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NATIONAL RECONNAISSANCE OFFICE
14675 Lee Road
Chantilly, VA 20151-1715

30 June 2014

Ref: Mandatory Declassification Review (MDR)
NRO Case #E12-0052

This is in response to your letter dated 13 June 2012 requesting a mandatory classification review of the document titled, *"The Air Force and the National Security Space Program 1946-1986."*

A search was conducted and one record was located in response to your request totaling two hundred and nineteen pages. An NRO review of classified information followed, pursuant to the provisions of Executive Order 13526, and NRO equities requiring continued protection have been redacted. Material withheld is exempt from automatic declassification under Section 3.3 (b)(1) of E.O. 13526. This information remains currently and properly classified and is exempt from release under FOIA exemption (b)(1).

You have the right to appeal this determination by addressing your appeal to the NRO Appeal Authority, 14675 Lee Road, Chantilly, VA 20151-1715 within 60 days of the above date. Should you decide to do this, please explain the basis of your appeal.

If you have any questions, please contact Kim Condas at (703) 227-9411 and reference case number E12-0052.

Sincerely,

Kimberley W. Condas
Declassification Team Lead,
Information Review and Release Group

Enclosure: The Air Force and the NSP Program (219 pgs.)

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THE AIR FORCE

AND

THE NATIONAL SECURITY SPACE PROGRAM

1946 - 1988 (U)

by

R. Cargill Hall

USAF Historical Research Center

1988

~~TOP SECRET~~
HANDLE VIA ~~TALENT-KEYHOLE~~
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FOREWORD

(U) In the spring of 1983, the first Commander of Air Force Space Command asked the Assistant Vice Chief of Staff, Headquarters United States Air Force, if the Office of Air Force History could prepare a short, unclassified history of the Air Force in Space. General James V. Hartinger believed that his new command needed to be reminded that the service already possessed a rich and varied experience in Space and space systems that extended back over two decades.

(U) This office had already concluded itself that such a project was needed. Several monographs and histories had been produced earlier on limited aspects of the subject, and a project was underway to write a one-volume history of the Air Force which would need coverage of the Space story.

(U) One additional inducement was the presence at the United States Air Force Historical Research Center of the leading historian of Astronautics in the United States, Mr. R. Cargill Hall. He graduated from Whitman College in 1959 with a degree in Political Science. While earning an M.A. from San Jose State University in 1966 in Political Science and International Relations, Mr. Hall joined the Lockheed Missiles and Space Company as an operations research analyst and historian. For ten years after that he headed the history office at the California Institute of Technology's Jet Propulsion Laboratory and under contract to the National Aeronautics and Space Administration authored Lunar Impact: A History of Project Ranger (Washington: NASA, 1977). From 1977 to 1981 he served as an historian at HQ SAC and HQ MAC respectively, moving to the USAF Historical Research Center as Chief of the Research Division, his present position, in 1981. Mr. Hall's articles have appeared in the American Journal of International Law, The Journal of Air Law and Commerce, Technology and Culture, Air University Review, and Aerospace Historian. He edited the two-volume Essays on the History of Rocketry and Astronautics: Proceedings of the Third Through Sixth History Symposia of the International Academy of Astronautics (1977, new ed., 1986). He was awarded the Goddard Historical Essay Trophy by the National Space Club in 1962 and 1963.

~~(S)~~ Because the history program possessed such an historian, and because of the need for such a study, the office eagerly agreed to pursue the project with the concurrence of Assistant Vice Chief of Staff, Hans H. Driessnack. Mr. Hall immediately undertook the project as an additional duty and by 1985 had completed a draft history which he circulated to several knowledgeable scholars and participants in the Air Force's Space effort. Although he used only unclassified sources, the draft so effectively and comprehensively told the story that it was decided not to continue the project in unclassified form. Should Mr. Hall as an historian of the Air Force with the nation's most distinguished reputation in this field write an official history it would have been seen to confirm information and analysis, the veracity of which interested agencies hope to keep uncertain. As a result, the appropriate organizations in Washington provided Mr. Hall access to all the relevant documents in order to write a classified history for the use of the government.

~~(S/TK)~~ Once cleared, Mr. Hall, still as an additional duty, from 1986 to 1988 prepared this document. He possessed full access to the people and documents necessary to tell the story. The manuscript was then reviewed by members of the National Reconnaissance Office staff, by an historian on the CIA history staff who recently researched and wrote a study on Overhead Reconnaissance, and by me.

~~(S/TK)~~ The result is the most comprehensive history to date of the Overhead Reconnaissance Space Program. It exists in two versions. The original draft fully annotated is retained for reference purposes at the National Reconnaissance Office. The TK version, exactly the same except for minor changes, has been prepared for wider circulation to interested agencies and commands. As such, it should prove extremely valuable to commanders, senior managers, planners, programmers, action officers, and operators in what is already a crucial frontier of the nation's effort to defend itself in peace and in war.

RICHARD H. KOHN
Chief, Office of Air Force History
August 1988

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PREFACE

(S/TK) Within the next few years United States political and military leaders will be setting the course of military space operations for the future. They will determine national space policy objectives, the attendant strategy, the mix of space forces required, and the military doctrine for employing these forces. A thorough understanding of astronautical history is thus crucial if these decisions are to be reasoned and informed, the more likely to increase national security and reduce the prospects of armed conflict than they are to imperil command and country. With the thought of contributing to that understanding, at the request of the Office of Air Force History, through the Office of the Secretary of the Air Force, I undertook this brief history of the United States Air Force and the national security space program, 1946-1986. Officials in the Air Force and the National Reconnaissance Office decided on classifying this work at the TK level so that it could be made available to a larger number of people directly involved in space program planning and flight operations.

(S) In 1949 Soviet scientists successfully tested an atomic bomb. That test ended the American nuclear monopoly and it encouraged the building of even more awesome thermonuclear weapons. It also caused American leaders in the early 1950s to judge an atomic surprise attack on this country to be a distinct and terrifying possibility. A nuclear Pearl Harbor, all could agree, had somehow to be precluded; more than ever before, forewarned meant forearmed. Early warning of a surprise attack, that is a warning days or weeks in advance, could only be secured through overhead reconnaissance conducted from very high altitudes. This national requirement precipitated the U.S. military space program, and in this history of the Air Force in space, strategic reconnaissance became quite naturally a principal focus of attention.

~~(S)~~ This history does not address military space programs that are largely unclassified, the communication and navigation satellite efforts, for example; that activity is for the most part available in the open literature. This is not exclusively an "Air Force" history. Nor is it a technical history of reconnaissance satellites or their missile-detection and meteorological companions performing related defense-support functions in space. Rather, this work addresses the Air Force role as it evolved in the military space program and the important political, military, and policy issues that shaped the enterprise at its hard core. I have attempted to explain how and why American leaders began a national space program, why they divided and organized it in military and civil branches, and why the Air Force was appointed to manage and conduct--but not direct--much of the nation's military spacefaring. I further sought to plumb the reasoning behind early U.S. space policy as it related to national security space operations, and analyze the profound effects that reconnaissance satellites have had on international relations during the last quarter century. The study is therefore broader in scope than the title alone might at first imply.

~~(S/TK)~~ A number of individuals contributed materially to this work, and I am indebted to them. Edward V. Stearns and William W. Kellogg shared their recollections of the early days at

Rand and Lockheed; Larry E. Jenkins and Stanley I. Weiss of Lockheed critiqued the Agena story; Lt Col Donald B. Dodd, USAFR, helped greatly with unclassified research; Donald Welzenbach of the CIA History Office counselled on technical details and critiqued the draft chapters; Jimmie D. Hill of the National Reconnaissance Office provided background on the NRO in an institutional setting; and Colonel William Davidson (SAF/AAZ) obtained key documents that made this study possible. Finally, special thanks are owed [redacted] [redacted] and [redacted] in the National Reconnaissance Office. 3.3 (b)(1) Despite a full schedule, they conscientiously edited and typed the manuscript as an "additional duty." Any errors of omission or commission that may remain are mine alone.

R. Cargill Hall
Washington DC
August 1988

CHAPTER ONE

SPACEFLIGHT BEGINNINGS

(U) On the morning of 28 May 1940 Robert H. Goddard met in Washington, D.C., with representatives of the Army Air Corps, Army Ordnance, and Navy. The Nazi invasion of the Low Countries and entrapment of the British Expeditionary Force at Dunkirk dominated the news. The threat of war charged the political atmosphere in the capital, unquestionably adding to these deliberations a sense of urgency. At the meeting, arranged by the philanthropist and aeronautical benefactor Harry F. Guggenheim, the American rocket pioneer briefed the military representatives on work at his rocket test site in New Mexico. He offered to develop for the armed services rocket missiles to meet future defense needs. Brigadier General George H. Brett, Chief of the Army Air Corps Materiel Division, and his Navy counterpart, argued that manned aircraft could deliver more high explosives more accurately against an enemy than any foreseeable unmanned ballistic rocket. But rocket propulsion, they agreed, would be of great importance for jet-assisted takeoff of heavily laden military aircraft. The Army Ordnance representative, who remained unimpressed, advised Goddard to direct his efforts toward improving a weapon that ordnance judged crucial to the outcome of the next war, the trench mortar.[1]

(U) However disappointed Goddard must have been, American military leaders soon embraced scientific research for a multitude of advanced weapons.[2] Indeed, in June 1944 Army Ordnance awarded to Caltech's Jet Propulsion Laboratory a contract that would produce America's first tactical ballistic missiles.[3] By the end of World

War II General H. H. Arnold, commander of the Army Air Forces, could confidently assure Secretary of War Robert Patterson that the United States would shortly build long-range ballistic missiles to deliver atomic explosives and "space ships capable of operating outside the atmosphere."[4] Ten years later, both of the programs that Arnold forecast were underway.

(U) If the history of military rocketry has been surveyed and for the most part made available, that of the military and intelligence space programs for a variety of reasons has been largely unavailable. Ironically, this crucial history, one involving the monitoring of international arms limitation treaties and the maintenance of peace, because of security restrictions, remains unknown even to many of those directly involved. In 1981 Air Force leaders met in Colorado to consider military space missions and doctrine. After extended discussion they could not be certain whether the Air Force had advocated a military space program in the early 1950s, or whether the service had been "pushed" into it by others in the government. They could readily agree, in the absence of evidence to the contrary, that the program had evolved over the years in an unplanned, "inductive" manner.[5] In fact, most of it evolved neatly against a novel, albeit informal, deductive plan.

Origins of the Military Space Program

(U) When in late 1945 General Arnold counselled the Secretary of War on prospective weapon developments, he also acted to ensure that the Army Air Forces would in future be equipped with modern weapons superior to any held by a potential adversary. The commander of the Army Air Forces set up an independent consultant group, Project Rand,* to perform operations research and provide advice. To guide a formative Rand and oversee aeronautical research, he created a new position at headquarters, that of Deputy Chief of Air Staff for Research and Development. Arnold selected for this position a young man with a reputation for accomplishing difficult assignments, Major General Curtis E. LeMay.[6]

(U) During 1946 and 1947, at a time of demobilization and declining budgets, LeMay directed improvements in research and development. At Headquarters Army Air Forces in Washington, he established a Weapons Board (later called the Aircraft and Weapons Board) to evaluate and recommend new weapon systems. He planned new research facilities, in particular a research and development center eventually located at Tullahoma, Tennessee and later named after General Arnold. LeMay obtained more funds for Wright Field in Dayton, Ohio, the focal point of the Army Air Forces' research and development program. Among the first studies at Project Rand, he asked for an engineering analysis of an earth satellite vehicle.[7]

(U) General LeMay requested the satellite study in March 1946 after learning of a similar investigation at the Navy Bureau of Aeronautics.[8] He wanted the Rand evaluation completed swiftly,

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*(U) Project RAND (Research and Development) was contracted to the Douglas Aircraft Company, Santa Monica, CA. In subsequent years only the first letter of Rand was normally capitalized, a practice followed hereafter in this work.

in time to match the Navy presentation scheduled for the next meeting of the War Department's Aeronautical Board.* Representatives of the Army Air Forces and the Navy presented their preliminary findings at a 15 May 1946 meeting of the board's Research and Development Committee. Based on these findings, those present agreed that the design and construction of unmanned earth satellites and their carrier rockets appeared technically feasible. In fact, Rand estimated that this task could be completed within five years, by 1951. Although Rand engineers ruled out the satellite as a strategic weapons carrier, they claimed for it a number of important military-support functions including meteorological observation of cloud patterns and short-range weather forecasting, strategic reconnaissance, and the relaying of military communications.[9] The Navy representatives likewise emphasized using earth satellites for fleet communications and as a navigation platform from which to guide missiles and pilotless aircraft.[10] None of the military members present, however, could agree on a joint satellite program, nor confirm that these uses of an earth satellite would justify the anticipated costs.

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*(U) The Aeronautical Board, formed during World War I and made up of ranking military members of the Army and Navy air arms, reviewed aeronautical developments and attempted to reconcile "the viewpoints of the two services for the mutual benefit of aviation." The earth satellite proposals passed from the Aero Board to the War Department's Joint Research and Development Board (JRDB) in early 1947 and, in late 1947 to the JRDB's successor, the Research and Development Board (RDB). Civilian scientists were well represented on the JRDB and RDB, which evaluated and approved all missile and aeronautical research and development among the military departments, and attempted, frequently without success, to prevent duplication of effort.

(U) The study of automatic earth satellites proceeded separately at Rand and the Navy Bureau of Aeronautics while the postwar armed services jockeyed for position in a sweeping military reorganization. President Truman signed the National Security Act on 26 July 1947 that created the National Military Establishment and separate military departments of the Army, Navy, and Air Force. Beginning in September 1947 the three service secretaries reported to a new cabinet officer, the Secretary of Defense. But the reorganization did not immediately assign to any of the military services responsibility for new weapons. The newly-formed Research and Development Board in the Department of Defense postponed any decisions of service jurisdiction over the deployment or operation of intermediate range and intercontinental ballistic missiles--rockets that would be required to propel man-made satellites into earth orbit. Meantime, in the absence of such an assignment, Air Force leaders concentrated their efforts on procuring large, long-range, air-breathing cruise missiles that complemented the manned strategic bomber.[11]

(U) The Research and Development Board, which inherited supervision of the military space studies in the Defense Department, assigned them in December 1947 to its Committee on Guided Missiles. This committee, in turn, formed a Technical Evaluation Group composed of civilian scientists to evaluate the Navy and Air Force programs and recommend a preferred course of action. Chaired by Walter MacNair of Bell Telephone Laboratories, on 29 March 1948 the group delivered its findings and recommendation. The members judged the technical feasibility of an earth satellite to be clearly established; they concluded, however, that neither service had as yet established a military or scientific use commensurate with the vehicle's anticipated costs. Consequently, the group recommended deferring the construction of earth satellites and consolidating all studies of their use at Rand.[12] Adopted by the Research and Development Board, the findings and recommendations ended Navy satellite work for a number of years and focused the study of military satellites at Rand's headquarters on the west coast, in Santa Monica, California.

(U) Rand's* earth satellite work in the late 1940s and early 1950s embraced system and subsystem engineering design, the preparation of equipment specifications, and studies of military uses. It attracted a host of uncommonly able individuals, among them James Lipp, Robert Salter, Richard Raymond, Edward Stearns, William Kellogg, Louis Ridenour, Francis Clauser, Harold Luskin, and Eugene Root. Luminaries from the academic community, such as Harold Lasswell of Yale and Ansley Coale of Princeton, participated in special conferences like the one at Rand in 1949 that surveyed the prospective political and psychological effects of earth satellites.[13] All of these men had a hand in shaping the formative military space program. And all of them could agree by the early 1950s that the most valuable, first-priority military use of a satellite vehicle involved its strategic reconnaissance applications: a platform from which to observe and record activity on the earth.

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*(U) In 1948 Project Rand reorganized as a non-profit consulting firm, The Rand Corporation.

(U) Back in November 1945, with turbojet aircraft already flying, General Arnold concluded that the next war would provide the country little opportunity to mobilize, much less rearm or train reserves. The United States could not again afford an intelligence failure like the one at Pearl Harbor and be caught unaware in another surprise attack. In future, he had cautioned Secretary of War Patterson, "continuous knowledge of potential enemies" including all facets of their "political, social, industrial, scientific and military life" would be necessary "to provide warning of impending danger." Arnold knew well that defensive, pre-hostilities reconnaissance was but one side of a double-edged sword; the other edge cut straight the way for offensive strategic aerial warfare: "The targets of the future may be very large or extremely small--such as sites for launching guided missiles," he declared. Identifying them, like advance warning, also required "exact intelligence information."[14]

(U) The extreme secrecy that cloaked events within the Soviet Union promoted the focus on intelligence gathering. When relations between the United States and the USSR soured after World War II, little intelligence about contemporary Soviet military capabilities existed in the West. In the absence of these hard facts in the late 1940s, perceptions of the intent of Soviet foreign policy assumed much greater importance. At that time American leaders acted on a perception of a "growing intent toward expansion and aggression on the part of the Soviet Union."[15] Shortly after the Soviets detonated an atomic bomb in 1949, the newly-formed Board of National Intelligence Estimates in the

Central Intelligence Agency (CIA) warned of the possibility of a Soviet surprise attack, albeit a limited one, on the continental United States. That prospect, acknowledged in the National Security Council and underscored by the unexpected Korean conflict in June 1950, thereafter haunted the nation's military and civilian leaders.[16]

(U) Among America's leaders in the 1950s, the desire to preclude any chance of a nuclear surprise attack was particularly acute. They had, as Dwight D. Eisenhower's biographer aptly phrased it, "Pearl Harbor burned into their souls in a way that younger men, the leaders in the later decades of the Cold War, had not." Certainly this was true of Dwight Eisenhower in 1953 when he took the oath of office as President, for the subject thoroughly dominated his thinking about disarmament and relations with the Soviets for the next eight years. Besides seeking ways to prevent a surprise attack, Eisenhower also sought "to lessen, if he could not eliminate, the financial cost and the fear that were the price of the Pearl Harbor mentality." To that end he could agree entirely with General Arnold's views that continuous knowledge of one's potential enemies was essential "to provide warning of impending danger." The way to get it, Eisenhower knew from wartime experience, was through overhead reconnaissance.[17]

(U) To secure hard intelligence about Soviet capabilities, the CIA and the Air Force undertook at the beginning of the 1950s a variety of projects. Intelligence officers sifted captured German documents for aerial reconnaissance photographs of the USSR; that these photographs dated from the early 1940s suggests the magnitude of the problem facing American planners. The interrogation of German prisoners of war returning from forced labor in the Soviet Union between 1949 and 1953 helped shed somewhat more light on the status of that country's military and industrial might. The Strategic Air Command began flying RB-50s and RB-47s about the periphery of the USSR on electronic and photographic reconnaissance missions, and obtained considerable information about border installations and defenses. But these missions yielded nothing substantial about the Soviet heartland and the state of its economy, society, and military capabilities and preparations.[18]

(U) Seeking this information, The Rand Corporation proposed and the Air Force conducted the WS-119L program. Beginning in January 1956, on the approval of President Eisenhower, Air Force personnel loaded automatic cameras in gondolas suspended beneath large Skyhook weather balloons, and during the next four weeks launched 516 of these reconnaissance vehicles in Western Europe. The balloons drifted on prevailing winds at very high altitudes eastward across the Eurasian continent, through Soviet airspace. But under the terms of international law to which the United States was party, they clearly violated Soviet national sovereignty. Those that succeeded in crossing released their gondolas on parachutes, which were recovered in mid-air by C-119 cargo aircraft near Japan and Alaska.* Because the aerial path of the balloons

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*(U) In the event aerial retrieval proved unsuccessful, the gondolas were designed to float on the ocean surface and radiate a signal for 24 hours. Sixty-seven balloons actually reached the recovery area; of these, the Air Force retrieved 44 photographic gondolas. (See Reference 19, <u>supra</u>, p. 647.)

could not be controlled, however, the pictures might as easily be of cloud cover or a Siberian forest, as of a factory or a flying field. This program, which produced limited intelligence and strongly-worded Soviet protests, was quietly cancelled on 7 February 1956 at the President's direction. Although the Air Force would subsequently launch a few more of these balloons that operated at higher altitudes, Eisenhower quickly terminated that effort, too. Provoking Soviet retaliation by violating its airspace hardly served the purpose of preventing a surprise attack through overhead reconnaissance.* Meantime, other, more promising avenues of gathering the information appeared.[19]

Research and Initial Development

(U) While the CIA and the Air Force endeavored to gather information about the Soviet Union from whatever the source, the Department of Defense acted on the issue of military roles and missions. On 21 March 1950 Secretary of Defense Louis Johnson assigned to the Air Force responsibility for long-range strategic missiles, including ICBMs. A few weeks later the Research and Development Board vested jurisdiction for military satellites in the same service. With these responsibilities, Air Force leaders directed Rand to complete studies of an earth satellite used for strategic reconnaissance.[20]

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*~~(S)~~ The term "overhead reconnaissance" is used in this history generically, meaning all reconnaissance conducted overhead; it does not apply exclusively to satellites.

~~(C)~~ The Rand report, issued in April 1951, described a spacecraft fully stabilized on three-axes, one that employed a television camera to scan the earth and transmit the images to receiving stations. Assuming some technical improvement in the television system, Rand forecast a resolution at the surface of 100 feet; that is, one could discern objects 100 feet on a side. Launched into polar orbit, the satellite would provide what no other known source could even approach: "continuous coverage over most of the USSR every day." Resolution might be improved to values as low as 40 feet at the surface, although the increased resolution would be achieved "at the expense of coverage." Any coverage, Rand reminded the service, had to occur when "weather permits ground observation."[21] These findings encouraged Air Force leaders to believe that directed, periodic reconnaissance of the Soviet Union might soon be conducted from very high altitudes. To confirm the Rand findings, on 19 December 1951 Headquarters USAF authorized the firm to subcontract for detailed spacecraft subsystem studies. And a few weeks later, in January 1952, Air Force leaders approved a seminal "Beacon Hill" survey of strategic reconnaissance by consultants convened under the auspices of Project Lincoln at MIT.[22]

~~(C)~~ The Beacon Hill Study Group, which first met between 7 January and 15 February 1952, considered improvements in Air Force intelligence processing, sensors, and vehicles. Chaired by Carl Overhage of Eastman Kodak, the 15-member civilian group included James Baker of the Harvard Observatory, Edwin Land (the founder of Polaroid), Stuart Miller of Bell Labs, Richard Perkin (co-founder of Perkin-Elmer), scientific consultant, Louis Ridenour, Allen

Donovan of Cornell Aeronautical Labs, and Edward Purcell of Harvard University. These individuals concluded their deliberations in May and issued a final report in June 1952.

~~(C)~~ The Beacon Hill Report recommended to the Air Force specific improvements in the orientation, emphasis and priority assigned to strategic intelligence, and solutions to the problems involved in its collection, reduction, and use. The study group also suggested refinements in visual and radar-imaging sensors, and especially in those sensors that intercepted electromagnetic emissions (radar activity and radio communications). The improved sensors, the group advised, could be flown near Soviet territory in advanced high-altitude aircraft, the WS-119L balloons, sounding rockets, and in long-range drones such as the Snark or Navaho air-breathing missiles. Whatever the choice of vehicles, study group participants reminded the service that actual "intrusion" over Soviet territory and violation of its national sovereignty required the approval of political authorities "at the highest level." Reconnaissance satellites, mentioned only in passing and then only as space vehicles of the future in the grip of Newtonian mechanics, were however identified as certain intruders that would have to "overfly" the Soviet Union.[23]

~~(C)~~ Elsewhere around the country, various firms under contract to Rand were designing and evaluating specific satellite reconnaissance equipment, including a television payload (Radio Corporation of America), vehicle guidance and attitude control devices (North American Aviation), and a nuclear auxiliary electrical power source (Westinghouse Electric Corporation, Bendix

Aviation, Allis-Chalmers, and the Vitro Corporation). This effort, known collectively as Project Feed Back, confirmed that an automatic reconnaissance satellite could be built soon without any exceptional delays, and at an affordable cost. Whatever the ramifications of overflight might be, in September 1953 Rand officials recommended that such a satellite be built,[24] and a few months later concluded their preliminary work and published a final report.

~~(C)~~ Issued on 1 March 1954, the Project Feed Back summary report described a military satellite for photo-reconnaissance, mapping, and weather analysis, along with examples of the necessary space hardware and ground-support systems. Photographic film would indeed provide better image quality. But Rand recommended a television system because recovery of a photographic payload on earth appeared unattainable in the near future, and the developing, fixing, and scanning of photographic film onboard in a vacuum, zero-gravity environment, amidst the radiation of a nuclear power source, simply presented too many technical problems. The second stage booster-satellite would be launched into a low-altitude, "sun synchronous" polar orbit inclined 83 degrees to the equator. Launched at the proper time of day at this inclination, the satellite would precess in 1 year through 360 degrees, allowing the television camera to operate in maximum daylight brightness over targets of interest throughout all seasons.[25]

~~(C)~~ The image-orthicon television camera RCA proposed for the mission used a video magnetic tape recorder to store the pictures for later readout to ground receiving stations. The initial satellite mapping system featured a 38-inch focal length lens to provide a surface resolution of 71 feet. An advanced reconnaissance system planned for later vehicles was expected to achieve a surface resolution of 18 feet, far better than the 40 feet forecast a few years before. No more than three satellites were considered for operation in orbit simultaneously, for three vehicles "would give virtually complete coverage [of the USSR] daily." The satellite control facility in the United States would have to be designed to accept a "continuous flow" of pictures "equivalent to the output of one vehicle with one shift of personnel, allowing expansion to three shifts to handle three vehicles."[26] Rand engineers expected this satellite reconnaissance system to produce "30 million pictures in one year of operation," a sum equivalent to all the pictures held in the USAF Photo Records and Services Division acquired from all sources in peace and war over the previous 25 years![27] Just where the photo-interpreters needed to evaluate this mountain of information might be found, Rand did not say.

(U) In early 1954, however, the problem that faced American policymakers was not too much intelligence information about the Soviet Union, but far too little. Attempts to fly around or over the USSR had thus far produced only limited information; details of Soviet military preparations and capabilities remained as much an enigma as ever. Continued Soviet production of nuclear weapons and the means to deliver them, such as the Bison long-range bomber, coupled in August 1953 with the Soviet detonation of a thermonuclear bomb particularly disturbed President Eisenhower. As a former Supreme Commander of the Allied Expeditionary Force in

Western Europe, he had helped engineer the destruction of the Axis powers during World War II and knew firsthand the enormous devastation that accompanied modern, total war. An aerial surprise attack on the United States employing nuclear weapons, even a limited one, could lay waste to most of the metropolitan areas on the east and west coasts. Moreover, with government agencies unable to gauge the exact nature and extent of a Soviet military threat, the President found himself at a distinct disadvantage in selecting the appropriate level of military preparedness to combat it. This situation, Eisenhower made clear at a meeting of his National Security Council on 24 February 1954, had to be resolved--and soon. Shortly thereafter, as a first step to counter a possible surprise attack, he approved a Council recommendation to design and construct a Distant Early Warning (DEW) picket line of radars across the North American Arctic, to detect and track any Soviet bombers that might be directed against this country.[28]

(U) Civilian scientists appointed to the Science Advisory Committee in the Office of Defense Mobilization, meantime, had been examining similar issues under the prodding of Trevor Gardner, the "technologically evangelical assistant secretary of the Air Force for research and development." Learning of these studies, the President's special assistant for security affairs, General Robert Cutler, invited key committee members to the White House. Meeting with them on 27 March 1954, Eisenhower discussed his concerns about a surprise attack on the United States and the prospects for avoiding or containing it. "Modern weapons," he warned, "had made it easier for a hostile nation with a closed society to plan an attack in secrecy and thus gain an advantage denied to the nation with an open society." The President, in spite of the Oppenheimer case, apparently viewed the scientists as honest brokers in a partisan city, and he challenged them to tackle this problem.[29]

(U) They did. Lee A. DuBridge, President of the California Institute of Technology and Chairman of the Science Advisory Committee, and James R. Killian, Jr., President of the Massachusetts Institute of Technology, formed a special task force to consider three areas of national security: continental defense, strike forces, and intelligence, with supporting studies in communications and technical manpower. Approved by President Eisenhower in the spring, the Surprise Attack Panel, or the Technological Capabilities Panel (TCP) as it eventually became known, chaired by Killian, conducted its work between August 1954 and January 1955. Its membership included many of those who had produced the Beacon Hill Report, and represented the best that American science and engineering offered. Its report, Meeting the Threat of Surprise Attack, was presented to a meeting of the National Security Council on 14 February 1955; by all published accounts that report affected the course of national security affairs enormously.[30]

~~(S)~~ The Technological Capabilities Panel report resulted in a number of important alterations in American defense preparedness. Among other things, it recommended accelerating procurement of the liquid-propellant intercontinental ballistic missile (Atlas ICBM), constructing land- and sea-based intermediate-range ballistic missiles (later Thor, Jupiter, and Polaris IRBMs), and speeding construction of the DEW line in the Arctic (declared operational in

August 1957). Even more important, perhaps, were the recommendations to acquire and use strategic pre-hostilities intelligence. The Technological Capabilities Panel urged construction and deployment of the U-2 reconnaissance aircraft* that could overfly the Soviet Union at very high altitudes. The committee also identified a time table of changes in the relative military and technical positions of the two super powers.[31] In its section on intelligence applications of science, the TCP report recommended a program leading to development of a small scientific satellite that would operate at extreme altitudes above airspace, and urged a re-examination of international law with regard to establishing the principle "Freedom of Space." But James Killian, who chaired the TCP, viewed the military reconnaissance satellite as a "peripheral project" and refused it active support until the Soviets launched Sputnik I nearly three years later.[32]

~~(S)~~ Back in the summer of 1954, shortly after authorizing the Technological Capabilities Panel surprise attack study, President Eisenhower approved formation of an organization devoted exclusively to that subject: the National Indications Center (NIC). The Center, chaired by the Deputy Director of Central

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*(U) Indeed, Eisenhower had already approved development of the U-2 during the TCP deliberations, on 24 November 1954, and the National Security Council assigned the project to the CIA instead of the Air Force. Under the guidance of Richard M. Bissell, Jr., CIA Special Assistant to DCI, Colonel O. J. Ritland, USAF, and Clarence L. "Kelly" Johnson of Lockheed Aircraft Corporation, the first U-2 was airborne within eight months, on 6 August 1955. (Stephen Ambrose, Ike's Spies New York: Doubleday & Co., 1981, p. 268; see also Leonard Mosley, Dulles New York: Dial Press, 1978, pp. 365-366.)

