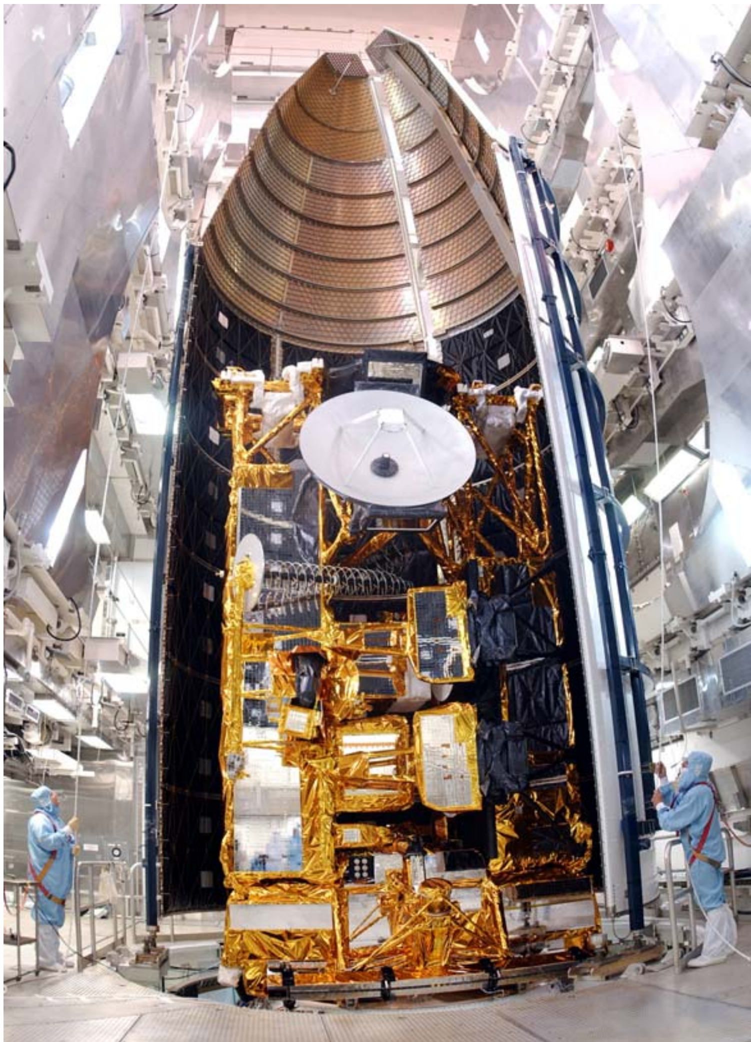
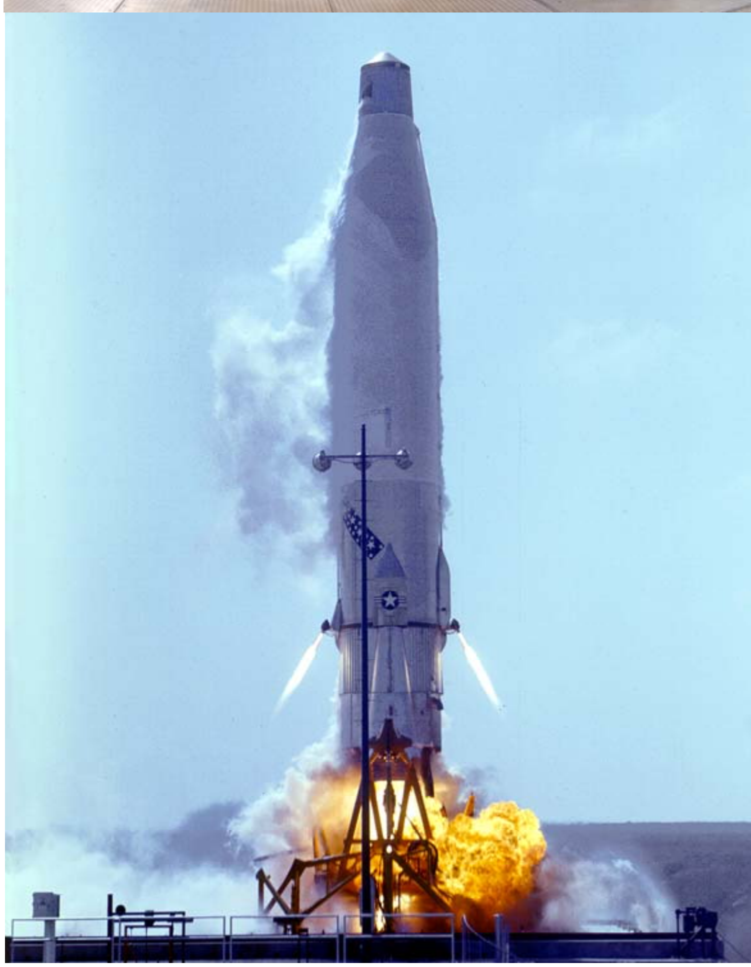
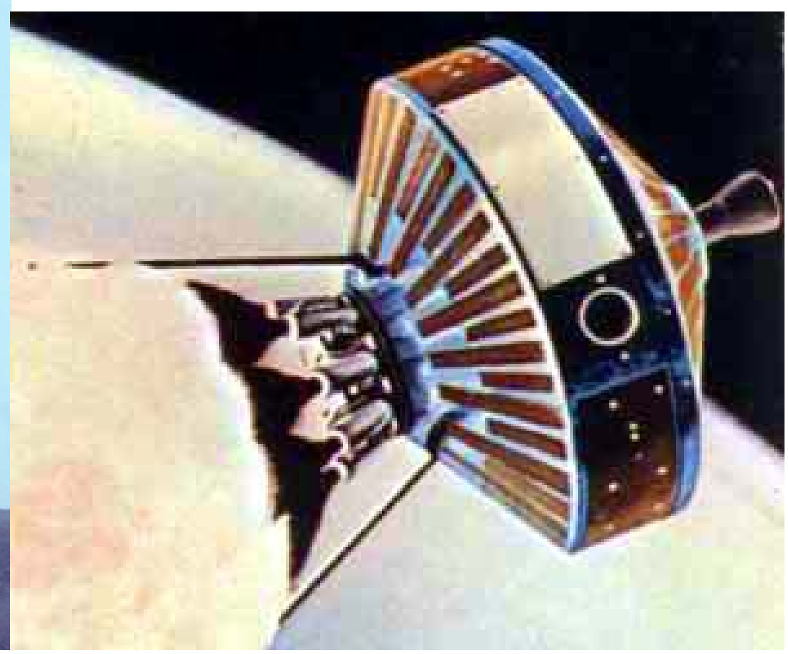




Historical Overview of the Space and Missile Systems Center, 1954-2003



Pictures on front cover, clockwise from bottom right:
Artist's concept of the Air Force Pioneer lunar probes' fourth stage, 1958;
IOC launch for the Atlas missile, 9 September 1959;
fifth Milstar satellite inside the payload fairing of its Titan IVB launch vehicle, January 2002 (photograph courtesy of Lockheed Martin Missiles and Space);
launch of the first Atlas V Expendable Launch Vehicle, 21 August 2002 (photograph courtesy of International Launch Services)

HISTORICAL OVERVIEW

of the

SPACE AND MISSILE SYSTEMS CENTER

1954-2003

History Office
Space and Missile Systems Center
Los Angeles AFB, CA

50th Anniversary Edition

PREFACE

This pamphlet provides a brief historical overview of the Space and Missile Systems Center and its antecedents during approximately the first 50 years of their existence. The Center's organizational ancestors include the Western Development Division and the Air Force Ballistic Missile Division of the 1950s, Space Systems Division and Ballistic Systems Division of the 1960s, the Space and Missile Systems Organization of the 1960s and 1970s, and Space Division and the Ballistic Missile Office of the 1980s. This history describes the evolution of their mission and organizational structure, the history of base facilities, and the history of the principal space and missile programs managed by SMC and its predecessors. Although this essay touches on a few space programs managed by other agencies, its focus is institutional: it is about the work and infrastructure of SMC rather than other organizations, however worthy.

For several reasons, this overview does not discuss or even mention some significant space and missile programs managed by SMC and its predecessors during the last fifty years. For one thing, there are too many to cover in a narrative as brief as this one. Many fascinating but less prominent efforts must be left to more detailed histories. Furthermore, although we have tried to mention the most prominent space programs that have been declassified during the last ten years, many important efforts are still classified in whole or in part and must be left to the historians who will follow us. Finally, the field of military space history is rich in potential subject matter, but relatively new and unplowed. Therefore, the authors' lack of knowledge will inevitably cause some important programs, events, and insights to be left out. To fill those unintentional gaps, we ask the participants to contact us with their valued comments and suggestions for our next edition.

History Office
Space and Missile Systems Center
February 2003

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CHAPTER I: MISSION AND ORGANIZATION

Organizational Evolution

The Space and Missile Systems Center traces its ancestry back to the Western Development Division (WDD) of the Air Research and Development Command (ARDC). WDD was activated on 1 July 1954 and was redesignated the Air Force Ballistic Missile Division (AFBMD) on 1 June 1957. The organization's original mission was to develop strategic missiles for the Air Force, but ARDC added the responsibility for developing the first military satellite system on 10 October 1955. The responsibility for strategic missiles remained with AFBMD and its successors through the decades that followed, but the Department of Defense (DOD) continued to modify and add to its assignment of the responsibility for the space mission. In February 1958, the Eisenhower administration activated the Advanced Research Projects Agency (ARPA) and placed it in charge of all military space programs during their research and development phases. In September 1959, ARPA lost its dominant role, and Secretary of Defense Neil McElroy divided responsibilities for developing military satellites among the three services. The Army was to develop communication satellites; the Navy, navigation satellites; and the Air Force (in effect, AFBMD), reconnaissance and surveillance satellites. Only the Air Force, however, was to develop and launch military space boosters. This arrangement continued until March 1961, when Secretary of Defense Robert McNamara gave the Air Force a near monopoly on development of all military space systems, ending the role of the Army and the Navy except under exceptional circumstances. Some important exceptions to this developmental monopoly occurred during the next 40 years. For example, the development of reconnaissance satellites and related systems soon came under the authority of the National

Members of the Weapon System 117L program gather at the Western Development Division in 1956, soon after the first Air Force satellite program was transferred from Wright Air Development Center.

Reconnaissance Office (NRO), and the Navy developed the first successful space-based navigation system. However, the Air Force continued to exercise a predominant responsibility for military space efforts.[1]

By 1961, therefore, AFBMD had two parallel missions to perform, but it was not necessarily clear that the two missions belonged together. Over the next several decades, in fact, the missile and space functions were separated and rejoined repeatedly, causing numerous reorganizations and redesignations. Because of the increasing importance of space systems, the space and missile functions were separated on 1 April 1961, when AFBMD was inactivated and replaced by the Ballistic Systems Division (BSD) and the Space Systems Division (SSD). On 1 July 1967, the space and missile functions were reconsolidated in the interest of economy, and BSD and SSD were merged to form the Space and Missile Systems Organization (SAMSO). Space and missile functions were separated a second time on 1 October 1979, when SAMSO was divided into the Space Division and the Ballistic Missile Office. These two organizations were redesignated Space Systems Division (SSD) and Ballistic Systems Division (BSD) on 15 March 1989. By the early 1990s, missile programs were being cut back because the cold war had ended, and a final series of redesignations and realignments brought the space and missile functions together for a third time. On 5 May 1990, BSD was redesignated the Ballistic Missile Organization (BMO) and realigned under SSD. On 1 July 1992, SSD was redesignated the Space and Missile Systems Center (SMC), the name it bears today. Finally, in September 1993, BMO was inactivated and absorbed by SMC, recreating the situation that had existed in the 1950s and again in the 1970s, when a single organization was responsible for both space and missile programs.

The Aerospace Corporation

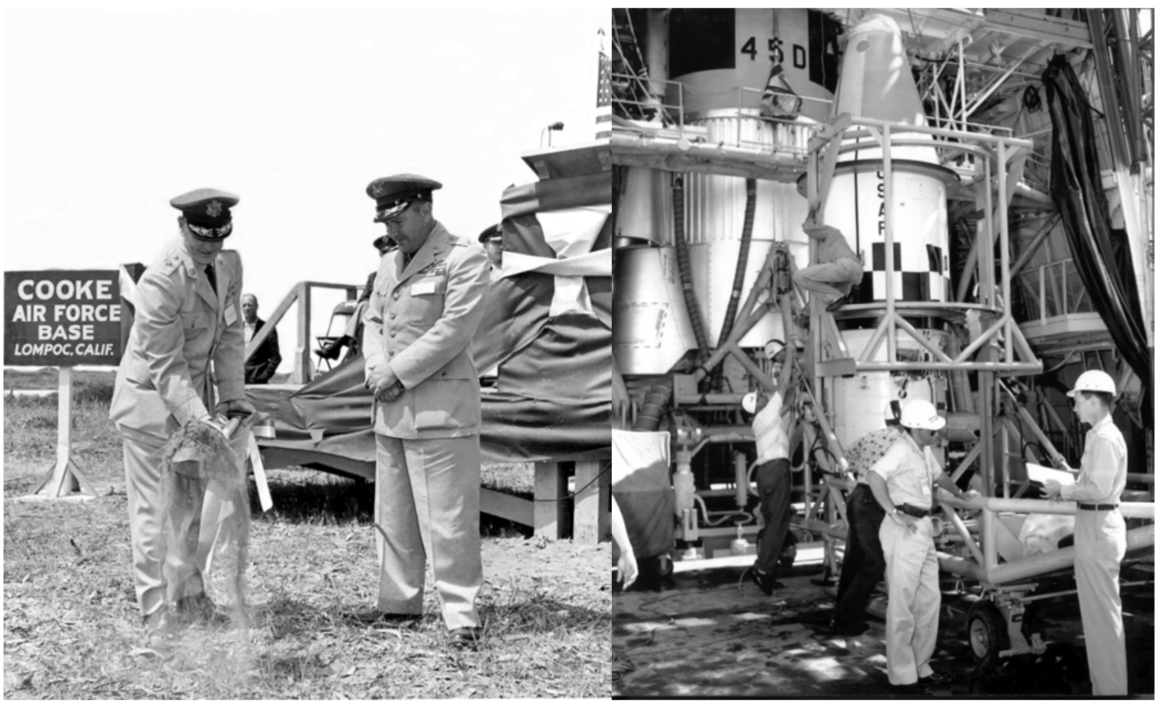
SMC and its predecessors have been supported over the years by private sector organizations that have provided systems engineering for its programs and technical direction to its contractors. The first such organization was the Ramo-Wooldridge Corporation, chosen in 1954 to provide systems engineering and technical direction for WDD's missile programs. In 1958, Ramo-Wooldridge merged with Thompson Products to form Thompson-Ramo-Wooldridge (TRW). However, Congress expressed reservations about the propriety of a profit-making entity serving an agency of the government so closely and exclusively. In 1959, Congress recommended that a nonprofit agency be established as the systems engineering arm of the Air Force for space and missile programs. In June 1960, a nonprofit organization—The Aerospace Corporation—was created at the initiative of the Secretary of the Air Force to perform that function. At that time, plans called for TRW to continue providing systems engineering for existing missile programs and for Aerospace to provide systems engineering for all space programs and for future missile programs. As it turned out, Aerospace did perform some work in the missile field, but it focused primarily on space,

[1] That predominance was recognized by DOD's Commission to Assess U.S. National Security Space Management and Organization in its report published on 11 January 2001. It was translated into policy when Secretary of Defense Donald Rumsfeld, acting on the Commission's recommendations, assigned to the Air Force the "responsibility for planning, programming, and acquisition of space systems" in his assessment of the Commission's report provided to Congress on 8 May 2001.

and TRW remained the primary source of systems engineering for missile programs.

Field Units

Changes in the organizational structure of SMC and its predecessors have been paralleled by changes in field units. Through those field units, its predecessors were involved not only in the development and acquisition of space systems but in space operations as well. Beginning in the 1950s, SMC's predecessors provided or acquired units that controlled military satellites in orbit, conducted satellite launches as well as R&D missile launches, and operated the ranges that supported those launches.[2] The satellite control function was originally performed by the 6594th Test Group, created by AFBMD in 1959, and later by the Air Force Satellite Control Facility, which replaced the Test Group in 1965. During the 1960s, launches were performed by the 6595th Aerospace Test Wing at Vandenberg Air Force Base (AFB) and by the 6555th Aerospace Test Wing at Cape Canaveral Air Force Station (AFS). In 1970, the 6555th became a Group and was realigned under the 6595th, and the 6595th was realigned under a new field unit, the Space and Missile Test Center (SAMTEC). SAMTEC was responsible for overseeing launches at both Vandenberg and the Cape and for operating the Western Test



Left: Brigadier General Osmond Ritland, then vice commander of WDD, breaks ground at Cooke AFB on 8 May 1957 for the construction of space and missile facilities on the west coast. Cooke was soon renamed Vandenberg AFB. Right: Officers of AFBMD's 6555th ATW discuss their final inspection of the Agena spacecraft (in cradle) for the launch of MIDAS 2 on Atlas 45D (in background) on 24 May 1960.

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[2] The ranges themselves—that is, the facilities as opposed to the organizations that conducted launches—were controlled during the 1950s and 1960s by organizations that did not report to AFBMD. The ranges reported directly to Air Force Systems Command and were designated the Air Force Missile Test Center at Cape Canaveral and the Air Force Space Test Center at Vandenberg AFB. From 1964 to 1970, both ranges—known then as the Eastern Test Range and the Western Test Range—were overseen by the

Range that supported launches out of Vandenberg. In 1977, it also acquired responsibility for running the Eastern Test Range that supported launches at the Cape. In 1979, SAMTEC was redesignated the Space and Missile Test Organization (SAMTO) and was restructured with two major field units of its own, the Eastern Space and Missile Center (ESMC) and the Western Space and Missile Center (WSMC). ESMC and WSMC conducted launches and operated the ranges on the east and west coasts respectively.

SMC's responsibility for space operations began to change on 1 September 1982, when Air Force Space Command was activated to serve specifically as an operational command for military space systems. In the years that followed, Space Command gradually took over the operational functions previously performed by SMC's field units, and, in the process, it absorbed most of the units themselves. The Air Force Satellite Control Facility was inactivated on 1 October 1987, and most of its personnel and functions were taken over by wing-level units assigned to Space Command. HQ SAMTO was inactivated on 1 October 1989. A year later, the Eastern and Western Space and Missile Centers were reassigned to Space Command, and the transfer of launch operations to Space Command began.[3]

While SMC's predecessors lost field units involved in operations, they temporarily gained units involved in research. In October 1982, the Air Force Space Technology Center (AFSTC) was activated at Kirtland AFB and assigned to Space Division. At the same time, three pre-existing laboratories were assigned to the AFSTC—the Air Force Weapons Laboratory, the Air Force Geophysics Laboratory, and the Air Force Rocket Propulsion Laboratory (later redesignated the Air Force Astronautics Laboratory). Creation of the AFSTC centralized Air Force space technology efforts and reoriented them to better serve the needs of the program offices at Space Division. In December 1990, the AFSTC was redesignated the Phillips Laboratory, and the three laboratories formerly assigned to it were folded into it to form a single super laboratory. In January 1993, Kirtland AFB, where the Phillips Laboratory was located, was transferred to SMC, and the 377th Air Base Wing, the host wing at Kirtland, was assigned to SMC as well. Nevertheless, SMC's subordinate units and their missions were stripped away again during the late 1990s. Phillips Laboratory became part of the newly created, centralized Air Force Research Laboratory on 8 April 1997. The 377th ABW was reassigned to the Air Armament Center at Eglin AFB, Florida, on 1 October 1998 to centralize air armament issues within the Air Force. Some space and missile programs managed at Kirtland AFB were closely tied SMC's central mission and were not reassigned. In general, they provided test and evaluation, launch of experimental payloads, and on-orbit operations from the Space Shuttle. These programs were placed under a single SMC detachment—Detachment 12—on 29 June 2001.

National Range Division, which reported directly to Air Force Systems Command. In 1970, the Space and Missile Test Center (SAMTEC) was set up under SAMSO to oversee both the launching organizations and the ranges as explained above.

[3] Launch operations were transferred incrementally. The Delta II and Atlas E launch operations were transferred first, followed by the Atlas II, Titan II, and Titan IV launch operations.

The Space Commission of 2000

During the years 2000-2001, changes in SMC's relationship to its higher headquarters underwent profound changes. Supporters of more highly centralized military space functions had been gaining strength within Congress, and they inserted language in the National Defense Authorization Act for FY 2000 calling for a commission to assess the management and organization of space activities that supported national security. When constituted, the Commission to Assess United States National Security Space Management and Organization included prestigious space experts drawn from DOD and Congress, and its report, published on 11 January 2001, carried great weight.[4] The Commission emphasized the importance of the Air Force's management of space programs by recommending that the Secretary of Defense formally designate the Air Force as the executive agent for space within the Department of Defense. Among other managerial changes, the Commission proposed consolidating the Air Force's management of space efforts by realigning SMC from Air Force Materiel Command (AFMC) to Air Force Space Command (AFSPC), thus bringing the developers and operators of military space systems together under one major command. During a ceremony at Fort MacArthur on 1 October 2001, SMC's flag passed from the hands of AFMC's commander to the hands of AFSPC's commander, thus beginning in fact as well as in symbol a significant change in the management of military space programs.

As we have noted, developers and operators had worked together under SMC's organizational predecessors a generation earlier. Now, however, the managers at the top of the organizational pyramid for space would be members of the operational rather than the developmental community. With developers and operators in the same organization, the management and organization of Air Force space efforts had come full circle. However, space efforts were now better integrated with other defense efforts.

Another significant change in the management of Air Force space programs also resulted from the recommendations of the Space Commission. Until 1986, space and other acquisition efforts managed by the Air Force had reported on the status of their programs through the organizational chain of command. In 1986, however, the President's Blue Ribbon Commission on Defense Management, known as the Packard Commission, recommended that managers of individual programs report to Program Executive Officers (PEOs), who would report to Service Acquisition Executives in the service secretariats. The Air Force began to implement this recommendation in 1987, designating acquisition programs with large budgets as Executive Programs and leaving the other programs to the oversight of product division commanders. The new system created few changes in practice because product division commanders were usually designated as PEOs for the Executive Programs managed by their organizations. However, in 1989 the President asked for another review of the defense procurement process. The review was known as the Defense Management Review, and it endorsed the recommendations of the Packard Commission but proposed that product division commanders not be allowed to serve as PEOs. The Air Force implemented this proposal

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[4] Not the least cause of the Commission's influence was the fact that the incoming Bush administration's Secretary of Defense, Donald Rumsfeld, had chaired the Commission during most of its term.

General Lester L. Lyles, commander of Air Force Materiel Command, hands SMC's flag to Lieutenant General Roger G. DeKok, vice commander of Air Force Space Command, during ceremonies observing SMC's transfer to a new major command. Lieutenant General Brian A. Arnold, commander of SMC, stands at right. (Both General Lyles and Lieutenant General DeKok were former commanders of SMC.)

in January 1990, appointing new PEOs for major areas of acquisition, including space. Eventually, all of the PEOs were reassigned to the area of Washington, D.C., to improve communications with acquisition executives in the Pentagon. The PEO for Space was reassigned to Washington effective 1 September 1990.

When the Space Commission issued its report on 11 January 2001, it recommended that the PEO for Space be transferred from the Pentagon back to SMC in order to consolidate SMC's space research, development, and acquisition responsibilities under Air Force Space Command. The Air Force PEO for Space was physically reassigned to SMC in June 2001 during the transition to the Commission's recommendations. On 19 February 2002, Secretary of the Air Force James G. Roche officially assigned the responsibilities of the PEO for Space to SMC's commander, directing that all acquisition programs at SMC were to be considered PEO programs. In matters of execution and support for space acquisition programs, the commander of SMC would report directly to the Under Secretary of the Air Force or, in his absence, to the Secretary of the Air Force.

CHAPTER II: FACILITIES

Headquarters

When WDD was established on 1 July 1954, it set up temporary headquarters in a former parochial school and parish church at 401-409 East Manchester Boulevard in Inglewood, California. The old schoolhouse was only a stopgap solution, however, and early in 1955, WDD moved into buildings on Arbor Vitae Street in southwest Los Angeles, near Los Angeles International Airport. These offices housed not only Air Force and civil service personnel, but also personnel working for the Ramo-Wooldridge Corporation, which supported WDD's missile programs.

These buildings, formerly St. John's Catholic Church and school, housed WDD in the first six months after its creation. The Ramo-Wooldridge Corporation leased the buildings, which were no longer occupied, to use as office space. The largest building, at left, was the church, the building in the center was the rectory, and the building at right was the school administration building. WDD removed several prefabricated classroom buildings to provide parking space.

In 1955, Ramo-Wooldridge purchased 40 acres on the southeast corner of Aviation and El Segundo Boulevards in El Segundo. The site was three miles from the Arbor Vitae complex but was the closest site available. Beginning in the middle of 1956, a complex of seven buildings was constructed on the site to provide offices and laboratories for Ramo-Wooldridge's operations. That complex, known as the Research and Development (R&D) Center, was completed in the fall of 1958, and employees of the Corporation's Space Technology Laboratories moved into it.[5]

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[5] The Ramo-Wooldridge Corporation's Guided Missile Research Division was renamed Space Technology Laboratories in 1957, just before it moved into the R&D Center. As noted in the previous section, Ramo-Wooldridge became Thompson-Ramo-Wooldridge (TRW) in 1958.

The Arbor Vitae Complex and the R&D Center provided much more room than the old schoolhouse, but they did not provide enough. By the late 1950s, the missile program had expanded, and WDD (now AFBMD) had become involved in space programs as well. The manpower associated with these growing programs left the Arbor Vitae complex and the R&D Center extremely congested, and AFBMD had to find additional facilities for its staff and their activities. Trailers were rented and parked at the Arbor Vitae complex and the R&D Center, and additional buildings were rented in southwest Los Angeles, Inglewood, Hawthorne, Lawndale, and Torrance.

In April 1961, AFBMD was divided into Ballistic Systems Division (BSD) and Space Systems Division (SSD). BSD moved to Norton AFB in San Bernardino, California, between July and September 1962. Employees of TRW who performed systems engineering for missile programs went there as well. Meanwhile, in December 1960, the Air Force purchased the R&D Center from TRW to serve as a home for The Aerospace Corporation, which had been created in June 1960 and was now supporting Air Force space programs. As a result of these changes, SSD now occupied the Arbor Vitae complex, and Aerospace occupied the R&D Center. The departure of BSD and TRW relieved pressure on the facilities, and there was now enough office space for SSD and Aerospace.

Douglas Aircraft's El Segundo Division displays its products during an open house on 14 November 1954. Area B of Los Angeles AFB now occupies the area pictured here. The aircraft paint booth in the background was modified to create Building 219, the People Center. The airplanes shown are (left to right) AD-5 Skyraider, AD-6 Skyraider, A4D Skyhawk, A3D Skywarrior, F4D Skyray, F3D Skyknight, and A2D Skyshark. (Photograph courtesy of The Boeing Company)

While the office space problem had been solved, another problem remained: the fact that the Arbor Vitae complex and the R&D Center were three miles apart. It was obviously more efficient to consolidate SSD and Aerospace in one place, and during 1961-1962, a plan was devised to bring that about. The plan involved the acquisition of two pieces of real estate adjoining the R&D Center. One, a 50-acre parcel at the northwest corner of Aviation and El Segundo Boulevards, was part of the Douglas Aircraft Corporation's El Segundo aircraft plant. The fifty acres in question were owned by the Navy, though they had been used by Douglas during and after World War II as part of its aircraft manufacturing facilities. This 50-acre site was transferred to the Air Force's ownership in October 1962.

The other site involved in the consolidation plan was a 31-acre parcel owned by the Utah Construction and Mining Company at the southwest corner of the same intersection. The Aerospace Corporation acquired that site in November 1962 and built its new headquarters there between February 1963 and April 1964. As Aerospace personnel moved into their new headquarters, Air Force people moved into the R&D Center and the Navy's portion of the former Douglas Aircraft facility. By 30 April 1964, this process was complete, and the Air Force property at the intersection of Aviation and El Segundo Boulevards was designated Los Angeles Air Force Station (AFS). The R&D Center became Area A of Los Angeles AFS, and the former portion of the Douglas Aircraft plant became Area B.

Building 105 in Area A of Los Angeles AFB, as it appeared during the 1960s and early 1970s. Command Section offices have always been on the sixth floor of Building 105. The Thor Agena launch vehicle in front of the building, a local landmark for many years, was toppled by a gust of wind on 25 March 1975.

