging "extraordinary corrective actions" and the personal attention of top Lockheed management to the elimination of defects in the system. Lockheed's response was to propose a further round of tests in environmental chambers plus diagnostic flights in which the capsule would be specifically instrumented for recovery system telemetry.

Discoverer XII, carrying diagnostic instrumentation, climbed away from the Vandenberg launch stand on 29 June 1960, but only briefly. Erratic horizon scanner operation had caused a nose-down position during separation of the Agena from the Thor booster. In this instance, no substantial delay in the next scheduled launch was imposed although a brief halt permitted modification of relatively minor components. Once again, however, some CIA personnel revived the suggestion that the low reliability of Discoverer was cause for cancelling any further effort on Corona past the scheduled 1960 flights. Bissell, who continually fought for program continuance in the face of such odds, felt that the best course probably would be to concentrate on recovery subsystem perfection and to accept any recovered film as a program bonus rather than as an objective.

Two circumstances quite outside the Discoverer-Corona program made the situation unusually difficult during the summer of 1960. The first was the 1 May capture of a U-2 reconnaissance aircraft well inside Soviet boundaries and President Eisenhower's prompt cancellation of further U-2 operations. The second was the approaching maiden flight of the first Samos (former Sentry) reconnaissance satellite, scheduled for September-October. There was a general feeling in the Air Staff that Corona was a "poor man's" system which had slight prospect of achieving any real results. Weight limited by the thrust of the Thor booster, the Corona system was considered a relatively handicapped competitor to the Atlas-boosted Samos. Additionally, early Samos flights were intended to provide some demonstration of the effectiveness of a readout system which, if successful, presumably would eliminate concern for complicated recovery techniques. Finally, the high magnification camera (E-5) being developed under Samos in the late summer of 1960 was integrated with a recovery system considerably more "sophisticated" than that of Corona in several important respects. On the whole, therefore, Samos offered a convenient alternative to Corona and one which gained in attractiveness as Corona difficulties persisted.[redacted]

Because of such factors, the launch of Discoverer XIII on 10 August 1960 took on added importance. The second of the diagnostic flights programmed into Discoverer had become a hinge on which the fate of the future program possibly depended.

Launch, orbit, capsule separation, and reentry were near perfect. Although confusion among the C-119's in the impact area prevented aerial recovery, the capsule was retrieved from the water 94 miles south of its predicted descent point. On the morning of 12 August, Major R. J. Ford of the BSD Corona office sent a terse message across the cryptographic lines to Washington: "Capsule recovered undamaged." It was both the shortest and the most important of the thousands of communications over that network in the previous two years.

Return of the capsule to the mainland and its ultimate disposition were supposed to conform to a pattern laid down 18 months earlier. The plan called for capsule delivery to a courier from BMD, the courier's return to California by commercial airliner, and the surreptitious exchange of the container for a dummy shortly thereafter. The nominal capsule container would go to Lockheed by a rather obvious route, while the real capsule (repackaged so as not to resemble the original) left Sunnyvale, California, in an unmarked truck for covert shipment to the processing facility at [redacted] Examination of the real capsule would certainly disclose that it included a film entry aperture, so its concealment from all non-Corona personnel was vital if the cover was to be maintained.

Although Discoverer XIII had no film aperture and carried neither camera nor film, being fully occupied by instrumentation and telemetry equipment essential to the diagnostic mission of the flight, the recovery process was scheduled to be a full-scale dress rehearsal for handling of a "hot" capsule. But after the capsule and its courier reached the mainland, the affair began to resemble a very bad melodrama. The courier disregarded his instructions and, shouldering aside frantic protests from alarmed Corona participants, took the capsule directly to ARDC headquarters for presentation to General Schriever. Along the way, the courier ignored previous agreements concerning the handling of the capsule, having "unofficially" acquired the special tools needed to open it, and apparently tampered with the inner container. Lockheed engineers, who ultimately got the container for examination, were unable to tell whether breaks in the capsule skin had resulted from the unauthorized tampering or had been caused by reentry and recovery shocks. Since no film had actually been enclosed in the Discoverer XIII capsule, no long-term

[redacted]

harm resulted. But the Corona group at BMD, after expressing eloquent distaste for the courier's peculiar behavior, promptly revised the courier selection process.

Discoverer XIV, launched on 18 August, paralleled the performance of its predecessor in most important respects. Additionally, it carried a Corona camera, and the camera worked perfectly. Although the Agena had less than optimum pitch-down angle at the time of capsule separation, and the capsule actually descended 430 miles south of the predicted impact area, the C-119's were on hand to complete a smooth aerial recovery--the first in history. And, this time the capsule handling process followed plans. After an overt return to Moffett Naval Air Station, the capsule was switched to the unmarked container and sent to [redacted] for final processing of the film. The fact that press photographs of the XIV capsule were forbidden was explained by citing the need for close examination of the instruments before they had been disturbed. (In the instance of Discoverer XIII, the courier had actually told a newspaperman friend of his planned itinerary, thus making photographs almost inevitable.)

Initial reaction to the film from XIV was unbridled jubilation. CIA told Colonel Worthman the photo interpreters had called it "terrific, stupendous," and had confessed "we are flabbergasted." Worthman's conservative report to General Ritland was that "apparently design specifications on resolution have been met . . ." The photographs were of "very high quality," and as a bonus it developed that at least half of the frames exposed over the Soviet Union were clear of cloud cover.

Detailed analysis of the XIV results showed that 3000 feet of film had been recovered--essentially all of the 20 pounds stored in the cassettes. Something in excess of 1,650,000 square miles of Soviet territory were laid out for the photo interpreters. Resolution was conservatively estimated to be 55 lines per millimeter, and ground objects ranging upwards from 35-foot dimensions were identifiable.

The drought was over. Although two failures to recover and one camera breakdown kept the next batch of "take" from photo interpreters until the recovery of XVIII capsule on 10 December 1960, there was no longer any question of the feasibility of any major element of the Corona operation. Discoverer XVIII, moreover, had carried an improved camera--C', called "C-prime"--and nearly twice the weight of film recovered from XIV. It remained in orbit three days rather than one, provided roughly twice as much coverage (3,800,000 square miles), gave 20 percent better resolution (65 lines per millimeter for

XVIII as opposed to the 55 of XIV), and the recovered frames permitted identification of some ground objects only 25 feet on each side.

What remained was to improve the equipment and the product still further. It had taken nearly two years to progress from first flight to useful intelligence, but in those two years significant changes both in the technical and the program status of Corona had occurred. Moreover, during the critical months of 1960 when the Corona program finally passed the "make or break" point, a variety of new factors had completely altered the character of the national satellite reconnaissance program.

There was no doubt, however, that the crisis had been passed. The circumstance of a successful passage was due largely to the intelligent perserverance of a few key individuals who never lost faith, whatever the momentary discouragements. Chief among these was CIA's Bissell, whose intervention at White House levels was vital during those periods when flight failures were prompting frequent suggestions that everybody concerned should forget all about Corona. The program managers at BMD kept their enthusiasm high--at least for public consumption--but it was Bissell who took the brunt of Presidential displeasure and whose calm assurance in the face of recurrent failures meant program continuance. On the Air Force side, the determination of the successive Corona program directors, Colonels Sheppard and Worthman, kept the effort alive in the face of general degeneration of confidence at higher levels. And more than any other individual, Lieutenant Colonel C. L. Battle, Discoverer Program Director, kept engineering efforts on the right course and at the proper pace.

*** NOTICE OF REMOVED PAGES ***

Pages 103 through 110 of CORONA, ARGON, LANYARD programmatic information are not provided because their full text remains classified.

III THE MATURATION OF CORONA (1961-1972)

Between 21 January 1959 and 18 August 1960, 15 satellite missions were attempted under the program title "Discoverer." The general public was told they were research and development flights intended to investigate the feasibility of orbiting, operating, and recovering several vaguely identified scientific payloads. The intelligence community most sincerely hoped that the Soviet Union believed that fable, because the entire "Discoverer" program was really an elaborate facade covering the development and initial operation of an interim reconnaissance satellite called Corona.

The Corona program had been conceived in response to the perceived urgency of satellite reconnaissance at a time--late 1957--when there was slight near-term prospect of obtaining useful intelligence from the highly structured, unduly ambitious Samos satellite program of the time.

Whether the Russians believed that Discoverer was pretty much what it was publicly represented to be remained an intriguing question, withal one that had transient importance. The Russians may have had "inside" intelligence by way of conventional espionage, of course. In that case the question would appear to be irrelevant. Any hard information about the intelligence function of the Discoverer program would be consistent with bits and pieces of data the Soviets had accumulated between 1956 and 1960--in particular, whatever they retrieved from American reconnaissance balloons (Project Genetrix) between 1954 and 1956, and from the Powers U-2 in May 1960. By nature, the Russians would be inclined to suspect intent; any surreptitiously obtained intelligence data would have confirmed purpose; and the photo systems they had earlier captured would have clarified feasibility. Suspicion of intent and knowledge of capability might be enough, even without supporting intelligence.*

But it also seems possible that an intensive analysis of American purpose and capability might have induced the Russians to accept Discoverer at face value, at least in its early years, and perhaps even through much of the 14-year Corona program. First, it was by no means obvious that the U.S.--or anyone else--could actually build and operate a useful satellite reconnaissance system based on the Thor-Agena booster-spacecraft combination and 1958 camera-system technology. Compared to other systems earlier proposed, Corona was tiny. The camera weighed only 92 pounds, and the entire payload including film,

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* American intelligence estimates are often based on assumptions of intent and postulations about capability. It is only reasonable to credit the Soviets with similar habits.

only 53 more. High resolution photographic systems were notoriously heavy. Soviet intelligence analysts could very reasonably have concluded that Discoverer was intended to test the feasibility of various reconnaissance subsystems, perhaps even a limited capability prototype camera, but they would not necessarily conclude that Discoverer was an operationally useful system in its own right.

A second factor of some importance was development style. All the available evidence would suggest to the Soviets that the preferred, almost exclusive strategy for United States military systems development was the massive-resource approach applied to other widely known programs--including Samos. The style of Corona development was the complete antithesis of normal U.S. practice. It was relatively cheap; limited resources and relatively few people were involved in its development, and notwithstanding its extremely clever design it was a rather conservative extension of the existing state of the art. No other important American program of the time had those attributes, and certainly no other military space program. (Knowledge of the almost pathetic Vanguard and Explorer programs of 1957-1960 could not but reinforce the assumption that "simple" American space systems were likely to be unimpressive in performance.)

Capability was a third factor. Although they had undamaged <u>Genetrix</u> camera systems to examine at leisure (and, after May 1960, the U-2 cameras), and had taken over most of the German optical and camera industry at the end of World War II, the Russians nevertheless appeared to be well behind the U.S. in that area of technology as late as 1965. <u>Corona</u>, despite its small size, was an extremely capable system. Its performance surprised even those who built it and system performance improved spectacularly once the early problems of <u>Corona</u> development had been overcome. From the Soviet viewpoint, orbiting a camera system limited in weight by the payload capacity of the Thor-Agena combination could well have no operational significance. It would have been counter to good sense, as the Russians saw it, to have invested in so unpromising an undertaking; they might logically have concluded, therefore, that the Americans would not.

Finally, there was the apparent nature of the Discoverer program. It was one of several "minor" space programs hastily composed in response to the stimulus of Sputnik late in 1957. The main thrust of the American reaction to Sputnik was to pour larger resources into the development of much publicized missiles and military satellites--principally Atlas, Thor, and Samos--and to invest in other systems with little but "image" value. Space launches were widely publicized;

many were failures. Administration officials, legislators, and military spokesmen concerned about a response to the Soviet "space threat" typically emphasized the major programs, including Samos, and depreciated such "irrelevant" programs as Discoverer, Explorer, Echo, and Pioneer because they had no evident military utility. Most really believed that to be true. Given the notorious American habit of publicizing the goals, status, and (often) the details of major military programs, however sensitive, the Russians might well have considered any departure from that pattern so uncharacteristic as to be incredible. Occasional European press references to Discoverer as a "spy satellite" signified little except that speculation was an entertaining diversion. A great many Americans who were privy to the inner workings of the U.S. space effort between 1958 and 1964--or thought they were, having apparent access to most of the classified details--never suspected Discoverer to be other than what it pretended to be. The more one knew about the inner workings of the U.S. R&D process, the less likely he was to suspect that a <u>Corona</u> program could ever be conducted.

Perhaps the Russians were similarly misled. The question was not likely to be answered for a great many years. But in any event, if the Russians were not completely convinced of the innocent nature of "Discoverer," they must have taken considerable comfort from the thoroughly discouraging progress of the program during its first 18 months. Of 15 attempts, only two missions proceeded more-or-less successfully from launch through capsule recovery. And only one of the recovered capsules contained film; the other actually was an engineering development satellite.

The first firing ended in a launch pad explosion and the destruction of booster and vehicle. (No recovery capsule was part of either of the first two attempted missions; both were what they pretended to be, experimental flights.) The second launch was successful. It was therefore called "Discoverer I," a semantic evasion that papered over the initial launch failure so artfully that the unsuccessful operation was forgotten by virtually everybody. The operation called Discoverer II, really the third in the series, included a recovery capsule but no camera or film--which proved fortunate, because the capsule apparently reentered somewhere near Spitzbergen, Norway. The inability of a retrieval team to locate the capsule convinced some suspicious observers that it had been purloined by the Russians, although the evidence supporting that conclusion was slight and tenuous.* In any case, although

* The purported ability of mission analysts to predict the impact points of reentry bodies that came down far from planned recovery zones was highly regarded, notwithstanding a consistent lack of success over

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stealing it would have been a Soviet triumph of sorts, and the retrieved data certainly could have been highly useful to the Russians, the lost capsule represented no real threat to the security of Corona. It actually contained the instrumentation devices represented to be its payload, a circumstance that was true for only three of the remaining flights in the first 15 Discoverer missions.

In six of the ten mission attempts that followed Discoverer II, the Agena spacecraft failed in one mode or another. The other four were marked by assorted malfunctions of film transport, orbiting vehicle, or reentry system. All ten were failures.

Discoverer XIII carried a diagnostic payload rather than a camera, an expedient forced on the program by the continuing mission failures. Its capsule was recovered on 11 August 1960. Various aspects of the flight were marred by minor difficulties, and the capsule itself had to be retrieved from the water because of confusion among aircraft sent to catch it during its final parachute descent.

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several years in efforts to locate a variety of misplaced reentry items. Toward the end of the 1960s and early in the 1970s, bits and pieces turned up thousands of miles from impact points predicted on the strength of good tracking data. One such case involving Corona is discussed later in this chaper. In another case, pieces of a [redacted] vehicle purported to have come down in central Africa were found on farmland in southern England. Such developments tended to support the comforting assumption that neither the Russians nor anybody else had found the missing Discoverer II capsule.

