A HISTORY OF THE MILITARY POLAR ORBITING METEOROLOGICAL SATELLITE PROGRAM

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OFFICE OF THE HISTORIAN
NATIONAL RECONNAISSANCE OFFICE

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Preface

In 1961, at the height of the Cold War, a director of the National Reconnaissance Office (NRO) authorized the construction and launch of a small meteorological satellite to support CORONA and other film-limited imaging satellite systems. Though undertaken as an "interim" measure while awaiting completion and launch of a national weather satellite, in the months that followed the NRO spacecraft would incorporate so many desirable features and perform so admirably that it became the template adopted for all American civil and military low altitude meteorological satellites. I researched and wrote the first installment of this history, which covered these actions and events, using available classified records while assigned temporarily to NRO headquarters in the mid 1980s. After returning to the NRO as its historian in the late 1990s, and upon declassification of the original work and endnotes in February 2000, I shared it with the early program participants and completed the story through the turn of the Millennium and the consolidation of American military and civil meteorological satellite programs into a National Polar-orbiting Operational Environmental Satellite System (NPOESS).

People act. They make decisions that trigger events. To the extent practical, this brief history turns on the people who shaped the story, particularly for the early NRO years when the effort was highly classified, handled in compartmented channels, and little known even to those who received and used the meteorological products. The people on which I focused in this story, the successive program directors and their immediate associates, brought to the meteorological satellite enterprise different technical skills and management approaches—all of them operating in a bureaucratic framework that changed with organizational realignments. Over the years, as the program moved from the NRO to the regular Air Force, and eventually to the Department of Commerce, they found themselves dealing with more federal regulations, more officials whose approval they required before choices and actions could be made or taken, and much more Congressional oversight. That they acted to identify and select the best outcome for this national effort I think goes without saying. That the choices made often produced outcomes that departed markedly from initial expectations is likewise apparent.

The scope of this work, limited primarily to the program itself, did not permit its treatment in the larger political and social context.* I touch on but do not explore and analyze the

*In terms of its social and economic ramifications, for example, nighttime images of the Earth furnished by program's interactions with the major contractors, with officials in other federal agencies such as the National Aeronautics and Space Administration and the National Oceanographic and Atmospheric Administration, or with Congressional representatives and their staffs who, by the mid 1970s, largely determined how many and what kinds of meteorological satellites would best serve the country. A comprehensive history remains to be written. In that effort, I hope the historian of record will find in this work a useful building block. Not all readers will agree with my interpretation of events, or with my skepticism about the outcome of a cost-effective, combined military-civil NPOESS. Noteworthy military attempts to specify and contract for "one size fits all," except perhaps for certain hosiery, mostly have failed in terms of meeting diverse performance requirements on a fixed schedule and at a reduced cost. I would be pleased, however, if the NPOESS team overturns precedent. Any errors of fact that remain are mine.

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defense meteorological satellites (such as Fig. 16. in this monograph), permitted geographers and social scientists to make informed estimates of population densities in various regions. Cf., C. D. Elvidge, K. E. Baugh, E. A. Kihn, and E. R. Davis, "Mapping City Lights with Nighttime Data from the DMSP Operational Linescan System," *Photogrammetric Engineering and Remote Sensing,* Vol. 63, No. 6, 1997, pp. 727-734; Paul Sutton, Dar Roberts, Chris Elvidge, and Hank Meij, "A Comparison of Nighttime Satellite Imagery and Population Density for the Continental United States, *Photogrammetric Engineering and Remote Sensing,* Vol. 63, No. 11, 1997, pp. 1303-1313; and Paul Sutton, "Modeling Population Density With Nighttime Satellite Imagery and GIS," *Computer, Environment, and Urban Systems,* Vol. 21, No. 3/4, 1997, pp. 227-244.