SSD's successors have remained at Los Angeles AFS, which was redesignated Los Angeles Air Force Base (AFB) on 15 September 1987. For several decades, Air Force elements responsible for development and production of ICBMs remained in San Bernardino. This geographical separation continued even during the SAMSO era, when the missile and space functions belonged to the same organization. However, the situation finally changed because of the drawdown of missile programs following the end of the cold war. The old BSD/BMO headquarters in San Bernardino closed in September 1995, and the few remaining personnel moved to Los Angeles AFB.

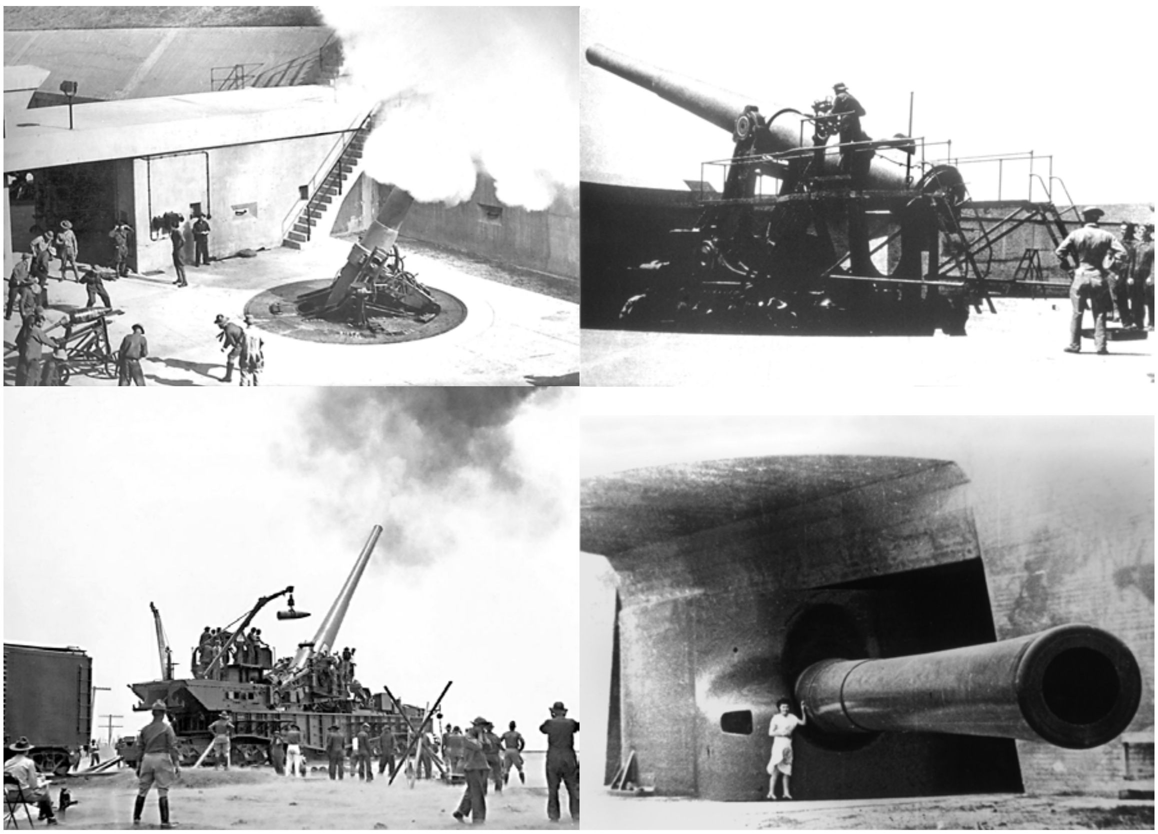
In the years since it was established, Los Angeles AFB has expanded by the acquisition of two geographically separated annexes. One, referred to as the Lawndale Facility or Annex 3, is 13 acres in size and is located on Aviation Boulevard in the city of Hawthorne, about a mile south of the main base. The Lawndale Facility has one building, a former Army missile plant. The facility was acquired by the Air Force in 1982, and renovation of the building was completed in December 1986. It was then used as office space by personnel working in ballistic missile defense programs managed by Space Division, and later by the Space-Based Laser Program managed by SMC, the Defense Systems Management College, and the Defense Technical Information Center.

Fort MacArthur

The other annex is Fort MacArthur, another former Army installation acquired by the Air Force in 1982. It is 96 acres in size and is located in the community of San Pedro, about 13 miles south of the main base. The Fort now serves as a housing area for military personnel who work at Los Angeles AFB, but it had a long and proud history as an Army installation before it was acquired by the Air Force. We will briefly discuss that early history and then focus on the acquisition of the Fort by the Air Force and the construction of housing for Air Force personnel.

The area occupied by Fort MacArthur has been a government reservation since at least the mid 19th century. When ships of that era discharged cargo on the shore of San Pedro Bay, a tract of land was used primarily for traffic at the boat landing. This tract was defined and protected in 1846 by the last Mexican governor of California, Pio Pico, who confirmed the private ownership of Rancho de los Palos Verdes but required the owners to leave free "500 varas square" (44.25 acres) at the port of San Pedro. After the United States government acquired California from Mexico, it continued to recognize the 500 varas square as a government reservation, and in 1888, President Grover Cleveland declared the area a military reservation. In 1914, the reservation became Fort MacArthur, named in honor of Lieutenant General Arthur MacArthur, a military leader in the Spanish-American war, a governor of the Philippines, and the father of future General of the Army Douglas MacArthur. At that time, the Fort comprised three parcels of land: the original 500 varas square, later known as the Middle Reservation; an area on Point Fermin, later known as the Upper Reservation; and a small plot on Terminal Point. The Middle Reservation would later be expanded to take in much of the area along the bluffs to the south, and the Fort would also acquire other property, including a parcel fronting on Cabrillo Beach, known as the Lower Reservation, and parcels at White Point and Point Vicente.

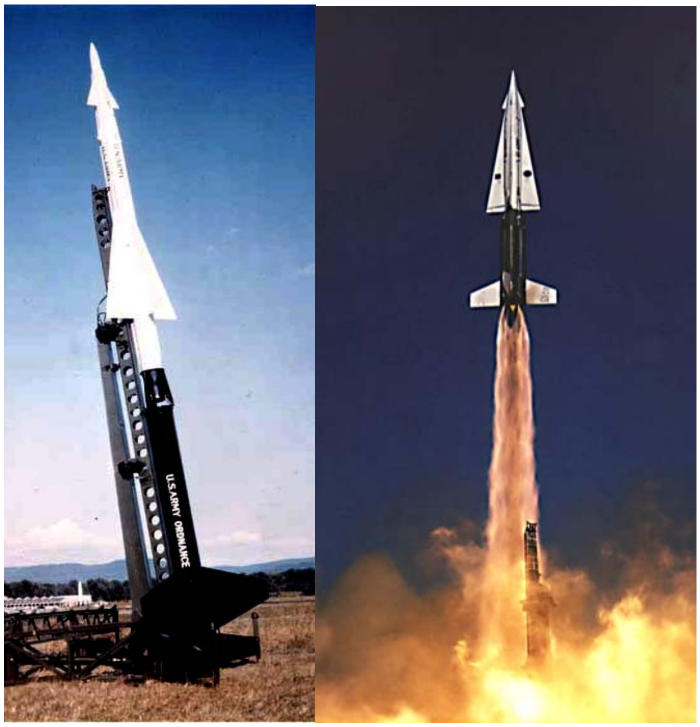
Fort MacArthur was established to provide a home for coastal artillery batteries that the government had decided to build at San Pedro. In 1917, the Army completed construction of four batteries of 14-inch disappearing carriage rifles and two batteries of 12-inch mortars on Point Fermin. By 1919, it had constructed housing and headquarters buildings on the Middle Reservation in the Mission Revival and California Craftsman architectural styles. In 1917, the fort was garrisoned by the 1st Coast Artillery Company, Fort MacArthur, and, by 1918, by the 2nd and 3rd Companies of the Coast Defenses of Los Angeles. During World War I, the fort guarded the harbor and served as a training and staging area for Army units departing for the European theater. Over 4,000 soldiers at one time were stationed at the fort before the end of the war.



Major types of armament emplaced at Fort MacArthur: 12- inch mortar (upper left); 14- inch disappearing carriage rifle (upper right); 14- inch railway gun (lower left); and 16- inch rifle (lower right). (Photographs courtesy of Fort MacArthur Museum)

During World War II, the fort maintained its defenses, trained artillerymen for service overseas, and processed soldiers entering and leaving military service. None of the large guns was fired at enemy targets, but a small gun shelled a suspected enemy submarine in the first month of the war. The armament was modernized again in 1943 when two 16-inch rifles were emplaced at White Point near the Upper Reservation. All of the major armament was inactivated and most of it sold for scrap between 1943 and 1948.

Fort MacArthur's mission changed radically after the war. In 1948, it became a major training center for Army reservists. Reserve units from all of southern California reported to the fort for supervision and training. In 1954, the fort became an antiaircraft missile site when a Nike Ajax missile battery (Nike Site LA-43) was emplaced on the Upper Reservation. Fifteen other Nike sites were built in remote locations around southern California, all controlled by the 47th Artillery Brigade headquartered at Fort MacArthur until 1969, and later by the 19th Air Defense Artillery Group. During 1958-1963, the Nike Ajax missiles were replaced by the more powerful Nike Hercules missiles, capable of carrying nuclear warheads.



Left: A Nike Ajax missile, probably at Redstone Arsenal, Alabama, in the 1960s. It was 32 feet long and flew at Mach 2.3 to a range of 30.7 miles and an altitude of 60,000 feet. It carried three conventional warheads detonated by ground command. Fort MacArthur had about 20 Nike Ajax missiles from 1956 to 1963. Right: A Nike Hercules missile at White Sands, New Mexico, probably in the 1960s. The missile was 40 feet long. It flew at Mach 3.65 to a range of 96.3 miles and an altitude of 100,000 feet. It carried one conventional or nuclear warhead detonated by ground command. Fort MacArthur had 12 Nike Hercules missiles from 1963 to 1974. (Photographs courtesy of Redstone Arsenal Historical Information)

By 1974, the NIKE sites had become obsolete and were shut down, causing the Army to reduce its presence at Fort MacArthur. The Army retained the Middle Reservation as an administrative center for support of active and reserve Army and National Guard units in southern California. However, it disposed of all other land attached to the fort, which included the Lower Reservation, the Hospital Area, the Upper Reservation, White Point, and Point Vicente. In 1975, Fort MacArthur became a sub-post of Fort Ord and was manned by an Army support detachment.

In 1978, the Army announced that it would transfer its support units from Fort MacArthur to the Los Alamitos Armed Forces Reserve Center and would declare the remaining land excess. At that point, SAMSO was looking for a site to build housing for its military personnel, many of whom could not afford to buy or even rent housing in the very expensive Los Angeles market. SAMSO saw Fort MacArthur as the solution to its problem, and it asked the Air Staff to place a hold on the land. In September 1979, the Department of Defense approved the transfer of Fort MacArthur from Army to Air Force jurisdiction. After some initial delays, Congress appropriated funds for construction of military housing at the Fort, and 370 townhouses were built there between November 1981 and December 1985. In addition, 33 existing homes at the Fort were renovated. Fort MacArthur was officially transferred from Army to Air Force control on 1 October 1982, and Air Force families began moving into the first of the newly built townhouses at that point.

Additional Housing

While the construction of townhouses at Fort MacArthur alleviated the housing problem for Air Force personnel in Los Angeles, it did not completely solve it, and even before construction was finished, Space Division began looking for a place where it could build another 170 units. It targeted 50 acres at White Point, which the Army had declared excess in 1975 and turned over to the City of Los Angeles. The city was unwilling to transfer this land to the Air Force, but a compromise was eventually reached whereby the Air Force received title to 11.34 acres at White Point and 22.09 acres of nearby Bogdanovich Park. An agreement to this effect was signed in April 1987, and between August 1987 and August 1989, 170 units of military family housing were built at the White Point site, which was renamed Pacific Heights, and at Bogdanovich Park, which was renamed Pacific Crest.

SMC gave up its original plans to build 150 additional units of housing on Fort MacArthur's Upper Reservation because of environmental concerns. Instead, it decided to build a final increment of housing consisting of 71 units on another 24.4 acres of White Point. The site, then occupied by Navy housing, was available because of the closure of the United States Naval Station in Long Beach. This project was delayed during 1997 by concerns about the historical preservation of sites associated with the large guns which had guarded the Harbor of Los Angeles during World War II and earlier. The Air Force satisfied those concerns by undertaking preservation efforts, and construction proceeded. The construction contractor finally completed the 71 units on 7 November 2000. The new housing site was named Pacific Heights II. Its completion gave Los Angeles AFB a total of 644 units of military family housing at Fort MacArthur, Pacific Heights, Pacific Crest, and Pacific Heights II, making the base a much more attractive assignment for military families.

CHAPTER III: BALLISTIC MISSILES

The Air Force ballistic missile program had its origins in studies and projects initiated by the Army Air Corps immediately after World War II. These efforts aimed at mating the German V-2 ballistic missile and the atomic bomb, a union that carried the potential for a revolution in strategic warfare. Technical problems held the program back at first, but the situation was changed drastically by the so-called "thermonuclear breakthrough" of the early 1950's. This breakthrough made it possible to manufacture high-yield nuclear weapons that were small enough and light enough to be carried as warheads aboard ballistic missiles.

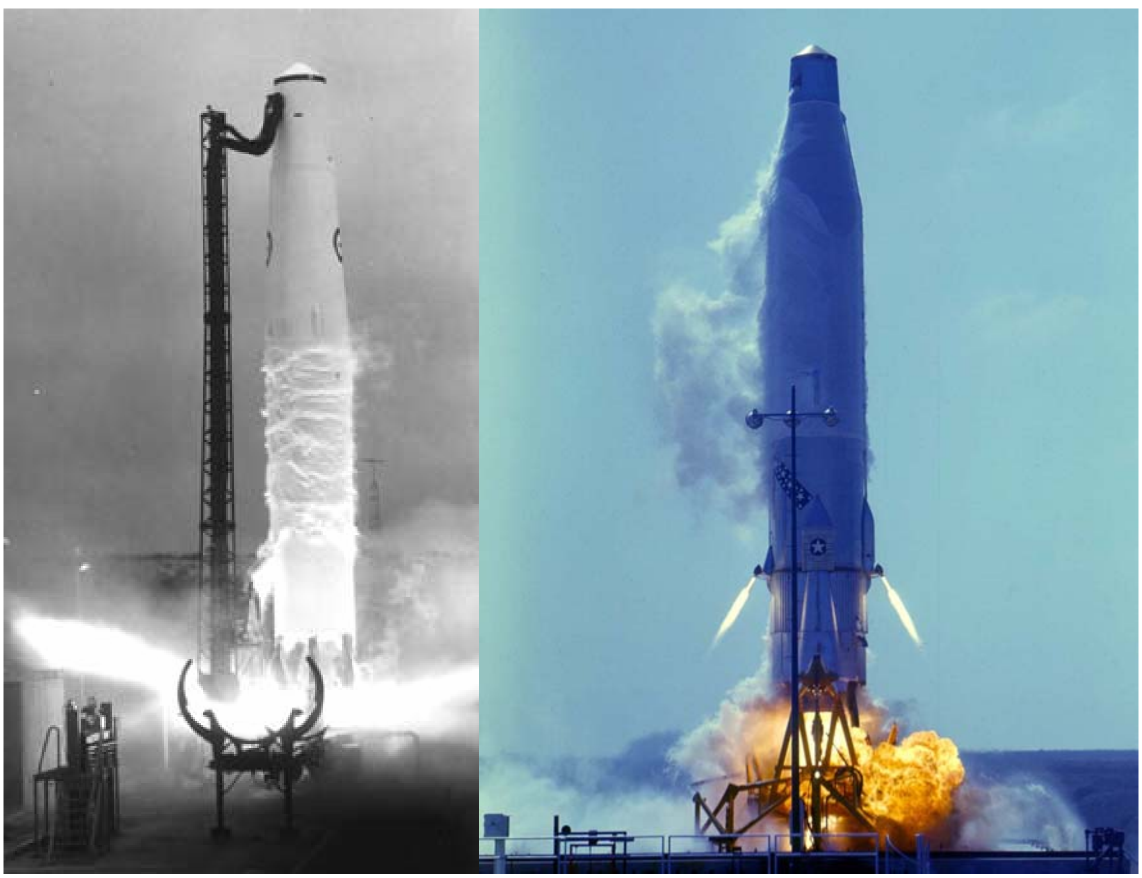
Atlas, Thor, and Titan I

Faced with growing evidence of the Soviet Union's development of thermonuclear weapons and ballistic missile technology in 1953, the Air Force Secretariat's architect for research and development, Trevor Gardner, chartered the Strategic Missiles Evaluation ("Teapot") Committee, chaired by Professor John von Neumann, to diagnose the slow pace of America's strategic missile programs. The Committee recommended in 1954 that Project Atlas, the only American ICBM then under development, be reoriented and accelerated. The Air Force established the Western Development Division to carry out that task, sending Brigadier General Bernard A. Schriever to Los Angeles to set up and command the new organization in August 1954.

The three people most directly responsible for the success of the early Air Force Strategic missile programs: Trevor Gardner (Assistant Secretary of the Air Force for Research and Development), then-Maj Gen Bernard A. Schriever (commander of the Western Development Division), and Dr. Simon Ramo (CEO of the Ramo-Wooldridge Corporation).

At first, the Division was responsible for developing only the Atlas, which was being designed and built by the Consolidated Vultee Aircraft Corporation (Convair). It was an intercontinental ballistic missile with liquid-fuel engines and a stage-and-a-half configuration. Within a year, the Division also became responsible for developing an alternate missile called the Titan. A more advanced, two-stage missile to be built by the Martin Company, the Titan was a hedge against failure or delay in the Atlas program. By the end of 1955, the Division was also developing an intermediate range ballistic missile, the Thor, under contract to Douglas Aircraft Company. Finally, it was charged with achieving initial operational capability for the three missile systems. That meant deploying them, a massive undertaking in itself. In barely 18 months, the mission of the Division had undergone an enormous expansion.

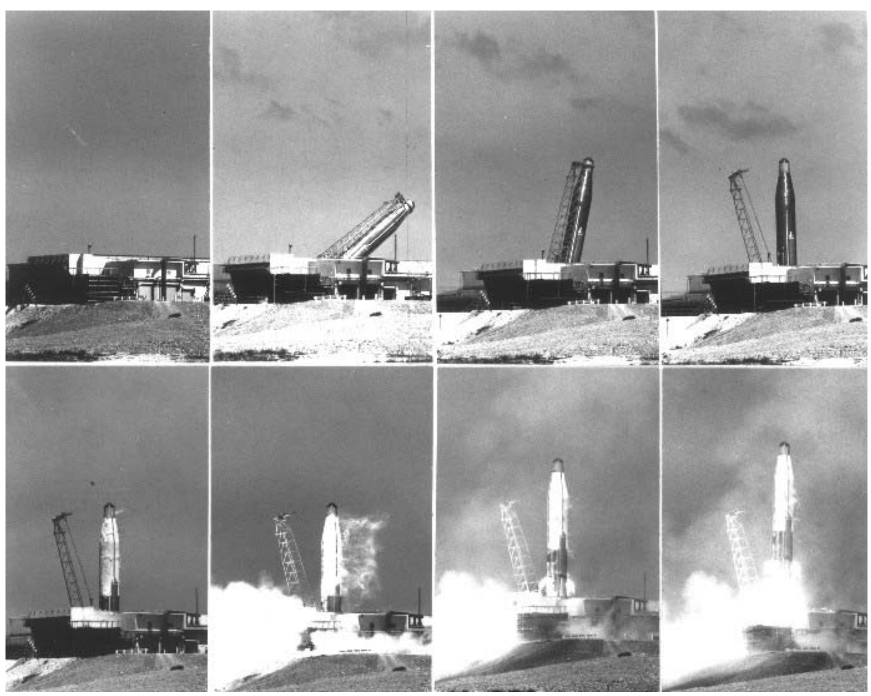
To develop operational missile systems as soon as possible, the Division replaced the conventional pattern of sequential development with concurrent development. Within the framework of a single overall plan, tasks related to development, production, testing, and initial operational capability proceeded simultaneously. Although the concept of concurrency was not new, the Division applied it on a scale never before used in military development programs.



Left: "Lion's Roar," the first launch of a Thor IRBM by an RAF crew, takes place at Vandenberg AFB on 16 April 1959; Right: the first SAC launch of an Atlas missile (Atlas 12D) takes place at Vandenberg AFB on 9 September 1959. SAC then declared the Atlas weapon system operational.

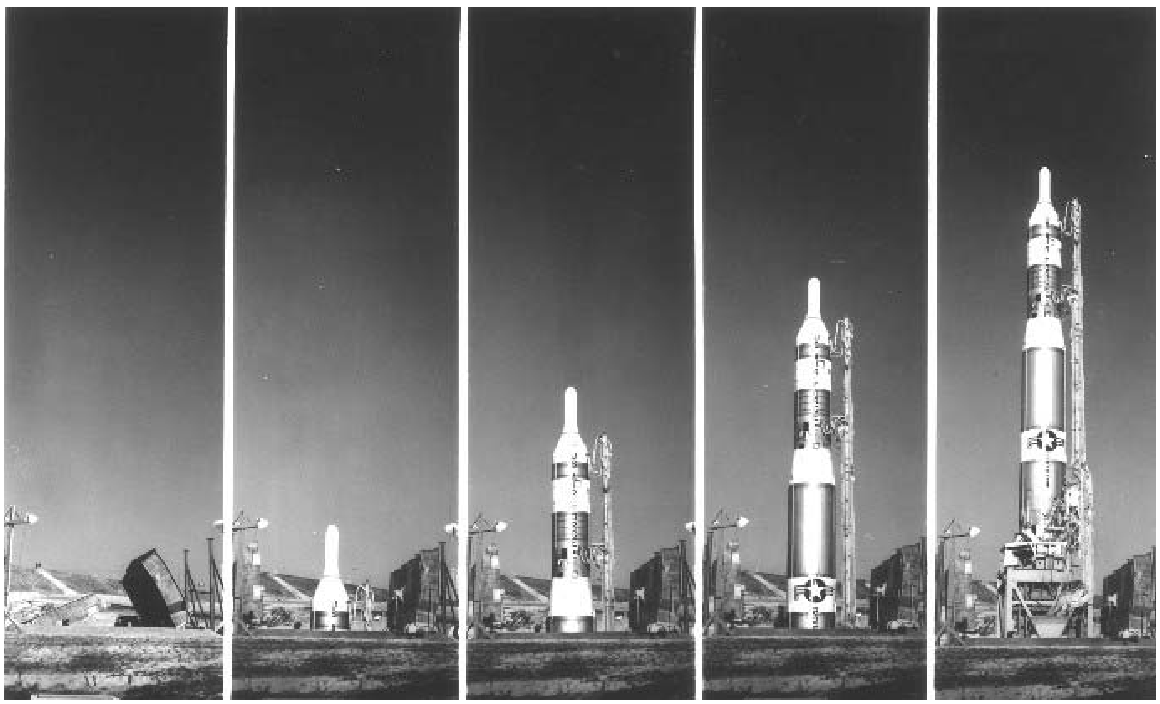
Titan I missile J-7 begins the first successful flight test of an operational Titan I ICBM on 10 August 1960 at the Atlantic Missile Range.

The development of ballistic missile systems slowed in 1956-1957, when the Eisenhower administration made large cuts in defense spending to balance the budget. However, on 4 October 1957, the Soviet Union used an ICBM to launch the first man-made satellite. Sputnik's impact was dramatic. The United States' missile program was given renewed impetus, restrictions were lifted, previous program priorities were reinstated, and funding was vastly increased.



Atlas missile 25-D rises to a vertical position and begins a test flight on 22 April 1960. Atlas Ds—the first Atlas missiles to become operational—were stored in unprotected, above-ground, horizontal launchers. Later models of the Atlas were better protected. Atlas Es were stored in semi-hardened horizontal launchers, and Atlas Fs were stored in hardened vertical silos.

On 20 September 1957, even before Sputnik, the Air Force Ballistic Missile Division successfully launched a Thor missile from Cape Canaveral, Florida. On 17 December, the Division carried out the first successful Atlas launch, also from Cape Canaveral. Following these successes, the Air Force missile program progressed rapidly. Deployment of the Thor was completed in 1960 at four 15-missile Royal Air Force squadrons in England. By the end of 1962, 132 Atlas launchers had been turned over to squadrons of the Strategic Air Command (SAC) by Ballistic Systems Division's Site Activation Task Forces (SATAFs). The Titan I made its first successful operational flight in 1960, and the SATAFs turned over all 54 Titan I launchers to SAC during 1962. By the end of 1962, therefore, all three first-generation missiles were in place and ready for operation.



A Titan I missile emerges from its silo at Vandenberg's Operational System Test Facility in 1960. The Titan I was stored and fueled in a hardened underground silo, but an elevator had to lift it out of the silo before it could be launched. The entire launch sequence took about 15 minutes. Ultimately, the Titan I was deployed in 54 such silo-lift launchers divided among seven operational sites. All became operational in 1962, and all were inactivated in 1965.

Titan II and Minuteman

In the late 1950's, the Ballistic Missile Division began developing two second-generation missiles, the Titan II and the Minuteman. Like the original Titan I, Titan II was a two-stage, liquid fuel missile. Unlike its predecessor, however, it used storable propellants and an all-inertial guidance system, and it could be launched from hardened underground silos. These improvements gave the Titan II quicker reaction time, greater survivability, and improved performance. The first Titan II unit achieved operational status in June 1963 and the last in December of the same year.

The Minuteman was the first American intercontinental ballistic missile to use solid rather than liquid fuel. It possessed all the virtues of the Titan II, and its use of solid fuel gave it two additional advantages: greater simplicity and economy. The first Minuteman flight test missile was launched on 1 February 1961, and the first two flights of Minuteman missiles was turned over to the Strategic Air Command on 11 December 1962. By the end of 1965, Minuteman missiles had been deployed at four bases in the north central United States, and the older, less efficient, and less economical Atlas and Titan I missiles had been retired from the active inventory. The Minuteman, along with the Titan II, became the mainstay of the nation's strategic missile force. Together with SAC's manned bombers and the Navy's Polaris/Poseidon missile-launching submarines, these missiles formed the triad of strategic deterrent forces that were maintained on day-to-day alert to counter any nuclear attack on the United States or its allies.

A Titan II ICBM undergoes a test launch from an underground silo. Unlike Titan I missiles, which had to be raised to the surface before launch, the Titan II's liquid rocket engines were ignited while it was still in the silo. Therefore the silo had to be constructed with flame and exhaust ducts as shown in this photograph.

Just as the Atlas and the Titan I had been replaced by the Titan II and the Minuteman, the original Minuteman was itself replaced by the more advanced Minuteman II and Minuteman III. The Minuteman II incorporated a new, larger second stage, improved guidance, greater range and payload capacity, and greater resistance to the effects of nuclear blasts. The Minuteman III, for its part, possessed an improved third stage, employed more penetration aids to counter anti-ballistic missile defense systems, and was equipped with up to three independently targetable warheads. By the end of 1975, 450 Minuteman IIs and 550 Minuteman IIIs were in place and ready for operation at six bases in the north central United States.

Other portions of the ballistic missile force were becoming obsolete. The Air Force issued direction to deactivate Titan II missiles on 30 April 1982. The 55 operational missiles were removed from their silos during 1982-1987 and placed into storage for possible conversion to space launch vehicles.

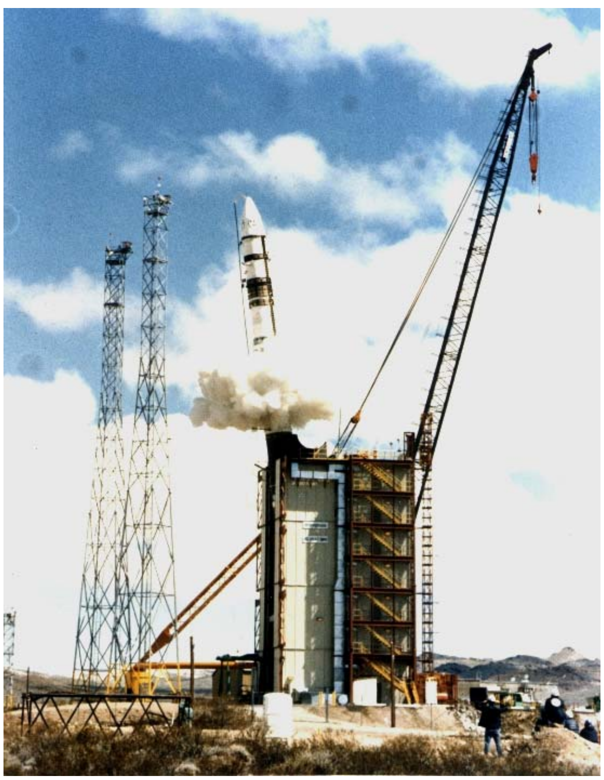
Peacekeeper and Small ICBM

Under the terms of the 1972 Strategic Arms Limitation Agreement with the Soviet Union, this country was barred from increasing the number of strategic missiles in its operational inventory. If it wished to maintain its strategic position *vis a vis* the Soviet Union, therefore, it had to do so by improving the quality of its missiles rather than by increasing the quantity. With this objective in view, an advanced development program was started in late 1973 to define the technology and design concepts for a new strategic missile called Missile X. A great deal of effort was devoted to studying alternate basing concepts for this missile, including air-mobile and ground mobile concepts.

