Chapter 2
Rockets, Communications and Deploying Ballistic Missile Defense, 1958-1975

Satellites and Communications

The decisions taken in 1958 diminished the Army's overt space role but reaffirmed its missile defense role. While the Army gave NASA control of all aspects of the Army Launch Vehicle Program and the Air Force gained control of the Jupiter-C IRBM program and responsibility for developing an ICBM, the Army continued to bear the primary responsibility for Ballistic Missile Defense. The Navy transferred the Vanguard Program and part of the Naval Research Laboratory to NASA while retaining proponency for sea-launched missiles. Through 1960, the Army continued to contribute to communications, meteorological, reconnaissance, research and exploration satellites.[1] The first Vanguard satellite, with its instruments transmitting data using batteries designed by the Army Signal Corps, continued to send data to earth until 1964. This satellite remains in orbit today and will stay in orbit for another 2000 years. The Vanguard I launch was quickly followed by Explorer III (26 March 1958), the first satellite to carry an on-board tape recorder to store data to be transmitted to a ground station when it came in range. Explorer IV (26 July 1958) was placed in an elliptical inclined orbit by a Juno I rocket. It gathered data from a high altitude nuclear explosion and measured solar radiation for three months.

In December 1958, the Army and Air Force put the first communications satellite in orbit. Called Project SCORE (Signal Communications by Orbiting Relay Equipment), the Army Signal Research and Development Laboratory began working on the satellite that June. Since the Air Force proposed placing the entire Atlas rocket into orbit, the communications equipment was integrated into the rocket's fairing pods. The rocket was placed in a low earth orbit and the satellite's life expectancy was approximately two weeks. The satellite could receive, store and send voice and coded signals-one voice channel or seven teletype channels on two tape recorders. Shortly before the satellite was launched, a tape-recorded message from President Eisenhower was placed aboard. The system worked and the president's message was broadcast on short wave radio. In addition, the satellite responded to real-time and store-forward voice and teletype transmissions.[2]

When Vanguard II was launched into low earth orbit (17 February 1959) it carried an Army developed cloud imaging sensor. However, stability problems (the satellite wobbled in orbit) precluded imaging efforts. That same year, the Army Signal Corps, the Weather Bureau, RCA and several other organizations collaborated to develop a weather satellite. For the Army, this built on the work done on the first two Vanguards and on an experiment placing a television camera in orbit to take pictures of the earth. This was expanded to create the first weather satellites, TIROS I and II (Television Infrared Observation Satellite), which NASA launched in April and November 1960. The satellites used multiple television cameras to transmit pictures of cloud patterns to ground stations in New Jersey and Hawaii. The program proved so successful that eight satellites were put into orbit between 1960 and 1965.[3]

The Army was also involved in communications satellites. The Courier was the first to transmit ultra-high frequency (UHF) radio waves. The attraction of this portion of the electromagnetic spectrum was that it was relatively unused and free from man-made or atmospheric interference. In 1958, as the SCORE project started, the Army began work on the ADVENT and COURIER programs. ADVENT, put into operation in 1960, was “a twenty four hour, equatorial synchronous, military satellite communication program” established at the Advanced Research Project Agency’s (ARPA) direction.[4] COURIER was more advanced and could simultaneously transmit and receive “about 68,000 words per minute while traveling through space at 16,000 miles per hour and send and receive facsimile photographs.”[5] Data could also be stored for later transmission. It was the first satellite powered by long life solar cells that recharged nickel cadmium storage batteries. Although the COURIER’s effective life was only seventeen days, it proved that all types of messages and data could be received and transmitted by satellite.[6]

The Army’s work served as a catalyst for a telecommunications revolution. Satellites stitched the world together in a way very different from either wires or cables. In 1962, NASA and AT&T joined to launch Telstar, the world’s first active communications satellite, picking up, amplifying and re-broadcasting signals from one point on earth to another. Telstar broadcast the first live television pictures between continents, illustrating this new technology’s potential. Later that same year, Congress passed the Communications Satellite Act of 1962 establishing the quasi-governmental Communications Satellite Corporation (COMSAT). This body managed an international syndicate, INTELSAT, whose members shared access to a global telecommunications satellite system. This system increased the number of transoceanic telephone circuits and made live television coverage possible anyplace on the globe.[7]

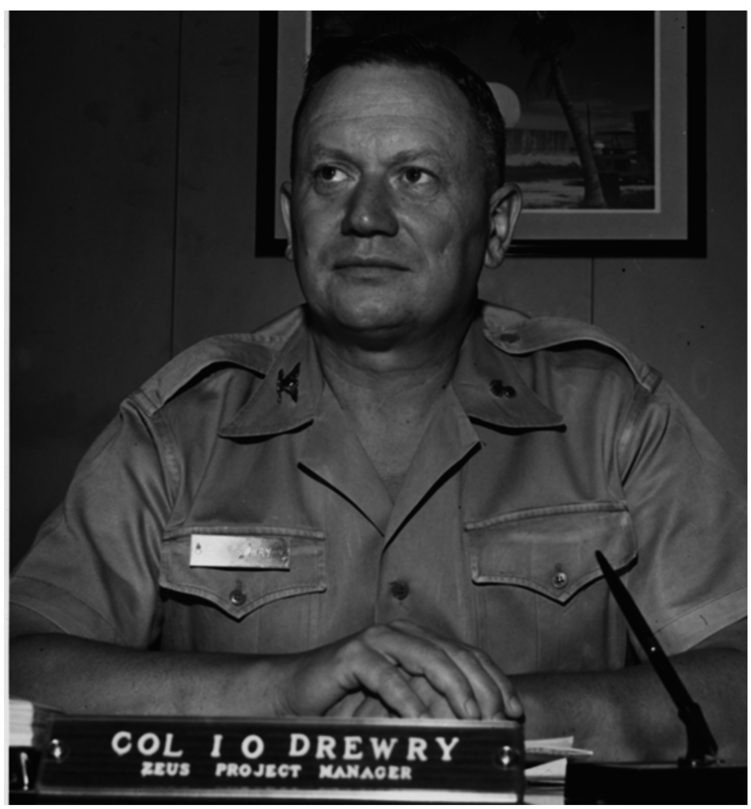
NASA continued to use Army developed Jupiter/Juno missiles for space probes to the moon and the sun. Pioneer II was launched in December 1958 and traveled 63,580 miles on a voyage to the moon. In March 1959, an Army rocket launched Pioneer IV on a voyage to the moon. Pioneer IV passed within 37,300 miles of the moon before going into permanent solar orbit. However, the Soviet Luna I probe that passed within 3,700 miles of the lunar surface overshadowed this achievement. A Juno II also successfully launched the Explorer VII satellite in October 1959. The Explorer VII carried a scientific package for detecting micrometeors, measuring the earth’s radiation balance, and conducting other experiments.[8] It was the last of the satellites launched as a part of the IGY and its scientific instrument package began a new era in weather forecasting and meteorology.

NIKE-ZEUS Testing

Fig. 2-1. Emblem of the NIKE-ZEUS Project Office.

The division of responsibility between the Army and the Air Force over missiles began in 1944, shortly after the German V-1 attacks began. The Army divided guided missile development responsibility between the Army Air Forces (AAF) and the Ordnance Department, intending to lessen secrecy and to promote data sharing. The AAF was given "development responsibility…for all guided or homing missiles dropped or launched from aircraft…[or those] launched from the ground which depend for sustenance primarily on the lift of aerodynamic forces." The Ordnance Department would develop missiles "which depend for sustenance primarily on momentum of the missile." In January 1945, the General Staff made the Ordnance Department responsible for developing a missile suitable for antiaircraft use.[9] This division of labor continued through the postwar era, with the Air Force claiming responsibility for intercontinental ballistic missiles as the logical extension of long-range bombers, while the Army viewed missiles as very long-range artillery weapons. In January 1958, Secretary of Defense Neil McElroy assigned the Army primary responsibility for developing all aspects of ballistic missile defense, including missiles, launch sites, radars and computer components. At the same time, the Air Force continued its responsibility for developing early warning radars, tracking and acquisition radars and communications links to ballistic defense installations.

Fig. 2-2. Brigadier General Ivey Drewry became the first NIKE-ZEUS Project Manager in August 1962. Brigadier General Drewry led the Army's missile defense program until his retirement in November 1967.



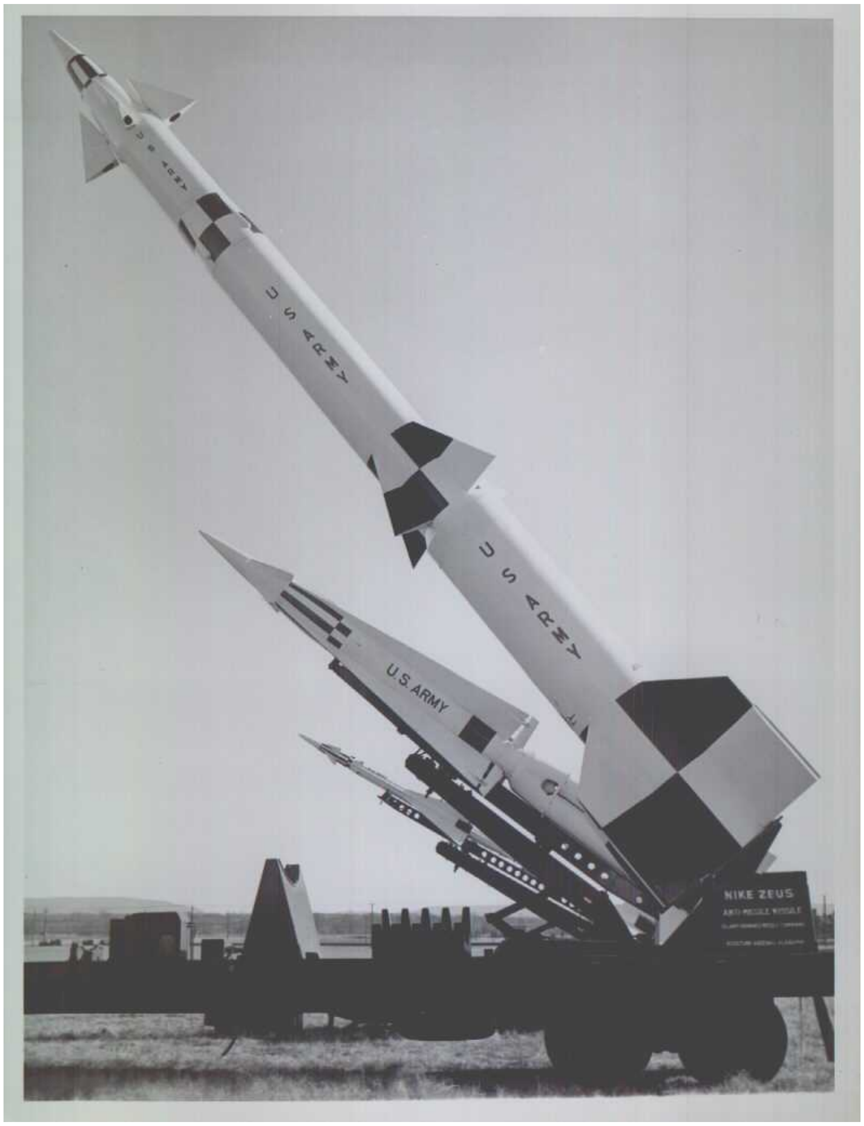


Fig. 2-3. The NIKE Family of missiles. From back to front: NIKE-AJAX, NIKE-HERCULES and NIKE-ZEUS.

The importance of the BMD program became apparent in August 1957 when the Soviet Union announced a successful ICBM test flight using its SS-6 ICBM.[10] In January 1958, the National Security Council assigned the highest national priority ("S-Priority") to the NIKE-ZEUS antimissile missile development program. One problem remained however – locating a site appropriate for field testing, which presented a new set of obstacles.

The test range should be located far enough away to allow ICBM testing in an uncluttered area that could be secured from "curious adversaries"[11] White Sands had been the desired location. Distances, however, would not allow the interceptor to be tested to its full capability.

Range restrictions, which forced the premature destruction of some shots, eventually eliminated a second choice, Point Mugu, California. The Atlantic Range, stretching south from Cape Canaveral, was eliminated because of the area's high population density and the absence of suitable American territory for testing and tracking facilities.

Following a requirements review, the Army Rocket Guided Missile Agency (ARGMA) decided that Kwajalein Atoll in the Marshall Islands presented the most logical solution because it was part of the Pacific Islands Trust Territories, served as an American naval base and had an already existing logistical structure. In addition, it was geographically perfect, within a day's flying distance of Hawaii, lying 4,800 miles from the United States, which made it ideal for testing interceptors against testing vehicles launched from Vandenberg Air Force Base, California .

In 1959, the DoD's Ballistic Missile Committee approved the test program, which began at White Sands Missile Range (WSMR), New Mexico; Kwajalein Atoll became the down range test site. The Kwajalein Test Center was officially established on 1 October 1960. Ultimately, the significance of the Kwajalein site to the Army's interceptor test program resulted in the transfer of the site from the U.S. Navy to the U.S. Army on 1 July 1964.[12]

Fig. 2-4. Testing began at the Kwajalein Missile Range in December 1961. This aerial view shows the island in January 1962.

On 26 August 1959, the NIKE-ZEUS flight test program began with the launch of the first NIKE-ZEUS missile at WSMR. Although deemed a partial success, the missile broke up shortly before sustainer-booster separation. This missile and two others fired in 1959 were designed for uncontrolled flights, constructed with fixed-fins and a dummy nose instead of the thrust vectoring nose. It was not until the fourth test, conducted on 3 February 1960, that a NIKE-ZEUS test flight completely at met all objectives.