[redacted]

Nevertheless, it was a program success--the first of any significance. It was also the first orbital object to be retrieved from space--by anybody.*

One week after Discoverer XIII was recovered and returned to Washington (to the accompaniment of enormous publicity that caused the carefully arranged cover plan to come apart), Discoverer XIV was launched. (It actually was the fifteenth in the Discoverer series and the ninth to carry a <u>Corona</u> camera.) Launch, orbital operations, and retrieval were highly successful, both as compared to earlier efforts and in terms of fulfilling formal mission plans. The retrieved capsule provided the first reconnaissance photographs of the Soviet Union ever taken from orbit. When interpreted, they put to rest the persistent legend of a "missile gap" and the 1958-1960 apprehension that numbers of Soviet intercontinental ballistic missiles were emplaced and targeted on the United States.**

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* Unless, of course, the Russians <u>did</u> find Discoverer II!

** In an episode reminiscent of nothing so much as the 1944 presidential election, when Thomas E. Dewey was constrained by wartime security from making potentially devastating revelations about Pearl Harbor, Richard M. Nixon in 1960 was constrained from revealing that the "missile gap" on which John F. Kennedy had earlier campaigned was an illusion. The Discoverer XIV payload was retrieved, and its intelligence information digested, two months before the 1960 election campaign ended. Kennedy, who was also aware of the mission results, stopped talking about the missile gap thereafter. But some of his

In December 1960, the 13th Corona mission was conducted as Discoverer XVIII. An unsuccessful recovery, a launch failure, and a camera mechanism failure marred the three intervening missions. The film recovered from "Discoverer XVIII" dispelled all residual concern about a Soviet lead in the deployment of intercontinental missiles and provided the basic hard intelligence around which incoming President John F. Kennedy and his defense secretary constructed their massive overhaul of U.S. defense priorities, goals, structures, and management processes.

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supporters did not, and Nixon's indirect assertions that there was no missile gap had no real impact because he had been saying as much earlier, when nobody really knew, and because he had subsequently adopted the policy of promising to enlarge the U.S. missile program in much the way Kennedy proposed. In later years, when the August 1960 findings became more widely known, there was surprisingly little discussion of the potential change in election results that might have occurred if the truth had been revealed.

C' to Mural

"Discoverer XVIII," the thirteenth Corona, carried an improved camera system known as C' (and, of course, called "C-Prime" in discussions). Both the original "C" and the subsequent C' had lenses with f/5.0 maximum apertures and 24-inch focal lengths. C' embodied structural and engineering changes that somewhat simplified the camera system and also returned a ground resolution averaging about 35 feet, as compared to the nominal 40 feet of the original C camera. The original C camera, flown on the first 12 Corona missions, produced the images recovered in August 1960. It saw no further operational use.

The C' camera had begun development in mid-1959 and had been adopted by the time a second Corona capsule was recovered, in December 1960. It was used on all subsequent Corona operations until the newer C''' ("C-triple-prime") camera replaced it on the 29th Corona mission, in August 1961. Three additional flights with C' cameras followed, interspersed with three additional C''' systems. By February 1962 the combination of two C''' cameras in a single Corona-Mural system was ready for use and thereafter all Corona missions incorporated stereo capability.

Between the appearance of C' and its eventual replacement by C''', there occurred rather more than six months of debate about the

[redacted]

merits of two competing approaches to an improved Corona. Disagreement about what was needed was compounded by uncertainty about the necessity of investing additional funds in any further improvement of Corona. In 1960 the reconnaissance community still held pretty generally to the assumption that the E-1 and E-2 readout systems would become available for operational use in 1961 and 1962; the E-2, in particular, promised to provide resolution somewhat better than that of Corona C', but with the further attraction of having near-real-time data accessibility through readout. Additionally, the E-5 stereo system, a recovery system with potentially much greater resolution and area coverage capability than Corona, was progressing toward flight and--nominally--toward a 1962 or 1963 operational readiness date. In late 1960 both E-6 and [redacted] entered development, and while neither was in any sense a Corona replacement, it was widely assumed that the combination of any of the high-resolution film recovery systems with one or both of the readout systems would almost surely make Corona redundant.

Such reasoning was predicated on the plausible assumption that the various Samos camera systems would reasonably well satisfy performance, cost, and schedule expectations then current. Nevertheless, there was some justification for improving Corona so as to enhance the quality of satellite photography during 1961; E-1, the only Samos sytem certain to be available that year, had only about 100-foot resolution capability. Yet neither large investments nor high risks seemed warranted, even though some members of the Corona project group, and others in the satellite reconnaissance community, had healthy doubts about the validity of expectations for the several Samos systems. Finally, of course, there was the irrepressible instinct of the firms who were supplying Corona systems to propose advancements and improvements that might extend the period of Corona production and use.

Both Itek and Fairchild Camera and Instrument Company had been involved in Corona from its start. They were not, on the whole, cheerful collaborators. Each would have preferred to be the sole supplier. Each, therefore, proposed modification of the C' camera in early 1961. Itek advocated a major redesign of the optics and a substantial modification of other aspects of the C' camera as a means of improving both resolution and reliability. Fairchild, then a component supplier to Itek but earlier a competitor for the entire Corona camera system, urged a different approach, suggesting retention of the original lens and image-motion-compensation system but with alterations that would result in the substitution of five-inch film for the three-inch

(70 millimeter) film then used. Both were responding to urging from the Corona program office to provide an improved Corona capability for use in 1961. Both proposals were referred to as C-61 or C'' systems, on the assumption that one would be chosen and would carry that designation.

Independent assessment of the two approaches was initially unfavorable to the Itek concept; the Aerial Reconnaissance Laboratory at Wright Field concluded that the Itek design was too complex and too advanced to be reliable, while Lockheed judged (on much the same ground) that although neither Itek nor Fairchild had a fully acceptable design, the Fairchild design was more promising. In consequence, a cautious start on the Fairchild system was authorized.

Eventual adoption of the Fairchild design would probably have resulted in a Corona resolution improvement on the order of that experienced in the transition from C to C' --about 15 percent. Such modest goals were abandoned in the wake of the first successful Corona operation in August 1960 when President Dwight D. Eisenhower sat through a private showing of the first recovered photography and, in the discussion that followed, heard Dr. Edwin Land, one of the early sponsors of the Corona program (and a determined advocate of the Itek approach), forecast that a 100 percent improvement in the quality of Corona photography could be achieved within six months. Impressed, Eisenhower authorized him to act on that premise and subsequently confirmed Land's authority in correspondence with Allen Dulles and Richard Bissell (then, respectively, director and deputy director of the CIA).

The basis of Land's optimism was exposure to an updating of the earlier Itek proposal, the largest change being the inclusion of a faster lens (f/3.5 rather than the f/5.0 of the C') and simplification of the system in lieu of some of the comprehensive structural changes earlier suggested. The great potential for improved resolution lay in that the faster lens could be used with slower and finer grain film than had been required for the earlier f/5.0 lens system.

With Eisenhower's endorsement in hand, Dr. Land proceeded to Boston and authorized Itek to proceed with development of the proposed camera. Both Bissell (who had learned of Eisenhower's action after the fact) and Colonel Paul Worthman, the Air Force project chief for Corona, had reservations about Itek's ability to carry out the promises implied by the proposal Land had endorsed, but in the event all they could do was to urge that additional C' camera systems be purchased against the danger that delivery of the new Itek system might be delayed.

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Earlier orders for long lead time items needed to proceed with the Fairchild C'' camera were cancelled late in September 1960, and three additional C' cameras were ordered to protect launch schedules against slippages that might be caused by any delay in the Itek program. The prospective bill for development of what was by then called C''' came to [redacted] the three "reserve" C' cameras cost about [redacted] each. About [redacted] was retrieved from the cancelled C'' development. Because previously programmed Agenas and Thors would serve all probable C''' and C' needs, no additional vehicle costs were immediately incurred.

As generally happened in such affairs, the original estimate proved to be understated; by February 1961, Itek was estimating an increase of about [redacted] in basic costs and had reduced the quantity to be delivered from 11 cameras (including three test items) to eight (including two test articles). CIA program monitors expected the eventual costs to be more nearly [redacted] for cameras than the [redacted] Itek had first estimated. And in the end the CIA was nearly right.

As delivered, the C''' camera and its faster lens system effectively performed the improvement originally promised, though not with complete initial reliability. But the faster optics in combination with slower film and improvements in image motion compensation schematics did have the effect of reducing image smear and improving resolution, though to some extent that improvement also reflected the incorporation of a flexible platten and revolving optics (in lieu of optics that swiveled back and forth). Fabrication changes resulted from the use of new structural materials, and the elimination of skewed film rollers with the introduction of air twists for turning the film as it moved from storage to take-up cassettes, vastly simplified the film transport operation. Nevertheless, C''' occupied the same space and used the same cassettes as C'. The combination of improved film, better equivalent shutter speeds, more effective image motion compensation, and larger maximum aperture improved ground resolution to an average 20 to 25 feet[*] (from about 35 feet for C').

In the interval between the successful recovery of a Corona capsule on 10 December 1960 and the next following operational success, a water pickup on 18 June 1961, four mission failures of various origins and two "Discoverer" launches with other than Corona payloads had occurred.

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[*] Resolution figures used here are those generally cited for "ground resolution" of the complete system. Under ideal conditions the C and C' cameras were capable of reproducing 100 to 130 lines per millimeter on the film, representing a 14- to 17-foot lens-film resolution, and a system resolution of 19 to 22 feet. The C''' had a lines-per-millimeter capability of 180 to 200, a 7-foot to 9-foot camera-film resolution potential, and a 10- to 12-foot system resolution potential. Corona-M,

The first 26 "Discoverer" mission attempts* included eight operations without camera payloads. Of the 18 that actually represented attempted Corona and Argon operations, three returned film properly exposed over the Soviet Union. The 26 Discoverer (or 15 Corona plus 3 Argon) missions extended over a period of almost precisely 30 months. Although the ratio of Corona successes to failures seemed appallingly bad by later standards of reconnaissance program achievement, and Argon was a disaster, the three successful Corona missions provided an enormous fund of intelligence information useful to the United States (about nine million square miles of coverage) and the Discoverer program was the vehicle by which the nation made its first spectacular advances in space technology.

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in similar terms, had about the same lines-per-millimeter capability but because of its convergent stereo configuration would nominally provide from 3.5- to 4.5-foot camera-film resolution and 6- to 7-foot system resolution. In practice, the "ground resolution" for Corona-M in its original configuration was from 12 to 17 feet, although some individual camera systems were not that capable. The gap between "system resolution" and "ground resolution" was largely a reflection of smear effects, contrast and sun angle phenomena, and performance anomalies characteristic of individual camera systems.

* Most program records show 25 Discoverer operations by the end of June 1961. As noted earlier, there were 26, counting the vehicle destroyed by a launch pad explosion on 21 January 1959. That operation is sometimes listed as Discoverer 0; the vehicle successfully launched on 28 February 1959 was called Discoverer I.

[redacted]

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The successful recovery that marked mission 1007 (18 June 1961) signaled the start of a far better record. Counting that flight, seven successful capsule recoveries in 13 missions marked the remainder of 1961. One of the failed missions carried Argon equipment (that singularly unfortunate system thus experiencing its fourth successive failure in four attempts), so in effect there were five Corona mission failures and seven successes. Half of the camera payloads were in the C' configuration and the remainder of C''' vintage, but three of the five failures involved C' instruments. The Argon failure (21 July 1961) was caused by loss of guidance on the Thor booster, followed by a destruct signal. All of the Corona mission failures were chargeable to one or another of the Agena subsystems. The culprits ranged from guidance through early gas exhaustion to ignition malfunctioning. In three instances, the Agena did not achieve orbit, and in a fourth an Agena power failure precluded separation and recovery of the capsule. No problems attributable solely to the camera system were experienced, and although none of the successful missions was untroubled by difficulty of one sort or another, the returns were extremely good on the whole.

In all, ten C cameras, ten C' cameras, and six C''' cameras were involved in the 26 monoscopic Corona mission attempts. Only one of the C missions returned film, but seven of C' and four of the C''' missions ended with retrieval. (The four Argon failures in four attempts have been sufficiently remarked.) Of the 30 photographic missions that were attempted in the first two years of Corona program operations, 12 were in large part successful; and of the 18 failures, 12 occurred in the first of the two years. If Argon payloads were not counted, the record was quite respectable.

Corona-Mural[*]

The notion of combining two of the original Corona cameras into a stereo system appeared in July 1960, a month before the first recovery of Corona film. Its genesis was discussion among the various contractors and program personnel; its first formal appearance was as a proposal from Lockheed Missiles and Space Division in the fall of 1960. Lockheed suggested using either a C' or C''' camera as each element of a stereo system, boosting the combination into orbit by means of a DM-21 Thor and a modestly improved Agena. C''' was the favored system, even though it had not yet flown in Corona, because the C''' camera was from 5 to 10 pounds lighter than its predecessor, and in Corona weight was always important.

By early 1961 the Lockheed proposal had received the conceptual endorsement of Air Force program managers; in January, Colonel Lee Battle, nominally Discoverer office chief but actually the technical

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* As suggested in a prefatory note for this volume, the term Corona-M will generally be used here to identify that part of the total Corona program identified in documents of the period as Mural and Corona/Mural. Mural was handled and treated as a separate compartment of the satellite reconnaissance effort until February 1962; for a brief time even some of the original Corona participants were kept innocent of knowledge that an improved successor to Corona-triple-prime was starting development. Continuation of that compartmentalization practice proved entirely impractical, of course, once Mural entered the hardware phase.

head of the Corona program, briefed Air Force Undersecretary Joseph Charyk on the notion and received his approval to proceed with initial development. At the time it appeared to Battle that an eight-mission program would cost about [redacted] spread over fiscal years 1961 through 1963. Charyk also squashed a tentative suggestion that the new system should be developed and operated "in the white," although he doubted the feasibility of indefinitely continuing the original management arrangement (a joint Air Force-CIA enterprise, then working very well) and planned to discontinue the "Discoverer" fiction.

Lockheed called the proposed new system "Gemini," to distinguish it from Corona. (NASA had not yet adopted that name for what became the second in the series of manned spaceflight systems developed in the United States.) Lockheed's notion was to conjoin two of the f/3.5 Petzval-lens cameras of 24-inch focal length in a faired module, using two recovery spools in a single recovery capsule (which would weigh 94 pounds plus film weight). The rearmost camera would look forward and the foremost camera backward.

As a way of testing the concept cheaply, Lockheed proposed diverting to "Gemini" the last two C''' cameras then available and using an available C' camera to fly in place of one of the C''' payloads. Theoretically, the "Gemini" combination would return ground

[redacted]

resolutions on the order of about six feet, though few program personnel really believed such results would follow immediately.

In February 1961, in the course of a discussion meeting called by Charyk and his principal CIA associate, Eugene Keifer, the proposal received sufficient support to warrant the selection of a code word designator. The CIA provided a list of eligibles on 3 February, and Mural was chosen. Until that time, project office people had tended to call the proposed system "the Twin Program," rather than "Gemini."

Charyk approved the start of work on six "stereo C''' " systems on 24 February, pending receipt of approval by President John F. Kennedy, who had taken office only a month earlier. The real request for approval went from Charyk to the new Secretary of Defense, Robert S. McNamara, early in March. Charyk observed at that point that the stereo system was needed because even with recent improvements Corona did not distinguish "small" objects with the required precision, and that because the C''' system was relatively well proven (perhaps a permissible exaggeration), the creation of a stereo capability was not "a significant R&D problem."

