Stanley R. Mickelsen Safeguard Complex
Vicinity of Nekoma, Cavalier County, North Dakota

Historic American Engineering Record Documentation for the Stanley R. Mickelsen Safeguard Complex

(HAER Number ND-9)

Volume 1
Historical Context

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(TOC not included in the original document)

STANLEY R. MICKELSEN SAFEGUARD COMPLEX

I. INTRODUCTION

NOTE: For shelving purposes at the Library of Congress, Nekoma vicinity in Cavalier County was chosen as the "official" location for all SRMSC HAER documentation.

Location:	The Stanley R. Mickelsen Safeguard Complex (SRMSC) consists of six individual facilities located in extreme northeastern North Dakota, in Pembina, Ramsey, Walsh, and Cavalier counties. The Missile Site Radar (MSR) is located 102 miles northwest of Grand Forks, North Dakota, and 12 miles south of Langdon, North Dakota, close to the small town of Nekoma, North Dakota. The Perimeter Acquisition Radar (PAR) is located 145 miles northwest of Grand Forks and 24 miles east of Langdon. The four Remote Sprint Launch (RSL) sites are located within an approximately 20 mile radius of the MSR.

Quad/UTM:

RSL-1	Alsen S.E.	14/5307 53750
RSL-2	Langdon West	14/5409 54105
RSL-3	Hanks Corner	14/5744 54103
RSL-4	Edmore N.E.	14/5553 53703
PAR	Concrete	14/5805 53973
MSR	Nekoma	14/5472 53819

Date of Construction:	April 1, 1970 - January 1, 1973
Present Owner:	U.S. Army Space and Strategic Defense Command Huntsville, Alabama
Present Use:	The PAR is leased to the U.S. Air Force as Cavalier Air Force Station and remains in use as a radar sensor for the North American Air Defense Command and Satellite Surveillance Network. The MSR, and all four RSLs, are held in inactive status by the U.S. Army Space and Strategic Defense Command.
Significance:	The SRMSC was the only operational Anti-Ballistic Missile (ABM) facility ever completed in the United States. The SRMSC was the culmination of 15 years of research and development in anti-ballistic missile efforts. The components utilized the achievements of the earlier developmental NIKE-ZEUS and NIKE-X ABM systems. It is generally recognized by Cold War historians that its construction and activation were instrumental in successfully negotiating the ABM and Strategic Arms Limitation Talks (SALT) Treaties with the Soviet Union.
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For information about which individual structures are included in this study, see the list below. Detailed coverage is given for the Missile Site Control Building and the Perimeter Acquisition Radar Building.

Building Number	Facility	HAER Number
027-088	Family Housing Units	ND-9-K
304	Area Engineer /Administration Building	ND-9-I
340	Post Chapel	ND-9-L
346	Gymnasium	ND-9-M
350	Community Center	ND-9-N
360	Administrative Headquarters Building	ND-9-AS
364	Industrial Building	ND-9-J
369	Fresh Water Pump House	ND-9-G
371	Polar Telephone Building	ND-9-AT
401	Limited Area Sentry Station	ND-9-A
430	Missile Site Control Building	ND-9-B
440	Missile Site Radar Power Plant	ND-9-AU
455	Universal Missile Building	ND-9-C
456	Warhead Handling Building	ND-9-E
460	Exclusion Area Sentry Building	ND-9-D
501-530, 541-556	Missile Launch Area	ND-9-F
705	Resident Engineer s Office Building	ND-9-AJ
707	Community Center	ND-9-AK
708	Bachelor Officers Quarters	ND-9-AL
709	Storage Building	ND-9-AM
720	Sentry Station	ND-9-AN
726	Controlled Area Sentry	ND-9-AO
730	Industrial Building	ND-9-AP
735	Fresh Water Pump House	ND-9-AQ
801	Limited Area Sentry Station	ND-9-O
805	Fuel Oil Pump Station	ND-9-AR
809	Cooling Tower	ND-9-S
820	Perimeter Acquisition Radar Power Plant	ND-9-R
825	Utility Tunnel	ND-9-Q
830	Perimeter Acquisition Radar	ND-9-P
1101	Limited Area Sentry Station	ND-9-U
1110	Remote Launch Operations Building	ND-9-V
1115	Exclusion Area Sentry Station	ND-9-W
2101	Limited Area Sentry Station	ND-9-Y
2110	Remote Launch Operations Building	ND-9-Z
2115	Exclusion Area Sentry Station	ND-9-AA
3101	Limited Area Sentry Station	ND-9-AC
3110	Remote Launch Operations Building	ND-9-AD
3115	Exclusion Area Sentry Station	ND-9-AE
4101	Limited Area Sentry Station	ND-9-AG
4110	Remote Launch Operations	ND-9-AH
4115	Exclusion Area Sentry Station	ND-9-AI
	Installation HDQs Building	ND-9-H
S301	Remote Sprint Launch Site #1	ND-9-T
	Remote Sprint Launch Site #3	ND-9-AB
	Remote Sprint Launch Site #4	ND-9-AF

II. HISTORY

A. INTRODUCTION

The Stanley R. Mickelsen Safeguard Complex (SRMSC) was authorized by Congress in 1969, and construction began in 1970. It was named for Lieutenant General Stanley Raymond Mickelsen, former Commanding General of the United States Army Air Defense Command.[1] The SRMSC was completed in October 1975 and was at full operational capacity for approximately two months until December 1975 when Congress ordered its inactivation. The SRMSC (see fig. 1-1) was the only operational Anti-Ballistic Missile (ABM) facility ever completed in the United States. The SRMSC consists of four remote Sprint launch (RSL) locations, the Missile Site Radar (MSR) complex which includes the Missile Site Control Building (MSCB), and the Perimeter Acquisition Radar complex which includes the Perimeter Acquisition Radar Building (PARB). It is generally recognized by Cold War historians that the construction and operation of the SRMSC were instrumental in achieving the ABM agreements and Strategic Arms Limitation Treaties (SALT) with the Soviet Union. The SRMSC, except for the Perimeter Acquisition Radar (PAR) site, was placed in inactive status until December 1991, when the United States Army Space and Strategic Defense Command (USASSDC) reacquired accountability for the property. The PAR site was leased to the United States Air Force (USAF) in September 1977, and currently remains operational as an early warning and surveillance radar. The USAF redesignated the PAR Site as Cavalier Air Force Station.

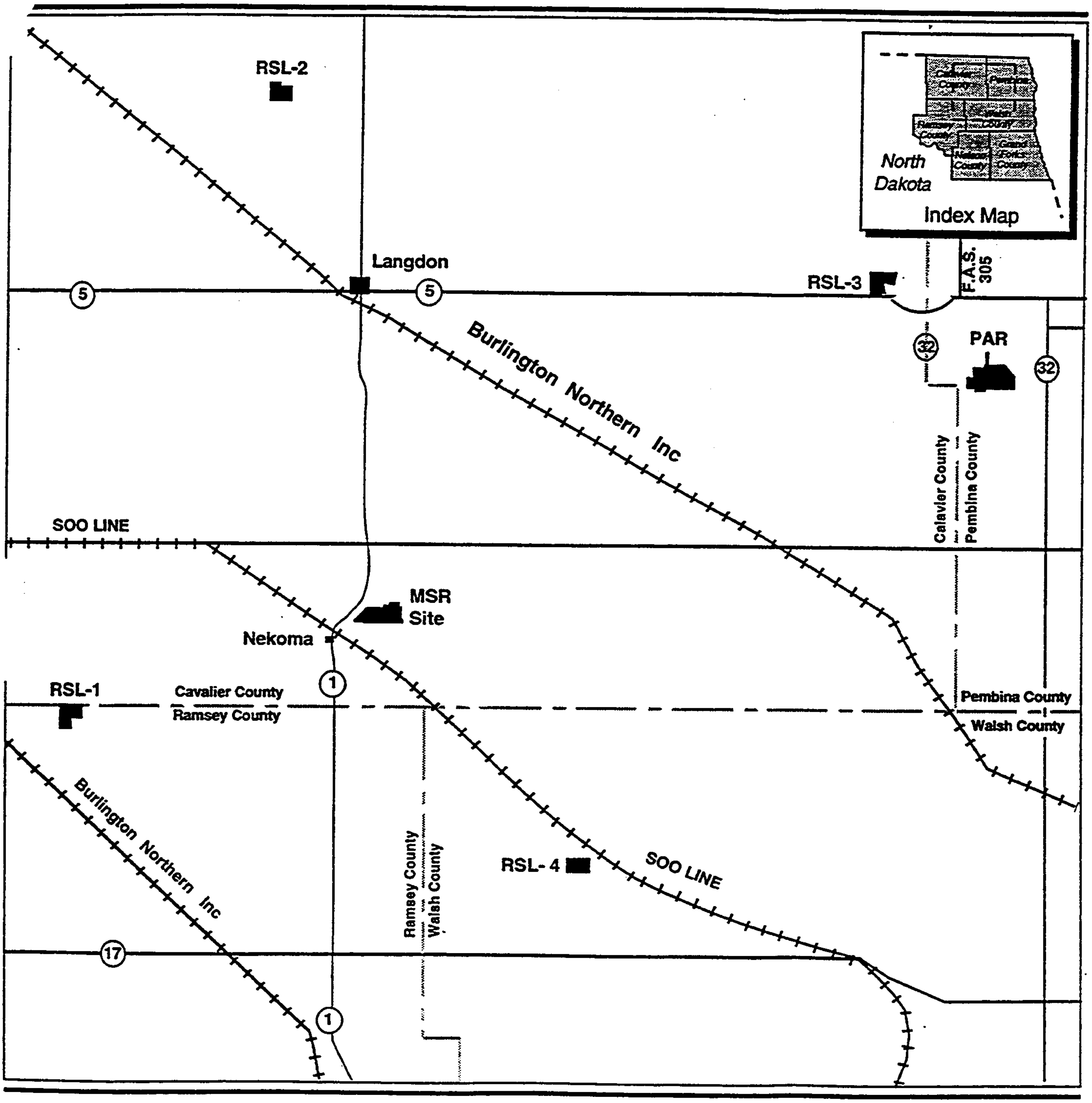
The Strategic Defense Initiative, announced by President Ronald Reagan on March 23, 1983, began an extensive research program to determine the feasibility of developing effective defenses against ballistic missile attacks. Subsequently, the Strategic Defense Initiative Organization, (which is now the Ballistic Missile Defense Organization [BMDO]), was established to plan, organize, coordinate, direct, and enhance the research and testing of technologies applicable to National Missile Defense (NMD) and Theater Missile Defense (TMD).
When it was determined that SRMSC was a candidate for NMD Initial Deployment, Section 106 of the National Historic Preservation Act (NHPA) compliance activities were initiated. From May 18 to May 21, 1992, a

preliminary cultural and biological survey was conducted at SRMSC, and discussions were held with the State Historical Society of North Dakota. The USASSDC representatives included personnel from the Command Historical Office. On June 8, 1992, the North Dakota State Historical Society responded to this initial survey with a statement that only the MSCB and PAR building were considered potential historic properties. The remaining buildings on the SRMSC were not considered significant, and ground disturbance within the complex boundaries precludes the discovery of archaeological resources. On July 15, 1992, a cultural resources work plan was prepared, consultation with the National Park Service initiated, and comprehensive historical studies on the MSCB and PAR and their significance began. This preliminary site survey was followed by a more comprehensive site visit on August 18, 1992.

As a result of this site visit, the North Dakota State Historic Preservation Officer (SHPO) expanded his initial evaluation, and the entire complex was identified as being potentially eligible for listing on the National Register of Historic Places.

The possibility of reactivation of SRMSC, and the subsequent alteration of the facilities there, prompted the USASSDC to develop a Historic Context and to prepare Historic American Building Survey and Historic American Engineering Record (HABS/HAER) documentation of the site.

Since 1983, ballistic missile defense activities have been modified by the Missile Defense Act of 1991, the 1993 Defense Authorization Act, and most recently by an announcement made on May 13, 1993 which refocused the BMDO's priorities toward TMD. Plans for the reactivation of SRMSC have been deferred. However, in compliance with the NHPA and Army Regulation (AR) 420-40, the HABS/HAER documentation has been continued.



Location Map

Kilometers
0 3 6 9
0 2 4 6
Miles

Stanley R. Mickelsen
Safeguard Complex

Figure 1-1

gn/SRMSC/016-03/02/95

B. PURPOSE OF THE DOCUMENTATION

The purpose of this document is to establish the history of the SRMSC within the historic Cold War context. Additionally, this document provides a description of the facilities at the SRMSC. The HABS/HAER documentation, which includes narrative descriptions, detailed photographs and construction drawings of each significant structure, provides a permanent archival record of the SRMSC for future historians and scholars.

Chapter 1 of this document describes the regulatory criteria which protect the historic properties and cultural resources at the SRMSC. Chapter 2 of this document examines the relationship between the United States and the Soviet Union, the Cold War which existed between them, and the development of ABM systems to counter the Soviet nuclear menace. Chapter 3 of this document describes facilities at the SRMSC and examines the construction of SRMSC and the impact it had on the communities near the Complex.

This document has been prepared under the procedures and guidelines for determining eligibility of historic properties for nomination to the National Register of Historic Places (NRHP) provided by the National Park Service in 36 Code of Federal Regulations (CFR) Part 60; the National Historic Preservation Act of 1966 as amended (NHPA), 16 United States Code (U.S.C.) Sections 470-470w-6; and Army Regulation (AR) 420-40, Section 2-12. The North Dakota Comprehensive Plan for Historic Preservation was also considered during the preparation of this document. This document will provide the historic context needed to make a determination of eligibility. The Department of the Army developed AR 420-40 (mentioned above) which prescribes management responsibilities and standards for the treatment of cultural resources in compliance with the NHPA. In accordance with the NHPA, AR 420-40, and Advisory Council guidelines and in consideration of the objectives of the North Dakota Comprehensive Plan for Historic Preservation, the USASSDC has undertaken an evaluation of the eligibility for listing on the NRHP of the SRMSC facility. This document will provide the historic context required to make such a determination, as well as to support the requisite HAER documentation. Properties usually must be 50 years old to be eligible for the register, but there is a specific exception for properties of exceptional importance.[2] This document is submitted to show the exceptional importance of the SRMSC facility.

III. THE COLD WAR AND THE DEVELOPMENT OF THE ARMY ANTI-BALLISTIC MISSILE DEFENSE SYSTEM

A. THE COLD WAR; ORIGINS OF THE CONFLICT

The Cold War is a term which describes the tense, strained relations which existed between the United States and the Union of Soviet Socialist Republics (USSR) in the period after World War II. It was during this period that the threat of Soviet nuclear aggression required an anti-ballistic missile (ABM) system to protect the American homeland. The Cold War was actually the climax of a gradual degeneration of relations between the two countries that began in the later part of the 19th century. Russo-American relations up to the period of deployment of the

Stanley R. Mickelsen Safeguard Complex (SRMSC), can be divided into four eras: Peaceful Coexistence 1780-1867; Emerging American Threat 1867-1917; Ideological Clash 1917-1945; and Cold War 1945-1972.

The earliest period of Russo-American relations was marked by cooperation and goodwill. A successful American delegation to St. Petersburg secured Russian recognition of the new American republic in 1780 and further negotiation led to a commercial treaty in 1832. This friendship was the result of several factors. The most important was a shared Russian and American antagonism towards Great Britain. Additionally, American foreign policy during this period followed an isolationist philosophy, and therefore did not interfere in other countries' affairs. This stance was apparently appreciated by the Russians as evidenced by the American Minister who reported that the American tradition of attending to our own affairs, and leaving other nations to do the same enhanced the Russo-American relationship. The Russian leadership recognized the United States sphere of influence in North America and eventually sold Russian America (Alaska) to the United States in 1867.[3]

In the years between the sale of Alaska and the fall of the Tsar (1867-1917), the United States Government and the American people slowly altered their perception of Russia. This seems to have been one sided, as there is no evidence of Russian reciprocation of this growing hostility. This gradual change in U.S. views occurred for two reasons. The first was the commercial expansion of America into Asian markets. The Russians had become competitors for the first time, and were a threat to U.S. interests. The second reason was an emerging American diplomacy which linked the internal affairs and domestic institutions with the foreign policy of a particular country. In the previous period, Americans remained friendly on a diplomatic level, without regard to what was occurring in the political or social systems within other countries. This change in attitude was due to the many dramatic social changes occurring in the U.S. following the American Civil War. During this period, hundreds of accounts were leaked to the U.S. concerning persecution of Russian Jews by Tsarist forces. This persecution was extended to American Jews visiting Russia. By the end of the 19th century, there was widespread public pressure for Washington to protest the Tsarist Jewish policy. In 1911 President William H.Taft abrogated the Russian-American Commercial Treaty of 1832.[4]

Following the downfall of the Tsar in 1917, the new communist regime was found to be more repugnant by Americans than that of the Tsar. The Communists continued the earlier ethnic persecution common under the Tsar and began persecution of political adversaries. American concerns over these internal actions were aggravated by the Revolution's stated goal of overthrowing capitalism. The United States responded to this threat by direct intervention in Soviet affairs. President Woodrow Wilson deployed American combat troops to intervene, against the communists, in the Russian Civil War. U.S. intervention was unsuccessful and Soviet-American political relations sank to their lowest level. Although other western nations granted recognition to the new Soviet regime in the years immediately after World War I, the United States withheld diplomatic relations on ideological grounds. It was not until 1933, during the administration of President Franklin D. Roosevelt, that the USSR was granted diplomatic recognition. Although it appeared that Roosevelt granted recognition to legitimize economic relations that had been thriving, despite the political situation between the countries, in reality, recognition was probably granted to facilitate cooperation in containment of the rising military powers of Germany and Japan. Relations worsened after this recognition, however, as news of the great purges by Soviet Premier Joseph Stalin reached the west. Only Germany's invasion of the Soviet Union changed the relationship between the United States and the USSR. President Roosevelt began supplying arms and equipment to the Soviets and a spirit of antagonistic cooperation prevailed until the Axis powers were defeated in 1945. Although the western nations cooperated with the USSR to defeat their common enemy, diplomatic conditions did not improve between East and West. As early as 1941, when the war was still going badly for the Soviets, Stalin made his intentions known to others in the anti-axis coalition - the USSR would extend its sphere of influence into Eastern Europe after the defeat of Nazi Germany.[5]

With the end of World War II, the uneasy coalition of anti-axis powers began to break up. Many points of friction began to develop between the USSR and the western nations, led by the United States. The most predictable issues were over Soviet control of East Germany and other Eastern European nations. Tensions were further heightened when communist forces threatened Greece and Turkey. Three events in 1949-1950 accelerated a move toward confrontation: the Soviet Union exploded its first atomic weapon and became a nuclear threat; the Chinese Communists gained control of China; and the Soviets and Chinese backed a North Korean invasion of South Korea. To contain the communist threat of expansion in Europe, a new coalition of western states called the North Atlantic Treaty Organization (NATO) was created. The Soviets countered by forming the "Warsaw Pact", a military coalition of eastern European nations. With the exception of a few neutral nations, the world polarized into two hostile factions and all international issues were measured with an East-West theme. The Cold War had begun in earnest and each camp used diplomatic maneuvers, threats, espionage, economic pressure, and propaganda to consolidate its position. Each faction's power, however, evolved from different sources in the post World War II era. The Soviet Union continued to maintain a very large land army after the war, deployed in the occupation of central and eastern Europe. The United States, which was held in greatest military respect due to possession of atomic weapons, quickly demobilized its large conventional military force in the years immediately after World War II.[6]

The nature of the Cold War dramatically changed when the Soviet Union successfully tested an Inter-Continental Ballistic Missile (ICBM) and successfully orbited Sputnik in 1957. The Soviets were no longer only a threat to Western Europe; with nuclear armed ICBMs, they could threaten the American homeland. The distant communist menace become a very real and immediate threat to the American people five years later when the Soviet Union targeted the United States with nuclear weapons based in Cuba. The world was on the brink of nuclear war for several anxious days in October 1962, before the Soviets, under U.S. pressure, removed the weapons. The Cuban Missile Crisis, and the Chinese entry into the nuclear arms race in 1964 convinced U.S. planners that a defense based on offensive nuclear weapons was not a complete deterrent against communist aggression. In 1967, the U.S. determined to develop an anti-ballistic missile (ABM) system which would protect the American homeland by intercepting incoming Soviet ICBMs. The Stanley R. Mickelsen Safeguard Complex was the eventual product of that 1967 decision.