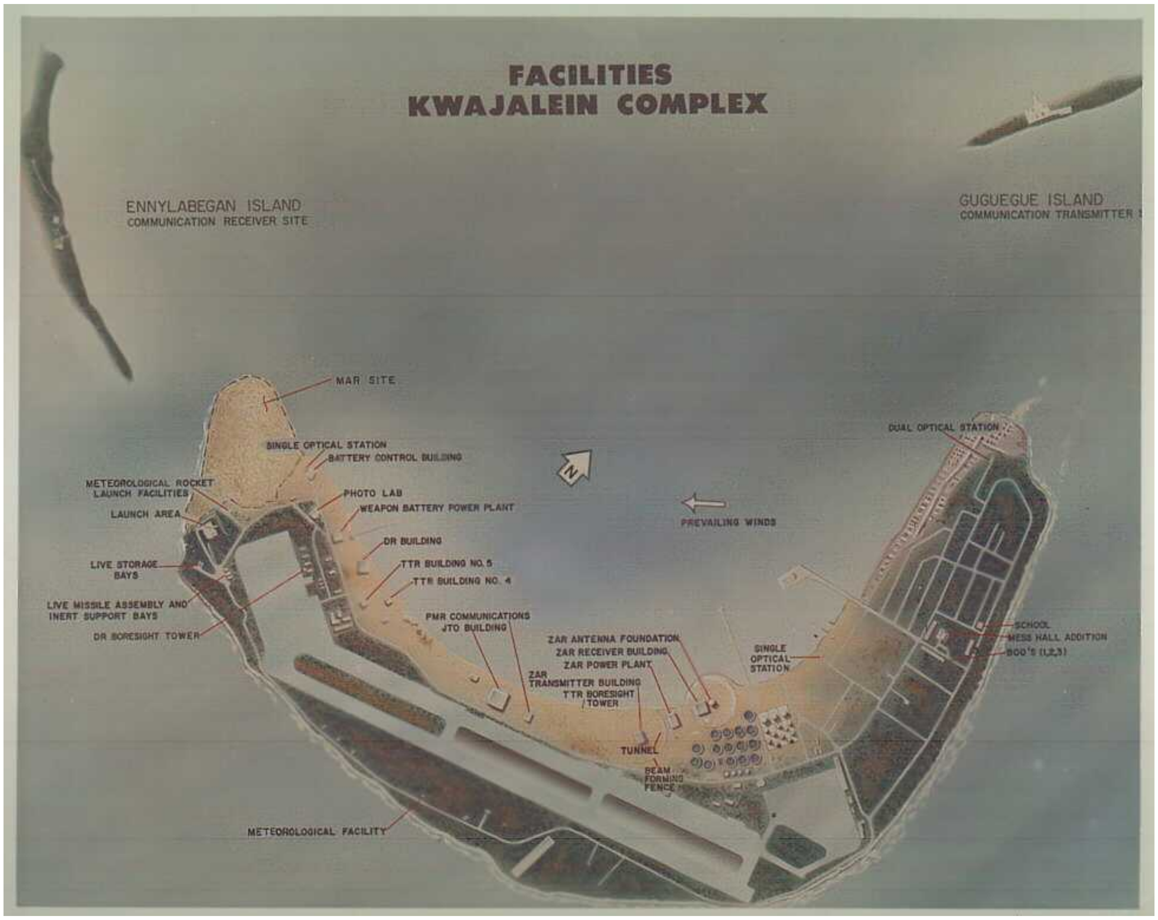


Fig. 2-5. A map of the facilities at the Kwajalein Complex in the 1960s.

By the end of its first year, the NIKE-ZEUS test program had completed five successful tests using two different versions of the missile.[13] Nevertheless, the argument against ABM development and in favor of the production of offensive systems remained strong. On 18 October 1960, the President's Science Advisory Committee concluded, "There has been very considerable progress in the ZEUS program within the last year. This does not, however, appear to be any reason for changing the major conclusion we drew last year… that with respect to defense of population against a major attack, fallout shelters should have priority over extensive ZEUS deployment." They recommended instead continued research and development in conjunction with full testing at the Kwajalein site followed by "very limited deployment in the near future."[14]

In contrast, the 21 November 1960 report to the Chief of Staff by the NIKE-ZEUS Ad Hoc Advisory Committee provided three recommendations: (1) That the production program for the NIKE-ZEUS batteries begin immediately at the rate of four per year; (2) The units be deployed in the defense of the North America in support of the antimissile defense plans established by the

North American Air Defense Command; and (3) The present NIKE-ZEUS research and development program be continued with the primary objectives of determining the system effectiveness against various types of threats and of improving this effectiveness consistent with the state of the art.

While it was testing the ZEUS, the Army pursued funding for a production program that aimed for operational status in 1962.[15] Secretary of Defense McElroy favored a continued research and development effort and no funds were granted in fiscal year (FY) 1959. Congress reversed itself and provided $137 million in production funds for FY 1960, but the Eisenhower administration refused to spend the funds.

Fig. 2-6. Pictured are the many different radars of the NIKE-ZEUS system. The photo was taken at Kwajalein, 20 July 1963.

In January 1961, the ARGMA submitted a revised "NIKE-ZEUS Defense Production Plan" which called for producing and deploying 70 batteries for 29 defense centers at a cost of $8 billion over eight years.[16] At the same time, a new administration had entered the White House and President John Kennedy ordered a review of the BMD program.[17] Robert McNamara, the new Secretary of Defense, determined that deploying the NIKE-ZEUS system was neither technologically feasible nor cost effective. Unimpressed by the challenges that the system would pose to Soviet planners, he argued that the Soviets could simply counter by increasing the number of their offensive missiles and overwhelming the system. Nevertheless, he approved significant funding for a continued research and development effort that would keep the program at a "top priority" level.

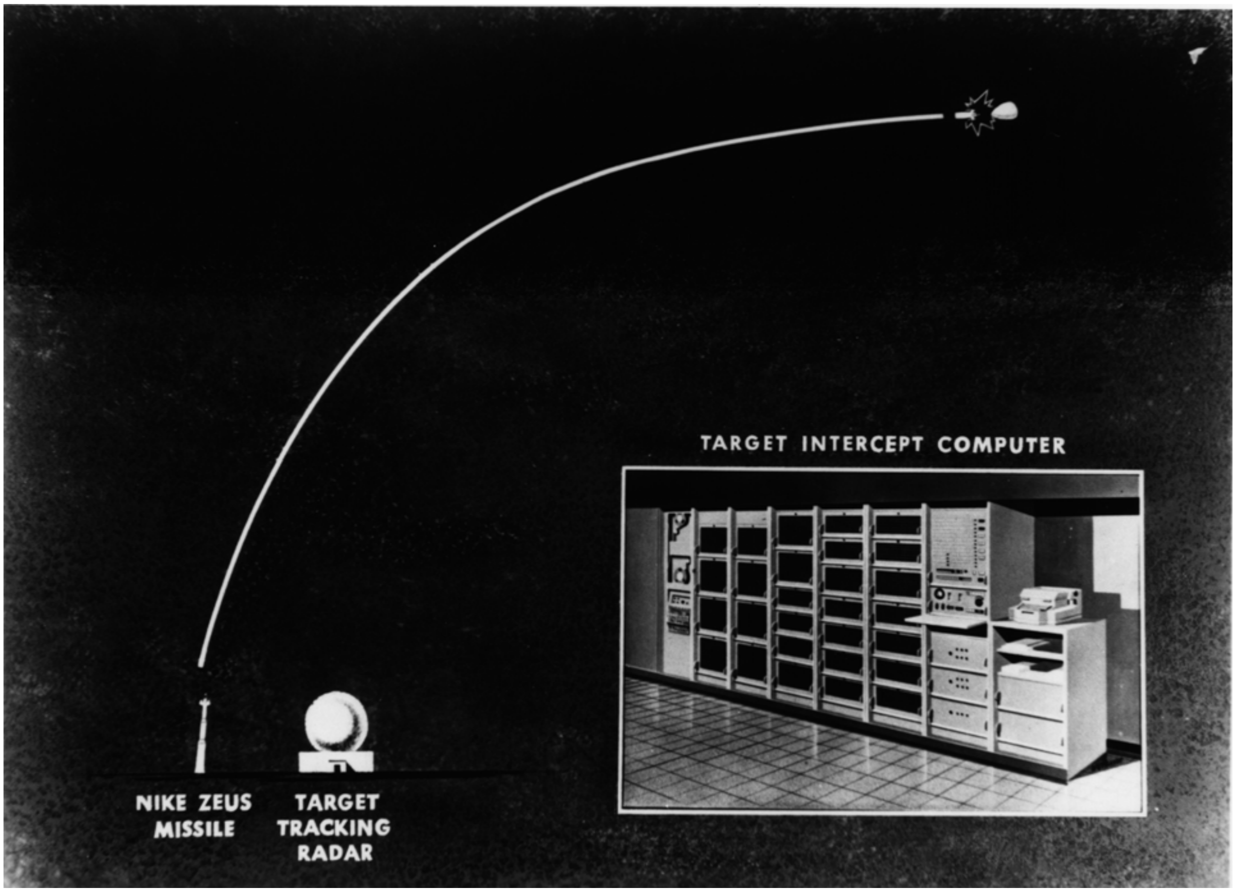


Fig. 2-7. Artist's conception of the target track radar and the target intercept computer.

The First Intercept

The research and development program proceeded even as the political developments unfolded. In May 1961, an advanced ZEUS missile was successfully fired at White Sands. Systems demonstrations began in November 1961. On 14 December, the NIKE-ZEUS system intercepted a NIKE-HERCULES missile in the first integrated system test.[18] The ZEUS passed within 100 feet of the HERCULES missile, well within the distance defined for a successful nuclear intercept.

Fig. 2-8. On 12 December 1962, the NIKE-ZEUS Project Office achieved the first fully successful intercept of an ICBM, seen in the horizon over the ZEUS Acquisition Radar.

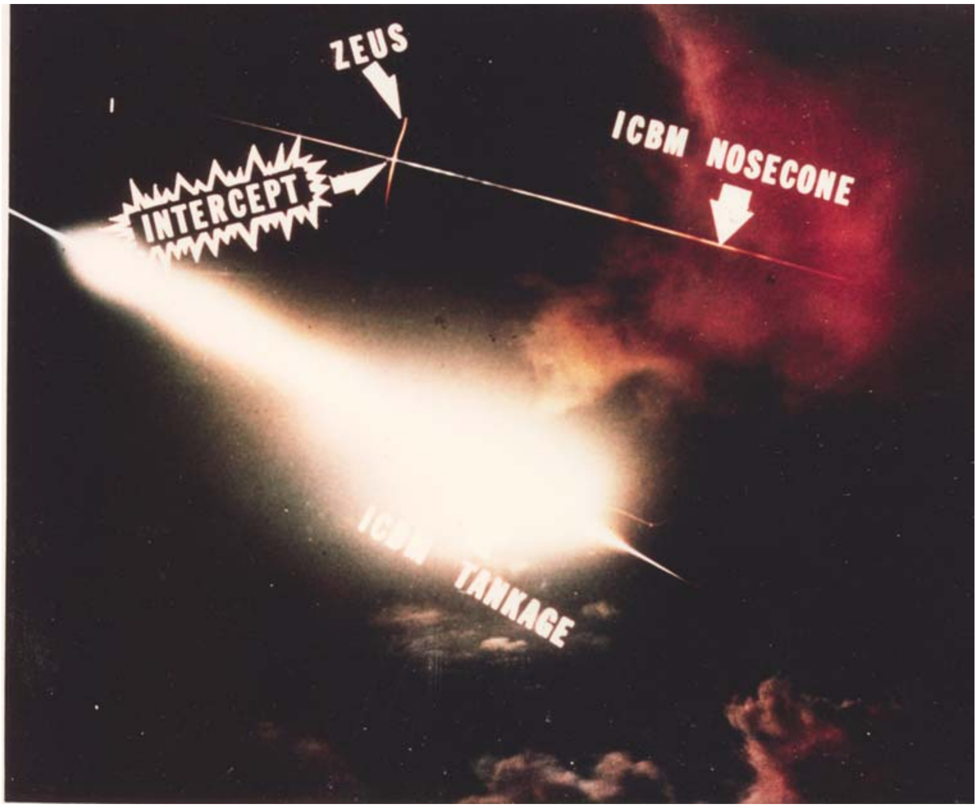


Fig. 2-9. An annotated photograph illustrating the Army's successful ICBM intercept.

The most important demonstration took place on 26 June 1962 with the first attempted intercept of an ICBM fired from Vandenberg AFB to Kwajalein, a distance of 4,500 miles. Unfortunately, the radar malfunctioned and the interception attempt failed. A second attempt on 19 July 1962 intercepted an Atlas D nose cone traveling 16,000 mph. One wire service release declared the intercept a "majestic bull's-eye, comparable some have said, to a bullet hitting a bullet." Project Office officials declared the test only partially successful.[19] The U.S. Army made history on 12 December 1962 when the NIKE-ZEUS Project office made a fully successful intercept of an ICBM nose cone, passing well within the acceptable limits for a simulated nuclear warhead.

Fig. 2-10. A NIKE-ZEUS missile on a launcher during testing at White Sands Missile Range.

A New Mission: Project MUDFLAP

As related above, after the Soviet Union launched the first man-made satellite Sputnik I, American interests focused upon matching and surpassing this feat. By 1959, however, new concerns had arisen. In June of that year, Dr. Walter Dornberger, a former German general who helped develop the V-2 and worked as an Air Force and NASA consultant in 1950s, warned the audience at the Dr. Robert H. Goddard Memorial Dinner that the United States should prepare a defense against nuclear bombing from earth-orbiting satellites.

On 27 April 1962, Secretary of Defense McNamara announced a new requirement for the NIKE-ZEUS system. By 1 May 1963, the NIKE-ZEUS Project was to provide the capability for a satellite interception demonstration at Kwajalein, known as Project MUDFLAP.[20] Bell Labs modified a ZEUS missile and began testing at White Sands in December 1962. Their missile ultimately reached an altitude of 151 nautical miles. In March 1963, testing transferred to Kwajalein and, on 23 May 1963, a NIKE-ZEUS missile successfully intercepted an AGENA D earth satellite. From this moment forward, the missiles and personnel at Kwajalein were maintained in a state of readiness to launch a ZEUS in an anti-satellite mode. Training and test launches continued in 1964, until officials terminated the "ready requirement."

After deciding not to deploy the NIKE-ZEUS system, no further live ICBM target tests were conducted.[21] With simulated targets and other programs, the test program continued until 9 December 1964 at White Sands Missile Range and May 1966 at Kwajalein.[22] Ultimately, the NIKE-ZEUS test program conducted 79 developmental and 68 systems tests, 147 firings altogether. Of the developmental firings – 56 at White Sands and Point Mugu and 23 at Kwajalein – 22 were failures, 12 were partial successes and 45 were full successes. Similarly, the Systems Tests conducted at White Sands and Kwajalein recorded 7 no tests, 15 failures, 7 partial successes and 39 successes.