As formally approved in April 1961, the "C''' Stereo" system (not yet known as Mural) involved the fabrication of one engineering vehicle

[redacted]

carrying C''' cameras originally intended for individual flight and the procurement of five additional sets of cameras to be launched between April and August 1962. In actuality, the CIA had provided initial funds to Lockheed a month earlier, but with the proviso that not more than [redacted] should be spent in what remained of fiscal year 1961. That action proved premature; on 28 March the agency abruptly instructed Lockheed to halt all work on the stereo system. The sudden reversal seemed to have been occasioned by Charyk's objection to the unauthorized and premature expenditure approval and by a general realization that neither specifications nor program structure had been reviewed at the higher levels of the CIA and the DoD. Charyk also had reservations about the agency's unilateral decision that Lockheed would be system manager and Itek an associate contractor, a departure from the arrangement earlier used in Corona. Charyk (with the support of CIA deputy director Richard Bissell) wanted the Air Force-CIA program office, supported by the Air Force Ballistic Missile Division, to act as "system engineering/technical direction" authority. Of course the Charyk-Bissell preference carried the day.

For the moment, Mural was compartmented separately from Corona and only 300 of the 2700 various Corona participants were aware of the details and plans agreed to in the Spring of 1961. Not until

January 1962 were the several agencies involved in Corona all made aware of the improved capability to be provided by Mural, although as early as July 1961 details of the Mural program were made available to senior officials in the National Photographic Interpretation Center, the Army Mapping Service and similar organizations. The mapping service subsequently protested that it had not been adequately advised on Mural matters, perhaps because of a prospective interference with plans to fly more Argon missions. Charyk and Bissell were obliged in February 1962 to emphasize that Mural was in no respect a dedicated mapping system and probably had little application to that function. Apparently the mapping service had concluded that Charyk and Bissell were attempting to monopolize payload control, which was not a fair reflection of the real state of affairs even though Charyk was indeed sponsoring the development of the E-4 system, a nominal alternative to Argon.

The furor may actually have been occasioned by measures leading to incorporation of a framing camera (an Itek stellar-indexing camera system) in the Mural vehicle. The preliminary decision to add that capability came in October 1961 and was formally confirmed the following December. The framing camera provided "a fixed geometric reference to be used in plotting and rectifying the longer

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focal length higher resolution panoramic photographs." It could aid in the construction of maps (as, for that matter, could any mono or stereo imagery), but as Charyk subsequently explained to the Director of the Defense Intelligence Agency, "the framing camera is not and never has been considered as a substitute for the mapping projects such as ARGON . . ." (Much later, the incorporation of a considerably better stellar-indexing camera, DISIC,* gave Corona a mapping capability somewhat superior to that of Argon, but such quality was not available in 1961.) The underlying problem was that the Army (and its executive agent, the DIA) still wanted to develop and operate a satellite mapping system independent of the embryonic National Reconnaissance Office, and any actions that tended to reduce the possibility of such an outcome roused objections from the Army Mapping Service. The subsequent disappearance of Argon's proposed successor (called [redacted] and the cancellation of the E-4 (mapping camera) phase of Samos, even after four cameras actually had been procured and checked out, had the eventual effect of eliminating flights by dedicated mapping camera systems, but that too was still in the future in 1961.

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* Dual-Integrated-Stellar-Index-Camera. DISIC had a 3-inch lens, equal in focal length to that of Argon and superior in resolution, although resolution advantages arose partly in film quality improvements.

Like the original Corona, Corona-M was intended to be an interim, transitional means of satellite reconnaissance. It was conceived as an expedient device for temporarily providing stereo coverage of denied areas, as an instrument to be used until more sophisticated systems then in development could be brought to operational readiness. That, at least, was the view from the upper echelons. In the Corona office, and in Itek and Lockheed project organizations, Corona-M represented an expedient way of providing for the continued production of a successful system, one that might with relatively slight investment be made capable of competing successfully with more costly and complex systems in development elsewhere. Thus as early as March 1962, shortly after the first Corona-M mission, Itek proposed (with CIA sponsorship) an "M-2" (Mural-2) system consisting of a re-engineered Mural with one 40-inch, f/3.5 tube of optics serving two plattens. Itek suggested that the system could provide resolution on the order of four to five feet, a contention that was disputed by [redacted] and Eugene Keifer of Charyk's staff. The M-2 proposal, as such, remained a contender for development until June 1963, when a special panel headed by E.M. Purcell formally advised the CIA that the "M-2" was "not a wise investment" when compared to various alternative ways of improving Corona performance. It did not vanish,

[redacted]

however; in a different guise, Itek's original proposal resurfaced a year later as the genesis of the Corona J-4.*

The assumption that Corona-M would be no more than a stopgap system stemmed from the continued existence of the Samos E-5, intended to be a considerably more sophisticated, higher resolution search system. Unfortunately, E-5 development was frustratingly unsuccessful. The subsequent adaptation of a single modified E-5 camera with stereo capability to a Corona-configured recovery system (as Lanyard) proved generally disappointing. As long as no better system qualified, and while the unquestioned need for search missions by reconnaissance satellites remained, Corona would survive. And it did.

The first Corona-M mission, in February 1962, was largely successful. The auxiliary framing camera did not operate correctly (post flight analysis suggested that nitrogen purging of the payload section during countdown had dried out the framing camera film and that the resulting shrinkage had put too much tension on the film transport system), but results otherwise were quite good. By that time, Itek (the camera contractor) was in the process of assembling the sixteenth and last of the then-scheduled Corona-M systems, delivery

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* "M-2" and other proposals for "advanced" Corona systems are more extensively treated later in this section.

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being due by late June. Payloads had been delivered at a rate of about three a month, and Itek was preparing to assign its Corona-M production personnel to other tasks--or to dismiss them. Corona-M launches were scheduled at intervals of about two weeks through exhaustion of the inventory; reordering, if required, had to be decided by April 1962 in order to avoid interruption in the regime of regular launches.

The then-probable successor to Corona-M was the E-6 payload, the last survivor of the original Samos program. Intended to be an area coverage system with 8-foot to 10-foot resolution, E-6 (also known as Program [redacted] or Program [redacted] had begun development concurrent with [redacted] in October 1960 and was to begin initial operations following an abbreviated set of development flights scheduled to start in March 1962.

The first E-6 launch was conducted in April 1962, and with a frustrating similarity to the experience of the cancelled E-5 program, was marked by indicated success in camera functioning and total failure in recovery. Notwithstanding that beginning, the National Reconnaissance Office (NRO) ordered 19 follow-on E-6 systems early in 1962, augmenting the original order for five systems. But given the signal lack of success in all reconnaissance satellite recovery operations to that time--except for Corona--prudence seemed desirable. Therefore, NRO Director Dr. Charyk also approved an order for six additional Corona-M systems.

The schedules then existent called for one Corona-M and one E-6 system to be orbited each month, starting in July 1962. Together they were to provide about the same coverage as would a two- to three-per-month launch schedule for Corona-M. (The Corona-M system then had typical stereo resolution that ranged from 10 feet to about 15 feet; E-6 was designed to provide 10-foot or better resolution, also in stereo.)

Operational flexibility greater than that implied by the official order book was theoretically provided by the adaptability of the Thor-Agena combination. Although there were in practice some significant differences in interface configuration, and although the Lanyard required boost by a Thor augmented by three strap-on X-33 solid rockets, the basic Corona, Argon, and Lanyard payloads all used Agena stages and Thor boosters. (Late in 1961, the search-function part of the reconnaissance program exploited that flexibility to substitute Corona payloads for Argons initially scheduled--to the extreme distress of the Army's mapping specialists. There had been four successive Argon mission failures between February and July 1961--all of which would probably have been Corona failures had that payload been orbited--and not until May 1962 did an Argon mission end in apparent success. Even then, stellar and terrain camera malfunctions degraded the recovered film.)

The second Corona-M operation (Mission 9032) began with a 17 April 1962 launch and ended in successful recovery of the capsule by air catch on 20 April. The returned film included images of Sacramento metropolitan airport taken from a height of 115 nautical miles. On the prints were impressions that interpreters could identify as runway markings, small civilian aircraft, and automobiles ("just at the detection threshold"). Two-engined aircraft could be distinguished from four-engined aircraft, which encouraged the somewhat optimistic estimate that Corona-M could resolve objects seven feet on a side. [redacted]

Between the initial success of Corona-M in March and the end of June 1962, six reconnaissance vehicles in that configuration were launched from Vandenberg. Of that set, four were successful to the extent that film with intelligence utility was retrieved, although only in one instance did the accessory framing camera operate correctly. A 28 April launch (Mission 9033) ended with failure of the recovery parachute to deploy, and the very successful orbital operations of mission 9036 (3 June launch) were capped by fatal misadventure: one of the extended booms on the aircraft recovery apparatus hit and collapsed the recovery parachute, the capsule fell 12,000 feet into the ocean and sank before frogmen could reach it, apparently because the flotation devices were damaged either by the boom or from the extended fall. Three of the four otherwise successful missions were marked by various malfunctions of the framing camera--a disorder eventually traced to faulty shutter design but initially attributed to a variety of assembly and checkout shortcomings.

In the same period, from February through June, a second E-6* mission was attempted. Orbital operation was erratic owing to an Agena gas leak, fuel depletion prompted a decision to attempt early recovery (at night, on a south-to-north pass rather than the usual north-to-south), and at the end an electrical failure in the squib circuitry kept the reentry vehicle from separating. The Agena and capsule reentered as a unit, some 600 miles north of the planned recovery area. Both were lost.

The third, fourth, and fifth E-6 missions were attempted between 18 July and 11 November 1962. In one instance the Agena would not refire and no reentry maneuver could be conducted, and in the others the recovery system malfunctioned. [redacted] In no instance was film retrieved.

While those unhappy events proceeded, Corona-M extended its record of successful operations to ten, the next mission failure (mission

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* In addition to its earlier abundance of numerical designators--E-6, Program [redacted] and Program [redacted]--the activity had by June acquired the designator Program [redacted]. Although an anachronism, the designator E-6 has been used throughout this section; there is no other way of providing recognition continuity for the reader.

9049, December 1962) occurring from precisely the same cause as its predecessor: parachute damage inflicted by booms attached to the recovery aircraft. Given such diametrically different program results, the consequences were virtually inevitable. [redacted] director of all the photographic satellite programs except Corona, recommended cancellation of E-6. Charyk unhesitatingly agreed.* In consequence, the "interim" Corona-M program became the sole wide area search system in the reconnaissance satellite inventory--or in development. Its string of ten successive "good" missions was not a record of complete excellence, of course. Except for mission 9037, the 22 June 1962 launch, each of the ten experienced some major or minor difficulty. Framing camera failure was the most common. (A new camera introduced late in 1962 largely overcame that source of mission difficulty.) One mission in July 1962 (9039) experienced programmer failure and was forced to early recovery, and another payload orbited in September (9043) stabilized in an unexpectedly high orbit--following a malfunction of a velocity meter--and began to pass repeatedly through the "[redacted]

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* The lessons of E-6 experience were chiefly responsible for the very different way in which [redacted] development was thereafter conducted.

[redacted] flight controllers called down the capsule after 24 hours.* In other respects, and particularly in terms of quantities of highly useful photographs of denied areas, the Corona-M operations were highly successful.

An additional impulse for reliance on Corona-M rather than on the unpromising E-6, or even the attractive but troublesome Lanyard, was the continued evolutionary improvement in Corona capability. By the summer of 1962, the concept of a Corona-J system had emerged, been evaluated, and translated into development and procurement schedules. Corona-J was to be a Corona-M payload with two recovery capsules, separately recovered, and capable of storage in orbit between two intervals of camera operation. (Such inactive storage on orbit was called Zombie operation.) The additional weight created by essentially doubling the film load and adding one complete additional recovery system was to be offset by launching the Agena-Corona combination as the upper stage of an augmented Thor --the booster originally created to provide a launch capability for the relatively heavy Lanyard.

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* [redacted]

The peculiar nature of the Lanyard program and its gradual transformation from a Samos-oriented to a Corona-oriented program was strikingly illuminated by the increasingly frequent references to Lanyard as "Corona-L." The success of selective and evolutionary inbreeding of technology, an example of a highly appropriate development strategy, was marvelously illustrated in the Corona-Lanyard-[redacted] programs. Lanyard, a transform of the Samos E-5 effort, was the occasion for generation of a high-thrust version of the Thor booster and demonstrated that the relatively small Corona recovery capsule could be successfully adapted to the needs of a wide-film, big-optics, photo reconnaissance system. Lanyard was essentially a single-camera stereo adaptation of the first two-camera stereo reconnaissance system to proceed from concept into development; the stereo concept subsequently appeared--with much greater operational utility--in both E-6 and [redacted] before the first operationally successful stereo camera, Corona-M, was proposed. The influence of E-5 and [redacted] concepts on Corona-M was not readily demonstrable but could reasonably be postulated. In any case, the claims of E-5 to primacy in stereo applications were indisputable.

It is not entirely possible to prove that the adaptation of an E-5 (Lanyard) camera to the Discoverer-Corona reentry system prompted later attention to the prospect of similarly converting [redacted] but when

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E-5 and E-6 experience demonstrated the inherent frailties of "big capsule" reentry systems, [redacted] was adapted to the Corona capsule, very probably eluding the unhappy fate of the earlier "big capsule" systems in consequence. Similarly, the feasibility of operating in a double-bucket mode had been extensively demonstrated through Corona-J more than four years before the first double-bucket [redacted] reached its launch stand.

The technique of incremental and sequential development, and of building carefully on a base of demonstrated technology, was epitomized by Corona and [redacted] in their various models, but was also exploited for other satellite systems developed under the aegis of the National Reconnaissance Program in the years before 1967. That experience had a clear and substantial influence on the selection of development strategies for other major defense programs of the late 1960s and early 1970s. In some degree, the NRP experience affected strategy selection because the same senior officials were involved in both NRP and "other defense system" development activities. Drs. Alexander Flax and John McLucas, NRO directors, and David Packard and John Foster, who held the second and third most powerful posts in the Department of Defense, were particularly influential in that respect.

Another influence that could not be acknowledged or cited either in the open literature or in the "normal" security system was the advocacy of development strategies tested in NRO programs by various analysts who contributed to the many studies of alternative system acquisition policies that were sponsored by the Department of Defense between 1967 and 1972. In particular, several major reports from the Rand Corporation, the "Blue Ribbon Panel Report" of 1969, and the findings of the Congressional Commission on Government Procurement (published in March 1973) reflected in varying degrees the conclusions of one analyst who had an opportunity to examine in detail the 10-year record of satellite development by the National Reconnaissance Office. He contributed to the underlying research and analysis and initially voiced many of the findings later stated in the three study activities. In the wake of such studies, DoD altered its accustomed acquisition policies to allow for programs based on incremental, sequential development procedures and the selective exploitation of proven state-of-the-art technology.