B. DEFENDING THE HOMELAND; SUPPORTING THE FORCE

The history of strategic defense is the story of meeting and overcoming technological threats. The U.S. Army has played a pivotal role in that process since 1794 when the U.S. Congress tasked the Army to build and staff coastal defense fortifications. As the threat changed from cannon-bearing ships to bomb-laden aircraft, the Army changed the focus of its defense from coastal forts to urban defense anti-aircraft installations. Two World War II technology achievements, one German and the other American, resulted in the next revolution of strategic defense.

1. WORLD WAR II

The first event occurred on September 8, 1944, when German V-2 ballistic missiles crashed into London, England. The second took place on August 6, 1945, when a single American B-29 Bomber, the "Enola Gay," dropped the first atomic bomb on Hiroshima, Japan. Before the advent of missile and atomic technologies, defenders succeeded if they could account for ten to fifteen percent of an attacker's bomber force with air intercepts and anti-aircraft fire. Because of the immense destructive capabilities of nuclear weapons, ICBMs and nuclear armed bombers demanded nearly 100% attrition.[7]

The search for a defense against incoming missiles began in 1944. While radar proved capable of acquiring (detecting) the V-2 when it reached an altitude of 5,000 feet and provided sufficient data to compute time and point of impact, the missile itself remained nearly impervious to World War II gunnery systems. It was calculated that it would take a barrage of 320,000 anti-aircraft shells to destroy a single V-2. The duds and fragments of those shells would produce more casualties than the exploding V-2. The only solutions were bombing the V-2 factories and capturing the launch sites. Historian Donald Baucom concludes that "the origins of the United States antiballistic missile program may be traced to these efforts to stop the German V-2s."[8]

Germany's war-time research and development efforts laid the foundation for an incredible rocket program. The Allies discovered documents which showed advanced development of an ICBM capable of reaching New York City.[9] The future defense implications were not lost on American military officers who recommended the initiation of a research and development program aimed at developing defenses against missiles like the V-2. As early as December 1945, the U.S. Army Air Force's Scientific Advisory Board discussed the use of homing rockets, armed with nuclear explosives and some form of energy beam, to defend against attacking missiles.[10]

Less then one year later, the War Department Equipment Board, chaired by General Joseph W. Stilwell, concluded that:

> Guided missiles, winged or non [-] winged, traveling at extreme altitudes and at velocities in excess of supersonic speed, are inevitable. Intercontinental ranges of over 3,000 miles and payloads sufficient to carry atomic explosive [sic] are to be expected. Remotely controlled, and equipped with homing devices designed to be attracted to sound, metal, or heat, such missiles would be incapable of interception with any existing equipment such as fighter aircraft and anti-aircraft fire. Guided interceptor missiles, dispatched in accordance with electronically computed data obtained from radar detection stations will be required...the development of defensive measures against atomic weapons be accorded priority over all other National Defense Projects.[11]

The process to develop a defense against missiles began in February 1946, when the Army Air Force awarded two contracts for the purpose of developing the characteristics for antimissile systems. Professor E. W. Conlon of the University of Michigan chaired Project WIZARD which sought to find the basis for developing a missile that could destroy a vehicle traveling up to 4,000 miles per hour at altitudes between 60,000 and 500,000 feet.[12] The second contract established Project Thumper which explored the interception of "rocket-powered ballistic and glide missiles and supersonic ram-jets." Project tests consisted of using V-2 type rockets for a first stage and a WAC CORPORAL for the second stage. The Thumper project was canceled in March 1948, while Project WIZARD continued until 1958, when it was merged with the NIKE-ZEUS antiballistic missile (ABM) project."[13]

2. THE EVOLVING THREAT

In 1949, the USSR exploded an atomic device and experimented with long-range bombers and missiles. Each advancement in aircraft and missile technology seemed to bring the danger of nuclear war a step closer. Improvements of American air defense were mandated.

C. ANTIBALLISTIC MISSILE DEVELOPMENT

1. THE FIRST GENERATION

In March 1955, the Army Ordnance Corps requested Bell Laboratories to undertake an eighteen month study, named NIKE II, to explore the next generation of air defense weapons to replace the anti-aircraft missiles and guns that defended many large cities. At first, the team devoted its efforts to a weapons system that could defeat advanced bombers while "keeping in mind ballistic targets and the desire to defend against extremely difficult ICBMs with a reasonable extension of current radar and missile technology".[14] By December 1955, the NIKE II study group presented its first report. The report's authors determined that to achieve a dual defense, a common missile with an interchangeable nuclear or conventional warhead was the best approach.[15]

While the interchangeable nose concept would soon be abandoned, the study provided a research focus for the first generation ABM program. Issues such as the intercept location of an in-bound ICBM and target discrimination were discussed in the NIKE II study.[16] They also produced research which led them to conclude that ICBMs would enter the atmosphere and decelerate at up to 60gs (gravities), based upon the shape of the reentry nose cone. This research indicated that tracking the incoming ICBM and developing the necessary intercept data were among the most complex challenges to be overcome. The technology of the day required the use of multiple radar sites, all connected with high speed communications equipment and computers that could track, plot, and offer a response that was automatic unless overridden by human intervention.[17]

These multiple radars had to be able to discriminate between decoys and real targets. World War II era decoys, such as chaff and balloons, were relatively simple to discern on radar from real targets. More advanced decoys, however, which are cut to the frequency length of the radar and fall at about the same rate as a reentry vehicle, are much more difficult for a radar system to discriminate. In any type of missile attack, the intercept decision-making process would be reduced to micro seconds.[18] Acquiring (detecting or finding on the radar screen) the missile early in the boost phase (initial flight phase), overcoming the difficulties associated with communications and data processing, and being able to discern between reentry vehicles and decoys were a few of the problems that the missile defense organizations of the U.S. Army faced as they began to explore the technologies associated with ICBMs and ABMs.

Lieutenant General James M. Gavin, Army Chief of Staff for Research and Development, recommended that the NIKE II be given a high research priority and that the NIKE II process be focused against ICBMs. In January 1956, the Army Policy Council was briefed. The council asked the NIKE II group if it was possible to achieve some sort of stop-gap defense measure against ICBM threats. The team's proposal directed all research and development efforts towards a final solution - the ability to acquire, discriminate, track, and destroy an incoming missile. Thus, what was required in either case, the team concluded, was a long-range, high-data rate acquisition radar. If development could begin in this critical area and if breakthroughs could be achieved, then an interim ABM system could be accomplished using the NIKE B missile and its associated system.[19]

The NIKE II team presented an ABM system concept plan to the Assistant Secretary of Defense for Research and Development in March 1956. The proposed system included a defensive missile equipped with interchangeable nose cones, a series of forward acquisition radars (FARs) that would be located well north of the defended areas, and point defense radars designated as Local acquisition radars (LARs). The system also included a high speed automated processing center, and a full Continental United States defense network.[20]

While parts of the NIKE II system concept would be altered or discarded, the 1956 concept defined ABM system technological requirements and its basing policy for the next 25 years. The technology requirements, including high-speed data processing and communications links, created the need for high speed integrated circuitry and new types of radars, all linked with sophisticated computerized command and control centers. It also relied on nuclear warheads to hit incoming ICBMs. In addition to setting the focus of research and development for the next 25 years, it spawned objections to the ABM system which would bedevil future ABM systems.

Since WWII, both the Army and the U.S. Air Force had been concurrently conducting ABM research and development programs. Following a lengthy debate between the two services, Secretary of Defense Charles E. Wilson issued a memorandum on November 26, 1956, assigning the U.S. Army responsibility for the "development, procurement, and manning of land-based surface-to-air missile systems for point defense."[21]

2. NIKE-ZEUS

The development of a new strategic defense system took on a new sense of urgency when the USSR launched a satellite, Sputnik I, in 1957. The Secretary of Defense assigned the mission of researching and building an ABM system to the Department of Defense (DoD) Advanced Research Projects Agency (ARPA) and the Army. The responsibility to examine defense measures, beyond the Army's ABM system, against Soviet missiles went to ARPA. The Advanced Research Projects Agency (ARPA)'s projects included studies on the effects of nuclear detonation in space and a collection of efforts called Project Defender.[22] The Project Defender team members reviewed projects such as lasers, particle beams, and a project entitled BAMBI (Ballistic Missile Boost Intercept) which explored such concepts as satellite tracking, spaced based interceptors, and ground based phased array (see p. 49 paragraph 2) radars.[23] Rather than establishing its own facilities, the ARPA made extensive use of the Army's facilities for advanced projects, and for projects like NIKE-ZEUS, was "to maintain surveillance and provide technical guidance and advice." In addition, ARPA also provided a portion of the funding for such projects.[24]

The Army selected Redstone Arsenal in Huntsville, Alabama, as the place to carry the NIKE II ABM program to its demonstration phase. The NIKE II program was renamed NIKE-ZEUS in 1958, and placed with the newly established Army Rocket and Guided Missile Agency (ARGMA), a part of the U.S. Army Ordnance Missile Command (AOMC). The responsibility for ballistic missiles fell to the Army Ballistic Missile Agency. The 3,233 civilians and soldiers who comprised ARGMA directed the development of such missile programs as Hawk, NIKE-AJAX, NIKE-HERCULES, Plato, and NIKE-ZEUS.[25]

The Army awarded the contract for the development of NIKE-ZEUS to Western Electric/Bell Laboratories. Already the Army had made significant changes in the system, the most important being to concentrate the development effort on an ICBM defensive missile instead of a dual purpose one. In addition to Western Electric/Bell, who served as the prime contractor, major subcontractor companies included McDonnell-Douglas, RCA, and Goodyear Aircraft Company. The mission of the NIKE-ZEUS team was to carry the NIKE II from concept to demonstration and meet major challenges - radars, interceptors, test ranges.[26]

The state-of-the-art radar system associated with NIKE ZEUS was a complex arrangement, made more so by the technology of the era. The mechanical rotating antennas required a series of interconnected radar sites for a single NIKE-ZEUS battery of missiles. Each proposed NIKE-ZEUS battery would require discrimination radars and

Target Track Radars (TTRs). These radars would isolate incoming reentry vehicles (nuclear warheads from incoming ICBMs) from debris or decoys. Once the actual reentry vehicle was identified, the radars would have to narrow their bandwidth in order to give precise automatic positioning and tracking duty within a few seconds. The radar design was further complicated by the fact that ICBM development was in its infancy and, therefore, little was known about its radar characteristics.

The ARGMA team examined several radar designs and settled on a radar equipped with a new design called "fly's eye" antenna.[27] Like most new projects, the "fly's eye" created a new challenge. Designers found it necessary to develop a stand alone Discrimination Radar (DR) that could provide precision tracking of the reentry vehicles(targets) for 6 to 10 seconds before intercept of the target by the ABM. The DR became the radar that selected the incoming warhead from among the debris and decoys.[28]

Extended range requirements first included forward acquisition radar (FAR) and local acquisition radar (LAR). The FAR was identified in the NIKE II study, but the NIKE-ZEUS team concluded that it was unnecessary. It was decided to eliminate the FARs and conduct search and acquisition with the LAR placed at each battery. This decision forced a change in LAR design, in order to make it more resistant to a nuclear detonation. This design change caused the LAR to be renamed the ZEUS Acquisition Radar (ZAR).

The ARGMA team's every effort plowed new ground. Each test brought new information and new questions. Little was known, for example, about the impact of the nuclear bursts at high altitudes. Following nuclear atmospheric tests, the ZAR had to be redesigned to a new frequency range.[29] It was determined that high altitude nuclear blast could impair radio communications. (Some might question the need for radar after a nuclear explosion, but hopefully, our defenses would not be overcome and we would want to continue to track other incoming reentry vehicles. Protection for people in the area would require hardened shelters with overpressure to protect against the radiation and tremendous pressure created by a nuclear explosion.)[30] With more than one reentry vehicle possible, it would be crucial to maintain radar surveillance. Pioneering new technologies did not stop with radars and computers. The NIKE-ZEUS missile was an extension of the NIKE missile family already in service at air defense sites around the United States. The ABM missile requirements, however, demanded an expansion of missile technology. Control mechanisms were redesigned and simplified, while experiments with composites such as tungsten and carbon changed the surfaces of the missile itself in order to compensate for aerodynamic heating caused by high velocity.[31]

3. TEST RANGES

Field testing an ABM system presented the Army with a new set of obstacles. Testing such a system demanded a test range that was large enough to allow ICBM testing, yet located in an uncluttered area that could be secured from curious adversaries. At first, White Sands Missile Range (WSMR), New Mexico, was used for developmental test flights, and overland testing was the desired test solution. Flight test engineers could retrieve parts from the crashed or destroyed missiles and exercise better observation of the down-range test. However, the WSMR location did not allow the NIKE-ZEUS to be tested to its full range. The Army then secured use of the Naval Test Range at Point Mugu, California, and installed a ZAR along with launching and computer equipment. Unfortunately, Point Mugu also proved unsatisfactory because of severe range safety restrictions which forced many of the NIKE-ZEUS shots to be prematurely destroyed. Other areas were also considered for testing, but many locations presented missile testers with security and safety problems because of proximity to large population areas.[32]

The ARGMA staff finally focused its search within the Pacific area. Following a careful review of many range requirements, it was decided that Kwajalein Atoll in the Marshall Islands represented the most logical location. Kwajalein was within a day's flying distance of Hawaii and, because it had been used as a Naval base since World War II, it already contained a logistical infrastructure. Geographically, the location was perfect. The atoll's 4,800 mile distance from the United States was the ideal range for testing NIKE-ZEUS against missiles launched from Vandenberg Air Force Base in California. On February 12, 1959, based upon the ARGMA recommendation, DoD approved Kwajalein Atoll as a test facility for the NIKE-ZEUS. The test center was officially established on October 1, 1960.[33]

4. THE FIRST INTERCEPT

An intensive prototype test program was carried out for the complex/system. Virtually every component of the NIKE-ZEUS system was tested and retested. Seventy-nine developmental firings of the NIKE-ZEUS were made and 68 missile performance in-system tests were accomplished for a total of 147 separate missile tests. At the same time, the radar systems were being checked by tracking everything from ICBM launches to balloons, aircraft, and parachutes. Targets were tracked with three dimension tracks, then passed on to the Target tracking radar (TTR). The ZEUS Acquisition Radar (ZAR) proved to be the first track-while-scan radar system that could successfully cover the entire hemisphere surrounding the radar position, detect the objects in space, remember their past positions, and predict where the objects would be in the next dimension. This information analysis was done automatically and represented state-of-the-art wired logic systems.[34]

The ARGMA staff felt confident enough to begin system demonstrations in November 1961. On December 14 of that year, a NIKE-ZEUS successfully intercepted a CORPORAL missile at WSMR. In March 1962, the Army carried out a second successful intercept at WSMR and moved to the next, most difficult phase of testing, the actual intercept of an ICBM from the Kwajalein test site. The Army assembled a complete NIKE-ZEUS system on the southern end of Kwajalein, including a ZEUS Acquitisiton Radar, one discrimination radar (DR), two TTRs, and three missile tracking radars (MTRs), along with the battery control equipment and the four NIKE-ZEUS launch cells. The first test took place on June 26, 1962. The ZAR acquired the ICBM target 446 nautical miles from Kwajalein and immediately transferred the track to one of the TTRs. The TTR successfully picked up the missile tank then transferred its track to the reentry vehicle at 131 miles. However, during reentry, as the missile tank began to break up, the TTR's logic circuits malfunctioned and the reentry vehicle was lost. There was no attempted intercept. On July 19, 1962, a second, partially successful test was conducted. The radar systems worked perfectly and a NIKE-ZEUS was fired, but the missile experienced a hydraulic power failure and went into an excessive roll. Success was achieved on December 12, 1962. The NIKE-ZEUS system worked to perfection when the interceptor came within 200 meters of the incoming ICBM, a distance well within the acceptable limits of the simulated nuclear warhead.[35]

The Army's goal had always been to field an ABM system, that is, to put in place an operating system. However, the unproven technology, the costs associated with deployment, and the effect upon the United States and USSR balance of power made deployment a contentious issue. Many critics argued that a more cost effective and certain defense could be gained by spending money on offensive weapons. The anti-ABM argument was summed up in an inter-DoD memorandum, dated October 29, 1958:

> If it works, then obviously every effort should be made to install it. If it cannot provide such a capability, it might be wiser to invest the funds in other ways to accomplish a similar result. Thus the provision of 200 pounds per square inch shelters for a large portion of Strategic Air Command [SAC] bombers was estimated by a recent study to cost $1.5 billion. While passive defense of SAC involves operational problems, there is no doubt as to its reliability.[36]

[The 200 pounds per square inch mentioned in the above quote refers to the pressure the shelters for the Strategic Air Command bombers could withstand. The passive defense refers to such measures as shelters for the bombers.]

On October 18, 1960, the President's Science Advisory Committee concluded that:

> 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 to the effect that production of NIKE-ZEUS on a large scale of 70 batteries is not now justified, nor do we believe it to be justified in the foreseeable future, that with respect to defense of population against a major attack, fallout shelters should have priority over extensive ZEUS deployment.[37]

The same memorandum urged that research and development be continued, along with full testing at Kwajalein, and "very limited deployment in the near future." The major concern was the ability of the system to discriminate between reentry vehicles and decoys.[38]

The Army's rebuttal, given by Major General Robert J. Wood, pointed out that a deployed ABM system was the only known defense against incoming ICBMs and that DoD had made the NIKE-ZEUS system a national priority for research and development. Contingent upon successful tests, the NIKE-ZEUS system was to be placed into production. Wood also provided evidence that the Soviets were also engaged in extensive ABM work. Moreover, the ZEUS system, he argued, was the only system that would be available during the 1960s.[39]

Colonel John G. Zierdt, the ARGMA commander in 1960, viewed the problem from the perspective of a project manager. He believed that there was an:

> absolute necessity of establishing a goal, and committing the authority and resources necessary to its realization, and then having the good sense to leave that part of the effort alone.... the management of the NIKE-ZEUS system development effort and our inability to obtain solid decisions is, I believe the most singularly damaging influence and is the most difficult to cope with.[40]

Congress accepted the Army's argument and, in 1959, appropriated $137 million for pre-production planning efforts. The money, however, was not released by the Eisenhower Administration.[41] Historian Donald Baucom suggests that the deployment issue became a part of election year politics and this political battle continued into the administration of President John F. Kennedy.[42]

When President Kennedy took office, he directed Secretary of Defense Robert S. McNamara to review the ABM program. In April 1961, McNamara decided that it was neither technically feasible nor cost effective to deploy the NIKE-ZEUS system. Although McNamara recognized the difficulties the system would cause to Soviet planning, he believed the NIKE-ZEUS system could easily be overcome by massive attacks and decoys, and might well cause the Soviets to increase their number of offensive missiles. In order to protect a significant part of the country, it would cost $15 billion. Secretary McNamara did not find the capabilities of the NIKE-ZEUS system to be worth the cost of deployment. Nevertheless, McNamara did recommend $270 million for a research and development program.[43]

The NIKE-ZEUS project made long-lasting contributions to the ABM program. It created an Army-industry team equipped with scientific skills that continue to the present. The NIKE-ZEUS team proved, with their successful intercept, that it is possible to intercept an ICBM. They established a site to test missiles, an effort aided, in part, by the good will of the Marshallese people, and later, by the government of the Republic of the Marshall Islands.[44] In addition to its use as a test range, Roi-Namur at Kwajalein Atoll was selected by the ARPA as the site of the Pacific Range Electromagnetic Signature Studies (PRESS) Project. The ALTAIR and TRADEX radars and associated support facilities constructed on Roi-Namur were used for deep space tracking and intercept confirmation for the ABM program.[45] Finally, the success of the NIKE-ZEUS program led to the decision to develop the next generation of ABMs.