A Peacekeeper missile is launched from its silo. Unlike the Minuteman, which was launched by igniting the stage 1 motor while the missile was still in the silo, the Peacekeeper was ejected from its silo by hot gas, and its stage 1 motor was ignited when it was about 100 feet above the ground. (Photograph courtesy Air Force Space Command Public Affairs Office)

Missile X was renamed the Peacekeeper by President Reagan on 22 November 1982. It was a four-stage ICBM capable of precisely delivering 10 reentry vehicles to different targets more than 6,000 miles away. It successfully carried out its first flight test on 17 June 1983, when a Peacekeeper that had been cold-launched from a canister at Vandenberg AFB reached its target in the Kwajalein Missile Range. In April 1983, the President accepted the recommendation of the Scowcroft Commission that the Peacekeeper be temporarily based in existing Minuteman silos. The first ten missiles went on alert between 17 October and 22 December 1986, and the basing program achieved full operational capability when the fiftieth missile entered its silo on 20 December 1988. DOD accepted a concept for a permanent basing mode in 1986. It involved placing 50 Peacekeeper missiles on 25 trains, which would be kept in protected shelters scattered throughout the country. When war threatened, the trains would be released to travel over the commercial rail network until their missiles had to be launched. The program entered full-scale development in May 1988. By the early 1990s, however, the Cold War was winding down, and the Soviet threat was diminishing. In a dramatic speech delivered in 27 September 1991, President Bush announced a wide-ranging plan to unilaterally reduce the American nuclear arsenal and eliminate several categories of weapons. As part of the plan, he announced the cancellation of the Peacekeeper Rail Garrison program.

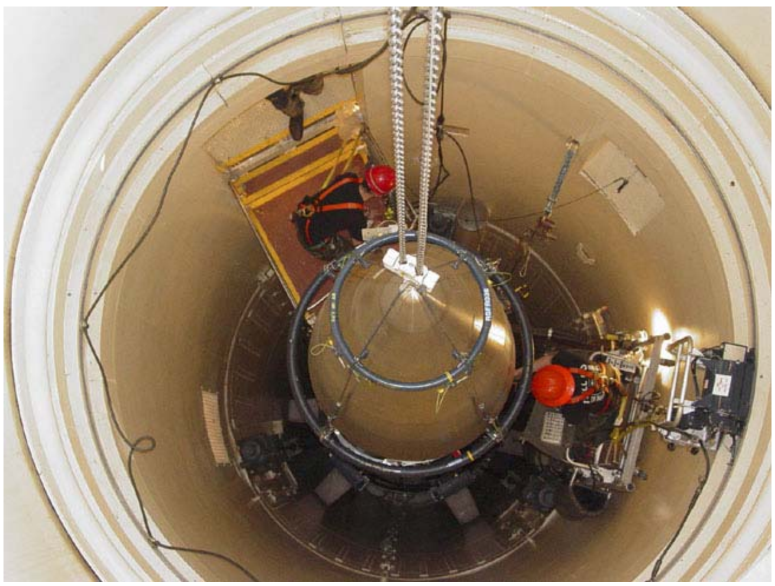
The Scowcroft Commission had also recommended the development of a new, lightweight missile carrying only one reentry vehicle. President Reagan authorized full-scale development of the Small ICBM (SICBM) in December 1986. SICBMs would be housed in mobile launchers based at widespread locations. When hostilities threatened, the launchers would drive out onto the roadways and scatter across the country. The program narrowly escaped termination in 1988 because of reduced funding. It achieved its first totally successful flight test on 18 April 1991, when a SICBM that had been cold-launched from a canister at Vandenberg AFB reached its target in the Kwajalein Test Range. Nevertheless, President Bush canceled the SICBM program in January 1992 because strategic tensions seemed to have decreased after the end of the Cold War.



A simulated Small ICBM being ejected from its launch canister in the Canister Assembly Launch Test Program (CALTP). Like the Peacekeeper, the Small ICBM was to be "cold launched." The missile was to be ejected from a canister, and its stage 1 motor was to be ignited after the missile was in mid-air. The CALTP program tested the launch eject system and the effects of a cold launch on stage 1 of the missile.

Effect of ICBM Reduction Agreements

The Strategic Arms Reduction Treaty of 1991 (START I) and the START II treaty of 1993 progressively reduced the number of warheads that the United States and Russia could maintain and eliminated missiles with multiple warheads. These provisions required the United States to reduce the number of Minuteman missiles, permanently reconfigure the remaining missiles to launch only one warhead each, and scrap its Peacekeeper missiles. In response, the last Minuteman II missiles were dismantled and stored for use as launch vehicles in 1996, and 150 Minuteman III missile sites were destroyed during 1999-2001. By 2002, the entire Minuteman force consisted of only 500 Minuteman III missiles at three deployment sites. Though START II was never ratified by the United States, subsequent diplomatic agreements limited the number of warheads in each national arsenal even further, and the Moscow Treaty of May 2002 set limits well below START II. After the Moscow Treaty, it appeared that the last Peacekeeper missiles would have to be scrapped in 2012, leaving only the aging Minuteman III missiles on strategic alert. To maintain them, SMC's ICBM Program Office at Ogden Air Logistics Center conducted major Minuteman life extension programs which replaced guidance systems, solid rocket motors, and power systems on the missiles as well as improving communications, command, and control equipment in the launch facilities. Nevertheless, by 2003 the status of ICBM programs was again in doubt. In June 2002, the United States unilaterally withdrew from the Anti-Ballistic Missile Treaty of 1972 in order to develop a National Missile Defense System. In response, Russia announced that it would no longer be bound by the START II agreements.

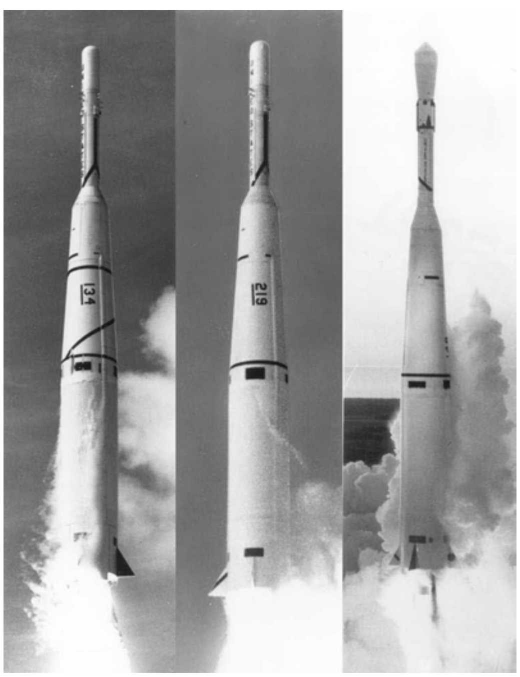


An Air Force Space Command crew removes the nose section of a Minuteman III missile in a silo at Malmstrom AFB, Montana, early in 2003. Portions of the missile were to undergo flight testing in a launch from Vandenberg AFB as part of Air Force Space Command's continuing evaluation program for the remaining inventory of ICBMs. (Photograph courtesy Air Force Space Command News Service)

CHAPTER IV: LAUNCH VEHICLES

Thor and Atlas Derivatives

The earliest launch vehicles used by the Air Force were Thor and Atlas missiles modified by the Air Force Ballistic Missile Division and Space Systems Division to serve as space boosters. Indeed, the Air Force achieved its first partial success in space with a lunar probe that was launched by a Thor missile with a Vanguard second stage, a configuration called the Thor Able, on 11 October 1958.[6] Its first satellite was Project SCORE, an Atlas B developmental missile containing a communications repeater in one of its side equipment pods. AFBMD launched the entire missile (minus the spent half stage) into orbit on 18 December 1958. Thor and Atlas missiles with only minor modifications continued to be used as space boosters for a long time, especially for military and civilian weather satellites. The last Thor launch occurred on 15 July 1980, and the last launch of a modified Atlas missile occurred on 24 March 1995, with both boosters carrying military weather satellites. As time went by, Thor and Atlas vehicles were improved and standardized, and families of Standard Launch Vehicles were created. The Thor gave rise to the series known as Standard Launch Vehicle 2, and the Atlas gave birth to the several varieties of Standard Launch Vehicle 3. Upper stages such as the Agena, the Burner II, and the Stage Vehicle System were developed for use with these vehicles. Together with their associated upper stages, Thor and Atlas launch vehicles constituted the backbone of the American space program.



At left are three early launches of Thor Able vehicles. Left to right: Explorer 6, launched 7 August 1959; Pioneer 5, launched 11 March 1960; Tiros 1,launched 1 April 1960. At right is Atlas 10B, the launch vehicle and satellite vehicle for Project SCORE, awaiting launch on 18 December 1958.

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[6] AFBMD launched three lunar probes in 1958 using Thor Able vehicles, only one of which was considered a partial success. See the section entitled Pioneer Lunar Probes in Chapter VII of this history.

Top: Agena A spacecraft 1056 for Discoverer XIV is being integrated with Thor 237 before launch on 18 August 1960. Bottom left: The first Thor Agena launch vehicle sits on the pad at Vandenberg AFB before launching Discoverer I on 28 February 1959. Bottom right: The first Atlas Agena combination rises from the pad at Cape Canaveral in an unsuccessful attempt to launch MIDAS I on 26 February 1960.

The launch vehicles developed by the Air Force Ballistic Missile Division and its successors were used not only by the Air Force, but also by the National Aeronautics and Space Administration (NASA), created in 1958. Civilian programs began using boosters based on the Thor missile immediately, and in 1959, NASA began developing the Delta upper stage for it from the second stage of the Thor Able—the first step in developing the highly successful Delta launch vehicle. NASA started using the Atlas vehicle in 1959, and its first manned space program, Project Mercury, relied on the Atlas for its orbital flights. Project Gemini, the agency's next manned program, employed Titan II boosters developed and procured by Space Systems Division. The Gemini Target Vehicle, an

Agena upper stage, was also developed by Space Systems Division (SSD). The Agena was later modified by NASA and employed extensively by both agencies. The Centaur upper stage, the most powerful upper stage in the national inventory, was born as an Air Force program before being transferred to NASA in 1960. It is noteworthy that much of this cooperation in developing and using launch vehicles was the result of a carefully considered series of written agreements, initiated in 1959 and expanded during the early 1960s, which made up a National Launch Vehicle Program.

Left: The first Atlas Centaur combination rises briefly from the launch complex at Cape Canaveral on 8 May 1962. The Centaur exploded 55 seconds later. Below: The first Centaur upper stage is unloaded after air transport to Cape Canaveral on 25 October 1961.

Left: A Titan II launch vehicle developed by Space Systems Division from the Titan II missile launches a manned Gemini capsule from Cape Canaveral. The Gemini missions took place during 1965-1966. Because they launched astronauts, these Titan IIs had to be "man-rated," meaning that they had to be made as safe as possible by adding redundant systems wherever that could be accomplished, by thoroughly inspecting for errors, and by giving the manufacturers incentives to build launch vehicles that were free of defects. After they were in orbit, the manned Gemini capsules accomplished rendezvous and docking with unmanned Agena Target Vehicles, also developed by Space Systems Division, perfecting techniques that would be used later in the Apollo program.

Titan III

Thor and Atlas boosters were complemented by the Titan III, a powerful booster capable of launching large, heavy payloads. Development of the Titan III was initiated in late 1961, and the first research and development vehicle was flown on 1 September 1964. This vehicle, a Titan IIIA, consisted of a modified Titan II core topped by an upper stage called the Transtage. A new configuration, the Titan IIIC, was successfully launched from Cape Canaveral on 18 June 1965. The IIIC used two strap-on solid rocket motors that generated around one million pounds of thrust each. From 1965 through 1989, Titan III vehicles performed well in a wide variety of missions and configurations. The family expanded to include the Titan IIIB Agena D, the Titan IIID, and the Titan IIIE Centaur, which was used by NASA for space projects such as the Viking missions to Mars. The final variety of Titan III, the Titan III (34)D, was used during the 1980s as a backup and alternative to the manned Space Shuttle. The last 34D was launched on 4 September 1989.

Left: A Titan IIIC launches seven satellites for the Initial Defense Communications Satellite Program and one experimental satellite on 16 June 1966. Right: A Titan 34D rises from the pad at Cape Canaveral.

Space Transportation System

During the 1970s, NASA developed a Space Transportation System employing a manned, reusable Space Shuttle to replace most expendable launch vehicles. In addition to monitoring the development of the Shuttle to ensure that it would satisfy DOD's requirements, SAMSO contributed several important elements to allow DOD to make full use of the system. It developed and almost completed a launch and landing site at Vandenberg AFB to allow the Shuttle to be launched into polar orbits. It also developed the Inertial Upper Stage (IUS), an upper stage for large Shuttle payloads requiring higher orbits. The IUS was adapted for use with the Titan III and, later, the Titan IV expendable system as well. Although it had a troubled and costly developmental period, the IUS came to be considered an accurate and reliable launch system.

Left: The Space Shuttle's test orbiter ***Enterprise*** *is used for a fit check at SLC-6, the almost completed STS launch facility at Vandenberg AFB, in November 1984.*
Right: IUS-1 enters thermal vacuum testing at Boeing's Seattle facility in May 1982. It launched NASA's TDRSS-A satellite from the Space Shuttle on 4 April 1983.

On 28 January 1986, a Space Shuttle exploded during launch, killing the crew of the orbiter *Challenger*. NASA was forced to suspend all Shuttle launches while it investigated the cause of the explosion and assessed its implications. Military payloads as well as civilian payloads scheduled for the Shuttle had to obtain launches on expendable boosters or wait. Shuttle flights did not resume until 29 September 1988. The disaster had further implications for SSD. Development of the Shuttle facilities at Vandenberg ended after the disaster because of deficiencies in the design of the launch pad and because of national policy changes in favor of returning to expendable launch vehicles for national security missions.

Although eventually the Air Force was able to shift some of its most critical payloads to Titan vehicles, the Titan program happened to be suffering from launch failures of its own when the *Challenger* disaster occurred. After consecutive launches of Titan 34Ds failed on 28 August 1985 and 18 April 1986, further launches were suspended while the causes were investigated. They resumed on 26 October 1987, restoring the only available alternative to the Space Shuttle for large payloads.

Titan IV

The *Challenger* disaster gave added weight to the argument for having a variety of expendable launchers available so that failures in one type would not again affect so many payloads. Space Division had already begun the development of a larger, more capable Titan booster known as the Titan IV in 1985. Launched for the first time on 14 June 1989, the Titan IV could be used with either an IUS or a newly developed version of the Centaur upper stage. It was capable of placing 10,000 pounds into geosynchronous orbit using the Centaur. The Titan IV's performance would be considerably enhanced by upgraded solid rocket motors. Their development was delayed when the first qualification motor exploded during a test firing on 1 April 1991, but they successfully completed the final test firing on 12 September 1993. Vehicles without the upgraded motors were known as Titan IVAs, and those with the new motors were called Titan IVBs. For some smaller payloads, Space Division began converting the obsolete Titan II ballistic missiles that had been removed from their silos during 1982-1987.[7] They could place about 4,200 pounds into low-earth, polar orbit, and the first was launched on 5 September 1988.

Left: A Titan II launches the first DMSP Block 5D-3 satellite on 12 December 1999. Center: A Titan IVA on the launch complex at Cape Canaveral before launching the second Milstar satellite on 6 November 1995. Right: A Titan IVB launches a satellite for DOD in 1999. (Photographs courtesy of Lockheed Martin Corporation)

Delta II, Atlas II, and Atlas III

During the suspension of Shuttle flights, Space Division began procuring two new medium launch vehicles—the Delta II and the Atlas II. Development and production of the Delta II, an improved version of the Delta launch vehicle, began in January 1987. It was procured primarily to launch the constellation of 24 operational Global Positioning System (GPS) satellites, and it launched the initial operational constellation without a single failure.[8] The Delta II was developed in two consecutive configurations. The first of these launched the first nine GPS satellites from 14 February 1989 to 1 October 1990, while the second, more powerful version launched the later, heavier GPS satellites from 26 November 1990 to 10 March 1994, completing the constellation. During this entire

[7] A total of 55 Titan II missiles were removed, but only 14 were finally converted to space launch vehicles.

[8] See note 30 below under Navigation Systems in Chapter V.

period, a Delta II successfully launched a GPS satellite about every two months, an accomplishment rarely equaled.[9] Delta IIs also launched other payloads, both military and commercial. On 12 August 1991, and again on 9 April 1993, SMC awarded contracts to Boeing for additional Delta II launch vehicles to replenish the GPS constellation, and they continued to launch replacement GPS satellites, suffering only one failure by early 2003.

Development and production of the Atlas II, an improved version of the Atlas/Centaur launch vehicle, began in June 1988. The Atlas II would be able to launch somewhat heavier payloads in the medium-weight class, and DOD intended it for Defense Satellite Communications System (DSCS) satellites as well as some experimental satellites. It was also used in many commercial launches. Lockheed Martin, the developer, launched the first commercial payload to use an Atlas II on 7 December 1991, and it launched the Air Force's first DSCS III satellite on 11 February 1992. In 1995, SMC began using a modification of the Atlas II known as the Atlas IIA, which employed a more powerful Centaur upper stage, and Lockheed Martin soon developed a further modification, the Atlas IIAS, which employed four strap-on solid rocket motors. The first military payload to use the Atlas IIAS was launched on 6 December 2000. By early 2003, about 15 military payloads, including four DSCS III satellites, had been launched on the Atlas II, IIA, and IIAS without any failures. In 1999, SMC used the existing Atlas contract to procure launches of a new Atlas vehicle, the Atlas III, that used a single-stage main propulsion unit called the RD-180. The RD-180 was designed and manufactured by a Russian contractor, NPO Energomash. One of the features that made the engine versatile for space launches was that it could be throttled on command to higher or lower thrust while in flight.

Left: The first Delta II launches the first GPS Block II satellite on 14 February 1989. Center: An Atlas IIA launches a DSCS III satellite on 20 January 2000. Right: An Atlas IIAS launches a satellite for the NRO on 7 December 2000. (Photographs at center and right courtesy of Lockheed Martin Corporation)

[9] However, the Thor Agena had successfully launched a series of 24 Corona satellites in 20 months during April 1964 – December 1965 and a series of 23 in 41 months during June 1967 – November 1970. The Titan IIIB Agena may have carried out 29 successful launches during June 1967 – October 1971.

Launch Broad Area Review

Unfortunately, six closely spaced failures hit American launch programs from August 1998 to May 1999. They included three Air Force Titan IVs and destroyed three important payloads: a satellite from the National Reconnaissance Office, an early warning satellite from SMC's Defense Support Program, and a military communications satellite from SMC's Milstar program.[10] At the direction of both Congress and the president, DOD set up an independent review known as the Launch Broad Area Review (BAR) to study the causes of the failures and recommend remedial measures. The BAR confirmed that the immediate causes were unrelated, but it issued a set of recommendations on 1 November 1999 that broadened SMC's responsibility for each DOD launch from acquisition of the hardware through delivery of the spacecraft on orbit. As a result, SMC's responsibility for hardware and engineering throughout every launch became clear, explicit, and formal. By May 2003, Air Force launches were experiencing one of the longest unbroken strings of successful launches in history.

Evolved Expendable Launch Vehicle

Programs to develop a new generation of launch vehicles got off to a slow start. In 1987, the Air Force and NASA had begun a cooperative program to develop a more efficient family of boosters to replace the Space Transportation System and expendable launch vehicles. The program was known at first as the Advanced Launch System and later as the National Launch System before Congress ceased to fund it. In 1993, the Air Force and SMC tried a new, more frugal approach known as the Spacelifter program, which intended to develop a new launcher using existing technology. Nevertheless, the Secretary of Defense canceled it for reasons of cost later that year.

Efforts to develop a new, more efficient launcher received a badly needed endorsement when President Clinton signed a National Space Transportation Policy on 5 August 1994. Among other provisions, it assigned responsibility for expendable launch vehicles to DOD and directed DOD to develop improved versions of existing vehicles. The response was SMC's Evolved Expendable Launch Vehicle (EELV) program, which proposed to develop a family of launch vehicles for medium to heavy payloads based on existing vehicles or their components and using existing technology. SMC awarded four contracts for the initial phase of the EELV program on 24 August 1995, and it selected two proposals on 20 December 1996.[11] On 16 October 1998, SMC awarded contracts for both concepts covering the final stage of development.

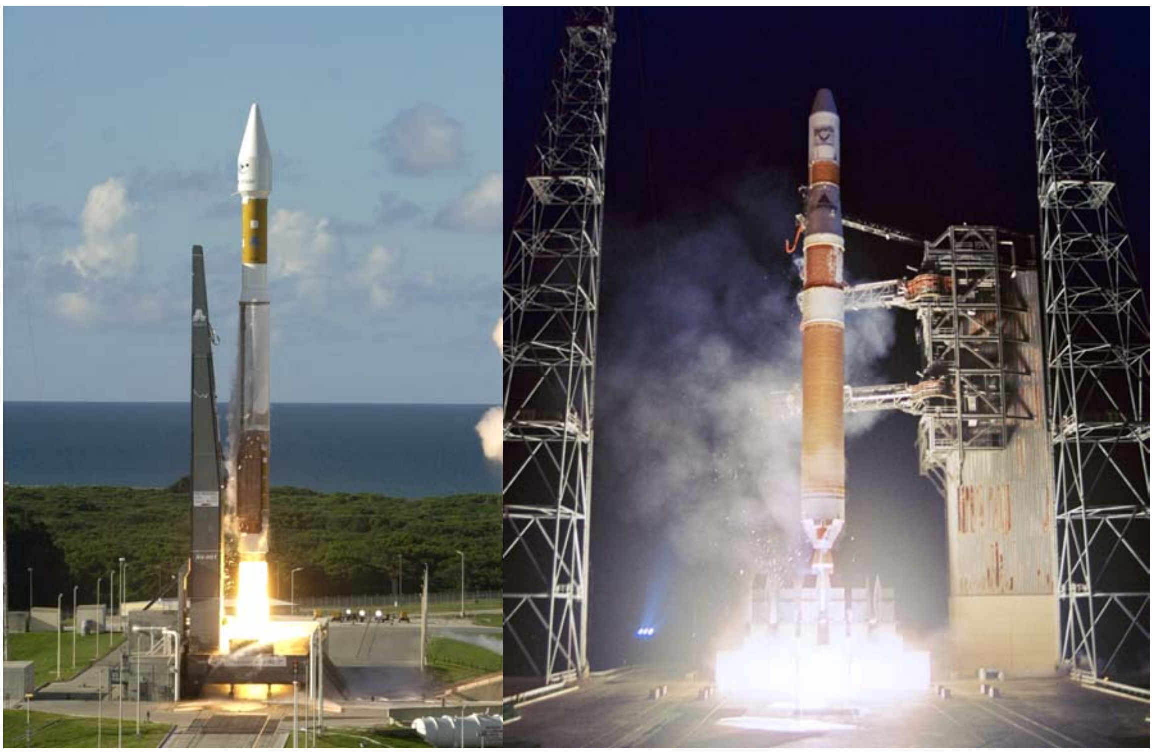
One of the two EELV contracts went to McDonnell Douglas (later acquired by Boeing) for a proposed family of upgraded Delta launchers known collectively as the

[10] Two of the other launches involved Delta III rockets, and the other involved an Athena rocket. However, the payloads in these launches were commercial.

[11] At first, SMC planned for these two contractors to compete for full scale development, but in 1997, it decided to keep two contractors over the life of the program because their products could be sold to a larger commercial market than originally anticipated and because two available launchers would tend to maintain competition for individual launches. For this and other innovations in acquisition, the EELV program was one of the Air Force's standard bearers in streamlined acquisition reform.

Delta IV. The Delta IV vehicles shared a first-stage common booster core (CBC) and a cryogenic second stage.[12] The first-stage engine, known as the RS-68, burned liquid oxygen and liquid hydrogen. Versions for somewhat heavier payloads added two to four strap-on solid-rocket auxiliary motors. The heavy version used three CBCs joined together in a line.

The other EELV contract went to Lockheed Martin for its proposed family of upgraded Atlas launchers known collectively as the Atlas V. The Atlas V vehicles also shared a first-stage CBC and second stage. The Atlas V's CBC employed the Russian-built RD-180 engine used in the Atlas III commercial launcher. The second stage consisted of a one- or two-engine cryogenic upper stage.[13] Heavier versions added one to five strap-on solid-rocket auxiliary motors. The heavy version of the Atlas V also used three CBCs joined together in a line.



Left: The first launch of the Atlas V EELV places Eutelsat's Hot Bird 6 commercial communications satellite into orbit on 21 August 2002 at Cape Canaveral. Right: The second launch of the Delta IV EELV places a DSCS III satellite into geosynchronous orbit on 10 March 2003 at Cape Canaveral. (Photograph at left courtesy of International Launch Services. Photograph at right courtesy of The Boeing Company.)

SMC awarded contracts on 16 October 1998 that provided launch services for Delta IV and Atlas V missions from both the east and the west coasts during FY 2002-2006. By the year 2000, however, agreements provided for launching the Atlas V from

[12] The second stage of the Delta IV used Pratt & Whitney's restartable RL-10B2 cryogenic liquid oxygen/liquid hydrogen engine, a variation of the RL-10 engine used in the Centaur upper stage.

[13] The upper stage of the Atlas V consisted of a one- or two-engine Centaur employing the RL-10A-4-2 restartable engine.

the east coast only and the Delta IV from both coasts. The first launch of the Atlas V, which took place at Cape Canaveral, placed a European commercial telecommunications satellite into the correct orbit on 21 August 2002. The first DOD payload for the Atlas V was scheduled for launch in 2003. The first launch of the Delta IV took place on 20 November 2002, also from Cape Canaveral, and it too placed a European telecommunications satellite into a nominal orbit. The first DOD payload for the Delta IV was a satellite from SMC's Defense Satellite Communications System III (DSCS III) program, which the launcher placed into a nominal geosynchronous orbit from Cape Canaveral on 11 March 2003. The first launch of a Delta IV from the west coast was scheduled to take place early in 2004. It would be the first launch of any kind from SLC-6, the launch complex which had been built originally in 1969 to launch the Manned Orbiting Laboratory.[14] It had been modified later for the Space Shuttle and now had been modified again for the Delta IV.

[14] For information about the Manned Orbiting Laboratory (MOL) program, see Chapter VII, Other Programs, later in this history.

CHAPTER V: SATELLITE SYSTEMS

Military satellite projects were added to the mission of the Western Development Division in the mid-1950's and came to play an increasingly important role in the activities of the Division's successors. The first satellite program was known as the Military Satellite System, or Weapon System 117L (WS 117L). The commander of Air Research and Development Command transferred responsibility for the program from Wright Air Development Center to WDD on 10 October 1955. WS 117L was, in concept, a family of separate subsystems that could carry out different missions, including photographic reconnaissance and missile warning. However, by the end of 1959, WS 117L had evolved into three separate programs: the Discoverer Program, the Satellite and Missile Observation System (SAMOS),[15] and the Missile Defense Alarm System (MIDAS). Discoverer and SAMOS were to carry out the photographic reconnaissance mission, and MIDAS was to carry out the missile-warning mission.[16]

Reconnaissance Systems

The Discoverer program aimed at developing a film-return photographic reconnaissance satellite. The satellite would carry a camera that took pictures from space as it passed over the Soviet Union and China. Film from the camera would be returned from orbit in a capsule; a parachute would be deployed to slow the descent of the capsule; and the capsule would be recovered either in mid-air or in the ocean. However, Discoverer's photo reconnaissance mission was not revealed to the public at the time. It was, instead, presented as an experimental program to develop and test satellite subsystems and explore environmental conditions in space.[17]

Left: The Agena spacecraft for Discoverer 13, mated to its Thor launch vehicle, waits on the pad at Vandenberg AFB before being erected. The covering cooled and protected the spacecraft. Right: Colonel C. Lee Battle, Discoverer program director, and a project officer observe the ground track of a satellite in 1960, taking care not to look at the Soviet Union.