Successful operation of overhead photoreconnaissance satellites, the RAND Corporation had warned the Air Force in the mid 1950s,[1] depended on accurate and timely meteorological forecasts of the Sino-Soviet landmass. Such forecasts would make possible cloud-free photography over areas of interest. Indeed, pictures of clouds retrieved from a film-limited spacecraft cost dearly—a fact made plain in 1960-1961 by the images returned from early CORONA missions. When an interdepartmental study of the subject ended in April 1961, however, the National Aeronautics and Space Administration, or NASA, received the U.S. franchise to establish requirements and develop meteorological satellites for both the Departments of Commerce and Defense in the National Meteorological Satellite Program. This program, its proponents contended, would avoid duplicated effort and produce at less cost a single National Operational Meteorological Satellite System (NOMSS) to meet all civil and military forecasting needs, including presumably those of the National Reconnaissance Program (NRP).[2]

But in the Pentagon in 1961, Under Secretary of the Air Force Joseph V. Charyk, who also headed the National Reconnaissance Office (NRO), remained unconvinced. NOMSS, at best two or three years away, also was supposed to support international meteorological data exchanges, an objective inconsistent with contemporary NRP requirements for secrecy. Moreover, the television camera of NASA's first experimental, "wheel-mode" TIROS weather satellite, spin stabilized to inertial space and launched the year before on 1 April 1960, viewed only an oblique swath of the Earth's surface occasionally in each orbit instead of once each time it revolved. Charyk knew that NASA officials did not believe a spin-stabilized weather

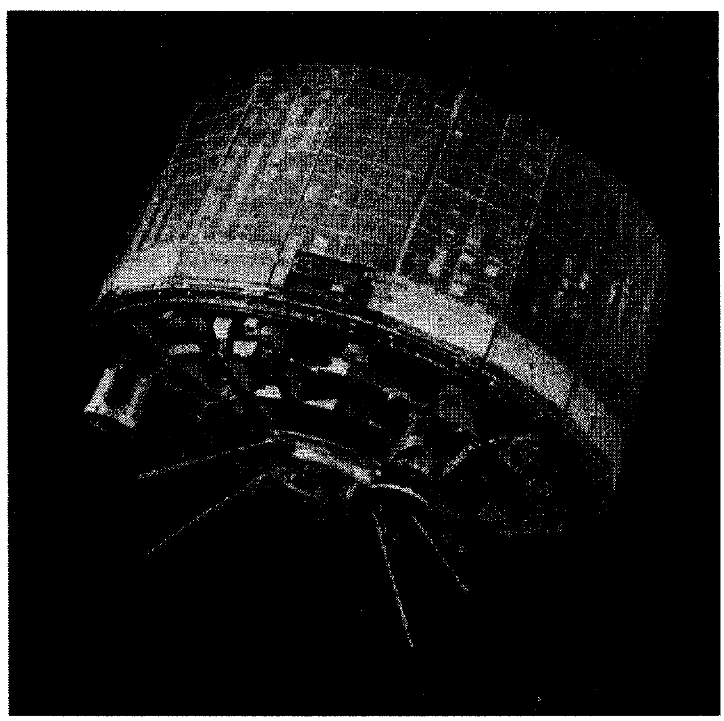

Fig. 1. TIROS Experimental Weather Satellite, 1960 (Note the vidicon lens at bottom left on the satellite.)

satellite 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 reconnaissance satellite flight operations in 1962.* He therefore acted to create an "interim" meteorological satellite program for the NRO. In the event, that program also would fashion the technology and flight operations for what would become the polar orbiting, low altitude national weather satellite system administered by the National Oceanic and Atmospheric Administration (NOAA).

A Temporary Meteorological Satellite Program

On 21 June 1961, Charyk spoke with Major General Robert E. Greer, Director of the Office of the Secretary of the Air Force for Special Projects (SAFSP) in El Segundo, California. He asked Greer to prepare a "minimum" proposal for four "Earth-referenced" wheel-mode 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 small fixed budget and a first launch in ten months. The Deputy Secretary of Defense approved it, and the Director of Defense Research and Engineering, Harold Brown, made available to the NRO the necessary funding. On 27 July 1961 Greer's deputy, Colonel Harry Evans, appointed Lt. Colonel Thomas O. Haig the first director of the Defense Meteorological Satellite Program (DMSP).† Haig, a meteorologist and electrical engineer, accepted the assignment on condition that he would *not* have to use the resident "systems engineering and technical direction" contractor,‡ could select his own small staff, and could use fixed price, fixed delivery contracts under his direct control throughout the program. Evans added a "kill switch" of