5. NIKE-X: REORGANIZING AND RESTRUCTURING FOR THE FUTURE

The level of effort required for the NIKE-ZEUS project exceeded the capabilities of the ARGMA organization. Therefore, in 1961, the Army disbanded ARGMA and formed the NIKE-ZEUS Project Office. Then in 1962, in an unassociated move, Secretary of Defense McNamara directed the Army to reorganize its entire structure. During this restructuring, the Army's Technical Services, including the Ordnance Corps and its subordinate organization, Army Ordnance Missile Command (AOMC), were replaced by the U.S. Army Materiel Command (AMC). This new command, AMC, was one of the few major Army commands. Under AMC were several major subordinate commands including the facility at Redstone Arsenal which was known as the U.S. Army Missile Command (MICOM). In the new organization, the NIKE-ZEUS Project Office remained at Redstone Arsenal and was supported by MICOM, but reported directly to the AMC Commander.[46]

On January 5, 1963, Secretary of Defense McNamara directed the NIKE-ZEUS Project Manager to develop a new ABM system, temporarily designated NIKE-X. This system was to incorporate the most advanced technology available into the ABM program.[47] This decision placed the ABM program among the highest priorities in DoD research. It would also provide the technology for the only ABM system deployed in the non-Communist world.

The close working relationship between the Advanced Research Projects Agency (ARPA) and the NIKE-ZEUS team now began to bear fruit. Two years before the successful intercept on Kwajalein, ARPA had funded projects to study phase-controlled scanning radars and they were immediately viewed as important to the ABM program. Phase controlled, ground radars which used computers to control the timing of the radar beam were more resistant to the effects of a nuclear blast capability; they could handle higher power and, therefore, achieve greater range; their beam widths were adjustable; and one radar could perform several functions, to include acquisition, discrimination, and tracking.[48] The Secretary of Defense's charter to utilize state-of-the-art technology for ABM meant that the door was opened to utilize new radar technologies.[49]

The Army reorganized the NIKE-ZEUS team on February 1, 1964. The NIKE-ZEUS Project Office was reorganized into the NIKE-X Project Office and, while it was located within the MICOM organization, the Project Manager reported directly to the AMC commander.[50] On June 19, 1964, the NIKE-X Project Office assumed responsibility for the Kwajalein Test Range from the United States Navy.[51] The advanced research continued under the direction of ARPA.

The Raytheon Company was awarded a contract for the development of a new missile site radar (MSR) in December, 1963. The phased array MSR was designed to be used at the missile site for discrimination, targeting, and tracking. By 1965, research indicated that, if the MSR was provided with its own data processing and command and control equipment, it could operate autonomously as a defense center for small cities. Another part of the NIKE-X radar system was the Multifunctional Array Radar (MAR), designed to provide long-range target acquisition and discrimination. Plans called for both the MSR and the MAR to be constructed on Kwajalein and Meck Islands. Both the MSR and the MAR were free-standing radars. The radars provided data that would be used to guide the ballistic missiles. There were no missiles or other weaponry attached to the these radars.

The teams assigned to work on the MAR II soon ran into difficulties; some components could not withstand the high power required to operate the radar, there were design problems with the time delay steering, and the overall cost forced the designers to develop a less expensive system for perimeter acquisition. The NIKE-X team elected to shift work on the MAR from a tactical radar to a pure research and development radar.

The radar was used to provide basic field data on target discrimination. At the same time the MAR radar was under development, a radar designated the Perimeter acquisition radar (PAR), a long-range radar to detect incoming enemy missiles at ranges of over 1000 miles, was also in the development process as an early-warning alert radar. The NIKE-X Project Office decided to redefine the PAR capabilities. This action included changing the design of the system from very high frequency (VHF) to ultra high frequency (UHF) in order to reduce the negative effects on communications/radio waves of an atmospheric nuclear blast. This change would soften the effect of the aurora encountered within the northern latitudes which causes radio frequency disturbance. While these changes in frequency required extensive design modifications, the NIKE-X system gained a much less costly radar and one that could also provide tracking for future long-range ABM missiles.[52]

Extraordinarily high speed data processing is critical to achieve a successful intercept. The NIKE-X team believed that reliable calculations at a rate of 30 million per second were required for a successful system. In the mid-1960s, not a single commercial system on the market or planned could reach that level of speed or reliability. Therefore, many experts, including the American Academy of Science, reported to the Army that, in their opinion, a multiprocessor could not be made to meet the required number of calculations or reliability.[53] Ignoring the critics, the NIKE-X team demonstrated a prototype in 1965 and installed the first successfully operating full-scale model in 1967.[54]

The NIKE-X system, unlike the NIKE-ZEUS, called for long range and short range interceptors. The long-range interceptor, designated the Spartan, was a third generation NIKE-ZEUS with a high-yield nuclear warhead designed to destroy an incoming ICBM in the exoatmosphere. [Generally used to describe outside the atmosphere, but the exoatmosphere is at least 300 miles or 500 kilometers (km) out from the earth's surface.] The experience gained in testing and developing the NIKE-ZEUS was evident in the speedy evolution of the Spartan missile. The NIKE-X test program was carried out in two phases, a 29-month detailed engineering design, hardware fabrication, and ground test phase followed by flight tests at Kwajalein. Extensive functional and environmental tests, as well as system integration, were conducted in the laboratory over a three year period. Only 15 actual flights were required to make the missile operationally ready. The Spartan program, as was the case with all the NIKE-X programs, contributed to the advancement of engineering and science. Those contributions include product reliability procedures, new techniques in nuclear hardness, special heat protection coatings, shock and vibration protection, improved integrated circuit technology, the first application of the Sperry fluid-sphere gyro, and a sealed hydraulic system.[55]

The Sprint missile, unlike its long-range counterpart, had to be designed to provide terminal defense on any azimuth. Terminal defense at the time usually referred to a concentrated defense of a small area, but it more recently is used for defense against the final stage of an incoming missile/reentry vehicle. The Sprint missile serves both purposes. Thus, it had to be capable of being launched from an underground emplacement quickly with fast burn capabilities, rapid acceleration rates, and high maneuverability. Like the Spartan, the Sprint required innovative engineering approaches to achieve its goals. Contributions by the Sprint team included developing a propellant with a burn rate greater than any other missile in the American inventory. The team devised special heat shield coatings, free of contaminants, so that the missile could be tracked by radar; shock proofing technology; missile communications that could be maintained through the ion layer; a special control system with the capability to maintain stability; and hardening technology to withstand nuclear blasts. The missile exceeded all its requirements in a series of flight tests conducted at the White Sands Missile Range, New

Mexico, and at Kwajalein.[56] While demonstrating its worthiness as a weapons system, the NIKE-X system was also developing its place in American strategic plans.

6. CONCERNS AND THREATS

Secretary of Defense McNamara was as cautious about NIKE-X deployment as he had been about NIKE-ZEUS deployment. His concerns were threefold: first, the $16 billion price tag for deployment; second, the growing belief that the best way to deter nuclear war was through the threat of massive retaliation; and third, the growing opposition of the scientific community.[57]

By the mid-1960s, some scientists had concluded that it was unrealistic to deploy an ABM system. It did not help the program when senior executives from the Reentry Body Identification Group, and the ARPA criticized parts of the ABM program. The centerpiece of their opposition was that the ABM program undermined nuclear deterrence. These people 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, one that could be in jeopardy if we continued to develop ABMs that required nuclear testing. In the October 1964 issue of Scientific American, the two strongest government opponents of the ABM program wrote "It is our considered professional judgment that this dilemma has no technical solution."[58]

The scientific argument and the associated costs were beginning to convince Secretary of Defense McNamara that an ABM system should not be deployed. He believed that it was more cost effective to secure defense through a mutually assured destruction strategy rather than building defensive weapons. Nonetheless, ABM enjoyed the third priority for defense research and development monies. It was preceded by research and development money for the Vietnam War and penetration aids for offensive weapons.[59]

In 1965, however, strategists began to contemplate limited strikes by nations other than the Soviet Union. In February 1965, the Army began to study the issue of defense against the "Nth country" threat, an attack launched by a country other than the Soviet Union. The Army's study group members postulated that such an attack would probably consist of a limited number of unsophisticated ICBMs that were inaccurate and designed to terrorize rather than neutralize strategic targets. The "Nth Country" threat was validated when the People's Republic of China exploded its first nuclear device in 1965 and announced that they were experimenting with missiles.[60]

The presence of an "Nth Country" threat meant that concerns over destabilization between the Soviet Union and the United States might not be a consideration for a limited defense. As a result, the problem became how to determine if the NIKE-X was the most cost effective way to defend against a limited attack. Several changes were made in the proposed NIKE-X system, to include a greater payload (a more powerful warhead), or to allow two or more missiles to be launched for a barrage-type kill and improved radars. In October 1965, a proposed system was designed which included four very high frequency (VHF) radars and 12 MSRs, with 20 modified NIKE-ZEUS missiles at each site. The following month, Dr. John S. Dulles, the Director of Defense Research and Engineering (DDRE), initiated a new study dealing with the active defense for hardened sites.[61] By limiting the threat, it allowed the technology to achieve a much more credible defense against an "Nth country" attack. The ABM technology would be overwhelmed, however, according to the results of the study.

On December 9, 1966, Secretary of Defense Robert S. McNamara directed the Army to study the possibility of Area and Hardsite Defense. The deployment plan study, known as the "Plan I-67 Area/Hardsite Defense," was designed to protect against two different threats, a deliberate urban/industrial attack by the People's Republic of China, and a deliberate attack by the Soviet Union against United States strategic forces. In addition to laying out the defense concerns, both McNamara and Dr. John S. Foster, Department of Defense Director for Research and Engineering, placed significant emphasis on minimizing the cost of production and deployment. On July 5, 1967, the study was completed and it met the criteria required by the Secretary of Defense: first, a specific threat design; second, a total investment not to exceed $5 billion; and third, achievement of initial operation within 54 months.[62]

A series of international events soon caused an increased awareness of the need for an ABM system. In 1967, the People s Republic of China exploded two additional nuclear devices and launched a nuclear-capable missile that hit its target. In December 1967, Secretary of Defense McNamara reported that the Soviets were in the process of fielding (fielding in this context means to put into place with operational readiness) an ABM system. As he was concerned about the destabilization effects of an ABM system, as well as the cost of production and deployment, McNamara offered President Lyndon B. Johnson a compromise to avoid deployment. McNamara suggested that the President call for money for deployment of an ABM system and, at the same time, begin arms control talks with the Soviet Union. If the arms control talks failed, the money could be used for deployment. On June 23, 1967, President Johnson and Soviet Premier Alexi Kosygin met at Glassboro, New Jersey. In an effort to gain the Soviet Premier's agreement on a decision not to continue deploying an ABM system, McNamara informed the Soviets that, if they continued with their ABM system, the United States would increase the number of offensive missiles in its arsenal. McNamara then suggested that the only way to avoid escalation was to negotiate restrictions on defensive weapons. Kosygin became visibly upset and retorted, "Defense is moral, offense is immoral!"[63]

In September 1967, McNamara announced the administration's decision to deploy an ABM system against China. In addition to protection against the possibility of a Chinese attack in the 1970s, there was the added value of protecting the ICBM missile fields, thereby increasing the deterrent capability of existing United States forces. In reality, however, McNamara was never a strong proponent of ABM deployment. He saw it as a serious threat to the stability given by nuclear deterrence.[64]

7. THE SENTINEL AND SAFEGUARD SYSTEMS

The decision to deploy an ABM system meant that the Army had to reorient the NIKE-X program from research and development to production and deployment and field a system within 54 months. The Army Chief of Staff directed that the NIKE-X Project Office become the NIKE-X Research and Development Program with the mission to continue high level research for the next generation of ABMs. A larger organization, designated the U.S. Army Sentinel System Command (SENSCOM), became the Army's organization responsible for producing and fielding the Sentinel system. The Sentinel System used the technological achievements developed over the years by the earlier NIKE-ZEUS Project Office and the NIKE-X Project Office and the successor research organization, the NIKE-X Research and Development Program. The SENSCOM reported directly to the Chief of Staff of the Army with its major components located in Huntsville, Alabama, and test facilities located in the Kwajalein Atoll. Because the project decisions were often required at a high level, the commander and a small support group worked in Washington.[65]

No sooner was the Sentinel program underway, when yet another series of events caused a change in the Sentinel program. The last year of President Johnson's administration saw rising public opposition to American involvement in the Vietnam War and to the military in general. The anti-war, anti-military groups protested spending even more money on defense and, instead argued that the money should be spent on domestic programs. When the people who lived in the cities where Sentinel sites were to be built learned that the missiles contained nuclear warheads, many joined the opposition to Sentinel deployment. McNamara's lukewarm endorsement of the ABM program, coupled with Assistant Secretary of Defense Paul Warnke's report that the People's Republic of China's missile program was farther behind than originally anticipated, increased the pressure on incoming President Richard M. Nixon to review the Sentinel program deployment decision.[66]

The Sentinel system consisted of the following four major subsystems:

* Perimeter acquisition radar (PAR) and associated PAR Data Processor (PARDP) for long-range surveillance and tracking of attacking ICBMs

* Missile Site Radar (MSR) and associated MSR Data Processor (MSRDP) for close-in target surveillance and tracking and for command guidance of defensive missiles

* Spartan missiles with high-yield (in the megaton range) nuclear warheads for long-range intercepts - the Spartan was developed from the NIKE-ZEUS missiles (see page 34.)

* Sprint missiles with low-yield (kiloton range) nuclear warheads for close-in, fast-response intercept.

The initial Sentinel deployment, to provide an area defense of the continental United States and Alaska, was to consist of 6 PARs, 16 MSRs, 480 Spartans, and 192 Sprints (see discussion on page 34 about the Sprint and Spartan missiles). The specific number of missiles that would be fired at an incoming target is not releasable at this time. An additional MSR and 28 Sprints were to be provided for Hawaiian defense. (An area defense was to defend a large geographical area with the protection of the population in mind.) The PARs would have their single arrays generally faced to the north. The MSRs would have one, two, or four array faces depending on their location and role in the defense. This initial deployment could grow to include defense of strategic missile bases by the addition of 208 Sprints and modification of the data processing hardware and software at the sites located near Minuteman bases. This system was to be closely netted and would have the ability to modify its response to specific attacks. Overall command and control, administration, and status of the system was to be effected through netting of local and area defense centers and these in turn, with the Continental Air Defense Command (CONAD).[47] The Sentinel would be located around Boston, Massachusetts; New York City, New York; Washington, D.C.; Detroit, Michigan; Albany, Georgia; Dallas, Texas; Grand Forks, North Dakota; Sedalia,

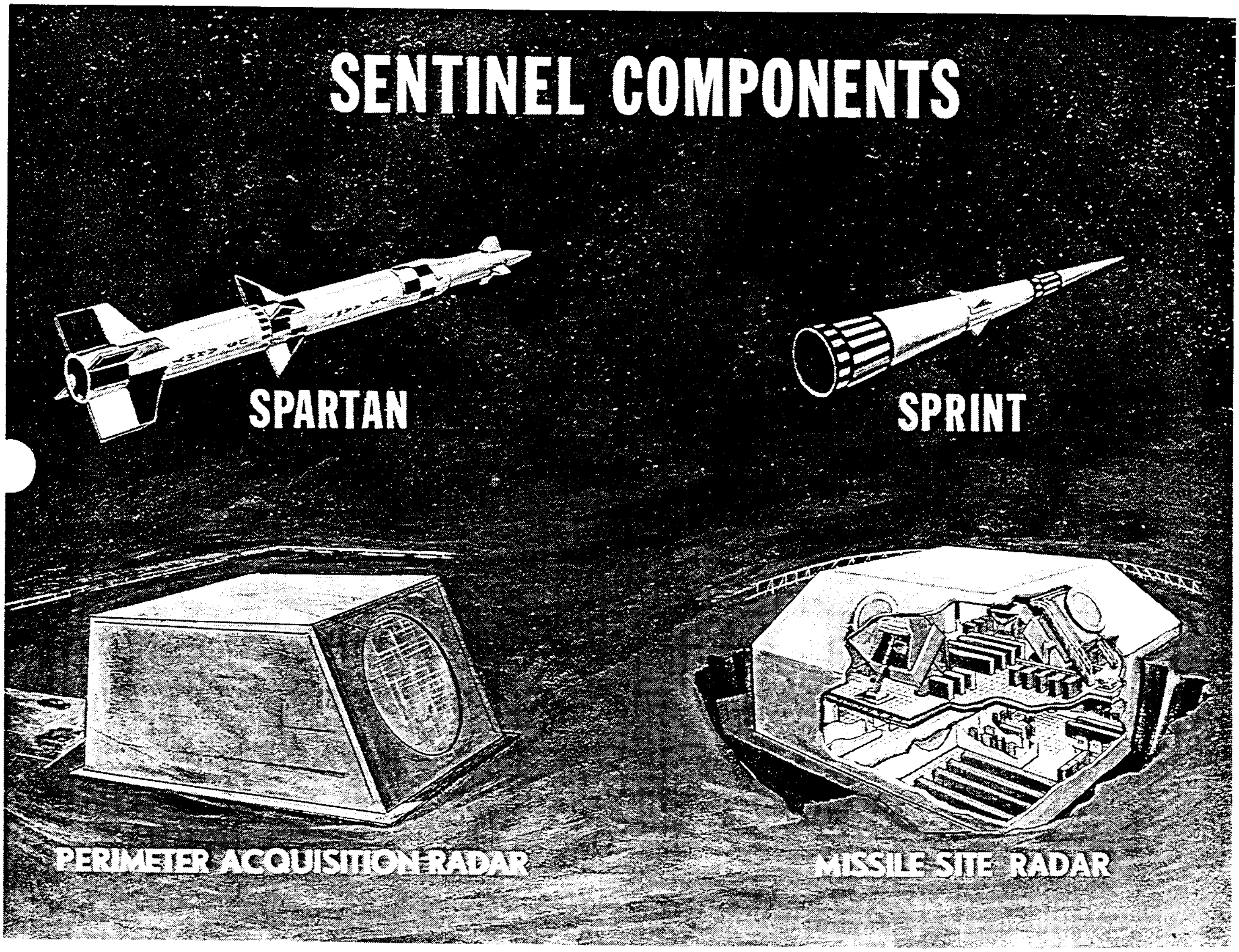


Figure 3 - 1

Contemporary Artist's Concept of Sentinel Components

Missouri; Cheyenne, Wyoming; Great Falls, Montana; Salt Lake City, Utah; San Francisco, California; Seattle, Washington; Hawaii; and Alaska.[68]

As noted, an area defense was to defend a large geographical area with the protection of the population in mind. Limited defense of certain metropolitan areas had been provided in the 1950s and 1960s by batteries of NIKE-AJAX and the later NIKE-HERCULES missiles. These were ground to air missiles (anti-aircraft missiles - not designed against ICBMs)[69]. However, the NIKE-HERCULES could take either a conventional, high-explosive, warhead, or a nuclear warhead, albeit low yield, and not in the power range of the ABMs. Yet that system appeared to escape the furor caused by the planned deployment of the more-widely discussed Sentinel ABM system.

On February 6, 1969, Secretary of Defense Melvin Laird ordered that all work on the Sentinel base construction cease until the strategic concepts associated with the program could be examined. On February 20, Deputy Secretary of Defense David R. Packard presented a report which offered the Nixon administration four ABM options. The first called for a thick ABM shield around 25 major American cities. A second alternative was the continuation of the Sentinel program that began in the Johnson administration. The third possibility was a Sentinel system deployed to defend ICBM fields. The final choice was to cancel plans to build an ABM system. President Nixon directed Packard to study all four of the options in greater detail.[70]

When President Nixon reviewed the Deputy Secretary's more detailed studies, he decided to deploy a system to protect ICBM fields. President Nixon announced the new deployment decision, called Safeguard, on March 14, 1969. The deployment concept called for 12 sites with construction to begin immediately at two sites - Grand Forks, North Dakota, and Malmstrom AFB, Montana. The construction of the ten remaining sites would follow after an evaluation of the strategic situation by the President and the Foreign Intelligence Advisory Board. When completed, the ten sites would provide a thin shield of protection against a small attack by the People's Republic of China or an accidental launch by anyone else. The debate, whether or not to allocate money for Safeguard, raged on in Congress throughout the spring and summer of 1969. On August 6, 1969, the decision to spend the money for the deployment of Safeguard passed despite three separate votes for denial of funding.[71]

The Army abolished the SENSCOM and, in its place, established the Safeguard Systems Command (SAFSCOM).[72] Like its predecessor, the SAFSCOM's primary effort was production and deployment. The challenge for the organization was to make the first site operational within 54 months.