Project Defender

Even as Secretary McElroy defined the specific ballistic missile defense (BMD) responsibilities of the services in January 1958, he assigned direction of the development effort to ARPA, in order "to make [the] most effective use of our overall national capability."[23] Project Defender was the ARPA-directed BMD effort. Scientists at ARPA explored broad concepts in missile defense.[24] With the boost missile boost intercept or BAMBI program, for example, they looked at satellite tracking to launch ground-based hit-to kill interceptors, which would intercept Soviet missiles over the Arctic. The Guidelines Identification Program for Antimissile Research (GILPAR) study examined lasers, neutral particle beams and "tailored-effects" produced by nuclear devices. As the Department of Defense leader of the BMD program, ARPA worked with the Army's NIKE-ZEUS program, providing funding and facilities for advanced testing. It also developed a new ground-based phased array radar system, which was incorporated into the Army's subsequent BMD initiatives.[25]

Continued Interest in Satellite Communications

In the early 1960s, the Army bowed out of its role in space exploration although it retained a role in satellite communications as well as its vitally important role in missile defense. The

Army was forced out by several developments, including the establishment of NASA and the subsequent demilitarization of many space missions, the DoD giving new space roles and missions to the other services, treaties, the centralized management, development and operation of long range military communications systems, and the distractions of the Vietnam Conflict.[26]

Vietnam skewed Army thinking away from space and using space-based instruments as a force multiplier. Between 1961 and 1973, the Army was slowly committed and subsequently withdrawn from Vietnam. An Army theater command was established and approximately two-thirds of the troops in-country were soldiers. The Army committed two corps headquarters, seven divisions, two separate infantry brigades, one airborne brigade and one air cavalry regiment to the theater. The war was the Army's major focus while American soldiers were involved in combat through 1973 as well as during the subsequent support effort. During its involvement, surviving and winning the conflict was the primary focus of the Army's efforts. Space-based satellites did not offer any direct tactical aid to the soldier on the ground. Satellite-assisted communication was the only way space-based assets influenced the ground fighting. The conflict in Vietnam demanded the Army's full attention, to the detriment of many other research and development initiatives.

Instead of thinking about space-based assets as force multipliers or used strategically to shape future wars, there was an understandable, natural desire to field robust, effective tactical weapons systems that troops could put to use immediately. Instead of thinking about the future of space-based systems, the Army concentrated on developing and fielding small, accurate battlefield missiles for ground support aircraft and the infantry. At the same time, however, the Army made substantial contributions to developing a worldwide communications network for the DoD, directly contributing to the design of the first geosynchronous satellite, SYNCOM, and to the Initial Defense Satellite Communications System. The Army also set up and managed the global network of ground stations that provided reliable communications to Army theater commands. In addition, the Army established the Strategic Communications Command to manage and operate the Army component of the Defense Communication System. In 1970, the Secretary of Defense modified an earlier directive and allowed each service to conduct research and develop programs that would serve its unique needs for battlefield surveillance, communication, navigation, mapping and charting. However, the Army was not able to take advantage of this opportunity until it began to think about the future of warfare and its place on the battlefield.

In a sense freed from concerns about the use of space, the Army concentrated its technological efforts on communications and on improving ballistic missile defense. The NIKE-ZEUS project continued with its successful test program but certain weaknesses proved troubling, such as the difficulty in differentiating between warheads and decoys.[27] Officials also believed that a saturation attack would overwhelm the capabilities of the discrimination radar as the Target Track and Missile Track Radars could only focus on one target or interceptor at a time. In addition, scientists had little data on reentry phenomena or the effect of the ZEUS warhead on other components. As a result, Department of Defense officials began to look to the needs of the future, while continuing with research and defense.

NIKE-X: A New Organization

Fig. 2-11. Emblem of the NIKE-X Project Office, which replaced NIKE-ZEUS in February 1964.

On 5 January 1963, Secretary of Defense McNamara directed that the development of an ABM be a priority program, and one that incorporated the most technologically advanced components and techniques available. This program, known as NIKE-X, incorporated a variety of studies and initiatives designed to develop the next generation ABM system intended to counter the ICBM threat envisioned for the 1970s. The NIKE-X system would be composed of higher speed, higher capacity radars and computers, and an interceptor missile fast enough to be launched and to intercept an enemy warhead after it reentered the atmosphere. Combined with the existing ZEUS long-range missile, the NIKE-X would provide a layered defensive network.

Oversight of the NIKE-X program was assigned to the NIKE-ZEUS Project Manager in 1963. One year later, on 1 February 1964, the Army officially changed the name of the project office from NIKE-ZEUS to NIKE-X.[28] The Army also assumed responsibility for the Kwajalein Test Range, a logical transfer of authority given the role of Kwajalein in the Army's ABM research and development effort.[29]

On 5 June 1965, anticipating a production order for the NIKE-X, the Secretary of the Army approved a centralization of all facets of NIKE-X and established the NIKE-X System Manager at the Department of the Army level.[30] Under the centralized arrangement, the System Manager oversaw all elements of research and development, testing, production, training and deployment. The concept was implemented one year later. General Harold Johnson, Chief of Staff of the Army, identified the program for "exceptional management" based on the "scope and importance to the national defense of the NIKE-X Ballistic Missile Defense System,"[31] At that time, he appointed the Chief of Research and Development, Lieutenant General Austin Betts, to serve as the NIKE-X System Manager. The NIKE-X Project Office and the NIKE-X Engineering/Service Test Organization were subsequently placed under the operational control of the System Manager, who in turn would report to the Army Chief of Staff.[32]

Within a year of his appointment, the System Manager had contacted the various army commands and agencies that would have a role in a future deployment. One of these letters of instruction assigned the Corps of Engineers the task of designing and constructing the nuclear-hardened tactical facilities and support structures that would be required in the event the system was deployed. In response, the Corps established a special NIKE-X Division in October 1967.[33] Its sole mission was "to develop criteria, design, and construct developmental, training, support, and tactical facilities" for the planned ABM deployment. In 1968, as a result of a Memorandum of Agreement with the Corps of Engineers, the Huntsville Division also came under the operational control of the NIKE-X System Manager, further centralizing the ABM program.

Fig. 2-12. Dual salvo launch seen near the headquarters of the NIKE-X Project Kwajalein Test Site.

Debating Deployment Options

In 1963, Secretary McNamara ordered a new study of the ABM initiative. His focus was the impact caused by an ABM system on deterrence and relations between the United States and the Soviet Union. The Commission, headed by Lieutenant General Austin Betts, supported the missile defense program. The Betts Report concluded:

> (1) offensive technology had not hopelessly outstripped defensive technology – rather, the two technologies were roughly equal; (2) a BMD system would limit damage in case of a nuclear attack, with the amount of limitation dependent on the scenario; and (3) BMD would not disrupt the balance of mutual nuclear deterrence.[34]

Despite these findings, no deployment decision was forthcoming.[35] Instead, McNamara informed the Senate, "without question, offensive capability or what I will call the capability for assuring the destruction of the Soviet Union is far and away the most important requirements [sic] we have to meet."[36] This argument coupled with the estimated $16 billion cost for a deployment and the growing opposition of the scientific community influenced the Secretary's cautious approach toward missile defense.

By the mid-1960s, some scientists had concluded that it was unrealistic to deploy an ABM system. Tests conducted by the Reentry Body Identification Group in 1958 revealed that multiple warheads could overwhelm the NIKE-ZEUS system.[37] A similar study conducted in 1959 by the President's Science Advisory Group produced comparable conclusions. Thus, a number of the government's leading scientists opposed an ABM deployment. In 1961, ARPA Director Dr. Jack Ruina testified, "that he felt a 'great deal of pessimism about ever developing a complete and adequate umbrella against ICBM attack.'"[38]

The basis of their opposition was that the ABM program undermined nuclear deterrence.[39] Opponents believed that it would be impossible to build an airtight defense, and the other side would simply build more and better ICBMs. Wrapped around the arguments were the on-going negotiations for a nuclear test ban treaty, an agreement that would always be in jeopardy if the United States continued to develop ABMs that required nuclear testing. The conflict within the government spilled into the public arena when two senior scientists published an article in the October 1964 issue of *Scientific American* on the futility of pursuing an ABM program. Herbert York, Department of Defense Director of Research and Engineering, and Jerome Wiesner, head of the President's Scientific Advisory Committee, argued that a deployment would not only prove ineffective but would lead to a new type of arms race. This arms race would focus on the development of improved warheads and penetration aids. They concluded, "It is our considered professional judgment that this dilemma has no technical solution."

The Evolving Threat: The Nth Country

In the 1960s, new international developments began to determine the progress and priorities of ABM research. In October 1964, the nuclear club expanded to include China. While the

Chinese had exploded a nuclear device, they did not yet have a delivery system. Within a year, however, this situation changed when they completed a device that could be delivered by bomber.[40] On 27 October 1966, China announced it had successfully test-flown a guided missile carrying a live nuclear warhead. In that same year, the Chinese deployed the Dong Feng-2 (also known as the CSS-1), an intermediate range ballistic missile with a range of over 1200 kilometers that could threaten American military bases in Japan.[41]

With these developments in China and continued advances in technology, the Secretary of Defense ordered new studies to reassess the development and the feasibility of ABM deployment. Beginning in 1965, strategists began to look at the possibility of limited strikes by nations other than the Soviet Union - the so-called "Nth country" threat. The team theorized, "such an attack would probably consist of a limited number of unsophisticated inaccurate ICBMs, designed to terrorize rather than neutralize strategic targets."[42] The dangers presented by Nth country threat scenarios somewhat lessened concerns over destabilization between the Soviet Union and the United States.

In February 1965, Bell Labs began to investigate modifications to the NIKE-X aimed at achieving effective "high altitude defense against relatively unsophisticated attacks with deployment growth to meet sophisticated threats."[43] The result was an M-Multifunction Array Radar supplemented by an off-the-shelf VHF radar to provide long-range detection of sneak attacks. The Missile Site Radar (MSR) and SPRINT remained the key elements to the system for missile guidance and short-range intercepts. Following this presentation, Bell Labs received authorization to revise the NIKE-X requirements, "providing a more cost-effective defense against a possible Nth-country threat, in addition to the more sophisticated Soviet-type threats."[44] The modifications would enable the system to provide "a general defense" for the entire continental United States.

Tasked by the Director of Defense Research and Engineering in October 1965, the Army and Bell Labs designed a system, which would provide a defense against a "simple" first-generation Nth country threat. The recommended deployment (DEPEX-II) employed a minimum amount of hardware: 4 VHF radars and 12 Missile Site Radars, with 20 modified ZEUS missiles at each site. Recognizing the limitations of such a deployment, in November 1965 three teams began research on active defense of hardened sites. During this phase, engineers developed the concept of "pitch and catch" for the missile launch phase, increasing the potential flight time for the SPRINT missile.[45] The advances made from these studies were significant. As a result, the Office of Deputy Chief of Staff for Operations concluded in "NIKE-X Studies for 1966 (X-66), Report to the SECDEF," that the likely effectiveness of NIKE-X validated the cost of deployment at DEPEX-II. The study also found that "NIKE-X would add to U.S. deterrence and provide significant reduction in fatalities in the event deterrence fails." Despite these assessments, Secretary McNamara continued to oppose any deployment options. A series of events in 1967, however, brought the ABM issue to the forefront.

1967: A Turning Point

In November 1966, Secretary McNamara announced that the Soviet Union had deployed an ABM system around Moscow. Sixty-four launchers surrounded Moscow, equipped with the Galosh, a nuclear-tipped interceptor with an estimated range of 200 miles.[46] With this announcement, McNamara hoped to undercut arguments for the deployment of an American ABM system and to gain support for increasing the deployment of offensive weapons to offset the Soviet defenses. Meanwhile, President Lyndon Johnson expressed growing concerns on this subject. Given the situations in China and the Soviet Union, and considering the Joint Chiefs of Staff recommendation in favor of ABM deployment, President Johnson was inclined to favor a deployment decision. Instead, McNamara proposed that the President tie ABM deployment funds to arms control talks with the Soviets. An ABM system need only be deployed if talks with the Soviets failed.

At the June 1967 Glassboro Summit, President Johnson tried to convince Soviet Premier Alexsei N. Kosygin to abandon Soviet missile defense efforts. Johnson argued that continued deployment would lead to another arms race. Without this agreement, the U.S. "would be compelled to increase the number of warheads in its ICBM arsenal to overwhelm any defenses."[47] Kosygin had already made his position known. In a February 1967 press conference, he observed, "a defensive system, which prevents attack, is not a cause of the arms race but represents a factor preventing the death of people." Kosygin countered the arguments of Johnson and McNamara at Glassboro by arguing that "Defense is moral; offense is immoral."[48]

Deployment Options: The I-67 Studies

In December 1966, the Department of Defense tasked Western Electric and Bell Laboratories to construct a NIKE-X deployment model that would combine both area defense and hardsite defense capabilities. The plan, officially designated "Plan I-67 Area/Hardsite Defense," had two primary objectives: "defense against a deliberate Chinese People's Republic industrial/urban attack (countervalue); and defense against a deliberate high-level ICBM attack from the U.S.S.R. (counterforce) aimed at U.S. strategic locations."[49] In subsequent meetings with Secretary McNamara, Bell Labs officials were directed "to minimize the cost of an ABM deployment, while providing a system of high reliability."

On 5 July 1967, after a six-month study period, officials briefed McNamara on the I-67 concept. Study results were based upon three conditions: "(1) specific design threat, (2) total investment cost not to exceed 5 billion dollars, and (3) initial operating capability within 54 months of deployment decision, thereby limiting choice of equipment to NIKE-X elements." The recommended deployment consisted of: 6 Perimeter Acquisition Radars (PAR), including one in Alaska, 17 Missile Site Radars (MSR) including one in Alaska and Hawaii, 480 Spartan interceptors and 455 Sprint interceptors. Of the Sprint deployment, 325 would be allocated for the defense of Minuteman sites. At that meeting, McNamara ordered a 30-day study of the evolving threat posed by China and the ability of the system to grow accordingly. The Montgomery Committee found that the NIKE-X DEMOD I-67 "constituted an adequate base for proceeding."

Arguments favoring the deployment of an American ABM system had continued in 1967 as the Chinese threat was renewed. In June 1967, the Chinese exploded their first thermonuclear device. This achievement was followed in October, by the successful launch of a nuclear-tipped missile that struck its intended target. In December, the Chinese conducted another nuclear test.