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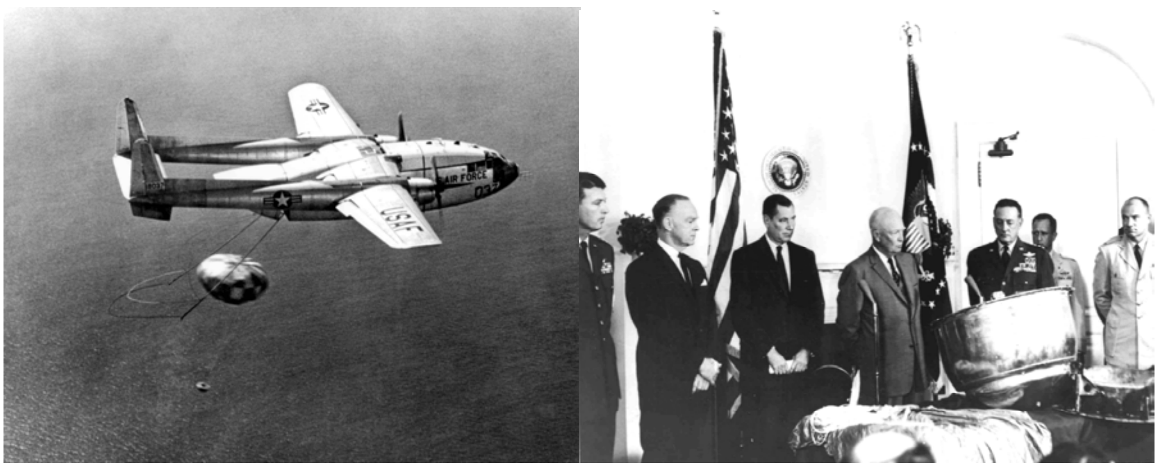
[15] SAMOS may have been made into an acronym after the name had been selected to go with MIDAS.

[16] Under the WS 117L program, the visual reconnaissance payloads (which became the Discoverer and SAMOS programs) were known as Subsystem E, and the infrared reconnaissance payload (which became the MIDAS early warning program) was called Subsystem G. The spacecraft, which finally became the Agena upper stage, was called Subsystem A for the airframe and Subsystem B for the propulsion elements.

[17] Nevertheless, some Discoverer missions carried experimental payloads instead of or in addition to their

The Discoverer Program carried out 38 public launches and achieved many technological breakthroughs. Discoverer I, launched on 28 February 1959, was the world's first polar orbiting satellite. Discoverer II, launched on 13 April 1959, was the first satellite to be stabilized in orbit in all three axes, to be maneuvered on command from the earth, to separate a reentry vehicle on command, and to send its reentry vehicle back to earth. Discoverer XIII, launched on 10 August 1960, ejected a capsule that was subsequently recovered in the Pacific Ocean, the first successful recovery of a man-made object ejected from an orbiting satellite. Discoverer XIV, launched on 18 August 1960, ejected a capsule that was recovered in mid-air northwest of Hawaii by a JC-119 aircraft, the first successful aerial recovery of an object returned from orbit. The capsule from Discoverer XIV was the first to return film from orbit, inaugurating the age of satellite reconnaissance. Satellite reconnaissance filled a crucial need, because President Eisenhower had suspended aerial reconnaissance of the Soviet Union just three months earlier after the Soviets had shot down the U-2 spy plane piloted by Francis Gary Powers.



Left: A recovery crew of the 6593rd Test Squadron (Special) performs a midair capsule recovery in a JC-119 aircraft. Recovery crews flew JC-119s for the first 29 Discoverer missions and JC-130s after that. Right: President Eisenhower holds a news conference on 15 August 1960 to exhibit the capsule from Discoverer 13, recovered from the ocean four days earlier. Behind the president, left to right, are Lieutenant General Bernard Schriever (commander of Air Research and Development Command), Dudley Sharp (Secretary of the Air Force), Thomas Gates (Secretary of Defense), General Thomas White (Air Force Chief of Staff), unidentified officer, Colonel Charles Mathison (commander of 6594th Test Group).

The Discoverer Program officially ended after the launch of Discoverer XXXVIII on 27 February 1962. In reality, however, it continued in clandestine form until 31 May 1972 (the date of the last film recovery), carrying out 145 launches[18] under the secret code name Corona. At the direction first of President Eisenhower and later of President Kennedy, the direction and management of Corona and other satellite reconnaissance programs passed to a new DOD agency, the National Reconnaissance Office (NRO),

normal reconnaissance payloads. Mission 3 carried biological experiments, and mission 2 carried simulated experiments, but both were lost in launch failures. Missions 19, 21, 49, 52, 57, 73, 92, and 99 gathered infrared background data for the MIDAS program. Other missions carried geodetic payloads. For short descriptions of Corona payloads, see Curtis Peebles, The Corona Project, Naval Institute Press, 1997.

[18] Including the 38 Discoverer launches.

when it was created in 1961.[19] Corona's first major accomplishment was to provide photographs of Soviet missile launch complexes. It also identified the Plesetsk Missile Test Range, north of Moscow, and provided information about what missiles were being developed, tested, and deployed. These and other accomplishments came to light when the CORONA Program was declassified in February 1995.

SAMOS, the second program that evolved from WS 117L, aimed at developing a heavier reconnaissance payload that would be launched by an Atlas Agena booster rather than the Thor Agena used to launch Discoverer. The payloads were intended to collect photographic and electromagnetic reconnaissance data. The photographic data would be collected by cameras in the Agena spacecraft, like the Corona payloads. However, the film would be scanned electronically in orbit and transmitted to ground stations. SAMOS had three unclassified launches from the west coast: 11 October 1960, 31 January 1961, and 9 September 1961. Only the launch in January 1961 was successful. In 1962, a veil of secrecy was drawn across the SAMOS program, and the Air Force stopped releasing information about it. After several more classified launches, however, it was apparent that the technology for the electro-optical film readout system was not yet sufficiently advanced, and Air Force undersecretary Joseph V. Charyk canceled further work on the payload.[20]

Although SMC did not directly manage the development of imaging reconnaissance satellites after this, it did manage programs that were linked to them or their products. One of the most important was the Defense Dissemination System (DDS), whose broad outlines were declassified in 1996. The Defense Dissemination Program Office (DDPO) was established at SAMSO in July 1974 to develop a means to securely and rapidly provide reconnaissance imagery in nearly original quality to both strategic and tactical users. The DDPO developed a system consisting of segments for processing, transmitting, and receiving. The system was deployed to four strategic sites during 1976-1978, providing the first electronic dissemination of digital imagery for targeting and strategic threat assessment. The DDS went through three more generations of increasingly sophisticated improvements for compressing, transmitting, receiving, and reconstructing imagery for military users in the field. One of the third-generation DDS units was deployed to the Persian Gulf to support Operations Desert Shield and Desert Storm. Fourth-generation DDS units were fielded to 70 strategic and tactical users by 1998. However, the DDPO itself ceased to exist as a program office on 1 October 1996,[21] when it was combined with other agencies to create the National Imagery and Mapping Agency (NIMA).

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[19] On 31 August 1960, Secretary of the Air Force Dudley C. Sharp created an Office of Missile and Satellite Systems. Reconnaissance programs under that office reported to the secretary of the Air Force through an undersecretary, Joseph V. Charyk. On 6 September 1961, the new Kennedy Administration established the NRO. Its joint directors, the undersecretary of the Air Force and the deputy director of the CIA, reported directly to the deputy secretary of defense for reconnaissance matters.

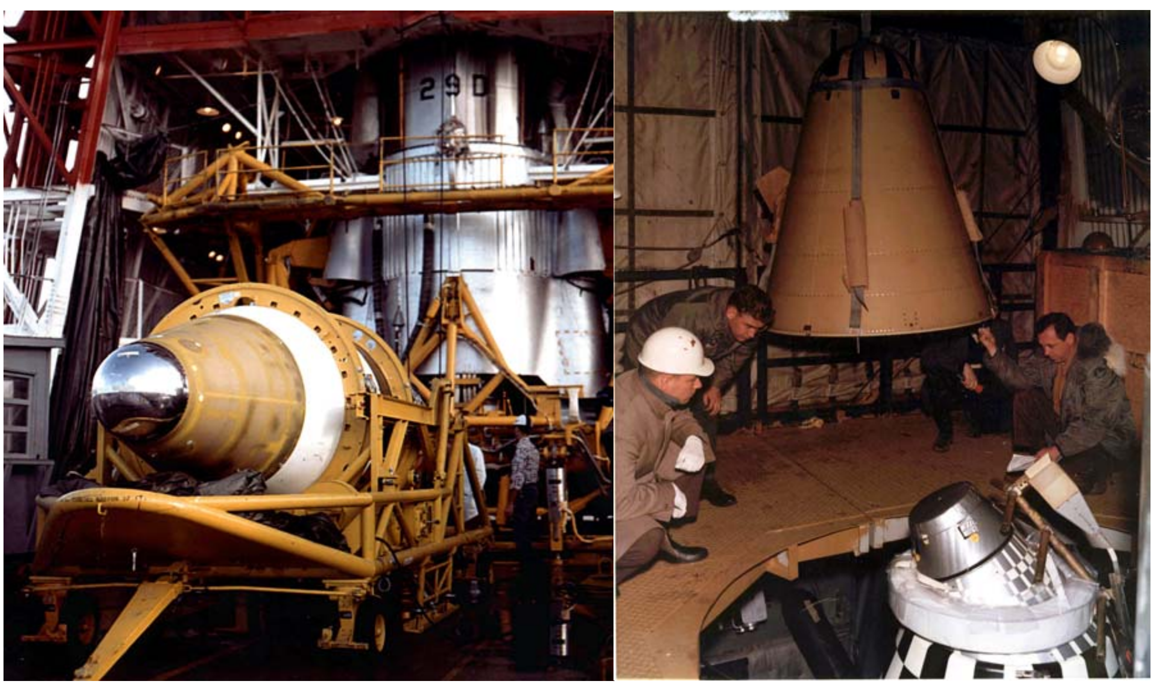
[20] However, the technology was secretly transferred to NASA, which used it successfully in its Lunar Orbiter imaging lunar satellites. See R. Cargill Hall, "SAMOS to the Moon: The Clandestine Transfer of Reconnaissance Technology Between Federal Agencies," NRO Office of the Historian, October 2001.

[21] As an organization, the DDPO was characterized by unusually high *esprit de corps*. It received a larger number of Air Force Organizational Excellence Awards than any other program office in SMC's history.

Infrared Early Warning Systems

The MIDAS program, the third offshoot of WS 117L, focused on developing a satellite with an infrared sensor to detect hostile ICBM launches. It began its life as a separate program when AFBMD placed the infrared portion of WS 117L under a separate contract with Lockheed effective 1 July 1959. The payload consisted of an infrared sensor array and telescope inside a rotating turret mounted in the nose of an Agena spacecraft. Plans which were never carried out called for an operational constellation of eight satellites in polar orbits to constantly monitor launches from the Soviet Union. Unfortunately, the program's first four test satellites launched in 1960 and 1961 ended in a launch failure and early on-orbit failures.

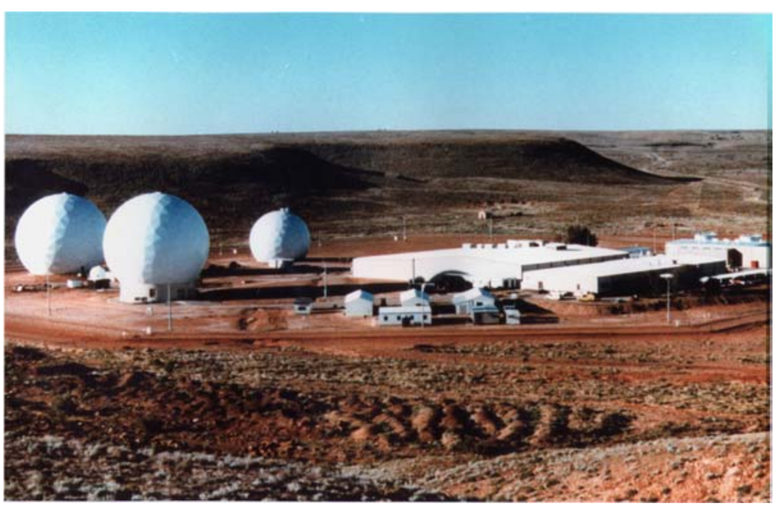
DOD kept the program in a research and development phase rather than approve an operational system in 1962. The MIDAS program was lengthened and renamed Program 461. The next two launches in 1962 also ended in an early on-orbit failure and a launch failure. Finally, a satellite launched on 9 May 1963 operated long enough to detect 9 missile launches. After another launch failure in 1963, the last Program 461 satellite, launched on 18 July 1963, operated long enough to detect a missile and some Soviet ground tests. Data collection and analysis continued until 1968 under Lockheed's contract for Program 461 to support the next early warning program. Additional launches in 1966, using improved spacecraft and sensors, demonstrated the system's increasing reliability and longevity. Although a launch on 9 June 1966 failed, launches on 19 August and 5 October 1966 placed their spacecraft into highly useful orbits, where their infrared sensors gathered data for a year, reporting on 139 American and Soviet launches. The MIDAS program and its successors were declassified in November 1998.



Left: The Agena spacecraft for MIDAS I waits for installation on Atlas 29D before its unsuccessful launch on 26 February 1960. Right: The payload for an advanced version of MIDAS, known as AFP 461, is covered with the Agena's nose cone before its unsuccessful launch as MIDAS 6 on 17 December 1962.

DOD initiated a new program late in 1963 to develop an improved infrared early warning system, which ultimately became the Defense Support Program. After an early phase known as Program 266, a contract for development of Program 949, the Defense Support Program (DSP), was awarded to TRW for the spacecraft on 6 March 1967 and to Aerojet for the infrared sensor on 1 March 1967. The new concept involved placing the satellites into orbits at geosynchronous altitude, where only three or four would be necessary for global surveillance. Like MIDAS, the satellites would employ telescopes and IR detectors, but the necessary scanning motion would be accomplished by rotating the entire satellite around its axis several times per minute. An evolving network of two, and later three, large ground stations in Australia, Europe, and the continental U.S. controlled the spacecraft and data. The first DSP satellite was launched on 6 November 1970, using a Titan IIIC launch vehicle. A long series of increasingly larger, more sophisticated, and more reliable satellites followed,[22] all of them except one launched on

Right: The first DSP satellite, known as DSP Flight 1, is shown in testing at the facilities of TRW, the prime contractor. It was launched on 6 November 1970 from Cape Canaveral.



Left: The first operational fixed ground station for DSP, known as the Overseas Ground Station (OGS), was located at Woomera Air Station, Australia. It became operational in 1971.

[22] DSP satellites launched during 1970-1973 weighed 2,000 pounds, had a design life of 1.25 years, and incorporated 2,000 lead sulfide detectors operating in the short wave infrared range; they could see targets only below the line of the earth's horizon. Satellites launched beginning in 1989 weighed 5,250 pounds,

Titan III or Titan IV vehicles.[23] By early 2003, twenty DSP satellites had been successfully launched.[24] They provided a level of early warning that was, by then, indispensable for both military and civil defense. They also carried sensors that performed nuclear surveillance, a mission inherited from the Vela system. Although designed for strategic uses, DSP proved to be more versatile. During the Persian Gulf War, it provided early warning against tactical missiles as well. By 1997, SMC and Air Force Space Command had exploited that capability by adding central processing facilities and tactical ground stations to provide DSP tactical data to battlefield commanders more rapidly and efficiently.

During the early 1990s, SMC pursued concepts and technologies for follow-on systems to replace the Defense Support Program (DSP). By 1994, the concept for a system to succeed DSP was known as the Space-Based Infrared System (SBIRS). SBIRS would be an integrated system that would support several missions: missile warning, missile defense, battlespace characterization, and technical intelligence. The SBIRS concept actually included two planned satellite systems, referred to as SBIRS High[25] and SBIRS Low.[26] Both were heirs of infrared technology developed for the Ballistic Missile Defense Program (earlier known as the Strategic Defense Initiative) during 1983-1995. SBIRS High was focused on the detection and tracking of missiles during the earlier phase of their flight, while their motors were generating heat and infrared signatures in short wave lengths. SBIRS Low would add the capability of tracking and reporting other data about missiles during the middle portions of their flight, when their infrared signatures were at longer wave lengths. SMC awarded a ten-year development contract for SBIRS High to Lockheed Martin on 8 November 1996. The SBIRS High program had to be restructured during 2001 to deal with potential cost and schedule overruns, but its technical progress continued. In December 2001, a consolidated SBIRS Mission Control Station (MCS) at Buckley AFB, Colorado, was declared operational. The MCS provided a central capability for command and control of all operational DSP satellites. The completion of this first segment of the ground system upgrade allowed older DSP ground stations to be closed. Plans called for the ground system to continue to evolve to

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had a design life of 3 years, and incorporated 6,000 lead sulfide detectors with an additional set of mercury cadmium telluride detectors operating in the short wave and medium wave infrared range; they could see targets both below and above the line of the earth's horizon. See Major James Rosolanka, "The Defense Support Program (DSP): A Pictorial Chronology, 1970-1998," SBIRS Program Office.

[23] DSP-16 was launched on a Space Shuttle (STS-44) on 24 November 1991.

[24] Two more DSP satellites remained in storage: Flights 22 and 23. No more were under contract because plans had called for DSP's successor, the Space-Based Infrared System, to reach operational status in time to take over operations from DSP's orbital constellation.

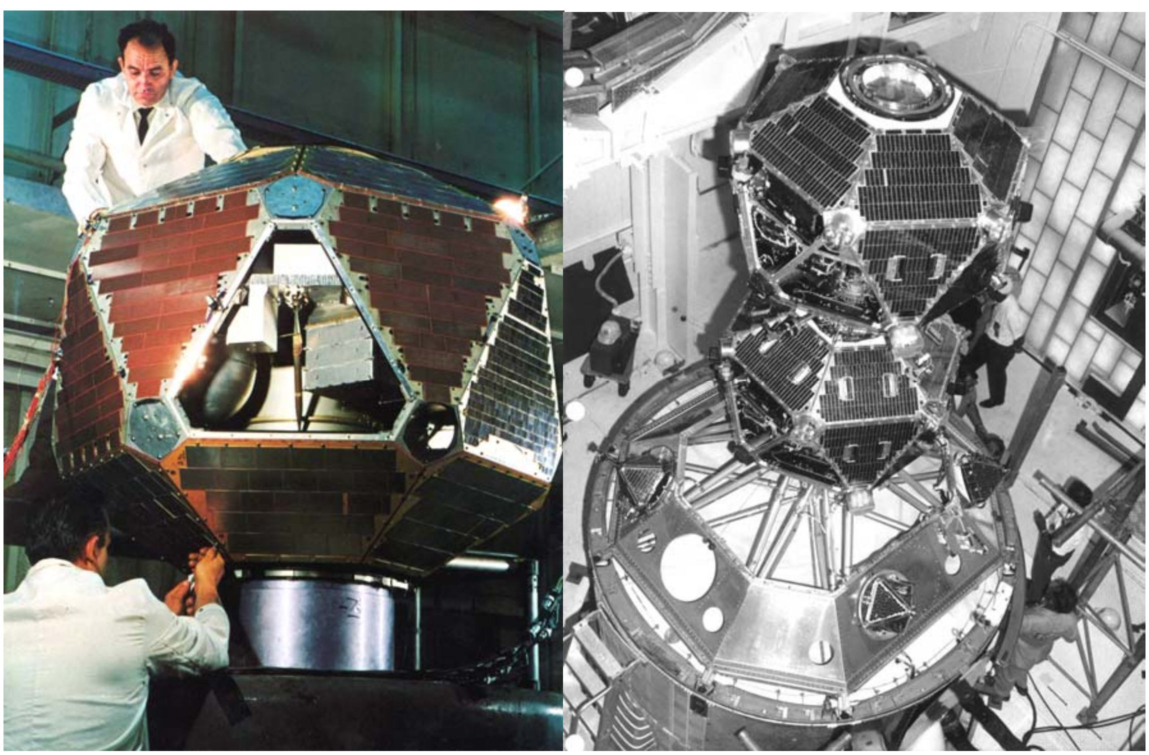
[25] The technological basis for the high-altitude follow-on system to detect missile launches was an earlier program under OSD's Strategic Defense Initiative (SDI) known as the Boost Surveillance and Tracking System (BSTS). It had been transferred to the Air Force in FY 1992 and had gone through several conceptual changes known as the Advanced Warning System (AWS), the Follow-on Early Warning System (FEWS), and the Alert Locate and Report Missiles (ALARM) program.

[26] The technological basis for the low-altitude follow-on system to track missiles in the middle portion of their trajectories had also been an SDI program. It had been known as the Space Surveillance and Tracking System (SSTS) during the mid and late 1980s and as Brilliant Eyes during the early 1990s.

support satellites of the SBIRS High system. By early 2003, a payload for elliptical orbits in SBIRS High was undergoing ground testing. To prepare for the development of SBIRS Low, SMC awarded contracts for on-orbit demonstrations to TRW on 2 May 1995 and to Boeing on 2 September 1996. However, the SBIRS Low program began a gradual transfer of oversight back to the Missile Defense Agency during the same period.

Nuclear Surveillance

In addition to reconnaissance and missile warning, SMC and its predecessors have developed satellites to serve a number of other purposes, among which are nuclear surveillance, weather observation, navigation, and communication. The first space system to accomplish nuclear surveillance was called Vela Hotel—later, simply Vela. Representatives of the Air Force Ballistic Missile Division (AFBMD), the Atomic Energy Commission, and NASA met on 15 December 1960 to initiate a joint program to develop a high-altitude satellite system that could detect nuclear explosions. Its primary purpose was to monitor compliance with the Nuclear Test Ban Treaty then being negotiated in Geneva. During 1961-1962, the Atomic Energy Commission developed detectors and flew experimental versions on Space Systems Division's Discoverer satellites. SSD issued a contract for the spacecraft to Space Technology Laboratories (later part of TRW) on 24 November 1961. The first pair of satellites was launched using an Atlas Agena on 16 October 1963, a few days after the Nuclear Test Ban Treaty went into effect, and two more pairs were launched on 16 July 1964 and 17 July 1965. Six Advanced Vela satellites, containing additional, more sophisticated detectors, were

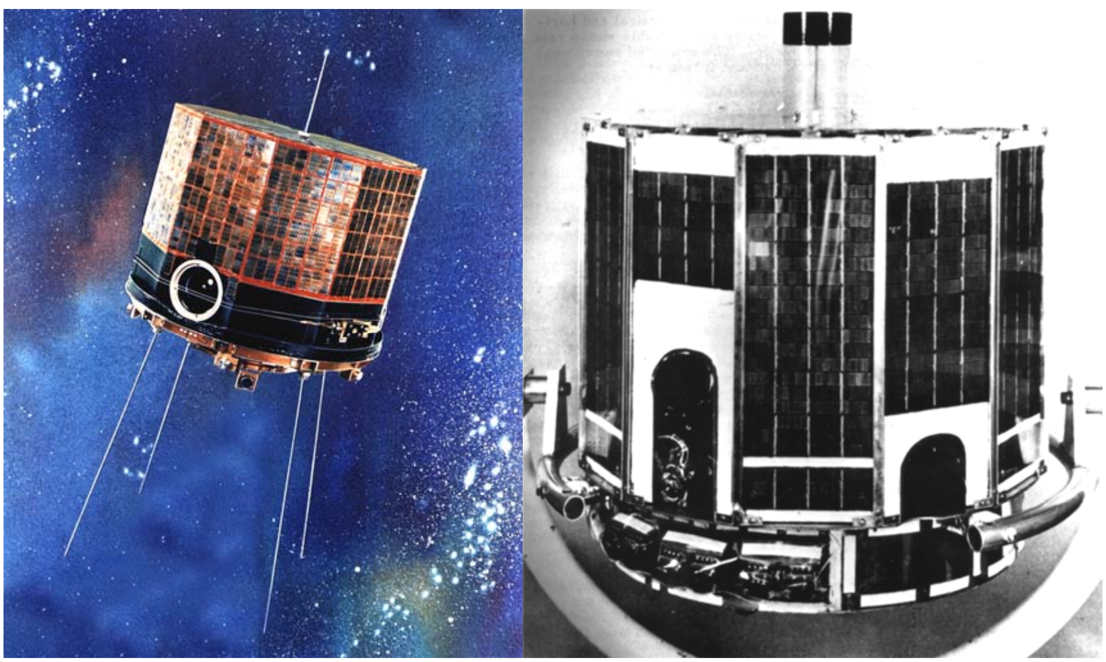


Left: A Vela satellite in fabrication at TRW's facility. Right: A pair of Vela satellites (Vela 5A and 5B) mounted on their Titan IIIC launch vehicle before installation of the fairing. They were launched successfully on 23 May 1969.

launched in pairs on Titan IIIC vehicles on 28 April 1967, 23 May 1969, and 8 April 1970. The Vela satellites successfully monitored compliance with the Nuclear Test Ban Treaty and provided scientific data on natural sources of space radiation for many years. The least successful of the original satellites operated for ten times its design lifetime of six months. The last of the advanced Vela satellites was deliberately turned off on 27 September 1984, over fifteen years after it had been launched.

Meteorological Systems

Providing the systems with which to conduct military weather observations from space is presently the mission of the Defense Meteorological Satellite Program (DMSP), which maintains a constellation of at least two operational weather satellites in polar orbits about 450 miles above the earth. DMSP satellites now carry primary sensors that provide images of cloud cover over the earth's surface during both day and night, and they also carry other sensors that provide additional types of data on weather and on the space environment. The first DMSP satellites were developed by a program office physically located with Space Systems Division but reporting to the National Reconnaissance Office (NRO),[27] which needed analyses of cloud cover over Eurasia to plan its photographic reconnaissance.[28] The program office awarded a development contract for weather satellites employing television cameras to RCA in 1961. DMSP



Left: A DMSP Block I satellite, launched 1962-1963. Blocks II and III were similar. Right: DMSP Block IV satellites, launched 1966-1969, included the first major improvements in DMSP sensors.

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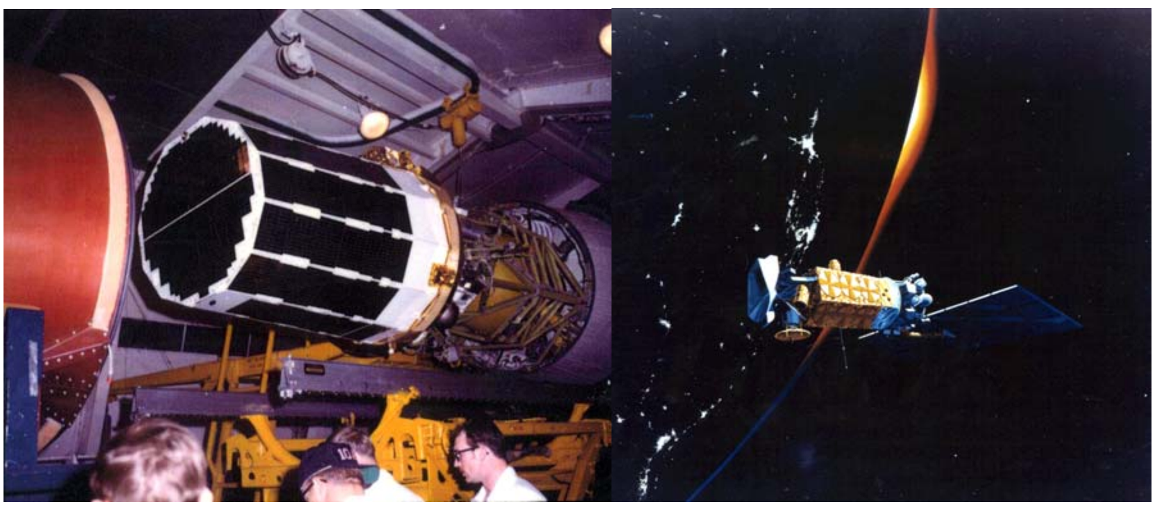
[27] See R. Cargill Hall, A History of the Military Polar Orbiting Meteorological Satellite Program, National Reconnaissance Office, September 2001.

[28] Although NASA was developing a National Operational Meteorological Satellite System, the NRO's director, Under Secretary of the Air Force Joseph V. Charyk, did not believe it would adequately support the NRO's missions. See note 27 above.

Block I began with five launch attempts on Scout launch vehicles during 1962 and 1963, all but one of which failed.[29] Later Block I launches on Thor Agena and Thor Burner I vehicles were more successful. DMSP Block II and Block III satellites, also launched on Thor Burner I vehicles, provided weather data for tactical applications in Southeast Asia.