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*TIROS (Television Infrared Observation Satellite) had emerged from the Air Force WS-117L reconnaissance satellite competition back in 1956. After Lockheed won the primary contract, RCA officials, whose proposal had not been selected, sold the concept of a television infrared weather satellite to the Army Signal Corps at Belmar, New Jersey, which, along with the Advanced Research Projects Agency, funded further work. After NASA began operating in October 1958, it acquired TIROS along with a number of the key Signal Corps personnel. As the 1960s began, plans called for equipping TIROS with infrared horizon sensors that would determine horizon crossings and trigger picture taking of the scenes below.

†This program, needless to say, had a succession of numeric and alphabetic names, including Program II, P-35, 698BH, 417, and Defense Systems Applications Program (DSAP). In order to avoid confusion, the current designation DMSP is used throughout this history.

‡To Haig's view, an SE&TD contractor could only justify its existence by introducing changes. Since changes involved time and cost money, SE&TD support was incompatible with fixed price, fixed delivery contracting. See Thomas O. Haig, "'Technical Direction': Outmoded Management Concept?" in *Perspectives in Defense Management*, Industrial College of the Armed Forces, May 1967.

his own: if the first launch could not be met on schedule or if costs appeared certain to exceed the fixed budget, he instructed Haig to terminate the program and recover government funds immediately without further direction.[3]

In the months that followed, the DMSP effort operated on NRP funds under the NRO security blanket, but located physically outside the NRO Special Projects Office in El Segundo for purposes of cover and ease of operations.[4] Haig divided the work among those he initially selected: three officers and Renell LaBatt, "a very busy secretary."[*] He invested his own time in program management, with special attention paid to a contract he negotiated with RCA for the weather satellite. Captain Stephen Dvorchak, joined later by Captain Richard Geer, was assigned the Scout launch vehicle; a small, four-stage, solid propellant rocket built by Chance Vought and procured under NASA direction. To meet program performance requirements, Dvorchak substituted a high acceleration Lockheed Propulsion Company MG-18 solid-propellant motor in place of the standard Scout fourth stage Altair motor. Captain Luin Ricks handled ground support, tracking, command, and readout at the Air Force ground stations operated by the Lockheed Missiles and Space Division (LMSD). Finally, Major Charles Croft oversaw contract management at all the various firms involved, novel contracts that were "fixed price" instead of the customary "cost plus fixed fee."[5] The RCA fixed-price, fixed-delivery contract proved itself in December 1961 when a major structural member of the weather satellite, the base plate, failed during tests and company officials requested a three month delay for redesign. Croft, after discussion with Haig, advised RCA that it had ten days to produce a fix or the contract would be terminated under procurement regulations "at no cost to the government." The

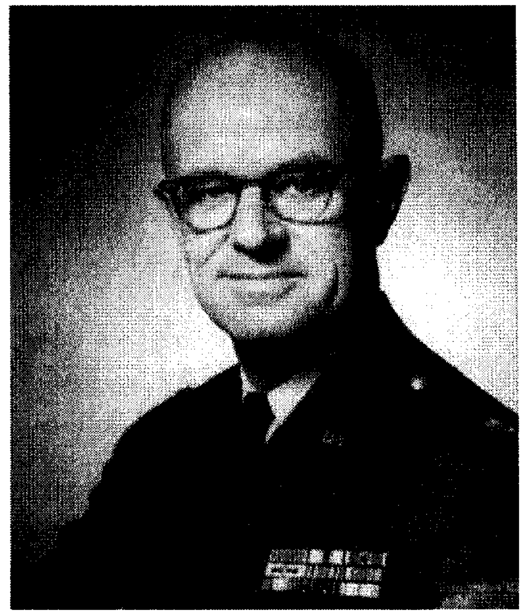

Fig. 2. Lt. Col. Thomas O. Haig, First DMSP Program Director

[*]By the end of 1962 the program office staff had increased to five officers and two secretaries, including Etta Holt. Three or four SAC officers also were assigned at that time, involved primarily with the Scout launch vehicle and ground support. This small number grew to about 15 military and civilians by the mid-1960s, when the program transferred from the NRO to Air Force Systems Command.