Corona-J*

Although Corona-J had not been formally approved for development until October 1962, the CIA in July 1962 authorized Lockheed, as the prime contractor, to proceed with preliminary engineering design of the system. (Itek's work had been separately covered.) Approval for fabrication and long lead-time procurement reached Lockheed in November, still in advance of the final contract. At that point, first launch was planned in May 1963 with a one-per-month initial launch rate following, but with provisions for a two-per-month rate starting as early as July 1963. That rather short schedule was made possible by the expedient of converting previously built Corona-M systems to the Corona-J configuration. Formal notification of the imminence of Corona-J operations reached NPIC, the CIA, and the USIB's Committee on Overhead Reconnaissance early in December--by which time it seemed clear that first flight would occur in "early summer" rather than May 1963.

The rationale for the Corona-J program was heavily dependent on assumptions about the utility of Zombie-mode operations. Effectively,

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* Corona-J consisted of a thrust-augmented-Thor, an Agena D, two modified Mk Ia recovery systems, and a modified Corona-M camera. In effect, a Corona-J mission provided a capability of performing two Corona-M missions at the cost of one booster, one Mural camera system, two reentry vehicles, and two stellar-index camera installations (one for each capsule).

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the mission plan was to use the system in a four-day mission, recover the forward capsule, and program the remaining on-orbit elements for a "controlled tumble" of as much as 20 days, with electrical power and stabilization control gas closed off. At the end of the period of inaction, but one day before further reconnaissance use was planned, controllers would reactivate the satellite for a second four-day period of photography. Some 15,000 feet of film were carried for each of the four-day periods of operation.

Although the first of eight 1963 Corona-J missions was originally scheduled for May 1963, launch did not actually occur until August, a delay only partly chargeable to difficulties of payload development. A rash of problems with the Agena in both Corona-M and Lanyard programs and a launch failure in the first attempt to use the TAT (Thrust Augmented Thor) booster caused a sudden and alarming interruption of intelligence returns from satellite overflights during the early months of 1963. The first two Lanyard missions failed because of Agena breakdown and the third experienced a camera failure after only 32 hours in orbit; one Argon and three Corona-M operations between January and April 1963 were either failures or significantly disappointing, three because of Agena problems and the fourth because of the TAT failure--a consequence of oversight on the part of a launch crew member. In light of that sequence of events, Brockway McMillan, who had succeeded Joseph V. Charyk as director of the National Reconnaissance Office in March 1963, decided to launch proven Corona-Ms rather than untried Corona-Js during the early summer of the year. The success of Corona-M flights 9054, 9056, and 9057,* renewed the flow of photography on which intelligence analysts had become increasingly dependent and induced McMillan to approve the first Corona-J mission.

If the dependence of the United States on satellite photography returned by Corona had not been adequately acknowledged earlier, the lacuna of early 1963 and following Corona successes corrected that oversight. John McCone, then Director of the CIA, wrote McMillan following the April 1963 mission success that "the importance of this type of intelligence to our National Security cannot be over-emphasized and it is essential that there be no repetition of the hiatus in this type of coverage such as has existed for the past 3 months." McCone added, referring to various procedural changes introduced during the effort to eliminate Corona faults responsible for the various mission failures, "in view of the overriding importance of this type of intelligence,

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* 9055, the missing number in the series, was actually the Argon mission of 26 April, the sixth Argon failure against one "good" operation and one "partial success."

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...[Defense Undersecretary Roswell] Gilpatric and I have agreed that the NRO will continue to employ the special inspection procedures on all forthcoming flights in order to insure that the possibility of failure is minimized. We desire that action be taken accordingly." One of the additional precautions that McMillan immediately instituted, in addition to continuance of the "special inspection and system checks" introduced earlier, was to instruct [redacted] that "experiments and additional payloads" were not to be carried on future Corona or [redacted] flights if there was any possibility that their inclusion would jeopardize the primary mission: " . . . the successful recovery of photography from the main payloads."

Notwithstanding such precautions, Corona-J operations began somewhat inauspiciously, as had the original series of Corona launches four years earlier. Not until the third mission (1004)*, in February 1964 did the planned and the actual sequence of events come into acceptable

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* Mission 1004 was actually the third Corona-J and 1003 the fourth. Printouts of launch records included in the continually updated "NRP Satellite Launch History" list operations in order of mission number; the computer is not programmed to call attention to calendric inconsistencies. The explanation for the 1003/1004 sequencing disorder is relatively straightforward: 1003 was scheduled for a January 1964 launch, had been checked out on the launch pad, and was in the process of final countdown when a violent windstorm damaged the payload. The damage was severe enough to warrant returning the camera-capsule

correspondence. The problem was a fundamental failure in mission concept. In each of the first two flights, capsule number one was recovered complete with four days of film take, but the second capsule was lost. On one occasion an inverter failed and the camera system could not be reactivated after a period of Zombie operation (the recovery system later failed, also), while a decoder breakdown in the Agena system made it impossible to reactivate the system and caused the loss of capsule number two during a mission conducted in September 1963.

In some respects, the first two attempts to operate Corona-J could not be counted as major failures, because in fact one capsule complete with film was recovered in each instance and that recovery represented an achievement comparable to the success of any earlier Corona mission. But the cost was substantially greater, and it was also true that each of the first Corona-J missions had been intended to provide more and better data than could have been obtained from two of the earlier Corona-M operations.

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section to its manufacturers for repair and recalibration. The next vehicle scheduled for launch, already numbered Mission 1004, was moved forward on the schedule. Mission 1003 reappeared as a March 1964 operation. Owing to electrical problems in the Agena, it became one of the increasingly rare total failures of the Corona program.

The fourth Corona-J mission was catastrophically brief; Agena guidance failed shortly after launch and the vehicle arched into the Pacific Ocean (24 March 1964). The fifth (1005, on 27 April 1964) had an uneventful launch, but after 350 camera operations the film broke, then the Agena power supply failed, and finally the capsule ignored signals to deboost and re-enter.

Unlike other failed units, the reentry capsule launched and then lost on mission 1005 reappeared later--and spectacularly. Calculations of the anticipated decay of the capsule led to an initial prediction that it would impact in the Pacific, west of the coast of South America and about 10 degrees north of the Pole. A later calculation based on better orbital trace measurements indicated a probable impact of fragments somewhere in Venezuela. Observation stations in the Carribean area were alerted to watch the skies on 26 May 1964, the indicated date of reentry, and on that date Maracaibo, Venezuela, actually reported sighting five bright pieces passing overhead, presumably on their way to impact in the ocean off the South American coast. That seemed to be that.

More than two months later, on Saturday, 1 August 1964, a Venezuelan commercial photographer, one Leonardo Davilla, telephoned the U.S. Army Attache in Caracas to report that an object which appeared to be part of a space vehicle had been found nearly a month earlier, on

7 July, on a farm some 500 miles south of Caracas in a remote rural region of the Andes near the Columbian border. The object, Davilla reported, carried among other markings one that read "United States," and another that read "Secret." Davilla did not mention that he had photographed "the object" or that the farmer on whose land it lay had been trying to sell it--as a whole or in parts.

Not until Monday, 3 August, after a second call from Davilla, did the Army attache notify the assistant Air attache of the reported find. They were unable, that day, to find an aircraft to take them to the site of the impact. On Tuesday, after interviewing a commercial pilot who had also viewed "the object" at close range and--predictably--had returned to Caracas with a souvenir piece, the Army attache flew to La Fria, the village nearest the find, only to discover that the Venezuelan army had arrived first and had taken the object to San Cristobal, the provincial capital.

Requests for release of the object to U.S. authorities were initially unavailing. With the U.S. Army attache in tow, the Venezuelan army flew it to Caracas, promising to deliver it to the Americans on the following Friday, 6 August. There intervened yet another delay, however. Upon its arrival in Caracas the object (now known to be the remains of the Corona reentry vehicle from mission 1005) was taken

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directly to the office of the Venezuelan Minister of Defense. It finally returned to American hands on Tuesday, 10 August.

Well before reports of the capsule's survival reached American authorities, Davilla photographed it, local farmers attracted by one of the gold discs* attached to the upper section of the capsule had hacked away at its skin to get at more of the gold, one of the farmers had transformed the parachute lines into a harness for his horse, and assorted bits and pieces had been removed as souvenirs by assorted passersby. On 4 August the local Reuters correspondent had reported the find in a dispatch that several wire services picked up. It appeared in the Washington Star and the New York Times on 5 August.

The Pentagon issued a "no comment."

The Army attache noted finding an American five-cent piece and a quarter among the odds and ends in the wreckage.** He also took possession of the film that remained in the fractured cannisters. It was "well cooked."

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* Gold discs inside the ablative shield acted as heat dispersion media. As they melted they actually sheathed the capsule in foil-thick pure gold.

** Two quarters and a buffalo nickel had been found in one of the capsules recovered in 1961.

The impact and farmers "have pretty well reduced internal equipment to junk," the CIA agents earlier dispatched to Caracas reported on 10 August. But great numbers of people had seen the capsule, photographs had been circulated in Caracas and printed in the local newspaper (although it was incorrectly reported to the NRO that all known copies and the negatives had been retrieved), and it was obvious that local Communist bloc people could easily have seen the remains and certainly had copies of the newspaper photographs. At least one part--the radio transmitter beacon--firmly attached to the capsule when it went to the Minister of Defense was missing when Americans finally recovered it on 10 August, the implication being that it too had become a souvenir. Also missing were the parachute (which had not been deployed during descent), the beacon light, part of the ablator, most of the parachute cover, the thrust cone, the rocket motor, and all but one of the gold discs. The capsule had been compressed to about two-thirds of its original length by the impact, and the spooled film was beyond salvage. But, in Dr. McMillan's ironic words, the experience had redeeming features: it "provided valuable engineering data on non-optimum re-entry survivability." The incident also demonstrated that the inherent stability and good ablative shielding of the capsule made random-entry survival a very real possibility--which was somewhat disconcerting to security people.*

In the end, two positive actions resulted from the "1005 incident." First, all classification markings were removed from orbital Corona vehicles before launch and a "reward for return to American authorities" notice, in eight languages, was substituted. Second, inspection procedures were reinforced to protect against the stowage of more American souvenir coins during fabrication and checkout. The 1961 injunction that such objects must not be carried because they might interfere with system functioning had obviously lost its effectiveness.

In the wake of the first two Corona-J flights, both rated partially successful, ground tests of J- systems had been disappointing. Program

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* Security had yet another epilogic trauma even after the remains had been retrieved from the Venezuelan Ministry of Defense. In order to obscure the destination of the packaged capsule wreckage, the real Corona parts were sent to Lockheed by way of a secure air route and a dummy package containing paper, odds and ends of metal scrap, and pieces of wood, was boxed for shipment to the home address of a DIA officer assigned to the Pentagon. Unhappily, the scrap fill plus the carton weighed only 80 pounds although the shipping manifest specified a 250-pound cargo. Alert customs officials at McGuire Air Force Base decided they had uncovered a dope cache and opened the box. After fruitlessly sorting through the expensively freighted junk, they contacted the addressee and advised him sternly that they were "going to investigate." Stalling customs for the moment, the officer put through a frantic call to the CIA to "cut this one off." The Agency, with its own contacts in the Customs Bureau, retrieved and destroyed the box six days later.

managers therefore had decided to use Corona-M payloads to provide required reconnaissance coverage while extended development and fix of J-system technology continued. Apart from the operating defects that had prevented recovery of the second capsule in each of the first two Corona-J operations, the camera system had displayed a reluctance to perform according to expectations. Engineers diagnosed the basic difficulty as one of adjusting for correct tension in the film transport system. The flight problems--in the Agena--involving inverter operation and command system responsiveness were countered by installing redundant equipment.

As happened with infuriating regularity in the satellite reconnaissance program, perverse fates intervened in the "sensible" decision to revert to reliance on Corona-M so that Corona-J problems could be resolved free of pressure for immediate operational returns. Two of the last three Corona-M missions (9060 and 9061) were unsuccessful--one because of a Thor failure--the second in two years and only the fifth in 79 attempted Thor-Agena launchings.* Cancellation of Lanyard following its third launch and first partial success had made two additional TAT vehicles available and indirectly accounted for the

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* The source for that accounting of Thor performance, a November 1963 briefing paper prepared for McMillan, says there were only four Thor failures and ignores the "improved Thor" (TAT) failure of 27 February 1963.

allocation of two basic Thor-Agena combinations to the Argon program for August and October 1963 launches. Perversity took a hand there too; both went well, providing the second and third largely successful Argon operations in ten mission attempts. (Another Argon was charitably accounted a partial success.) The Corona-M launches of November 1963 were failures. Apart from the Thor malfunction, an Agena breakdown caused failure of capsule reentry as the climax of a mission that began with a 27 November launch. But the final Corona-M (9062) redeemed its breed, operating almost flawlessly from its 21 December launch to capsule recovery on 26 December 1963. The paradox remained, however; in its final days the nominally reliable Corona-M experienced major mission problems, while the almost untested Corona-J operated reasonably well. Two Corona-J capsules and one Corona-M capsule were recovered between August and December 1963, and two were lost in each program.

That the Zombie mode itself, or the effort to operate Corona-J in a Zombie mode, was fundamentally unavailing had become apparent with the second successive failure to operate and recover the dormant capsule in a dual-capsule Corona-J mission. That reactivation after storage on orbit was more difficult than had been anticipated was finally acknowledged early in 1964. On 13 February Dr. McMillan

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issued instructions that until further notice all Corona-J systems were to be operated on "continuous missions" interrupted only to the extent necessary to recover the first capsule, after which they were to resume photographic operations. After recovery of the second capsule, McMillan ruled, such Zombie-mode experiments as were necessary and appropriate could be conducted.

That solved the problem. The next launch of Corona-J, mission 1004 on 15 February 1964, was followed by the first successful recovery of both capsules. For practical purposes, the "storage on orbit" concept that had largely justified the development of Corona-J and had been operational doctrine since the conception of the system more than a year earlier was abandoned, withal temporarily.

Unfortunately, the next two succeeding Corona-J flights were those that ended in the ocean off Vandenberg and in the Andes, so there was no immediate opportunity to revalidate Corona-J as an eight-day rather than a 20-day system. In both of the succeeding Corona-J flights, Agena electrical problems were responsible for the failures. The sixth Corona-J, launched on 4 June 1963, experienced none of the Agena problems of its predecessors and both its capsules were recovered--again without any pause for "zombie" storage on orbit. The seventh, eighth, ninth, and tenth Corona-J missions were happy parallels of the sixth. Although minor difficulties and flight defects appeared, all planned launches were successful, the cameras operated acceptably, and all orbited capsules were retrieved. By August, Corona had provided as much gross coverage of denied areas as had been obtained through the whole of the preceding year, and that notwithstanding several major mission failures earlier in the year. The Corona total was supplemented by excellent returns from two [redacted] missions and spotty photography from two other recovered [redacted] capsules.

Thereafter, for nearly a year, Corona operations could best be summarized as routine and returns as excellent. In November 1964 the Corona camera suffered its first in-flight breakdown in 46 operational opportunities, and there was some unverifiable suspicion that even in that instance the malfunction might have originated in Agena electrical problems.

