NIKE ZEUS:

AMERICA'S FIRST ANTI-BALLISTIC MISSILE

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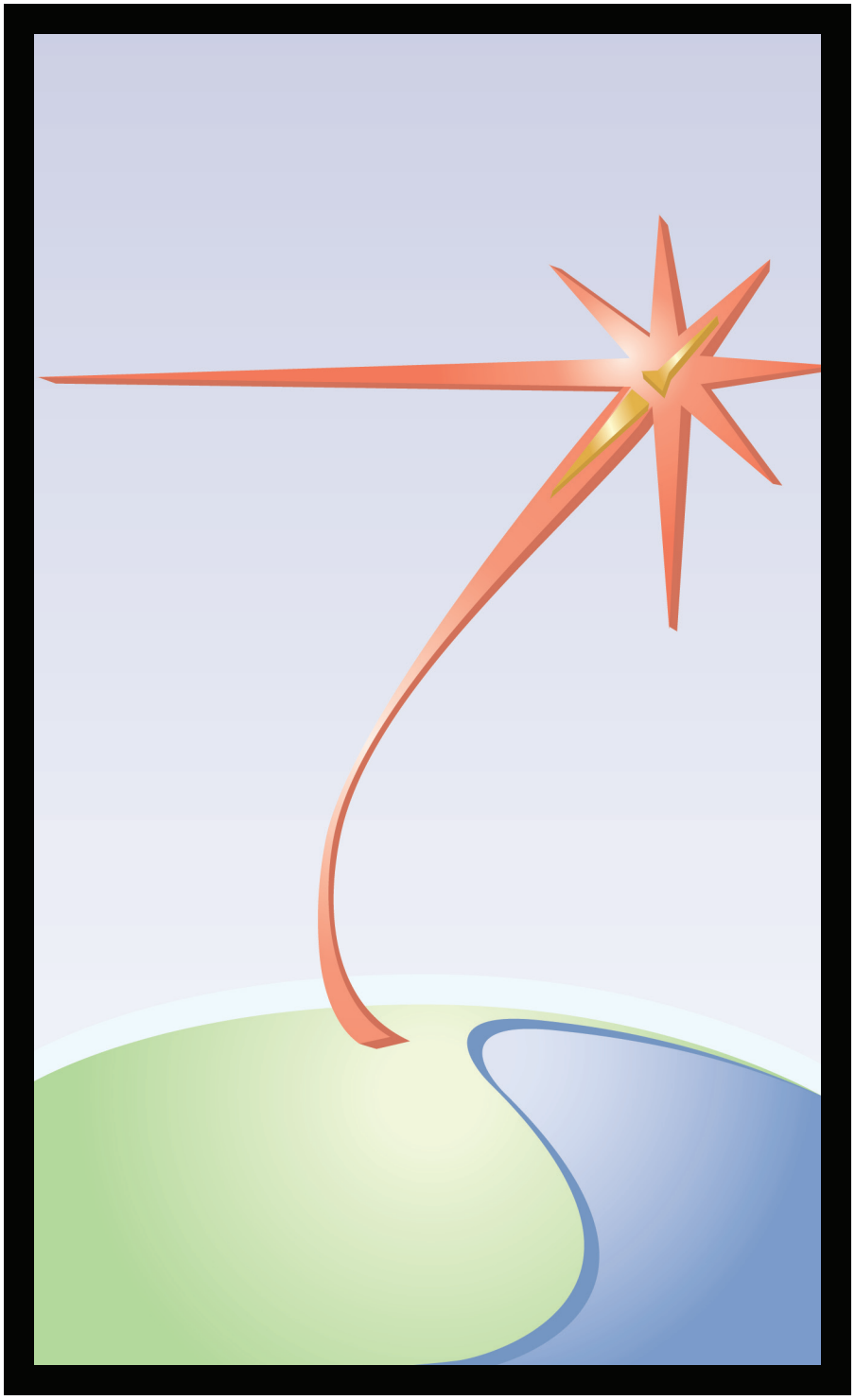

Strategic Defense Initiative Organization (SDIO)
1984 – 1994

Ballistic Missile Defense Organization (BMDO)
1994 – 2002

Missile Defense Agency (MDA)
Established January 2, 2002

Foreword

The mission of the Missile Defense Agency History Office is to document the official history of America's missile defense programs and to provide historical support to the MDA Director and staff.