NIKE-X Becomes SENTINEL

Fig. 2-13. The Sentinel became the new symbol in 1967.

Although still opposed to the concept, in an 18 September 1967 speech to the UPI Editors and Publishers in San Francisco, Secretary of Defense McNamara announced the government's decision to deploy a light ABM system composed of NIKE-X components.[50] This system, identified as SENTINEL, would provide protection for urban/industrial areas against possible ICBM attacks by China.[51] It would also provide a defense in the event of an accidental launch by any power. Finally, the plan included an option to defend the Air Force's MINUTEMAN missile sites.

Deployment preparations began almost immediately. The Army had 54 months to reorient the program from research and development to production and deployment. The initial deployment consisted of 6 PARs, 17 MSRs, 480 Spartans, and 220 Sprints. On 1 November 1967, the Department of Defense announced the locations of the first ten SENTINEL sites: Boston, Chicago, Grand Forks Air Force Base, North Dakota, Salt Lake City, Detroit, Seattle, Hawaii, New York, and Albany, Georgia.[52] Two weeks later, the Secretary nominated the SENTINEL System production program to the S category of the master urgency list.

Two days after the deployment announcement, the Secretary of the Army signed the SENTINEL System Manager charter. The SENTINEL System Manager reported directly of the Chief of Staff of the Army and functioned as an element of the Office of the Chief of Staff. His mission, as stated in the charter, was to "develop and, when so directed, assure the timely, effective deployment of the SENTINEL System, and provide a single point of contact within the Department of the Army for the coordination and direction of all activities pertaining to the SENTINEL System."[53] Organized in the centralized manner devised by the NIKE-X Project, the SENTINEL System Manager headed the SENTINEL System Organization that was composed of the SENTINEL System Office in Washington, D.C., the SENTINEL System Command in Huntsville, Alabama, and the Sentinel System Evaluation Agency in White Sands Missile Range, New Mexico. Since the primary focus for this new organization was to be on systems/operations of the SENTINEL system, a parallel command was established to address further R&D efforts: the Ballistic Missile Defense Research Office.[54] As part of this reorganization, the Assistant Secretary of the Army for Research and Development recommended the transfer of ARPA's

ABM research, and, in March 1968, ARPA's Project Defender transferred to the Army and the Ballistic Missile Defense Research Office.

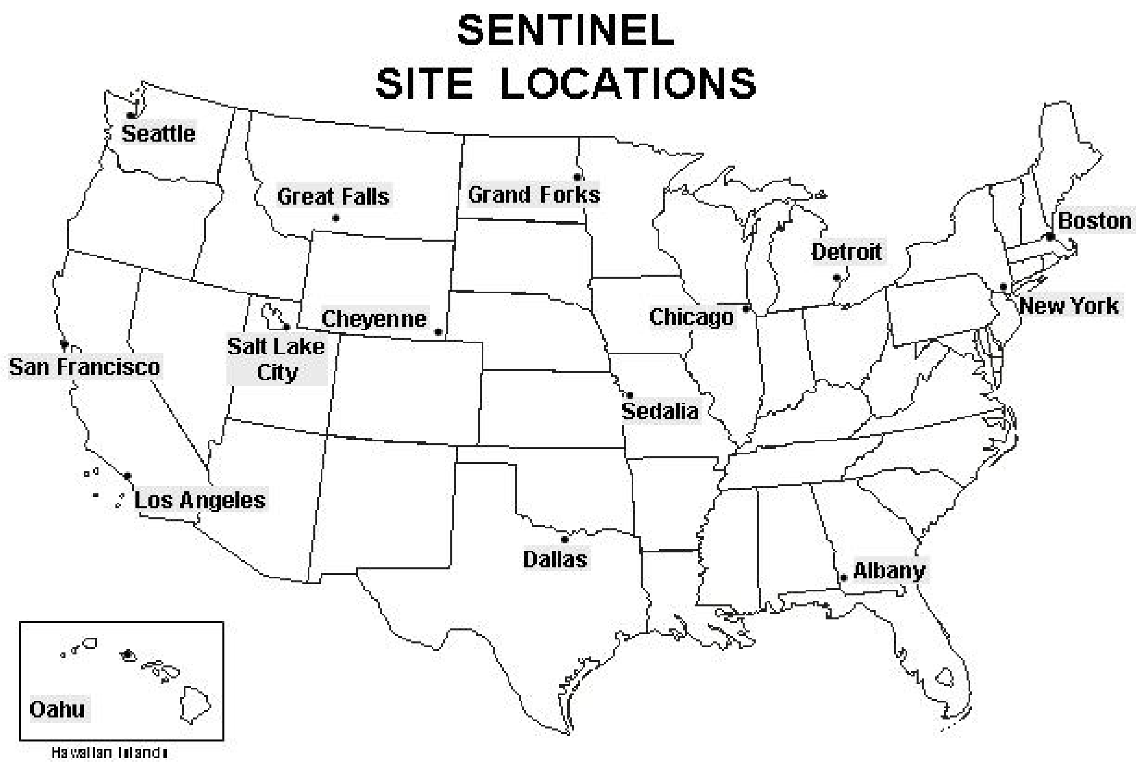


Fig. 2-14. SENTINEL sites were established to defend urban and industrial areas. The map does not show the sites in Washington, D.C. and Fairbanks, Alaska that were never publicly announced.

Even as the SENTINEL organization geared up for production in 1968, the attention of the Army and the nation was diverted.[55] The Army had an increasing role in the war in Vietnam and was less inclined to support funding for more than a thin ABM system. The public was also focused on Vietnam and becoming increasingly anti-military. Secretary McNamara and Assistant Secretary of Defense Paul Warnke announced that the Chinese program currently lagged a year behind expectations, which suggested that the need for a deployment was less urgent. Finally, the Johnson Administration signed the Treaty on the Nonproliferation of Nuclear Weapons and agreed to begin strategic arms limitation talks with the Soviet Union to limit both offensive and defensive nuclear weapons.

SENTINEL Deployment Suspended

Congress approved land acquisition near Boston for construction of the first SENTINEL site on 13 September 1968. Opposition, however, grew, and the SENTINEL sites served as rallying points for protesters. Scientists and residents raised safety concerns with the deployment of nuclear weapons near urban centers. Others argued that an ABM site in their neighborhood would make their city a target rather than protect it from attack.

The controversy continued unabated with the inauguration of the new administration. As a result, on 20 January 1969, President Richard M. Nixon took office and initiated a Department of Defense review of strategic offensive and defensive priorities. In conjunction with this order, the new Secretary of Defense Melvin Laird ordered a temporary halt to the SENTINEL deployment pending the results of this review.

NIKE-X/SENTINEL Components

On 25 September 1964, the Army Materiel Command awarded what was then the largest single contract in Army history. Western Electric Company received a $309,664,200 contract to fund research and development work and testing on the NIKE-X from October 1964 through September 1965. Although no deployment decision had been made at that time, this contract represented a definite commitment to BMD research and development. The primary focus of this initiative was on the Multifunction Array Radar, the Missile Site Radar, the Sprint missile and the Zeus/Spartan missile.

ZEUS DM/SPARTAN

The oldest component of the SENTINEL deployment was the SPARTAN. In June 1965, Deputy Director for Research and Engineering, Dr. Harold Brown, directed the Army to prepare a proposal to use a modified ZEUS missile in the barrage defense role. This research produced the SPARTAN (originally known as the ZEUS DM 15X-2).[56] Launched from an underground cell, the SPARTAN was a three-stage interceptor armed with a high-yield nuclear warhead designed to destroy ICBMs in the exoatmosphere.[57]

Building upon the knowledge gained in the ZEUS testing and incorporating the projected tactical design into the first flight missile, the development test program was comparatively short, comprising just 15 missile flights. The SPARTAN test program began on 30 March 1968 with the first launch of a SPARTAN missile from Kwajalein. The program concluded seven years later on 17 April 1975. In addition to the flight tests, twenty missiles were fired as part of the SAFEGUARD System Test Program and five production missiles were used in the Product Assurance Verification Test. These tests, conducted against intermediate range ballistic missiles, intercontinental ballistic missiles, space points, and simulated targets, demonstrated the versatility of the SPARTAN interceptor with regard to range, altitude, dynamic pressure, and third-stage ignition. The SPARTAN program made many contributions to interceptor technology. Among the innovations found in this missile are nuclear hardening technology, an ablator to protect the missile from extreme heats, a missile guidance set to "[ensure] proper operation during severe shock, vibration and noise," and a fluid-sphere gyro that increased reliability over conventional gyros.

Fig. 2-15. Elliptical footprint of the area covered by a SPARTAN missile system from a hypothetical base in Iowa.

2-16. The control and guidance sections of the SPARTAN missile are loaded into a launch cell on Meck Island.

SPRINT

Developed as part of a 1962 study, the second interceptor was the two-stage, short-range SPRINT.[58] Armed with a low-yield nuclear warhead, the SPRINT was designed to maneuver within the atmosphere to intercept warheads that had survived the area defense provided by SPARTAN. This maneuverability maximized the time available for discrimination of warheads and decoys.

In order to meet anticipated deployment deadlines, the SPRINT test program began almost immediately. The 1963 SQUIRT flight tests, for example, looked at heat shield materials for the SPRINT. The first test of the SPRINT itself came in November 1965 at White Sands Missile Range. The developmental test program ended on 12 August 1970 following the forty-second SPRINT launch. In the next phase, the SPRINT was integrated with the other components of the system. In 34 tests at Kwajalein Missile Range, the SPRINT successfully intercepted 32 targets - IRBMs, ICBMs, space points, and simulated targets, well within the required miss distances.[59] The SPRINT test program concluded on 30 April 1975 with the intercept of a short-range low altitude space point.

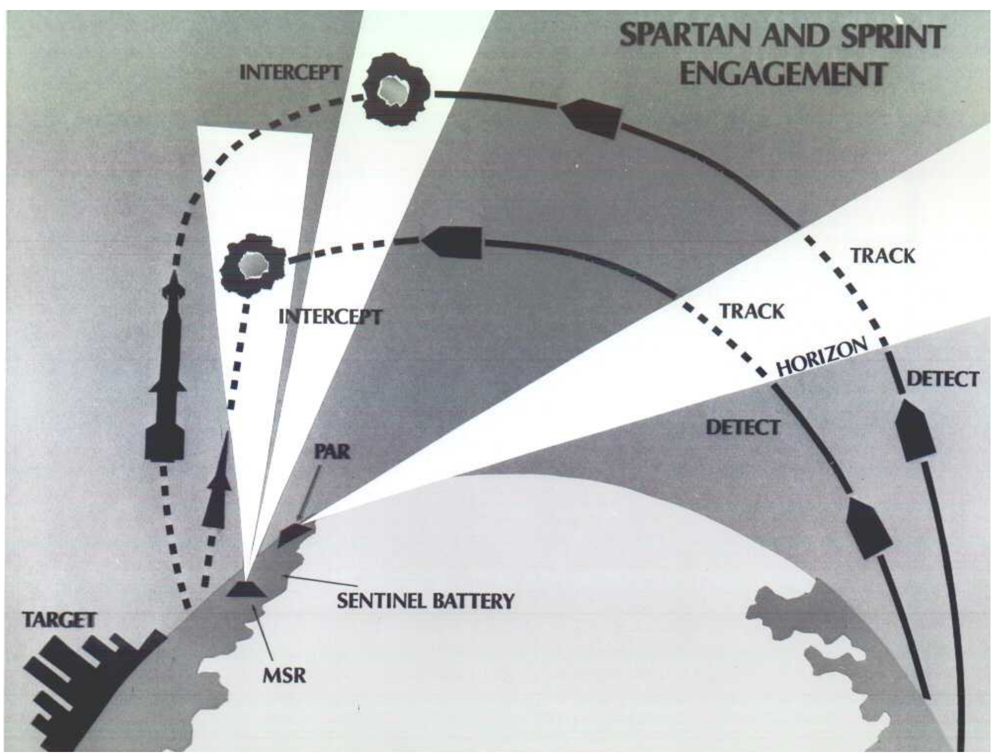


Fig 2-17. Artist's conception of the SPRINT and SPARTAN engagement concept from a coastal SENTINEL battery.

2-18. SPRINT test vehicle #2 on 4 June 1965 at White Sands Missile Range.

By all accounts, the SPRINT was an engineering marvel. Flying at tremendous speeds, "the missile's skin became hotter than the interior of its rocket motor and glowed incandescently." Its ability to accelerate to extreme velocities and maneuver within the atmosphere represented significant advances in missile technology. Among the many innovations attributed to this project were new valves to control airflow for high speed acceleration, a new high-burn rate propellant, special heat shield coatings that enabled radar tracking, missile communications that could be maintained through an ion layer, shock proofing and nuclear hardening technologies.