Intelligence and composed of intelligence specialists drawn from the CIA, NSA, and Departments of Defense and State, formed the interagency staff of the National Watch Committee, which in turn consisted of Presidential confidants such as the Secretaries of State and Defense, and the Director of Central Intelligence. National Security Council Directive 5412 chartered the NIC on 1 July 1954 for the express purpose of "preventing strategic surprise". The Center drew on information furnished by all national intelligence organizations, including any photographic and electronic evidence acquired from overhead reconnaissance. Eisenhower, as one of the NIC participants recalled, was a man "boresighted on early warning of surprise attack."[33]

~~(S/TK)~~ Essentially, the National Indications Center assayed the military, economic, and social demands involved in mounting a surprise attack and issued a weekly "watch report" to the watch committee members. Staffers expanded an indications list of key indicators developed earlier under the direction of [redacted] 3.3 (b)(1)
[redacted] in the CIA, and applied it to developments that would presage surprise attack in the nuclear age.* That is, presuming

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*(U) A Rand study doubtless figured in these deliberations and actions, though a direct linkage is not established at this time. One year earlier, three months after President Eisenhower's inauguration, Andrew W. Marshall and James F. Digby issued Rand Special Memorandum SM-14 (TS), <u>The Military Value of Advanced Warning of Hostilities and its Implications for Intelligence Indicators</u>, April 1953 (Rev. July 1953). The authors compared intelligence warning of attack to the performance of military forces, and urged attention to short-term indications of Soviet preparations for surprise attack. Copies unquestionably circulated within the Intelligence Community, including the CIA. [redacted] 3.3 (b)(1)
advised the author that the British first developed an indicators

rational political leadership, one state intending to attack another would need to prepare carefully, say from dispersing its industry and population many months in advance, to the calculated deployment of military forces on land and sea just days or hours before "M-day." Thus, the proper intelligence "indicators" applied against this matrix would yield readily identifiable signals, much like a traffic light: green-normal activity, amber-caution, red-warning. These indicators linked to "defense conditions" (DEFCON 5 through 1) enabled leaders to mobilize resources and establish force readiness postures. The military, economic, and technical indicators listed in this matrix successfully predicted the Suez War in 1956, and have been monitored and reported in one form or another to the President and other command authorities, such as the Strategic Air Command, ever since. The National Indications Center itself, however, was dissolved in March 1975, shortly before near real-time imaging from reconnaissance satellites became possible. After January 1977, these particular satellites filled the need for "indications and warning" (INW) on a daily basis.[34]

Establishing Space Policy, Organizing the Space Program

(U) Although Dwight Eisenhower worried considerably about the danger of a Soviet surprise attack in the mid-1950s, he was also determined, if at all possible, to keep outer space a region

list in 1948 to identify actions the Soviets would have to take to occupy Berlin. He subsequently altered and expanded the list at the CIA in the late 1940s and early 1950s to identify actions that would warn of a surprise attack against the United States.

open to all, where the spacecraft of any state might overfly all states, a region free of military posturing. By adopting a policy that favored a legal regime for outer space analogous to that of the high seas, the President would make possible the precedent of "free passage" in space, with all that that implied for overhead reconnaissance. This choice also favored non-aggressive, peaceful spaceflight operations, especially the scientific earth satellite program of space exploration that civilian scientists now urged as part of the U.S. contribution to the International Geophysical Year (IGY).* Nonetheless, Eisenhower still faced insistent military commanders who, in the absence of firm intelligence and anxious to prepare for any contingency, pressed relentlessly for larger forces on land, at sea, in the air--and in outer space.[35]

~~(S)~~ The military services, to be sure, sought approval for various missions in missilery and spaceflight. A few months after Rand's Feed Back report appeared, the Air Force acted on its recomendations. On 29 November 1954 Headquarters Air Research and Development Command issued System Requirement (SR) No. 5 that called for system design studies of an Advanced Reconnaissance Satellite, one that would employ visual imaging, ferret, and "other" sensors. For visual imaging, a resolution of 20 feet at the earth's surface was set as the goal. On 16 March 1955, a few

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*(U) In 1952 the International Council of Scientific Unions established a committee to arrange another International Polar Year to study geophysical phenomena in remote areas of the earth (two previous polar years had been conducted, one in 1882-83 and another in 1932-33). Late in 1952 the council expanded the scope of this effort, planned for 1957-1958, to include rocket research in the upper atmosphere and changed the name to the International Geophysical Year.

weeks after the National Security Council acted on the findings of the Technological Capabilities Panel, Headquarters USAF issued General Operational Requirement No. 80 (SA-2c) that endorsed SR No. 5, and approved construction of and provided technical requirements for strategic reconnaissance satellites. The objective: continuous coverage of the earth to "determine the status of a potential enemy's warmaking capability." In April 1955 the Naval Research Laboratory proposed a "Scientific Satellite Program" for the IGY, using as a first-stage booster the Viking sounding rocket. Meantime, the Army's Redstone rocket team led by Major General John B. Medaris and Wernher von Braun, which had for some months urged a small, inert earth satellite launched with the Jupiter IRBM, increased the pressure in the Department of Defense for approval of their proposal, called Project Orbiter. These events, and the others they precipitated, made 1955 the most momentous of years for the inchoate American space program.[36]

~~(S)~~ Early in May 1955, officials in the Department of Defense agreed that the country should launch scientific earth satellites as a contribution to the IGY. This recommendation, endorsed by the Technological Capabilities Panel composed of leading scientists, was submitted on 13 May to the National Security Council. NSC members meeting on 26 May likewise endorsed the plan and established national policy guidance: The scientific satellite project would not interfere with development of high priority ICBM and IRBM weapon systems; emphasis would be placed on the scientific and peaceful purposes of the endeavor; the scientific satellites would help establish the principle in international law of "Freedom of Space" and the right of unimpeded overflight that went with it, and serve as a technical precursor for subsequent American reconnaissance satellites. "Considerable prestige and psychological benefits," council members added, "will accrue to the nation which first is successful in launching a satellite."[37] The next day, "after sleeping on it," Eisenhower approved this project.[38]

~~(S)~~ On the President's decision, the United States had tentatively set out to pursue two closely-associated space programs: Instrumented military applications and civilian scientific satellites. Presidential advisors still perceived reconnaissance satellites to be a long way off; the IGY and its scientific satellites, however, were clearly identified as a stalking-horse to establish the precedent of overflight in space for their eventual operation. Charged with the military reconnaissance satellites, the Air Force earlier in 1955 had selected three firms to compete in a one year design study: Lockheed Aircraft Corporation, (teamed with CBS Labs and Eastman Kodak), the Glenn L. Martin Company (with Philco), and RCA (with Douglas Aircraft). Neither the military nor the scientific satellite program, however, had as yet selected a contractor to conduct the work. And neither shared a national priority.

(U) Out in Burbank, California, in Kelly Johnson's Lockheed "skunkworks," the CIA's U-2 project quite clearly claimed the highest of national priorities. With the first of these turbojet powered gliders nearing completion, with an operating ceiling anticipated in excess of 70,000 feet, Eisenhower learned that the United States could soon overfly parts of Soviet airspace at will.[39]

No known jet fighter aircraft operated at altitudes above 50,000 feet. But however safe manned overflight might appear, and however attractive the chance to know more about Soviet military capabilities might be, any unauthorized penetration of another state's airspace represented a clear violation of international law, a violation, that is, unless the leaders concerned agreed to such flights.

(U) On 21 July 1955, at a summit meeting in Geneva, Eisenhower advised his Soviet counterparts of just such a prospect. The President, in an unannounced addition to a disarmament proposal, directly addressed the subject that most concerned him. The absence of trust and the presence of "terrible weapons" among states, he asserted, provoked in the world "fears and dangers of surprise attack." To eliminate these fears, he proposed that the Soviet Union and the United States provide "facilities for aerial photography to the other country" and conduct mutually supervised reconnaissance overflights.[40] Before the day ended, the First Secretary of the Communist Party Nikita Khrushchev rejected the President's plan, known eventually as the "Open Skies" doctrine, as an obvious American attempt to "accumulate target information." "We knew the Soviets wouldn't accept it," Eisenhower later confided in an interview, "but we took a look and thought it was a good move."[41] Though the Soviets might object, they were forewarned. Eleven months later he would approve the first U-2 overflight of the Soviet Union.[42]

(U) Back in the United States a few days later, on 29 July 1955, Eisenhower publicly announced plans for launching "small unmanned, earth circling satellites as part of the U.S. participation in the International Geophysical Year" scheduled between July 1957 and December 1958, though he carefully omitted any reference to the underlying purpose of the enterprise. He assigned responsibility for directing this program to the National Science Foundation, with "logistic and technical support" to be furnished by the Department of Defense. A few weeks later the Defense Department selected the Naval Research Laboratory's Vanguard proposal, one that combined modified Viking and Aerobee-Hi sounding rockets for the scientific satellite booster, and named the Navy manager for logistics and technical support.[43]

~~(S)~~ Within a year, in June 1956, the Air Force chose Lockheed's Missile Systems Division, quartered in Sunnyvale, California, to design and build the military satellites, termed collectively the WS-117L program. Lockheed's winning proposal featured a large, second-stage booster-satellite that in orbit could be stabilized on three axes with a high pointing accuracy. This vehicle, to become known as "Agena," would be designed to meet Air Force plans for a reconnaissance satellite with full operational capability in the third quarter of 1963.[44] If the diminutive Vanguard scientific satellite was projected to weigh tens of pounds and be launched by a modified sounding rocket, the proposed Air Force satellite would weigh thousands of pounds and be launched atop an Atlas ICBM.*

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*(U) In the mid-1950s, Convair's James W. Crooks, Jr., constantly reminded audiences at Wright-Patterson AFB and elsewhere that the Atlas had the capability to lift the weight of a new Chevrolet, 3,500 lbs., into low earth orbit. In fact, as events turned out, Atlas with a powered upper stage could lift a good deal

~~(C)~~ Encountering problems in development of the needed technology, Lockheed recommended photographic payloads instead of the image-orthicon television system that required complex image dissection and video-tape recording. By substituting batteries and solar cells in place of a nuclear auxiliary power source, the photographic film, developed on board, could be scanned and the pictures radioed to ground-based receiving stations using available technology. At CBS Labs, Peter Goldmark led the team that fashioned the flying-spot film scanner and earth-space communication links; Kenneth MacLeish, his counterpart at Eastman Kodak, was responsible for the cameras. A mapping camera would provide a resolution of 100 feet at the surface of the earth; another camera would employ a lens of greater focal length for a resolution of 16 feet. Among other military payloads, Lockheed also recommended for development those already identified by intelligence agencies, the Navy and Rand (electronic and weather reconnaissance, navigation and communications), and added one of its own: An infrared radiometer and telescope to detect the hot exhaust gases emitted by long-range jet bombers and, more importantly, large rockets as they ascended under power through the atmosphere.[45] This novel aircraft-tracker and missile-detection innovation proposed by Joseph J. Knopow, a young Lockheed engineer, fit nicely into the surprise attack warning efforts of the day, and unquestionably helped tip the scales in Lockheed's favor. The Air Force awarded the firm a contract for this program a few months later in October 1956.

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more--about 10,000 lbs into low earth orbit.

~~(S/TK)~~ Thus, a year before Sputnik, the United States possessed two modest space programs that moved ahead slowly, staying within strict funding prescriptions and avoiding unwanted interference with the development of the nation's long-range ballistic missiles just underway. They shared a low priority among other high-technology programs, and the Eisenhower Administration discouraged government officials from public discussions of spaceflight.[46] Seeking to justify increased funding, a higher priority, and continued Air Force control of the reconnaissance satellite program, in mid-June 1957 Major General Bernard A. Schriever, Commander of the Air Force Ballistic Missile Division, met with James Killian, now Chairman of the President's Board of Consultants on Foreign Intelligence Activities (PBCFIA, later known as the President's Foreign Intelligence Advisory Board--PFIAB--which eventually recommended establishment of a special management structure for satellite reconnaissance) But the CIA's U-2 program was now producing solid intelligence results, and the meeting did not persuade the President's intelligence advisors to actively support the Air Force reconnaissance satellite program. In July the Defense Department imposed spending limits on Lockheed's satellite work.[47]

(U) This condition changed dramatically a few months later, in October-November 1957, after the Soviet Union launched Sputniks I and II. Despite Presidential assurances,* the Soviet space

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*(U) In his first news conference after the launch of Sputnik I on 9 Oct 1957, President Eisenhower let slip his real interest in the event, though it went unnoticed in the excitement of the day.

accomplishments fueled a national debate over U.S. defense and science policies. Eisenhower and his advisors had clearly overlooked the psychological shock value of earth satellites that Rand had identified and the National Security Council had underscored just a few years before. What had begun as an evenly, if slowly-paced, research and development effort was to be spurred forward at a gallop.[48]

~~(S/TK)~~ The sputniks, with their "Pearl Harbor" effect on informed opinion, introduced into space affairs the issues of national pride and international prestige. The administration now moved quickly to restore public confidence at home and prestige abroad. In short order the Defense Department authorized the Army to launch a scientific satellite as a backup to the National Science Foundation-Navy Vanguard Project, and the President created the Advanced Research Projects Agency (ARPA), assigning to it temporarily responsibility for directing all U.S. space projects. James Killian had also changed his mind, and on 7 February 1958, President Eisenhower, following a briefing by Edwin Land, approved a covert reconnaissance satellite project to be funded and directed by the CIA, and technically managed by the Air Force and ARPA in a manner reminiscent of the U-2 project. Eventually known as KH-1 through KH-4 to the witting (and as Discoverer - a scientific project - to those who were not), this reconnaissance satellite, which was to be placed in orbit sooner with a Thor IRBM launcher,

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"From what they say they have put one small ball in the air," the President declared, adding, "at this moment you [don't] have to fear the intelligence aspects of this." Public papers of the President of the United States: Dwight David Eisenhower, 1957 (Washington, DC: USGPO, 1958 (210), p. 724.)

featured a Rand-recommended film payload to be recovered in mid-air.* Finally, in March the Secretary of Defense ordered ARPA to launch space vehicles to "provide a close look at the moon."[49]

(S) The popular demand to get on as rapidly as possible with the exploration and use of space was undeniable. To guide this activity, Eisenhower declared on 2 April 1958, a unified national space agency had to be established.[50] Few disagreed, least of all prominent American scientists who had begun to consider seriously the future of research in space, the prospects for obtaining more federal funds for this activity, and the ways of organizing it within the government that met their expectations of scientific independence, integrity, and excellence. During the subsequent dialogue and in legislative action, the nation's political leaders endorsed the President's choice of civilian control of expanded U.S. space activities. Aside from national defense space operations, for which the intelligence agencies and the Department of Defense remained responsible, the National Aeronautics and Space Act declared that all non-military aeronautical and space activity sponsored by the United States would be directed by a civilian agency guided by eight objectives. First among them was basic scientific research, defined as "the expansion of human knowledge of phenomena in the atmosphere and space . . . ." Signed into law by President Eisenhower on 29 July, the act wrote a broad and

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*(TS/TK) After the launch of Sputnik I on 4 October 1957, James Killian, the President's intelligence advisor soon-to-become science advisor, reconsidered reconnaissance satellites. By the end of the month he supported the proposal that became the KH-4.

comprehensive mandate for the peaceful pursuit of new knowledge and accompanying technology in space.[51]

~~(S/TK)~~ The National Aeronautics and Space Administration, or NASA, began operating on 1 October 1958 with the ongoing scientific satellite and planetary flight projects inherited from the National Science Foundation and ARPA. Air Force and other service leaders, limited exclusively to approved military spacefaring, still had to translate existing plans into functioning systems. Those instrumented military satellite projects already underway and projected at the end of 1958 formed the basic military space program.* The plan, which encompassed five functional areas, each consisting of one or more military space projects, appears in Table 1.** Though in years to come the Air Force would for the most part retain responsibility for building, launching and operating military spacecraft, development and operational direction of the

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*(U) Various Air Force officials, it is true, attempting to gain responsibility for directing the nation's space program in 1958, did graft to this basic plan and present to Congress all sorts of exotic space proposals including manned and unmanned orbital bombardment systems, and even lunar military bases from which to attack countries on earth. Besides flying in the face of stated administration commitments to explore and use outer space for peaceful and defensive purposes only, these proposals gained few adherents outside of those who viewed the Soviet Sputniks with undenied hysteria.

**(U) This plan, it is also true, does not appear in this form in contemporary documents. Table 1 contains the unmanned military space projects approved or proposed in late 1958 arranged by functional category, excluding the offensive systems mentioned in the preceding note. Notwithstanding the variations that marked it afterwards, the plan describes the basic American military space program in effect today.

individual projects were frequently assigned to the National Reconnaissance Office (NRO) or to one or another of the military services,[52] with the respective products furnished to a variety of government agencies.

~~(S/TK)~~ When NASA opened for business in 1958, periodic U-2 flights over limited areas of the USSR had been underway for more than two years. While the Soviets had protested privately through diplomatic channels, administration leaders knew that improved missiles would soon preclude all aerial overflights, and President Eisenhower had in early 1958 approved the KH-4 reconnaissance satellite project. Late in the year, the President officially notified the Russians once again that the United States specifically sought, through aerial and space reconnaissance, to allay fears of surprise attack. He did so by submitting a third, much more significant Open Skies proposal at an extraordinary "Surprise Attack Conference" sponsored by the United Nations in Geneva.* Making his proposal the more remarkable, Eisenhower authorized his representatives, William C. Foster of the Arms Control and Disarmament Agency and the Harvard chemist George Kistiakowsky, to include a "sanitized" version of the threat and warning portions of the intelligence surprise attack indications matrix, supplied by the National Indications Center, thereby

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*(U) The second proposal Eisenhower submitted to Nikolai A. Bulganin, Chairman of the Soviet Council of Ministers on 2 March 1956, eight months after the original proposal in Geneva. Here, Eisenhower agreed to accept on-site inspection teams if the Soviets would accept Open Skies. It, too, was rejected. See Stephen E. Ambrose, Eisenhower: Volume II, The President (New York: Simon and Schuster, 1984), p. 311.

furnishing Soviet officials key indicators with which to measure the military status of NATO states--if they had not already devised similar warning indicators independently. The Soviets once again rejected Open Skies, but U.S. commitments and intentions on this issue were here made plain.[53] Even though the Soviets refused to accept Open Skies in international conference, might not the precepts of international law now be applied to achieve it?

(S) One year earlier Soviet Sputniks I and II had overflown international boundaries without provoking diplomatic protests. Four days after Sputnik I, Eisenhower and Assistant Secretary of Defense Donald Quarles discussed the issue. Quarles suggested: ". . . the Russians have in fact done us a good turn, unintentionally, in establishing the concept of freedom of international space . . . . The President then looked ahead . . . and asked about a reconnaissance [satellite] vehicle."[54] The American Explorer and Vanguard satellites that followed the first Sputniks in early 1958 likewise transited the world freely, and again states did not object. This tenuous principle, the evidence indicates, President Eisenhower purposely sought to exploit and codify when he signed the space act that formally divided American astronautics between civilian science and military applications directed to "peaceful," that is, scientific, or defensive and nonaggressive purposes.

(S) President Eisenhower amplified his space policy with National Security Council directives in August 1958 and December 1959. The first of these judged future reconnaissance satellites to be of ". . . critical importance to U.S. national security", identified them with the peaceful uses of outer space, and set as an objective the ". . . 'opening up' of the Soviet Bloc through improved intelligence and programs of scientific cooperation." The second directive described the reconnaissance satellite and the military-support missions in space that fell within the rubric of peaceful uses; identified offensive space-weapon systems for study; and noted a positive milestone in international law: The United Nations Ad Hoc Committee on the Peaceful Uses of Outer Space now accepted the ". . .'permissibility of the launching and flight of space vehicles . . . regardless of what territory they passed over during the course of their flight through outer space.'" But the UN Committee, the directive noted further, at the same time emphasized that this principle obtained only for flights involved in the ". . .'peaceful uses of outer space.'"[55]

~~(C)~~ Hewing to the policy of peaceful space activities, the Eisenhower administration would, in the months ahead, permit only the study of offensive space weapons such as space-based ABM systems, satellite interceptors, and manned orbital bombers that could threaten the precedent of free passage. This policy secured two objectives simultaneously and permitted the launch and operation of military reconnaissance spacecraft: First, it reinforced the Sputnik precedent as an accepted principle among states, officially recognizing free access to and unimpeded passage through outer space for peaceful purposes. Second, by limiting military spacefaring to defense-support functions, it avoided a direct confrontation with the Soviet Union over space reconnaissance and ensured at least an opportunity to achieve "Open Skies" at altitudes above the territorial "airspace" of nation states. At the end of 1958, however, the actual launch and operation of reconnaissance spacecraft had yet to test the President's policy--and Soviet reaction.

CHAPTER TWO

SPACEFLIGHT OPERATIONS UNDERWAY

~~(TS/TK)~~ The Air Force general operational requirement for a strategic reconnaissance satellite issued in March 1955, called for a date of "availability" 10 years later, in 1965.[1] That date bespoke the low priority first accorded the satellite reconnaissance system by the National Security Council and clearly marked the satellite to follow and complement the U-2. But the Soviet space successes in 1957 helped accelerate all American space activity, including reconnaissance satellites. On 7 February 1958, President Eisenhower approved the KH-4 satellite project, predicated on recovering film capsules from orbit, with an initial operational capability in 1960. The overriding purpose of these efforts at overhead reconnaissance, whether electronic or visual, remained that of improving the "gross warning of impending attack" and enhancing the target folders of the Strategic Air Command.[2] Later, beginning in the 1970s, overhead reconnaissance would also serve the purposes of verifying certain aspects of arms-control treaties and providing "real-time" indications and warning.

~~(C)~~ The impetus that sputnik transferred to American space affairs proved most fortuitous, for the Soviet Union, using a new ground-to-air missile, shot down a CIA U-2 reconnaissance aircraft operating at design altitude (above 70,000 feet) on 1 May 1960 deep over the Soviet heartland.* That event scuttled plans for a summit

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*~~(S/TK)~~ On the President's orders, all previous flights traversed relatively short, "u-shaped" trajectories in and out of Soviet territory. This was the first (and last) attempt at

conference among Soviet and Western leaders scheduled later in May, and consigned future aerial-reconnaissance missions once more to flights about the periphery of the USSR. It also precipitated a thorough reappraisal of the Air Force reconnaissance satellite program at the highest levels of the government.[3]

Directing and Managing Overhead Reconnaissance

(U) As General H. H. Arnold had perceived years before, the reconnaissance photographs and other data furnished by the U-2 flights over the Soviet Union divided logically between development/technical (threat and warning) intelligence, on the one hand, and operational (targeting and countermeasures) intelligence, on the other. In the most important first category, they had revealed ". . . only a moderate test effort and, to the end of the flights, no deployment of operational ICBMs."[4] In Paris in mid-May 1960, Soviet Communist Party Chairman Nikita Khrushchev loudly condemned the U-2 overflights as an aggressive act in violation of international law. But before the Summit Conference dissolved, the Soviet leader advised French President Charles de Gaulle that the USSR did not object to earth satellites carrying photographic cameras in outer space. That remark, President Eisenhower's new Special Assistant for Science and Technology George B. Kistiakowsky recalled, eventually "...became the foundation of a consistent policy (on reconnaissance satellites) of both superpowers."[5]

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unauthorized aerial intrusion across the entire country, from Pakistan to Norway.

(TS/TK) Having cancelled any further aerial-reconnaissance overflights of the USSR, President Eisenhower on 26 May 1960 asked that an ad hoc group be formed to assess the nation's defense intelligence requirements, the ability of the Air Force Samos reconnaissance satellites to meet them, and the Defense Department plans for employing the system. To conduct that assessment, science advisor Kistiakowsky formed a small panel that included Polaroid's Edwin H. Land, a member of the President's Scientific Advisory Committee (PSAC); Joseph V. Charyk, Under Secretary of the Air Force; and Carl F. C. Overhage of Lincoln Laboratory. In the wake of the U-2 incident, and looking to satellites as a replacement, Eisenhower wanted the panel's conclusions and recommendations presented to the National Security Council as soon as possible.[6] In the weeks that followed, Charyk, Land, Kistiakowsky, and Kistiakowsky's associates in PSAC, performed the bulk of the review and staff work. The importance of their efforts was underscored on 19 August 1960 when the Air Force recovered the first film capsule ejected from an earth-orbiting KH-4 satellite.* Based on this recovery, and in spite of the loss of the U-2 four months before, it now appeared that the United States could continue to monitor selected activity in the Soviet Union, this time from outer space.[7]

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*(C) Project personnel, led by Colonel Lee Battle at the Air Force Ballistic Missile Division in Los Angeles, and James Plummer at Lockheed Sunnyvale, had identified and fixed the cause of numerous reentry capsule failures just a few weeks earlier. Many of the techniques used in the aerial recovery of this satellite capsule near Hawaii, it is worth noting, were conceived by William Kellogg and Stanley Greenfield at Rand and developed in the early 1950s to recover the balloon capsules in the WS-119L program.

~~(TS/TK)~~ In the summer of 1960 the original Air Force reconnaissance satellite effort at Lockheed, first known as WS-117L, and later renamed the Samos program, consisted of some six or seven different payloads in various stages of planning and development. Unlike the KH-1--originally part of the WS-117L effort--the Samos component had never been highly classified and its planning and contracting was widely reported in the press, which became a source of acute embarrassment after the U-2 episode in May. The Ballistic Missile Division (BMD) of the Air Research and Development Command (ARDC) contracted for and directed procurement of the upper stage booster-satellite at Lockheed. BMD also launched the satellite vehicles from missile ranges on the east and west coasts, and commanded them on orbit. Air Force plans ultimately called for the Strategic Air Command to direct the operational Samos system from Omaha, with the product furnished to government users. But this arrangement, in the opinion of a majority on the satellite reconnaissance review panel, did not best serve the interest of the country.[8]

~~(TS/TK)~~ The panel members agreed that the intelligence to be acquired by Samos reconnaissance satellites, like that acquired by U-2 aircraft, was a national asset that should not be entrusted to any single military service. Indeed, as an intelligence user, and besides information on air defenses, the Strategic Air Command needed only operational targeting information. This consideration, the need for clandestine operations to avoid a confrontation with the Soviet Union on this issue, and Air Force management practices that had yet to produce positive results with the Samos film-readout system, caused panel members to recommend that executive responsibility for and direction of the Samos reconnaissance satellite program be vested firmly at the highest civilian levels of the Office of the Secretary of Defense, and that the Air Force, acting through a streamlined organization directly under the Air Force Secretary, manage it for the national intelligence directors. Moreover, to speed development of an operational system, panel members urged that first priority go to film-recovery efforts such as the KH-4, with a lower priority accorded the Samos program. These conclusions and recommendations, with assent from Secretary of the Air Force Dudley C. Sharp making them unanimous, were presented to the President and the National Security Council on the morning of 25 August 1960.[9]

(TS/TK) To prevent a surprise attack and ensure the security of the United States, President Eisenhower had to know at any given moment the military posture of the Soviet Union. A few days earlier he had publicly announced increased funding of the Samos reconnaissance satellite program.[10] Now, he listened attentively to the presentation and approved all of the recommendations made by the satellite reconnaissance panel. The reorganized and covert program would be directed for him by the Secretary of Defense and the Director of Central Intelligence (DCI), through the Office of the Secretary of the Air Force. The development and operation of the KH-4 and Samos satellites would be paid for by the Defense Department and managed by the CIA and Air Force, with a line of command running directly from the Secretary of the Air Force to the Air Force officer in charge on the West Coast.[11] In this arrangement, the Air Force retained control of the Samos series of reconnaissance vehicles, while the CIA remained in charge of the KH-4 and KH-5 payloads. Besides clearly identifying those civilians responsible for directing the consolidated effort and streamlining its military management, the NSC accorded reconnaissance satellites the highest of national priorities. No longer a backup to the U-2, they would become the linchpin of the nation's strategic intelligence effort. In his diary that evening, George Kistiakowsky mused: "If the Defense Department sticks by its agreement with our recommendation of Samos . . . this may be a major accomplishment of my eighteen months in office."[12]

(TS/TK) The Defense Department and the other institutional participants that acted on a NSC directive issued shortly thereafter did adhere to the Samos agreement. The special offices rapidly appeared, one in the Office of the Secretary of the Air Force and a second on the west coast near the Ballistic Missile Division (later Space Systems Division), in Inglewood. On 31 August 1960, Air Force Secretary Sharp established within the Pentagon the Air Force Office of Missiles and Satellite Systems (in September 1961 redesignated Office of the Secretary of the Air Force for Space Systems [SAFSS] and, still later in May 1962, its covert cover, the National Reconnaissance Office [NRO]).* This office would control and fund the reconnaissance satellite program under the direction of Air Force Under Secretary Charyk and a CIA-KH-4 representative, Richard M. Bissell, Jr., both of whom reported to the Deputy Secretary of Defense.** [13] Sharp appointed

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*This was implemented through an operational security system,

**Bissell, for reasons of his own, chose not to actively

Major General Robert E. Greer director of the new Office of the Secretary of the Air Force Special Projects (SAFSP) to technically manage the operation from the west coast.[14] Greer, with two stars, reported directly to Charyk and could task the Ballistic Missile Division as needed. (The Ballistic Missile Division in 1961 bifurcated into the Ballistic Missile Division and Space Systems Division; SSD remained in Inglewood near General Greer's SAFSP office, while BMD moved to Norton AFB in San Bernadino.) These actions entirely removed Air Force Systems Command (formerly ARDC) from any directive role in the covert program. They also marked the formal division of the U.S. space program into three branches: civil, military, and reconnaissance (the NRO).

~~(TS/TK)~~ As head of the nation's satellite reconnaissance programs, Air Force Under Secretary Charyk reported directly to the Deputy Secretary of Defense and possessed in these matters greater power than the Air Force Secretary or Chief of Staff. Only a few members of the Air Staff, the Chief and Vice Chief of Staff, the Deputy Chief of Staff for Research and Development, and the Assistant Chief of Staff for Intelligence, knew that the SAFSS was a cover for Charyk's secret space reconnaissance position. Except for those in Space Systems Division who worked with General Greer, and others who received air defense and targeting intelligence at SAC, organizational actions excluded Headquarters USAF and virtually all field commands from any participation in or knowledge of this activity.[15] Indeed, with the President's approval, the

participate in SAFSS affairs until June 1961.

reconnaissance satellite program itself disappeared entirely from "open" governmental discussion, if not entirely from public view.