This pamphlet, one in a series of products intended to quickly acquaint interested readers with the history of America's missile defense programs, describes the nation's first serious effort to develop an Anti-Ballistic Missile (ABM) system that could intercept an Inter-Continental Ballistic Missile (ICBM). This pioneering U.S. Army effort to develop an ICBM defense system was ambitious and controversial. However, the groundbreaking Nike Zeus ABM program defined the future of missile defense in several important ways and was not devoid of success. The Nike Zeus system served many purposes over its lifetime, educating a generation of ABM system developers, and laying the foundation on which today's ballistic missile defense systems are based.

Constructive comments and suggestions from readers are welcome. Please forward them to Dr. Lawrence M. Kaplan, MDA Historian, at lawrence.kaplan@mda.mil, or by telephone at (703) 882-6546.

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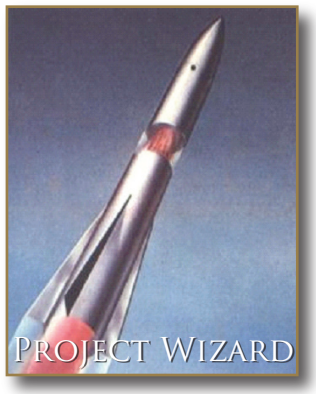
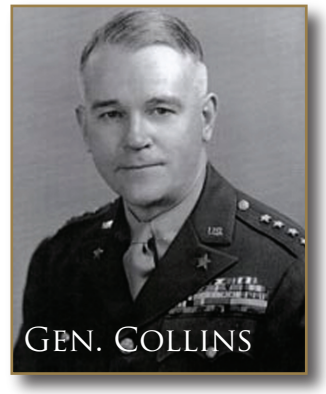
As the Cold War unfolded after WWII, the United States realized that it faced a hostile and expansionist Soviet Union. The growing threat of Soviet long-range aircraft and missiles posed an unprecedented challenge to America's defense. In response, the policies of containment and deterrence became the cornerstones of American strategic doctrine, with a heavy reliance on offensive nuclear weapons ("massive retaliation" in the Eisenhower administration, "Mutual Assured Destruction [MAD]" in the Kennedy administration) and, ultimately, a triad of bombers and land- and sea-based ballistic missiles to discourage any Soviet or Soviet-supported aggression.



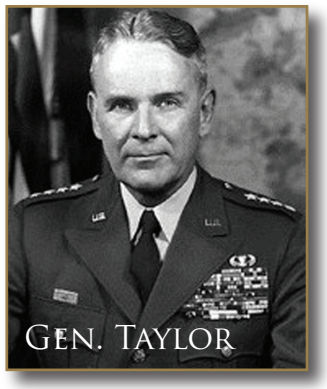
Although deterrence relied primarily on offensive capability, strategic missile defense became an increasingly desirable adjunct to American strategic doctrine. In the early 1950s, the Army was at a significant disadvantage, without a strategic offensive mission, when competing for annual budget money with the other services. In 1955, this situation began to change after intelligence reports of an impending Soviet ICBM threat spurred the Department of Defense (DoD) to launch several high-priority offensive missile programs that were managed by the services. These competing service programs were intended to achieve early operational capabilities, but they also succeeded in blurring distinctions among the services' roles and missions. Heightened concerns about ballistic missile defense also created an environment in which the Army sought to compete with the Air Force's Project Wizard ABM, which began in 1946, for a role in strategic missile defense.