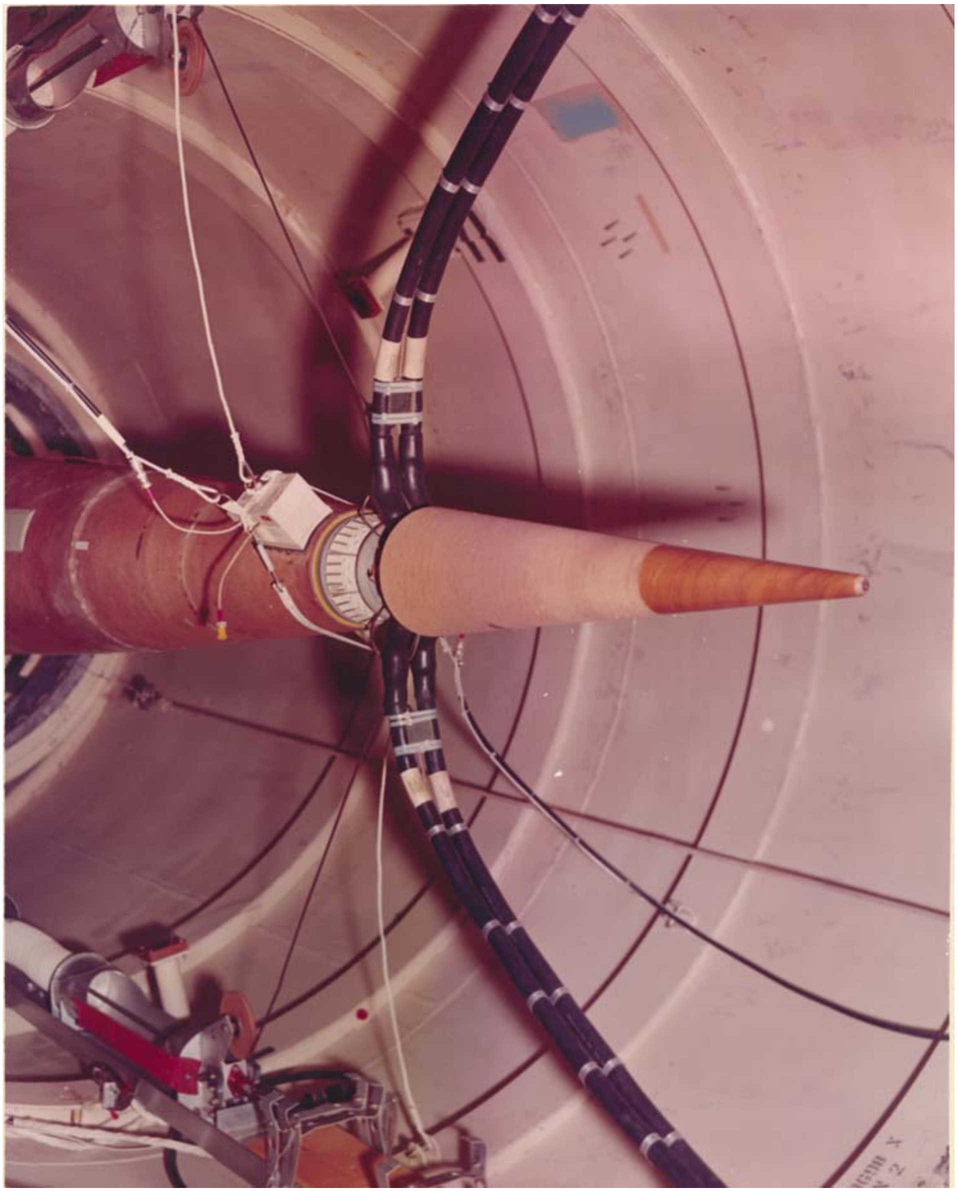


Fig. 2-19. SPRINT missile in launch cell for FLA-1 on 16 November 1965.

Multifunction Array Radar (MAR)/Perimeter Acquisition Radar (PAR)

In 1960, Bell Labs and the Army began to explore phase controlled scanning antenna radars.[60] Benefits from this type of system were many. These antennas had increased blast resistance capability, greater power handling capability, flexibility of beam adjustment, and the ability to combine multiple functions in one radar. In addition, the inertia-less beams in the phased array system could more easily support a "high-traffic-level-threat." The ARGMA granted authorization to develop a prototype Multifunction Array Radar (MAR), to be constructed at White Sands in June 1961. Testing of the MAR revealed the need to conduct exhaustive tests on such elements as the Traveling Wave Tube, which was incorporated into full radar in the thousands. Nevertheless, the White Sands experiments demonstrated the stability and accuracy of the system as well as the broad frequency bandwidth capability and microsecond switching. The experiments also illustrated the significant role of the centralized digital computer, which controlled all radar functions and executed large-scale, real-time data processing. The phased array radar was able to steer its beam electronically in a few millionths of a second.

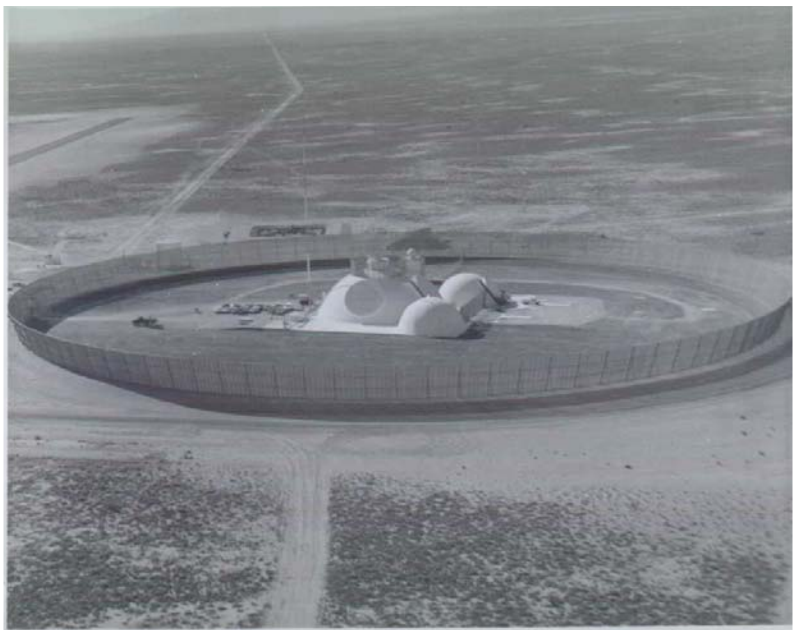


Fig. 2-20. The Multifunction Array Radar was constructed at White Sands Missile Range.

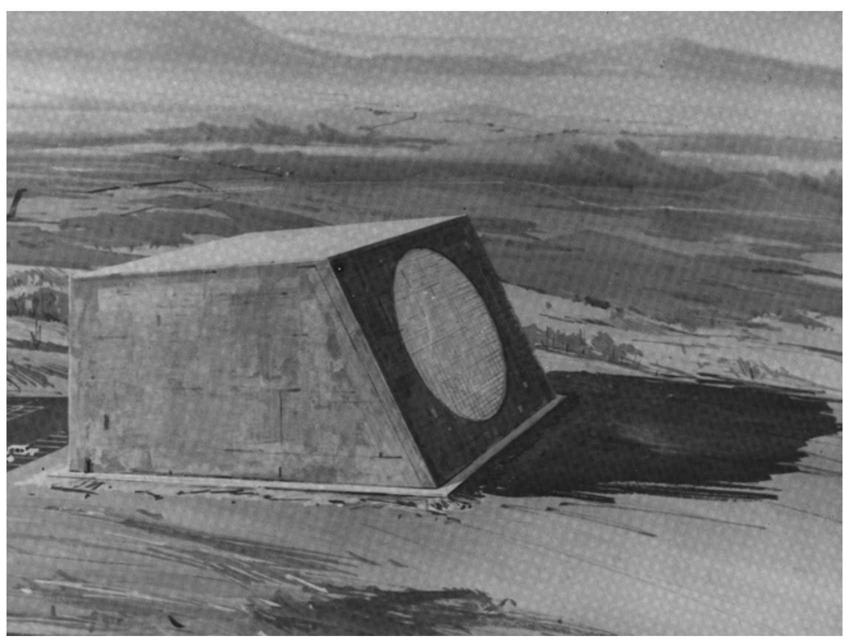


Fig. 2-21. Artist's concept of the Perimeter Acquisition Radar.

As part of the proposed NIKE-X deployment, the MAR was defined as an L-band, high-power, phased array radar. Serving as the primary sensor in the system, the MAR had four functions: (1) search and verification, (2) threat evaluation, (3) target track, and (4) missile track. The long-range tracking and discrimination requirements dictated a high power requirement for the MAR and thus a separate transmitter and receiver array faces.[61] The systems costs associated with MAR and the revised deployment requirements from the I-67 study resulted in the final deployment of the less expensive Perimeter Acquisition Radar (PAR).

The configuration planned for the PAR was comparable to that of the MAR-I system tested at White Sands. This factor combined with the availability of UHF components produced a PAR design that was considered to be off-the-shelf technology. Therefore, a complete prototype of the system was never constructed. The one and only PAR system, is located near Grand Forks, North Dakota.

The PAR was a nuclear-hardened, electronically steered, phased array radar operating at ultrahigh frequency (UHF). Initially designed as an early warning system, the final version of the PAR provided tracking for the SPARTAN intercept. With a detection range of 1,000 to 2,000 miles, its primary role was to provide long-range surveillance to detect enemy missiles. In a secondary function, the PAR provided data on satellites for the North American Air (now Aerospace) Defense Command. Although other components of the I-67 deployment were terminated later, the PAR still operates as part of the Air Force's early warning system.

Missile Site Radar

In the initial design concept, the Missile Site Radar (MSR) would provide multiple tracking of defensive missiles and short-range target tracking.[62] Subsequent studies, addressing the defense of smaller cities, produced changes in the MSR design. In 1965, the role of the MSR increased to include search, acquisition and tracking of incoming targets. To achieve this mission, each MSR would be equipped with its own data processing and command and control center allowing independent operations.

The MSR was an S-band phased-array radar. Unlike the PAR, the MSR was designed to have one, two or four antenna faces, each equipped for both transmitting and receiving. A prototype MSR, constructed on Meck Island in the Kwajalein Atoll, began operations in January 1969 and participated in the full series of tests of the SPRINT and SPARTAN missiles. Designed for continuous operation, the MSR operated at a higher average power than any other radar in its frequency. In conjunction with its Missile Site Data Processor, the fully operational MSR processed "its own autonomous target data as well as data from the … PAR, discriminates between warheads and other objects, and launches and guides interceptor missiles on appropriate trajectories via an RF command guidance link to the SPARTAN and SPRINT missile farms."[63]

Fig. 2-22. Cut-away drawing of the tactical Missile Site Radar.

A New Direction: SAFEGUARD

Fig. 2-23. The Institute of Heraldry issued this shoulder sleeve insignia on 8 May 1969. It remained a symbol of this organization until the mid-1990s.

As a result of the controversy over the proposed SENTINEL deployment, the Nixon administration ordered a review of strategic offensive and defensive priorities. Secretary of Defense Laird instructed Deputy Secretary of Defense David Packard to conduct a review of the Pentagon budget and the U.S. strategic force structure. The scope of both studies encompassed the SENTINEL anti-ballistic missile system. On 20 February 1969, one month after beginning his study, Packard presented his findings to the President. Packard's presentation included four options. The first called for the deployment of a "thick" ABM system that incorporated long- and short-range missiles to protect the 25 largest cities in the nation. The second proposal was the continuation of the SENTINEL system as defined during the Johnson administration. The third option, known as I-69, called for the deployment of the SENTINEL system to protect ICBM fields rather than cities. The fourth and final proposal was not to construct an ABM system.

Directed to conduct a thorough study of all four options, Packard returned with a recommendation for the I-69 deployment. Unanimously endorsed by the Joint Chiefs of Staff, I-69 was a phased deployment plan with 12 sites across the nation. The first phase would provide protection for some of the Minuteman sites and the second would complete Minuteman coverage and "cope with more sophisticated threats."[64] An initial deployment at two sites would save $500 million in the first year, while still supporting R&D and only delaying full operating capability by 9-12 months.

When compared to the original SENTINEL system, the I-69 Modified SENTINEL would provide increased coverage of the National Command Authority, with the addition of 20 SPARTAN and 50 SPRINT missiles to protect Washington from a Soviet attack.[65] Although fewer SPRINT missiles would be deployed, they would be better distributed thus protection of the MINUTEMAN sites was virtually unchanged. The primary change came in area defense. By relocating and orienting radars to look in directions other than North, the new system would be able to provide protection against Soviet submarine-launched or fractional orbital space bombardment missiles. The reduction in radars, however, eliminated the defense of Hawaii and Alaska and resulted in some gaps in the continental United States. The modified SENTINEL found support in two distinct camps. The first held that the "deployment [filled] important gaps in the protection of our deterrent and [provided] options for meeting possible new threats … that have not yet appeared, such as accurate Soviet MIRVs." The second saw the deployment "primarily as a useful first step toward obtaining a major damage limiting capability against the Soviet Union as well as a necessary step in maintaining an invulnerable deterrent."

Given the build-up in the Soviet offensive forces and their deployment of an ABM system, President Nixon favored the deployment of an American defensive system. On 14 March 1969, President Richard Nixon officially redirected the BMD program – creating the SAFEGUARD program. In his speech, Nixon specified three defense objectives. The first priority was "protection of our land-based retaliatory forces against a direct attack by the Soviet Union." The second was to provide a "defense of the American people against the kind of nuclear attack which Communist China is likely to be able to mount within the decade." And, the third sought to provide "Protection against the possibility of accidental attacks from any source." Nixon declared that the purpose of SAFEGUARD was "… to deny other countries the ability to impose their will on the United States and its allies under the weight of military superiority."

Components remained unchanged from the SENTINEL system but deployment concepts were redrawn. This new SAFEGUARD System was to be a phased deployment, rather than the SENTINEL's fixed deployment schedule. Construction would begin with two Phase I sites – Malmstrom Air Force Base, Montana, and Grand Forks Air Force Base, North Dakota, and a Ballistic Missile Defense Center (BMDC) at Cheyenne Mountain, Colorado. Annual reviews, by the President and the Foreign Intelligence Advisory Board, would assess the need to construct the other ten sites, based upon technical developments, threat and diplomatic context.

The nation and the Senate, however, remained divided on the ABM issue.[66] Throughout the spring and summer, opponents published reports that the SAFEGUARD system was "neither

Fig. 2-24. The initial SAFEGUARD deployment, proposed in 1969, with the first two approved sites circled.

feasible nor desirable." The division in the Senate remained very close. Then on 14 July, Senator Winston Prouty (R-VT), broke with his state's leadership and spoke in favor of missile defense. As he stated, in the event of a missile attack "I discovered that there are now two grim alternatives – do nothing or push the button that unleashes our devastating nuclear fury … SAFEGUARD provides an additional alternative, an extra button."[67] The debate would continue, culminating in the 6 August 1969 vote on the authorization bill. Although three separate amendments sought to restrict ABM to an R&D effort, the SAFEGUARD deployment authorization passed.[68]

Reorganization: SENSCOM to SAFSCOM

With the president's announcement, the Army organization established with the SENTINEL system deployment was redesignated SAFEGUARD.[69] The SAFEGUARD System Manager's mission was unchanged. As defined in the 1969 Charter, the new system manager's duties were to "develop and assure the timely, effective deployment of the SAFEGUARD Ballistic Missile Defense System, and provide a single point of contact within the Department of the Army for the coordination and direction of all activities pertaining to the SAFEGUARD BMD System."[70] The first site was to be operational within 54 months.