~~(TS/TK)~~ The reconnaissance satellite management arrangement that the President approved on 25 August 1960 was amended a year later, on 6 September 1961. In an agreement with the Deputy Director of Central Intelligence, Lt General Charles P. Cabell, and the Deputy Secretary of Defense, Roswell Gilpatric established the National Reconnaissance Program (NRP). The NRP consisted "of all satellite and aerial overflight reconnaissance projects" operated by U.S. agencies, specifically those programs controlled by the Under Secretary of the Air Force (designated Special Assistant for Reconnaissance to the Secretary of Defense) and the Deputy Director for Plans of the Central Intelligence Agency. Under terms of this agreement, the NRO, still known publicly as the SAFSS, funded the NRP and operated under the streamlined management arrangements already established. The SAFSP on the West Coast acquired certain NRP* spacecraft and performed launch integration for all of them.[16]

~~(TS/TK)~~ Efforts to convert the 6 September 1961 CIA-Air Force agreement into a workable division of responsibilities led to an exchange of proposals during the period 22 November to 5 December 1961. Following Bissell's resignation in February 1962, unwanted tension developed between the Agency and the Air Force which led, over the next four years, to the negotiation and signing

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*~~(TS/TK)~~ The National Reconnaissance Program, in turn, became one element of what became eventually the five-component National Foreign Intelligence Program (NFIP). See note at Page 36.

of three more NRP agreements. The second NRP agreement, negotiated by General Curtin and Colonel Martin for the Air Force and Bissell's successor at CIA Herbert Scoville and his assistant Eugene Kiefer, was signed by DCI John A. McCone and Deputy Defense Secretary Roswell Gilpatric on 2 May 1962, only 10 weeks after Bissell's departure. This document set forth the responsibilities of the NRO in conducting the National Reconnaissance Plan and established a single Director (DNRO) jointly appointed by the Secretary of Defense and the DCI. It made no mention of a deputy director (DDNRO), because Charyk was loathe to create a new hierarchy in the Pentagon. A DoD Directive officially named Charyk DNRO on 14 June 1962.

~~(TS/TK)~~ The absence of high-level CIA participation in the new NRO bureaucracy fostered continuing tension between the two major participants, the CIA and the Air Force, which soon led to a third NRP agreement, signed by DCI McCone and Deputy Defense Secretary Cyrus Vance on 13 March 1963. This pact, however,was honored more in the breach than in the observance and a fourth NRP agreement had to be negotiated in the summer of 1965. After almost four years of contention, the two sides finally secured an agreement that worked. Signed by McCone's successor as DCI, Admiral William F. Raborn, Jr., and Deputy Defense Secretary Cyrus Vance on 11 August 1965, the document provided that the Secretary of Defense would appoint the NRO's Director (Air Force) and concur in the choice of a Deputy Director (CIA), and delineated their responsibilities. It also formally established the NRO Executive Committee (ExCom), comprised of the Deputy Defense Secretary, the DCI, and the Special Assistant to the President for Science and

Technology, to "guide and participate in the formulation of the NRP" and approve its budget.[17]

~~(TS/TK)~~ While these actions provided the organizational framework in which to fund and conduct the NRP, the U.S. Intelligence Community established the specific requirements that the program needed to fulfill. With the U-2 program underway in 1958, President Eisenhower approved formation of a U.S. Intelligence Board (USIB) which, among other intelligence concerns, was responsible for establishing requirements for collecting and disseminating signals intelligence (SIGINT), missile and nuclear intelligence, and imagery. Chaired by the DCI, the USIB was composed of representatives from the intelligence agencies, the FBI, AEC, the National Security Council, Departments of State and Defense, and the Joint Chiefs of Staff. In January 1959 the USIB established a Satellite Intelligence Requirements Committee (SIRC), later renamed the Committee on Overhead Requirements (COMOR), that identified intelligence targets in the Sino-Soviet Bloc to be examined and set their respective priorities.[18]

~~(TS/TK)~~ Seeking to avoid the costs of duplicated image-evaluation laboratories, in January 1961 President Eisenhower approved formation of a single National Photographic Interpretation Center (NPIC), an organization directed for many years by CIA's Arthur C. Lundahl. NPIC evaluated and distributed the pictorial "take" of the satellite and aerial reconnaissance systems. On the SIGINT side at that time, the National Security Agency (NSA) processed the bulk of communications intelligence (COMINT) and provided cryptologic services, while the military services processed most of the electronic intelligence (ELINT), primarily for electronic warfare purposes. This separation blurred in the early 1960s as NSA asserted its charter under National Security Council Intelligence Directive (NSCID) 6 (15 September 1958) to be responsible for processing all SIGINT, including ELINT, collected by reconnaissance satellites.

~~(TS/TK)~~ The USIB's Committee on Overhead Requirements, meantime, was redesignated the Committee on Imagery Requirements and Exploitation (COMIREX) in 1966. Besides setting the nation's intelligence requirements and priorities, its members also considered how these requirements would be filled. COMIREX established unified standards of imaging quality and terminology, and assessed the exploitation of the intelligence products. A separate entity, the SIGINT Overhead Reconnaissance Subcommittee (SORS), was established to task the SIGINT collectors. The USIB itself was renamed the National Foreign Intelligence Board (NFIB) in 1975 and has continued to the present day.[19]

~~(TS/TK)~~ The institutions that set intelligence requirements and priorities might have evolved in a reasonably straightforward fashion, but NRO's relationship with the Defense Department and the Intelligence Community changed markedly between 1961 and 1986. The change began on 26 January 1973 when President Nixon abolished the position of Special Assistant to the President for Science and Technology, thereby removing a key member of the ExCom--along with a representative from the Bureau of the Budget, who had previously accompanied the science advisor to ExCom meetings. A short time later President Nixon appointed the Director of Central

Intelligence, Richard Helms, his successors, James R. Schlesinger and subsequently William Colby, as Chairman of the NRO ExCom in place of the Deputy Secretary of Defense. Thereafter, Deputy Defense Secretary Kenneth Rush, who outranked the DCI, also ceased attending the DCI-chaired ExCom meetings and sent Assistant Secretary of Defense for Intelligence, Albert C. Hall, in his place. The DCI chairman thus found himself, the only one remaining of three original members, without an ExCom link to the White House on the one hand, and, on the other, unable to command the rapid response from Defense Department organizations that his predecessor could demand. Securing additional funding for NRP project requirements became an increasing problem and the time needed to implement ExCom decisions began to grow.[20]

(TS/TK) Seeking to eliminate these and other problems, on 18 February 1976 President Gerald Ford issued Executive Order 11905, which abolished the ExCom and replaced it with the Committee on Foreign Intelligence (CFI). Chaired by DCI Colby, the CFI was comprised of two other principal members: the Assistant Secretary of Defense for Intelligence and the Deputy Assistant to the President for National Security Affairs. But where the ExCom previously focused exclusively on the affairs of the NRP and the NRO, the CFI was chartered to control budget preparation and resource allocation for the entire National Foreign Intelligence Program (NFIP).* The magnitude of this enterprise was such that no

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*(TS/TK) The NFIP consists of the NRP, the Consolidated Cryptologic Program (CCP), the CIA Program (CIAP), the General Defense Intelligence Program (GDIP), and "special efforts."

three individuals could easily manage and direct it. The DCI, therefore, began to use the staff of his Deputy Director for the Intelligence Community, later known as the IC Staff (which had grown up around the USIB/NFIB), to manage CFI operations. In 1977, DCI Stansfield Turner created three more deputy directors: a Deputy Director (DD/DCI) for Resource Management [redacted], a DD/DCI 3.3 (b)(1) for Collection and Tasking (General Frank Camm), and a DD/DCI for National Foreign Assessment (Robert Bowie). Thereafter the IC Staff expanded to support these three offices while it played an ever-increasing role in NRP planning and budget activities. The time required to secure decisions and take action on overhead reconnaissance projects increased accordingly. Finally, in the reorganization of the Intelligence Community ordered by President Jimmy Carter in 1978, DCI Turner abolished the Committee on Foreign Intelligence altogether, consolidated the National Foreign Intelligence Program in his office with "full and exclusive authority" over its budget, and used the IC Staff for its management.[21]

~~(TS/TK)~~ The cumulative effect of these organizational changes on the management of overhead reconnaissance was profound. By 1986 they had brought the NRO almost full circle, back near the point from whence it began 25 years earlier. The Director of the NRO and his CIA deputy in 1986 reported to the DCI and the IC Staff instead of the Deputy Secretary of Defense through the ExCom. Except for the biannual [redacted] 3.3 (b)(1) the Secretary of Defense was no longer directly involved with the NRO. The simplified chain of command that President Eisenhower approved in 1960 had grown much more complex and diffuse. The principle of "collegiality" that the ExCom represented in the NRP had disappeared. This change President Ronald Reagan rendered formal in National Security Decision Directive (NSDD) 293, 5 January 1988, when he made the DCI responsible for the National Foreign Intelligence Space Program, and assigned to the Secretary of Defense a supporting role.[22]

~~(TS/TK)~~ The NRO remained responsible for America's overhead reconnaissance programs, but had lost much of its authority to control them. In the 1980s the individual NRP project organizations began on occasion to deal directly with the IC Staff, which now controlled the funds, bypassing the NRO and its staff. Though its 1965 management charter remained unaltered, making the office legally a Defense Department entity, in terms of actually financing and implementing overhead reconnaissance, the NRO had become one among many other bureaucratic levels within the intelligence community. But however much the NRP management structure might have changed, satellite reconnaissance planning and flight operations continued to function within the national space policy framework forged by President Eisenhower and refined by his successors.

Refining United States Space Policy

~~(TS/TK)~~ President Eisenhower judged overhead reconnaissance in airspace to be a grave violation of sovereignty. Throughout his second term in office, however, he also held firmly to the view that overhead reconnaissance from outer space was neither unlawful nor militarily provocative, like that of placing offensive weapons in orbit. It was thus clearly acceptable within his dictum of "peaceful", nonaggressive U.S. spaceflight operations, did not require prior consent of the nations over which these satellites might pass, and did not jeopardize the concept of "freedom of space". But despite Khrushchev's private remarks in Paris in 1960, Soviet leaders continued publicly to label reconnaissance from space an illegal, warlike act (until they began to launch reconnaissance satellites of their own, when in September 1963 virtually all Soviet objections ceased). Considering this difference of interpretation over an activity that had yet to be ratified as acceptable in the international arena, after viewing the photographs from the first recovered film capsule, on 25 August 1960, the President ordered the 'take' kept in a special secret compartment, so as to avoid ". . . unnecessary affront to the Soviets."[23] For this reason and to protect details of space sensor capabilities, all of Eisenhower's successors have honored this practice and the photographs, with but few exceptions, have not been publicly released.

~~(TS/TK)~~ On assuming office in 1961, President John F. Kennedy adhered to Eisenhower's national space policy and likewise sought to avoid a confrontation with the Soviet Union over employing reconnaissance satellites. Because the Soviets continued to protest overhead reconnaissance at any altitude, in 1961 James Killian, Chairman of the President's Foreign Intelligence Advisory Board (PFIAB), instigated a tightened security control system for protecting information in the National Reconnaissance Program. On 23 March 1962, Deputy Defense Secretary Roswell Gilpatric issued DoD Directive 5200.13 that classified the details of all military satellite programs, including launch and operations. Finally, on 10 April Gilpatric wrote to Kennedy's Special Assistant, General Maxwell Taylor, cautioning the President about State Department concurrence in UN registration of satellite launches.[24] Taylor brought the matter to the attention of the President.

~~(TS/TK)~~ On 26 May 1962 President Kennedy issued National Security Action Memorandum (NSAM) 156 that instructed Secretary of State Dean Rusk to review the international political aspects of satellite reconnaissance and formulate a U.S. position that would promote its acceptance, reduce the chance of Soviet interference with flight operations, and "permit us to continue to work for disarmament and international cooperation in space."[25] The committee formed for this purpose, known as the "NSAM 156 Committee," was composed of representatives from the Departments of Defense and State, the CIA, NRO, NASA, the Arms Control and Disarmament Agency, and the White House. The unanimous policy recommendations it submitted were discussed in the National Security Council meeting on 10 July. Later that day Kennedy issued National Security Council Action 2454 approving 18 of the 19 committee recommendations.* (The last one, recommending a ban on placing weapons of mass destruction in outer space, Kennedy held for further study.)[26]

~~(TS)~~ The U.S. space policy formulated by the NASM 156 Committee and approved by the President in 1962, among other things, affirmed the "blackout" of information regarding reconnaissance satellites, while it called for more open public reference to the general military space program. It reaffirmed the Eisenhower dictum that outer space is free and open to all, like the high seas, and that the United States would continue to reject any position that held reconnaissance from space to be anything other than a peaceful application. The United States would continue in international forums to seek acceptance for the "legitimacy of the principle of reconnaissance from outer space," and would make no distinction between civil and military earth observation from space; that is, if applications such as weather observation were deemed acceptable, so must be the other applications. Finally, the policy declared that "interference with or attacks on any space vehicle . . . in peacetime are inadmissible and illegal." Work on antisatellite systems were to be downplayed, and "any actual test of such a capability" would require White House approval.[27]

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*(U) According to Raymond L. Garthoff, the NSAM 156 Committee continued to function and report to the President on this matter until 1969, when President Nixon assumed office. By that time reconnaissance satellite overflight had for the most part become accepted through custom and precedent in international law.

(S) By the early 1960s reconnaissance satellites had become critical to U.S. security, and Kennedy, like his predecessor, opposed any project that threatened orbital satellite operations or the freedom of passage in space. Thus, despite the protests of Air Force officials anxious to control the "high ground," a few months later in December 1962 the Defense Department cancelled development of an unmanned orbital antisatellite known as SAINT (Satellite Interceptor). Underscoring this policy decision a year later on 10 December 1963, Secretary of Defense Robert S. McNamara cancelled the Air Force manned Dynasoar (X-20) project. At first proposed and publicized as an orbital bomber and later justified as a research vehicle, Dynasoar was judged to be an inchoate offensive space-weapon system. The United States continued to work on ground-based antisatellite systems, but would not be the first to place offensive weapons in "free space."

Space Reconnaissance Applications

(TS/TK) Although details of the U.S. reconnaissance satellite program were now made available only to those with the requisite security clearances, the endeavor continued to be mentioned periodically by Soviet and U.S. leaders, and in the scientific and trade journals. In the years that followed, the thrust of this space effort hewed rather closely to the military and reconnaissance support program outlined in late 1958 (Table 1). Until the 1970s, reconnaissance imaging missions divided between relatively low-resolution area surveillance and photogrammetric cameras, and high-resolution (close-look "spotter") cameras, with film cartridges returned physically to earth in reentry capsules.

Both were launched into polar orbits, but the close-look missions operated in very low earth elliptical orbits (with a perigee of 60-100 miles), while area surveillance missions moved in somewhat higher orbits (with a perigee of 110-120 miles).

~~(TS/TK)~~ As events turned out, the low- and high-resolution missions divided between the KH-4 Project and the KH-7 Project, respectively. Remarkably, KH-4, begun as a short-term stopgap enterprise, continued with great success through 125 flights and six camera models, KH-1, -2, -3, 4, -4A, and -4B, until terminated in 1973. Ironically, Samos, the original reconnaissance satellite project, floundered under the guidance of ARDC (redesignated Air Force Systems Command in 1961) through a series of technical disasters. Although its technology would be applied to other programs, none of the Samos readout or recoverable payloads that flew on missions ever returned a single recognizable photograph of the Soviet Union, and the mismanaged effort was quietly cancelled in 1964. Fortunately for the Air Force, the covert KH-7, handled on the West Coast by General Greer's Office of Special Projects, fared much better.[28] The high-resolution KH-7 film recovery satellite, approved by President Eisenhower in September 1960, made its first flight with the KH-7 camera in 1963 and continued through 38 flights, concluding in 1967. An improved KH-7, known as "KH-8-cubed" and capable of stereo photography, commenced launching in 1964 and continued through 54 flights over 20 years, concluding in 1984. The monoscopic cameras carried by early KH-7s achieved a resolution at the earth's surface of [redacted] feet on a side. Later, 3.3 (b)(1)
KH-8 stereoscopic cameras regularly achieved resolutions of [redacted][29]

(TS/TK) By the early 1970s, besides color and stereo photography, and mapping accomplished by the KH-5 payload, KH-8 photographic payloads also featured color infrared-sensitive film. The resultant photographs of identical scenes, when compared with those taken on conventional film, would betray most attempts at camouflage.[30] (The light reflected by painted plastic or wood decoy aircraft, for example, is not the same as that reflected by metal aircraft.) Film-recovery payloads culminated in the KH-9 series of satellites that used the remarkable KH-9 cameras developed by the CIA, which President Nixon approved on 6 June 1969 at the expense of the Air Force's parallel Manned Orbiting Laboratory, which was to have employed a large, reflective KH-10 camera.

(TS/TK) KH-9 studies, approved by the USIB in 1964, culminated in designs tailored to both high resolution and wide area coverage, without the disadvantages introduced by the motion of a human onboard. It was one of the largest and certainly the most complex reconnaissance satellites ever built. Ten feet in diameter and 55 feet in length, it rivaled NASA's Space Lab in size. The KH-9 featured two panoramic counterrotating optical-bar cameras, and four recovery capsules--compared with two recovery capsules used in the later KH-4 and KH-7 vehicles. Some of the KH-9s contained a fifth capsule to return film from a mapping camera. Two reels supplied 160,000 feet of 5.5-inch-wide film for stereoscopic photography, an amount increased significantly to 208,000 feet on later flights with the development of ultra-thin based film. An accompanying stellar-index camera made it possible to extract mapping, charting, and geodetic data for the Defense Mapping Agency.

~~(TS/TK)~~ Called "Big Bird" in the media, twenty KH-9 vehicles were launched between June 1971 and April 1986. Responsibility for the KH-9 camera transferred from the CIA to the Air Force in July 1973, two years after the first KH-9 was launched. In 1973, two years after the first KH-9 was launched, the film supply also began to feature small amounts of color and false color infrared film. Besides detecting attempts at camouflage, these films also helped in assessments of narcotics trafficking, Soviet grain production, and chemical and biological warfare testing. Regrettably, the only failure to mar this remarkable satellite program occurred on the twentieth and last flight when the launch booster exploded above Vandenberg Air Force Base on 18 April 1986. By the 1980s, KH-9 lifetimes on orbit had increased greatly, and film capsules were periodically ejected for recovery on earth during missions that extended in length to eight and nine months.[31]

~~(TS/TK)~~ Imaging sensors flown since 1976 on the next generation KH-11 reconnaissance satellites use no film at all. An electro-optical system converts images of the earth's surface to digital bits for transmission in near real-time. Placed in orbit at an altitude of about 125 miles, these satellites relay their "take" via [redacted] 3.3 (b)(1)
communications satellites in highly elliptical orbits directly to a designated ground station. After Priority Exploitation (first look) is accomplished, the pictures are delivered to the National

Photographic Interpretation Center in southeast Washington. Because of its great cost, President Nixon approved KH-11 in September 1971 at the expense of another competing Air Force proposal for a Film-Readout KH-8. The first [redacted] KH-11 imaging satellites [redacted] was launched in December 1976 and pronounced operational in January 1977. President Jimmy Carter became the first American leader to use the product of the KH-11 system, the first imaging satellite not to be "film-limited." 3.3 (b)(1)

~~(TS/TK)~~ In the years that followed, these vehicles were directed increasingly to day-to-day indications and warning desired by the White House and Department of State. The original satellites produced up to [redacted] images per day. [redacted] 32 3.3 (b)(1)

~~(TS/TK)~~ Reconnaissance employed for operational and mapping purposes retained ardent proponents in the military and civilian intelligence communities throughout the 1970s and 1980s, but these uses no longer claimed the priority they had once enjoyed. Indeed,

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*~~(TS/TK)~~ The KH designations for imaging sensors ceased to be used with the Mission [redacted] satellites.

KH-9 and subsequent KH-11 imaging satellites proved eminently successful for technical indications and warning, replacing the National Indications Center in the mid-1970s, some 20 years after President Eisenhower created it to ensure against surprise attack.*

~~(TS/TK)~~ Still another kind of sensor searched for and intercepted radio and radar frequencies, and later transmitted the recordings to earth stations. Often called ferrets, these receivers, among other uses, identified and located air- and missile-defense radars, and determined their signal characteristics and detection ranges. Besides establishing the location and frequency characteristics, this information made possible the design of electronic countermeasures equipment to jam or mislead the radar. Initial Air Force ferret sensors, first designed for Samos, eventually became known as part of [redacted] Placed in 3.3 (b)(1) polar orbit at about 300 miles altitude, they catalogued radar, radio, and very-high-frequency communications traffic, contributing to estimates of the electronic order-of-battle. The last of these payloads was launched in 1971.[33]

~~(TS/TK)~~ Beginning in [redacted] 3.3 (b)(1)

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*(U) See Chapter 1, pp. 13-15.

[redacted] 35

3.3 (b)(1)

~~(TS/TK)~~ The U.S. Navy planned, built, and operated [redacted] ELINT satellite programs between 1960 and 1986. In fact, the Navy launched the first successful U.S. reconnaissance satellite, an ELINT bird, on 22 June 1960, two months before a KH-4 returned film from orbit. This [redacted] satellite series, also a part of [redacted]n the NRP, featured a crystal-video receiver that detected radar signals. Launched as subsatellites, these small, nearly spherical vehicles operated in near circular orbits inclined 67 degrees at about 500 miles altitude. Eight of these satellites provided valuable intelligence for periods in excess of five years before the last one was turned off on [redacted] 36 [redacted]

3.3 (b)(1)

3.3 (b)(1)

3.3 (b)(1)

[redacted] 3.3 (b)(1) and the present system is composed of four 3-satellite clusters.[37]

~~(TS/TK)~~ The technology of SIGINT reconnaissance, like that of the optical and electro-optical imaging systems, also progressed rapidly, [redacted] 3.3 (b)(1) [redacted] 38

~~(TS/TK)~~ Meantime in 1964, other studies began for a [redacted] 3.3 (b)(1) [redacted]

[redacted]9 3.3 (b)(1)

~~(TS/TK)~~ Back in 1974, a more [redacted] was proposed for development with a first launch scheduled in the late 1970s. Though strongly supported by U.S. intelligence agencies and the National Security Council, Secretary of Defense James Schlesinger and DIA Director Daniel Graham opposed the project, and the Appropriations Committee of the House of Representatives in 1975 denied it funding. [redacted]0 3.3 (b)(1) 3.3 (b)(1)

(U) Another kind of sensor that falls within the purview of overhead reconnaissance was conceived as "a treaty monitor." In an exchange of correspondence with Soviet leaders in 1957-1958, President Eisenhower explored the possibility of ending all tests of nuclear-weapons. These discussions led eventually to the Limited Test Ban Treaty of 1963, in which the signatories agreed not to explode nuclear or thermonuclear weapons in outer space, in the atmosphere, or in the oceans.* During the intervening 23 years, no state party to this treaty, including the Soviet Union and the United States, has violated its terms. Besides considerations of national self-interest, this impressive record is due in large measure to the satellite system perfected to monitor treaty compliance, first known as Vela Hotel.[41] That curious albeit appropriate name derived from the Spanish word vela, for "watchman," and the English word hotel, which stood for the collection of participating agencies: the Advanced Research Projects Agency, the Atomic Energy Commission, and the USAF.

(U) The sensors carried aboard Vela Hotel detected certain X-rays and gamma-rays associated with nuclear detonations. The Air Force launched initial Vela test satellites in pairs, into near-circular earth orbits at about 65,000 miles altitude, with the satellites positioned 180 degrees apart, on opposite sides of the earth. It was no coincidence that the first test flight in October 1963 followed by a few months U.S. ratification of the Limited Test Ban Treaty. Subsequent test flights of Vela satellite pairs in July 1964 and July 1965 proved equally successful, and confirmed

*(U) Soviet and American leaders ultimately excluded testing underground because the technical means to distinguish at a distance between a small earthquake or a nuclear explosion did not exist.

[redacted]

[redacted]

~~(TS/TK)~~ In the years that followed, as the original Vela satellites winked out, they were replaced by nuclear-effects detectors carried aloft on the satellites of other Air Force projects. Renamed the Integrated Operational NUDET Detection System (IONDS), in the early 1970s these sensors flew as passengers on satellites of the missile detection Defense Support Program and Defense Meteorological Satellite Program, in keeping with the defense policy "of launching fewer but larger spacecraft and using them for multiple functions." In 1975 IONDS sensors also began to be carried aboard [redacted] In the 1980s improved 3.3 (b)(1) Vela sensors continue to provide worldwide coverage of nuclear effects, also installed on satellites of the Navstar Global Positioning System. The last of the original Vela satellites launched in the late 1960s, meantime, was turned off by ground controllers in January 1985 after 15 years of operational service.[45]

~~(S)~~ All of the preceding reconnaissance sensors are passive; that is, they observe and record reflected or emitted energy. There is one kind of imaging sensor, however, that is active. It irradiates the earth's surface with microwaves and records the backscatter echoes. First considered at the CIA and Rand in the late 1940s and known as side-looking synthetic aperture radar, or simply imaging radar, it can operate in daylight and darkness, penetrate the cloud cover and haze that often obscures the earth from cameras and electro-optical scanners, and provide two-dimensional images nearly as good as those obtained by its optical cousins. Just how good the results are depends on the resolution achieved at the surface.

(U) The resolution of any image is limited by the Rayleigh criteria; as Caltech's Charles Elachi explained, it "depends on the ratio of the operating wavelength to the size of the sensor aperture or, in the case of radar, the length of the antenna." Because the wavelength of microwaves is very much greater than that of light, any acceptable radar resolution would demand a single antenna of enormous length, or an array of numerous antennas strung out along a baseline. With synthetic aperture radar, however, engineers took advantage of movement to achieve the same effect, "using the motion of the satellite to put the antenna in different locations and then combining the signals coherently, thus synthesizing a long aperture. The signal from the antenna in one position on the flight path is added to the signal from the next position on the flight path and so on a couple of thousand times."[46]

~~(TS/TK)~~ The National Reconnaissance Office sponsored and in 1964 the Air Force launched a test satellite which proved the technical feasibility of radar imaging from space. Fourteen years later, in June 1978, NASA and the Naval Research Laboratory launched Seasat, the first U.S. satellite publicly dedicated to remote microwave imaging of the earth's oceans. During four months of orbital operation, Seasat likewise demonstrated considerable promise.[47] [redacted] 3.3 (b)(1) [redacted][48]

~~(TS/TK)~~ [redacted] 3.3 (b)(1) [redacted][49]

~~(TS/TK)~~ The successful development and operation of all the visual-imaging and signal-intelligence satellites was to a large extent made possible by a novel division of American space efforts. The National Aeronautics and Space Act of 1958 created a civil space program directed by the National Aeronautics and Space Administration, and a Defense Department military space program in which each of the military services participated. In August 1960, President Eisenhower approved the separation of intelligence satellites into yet a third branch, thereby creating the National Reconnaissance Program directed by the National Reconnaissance Office. Thereafter, each branch of American astronautics operated with separate management, funding, direction, and Congressional oversight. The third branch operated entirely out of the public spotlight, featured at first a compact chain of command and unique contracting practices, and achieved national intelligence requirements much more rapidly and securely than would have been possible in normal military channels.

~~(TS/TK)~~ Whatever the public's perception of them, the programable, real time, automatic satellites launched after 1960 in the National Reconnaissance Program had become by 1986 indispensible to the nation's leaders and Intelligence Community. [redacted] 3.3 (b)(1) The KH-11 electro-optical imaging system also changed the nature of intelligence operations. The combined number of targets selected for imaging, known as the

"Target Deck", increased dramatically in size and geographic scope. One could now afford to take pictures almost anywhere in the world on missions no longer limited by a finite amount of film onboard. Collectively, instrumented NRP spacecraft provided hard visual and electronic evidence of economic and political affairs, and the military preparedness of foreign countries. They frequently furnished advance notice of the course of action selected by foreign leaders, giving American officials valuable time for a deliberated response. Just as President Eisenhower wished, they permitted more rational analysis in the sizing of U.S. military forces.

~~(S)~~ A few weeks before he died in 1969, intelligence officials provided Eisenhower an extraordinary briefing in his hospital room. Open Skies, he learned, had become a reality; the former World War II military commander, university president, and President of the United States could take pleasure in the certain knowledge that it had been, ultimately, his doing.

CHAPTER THREE

WEATHER RECONNAISSANCE: THE DEFENSE METEOROLOGICAL SATELLITE PROGRAM

~~(TS/TK)~~ The successful operation of overhead photo-reconnaissance satellites, as the Rand Corporation had warned in the mid-1950s, indeed depended on accurate and timely meteorological forecasts of the Sino-Soviet landmass. Such forecasts made possible cloud-free photography over areas of interest. Pictures of clouds retrieved from a film-limited spacecraft cost dearly--a fact made plain by the return from early KH-4 flights. In 1961, however, the National Aeronautics and Space Administration possessed the U.S. franchise to establish requirements and develop meteorological satellites with the Department of Commerce in the National Meteorological Satellite Program. This program, its proponents contended, would provide a single National Operational Meteorological Satellite System (NOMSS) to meet all civil and military forecasting needs, including presumably those of the National Reconnaissance Program.

~~(TS/TK)~~ But in the Pentagon, Under Secretary of the Air Force Joseph V. Charyk, who also headed the National Reconnaissance Office, was unconvinced. NOMSS, at best two or three years away, was also supposed to support international meteorological data exchanges, an objective inconsistent with NRP requirements for covert operations. Moreover, the television camera of NASA's first TIROS weather satellite launched the year before, on 1 April 1960, viewed only an oblique swath of the surface once in each orbit.* Charyk knew that NASA officials did not believe a spin-stabilized weather satellite, one that would keep its spin axis perpendicular to its orbit plane, could be developed soon, and certainly not inexpensively and in time to furnish strategic meteorological forecasts for the NRP in 1962 when Samos flight operations were scheduled to begin. Charyk would become the driving force in the development of a military weather satellite program that operated independently, but fashioned the technology and processes for what essentially became the national weather system administered by the NOAA.

A Temporary Meteorological Satellite Program

~~(TS/TK)~~ On 21 June 1961, Charyk spoke with Major General Robert E. Greer, Director of the NRP Office of the SAFSP in Inglewood, California. He asked Greer to prepare a "minimum" proposal for four, small, earth-referenced weather satellites to be launched on NASA Scout boosters. Greer responded with just such a plan for a 22-month program, one that specified a fixed budget of 3.3 (b)(1)
[redacted] and a first launch in 10 months. The Director of Defense Research and Engineering, Harold Brown, approved the necessary funding through the NRP, and by the end of July 1961 Lt

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*~~(TS/TK)~~ TIROS, ironically, also spun out of the Air Force WS-117L reconnaissance satellite competition in 1956. After Lockheed won the primary contract, RCA officials sold the concept of a television infrared weather satellite to the Army Signal Corps at Belmar, New Jersey, which funded further work. After NASA began operation in October 1958, it acquired TIROS along with a number of the key Signal Corps project personnel.

Colonel Thomas O. Haig had been appointed the first director of the Defense Meteorological Satellite Program (DMSP).* Haig accepted the job on condition he would not have to use the Aerospace Corporation for systems engineering, could select his own small staff, and could directly control contracting with the aerospace firms.[1]

~~(S)~~ In Inglewood, Haig divided the work among three other men and "a very busy secretary."** He invested his own time in program management and the satellite. Captain Richard Geer was assigned the Scout booster, a small, four-stage, solid-propellant vehicle procured under NASA guidance. Geer redesigned parts of the upper stages to meet special program needs. Captain Luin Ricks handled ground support, tracking, command, and readout at the Air Force ground stations. Finally, Captain Charles Croft oversaw contract management at the various firms involved, novel contracts that were "fixed price" instead of the customary "cost plus fixed fee."[2]

~~(TS/TK)~~ Neither the Scout booster nor the satellite featured redundant equipment, and a failure anywhere in the system meant the loss of a mission. The enterprise was regarded by all concerned as a single purpose, minimum cost, high-risk program. The 100-pound

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*~~(TS)~~ This program has had a succession of names: Program II, 35, 698BH, 417, and Defense Systems Applications Program (DSAP). In order to avoid confusion, the current designation DMSP is used throughout this chapter.