The Safeguard ABM system was designed to protect U.S. Minuteman ICBM bases from attacks by enemy ballistic missiles. Development of the Safeguard system began with a redirection of the Sentinel program in March 1969. Its deployment plan called for a number of sites to be constructed primarily in the western part of the United States. Each Safeguard site was designed to protect an area of 600 by 900 miles. As a result of the Strategic Arms Limitation Treaties (SALT) and related program decisions, actual deployment was subsequently limited to a single complex in North Dakota and a system command center in Colorado.

The initial Safeguard plan called for up to 12 sites deployed in two phases. The first phase, for which authorization was originally granted, provided Minuteman defense at Grand Forks AFB, North Dakota, and at Malmstrom AFB, Montana, together with a Ballistic Missile Defense Center (BMDC) at Cheyenne Mountain, Colorado. The second phase would have added Minuteman defense at Whiteman AFB, Missouri, and at Warren AFB, Wyoming, as well as defense of the National Command Authority (NCA) in Washington, DC. This phase also retained the option to add additional sites to protect SAC bases and population centers. In March 1971, approval was granted to proceed with the installation at Whiteman and to plan for the Warren site. Whiteman was designated as the Fire Control Center (FCC) and Malmstrom as the Alternate FCC. The FCC was an intermediate command center reporting to the BMDC. A year later, however, authorization for the Whiteman site was rescinded, and Malmstrom was designated as the FCC. In accordance with the terms of the SALT agreement of June 1972 and a subsequent Congressional decision not to authorize the permitted deployment in the Washington, DC, area, the Safeguard system was further reduced to provide Minuteman defense only at Grand Forks AFB.

Thus, the planned deployment consisted of a PAR and a Missile Direction Center (MDC) in North Dakota, both under the overall command of the BMDC in Colorado. Included in the MDC was an MSR and associated Sprint and Spartan missile farms.

The three types of sites in the Safeguard system were to be interconnected by communications links. The PAR site was planned as a single-faced, phased-array radar to provide early detection and target trajectory data on threatening ICBMs. Functions of this site included long-range surveillance, detection and selection of threatening objects, and ICBM threat tracking for Spartan intercept. This last capability significantly increased the long-range Spartan field of fire. The PAR site was not planned to perform missile guidance but instead to transmit trajectory and target classification data over the tactical communication links to the MDC. The MDC would use this information together with data from its own multi-faced, phased- array MSR.

This site would provide additional surveillance and target tracking as well as track and guidance for Sprint and Spartan missiles. Both PAR and MDC sites would report to the BMDC, which would provide a command interface with other military systems and a means of disseminating command directives and controls.

The PAR and MSR would be controlled through digital commands issued by co-located Data Processing Systems (DPS). These commands were planned to manage such radar functions as beam pointing, frequency selection, receiver gating, threshholding, etc. In addition, application programs in the PAR and MSR would manage the major system functions of surveillance, tracking, target classification, radar testing, inter-site communication, and command/control/display. At the MDC, other programs would support engagement management and missile guidance. The BMDC DPS would primarily perform command, control, and display functions.

In May of 1974, all ballistic missile defense (BMD) efforts were consolidated under management in the Ballistic Missile Defense Organization. SAFSCOM became the Ballistic Missile Defense Systems Command (BMDSCOM).

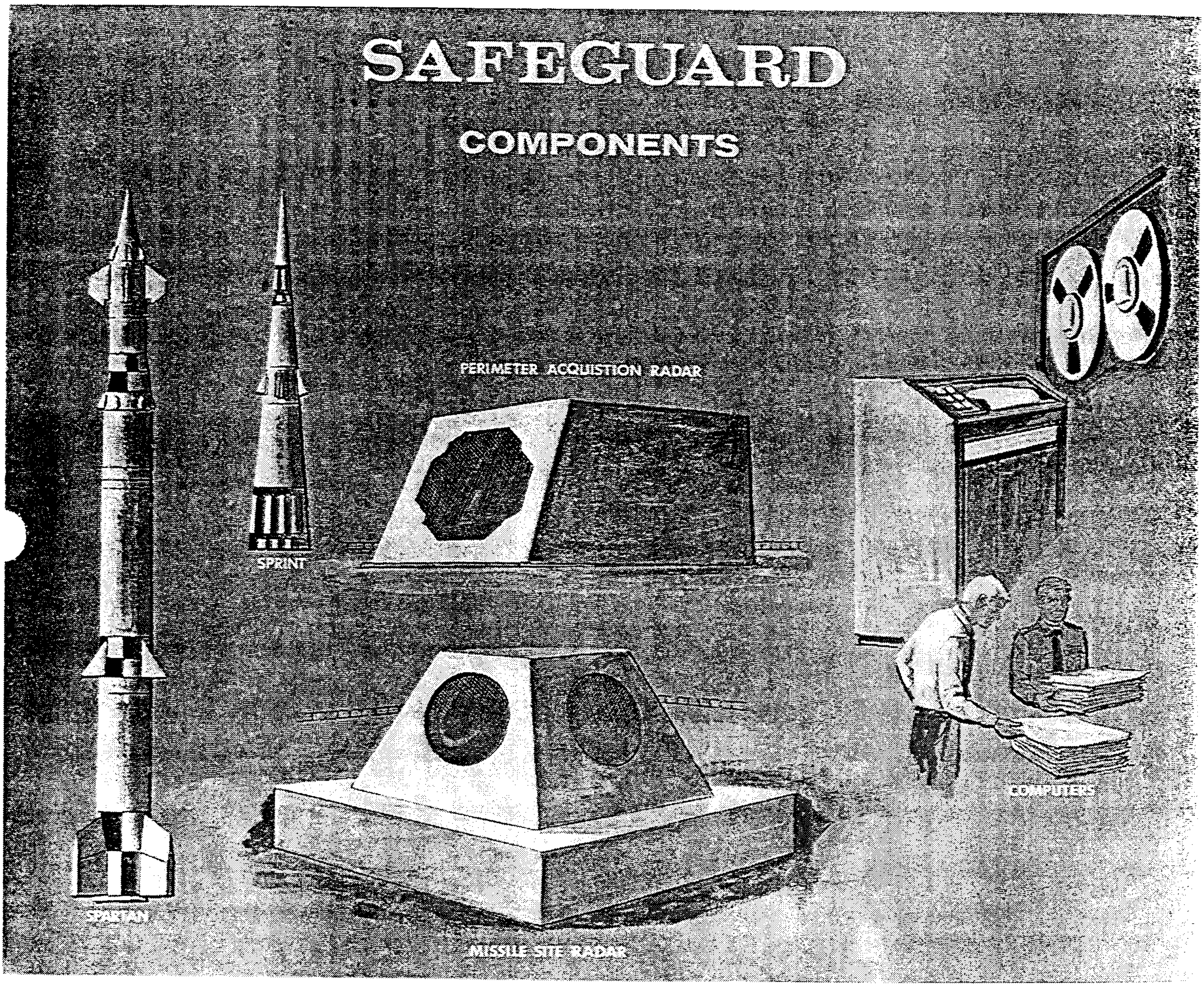


Figure 3 - 2

Contemporary Artist's Concept of Safeguard Components

Two primary factors determined the BMD direction in the 1970s. First, on May 26,1972, the United States and the Soviet Union signed the Treaty on the Limitation of Antiballistic Missile Systems. Although the treaty permitted both signatories to deploy defensive systems at two separate locations, Congressional action in the Fiscal Year 1973 Authorization Bill limited U.S. deployment to the site near Grand Forks, North Dakota. In July 1974, the United States and the Soviet Union entered into a second agreement which limited each country to only one ABM site that could be located either at the NCA or at an ICBM complex. The agreement was incorporated into a Protocol to the 1972 ABM Treaty, ratified by the Senate in November 1975, and put into effect with the signature of the President in May 1976.

Congressional guidance also affected Safeguard. Despite intense Senatorial debate over deployment, changes in appropriations, and the complexity of the project itself, SAFSCOM had produced a viable system within the time schedule and budget constraints. The equipment readiness date for the North Dakota site was achieved on October 10, 1974, a target that had been established in 1970. Installation of the missiles began in 1974; initial operating capability was reached in April 1975; and the Safeguard system achieved full operational capability on October 1, 1975. The DoD hoped to keep the site functional for at least one year in order to obtain operational experience. Some Congressional leaders, however, feared an increased vulnerability for a single site because of Soviet ICBMs with multiple independently targeted reentry vehicles (MIRVs).[73] Congress directed that operation and maintenance of the Safeguard system, except for the PAR, be terminated.

The experience gained in developing and deploying the Safeguard system was invaluable. Major technological breakthroughs and advances in the state-of-the-art, in both components and systems integration, resulted. This put the United States in a favorable technological position which was to be preserved following the BMD redirection exclusively to research and development.

8. BALLISTIC MISSILE DEFENSE AFTER SAFEGUARD

Even as the Grand Forks, North Dakota, Safeguard site was being constructed, discussions with the Soviet Union and new technologies were changing the future of ABM defense. In 1972, the United States and the Soviet Union signed the Treaty on the Limitation of ABM systems as part of the Strategic Arms Limitation Treaty (subsequently known as SALT I). That treaty allowed each signatory to build two ABM sites; one at a location selected by the signatory and one at each of their National Command Centers (in Washington, D.C. and Moscow, USSR). In 1974, a protocol was added to the treaty limiting each side to only one ABM site. Both the treaty and the protocol were ratified by the U.S. Senate in 1975. With the arms limitation agreement in effect, the U.S. Congress determined that, once completed, the continued operation of Safeguard was not justified. As noted above, full operational capability was achieved on October 1, 1975, three days ahead of the date scheduled.[74] The only deployed ABM system in the non-communist world, however, would prove to be short-lived.

On February 10, 1976, the Safeguard mission was officially terminated. Even though, the protocol added to the Strategic Arms Limitation Treaty (SALT II) allowed the United States to retain one operational ABM site and the Soviet Union did keep such a site operational, the United States voluntarily shut down its ABM systems. Only the PAR remained operational as part of the early warning system.[75] It was transferred to the U.S. Air Force, for this purpose.

Shortly before the termination of Safeguard, the command was reoriented from a production and deployment organization to a research organization. The Secretary of the Army, on March 26, 1974, announced plans to realign and combine BMD management under a single organization.[76] On May 20, 1974, SAFSCOM became the U.S. Army Ballistic Missile Defense Organization (BMDO).

According to Mr. William P. Clements, Jr., Deputy Secretary of Defense, the purpose of the reorganization was to strengthen the American deterrent by maintaining a dynamic technological program. It was to provide a management structure conducive to attracting and keeping competent personnel; to enable the BMD program to speak with one voice; to create a centralized mechanism for reporting to the BMD Program Manager; to eliminate separation of responsibility for Kwajalein Missile Range (KMR) support; and to reduce management overhead.[77] The BMDO, like SAFSCOM, remained a field element of the Office of the Chief of Staff of the Army. The command's mission was to deploy and operate the Safeguard System, execute the Site Defense program, conduct research and development in advanced BMD technology, and manage the KMR.

Concurrent with later Safeguard planning, the concept of Site Defense, also known as Hardsite Defense, began with studies in 1969. The program, officially designated in 1971, became a prototype demonstration program designed to use new technology to augment the Safeguard System in protecting the Minuteman missile sites. The Site Defense program was to protect against a more advanced threat to include MIRVs, decoys and other penetration aids. Software, both more complex and less expensive than that for Safeguard, was employed, and commercial hardware could be specially adapted to BMD operations. The site defense system included a small phased-array radar, a data processing system, and the Sprint II missile.[78]

Building on the site defense program, the BMDO proposed the Low Altitude Defense (LoAD) system for defense of the MX (Missile Experimental) missile sites in the multiple shelter basing system.[79] The US Air Force planned to replace the Minuteman missile with the MX (Missile Experimental). The multiple shelter basing system would have each of 200 MX missiles based in a complex of twenty-three shelters with the missile shuttled between the shelters so that the enemy would not know the exact location of the missile. The LoAD system was designed largely as a BMD system that could be located with the MX (Missile Experimental). In 1982, the Secretary of Defense issued a BMD Program Directive to support all MX basing options, with particular concentration on this closely based system. The directive called for the development of a nonnuclear endoatmospheric (within the earth's atmosphere) weapon. The BMDO response was to convert the single-stage LoAD, now known as Sentry, to a nonnuclear interceptor, as the required technology matured. The LoAd/Sentry differed in design from the

Sprint, but the significant change was the nonnuclear aspect. It, like the Sprint, was a within the atmosphere interceptor.

Sentry included a small phased-array radar with distributed data processing and a small, high-acceleration missile with a nuclear warhead similar to that of the Sprint. The LoAD/Sentry was developed as a next generation system with McDonnell Douglas as the prime contractor. Smaller than the Safeguard system, it operated with a lower search ceiling and a shorter reaction time. The most innovative design feature used distributed data processing instead of the large mainframe used in earlier systems. The LoAD/Sentry operated at low altitudes, making it difficult for our enemies to design successful decoys.[80]

In early 1983, President Ronald Reagan established a commission on strategic forces chaired by Lieutenant General Brent Scowcroft (USAF, Retired). The Scowcroft Commission was tasked to investigate the basing of ICBMs and the updating of strategic forces. Issued in April 1983, the Scowcroft report recommended vigorous research in BMD technologies. However, it concluded that no currently available BMD system was effective enough to deploy. It also recommended, at least on a short term basis, siting MX missiles in existing silos. For the long term, it proposed the usage of small offensive ICBMs.[81] The report of the commission was one of the factors that led to the cancellation of the Sentry program in 1984.

The research program implemented at the Ballistic Missile Defense Advanced Technology Center (BMDATC) was a "broad research effort to develop the technology of all BMD components and functions, to include reentry phenomenology, computers, advanced interceptor missiles, optical and radar sensors," and the ongoing assessment of new and emerging technologies. The program was to provide the advanced technological foundation for future BMD system concepts, particularly emphasizing approaches that could yield fundamental breakthroughs in BMD capabilities. Another facet was "to provide the technological basis for substantial improvements in nearer-term BMD systems."[82]

Research was not confined to traditional interceptors. The research and development efforts of the BMDATC were configured to accomplish two main objectives. These were to maintain U.S. leadership in BMD technology to prevent the Soviet Union from achieving a technical advantage; and to maintain and develop a credible capability to deploy a required BMD system as a hedge against future strategic uncertainties.[83]

Despite reduced funding levels for ABM research, from 1974 until 1984, the ABM team was able to study, experiment, and, later, prototype the next generation of ABM defense systems. Many of the concepts they worked with were natural follow-ons to Safeguard. Others were entirely new concepts that would, as predecessor systems had, bring new technologies to bear on strategic defense. The thrust of ABM research rested on a tripod of developing new and improved sensors, non-nuclear interceptors, and defensive strategies.

A number of advances were made in radar technology. In 1978, the Systems Technology Radar (STR) was installed on Kwajalein. The STR was a major improvement over earlier radars because it could generate more useful waveforms with much less hardware. The STR was also important in the new layered defense concept. It had the potential to serve as the underlay radar in LDS or as a stand-alone terminal defense.[84]

Target discrimination had always been a concern to ABM system design teams. In 1978, an important breakthrough occurred with the Designated Optical Tracking (DOT) program. This program tested the ability of probe-launched, long-wave, infrared (LWIR) sensors to track reentry vehicles prior to their return to the atmosphere. Five successful DOT launches proved that the LWIR could discriminate, designate, and track a reentry vehicle. They also provided research data on the impact of radar, celestial background, optical chaff penetration aids, and atmospheric conditions on LWIR sensors.[85]

The BMDO had several data collection projects underway in the late 1970s and early 1980s. Experimentation with the LWIR continued in the Optical Aircraft Measurements Program (OAMP). An LWIR sensor, to collect target signature data, was placed on a modified C-135B aircraft. In October 1983, the BMDO's System

Technology Program, building upon DOT and OAMP, received permission from Mr. James Ambrose, the Under Secretary of the Army, to proceed with the Airborne Optical Adjunct (AOA). The AOA was planned "to experimentally investigate the technical feasibility of using airborne optical sensors for detecting, tracking and discriminating ballistic missile reentry vehicles and handing over trajectory data to ground-based radars."[86] It was also to demonstrate a multi-mission airborne threat acquisition system.[87] The program involved two sensors and on-board data processing capable of handling a large threat. Even though funding restrictions reduced the number of sensors from two to one, a five-year contract was awarded to Boeing Aerospace Company in July 1984.[88] The AOA would be continued with DoD funding under the Strategic Defense Initiative (SDI).

The Advanced Ballistic Missile Defense Agency (ABMDA)-Huntsville began a study in 1970 to define requirements for a shipboard phased-array radar and by 1979 the design was in its concept definition phase. The COBRA JUDY, a shipborne signature collection system housed aboard the USNS Observation Island, consisted of an S-band phased array and an X-Band dish radar. COBRA JUDY was operational by 1983.[89]

In the late 1970s and early 1980s, President James E. Carter's administration emphasized investigation into Directed Energy Weapons (DEW). In conjunction with this policy, Secretary of Defense Harold R. Brown directed the services to emphasize the use of lasers in space.[90] The BMDATC studied several types of lasers, including chemical and high energy. The BMDO also established an office to "validate, through experimentation, scalable technology for the ground elements of a free electron laser system capable of boost intercept of strategic missiles."[91]

The Ballistic Missile Defense Advanced Technology Center (BMDATC) explored a wide variety of other technologies. Among these were nuclear hardening and sensors. The endoatmospheric nonnuclear kill interceptor technology was also under study by that time. In another field, ladar (laser radar) sensor technology offered the potential for high accuracy and resolution because of its short wave lengths and high power capabilities. The BMDATC, in a related area, investigated more powerful and cheaper radar components, such as microwave power semiconductors used in the phased-array radar. In addition, researchers studied millimeter wave integrated circuit technology and electro-optical signal processors that provided an analytic data base.[92]

Traditional interceptor technology was taken to new dimensions in the 1970s and 1980s. The first ABM interceptors were tipped with nuclear warheads and, when detonated, contaminated the atmosphere and generated an electromagnetic pulse which disrupted electronic systems.[93] New knowledge of these hazards spurred concerns among the general public and the scientific community. One of the most successful projects since Safeguard was the Homing Overlay Experiment (HOE). The HOE proved that an exoatmospheric intercept of an ICBM mock reentry vehicle could be achieved, by using a long-wavelength infrared optical homing sensor and a nonnuclear kill mechanism.[94] During four test flights at KMR, the HOE was pitted against Minuteman I missiles launched from the Western Space and Missile Center at Vandenberg Air Force Base, California. On June 10, 1984, the HOE intercepted a non-nuclear, exoatmospheric reentry vehicle, thereby demonstrating that it was possible to "hit a bullet with a bullet."[95]

D. STRATEGIC DEFENSE INITIATIVE

A new era in ABM began on March 23, 1983, when President Ronald Reagan announced his concept for the Strategic Defense Initiative (SDI), popularly known as "Star Wars." The goal for the SDI was "to create a nationwide defense shield against ballistic missiles that would make nuclear weapons impotent and obsolete."[96] The concept was not always well received as opponents argued that the Reagan administration was "ambiguous" in its goals and relied heavily on "exotic" technologies.[97] Nevertheless, in 1984, President Reagan created the Strategic Defense Initiative Organization (SDIO).