Earlier in the decade, in a 1952 antimissile missile program review, General J. Lawton Collins, the Army Chief of Staff, determined that the Army should develop only a theater-defense ABM system for deployed forces, since Project Wizard already focused on point

defense for the Continental United States. In March 1955, as part of its ABM research, the Army commissioned Bell Telephone Laboratories to conduct an 18-month "Nike II" study (Bell Labs, with its parent, Western Electric, had developed the first-generation Nike I [Ajax] Surface-to-Air antiaircraft guided Missile [SAM] and was then developing the faster, longer-range, next-generation Nike B [Hercules] SAM).

The Nike II Study examined Continental United States air defense requirements for the 1960s against both high-performance air-breathing threats and long-range ballistic missiles. Initially, the study explored the possibility of a common antiaircraft defense system that covered all high-altitude threats (and employed a missile with different warheads, one for use against missiles and one for use against aircraft), but, in June 1955, the focus of the study shifted, at the Army's request, to primarily missile defense. The revised thrust of the study, including the hardware developments associated with it, was intended to provide a step along the way to a final ABM solution. This focus-shift coincided with General Maxwell D. Taylor's appointment as Army Chief of Staff.



General Taylor aggressively sought to increase the Army's share of the budget, and, as an opponent of massive retaliation, became a staunch advocate for expanding all of the Army's capabilities for more conventional warfare, particularly pushing those for air defense into the missile defense arena.

The study proceeded on the assumption that a very precisely guided nuclear warhead would be necessary to ensure successful interception of a ballistic missile. The first question the study addressed was where in the attacking missile's trajectory an intercept should take place. Given the limited information-collection capabilities of the time against hostile missile launches, the midcourse intercept option was deemed too difficult to be feasible. In its place a terminal-phase interceptor was proposed. Studies also indicated that the most attractive guidance method for a terminal-phase interceptor would be one based on the Nike Ajax/Nike Hercules command systems. Technological limitations at the time suggested that a homing system would be unworkable.

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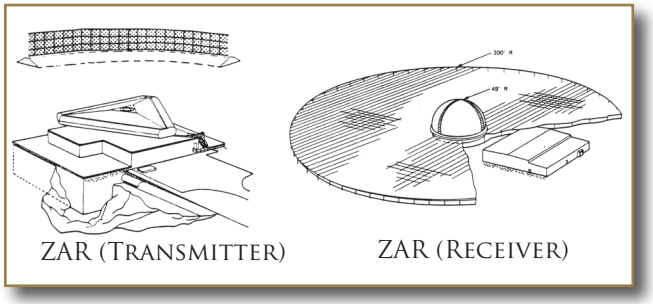
The study also recognized that an extensive communications network, integrating detection, acquisition, tracking, and fire control radars, data processing, computation, and tactical control would be necessary to make the system work. All of these disparate parts would have to work together very rapidly, as an integrated whole. Given warning times of only 10-15 minutes of an incoming missile attack, most actions had to be semi-automated with a human operator only able to veto a programmed launch.

The challenge of discriminating a real warhead from a cloud of debris and different kinds of radar decoys continued to trouble both the study participants and the system's customers, as was emphasized in several presentations to Army decision-makers. They also recognized that high rates of arrival of ICBMs over their targets and the difficulty of discriminating decoys from real warheads would require a system capable of engaging up to 20 targets per minute.

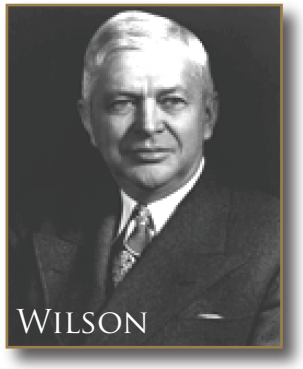
In January 1956, Bell Labs advised the Army that a long-range, high-data-rate, acquisition radar would be an essential component of any ballistic missile defense system. Bell Labs also advised that if development of this vital radar could begin immediately, an interim ABM defense might be possible with the developmental Nike B (Hercules) missile system.