In order to achieve this mission, the Army began to establish supporting commands dedicated to the SAFEGUARD mission. The SENTINEL Logistics Command, a major subordinate command of the Army Materiel Command became the SAFSLOG. The U.S. Army Strategic Communications Command organized the SAFEGUARD Communications Agency at Fort Huachuca, Arizona.[71] These were followed by SAFEGUARD System Site Activation Commands at Grand Forks and Malmstrom created in 1970, and in Colorado Springs for the Ballistic Missile Defense Center and Fort Bliss, Texas for the Central Training Facility established in 1971. In April 1971, the SAFSLOG established the U.S. Army SAFEGUARD Depot Activity at Redstone Arsenal, Alabama. Following training, the depot cadre was assigned to Glasgow Air Base, Montana.[72] Other participating agencies were the U.S. Continental Army Command, U.S. Army Air Defense Command, Office of the Chief of Engineers, Office of the Surgeon General, U.S. Army Combat Developments Command, U.S. Army Security Agency and the U.S. Army Intelligence Command.

Deployment-Phase II

On 30 January 1970, President Nixon announced his decision to extend the deployment of SAFEGUARD to include a third site - Whiteman Air Force Base, Missouri. At the same time, advance preparation was to begin at five additional sites - Washington, D.C. and Warren Air Force Base, Wyoming, and unnamed sites in the Northeast, Northwest, and the Michigan-Ohio area. When submitting the proposal to Congress, Secretary Laird included additional SPRINT missiles at the first two sites. Although Laird described this proposal as “the minimum we can and must do both in cost and in system development, to fulfill the President’s national security objectives,” the Senate Armed Forces Committee did not approve the entire package.[73] In October 1970, funds were granted for the Whiteman site and advance preparation at Warren, but no monies were allocated for the other four sites. With this decision, the Whiteman site was designated the Fire Control Center, an intermediate command center reporting to BMDC, with Malmstrom to serve as the alternate.

Fig. 2-25. Phase Two of the SAFEGUARD deployment with the four authorized sites circled.

After a thorough review of the SAFEGUARD program, Secretary of the Army Stanley Resor presented the President's request for FY 1972. The plan called for continued construction at the Grand Forks and Malmstrom sites, initial construction at the Whiteman site and "steps toward deployment of a fourth site at either Warren AFB or in the Washington, D.C. area."[74] Lieutenant General Alfred Starbird explained to Congress that while "a full light area defense deployment of the entire U.S. [continued] to be a desirable objective," this plan enables the Army to be responsive to the threat. The addition of Warren AFB "would allow timely deployment of additional MINUTEMAN defense and light defense of some inland strategic bomber bases and command and control center at Omaha and Colorado Springs." Meanwhile, the National Command Authority was deemed vulnerable to attack by both ICBMs and SLBMs and officials believed that a Washington deployment would add credibility to the deterrent. Before any decision was made on this controversial proposal, however, the United States and the Soviet Union signed the Anti-Ballistic Missile (ABM) Treaty, which imposed limits on the nation's ABM program.

The Anti-Ballistic Missile Treaty

Even as the Senate debated the Phase I deployment of SAFEGUARD in the summer of 1969, officials observed the system's potential use in arms negotiations. Senator Henry Jackson (D-WA) stated, "anyone who wants a successful negotiation with the Soviets to halt the further evolution of dangerous strategic armaments should be a strong proponent of the SAFEGUARD ABM." He added "the chance is promising that we could come to an agreement with the Soviet Union for a limited ABM defense on both sides … provided that we do not foolishly throw that chance away by now scuttling our own program."[75]

Negotiations with the Soviets soon began. In November 1969, the United States and the Soviet Union initiated the Strategic Arms Limitation Talks (SALT I) to place limits on both ABM defensive systems and strategic nuclear offensive systems. Secretary of Defense Melvin Laird opposed cuts to the SAFEGUARD program or a halt to the deployment plans arguing that these would damage the American position in these talks. A new role was thus attributed to the SAFEGUARD System: that of a bargaining chip in the SALT talks.

Following two and a half years of meetings and back channel discussions, the two nations came to an agreement on ABM systems. On 26 May 1972, President Nixon and Soviet General Secretary Leonid Brezhnev signed the Anti-ballistic Missile (ABM) Treaty.[76] Ratified by the U.S. Senate on 3 August 1972, the treaty went into effect on 3 October 1972.

The ABM Treaty limited both nations to two ABM sites: one near the National Command authority, and the other near an ICBM complex. Each site could be equipped with 100 interceptors and launchers, with an additional 15 launchers located at test sites. The treaty also specified the number and type of radars that could be constructed at the different sites. While deployed systems could be upgraded and modernized both nations agreed "not to develop, test, or deploy ABM systems or components which are sea-based, air-based, space-based, or mobile land-based."[77]

Further restrictions were placed on the ABM program on 3 July 1974, when President Nixon and General Secretary Brezhnev signed a protocol to the 1972 ABM Treaty. The protocol limited each country to one ABM site, located at either the National Command Authority or an ICBM complex. With the reduction in sites, the number of interceptors and launchers permitted was also reduced from 200 to 100. This agreement went into force on 24 May 1976.

SAFEGUARD Deployed - Site Activation

Groundbreaking for the Phase I SAFEGUARD sites began with the PAR site, near Concrete, North Dakota, in April 1970. This was followed in June 1970 with site preparation at the second SAFEGUARD site at Malmstrom AFB, Montana. Construction began on the Ballistic Missile Defense Center in Cheyenne Mountain one year later in December 1971.

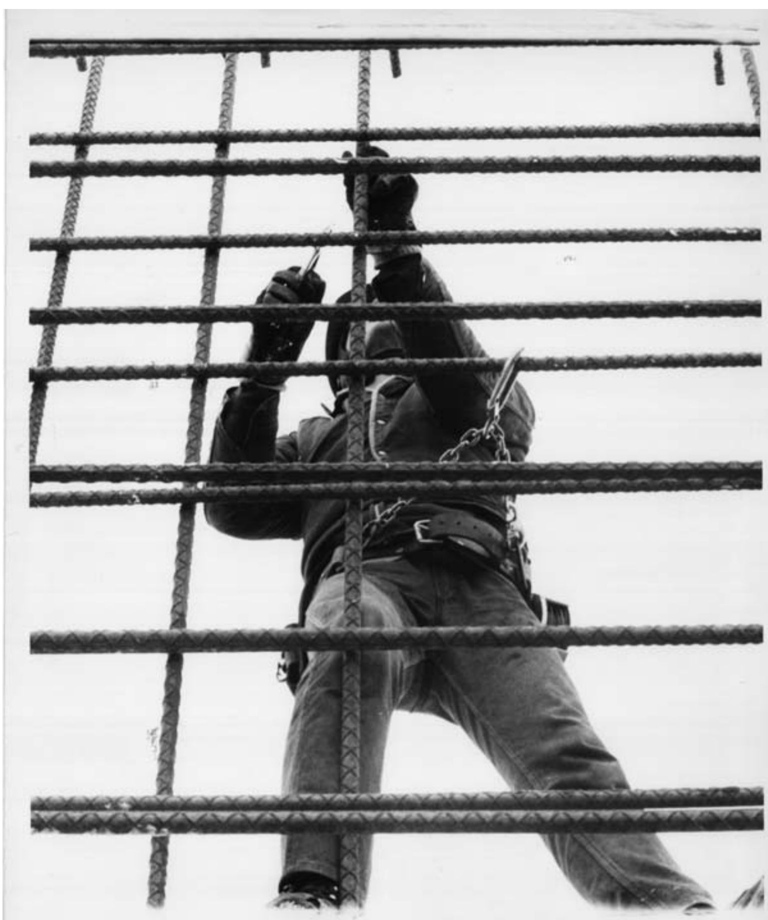


Fig. 2-26. Tying rebar-construction began on the nuclear hardened facilities in 1970.

Fig. 2-27. Despite weather conditions, which ranged from -40°F to 100°F, the Top-Out Pour for the Missile Site Control Building took place on 12 October 1971.

With the signing of the ABM Treaty, however, Secretary Laird advised that several actions be implemented immediately.[78] The SAFEGUARD deployment in North Dakota would remain unchanged. The Army was, however, to suspend (1) construction of the SAFEGUARD site at Malmstrom AFB, Montana, (2) all future work at the other sites, and (3) all R&D programs which are prohibited by the treaty. At the same time, Laird recommended preparing for the dismantling of the Malmstrom site, which would begin with the ratification of the treaty.[79] Finally, the Army and the SAFEGUARD System Organization were to initiate planning to cancel the 12-site deployment, but were to address the deployment of an ABM site near Washington, D.C. "on the fastest reasonable schedule." Any planning for a Washington ABM site ended with the 1974 protocol. At that time, the United States elected to maintain an ABM facility at an ICBM complex, while the Soviets continued to operate their Galosh system around Moscow.

The Stanley R. Mickelsen SAFEGUARD Complex

As mentioned above, the components of the SENTINEL and SAFEGUARD systems were identical - the Perimeter Acquisition Radar (PAR), the Missile Site Radar (MSR), SPRINT and SPARTAN missiles. The deployed system included all of these elements in various configurations near Grand Forks, North Dakota. The word complex was chosen to reflect the geographically dispersed organization. The PAR site is located near Concrete, the MSR near Nekoma, while the four Remote SPRINT Launch (RSL) sites can be found near Hampden, Dresden, Concrete, and Fairdale. On 21 June 1974, Army officially designated the SAFEGUARD tactical facilities in North Dakota the Stanley R. Mickelsen SAFEGUARD Complex (SRMSC).[80]

Fig. 2-28. Lieutenant General Stanley R. Mickelsen (1895-1966) recognized for his support of the Ballistic Missile Defense Program.

On 1 October 1974, the SRMSC achieved its equipment readiness date, with the completion of the construction and equipment installation phase. The Army officially accepted and dedicated the complex, the first new military installation since World War II. Delivery of missile warheads began in February 1975 after SRMSC received certification for its nuclear mission. The SAFEGUARD system achieved initial operating capability on 1 April 1975. On this date, operational control of 28 Sprint and 8 Spartan missiles and the "fully netted" system was turned over to the commander of the Continental Air Defense Command.

On 28 September 1975, three days ahead of schedule, the Stanley R. Mickelsen SAFEGUARD Complex reached full operational capability and became the first and only ABM system in the western world. In addition to the radars, the fully operational system included a total of 30 SPARTAN and 70 SPRINT missiles. As directed by the Secretary of Defense, SAFEGUARD was used as an educational source for the development and deployment of an ABM system.

Command and Control

The 1969 SAFEGUARD System Charter assigned to the SAFEGUARD Organization oversight of the research, development and deployment of the American ABM system. That same document specified that the ultimate user of this system would be the Army Air Defense Command (ARADCOM). Preparations began in October 1971, when the ARADCOM issued General Orders creating the first two units to man the SAFEGUARD sites - the U.S. Army SAFEGUARD Command, Grand Forks and the U.S. Army Surveillance Battalion, Grand Forks. With an authorized strength of 684, the mission of the SAFEGUARD Command was to "defend the Continental United States from a ballistic missile attack; specifically, to establish an area defense for existing retaliatory missile sites." Stationed at the PAR site, the 400 personnel of the Surveillance Battalion were "to provide long range surveillance and early warning of a ballistic missile attack against the Continental United States."[81] Both units had an organizational date of 1 September 1973.

In 1974, the Department of Defense deactivated ARADCOM. The SAFEGUARD Command, Surveillance Battalion, and Ballistic Missile Defense Center subsequently transferred to the Ballistic Missile Defense Organization effective 3 September 1974.[82] The SAFEGUARD mission was essentially distributed between the Ballistic Missile Defense Program Manager (administrative) and the Continental Air Defense Command (operational).[83] The CONAD subsequently assumed operational control of the SRMSC when it reached initial operating capability. The CONAD itself was inactivated on 30 June 1975. Responsibility for an operational SAFEGUARD subsequently rested with the Aerospace Defense Command, whose duties included U.S. air defense and aerospace surveillance.

Fig. 2-29 and 2-30. As construction progressed in North Dakota, missile testing continued on Kwajalein. The SPARTAN missile is launched from Mount Olympus (right). The final SPARTAN launch (M2-25) occurred on 17April 1975 (below).

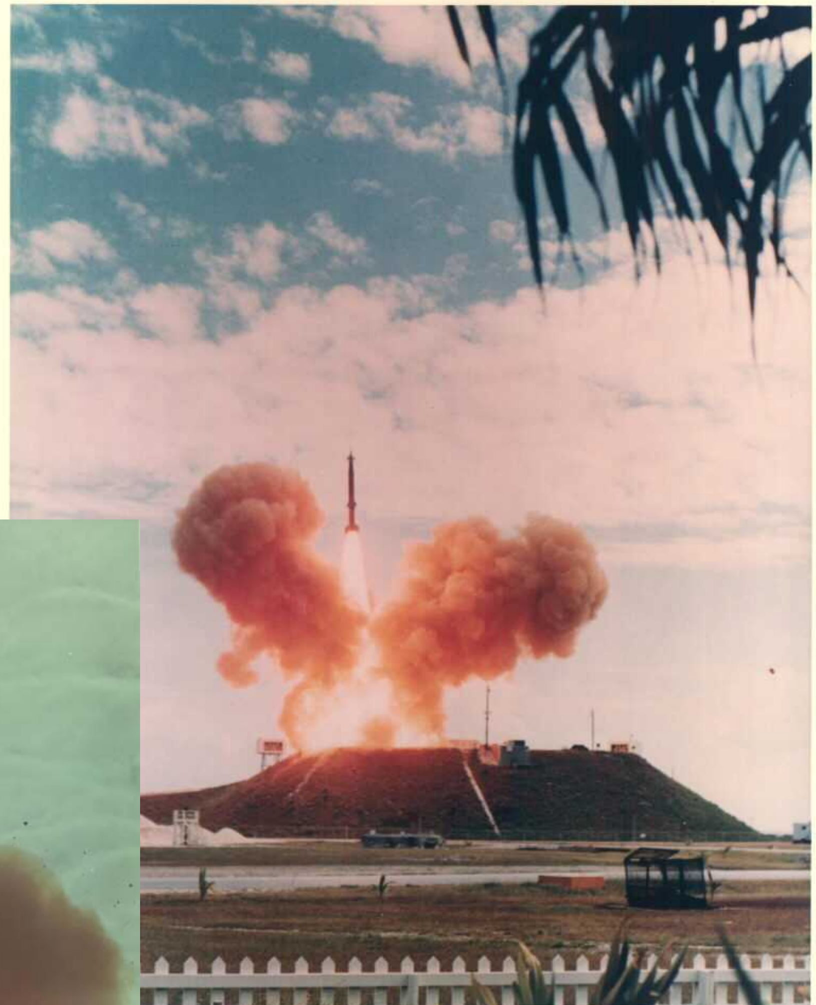
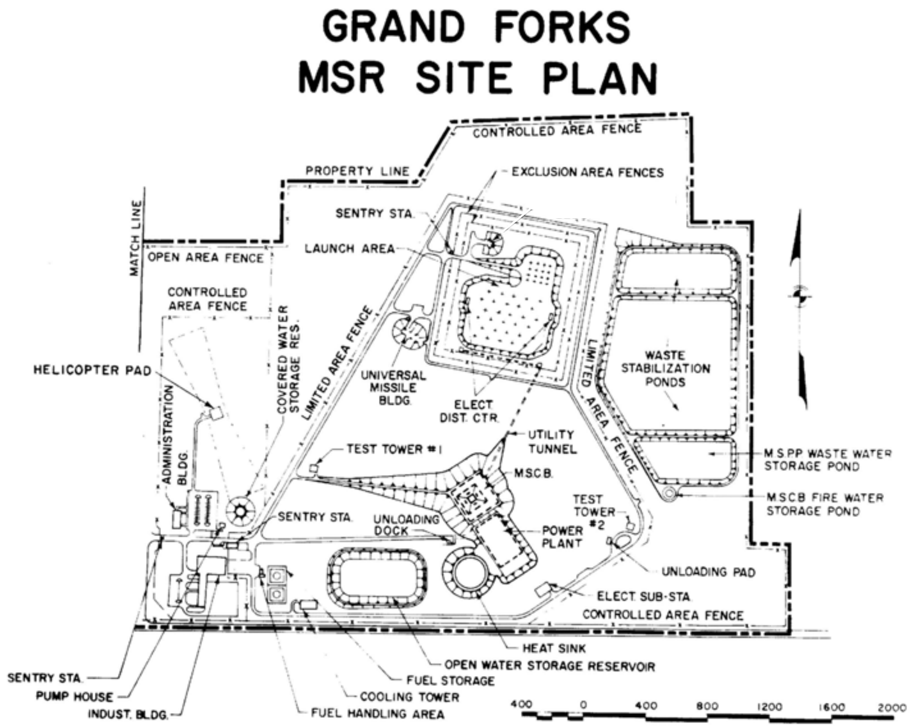