The SDIO was structured as an independent defense agency with its Director reporting to the Secretary of Defense. The organization had the responsibility to direct and manage research associated with surveillance, acquisition, tracking and kill assessment; directed energy weapons and kinetic energy weapons technologies; and survivability, lethality, and key technologies (SLKT).[98] The SDI management focused its initial efforts on three tasks: ensuring continuity of relevant programs, tailoring programs to fit the needs of the SDI, and initiating new programs to expand and accelerate the pre-SDI effort in BMD. The overall goal was to provide the technical knowledge necessary to support an informed decision, in the early 1990s, on development and deployment of an ABM system for the United States and its allies.

The Army's 24 years of ABM experience was the foundation for SDIO. It allowed the SDIO to protect the technology base, increase the emphasis on proof-of-feasibility experiments with increased investment in high risk, high payoff approaches, and continue examining multi-layered defense.[99]

During this period, another important interceptor program was the Small Radar Homing Intercept Technology (SRHIT). Its purpose was to explore guidance and control technology to expand upon our ability to conduct nonnuclear kills of strategic nuclear missiles within the atmosphere. The SRHIT (later renamed the Flexible Lightweight Agile Guided Experiment [FLAGE]) was steered by hundreds of small rocket motors arrayed in a band around the forward part of its body. The experiments tested the accuracy achievable with a highly maneuverable homing flight vehicle.[100]

In the early 1980s, studies continued on a number of other emerging technologies. The staff of the BMDATC investigated optics, optical signatures and laser effects, sensors and laser effects; sensor and laser devices; nuclear hardening; optical sensor evaluation, and field measurements. The BMDATC founded and managed the BMD Advanced Research Center (ARC) in Huntsville, Alabama, the focal point for advanced BMD data processing technology research. The ARC housed several computer systems and, to the present day, is used for computer research and simulation studies. The BMDATC also addressed improvements in computer software engineering.[101]

The 1980s also saw further exploration of radar technology. On July 1, 1984, the BMDO established the BMD Radar Project Office, later known as the Terminal Imaging Radar (TIR) Project Office.[102] Its aim was to investigate a follow-on to the radar function of the LoAD/Sentry program. The TIR, a terminal defense radar, used a distributed data processor and associated hardware to acquire, track, and perform high altitude discrimination. Its ability to receive data from the AOA illustrates the improved inter connectivity of sensor systems.

The TIR Project Office, which later became the Ground Based Radar (GBR) Project Office, awarded a contract to Raytheon to integrate and manage a terminal defense program. This program consisted of a terminal defense radar, a distributed data processor, and associated software. The contract was later redirected to a terminal radar in line with the goals of the newly created SDIO. On June 20, 1984, SDIO approved a recommendation that GBR become one of these programs. The GBR project was to validate the ability to measure the phenomenology necessary to discriminate multiple targets in real time at high endoatmospheric altitude, using a ground-based, X-band phased-array radar.[103]

A 1983 BMDO study on high altitude defense resulted in the establishment of the Exoatmospheric Reentry-vehicle Interceptor Subsystem (ERIS) Project Office. The ERIS project was "to develop and demonstrate an integrated interceptor technology for a nonnuclear midcourse defense system."[104] The HOE project had produced system and technological information that would support the ERIS project. The ERIS project was later incorporated into the projects supported by the SDIO.

Also, in 1983, a BMDO high altitude study supported the establishment of a project office for a High Endoatmospheric Defense Interceptor (HEDI) in October 1984. HEDI had a direct technological lineage with LoAD. The goal was to develop a nonnuclear interceptor to operate in the upper levels of the atmosphere in conjunction with the ground based radar.[105]

E. THE STRATEGIC DEFENSE COMMAND AND BEYOND: 1986-1992

In the period since 1986, the world has seen many changes. The Berlin Wall, dividing Communist East from Democratic West, has fallen, resulting in a united Germany. Other Soviet block countries have followed suit and elected non-communist leadership. Even President Ronald Reagan's "Evil Empire", the Soviet Union, has disintegrated into its component parts, thus leaving the United States as the sole so-called "super power".

Despite the end of the traditional Cold War enemies of the United States, a threat still exists. In 1990 and 1991, the world focused its attention on the activities of Saddam Hussein, President of Iraq. During the subsequent Gulf War, the Scud missile was recognized as a new threat in the ballistic missile arsenal. A 1992 study on BMD proliferation found that "thirteen countries have produced or [are] in the process of producing" long range ballistic missiles.[106] This threat is spreading. The Scud has been used repeatedly in the current (1994) war in Yemen. In addition, North Korea's recent refusal to allow international inspections of their nuclear facilities and Pakistan's efforts to attain a nuclear arsenal illustrate the continuation of an old threat - nuclear missiles.

In May 1993, the SDIO was renamed the Ballistic Missile Defense Organization (BMDO). At the same time, it was announced that the new organization would report to the Under Secretary of Defense for Acquisition and Technology rather than directly to the Secretary of Defense. This change reflects the death of "Star Wars", as the attention of the BMDO strictly focuses on the capabilities of ground-based systems.

The evolution of the ballistic missile defense continues. The mission, however, is virtually unchanged since the creation of this organization in 1955--to conduct a research and development program designed to counteract the threat of enemy missiles against the nation and the soldier in the field.

IV. STANLEY R. MICKELSEN SAFEGUARD COMPLEX

A. INTRODUCTION

Safeguard was truly a remarkable set of accomplishments. Politically, it reflected the impact of being produced by a democratic nation. The very size and location of the Safeguard system could be viewed as a compromise welded in open political debate. As noted earlier, the Safeguard funding and deployment issues were made against a background of widely publicized, hotly debated issues. This during a time when daily our attention was drawn to events in the Vietnam Conflict. Congressional testimony by Secretary of Defense Melvin R. Laird on May 22, 1969, provided telling reasons to implement Safeguard. He listed clearly the Soviet threat as well as the possibility of Chinese ICBM deployment. He reminded Congress that the Russians were building their own antiballistic missile system - the mutually assured destruction theory had not deterred them from proceeding with developing an ABM system for their capitol city.[107]

The points of view about Safeguard and ABM defense varied widely. Congressional testimony by Ambassador Gerard Smith (chief U.S. negotiator) after the 1972 ABM Treaty on the effect militarily on size of missile fields on Safeguard reflected the divergence of views:

> [Senator Henry Jackson Democrat-state of Washington] Senator Jackson: Why in your view, did the Soviet Union insist on limiting the number of interceptors in the US ABM system at Grand Forks to only 100?
>
> [Ambassador Gerard Smith] Mr. Smith: The Soviets did not insist on that. We proposed it and they accepted it. We never had any substantial difference in numbers. At one time there was a very slightly higher number suggested, but the figure that we were shooting for was a figure to keep ABM deployment to a low level. This seemed a reasonably low figure. It is about the level that was projected for the Grand Forks deployment and, therefore, this was not a Soviet proposal.
>
> Senator Jackson: Why did we propose such a low number when we know or should know that it would be totally inadequate for the defense of Minuteman: You see, I would have argued for zero ABM, instead of an ineffective ABM.
>
> Mr. Smith: I am glad to hear you say that because I personally share your view about zero. It seems to me, in the future that is not ruled out, and I hope I can count on your backing for such a proposal. But the conclusion was that it would be better to have a small system at this time, while the offensive missiles were not under a definitive limitation, than to have zero. The number 100 seemed to be a figure that was consistent with the concept of arms control.

> If we had proposed 500 or 600 or 1000, I think it would have looked very unlike arms control but instead an arms buildup.[108]

Despite Senator Jackson's displeasure with the limited number of missiles allowed (only 100), Safeguard deployment proceeded on schedule. Scientists, engineers, and computer specialists raced against the clock to produce data processors, systems that could support the huge radars and control the missile systems also. Safeguard brought about developments in software by creating demands that could not be met by then-current technology. Tests of the missiles themselves continued as well as necessary planning for the operation and maintenance of the entire complex.

Following a decade of technological development and system tests, a single Safeguard ABM site was authorized by Congress to be constructed near Nekoma, North Dakota, to defend Minuteman ICBMs based near Grand Forks, North Dakota. Construction of the Stanley R. Mickelsen Safeguard Complex (SRMSC) began in April 1970 and involved a monumental effort in planning and coordination of personnel recruitment, training, and scheduling as well as materials acquisition, storage, and transfers on site. While working with advanced technologies requiring materials and construction methods never used previously on this scale, the facility was completed on schedule. The construction effort itself was a significant civil engineering challenge. The construction itself required a large work force which placed extreme demands on the surrounding communities' existing infrastructure. The SRMSC project was the largest single contract awarded by the U.S. Army Corps of Engineers to that date, resulting in a total project cost of $468 million. At the peak of construction during the summer and fall of 1972, approximately 3,200 workers were employed. An extraordinary amount of material was used in constructing SRMSC, to include 714,000 cubic feet of concrete, 27,500 tons of reinforcing steel, and 2,273 miles of wire (not including that required for radars or weaponry). Further complicating construction was the remoteness of the site, and weather extremes that ranged from 100° Fahrenheit (F) temperatures in summer to -40° F temperatures and frequent blizzards in winter. Through all of this adversity, the necessary accommodations were made and work schedules were maintained. The end result was a large complex dedicated to ballistic missile defense.

For higher resolution versions of this photo:

http://srmsc.org/images1/7517b.jpg (medium)
http://srmsc.org/images1/7517c.jpg (large)

The only Safeguard deployment was named for Lieutenant General Stanley R. Mickelsen (B. 1895 - D. 1966), Former Commanding General (1954-1966) of the U.S. Army Air Defense Command.

Figure 4-1

Photograph showing rebar used in construction

B. FACILITY DESCRIPTION

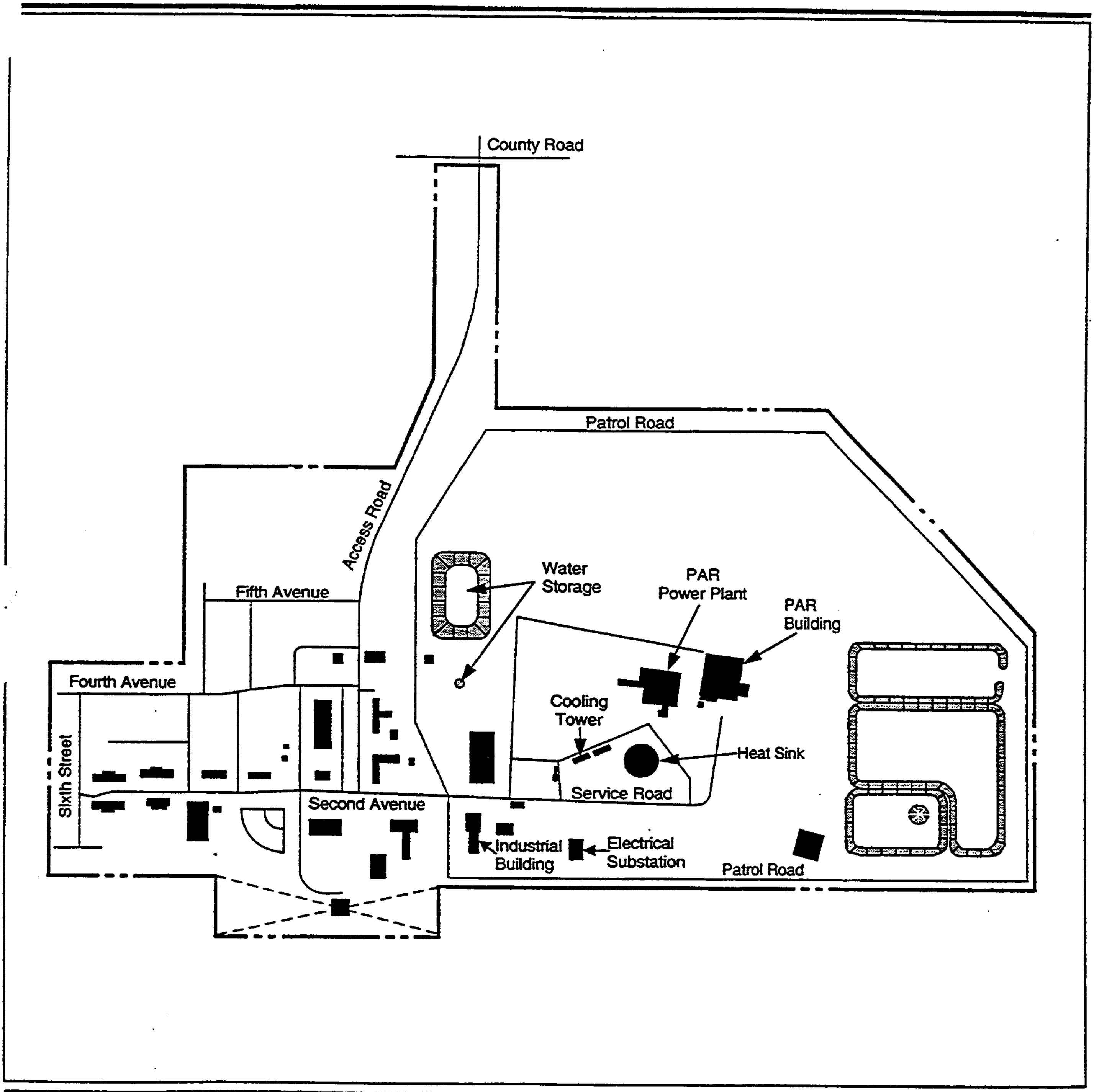
Located in the farm fields of northeastern North Dakota, near the Canadian border, the Safeguard system located at the SRMSC consisted of two types of phased-array radar, the MSR and the PAR; two types of missiles, the Spartan and the Sprint; a high-speed data processing system; and a communications network which tied the components together into an integrated weapons system allowing personnel to control the radars and conduct engagement planning and execution. Both the PAR and MSR sites were considered small, self-contained communities. The four Remote Sprint Launch (RSL) sites, clustered about the MSR at varying distances, were manned by personnel garrisoned at the MSR site. As the radar must be close to the point where the missile comes into the atmosphere and the response time was short, an MSR and Sprint site could protect an area only a few tens of kilometers across and had to be located near that area. The Sprint defended both the radars and nearby retaliatory Minuteman missile fields.

1. FACILITY DESIGN CONSIDERATIONS

The functions and relative locations of the Safeguard facilities necessitated three distinctly different design approaches. As mentioned earlier, certain facilities had to be hardened in order to withstand the shock waves of nuclear weaponry. On the other hand, some facilities only had to be hardened to the extent that, under nuclear attack, their components would not form debris that would restrict or interfere with tactical operations. The remaining facilities were of conventional construction.[109]

2. PERIMETER ACQUISITION RADAR FACILITY

The Perimeter Acquisition Radar (PAR) was the long-range eye of the system with a detection range of well over 1,610 km (1,000 mi) which was required for surveillance, detection, and tracking of multiple targets for Spartan missile intercept (see Figure 4-2 for complex plan). This 279 acre site is 145 km (90 mi) northwest of Grand



EXPLANATION

---- Base Boundary

60 0 60 120 Meters

200 0 200 400 Feet

Perimeter Acquisition Radar Complex Site Layout

Stanley R. Mickelsen
Safeguard Complex

Figure 4-2

gr/SRMSC/017-03/02/95

Forks and 39 km (24 mi) east of Langdon, North Dakota. The PAR faced northern ICBM threat corridors so as to provide surveillance over the polar region. It was located as close to the northern border of the United States as feasible.[110] To withstand nuclear blasts and electromagnetic radiation, the radar equipment was mounted in a reinforced concrete structure, the PAR Building (PARB) with a one acre base. The front face of the building supports a somewhat octagonal, 30-meter wide array of 6,888 dipole antenna elements connected to the electronic elements within by some 76,200 m (250,000 ft) of coaxial cable.

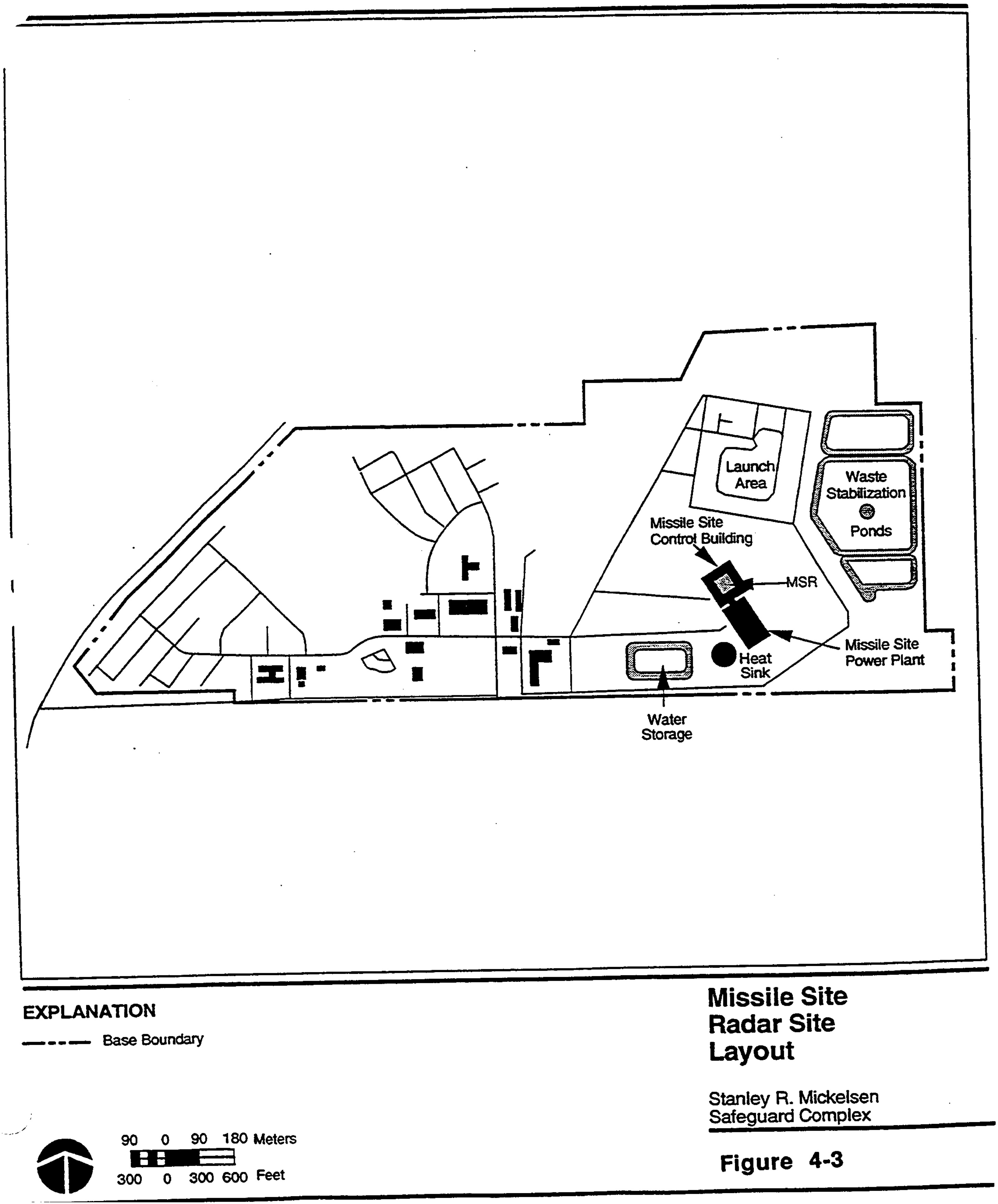
Phased-array radars eliminated the slow, mechanical pointing of antennae, substituting an electronic system for steering radar beams at high speeds. The elements were reported as radiating at 442 MHz with a power of 1.1 kilowatt (kW) each. The PAR had an azimuth coverage of approximately 120^{o}, a resolution less than 1.5 km, and a missile detection range believed to be about 3,300 km (2,071.4 mi).[111] The range considered the fact that the earth is round and, hence, targets can only be detected once they breach the horizon.