Wider military uses for weather data led to an important change in the program's reporting structure when, on 1 July 1965, it became a program office under Space Systems Division. Development of more capable and more complex satellites also came to fruition with DMSP Block 4 satellites, seven of which were launched during 1966-1969. Television resolution improved from 3 to 4 nautical miles with Blocks I and II to 0.8 to 3 nautical miles with Block 4, along with many other improvements in the sophistication of secondary sensors. Block 5A satellites introduced the Operational Line Scan (OLS) sensor, which provided images of clouds in both visual and infrared spectra. Television resolution improved to 0.3 nautical miles in daylight. Three Block 5A, five 5B, and three 5C satellites were launched during 1970-1976 on Thor Burner II launch vehicles. Larger and much more sophisticated Block 5D-1 satellites were also developed during the 1970s, but only five were built. In 1980, the fifth 5D-1 satellite was lost in a launch failure, and the operational 5D-1 satellites in orbit ceased to function prematurely. From August 1980 to December 1982, when the first Block 5D-2 satellite was successfully launched, meteorological data was supplied to DOD entirely by civilian



Left: The payload fairing is being installed over a DMSP Block 5A satellite mated to a Burner II upper stage on a Thor Burner (LV-2F) launch vehicle about 1970-1971. Right: This artist's concept depicts a DMSP Block 5D-3 satellite in an early-morning orbit. The DMSP constellation consists of two operational satellites and two spares in sun-synchronous polar orbits. One of the operational satellites crosses the equator (northward) early in the morning, and the other does so at noon local time.

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[29] The first launch attempt took place on 23 May 1962, but it failed. The first successful launch was the second attempt on 23 August 1962. Later unsuccessful Scout launches took place on 19 February 1963, 26 April 1963, and 27 September 1963. Successful Thor Agena D launches were carried out on 19 January 1964 and 17 June 1964. Block I launches on Thor Burner I rockets took place on 18 January 1965 (failure) and 18 March 1965 (success). Block II launches on Thor Burner I vehicles were on 9 September 1965 (success), 7 January 1966 (failure), and 30 March 1966 (success). The only Block III satellite was launched successfully on 20 May 1965 using a Thor Burner I launch vehicle. See note 27 above.

satellites. Nine Block 5D-2 satellites were launched during 1982-1997 on Atlas E and Titan II launch vehicles. In 1989, Space Systems Division began the procurement of five Block 5D-3 satellites from General Electric (later acquired by Lockheed Martin). By early 2003, the first of these was scheduled for launch later in the year.

Civilian weather satellites were operated by the National Oceanic and Atmospheric Administration (NOAA). Proposals to merge the civilian and military meteorological systems had been made from time to time since the early 1970s.[30] On 5 May 1994, President Clinton issued a presidential decision directive ordering the convergence and eventual merger of the two programs into a new national space-based system for environmental monitoring. A Tri-Agency Integrated Program Office (IPO) made up of representatives from NOAA, NASA, and DOD would be responsible for carrying out major systems acquisitions, including satellites and launch vehicles. However, NOAA would have overall responsibility for operating the new system, which was soon named the National Polar-orbiting Operational Environmental Satellite System (NPOESS). A major step in convergence occurred on 29 May 1998, when NOAA's Satellite Operations Control Center (SOCC) took over satellite control authority as well as actual operational control of the existing DMSP system. The IPO issued competitive contracts to Lockheed Martin and TRW on 13 December 1999 for an early phase of the NPOESS development program called Program Definition and Risk Reduction, and it issued five development contracts for NPOESS sensors during 1997-2001. A flight demonstration satellite known as the NPOESS Preparatory Project (NPP) was scheduled for launch in late 2006. It would be a joint mission involving NASA and the IPO.

Navigation Systems

The world's first space-based navigation system was called Transit. It was developed by scientists at Johns Hopkins University's Applied Physics Laboratory in 1958. DOD's Advanced Research Projects Agency (ARPA) initiated the development program in September 1958 and assigned it to the Navy a year later. The Air Force Ballistic Missile Division launched the Navy's first Transit satellite on 13 April 1960. The system achieved initial operational capability in 1964 and full operational capability in October 1968. It used three operational satellites to produce signals whose Doppler effects and known positions allowed receivers—primarily ships and submarines—to calculate their positions in two dimensions. Transit established the principle and much of the technology of navigation by satellite and prepared military users to rely on such a system. However, it was too slow for rapidly moving platforms such as aircraft. Transit's signals were turned off deliberately in December 1996 because DOD had decided to rely on a newer, faster, and more accurate system.

All of DOD's navigation and position-finding missions are now performed by the Global Positioning System (GPS). The system consists of 24 operational satellites that broadcast navigation signals to the earth, a control segment that maintains the accuracy of the signals, and user equipment that receives and processes the signals. By processing

[30] The Defense Meteorological Satellite Program was declassified in 1973.

signals from four satellites, a user set is able to derive the location of each satellite and its distance from each one. From that information, it rapidly derives its own location in three dimensions.

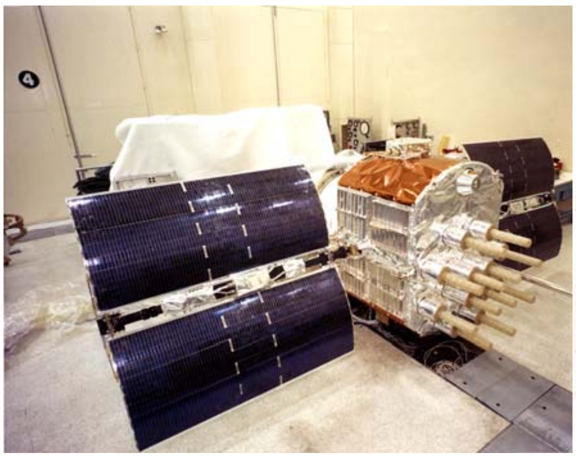
Left: The second Transit satellite (Transit 1B) undergoes checkout at Cape Canaveral before launch on 13 April 1960. Right: This artist's concept depicts the second Navigation Technology Satellite (NTS-2) in orbit. NTS-2 was used as part of the GPS Block 1 test constellation.

Besides Transit, GPS had two immediate programmatic ancestors: a technology program called 621B, started by SAMSO in the late 1960s, and a parallel program called Timation, undertaken by the Naval Research Laboratory in the same period. 621B envisioned a constellation of 20 satellites in synchronous inclined orbits, while Timation envisioned a constellation of 21 to 27 satellites in medium altitude orbits. In 1973, elements of the two programs were combined into the GPS concept, which employed the signal structure and frequencies of 621B and medium altitude orbits similar to those proposed for Timation.

Deputy Secretary of Defense William P. Clements authorized the start of a program to "test and evaluate the concepts and costs of an advanced navigation system" on 17 April 1973, and he authorized the start of concept validation for the GPS system on 22 December 1973. GPS was acquired in the classical three phases: validation, development, and production. During the validation phase, Block I navigation satellites and a prototype control segment were built and deployed, and advanced development models of various types of user equipment were built and tested. During the development phase, additional Block I satellites were launched to maintain the initial satellite constellation, a qualification model Block II satellite was built and tested, and manufacture of additional Block II satellites was initiated.[31] In addition, an operational

[31] Block I, Block II, and Block IIA satellites were built by Rockwell International, which sold its aerospace and defense divisions to Boeing in 1997.

control segment was activated, and prototype user equipment was developed and tested. During the production phase, a full constellation of 24 Block II and IIA (A for advanced) satellites was deployed. User equipment was also produced and put into operation by issuing it to foot soldiers and installing it in ships, submarines, aircraft, and ground vehicles. The full constellation was completed on 9 March 1994, allowing the system to attain full operational capability in April 1995. SMC began launching the next block of GPS satellites, known as IIR (R for replacement), in 1997.[32] The following block of GPS satellites, which incorporated further improvements, was known as Block IIF (F for follow-on). SMC awarded a contract for their production on 22 April 1996.[33] By 2003, they were scheduled to be available for launch beginning in 2006.



Top: A GPS Block I satellite (left) and a GPS Block II satellite (right) undergo acceptance testing at Arnold Engineering Development Center. Bottom left: An artist's concept depicts a GPS Block IIR satellite in orbit. Bottom right: An artist's concept depicts a GPS Block IIF satellite in orbit.

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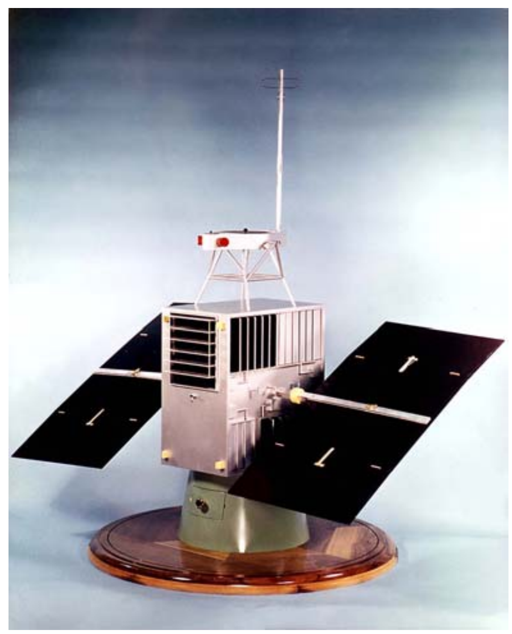
[32] The launch of the first IIR satellite on 15 January 1997 failed when the Delta launch vehicle exploded. It was the first failure of a Delta II vehicle and only the second launch failure in the history of the GPS program. The first GPS Block IIR satellite to attain orbit and become operational was launched on 23 July 1997.

[33] SMC (then called Space Systems Division) had awarded the contract for Block IIR satellites to General Electric (later part of Lockheed Martin) in 1989. It awarded the contract for Block IIF satellites to Rockwell International (later part of Boeing). See note 31 above.

GPS can support a wide variety of military operations, including aerial rendezvous and refueling, all-weather air drops, instrument landings, mine laying and mine sweeping, anti-submarine warfare, bombing and shelling, photo mapping, range instrumentation, rescue missions,[34] and satellite navigation. GPS is also the focus of a growing civilian market. By 2003, it was widely used commercially, and some of those commercial applications, such as airline navigation, were critical. At one time, the GPS signal available to civil users contained intentional inaccuracies, a condition known as selective availability. At President Clinton's direction, the intentional inaccuracies were set to zero on 1 May 2000, providing significant improvements in the accuracy available to the system's civil users.

Communications Systems

The world's first communications satellite was launched by the Air Force Ballistic Missile Division, SMC's predecessor, on 18 December 1958. The SCORE payload consisted of commercial communications equipment modified by the Army Signal Corps and installed in an Atlas B missile as a proof-of-concept mission for orbiting communications repeaters. The project was executed under ARPA's direction.

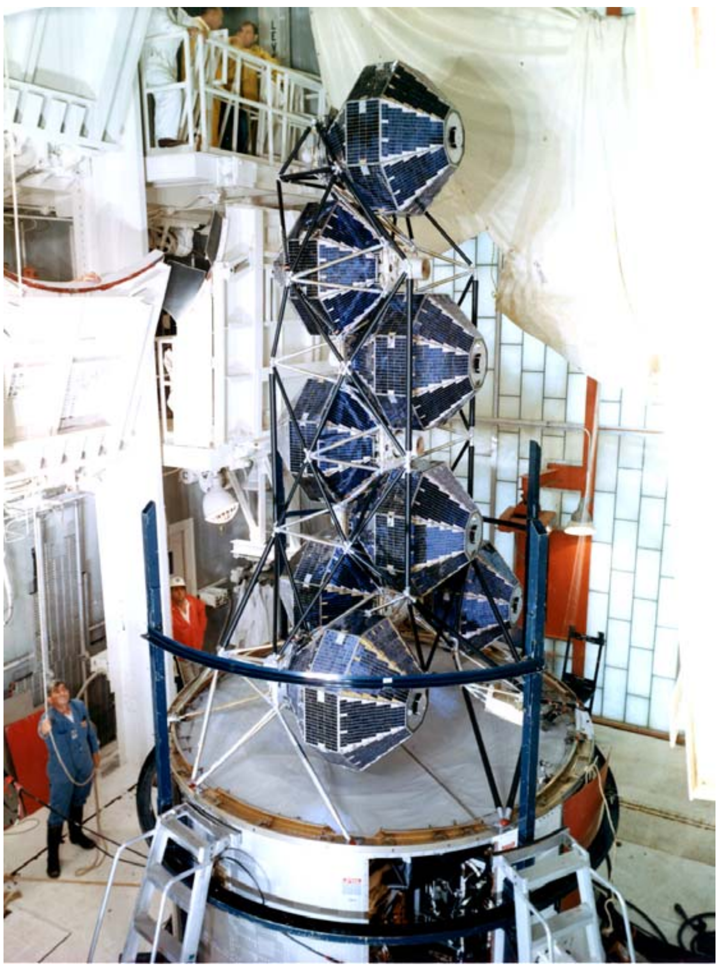


Left: The Courier 1B satellite undergoes testing at Patrick AFB before launch on 4 October 1960. Right: A conceptual model of a satellite for Project Advent. No satellite was ever actually launched for Advent.

[34] We should take note of a particularly important military application of GPS known as the Combat Survivor Evader Locator (CSEL) system. CSEL was based on an earlier Air Force Space Command procurement called Hook-112 and was designed to enable rescue forces to find, track, and communicate with downed American pilots in hostile territory while making sure they were truly American personnel in need of assistance. It was a technologically sophisticated combination of hand-held radio unit and GPS receiver. Secretary of Defense William J. Perry approved the program in December 1995, and SMC issued a development contract to Rockwell (later absorbed by Boeing) in February 1996. A series of operational assessments and developmental tests were conducted between 1998 and 2002, and the first limited production units were delivered in late 2002. CSEL entered multiservice operational test and evaluation in June 2003 and was scheduled to begin full-rate production early in 2004.

AFBMD launched the entire missile, minus the spent half stage, into a low orbit, where it remained for about a month,[35] relaying voice and telegraph messages between ground stations in the United States. Among its first experimental transmissions was President Eisenhower's Christmas message to the world, the first time that a human voice had been transmitted from space. The world's second military[36] communications satellite was Courier 1B, developed by the Army Signal Corps under ARPA's direction. AFBMD successfully launched it on 4 October 1960, using a Thor Able Star launch vehicle. Courier further tested the feasibility of orbiting communications repeaters but did so with a spherical, self-contained satellite that included solar cells and rechargeable batteries. Unfortunately, the spacecraft suffered a command system failure after 17 days in orbit.

The first military satellite communications system to be used for operational purposes was known as the Initial Defense Communications Satellite Program (IDCSP). The development program began in 1962, following the cancellation of an earlier, unsuccessful development program called Project Advent. The IDCSP system consisted



Left: The payload fairing is being installed on Titan IIIC-16 at Cape Canaveral. Enclosed in a dispensing mechanism are the last eight satellites of the Initial Defense Communications Satellite Program (IDCSP), successfully launched on 13 June 1968. The IDCSP satellites were small and very simple, with no batteries and no active attitude control system. The dispenser ejected them one at a time into a near-synchronous orbit.

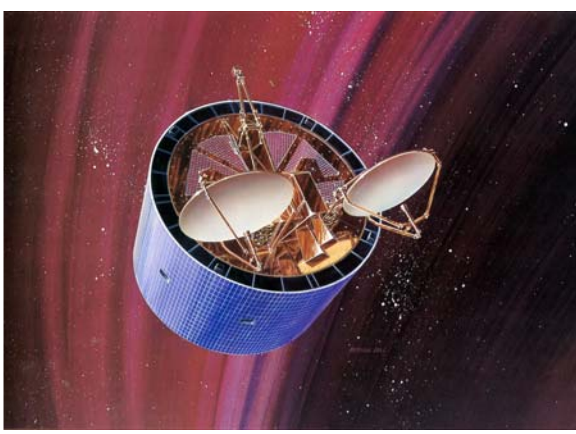
[35] SCORE stopped transmitting when its batteries were exhausted on 31 December 1958. It had no solar cells or other sources of power. It reentered on 21 January 1959.

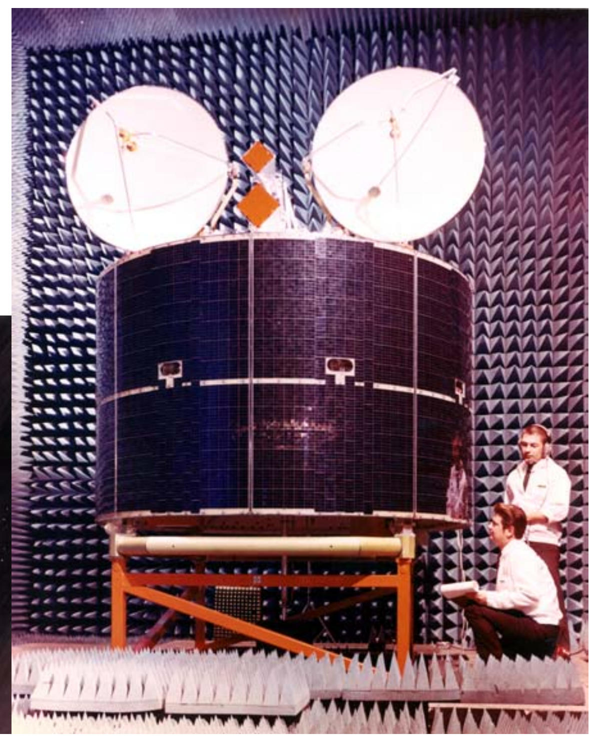
[36] Echo 1, a metallized balloon that acted as a passive experimental communications satellite, was successfully launched by NASA on 2 August 1960.

of small, 100-pound satellites launched in clusters. Twenty-six such satellites were placed into orbit in four launches carried out between June 1966 and June 1968.[37] Two fixed and thirty-four mobile ground terminals also became operational in 1968. IDCSP transmitted both voice and photography to support military operations in Southeast Asia. It provided an experimental but usable worldwide military communications system for the Defense Department for ten years until a more sophisticated system could be developed.

That more sophisticated system was known as the Defense Satellite Communications System, Phase II (DSCS II). The DSCS II satellites were much larger and more sophisticated than the IDCSP satellites, offering increased communications capacity, greater transmission strength, and longer lifetimes. In addition to horn antennas for wide area coverage, they had dish antennas that were steerable by ground command and provided intensified coverage of small areas of the earth's surface. SAMSO awarded a development contract for the DSCS II system to TRW on 3 March 1969, and the first pair of satellites was launched on 2 November 1971. It was the first operational military communications satellite system to occupy a geosynchronous orbit. Two launch failures delayed completion of the satellite network, but by January 1979, the full constellation of four satellites was in place and in operation. A total of 16 DSCS II satellites was built and launched[38] during the life of the program, with the last launch occurring on 4 September 1989.

Below left: An artist's concept depicts a DSCS II satellite in orbit.
Right: A DSCS II satellite undergoes testing in an anechoic chamber.





[37] There were five attempted launches of IDCSP satellites on Titan IIIC launch vehicles during 1966-1968, but the second launch was unsuccessful because of a structural failure in the Titan. Each launch dispensed from three to eight IDCSP satellites into near-synchronous orbits.

[38] DSCS II satellites were launched in pairs using Titan IIIC vehicles through 1979.

In 1973, planning began for the Defense Satellite Communications System, Phase III (DSCS III). DSCS III satellites carry multiple beam antennas to provide flexible coverage and resist jamming, and they offer six active communication channels rather than the four offered by DSCS II. The first DSCS III satellite was successfully launched on 30 October 1982, and a full constellation of five DSCS III satellites was completed on 2 July 1993. Two DSCS IIIs were launched into orbit from a Space Shuttle on 3 October 1985. The constellation was replenished with five launches from 28 November 1993 to 20 October 2000. By early 2003, only two unlaunched DSCS III satellites remained in the inventory. In view of the fact that the DSCS III system would have to support tactical military operations until a follow-on system could be acquired,[39] SMC began an initiative to improve the tactical utility and extend the lifetime of DSCS III satellites. Known as the Service Life Enhancement Program (SLEP), the initiative added improvements to the last four DSCS III satellites before they were launched. Lockheed Martin was placed under contract to carry out the SLEP modifications on 28 March 1996.

Left: An artist's concept depicts a DSCS III satellite in orbit.
Below: A DSCS III satellite is prepared for testing.

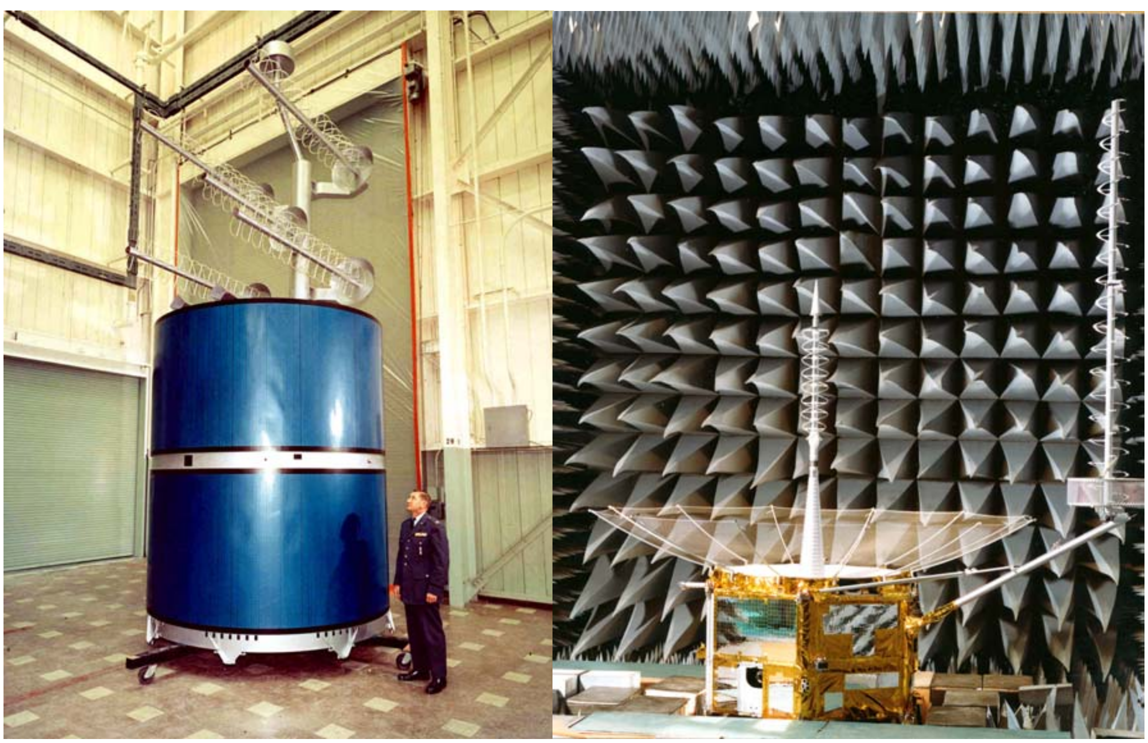
DSCS satellites were developed to serve users who transmitted message traffic at medium to high data rates using relatively large ground terminals. However, satellites were also needed to serve users who transmit at low to medium data rates, using small, mobile or transportable terminals. During the 1960s, experimental satellites were placed into orbit to test technology that might perform this tactical communications mission. Lincoln Experimental Satellites 5 and 6, launched on 1 July 1967 and 26 September 1968, were solid-state, ultra high frequency communication satellites built by Lincoln Laboratory. The 1,600 pound Tactical Communications Satellite, launched on 9

[39] See the Wideband Gapfiller Satellite (WGS) system discussed below.

February 1969, operated in both ultra high frequency and super high frequency and tested the feasibility of communications with small, mobile, tactical communications equipment that could be used by ground, naval, and air forces. In July 1970, an initial operational capability for tactical communications was established, using the Tactical Communications Satellite and Lincoln Experimental Satellite 6.

These experimental satellites paved the way for the Fleet Satellite Communications System (FLTSATCOM), the first operational system serving tactical users. The Navy managed the overall program, but SAMSO managed acquisition of the satellites. Development of FLTSATCOM was authorized on 27 September 1971, and five satellites were launched from 9 February 1978 to 6 August 1981. Four achieved orbit and went into operation, but one was damaged during launch and never became operational. Three replenishment satellites were launched from 5 December 1986 to 25 September 1989. Two reached orbit, but one was lost when its booster was hit by lightning.

In addition to the long-haul users served by DSCS and the tactical users served by FLTSATCOM, there was a third group of users—the nuclear capable forces—who could be satisfied with very low data rates but required high availability, worldwide coverage, and the maximum degree of survivability. The Air Force Satellite Communications System (AFSATCOM) was developed to serve their needs and allow the Air Force to command and control its strategic forces. The space segment of the system relied on



Left: SAMSO's TACSAT program director poses with TACSAT I in the testing facilities of the prime contractor, Hughes Aircraft Company, about 1969. SAMSO launched TACSAT using a Titan IIIC on 9 February 1969, and it operated successfully for 46 months. Right: A FLTSATCOM satellite undergoes testing in an anechoic test chamber.

transponders (receiver/transmitters) placed on board FLTSATCOM satellites and other DOD spacecraft. The space segment of AFSATCOM was declared operational on 15 April 1978, and the terminal segment attained initial operational capability on 22 May 1979.

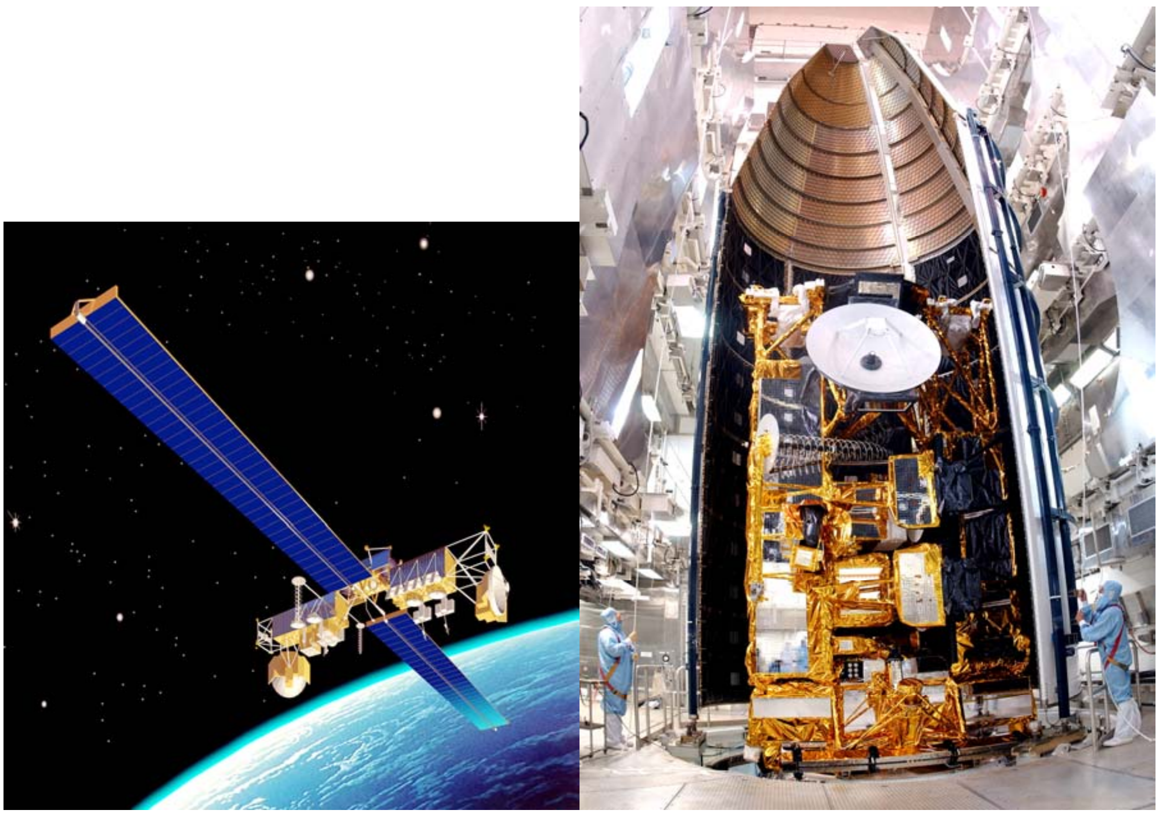
The communications satellites discussed above were all acquired for the U.S. military, but other communications satellites were acquired for the United Kingdom and the North Atlantic Treaty Organization during the 1960s and 1970s. The British Skynet program began in 1966. The first of two Skynet I satellites was placed into orbit on 21 November 1969 and provided the United Kingdom with its first military communications satellite system. The second Skynet satellite was launched from Cape Canaveral on 19 August 1970, but a malfunction in the launch vehicle caused permanent loss of contact with the satellite. In 1970, SAMSO and the United Kingdom began development of a more advanced Skynet II satellite system. The first Skynet II satellite was launched on 18 January 1974, but a malfunction in the launch vehicle again caused the loss of the satellite. The second Skynet II satellite, launched on 22 November 1974, attained orbit successfully and was turned over to the United Kingdom in January 1975.