After the first two unsuccessful attempts at "zombie" operations in August and September 1963, program managers prudently made no further effort to exercise that theoretical mission potential until December 1964 (mission 1015), when they put the system in a standby mode for four days following recovery of the first capsule. (Standby operation, originally conceived as a low-cost way of providing required periodic search coverage at intervals of about two weeks, was by late 1964 seen as providing insurance against weather pattern changes, needs to readjust orbits to more favorable altitudes, or requirements to hold cameras in orbit in anticipation of a specific event for which coverage was wanted.)

Launch crews demonstrated further enlargement of Corona-J utility in April 1965 by keeping a complete system in one-day-from-launch (R-1) status for two weeks, a considerable enhancement of system responsiveness. Gradual extension of mission life for Corona-J from its original six days to 10 days was one product of the proven "zombie mode" operation. Modest enlargements in the thrust capacity of TAT (by means of a Thor fuel tank enlargement, the vehicle being called Thorad)* and in the orbital durability of the Agena were undertaken early in 1965, the goal being 14-day mission operations. Launches of the improved system were scheduled to begin in July 1967. [redacted]

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* Thorad differed from the original TAT (Thrust-Augmented-Thor) in having 13 feet more length to accommodate additional fuel and oxidizer, and in some relocation of components. With Sargeant strap-on solid rocket boosters attached, a Thorad-Agena D combination could put into orbit 400 pounds more than could TAT-Agena. Modification of launch facilities at Vandenberg (to accommodate the taller Thorad) and the engineering required to transform TAT into Thorad cost about [redacted] Unit cost of Thorad was only about [redacted] more than for TAT. [redacted]

One reason for the relative modesty of efforts to improve Corona-J, as compared to earlier improvements of Corona-C and Corona-M, was the apparent imminence of a development start on a new search system in 1964 and later. There were two prime candidates, one [redacted] sponsored by the CIA with support from some influential members of the President's Foreign Intelligence Advisory Board, and the other [redacted] by Dr. McMillan, the NRO staff in the Pentagon, development specialists in the Directorate of [redacted] (on the West Coast), and other members of the intelligence board.*

During McMillan's tenure as Director of the National Reconnaissance Office, the familiar question of what system should be developed to replace Corona, and when, was continually complicated by contention over who should have development and operational responsibility for the successor system and--at the end--what lasting role the NRO should have in the total National Reconnaissance Program. Those issues, and others, had embroiled McMillan and Dr. A.D. Wheelon, the CIA's Deputy Director for Science and Technology, in a bureaucratic

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* The [redacted] and [redacted] designators survived until a new search system received USIB approval on 22 April 1966, after which, for precisely eight days, the new system carried the code name [redacted] On 30 April, [redacted] became the approved program title.

power struggle that had undercurrents of both personal and institutional antagonism. Assignment or reassignment of responsibility for Corona development and operations was one other element of the involuted controversy, particularly after it became obvious that the "interim" and "transitory" status repeatedly assumed for Corona and its variants from the early days of the program was thoroughly erroneous. By late 1964 virtually all participants in the satellite reconnaissance program were willing to concede that Corona would be in use for several years more.

By the late summer of 1965, the interwoven controversies involving institutions, technological goals, management authority, and personal prerogatives had become so troublesome that the only reasonable way out was the departure of the principals. Dr. McMillan let it be known that he was returning to private industry, and Dr. Wheelon made a similar choice. Dr. Alexander H. Flax, Assistant Secretary of the Air Force (R&D), became acting Director, NRO, during McMillan's absence late in August and formally succeeded to the post when McMillan's resignation became effective, on 1 October 1965. Earlier, James Q. Reber of the CIA had been named Deputy Director of the NRO. No CIA official assumed the role Dr. Wheelon had earlier played; Reber became, for practical purposes, the CIA representative and the channel between the CIA and NRO participants in the National Reconnaissance Program.

One of the peripheral casualties of the skirmishing during the Summer of 1965 was most of the activity aimed at further improvement of the Corona system which by then had progressed to an operational Corona-J with some attractive potential for further growth. Flax inherited a host of troublesome problems of technology, organization, and future system planning (although the decision to proceed with what later became [redacted] had been essentially confirmed at the time of his appointment); the future of Corona was not quite as certain as was assumed in August 1965, and that too became an item of concern for the new Director.

The long-simmering differences between CIA and NRO participants in the Corona program, mostly concentrated about questions of responsibility and authority, were amicably resolved in April 1966, some six months after Dr. Flax became Director of the NRO. In essence, the arrangement (approved by the Executive Committee for the National Reconnaissance Program on 26 April) made Flax the ultimate authority for systems engineering, specifications, integration problems, the master program plan, system facilities, integrated funds reporting, and on-orbit operations. Lockheed, which had been

[redacted]

working under the aegis of a verbal agreement with the CIA since mid-1964, was afforded formal contractual coverage for work in progress--including activity that related to the integrated stellar-indexing camera that later became DISIC. (Lockheed had spent about $2 million of its own money on what was then called ISIC.) In terms of general management authority, Dr. Flax accepted the principle that no change to accepted procedures should be introduced if it would "unduly disrupt" the continuing program. The CIA's ultimate responsibility for the Corona camera was confirmed, as for the original stellar-index system, the reentry vehicle, the payload assembly structure, and engineering integration of those elements into the total payload subassembly. The NRO's Director of Satellite Programs [redacted] was confirmed in responsibility for the booster, the Agena, the DISIC program, overall system integration in preparation for launch, the launch itself, on-orbit command and control, and capsule recovery operations. [redacted] authority extended to all aspects of Corona except payload subsystem engineering, payload contract supervision, and payload technical data, for which CIA's System Program Director for Corona retained responsibility. However, each of the participants was guaranteed free and full access to all program data, both for engineering and for orbital operations, and that arrangement alone succeeded in eliminating one of the most irksome of the earlier problems of working arrangements.

<u>Corona</u> itself, as a system, had made rather remarkable progress during the McMillan era of the NRO. In terms of capsules launched as against capsules successfully retrieved, the record from March 1963 to February 1964 was nine successes in 13 trials; for the following 12 months, it was 23 successes in 28 trials. That represented an increase of successes from an initial 69 percent to a later 82 percent--and notwithstanding some difficulties during the summer of 1965, the ratio did not appreciably worsen.

Quite apart from any pending issues of what system would eventually replace <u>Corona</u>, and when, small but continuing improvements and modifications of the existing <u>Corona-J</u> system culminated, late in 1966, in a modestly significant model change. Oddly enough, although what became the <u>Corona J-3</u> (the earlier payload thereafter being called <u>Corona J-1</u>) represented considerably less in the way of new technology or added operational capability than had earlier changes, it received not merely a separate designator in the <u>Corona-J</u> series, but a separate serial designator for mission numbering purposes. The <u>Corona J-1</u> missions continued to be numbered in the series that started with 1001 (August 1963) and ultimately reached 1052 (September 1969). <u>Corona J-3</u> missions began with an 1101 serial (September 1967) and extended through 1117, the final flight in the Corona program (May 1972). J-1 and J-3 missions were much more intermixed than had been the case with earlier transitions from C to C', to C''', to Mural, and thence to the Corona J-1.

Even though the J-3 designation signified a model improvement of Corona, the J-1 model had gradually but significantly been improved during its operational life. Lifeboat, a back-up system for insuring de-orbit of the recovery vehicle in the event of Agena power failure, was incorporated following its development and demonstration as an element of [redacted] Orbit-adjust capability was also added, again partly in consequence of [redacted] experience. From eight days of operational camera life in 1964, the J-1 extended its mission capability to 15 days during 1967. And the J-1 was a participant in the remarkable skein of successes from 1966 to 1970, during which time 28 capsules were placed in orbit and 28 capsules were recovered. Reliability had appreciably improved since 1962, when a single one-day mission success in four attempts was rightly hailed as a spectacular intelligence accomplishment.

Corona Improvement Proposals

The J-3 model of Corona provided a capability to operate at 85 rather than 100-nautical-mile altitudes, with a corresponding improvement in resolution and scale. It incorporated a constant-rotating camera with fewer oscillating parts, thus improving stability on orbit, reducing smear, and further enhancing resolution capability. Added functions permitted optional on-orbit selection of exposure and filter modes. It accommodated alternative film loads.* The dormancy capability gained increased significance. Not only could the new Corona be held inactive against the occurrence of better weather, but it could be adapted to changes in photographic requirements while on orbit.

A final major change was the addition of the DISIC to the Corona complement of photographic equipment. DISIC--which had a three-inch focal length lens--provided a star-calibration capability that was largely unaffected by the orientation of the orbital vehicle. The earlier stellar indexing system had become ineffective whenever the main camera was positioned so that the stellar camera looked toward the sun; in DISIC, one camera was always pointed at least 90 degrees

* Several of the improvements derived from [redacted] experience. The J-3 was also the first Corona to be flown with its recovery capsules facing forward, in the direction of flight.

away from the sun. The incorporation of DISIC in combination with a variety of other improvements in camera precision effectively created a mapping capability in Corona J-3 that finally obviated any need for flying dedicated mapping missions. (No Argon payloads had been flown since August 1964, although two still were being held in reserve. With the addition of DISIC to the Corona system, the requirement for additional Argon missions or for a successor to Argon vanished.)

Through the extended period of Corona-M, Corona J-1, and Corona J-3 operations, two quite different approaches to modifications and improvement of the species contended for acceptance. One stemmed from the Corona M-2 proposal that Itek had originated in March 1962, and which had nominally been put to rest by action of the Purcell Panel in June 1963. Basically, the M-2 proposal conceived of modifying the original Corona-M to accept a single lens of 40-inch focal length, that lens tube serving both plattens of the film subsystem.* Its lack of acceptance in 1962 and 1963 had been caused by three factors: first, the doubts of some CIA and Air Force program managers that Itek's expectations for the lens and the system were realistic; second, the pronounced preference of the Purcell Panel and other review bodies for fundamental but less sweeping functional improvements in the Corona-M; and third,

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* Lanyard had operated in a similar mode.

the commitment of both Air Force and CIA elements of the NRP to a new search system, one that would replace rather than augment Corona.

That complex of institutional and technical motivations experienced some shifts of position from time to time. Thus about 10 months after he had first argued against funding Itek's proposal for development of a Corona M-2 model, [redacted] (a senior member of the NRO directorate) urged Dr. Charyk to accept the proposal. Lockheed also endorsed Itek's approach, at least to the extent of requesting funds and proposing development schedules, and Itek proceeded far enough with the basic idea to construct a menu of technical and financial details.*

Complicating consideration of the M-2 version of Corona was a parallel Itek proposal that concentrated on detail changes and put major redesign in a subordinate category. After visiting Itek early in January 1963, Dr. Charyk became very interested in applying various of the Itek notions to the basic Corona-M system, although nothing was then said about a new lens-film system. His request that the CIA

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* Thus Corona M-2 as foreseen in March 1963 would have been composed of a 40-inch f/3.5 Petzval lens (scaled up from the Mural-C''' design), two separate film plattens, and a convergent panoramic stereo configuration. Rather than the 70 millimeter film of all preceding Coronas, the M-2 version would have used 5-inch film (for which Lanyard provided some background experience).

comment on Itek's approach elicited a reply that most of the Itek items were then being considered for gradual introduction into the Corona program via the technical change route. Dr. Herbert Scoville, CIA's Deputy Director for Research, suggested that weight control, optical improvements, adaptation for ultra-thin-base film, automatic exposure control, modification of the film drive, and improved thermal control (all among the items on Itek's list) were being individually considered. He maintained, therefore, that a one-point redesign of the Corona system to incorporate such diverse changes was not warranted.

The issue thus informally joined was tested more or less formally by way of a study performed by [redacted] organization at Charyk's direction. The impetus for the study was a discussion of mid-March between Charyk and [redacted] its product was a formal report of 15 April 1963. The nominal object was to compare the potential of a revised E-6 Samos system with Itek's M-2 proposal. The conclusion, stated as a series of recommendations, was that M-2 development should be continued toward flight test in parallel with development of a re-engineered E-6 (with a different reentry capsule, based on Corona designs), after which the most promising of the two should be chosen for full development and deployment. That choice, [redacted] panel suggested, should be delayed until on-orbit experience had demonstrated the superiority of one of the pair.

The rationale for the comparison study was a statement of need from the National Photographic Interpretation Center (NPIC) and an anticipated endorsement of the NPIC "requirement" by the United States Intelligence Board (USIB).* The M-2 variant of Corona actually seemed to have a potential for better resolution than would an "improved E-6," but (in the judgment of the study group) there was somewhat less assurance that the resolution Itek promised was really achievable. Each of the proposed new systems would ultimately require a larger recovery capsule, given the necessity of using five-inch film widths to provide the promised performance of the M-2. The M-2 had a slight theoretical cost advantage, both for development and for recurring mission costs--about 20 percent in each category, based on almost identical development-deployment schedules. At the end, the study group decided that the M-2 offered "by far, the greatest promise and minimum design risk of any design available for this time period"--except for the "improved E-6."

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* The sequence of events was roughly this: E-6 had begun development in November 1960 as a means of satisfying a USIB requirement for 10-foot search coverage resolution at a time when Corona was returning about 20-foot resolution "a small percentage of the time." By early 1962, Corona-Mural had been developed, providing resolutions of about 15 feet for about 15 percent of the returned photography. Given that performance, NPIC in July 1962 expressed disinterest in any "new" system unless it could offer substantial improvement over the Corona-Mural

[redacted]

The upshot of the study activity, for the moment, was a renewed plea for consideration of M-2 development (from Itek), and a decision that Itek was--for the moment, at least--not to expend funds on M-2 development additional to those earlier spent. As [redacted] explained to [redacted] in May, the underlying problem was not merely the choice of a follow-on search system, but that in the absence of any new development requirement Itek had no challenge--a disturbing circumstance in light of the fact that Itek was "the most successful satellite reconnaissance team in the U.S."

The Purcell Panel report of July 1963 said many things about the need for improvements in satellite reconnaissance, but for Corona the key aspect was a judgment that an improved Corona-M system (not an M-2, which was considered to be a new variant of Corona) afforded the greatest near-term opportunity for improving search coverage. Given the generally mixed opinions on Corona M-2, a budget constraint of some immediate importance, and the findings of the Purcell Panel and [redacted] Evaluation Committe, McMillan in

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returns. E-6 did not then promise as much; a potential 6- to 8-foot resolution in the relatively distant future was the best that could be anticipated. That conclusion, and the abysmally poor flight performance of the E-6 system, caused its cancellation in 1962. The NPIC restatement of a need for 5-foot search resolution, early in 1963, caused consideration of re-engineering the E-6 (principally by adapting a Corona-style film recovery system to replace the highly unsatisfactory capsule system of the original E-6), but at that point Itek was offering the considerably cheaper M-2 version of Corona for consideration, and the M-2 also promised resolutions on the order of 5 to 6 feet.

July 1963 directed that all work on both M-2 and a high-resolution-lens variant for Corona applications be halted. In place of such activity, McMillan wanted additional work on Corona subsystems leading to more consistent performance of the existent system. Because the Purcell Panel recommendations had been rather general, McMillan also wanted the Corona office to propose specific improvement modes.