Fig. 2-31 and 2-32. During flight, the SPRINT missile achieved such speeds that it would become incandescent. SAFEGUARD tests included salvo tests for both missiles. A SPRINT salvo launch. (right)



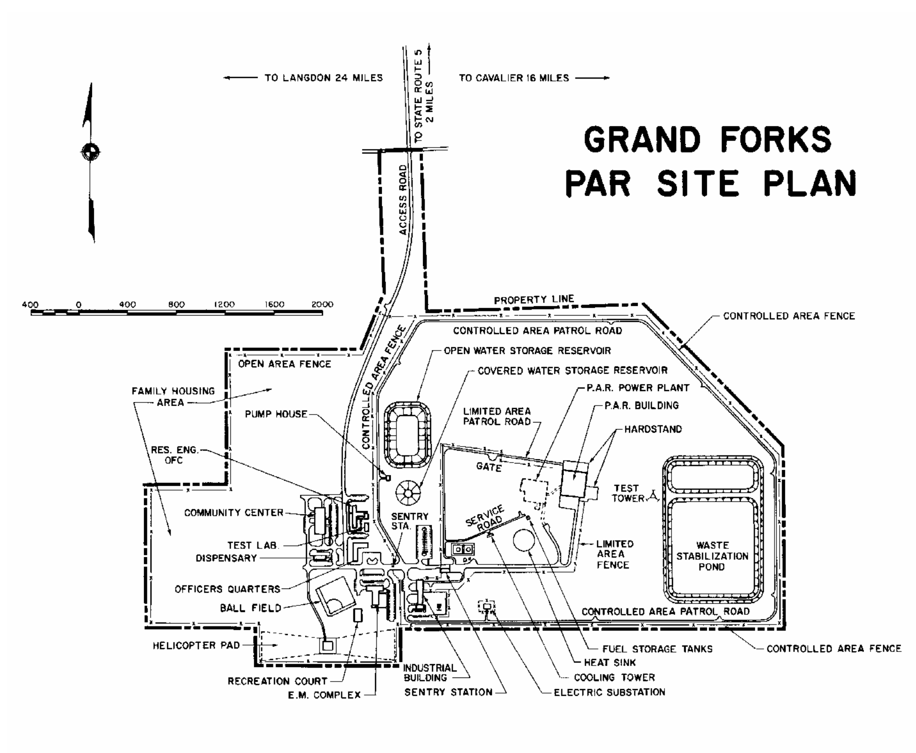


Fig. 2-33 and 2-34. Site plans for the MSR and the PAR illustrate the vastness of the complex. The MSR complex at 433 acres was much larger than the PAR, which encompassed 279 acres.

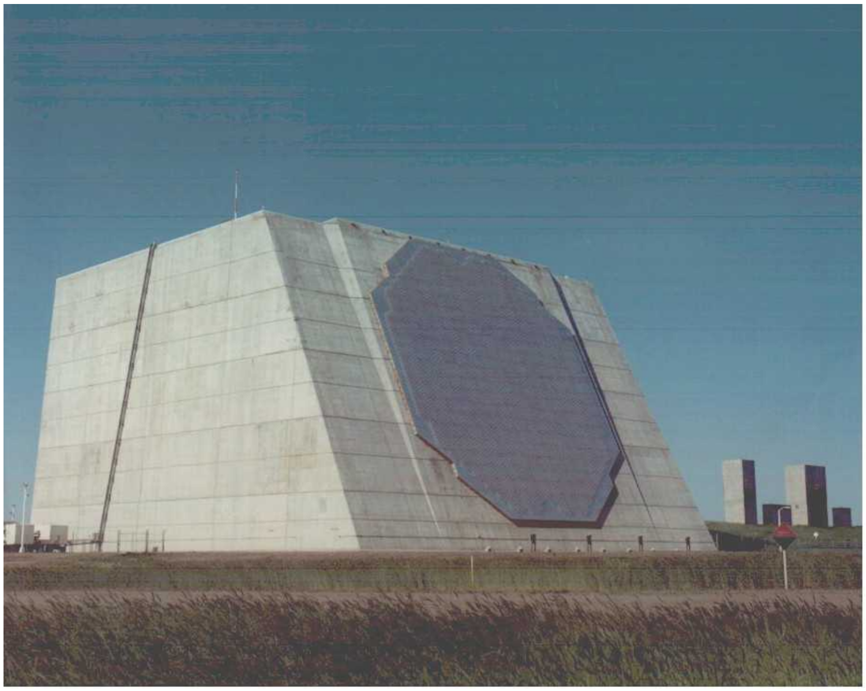


Fig. 2-35. The PAR building, the largest radar facility of its kind measures one acre at its base and has the equivalent height of a 12-story building. The PAR is now operated by the U.S. Air Force.

Fig. 2-36. Four remote SPRINT launch sites equipped with 12-16 SPRINT launch stations provided additional protection.

Fig. 2-37. The SAFEGUARD site became the western world's only operational ABM site. The MSR and its missile silos stand ready to protect the nation.

Deactivation

On the same day that the SRMSC reached full operating capability, the House Appropriations Committee recommended the deactivation of the SAFEGUARD site by the end of the fiscal year. They reasoned that the costs of operating such a system, combined with the limitations imposed by the ABM Treaty and the development of MIRVed missiles by the Soviet Union, would render the benefits from the system negligible.[84] The rest of the House concurred on 2 October 1975.

In response to the House action, Secretary of Defense James Schlesinger submitted a request to the Senate Appropriations Committee that the SAFEGUARD remain operational.[85] In his letter, Schlesinger emphasized the valuable experience to be gained from operating such a complex system. He added that the PAR system could provide a supplement to the nations' early warning system as it could detect missiles over the Arctic region. More importantly, Schlesinger argued, the United States should not terminate its ABM system without gaining some concessions from the Soviets.

While the Senate Appropriations Committee concurred with Schlesinger's arguments, the Senate as a whole, in a series of "relatively close votes," opted to discontinue operation of the SAFEGUARD complex. A strong factor in this development was Senator Edward Kennedy's amendment to the FY 1976/7T Appropriations Bill introduced on 18 November 1975. The amendment read, "Provided further that funds provided in this act for the Operation and Maintenance of the ABM Facility (other than funds provided for operation and maintenance of the PAR) may be used only for the purpose of the expeditious termination and deactivation of all operation of that facility." The amendment was incorporated into the final legislation signed on 9 February 1976.[86]

In December 1975, the Joint Chiefs of Staff ordered the SAFEGUARD Command to terminate the BMD mission. As directed by Congress, the Joint Chiefs of Staff ordered the deactivation of SAFEGUARD on 10 February 1976. At that time transmission for the Missile Site Radar and the missile launch capability were terminated. The removal of missiles and warheads, begun in December 1975, was completed in September 1976. Contractors salvaged materials from the MSR and RSL sites and later sealed the structures and silos. With the completion of this process in September 1977, the SRMSC entered caretaker status.

With the completed link to the North American Air Defense Command (NORAD) Combat Operations Computer, on 3 January 1977 the PAR became a part of the NORAD Early Warning Sensor system. The Air Force assumed tactical responsibility for the site on 22 August. The entire PAR complex was subsequently transferred to the Air Force on 1 October 1977 as the PAR Attack Characterization System. Operated by the Aerospace Defense Command, at Peterson AFB, Colorado, the PAR's space track capability became operational in December of that year.[87] The Air Force continues to operate the PAR radar system to this date. Its missions are "to provide detection and warning of a ballistic missile attack against the U.S. and Canada" and "to track thousands of man-made objects orbiting ... the earth."[88] Ultimately, the Stanley R. Mickelsen SAFEGUARD Complex remained in operation for 136 days. To date (2002), no other ABM system has been deployed by the nations of the western world.

A Tentative Return to Space

As the ballistic missile defense program became more technologically sophisticated, it appeared to be operating in many ways apart from an Army severely traumatized by its Vietnam experience. As the Army retreated into itself, making an inventory of its problems and challenges, it reverted to a more traditional form of existence. After the almost simultaneous ends of the Vietnam commitment and conscription, the Army was free to re-concentrate its efforts on becoming a professional all-volunteer force trained and prepared to fight a conventional war against a conventional enemy. Many date the Army's rebirth after Vietnam to the DePuy reorganization and formation of Forces Command and Training and Doctrine Command. This was followed by doctrinal debates between 1975 and 1982 over the significance of the Army's 1944-1945 experience in Europe and lessons derived from the 1973 Yom Kippur War as well as the DePuy-Gorman Training Revolution that created the Combat Training

Centers. The first stirrings of this revival may also be seen in 1973 with the formation of the Army Space Program Office (ASPO). ASPO was designed to carry out the Army Tactical Exploitation of National Capabilities Program (TENCAP) by serving as a liaison to other national program offices. ASPO uses the TENCAP to find ways the Army can exploit the current and future tactical potential of national intelligence programs by integrating them and their products into its tactical military decision making process as rapidly as possible. The TENCAP marshals data from various intelligence and electronic warfare communications and processing systems and integrates them to provide theater commanders and tactical units with timely targeting, battle planning and battle damage assessment information. The TENCAP systems provide for receiving, processing, exploiting, storing and disseminating combat intelligence data from national and selected theater collectors. The TENCAP owes its strengths to ASPO's relatively flat organizational structure and its adoption of the "80 percent solution;" field the product to the ultimate users and gain feedback from them. It is an activist program that helps reduce risk and cost. Engaging in an active dialogue with the end-users of its products ensures that problems are quickly identified, workable solutions are developed rapidly and the end user is always aware of product improvements. This method enabled ASPO to field a family of TENCAP systems.[89] The Army's operation of TENCAP has served as a model to the sister services.

End Notes

[1]"Major General Robert O. Hammond and Captain Frank B. Bragg, Army Space Program Fact Sheet." In addition, the Army Map Service made the maps of the moon used by the Apollo astronauts and the Army Corps of Engineers built most of NASA's launch, test and research facilities.
[2]Raines, pp. 331-332; McDougall, p. 190.
[3]McDougall, p. 221; Charles C. Bates and John F. Fuller, *America's Weather Warriors, 1814-1985* (College Station: Texas A&M University Press, 1986), pp. 174-176; Raines, p. 333; Mitchell, p. 24. See also, Army Space Reference Text, Chapter 2: Army Space History, compiled at TRADOC and available at http://www.fas.org/spp/military/docops/army/ref_text/, accessed on 4 February 2003.
[4]Mitchell, p. 24.
[5]Raines, p. 332.
[6]See Army Space Reference Text, Chapter 2: Army Space History and Mitchell, p. 24 and Raines, p. 332.
[7]Raines, p. 333; MacDougall, pp. 353-360 and 431; Bilstein, p. 56. Also, see Andrew J. Butrica (ed.), *Beyond The Ionosphere: Fifty Years of Satellite Communication* (Washington, D.C.: National Aeronautics and Space Administration, NASA History Office, 1997). Pertinent contributions to this volume include Daniel R. Headrick, "Radio Versus Cable: International Telecommunications Before Satellites," pp. 3-7, Donald C. Elder, "Something of Value: Echo and the Beginnings of Satellite Communications," pp. 33-40, Donald R. Glover, "NASA Experimental Communications Satellites, 1958-1995," pp. 51-64 and David J. Whalen, "Billion Dollar Technology: A Short Historical Overview of the Origins of Communications Satellite Technology, 1945-1965," pp. 95-127.
[8]See http://history.msfc.nasa.gov/milestones/chpt4.pdf accessed 7 February 2003.
[9]Green, et al., p. 234. While the AAF was responsible for developing missiles, Ordnance was responsible for developing and supplying warheads and "destructor sets" for these missiles.
[10]The SS-6 was described as "a single stage missile with clustered engines that developed twice the power of the American Atlas or Titan ICBMs."
[11]Walker, et.al. *Four Decades*, p. 15.
[12]The test site transferred from the U.S. Navy to the Army's NIKE-X Project Office under AMC General Orders 47, dated 19 June 1964.
[13]Beginning with the ninth test, a new advanced ("wingless") missile design was introduced.
[14]"Memorandum for Record, Subject: NIKE-ZEUS, 18 October 1960, The President's Advisory Council."
[15]Baucom, *Origins*, p. 14, 17 and Walker, et al, *Four Decades*, pp. 18-19.
[16]To fully equip 70 batteries required the production of 3,160 missiles.
[17] Baucom, *Origins*, p. 14, 17 and Walker, et al, *Four Decades*, pp. 18-19.
[18]Two other firsts were attained on 14 December 1961. A NIKE-ZEUS fired from Pt Mugu made the longest and highest flight to date and the Kwajalein Test Facility achieved its first test firing of a NIKE-ZEUS, in this case against a space point.
[19]Due to a roll-over anomaly in the last ten seconds of flight the ZEUS passed within 2 kilometers of the target. Quoted in Bell Labs, *Kwajalein Field Station*, p. 55.
[20]Bell Labs, *Program History*, pp. I-31-I-32 and Bell Labs, *ABM Research and Development at Bell Laboratories: Kwajalein Field Station* (Whippany, NJ: Bell Labs for the U.S. Army Ballistic Missile Defense Systems Command, 1975), p. 56.
[21]The thirteenth and final live fire test took place on 14 November 1963 with the successful intercept of a TITAN I boosted ICBM.
[22]Target Track Radar-4 continued to operate on Kwajalein, in support of various test programs, until February 1974.
[23]The ARPA already oversaw advanced military research on space and missiles. President Eisenhower had created ARPA in response to the Soviet's 1957 Sputnik launch.
[24]Baucom, *Origins*, pp. 15-17.
[25]*Ibid*, p. 17. With this phased array radar, ARPA "demonstrated the ability to electronically steer a radar beam in two dimensions using computes to control the beam."
[26]In 1961, the DoD gave the Air Force the mission of operating military satellites and space vehicles. The Defense Communications Agency assumed most of the Army's role in developing the communication payloads for satellite