RCA program manager appeared three days later with revised internal schedules that met the original launch date.

Neither the Scout booster nor the RCA satellite mounted redundant equipment, and a failure anywhere in the system meant the loss of a mission. All of those involved regarded the enterprise as a single purpose, minimum cost, "high-risk" program. Smaller and lighter than the original TIROS, the 100-pound TIROS-derived RCA satellite 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 the early NRO weather satellites at about 12 rpm by small spin rockets. By adopting a concept advanced by Haig and Lt. Ralph Hoffman, however, the spin axis was maintained perpendicular to the orbit plane by torquing the satellite against the Earth's magnetic field, the forces supplied through a direct-current loop around the satellite's perimeter. A ground command would cause the electric current to flow in the desired direction to generate the torque. Those few NASA officials who knew about it viewed the NRO-Air Force program as a no-risk test of a modified four-stage Scout with an "Earth-referenced" wheel-mode weather satellite.[6]

If it operated correctly, the RCA shuttered television camera (a photosensitive vidicon tube) would be pointed directly at the Earth once each time the satellite rotated. At the programmed interval, when infrared horizon sensors indicated the lens was vertical to the Earth, the vidicon would take a picture of an 800-mile-square area of the surface below, with the image recorded on tape as an analog signal for later transmission to the ground. Launched into a sun-synchronous 450 nautical mile circular polar orbit, the RCA 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 on each pass over the western hemisphere; at the ground stations, the video pictures of cloud cover over the Eurasian landmass would be relayed to the Air Weather Service's Air Force Global Weather Central collocated with Headquarters Strategic Air Command at Offutt AFB, near Omaha, Nebraska.[7]

Haig's "blue suit" program team met its ten-month schedule, although, as the high-risk aspects of the effort suggested, without immediate success. The polar-orbiting DMSP satellites were to be launched from the West Coast range on Point Arguello, at Vandenberg AFB, located near the town of Lompoc, California. As events transpired, a standard four-stage Scout booster carrying an NRO GRAB satellite was first in line, and was viewed as a system test by the DMSP office. This vehicle, launched on 25 April 1962, ended in a Scout booster failure within sight of those in the blockhouse. The temperamental Scout booster, this time with an MG-18 fourth stage, failed again during launch of the first NRO weather satellite on 23 May when the vehicle self-destructed towards the end of second stage ignition. The second DMSP launch on 23 August 1962 resulted in success, although the Lockheed 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.[8]

Fig. 3. First DMSP Launch, 23 May 1962

Lt. Colonel Haig reported to General Greer at the NRO Special Projects Office in El Segundo, but Joseph Charyk took a personal interest in the affairs of the weather satellite program initiated to satisfy NRP requirements.* That program now possessed the first U.S. military satellite

*The DMSP Program Manager normally briefed Charyk monthly at NRO Headquarters in the Pentagon, and then back-briefed General Greer on his return regarding any directions he had received from the DNRO.

Fig. 4. Joseph V. Charyk,
Under Secretary of the Air Force

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.) At the Pentagon on the morning of 24 September 1962, Charyk advised Haig that NASA's planned Nimbus weather satellite, or NOMSS, would be delayed, and that he should plan one additional year for the interim NRO meteorological satellite program. Haig, who had guessed as much, had next year's budget charts ready. Lockheed claimed a major part of the total budget for ground-support operations, but, the Lt. Colonel insisted, he could build two ground stations and a control center, man them with blue-suiters, and operate the weather satellites in support of the NRP for one-eighth the amount bid by the contractor.[9]