Unlike a conventional dish-type radar, whose beam is steered by heavy moving equipment, the PAR beam was directed electronically by its data processor through its antennae. It could change its scan to any point in its coverage area within a few millionths of a second. As with the MSR, the computer that steered the beam could follow several targets simultaneously by ordering a sequence of beams in the appropriate direction, creating a wide, low resolution beam when searching, or a sharp, thin beam when tracking. Target information provided by the PAR was refined with successive scans and was concurrently transmitted to the central logic and control sites, the Safeguard computer housed on the second floor of the MSCB, for use in developing engagement data. The PAR was used to detect, track, and transfer to the MSR the targets at ranges and altitudes suitable for Spartan intercept; it did not plan, select, or guide them. Other targets detected early with trajectories unsuitable for Spartan were delegated to the MSR for all Sprint interceptions.

With an approximate volume of 121,763.1 cubic meters (m^3) (4,300,000 cubic feet [ft^3]) the PARB remains a massive structure. It was, at the time of its completion on 21 August 1972, the largest radar facility in the world and the second tallest structure in North Dakota. The size and shape of the PARB were based primarily on the radar antenna requirements and the equipment that needed to be sheltered. The building contained approximately 155,143 m^2 (167,000 ft^2) of floor area, of which about half was for Weapon System Equipment (WSE), related shops, and storage areas. The other half was for Tactical Support Equipment (TSE) and related support areas. There were no missiles at the PAR site. Other PAR facilities included a partially-buried, earth-mounded power plant connected to the PARB by a 40-meter (130-ft) tunnel; buried fuel tanks; a heat sink; sentry stations; a water storage pond; an industrial building; waste water stabilization ponds; a community center; enlisted men's quarters and dining complex; officers' quarters complex; a dispensary; and a gymnasium.

3. MISSILE SITE RADAR FACILITY

The MSR site housed the shorter range missile control radar and nearly half of the defensive missiles (see Figure 4-3 for complex plan). It was 470 acres in size, 164 km (102 miles northwest of Grand Forks, and 19 km (12 mi) south of Langdon, about one mile from the tiny agrarian town of Nekoma. About 40 km (25 mi) separate the MSR and PAR sites. The radar was of a phased-array type with more than 20,000 antenna elements distributed equally among its faces; its function was locating and tracking incoming ballistic missiles, discriminating between warheads and other objects, providing intercept trajectories, launching and guiding Sprint and Spartan missiles, and using target data acquired from the PAR. A circular phased-array about 4 m (13 ft) in diameter was mounted on each of the four faces of the pyramid, generally pointed toward the north east, north west, south east and south west. It had a detection range of some 1,100 km (690.5 mi). Although the radar could only transmit or receive in one direction at a time from a face, the collaboration of all the faces provided a 360^0 azimuthal coverage. The MSR scanned the complete hemisphere. Its northwest and northeast faces were positioned toward the same ICBM threat corridor scanned by the PAR. These were the only two faces ever activated.[112] In the event of loss of PAR data, the MSR could conduct further surveillance and engage attackers within its capabilities. At the time, the MSR transmitter operated at a higher average power than any other radar in its frequency band.



Missile Site Radar Site Layout

Stanley R. Mickelsen Safeguard Complex

Figure 4-3

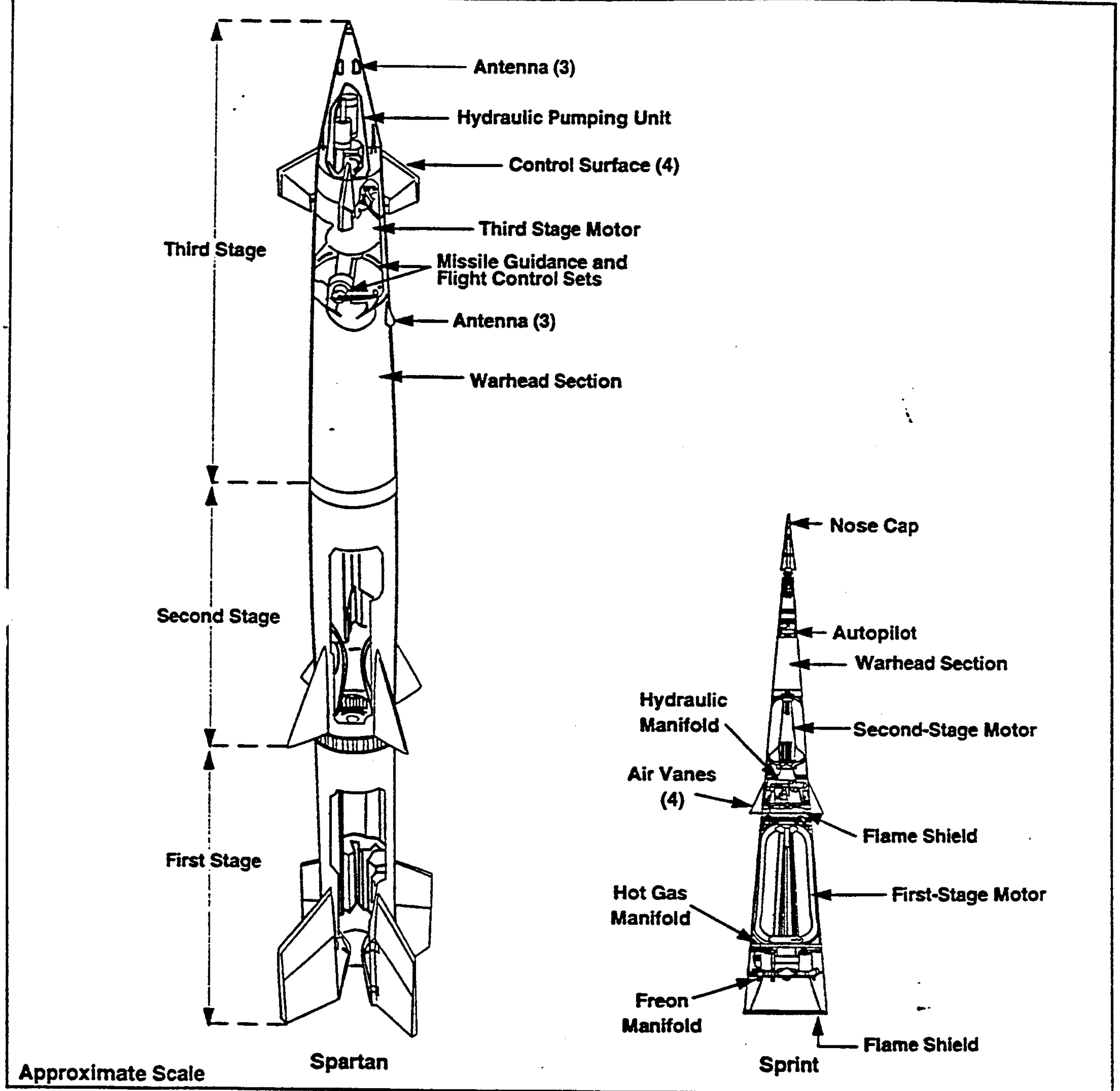
The sensitivity and selectivity of the receiver enabled the detection and discrimination of targets within a background of electrical noise and debris and could detect targets of small cross section at ranges of several hundred miles. This also enabled it to engage an incoming salvo without destroying its own warheads. Also important, in battle conditions, was the fact the MSR could suffer the loss of hundreds of its antenna elements, before its operations would be appreciably deteriorated.

As with the PAR, the radar equipment was housed in the MSCB, a reinforced concrete structure shielded against nuclear electromagnetic radiation. The MSCB was designed to contain all tactical operational control functions associated with surveillance, target acquisition, and Safeguard missile guidance and control. It had approximately 11,798.3 m^2 (127,000 ft^2) of usable floor area, two subterranean main floors, and two above-ground turret floors which housed weapon and tactical support equipment and contained the four phased arrays for providing hemispheric coverage. The underground building was 21.5 m^2 (231 ft^2) and 16 m (53 ft) high. The above-ground exposed antenna turret was 12.6 m^2 (136 ft^2), 24 m (79 ft) in height and had a sloping angle of 56 degrees. As a whole, the building looked like a truncated space-age pyramid.

Other MSR site facilities included an associated partially-buried, earth-mounded power plant, a heat sink, fuel storage tanks, two test towers, the Universal Missile Building, the Warhead Handling Building, Sprint and Spartan launch areas, sentry stations, an industrial building, a cooling tower, water storage ponds, waste water stabilization ponds, enlisted men's quarters and dining complex, officers' quarters complex, a community center, a dispensary, a chapel, a gymnasium, outdoor recreational facilities, family housing, and miscellaneous structures.

4. MISSILES

Two types of missiles were to be employed in support of the mission: Spartan and Sprint (see Figures 4-4 and 4-6). The Spartan was the long-range interceptor, a three-stage, 55-foot, solid-propellant missile designed to intercept attacking ballistic missiles at long ranges outside the atmosphere. Each missile was stored in an



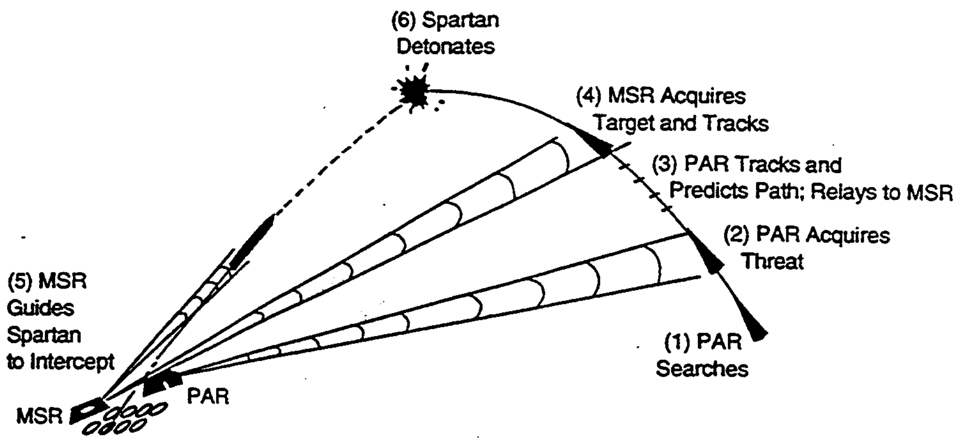
EXPLANATION

Safeguard ABMs

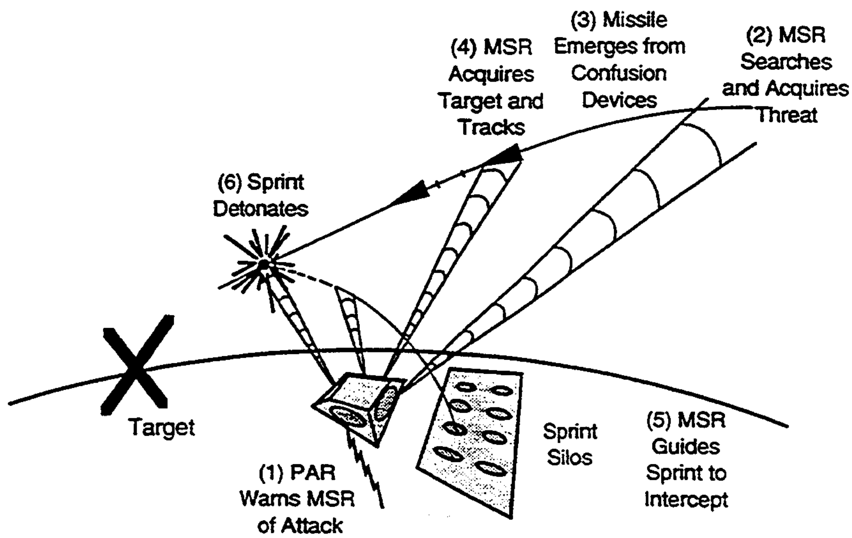
	Spartan	Sprint
Type:	Land-based, silo-launched ABM	Ground-to-air missile interceptor
Guidance:	Radar command	Radar command
Warhead:	Thermonuclear, appx. 5 megatons	Nuclear, low-kiloton range
Missile length:	16.825 meters	8.2 meters
Launch weight:	13,000 kilograms	3,400 kilograms
Max engagement altitude:	About 550 kilometers	40-kilometer range
Range:	644 kilometers	40 kilometers

Figure 4-4

gr/SRMSC/021-05/23/95(L2)



Missile Engagement by Spartan System (Area Defense)



Missile Engagement by Sprint System (Terminal Defense)

Safeguard ABM System Threat Response

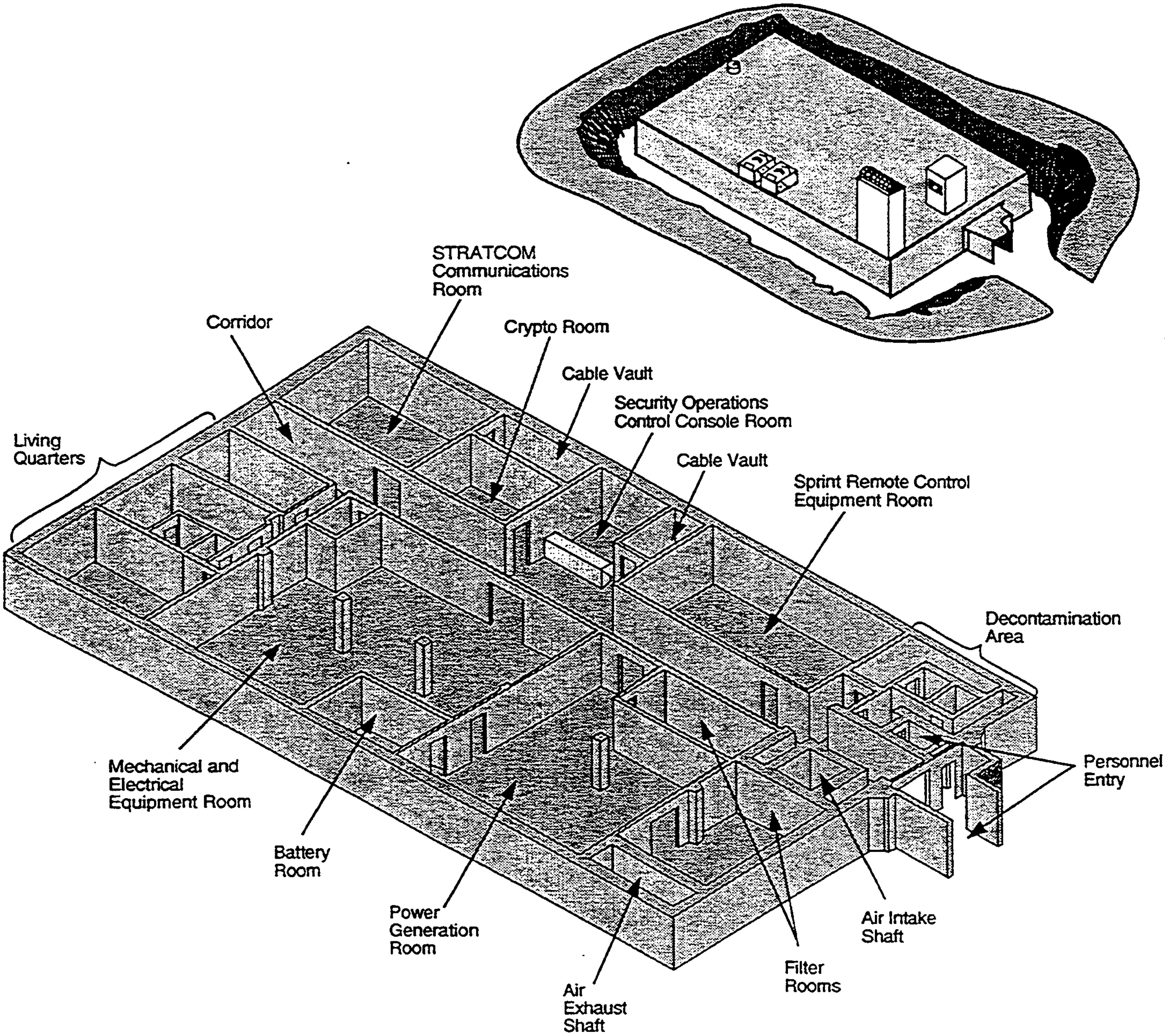
Figure 4-5

underground silo and was guided to its target by the MSR and its data processors. Spartan was capable of maneuvering both in and out of the atmosphere. Its nuclear warhead ejected hot x-rays, deadly to nuclear-armed reentry vehicles. The third stage, which operates outside the atmosphere, could be ignited from the ground on command, entirely automated through the Safeguard data processing system or, when necessary, by manual intervention. The nuclear warhead was equipped with elaborate safety devices to preclude detonation until after it reached a safe altitude.

Short-range interception called for the Sprint missiles. They were to be used for terminal defense (i.e., a concentrated defense against ICBMs that had penetrated the long-range defense or had passed into the atmosphere). These were two-stage, solid-propellant missiles designed to intercept nuclear reentry vehicles at a relatively close range. They used warheads which contained high-energy neutron kill mechanisms, designed to minimize the blast and debris effects in the area of detonation. Sprints were also stored in underground, environmentally controlled cells. Like the Spartans, they could be automatically or manually fired, by launching with a gas-propelled piston through an explosively fragmented cell cover. They had several safety features as well. Once the missile was above the cell and airborne, the booster would ignite. Sprints had an extremely high acceleration, reaching their intercept altitude within seconds, and their design included an ablative heat shield to withstand far more heat and pressure than any previous missile. Indeed, their electronic and mechanical components could sustain acceleration loads exceeding 100gs, and air friction heat to roughly 3,000°F.

5. REMOTE SPRINT LAUNCH SITES

The four RSL sites, located within 32 km (20 mi) of the MSCB, were in the general area of the Minuteman missiles which they were to defend. Each occupied from 36 to 45 acres of land. The sites were composed of sentry stations, heat sinks, fuel storage tanks, waste stabilization ponds, a Sprint missile launch area containing 12 to 16 launch stations, and a hardened, buried, reinforced-concrete Remote Launch Operations Building (RLOB), a single-story structure that controlled and monitored the RSL sites as the signals from the MSCB directed (see



Remote launch operations building

Remote Launch Operations Building

Figure 4-6

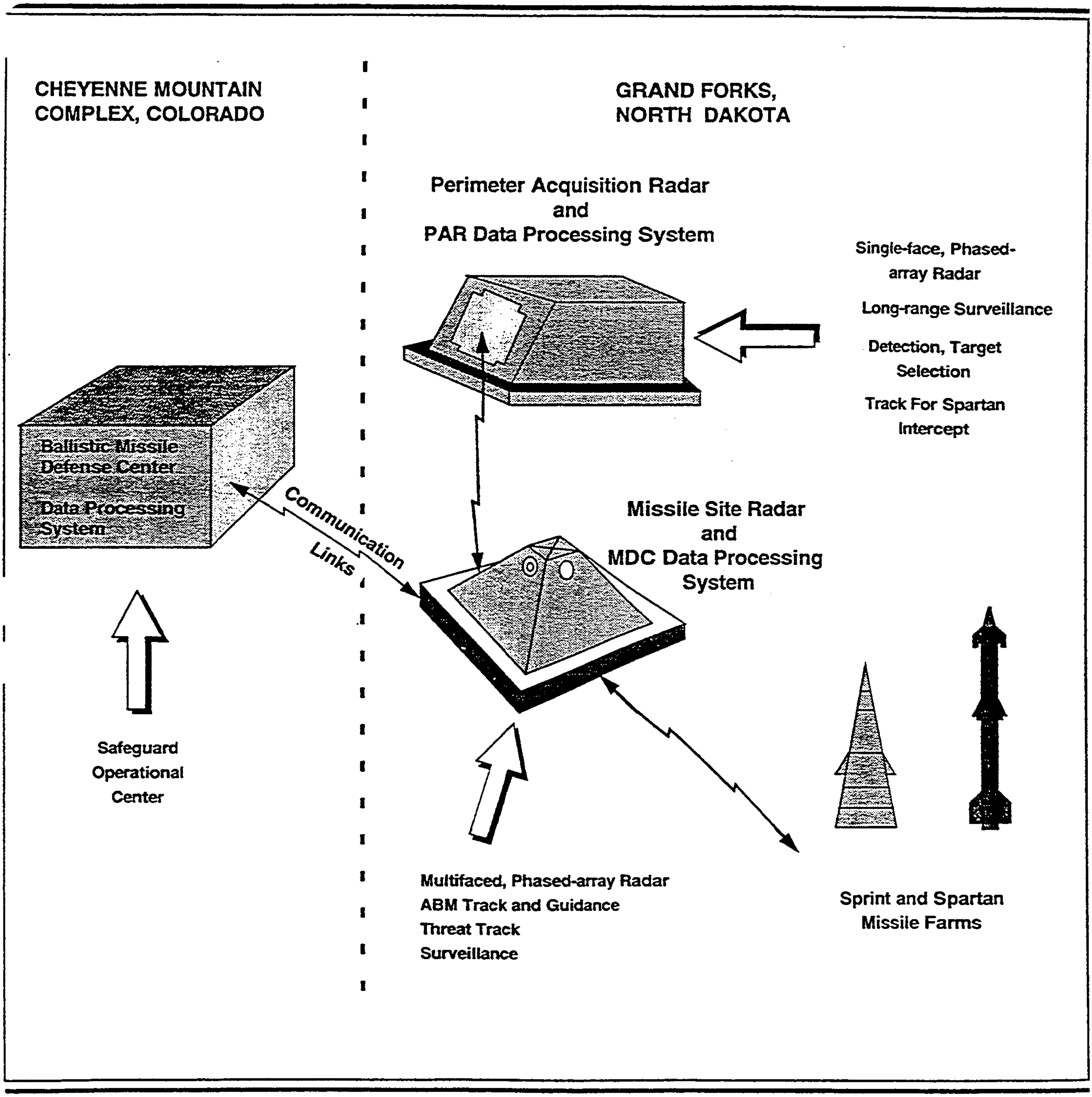
Figure 4-6). The approximate exterior dimensions were 43 by 24 m (142 by 80 ft) around and 5 m (17 ft) high. The RLOB also had an access tunnel, 1 m^2 (11 ft^2) and 27.4 m (90 ft) long.