ZEUS ACQUISITION RADAR



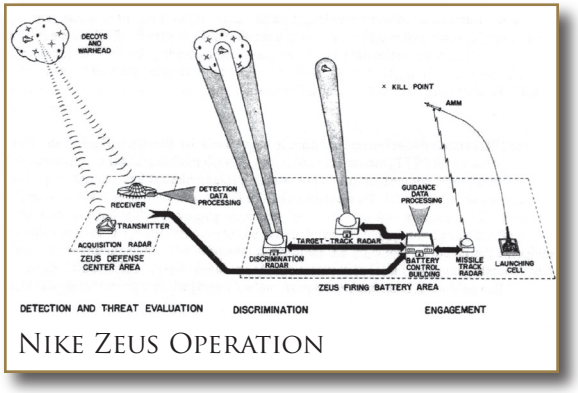
In November 1956, Secretary of Defense Charles E. Wilson attempted

to disentangle Army and Air Force air defense responsibilities by distinguishing between "area" and "point" defense. The first, assigned to the Air Force, involved "the concept of locating defense units to intercept enemy attacks remote from and without reference to individual vital installations, industrial complexes or population centers." Point defense, an Army responsibility, was "the defense of specified geographical areas, cities and vital installations." Air defense missiles designed for point defense were to be limited to horizontal ranges of approximately 100 nautical miles. Even so, it was not easy to draw a clear distinction between area and point defense, and a rivalry grew between the Army and Air Force as they developed competing surface-to-air air defense missiles.


WILSON

While these studies were being conducted, many scientists, in both the government and academia, derided the idea that it would be feasible or even possible to "hit a bullet with a bullet," as a missile intercept was commonly called. Many campaigned incessantly against the proposed ABM developments. On the other hand, over 50,000 simulation runs conducted by Bell Labs during the same period demonstrated that ICBMs could be successfully intercepted.

In February 1957 the Army initiated the Nike II development program, with Bell Telephone Laboratories and Western Electric as prime contractors, and changed the program's name to Nike Zeus. The contract laid out a six-year development program for the Nike Zeus system. The proposed nuclear-capable Zeus exoatmospheric interceptor represented the third generation in the Nike air defense guided



NIKE ZEUS OPERATION

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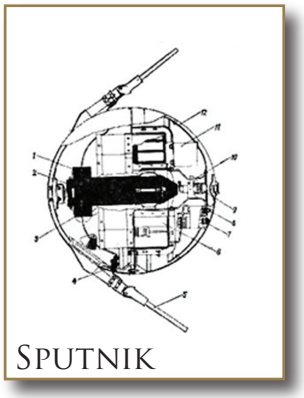
missile family. Nike Zeus was intended to be part of an integrated ABM defense system, including advanced radars for acquisition and tracking, and battle management communications equipment, that the Nike II studies had indicated would be necessary.

Because so much of the developmental work done under the Nike Zeus program's auspices was ground-breaking, technical challenges abounded. The proposed missile design, the design architecture of the system's radars, the computer and communications integration, and even finding adequate ranges for testing, had to be worked through for the first time. From the outset these technical challenges and projected high costs made Nike Zeus a continuing focal point for criticism, particularly from the Air Force and the scientific community.

This is not to say that at least partial answers to some of the most serious challenges were not forthcoming. For example, concerns about the effects of high-altitude nuclear bursts on radar signals were addressed in theory and later verified in tests at Johnston Island in the South Pacific. Further study showed that radar-signal attenuation due to nuclear burst effects is reduced by the square of the radar frequency – the higher the frequency, the more effectively nuclear effects are mitigated. As a result, the design of the Nike Zeus acquisition radar was modified to double the planned frequency of tactical models from 500 to 1,000 megahertz. These higher frequency radars, however, were never produced or tested.

In the midst of this growing controversy, on October 4, 1957, the Soviet Union launched Sputnik, the world's first artificial satellite. This catalytic event fueled perceptions of a "Missile Gap" between the U.S. and the Soviets, heightened concerns about American vulnerabilities to a Soviet ICBM attack, and created a political environment more supportive of developing and fielding even a problematic ABM system.