Development of the NATO satellites began in April 1968, with the initial series of satellites being known as NATO II. One NATO II satellite was placed in orbit on 20 March 1970 and another on 3 February 1971. Both the Skynet and NATO satellites were designed to be compatible and usable with each other and with the Defense Satellite Communications System. Work on a more advanced system, NATO III, began in 1973, and three NATO III satellites were successfully launched between 1976 and 1978. The

Left: The first NATO III satellite (NATO IIIA) is prepared for testing by two technicians at Philco-Ford Corporation, the prime contractor. SAMSO launched the satellite successfully on a Delta launch vehicle from Cape Canaveral on 22 April 1976.

constellation was replenished in November 1984, when a fourth satellite was successfully launched.

The next space communications system to be acquired by SMC was Milstar. Milstar I satellites carry a low data rate payload that provides worldwide, survivable, highly jam-resistant communications for the National Command Authority and the tactical and strategic forces.[40] Advanced processing techniques on board the spacecraft as well as satellite-to-satellite cross linking allow Milstar satellites to be relatively independent of ground relay stations and ground distribution networks. Space Division awarded concept validation contracts for the satellite and mission control segment of Milstar I in March 1982 and a development contract to Lockheed on 25 February 1983. The first Milstar I was successfully launched[41] on 7 February 1994, and the second, on 6 November 1995. In October 1993, SMC awarded a contract for development of the Milstar II satellite, which carried both low and medium data rate payloads. The addition



Left: An artist's concept depicts a Milstar II satellite in orbit. Right: The fifth Milstar satellite is enclosed in the payload fairing on top of its Titan IVB launch vehicle. Its successful launch on 15 January 2002 completed the operational constellation of four Milstar satellites. (Images courtesy Lockheed Martin Missiles and Space)

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[40] Unlike DSCS, which operated in the SHF range (superhigh frequency: 3,000-30,000 megaherz), Milstar operated in the EHF range (extremely high frequency: 30,000-300,000 megaherz). EHF had rarely been used for military communications before Milstar. This frequency range provided natural resistance to jamming. EHF also allowed users to employ smaller, highly mobile terminals.

[41] All Milstar satellites have been launched on Titan IV or IVB vehicles.

of the medium data rate payload greatly increased the ability of tactical forces to communicate within and across theater boundaries. Only four Milstar II satellites were produced because DOD had decided in 1993 that they were to be replenished by a new, lighter, cheaper series of Advanced EHF satellites. Unfortunately, the first Milstar II satellite went into an unusable orbit on 30 April 1999. The next two Milstar II satellites were successfully launched on 27 February 2001 and 16 January 2002 to complete an on-orbit constellation of four satellites. The sixth and last Milstar satellite was successfully launched on 8 April 2003.

In view of the limited future of the Milstar system, SMC also began the acquisition of a follow-on EHF[42] military communications system, known ultimately as the Advanced EHF system or AEHF. The system would be compatible with Milstar elements and would incorporate them throughout their useful lifetimes. Like Milstar, but greatly enhanced, the AEHF system would feature on-board signal processing and satellite crosslinks to eliminate reliance on ground stations for routing data. Data uplinks to the satellites and crosslinks between satellites would operate at EHF, and downlinks would operate at SHF. Whereas Milstar offered low and medium data rate payloads, AEHF satellites would have high data rate payloads as well, providing up to 8.2 million bits of data per second. All services would use AEHF terminals, which would be located on a wide variety of platforms on land, sea, and air. By 2003, plans called for Delta IV and Atlas V launch vehicles to begin launching an operational constellation of three AEHF satellites into inclined geosynchronous orbits in 2006. SMC awarded two competitive contracts for system definition of AEHF on 23 August 1999.[43] On 16 November 2001, it awarded a contract to the team of Lockheed Martin and TRW for a System Development and Demonstration phase of the AEHF system, including production of the first two satellites and the Mission Control Segment.

In 2000, SMC also led a multi-service program to acquire a new series of communications satellites known as the Wideband Gapfiller Satellite (WGS) system to augment DSCS III after about 2004 and finally replace it. Ultimately, WGS would create an Advanced Wideband Satellite system beginning in about 2008. However, the capabilities of the WGS system would be vastly enhanced in comparison to DSCS. WGS would be able to support 96 channels of communication, and it would provide not only two-way tactical military communications, but also a network for a new one-way, wideband satellite broadcast system called the Global Broadcast Service (GBS).[44] SMC

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[42] See note 40 above.

[43] However, these contracts were later modified because of a change in acquisition policy. The System Definition Phase was completed with Lockheed Martin as the prime contractor and with TRW (acquired by Northrop Grumman in 2002) and Hughes as the major subcontractors.

[44] The Global Broadcast Service, a joint-service program, became operational about 1999, using its own transponders on the Navy's UHF Follow-on satellites. GBS was a system for extremely rapid, one-way transmission of high-volume data such as weather, intelligence, and imagery from higher echelons to large groups of dispersed users with small, mobile receivers.

awarded a contract[45] for design and advance procurement of WGS to Boeing Satellite Systems on 7 January 2001. Planners envisioned a constellation of three to six WGS satellites launched on Delta IV and Atlas V vehicles. On 31 January 2002, SMC authorized Boeing to begin production of the first two satellites, and it authorized production of the third satellite on 21 November 2002.

Below: Artist's concept of an Advanced EHF satellite in orbit. Plans called for these satellites to augment and replace the Milstar system.
Right: Artist's concept of a Wideband Gapfiller satellite in orbit. Plans called for these satellites to augment and replace the DSCS constellation.

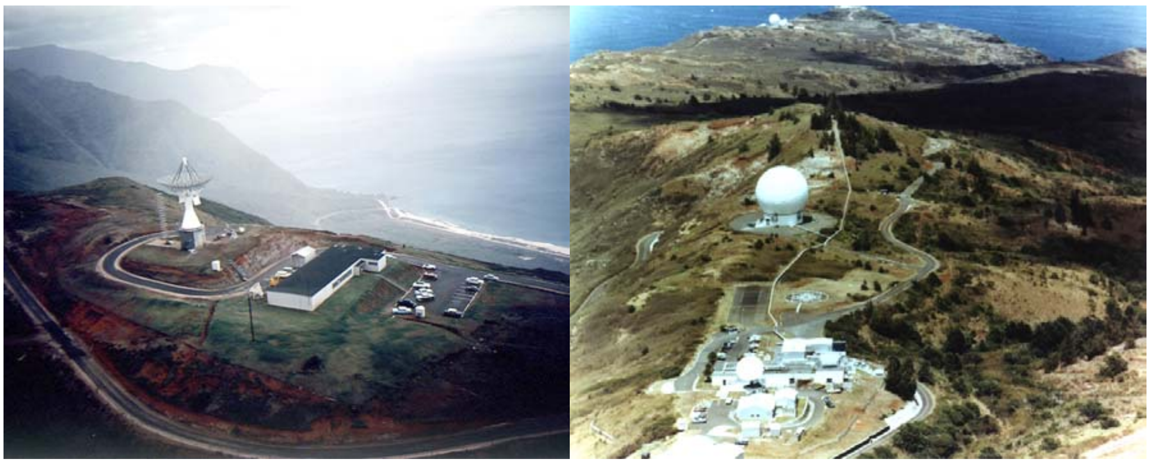
[45] The contract for procurement of the Wideband Gapfiller Satellite was a "near commercial" acquisition, one important feature of which was that little technological development was involved, since most of the components could be obtained commercially.

CHAPTER VI: AIR FORCE SATELLITE CONTROL NETWORK

American military satellites are controlled in orbit by the Air Force Satellite Control Network (AFSCN), a worldwide system which tracks the satellites, receives and processes data transmitted by them, and sends commands to them. Dedicated control segments support individual satellite systems, but a common user element provides support to all satellites belonging to DOD. The common user element presently consists of two control nodes, two scheduling facilities (one at each node), eight remote tracking sites, and the associated communication links.

Top left: A TLM 18 high gain telemetry antenna for the Discoverer program nears the end of construction at Point Mugu in 1958. Top right: A photograph taken in 1959 shows part of the inside of Lockheed's satellite control center. Bottom left: A photograph taken in 1961 shows part of the newly completed master control room in the Air Force Satellite Test Center at Sunnyvale, California. Bottom right: This photograph shows the operations center, known as the Blue Cube, of the Air Force Satellite Control Facility at Sunnyvale AFS, California, as it appeared during the late 1960s and early 1970s. The Blue Cube was constructed during 1967-1968. The Satellite Test Annex was named Sunnyvale AFS on 1 January 1971 and Onizuka AFB on 24 July 1986.

The common user element of the AFSCN was originally activated to support the Discoverer program of the late 1950s and early 1960s. The Air Force Ballistic Missile Division (AFBMD) first established an interim satellite control center at a facility belonging to Lockheed Missile and Space Division in Palo Alto, California, on 15 August 1958.[46] On 6 April 1959, AFBMD established the 6594th Test Wing to operate the control center, and on 1 March 1960, the 6594th transferred its operations to a permanent control center in Sunnyvale, California. The installation in Sunnyvale was originally referred to as the Satellite Test Annex, then as Sunnyvale AFS, and finally as Onizuka AFS.[47] The control center at Sunnyvale was complemented at one time or another by remote tracking stations established at nine different locations between 1959 and 1961. In later years, some of those tracking stations were taken out of service, others were added,[48] and a second control center was also added—the Consolidated Space Operations Center (CSOC), located at Schriever AFB, Colorado.[49]



Left: The Air Force satellite tracking station at Kaena Point on the island of Oahu, Hawaii, soon after its construction in 1959. Right: Kaena Point in about the early 1990s.

Secretary of Defense Harold Brown authorized development of the CSOC in 1979. Originally, it was to consist of two parts—a Satellite Operations Complex (SOC), which would be used for on-orbit control of military satellites, and a Shuttle Operations and Planning Center (SOPC), which would be used for the planning and control of DOD's missions on the Space Shuttle. However, the SOPC was canceled on 13 February 1987, leaving the CSOC with one mission, that of satellite control. The CSOC came on

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[46] Lockheed was the prime contractor for WS 117L (the original military satellite program out of which the Discoverer program emerged in 1958), including the on-orbit tracking and control efforts, known as Subsystem H for the ground systems and Subsystem D for the components on the spacecraft.

[47] During the late 1980s and early 1990s, Onizuka was an Air Force base rather than an Air Force station.

[48] At the time this overview was written, there were eight remote tracking stations. Their locations (with the years in which they were built) were as follows: Vandenberg Tracking Station (1959) at Vandenberg AFB, California; New Hampshire Station (1959) near New Boston, New Hampshire; Hawaii Tracking Station (1959) on the island of Oahu, Hawaii; Thule Tracking Station (1962) at Thule AFB, Greenland; Guam Tracking Station (1965) at Anderson AFB, Guam; Oakhanger Telemetry Control Station (1978) near London, United Kingdom; Colorado Tracking Station (1989) at Falcon AFB, Colorado; and Diego Garcia Tracking Station (1991) on the island of Diego Garcia in the Indian Ocean.

[49] The facility that supported the CSOC was called Falcon AFB at the time that the CSOC became operational. It was renamed Schriever AFB in honor of General Bernard A. Schriever in 1998.

line gradually, starting in 1989. It successfully completed Initial Operational Test and Evaluation on 13 August 1993, and SMC turned it over to Air Force Space Command for operation on 27 September 1993.

The hardware and software used in the AFSCN has undergone numerous upgrades during the last four decades. One of the most significant upgrades was the Data Systems Modernization (DSM) program, which introduced state-of-the-art computer hardware and software to perform command and control of orbiting satellites. The program was initiated in 1980, and by February 1992, the new system was able to perform all of the functions needed to support the satellites then in orbit. DSM was more reliable than the old system, cheaper to maintain, and faster in its operation, allowing it to support a steadily increasing satellite support workload.

The Consolidated Space Operations Center (CSOC), now the headquarters of Air Force Space Command's 50th Space Wing, is shown soon after its completion. SMC developed, built, and tested this satellite control node and its support facilities, turning the complex over to Air Force Space Command in 1993.

Another significant upgrade was the Automated Remote Tracking Station (ARTS) program, which introduced more modern equipment at the tracking stations. The contract for Phase I of the ARTS program was awarded to Ford Aerospace and Communications Corporation on 1 June 1984, and the contract for Phase II was also awarded to Ford Aerospace on 5 August 1988. The Phase II contract expired in March 1995. By that time, ARTS equipment had been installed at all the existing tracking stations and had been used to establish new tracking stations in Colorado Springs and on the island of Diego Garcia. The new equipment offered improved reliability, increased the operational capacity of the tracking stations, and automated many of the functions they performed. Automation and improved reliability reduced the manpower required to operate and maintain the tracking stations and reduced operations and maintenance costs.

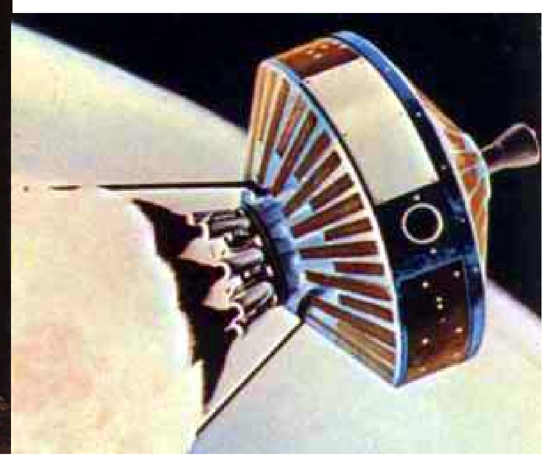
SMC awarded a series of contracts dealing with the AFSCN to Lockheed Martin in 1996. These efforts would modernize most segments of the AFSCN and increase its capabilities. They covered range and communications development, network operations, network integration, and command and control sustainment. By early 2003, the contractor had completed most of these efforts except for certain improvements to the AFSCN's communications segment. However, the program office decided to consolidate sustainment of the AFSCN with ongoing development, systems engineering, and integration. On 18 December 2001, SMC awarded the effort, known as the Satellite Control Network Contract, to Honeywell Technology Solutions.

By 2002, SMC was also managing a coordinated series of modernization projects, known as the Remote Tracking Station Block Change, to upgrade and standardize each of the tracking stations in turn. Design reviews took place in 2002 and 2003, and the tracking stations were scheduled to actually receive the changes from 2004 through 2009.

CHAPTER VII: OTHER PROGRAMS

Pioneer Lunar Missions

The first Air Force spacecraft to be launched and the first space missions to be actually carried out by the Air Force were the Pioneer lunar probes of 1958. They were also the world's first attempted deep space or lunar probes; the first program to receive direction from the Advanced Research Projects Agency when it was created in 1958; and among the first space programs to be transferred to the newly created National Aeronautics and Space Administration. The Thor Able launch vehicle which these missions employed was the first step in the development of the Delta vehicle.



Left: The Thor Able Launch Vehicle for Pioneer 1 stands on the pad at Cape Canaveral before launch on 11 October 1958.
Below right: An artist's concept depicts the fourth stage spacecraft and propulsion assembly developed by STL for the Air Force Pioneer lunar missions.

In January 1958, the Air Force Ballistic Missile Division (AFBMD) and its technical advisory contractor, Space Technology Laboratories (STL), proposed using the newly developed Thor missile with the second stage of the Vanguard[50] rocket to launch the first missions to the moon. The new launch configuration was named the Thor Able. The stated purposes of the missions were to gather scientific data from space and to gain international prestige for America by doing so before the Soviet Union. After the Eisenhower administration activated the Advanced Research Projects Agency (ARPA) on 7 February 1958, the new agency's first directives to the military services dealt with lunar probes. AFBMD was to launch three lunar probes using the Thor Able configuration; the Army Ballistic Missile Agency (ABMA) at Redstone Arsenal, Alabama, was to launch two lunar probes using its Juno II vehicle; and the Naval Ordnance Test Station (NOTS)

[50] Vanguard was a three-stage launch vehicle and small scientific satellite developed by the Naval Research Laboratory. It made the first attempt to launch a U.S. satellite on 6 December 1957 but exploded on the pad. However, it successfully launched the second U.S. satellite on 17 March 1958.

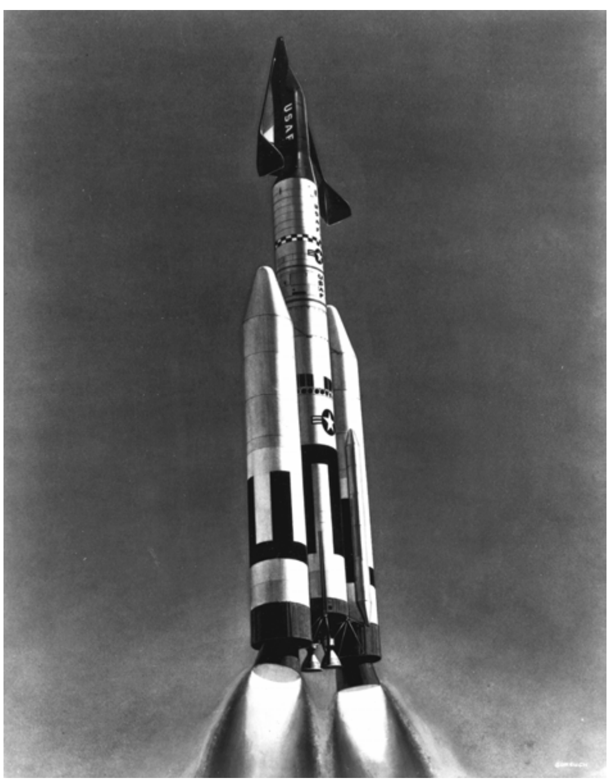
at China Lake, California, was to provide a miniature imaging system to be carried on the lunar probes.

STL designed and assembled the spacecraft and experiments in its R&D Facility, now Area A of Los Angeles AFB, and it assembled and tested the upper stages and spacecraft in the Ramo-Wooldridge hangar at Los Angeles International Airport. Each spacecraft contained experiments to measure the earth's and moon's magnetic fields, the intensity of radiation fields in space, and the number and intensity of micrometeorites, as well as a scanner able to return a rudimentary image of the moon at closer range.

AFBMD launched its lunar probes—known as Pioneer 0, 1 and 2—on 17 August 1958, 11 October 1958, and 8 November 1958. Unfortunately, the first and third probes suffered launch failures, and the second traveled only 71,700 miles into space, about a third of the way to the moon. Nevertheless, Pioneer 1 (the second probe) returned much useful scientific information, especially about the extent of the Van Allen Radiation Belts, and can be considered the world's first successful deep space probe. The Army's second lunar probe, Pioneer 4, actually achieved escape velocity and flew by the moon after launch on 3 March 1959. By then, however, the Soviet Union's Luna 1 spacecraft had already achieved the first successful lunar flyby on 4 January 1959.

Manned Orbiting Laboratory

Although most manned space programs were assigned to NASA in 1958, the Air Force retained a modest effort to explore the potential of manned military missions in the upper atmosphere and near-earth orbit. It was known as the Dyna-Soar or X-20 program. Development of the aerodynamic, manned vehicle was managed by Wright Air



Left: An artist's concept of the Dyna-Soar system depicts the Titan IIIC launch vehicle developed by AFBMD and the manned, aerodynamic vehicle developed by Wright Air Development Center. The program was canceled in 1963 before flying any hardware, but AFBMD and its successors proceeded to develop the Titan IIIC into one of the most important launch vehicles in the Air Force inventory

Development Center at Wright Patterson AFB. Development of the launch vehicle, which became the Titan IIIC space booster after several changes in requirements, was managed by AFBMD. When President Johnson's Defense officials decided that the missions envisaged for Dyna-Soar could be performed better by NASA's Gemini capsules or something like them, the program was canceled on 10 December 1963. At the same time, Secretary of Defense Robert S. McNamara announced the beginning of a program to develop an orbiting laboratory module for manned military space missions. The module would be called the Manned Orbiting Laboratory (MOL), and it would provide a shirt-sleeve environment in which military astronauts would be able to conduct experiments in near-earth orbit for up to thirty days.

Right: An artist's concept of the Manned Orbiting Laboratory (MOL) in orbit. The white, cylindrical element was the laboratory itself; the darker element was a Gemini capsule that would be used to bring astronauts to the lab and return them to earth after their mission was over.

General Schriever, by then commander of Air Force Systems Command, assigned the management of all manned military space programs, including MOL and its launch vehicle, to Space Systems Division. SSD issued contracts for the preliminary design work to Boeing, GE, Douglas, and Lockheed on 1 March 1965. On 25 August 1965, President Lyndon B. Johnson announced that he had approved a development plan for MOL that would cost about $1.5 billion. Douglas Aircraft Company would design and build the spacecraft under SSD’s management, and it would be launched by a new configuration of the Titan IIIC launch vehicle to be called the Titan IIIM. Unfortunately, the program experienced delays, weight and cost increases, and changes in mission, launch site, and launch vehicle. Its only launch occurred on 3 November 1966, when a MOL heatshield incorporating a hatch cover survived a suborbital reentry test on a Gemini capsule. On 10 June 1969, the Office of the Secretary of Defense (OSD) announced the cancellation of the program because of high projected cost increases and because advances in automated, unmanned space systems made it unnecessary. By the time the program was canceled, work was almost finished on construction of a new launch site for the program's Titan IIIM booster at Vandenberg AFB. That launch site was modified ten years later for the Space Shuttle, and it was modified again during 2002-2003 for launches of the Delta IV Evolved Expendable Launch Vehicle.

This group photo, taken in 1968, shows 14 of the 17 MOL astronauts. The first group of eight astronauts was selected in November 1965, the second group of five in June 1966, and the third group of four in June 1967. Following cancellation of the MOL program, seven of the former MOL astronauts became astronauts for NASA, and three later attained general officer or admiral rank. James Abrahamson (top right) became a lieutenant general and Director of the Strategic Defense Initiative Organization. Robert Herres (top left) became a four-star general and Commander-in-Chief of the U.S. Space Command. Richard Truly (bottom right) became a vice admiral and head of the U.S. Naval Space Command. After retiring from the Navy, Admiral Truly joined NASA, serving first as Associate Administrator for Space Flight and later as Administrator.

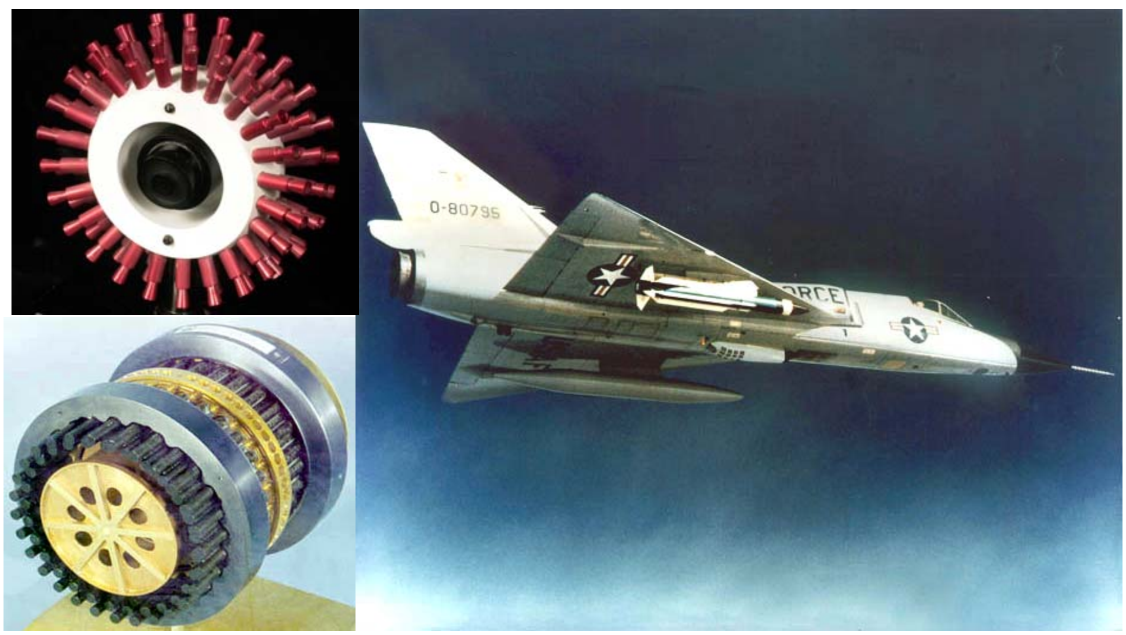
Antisatellite Systems

The nation's first operational antisatellite weapon system was known as Program 505. It was developed by the U.S. Army, using Nike Zeus missiles originally designed for an anti-ballistic-missile role. The Army based the missiles on Kwajalein Atoll in the Pacific, conducted tests, and declared the system operational on 1 August 1963. Nevertheless, Secretary of Defense McNamara abandoned it in favor of the Air Force's antisatellite system in 1964.

The Air Force's antisatellite system was brought into being by Space Systems Division during late 1963 and early 1964. A ground-based system known as Program 437, it employed Thor missiles with nuclear warheads which could be shot into space accurately enough to destroy or disable a hostile space-based weapon or satellite. Secretary of Defense McNamara approved the system's development on 20 November 1962. Thor boosters were modified, combined with ground equipment from deactivated Thor missile sites in England, and deployed to Johnston Island in the Pacific. There they were maintained and operated entirely by Air Force military personnel. Four test launches without live warheads took place, the first on 1 February 1964. Only three of them were successful, but the system was declared fully operational on 1 June 1964, with Air Defense Command as the using command. The capability remained in place, though with few dedicated launchers and a temporary loss of warheads, until it was placed on 30-day standby status on 2 October 1970. The launch facilities on Johnston Island were deactivated on 1 April 1975, and the program was abandoned entirely.[51]

While it was still active, however, SSD added a satellite-inspection capability to the system. On 23 May 1963, SSD's higher headquarters, Air Force Systems Command, ordered studies of the possibility of using Program 437's assets to inspect and photograph hostile satellites on orbit. SSD developed such a system, known as Program 437AP (for Alternate Payload), and conducted several test launches from 7 December 1965 through 2 July 1966. Some of the tests were successful in returning photographs of the targeted Agena spacecraft. The system employed cameras and recovery capsules developed by the Corona program. Nevertheless, the Air Force canceled Program 437AP on 30 November 1966.[52]

During the 1970s, SAMSO began to develop a concept for a follow-on antisatellite weapon system that would not use nuclear warheads. The weapon was actually developed in two successive, related efforts. The first effort was known as Project Spike. It involved launching a two-stage missile from an F-106 aircraft. The missile would release a terminal homing vehicle guided by solid rocket motors on a trajectory to intercept the selected satellite, which it would destroy by impact. The program conducted a static flight test with the ARM missile, fitted with a dummy



The two contractors involved in Project Spike, General Dynamics and Ling-TEMCO-Vought (LTV), designed very different miniature homing vehicles. A plastic model of General Dynamics' vehicle, known as the Gimbaled Miniature Vehicle, is shown at top left. A plastic model of LTV's vehicle, which ultimately became the concept for the later Air-launched ASAT, is shown at bottom left. The vehicles were designed to be launched from an F-106 fighter using a standard Anti-Radiation Missile (ARM) shown under the right wing of the F-106 above. Both were designed to destroy a satellite by impact. The many thrusters on both vehicles were necessary to balance them and adjust their trajectories in flight.

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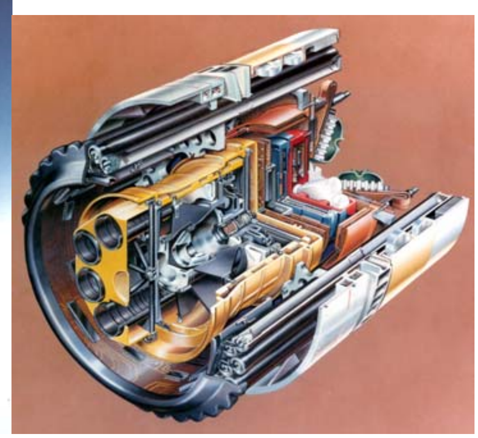
[51] Clayton K.S. Chun, Shooting Down a "Star": Program 437, the US Nuclear ASAT System and Present-Day Copycat Killers, Air University Press, April 2000.

[52] Much of the information about ASAT programs was provided by Major General Thomas P. Taverney.

payload representing the homing vehicle, mounted on a special rack on the F-106.