By mid-August 1963 the Corona office had identified those items of detail improvement that seemed most likely to satisfy the specified NRO requirement. They included more careful lens selectivity and the procurement of better optical glass; more precise camera focus adjustment, through expanded testing; incorporation of yaw steering and vernier attitude control features; experimentation with automatic exposure control devices, ultimately leading to their incorporation in production systems; a better programmer; and experiments using high sensitivity film (for night photography) and color film in orbit. (In essence, these and related improvements, plus dual recovery capsule capability, led directly to the Corona J-3 system.) McMillan accepted the basic recommendations late in August, and early the following month reported to the Director, CIA, his plans for acting on them.

But an imminent funding crisis intervened, and late in September the advance authorization of work on the menu of Corona improvements was revoked--a development that prompted a modest flareup of anxiety about the soundness of Corona management arrangements and, in the end, a suggestion from [redacted] that the Corona Configuration Control Board (which ultimately decided what modifications would be incorporated in production systems) be overhauled. As with similar proposals earlier and later, [redacted] suggestion had no effect.

The Corona improvement menu, or those elements of it that led more or less directly to improvement of the quality of Corona imagery without involving substantial changes in the configuration of the basic system, was ultimately incorporated in system specifications. Perhaps more significant, in January 1964 the CIA funded an Itek study of a successor search system, a development that led over the next two years to the [redacted] and [redacted] system proposals [redacted] with [redacted] and under direct NRO sponsorship), and by that route to the April 1966 endorsement of what later became [redacted] The flareup of Agena problems in early 1964 was responsible for a short-lived proposal to install Corona hardware in a [redacted] orbital control vehicle (OCV), but the additional cost of the vehicle and the Atlas booster needed to put it into orbit doomed the suggestion. (Subsequent abandonment of the original [redacted] OCV in favor of the Agena-configured [redacted] system indicated that reservations about the benefits of the proposed change were well founded.)

That left what became the Corona J-4 proposal as the only surviving prospect for a successor search system that descended more or less directly from the Corona of 1960. The Corona J-3 system was admittedly a model change, a means of rather inexpensively improving the quality of Corona photography, and Corona J-3 did not seem a contender for continuance once a new search system entered development. With the approval of [redacted] by the USIB, in April 1966, the management controversy involving Corona disappeared; the NRO's Director of [redacted] became responsible for virtually all Corona development and operational activities.

By late 1968, Corona was being treated as a terminal system. On the occasion of the 100th Corona flight, in December 1968, a review of program performance sent to all program participants by the CIA's director of special programs emphasized two basic Corona achievements, one the coverage of Soviet ICBM sites, the other the coverage of the Middle East crises and the Arab-Israeli War of 1967 ("The Six-Days War"). (Corona photography had confirmed Israeli claims that otherwise would have been justly treated as "an exaggeration of the facts.") Problems were of a relatively minor sort: the introduction of ultra-thin-base film on Corona flights early in 1969 caused some difficulties that attracted management attention; four years earlier, such problems would scarcely have merited mention in monthly program summaries. Corona was, to all intents and purposes, a fully mature system--and one with no real prospect of enduring in operations past the introduction of [redacted] an event that was apparently imminent. The possibility that more Coronas than were in the inventory might be needed to provide an adequate overlap with [redacted] received careful scrutiny between June 1969 and January 1970, and on three occasions the review committee concluded that no additional Coronas need be purchased. Although there were dissenting opinions here and there, and particularly in the Bureau of the Budget (Office of Management and Budget), and in the office of the President's Science Advisor, the decision was repeatedly reaffirmed.

Yet through and past all that, efforts to preserve and extend Corona capability continued.

Between May 1967 and October 1968, consideration of an improved Corona-J, eventually to be called Corona J-4, reached the stage of serious evaluation of performance potential and probable costs. The system being considered would include an improved camera--one of two Itek designs having focal lengths of 32 and 40 inches--with central resolution of 4.5 feet or better, a 12-inch focal length stellar-indexing camera, and a more powerful booster than required for the J-3 model. That combination of elements would provide a potential 18-day orbital lifetime for a Corona J-4 system.

The assumption underlying consideration of a still further improved Corona was that it could enter use between January and April 1971, supplanting and supplementing the J-3 Corona that then provided basic search coverage. Program plans current in 1968 showed the last Corona-J systems scheduled for launch by June 1971; procurement of 20 Corona systems in a J-4 configuration would permit Corona operations to continue through mid-1973. Development and procurement of the camera systems had an estimated cost of [redacted] to [redacted] to which would be added recovery vehicle and orbital vehicle costs (about [redacted] and the cost of 20 booster systems. Buying the J-4 in preference to additional J-3 Coronas would effectively create an enhanced search capability at an estimated per-launch additional cost of about [redacted] That real costs would exceed estimates by 15 to 20 percent was virtually certain, however. [redacted]

By June 1967, initial expectations of quick progress in [redacted] development had largely dissipated. Acknowledgement of difficulties came late in the month, when Dr. Flax formally advised the Deputy Secretary of Defense (Cyrus Vance) that the first launch of [redacted] had been deferred from April 1969 to October 1969, and then to April 1970. The extension relaxed the funding pressures created by technical problems in [redacted] development, but it also required a further extension in the use of Corona to December 1970, the least overlap with [redacted] that Flax deemed prudent.

The fundamental problem underlying delay in [redacted] as Flax subsequently explained it to Vance, was that work on the camera system paced the balance of the program, and it had encountered major difficulties. They arose in part, Flax explained, because the [redacted] requirement was "not really an intelligence collection requirement, but a statement of system parameters." The NRO had therefore found it difficult to optimize the system design "to meet real collection needs" and had been obliged to consult both COMOR (Committee on Overhead Reconnaissance) and USIB to clarify the requirement. In the Spring of 1967, Richard Helms, CIA director, had asked Flax to delay the start of work on supporting [redacted] subsystems until recently disclosed problems of [redacted] cost effectiveness could be resolved. Not until June 1967 had [redacted] the camera contractor, fully resolved system definition uncertainties--all of which implied a continuing requirement for additional Corona operations. Indeed, although the prospect was not specified then, further Corona improvement was not out of the question.

The proposals to improve Corona through the incorporation of new optics and by the inclusion of several refinements in detail thus reached one peak of interest in 1967, while [redacted] still was incompletely defined and at a time when requirements for photography in the coming five years were less than certain. One proposal, both then and later, was to use an improved (J-4 model) Corona in combination with [redacted] to satisfy national needs for search and surveillance in the 1970s. The camera proposed in 1967 was an improved-optics version of the constant-rotator Corona J-3 camera. By all indications, it could provide five-foot resolution capability and, in combination with [redacted] would satisfy basic national satellite reconnaissance requirements in the early 1970s at a price several hundreds of millions of dollars less than that of [redacted] director of the NRO staff at the time, suggested to Dr. Flax that one implication of the renewed interest in a Corona J-4 was that perhaps [redacted] should be scaled down--four- to five-foot resolution, 16-day orbital life, and two recovery capsules being an attractive compromise. As in the past, one of the principal motivations for continued attention to the Corona J-4 alternative--and to a scaled-down [redacted]--was cost.

Recurrent proposals to cancel the [redacted] program and to substitue a composite Corona [redacted] capability--or more precisely, an improved Corona (presumably some version of the J-4 camera) and an improved [redacted]-eventually tended to focus on financial benefits. In June 1968, while the fiscal 1970 budget was being shaped, they extended

[redacted]
Handle via [redacted] ~~Talent Keyhole~~
Controls Only

also to some assumptions about Corona performance that were little warranted. The Bureau of the Budget argued that Corona could achieve a 4.5-foot "best resolution," and that in combination with the [redacted] anticipated "best resolution" of [redacted] such a capability would entirely satisfy foreseeable needs,

In fact, Corona was theoretically capable of returning photography with 4.5-foot resolution, and actually did as much somewhat later, but the usual resolution of returned Corona J-3 photography tended to be from seven to ten feet, with occasional excursions to six feet. If the USIB statement of requirements were accepted at face value, Corona J-3 would not serve. The prospective savings assumed to result from the substitution of Corona for [redacted] in combined operations with [redacted] were overstated (no account was taken of the cost of buying additional Corona systems to replace [redacted], for instance) and were predicated on the assumption that [redacted] costs would substantially exceed estimates. Counter arguments did not explicitly refute that assumption, but rather denied it by assuming that estimates of the time were accurate. That, too, was a gross error; as had been true of virtually all orbital reconnaissance systems, [redacted] did eventually incur substantial cost growth, the actual costs exceeding those predicted by the Bureau of the Budget. "Additional costs" for Corona J-4 systems probably would have been

[redacted]

about [redacted] that would have been offset, in the event, by the considerable excess of real [redacted] costs over those estimated in 1968. But the central argument remained that of coverage and resolution, and there [redacted] had an unassailable advantage.

The proposed Corona J-4 system was not evaluated solely in cost-benefit terms, however. It was, in a very real way, a competitor and potential rival of [redacted] the surveillance system designed to satisfy a requirement for Corona area coverage at [redacted] resolutions. The April 1966 decision by the Executive Committee of the National Reconnaissance Program to proceed with [redacted] development had capped a two-year controversy over a "successor search system." At the time it was approved for development, [redacted] was scheduled for first launch late in 1968 or early in 1969. In its initially specified configuration, [redacted] was intended to provide resolution of [redacted] or better, [redacted] operation, a mission life of at least [redacted] and periodic recovery of film from [redacted] recovery capsules.

[redacted]

[redacted]

[redacted]

Further, the cost-effectiveness issue was real, not contrived. Corona missions cost between [redacted] and [redacted] operations would cost about [redacted] each. Development of [redacted] would presumably cost between [redacted] and [redacted]** Corona J-4 could be developed for no more than about [redacted] and perhaps

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* And, it must be noted, [redacted] was making steady progress toward [redacted] resolution capability (from its original [redacted] performance) in those years.

** In the event, it cost more. The J-4 cost estimate was more likely to be accurate because it essentially involved the addition of new subsystems with relatively conservative new technology to a proven operational system.

less if the 32-inch rather than the 40-inch focal length camera were selected. (Flying the Itek-proposed 40-inch camera in a Thor-Agena combination promised to require either a "hammerhead" configuration for the payload or an enlarged-diameter Agena; designers were wary of the first, and the second would be costly.) At the time that Corona J-4 made its last serious bid for consideration as an alternative to [redacted] several potentially expensive system options were being evaluated for later development--particularly readout systems--and there was considerable concern in executive quarters about the inability of budget managers to provide the very large additional sums needed to exploit such options.

In some respects the [redacted] system proposed in 1965 was, of course, still another competitor to Corona J-4 in that it involved a camera of either 44 or 62 inches (focal length), 2.5- to 3.0-foot resolution, and a 30 million square mile (per mission) coverage capability. [redacted] was also a panoramic camera system (not unlike Corona) with stereo coverage and with estimated single-mission costs (in 1965) of between [redacted] and [redacted] assuming an eight-missions-per-year launch schedule. (Like other preliminary cost estimates, those probably were understated.)

In the face of such competition, J-4 was little favored by anyone other than its proposer (Itek)* until [redacted] went into the development schedule in mid-1966, and thereafter was favored mostly by those who felt that [redacted] was representative of an excess capability--and unwarranted costs.

That [redacted] was an approved program with reasonable promise of success did not preclude consideration of options that either began with or included the cancellation of that program and "indefinite" reliance on Corona. In August 1967, more than a year after the formal start of the [redacted] program, but while the camera subsystem still was the only element in accelerated development, the NRP Executive Committee examined five alternative approaches to providing adequate satellite reconnaissance capability for the 1970s. The most extreme of the options was to develop a Corona variant capable of producing resolution at about the 4.5-foot level. It was disapproved on the grounds

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* [redacted]

[redacted]

that development of an improved Corona would cost about as much as completing [redacted] development. (That observation emerged in November 1968, after [redacted] had made some progress toward operational readiness, but before an initial schedule slippage of more than one year had been acknowledged and before there was readiness to face the prospect that another schedule slippage of about the same magnitude was pending.)

The second option considered in August 1967 was simply to delay [redacted] availability for a year--a contingency then discarded as unnecessarily costly, but subsequently imposed on the [redacted] program by necessity rather than choice. In November 1968 the option was to cancel [redacted] and substitute for the planned [redacted] operations (either four or five flights of each per year) a [redacted]-Corona combination involving seven flights of each annually. What made the cancellation attractive in 1968 was the prospect that it would permit a budget saving of between [redacted] and [redacted] in fiscal years 1968 through 1973. But the offset would be expressed in ground resolution; there was virtually no possibility of improving Corona to the point of providing resolution better than about 4.5 feet, and in the view of CIA, DIA, and NPIC analysts, search resolution as good as 3.0 feet was needed.*

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* Interestingly, CIA Director Richard Helms was not convinced, in the Spring of 1968, that getting [redacted] resolution, as promised on the [redacted] program, was worth its cost.

Finally, the National Reconnaissance Office concluded (in a position paper for the use of the Deputy Secretary of Defense during an Executive Committee Meeting of mid-November 1968) that "the CORONA system has reached the limit of its improvement. The current system uses Thor-Agena launches with a fixed-film panoramic camera. A significant improvement to the system to bring resolution below five feet would require a new booster and an optical bar camera. This . . . would entail a development costing [redacted] dollars." The judgment: an austere [redacted] program was preferable to cancelling [redacted] and relying on Corona for the 1970s.

In cost-effectiveness terms, the comparison had this appearance:

System	Resolution (feet)	New or Remaining Cost for Development [redacted]	Operational Costs [redacted] (per year)	Contract Needs (new)
Corona J-3	7-10	0	[redacted]	none
[redacted]	[redacted]	[redacted]	[redacted]	none
Corona J-3 mod	5.5-8	[redacted]	[redacted]	sole source
Corona J-4	4-7	[redacted]	[redacted]	new competition

In such terms, the Corona modification would provide "marginally better resolution at much higher operating costs . . ." while the radically changed Corona "would have development costs as high or higher than [redacted]"

That was the Department of Defense-CIA position. The Bureau of the Budget argued that the Corona-[redacted] combination was quite adequate for intelligence needs and that [redacted] did not offer a sufficiency of improvement great enough to justify its higher cost. Dr. Flax disputed that whole contention, using arguments first expressed when [redacted] was proposed as a Corona successor: both resolution and coverage were essential. The BoB maintained, however, that when [redacted] was approved for development it was competing with a Corona capable of best resolution of about 10 to 15 feet, and that now (1968), Corona had six- to eight-foot resolution capability and further potential for low-cost improvement. Even without major changes, the budget people contended, Corona afforded a fully adequate search capability at a five-year cost some [redacted] below that of [redacted].

In the end, [redacted] survived the 1967-1968 pressures for cancellation and Corona remained a terminal system. Apart from technical and requirements considerations, and institutional preferences, the issue hinged on budgetary provisions, and at the time the proposed fiscal year 1970-1971 budgets seemed adequate. That [redacted] would cost more than originally estimated was apparent; the extent of that cost growth was not. Nor had the satellite reconnaissance program yet begun to experience the considerably more severe budgetary pressures that accompanied the change in administrations following the election of 1968. Such influences were nearly certain to reopen what were widely assumed to be closed issues--including the future of Corona.