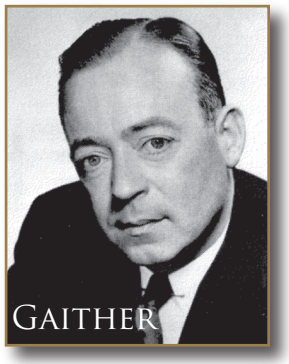

SPUTNIK

In addition, U.S. knowledge of Soviet flight tests of the V-1000/SA-5 Griffon ABM, which had begun in 1957, would have provided an additional spur to American ABM development efforts.

This system's performance provided the basis for Soviet Premier Nikita Khrushchev's 1962 boast that the Soviets could hit a fly in space.

As with any groundbreaking system in development, the early Nike Zeus test results were mixed at best. Though the radar and communications systems progressed reasonably well, many early test firings of the missile failed because of design flaws or overly cautious restrictions at the Navy's Point Mugu missile range on the California coast, near Oxnard and Los Angeles.

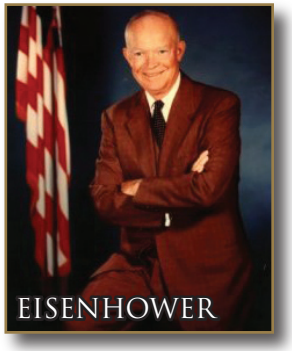
In early November 1957, about a month after the Soviet Sputnik launch, the presidentially-appointed Gaither Panel (named after its chairman, H. Rowan Gaither, Jr., then-chairman of the board of directors of the Ford Foundation and a founder of the RAND Corporation), submitted its report on continental defense, "Deterrence and Survival in the Nuclear Age," to the Eisenhower administration. The report assigned the highest priority to protecting the nation's primary deterrent, the Strategic Air Command's (SAC) bombers, from a surprise Soviet attack, and recommended having active missile defense at SAC bases. This included developing radars capable of providing early warning of missile attacks, hardening radars against countermeasures, and employing interim antimissile defenses using available weapons such as the Nike Hercules and land-based versions of the Navy's Talos air defense missile.



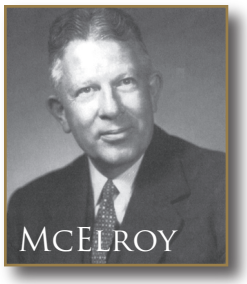
The report stated:

> *[T]he importance of providing active defense of cities or other critical areas demands the development and installation of the basic elements of a [missile defense] system at an early date. Such a system initially may have only a relatively low-altitude intercept capability, but would provide the framework on which to add improvements brought forth by the research and test programs.*

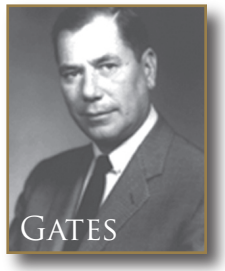
For passive defense of the civil population, the report recommended a nationwide program of fallout shelters that arguably could have saved more lives for the same amount of money than any other type of defense. However, the prospects of an expensive shelter program, then estimated at $22 billion over a five-year period (1959-1963), received a cool reception from the administration. President Eisenhower, a fiscal conservative, was unenthusiastic about spending billions on shelters rather than on additional active defense measures.



By early 1958 the Army and Air Force rivalry over dominance of the strategic missile defense program prompted Secretary of Defense Neil H. McElroy to settle the dispute. On January 16, 1958 he assigned the active strategic defense mission to the Army. Later that month, the Nike Zeus program received additional support from a National Security Council position paper (NSC 5802) on continental defense, which called for "an anti-ICBM weapons system as a matter of the highest national priority."



The Joint Chiefs of Staff argued for a firm administration commitment to accelerate Nike Zeus development, but Eisenhower's defense secretaries, Neil H. McElroy (1957-59) and Thomas S. Gates (1959-61),



along with many in the scientific community, were not convinced the program was worth the cost and effort to rush to an early deployment. Eisenhower was also skeptical, questioning whether an effective ABM system could be developed in the 1960s. The same attitude continued into the Kennedy administration (1961-1963).