**~~(S/TK)~~ By the end of 1962 the staff had increased to five officers and two secretaries. This small number was maintained until the mid-1960s, when the program was transferred to Air Force Systems command.

TIROS-derived satellite itself was shaped like a 10-sided polyhedron, 23-inches across and 21-inches high. A spinning motion, introduced on injection into orbit, was maintained on early satellites at about 12 rpm by small spin rockets. The spin axis was also maintained perpendicular to the orbit plane by torquing the satellite against the earth's magnetic field, the forces supplied through an electric-current loop around the satellite's perimeter. A ground command would cause the current to flow in the desired direction to generate the torque. Those NASA engineers who knew about it viewed the NRO-Air Force program as a no-risk test of the modified four-stage Scout and the earth-referenced "wheel-mode" weather satellite.[3]

~~(S)~~ If it operated correctly, the television camera would be pointed directly at the earth once each time the satellite rotated. At the programmed interval, when horizon sensors indicated the lens was vertical to the earth, the camera could snap pictures of an 800-mile-square area of the surface below. Launched into a sun-synchronous 450-mile circular polar orbit, the television system would provide 100 percent daily coverage of the northern hemisphere at latitudes above 60 degrees, and 55 percent coverage at the equator. Readout of the tape-recorded pictures was planned to occur over the western hemisphere; at the ground stations, video pictures of cloud cover over the Eurasian landmass would be relayed to the Air Weather Service's Air Force Global Weather Central at Headquarters SAC, Offutt AFB, Nebraska.[4]

~~(S/TK)~~ Haig's Air Force "blue suit" program team met its 10-month schedule, although, as the high-risk aspects of the effort suggested, without immediate success. A test launch at Vandenberg AFB on 25 April 1962 ended in a Scout booster failure. The temperamental Scout booster failed again during launch of the first NRP weather satellite on 23 May. The second launch on 23 August 1962 resulted in success, although the ground-control team failed at first to track the weather satellite. Each day at high noon the vehicle took pictures as it transited the Soviet Union. Weather pictures of the Caribbean returned by this vehicle two months later in October also proved crucial during the "Cuban Missile Crisis," permitting effective aerial reconnaissance missions and reducing the number of aerial weather-reconnaissance sorties in the region.[5]

~~(TS/TK)~~ Lt Colonel Haig reported to General Greer in Inglewood, but Joseph Charyk took a personal interest in the affairs of the NRO weather satellite program. That program now possessed the first U.S. military satellite to be commanded and operated on orbit on a daily basis over an extended period of time. (The first spacecraft ultimately ceased transmissions on 23 March 1963.) In late October 1962 Charyk summoned Haig to Washington and advised him that NASA's planned Nimbus weather satellite, or NOMSS, would be delayed, and that he should plan one additional year for the program. Haig, who had guessed as much, had next year's budget charts ready. Contractors wanted $7.8 million for ground-support operations, but, the Lt Colonel insisted, he could build two ground stations and man them with "blue-suiters" for $1.5 million.[6]

~~(S)~~ Charyk approved the proposal on the spot. He then picked up the phone and called the Commander in Chief of the

Strategic Air Command (CINCSAC). In short order, Lt Colonel Haig found himself on an airplane bound for Omaha and a meeting next day with the SAC commander. At Headquarters SAC, Haig met with General Thomas S. Power and the SAC staff. When he left an hour later, "it was with a promise of all the people I needed and, 'if anybody gets in your way, call me!'" from General Power.[7]

~~(S)~~ During the ensuing weeks, Haig and his associates in the program office worked at all hours, every day. They found surplus Nike sites in the state of Maine (Loring AFB), and Washington (Fairchild AFB), procured six large van bodies from Norton AFB in San Bernadino, located two abandoned antenna mounts on Antigua Island in the Caribbean, and wrote a fixed-price contract for two 40-foot radar dishes and the associated electronic gear. In between they helped screen SAC military personnel "until we had two groups of very good men" to operate the tracking stations. In July 1963, ten months after go-ahead, the program office transferred DMSP satellite ground tracking and readout to its own stations in Maine and Washington. About the same time, a command and control center for the DMSP began operating one floor below Air Force Global Weather Central in Building D, the old Martin bomber plant, at Offutt AFB, Nebraska.[8]

~~(TS)~~ The first weather satellite to be controlled by the DMSP ground stations manned by SAC personnel, instead of contractor personnel, was flight number three launched on 19 February 1963. The NASA Scout booster upper stages, which again malfunctioned, placed the satellite in an orbit unsuited to strategic weather reconnaissance operations for more than a few months at best. In late April the satellite's primary tape-recorder control circuit failed, and with it the storage of primary data for later transmission, although direct readout continued for a few weeks more. A new experiment added to the sattelite continued to function nicely for many months. The addition was an infrared radiometer that registered the earth's background radiation and indicated the extent of night-time cloud cover. At Global Weather Central, the 3d Weather Wing used computer programs written by Air Weather Service personnel to produce operational maps of the cloud cover at night over the regions observed. Indeed, the infrared experiment proved so successful that it soon became a permanent feature on DMSP satellites, eventually also providing measurements of cloud height and the earth's heat balance.[9]

(TS/TK) The fourth and fifth DMSP launches on 26 April and 27 September 1963 resulted once again in Scout booster failures. The gap in weather reconnaissance that began in May 1963 would continue until January 1964. NASA, which procured the Scout vehicles for the NRP, refused to make changes in booster design and procurement that the program office believed indispensible to improve reliability. After considering other booster prospects, on 7 October 1963 the program director, Colonel Haig, with the approval of Joseph Charyk's NRO successor, Brockway McMillan, cancelled the last two Scout vehicles on the original contract and all six of them on a follow-on order.[10]

(S/TK) Haig had, since the fourth launch, sought a replacement booster that would provide improved reliability and at least equivalent weight-lifting capacity. He knew that a number of liquid-propellant Thor and Jupiter intermediate-range ballistic missiles, returned a few months before from England and Turkey as part of the U.S. concession in the Cuban Missile Crisis, were stored in San Bernadino. He was also acquainted with a solid-propellant rocket being tested in Redlands, California. This rocket used the motor casing of the Scout fourth stage, and when Greer and Haig put the new solid rocket together with the Thor IRBM on paper, the combination would just get the military meteorological satellite into orbit. "Without delay, we found the remnants of a SAC Thor launch crew and with their help designed the Thor solid-stage interface hardware, developed a flight profile, [and] confirmed it on a Thor simulator. . . ", Haig recalled years later. Approved by the Director of the NRO in December 1963, and by CINCSAC General Thomas S. Power, SAC personnel would now launch the new vehicle and control the weather satellite on orbit. Haig set to work ordering and testing the "Burner I" booster. Although the "Burner I" solid-propellant second stage would perform as advertised, it burned and accelerated rapidly, subjecting weather satellites to 25g loads. Haig subsequently contracted for an improved solid-propellant upper stage and the Thor-"Burner-II" was born. This combination, eventually using an additional solid-propellant third stage to increase the weight-lifting capacity, continued to be used in the program until the early 1980s.[11]

~~(S/TK)~~ Before a "Thor-Burner" mission could be mounted, and to close gaps in strategic weather coverage of the Eurasian landmass after the Scout launch failure of 27 September 1963, the program office pressed into service the Thor-Agena launch vehicle.

Thor-Agena, also used to launch the KH-4 satellites, was larger and more expensive than needed for DMSP. But it could carry into orbit two of the satellites simultaneously. On 19 January and 17 June 1964, Thor-Agenas did just that, successfully placing a total of four weather satellites into orbit. Although a Thor-Burner failed in its first launch on 18 January 1965, this booster combination in succeeding months and years achieved an enviable 83 percent launch success record before it was succeeded by the Atlas booster in the 1980s.

~~(TS/TK)~~ At first extended from year to year as an interim measure awaiting the NOMSS, by mid-1965 the NRO weather satellite effort looked like a formal, separate program. As its primary mission, DMSP furnished the NRP daily (morning coverage, primarily, during the first few years) meso-scale observations of cloud distribution and organization over the Eurasian landmass. Beginning in 1965 two DMSP polar-orbiting, sun-synchronous weather satellites would normally function in circular orbits at 450 miles altitude. One, a morning bird, passed over the Soviet Union about 0700 local time and relayed weather conditions at first light. A second, late morning (but called a "noon") bird, began the same track about 1100 local time, showing the change in cloud cover with the increase in atmospheric heating during the day.

~~(S/TK)~~ Reflecting on their accomplishments many years later, Colonel Haig counted four principal DMSP contributions to astronautics. First, the novel NRP management scheme made possible a small program office that exercised technical direction without the assistance of a systems-engineering contractor, and could act quickly. The office used fixed-price development contracts, all blue-suit operations, and achieved an excellent success record at an annual cost that was 50-to-75 percent less than equivalent NASA weather satellite programs. Second, because the spin axis of the "wheel-mode" satellite could be maintained perpendicular to the orbit plane by electrically torquing it against the earth's magnetic field, Haig reasoned that one could spin or de-spin the vehicle by driving it electrically like the rotor of a direct-current motor, and dispense with the solid rockets needed to accelerate the rpm on orbit. The scheme proved theoretically feasible on paper; Haig wrote it into the second-year contract and it worked in space. Third, when the DMSP ground stations were assembled in 1963, the program office eliminated the costly "boresight tower" used routinely to determine a tracking/readout antenna's pointing vector and the transmitter used to check the receiving system sensitivity during operation. Program personnel substituted instead a technique of scanning the sun to establish the pointing vector and using a hermetically sealed low-energy transmitter in the center of the antenna reflector to check receiving sensitivity. The DMSP station test procedures worked just as accurately at far less cost, and they became standard practice for nearly all readout systems. Finally, DMSP altered established Air Force techniques of satellite tracking. Captain Luin Ricks refused to believe that the tracking problem was as arcane as contractor personnel made it appear. Working with SAC personnel, Ricks prepared a much simpler tracking program*

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*(S) A single set of punched paper tapes at each ground tracking station eliminated the requirement to transmit an antenna programming tape before each pass. Every pass by a DMSP satellite

thereafter used with great success by the DMSP ground stations and by the ground stations of other satellite programs.[12]

(TS/TK) When in mid-1965 Colonel Thomas O. Haig stepped down as the program director, DMSP had eclipsed all other overhead meteorological endeavors. Initial NASA skepticism notwithstanding, DMSP had pioneered the space technology so well, so quickly, and so inexpensively that the space agency, prodded firmly by the Department of Commerce, embraced a carbon copy of the DMSP "wheel-mode" Block-I satellite, called the TIROS Operational System (TOS), as an interim civil weather satellite.* And besides strategic weather reconnaissance furnished to the NRP, Defense Meteorological Satellites (DMS) had also begun to provide tactical weather reconnaissance of preselected regions to transportable ground stations overseas, with significant effects on military operations in Southeast Asia.[13]

Toward a Permanent Program: From Strategic to Tactical Applications

(S/TK) Strategic weather reconnaissance recorded for the NRP might command the primary mission of the DMSP, but American military services still wanted tactical weather data to meet a variety of operational needs. By 1963 it was plain that NASA's

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in any orbit between 250 and 550 nautical miles altitude could be supported by the tape set with a maximum antenna pointing error of 1.5 degrees.

*(S) The first one, called ESSA-1, was launched in February 1966, four years after DMSP proved the concept.

sophisticated Nimbus-NOMSS satellite would be extensively delayed and, when finished, likely too complex and expensive to satisfy Defense Department and NRP meteorological requirements--tactical or strategic.* On 23 January 1963, Harold Brown, Director of Defense Research and Engineering, requested a reassessment of the tactical requirements by the Joint Chiefs of Staff (JCS). Would the National Meteorological Satellite Program and its planned NOMSS, Brown inquired, meet them? The JCS replied in the negative; its leaders urged that the Defense Department build and operate a direct-readout weather satellite able to relay high-quality, day-and-night tactical meteorological data to transportable ground and shipboard terminals "ASAP".[14]

~~(S/TK)~~ The political and bureaucratic climate in 1963 did not favor an all-military tactical weather satellite system. All of the military meteorological satellite requirements would continue to be furnished to NASA and the Department of Commerce for the NOMSS.** To assess and combine those requirements, in early 1964, the Defense Department established in the Air Staff a Joint Meteorological Satellite Program Office (JMSPO). After further agitation by the military services, the Defense Department and the NRO approved a test of the DMS applied to tactical operations in the 1964 Strike Command Goldfire exercise at Fort Leonard Wood in

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*(U) A Nimbus first launch scheduled in June 1962 had slipped to 1964; in fact, these vehicles would eventually be directed to research purposes, never to become the NOMSS.

**(U) The Bureau of the Budget issued BOB circular A-62 on 13 November 1963 that reaffirmed and established policy for Defense Department participation in the National Meteorological Satellite Program.

southwest Missouri. Air Force Global Weather Central at Offutt AFB relayed weather reconnaissance pictures directly to the Army and Air Force users supporting ground and paratroop exercises at the fort, and for the deployment of fighter aircraft on a transatlantic flight. Later in the year, between 24-26 November, Global Weather Central furnished tactical weather data over Central Africa to the Military Airlift Command, which proved crucial in the successful airlift of Belgian paratroopers from Europe to Stanleyville in the Congo, where hostages seized during an uprising, were freed. The weather data proved to be of considerable value in these tactical operations, analysis revealed, but improvements were needed. Coverage had to be received daily at local ground stations before meteorologists could depend on a satellite as a primary source of data, and a resolution at the surface better than the 3 nautical miles provided by the DMSP Block-I satellites was judged "extremely desirable."[15]

~~(S/TK/SAR)~~ In Southeast Asia, meantime, Radio Hanoi ceased broadcasting local weather observations in September 1964, and Air Weather Service Detachment 14 in Saigon faced the task of forecasting with limited and unreliable data. When U.S. air strikes against North Vietnam commenced in February 1965, Det-14 personnel found themselves unable to meet the demand for weather information from the 2d Air Division and the Studies and Observation Group of the Military Assistance Command Vietnam (MACV), which conducted clandestine operations against North Vietnam. In response, the Air Force, with Defense Department and NRO approval, on 18 March 1965 launched a noontime military meteorological satellite modified for direct readout to support tactical operations in Southeast Asia, and erected a DMSP readout station at Tan Son Nhut Air Base, Saigon, in South Vietnam. The new station began operating on 18 April 1965 and furnished to military users, within 30 minutes of receipt, complete cloud-cover data for North Vietnam, South Vietnam, and parts of Laos and the Gulf of Tonkin.[16]

~~(S/SAR)~~ All three military services and MACV put to immediate use the DMSP tactical meteorological data retrieved by Det-14. In the spring of 1965 commanders could scrub, delay, or recall aerial sorties, or divert them to secondary targets based on hard weather information. The Naval Advisory Group and the MACV Studies and Observation Group used DMSP-generated forecasts to schedule the operation of their fleets of small boats that operated along the coast of the Indo-China Sea and the Gulf of Tonkin. Before long, mobile, air-transportable DMSP ground terminals were installed at Udorn AB, Thailand, and Osan AB, South Korea. Another fixed site, like the original one at Tan Son Nhut, appeared at Hickam AFB, Hawaii. Finally, on 20 May 1965 at Vandenberg AFB, SAC personnel launched a special DMS reserved exclusively for direct-readout tactical applications. DMS data so improved the timeliness and accuracy of weather forecasts in Southeast Asia that the military services, in October 1965, cancelled all daily, routine aerial weather-reconnaissance sorties.[17]

~~(S/TK/SAR)~~ These impressive results were enough to prompt action from Defense Department officials, who now sought to break the NASA/Department of Commerce franchise on a NOMSS and pursue openly a separate military weather satellite program for strategic and tactical applications. On 22 June 1965, Under Secretary of the Air Force and NRO Director Brockway McMillan advised General John P. McConnell, incoming Chief of Staff, USAF, that the DMSP would transfer from the NRP to USAF funding and direction, effective 1 July 1965 (the beginning of FY 1966). The program office in El Segundo would move from the Air Force Special Projects office to the Space Systems Division next door, in Air Force Systems Command, with Headquarters USAF assuming overall management responsibility for what McMillan termed as an "ongoing development/operational program". The Strategic Air Command would continue to launch the satellites and operate the DMSP control center and ground terminals in the continental United States; Air Weather Service would man the direct readout terminals overseas, while continuing to operate Air Force Global Weather Central and process DMSP strategic weather data at Offutt AFB. This program, McMillan observed in closing, "has been entirely a 'blue suit' effort. The cost has been remarkably low; the results have consistently exceeded expectations." Perhaps anticipating an excess of public affairs enthusiasm on the Air Staff, he regretted to say that security restrictions precluded any public recognition of DMSP accomplishments.[18]

~~(TS/TK)~~ This change introduced a more complex dual-management chain. On the Air Staff, overall management responsibility devolved on the Deputy Chief of Staff for Research and Development because the DMSP was programmed and budgeted as an advanced development line item. The Director of the NRO retained a strong interest, monitoring DMSP through Air Weather Service personnel assigned to his staff. Operational requirements flowed from the NRO through the Air Weather Service to the West Coast program office. Technical guidance moved from the Deputy Chief of Staff for Research and Development through Air Force Systems Command to the program office. The program office, the focal point at Space Systems Division, exercised authority for planning, directing, contracting, and system engineering.

~~(S/SAR)~~ A few months later on 28 September 1965, making the change to a permanent program complete, officials of the Defense Department and Department of Commerce signed an agreement that eliminated the requirement for prior coordination of "aeronomy" and "meteorological reconnaissance programs." Thereafter, except for periodic reassessments demanded by the Bureau of the Budget (later the Office of Management and Budget) and Congress,* the Defense Department all but withdrew from the NOMSS concept.[19] A few years later, in December 1972, DMSP meteorological data also began to be furnished routinely to the Department of Commerce/National Oceanic and Atmospheric Administration (NOAA) and its National Weather Service at Suitland, Maryland. At that time, security restrictions on DMSP tactical applications were removed,** and another Under

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*(U) For example, in November 1979 President Jimmy Carter, overriding OMB protests, reaffirmed the positions of the departments of commerce and defense that favored maintaining separate civil and military polar-orbiting weather satellite programs until future block changes were adopted. Even that restriction was removed by President Reagan in presenting his 4 July 1982 National Space Policy.

**~~(S)~~ With the use of DMSP tactical weather data in Southeast Asia, knowledge of the program became widespread. In early 1969 Program 417 linked to its tactical applications appeared in the open literature. Practical adjustments that acknowledged at least

Secretary of the Air Force, John L. McLucas, publicly announced the existence of DMSP in an article in Air Force Magazine.[20]

~~(TS/TK)~~ Back in 1964, when tests began of the meteorological satellite applied to tactical military operations at home and abroad, the NRO approved modification of three additional satellites for direct readout. These 160-pound vehicles, identical in size and shape to their 100-to-120 pound Block-I predecessors, also sported improved infrared radiometers and were known collectively as Block-II. Launched during 1965 and 1966, two of them attained earth orbit and provided tactical meteorological data for operations in Southeast Asia. A fourth satellite, the one equipped and launched expressly for tactical uses on 20 May 1965, came to be called Block III. The reason for this curiosity, a "one-vehicle block," involved efforts to distinguish it from its Block II cousins that also supported the primary strategic mission for the NRP. But before direction of the DMSP passed from the NRO to the Air Staff in 1965, Colonel Haig, the program director, secured permission to begin the design of a new, more powerful military meteorological satellite that met more completely the demands of its customers.[21]

~~(S/SAR)~~ The Block-IV satellite, slightly larger than those in Blocks I and II, was 30 inches in diameter, 29 inches high, and weighed 175 pounds. Though still spin-stabilized, the satellite provided much improved weather coverage. Previously, the single

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that part of the enterprise could no longer be avoided. (See "Industry Observer," Aviation Week and Space Technology, 27 January 1969, p. 13.)

1/2-inch focal length vidicon television camera in Block-I and -II satellites furnished a nadir resolution of 3-to-4 nautical miles (nm) over an 800-nm swath, with significant gaps in coverage of the earth at the equator. Block-IV vehicles carried two one-inch focal length vidicons canted at 26 degrees from the vertical that provided global coverage of the earth (contiguous coverage at the equator), along a 1,500-nm swath. The resolution varied from 0.8 nm at the nadir to 3 nm at the picture's edge. Besides a multisensor infrared subsystem, Block-IV also incorporated a high-resolution radiometer that furnished cloud-height profiles. A tape recorder of increased capacity stored pictures of the entire northern hemisphere each day, while the satellite furnished real-time, direct local tactical weather coverage to small mobile ground or shipboard terminals.[22]

~~(S)~~ Under the guidance of a new program director, Air Force Lt Colonel Leslie W. Cowan, eight Block-IV defense meteorological satellites were procured and seven launched between 1966 and 1969.* In 1966 Cowen also began work on the next series of satellites, DMSP Block-V. These military meteorological spacecraft of the late 1960s departed entirely from the TIROS-derived technology of their predecessors. They incorporated a line-scan sensor that provided images of the earth and its cloud cover in both the visual and infrared (IR) spectral regions. With this system, nadir visual-imaging resolution at the earth's surface improved to 0.3 nm during daytime and 2 nm at night through quarter-moonlight illumination

*~~(S)~~ All seven successfully achieved orbit. The eighth vehicle, not needed to meet operational requirements, was donated to the Chicago Museum of Science and Industry.

levels. The higher resolution (less than 0.5 nm) now satisfied the requirements of tactical users. The infrared subsystem furnished 2-nm resolution at the surface day and night, as well as cloud-height profile and heat-balance data. Complete global coverage was transmitted over an encrypted S-Band digital data link.

~~(S)~~ To achieve the pointing accuracy required for the Block-V line-scan sensor, the spacecraft was earth-oriented, that is, stabilized on all three axes. A momentum-bias attitude-control system consisted of a momentum wheel and horizon scanner, and magnetic coils. The wheel and scanner controlled the pitch axis, while the magnetic coils controlled the roll and spin axes, replacing the momentum dissipated by friction in the bearing between the momentum wheel and the main body of the spacecraft. The Block-V satellite remained 30 inches in diameter, but the height increased to 48 inches and its weight rose to 230 pounds. Positioned horizontally on orbit, it closely resembled an overturned garbage can. Three Block-VA spacecraft were built before military demands for greater tactical meteorological support dictated further changes.[23]

~~(S/SAR)~~ In 1969, all three military services looked forward to still greater tactical weather support from the improved DMSP, and all three sought to obtain it on a daily basis. To that end, the three service assistant secretaries for research and development agreed on a "joint-service utilization plan" for DMSP.[24] On 29 March 1969, John S. Foster, Jr., Director of Defense Research and Engineering, approved the plan* and the funds needed to improve Block-V spacecraft to ensure receipt of DMSP weather data on terminals aboard ship.[25] The result was Block-VB and -C. Longer, at 84 inches in height, and heavier, at 425 pounds, these spacecraft exclusively required use of the uprated booster called Thor-Burner IIA. Block-VB spacecraft added a large sunshade on the "morning birds", a more powerful 20-watt traveling-wave-tube amplifier (TWTA) transmitter that radiated ample power for receipt aboard ships, a second primary data recorder, and a gamma-radiation detector. Block-VC added a vertical temperature/moisture profile sensor and an improved IR sensor that now achieved a resolution of 0.3 nm at the earth's surface.[26]

~~(S/TK)~~ In all, three Block-VA, five Block-VB, and three Block-VC DMSP satellites were built and launched between February 1970 and February 1976.[27] Collectively, they furnished the strategic (global, stored) and tactical (direct readout) weather coverage required by the NRO and the JCS, although their full operational life expectancy on orbit averaged at best about 10 months. Meantime, the DMSP office at the Space Systems Division in Inglewood enlarged, matured, and its early peripatetic motion slowed in efficiency considerably. Transferring the military meteorological satellite program from the NRO to Air Force Systems Command in 1965 had reduced security restrictions, to be sure, but it also introduced bureaucratic layering and returned the program

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*~~(S)~~ The joint-service DMSP use plan would later be revised and updated, in June 1973 and again in late 1976. Shipboard readout terminals had by the mid-1970s been installed aboard the aircraft carriers USS Constellation and USS Kennedy, assigned to the forces of CINCPAC and CINCLANT, respectively.

to conventional Air Force contracting practices, increasing the number of program personnel involved in decision-making. Bespeaking these changes, the last Block-VC satellite launched on 19 February 1976 failed because of incorrect propellant-loading calculations; before reaching orbit the booster exhausted its propellant and fell back to earth.[28]

Fine-Tuning the DMSP

(S) The 10-sided, tub-shaped Air Force polar-orbiting weather satellite had by the early 1970s reached the end of its growth potential. Moreover, this design, which took advantage of spin-stabilization for thermal control, was ill-suited to Block-V operation in a "de-spun" three-axis-stabilized attitude. An entirely new design was needed: one tailored to earth-oriented orbital flight, one that offered growth potential to meet the increasing demands of its military and civilian clients. Indeed, besides the National Oceanic and Atmospheric Administration (NOAA) offices in Suitland, Maryland, that began routinely to receive DMSP weather data in late 1972, a digital facsimile system had been installed in September 1972 at the National Military Command Center to receive weather data transmitted from Air Force Global Weather Central to the JCS. Shortly thereafter, a second digital facsimile system was installed at Headquarters Tactical Air Command at Langley AFB, Virginia, and a third at the Army's White Sands Missile Range in New Mexico, for its use in environmental research.[29]

~~(S)~~ Another reason for starting a new Block-VI military meteorological satellite derived from the short lifetimes on orbit of the Block-V series. A larger, heavier machine would furnish space and power for redundant components. If one component failed, another could be activated in its place. Studies of the Block-VI satellite, which proceeded in the late 1960s on the basis of a mean-mission lifetime on orbit of 16 months minimum, began in the early 1970s under a new Program Director, Lt Colonel Wilbur B. Botzong.* But DMSP Block-VI with that designation was not to be. In the partisan realm of Washington politics, a new block number meant "a new start." At best it would entail special justification and involve unusually close scrutiny at the Office of Management and Budget (OMB) and in Congress. And officials in OMB were known still to favor combining the civil and military meteorological satellite programs. At worst, a Block-VI would fail to receive approval and spark another effort to merge the two programs. Air Force officials therefore elected to term the new spacecraft a modification: DMSP Block-5D. For those acquainted with the nomenclature, the Roman numeral converted to an Arabic numeral signified the block change. In Washington, those unacquainted with its significance appropriated funds for five of the "modified" Block-5D spacecraft in fiscal year 1972. The contract, signed in 1972, set a required launch date for the first 5D satellite in the fall of 1974.[30]

~~(S/TK)~~ This sleight-of-hand notwithstanding, with work underway on Block-5D, in November 1972 the OMB requested that the

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*~~(U)~~ Lt Col Botzong would see this work completed successfully before his reassignment to other duties in 1974.

Department of Commerce and the Defense Department reexamine a single consolidated civil and military meteorological satellite program, and the possibility of using a single spacecraft to satisfy the demands of both. Either action would unquestionably result in substantial dollar savings, and a steering group composed of representatives from NOAA, the Defense Department, and NASA was formed to consider these questions. Their report, issued in mid-1973, concluded that the greatest savings would be realized in a single national meteorological satellite system managed by the Air Force, using a standard DMSP Block-5D satellite. This uncivil solution was quickly rejected by Congressmen who argued that it would violate the National Aeronautics and Space Act, which dictated a separation of military and civil spacefaring, and by officials in the Department of State who warned of adverse international repercussions. Subsequent interagency deliberations led by Air Force Under Secretary James W. Plummer, the Director of the NRO, resulted in an agreement in July 1974 to achieve major cost savings by adopting a variant of the DMSP Block-5D satellite for use in both the civil (TIROS-N) and military polar-orbiting, low-altitude, meteorological space programs. The larger, joint-use version, needed by the NOAA to support additional sensors, was identified as Block-5D-2. The five original Air Force spacecraft thus became DMSP Block-5D-1.[31]

(U) The Block-5D-1 design that emerged back in the early 1970s resembled more closely the conventional earth-oriented satellites of this period. Sized to fit the Burner solid-propellant upper stage on the Thor, it was five feet in diameter and 20 feet long. The satellite consisted of three sections: a square precision-mounting platform on the forward end supported the sensors and other equipment required for precise alignment; in the center, a five-sided equipment-support module contained the bulk of the electronics and featured one or two pinwheel louvers on four sides for thermal control; and at the aft end, a circular reaction and control-equipment support structure housed the spent third stage solid-propellant rocket motor and contained reaction-control equipment. A deployable, 6-by-16 foot sun-tracking solar array was also mounted aft, on this section. With its complement of sensors, the spacecraft weighed 1,150 pounds, over twice the weight of its Block-VC predecessors. To heft the additional weight into orbit, the program office contracted for a new, larger, solid-propellant second stage. The original Burner-IIA second stage, now adapted as a third stage and fixed to the satellite, was used during ascent to inject the vehicle into its circular, sun-synchronous 450nm earth orbit.[32]

(U) Once in orbit, the 5D-1 spacecraft had to point and control the optical axis of the primary imaging sensor to within .01 degree, in effect making the satellite "a spaceborn optical bench". This was achieved by automatic momentum exchange between three momentum wheels; one each positioned in the yaw, roll, and pitch axis and magnetic coils that interacted with the earth's magnetic field and prevented the accumulation of wheel secular momentum. The wheels and coils were coupled with three orthogonal gyroscopes that measured short-term changes in attitude, and a star sensor that updated attitude position to bound the effects of gyro drift. A backup system, composed of an earth sensor that furnished pitch and roll information, and a sun sensor that provided yaw information, ensured attitude control about one-tenth as accurate as the primary system. The software programs for both systems were stored in two redundant central computer and processing units.[33]

(U) Besides performing spacecraft-control functions autonomously on orbit, the integrated 5D computers and attitude-control system also controlled the Thor booster and its upper stages during ascent and orbit injection. A pre-set (but reprogrammable in orbit) software code contained in both of the central computers made possible autonomous orbital operations. All of these control and maintenance functions were directed to a single purpose: support of the primary imaging sensor, an improved electro-optical Operational Linescan System (OLS). The OLS consisted of a scanning optical telescope oscillated in a sinusoidal (side-to-side) motion by counter-reacting springs and a pulsed motor. In a nominal orbit, the OLS covered a swath width of 1,600 nm and furnished a nadir resolution at the earth's surface of 0.3 nm in the visual and infrared spectra, with a resolution of 0.5 nm at the edges. The OLS could also produce "smoothed" images with a constant resolution of 1.5 nm across the scan. The visual and thermal data acquired on cloud cover and cloud-height profiles could be stored in three tape recorders for transmission to earth in an encrypted, digital format. Direct readout, of course, was available to tactical users.[34] The increased amount of data, which could not be effectively transmitted over the leased land lines used previously, began to be relayed from the DMSP ground stations to Air Force Global Weather Central at Offutt AFB via commercial communications satellites beginning with the first launch of a Block-5D in 1976.