Notwithstanding the occasional Bureau of the Budget efforts in 1967 and in 1968 to induce substitution of Corona for [redacted] in the National Reconnaissance Program, it was not until the change of administrations occurred in January 1969 that such an alternative became a real possibility. [redacted] the proposed Corona follow-on, had then been dead for nearly three years, and [redacted] had been in development as long.) One of President Richard M. Nixon's prime objectives was to reduce and reorient defense spending. The Budget Bureau responded, early in March 1969, by reviving the proposal that [redacted] be cancelled and that its function be satisfied by a combination of [redacted] and "improved" Corona operations. Robert Mayo, the President's new budget director, argued that the five-year cost differential could be as large as [redacted]-a contention that the Central Intelligence Agency flatly denied. In its initial 1969 incarnation, the revived proposal to cancel [redacted] was not supported by the Department of Defense, and consequently it found little favor with the White House.

That seeming anomaly was a reflection of a characteristic of American government. Although the Bureau of the Budget and the Department of Defense had new senior officials, they were limited in their appreciation of circumstances by the information they received from officials who would carry over from one administration to another (the career officers, civil and military) or who had not yet been replaced by new appointees (as was the case with Dr. Flax, who remained in office until Dr. John L. McLucas succeeded to the post of NRO Director in April 1969; McLucas had become Air Force Undersecretary in February, but not NRO Director). Thus the BoB and DoD positions were in large part reflections of positions taken earlier by career employees, not appointees, and the CIA position was wholly unchanged. The arguments that Mayo used in March, and the response from the NRO and the CIA, were replays of arguments used by the same people in 1967 and 1968. What was different was the audience and the spokesmen. David Packard was the new Deputy Secretary of Defense, and he had firm views about bureaucracy, efficiency, and economy. Dr. McLucas still was an unknown quantity, but he was Undersecretary of the Air Force, and thus more involved in the continuing affairs of the "regular" Air Force than Flax had been as Assistant Secretary, R&D. Dr. Lee DuBridge, President Nixon's new science advisor, was another unknown, Mayo's position was predictable; he had been appointed under injunctions to cut defense costs, and he proposed to do so.

Reacting to Mayo's proposal to cancel [redacted] David Packard advised Dr. McLucas on 31 March 1969 that, "This issue is closed with BoB for now and no future action is necessary." The firm wording suggested an end to consideration of reliance on a Corona-[redacted] rather than a [redacted] capability for satellite reconnaissance in the 1970s. McLucas, Richard Helms (Director of Central Intelligence), and John S. Foster (Director, Defense Research and Engineering) so interpreted it. So did the NRO staff.

But Robert Mayo and the newly installed senior staff of the Bureau of the Budget resurrected the question in another guise. They had continued to investigate various alternative ways of performing their principal assignment from President Richard Nixon: to reduce the defense budget.

The choice they next presented to the President was no less difficult and in many respects was more important. Late in March

NOTICE OF REMOVED PAGES

Pages 192 through 196 are not provided because their full text does not contain CORONA, ARGON, LANYARD programmatic information.

[redacted]

That Corona had been a major consideration in the pre-Nixon deliberations was evident; the Bureau of the Budget had been the principal source of support for Corona continuation and improvement in 1968 and after. Without an existent Corona capability, and the potential for its improvement, no serious proposal for continuing [redacted] and cancelling [redacted] could have been made. It was a wry commentary on the turns and twists of reconnaissance program policy that the early success of Corona was a principal justification for the eventual cancellation of the several generally unpromising Samos systems of the early 1960s, to the considerable distress of the Air Force, but that the survival of [redacted] a 1970s system for which the Air Force had even greater fondness, was very nearly secured by the continued excellence of the Corona a decade later.

NOTICE OF REMOVED PAGES

Pages 198 through 199 are not provided because their full text does not contain CORONA, ARGON, LANYARD programmatic information.

[redacted]

Toward the middle of 1969, as the Corona program once again wound down toward finality, some of the various problems normal to that phase in any major program began to have their effect. In the period between September 1968 and August 1969, three camera failures and three lesser malfunctions had significantly lessened the value of six Corona missions. In July 1969 (mission 1107) a mechanical failure interrupted operation of the forward-looking camera almost as soon as the "operate" command was sent. A similar failure in September 1968 (mission 1048) had occurred after about two-thirds of the film had been expended, and in February 1969 (mission 1106) the aft-looking camera had failed, probably because of a break in the film at a splice point. Mission 1050, in March 1969, ended prematurely after a failure of the Agena guidance system, and two other missions (1049, December 1968, and 1051, May 1969) returned degraded film. Although all represented serious problems, in varying degree, mission 1107 was the first in more than five years marked by failure of the camera system to operate in a stereo mode, even though in some earlier instances stereo operation had been possible through only part of a mission.

The fundamental problem appeared to be a gradual but not yet severe degradation of quality control in the Lockheed facility (which actually was a [redacted] facility occupied wholly by Lockheed people working on Corona). Its underlying cause was the tendency of the best people in any operation to leave once that operation entered its terminal phases--and the prospect that Corona would continue, in any form much past the onset of [redacted] flights was nonexistent by the Spring of 1969. Indeed, as far as Lockheed and Itek probably knew, that prospect had vanished a year earlier; the perturbations of early 1969 were at such a high level that neither contractors nor project office people were likely to have known that even late in 1969 there remained a faint possibility of substituting an improved Corona for [redacted] in the search-surveillance operations of the 1970s.

As skilled workers resigned, their places became increasingly difficult to fill; the lack of an "open" work area where new employees could function during the extended period usually required to complete security clearance procedures and the definitely limited future of Corona work militated against any easy solution.

Further, as both manufacturing and production tapered off, the availability of replacements for failed items lessened. A spares program had not hitherto been essential because manufacturing had continued at a level rate for more than 10 years, and owing to the nature of space systems, "spares" were needed only to replace articles that failed in test.

The best that could be done immediately was to overhaul procedures so as to reinvigorate quality assurance testing and to provide for adequate spares. In time, the [redacted] facility" would have to close down, but that was not yet. For the longer term, considering that Corona would remain operational for another 18 to 24 months, [redacted] CIA's Corona manager, arranged for a partial integration of [redacted] and Corona program activities, thus insuring some continuity and a rational phase down of Corona as [redacted] neared operational readiness. The solution to personnel problems was to offer the experienced [redacted] people employment with either Lockheed-Sunnyvale or [redacted] (developing the [redacted] camera system), but to delay the actual transfer until all Corona systems had been completed and delivered. Refurbishment of various items of Corona equipment as a sort of spares program (thus overcoming a shelf-life difficulty that underlay part of the quality control deficiency) would smooth out some of the workload fluctuations at the [redacted] plant.* Transfer of the checkout operation to a real Lockheed plant was the ultimate solution, of course.

The stretchout of Corona operations to provide overlap with initial [redacted] missions created some interesting difficulties in its own right. By August 1969 it was apparent to [redacted] managers that their system might not be able to supplant Corona either as fully or as soon as earlier planned; the likelihood that all available Corona systems actually would be flown, instead of having the last two or three treated as surplus, created unique pressures. That situation had never arisen in earlier program terminations. (All of the Samos programs had ended with surplus systems available, as had [redacted] and Argon.) Indeed, a very real problem existed in the fact that the last really operable Corona system in the inventory (CR-8) had been a test bed for ultra-thin-base film and would have to be requalified

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* [redacted]

for the ultra-thin film being used in the last lot of Corona J-3 systems. The combination of test operations, requalification, and normal test and certification would cause the system to experience more than 90,000 operating cycles by the time it went into orbit--a number so large as to make continued reliability highly doubtful. Refurbishment was plainly in order, although it would cost nearly [redacted] to re-cycle the system and a major portion of the cost arose in the necessity of having Itek reopen manufacturing and test facilities closed down with the delivery of the last regularly scheduled Corona cameras, some weeks earlier.

The film test sequence and two on-orbit exercises of ultra-thin-base film had demonstrated that the new material was essentially superior to the standard-thin film earlier adopted. Although some peculiar anomalies affected the ultra-thin film during the first 48 hours of any flight, degrading imagery during that period, quality was never poorer than that of the earlier Corona J-1 systems, and after the film had stabilized (a flatness problem) imagery was appreciably better than anything obtainable on standard-thin film.

Even in August 1969 the realities of [redacted] scheduling had not become fully apparent to reconnaissance program managers. Consequently, the "refurbished" Corona intended to be the last operational system in the

[redacted]

series was scheduled for a November 1971 launch. In the event, the date proved to be May 1972, and the August 1969 decision to update system CR-8 proved exceedingly prescient. It was needed as a gap filler when [redacted] availability was repeatedly delayed.

The decision to use what were for practical purposes the last flyable Corona systems in running out the Corona overlap with [redacted] received a final stamp of approval in February 1970. A special [redacted] review committee carefully considered the prospect of a [redacted] slippage that would extend past the availability of the last Coronas and concluded that even if a slippage occurred (as it did, later), a sufficient margin of safety existed. Therefore the committee recommended abandoning plans to purchase additional Corona systems. By 12 February, Richard Helms of the CIA and Lee DuBridge, the President's Science Advisor, had concurred in the recommendation.

One other remote possibility remained for the continued use of Corona, though surely not under that name or with Corona operational objectives. The National Aeronautics and Space Administration (NASA) had approached the National Reconnaissance Office in 1969 with a tentative plan to satisfy requirements for an earth resources survey satellite by adapting Corona systems and technology. The notion intrigued the NRO because that option would effectively preserve a Corona manufacturing capability against some contingency that might warrant later use of the system. Corona superbly satisfied NASA's basic requirements for multispectral imagery and for stereoscopic coverage. And because Corona was a thoroughly reliable, fully developed system for which complete fabrication and testing facilities existed, it would provide a most inexpensive way of satisfying NASA needs. But NASA had to choose between Corona and alternative specialized earth resources survey systems; the NASA budget could not support both. Given the institutional tendencies of both NASA and the NRO, the outcome was predictable.

In early March 1970, NASA advised McLucas that no money for the procurement of Corona systems could be included in the fiscal 1972 NASA budget. Homer Newell, NASA's Associate Administrator, asked McLucas to preserve Corona production capability against a possible budget allocation for a NASA-Corona in fiscal 1972. But the NRO budget was no more flexible than the NASA budget in such matters. Although McLucas assured Newell that the NRO would attempt to make surplus Corona vehicles available to NASA, in fact that contingency could be considered only if [redacted] were to become fully operational in accordance with optimistic 1970 schedules. Should that occur, of course, two or more Corona missions might well be scrubbed, there being little value to operating Corona once [redacted] much superior capability could be brought fully to bear.

Expectations that some surplus Coronas might become available survived into the early months of 1970, as evidenced by a March 1970 request from the Defense Intelligence Agency that the NRO fly DISIC packages early in 1971, rather than (as scheduled) as part of the Corona missions intended for the late months of that year. (Fewer DISICs than Coronas were in the residual inventory.) The rationale: ". . . uncertainty as to whether the last few KH-4 systems may be operated." [redacted]

So late in 1970 that it really could have few implications for the program, the State Department provided an unexpected but highly interesting post-wake commentary on the value of the Corona in applications not contemplated when the program began. R. S. Cline, State's Director for Intelligence and Research, wrote Helms in September 1970 that ". . . the gap . . . between what policy-level officers in our government expect to be able to demand from our satellite reconnaissance program and what it actually can deliver in the next six to twelve months" had begun to concern him deeply. Cline explained that only "the unusual political circumstances in the current Arab-Israeli crisis" had permitted the U.S. to use "the old workhorse, the U-2." Otherwise, coverage would have been grossly inadequate--owing to a restricted flexibility in reconnaissance satellites that stemmed directly from the limited residual of Corona vehicles. When [redacted] became operational (and Cline suggested as an aside that he did not expect that to happen until well into 1971), coverage would be excellent--but at a cost of [redacted] a launch, [redacted] was not suited to crisis scheduling. Nor was [redacted] Given the probable five- to six-year wait for an operational readout system, Cline suggested that it might be advisable to "reassess [the] need for a satellite crisis capability at least as good as that previously provided by the KH-4 (Corona) standby."

Cline's object was to stimulate a new examination of the basic issue, but he conceded that funding problems and previous commitments made a satisfactory solution unlikely.

Cline sent copies of his letter to both Lieutenant General D. V. Bennett, Director of the Defense Intelligence Agency, and [redacted] who was charged by Packard with integrating various defense intelligence activities. Bennett promptly contacted Dr. McLucas and Deputy Secretary of Defense Packard to express basic agreement with Cline's stand, again expressing concern about the potential intelligence gap that would be created by exhaustion of the Corona inventory. Packard responded by suggesting that McLucas "look at cost and

[redacted]

schedule problems with more KH-4 insurance." He reiterated the suggestion during a meeting with McLucas shortly thereafter. Indeed, by early October Packard had concluded that Coronas might be needed ". . for a long time, either to cover a launch failure or operational failure, or to cover a crisis situation where there is nothing scheduled and we might want to launch an extra photo bird."

Packard pressed Helms on that issue in November. Helms responded that additional Corona vehicles could not be obtained in less than 24 months because of manufacturing lead time considerations and that [redacted] was virtually certain to be satisfactorily operational by then (1973). He further suggested that Corona vehicles would have but limited usefulness in the sorts of crises the U.S. had experienced in the preceding five years, a conclusion based on the findings of a still incomplete study being conducted by the Agency. On such grounds, he doubted that the utility of additional Coronas would be worth the [redacted] each probably would cost (a cost driven substantially higher than in the past by the necessity of reestablishing production facilities). And, he added, if [redacted] continued to conform to its schedule, Coronas would be left over for crisis use should that need arise. Finally, Helms concluded, he ". . . would prefer not to spend any of the intelligence budget at this time for additional Corona vehicles,

[redacted]

[instead believing] our objective will be better served by planning to use such funds as can be made available to help cure any [redacted] problems that might arise in the early flight program." Again, it appeared, the subject had been closed. And again, appearances proved deceptive.

Late in December 1970, Dr. John Martin* in the President's Office of Science and Technology suggested consideration of a new Corona option: ordering a small number of Corona vehicles under a contingency plan that would call for cancelling the order once complete [redacted] operational readiness had been demonstrated. The option was considered in some detail during the National Reconnaissance Program Executive Committee meeting of 29 January 1971. In the course of the discussion, [redacted] the NRO Comptroller, estimated that additional Corona systems could be purchased and operated at costs ranging from [redacted] each in lots of two, to [redacted] each in lots of six. Assuming an immediate decision to proceed with the purchase of three systems (an optimum number representing the crossover between high unit costs for fewer systems

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* [redacted]

[redacted]

Handle via [redacted] ~~Talent Keyhole~~ Controls Only

[redacted]

and a package price for so many systems that the total would cause major perturbation of fiscal 1971 and 1972 budget ceilings), cancellation after two months would cost about [redacted] and after five months about [redacted] That calculation had been performed as a direct response to a question from Dr. E. E. David, the President's Science Advisor (and a member of the NRP Executive Committee); if additional Corona systems were immediately ordered, but a successful [redacted] launch in March 1971 allowed termination of the procurement, what would be the costs? What if in June or July?