6. BALLISTIC MISSILE DEFENSE CENTER (BMDC)

The BMDC was the only component of the SRMSC that was not located in North Dakota. The BMDC, located in Colorado, interfaced Safeguard and North American Air Defense (NORAD)/Continental Air Defense Command (CONAD) operations. As such, the BMDC monitored the operations of the SRMSC. It was the highest echelon of command and control in the Safeguard system, allowing the Commander-in-Chief of CONAD (CINCONAD) to exercise operational command and provide the capability of the Commanding General of the Army Air Defense Command to exercise command and technical supervision of the force employing the Safeguard weapons system (see Figure 3-2). BMDC interfaced with the CONAD Combat Operations Center (COC) to provide the means for the CINCONAD to exercise operational control of Safeguard, to provide SRMSC with attack warning and other data concerning BMD information generated outside of the Safeguard system, and to perform other necessary functions. Command and control personnel could observe and analyze BMD operations and intervene as directed to modify the automatic weapon system response.

The BMDC was housed in one of eleven steel buildings constructed in the 4.5 acres of tunnels in the NORAD/CONAD complex. The building was 39 m (128 ft) long, 12.8 m (42 ft) wide, and three stories tall. A power center and mechanical equipment room were situated above the third level. The BMDC was free standing and shock mounted on rows of huge springs made from 7.6-c (3-in) steel rod. The BMDC's walls of 9.7-c (3.8-in) steel plate would protect its electronics against the electromagnetic effects of a nuclear blast.

The BMD Operations Room (BMDOR), located on the first floor of the BMDC, is where the status and operation of the SRMSC were monitored through command and control consoles and four six-foot-square display boards by



Safeguard ABM System

Figure 4-7

Safeguard command and control personnel. Here, too, directions received from CINC of CONAD were transmitted to the complex in North Dakota.

7. DATA PROCESSING SUBSYSTEM

The Data Processing Subsystem (DPS) was located within the PARB, the MSCB, and the BMDC. The DPS acted as the control center for Safeguard, uniting the diverse elements into an integrated system. It accepted data from the radars and other sites, applied system constraints and authorizations, interpreted the information received, performed analytical calculations, allocated resources, and generated actions to launch and guide missiles to intercept selected targets. The hardware was composed of digital and analog processing equipment with associated memories, displays, and control equipment. Much of this equipment represented state-of-the-art breakthroughs in hardware design and manufacture. The DPS program development included sophisticated algorithms, program design testing, and extensive simulation of tactical exercises.

C. CONSTRUCTION/ENGINEERING

Initially, construction of Safeguard sites was announced for two locales: near the Grand Forks AFB, where groundbreaking took place on 6 April 1970, and at Malmstrom AFB, where construction began in June. However, as a result of the ABM Treaty, only one ABM site was permitted within a U.S. Minuteman field (the other would protect Washington, DC). Therefore, on 27 May 1972, construction at Malmstrom was abandoned by order of the Secretary of Defense. Deployment was to be narrowed further, when on 3 July 1974, the protocol to the treaty limited the U.S. and the USSR to one site only.

By this point, the North Dakota site was 85-percent complete and mostly on schedule. The terminal date of construction, otherwise known as the Beneficial Occupancy Date (BOD), was the major goal of the construction schedule. The BOD had been established as August 21, 1972 for the PARB and 1 January 1973 for the MSCB;

both dates were met. Although the signing of the ABM Treaty relieved much of the deadline pressure, the timely fulfillment of these commitments for Grand Forks represented one of the major objectives during the period of transition that followed the treaty.

Preparation for the turn-over of the sites to the Army Air Defense Command was underway in September 1971, when the announcement was made of the creation of the first two units to man Safeguard installations. The first unit was the Army Safeguard Command, Grand Forks, with an authorized strength of 784 personnel. This number consisted of 62 officers, 22 warrant officers, 432 enlisted men, and 168 civilians. Their mission was to "defend the continental United States from a ballistic missile attack; specifically, to establish an area defense for existing retaliatory missile sites." This unit would man the MSR and be the command element for the Grand Forks Safeguard detachment.

The second unit, the Army Surveillance Battalion, Grand Forks, was assigned to the PAR with the mission of providing long-range surveillance and early warning of ballistic missile attack against the CONUS. The battalion's authorized strength of 401 called for 41 officers, 14 warrant officers, 209 enlisted men, and 136 civilians.

The initial alignment of the PAR radar was completed by August 1973. During this month, the first satellite track and the first radio-star track were successfully accomplished. The Equipment Readiness Date, indicating the completion of the construction phase, was October 10, 1974. Initial operating capability was reached by April 1, 1975. Full Safeguard operational capability was reached on October 1, 1975. The SRMSC was the only operational ABM facility ever completed in the United States.

1. METHODS

A primary objective of the Safeguard design was the standardization of components and construction details within and between the facilities. Out of a total of 10,098 separate pre-manufactured components, the standardization effort resulted in only 1,703 different makes and models of these components. As a consequence of this standardization effort, a significant portion of the components was purchased by the Government under competitive bidding procedures and furnished to the construction contractor for installation. Several benefits resulted from this approach, the first being initial savings due to direct procurement of components from vendors. A second cost savings came from the reduction in storage of repair parts, training documentation, special tools, and test equipment. Benefits were also realized from increased efficiency and expedited construction and material procurement. Ultimately, the ten-year life-cycle cost savings were estimated at $38 million.[113]

2. SCHEDULES

The priorities of the Safeguard program dictated a rigorous construction schedule with the shortest possible time allocated for completion of the building shells and installation of their tactical support equipment (air conditioning, electrical lines, cooling system, utilities, etc.). By the BOD, the Weapon System Contractor (WSC) had to be admitted to begin installation of the radars and attendant components. In order to meet the BOD, interim goals had to be on schedule. Intermediate deadlines were most important during the 1970 construction season; the first and second levels of the PARB and MSCB had to be roofed before the onset of severe cold made outside work impossible.[114] The PARB was to be roofed by September 1971 and ready for the WSC in August 1972. The MSRB was to be roofed by October 1971 and ready for the WSC a few months later. Thus, about two and one-half to three years were allowed for the majority of the construction.

The Area Engineer and his staff were responsible for ensuring that construction proceeded on schedule. Colonel Roy Beatty, previously Area Engineer for the Boston Sentinel project, was named Area Engineer for Safeguard.

Colonel Beatty did not begin working until after ground breaking, but a temporary area office was opened in Langdon on the day after his appointment. This area office at first occupied one room in the Langdon Masonic Temple, but later expanded to take in all of the basement and the entire first floor. The first Civil Service examinations for staffing the office were administered at the Post Office in Devils Lake, North Dakota, in January 1970, and permanent clerical personnel arrived soon thereafter. The office transferred its operations to the PAR site when an office building was completed there during the summer of 1970.[115]

3. RESTRICTIONS

The remoteness of the construction sites and the hostile climate in North Dakota required strict scheduling to ensure that work was completed within the time frame established by the SAFSCOM. Weather extremes ranged from 38°C (100°F) to -40°C (-40°F) with frequent ground blizzards. The result was a very short construction season and mandatory enclosed work areas. Every effort, including sustained two-shift operations, was made to maximize use of long, warm, dry days to complete steel and concrete work as rapidly as possible. A three-shift schedule using artificial lights was employed to hasten the work, and the contractor's work force increased from 340 men at the beginning of June to 1,545 by the first of August.

Another factor greatly affecting Safeguard scheduling was the highway load restrictions in effect at the time. In early spring, during the April/May ground thaw, the North Dakota highways would become increasingly susceptible to damage from heavy construction loads that were being transported to various worksites. To minimize this damage, the state imposed load restrictions for about 60 days. This restraint had to be considered when scheduling construction activity during the second quarter of the year.

4. MATERIALS

An extraordinary amount of material was used in constructing the Safeguard facilities. The PARB, MSRB, and their power plants required over 20,218 m^3 (714,000 ft^3) of concrete and over 25,000,000 kilograms (27,500 tons) of reinforcing steel. Also used for construction were 3,658 km (2,273 mi) of wire (not including radar or weaponry), 20 million kilograms (44 million pounds) of rebar, 1,207 km (750 mi) of conduit, 64 km (40 mi) of piping, and 621,418 kilograms (685 tons) of duct material.[116] Ten wells provided water for the coolant system through a 93-kilometer (58-mile) waterline capable of delivering 3,785 liters (1,000 gallons) of water per minute as required for the project.[117]

In late 1967, a search began for an adequate water supply of water for the planned project; a supply that would not impinge the limited resources of the local small communities. The result was the development, by late 1968, of a well field in the Fordville aquifer, a twenty square mile aquifer located some four miles north of the community of Fordville in Walsh county, some 33 air miles south east of the MSR site. The water system sometimes referred to as the "7th: SRMSC site, consists of ten noncontiguous wells scattered over 3.35 miles (each wellhead containing about a quarter-acre of property) and 3 booster pumping stations with their associated 100,000 gallon storage tanks, (each station comprising over an acre of land). This was the water source supply for the coolant system through a 93 km(58 mi) waterline capable of delivering 3,785 liters (1,000 gallons) of water per minute as required for the project.

5. PERSONNEL

The ABM project was the largest single contract award given by the U.S. Army Corps of Engineers at the time, resulting in a total project cost of $468 million. A competitive bidding process yielded a low bid of $137,858,850 by Morrison-Knudsen & Associates (M-KA), a team consisting of Morrison-Knudsen, Inc., Peter Kiewit Sons' Company, Fischbach & Moore, Inc., and C.H. Leavell & Co.

The ABM construction work force reached 2,200 by October of 1970 and, at the peak of construction during the summer and fall of 1972, about 3,200 persons were employed. By the end of June 1973, the authorized civilian strength had been reduced to 1,105. The overall support personnel was reduced to 58 percent of the manning level authorized prior to the signing of the ABM Treaty. Construction was completed early in 1974 and the facility was turned over to an operating work force of about 2,000 (of which 600 were military personnel) for a training and testing period. The operating work force was expected to stabilize at about 1,300 workers by mid-1975.[118]

6. LOCAL ECONOMICS

The local economy began to feel the effects of Safeguard construction in April 1970, with the arrival of project employees and their dependents. Up to the initial period of construction this region had experienced a decline in population. In many ways the mass influx was overwhelming.

The tight schedule of the Safeguard project gave the local communities less lead time for planning than was typical for a non- defense project. In order to prepare the communities, the Safeguard Command prepared a report indicating the projected population increases for each community and assessing the adequacy of existing facilities to meet the increased demands. Once construction was actually underway a revised, more accurate version was provided. Moreover, an Area Resource and Development agent was assigned to the area from 1970 through 1974 to serve as a technical assistant and a liaison between the Safeguard command and local community leaders.

Langdon is a prime example of the effects of the ABM project on a community. The economy of the Langdon area was greatly stimulated by the impact of the construction, and private business activity during this period expanded accordingly. Employment increased by 47.1 percent from 1969 to 1973 in Cavalier County, compared to only an 8.3 percent increase for North Dakota as a whole. From 1969 to 1971 total sales for Langdon businesses increased by 40.2 percent.

Employment increased 22.3 percent in Pembina County over the same period, while 10.4 and 14.5 percent increases were experienced in Walsh and Ramsey counties, respectively. Personal income in Cavalier County increased 202 percent between 1969 and 1972, compared to 27 percent for the entire state during the same period. After 1970, approximately 70 new businesses opened in the region and 45 expanded. Two new banks were opened in Langdon, and private sector utility systems were greatly expanded.[119]

Due to population increases, local communities experienced an increase in their tax base; however, the tax base did not increase at the same rate as civil growth. Two factors contributed to this discrepancy. First, because the ABM installation itself was Federal property, it was not subject to taxation. Second, the relocated workers lived largely in mobile homes, a negligible addition to the tax structure, or they resided in exempt government quarters.

With a rapidly growing citizenry and such a slowly increasing tax base, the communities affected by the project could have experienced severe financial difficulties. However, these problems were eased considerably by Federal impact payments. Also, increased sales volumes not only benefitted local merchants, but may have single-handedly saved some "main street" businesses from closure.[120]

7. HOUSING SHORTAGES

ABM workers settled primarily in two small towns near the construction sites -- Langdon and Cavalier. As Langdon was centrally located in relation to the various sites, it received the bulk of the population influx. Langdon's population nearly doubled in three years, rising from 2,182 residents in 1970 to 3,957 by 1973 -- an average annual growth rate of 22 percent per year. As a result, Langdon and the surrounding area experienced many of the problems associated with rapid population growth.

Housing shortages resulted in issuance of building permits for 72 single unit homes and over 270 rental units between 1971 and 1975. Nevertheless, a housing shortage still existed in the Langdon area. Of the workers employed in the project, about 70 percent relocated to the area, creating a need for almost 3,000 additional housing units (including group quarters) in the impact area within a two- to three-year period. Competition for housing caused rental rates to rise substantially for local residents relative to most local residents' income increases.

To offset the sudden growth, Federal impact payments were made to help communities adjust to the new situation. Initially Congress made no provisions for community impact funds, but Senators Young of North Dakota and Mansfield of Montana sponsored new legislation known as "The Young-Mansfield Amendment," which appropriated $14 million to help defray local community costs resulting from the construction in the North Dakota and Montana (the eventually canceled Malmstrom site) regions. Although initial payments were not received until March, these Federal funds did much to alleviate the financial burden of the areas most directly affected.

8. PUBLIC UTILITIES

Public utilities had to be upgraded to meet the requirements of the population explosion. This included local water and waste systems which were considerably expanded at a cost of roughly $1.3 million. In Langdon, the extant water mains were extended and a new water tower was constructed; however, due to increased pressures, over one hundred water main breaks occurred in the city's older lines during the winter of 1970-71. The sewer system upgrading was not quite as difficult, as an improved system was already in process prior to the ABM construction period. Solid waste, however, was a problem. The open dump system was replaced by a sanitary landfill. Telephone installations in Langdon soared. There was an increase from 4,164 phones in 1968 to 5,934 in 1974, resulting in increased service rates, difficulty in meeting the demand for experienced employees, and a considerable quantity of unpaid bills. Fortunately, the local electric company did not have serious difficulty in meeting the increased electrical demands resulting from the ABM project. Delinquent bills did not pose a major problem as the required deposit was usually sufficient to cover any unpaid bills.[121]

9. SCHOOLS

Constructed for the small, diffused community, the school systems required extensive modification to sustain the increase in enrollment. In the first year of the construction project alone, 637 children of ABM workers poured into the area's school systems. About 50 percent of these students were in the Langdon school system, causing overcrowded school facilities. During the early ABM project years, overcrowding and turnover were common problems. Other affected school systems were Grand Forks, Cavalier, Lakota, Edmore, and Nekoma. Enrollment for the Nekoma school system increased 155 percent (124 students) during the project. Impact payments of $2.3 million were made to affected communities for educational purposes, with Langdon receiving construction grants of $537,388. It was noted by local school administrators that despite the influx of students, truancy and dropout rates did not appreciably change. New children were easily integrated into the student body, and four of Langdon's five honor students in the 1974 graduating class were from families employed by the ABM project.[122]

10. OTHER FACILITIES

Law enforcement personnel and facilities were expanded in response to the ABM project. Federal grants of $71,000 and $104,000 allowed for the enlargement of the law enforcement staffs in Langdon and in Cavalier County, respectively. Overall funding for northeastern North Dakota totaled $481,000 between 1 January 1971 and 31 March 1974. Public opinion and police data provide conflicting reports as to increased criminal activity due to Safeguard construction. Police records in Cavalier and Grafton indicate no increase, but Langdon police data revealed that crime rates due to drug and alcohol violations, shoplifting, and burglaries did multiply appreciably.

Medical resources also underwent modifications. Primarily as a result of Federal impact funds (98 percent of the $449,180 cost), Cavalier County Memorial Hospital (CCMH) capacity was increased from 28 to 38 beds. Pembina County Hospital also expanded, but only 15 percent was covered by Federal funding. The augmented services were fortuitous, for the CCMH administrator noted an increase in industrial and traffic accidents associated with the project, and Langdon also experienced an increase in venereal disease. Furthermore, numerous problems with mental depression among migrant wives were reported by Langdon doctors. It appeared that the major causes of depression were a lack of extra curricular and social interaction activities and the extremely long, harsh cold winters which left many homebound.

The Safeguard construction initially strained local medical facilities, but many reported medical services of a higher caliber as the result of added staff and capacity. Those that did feel the medical support deteriorated complained primarily about doctor-to-patient ratios and long waits for appointments.

11. TRANSPORTATION NETWORKS

The Safeguard project made heavy demands on the area's transportation network, especially during the actual period of construction. The region between Grand Forks and Langdon was well supplied with railroads, but the line nearest the PAR site was 21 km (13 mi) away and had no direct delivery routes to the area. Additionally, roads linking the railroads to the PAR and MSR sites were two-lane, unsurfaced roads intended for light farm traffic. The size and number of vehicles supporting Safeguard construction would severely damage these rural roads, which were also affected by bitter cold which eroded the surfaces through splitting and surface freezing.[123]

Consequently, major street and highway construction and repair projects were undertaken. Defense Access Funds allowed improvement of any roads providing a means of admission to the worksites. By 1974, Federal support totaling roughly $700,000 aided in repairing damage by heavy construction truck traffic on Langdon roads, and an impact grant of $115,000 was provided for the streets of Nekoma. By March 31, 1974, the total street and highway repair costs had reached $11.6 million, of which 74 percent was Federal funds. State and Federal funding also covered half of the construction costs for a new airport in Langdon in 1969. This was followed in 1974 with a $134,000 Federal airport grant for general improvements and the addition of a much needed parking apron and taxiway.[124]

D. LOCAL, REGIONAL, AND NATIONAL ATTITUDES

1. LOCAL

The far-reaching influence of an ABM installation was not lost on the contemporary news media; it seemed that the furor would engulf the entire country. But even so, skeptics chose to keep the North Dakota news scene in the headlines, giving the foes of Safeguard a more basic, personal approach. One of the most critical articles appeared in The Nation in 1969:

> When the ABM was moved from the cities to the wide-open spaces, the hope of its sponsors was that opposition would wither away. Indeed, in some sections, the prospect of an influx of mammoth construction funds overrode all other considerations. Not in Fargo, North Dakota, however. At Fargo, population 50,000, and regarded as a slightly overgrown country town, several hundred citizens gathered to hear Rep. George Brown of California, a member of the Science and Astronautics committee, and Dr. George Stanford, a nuclear physicist attached to the Argonne National Laboratory in Chicago, deliver scathing attacks on Safeguard. The meeting adopted a policy statement to the effect that fallout over the wheatlands was no more acceptable than fallout over the cities . . . North Dakota is said to have the highest concentration of nuclear weaponry per acre of any state: evidently some of the citizens want no more of it.[125]

In retrospect, after SRMSC was nearly in full swing, opinions softened somewhat. In a North Dakota State University interview poll taken in 1974 of both long-time residents, newcomers, and local officials, four out of five respondents indicated that the overall effect of the Safeguard project had been beneficial in terms of the augmentation of business activity and employment opportunities, whereas only one in ten thought the effects were detrimental. When asked if they felt they were personally better or worse off as a result of the ABM impact, more than half believed the changes brought about by the project were beneficial. Only one in six insisted that the effects had been detrimental to their way of living. For instance, residents and community leaders felt that failure to provide adequate housing in the short run caused housing costs and rents to increase significantly.