~~(S)~~ A variety of secondary sensors were flown in different combinations on Block-5D-1 missions. Five of them frequently appeared on the spacecraft. An atmospheric density sensor measured the major atmospheric constituents (nitrogen, oxygen, and ozone) in the earth's thermosphere on the daylight portion of each orbit. A precipitating electron spectrometer counted ambient electrons at various energies. A scanning infrared radiometer furnished vertical temperature profiles, vertical water vapor profiles, and the total ozone concentration. A passive microwave-scanning radiometer profiled global atmospheric temperatures from the earth's surface to altitudes above 30 kilometers. Finally, a gamma-radiation sensor furnished by the Air Force Technical Applications Center detected nuclear detonations* as part of the ongoing Integrated Operations NUDET Detection System.[35]

(U) The complexity of the new satellite and design changes introduced along the way delayed Block-5D-1 flights from 1974 until 1976. But the value of autonomous flight operation was amply demonstrated during the first launch on 11 September 1976 when the spacecraft unexpectedly tumbled end-over-end in space. A few weeks later, intermittent communication with the tumbling satellite was established and ground controllers reprogrammed the computers. The attitude-control system thereafter slowed the rate of tumbling until the satellite stabilized on three axes and began operating properly. A flexible, versatile Block-5D design had made possible the recovery of a mission at first believed lost.[36]

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*(U) For additional details, see Chapter 2, pp. 45-47.

~~(TS/TK)~~ But the loss of the last Block-VC at launch a few months earlier, in February 1976, the degraded performance of the remaining VC spacecraft on orbit, and the delay in launching the first 5D-1 vehicle resulted in poor DMSP weather coverage between 1975 and 1977. The program office was forced to change DMSP status from fully operational to partially operational. The second 5D-1 satellite, launched on 5 June 1977, vaulted into a drifting orbit and by the spring of 1978 it had moved so far out of position that most of the OLS data was all but useless to the NRP. The third and fourth vehicles, launched from Vandenberg AFB on 30 April 1978 and 6 June 1979, respectively, fared better. With these meteorological satellites operating on orbit, the last 5D-1 vehicle was held for launch as a replacement, when needed.[37]

(U) While the Block-5D-1 enterprise moved ahead, work on the joint-use Block-5D-2, contracted for in 1975, proceeded slowly. The follow-on satellite was designed primarily to meet the needs of the NOAA. Technical changes introduced by the civilian and military co-users and prolonged studies of the proper booster for the 5D-2 brought delays and increased costs. In El Segundo, the DMSP program office at the Space and Missile Systems Organization (SAMSO, formerly the Space Systems Division), found it necessary to slip the first 5D-2 launch from 1980 to 1982. Meanwhile, between 1975 and 1980, a succession of six DMSP program directors arrived, were reassigned, and left. The era when an Al Haig or a Wil Botzong guided DMSP activity for years at a time appeared to be a thing of the past. In Washington, as the decade drew to a close, the sharp rise in cost of the new Block-5D-2 weather satellite moved a cost-conscious OMB and Congress in 1979 to reduce the number to be built for the Air Force from 13 to 9. Nine long-life follow-on satellites, reasoning held, was more than enough.[38]

(U) The electronic components of the follow-on satellites remained essentially the same as those in 5D-1, but the 5D-2 structure was lengthened from 20 to 22.5 feet. The extension increased the downward-facing sensor-mounting area and lengthened the equipment-support module amidships. That module now contained a second 50-amp-hour battery and sported two or three pinwheel temperature control louvers on four of its five sides. The solar array mounted on the aft reaction control equipment-support structure also increased in size to 8-by-16 feet, furnishing increased electrical power. Two important sensors were added to those in the 5D-1 complement: a topside ionospheric sounder provided detailed global measurements of the electron distribution in the earth's ionosphere, and a microwave imager (flown on the last few 5D-2 satellites) defined the extent of sea ice and sea-state conditions (wave height and patterns) on the world's oceans.* Withal, these changes increased the weight of the Block-5D-2 spacecraft to 1,792 pounds, a sum too great for the Thor-Burner booster combination. The launch vehicle ultimately selected for the 5D-2 meteorological satellite in 1980, after 16 months of indecision, was the Atlas, an improved version of the liquid-propellant intercontinental ballistic missile deployed briefly in the early 1960s. The solid-propellant Burner-IIA upper stage, fixed to the aft end of the satellite was retained, again

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*~~(TS/TK)~~ Work on the intelligence microwave imager began in earnest in 1975. See Chapter 2, p. 48-49.

used at altitude to drive the vehicle into a circular 450 nm orbit.[39]

(U) In late 1979 a conjunction of circumstances precipitated a crisis. For some in late 1979, the time had arrived. In mid-October the Pittsburgh Pirates won the World Series in seven games. On 3 November in Tehran, Iran, Shiite militants seized the American Embassy, imprisoned the staff, and dared the United States to do anything about it. A few weeks later, on Christmas Day, the Soviet Union began airlifting military forces into nearby Afghanistan, intent it seemed on securing a vassal state. But for others, including the Defense Meteorological Satellite Program, time had run out. In September 1979 the first of the Block-5D-1 polar-orbiting satellites, which had begun to fail earlier in the year, ceased all effective operations. The third satellite followed it at the beginning of December 1979. Shortly after the new year began, in March 1980, the second satellite used for tactical weather support in a drifting orbit, failed. The fourth vehicle, meantime, encountered electrical problems, began to falter, and ground controllers placed it in a "backup mode" on 29 December 1979. The fifth and last Block-5D-1 satellite held in reserve was readied for flight and shipped to Vandenberg AFB. Officials in the DMSP program office could only hope for the best. With the Block-5D-2 vehicles delayed in development, a first launch could not occur until 1982, two years in the future. The sputtering fourth and the new fifth Block-5D-1 spacecraft had therefore to function on orbit for an extended period if the nation's strategic and tactical military meteorological needs were to be met completely.[40]

~~(S/TK)~~ On 15 July 1980, at Vandenberg AFB in California, a Thor-Burner launch vehicle carrying the last 5D-1 satellite roared to life and ascended skyward. For the first time in many years, the Thor-Burner combination failed. The second and third stage solid rockets apparently failed to separate, and the satellite fell into the South Pacific. Four weeks later in August, high above the earth, the fourth and last 5D-1 satellite completely ceased to function. In the mid-1970s the program had temporarily operated with a single satellite in orbit. Not since the early 1960s, however, had the program faced an absolute gap in military meteorological coverage. An investigation by Air Force Systems Command pinpointed funding cutbacks and weak program management resulting from the rapid turnover of program directors to be the principal contributing causes. These deficiencies might be rectified by 1982; meantime, the military services and the NRP would have to rely exclusively on NOAA satellites and other programs for tactical and strategic meteorological coverage.[41]

~~(TS/TK)~~ Having to rely on NOAA for satellite meteorological data was a bitter pill for Air Force officials to swallow. For years they had defended DMSP before Congress and the public as "indispensible" to military decision-makers, especially in times of conflict.[42] To be sure, since the mid-1970s, data from NOAA weather satellites had been received at DMSP ground stations and transmitted to Air Force Global Weather Central over an automated weather network, where it could be combined with information from the DMSP satellites and other ground and aerial observations obtained throughout the world. Between mid-1980 and 1983 these data, less that of the military weather satellites, would meet most military needs. In truth, however, the NOAA spacecraft were not designed to satisfy fully the high-resolution visual and infrared strategic meteorological requirements of the National Reconnaissance Program. At Air Force Global Weather Central, it was DMSP high-resolution data that permitted assessments of the cloud cover over the Eurasian continent and the issuance of rapid forecasts that predicted the percent probability of obtaining cloud-free photography over areas about to be transited by reconnaissance spacecraft. These time-critical forecast probabilities of cloud-free conditions were the key determinants in directing camera operations and film expenditure.[43] Fortunately, by mid-1980, many years accumulation of cloud-cover data from all sources allowed statistical modeling. Combined with the NOAA weather satellite data, cloud-cover estimates could be produced to direct overhead imagery operations.

~~(TS/TK)~~ Back in 1963-1964, only 50-to-60 percent of KH-4 satellite photographs proved to be cloud-free despite the support of DMSP meteorological satellites. Part of the difficulty stemmed from the differing terminology used by the intelligence customers that submitted target requirements to the Committee on Imagery Requirements and Exploitation (COMIREX).* In 1966 COMIREX adopted as a single standard the World Aeronautical Chart and its subdivisions, called World Aeronautical Grid Cells, or WAG Cells. Each WAG Cell was a uniform 12-by-18 nautical miles on a side around the world. Intelligence customers thereafter submitted

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*~~(TS)~~ For a discussion of COMIREX and its evolution, see Chapter 2, pp. 32-33.

target requests to COMIREX identified by WAG Cell location and sorted by ephemeris (e.g. which satellite orbital trace crossed a particular WAG Cell and at what time). At Offutt AFB, the Air Weather Service's Air Force Global Weather Central began work on a three-dimensional cloud analysis. The programs merged all overhead imaging and civilian weather reports into a global cloud analysis with a spatial resolution of 25 nm on a polar stereographic grid, by date and time of day. By the late 1960s, employing a software program devised by the Air Weather Service, Air Force Global Weather Central could estimate the probability of cloud-free access on any day and time throughout the year for any required target.[44]

~~(TS/TK)~~ This effort assumed increased importance in 1972 when KH-9 reconnaissance satellite operations began, for the twin cameras in this vehicle covered a 300-nautical mile-wide swath at the earth's surface. The early morning "scout" military weather satellite furnished weather conditions over the Soviet Union at first light. These data, used in the cloud analysis and forecast system, provided cloud-cover estimates that were transmitted from Air Force Global Weather Central to the Satellite Operations Center in the basement of the Pentagon and used as a short-term forecast to program satellite camera operations in the reconnaissance satellites that trailed the weather scout. The late morning "assessment" weather satellite told how accurate the cloud forecast had been, determined whether target requirements had been satisfied, and also contributed data to the weather model. Finally, personnel in the Defense Mapping Agency scanned the film returned by reconnaissance satellites and reported actual cloud cover to Air Force Global Weather Central after the fact, further contributing to the weather model data base.[45] By the late 1970s NRP KH-8, KH-9, and KH-11 satellites could return pictures of the earth up to 80-to-85 percent free of cloud cover. Without weather forecasts, only 38-to-40 percent of the imagery returned would be cloud-free. Probabilities of cloud cover generated by the weather analysis model and low-altitude NOAA satellite data thus met minimum NRP strategic weather forecast requirements during the 1980-1982 DMSP interregnum.[46]

~~(S/TK)~~ In December 1982 the first of the Block 5D-2 military weather satellites, a morning bird, was launched successfully atop an Atlas booster. The second and third satellites followed the first one into orbit in November 1983 and June 1987, respectively. These military meteorological satellites once again supplied the global coverage needed by the country's three military services and the NRP, and did so for many months. Indeed, the primary OLS on the first satellite did not cease functioning until mid-August 1987, providing nearly five years of effective operation, while the second and third satellites continue to function successfully. In the meantime, Defense Department and NOAA officials made plans for another improved version of what had become the standard U.S. civil and military low-altitude weather satellite, Block-5D-3.

~~(TS/TK)~~ Design studies of a larger and heavier Block-5D-3 satellite began in the late 1970s,* but funds for the military

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*(U) Air Force officials briefly considered calling this series of DMSP satellites Block-6, but abandoned the idea when President Jimmy Carter issued a directive in late 1979 that specified

version were not appropriated until mid-1980. The 5D-3 satellite, designed to be compatible for launch on NASA's Space Shuttle, would carry an improved OLS and a larger combination of secondary sensors. The length of the satellite increased to 24 feet, while the weight rose to 2,278 pounds. The spacecraft consisted of the same basic components as its immediate predecessors, but included a larger solar array, three 50-amp-hour batteries, and a redesigned sun-shade. The center section now sported four pinwheel temperature control louvers on four of its five sides. These and other design improvements combined to give the 5D-3 an anticipated mean mission lifetime on orbit of five years (60 months). The first of six 5D-3 spacecraft are scheduled to be delivered to the Air Force in June 1990. Following the loss of the Space Shuttle Challenger in January 1986, all of them are scheduled for launch atop a modified Titan-II intercontinental ballistic missile.[47]

(U) After the introduction of the DMSP Block-5D-1 satellites, Air Force leaders realigned the organization and operation of the program. Responsibility for launching DMSP spacecraft transferred in the mid-1970s from the Strategic Air Command (SAC) to Air Force System Command's Space Division. When the Air Force established Space Command in September 1985, the new organization gained responsibility for operating the ground

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military and civil meteorological satellite programs would continue to be conducted separately until the next satellite block change. (Presidential Directive 54, "Civil Operational Remote Sensing," 23 November 1979.)

stations in Maine and Washington State,* and the DMSP Command and Control Center at Offutt AFB, the latter functions also transferred from SAC. Following the disruption that occurred with the gap in satellite coverage during the early 1980s, and despite the inter-command politics that attended the organizational realignment, in 1987 the operational DMSP received the management attention it deserved, met its strategic and tactical commitments, and could be judged reasonably fine-tuned.

~~(TS/TK)~~ Fine-tuned or not, between 1962 and 1987 the Defense Meteorological Satellite Program had sparked a revolution in overhead meteorology. It introduced the "wheel-mode" satellite, novel attitude-control systems, new satellite-tracking programs, and the operational use of infrared imagery to the field of meteorology. Beginning in 1966 it acquired a tactical as well as strategic capability and furnished the needed weather support for both activities. Indeed, DMSP significantly increased the image-search system effectiveness of NRO reconnaissance satellites and of SAC SR-71 and U-2 reconnaissance aircraft, while it markedly reduced the number of aerial meteorological sorties. It also furnished special data to Intelligence Community users including the Nuclear Energy Intelligence Committee, the Defense Intelligence Agency, [redacted] 3.3 (b)(1) All the while, the mean mission lifetime on orbit of the military meteorological satellites increased from 90 days in Block-I, to five years on the most recent Block-5D-2 flights.

*(U) Back in 1979-1980 the DMSP program also arranged for data readout and relay of weather data from a third site, the Air Force Satellite Control Facility tracking station in Hawaii.

~~(S)~~ The Defense Meteorological Satellite Program also made-do with less. During the early years, and at least until the mid-1970s, DMSP development and production was accomplished with fewer personnel and at a cost less than one-half the cost of equivalent NASA and Department of Commerce efforts.[48] Rapid development and the remarkable DMSP technical performance by the mid-1960s prompted the civil sector to adopt the DMSP wheel-mode spacecraft as the standard for low-altitude, polar-orbiting meteorological applications. That choice was made formal in the mid-1970s when the DMSP Block-5D three axis-stabilized spacecraft was also selected for use in both programs. In the meantime, however, another blue suit-administered military satellite program had reached operational readiness. This one, like its reconnaissance and meteorological satellite cousins, also responded directly to President Eisenhower's predominant concern: early warning of surprise attack.

CHAPTER FOUR

MISSILE DETECTION AND ALARM

(U) In June 1955 Joseph J. Knopow, a 41-year-old electrical engineer in the Operations Analysis Office, Directorate of Operations, Headquarters USAF, joined the Lockheed Aircraft Corporation in Van Nuys, California.* The career move was hardly novel. Engineers of all kinds changed employers frequently in a burgeoning aeronautical industry at that time fashioning turbojet-powered intercontinental transports and ballistic missiles of equivalent range. In this instance, however, the confluence of Knopow's particular interests, the Air Force contract competition for a strategic surveillance satellite, and widespread concern over a possible Soviet nuclear surprise attack would affect directly the evolution of American defense early-warning systems.

MIDAS--The Early Years

(U) Shortly after arriving in Van Nuys, in the summer of 1955, Knopow's group was posted to Palo Alto, California, 400 miles north in the Bay area. There, the newly named Lockheed Missiles and Space Division, began work on the company's proposal for what would become known as the WS-117L satellite program. Back at the Pentagon in the early 1950s, Knopow had evaluated the technology of infrared systems for air-to-air and submarine detection. These studies, based largely on German Luftwaffe literature of a World

*(U) Knopow joined a select group led by Joseph Charyk that formed the nucleus of what would eventually become the Lockheed Missiles & Space Co.

War II air-to-air infrared detection system called "Kiel IV," prompted the electrical engineer to consider infrared detection in spaceborne applications. The proper lead-sulfide detectors, sufficiently cooled and combined with the needed optical telescope, he reasoned, could be employed in a satellite to detect ballistic rockets ascending through the atmosphere, and high-altitude, air-breathing vehicles.[1]

~~(S)~~ Knopow succeeded in convincing his Lockheed superiors of the infrared sensor's technical feasibility. The concept was adopted, identified as the "satellite infrared detection and surveillance system", and incorporated as Subsystem G in the firm's reconnaissance satellite proposal submitted to the Air Force in March 1956.* In this application, the Lockheed satellite was to be stabilized on three axes and positioned nose downward, very much resembling a pencil with its sharpened end pointed at the center of the earth. The payload would consist of a wide-field infrared telescope mounted on a ring at the forward end of the satellite. The ring, or spin table, would rotate 360 degrees about the vertical axis, scanning an annular area beneath the vehicle, extending at the outer circumference to 3 degrees above the earth's horizon, with the inner circumference defined by the limits of the field of view of the telescope. The telescope optical system would focus on a number of lead-sulfide detectors, and these would convert the infrared signals to electrical impulses which, after amplification, filtering, and processing, would be transmitted to the ground.[2]

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*(U) For additional details, see Chapter One, pp. 26-27.

~~(S)~~ In June 1956 the Air Force selected Lockheed as prime contractor for the WS-117L reconnaissance satellite, and awarded a contract to the firm for its development in October. Subsystem G, the infrared detection and surveillance system, was judged a promising application; Knopow set to work in earnest to see it realized. Now appointed subsystem manager, he subcontracted with the Aerojet-General Corporation for a Series-I infrared-detector payload devoted exclusively to ICBM detection,* and with Baird-Atomic, Incorporated, for an infrared scanner to be used in tests aboard balloons and aircraft. The latter effort was crucial, for it had to determine the precise nature of background radiation (radiation emitted from the earth, atmosphere, and clouds) that would be encountered by the infrared detectors viewing the earth from a satellite.[3]

~~(S)~~ However promising the Lockheed satellite infrared detection and surveillance system might have appeared in the late 1950s, many experts seriously questioned its technical feasibility. Background radiation, they argued, could not be distinguished from a target missile. It might also trigger "false alarms" in the satellite payload when sunlight, reflected from clouds, illuminated the detectors, for example, instead of the infrared energy radiated by a rocket engine's exhaust during powered ascent. More to the point, respected engineers designing infrared systems for ground applications worked with four to seven lead-sulfide detectors, and

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*(U) Though theoretically feasible, given the state of the art in 1956-1957, detection of high altitude air-breathing vehicles was judged too ambitious a step to attempt.

coupling 10 of them was considered the outer limit of the art. The gentlemen at Lockheed and Aerojet proposed 27 detectors--in earth orbit yet, and, using filters, in different parts of the spectrum![4]

(S) Officials of the Advanced Research Projects Agency (ARPA), Ralph Zirkind in particular, numbered among those with the gravest of doubts. Created in early 1958, ARPA controlled all military satellite programs until September 1959, and Knopow found himself increasingly called upon to explain program details and infrared theory in California and Washington. Since ARPA controlled the budget instead of the Air Force, he had no alternative but to comply. By mid-1958 aerial test flights had measured background radiation, and Lockheed settled on operating in the 2.7- and 4.3-micron regions of the spectrum. These regions were usually avoided for infrared scanning in earthbound applications because of the water-vapor absorption. Lockheed planned to operate earth-orbiting infrared payloads in the very same narrow parts of the spectrum to take advantage of the filtering effect that water vapor provided against background radiation. Still, the doubters persisted. Years later Knopow recalled:

> We made measurements from balloons. We made measurements from airplanes. We made measurements from the U-2. We made measurements of all kinds . . . and analyses, and were usually successful when we gave a briefing to [officials] from Washington. They agreed that by using the spectral characteristics and the spatial characteristics of the background elements such as clouds and water, we could detect an

> ICBM in the presence of clouds. But when they went back home . . . they would . . . see all those bright clouds, . . . and by the time they arrived in Washington, after about 2,500 miles of looking at that stuff, they got unconvinced and we had to go back to Washington and convince them again. And then we left them and by the time they came back to see us again it was a very difficult job getting them to believe that you could really see a missile launch in the presence of cloud backgrounds.[5]

~~(S)~~ The doubting Thomas's notwithstanding, Knopow had by mid-1958 convinced a majority of WS-117L program officials of the theoretical feasibility of the ICBM attack-alarm system, and began the fabrication of experimental payloads. Bespeaking that achievement, on 17 September the Air Force Ballistic Missile Division in Inglewood recommended accelerating the effort, and on 15 November 1958 ARPA issued Order No. 38-59 that separated the infrared detection and surveillance system from the basic WS-117L (Samos) program and established it as an independent satellite program identified as the Missile Defense Alarm System (MIDAS).* The formal recognition brought to Knopow the title Program Manager and a deputy: John C. Solvason. Both men dedicated themselves to MIDAS and for the next few years "lived" for the program; they ate, drank, slept, and thought about it 24 hours a day. The MIDAS staff at Lockheed, meantime, had increased in size from one individual in mid-1956 to about 50 engineers and administrative support personnel at the close of 1958. While Knopow divided his efforts between "convincing" the skeptics that remained and attending to the Agena satellites and

*~~(C)~~ The ARPA directive also proposed launching MIDAS satellites on Thor IRBM boosters, an approach that was not adopted.

infrared payloads scheduled for demonstration test flights in late 1959, other members of the staff devoted themselves to preparing "program development plans" for an operational MIDAS requested by the Air Force.[6]

~~(S)~~ If some officials at ARPA and others in the office of the Director of Defense Research and Engineering (DDR&E) had to be persuaded that MIDAS would work, by 1959 many Air Force officials needed to be restrained. Contemporary Soviet space triumphs and erroneous intelligence estimates that posited a "missile gap" in favor of the Russians had heightened fears of an ICBM surprise attack on the United States. On 9 February 1959 Headquarters USAF issued an amendment to General Operational Requirement 80 that called for a date of "operational availability" for MIDAS "not later than CY 1962." On 12 February Air Force Under Secretary Malcolm A. MacIntyre wrote Secretary of Defense Neil H. McElroy affirming that the service judged MIDAS to be a program of the highest priority, that its development was most urgent, and he requested additional funds to accelerate the effort. Key members of the U.S.-Canadian North American Air Defense Command (NORAD) and the Continental Air Defense Command (CONAD) also argued that MIDAS should be pressed into operational service at the earliest opportunity. Among them, Brigadier General Arthur J. Pierce, Director of NORAD Plans and Requirements, in a letter to the Joint Chiefs of Staff, asserted that the ballistic missile early-warning radar system (BMEWS), then abuilding in the far north, would provide inadequate alert since it was designed to give an optimum 15-minute warning of an ICBM attack. The Lockheed-Aerojet space-based system, he declared, would double the warning time to 30 minutes.[7]

~~(S)~~ An additional 15 minutes warning appealed mightily to key members of General Thomas Power's staff at the Strategic Air Command (SAC). More SAC bombers could be scrambled into the air, and the number of bombers maintained on airborne alert could be reduced. They too lent their support, and SAC came down hard in favor of an operational MIDAS. Underscoring this widespread support, on 18 September 1959, Secretary of Defense McElroy reorganized the military space program and assigned to the Air Force responsibility for MIDAS. Though the Lockheed program office could take heart in the organizational change and a growing Air Force advocacy, it translated ultimately into increased requests from the Ballistic Missile Division in Inglewood for program development plans of an operational MIDAS. And Knopow, still finding it difficult to sell the theoretical feasibility of a spaceborne-infrared detector in other quarters, had yet to demonstrate its technical feasibility in an actual test flight.[8]

~~(S)~~ Between 1958 and 1964 the Lockheed program office issued a number of program development plans, each responding to changes in Air Force requirements or direction. Because the absolute performance of the infrared detectors remained in question, the earlier plans proposed operation in low-earth orbits.* The plans specified multiple satellite configurations, usually 8-to-20 vehicles

*~~(S)~~ Increasing the altitude would decrease the number of satellites required; however, the strength of the infrared signal also decreased inversely with the square of the range, making it more difficult to detect the target and achieve the desired resolution.

in controlled polar (later, simplified random polar) orbits at an altitude of 1,000 nautical miles (nm), a distance increased to 2,000 nm in later plans. Early versions called for four test-evaluation flights in Phase I, six research and development flights in Phase II, and optimistically projected an operational system in the early 1960s in Phase III.[9] At the beginning of 1960, however, the first two MIDAS test and evaluation satellites were just being readied for launch at Cape Canaveral, Florida.

Trial, Tribulation, and Success

(S) Although ARPA officials had briefly considered launching MIDAS satellites atop a Thor booster, the weight of the Agena-A liquid-propellant, upper-stage booster-satellite and its Aerojet infrared payload precluded that option. A modified Atlas ICBM would comprise the first stage and, indeed, it was employed on all Lockheed MIDAS flights in the 1960s.

(S) At Aerojet, Marvin D. Boatright and Alfred H. Gale served as Knopow and Solvason's counterparts, and worked closely with William A. Hubbard, a physicist in the firm who conducted the payload-system calculations throughout the early MIDAS era. The Aerojet payload built for the first two low-altitude test demonstration flights* consisted of a Bouwers-concentric telescope and 27 lead-sulfide detectors. Mounted in a fork beneath the spin table, the telescope elevation could be adjusted on command. The spin table would rotate 360 degrees at two rpm about the vertical

*(U) Programmed for low-inclination orbits at 260 nm altitude.

axis of the satellite in a nose-down attitude. A comparable spin table would also be used on all Lockheed MIDAS flights.[10]

~~(S)~~ At Cape Canaveral in February 1960, Joe Knopow oversaw the final tests of the first MIDAS spacecraft and payload. On 26 February he watched the Atlas booster ignite and lift skyward until the engine flame could hardly be seen. Upon separation of the Agena, the Atlas exploded, and debris rained into the Atlantic Ocean. That evening the Orlando Herald headlined: "Spy in the Sky, Asleep in the Deep." Knopow never forgot it. Three months later, on 26 May 1960, the second and last of the Series-I MIDAS test flights rode successfully into a low-inclination 260 nm orbit atop another Atlas, but the satellite tumbled as it circled the earth and, after the first dozen orbits, the Agena communication link failed. The payload could not be operated as planned.[11] No Test.* At least that was the polite term engineers liked to use in these situations. Whatever it might be called, MIDAS remained undemonstrated for missile warning, and new voices in the Defense Department began to question the reliability of the MIDAS satellite as well as the feasibility of its infrared applications. The Lockheed program office, and Joe Knopow, felt the pressure.[12]

~~(S)~~ The program had proceeded thus far in part because panels of independent scientists had verified the Lockheed and Aerojet analyses of the space-based infrared applications. An ARPA

*~~(S)~~ The Aerojet payload did operate well even though tumbling, and observed backgrounds and the infrared energy from a star, presumed to be Betelgeuse.

board* back in February 1959 judged missile detection and alarm to be a straight forward method "based on a few physical laws and one that cannot readily be circumvented." Though more information was needed "on background characteristics and the technical complexities of necessary discrimination devices," the members urged "most strongly that development and test flights of this missile-detection system be pursued with top priority."[13] Shortly after the flight of MIDAS-2, between 6-9 September 1960, 12 members of the President's Scientific Advisory Committee, led by W. K. H. Panofsky of Stanford University, also evaluated MIDAS. This panel likewise found the concept to be sound. Though acknowledging major technical difficulties had yet to be overcome, panel members recommended vigorous efforts to achieve an operational system in 1963.[14]

~~(S)~~ Despite the scientific approbation, Defense Department leaders maintained the funding restrictions imposed on MIDAS earlier in 1960, and refused to approve an operational system. The Air Force program manager at the Ballistic Missiles Division in Inglewood, Lt Col Quentin A. ("Q") Riepe, advised Lockheed in August that this state of affairs bespoke "a lack of confidence that the current R&D program can provide a reliable and effective [operational] system." Accordingly, he redirected the program toward development and system test flights, with emphasis to be placed on assuring reliability of all system components.[15] Lending credence to Riepe's observation, at the Pentagon the Director of Defense Research and Engineering, Herbert York, approved the launch of two radiometric payloads to

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*(U) Composed of Carl Overhage, MIT; Sidney Passman, The Rand Corporation; Edward M. Purcell, Harvard University; and Chalmers W. Sherwin, University of Illinois.

measure more completely the earth's background radiation. Launched aboard Discoverer-XIX and Discoverer-XXI Agena satellites on 20 December 1960 and 18 February 1961, respectively, these devices transmitted data for several days and validated previous projections.[16] All of the available scientific evidence seemed to confirm the MIDAS concept. In 1961 one question remained unanswered: could Lockheed and the Air Force make it work?