The basic reason for Dr. David's concern was the [redacted] overlap with Corona. When [redacted] had been scheduled for December 1970 launch, Corona launches were planned so as to provide an 11-month overlap. When [redacted] incurred another schedule slip, the response was to order a special [redacted]* that would permit [redacted] operating at an altitude of 525 miles, to take relatively wide-area photographs that would partly satisfy an interim search capability requirement, thus protecting the 11-month overlap through March 1971. A [redacted] slip to June or July 1971 would leave a seven-month overlap potential. In the worst case, if [redacted] did not become operational until late 1971, a coverage gap of 5 to 11 months conceivably could result.

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*See Chapter on [redacted] for details of that modification.

Protective measures included further stretchout of Corona launchings (awkward at a time when, as it happened, there were rising demands for a greater frequency of Corona missions),* or buying another [redacted] and substituting a [redacted] for a scheduled [redacted]

In the end, it appeared to Dr. David that insurance against a major [redacted] slippage could be purchased for between [redacted] and [redacted] -if the decision to order more Corona systems were taken at once. He asked McLucas to poll the Executive Committee on the advisability of taking such action. The negative response disposed of the question and finally did write finis to Corona.

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* Again in February, the Defense Intelligence Agency urged Deputy Defense Secretary David Packard to schedule an additional and early Corona operation to satisfy immediate and urgent requirements arising, partly, from the untimely flight failure of Corona Mission 1112.

RESUME

In many respects, the evolution of Corona anticipated the later evolution of [redacted] Likenesses were not at all obvious, and surely were not planned, but they were extremely interesting in retrospect. [redacted] did not have to endure the long string of early mission failures that troubled Corona, but if [redacted] were viewed as the first successful satellite program to be conducted under "Air Force" rather than CIA auspices and predecessor "Air Force" satellite development activities were treated as precursors of [redacted] even that difference vanished. Of the thirteen attempted launches in various of the Samos programs, only one was marginally successful (the E-1 launch of January 1961), a record that almost precisely paralleled Corona's early history. [redacted] was intended from its start to be a stereo system, which was not the case with Corona, but otherwise the evolutionary pattern of camera and recovery system changes and improvements for one strikingly resembled that of the other. Both systems acquired vastly better optics within two years of their initial missions (C''' and [redacted], both profited appreciably from the development and introduction of improved film, both were operated as "single-bucket" stereo systems (Corona-M and the initial [redacted] before acquiring dual-recovery-vehicle capability (Corona-J and the double-bucket [redacted] and both experienced a five-fold improvement in resolution and reliability during their first 10 years of operations. The experience of the Corona program had, of course, a substantial direct influence on the evolution of [redacted] The adoption by [redacted] program managers of the Corona recovery capsule was but the best known of several examples that extended through optical, electro-mechanical, and orbit-control subsystems and into a host of specialized components, procedures, and technical devices.

Corona improvements included the addition of a stereo capability, a second recovery vehicle to increase film capacity, a lower orbital altitude to permit better photography, better optics, and many other changes. At the end, Corona missions lasted for 19 days and each brought returns on about seven million square nautical miles.

Sixteen Corona missions were flown in the last three years of the program, six in 1969, four in 1970, three in 1971, and two in 1972. Those flights used up the whole of the Corona inventory; the Corona function thereafter was served by [redacted] In its years of service, Corona had identified and accurately located all operational Soviet ballistic missile sites. More need not be said.

[redacted]

One of the principal issues of 1969 was whether or not to schedule additional Corona production as a safeguard against anticipated slippage in the first operation of [redacted] The response was to adjust the annual launch rate for Corona, stretching the program. Although it was a near thing, the last Corona available to the NRO managed to fill the data gap created by the need to delay the second [redacted] launch until problems disclosed by the first [redacted] could be corrected. [redacted]

In the final three years of Corona operations, three of the 16 flights ended in less than satisfactory fashion. Mission 1113, staged in February 1971, was the victim of a rare Thor booster failure; an attitude control system failure in March 1969 (mission 1050) caused abbreviation of a planned 16-day mission to three days, although intelligence returns were exceptionally good for the period in orbit; and failure of a solar array panel to deploy followed by a leak in the Agena gas system forced abbreviation of the final mission in May 1972 (mission 1117) to six days (against a planned 19 days). Yet, with the exception of the entirely aborted mission (the Thor failure), every Corona operation in the final series of launches returned reconnaissance information that ranged from good to exceptional in terms both of photographic quality and intelligence worth.

By the time the Corona series ended with the final capsule recovery on 31 May 1972, it had ostensibly included 145 missions--or mission attempts--in all. In actuality, if the generally ignored initial mission failure was counted, there were 146 flight attempts, of which 26 involved objectives and payloads other than those of the fundamental Corona program.* Thus 120 Corona operations were attempted. Starting with flight number 69 (mission 1001) of 24 August

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* The records of Corona missions, successes, and failures are confused because of the early admixture of the Discoverer and because so many operations did not include a Corona camera system. Two of the first 25 "Corona" flights carried infrared sensor systems developed for the subsequently cancelled Midas program; at the time they were publicly represented to be biomedical payloads. (Some biological specimens actually were carried but they constituted a tiny fraction of the total payload.) Two other "Corona" spacecraft of that period carried "diagnostic payloads" rather than cameras; such diagnostic instrumentation was inserted into the flight schedule in response to the initial sequence of mission failures and was intended to provide information that would identify and support the correction of spacecraft design defects. The end sum of "Corona" flights, nominally 145 but actually 146 in all, included 12 Argon mapping camera payloads, three Lanyard instruments, and two other payloads irrelevant to the Corona program (flights number 54 and 99). (Starting with flight number 54, two of the surviving summaries of Corona program activities have contradictory flight and mission numbers. Flight number 54 is not counted as a Corona program flight in one set, compiled in 1964, but is so charged in the final June 1972 accounting.)

1963, dual recovery capsules were usually flown. Only seven Corona missions after that time involved the older, single-capsule recovery system; 69 were of the dual-capsule Corona-J configuration (including both J-1 and J-3). In total the Corona program included 190 film capsules intended for recovery. Of that total, 165 film capsules actually were recovered, and all but four of them contained operational quantities of exposed film. From time to time, random system malfunctions of various kinds made some of the film no more than marginally useful to photo interpreters, of course, but in the end 161 capsules brought back a vast bulk of enormously useful reconnaissance information.

Through flight 16, film payloads weighing, variously, 10, 16, or 20 pounds were carried. Thereafter through flight number 75 (December 1963), the film payload per capsule averaged about 40 pounds, and from that time through the end of the program the per-capsule average was about 80 pounds (or approximately 16, 000 feet of film). In the period from 1966 through September 1970, when a total of 34 systems were placed in orbit, recoveries included 68 capsules containing 1, 058, 000 feet of film with images of 287 million square miles of the earth's surface. Those 34 successful injections also encompassed a total of [redacted]

As originally flown in 1960, the ground resolution of the monoscopic Corona camera was about 35 to 40 feet. That improved to about 35 feet with the introduction of the C' camera. Twelve years later, after a succession of improvements and changes that extended from reliability enhancement in a host of minor components to new boosters and spacecraft and four major evolutionary improvements in camera configuration, Corona routinely returned stereo photography with a normal resolution of seven to ten feet from 100 nautical mile photographic altitudes and had demonstrated a "best resolution" of 4.5 feet from 90 nautical miles. With a 19-days-on-orbit mission capability, a single Corona flight in the 1970-1972 period usually returned pictures of 8.4 million square miles of "denied" territory. Originally flown with only the sketchiest sort of weather information input, and thus subject to random cloud-cover degradation, Corona was, by 1972, capable of an adaptive response to weather information less than 90 minutes old. Further, the addition of a DISIC (dual improved stellar imaging camera), conceived in 1964 and first flown successfully in 1967, provided extremely accurate altitude and position information and added a supplemental mapping capability to Corona that largely offset the need for special mapping missions. (The Argon program, which had its last operation in May 1964, was not succeeded by another cartographic program chiefly because of the DISIC enhancement of primary Corona capability.)

Although the original concept of film returns by way of a recoverable reentry capsule proved highly successful once a set of relatively minor but irksome operational difficulties were overcome, improvements in that aspect of Corona operations in the years after 1961 were nearly as impressive as other system improvements. At the end of the program, film was routinely recovered from two independently controlled recovery capsules. The last Corona capsule recovery failure occurred in May 1965 (caused by a random malfunction of the vehicle recovery command system), although recourse to water pickup became necessary twice in the succeeding seven years (once in July 1967, again in August 1969).

In the context of its operational utility, exploitation of technology, and enhancement of the nation's fund of intelligence information, Corona had to be rated an outstanding success. Originally considered an interim system and assumed to have, at best, three or four years of operational utility, Corona remained the sole source of overflight intelligence for the United States for nearly five years, and was a primary source of basic information used to shape national defense policy for 12 years. Although designed as a search system, at the end Corona was providing better detail and resolution than several of the surveillance systems earlier touted to supplement it. Its eventual replacement, [redacted] was six years in gestation and about five times as costly, withal having an operational capability that Corona could never match.

In 12 years of operation, Corona cameras exposed more than 2,700,000 feet of film covering 750,000,000 square miles of the earth's surface. The last Corona satellites each carried more than 31,000 feet of 70-millimeter film, were capable of providing resolution of from six to ten feet, surveyed about seven million square miles during each mission, and returned cloud-free coverage of about three million square miles.

Corona achievements were legion. Among those accounted most memorable when the program ended was a list of "firsts" that ranged from "first satellite in polar orbit" through "first dual-capsule reentry capability" to "first low-altitude satellite to utilize a solar array." Corona was the first satellite to be recovered, the first to operate in stabilized flight, the first to be recovered from the water, the first to be caught in descent, the first to incorporate an engine restart capability, the first to carry a stereo camera (and, of course, the first to carry any camera at all), the first to perform orbit adjust maneuvers, the first to carry "piggyback" satellites, and the first to utilize explicit guidance equations in its control circuitry. There were others.

Corona was a principal policy reliance of four Presidents, their defense ministers, and their chief intelligence advisors. It was instrumental in providing data that shaped American responses to the Soviet missile buildup, to the Cuban crisis of 1962, and to a succession of crises and conflicts in the Middle East, along the Sino-Soviet border, in India, in Africa, and in Central Europe. The film recovery techniques conceived for Corona were to survive and supplant several more elegant predecessor and successor conceptions of the 1960s. [redacted] the only other fully capable U.S. photographic reconnaissance system to appear during that decade, probably owed its success to adoption of Corona recovery capsule technology. Accessory products of the Corona engineering effort included a variety of successively improved space vehicles (the several Agena variants), boosters (augmented Thor and Thorad), stellar-indexing systems (including the highly successful DISIC), vehicle stabilization systems, mission control systems, data processing techniques, and photo-interpretation processes. That Corona was at once the outstanding example of effective interaction between the Department of Defense and the Central Intelligence Agency and a principal issue of contention between them for nearly a decade may be a paradox explainable only in terms of Parkinsonian dialectics--but that also was part of the ultimate reality.

Even though quite a lot of miscellaneous information about Corona had leaked into the press from time to time, surprisingly little was made of it by supposedly well-informed space writers. Photographs published in Caracas had clearly shown the inside--and the film cannister--of a recovery bucket; aerial catch and sea retrieval operations had been repeatedly photographed; the Alsop article of 1963 had pretty accurately described both the antecedents and the initial importance of Corona; and it was all but impossible for intelligent observers of the strategic scene to ignore the recurrent implications of good U.S. photographic intelligence over Soviet territory in the 1960s. True, only small lots of people knew that until 1965 all of the many other U.S. reconnaissance satellite programs had been sterile. Nevertheless, to one looking at the indicators with knowledge of

[redacted]

their significance, the failure of outsiders to trumpet the existence and the importance of Corona was baffling. Nobody even seemed to notice its disappearance in the flurry of comment about "new" American satellite reconnaissance capabilities when [redacted] launches began.

As with the original [redacted] when Corona phased out there was a sentimental movement to preserve one example for posterity. That was a bit more difficult than for [redacted] however. Two complete [redacted] systems had survived, surplus to launch requirements when [redacted] became operational. The crunch caused by [redacted] slippages in 1970 and 1971 had essentially exhausted the reserve of Coronas. In order to create a museum display at the chosen secure site, in one of the buildings occupied by the National Photographic Interpretation Center in Washington, it was necessary to combine the well-worn development model of the J-3 version with tarnished recovery capsules actually retrieved from the final Corona mission in May 1972. Even the vehicles used for test and qualification of earlier Corona models had been sent into orbit at the end.

On 25 November 1972, the only surviving Corona became a museum display--though not yet accessible to the American public. The occasion was marked by the first, and perhaps the last, formal reunion of the many contributors to Corona's 15-year history:

Ritland and Bissel, Worthman and Battle and Buzard, Charyk and McMillan and Flax and McLucas, [redacted] and Scoville and [redacted] and [redacted] and a host of others--though not including any of the Rand scientists who in 1957 had opened the Pandora's Box by arguing that a cheap, simple, recoverable reconnaissance satellite obtainable in the short term was a far better prospect than a sophisticated, expensive, high-risk satellite with uncertain availability and doubtful utility.

And there was one final paradox. The success represented by Corona in the early 1960s had demolished plans to rely on readout satellites for information about Soviet strategic capabilities. [redacted]. Its need was justified, at least in part, by the urgency of continuing in an era of detente the sort of coverage Corona had provided for more than a decade of cold war.

And one final item: the bill. The 1958 program estimate for what it was assumed would be a total of 12 Corona missions (plus four launches to test equipment and concepts) was about [redacted]. Some early optimists had thought it could be bought off for [redacted] or so--plus launch and launch vehicle costs. The total cost, through May 1972, was between [redacted] and [redacted] (It was difficult to allocate costs for a variety of peripheral activities that were or were not counted as Corona-related from time to time, as the rules changed.) That worked out to an average of perhaps [redacted] for each attempted Corona mission; what with odds and ends not accounted for elsewhere, [redacted] was probably a more representative number, but the difference was relatively inconsequential. A great many totally valueless programs of the 1960s had cost more and had been cancelled before producing any results.

NOTES ON SOURCES

Note: Various items of detailed information used here and not otherwise attributed have been taken from "CORONA," by [redacted] an article published in the CIA Intelligence Journal of July 1973 under a Talent-Keyhole classification but subsequently withdrawn from circulation because it contained many elements of [redacted] category data. Although generally correct in matters of event and technical detail, the [redacted] article reflects an incomplete appreciation of the circumstances that brought Corona into being, the roles of early participants, and the interactions of Corona with other satellite reconnaissance activities. In part, that probably resulted from constraints imposed on the author in the matter of discussing such programs as [redacted] and [redacted] but it also reflects what appears to be an unbalanced and uncritical reliance on interview evidence obtained several years after the events had occurred. Program difficulties have been largely glossed over, in part by omission, in part by phraseology. Nevertheless, [redacted] article is a useful adjunct to Corona history; except for those major defects remarked above, its faults and flaws are of slight consequence.

***** NOTICE OF REMOVED PAGES *****

Pages 227 through 237 of CORONA, ARGON, LANYARD programmatic information are not provided because their full text remains classified.