The majority of residents felt the ABM project led to an overall improvement in public services and utilities. Additionally, interviews with Langdon high school students indicated that extracurricular and sports activities had been bolstered and that the new students' talents and skills only served to stimulate their own. At the same time, it should be noted that some students had a difficult time adjusting, due primarily to shortages in equipment and supplies.

The problems of Langdon were best summarized by one resident who, when asked of the impact of the Safeguard system on his town, commented, "The impact on Langdon can be compared to the problems a 180-pound person would have if he woke up one morning weighing 250 pounds."[126]

2. REGIONAL

In the early stages of Safeguard construction, many North Dakotans were not happy at the prospect of an ABM system in their area. Hence, "International ABM Day," an anti-war, anti-ABM event was planned to coincide with Armed Forces Day, 16 May 1970. The Safeguard sites at Grand Forks were obvious protest targets, and the first tangible indication of demonstrations there appeared as a short article in the Fargo, North Dakota, Forum on 19 April 1970. The same announcement spread to the Grand Forks Herald on 21 April and reappeared in several area newspapers and in newscasts after 30 April. By this time, representatives of the "North Dakota Citizens for a Sane Nuclear Policy" and the "North Dakota Clergy and Laymen Concerned," two of the sponsoring groups, were advocating mass demonstrations at Fargo, the Nekoma MSR location, and at the campus of the University of North Dakota at Grand Forks. In early May, organizers announced that some 2,000 people were anticipated from a five-state area, at which point this demonstration could become the "largest political protest ever staged in North

Dakota." Outside of the planting of wheat seeds, musical entertainment, and scheduled appearances by activists, including the notorious "Chicago Seven," officials were unsure as to what path the demonstrations might take.[127]

This anticipated "Festival of Life and Love" was a great matter of aggravation to both the Corps of Engineers and M-KA. The worries centered around the presence of M-KA's huge, costly earthmoving equipment at Nekoma and the possibility that the demonstration might disrupt the construction schedule. Accordingly, as the North Dakota anti-ABM activities took shape, Col. Beatty, representatives of M-KA, and security officers from Huntsville agreed on appropriate measures to preclude obstruction or property damage. Policies directed from the Huntsville Corps of Engineers to the Area Office recommended a cautious approach. They intended to provide for the comfort and freedom of the protesters without hinting at any potential for retribution. Local law enforcement officials were briefed and their assistance was solicited with the understanding that, in order to avoid any hostilities, a bare minimum of visibility was to be maintained. On the site itself, a plot was staked off for the demonstrators to use away from the large foundation excavation. On the plot were plastic sheeting, portable outhouses, and even a flatbed trailer complete with electric power for the use of orators and bands. Around the excavation itself, M-KA placed simple barricades and posted "no-trespassing" signs in the hopes of passive deterrence. Moreover, once it had been determined that North Dakota Governor William Guy would not authorize state resources for the protection of a Federal installation, all mobile equipment was evacuated to an off-site location, and the Saturday construction shift was canceled completely.

Demonstrators began arriving at the Nekoma site before noon on Saturday. According to United States Corps of Engineers' reports, 500 people had assembled on the site by 12:30 pm. No violence erupted, and no arrests were made. The "Festival of Life and Love" in North Dakota proved to be just one of hundreds of similar events across the United States during the time, but state officials had already taken sides. "In a stinging letter to Senator John Stennis, chairman of the Senate Armed Services Committee," said The Nation, "North Dakota Governor William L. Guy repudiated the notion that he should support the ABM program as good for his state's economy. . .Senator Milton Young has given a measure of support to ABM sites in North Dakota, but Senator Quentin Burdick has voiced opposition."[128] Indeed, North Dakota never fully endorsed Safeguard; some welcomed the boon to industry, citing higher salaries and better opportunities, whereas others pointed out the difficulty in meeting employee demands for increased wages.[129]

3. NATIONAL

Throughout the fall of 1968, opposition to the deployment of ABM Sentinel system had steadily grown more extensive and vocal, becoming a significant citizens' movement in the north-central and New England states as well as in some smaller isolated enclaves on the West Coast. The anti-ABM movement especially began to make itself heard after the adjournment of Congress in late October and the election of Richard M. Nixon as President in early November. Prior to this period, anti-ABM activists had been primarily limited to the scientific and academic communities. However, the well-publicized leadership in these circles and general local concerns about Sentinel's potential dangers vis-a-vis its actual worth prompted a spread of opposition to ABM programs.

In Washington, Senator Edward Kennedy maneuvered himself into the midst of the controversy, writing to the Secretary of Defense that Sentinel was technically deficient, dangerously sited, unduly costly, and deleterious to domestic priorities as well as to prospects for an arms agreement with the Soviet Union.[130] This letter fueled a bitter debate in Congress, which resulted in the House Armed Services Committee's threat to cut off approval for Sentinel land acquisition unless the entire ABM plan was reviewed. As a result of the subsequent Presidential review, the Sentinel gave way to what was to become the Safeguard system, but the arguments did not end there. Few issues in American history have been debated so long, so hard, and so seriously in public forums, the media, and Congress as the ultimate authorization of the Safeguard program. Regardless of opposition, though, this hotly contested issue was passed by the narrowest margin in the Senate when it authorized the go-ahead of the system on August 7, 1969, by a 50-50 vote, with Vice President Spiro Agnew casting the deciding vote.[131]

The debate did not stop on the floor of Congress; the Facts on File publication provides an overview of the public outcry at the time. For example, on May 3, 1969, a petition against Safeguard by the "Federal Employees for a Democratic Society" was circulated among Federal employees, collecting approximately 1,500 signatures from nine departments and agencies.[132] The Alliance for Labor Action, composed of the teamsters and auto workers, drafted a request for a deferral of the Safeguard ABM system that same year "on the grounds that it would increase, not U.S. security, but the threat of nuclear war."[133] The following year on 27 June, a Princeton professor of physics, brought into Congress to debunk the pro-Safeguard experts, called the project a "technically makeshift system".[134] Even as late into the construction as 19 January 1972, presidential hopeful George McGovern made ABM a part of his platform, saying that proceeding with Safeguard was the difference between "conservatism and paranoia," and between a "buying what we need" approach and a "wasteful arms race".[135]

In "The ABM Blues," The Nation editor Carey MacWilliams opined "the only true friends it (Safeguard) seems to have are the President, Secretary Laird, and of course, Gerald R. Ford, the House Republican leader." He also cited a meeting at the Massachusetts Institute of Technology, wherein scientist and students took part in a "research stoppage" and listened to scholarly anti-ABM sentiment.[136] Even in Canada, a dispute erupted over Safeguard when it was learned that the Canadian government was never consulted for permission by the United States to fire defensive warheads over Canadian soil.[137] This is not to say that the SRMSC project was universally maligned; there were a great number who saw Safeguard as an important check to Soviet missile advances, both in the military and in the scientific world. Rather, it demonstrates just how important the issue was to the nation and its neighbors as a whole. It also appears, years after the wrath and contention, that in a seemingly "middle-of-the-road" opinion for the time, one source stated: "Even if the complex never sees action, its champions assert, it is worth the cost, if its presence deters Russia from making the test."[138]

E. PHASE-OUT/ABANDONMENT OF THE SRMSC

In an informative 1969 article on Safeguard, a question was posed concerning the mission's fate should arms talks proceed. In the reply the author observes that: "Most likely deployment will be slowed, but not halted."[139] However, This was not the case. In early 1975, there were indications that the SRMSC might be closed and dismantled, and the ABM system found itself embroiled in yet more polemics:

> Even more dangerous is the action now contemplated by the Congress of closing down one ABM site authorized by the SALT I Treaty. . . . Yet Congress is heading toward a unilateral scrapping of this key defense system, already paid for, on the flimsy grounds of saving some operational funds and the fuzzy hope that Soviet restraint will make it unnecessary.[140]

Such predictions proved prescient. Grand Forks had proven too costly to justify continued operation in the face of the Soviet MIRVs; there was also the question of its feasibility, that is, how a system that had worked only in tests would respond in actual battle, short of instigating nuclear war. It was described as a "highly complex machine stretched out over the entire nation."[141] At any rate, it was argued that the effectiveness of one site was questionable and there was, under treaty guidelines, no way to bolster it. Basically, they had proved its potential, but couldn't afford to maintain it.[142]

The MIRVs were part of the technological advances that would have challenged the Safeguard system. Despite the treaty, the Cold War still remained the impetus for continued research and development in both the East and the West. For example, efforts were to continue on addressing effective defense against the MIRVs. While Safeguard used the technological advances developed either for the system itself or from earlier programs, the constant battle to avoid technical obsolescence continued.

Approximately 48 days after the SRMSC was fully operational, the Senate voted to concur with a House decision to close it down. The House's original decision did not provide for the transition period, but the Senate allotted $19 million. Still, FY76 ABM funding was cut drastically, narrowed down by several million dollars.

Furthermore, remaining monies were to be used for the purpose of the "expeditious termination and deactivation of all operations" at Grand Forks, effectively moth balling the system. Funds for the PAR were excluded. The decision to close the SRMSC was made to comply with guidance in Title III of the Operations and Maintenance Section of the FY76 Defense Appropriations Bill, effectively eliminating 433 military and 108 civilian authorized spaces by September 30, 1976.

It was not to be an easy dismantling. In a 1975 editorial in The Nation, Carey MacWilliams observed,

> Safeguard played havoc with the lives and fortunes of the people of Langdon, ND.... 1,500 persons, about a third of Langdon's population, were employed in connection with the ABM. Many others had found work and business opportunities in the influx of capital surrounding the Safeguard's construction. Workers migrated from all over the country for jobs on the missile site. When Safeguard closes... Langdon will be hit by a depression made in Washington.[143]

One Pentagon official, obviously displeased at the turn of events, commented that the House "wanted the system completely torn down and wheat growing at the site." Another feared the collapse of Grand Forks would extend into other areas of BMD and become a "national disaster."[144]

By February 1976, the first rumblings of economic hardships to come in the SRMSC area were being felt. In Cavalier and Pembina counties, unemployment rose to 7.5 and 8.6 percent, respectively. This put both towns above the overall North Dakota rate; up to that time Cavalier had usually been lower. It was thought that these February 1976 rates represented early indications of unemployment associated with Safeguard realignments.[145] There was an approximate loss of $1.3 million in regional procurement, primarily affecting Langdon, Walhalla, and Grand Forks.

There followed a major population loss in the region, whereupon the tax base was severely depleted. Local populations experienced a major drop, as evidenced by the following figures: Langdon, 45%; Elton, 43%; Nekoma, 49%; Osnabrock, 40%; Cavalier, 43%; Mountain, 55%; and Walhalla, 23%. Direct effects included decreased local procurements of goods and services by base and base payrolls. Indirect influences meanwhile were felt in the decrease in retail trade and personal services needs. A local official stated, "Had they planned for the "Boom-Bust" cycle . . . things would've been left at a level that their resources could have handled it . . . [instead] they were left with bonded indebtedness. . . ".[146] For example, one town had installed a new water system during the boom, but after the closure could not afford to hire a technician to read the meters. Also, in some areas, telephone switching centers had been built, with no money "up front," as it were. Companies that had anticipated recuperating their capital from the monthly phone bills were left in a poor position. As a result of the hardship, several claims were made against the Federal Government. Of the 126 processed, complaints were as diverse as radar interference with television reception and garage door openers, pastures ruined by the diversion of water flow, and even the contention by one resident that trucks entering and leaving SRMSC had turned her laundry yellow.

According to Delmar Lewis, Langdon High School Superintendent, the area schools were severely impacted; enrollment fell by approximately 50 percent after closure of the SRMSC.[147] In a poll conducted by North Dakota State University, it was observed that businesses that had extended themselves too far financially were predominately restaurants and groceries who intended to cater to the new military community. Anyone who had borrowed money to finance prospective business did not have the requisite funds to pay their debts once the boom abruptly terminated. Conversely, many expanded utilities precluded financial disaster, remaining intact by servicing the needs of other, smaller communities in their vicinity.

Adjustments in downgrading, according to some, were just as difficult as the adjustment upward had been.[148] Langdon's mayor, John MacFarlane, had choice words for the project in an interview with William K. Smith of the New York Times: "We didn't ask them to come". Langdon won't easily forget Safeguard, even if it eventually recovers from the shock of its withdrawal. The town's one permanent change, the Mayor told Stevens, was its loss of confidence in the government in Washington .[149]

F. SRMSC POST-CLOSURE ACTIVITIES

As tempers flared, dismantling was underway on-site. Between December of 1975 and the end of 1977, all missiles were removed from the MSR and RSL areas. Missile silos were sealed, the MSCB, along with its power plant, was salvaged (that is, a contractor was allowed to remove almost all useable/resalable materials resulting in these structures being stripped of wiring, stair rails, etc.) and then sealed. Warheads and interceptors were removed from the sites, and the silos were sealed and abandoned.

Inactivation in earnest began on February 10, 1976. As previously stated, the only component of the Safeguard system left in use was the Perimeter Acquisition Radar (PAR). It became part of the North American Air Defense Command (NORAD) as an early-warning perimeter acquisition radar Attack Characterization sensor, in direct support to its Attack Assessment mission. The PAR was rechristened Cavalier Air Force Station and assigned to the 10th Missile Warning Squadron, Space Command, which allowed the Department of the Air Force to use the PAR area and its waterlines for five years. This permit has been renewed twice; the option will come up again on 30 September 1996.

The PAR mission is now to serve as part of a Satellite Surveillance Network tasked to provide tactical warning and attack assessment of a sea-launched ballistic missile attack against the United States and Canada. Its second mission is to provide warning and attack assessment of an ICBM against the North American land mass (that is, should an ICBM be launched towards Canada or the United States). Finally, it provides space surveillance, tracking, and space object identification support for the U.S. Spacetrack system and intelligence operations.

After closure, the MSR and RSL sites fell into disuse. A portion of the MSR was excessed (declared in excess of federal government needs and disposed of) by the General Services Administration (GSA) in 1977. This area included the non-tactical portion of the site. While in possession of remaining portions of the SRMCS except for the PAR site, the GSA made little provision for maintenance and repair of many of the buildings. The harsh

North Dakota winters had caused significant damage to the unattended structures. When the U.S. Army Space and Strategic Defense Command, as a result of the Warren-Nunn BMD treaty stipulations, reacquired this land area in 1991, many of the facilities had suffered irreparable damage. The Missile Site Control Building, itself, had flooded; salvaging had left an access for ground water to seep in, and a mammoth effort was required to remove the water. Due to the hazards they represented, other buildings were simply dismantled. A few buildings, however, were retrievable and have been repaired and restored to assist in their protection from the mercurial climatic conditions. The remaining domestic structures have been removed for use as housing facilities.

G. SUMMARY

The Stanley R. Mickelsen Safeguard Complex (SRMSC) had a profound influence upon the surrounding economy and, as an ABM site, proved to be of importance on all levels. During its planning and construction phases, the ramifications of literally flooding a previously sparsely populated area produced a backlash of shortages in facilities and support infrastructure. With the help of Government funding, however, the shock was somewhat offset by a general betterment in existing resources. Moreover, Safeguard enabled the United States to actually gauge the cost of defense as opposed to offense and added immeasurably to missile and radar technology.

Perhaps its reputation rests on the fact that no other weapons system like it has been implemented before or since. It was located in a remote area and still remained self-sustaining. It is a tribute to the technical skill of the United States and a solemn reminder of the period in history we call the Cold War.

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VI. ACRONYMS AND ABBREVIATIONS

ABM	antiballistic missile
ABMDA	Advanced Ballistic Missile Defense Agency
ac	acre(s)
AFB	Air Force Base
AFS	Air Force Station
AMC	Army Materiel Command
AOA	Airborne Optical Adjunct
AOMC	U.S. Army Ordnance Missile Command
AR	Army Regulation
ARADCOM	Army Air Defense Command
ARGMA	Army Rocket and Guided Missile Agency
ARPA	Advanced Research Project Agency
BMD	Ballistic Missile Defense
BMDATC	Ballistic Missile Defense Advanced Technology Center
BMDC	Ballistic Missile Defense Center
BMDO	Ballistic Missile Defense Organization
BMDOR	Ballistic Missile Defense Operations Room
BMDSCOM	Ballistic Missile Defense Systems Command
BOD	Beneficial Occupancy Date
C	Celsius
CCMH	Cavalier County Memorial Hospital
CINCONAD	Commander-in-Chief of CONAD
CFR	Code of Federal Regulations

CONAD	Continental Air Defense Command
CONUS	Continental United States
DDRE	Director of Defense Research and Engineering
DOD	Department of Defense
DOT	Designated Optical Tracking
DPS	Data Processing Systems
DR	Discrimination Radar
F	Fahrenheit
FAR	Forward Acquisition Radar
FCC	Fire Control Center
FR	Federal Register
ft	foot (feet)
GMD	Global Missile Defense
GPALS	Global Protection Against Limited Strikes
ha	hectare(s)
HABS	Historic American Building Survey
HAER	Historic American Engineering Record
ICBM	Intercontinental Ballistic Missile
km	kilometer(s)
m	meter(s)
mi	mile(s)
MAR	Multifunction Array Radar
MDC	Missile Direction Center
MHz	megahertz
MICOM	U.S. Army Missile Command
MIRV	Multiple Independently Targeted Reentry Vehicle

MSCB	Missile Site Control Building
MSRDP	Missile Site Radar Data Processor
MSR	Missile Site Radar
MTR	Missile Track Radar
MWS	Missile Warning System
NATO	North Atlantic Treaty Organization
NCA	National Command Authority
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NMD	National Missile Defense
NORAD	North American Air Defense [Command]
NPS	National Park Service
NRHP	National Register of Historic Places
OAMP	Optical Aircraft Measurement Program
PAR	Perimeter Acquisition Radar
PARB	Perimeter Acquisition Radar Building
PARDP	PAR Data Processor
R&D	Research and Development
RLOB	Remote Launch Operations Building
RSL	Remote Sprint Launch
SAC	Strategic Air Command
SAFSCOM	Safeguard Systems Command
SALT	Strategic Arms Limitation Talks
SBI	Space-Based Interceptor
SDI	Strategic Defense Initiative
SDIO	Strategic Defense Initiative Organization

SENSCOM	Sentinel Systems Command
SHPO	State Historic Preservation Officer
SRMSC	Stanley R. Mickelsen Safeguard Complex
STR	Systems Technology Radar
TIC	Target Intercept Computer
TIR	Terminal Imaging Radar
TMD	Theater Missile Defense
TTR	Target Track Radar
TWT	Traveling Wave Tube
USASDC	U.S. Army Strategic Defense Command
USASSDC	U.S. Army Space and Strategic Defense Command
USSR	Union of Soviet Socialist Republics
VIRADE	Virtual Radar Defense
WSC	Weapon System Contractor
WSMR	White Sands Missile Range
ZAR	ZEUS Acquisition Radar

VII. ENDNOTES

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