~~(S)~~ At the Lockheed program office in Sunnyvale, California, Knopow and his colleagues recast MIDAS activity to meet the direction of Col Riepe. Succeeding MIDAS flights were divided among developmental ones in Series-II and Series-III, and prototype flights in Series-IV, with each series consisting of three or four flight vehicles.[17] In the Air Force major commands and Air Staff offices, however, enthusiasm for an operational MIDAS had hardly dimmed. On 16 January 1961, Secretary of Defense Thomas S. Gates, Jr., about to leave office with the Eisenhower Administration, approved an Air Force request to assign to a command "operational responsibility" for MIDAS. A few weeks later, on 13 February, Headquarters USAF assigned that responsibility to the Air Defense Command (ADC) and designated it to represent the service in all dealings with NORAD. Acting quickly, on 15 March ADC submitted another development plan for an operational MIDAS to Under Secretary of the Air Force Joseph Charyk. Charyk, who knew well the technical complexity of military spacecraft and their operation, disapproved. The service, he counseled Air Force Chief of Staff, General Curtis E. LeMay, had first to demonstrate conclusively MIDAS's early-warning techniques. On 22 June 1961, a few weeks before the launch of MIDAS-3, LeMay agreed.[18]

(S) Final preparations for the launch of MIDAS-3, the first of three test vehicles in Series-II, took place at the Point Arguello Launch Complex, Vandenberg AFB, California, in late June and early July 1961. MIDAS-3 consisted of an Agena-B, a new model booster-satellite. Five feet in diameter and 30 feet long, it was nearly twice the length of its Agena-A predecessor. The increased tankage and a new "dual-burn" rocket engine would permit reaching a planned circular polar orbit at an altitude of 2,000 nm, the orbit considered most appropriate for an operational MIDAS. Power was to be furnished by two solar arrays fixed to the aft equipment rack so as to maximize sunlight intercept, and coupled to storage batteries, instead of the batteries alone used on the first two missions. This vehicle and its Series-II companions carried a new infrared payload built by Baird-Atomic, one that featured 175 detectors capable of sensing ICBM targets at a maximum slant range of 4200 nm. The payload was designed to scan at a rate of 6 rpm, three times faster than the Series-I. During a 10-second period, approximately 25 million square nautical miles of the earth's surface would be viewed by the detectors, allowing as many as nine possible "looks" at an ICBM between the time it reached 35,000 feet and missile burnout. This number of looks was believed sufficient to identify the direction of missile travel.[19]

(S) On 12 July 1961 the Atlas booster carrying MIDAS-3 roared to life at Vandenberg AFB. The booster ensemble rose slowly and disappeared from view. Air Force and Lockheed program officials who followed its progress rejoiced on word that the Agena successfully reached a 2,000-nm circular polar orbit. An hour later they despaired. One of the two solar arrays had failed to deploy properly. Only limited payload data was obtained before a power failure occurred in the Agena. The mission was over after five orbits.[20] Air Force Under Secretary Charyk's reservations appeared well founded. At least that was what Defense Department leaders in the new Kennedy Administration soon concluded.

~~(S)~~ On 29 July 1961, while MIDAS officials on the west coast sought to determine exactly what went wrong with MIDAS 3, the Director of Defense Research and Engineering, Harold Brown, briefed Secretary of Defense Robert S. McNamara on the status of the program. Formidable technical problems remained, Brown declared, though he thought them solvable in time. The MIDAS satellite system would provide 5 to 20 minutes advance warning of an attack by liquid-propellant ICBMs, but he believed that detection of land- and sea-based solid-propellant rockets was at best, questionable. Program costs were also formidable: $500 million to complete R&D, another $500 million to complete an operational system, and Brown estimated annual operating expenses at $100-to-$200 million. Was an extra 5 to 20 minutes of warning worth the needed expense and effort? Brown advised McNamara that he would form a special task force to evaluate the program in general, and this question in particular.[21]

~~(S)~~ The group formed for this purpose began its evaluation in late September 1961. Chaired by Jack P. Ruina, Director of ARPA, and composed of experts drawn from within and outside the government,* during the next two months its members visited MIDAS

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*(U) Besides Ruina, the members were Benjamin Alexander, Defense Research Corp.; Robert S. Sargent, ODDR&E; Dean Gillette, Bell Telephone Laboratories; M. A. Ruderman, UC Berkeley;

contractor and government facilities around the country. Meantime in southern California, on 21 October, the Air Force launched MIDAS-4. An Atlas roll-control failure shortly after launch propelled the Agena into an improper ascent trajectory. After separating from the Atlas, the Agena used an abnormal amount of attitude-control gas during first and second burns as onboard systems sought to compensate for the trajectory dispersion. Once in orbit, the Agena's attitude continued to fluctuate and all control gas was exhausted by the time it completed its first revolution of the earth. One of two solar arrays aboard the tumbling Agena failed during the fourth orbit, power depleted, and all electrical equipment was shut down after the 56th orbit.[22] The "Ruina Group," as the Brown investigatory panel came to be called, unquestionably had much to consider.

~~(S)~~ The Ruina Group completed its deliberations and submitted its report, "Evaluation of the MIDAS R&D Program", to Harold Brown on 30 November 1961. Members of the group concluded that MIDAS was probably worth the effort, but that effort needed a new direction. Members believed the infrared system could probably detect large liquid-propellant ICBMs that emitted a high radiance, though they also agreed with Brown that it would probably be unable to detect solid-propellant rockets with depressed infrared signatures, such as Minuteman and Polaris. Moreover, Ralph Zirkind, ARPA's infrared specialist, believed the number of false-target alarms generated by the infrared payload could be as great as 1-10 per six-second scan for a liquid ICBM, and an incredible 2000-

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Montgomery Johnson, Ford Aeronautics; Hector R. Skifter, Airborne Instrument Laboratory; Lt Col G. T. Grottle, HQ USAF; and Knopow's old nemesis, Ralph Zirkind of ARPA.

4000 per scan for a solid-propellant Polaris-size missile if it were detectable. The complexity of the existing MIDAS spacecraft, the board continued, militated against a reliable operational system, and Air Force attention, riveted on achieving an early operational capability, had contributed to neglect of the research and development effort needed to attain it. The group therefore recommended that the program be redirected toward a simplified research and infrared-measurement effort. No further consideration of an operational system should be entertained, the group advised, until Lockheed and the Air Force demonstrated the technical feasibility of infrared missile-detection and alarm.[23]

(S) On 8 December 1961, Harold Brown sent the Ruina report to Secretary of the Air Force Eugene Zuckert. The report's conclusions and recommendations, Brown observed, were ones with which he agreed, and he expected the Air Force to act on them.[24]The report's intimations of mismanagement and misdirected effort were especially serious because, at that time, the service and Lockheed had yet to achieve a success in another important reconnaissance satellite program known as Samos. Air Force directives that complied with Brown's wishes soon moved down the chain of command.[25] But the first opportunity to refute at least the report's conclusions came in April 1962, with the launch of MIDAS-5.

(S) MIDAS-5, the third and last of the Series-II flights carrying a Baird-Atomic infrared payload, lifted from Vandenberg AFB on 9 April 1962. The spacecraft achieved its planned polar orbit, stabilized properly, and the solar arrays extended and began generating the needed electrical power. Turned on, the infrared payload checked-out during the first few orbits of the earth.* While Air Force personnel readied target missiles for launch when in view of the satellite, the hopes and aspirations of program officials soared. During the sixth orbit a massive electrical power failure occurred aboard MIDAS-5, and all control over the vehicle was lost.[26] Once again the mission ended prematurely--and the worst of the Ruina report implications seemed confirmed: the MIDAS program, if not the concept, was a resounding failure.

(U) Shortly after returning to Sunnyvale from the southern California launch site, Joe Knopow was rushed to the hospital where he underwent surgery for hemorrhaging ulcers. As often happens during the introduction of a new technical innovation, the innovator lights the fire, but others are called on to tend the hearth and fan the flames. So it was in this instance. The Lockheed Missiles & Space Company reassigned Knopow as Director of its Electronics Division. His deputy, John Solvason, picked up the reigns as MIDAS program manager.[27]

~~(S)~~ Solvason had his hands full. The new Lockheed manager on the west coast would supervise the MIDAS program as a research and development effort,** deal with a new investigatory committee

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*~~(S)~~ The Baird-Atomic payload employed a faceted outer optical element. The flight test returns later showed that each of the facet boundaries reflected sunlight, which inundated the system with noise. Whether it would have detected missile launches in the presence of high-level noise remained open to question.

**~~(S)~~ Heavy emphasis would be placed on systems analysis, systems development, and further radiometric measurements of the established by the Air Force in response to the Ruina report, and attend to the fabrication and test of the remaining Series-III MIDAS satellites. (In the wake of the Ruina report, the Defense Department cancelled Series-IV flights and substituted additional radiometric missions in their place to conduct further measurements of the earth's background radiation.) In Washington D.C., meantime, other officials sought to strictly compass Air Force efforts on the redirected program.

~~(S)~~ Knowing that Air Force leaders continued to favor an operational MIDAS in spite of the Ruina report, the Director of Defense Research and Engineering, Harold Brown, on 25 June 1962 wrote to the Assistant Secretary of the Air Force for Research and Development, Brockway McMillan. "As I have previously pointed out," Brown observed, "the MIDAS system should not be oriented toward an operational system at this time, . . ." but would remain ". . . an R&D program oriented toward developing the techniques necessary to resolve the remaining basic issues and must not [be directed] toward a specific operational date." Continued Air Force attempts to press MIDAS toward an operational system, he concluded, ". . . would make it almost impossible to solve the design and test problems which have so far resulted in the acquisition of very little in-flight data. By inhibiting the design of new payloads, it would also be likely to present us with a 'system' which generally did not work, and, when it did, could see only the few missiles of high radiance." The Series-

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earth's background radiation. The Air Force, nevertheless, still called on the Lockheed program office to produce another program development plan for a simplified operational MIDAS comprised of 15 satellites in random polar orbits. (Program 461 Historical Monograph, p. 2-47.)

III Aerojet-General payload design, Brown strongly implied, could not be relied upon. On 12 July, McMillan emphatically reminded Air Force Chief of Staff and former SAC Commander, General Curtis E. LeMay, that MIDAS R&D program objectives consisted of background radiometry measurements, target radiometry measurements, and ". . . feasibility demonstration of sensor detection at 300/kw/STR and 100/kw/STR radiance levels, and possibly at 30/kw/STR. . . ."[28]

~~(S)~~ Except for engineering changes intended to improve spacecraft reliability, the four remaining Series-III vehicles were essentially identical to those in Series-II with one important difference: They carried an improved Aerojet-General infrared payload. It featured a Bouwers concentric telescope with an 8-inch aperture. The detector array on the surface of the focal-plane assembly contained 184 lead-sulfide detectors arranged in eight vertical columns of 23 detectors each, which provided complete vertical coverage of a 24-degree 58-minute field of view. The 2.7-micron system provided both spectral and spatial background rejection, and emphasized boost-phase detection of missiles in the "Atlas class". The telescope rotated on its spin table at 6 rpm, like its Baird-Atomic predecessors, and also viewed 25 million square nautical miles of the earth's surface during a 10-second scan.[29]

~~(S)~~ Eight months after taking command of Lockheed's program office, on 19 December 1962, John Solvason watched nervously as MIDAS 6 was launched at Vandenberg AFB. Eighty seconds after liftoff the Atlas veered off course. A range safety officer pressed the destruct button and a shower of debris cascaded earthward. Another MIDAS found itself "asleep in the deep", this time in the Pacific Ocean.[30]

Was there no end to it? That question began to be debated more intensely among American defense leaders in the Pentagon, a debate now joined by angry politicians who were asked to approve funding of the hapless program that had already cost taxpayers some $425 million.

(U) During the first week of May 1963, while final preparations for the launch of MIDAS-7 were underway in southern California, Harold Brown found himself under heavy fire from both sides of the aisle when the subject turned to missile-detection and alarm during defense appropriation hearings in the House of Representatives. The MIDAS program, Brown observed, had been partially terminated earlier in the year and reduced to a few remaining test flights and experiments to explore design problems and background radiation. Should the infrared system prove itself, he concluded, it might again be reconsidered ". . . if a cheap, reliable launch vehicle, and simple satellites of long life can be designed." Even a research program was too much in the view of Daniel J. Flood, a Democrat from Pennsylvania. "What makes you", Flood demanded "want to turn this over to the Air Force and say, 'Go and sin no more,' with another [deleted] million? Do you not feel a little perturbed that these people are not qualified or competent or the proper agency to do the program. . . ? What about the Bureau of Animal Husbandry," Flood jibed, "or something like that?" George H. Mahon, a Texas Democrat, held Lockheed to be the more responsible. "To go back to a company that has failed, and to people who have failed to solve the problem, seems to be somewhat questionable", he asserted. "The Defense Department", Mahon continued, "should consider contracting with other companies for this program." Glenard P. Lipscomb, a

California Republican, emphatically agreed. "It is on the record that the company failed", he snapped. "I think the program is what I said failed", Brown replied.[31]

(U) The Air Force, Lockheed, and Aerojet would receive the reduced funds for MIDAS in FY-1964, but in early May 1963, the stinging indictment--failure--had been securely pinned to their backsides. Up and down the chain of command, program participants knew well that another flight failure would result in major changes, changes likely to include altered careers. That knowledge created an environment of palpable tension as preparations concluded at Vandenberg AFB for the launch of the second Series III spacecraft. John Solvason, Marvin Boatright, and their Air Force counterpart, Colonel Lewis Norman, checked and rechecked every important detail. Then they waited, hoping that the number 7 might also portend some luck.

~~(S)~~ On 9 May 1963, MIDAS-7 ascended from Vandenberg AFB and successfully achieved its planned, circular polar orbit at 2000 nm. Moreover, much to the relief and pleasure of all concerned, the spacecraft performed all but flawlessly for the next six weeks.* During this period MIDAS-7 detected all of the ballistic missiles launched within its field of view and relayed the data to a control center in Sunnyvale, California. These missiles included not only three liquid-propellant Atlas and Titan ICBMs, but analysis of tape recordings of intercepted data also revealed seven lower radiance solid-propellant Minuteman <u>and</u> Polaris missiles. The Aerojet Series-

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*(U) At which time it powered down as seasonal changes reduced the sun intercept on its fixed-direction solar arrays.

III payload achieved an operating radiance-level sensitivity, with signal-to-noise, of 50/kw/STR, far better than anything the Ruina group had supposed possible. MIDAS technology was undeniably demonstrated, payload performance markedly exceeded expectations in the detection of solid-propellant rockets, and background radiation posed no serious problems--false-target alarms were negligible. The Lockheed-Aerojet missile-detection satellite was fully vindicated.[32]

~~(S)~~ The last two of the Series-III MIDAS flights followed in quick succession. MIDAS-8, launched on 12 June 1963, failed again when the Atlas booster malfunctioned during ascent. MIDAS-9, launched a few weeks later on 18 July, achieved the desired 2000 nm orbit, but one of the two Agena solar arrays did not extend. The infrared payload, nevertheless, operated successfully for 96 orbits and detected one American missile launched within its field of view, as well as Soviet missile activity, before a power failure terminated the mission.[33]

(U) In the Defense Department, the unqualified success of the satellite missile-detection and alarm system would rekindle debate and provoke further studies of the program over the next three years. Although three more 2000-nm-altitude MIDAS vehicles would be subsequently approved and flown in 1966, for all practical purposes, the flight of MIDAS-9 rang down the curtain on the original program. American military leaders who evaluated its technical prospects now began to consider orbital operations at much greater altitudes, and additional missions--missions that would significantly expand the primary objective of basic missile-detection and alarm.

An Expanded Mission, A New Name

(S) Between mid-1963 and mid-1966, before a firm choice was made on the next generation of infrared-detection and surveillance satellites, American military leaders evaluated and again changed the direction of the MIDAS program. With the MIDAS concept vindicated, Harold Brown, Director of Defense Research and Engineering, triggered the first major change on 7 November 1963 when he ordered the Air Force to cancel the radiometric flights he had requested in late 1961. He now substituted in their place a three-flight MIDAS research test series, once more directed toward the detection of missiles, known as Program 461. The Aerojet payload in this series, however, would be designed specifically to detect lower-radiance sea-launched ballistic missiles (SLBMs) and medium-range ballistic missiles (MRBMs) in real time, and be capable of determining their launch locations, on two satellite sightings, within a range of 8-to-10 nm. The Lockheed spacecraft were again to be placed in circular polar orbits at 2000 nm, but possess a reliability of six months operational lifetime, or Mean Time to Failure (MTTF) as it was termed. Pending further studies, Brown informed Secretary of the Air Force Eugene Zuckert that the final objectives of the program remained to be established.[34]

(S) Eight years after Joe Knopow first interested Lockheed officials in infrared surveillance from space, the MIDAS program remained securely bracketed in research and development. At the close of 1963, while Air Force and Defense Department leaders considered what kind of follow-on effort should be pursued, Lockheed and Aerojet engineers set to work on the "research test series" of three satellites, identified as RTS-1, under the guidance of John Solvason and Marvin Boatright. The upper-stage Agena booster-satellite used in this instance was the Agena-D, a "standard Agena" that employed an improved rocket engine, common components tried and proven in other flight projects, and increased redundant features. Five feet in diameter and 34 feet long, the cylindrical vehicle closely resembled the Agena-B. Power requirements for a six-month life, however, accounted for a significant physical difference. This Agena carried four solar arrays positioned for maximum sun intercept in all four seasons: two fixed to the aft rack, as before, and two fixed to the forward rack, just aft of the infrared payload.[35]

~~(S)~~ Aerojet, now an Air Force associate contractor instead of a subcontractor to Lockheed, designed an improved infrared payload for the RTS-1 vehicles. It consisted of a Bouwers 8-inch aperture concentric telescope, improved spectral filters, and 442 lead-sulfide detectors. These detectors, smaller than earlier versions, were compatible with an optical image quality of 30 seconds arc. Because of the increased number of channels, Lockheed and Aerojet introduced a multiplexer to the payload side of the slip ring, thus reducing substantially the number of mechanical crossings of the spin table. Two star sensors were also added to improve attitude information. As before, the payload rotated on its spin table at 6 rpm, and had a maximum slant range of 4200 miles at 2000 nm altitude. Plans called for launch of the three RTS-1 vehicles in late 1965 and early 1966.[36]

~~(S)~~ Air Force leaders, meantime, had lost none of their zeal for an operational MIDAS, and on 28 January 1964 Headquarters USAF issued Specific Operational Requirement No. 209 for just such a system. A few months later, on 15 May, the Space Systems Division in Inglewood released the development plan for the follow-on program, tentatively identified as RTS-2. This series of three flights would develop and demonstrate the technology needed in the 1970s for an operational system capable of worldwide surveillance directed toward detection and warning of missile attack.[37] Still another Air Force plan, which called for three more MIDAS detection test series (DTS) satellites to be launched in the late 1960s, before RTS-2 became available, was axed in November 1964 during Defense Department FY-1966 budget deliberations.[38]

~~(S)~~ At the beginning of 1965, Air Force officials, with concurrence from the Director of Defense Research and Engineering, decided in favor of open contracting for the RTS-2 follow-on MIDAS program. Instead of consigning the enterprise to the existing spacecraft contractor, Lockheed Missiles & Space Company, it would be awarded through competitive procurement. This approach, its authors reasoned, would encourage new technical solutions to the problems of improved infrared-detection and surveillance and, at the same time, meet expressed Congressional sentiments that discouraged any automatic extension of the Lockheed MIDAS contracts. The Sunnyvale firm was by no means excluded, but it would have to compete to stay in.

~~(S)~~ On 1 March 1965, Space Systems Division issued a Request for Proposal for a RTS-2 advanced system definition study of a multi-mission MIDAS. Eight firms replied, and three were selected to submit studies: Hughes Aircraft, Lockheed Missiles & Space Company, and TRW Space Technology Laboratories. Advances in electronics and demonstrated payload performance strongly indicated that the vehicles could be operated successfully in stationary geosynchronous orbits--22,000 nm above the earth. That meant fewer (albeit more expensive) satellites and fewer ground stations would be needed in an operational system. Requirements therefore specified a geosynchronous orbit, with the RTS-2 satellites capable of detecting ICBM, SLBM, and MRBM launches, and of identifying their launch site(s). Each of these satellites was also to carry a secondary Vela-type payload that could detect nuclear/thermonuclear detonations above ground, in the atmosphere, and in outer space.[39]

~~(S)~~ During the summer of 1965, while the three aerospace firms prepared definition studies of the RTS-2, officials in the office of the Director of Defense Research and Engineering and others on the Air Staff continued to evaluate MIDAS technology and its mission in the 1970s. An improved infrared payload, reasoning held, would also be able to detect the flash of nuclear and thermonuclear weapons of 20 kiloton (kt) or greater yield at the earth's surface. Coupled with a Vela secondary payload that made possible missile-strike reporting by direct observation of the detonation of U.S. strategic missiles in enemy territory, the position of detonation could be established with an accuracy of within 5 nm. This capability would become increasingly important as enemy defense improved, eliminating any uncertainty about which missiles had actually struck their intended targets. Accordingly, the contractor studies for the RTS-2 received at Space Systems Division in September 1965 were held without evaluation. On 15 November Headquarters USAF redesignated this follow-on effort, now also featuring missile-strike reporting, as Program 266, eventually to become known as the

Defense Support Program (DSP),* and issued for it a "preliminary" technical development plan.[40]

~~(S)~~ John S. Foster, who had succeeded Harold Brown as the Defense Department's chief scientist in October 1965,** at the beginning of 1966 agreed that missile-strike reporting would be a major objective of the DSP. On 12 January 1966, Headquarters USAF defined this capability: determining that a missile, launched against an enemy, had successfully penetrated defenses and detonated in the vicinity of the intended target. A few months later, this objective was logically expanded to include Attack Assessment, defined as the ". . . detection and location of nuclear bursts directed against U.S. territory."[41] When requests for proposals for the DSP were reissued to the three aerospace contractors in April 1966,[42] the program objectives now embraced global early warning (which included detecting all types of ballistic missiles), launch-point determination, detection of n^{th} country launches, collection of intelligence data such as the staging and radiance levels of different missiles, and missile-strike reporting, attack assessment, and test-ban monitoring (earth and space). These objectives were to be achieved by DSP satellites operating in geosynchronous orbit, each with 15-month MTTF lifetimes. Although the program remained a research and development effort with the expanded mission to be

*~~(S)~~ Both MIDAS and its follow-on DSP carried other numerical designations over time. MIDAS was also called Program 239 and 461 in the mid-1960s, while DSP was known variously as Program 266, 949, and 647 late in that decade. To avoid confusion, the two commonly recognized names are used throughout this history.

**(U) Harold Brown became Secretary of the Air Force on 1 October 1965.

achieved in the 1970s, it nonetheless presented the contractors a challenging order to fill.[43]

~~(S)~~ Hughes, TRW, and Lockheed submitted their proposals for the DSP in late June 1966. Of the three, the Air Force on 23 August* selected TRW and Lockheed to present and negotiate their proposals, proceedings which concluded in late October. Aerojet, the infrared payload contractor, had teamed with TRW, while Lockheed had teamed for its payload with Baird-Atomic, Incorporated. The selection turned primarily on the integrated payload/spacecraft designs. Lockheed's proposal offered an improved version of the existing MIDAS, an Agena spacecraft stabilized on three axes in a nose-down attitude. The Baird-Atomic payload, mounted on a spin table and rotated at 6 rpm, would furnish the desired scanning to fulfill the specified missions. The TRW proposal, on the other hand, turned Lockheed's approach completely around. It too offered a cylindrical satellite in a nose-down attitude, but with the Aerojet infrared sensor rigidly attached to the forward end of the satellite and canted at 4.5 degrees from the longitudinal axis. Scanning would be achieved by spinning the entire vehicle at 6 rpm, using a novel "zero momentum" control system that employed a reaction wheel and gas jets. This approach eliminated the Lockheed spin table's rotating joint and the slip rings carrying power and data to and from the payload--features considered of dubious reliability at orbital lifetimes

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*~~(S)~~ John S. Foster, DDR&E, approved the DSP development plan that called for three R&D satellites and the expanded mission objectives on 20 August 1966, thus permitting the selection of contractors to proceed. (Rpt [S], Gerald T. Cantwell, "The Air Force in Space, Fiscal Year 1968," Part II, Office of Air Force History, October 1970, p. 1).

greater than one year. Withal, it was a relatively simple albeit elegant solution. And it won. The Air Force notified the contractors of TRW's selection on 15 December 1966, shortly after the launch of the last of three MIDAS RTS-1 satellites.[44]

(U) Word of the award was a bitter pill for Willis Hawkins and other Lockheed officials who had steadfastly believed in the technical feasibility of MIDAS and nurtured the program in good times and bad over 10 trying years. It was especially so for the program manager, John Solvason, and his deputy, Hugh W. Batten, who had invested a substantial portion of their careers in the enterprise. To be sure, the Sunnyvale firm had treated MIDAS as a proprietary effort and resisted attempts to establish Aerojet as an associate contractor and full partner. But it must also be said that Lockheed was responsive to an inordinate number of Defense Department changes and program redirections, met the demands of numerous scientific panels that evaluated MIDAS near-to-death, and erased the stigma of "failure" once used to characterize the entire endeavor. Indeed, two of the three Lockheed-Aerojet RTS-1 MIDAS satellites just launched in the preceding months, between June and November 1966, were performing almost flawlessly. Now, with technical success apparently in hand, the ultimate prize--contracts for the follow-on program--had been snatched away and awarded to others. It was unquestionably a most bitter pill to swallow in Sunnyvale, though the taste of it might still be sweetened if the Lockheed RTS-1 satellites performed reliably over time, and if TRW and Aerojet efforts proved the concept for an operational system in geosynchronous orbit.

~~(S)~~ The first of the three RTS-1 MIDAS satellites had been launched from Vandenberg AFB back on 9 June 1966, a few days before the Air Force began evaluating contractor proposals for the follow-on DSP. (Originally scheduled for launch in late 1965, the flight had been delayed by a variety of technical difficulties and a one-month strike of employees at Aerojet's plant in Azusa, California, where the payload was fabricated.) Lockheed's Agena-D booster-satellite had become, by 1966, one of the most trusted and reliable upper-stage rockets used in the military and civilian space programs, best known perhaps, as the target vehicle in the Gemini manned missions of the day. On 9 June, however, the Agena's Bell rocket engine failed to ignite for its second burn and, instead of a 2000-nm circular polar orbit, the satellite remained in a highly elliptical parking orbit with a perigee of 108 nm and an apogee of 2,246 nm. Worse, the Agena tumbled and its attitude-control gas quickly exhausted. No useful tests of the infrared payload could be performed, and a few months later, on 3 December 1966, the satellite dipped into the earth's lower atmosphere over Australia and incinerated.[45]

~~(S)~~ Launch of the last two MIDAS satellites followed rapidly. The second and third RTS-1 vehicles rose from Vandenberg AFB on 19 August and 5 October 1966, achieved the intended circular polar orbits, and operated successfully for 11 and 12 months, respectively, easily exceeding the 6-month MTTF lifetime planned for them. During this period, these two spacecraft also detected all Soviet and U.S. ballistic missiles launched within their field of view--139 rocket launches in all--and identified four Soviet launch sites, all of this accomplished in an environment of global cloud conditions once thought to preclude spaceborne missile-detection and alarm. By late 1967 the program could be acknowledged a national resource. One can only speculate what effects these flight test results might have had if the follow-on contractor selection had occurred one year later. "At this juncture," Marvin Boatright, Aerojet's MIDAS program manager frankly confided, "it would have been possible to have configured an operational deployment (using the Lockheed/Aerojet system)."[46] Whatever the "would have beens", at the end of 1966, the contractors for the follow-on program were TRW and Aerojet.

CHAPTER FIVE

LAUNCH BOOSTERS AND SATELLITE FACILITIES

(S) While numerous American engineers labored to perfect sensors for reconnaissance and missile detection that surveyed or operated at wavelengths across the electromagnetic spectrum, others fashioned the rockets, or launch boosters, that placed them in earth orbit. The national security space program, as one might expect, first conscripted for this purpose the liquid-propellant rockets designed and built in the mid-to-late 1950s for intercontinental warfare: Atlas, Thor, and, most especially, Titan.

Booster Rockets

(TS/TK) The first of these military rockets, Atlas, a one-and-a-half stage* ICBM built by General Dynamics-Astronautics, was a pressure-stabilized structure 71 feet long and 10 feet in diameter. Fueled with liquid oxygen and kerosene, its three main engines produced 387,000 pounds of thrust at lift-off and coupled with an Agena-B upper stage, could place 3,600 pounds (an Agena spaceframe and payload) in low earth-polar orbit. After approval of the KH-4 Project in February 1958, the Thor, a single-stage IRBM built by Douglas Aircraft, was pressed into service. Sixty-five

*(U) Because the engineers who designed this first ICBM could not be certain whether a liquid-propellant rocket engine would ignite in a hard vacuum, in the absence of pressure, all three Atlas main engines ignited on the ground. At altitude, the two outboard engines were shut down and jettisoned, while the center, sustainer stage engine continued to burn.

feet long and 8 feet in diameter, Thor also burned liquid oxygen and kerosene, but was powered by a single main engine that produced 150,000 pounds of thrust. Later Thor models beginning in the mid-1960s featured an engine uprated to 170,000 pounds thrust, longer propellant tanks (that increased Thor's length by 5 feet), and strap-on solid propellant rockets that raised the thrust at lift-off to ICBM proportions: 330,000 pounds. Combined with an Agena-B second-stage, this version of Thor could place about 3,000 pounds (an Agena spaceframe and payload) in low earth-polar orbit. These two booster rockets with other upper stages, such as the Centaur liquid hydrogen-oxygen vehicle employed on Atlas, and Burner solid-propellant vehicles used on Thor, launched a variety of civil and military spacecraft in the 1960s, 1970s, and 1980s. The Thor-Agena and Atlas-Agena, phased out in the 1970s, remained primarily associated with satellites in the National Reconnaissance Program (NRP).[1]

~~(TS/TK)~~ The Titan-III series of standard launch boosters consisted of a two-stage, liquid-propellant core rocket, 96 feet long and 10 feet in diameter. Built by Martin Marietta, Denver Aerospace, the first stage featured twin engines that burned "storable" propellants* Composed of a fuel mixture 50 percent

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*(U) Storable liquid propellants are not cryogenic, like liquid oxygen, and do not "boil" at temperatures just above absolute zero. These noxious storable chemicals are an American innovation, developed during World War II at Caltech's Jet Propulsion Laboratory. With them, one can fuel a rocket and it will remain ready to launch for many weeks. By 1964 storables had replaced cryogenic oxidizers in all military liquid-propellant rockets. Atlas, Thor, and Jupiter were retired from the active inventory and served thereafter only as space-launch boosters.

Aerozine 50 and 50 percent hydrazine, with nitrogen tetroxide as an oxidizer. The twin first-stage main engines produced 470,000 pounds thrust, while the single engine of the second stage, ignited at altitude, produced 100,000 pounds of thrust burning the same propellants. Coupled with an Agena third stage, the combination was designated Titan-IIIB. It was used, beginning in the late 1960s until 1987, to launch KH-8 vehicles. The next configuration, Titan-IIIC, featured two immense solid-propellant rocket motors strapped to opposite sides of the Titan first and second stages. Each of these, 85 feet tall and 10 feet in diameter, generated 1,200,000 pounds of thrust, giving this Titan a combined lift-off thrust approaching 2,400,000 pounds. This launch combination, which first saw service in 1966, also featured a Martin-built inertially guided third "Transtage" atop the stack, and could place 29,000 pounds (a Transtage spaceframe and payload) in low earth orbit. Although the Air Force used this vehicle to launch various payloads, Titan-IIICs were used exclusively in the NRP to launch [redacted] vehicles into near-geosynchronous orbit.[2]

~~(S/TK)~~ Titan-IIID, a radio-guided equivalent launch combination that did not use an upper stage, followed with a first launch in 1971. This vehicle was used only in the NRP from the western space center to launch the large KH-9 and KH-11 reconnaissance satellites into low earth-polar orbits during the 1970s and 1980s. Finally, the Titan-IIIE, a Titan-IIIC adapted by NASA for use at Cape Canaveral with a NASA-developed Centaur third stage, was employed in the civil space program to launch large spacecraft. The last Titan-IIIE launched the Voyager spacecraft on a Jupiter/Saturn flyby mission in 1977.[3] By that time, however, NASA leaders had decided against unmanned expendable launch vehicles (ELVs) and in favor of reusable manned launch vehicles. Future missions of all kinds, including various Air Force and NRP missions, waited on this new machine, which first flew in 1981.