Kennedy and McNamara

Development of the Nike Zeus system continued, with refinements in the design of the missile and the other components of the system. In late 1961 a Nike Zeus missile, supported by all of its associated system components, successfully intercepted a Nike Hercules target missile at White Sands Missile Range, New Mexico. The entire system was then transported to Kwajalein Atoll in the Marshall Islands in early 1962, where a series of tests against live ICBM targets was conducted, as the following chart indicates.

Mission Number	Date	Target	Remarks
K1	6-26-62	Atlas D	Failure
K2	7-19-62	Atlas D	Partial Success
K6	12-12-62	Atlas D	Success (first missile in salvo)
K7	12-22-62	Atlas D	Success (first missile in salvo)
K8	2-13-63	Atlas D	Partial Success
K10	2-28-63	Atlas D	Partial Success
K17	3-30-63	Titan I	Success
K21	4-13-63	Titan I	Success
K15	6-12-63	Atlas D	Success
K23	7-4-63	Atlas E	Success
K26	8-15-63	Titan I	Success
K28	8-24-63	Atlas E	Success
K24	11-14-63	Titan I	Success

Although this test program had been completed successfully, DoD had already decided that it would not proceed further with the development of Nike Zeus. The rapid evolution of the Soviet threat and the predicted

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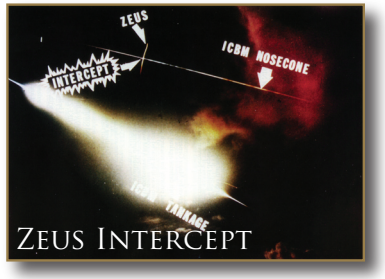
high-volume threat environment of a possible ICBM saturation attack appeared to be beyond the capabilities of the Zeus system. Technological advances in communications and computers, and development of more robust, sophisticated, and capable phased array radars, rendered the Nike Zeus system obsolete as originally conceived. In fact, initial studies of the layered successor system, Nike X, which employed many of these newer technologies (while keeping the Nike Zeus missile), had begun in 1960; the Kennedy administration, in fact, announced initial development of the Nike X program in January 1963. Although many advances in discrimination capabilities took place over the period of Nike Zeus's development, DoD decision-makers remained dissatisfied with the degree of certainty in identifying incoming ICBM warheads that could then be achieved.

Despite termination of its development, Nike Zeus continued to serve in the Satellite Test Program, Program 505, as a potential anti-satellite weapon into 1966. Begun in 1962, the program used modified Nike Zeus missiles in a variety of anti-satellite tests and also maintained them in readiness to intercept satellites, if required, during that time.



Zeus Intercept

In retrospect, Nike Zeus, despite its termination, was a successful, groundbreaking developmental program, laying the foundations for nearly all future U.S. ABM progress. The developers gained vital knowledge of what would work and what would not while advancing discrimination and characterization studies, radar and computer technologies, and high-speed, high-heat missile design. Moreover, on December 14, 1961, Nike Zeus was the first weapon to intercept a Nike Hercules missile (a second such intercept occurred in March 1962). On June 26, 1962, it was the first system to attempt inter-

cept of an Atlas D ICBM fired from 4,500 miles distance and the first to successfully intercept an Atlas D ICBM (on July 19, 1962, with a second intercept on December 12, 1962).

We can only speculate what impact knowledge of these developments, and understanding of U.S. ICBM capabilities, as well as of his own offensive and defensive capabilities may have had upon Soviet Premier Nikita Khrushchev's decision to deploy intermediate range ballistic missiles to Cuba in 1962. We do know, however, that the Nike Zeus project managers talked with the President in the period leading up to the Cuban Missile Crisis (October 18-29, 1962) and that a part of the discussion addressed the possible forward deployment of Nike Zeus to counter the potential threat of missiles launched from Cuba.

CASTRO AND KHRUSHCHEV

CUBA RINGS

MDA Historian
September 2006

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