systems. Today, the U.S. Army Satellite Communications Agency, created at Fort Monmouth in 1962, is responsible for managing ground terminals and ground support for space systems. In 1964, the SYNCOM III (Synchronized Communications Network) satellite was placed in geosynchronous orbit over the Pacific Ocean and served as a communications satellite. In 1966, the first eight satellites of the Initial Defense Communications System were launched. They were dispersed around the equator and eventually the system consisted of twenty-six of these satellites. Each satellite was able to place two points 10,000 miles apart in continuous communication. Each satellite could handle two high quality and five tactical quality voice circuits between two ground stations equipped with Army-developed steerable antennas. By 1967 the system was relaying photographs and other data from Vietnam to Hawaii and Washington. See http://www.fas.org/spp/military/docops/army/ref_text/, accessed on 4 February 2003.

[27]Baucom, *Origins*, p. 19.

[28]Army Materiel Command General Orders 4, dated 30 January 1964.

[29]The Kwajalein Test Range transferred from the control of the U.S. Navy to the Army on 19 June 1964.

[30]NIKE-X Project Office, Organization Plan for U.S. Army support of NIKE-X Deployment, dated 20 January 1965 (revised 19 March 1965). The centralized format became the basis for the execution of the SENTINEL and later the SAFEGUARD systems.

[31]General Harold K. Johnson, Memorandum to the Secretary of the Army, Subject: Revised Charter, NIKE-X Weapons System, dated 1 October 1967.

[32]Department of the Army General Orders 39, dated 14 October 1966 and DA General Orders 44, dated 10 November 1966. The NIKE-X System Manager continued to serve in the dual capacity as the Army's Chief of R&D.

[33]Unlike other COE divisions, the NIKE-X had neither civil works responsibilities nor geographical boundaries. Office of the Chief of Engineers General Orders 17 dated 9 October 1967. James Kitchens III, A History of the Huntsville Division – 15 October 1967 – 31 December 1976 (Huntsville, AL: Corps of Engineers, 1978), p. vii.

[34]Baucom, *Origins*, pp. 22-23.

[35]The focus at this time was on a terminal defense system operating at a moderate range. In this design "a battery at the most could defend one city; in the larger cities, more than one battery was required." "Stock Speech – Sentinel Anti-Ballistic Missile System" Fiscal Year 1968 Supporting Documents.

[36]Quoted in *Ibid*. This was from Senate testimony in 1965.

[37]Engineers addressed this and other criticism, that the ZEUS system could not distinguish between targets and decoys, in initiatives such as the 1967 Reentry Measurements Program

[38]"U.S. Expert Doubts Full ICBM Defense," *New York Times*, 17 February 1961, p. 9 cited in *Ibid*.

[39]Reprinted in part from Walker, *Four Decades*, p. 29.

[40]Michael Tronolone, Jr. (CPT), "More Than 50 Years of Nuclear Terror: A History of the Ballistic Missile Threat," *ADA Magazine* at http://147.71.210.21/adamag/August%202000/TBMHidst.html.

[41]*National Security Archive Electronic Briefing Book No. 26*: "The Chinese Nuclear Weapons Program: Problems of Intelligence Collection and Analysis, 1964-1972" edited by William Burr (31 March 2000) at http://www.gwu.edu/~nsarchiv/NSAEBB/NSAEBB26/index.html.

[42]Walker, *Four Decades*, p. 29.

[43]Bell Labs, *Project History*, p. I-41. Furthermore, with the addition of a larger nuclear warhead and a modified ZEUS missile, fired in a barrage mode the system "could provide large volume kill capability" and thus, "the NIKE-X was expanded to provide capability for a broad general defense of the whole continental United States."

[44]This umbrella was achieved in part by increasing the size of the nuclear warhead on a modified Zeus missile. M.D. Fagan, editor, *A History of Engineering and Science in the Bell System: National Service in War and Peace (1925-1975)* (Whippany, NJ: Bell Telephone Laboratories, 1978), p. 435.

[45]Bell Labs, *Project History*, p. I-43. Prior to this period and the development of the MSR, it was believed that the radar had to be locked onto the missile prior to launch.

[46]Soviet Defense Minister Malinovskii had proclaimed to the 22d Congress of the Communist Party in October 1961 that "the problem of destroying rockets in flight has been successfully solved." *New York Times*, 24 October 1961, p. 1 quoted in Daniel S. Papp, "From Project Thumper to SDI: The Role of Ballistic Missile Defense in U.S. Security Policy" *Aerospace Power Journal*, Winter 1987-1988, at http://www.airpower.maxwell.af.mil/airchronicles/apj/apj87/papp.html.

[47]Quoted in http://www.basicint.org/NMDhistory60.htm. See also *Foreign Relations of the United States 1964-1968*, Volume XIV – *Soviet Union*, edited by David C. Humphrey and Charles S. Sampson General Editor: David S. Patterson, Department of State Publication 10779 at http://www.state.gov/r/pa/ho/frus/johnsonlb/xiv/1400.htm.
[48]Aleksei Kosygin quoted in Baucom, *Origins*, pp. 34-35. Kosygin goes on to state "Some persons reason thus: Which is cheaper, to have offensive weapons that destroy cities and entire states or to have defensive weapons that can prevent this destruction? At present the theory is current in some places that one should develop whichever system is cheaper."
[49]Bell Labs, *Project History*, I-44.
[50]"Remarks by Secretary of Defense Robert S. McNamara Before United Press International Editors and Publishers San Francisco, California, September 18, 1967," reprinted in Annual Historical Review FY68.
[51]It was argued, in part, that "by deterring Communist China from nuclear blackmail, we hope to discourage nuclear weapon proliferation among the present non-nuclear nations of Asia." Excerpt from FY68 "Stock Speech."
[52]Three additional sites were added in May 1968 - San Francisco, Los Angeles, and Sedalia, Missouri. Two others were announced on 13 November 1968 - Warren AFB, Wyoming, and Malmstrom AFB, Montana. Two additional sites, Washington, D.C. and Fairbanks, Alaska, were never publicly announced. This deployment ensured that the combined footprint of the various batteries covered the entire nation.
[53]Charter of the SENTINEL System Manager, effective date 15 November 1967.
[54]Department of the Army General Orders 48, dated 15 November 1967. Under this GO, the Kwajalein Test Site transferred to the U.S. Army SENTINEL System Command, as a subordinate activity. The Research Office, which reported to the Army's Chief of R&D, was subsequently renamed the Advanced Ballistic Missile Defense Agency (ABMDA). The two organizations SENTINEL and ABMDA were collocated and coordinated both in Washington and in Huntsville.
[55]Baucom, *Origins*, pp. 38-39.
[56] The name was changed in January 1967 to avoid any confusion with the former NIKE-ZEUS initiatives.
[57]Bell Labs, *Project History*, Chapter 10 - "Spartan Missile Subsystem". The SPARTAN missile was 55 feet 2 inches in length with a total diameter of 43.1 inches.
[58]Bell Labs, *Project History*, Chapter 9. The SPRINT missile weighed 7600 pounds at launch and measured 27 feet in length and 4 feet 5 inches in diameter at the base.
[59]On 5 October 1973 during the first intercept test of a production Sprint test data showed that the interceptor actually hit the target.
[60]Bell Labs, *Project History*, pp. I-33-36, I-39-40, 2-16-24, and Chapter 8. Originally known as the Zeus Multifunction Array Radar (ZMAR) the name was changed to MAR with end of the ZEUS program. Compared to the mechanically steered and dish type radars used in NIKE-ZEUS, the phased array system operated at a higher speed and could be housed in nuclear hardened facilities.
[61]The MAR operated at 100MW at its peak and 2 to 3 MW average per transmitter face. Ibid, I-39.
[62]Ibid, 2-3, Chapter 7.
[63]Ibid, p. 7-5.
[64]Bell Labs, *Project History*, I-46.
[65]Memorandum from Henry Kissinger to President Nixon, 5 March 1969, Subject: Modified Sentinel System with attachment "Issues Concerning ABM Deployment." Declassified on 7 July 1998 by the National Archives. Located at http://www.gwu.edu/~nsarchiv/NSAEBB/NSAEBB36/18-04.htm.
[66]Baucom, *Origins*, pp. 43-50. Most members of the House of Representatives supported the program.
[67]Senator Winston Prouty quoted in Ibid, pp. 48-49 from the *Congressional Record*, 91st Congress, 1st Session, 14 July 1969, 115: 19420-23.
[68]Vice President Spiro Agnew cast the tie breaking vote.
[69]General Orders 18, dated 25 March 1969. These were the SAFEGUARD System Office, the SAFEGUARD Systems Command, and the SAFEGUARD System Evaluation Agency. The Kwajalein Missile Range was part of the SAFSCOM.
[70]SAFEGUARD System Charter, dated 20 June 1969.
[71]USASTRATCOM General Orders 115, dated 16 June 1969.

[72]Army Materiel Command General Orders 71, dated 15 April 1971 and SAFLOG General Orders 5, dated 21 July 1971. The SAFEGUARD Logistics Command and the SAFEGUARD Depot Activity merged with the SAFEGUARD Systems Command in January 1973.
[73]Statement of Secretary of Defense Melvin R. Laird on FY71 Modified Phase II SAFEGUARD Program, 24 February 1970 located in U.S. Army SAFEGUARD System Command *Annual Historical Summary 1 July 1969 to 30 June 1970*, Volume II: *Supporting Documents* (Huntsville, AL: SAFSCOM, n.d.).
[74] Statement by Lieutenant General Alfred D. Starbird, SAFEGUARD System Manager, Office of the Chief of Staff of the Army, Department of the Army before the Department of Defense Subcommittee, Committee on Appropriations, United States Senate, First Session, 92d Congress, dated 23 April 1971 located in U.S. Army SAFEGUARD System Command *Annual Historical Summary 1 July 1970 to 30 June 1971*., Volume II: *Supporting Documents* (Huntsville, AL: SAFSCOM, n.d.).
[75]Congressional Record, 91st Congress, 1st Session, 9 July 1969, 115; 18895 quoted in Baucom, *Origins*, p. 46.
[76]Copies of the ABM Treaty and its protocols can be found at the State Department web page at http://www.state.gov/www/global/arms/treaties/abmpage.html
[77]A 1 November 1978, Agreed Statement from the Standing Consultative Commission (SCC) sought to establish rules for the use of air defense radars at ABM test ranges and to clarify the meaning of the term "tested in an ABM mode."
[78]Memorandum from Secretary of Defense Laird to Secretary of the Army, dated 26 May 1972.
[79]Hampered by financial issues, labor disputes, and weather conditions, the Malmstrom site was not as developed as that at Grand Forks. At termination, construction was approximately eight percent complete. By July 1974, most of the Montana site had been removed or was buried beneath the earth. James Kitchens, *A History of the Huntsville Division, U.S. Army Corps of Engineers, 1967-1976* (Huntsville: U.S. Army Corps of Engineers, 1978).
[80]General Order 21, dated 21 June 1974. Lieutenant General R. Mickelsen, former Commanding General of the U.S. Army Air Defense Command, had in 1955 urged the Army "to make the ABM weapon a 'firm Army requirement' and assure its development at an optimum rate." Stephen Moeller, "Vigilant and Invincible: United States Army Air Defense Command," *Air Defense Artillery* May-June 1995:33.
[81]ARADCOM General Orders 354 and 355, dated 22 October 1971. The Command's 684 authorized employees were to be 62 officers, 22 warrant officers, 432 enlisted and 168 civilians. The 400 PAR personnel were to be as follows 41 officers, 14 warrant officers, 109 enlisted and 136 civilians.
[82]General Orders 30, dated 29 August 1974. In a separate reorganization, the SAFEGUARD System Organization became the Ballistic Missile Defense Organization in 1974.
[83]Operational control did not encompass such matters as administration, logistics, discipline, internal organization or unit training. These remained with the Ballistic Missile Defense Program Manager as the component commander for BMD forces.
[84]While multiple warheads were not a new phenomenon, MIRVed missiles were equipped with multiple independently targetable reentry vehicles.
[85]Baucom, *Origins*, p. 96.
[86]Public Law 94-212, dated 9 February 1976.
[87]Now known as Cavalier Air Force Station, the PAR was part of the Air Force's Aerospace Defense Command (1 May 1977 to 30 November 1979); the Strategic Air Command (1 December 1979 – 30 April 1983) and the Space Command (1 May 1983 - the present).
[88]"Cavalier Air Station Gets New Name," *Cavalier Chronicle*, 2 March 2000 electronic copy located at http://srmsc.org/ext0020.html.
[89]Sharon Carvalho, "The '80 percent solution' Concept Gets It to Field, Gets Users' Feedback," *The Eagle* March 1998:2.