(S/TK) After President Richard Nixon vetoed a manned flight to Mars as Apollo's successor back in 1970, the civilian space agency proposed a manned launch vehicle: The Space Shuttle. President Nixon approved the Space Shuttle on 5 January 1972, predicated on the assumption it would replace ". . . all present launch vehicles except the very smallest and very largest." Air Force and NRO officials participated in the design of the Space Shuttle throughout this period, in particular the sizing of its manned orbiter payload bay (15 x 60-feet) to accommodate anticipated spacecraft growth. In the years that followed, the service also contributed funds to its development. Reasoning held that the shuttle could meet the launch requirements of NASA and the Defense Department when used to place larger and more complex spacecraft into low earth orbit, and, when mated with the Air Force-developed solid-propellant Inertial Upper Stage (IUS) or the NASA-developed liquid-propellant Centaur, launch others into geosynchronous orbits. Some spacecraft, the USAF Scientific Advisory Board suggested, might be checked out on orbit, or retrieved from orbit and returned in the Space Shuttle bay for refurbishment and later reuse at a considerable savings of funds.[4]

(U) All of this might be possible if the fleet of Space Shuttles performed as advertised. That meant a number of variables had to be carefully controlled. First, the shuttle launch combination, which consisted of a manned orbiter spaceplane mounted on an external propellant tank with two 150-foot-high solid-propellant rocket boosters (SRB) strapped on the external tank's opposite sides, had to produce 6,000,000 pounds of thrust without any significant increase in the weight of the structure.* (Any increase in the weight of the orbiter or the associated rocket ensemble meant a corresponding decrease in the payload carried.) If the weight could be maintained and the thrust achieved, NASA's shuttle would deliver 65,000 pounds into low-inclination earth orbit, and 32,000 pounds into low earth-polar orbit. Second, NASA had to meet the low costs it projected to build and operate the Space Shuttle fleet. Space agency officials and their Air Force proponents explained to Congress that the move away from expendable "throw away" boosters to the "reusable" manned orbiters would indeed improve launch cost performance and reduce the price of placing a pound in orbit significantly. Only the external liquid-propellant tank was lost on each mission. The orbiter spaceplane, estimated reusable for 100 flights, would glide to an earth landing, and the two solid-rocket motor casings were to be recovered by parachute and reused as many as 20 times.[5]

~~(S/TK)~~ Although NASA and the Air Force planned for as many as 9 or 10 Space Shuttles, in the mid-1970s Congress had appropriated only enough funds to build four or perhaps five of

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*(U) Three primary shuttle-orbiter liquid-propellant rocket engines burned liquid oxygen-hydrogen drawn from the external tank, and contributed 380,000 pounds thrust to the total thrust of six million pounds. The SRB burned aluminum fuel and ammonium perchlorate oxidizer and contributed 5,600,000 pounds thrust to the total requirement.

them. That meant each orbiter in the smaller fleet would also have to be "turned around" and made ready for successive launches very quickly, at least in the routine two-week scenario that NASA promised, if the needs of the civil, military, and intelligence clients were to be met at cost and on schedule. Finally, while the Space Shuttle fleet was being fabricated during the 1970s, military and NRP spacecraft, designed to fly atop Atlas and Titan ELVs, had also to be reconfigured and made compatible for launch on the Space Shuttle. This effort became known as "dual compatibility"; of course, if the concept proved unachievable with a single spacecraft design, two separate spacecraft designs (ELV and shuttle) would become necessary, making cost effectiveness in satellites impossible. The Defense Department nonetheless pledged to NASA its full support for the shuttle. "Once the shuttle's capabilities and low operating costs are demonstrated," Deputy Secretary of Defense William P. Clements assured NASA Administrator James C. Fletcher in August 1974, "we expect to launch essentially all of our military space payloads on this new vehicle and phase out of inventory our current expendable launch vehicles."[6]

(S/TK) As events turned out, development of the Space Shuttle (and a first manned orbital flight in 1978) was delayed and its costs began to escalate in the late 1970s. To protect launch schedules and provide a more versatile ELV, members of the National Reconnaissance Office (NRO) and the Air Force Space Division in El Segundo agreed on a new Titan configuration to replace existing Titan-IIIs, one that could be used as a primary launch vehicle for some payloads and as a backup to the shuttle for others. Known as the Titan-34D, it consisted of stretched Titan-III core stages, and the two solid rockets increased in size from 5 to 5-1/2 segments. The Titan-34D could be used without a third stage (like the IIID), or with either one of two upper stages atop the stack: the inertially guided IUS or Transtage (to be used in launches from the eastern space center) and the radio-guided Titan-34D (to be used from the western space center). In 1976, the Air Force officials contracted for six 34Ds with Martin Marietta, with an eye to ordering more.[7]

(S/TK) Additional Titan-34Ds might have appeared a prudent hedge against further delays of the Space Shuttle, but in January 1977 that did not match the view of President Ford's departing Deputy Secretary of Defense Clements. A few days before leaving office, he executed a "NASA/DoD Memorandum of Understanding" that pledged the Defense Department to use the Space Shuttle as its ". . . primary vehicle for placing payloads in orbit." Air Force Under Secretary Hans Mark, the former Director of NASA's Ames Research Center who arrived later, with the administration of President Jimmy Carter, likewise favored original plans that placed all NRP spacecraft on the Space Shuttle as its primary launcher. Titan-34Ds would serve backup as needed, eventually being phased out.[8]

(TS/TK) By late 1977, however, as the Carter Administration considered the final FY 1979 budget, the Space Shuttle program nearly reverted to a research and development effort. The Office of Management and Budget (OMB) determined that the full cost to build five Space Shuttles and two launch sites (one at Kennedy Space Center and the other at Vandenberg AFB) was, in fact, much greater than the NASA-submitted estimates. On 29 November Hans Mark, Air Force Under Secretary and Director of the NRO, was summoned to the office of James McIntyre, Acting Director of OMB. There, he joined Secretary of Defense Harold Brown, Deputy Secretary of Defense Charles Duncan, and Director of Central Intelligence Stansfield Turner. NASA was not represented. McIntyre's staff presented three options for the shuttle's future: First, continue with plans for five orbiters and two launch sites; second, complete three manned orbiters and the east coast launch site only, which eliminated NRP flights in high inclination orbits and meant that the Space Shuttle program would revert to an experimental activity; or, finally, compromise on four manned orbiters and leave open the question of two launch sites. On 16 December 1979 the participants convened for a second meeting in McIntyres' office. Defense Secretary Harold Brown argued that "two launch sites. . . and at least four orbiters would be necessary to meet the requirements of national security." Moreover, he judged the nations prestige in space flight to be at stake, not to mention international agreements to use the shuttle with European space partners. Mark and Turner strongly supported Brown's position, and it carried. Early in 1978 Congress approved the compromise and the funding to construct both launch sites.[9]

~~(S)~~ Subsequently, under Mark's prodding, Air Force efforts to build a Space Shuttle launch complex for reconnaissance flights at the western space center got underway in earnest. NASA officials, meantime, despite facing further delays in the launch of the first shuttle, urged President Carter to formally name it the primary launch vehicle for all of the nation's astronautical activity--civil/commercial, military, and intelligence programs. To be the cheapest American launch system, the Space Shuttle, it seemed now, <u>had</u> to be the only launch system. But in his space policy directives issued in May and October 1978, President Jimmy Carter declined to do so.[10]

~~(S/TK)~~ Despite Under Secretary Mark's determined advocacy, various members of the NRO staff objected to the shuttle as the primary launcher for the NRP. They did so for a number of reasons that in retrospect indeed appear sensible. The man-rated shuttle, they argued, could only be launched in the best of weather; it certainly could not be launched easily in wartime; and coupling the fortunes of every program to a stable of four launch vehicles meant that everything had to work perfectly every time. Any significant failure meant that all space programs halted, and all would wait on a shuttle fix. The NRP, an asset crucial to the nation's security they were convinced, should not stop and start on the orders or practices of shuttle's managers at NASA. When Hans Mark stepped down as Director of the NRO in May 1979 to become Secretary of the Air Force, this reasoning temporarily prevailed. In November 1979 the Air Force Space Division and NRO, supported by Secretary of Defense Harold Brown, contracted for three more backup Titan-34Ds and, in May 1980, exercised an option for an additional two, bringing to 14 the number procured.* A few weeks later, on 9 June,

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*(U) A new NASA/DoD Memorandum of Understanding on the Space Shuttle executed somewhat earlier, on 27 March 1980, also deleted reference to the shuttle as the Defense Department's primary launcher. That change from the Clements agreement NASA officials sought to reverse a year later, in another administration.

with the consent of Air Secretary Force Mark, Headquarters USAF issued a program-management directive that affirmed the Titan-34D production line would not be closed until the Space Shuttle became operational.[11]

~~(TS/TK)~~ The first Space Shuttle launch took place successfully in April 1981 amid appropriate fanfare and intense national pride. President Ronald Reagan, who had defeated President Jimmy Carter in national elections a few months earlier, watched with pleasure and listened to the counsel of his NASA administrator, James M. Beggs. On 13 November, Reagan issued National Security Decision Directive (NSDD) 8, which declared the manned Space Shuttle to be America's primary launch vehicles for all space missions. The following year, on 4 July 1982, coincident with the fourth successful Space Shuttle mission that landed on Independence Day, Reagan proclaimed these launch vehicles to be operational and issued his own national space policy, National Security Decision Directive (NSDD) 42. However dubious some Air Force and NRO officials might remain, in these directives NASA formally received the exclusive launch franchise that President Carter had denied.[12]

~~(S/TK)~~ NSDD numbers 8 and 42 unquestionably pleased NASA leaders, but they decidedly troubled the new Director of the NRO, Air Force Under Secretary Edward C. Aldridge. Aldridge, who had served as the Deputy Assistant Secretary of Defense for Strategic Programs in the Ford Administration, assessed the military and civil astronautical launch options in the early 1980s and, unlike his predecessor, found them wanting. Despite the President's confidence in the Space Shuttle, Aldridge was aware that NASA had all it could do to turn a manned orbiter around between launches in two months, let alone the two weeks promised. Operational or not, the new manned orbiter spaceplane simply did not display the reliability and "maintainability" that its designer's had hoped to achieve, and NASA officials seemed nonplussed by the unfamiliar logistics of operating a space flight airline. Delays and rework (for example, replacing heat tiles that fell off during missions) increased costs, and various fixes increased the weight of the launch vehicle and reduced the weight of the payloads the shuttle could carry. Payloads scheduled for eventual shuttle flights into polar orbit were most severely affected, and that meant exclusively NRP spacecraft.

~~(S/TK)~~ Whatever the operational costs, all of the Space Shuttles had now to fly without serious interruption if national security mission schedules were to be maintained. In the Pentagon, as 1983 began, Aldridge and his NRO colleagues became increasingly skeptical that NASA could, with assurance, provide the needed NRP space-launch services. (Perhaps some of that same doubt had begun to surface at NASA headquarters, for news releases of impending Space Shuttle flights no longer featured the hyperbole* that

*(U) The shuttle prelaunch press kit issued in 1980 by the prime contractor, Rockwell International, advised the media: "The Space Shuttle is America's newest and most versatile manned spacecraft. Unlike its predecessors . . . [it] will provide a flexibility never before achieved in space operations . . . [and] allow space to be treated as the resource it is, rather than as a hostile environment to be tested, examined, and explored." Press Information, Space Shuttle Transportation System, Rockwell International Space Systems Group, July 1980, p. 1.)

preceded the first launch.) The concerns expressed by members of the NRO were widely shared among others on the Joint Chiefs of Staff and the Air Staff. In June 1983 Eberhardt Rechtin, President of the Aerospace Corporation, prepared a devastating critique of Space Shuttle economics for the USAF Scientific Advisory Board. In August, Air Force Vice Chief of Staff General Jerome F. O'Malley asked Space Division to further examine the total costs of launching military spacecraft on the Space Shuttle compared with launching them on ELVs. Systems Command subsequently expanded the study to include an assessment of how best to meet national launch requirements using a more secure mix of ELVs and the shuttle fleet.

(U) Results of this work were presented to Aldridge late in 1983, and what the Air Force Under Secretary heard confirmed what was already widely suspected: Manned shuttles were less flexible and more costly than equivalent unmanned ELVs; moreover, they could not assure continuous access to space except in the best possible circumstances; equally disturbing, attempts to achieve "dual compatibility" of military spacecraft designed for launch on both the shuttle and ELVs had not succeeded as planned. More and more spacecraft contractors, like TRW on the Defense Support Program, were seeking waivers to build two separate satellite configurations with attendant increases in cost. On 23 December 1983, Aldridge issued a memorandum, "Assured Access to Space", that directed Systems Command and the Space Division to plan for the immediate procurement of a new, commercial, ELV.[13]

~~(S/TK)~~ The commercially-procured ELV (to become known temporarily as the CELV) was also designated as a shuttle backup, and would be designed to meet limited NRP requirements through the end of the century. It was to be capable of launching 10,000 pounds into geosynchronous orbit from the eastern space center only, and carry spacecraft of the same dimensions as those assigned now to the Space Shuttle. Uprated variants of the Atlas and Titan were both possible contenders, and shortly after the holidays, on 6 January 1984, Aldridge advised Space Division in El Segundo that he wanted the effort accelerated and a contract awarded for 10 of the new boosters by the end of June. This order, on the surface at least, seemed to belie NSDD 42 and contradict space agency contentions that the procurement of more ELVs would automatically increase the cost of the nation's space effort.[14]

(U) To be sure, word of the Air Force launch-vehicle initiative had by now reached NASA headquarters, and Administrator James Beggs reacted vigorously and adversely. Even a backup ELV used for launching spacecraft into geosynchronous orbit from the east coast threatened the primacy of Space Shuttle. In late January 1984, he urged administration officials to prepare for the President another National Security Decision Directive consigning the CELV question to a joint NASA/DoD study committee. When that failed, he protested in May directly to Secretary of Defense Caspar W. Weinberger and Air Force Secretary Verne Orr, and at the same time entered his objections before Congress. The Air Force request for proposals had already been issued, however, and the space agency's Marshall Space Flight Center responded with a CELV proposal of its own; one derived largely from shuttle components. NASA might want desperately to remain the organization controlling America's space-launch vehicles--manned or unmanned--but the specter of a government agency competing with commercial firms for government contracts propelled that question directly before the Air Force General Counsel.[15]

(U) Congress, meanwhile, appeared generally willing to fund the acquisition of 10 CELVs to complement the Space Shuttle in the interests of national security. It would not, however, approve of the commercial contract arrangements that the Air Force proposed. The service therefore deferred CELV source-selection proceedings in June 1984, and returned the bids unopened to the contractors. New bids were requested based on conventional government contract and funding procedures, with selection of a contractor to be made in December 1984. If NASA's Marshall Space Flight Center resubmitted a CELV proposal, the General Counsel advised, it should be considered only after a commercial source was selected, and then only as a government alternative.

(U) This last legal fillip unquestionably disappointed NASA leaders anxious to preserve the Space Shuttle or a shuttle-derivative as the nation's launch vehicles of record. But by the fall of 1984, the elemental prudence of ensuring American access to space with additional unmanned CELVs* had been embraced just about everywhere else except NASA headquarters. The Joint Chiefs of Staff had already come down solidly in its favor. In August, President Ronald Reagan issued National Security Decision Directive

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*(U) In June 1984 the Air Force altered the name of the proposed unmanned booster rocket from "commercial" ELV to "complementary" ELV, being careful not to refer to it as anything more than a backup booster. In any event, the abbreviation CELV remained the same.

(NSDD) 144, "National Space Strategy," which, among other things, endorsed Air Force procurement of a limited number of CELVs, though only as backups to the Space Shuttle. Called upon to examine the same question in September, a special committee of the National Research Council, National Academy of Sciences, likewise affirmed the wisdom of this course of action. Finally, on 24 September 1984, Secretary of Defense Weinberger wrote the chairman of key Congressional committees urging their approval for the reprogramming of funds in FY 1985 to procure the first two CELV vehicles (plans called for two to be purchased per year for five years).[16]

(U) In late 1984, while Congress considered funding the CELV, Space Division completed an evaluation of the CELV proposals and on 11 December announced the winner. It selected Martin Marietta's proposal for an uprated Titan (to be known as Titan-IV) over a General Dynamics proposal for a reconfigured Atlas. The revised Titan retained a diameter of 10 feet, but extended the length of the first and second stages, which increased the liquid propellant capacity, and extended the two strap-on solid rocket motor casings from 5-1/2 to 7 segments (with a corresponding increase in length of the solid rockets from 90.7 to 112.9 feet). The ensemble featured a 15-foot diameter hammerhead nose-fairing and could be employed either with an upper stage (Centaur or the Inertial Upper Stage), or without an upper stage. Evaluation of the NASA proposal, known as the SRB-X, and the Titan-IV followed immediately. On 28 January 1985 Space Division announced that it found the Titan-IV superior to SRB-X and, in February, awarded

Martin Marietta $5.1 million for research and development. Basic contract funding, however, still awaited congressional action.[17]

~~(C)~~ Congress, as it turned out, especially those members who advocated the Space Shuttle, wanted further certification of the Titan-IV. Secretary of the Air Force Verne Orr, on 15 January 1985, submitted to Congress a special analysis requested in November,* which reviewed the various advantages of employing ELVs in the military space program. NASA and Air Force officials subsequently discussed the proper role of ELVs in the space program in late January, and reached an agreement that President Reagan released on 25 February 1985 as National Security Decision Directive 164. The Defense Department would hereafter launch "at least one-third of its missions" on Space Shuttles over the next 10 years; two-thirds would fly on unmanned ELVs. Instead of serving as a shuttle backup, ELVs had reemerged as the primary booster rocket in the national security space program. With that milestone now acknowledged by all parties, Congress approved the reprogramming of Air Force funds on 7 June 1985, and the service immediately ordered from Martin Marietta the first of 10 Titan-IVs.[18]

(U) The 1985 Congressional action allowing the procurement of ELVs proved prescient. Seven months later, on 28 January 1986, the Space Shuttle Challenger exploded shortly after launch. That accident underscored a human tragedy for all Americans and marked an enormous setback in the nation's space program. Challenger's

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*(U) Rpt, "Complementary Space Launch Strategy for Assured Access to Space," 15 January 1985.

impact and petard reverberated throughout Washington; with it, accepted views turned suddenly about and the "Maginot Line" concept of spacefaring with four manned launch vehicles entirely evaporated.* Although the first Titan-IV would not be delivered to the Air Force until late 1988, the Defense Department now began a series of actions which, by the end of 1987, had all but eliminated the Space Shuttle from the national security space program. As a first step, the costly Space Shuttle launch complex (SLC 6) at the western space center was moth-balled--likely never to be used. Construction of a Titan-IV launch complex was approved in its place bringing the total to one Titan-II and two Titan-IV launch pads at Vandenberg. Whenever the shuttle flew again, it could do so only from the eastern space center.

~~(S)~~ Next, the medium-sized military payloads were removed from the Shuttle on the first of two competitions for new launch vehicles. The first of the new medium ELV competitions was won by McDonald Douglas' Delta-II. The Delta-II was sized for the Global Positioning System (GPS) launches beginning in late 1988 (to be launched from the eastern space center only with two launch pads). The second of the new medium-launch vehicles, the Atlas-II, was sized for DSCS launches beginning in late 1989 (to be launched from the eastern space center only from two launch pads as a standard vehicle with a Centaur upper-stage). The primary reason for these additional launch vehicles was the large backlog of shuttle

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*~~(TS/TK)~~ This philosophical change, and the fragility of "assured space access," was underscored a few weeks later on 18 April 1986 when a Titan-34D carrying the last KH-9, spacecraft 1220, exploded a few seconds after launch damaging both Titan launch pads at Vandenberg.

payloads and the inability of DoD to exercize total preemption for shuttle flights. The backlog resulted from the decreasing flight rate of Shuttle, now projected at 10 per year, and the extended downtime of the Shuttle between flights.

(S/TK) The last step increased purchases of Titan-IVs for 43 launches through 1995, and expanded the launch infrastructure. Production enhancements and launch site improvements would allow a much higher Titan-IV launch rate (approaching 12 per year in 1995). Thus, to meet launch needs through the end of the century, the NRO and the Air Force would depend on Titan-IVs, refurbished Titan-IIs, Delta-IIs, and Atlas-IIs. Because of the long lead times in returning these launch systems to operation, the NRP and Air Force were still expected to fly shuttle missions through 1990.[19]

(TS/TK) Compounding NASA's problems, the technical fix required for the Space Shuttle fleet significantly increased costs, not to mention the weight of the manned-launch system. The shuttle orbiter, NASA advised the Air Force in late 1986, would hereafter lift only 55,000 pounds into low-inclination orbits and 16,000 pounds into polar orbits. Polar-orbit missions no longer mattered, for they had moved to Titan-IV when the shuttle lost its capability to lift heavy payloads. Ultimately, however, they, too, were scheduled for flight on ELVs. After 1990, the Air Force and the NRO would project only one or two shuttle flights per year, while reserving portions of the shuttle bay for experiments in the military and intelligence space programs.[20]

~~(TS/TK)~~ In 1987-1988, for all practical purposes the Defense Department returned the manned Space Shuttle to NASA. New national space policy directives confirmed that the shuttle would in future only be used for launching military spacecraft where the presence of man in space was required.[21]

The Air Force Agena

~~(S/TK)~~ The Agena, perhaps more than any other single space booster between 1958 and 1987, "put the Air Force and the National Reconnaissance Program in space." These upper-stage vehicles, all built by the Lockheed Missile & Space Company in Sunnyvale, California, also served as stabilized reconnaissance platforms for various sensors in orbit. First contracted for in 1956 after Lockheed won the Air Force competition for reconnaissance satellites,* it progressed through a series of models, with the first of them, Agena-A, used briefly between 1959 and 1961. Five feet in diameter and 17-to-19 feet long for a typical Atlas mission, the Agena-A weighed 8,200 pounds at separation, a figure that decreased with the consumption of propellants to 1,600 pounds in low-earth orbit. It featured small, nested propellant tanks and a single-burn, Bell Aerosystems model 8048 pump-fed rocket engine. This engine burned the storable propellant UDMH as fuel and Inhibited Red Fuming Nitric Acid (IRFNA) as oxidizer, and delivered 16,000 pounds of thrust. Attitude control was provided by the expulsion of nitrogen cold gas, and orbit lifetimes of two to five days were typical.

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*(U) See Chapter 1, pp 17-18.

(U) The more advanced Agena-B used by the Air Force and NASA between 1960 and 1966 had integral propellant tanks with twice the propellant capacity of the A model, and a modified Bell engine. This model 8096 engine consumed the same propellants and produced the same thrust, but it could be restarted in space by using ullage rockets for additional burns--a feature that provided improved orbit parameters and yielded more pounds in orbit at less cost. The additional tankage lengthened the Agena-B from 25 to 37 feet, dependent on the mission and nose-shroud configuration, and increased the weight at separation to 17,000 pounds with 3,600 pounds reaching low-earth orbit. A freon-nitrogen gas mixture used for attitude control increased orbit lifetimes to 15 to 20 days.[22]

(U) During the first few years of the space program, Lockheed fabricated the Agena-A and -B booster-satellites on a "job-shop" basis; that is, the firm tailored each vehicle (or group of vehicles) to meet the technical requirements of a specific flight project. Although the spaceframe configuration remained basically the same, the orbital orientation (nose forward, nose aft, or nose down), the autopilot gains and compensation, the wiring, the location of various equipments, and the size and shape of equipment racks differed significantly. This built-in dissimilarity made transfer of Agenas from one project to another impractical without major modifications. The cost of major modifications, in turn, made such transfers uneconomical. Seeking a "standard" Agena with more common features, in 1961 the Air Force requested that Lockheed officials study the problem and recommend a new design.[23]

~~(S/TK)~~ Using design concepts advanced by Assistant Chief Engineer Larry Edwards, Lockheed's recommendatory report prompted the Air Force on 25 August 1961 to contract for the standard Agena-D,* with a first launch scheduled in January 1963. Air Force Under Secretary and NRO Director Joseph V. Charyk called on Kelly Johnson at the firm's corporate headquarters to recommend further improvements. Johnson's report, issued on 25 October 1961, resulted in a novel Agena-D project organization that telescoped schedules by combining the management and design teams, and much of the production activity, in a building of its own--a separate "skunk works" in Sunnyvale. Lockheed selected Fred O'Green to manage the project; eight months after contract award the Air Force accepted delivery of the first Agena-D on 16 April 1962, and launched it successfully atop a Thor from the Western Space and Missile Center on 27 June 1962. The National Reconnaissance Program continued to use Agena-Ds throughout the 1970s, and some still provided infrequent launch missions in the 1980s. NASA also used the Agena extensively in the 1960s and 1970s. More than 35 of them launched lunar and planetary deep-space probes, and one served as the satellite platform for the SeaSat ocean-surveillance mission that flew in 1978. Agenas became perhaps most visible when NASA

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*(U) In early 1961, the Air Force rejected a Lockheed proposal to develop an Agena-"C." Agena-C involved doubling the diameter of the vehicle to 10 feet, major changes in propellants, tank design, and a modified Bell Rocket engine. See Rpt (U), LMSC/448266, Proposal: Design and Development of Agena-C, 21 June 1961. This Agena was similar in concept to the General Dynamics' Centaur and Martin's Transtage, which perhaps explains why the Air Force did not pursue the development.

employed them as rendezvous vehicles in the manned Gemini space program.[24]

~~(S)~~ The Agena-D had the same basic dimensions and weight as the Agena-B, but offered an improved, common configuration to which optional and "project peculiar" equipment could be added or deleted after delivery to the Air Force. Among other things shared in common, Agena-Ds had removable, separate wire harnesses, major equipment grouped into four convenient modules (guidance, power, telemetry, and beacon), a standard payload "interface console", and an open-frame aft rack above the Bell engine that allowed plug-in optional equipment, such as solar panels, to be easily installed. Besides solar panels, optional equipment included another Bell pump-fed rocket engine (model 8247) that could be restarted in space up to 16 times using a novel passive-containment propellant system inside the propellant tanks, a secondary propulsion system, 3.3 (b)(1)
[redacted][25] In a typical mission the Agena-D weighed nearly 19,000 pounds at separation and 5,000 pounds in low-earth orbit. Pulsed attitude-control gas jets introduced on this Agena dramatically increased orbit life times from 15 to 20 days, to 60 to 90 days, in part by permitting the vehicle [redacted] 3.3 (b)(1)
[redacted]*

* ~~(TS/TK)~~ The [redacted] was abandoned after three, successive failures in the KH-4 program. Excess use of control gas and degradation due to cold were the big factors.

~~(TS/TK)~~ The secondary propulsion system consisted of two small, pressure-fed, multi-start liquid-propellant rocket engines. Engineers packaged each engine and its propellant tanks in a separate module for installation on opposite sides of the Agena-D aft rack. In space, they were used to make small, corrective adjustments in the Agena's earth orbit. [redacted] 3.3 (b)(1)

[redacted] 26

~~(S)~~ In the late 1960s Lockheed's Agena, like the reconnaissance sensors it carried, disappeared almost entirely from public view. In 1966-1967 the firm proposed an improved Agena-E to be used atop the Titan-III. Although this Agena retained the 5-foot diameter of its predecessors, it featured a lengthened forward-equipment rack, a new multi-start rocket engine, and a much improved attitude-control system. Combined with an "integral" secondary propulsion system that used the same propellants as those burned by the primary engine, the proposed Agena had the capability for much improved on-orbit maneuvering.[27]

~~(TS/TK)~~ But this Agena never went beyond the proposal stage. Instead, during discussions in late 1967 and early 1968, Air Force leaders dropped the Agena in favor of "Project 467", a Satellite-Control Section (SCS) 10 feet in diameter and 6 feet long that employed the Agena-E's integral secondary-propulsion system and could provide on-orbit utilities and propulsion for National Reconnaissance Program payloads in excess of 20,000 pounds.* A Titan-III upper stage was eliminated entirely, and the SCS and KH-9 payload flew atop the Titan sustainer stage (Titan-IIID). The increased SCS diameter and extra propellant tankage supported much more volume and weight in low-earth orbit, and provided greater maneuverability and much longer lifespans. Indeed, while Agena-B operated on orbit for 15 to 20 days, and Agena-D extended that time 60 to 90 days, the SCS-KH-9 operated on orbit for substantially more than 90 days.[28] The SCS also featured large deployable solar arrays, precursors of the Flexible Rolled-Up 1.5-kw Solar Array tested in October 1971 on an Agena-D in the Defense Space Test Program.[29] The deployable systems developed also included a large, unfurlable dish antenna with which the SCS could acquire and transmit prodigious amounts of data.

~~(TS/TK)~~ In the early 1980s, as the KH-8 and KH-9 projects neared an end, Air Force officials terminated SCS production. The

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*~~(TS/TK)~~ This approach had been pioneered on the Atlas-Agena boosted KH-7/KH-8 series. For these capsule-recovery missions, the contractor furnished an orbital-control vehicle (OCV) that enveloped the payload, and attached to the Agena by means of a ring and planetary gear that allowed the OCV to be turned independently of the Agena to position the camera. Senior contractor officials recommended that this cumbersome arrangement be reduced to two distinct modules, one containing the payload and one providing orbital support. That led to the SCS, and ultimately to the end of the Agena in the National Reconnaissance Program.

Agena line had also been shut down and, for the first time in a quarter-century, none of them were to be found in assembly at the Lockheed plant in Sunnyvale.