Project Spike did not enter the development stage, but its technology and design provided the basis for a later antisatellite development program known as the Air-launched ASAT, which SAMSO began to develop in 1976.[53] Like Project Spike, the Air-launched ASAT employed a miniature homing vehicle propelled into space by an air-launched two-stage missile, although in this case the missile was released from an F-15 fighter. The miniature vehicle used a longwave infrared sensor to acquire its target, steered toward the target by selectively firing small rocket motors, and destroyed the target by force of impact. The system achieved a high degree of technological success. Its first free-flight test on 21 January 1984 was successful, although its second test on 2 November 1984 was not.[54] Finally, on 13 September 1985, the ASAT successfully carried out its only flight test against an orbiting satellite,[55] which it destroyed by impact. Despite some further successful testing, the Air-launched ASAT program was terminated by the Air Force on 14 March 1988 because of Congressional restrictions against testing and budgetary constraints.

Left: The Air-launched Antisatellite missile is released from its F-15 launching aircraft and its motor is ignited. At a certain point in its trajectory, the missile released a miniature homing vehicle which destroyed the satellite by impact. Below: A cutaway view of the ASAT's miniature homing vehicle. The rockets were mounted in an outer ring around the vehicle, and the infrared seeker assembly was in the center.



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[53] The program was authorized by President Gerald Ford's National Security Decision Directive 333. See David N. Spires, Beyond Horizons, Air Force Space Command and Air University Press, revised edition, 1998, p. 188.

[54] The first free-flight test did not include a miniature homing vehicle. The second test used a star as a target for the homing vehicle's sensor.

[55] The satellite used as a target was P78-1, an experimental satellite launched in 1979 by SAMSO's Space Test Program.

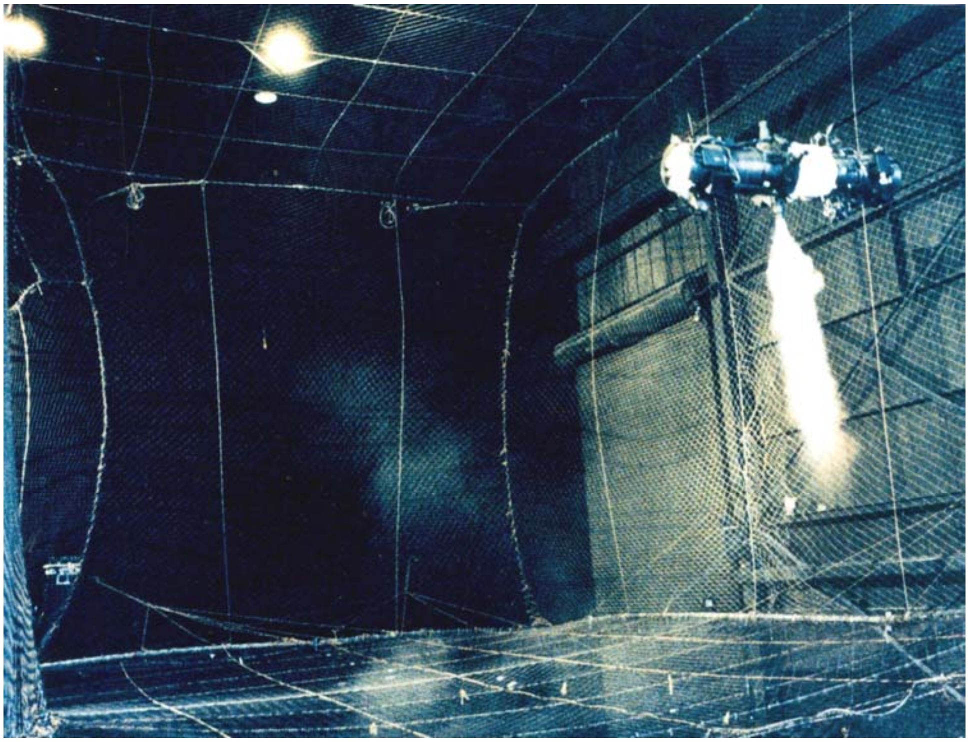
Ballistic Missile Defense

In 1983, DOD began work on developing a national defense against ballistic missiles. Originally, the effort was known as the Strategic Defense Initiative (SDI) and was directed primarily at strategic missiles launched by the Soviet Union. By the early 1990s, however, the Cold War was winding down, and certain third-world countries were posing a new threat, exemplified by the Scud missiles launched by Iraq in the Persian Gulf War of 1991. In response to the change in circumstances, the missile defense effort was redirected toward a more limited protection of U.S. territory, troops and allies from the more limited threat posed by third-world ballistic missiles. The new overall concept was called Global Protection Against Limited Strikes (GPALS), and the Strategic Defense Initiative was renamed Ballistic Missile Defense (BMD).

Included under the umbrella of SDI, and later BMD, were programs for surveillance systems to detect and track enemy missiles and for directed and kinetic energy weapons to destroy those missiles. Funding and direction for these programs came from OSD's Strategic Defense Initiative Organization (SDIO), later renamed the Ballistic Missile Defense Organization (BMDO) and later still the Missile Defense Agency (MDA). Space Division was involved in the earliest studies and continued to execute the major programs assigned to the Air Force. On 5 August 1987, the Defense Acquisition Board selected three of SSD's programs for demonstration and validation: the Boost Surveillance and Tracking System, which would track enemy missiles in the early phase of their ballistic trajectory; the Space Surveillance and Tracking System, which would track them in the mid-course phase of their ballistic trajectory; and the Space-Based Interceptor, an orbiting, rocket-propelled weapon system that would destroy enemy missiles by impact. These systems were expected to become part of the first phase of a Strategic Defense System. As the overall concept for that system evolved, the three programs were affected in different ways.

The Space-Based Interceptor (SBI) system was to consist of groups of interceptors housed in orbiting modules with housekeeping and battle functions. In 1990, the SDIO decided to pursue an alternate system based on a weapons concept called Brilliant Pebbles, which would consist of many highly autonomous interceptors floating independently in orbit. Development of Brilliant Pebbles was transferred from the BMDO to SMC in FY 1993. By that time, however, the program was being cut back, and it was terminated in 1994 as interest shifted away from defense against strategic missiles and toward defense against theater ballistic missiles launched by third-world countries. In August 1994, OSD approved a concept for a Boost Phase Interceptor (BPI) that would respond to the new threat. It endorsed a BPI technology demonstration led by the Air Force, and SMC was to manage the program and acquire the BPI missile. Congress appropriated funding for the BPI for 1995, but future funding support from the Air Force and BMDO appeared uncertain.

The SDIO's decision to replace the SBI system with a system using many highly autonomous interceptors affected the Boost Surveillance and Tracking System (BSTS) as well as SBI. The independent targeting capabilities to be incorporated into each autonomous interceptor reduced the SDIO's requirements for separate systems of sensors such as BSTS, and management of BSTS was therefore transferred to the Air Force. As



A partially successful hover test of a laboratory model of the Space-Based Interceptor (SBI) is conducted at the Air Force Astronautics Laboratory, Edwards AFB, California, in November 1988. This pre-prototype interceptor was demonstrated successfully in three series of SBI hover tests at the Astronautics Laboratory. The first series tested the interceptor's guidance and propulsion systems. The second series demonstrated the ability of the interceptor's integrated seeker assembly to lock on to a thrusting rocket plume and then shift its aimpoint from the hot, bright plume to the relatively cold, dim body of the rocket. This was a critical and previously unsatisfied requirement for any anti-ballistic-missile weapon system using infrared seekers. The last hover, the only one in the third series, took place on 10 April 1992. It tested a vehicle that was partially miniaturized and much closer in weight to an operational interceptor. The hover accomplished almost all of its objectives despite an anomaly late in the test. The SBI pre-prototype interceptor became the pre-prototype for the SDIO's preferred space-based weapon system, Brilliant Pebbles, which was terminated in 1994 for lack of funding.

an Air Force program, the system would improve upon and replace the existing DSP system. It would detect and track enemy missiles but would not have to provide extremely accurate targeting information that would allow kinetic or directed energy weapons to shoot the missiles down.

After being transferred to the Air Force, BSTS was renamed the Advanced Warning System (AWS) and then the Follow-on Early Warning System (FEWS). In November 1993, the FEWS program was canceled and replaced with a cheaper alternative called the Alert Locate and Report Missiles (ALARM) program. Before the ALARM program could really get started, however, it was replaced in its turn by the Space-Based Infrared System (SBIRS).[56]

Unlike BSTS, the Space Surveillance and Tracking System (SSTS) remained an

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[56] For an overview of the family of infrared detection programs known as SBIRS, see the section called Infrared Early Warning Systems under Chapter V, Satellite Systems, earlier in this history.

SDI program, but it went through several restructurings and changes in concept. The program's flight experiments were canceled, and its planned constellation of satellites became smaller and cheaper. In July 1990, the SDIO renamed the program Brilliant Eyes, and Brilliant Eyes became a far simpler system as interest shifted from protection against Soviet strategic missiles toward protection against shorter range, third-world missiles. In FY 1995, funding for Brilliant Eyes was reduced, and the program's development efforts were cut back. However, plans called for SBIRS satellites in low earth orbit to use Brilliant Eyes technologies to track missiles in the middle portion of their trajectories.

Space Test Program

The Space Test Program (STP) provided space flight opportunities for research and development payloads sponsored by DOD agencies that did not have their own funds to develop, launch, and operate spacecraft. Each year, the Air Force Secretariat convened the Space Experiments Review Board (SERB), comprised of voting members from all DOD agencies. The SERB reviewed requests for space flights and produced an annual list of requests that it had approved, arranged in order of priority for available flights. Each year, STP flew as many SERB payloads as possible, considering priority, opportunity, and funding. SMC and its organizational predecessors had managed STP for DOD since the program officially began in 1965.

Space Systems Division first set up an office for planning and coordination of flights for space experiments on 1 December 1963. An important consideration in planning for such flights was the fact that the new Titan IIIC launch vehicle (which made its first flight on 18 June 1965) would soon provide more opportunities for launching secondary payloads. As the most powerful launch vehicle in the inventory, it would be capable of launching more and heavier payloads on each mission than it was then scheduled to carry. In view of that, a memorandum of 6 May 1965 from the Director of Defense Research and Engineering asked the Air Force to identify experiments worthy of including in the new vehicle's multiple payload dispensers. On 12 July 1965, General Schriever, then commander of Air Force Systems Command (AFSC), ordered the establishment of a command program managed by SSD to rank all experiments whose sponsors proposed to use the excess payload capacity of the new Titan IIIC. AFSC expanded the types of launch vehicles that would be used in the program a few months later. SSD soon named the new program the Space Experiments Support Program (SESP) and, in September 1965, convened the first meeting of representatives from various government agencies to select experiments for available launches. On 12 March 1968, the Air Staff announced that SESP would be responsible for providing all flight opportunities for research and technology experiments sponsored by government agencies.[57] The program was renamed the Space Test Program (STP) in July 1971 to better describe the broader mission it was beginning to perform.

[57] SESP had formerly flown only development and engineering experiments, and the Air Force's Office of Aerospace Research had supported scientific and research experiments. SESP now would be responsible for all of those experiments.

The first SESP mission (P67-1[58]) was launched on 29 June 1967 using a Thor Burner II launch vehicle. It consisted of two separate satellites carrying geodesy and aurora experiments for the Army and Navy. By the middle of the year 2003, STP had flown 168 missions carrying 435 experiments. Many of those missions tested concepts and technology for later operational military satellite systems. In fact, from the early 1970s to the early 2000s, every operational satellite system for DOD flew preliminary experiments through SESP or STP.

We can mention here only a few of the program's best-known missions. The Navigation Technology Satellites NTS-1 and NTS-2 (STP missions P73-3 and P76-4) tested technology—and, in the case of NTS-2, served as a prototype—for satellites of the Global Positioning System. Lincoln Experimental Satellites LES-6 and LES-8/9 (P67-2 and P74-1) demonstrated technology for tactical satellite communications. SOLWIND (P78-1) collected images of the solar corona and finally served as a target for the Air-launched ASAT in 1985. Spacecraft Charging at High Altitudes (SCATHA, P78-2) collected data about the buildup of electrical charges on spacecraft. The Combined Release and Radiation Effects Satellite (CRRES, STP mission P86-1) tested the effects of radiation on electronic components. The Cryogenic Infrared Radiance Instrument for Shuttle (CIRRIS-1A), also known as AFP-675, conducted experiments from the space shuttle (STS-39) dealing with infrared background and detection.[59]

Two of the more recent successes managed and flown by STP were the Advanced Research and Global Observation Satellite (ARGOS, STP mission P91-1) and Coriolis (STP mission P98-2). ARGOS carried nine experiments in a sun-synchronous orbit. It returned data from tests dealing with ionospheric weather, electric propulsion, physics of gas ionization, plume detection, and distribution of orbital debris. ARGOS was the largest, heaviest, most complex, and most costly STP mission to date. Coriolis was managed, launched, and operated by STP. It hosted experimental sensors that provided data about earth and space environments. STP's mission of flying as many experiments as possible—often by having more than one payload share its available spacecraft—sometimes created engineering challenges and ingenious solutions. In the case of Coriolis, for example, one of its sensors (WindSat) had to spin at 31 rpm, while the other (the Solar Mass Ejection Imager) had to lock onto the sun without moving.

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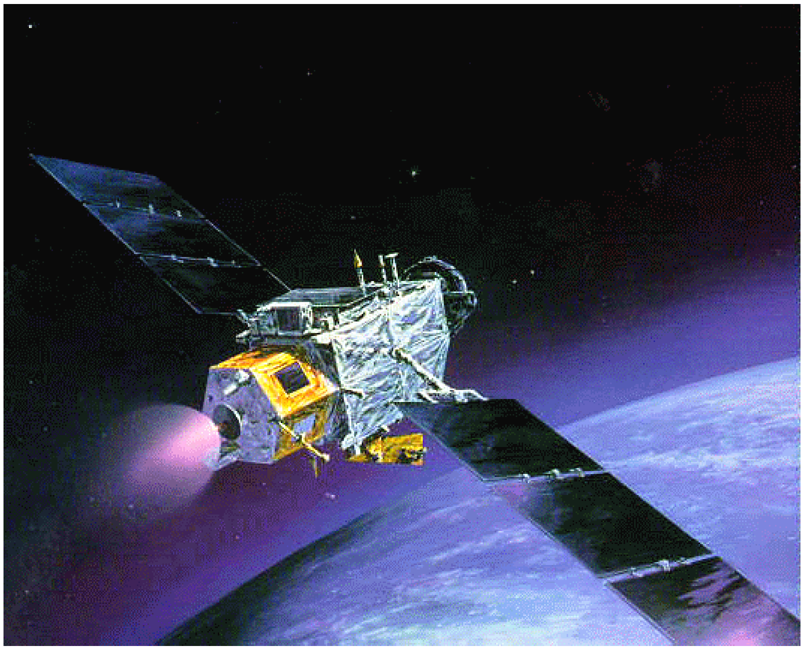
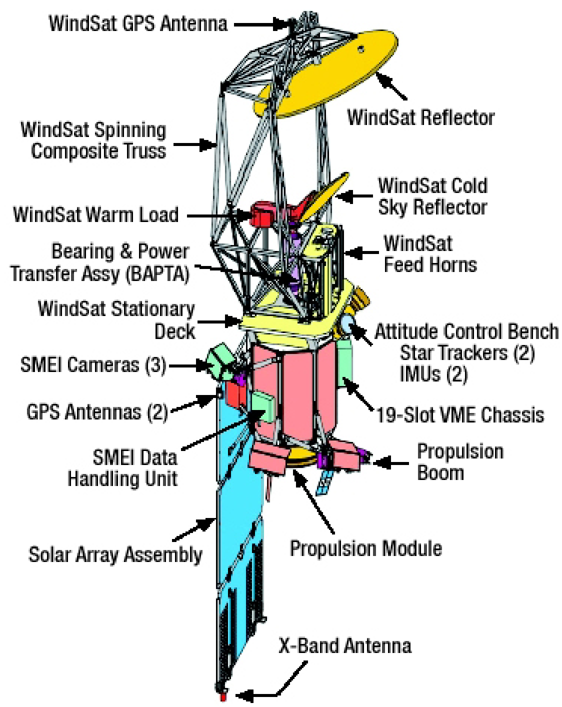
[58] The mission designations used by SESP and STP indicated by their first letters whether the experiments were the primary (P) or secondary (S) payloads for that launch. Later, when STP manifested experiments on the space shuttle, it designated them with the number that NASA assigned to the shuttle mission—for example, STS-83. The designations also showed the year (P**67**-1) and the sequence (P67-**1**) in which the experiments were first manifested for launch. Each experiment within the mission was designated by a name or acronym: for example, the Army experiment on P67-1 was SECOR (Sequential Collation of Range), and the Navy experiment was Aurora I.

[59] The launch dates for the STP missions listed in this paragraph are: P73-3, 14 July 1974; P76-4, 23 June 1977; P67-2, 26 September 1968; P74-1, 15 March 1976; P78-1, 24 February 1979; P-78-2, 30 January 1979; P86-1, 25 July 1990; STS-39, 28 April 1991; P98-2, 6 January 2003.



Left: An artist's concept of the Advanced Research and Global Observation Satellite (ARGOS, STP mission P91-1) in orbit. It carried two technology demonstrations and seven high-priority experiments related to ionospheric studies, electrical systems, and electric propulsion. The experiments were provided by research agencies within the Navy, Army, and Air Force. ARGOS was launched successfully using a Delta II booster on 23 February 1999.



Right: A diagram of the Coriolis satellite shows the major components of its two primary experiments. One was the Naval Research Laboratory's WindSat, which measured wind speed and direction at the surface of the ocean using microwave emissions. It was designed to reduce developmental risks for a new sensor for the NPOESS meteorological satellites (page 42). The other was the Air Force Research Laboratory's Solar Mass Ejection Imager (SMEI), which used three cameras to monitor the propagation of the sun's coronal mass ejections through space, thus warning several days in advance of geomagnetic storms which could disrupt satellite communications and navigation. Coriolis was launched successfully using a Titan II booster on 6 January 2003.

STP performed its mission of providing spaceflight opportunities for experimental payloads in other ways as well. For example, it led in the development of standardized racks, containers, interfaces, and platforms for experiments to be flown as secondary payloads on the space shuttle, Evolved Expendable Launch Vehicles (EELVs), and the International Space Station.[60] STP also put the first internal and external research and development experiments on the International Space Station.[61]

[60] Those standardized devices included the SPARTAN 401 platform deployed by the space shuttle, the Shuttle Hitchhiker Experiment Launcher System (SHELS), the Bridge Launcher System (BLS) pallet for the space shuttle, the EELV Secondary Payload Adapter (ESPA), the Canister for All Payload Ejections (CAPE), and the Window Observation Research Facility (WORF).

[61] The first internal experiment on the International Space Station was the Middeck Active Control Experiment (MACE II), and the first external experiment was the Materials on International Space Station Experiment (MISSE).

CHAPTER VIII: INCREASING RELIANCE ON SPACE SYSTEMS IN COMBAT

The space systems acquired by SMC's predecessors during the 1970s and 1980s made significant contributions to the success of Operation Desert Storm, when United Nations forces led by the United States liberated Kuwait in 1991 after the 1990 Iraqi invasion. It was the first major test of space support for a large military campaign. Once enough ground terminals were brought into the region, DSCS provided 84 percent of the super-high-frequency, long-haul, intertheater communications required for operations, and it supplied much of the short-range, intratheater communications as well. The GPS Program Office made emergency buys of critically needed Small Lightweight GPS Receivers (SLGRs). The various kinds of GPS user equipment greatly increased the American advantage during Desert Storm by helping ground troops navigate through the featureless desert, helping naval vessels map mine fields and maneuver through them, and by helping Air Force and Navy aircraft navigate to their targets and deliver their weapons more accurately. The DMSP Program Office deployed existing weather terminals and quickly procured a new terminal—the Rapid Deployment Imagery Terminal (RDIT)—to support American forces in the Persian Gulf. DMSP provided commanders with high resolution, near real time weather information that was an important part of planning air and ground operations. Finally, DSP played a significant role during Operation Desert Storm, when it detected hostile tactical missiles fired at targets in Israel and Saudi Arabia.


Above left: An American soldier holds one of the Small Lightweight GPS Receivers (SLGRs) used during Operation Desert Storm. Above right: An artist's concept depicts a DMSP Rapid Deployment Imagery Terminal (RDIT) used during Operation Desert Storm.

In 1999, the North Atlantic Treaty Organization launched Operation Allied Force to stop the ethnic cleansing campaign in Kosovo that was being conducted by the Yugoslavian armed forces directed by President Slobodan Milosevic. NATO, with U.S. Air Force units as its largest component, conducted air strikes against Serbian targets rather than launching a traditional military campaign with massed ground forces. Air Force space systems played a vital role in this unique air war. The satellites acquired by SMC provided more information faster and more accurately than they had during Operation Desert Storm. GPS had attained initial operational capability in 1993, when it completed its

24-satellite constellation. Therefore it was available 24 hours a day. During Desert Storm, only nine percent of the Allied munitions had been GPS-guided "smart" bombs, but in Operation Allied Force, the majority of the munitions were smart bombs that hit targets with remarkable precision. They played an important part in efforts to avoid civilian casualties and collateral damage from NATO's air attacks. DMSP meteorological information was used to predict and exploit the frequently bad weather over Yugoslavia. The high quality of DMSP's cloud imagery and forecasts allowed strike planners to more confidently identify targets for precision weapons. Images from surveillance satellites were one of the most important sources of data in choosing targets and in assessing damage after they were attacked. DSCS and Milstar satellites provided the most important medium of communications for both aircraft and NATO commanders during the campaign. After a 78-day campaign, Milosevic capitulated and agreed to NATO's peace terms. Operation Allied Force proved that, if the conditions are right, a war can be won using primarily air power and space support.

The United States launched Operation Enduring Freedom in October 2001 against the Taliban regime in Afghanistan, which harbored Osama bin Laden and his Al Qaeda terrorist organization. Members of that organization had carried out terrorist attacks on 11 September 2001 against the World Trade Center in New York and the Pentagon. Air Force space systems provided information even more accurately and rapidly than they had during Operation Allied Force. Initially, small groups of elite American military units were deployed to Afghanistan to support the anti-Taliban Afghan fighters. These Americans carried 2.75-pound Precision Lightweight GPS Receivers (PLGRs) and satellite-based communication devices that they used to pinpoint enemy targets and call

Left: A U.S. Marine prepares for combat in Operation Enduring Freedom by checking out a commercial GPS unit. (U.S. Marine Corps photograph)
Below left: A B-52 navigator plots a course over Iraq in April 2003 using GPS user equipment. (U.S. Air Force photograph)
Below right: An Air Force operator works with satellite weather images at a tactical terminal in Iraq in March 2003. (U.S. Air Force photograph)

in devastating air strikes against them. GPS-guided munitions struck with great accuracy and reduced the number of air sorties needed to destroy a target. The advanced DSCS, upgraded Milstar, and evolving GBS space systems provided American forces with a variety of improved high-speed, long-range communications. The quantity of intelligence and data relayed from space was unprecedented. DMSP provided meteorological information in support of the air campaign, and it also supported ground troops, who had to endure harsh regional weather. The Taliban regime was overthrown in early 2002, and Al Qaeda lost its base of operations and scattered. During Operation Enduring Freedom, Air Force space systems provided an indispensable support system that was always accepted, valued, and used by American forces in the air, on the ground, and at strategic headquarters.

Operation Iraqi Freedom began with an invasion of Iraq on 19 March 2003 by a coalition of American, British, and Australian Forces planning to end the regime of Saddam Hussein. The operation was still in progress at the time this history was written, but it seemed clear that space-based systems would provide even greater precision, speed, and other economies of force than they had during earlier military operations. Lieutenant General Brian A. Arnold, SMC's commander, described the contributions of space systems to improvements in the timeliness of weapons delivery by saying that the average time involved in identifying and hitting a target had been about a day during Operation Desert Storm, about 45 minutes during Operation Enduring Freedom, and about 11 minutes during Operation Iraqi Freedom. He added that future improvements could come by downloading data—GPS positioning data, for example—directly from space systems into munitions.[62] Clearly, Air Force space systems had not only contributed to an American military advantage, they were on the verge of creating radical changes in the prosecution of war.

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[62] Richard Tuttle, "New Tactics: Fast-paced Technology In the Air and On the Ground Opens Doors in Iraqi Freedom," Aviation Week and Space Technology, 9 June 2003.

APPENDICES

A. Dates Of Organizations, Commanders and Vice Commanders of SMC and Its Predecessors, and Commanders of 61st Air Base Group and Its Predecessors

B. Emblem of the Space and Missile Systems Center

C. Organizational Emblems Used by SMC and Its Predecessors

D. Emblems Used by the 61st Air Base Group, Its Predecessors, and Its Squadrons

E. Meaning of Streamers on SMC's Organizational Flag

F. Air Force Organizational Excellence Awards and Air Force Outstanding Unit Awards to Headquarters Elements of SMC and Its Predecessors

DATES FOR SMC, ITS ORGANIZATIONAL PREDECESSORS, AND THEIR COMMANDERS

Western Development Division
(1 Jul 1954 – 31 May 1957)

Maj Gen Bernard A. Schriever	*2 Aug 1954 – 31 May 1957*

Air Materiel Command Contingent

Special Aircraft Project Office (SAPO)
15 Aug 1954 – 14 Mar 1956

Ballistic Missiles Office
15 Mar 1956 – 11 Sep 1958

Ballistic Missiles Center
12 Sep 1958 – 1 Apr 1961

Air Force Ballistic Missile Division
(1 Jun 1957 – 31 Mar 1961)

Maj Gen Bernard A. Schriever	*1 Jun 1957 – 24 Apr 1959*
Maj Gen Osmond J. Ritland	*25 Apr 1959 – 31 Mar 1961*

Deputy Commander for Aerospace Systems
(*1 Apr 1961 – 10 Oct 1962)*

Lt Gen Howell M. Estes, Jr.	*1 Apr 1961 – 10 Oct 1962*

Space Systems Division
(1 Apr 1961 – 30 Jun 1967)

Maj Gen Osmond J. Ritland	*1 Apr 1961 – 13 May 1962*
Lt Gen Howell M. Estes. Jr.	*14 May 1962 – 2 Oct 1962*
Maj Gen Ben I. Funk	*3 Oct 1962 – 31 Aug 1966*
Maj Gen Paul T. Cooper	*1 Sep 1966 – 30 Jun 1967*

Ballistic Systems Division
(1 Apr 1961 – 30 Jun 1967)

Maj Gen Thomas P. Gerrity	*1 Apr 1961 – 30 Jun 1962*
Maj Gen W. Austin Davis	*1 Jul 1962 – 18 Jul 1964*
Maj Gen Harry J. Sands, Jr.	*19 Jul 1964 – 19 Jul 1966*
Maj Gen John L. McCoy	*20 Jul 1966 – 30 Jun 1967*

Space and Missile Systems Organization
(1 Jul 1967 – 30 Sep 1979)

Lt Gen John W. O'Neill	*1 Jul 1967 – 31 Aug 1969*
Lt Gen Samuel C. Phillips	*1 Sep 1969 – 24 Aug 1972*
Lt Gen Kenneth W. Schultz	*25 Aug 1972 – 28 Aug 1975*
Lt Gen Thomas W. Morgan	*29 Aug 1975 – 28 Apr 1978*
Lt Gen Richard C. Henry	*28 Apr 1978 – 30 Sep 1979*

Space Division
(1 Oct 1979 – 14 Mar 1989)

Lt Gen Richard C. Henry	*1 Oct 1979 –1 May 1983*
Lt Gen Forrest S. McCartney	*1 May 1983 – 30 Sep 1986*
Lt Gen Aloysius G. Casey	*9 Oct 1986 – 23 Jun 1988*
Lt Gen Donald L Cromer	*24 Jun 1988 – 14 Mar 1989*

Ballistic Missile Office
(1 Oct 1979 – 14 Mar 1989)

Maj Gen John W. Hepfer	*1 Oct 1979 – 31 Oct 1980*
Maj Gen Forrest S. McCartney	*31 Oct 1980 – 19 May 1982*
Maj Gen Aloysius G. Casey	*19 May 1982 – 30 Sep 1986*
Maj Gen Edward P. Barry, Jr.	*30 Sep 1986 – 14 Mar 1989*

Space Systems Division
(15 Mar 1989 – 30 Jun 1992)

Lt Gen Donald L. Cromer	*15 Mar 1989 – 31 May 1991*
Lt Gen Edward P. Barry, Jr.	*8 Jul 1991 – 30 Jun 1992*

Ballistic Systems Division
(15 Mar 1989 – 4 May 1990)

Maj Gen Edward P. Barry, Jr.	*15 Mar 1989 – 30 May 1989*
Brig Gen Ralph G. Tourino	*30 May 1989 – 4 May* 1990

Space and Missile Systems Center
(1 Jul 1992 –)