Under Secretary of the Air Force and NRO director Charyk approved the cost-saving proposal on the spot. Then he picked up the phone and called Air Force Chief of Staff General Curtis E. LeMay and arranged for an appointment. That afternoon at the Pentagon, Haig explained to the Chief of Staff how Air Force personnel could man and operate two weather satellite ground stations and a control center. The general listened intently and, when Haig left an hour later, "it was with a promise of all the people I needed from the Strategic Air Command [SAC] and, 'if anybody gets in your way, call me!'" from LeMay. At the General's direction, Haig boarded an airplane bound for Omaha and, next day at Headquarters SAC, briefed CINCSAC General Thomas S. Power and his staff. SAC's leaders promptly committed to the Defense Meteorological Satellite Program all the personnel it required.[10]

During the ensuing weeks, program personnel worked at all hours, every day. They found surplus Nike anti-aircraft rocket sites in the states of Maine (near Loring AFB), and Washington (near 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 with Radiation Incorporated for two 40-foot radar dishes and 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 from Lockheed to its own stations in Maine and Washington. About the same time, a command and control center for the DMSP manned by SAC personnel began operating one floor below Air Force Global Weather Central in Building D, the old Martin bomber plant, next door to SAC Headquarters at Offutt AFB, Nebraska.[11]

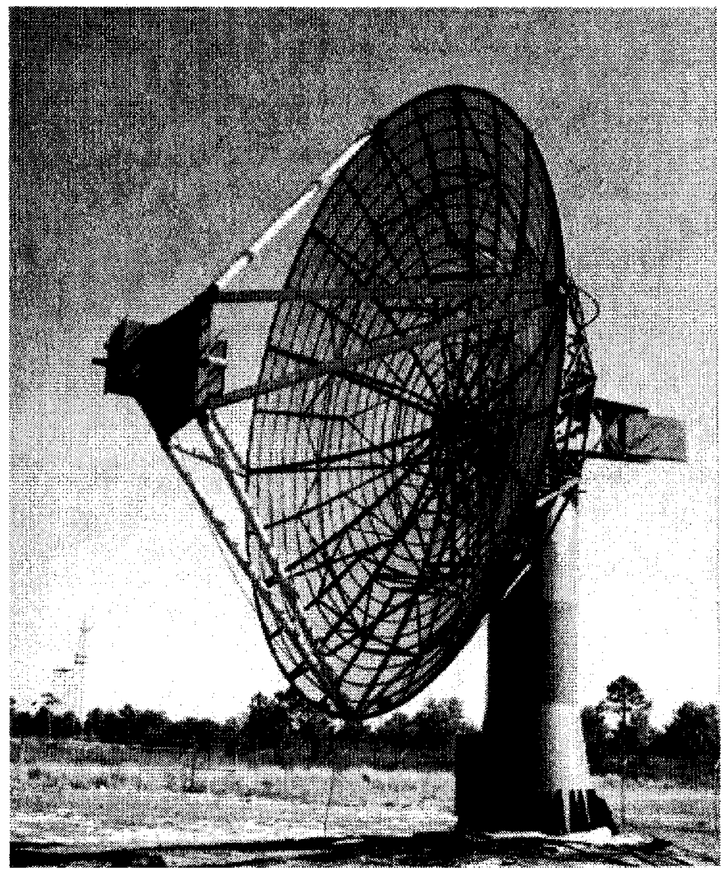

Fig. 5. Air Force Surplus Antenna Mount with 40 ft. Diameter Reflector Adapted for DMSP

The first DMSP weather satellite to be controlled at the ground stations manned by Air Force personnel was flight number three launched on 19 February 1963. At Vandenberg AFB, another Air Force team, the Systems Command 6595th Aerospace Test Wing, conducted launch operations.* In this instance, the Scout booster upper stages again malfunctioned and 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 commanded transmission, although direct vidicon readout continued for a few weeks more. A new experiment, however, continued to function nicely for

*A few years later, when the Thor booster replaced Scout as the DMSP launch vehicle, launch duties transferred from the 6595th ATW to SAC's 4300th Support Squadron, which had experience with Thor rocket launches. "It was a source of great pride to SAC," Richard Geer recalled, but the transfer proved "galling to some in the 6595th." Moreover, office reasoning held, "SAC would not tolerate launch failures."