Space Flight Facilities

~~(TS/TK)~~ The principal space flight facilities for the National Reconnaissance Program, constructed in the 1950s and 1960s, consisted of the launch centers, various tracking and control networks, and at first two primary Satellite Operations Centers. The first of these components included the Air Force eastern and western space and missile centers.* The eastern space center, headquartered at Patrick Air Force Base on Cape Canaveral, Florida, supported missile tests of the military services beginning in the 1940s. In the 1950s the services launched long-range cruise and ballistic missiles from the center on south-easterly trajectories into the South Atlantic. Besides supporting land- and sea-launched missile tests, after 1960 the space center at Patrick launched all American spacecraft flown eastward into low-inclination equatorial orbits, including NASA's manned space flights and, in the 1980s, the Space Shuttle. After contracting for the Agena satellite, the Air Force established Vandenberg Air Force base and the western space center on the Southern California coast, near Lompoc, because of the site's clear access for space

*(U) These two organizations have, over time, shared various names, the most popular being Eastern Test Range and Western Test Range. On 1 October 1979 the Air Force redesignated the ranges: Eastern Space and Missile Center, and Western Space and Missile Center. To avoid confusion, the current names are used throughout this history.

launches into polar orbit. From this center and nearby Point Arguello, the Air Force has, since 1958, tested ballistic missiles and reentry vehicles fired into the South Pacific, and launched National Reconnaissance Program (NRP) spacecraft southward into high-inclination and polar orbits. All American high-inclination and sun-synchronous space-reconnaissance missions originate here. In the late 1970s and early 1980s the service also built a complex at Vandenberg to launch and recover the Space Shuttle, although that facility was moth-balled after the Challenger accident in 1986.[30]

~~(TS/TK)~~ The Satellite Control Facility, another important element originally operated by Air Force Systems Command, today, by the Air Force Space Command, consists of radio tracking, telemetry, and command stations in different locations around the earth, a Satellite Operations Center from which to direct the activities of these stations, and the communications network that ties these stations and the control center together.* While the launch vehicle and automatic spacecraft functioned to position the active or passive sensors in space, the Satellite Control Facility (SCF) served as the spacecraft position-indicator and sensor-output recorder, and as the source of commands transmitted to the spacecraft that altered its position or sensor operation in space. Conceived and described by Rand engineers in the 1954 Feed Back Report, the Air Force and its contractors constructed and refined

*(U) The Air Force Satellite Control Facility operated by Space Command should not be confused with the network of missile early-warning stations operated by Space Command, or with the network of stations for the military meteorological satellites first operated by the Strategic Air Command (see Chapters 3 and 4).

the three-component SCF after 1958, at first exclusively for the NRP. With the passage of time, however, most NRP flight projects acquired their own dedicated tracking and control stations, and the SCF assumed a more limited role for the NRP. In 1986 only [redacted] vehicles were still tracked and controlled on orbit by the SCF. For the rest of the reconnaissance flight projects, the SCF tracks and controls the vehicles from launch through checkout on orbit, at which time control is passed to the project-dedicated mission ground station, [redacted]

~~(TS/TK)~~ The radio-tracking and command stations built expressly for military spacefaring have, therefore, varied in number over the years. They also varied according to the specific space projects. In 1986 seven stations comprised the basic SCF net that still handled a variety of military spaceflight missions. The oldest of these, located at Kaena Point on the island of Oahu, Hawaii (since 1958), remains one of the most important, in part because of its connection with the Recovery Control Center at Hickam AFB which, until 1986, directed USAF recovery forces that retrieved reconnaissance film capsules programmed to descend from orbit in the vicinity of the Hawaiian Islands. Moving westward, the other six stations are located at Guam in the South Pacific (since 1965), on Mahe Island in the Seychelles Group in the Indian Ocean (since 1963), at Oakhanger (since 1978) in the United Kingdom, at Thule, Greenland (since 1961), at New Boston in New Hampshire (since 1959), and back at Vandenberg Air Force Base (since 1959), from whence most of the reconnaissance space flights originate. During the late 1960s and early 1970s the Air Force adopted for these stations many uniform features, including two standard tracking, telemetry, and command dish antennas with diameters of 46 and 60 feet.[31]Typically, for a reconnaissance mission in a low-earth orbit, the swiftly-moving satellite remained within view of the antenna only for a few minutes, and the antenna had to be geared to pivot rapidly while simultaneously tracking the vehicle, commanding it, and receiving its telemetered messages. Many of SCF ground stations continue to function as backup, when needed, for the NRP.

~~(TS/TK)~~ In late 1962, the Satellite Operations Center moved from CIA's Langley, Virginia, headquarters to the basement of the Pentagon, and it opened for business on 14 January 1963. Until 1977 virtually all of the tasking for earth satellites in the National Reconnaissance Program was issued from the Pentagon.[32]

~~(TS/TK)~~ Except for NRP vehicles, most other military satellites are controlled from the SCF "Satellite Test Center" in Sunnyvale, California. Indeed, before 1963 it served as the operations center for early KH-4 missions. The Satellite Test Center in early 1959 consisted of a few rooms with plotting boards adjacent to Lockheed's computer facility in Palo Alto, California. During the flight of Discoverer-I in February 1959, this center made contact with the satellite and managed to record 514 seconds of satellite telemetry. Members of the 6594th Test Wing (Satellite), the organization responsible for operating the Satellite Control Facility, worked closely with engineers in the temporary Palo Alto control center; meantime, the Air Force received 11 acres of land for a permanent control center just down the road in Sunnyvale, next door to Lockheed's Agena plant. The permanent Satellite Test Center, a two-story blockhouse, opened for business in June 1960 and in April 1961 the 6594th formally took charge of all flight operations. At the end of 1961 the control center used two computers and could support as many as three satellite missions simultaneously.[34]

~~(S)~~ Improvements to the Sunnyvale center followed rapidly. In 1965, to handle the increasing number of military space flight projects, a single mission-control room was abandoned in favor of separate mission-control rooms, one for each flight project. In 1966 five CDC 3600s replaced the two 1604s; a year later, seven CDC 3800 computers added to the center's capacity to quickly process information. To service flights of the planned Air Force Manned-Orbiting Laboratory, the Air Force in 1967-1968 constructed next door to the original control center an "Advanced Satellite Test Center", a windowless ten-story, five-floor blockhouse known informally as the "Blue Cube." The new test center increased enormously mission-control capabilities, although, until the arrival of the Space Shuttle, the center itself was destined to support only instrumented, automatic military spacecraft. A few numbers indicate the extent of that support: In 1960 the Satellite Test Center made 300 satellite contacts and logged 400 hours of flight operations; in 1982 those figures had mushroomed to 94,000 contacts and 82,000 hours of flight operations.[35]

~~(TS/TK)~~ In 1987 the Satellite Test Center (STC) at Sunnyvale was augmented by a new Consolidated Space Operations Center (CSOC) located at Falcon Air Force Station in Colorado Springs. The CSOC was to serve as a backup for STC, while also functioning as the primary link with the manned Space Shuttle flights conducted by the NRO. With the disappearance of the Space Shuttle from the military space program, the shuttle activity was eliminated at DCOC, and the STC and CSOC complemented each other controlling the spacecraft.

(S/TK) The third element of the Satellite Control Facility, the communications network that tied the remote tracking stations, the test center, and the Satellite Operations Center together, was comprised at the time of the first KH-4 flight in 1959 of landlines, radio links, and submarine cables. It was not surprising, therefore, to find all of the original tracking stations located within the continental United States, Alaska, and Hawaii. In 1961 the Air Force installed secure circuits capable of 10 words per minute that linked the test center in Palo Alto with the tracking stations in the United States; that service was extended in 1962 to include all of the remote stations overseas. A "multi-satellite augmentation program" further expanded the Satellite Control Facility communication network in 1963-1964. Inside the Satellite Test Center in Sunnyvale, a communications room now housed a high-frequency radio station with four independent voice channels tied to the telephone system, and a semi-automatic teletype switch and 28 teletype machines, with a broadcast feature that allowed transmission to any one or all of the tracking stations. In July 1964, however, Secretary of Defense Robert McNamara announced that the Defense Department would build and launch military communications satellites. That announcement portended major changes in the Satellite Control Facility communications network.[36]

(U) The first seven military communications satellites, called the Initial Defense Satellite Communication System and placed in orbit in June 1966, did lead to dramatic changes in the communications network. Each of these communications satellites could relay 600 voice or 6,000 teletype channels, and when another eight of them successfully attained orbit in January 1967, the Air Force adopted an "advanced data system", a new communications net that would use the communications satellites to connect the tracking stations with the new Sunnyvale Satellite Test Center, and the Satellite Operations Center in the Pentagon. Previously, satellite telemetry was received and processed at a tracking station, and then relayed to the Satellite Test Center at 1,200 bits (kilobits) per second, a process that entailed unwanted delay. Now satellite telemetry received at a tracking station would be immediately relayed to a communications satellite, which then transmitted the data without delay directly to the Satellite Test Center in Sunnyvale. The new network provided much improved communications and data handling service. The tracking station in Hawaii became the first connected with this advanced "Bent Pipe" system* to support space-flight operations in "real time"** in March 1969.[37]

~~(S/TK)~~ Taking advantage of second-generation, more powerful, military communication satellites that began to be launched in

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*(U) This term referred to the instant relay or "piping" of telemetry from space to ground to space to ground; thus, bent pipe.

**(U) "Real time" is military terminology for instantly, or immediately, or as the event occurs.

1971, the Air Force improved the communications network with a wideband-communications system capable of handling 1.5 million bits (megabits) of data per second between the tracking stations and the stateside centers. An interim system began to function in September 1971; the complete wideband communications system became operational in 1974 and eliminated the last submarine cable that tied Thule, Greenland, to the network. Augmented by commercial communication satellites and military Satellite Data System communication satellites, by the early 1980s the wideband system featured a duplexed, multichannel, digital data link.[38]

(U) However rapid the relay of data in space might become, by the late 1970s the transmission and receipt of enormous quantities of information exceeded the ability of computers at the Satellite Test Center to process it expeditiously. Addressing this deficiency, in December 1980 the Air Force awarded International Business Machines (IBM) a contract for a Data System Modernization program. This program, completed in 1987, substituted IBM 3083/3088 computers and 4341 processors for the Satellite Test Center's vintage CDC and Varian computers, and replaced the Univax computers at the tracking stations. With associated software and display consoles, the program increased the combined data-handling capacity of eight spaceflight project mission control rooms from 1.5 million operations per second to 25 million operations per second. The Satellite Control Facility thus increased again the speed of communications processing on earth by orders of magnitude.[39]

~~(S/TK)~~ The various spaceflight facilities on earth and the reconnaissance vehicles they supported in the 1980s scarcely resembled those that inaugurated military satellite operations in 1959. Along the way they had opened acts and events everywhere to the viewing--or listening--from space. Technically, politically, and militarily the change was a profound one, especially for leaders of the United States and the Soviet Union.

CHAPTER SIX

SPACE RECONNAISSANCE: AN ASSESSMENT

(U) Three conditions made possible the swift, radical transformation of space reconnaissance that occurred in the 1960s and 1970s. First, the physical laws of motion ensured that a satellite vehicle, launched at the proper inclination to the equator and placed in orbit at the proper altitude, could be made to pass periodically over any spot on earth. Second, in the wake of the IGY, leaders of the major states eventually agreed with President Dwight Eisenhower that outer space, like the "high seas", was a region open to all, free of any claims of national sovereignty, and in times of peace, an international sanctuary for strategic intelligence systems. Spacecraft operating in outer space, unlike aircraft operating in the atmosphere, could thus "overfly" any state without permission and without violating national sovereignty.* Finally, after transistors replaced vacuum tubes, the design and fabrication of ever-smaller electrical components metamorphosed into solid-state electronics; incredibly powerful satellite sensors and robot-like computer-sequencers, and the rapid encoding, radio and laser transmission, and decoding of immense amounts of information became commonplace.

An Evolving Role

*(U) The exact point where airspace and national sovereignty ends and outer space begins, on the other hand, has never been agreed upon, though that demarcation obviously lies at or beneath the lowest point (perigee) of a sustained satellite orbit (that is, an orbit consisting of one or more complete revolutions about the earth).

~~(S)~~ Sorting out and analyzing space reconnaissance data, as Rand predicted, became a monumental task. Miles Copeland, an intelligence officer who served in the Office of Strategic Services and retired from the CIA, reflected: "A satellite circling the world . . . will pick up more information in a day than the espionage service could pick up in a year."[1] Automatic spacecraft prompted a revolution in intelligence operations. Within ten years, the "intelligence problem" had come full circle from the early 1950s, when virtually no reliable information on Soviet military capabilities was to be had, to the 1960s when intelligence officers faced an avalanche of satellite data, almost all of it totally reliable. (For example, if the resolution of a picture improved by a factor of three, the amount of data increased by a factor of nine.) Indeed, by the 1970s the electronic and visual information generated by strategic reconnaissance satellites began to occlude the system that interpreted and passed it on to national command authorities in the executive branch. Even relying on more powerful computers and increased numbers of trained analysts, the surfeit of data created a processing bottleneck.[2]

~~(TS/TK)~~ In the 1980s a full 40 percent of the National Reconnaissance Program (NRP) visual-imaging product and upwards of 70 percent of the SIGINT product, for various reasons, simply went unanalyzed. The overhead costs for personnel and the processing of these data on earth doubtless began to match the costs of the launch vehicles and space satellites themselves. But despite the collective costs, these reconnaissance data had quickly become so vital to world order that no major state could afford not to have them. The Soviet Union launched its first reconnaissance satellite in 1962, a move followed in 1975 by the People's Republic of China. Two more spacefaring states, France and Japan, announced plans for launching similar satellites in the 1980s.[3]

(U) Although Soviet leaders at first vigorously opposed the use of "spy satellites", when the United States "blacked out" all mention of these vehicles in 1962 and the USSR simultaneously began launching reconnaissance satellites, their public objections ceased abruptly. In July 1963 Soviet Premier Nikita Khrushchev advised Belgian Foreign Minister Paul Henri Spaak that the function of on-site inspection of nuclear tests ". . . can now be assumed by satellites. Maybe I'll let you see my photographs."[4] Ten months later Khrushchev chided former Senator William Benton for continued U.S. aerial reconnaissance overflights of Cuba. Photography from space precluded the need of such provocative acts, he asserted. "If you wish, I can show you photos of military bases taken from outer space. I will show them to President [Lyndon] Johnson, if he wishes." And, as if recalling President Eisenhower's 1955 Open Skies proposal, he added: "Why don't we exchange such photographs?"[5] On his part, President Lyndon Johnson told a meeting of American educators in 1967 that these satellites ". . . justified spending 10 times what the nation had already spent on space." "Because of this reconnaissance," the President confided, "I know how many missiles the enemy has."[6] More than numbers, the President also knew the approximate capabilities, if not the state of readiness, of the Soviet ICBMs.

(U) Although of uncertain legality at the start of the space age, leaders of the major states at first tacitly and then in the mid-1960s openly sanctioned space-reconnaissance satellites as an acceptable and legitimate activity. By the early 1970s reconnaissance satellites were formally recognized in treaty law. The SALT-I Treaty of 1971 and its companion Antiballistic Missile Treaty and Interim Strategic Weapons Accord of 1972 explicitly called for these state-owned vehicles, diplomatically termed "national technical means of verification", to monitor compliance with key treaty terms.[7] The ABM Treaty also proscribed interference with them directly, say by antisatellites, and indirectly, by resorting ". . . to camouflage designed to spoof these devices." Indeed, the Standing Consultative Commission, created by this treaty as a forum for addressing any questions that arise between the signatories, apparently invests most of its time "discussing purported instances in which one side or the other is said to be trying to . . . confuse the other's [reconnaissance] satellites."[8] As treaty monitors, President Jimmy Carter declared emphatically in 1978, "photoreconnaissance satellites have become an important stabilizing factor in world affairs" that contributed immensely "to the security of all nations."[9]

~~(S/TK)~~ Back in the late 1960s, when KH-4 satellites were this nation's primary search system, the Intelligence Community had compiled a list of approximately 12,000 targets of interest. Each target, and its map coordinates, was punched on a Hollerith computer card allowing a computer to organize the targets quickly and efficiently. Thus arose the term "target deck". At that time, 95 percent of the KH-4 targets (11,500) were located in the Sino-

Soviet bloc, the rest were in such areas of tension as the Middle East and Southeast Asia. Satellite managers in the National Reconnaissance Office (NRO) were reluctant to expend KH-4's limited film supply on targets outside the Sino-Soviet bloc.[10]

~~(S/TK)~~ The advent of the more powerful KH-9 system in the early 1970s, with a much larger film supply and longer lifetime on orbit, saw the target deck double in size to 24,000 targets, 85 percent (20,500) of which were in the Sino-Soviet bloc. The increasing proportion of non-Sino-Soviet targets (15 percent or 3,500) reflected this nation's growing interest in other areas of the world, particularly the Middle East, Africa, and Latin America. At the same time, President Nixon's 1972 opening of relations with the People's Republic of China somewhat diminished the urgency for filming that nation. The more powerful KH-9, however, could film 9,000 more Sino-Soviet targets than the KH-4.[11]

~~(TS/TK)~~ President Carter's 1978 public acknowledgement of U.S. reconnaissance satellites referred obliquely to the dramatic changes in the defense role they played and the enormous national security implications of their products. COMINT satellites [redacted] for example, furnished data vital for SALT deliberations. The more powerful electro-optical visual-imaging satellites that became operational in January 1977, when the Carter Administration took office, also profoundly changed intelligence operations. These KH-11 spacecraft were no longer film-limited, and they returned pictures in near-real time over a period of many months. Except for cloud cover, available electrical power now represented the only limit to picture-taking.[12]

3.3 (b)(1)

~~(TS/TK)~~ Not only were target decks altered in response to "unlimited" picture-taking opportunities, but the President and his key advisors could (and did) request immediate pictures of targets of interest, and that directly interrupted normal targeting operations. When the KH-11 system began returning near-real-time imagery, its target deck also began growing exponentially. By 1979 it had nearly doubled the KH-9 deck to 40,000 targets, only slightly more than half of which were Sino-Soviet related. Actually, the number of Sino-Soviet targets remained constant at about 21,000, while targets elsewhere in the world increased from about 3,500 to nearly 20,000.[13]

~~(TS/TK)~~ This interjection of Presidential authority and the growth of non-Sino-Soviet targets had a profound effect on the entire Intelligence Community. Because all imagery has to be analyzed and the amount of non-Sino-Soviet imagery now rivaled imagery of Iron Curtain targets, all Intelligence Community assets in these areas grew accordingly. Also, the sheer power of KH-11 system and its ability to obtain, at the President's request, urgent imagery of crisis areas during the course of a single workday, wrought profound changes on the institution developed to oversee space-reconnaissance systems. In 1977 COMIREX became a 24-hour-a-day operation, as did the analytical effort (PEG). Indeed, today's PEG operation has become this nation's new National Indications Center.*

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*(U) See Chapter 1, pp. 14-15.

~~(TS/TK)~~ Finally, beginning in the mid-1970s, other automatic spacecraft greatly expanded the scope and responsiveness of foreign intelligence operations, [redacted] 3.3 (b)(1)

The MIDAS/DSP* satellites relayed to earth within minutes information on natural disasters or man-made events that generated thermal (infrared) radiance--forest fires, aircraft accidents and shipboard fires, artillery duels, munition plant explosions, and so forth. Within hours, visual-imaging satellites returned photographs of the event. Indeed, during the Iran-Iraq War, DSP vehicles provided an accurate count of long-range missiles launched against cities, and of the number that exploded on target. Withal, by 1986 the role of automatic NRP and related satellites had evolved from one that focused primarily on strategic and technical reconnaissance for pre-hostilities warning of nuclear surprise attack, to a much broader endeavor that also embraced near-real-time indications and warning across the entire spectrum of international political and military action, from low-intensity terrorist activity to warfare between states.

National Space Policy Revisited

~~(S)~~ Between 1955 and 1988, national space policy likewise evolved through presidential directives issued through the National Security Council, public law,** public presidential declarations,***

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*(U) See Chapter 4.

**(U) For example, the National Aeronautics and Space Act, and international convention.* Of all these sources of space policy, only the first category is unavailable for public scrutiny. This source most directly affected the evolution and security of the nation's efforts to acquire overhead reconnaissance and was thus most closely held; so closely held, in fact, that the National Security Council directives have been unavailable to all save a few military and political leaders. These directives began with President Dwight D. Eisenhower; he framed the nation's space policy edifice. His successors either embraced the Eisenhower design or, at most, refined it by adding a window here and a door there. Only one of them, President Ronald Reagan, offered a fundamental alteration to the structure (the Strategic Defense Initiative of 1983), and that alteration remains the subject of political and legal contention.

~~(S/TK)~~ When Eisenhower left the White House in 1961, the form and substance of the nation's space organization and policy were essentially complete. The space program had been organized and divided among three components: civil, military, and intelligence--each with its own source of funding, direction, and Congressional oversight. But the intelligence effort, known collectively today as the National Reconnaissance Program,

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or the Comsat Act.

***(U) President Eisenhower's announcement of an American satellite program as part of the International Geophysical Year was illustrative of this category.

*(U) The various UN-generated treaties on outer space and the arms control treaties, such as the SALT-I and ABM conventions, have all shaped national space policies.

represented the linchpin around which everything else pivoted. Indeed, Eisenhower designed and built the nation's space policy to ensure the President and his military commanders received the intelligence data necessary to prevent a massive surprise attack on the United States in an age of thermonuclear weapons. His space policy secured that goal; indeed, it served the nation so well that it remained essentially unaltered for a quarter century.*

~~(S)~~ In 1954-1955, the President and his advisors fully appreciated that new surface-to-air missiles, if not international law, would preclude extended overhead reconnaissance within Soviet airspace. U-2 overflights were initially estimated to be secure only for 24 months; moreover, Eisenhower himself viewed unauthorized aerial overflight of another state to be extremely provocative and a grave violation of national sovereignty. Overhead reconnaissance from outer space, however, was at that time recognized to be technically and legally quite another matter.

~~(S/TK)~~ In July 1955 Eisenhower publicly approved a scientific satellite program. That program would, it was privately hoped, establish the precedent of "freedom of space"--the recognized right of overflight at extreme altitudes--for reconnaissance satellites projected eventually to follow. During the IGY this tenuous precedent appeared to take root in the United Nations. Three years later, in 1958, Eisenhower signed the

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*(U) Regrettably, the vital intelligence aspects of surprise attack prevention--and its attendant security classification--have caused President Eisenhower's immense contributions to national defense preparedness in the 20th century to be overlooked or misinterpreted by virtually all historians.

National Aeronautics and Space Act that provided America an open, civilian space program unfettered by security restrictions, a program much to the liking of American scientists, a program calculated to further the principle of freedom of space among nations. Finally, in August 1960, Eisenhower separated intelligence satellite efforts from the military space program, and approved formation of what became known as the National Reconnaissance Office. Throughout this period the Eisenhower administration frequently invoked the term "peaceful uses of outer space", a term that clearly embraced military defense-support space missions, specifically overhead reconnaissance from space. By 1961, certainly, political leaders in the executive branch increasingly viewed space-based offensive weapon systems as a potential threat to what had become vital, national space-reconnaissance assets.

(S/TK) President John F. Kennedy, who had ridden into office in part on the strength of "a missile gap" that did not exist, embraced Eisenhower's national space policy. The intelligence product of the space-borne segment of the NRP had in 1962 become so important to national security that Kennedy moved beyond Eisenhower. He ordered all official discussion of the subject "blacked-out", and later, cancelled two Air Force weapon systems that could be employed offensively in space: Dynasoar and the Satellite Interceptor, or SAINT as it was known. Air Force leaders who had welcomed Kennedy to office, but failed to understand what the expression "peaceful uses of outer space" really represented, were mystified and very angry. But whatever the reason for the disparity that occurred between national space policy and Air Force space planning, enormous amounts of time, effort, and money now had simply to be written off.

(S) Succeeding presidents with but one exception have either accepted the national space policy forged by their predecessors, or refined it in its application to civil and commercial spacefaring. Presidents Lyndon B. Johnson and Richard M. Nixon issued space policy directives encouraging international cooperative space ventures;[14] ventures that tended to "open up" the Soviet Union and culminated in the U.S.-Soviet Apollo-Soyuz project in the mid-1970s. But the cornerstone of America's space policy was at the beginning and remains today: the national right of unimpeded overflight as it relates to the acquisition of strategic intelligence. President Jimmy Carter restated succinctly the Eisenhower dictum as the first principle in his own space policy directive, and it reappeared as the first principle in President Ronald Reagan's primary space policy directives:[15]

> a. Commitment to the principles of the exploration and use of outer space by all nations for peaceful purposes and for the benefit of all mankind. "Peaceful purposes" allow for military and intelligence-related activities in pursuit of national security and other goals.

(TS/TK) Although Presidents Johnson, Ford, and Carter approved offensive weapon systems that could be employed against space vehicles, all were earth-based.[16] The Ford-generated requirement for an anti-satellite system remains in effect, though it has not been implemented in the face of stiff Congressional opposition. Meantime, the United States in 1968 agreed to prohibit stationing weapons of mass destruction in outer space, and, it seemed, would not be the first to station any offensive weapon systems there even though the Soviet Union in the late 1960s and 1970s tested a ground-based orbital anti-satellite weapon of limited capabilities. To date, neither state has attempted to "station", or deploy, offensive weapons in space, but that state of affairs may change. In March 1983 President Ronald Reagan authorized research and development of the Strategic Defense Initiative, or SDI, currently directed toward the creation of armed, earth-orbiting battle stations designed to destroy intercontinental and intermediate-range ballistic missiles launched against the United States. The term "peaceful uses of space" subsequently expanded in 1988 from the customary defense-support functions to include at least SDI weapons in orbit.[17] That change could eventually have a profound affect on the conduct of the National Reconnaissance Program.

The National Reconnaissance Program and National Security

(S-TK) If overhead reconnaissance drove national space policy after 1955, it also set the tone and tempo of military spacefaring. The tone, in keeping with Eisenhower's desire to establish the precedent of free access to and unrestricted passage in outer space--thereby ensuring reconnaissance overflight--remained during this period one of military-support applications. And, with the exception of automated navigation and communications satellites, the strategic reconnaissance satellite program sparked all other defense space projects: instrumented missile-early-warning satellites, military weather satellites (to direct operation of visual imaging sensors), geodetic satellites, naval electronic-reconnaissance satellites, and studies of antisatellite vehicles that would later claim political and military attention. The tempo was set by rapid advances in electronics and related space technologies during the 1960s and 1970s, advances that improved the reliability of U.S. military satellites and extended their lifetime on orbit from months to years. These technical advances also prompted a marked decline in U.S. military launch rates, and provoked concern among some Americans who misinterpreted that decline as a sign of weakness when compared with the Soviet space program. To allay those concerns, on 14 September 1987, Secretary of Defense Caspar Weinberger explained the difference:[18]

> In terms of operational military capability, now and in the future, the U.S. exceeds equivalent Soviet capability in terms of the quality,

> quantity, accuracy and timeliness of mission data to the users; not in the ambiguous and less meaningful comparisons of tons of cargo placed in orbit or number of man-days in space. Using those operational measures of merit, we are clearly superior.

~~(S/TK)~~ The technical superiority to which Weinberger referred was in large measure pioneered on NRO satellites. In fact, the extraordinary success of automatic reconnaissance satellites slammed the door on early Air Force hopes for manned space missions. Back in 1963 the Defense Department approved the Air Force Manned Orbiting Laboratory (MOL as it came to be called), combining area surveillance and close-look reconnaissance systems. In 1969, running well behind schedule and ahead of projected costs, President Richard Nixon cancelled MOL in favor of the automatic KH-9 satellite. Instrumented spacecraft would perform space-reconnaissance missions in the 1970s and 1980s more economically. Not until the advent of the Space Shuttle in 1981, which could transport large, automatic satellites into orbit and return them to earth, would a "cost effective" role for military men in space be claimed, but even that claim has yet to be substantiated.

~~(S/TK)~~ The dedication of military and civilians alike made President Eisenhower's 1955 "Open Skies" proposal a reality in the space era.[19] Eisenhower and his advisors vested direction of strategic spaceborne reconnaissance in presidentially-appointed civilian authority, the Secretary of Defense, who acted through the National Reconnaissance Office, Under Secretary of the Air Force, and a branch office on the west coast. Inside the NRP, and outside it in other military astronautical endeavors, the Air Force remained responsible for fashioning much of the technology, launching all of the spacecraft, and managing most aspects of the national security space program, with those responsibilities first made formal in Defense Department directives on 6 and 28 March 1961.[20] During the 1960s, in the absence of a single military space organization comparable to NASA, the Air Force Systems Command (the research and development arm of the service) became almost by default responsible for operating many military space systems. In 1982 the Air Force and the Defense Department, acting to separate development and operations along more traditional lines, established Air Force Space Command that has assumed many of the operating functions performed previously by Systems Command or Strategic Air Command.

~~(S/TK)~~ However organized between 1958 and 1982, the successes of intelligence satellite projects have been without question, astounding. Automatic NRO satellites among other contributions have established with considerable accuracy the actual military capability and state of preparedness of foreign countries. They have made possible key terms in arms-limitation and nuclear test-ban treaties that can be monitored and verified.* And just as

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*~~(S)~~ In the 1970s the introduction of MIRV warheads on ballistic missiles and in the 1980s of small ground-, sea-, and air-launched cruise missiles capable of carrying either conventional or nuclear warheads, ended all opportunities to know with any certainty the number of nuclear warheads a nation possesses. On this crucial issue, neither overhead reconnaissance nor even on-site inspection can provide a definitive answer; this situation has led today to disparate counts of Soviet strategic warheads among American intelligence agencies. In the future, with

President Eisenhower so earnestly hoped, they have sharply reduced the ability of any major state to prepare for and launch a surprise attack on its neighbor.* The first KH-4 satellite launched into orbit in early 1959, not the first Sputnik or Vanguard satellites, marked the beginning of this new era. Although its significance can be compared today with the advent of nuclear weapons, in 1959, few among those directly involved in the military space program "realized that a new era was at hand. Still fewer could then foresee the remarkable impact . . . [strategic spaceborne reconnaissance] would have on international relations in this century and far beyond."[21]

~~(S/TK)~~ On 19 August 1985, twenty-five years after the recovery of the first KH-4 film capsule, members of the original project gathered to be recognized at CIA headquarters in Langley, Virginia. Among that select fraternity could be found representatives of business, the universities, and military and government service who understood the significance of those first photographs, but who had, for reasons of national security, remained unrecognized. DCI William Casey read to those assembled a letter from the President of the United States, Ronald Reagan:

> No words can adequately convey the respect and gratitude that I feel, and I am sure that all

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this question an unknown to opponents, the "risk factor" can be expected to greatly complicate any planning for an offensive "first strike" surprise attack.

*~~(S)~~ Systematic strategic reconnaissance has precluded the most important types of military surprise, and, without that advantage, aggression against an opponent forewarned becomes unfeasible or entails insuperable risks.

Americans would feel if they could know, of the dedication and selflessness of the people who have given so much to the security of the United States.

Through their work, I can request photographs of almost any area of the surface of the earth and have them in my hands in a matter of hours. It is a feat of which President Eisenhower and those before him could only dream. It was he who played the crucial role in the development of overhead reconnaissance. It was his commitment to and understanding of the vital contribution that reconnaissance could make to our nation's security that provided the impetus to this project 25 years ago.

During the Eisenhower Administration, a new generation of photo-reconnaissance technology was developed that radically changed the entire concept of intelligence gathering. Improved collection--from reconnaissance balloons to satellites--has resulted in our acquiring an ever-increasing volume of detailed intelligence crucial to our national security and that of our allies.

President Eisenhower once said to the grand old man of this business, General George Goddard, that without aerial reconnaissance: ". . . you would only have your fears on which to plan your own defense arrangements and your whole military establishment. Now, if you are going to use nothing but fear, . . . you are going to make us an armed camp." His statement is no less true today. The knowledge which only overhead reconnaissance can provide is absolutely vital to the security of the United States.[22]

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