Lt Gen Edward P. Barry, Jr.	*1 Jul 1992 – 16 Nov 1994*
Lt Gen Lester L. Lyles	*17 Nov 1994 – 18 Aug 1996*
Lt Gen Roger G. DeKok	*19 Aug 1996 – 12 Aug 1998*
Lt Gen Eugene L. Tattini	*13 Aug 1998 – 25 May 2001*
Lt Gen Brian A. Arnold	*25 May 2001 – 20 May 2005*
Lt Gen Michael A. Hamel	*20 May 2005 -*

Program Executive Officers for Space
(at HQ USAF Sep 1990 – Jun 2001)
(15 Feb 1990 –)

Maj Gen Garry A. Schnelzer	*15 Feb 1990 – 1 May 1995*
Mr. Brent R. Collins	*28 May 1996 – 31 Dec 2000*
Maj Gen Craig R. Cooning	*1 Jan 2001 – 18 Feb 2002*
Lt Gen Brian A. Arnold	*19 Feb 2002 – 20 May 2005*
Lt Gen Michael A. Hamel	*20 May 2005 –*

DATES FOR SMC, ITS ORGANIZATIONAL PREDECESSORS, AND THEIR VICE COMMANDERS

Western Development Division
(1 Jul 1954 – 31 May 1957)

Brig Gen Osmond J. Ritland	*23 Apr 1956 – 31 May 1957*

Air Force Ballistic Missile Division
(1 Jun 1957 – 31 Mar 1961)

Brig Gen Osmond J. Ritland	*1 Jun 1957 – 24 Apr 1959*
Brig Gen Charles H. Terhune, Jr.	*25 Apr 1959 – 22 Jun 1960*
Brig Gen Harvard W. Powell	*23 Jun 1960 – 31 Mar 1961*

Deputy Commander for Aerospace Systems
(*1 Apr 1961 – 10 Oct 1962)*

Brig Gen Harvard W. Powell	*1 Jul 1961 – 10 Oct 1962*

Space Systems Division
(1 Apr 1961 – 30 Jun 1967)

Maj Gen Robert E. Greer	*1 Apr 1961 – 30 Jun 1962*
Brig Gen Harvard W. Powell	*1 Jul 1962 – 9 Jun 1963*
Brig Gen Joseph J. Cody	*10 Jun 1963 – 31 Jul 1964*
Brig Gen Paul T. Cooper	*1 Aug 1964 – 31 Aug 1966*
Brig Gen David V. Miller	*1 Sep 1966 – 30 Jun 1967*

Ballistic Systems Division
(1 Apr 1961 – 30 Jun 1967)

Brig Gen Don Coupland	*1 Apr 1961 – 10 Sep 1961*
Maj Gen Donald R. Ostrander	*11 Sep 1961 – 21 Sep 1962*
Brig Gen Harold K. Kelley	*7 Mar 1963 – 4 Aug 1963*
Brig Gen Samuel C. Phillips	*5 Aug 1963 – 9 Jan 1964*
Col Ray E. Soper	*12 Aug 1964 – 31 Oct 1966*
Col Robert I. Barrowclough	*1 Nov 1966 – 30 Jun 1967*

Space and Missile Systems Organization
(1 Jul 1967 – 30 Sep 1979)

Maj Gen Paul T. Cooper	*1 Nov 1967 – 31 Jul 1968*
Brig Gen Louis L. Wilson, Jr.	*1 Aug 1968 – 31 Jul 1970*
Brig Gen Robert A. Duffy	*1 Aug 1970 – 31 Jul 1971*
Brig Gen Thomas W. Morgan	*1 Aug 1971 – 12 Nov 1972*
Brig Gen Herbert A. Lyon	*13 Nov 1972 – 29 Mar 1974*
Maj Gen Richard C. Henry	*16 Aug 1974 – 31 Aug 1976*
Maj Gen Howard E. McCormick	*1 Sep 1976 – 1 Jul 1978*
Maj Gen Gerald K. Hendricks	*1 Jul 1978 – 30 Sep 1979*

Space Division
(1 Oct 1979 – 14 Mar 1989)

Maj Gen Gerald K. Hendricks	*1 Oct 1979 –1 Jun 1982*
Maj Gen Forrest S. McCartney	*1 Jun 1982 – 1 May 1983*
Maj Gen Bernard P. Randolph	*1 May 1983 – 10 Jun 1984*
Brig Gen Donald L. Cromer	*7 Jan 1985 – 30 Jun 1986*
Lt Gen Donald K. Kutyna	*1 Jul 1986 – 1 Nov 1987*
Maj Gen Robert R. Rankine, Jr.	*1 Nov 1987 – 14 Mar 1989*

Ballistic Missile Office
(1 Oct 1979 – 14 Mar 1989)

Brig Gen Forrest S. McCartney	*1 Oct 1979 – 31 May 1981*
Col Stanley S. Berry	*2 Jun 1981 – 30 Jun 1984*
Brig Gen David B. Englund	*1 Jul 1984 – 28 Jul 1985*
Brig Gen Edward P. Barry, Jr.	*1 Sep 1985 – 29 Sep 1986*
Col C.J. (Cass) Schichtle, Jr.	*6 Oct 1986 – 31 Mar 1987*
Col Roger A. McClain	*1 Apr 1987 – 14 Mar 1989*

Space Systems Division
(15 Mar 1989 – 30 Jun 1992)

Maj Gen Robert R. Rankine, Jr.	*15 Mar 1989 – 30 Mar 1990*
Brig Gen Jean E. Klick	*31 Mar 1990 – 8 Jul 1991*
Brig Gen Eugene L. Tattini	*3 Sep 1991 – 30 Jun 1992*

Ballistic Systems Division
(15 Mar 1989 – 4 May 1990)

Col Roger A. McClain	*15 Mar 1989 – 31 Mar 1990*
Col James B. Young	*1 Apr 1990 – 4 May 1990*

Space and Missile Systems Center
(1 Jul 1992 –)

Brig Gen Eugene L. Tattini	*1 Jul 1992 – 2 Dec 1994*
Col John S. Boone	*27 Nov1995 – 21 Jul 1996*
Brig Gen John L. Clay	*22 Jul 1996 – 20 Aug 1998*
Brig Gen Michael A. Hamel	*21 Aug 1998 – 18 Aug 1999*
Brig Gen William M. Wilson	*19 Aug 1999 – 19 Oct 2001*
Maj Gen Craig R. Cooning	*20 Oct 2001 – 23 Jun 2004*
Brig Gen Larry D. James	*6 Jul 2004 – July 2005*
Brig Gen William N. McCasland	*Oct 2005 – 1 June 2007*
Brig Gen Ellen M. Pawlikowski	*10 July 2007* -

GROUPS, WINGS, AND THEIR COMANDERS SUPPORTING SMC AND ITS PREDECESSORS

6592nd Support Group
(16 Nov 1959 – 15 Jul 1961)

Col W.R. Morton	*16 Nov 1959 – 15 Jul 1961*

6592nd Support Wing
(15 Jul 1961 – 10 Oct 1962)

Col W.R. Morton	*15 Jul 1961 – 30 Sep 1962*

6592nd Support Group
(10 Oct 1962 – 1 Aug 1971)

Col Roy D. Russell	*1 Oct 1962 – 1 Mar 1966*
Col Howard E. Short	*1 Mar 1966 – 30 Dec 1966*
Col Julius B. Summers	*1 Jan 1967 – 1 Nov 1968*
Col Neil W. Wemple	*1 Nov 1968 – 1 Aug 1969*
Col Roy E. Guy	*1 Aug 1969 – 1 Aug 1971*

6592nd Air Base Group
(1 Aug 1971 – 30 Sep 1993)

Col Roy E. Guy	*1 Aug 1971 – 1 Jul 1972*
Col Calvin C. Schneider	*1 Jul 1972 – 13 Sep 1974*
Col Judson A. Herriott	*13 Sep 1974 – 1 Aug 1976*
Col Joseph L. Pospisil	*2 Aug 1976 – 28 Nov 1977*
Col Robert H. Krumpe	*28 Nov 1977 – 26 Nov 1980*
Lt Col John K. Bergen	*26 Nov 1980 – 1 Jul 1982*
Lt Col Jean E. Klick	*1 Jul 1982 – 14 Aug 1984*
Lt Col Gary L. McKenzie (Acting)	*14 Aug 1984 – 1 Nov 1984*
Col Edward B. Steele	*1 Nov 1984 – 24 Jan 1986*
Col William E. Sawyer	*24 Jan 1986 – 19 Oct 1988*

655th Air Base Squadron
(30 Sep 1993 – 1 Oct 1994)

Col Quentin M. Thomas	*30 Sep 1993 – 29 Apr 1994*
Col Andrew Jasinski	*29 Apr 1994 – 1 Oct 1994*

61st Air Base Group
(1 Oct 1994 –)

Col Andrew Jasinski	*1 Oct 1994 – 8 Sep 1995*
Col Gilbert A. Engel	*8 Sep 1995 – 12 Sep 1997*
Col Dieter V. Barnes	*12 Sep 1997 – 18 Jun 1999*
Col David E. Price	*18 Jun 1999 – 26 Sep 2000*
Col Phil W. Parker	*26 Sep 2000 – 27 Sep 2002*
Col Brian E. Kistner	*27 Sep 2002 – 11 May 2004*
Col Carl E. Brazelton	*11 May 2004 – 21 Jul 2004*
Col Joseph M. Codispoti	*21 Jul 2004 –*

EMBLEM OF THE SPACE AND MISSILE SYSTEMS CENTER

Significance

Blue and yellow are the Air Force colors. Blue alludes to the sky, the primary theater of Air Force operations. Yellow refers to the sun and the excellence required of Air Force personnel. The globe represents the night and day missions that the satellite and missile systems must perform. The four pole stars symbolize the communication, navigation, surveillance and weather satellites utilized by the Center. The flight symbol stands for deployed missile systems.

Color Conversion for Design Elements on Disc

Full	Cable	PMS	Subdued	Cable
Ultramarine Blue	67118	Reflex Blue	Flag Blue	67124
Air Force Yellow	67103	116	Black	67138
Black	67138		Spruce Green	67130
White	67101		Olive Drab	67133
Scarlet	67111	200	Garnet	67158
Bluebird	67117	542	Olive Drab	67133

ORGANIZATIONAL EMBLEMS USED BY SMC AND ITS PREDECESSORS

	The organization now known as SMC began on 1 July 1954 as the Western Development Division (WDD) of **Air Research and Development Command** (ARDC). During their first few years, WDD and its organizational successor, the Air Force Ballistic Missile Division (AFBMD), used ARDC's emblem.
	The organization first began to use its own emblem in the early 1960s. The **Air Force Ballistic Missile Division** (AFBMD) selected an emblem based on ARDC's, and it was approved on 2 November 1960. However, AFBMD was divided into two new organizations, Ballistic Systems Division and Space Systems Division, on 1 April 1961.
	**Ballistic Systems Division** (BSD) adapted AFBMD's emblem to emphasize its own mission, the development of ballistic missile systems. BSD's emblem was approved on 14 February 1962.
	**Space Systems Division** (SSD) also adapted AFBMD's emblem to emphasize its own mission, the development of military space systems. SSD's emblem was approved on 5 July 1962.
	When space and missile development programs were reunited under the **Space and Missile Systems Organization** (SAMSO) in 1967, SAMSO developed a new emblem to represent both aspects of its mission. The new emblem was approved on 22 May 1968.

	After SAMSO was divided into two new organizations based on its space and missile functions, the **Ballistic Missile Office** obtained approval on 1 December 1980 to use the emblem developed by the Ballistic Systems Division. It was in continuous use by the Ballistic Missile Office, Ballistic Systems Division, and the Ballistic Missile Organization until the last of these became a detachment of SMC on 2 September 1993.
	Space Division, the other of the new organizations into which SAMSO was divided, reinterpreted and continued to use to use the emblem developed by SAMSO. It was in successive and continuous use by SAMSO, Space Division, Space Systems Division, and SMC from May 1968 to August 2002.
	After the space and missile functions were reunited under the **Space and Missile Systems Center** (SMC) in 1992, it continued to use the old SAMSO emblem for ten years. However, when SMC was realigned from Air Force Materiel Command (AFMC) to Air Force Space Command (AFSPC), the organization's leaders proposed a new emblem to better express SMC's mission and its new allegiance to AFSPC. The new emblem was approved on 2 August 2002.

EMBLEMS USED BY THE 61st AIR BASE GROUP AND ITS PREDECESSORS

	The **6592nd Support Group** was the original designation of the organization responsible for the infrastructure used by SMC's predecessors. The Group was established on 16 November 1959. Its emblem was approved on 10 September 1969.
	The 6592nd Support Group was redesignated the **6592nd Air Base Group** on 1 August 1971. The Group developed a new emblem, which was approved on 27 July 1983.
	The 6592nd ABG was redesignated the **655th Air Base Squadron** on 1 October 1993 as a result of an Air-Force-wide restructuring of support groups. Since squadrons are authorized to display their emblems within disks, not shields, the 655th ABS adapted the emblem of the 6592nd ABG. This adaptation was approved on 19 January 1994. The 655th ABS was inactivated on 1 October 1994.
	The **61st Air Base Group** was activated at Los Angeles AFB on 1 October 1994. It was so designated by HQ USAF to preserve the heritage of a highly decorated transport and troop carrier group established in 1940. The 61st participated with distinction in many campaigns of World War II as well as the Berlin Airlift and later actions. The emblem is that of the original group, approved in 1951.

EMBLEMS OF THE SQUADRONS ASSIGNED TO THE 61ST AIR BASE GROUP

	The **61st Mission Support Squadron** was constituted and activated on 1 March 1941 as the 61st Air Base Squadron (Special). It was disbanded on 30 April 1944. It was activated at Los Angeles AFB on 1 October 1994. It uses the emblem of the 61st Air Base Group, its parent organization.
	The **61st Medical Squadron** was constituted and activated on 1 July 1948. It was activated on 1 December 1970 at Los Angeles AFS. Its emblem was approved on 3 August 1988. Known in 1970 as the USAF Dispensary, Los Angeles, it was redesignated a USAF Clinic in 1972, an Air Force Systems Command Clinic in 1987, the 655th Medical Squadron in 1992, and the 61st Medical Squadron in 1994.
	The **61st Communications Squadron** was constituted and activated on 1 July 1948 as the 61st Communications Squadron, Troop Carrier, Medium. It was inactivated on 2 June 1951. It was activated at Los Angeles AFB on 1 October 1994. Its emblem was approved on 13 May 1996.
	The **61st Security Forces Squadron** was constituted and activated at Los Angeles AFB on 1 July 1998. Its emblem was approved on 24 June 1998.
	The **61st Contracting Squadron** was constituted and activated at Los Angeles AFB on 1 May 2002. Its emblem was approved on 9 April 2004.
	The **61st Civil Engineering and Logistics Squadron** was constituted and activated on 1 July 1948 as the 61st Installations Squadron, Troop Carrier, Medium. It was inactivated on 2 June 1951. It was activated at Los Angeles AFB on 1 February 2005. It uses the emblem of the 61st Air Base Group, its parent organization, although it is in the process of requesting approval for an emblem of is own.

MEANING OF STREAMERS ON SMC'S ORGANIZATIONAL FLAG

The first streamer represents the Air Force Organizational Excellence Award presented to Space Division on 21 June 1988 for the period 1 January 1986 -31 December 1987. The award cited Space Division's accomplishments in leading the national space launch recovery effort and restoring access to space in view of the launch vehicle disasters of 1985-1986, including the loss of the Space Shuttle ***Challenger*** on 28 January 1986.

The second streamer represents the Air Force Organizational Excellence Award presented to the Space and Missile Systems Center on 23 July 1996 for the period 1 July 1993 - 30 June 1995. The award cited SMC's accomplishments in leading a renaissance in the research, development, acquisition, and testing of space and missile systems and for implementing critical acquisition reform initiatives.

The third streamer represents the Air Force Organizational Excellence Award presented to the Space and Missile Systems Center on 5 December 2002 for the period 1 October 2001 to 1 October 2002. The award cited SMC's accomplishments in managing, developing, procuring, and sustaining thirty-three weapon systems; in providing continuous support to U.S. warfighters; and in providing unprecedented support for successfully attacking targets during Operation Enduring Freedom and Operation Noble Eagle (American counter-terrorist operations in Afghanistan).

Air Force Organizational Excellence Awards and Air Force Outstanding Unit Awards to Headquarters Elements of SMC and Its Predecessors

[Abbreviations: AFMCSO = Air Force Materiel Command Special Order; AFSCSO = Air Force Systems Command Special Order; AFSPCSO = Air Force Space Command Special Order; DAFSO = Department of the Air Force Special Order; PO = Program Office; SPO = System Program Office]

Minuteman SPO (Space and Missile Systems Organization)
Air Force Organizational Excellence Award (DAFSO GB-1017, 1970)
for the period 15 October 1968 – 15 October 1970

Deputy for Reentry Systems PO (Space and Missile Systems Organization)
Air Force Organizational Excellence Award (DAFSO GB-1017, 1970)
for the period 1 June 1968 – 1 October 1970

Defense Support SPO (Space and Missile Systems Organization)
Air Force Organizational Excellence Award (DAFSO GB-582, 1971)
for the period 1 May 1969 – 15 May 1971

Defense Systems Applications SPO (Space and Missile Systems Organization)
[later known as Defense Meteorological Satellite SPO]
Air Force Organizational Excellence Award (DAFSO GB-702, 1971)
for the period 1 October 1966 – 31 July 1971

Special Projects SPO (Space and Missile Systems Organization)
Air Force Organizational Excellence Award (DAFSO GB-54, 1972)
for the period 1 March 1967 – 31 March 1971

Deputy for Launch Vehicles (Space and Missile Systems Organization)
Air Force Organizational Excellence Award (DAFSO GB-54, 1972)
for the period 1 July 1967 – 1 June 1971

Site Alteration Task Force, Ellsworth AFB, SD
(Space and Missile Systems Organization, Deputy for Minuteman, Detachment 33)
Air Force Outstanding Unit Award (DAFSO GB-594, 1972)
for the period 9 June 1972 – 10 July 1972

Minuteman SPO (Space and Missile Systems Organization)
Air Force Organizational Excellence Award (DAFSO GB-787, 1972)
for the period 16 October 1970 – 1 May 1972

Deputy for Development Plans (Space and Missile Systems Organization)
Air Force Organizational Excellence Award (DAFSO GB-137, 1973)
for the period 1 April 1970 – 30 June 1972

Deputy for Reentry Systems PO (Space and Missile Systems Organization)
Air Force Organizational Excellence Award (DAFSO GB-137, 1973)
for the period 2 October 1970 – 30 April 1972

Aerospace Data Facility (Space and Missile Systems Organization, Detachment 3)
Air Force Organizational Excellence Award (DAFSO GB-410, 1973)
for the period 1 July 1971 – 30 June 1972

Directorate of Civil Engineering (Space and Missile Systems Organization)
Air Force Organizational Excellence Award (DAFSO GB-20, 1974)
for the period 1 January 1971 – 31 December 1972

Deputy for Technology (Space and Missile Systems Organization)
Air Force Organizational Excellence Award (DAFSO GB-20, 1974)
for the period 1 January 1971 – 31 December 1972

Defense Support SPO (Space and Missile Systems Organization)
Air Force Organizational Excellence Award (DAFSO GB-493, 1974)
for the period 16 May 1971 – 15 May 1973

Comptroller (Space and Missile Systems Organization)
Air Force Organizational Excellence Award (DAFSO GB-971, 1974)
for the period 1 January 1971 – 31 December 1973

Deputy for Launch Vehicles (Space and Missile Systems Organization)
Air Force Organizational Excellence Award (DAFSO GB-493, 1974)
for the period 2 June 1971 – 30 June 1973

Defense Meteorological Satellite SPO (Space and Missile Systems Organization)
Air Force Organizational Excellence Award (DAFSO GB-1192, 1974)
for the period 1 August 1971 – 30 September 1973

Directorate of Civil Engineering (Space and Missile Systems Organization)
Air Force Organizational Excellence Award (DAFSO GB-667, 1975)
for the period 1 January 1973 – 31 December 1974

Minuteman SPO (Space and Missile Systems Organization)
Air Force Organizational Excellence Award (DAFSO GB-937, 1975)
for the period 2 May 1972 – 31 December 1974

Staff Judge Advocate (Space and Missile Systems Organization)
Air Force Organizational Excellence Award (DAFSO GB-196, 1976)
for the period 1 August 1971 – 15 April 1975

Deputy for Reentry Systems PO (Space and Missile Systems Organization)
Air Force Organizational Excellence Award (DAFSO GB-393, 1976)
for the period 1 July 1973 – 30 June 1975

Deputy for Space Communications Systems (Space and Missile Systems Organization)
Air Force Organizational Excellence Award (DAFSO GB-873, 1977)
for the period 1 January 1974 – 1 May 1976

Defense Meteorological Satellite SPO (Space and Missile Systems Organization)
Air Force Organizational Excellence Award (DAFSO GB-345, 1979)
for the period 1 October 1973 – 30 September 1978

Navstar Global Positioning System PO (Space and Missile Systems Organization)
Air Force Organizational Excellence Award (DAFSO GB-345, 1979)
for the period 22 December 1973 – 30 September 1978

Defense Dissemination SPO (Space and Missile Systems Organization)
Air Force Organizational Excellence Award (DAFSO GB-345, 1979)
for the period 1 January 1975 – 30 June 1978

Deputy for Reentry Systems PO (Ballistic Missile Office)
Air Force Organizational Excellence Award (DAFSO GB-238, 1980)
for the period 1 July 1975 – 31 January 1979

Deputy for Space Communications (Space Division)
Air Force Organizational Excellence Award (DAFSO GB-238, 1980)
for the period 2 May 1976 – 31 December 1979

Satellite Data SPO (Space Division)
Air Force Organizational Excellence Award (DAFSO GB-238, 1980)
for the period 1 July 1977 – 1 October 1979

Satellite Data SPO (Space Division)
Air Force Organizational Excellence Award (DAFSO GB-058, 1981)
for the period 2 October 1979 – 19 January 1981

Aerospace Data Facility (Space Division, Detachment 3)
Air Force Organizational Excellence Award (DAFSO GB-060, 1981)
for the period 1 January 1977 – 19 January 1981

Deputy for Space Launch and Control Systems (Space Division)
Air Force Organizational Excellence Award (DAFSO GB-235, 1981)
for the period 1 August 1978 – 1 May 1980

6592nd Air Base Group (Space Division)
Air Force Outstanding Unit Award (DAFSO GB-465, 1981)
for the period 1 January 1979 – 31 December 1980

Defense Support SPO (Space Division)
Air Force Organizational Excellence Award (DAFSO GB-447, 1982)
for the period 15 May 1978 – 31 December 1981

Defense Dissemination SPO (Space Division)
Air Force Organizational Excellence Award (DAFSO GB-447, 1982)
for the period 1 July 1978 – 31 December 1980

Deputy for Space Communications (Space Division)
Air Force Organizational Excellence Award (DAFSO GB-447, 1982)
for the period 1 January 1980 – 31 December 1981

Quality Assurance Division, Directorate of Contracting and Sup (Space Division)
Air Force Organizational Excellence Award (DAFSO GB-447, 1982)
for the period 1 April 1979 – 30 April 1981

Range Instrumentation and Equipment SPO (Space Division)
Air Force Organizational Excellence Award (DAFSO GB-447, 1982)
for the period 1 May 1979 – 1 May 1981

Space Defense SPO (Space Division)
Air Force Organizational Excellence Award (DAFSO GB-447, 1982)
for the period 1 August 1979 – 31 June 1981

Deputy for Technology (Space Division)
Air Force Organizational Excellence Award (DAFSO GB-449, 1983)
for the period 1 September 1979 – 30 September 1982

Ballistic Missile Office (Air Force Systems Command)
Air Force Organizational Excellence Award (DAFSO GB-449, 1983)
for the period 1 October 1979 – 30 September 1981

Space Division (Air Force Systems Command)
Air Force Organizational Excellence Award (DAFSO GB-449, 21 June 1988)
for the period 1 January 1986 – 31 December 1987

Deputy for Launch Systems (Space Systems Division)
Air Force Organizational Excellence Award (AFSCSO GB-81, 23 August 1989)
for the period 1 January 1988 – 25 March 1989

Ballistic Systems Division (Air Force Systems Command)
Air Force Organizational Excellence Award (AFSCSO GB-81, 23 August 1989)
for the period 1 January 1987 – 31 December 1988

Air Force Strategic Defense Initiative Programs (Space Systems Division)
Air Force Organizational Excellence Award (AFSCSO GB-79, 15 August 1990)
for the period 1 June 1988 – 31 May 1990

Advanced Systems PO (Space Systems Division)
Air Force Organizational Excellence Award (AFSCSO GB-113, 23 August 1991)
for the period 1 July 1990 – 31 July 1991

Launch Programs (Space Systems Division)
Air Force Organizational Excellence Award (AFSCSO GB-113, 23 August 1991)
for the period 4 May 1989 – 30 April 1991

Satellite Control and Data Handling SPO (Space Systems Division)
Air Force Organizational Excellence Award (AFSCSO GB-113, 23 August 1991)
for the period 1 July 1989 – 30 June 1991

Financial Management and Comptroller (Space Systems Division)
Air Force Organizational Excellence Award (AFSCSO GB-76, 15 June 1992)
for the period 1 September 1990 – 29 February 1992

Advanced Systems PO (Space and Missile Systems Center)
Air Force Organizational Excellence Award (AFMCSO GB-248, 8 August 1994)
for the period 31 January 1992 – 31 January 1994

Space and Missile Systems Center (Air Force Materiel Command)
Air Force Organizational Excellence Award (AFMCSO GB-290, 23 July 1996)
for the period 1 July 1993 – 30 June 1995

Launch Programs SPO (Space and Missile Systems Center)
Air Force Organizational Excellence Award (AFMCSO GB-290, 23 July 1996)
for the period 1 January 1994 – 31 December 1995

61st Air Base Group (Space and Missile Systems Center) including
61st Communications Squadron, **61st Medical Squadron**, and **61st Mission Support Squadron**
Air Force Outstanding Unit Award (AFMCSO GB-129, 3 March 1997)
for the period 30 September 1995 – 31 December 1996

Defense Dissemination PO (Space and Missile Systems Center)
Air Force Organizational Excellence Award (AFMCSO GB-244, 24 June 1997)
for the period 1 September 1994 – 30 September 1996

Advanced Systems Directorate (Space and Missile Systems Center)
Air Force Organizational Excellence Award (AFMCSO GB-121, 22 June 1999)
for the period 1 May 1997 – 30 April 1999

SMC Operating Location AW [Space Test Program, Space and Missile Test and Evaluation Directorate] (Space and Missile Systems Center)
Air Force Organizational Excellence Award (AFMCSO GB-173, 29 February 2000)
for the period 1 March 1998 – 29 February 2000

Defense Meteorological Satellite SPO (Space and Missile Systems Center)
Air Force Organizational Excellence Award (AFMCSO GB-173, 29 February 2000)
for the period 1 January 1998 – 31 December 1999

Military Satellite Communications Joint Program Office (Space and Missile Systems Center)
Air Force Organizational Excellence Award (AFMCSO GB-173, 29 February 2000)
for the period 1 January 1999 – 31 December 1999

61st Air Base Group (Space and Missile Systems Center)
Air Force Outstanding Unit Award (AFMCSO GB-164, 20 July 2000)
for the period 1 January 1999 – 31 December 1999

SMC Detachment 9 [Vandenberg AFB] (Space and Missile Systems Center)
Air Force Organizational Excellence Award (AFMCSO GB-134, 2002
for the period 1 October 1999 – 30 September 2001

Space and Missile Systems Center (Air Force Space Command)
Air Force Organizational Excellence Award (AFSPCSO GA-11, 5 December 2002)
for the period 1 October 2001 – 1 October 2002

61st Air Base Group (Space and Missile Systems Center) including
61st Communications Squadron, **61st Medical Squadron**, **61st Mission Support Squadron, 61st Contracting Squadron, 61st Security Forces Squadron,** and **61st Logistics Readiness Flight**
Air Force Outstanding Unit Award (AFSPCSO GA-14, 10 January 2005)
for the period 1 October 2002 – 30 September 2004

SMC Detachment 11 [Peterson AFB] (Space and Missile Systems Center)
Air Force Organizational Excellence Award (AFSPCSO GA-11, 10 January 2005)
for the period 1 July 2003 – 30 June 2004

Launch Programs SPO (Space and Missile Systems Center) including
SMC Detachment 8 [Cape Canaveral AFS] and **SMC Detachment 9 [Vandenberg AFB]**
Air Force Organizational Excellence Award (ASPCSO GA-10, 10 January 2005)
for the period 2 October 2002 – 31 August 2004
Space and Missile Systems Center (Air Force Space Command)
[with detachments and operating locations]
Air Force Organizational Excellence Award (AFSPCSO GA-05, 21 February 2006)
for the period 1 October 2003 to 30 September 2005

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