Chapter 3: Minuteman and the Next Generation (1960s–present)

The Missile Gap and Minuteman

Although the liquid-fueled Atlas and Titan systems were operational by the early 1960s, the Air Force actively sought to develop another Intercontinental Ballistic Missile (ICBM)–one powered by solid fuel that would be more cost-effective, smaller, and better suited to mass production. This push for improved technology was largely driven by the desire to surpass Soviet missile technology and overcome what seemed a growing "missile gap." The Soviet Union's successful launch of "Sputnik," the world's first man-made orbiting satellite, in 1957, had rattled American policymakers and military strategists to their core.[i] Sputnik seemingly demonstrated that the Communist World was clearly in the lead in missile technology, and on 23 October 1957, a board of civilian consultants told Central Intelligence Agency (CIA) Director Allen Dulles that the United States trailed the Soviets in this vital field by "two to three years." Production of a Soviet ICBM capable of striking the United States was "nearly" a reality, they warned, and they predicted Soviet deployment of a dozen such missiles by the end of 1958. In their words, the United States was entering "a period of grave national emergency." Within two years, Congressional hearings concerning the "missile gap" provided the public with a view into the superpower race for rockets, whole they simultaneously offered the Air Force opportunity to promote expensive new missile systems. Estimates of Soviet capabilities varied widely through these years. The Kremlin did not publicize its military plans and what claims it did make were rarely trusted in the West, nor did it need to endure the public process of Congressional funding as the Pentagon. Senator Stuart Symington, formerly the first Secretary of the Air Force, used CIA estimates to inform Eisenhower during the Summer of 1958 that the Soviets might have as many as 500 ICBMs by 1961. Flights by high-altitude spy planes such as the U-2 in 1959 and 1960 later fostered lower estimates of Soviet capabilities, though no one in the West could know for certain the true measure of Soviet missile strength.[ii]

Though Democrats would make the "missile gap" an important political issue in the 1960 election, later records disproved its existence. The United States actually possessed greater nuclear strike capabilities at this time. Not only did Western forces field larger bomber forces, but though exact numbers of Soviet capabilities remain impossible to state with accuracy, a problem compounded by their varied range and destructive capabilities, so too was the West ahead in missiles. Before departing office, for example, the Eisenhower Administration increased the scope of its second-generation missiles to 384 Polaris and 540 Minuteman, as opposed to less than one hundred fully capable Soviet ICBMs. Everyone expected both sides to only increase their nuclear strike capabilities in the years to come–just as American policymakers planned to deploy systems such as the Minuteman for decades at least, though in the final analysis, domestic politics and budgetary restraints (or opportunities) affected American missile deployments as much as estimates of Soviet capabilities. As historian Peter Roman has concluded, "ironically, the administration had finally initiated the buildup that the missile gap critics had clamored for–and did it just as intelligence estimates of Soviet missiles were being revised downward." Indeed, the Air Force took advantage of the political atmosphere fostered by the Congressional inquiries and public concern over the missile gap to present an initial plan to Congress for accelerating the Minuteman program beginning in 1960, calling for 445 Minuteman missiles to be operational by January 1965 and eight hundred missiles by June 1965, leaving an exasperated Eisenhower to exclaim "perhaps we should go crazy and produce ten thousand Minutemen." In an era of Cold War fear, the only proper number of nuclear arms seemed the number capable of installing confidence in one's own public, and confidence of an assured retaliation in one's enemy.[iii] The new Minuteman missile, designed to be hidden and protected in a hole in the ground, was referred to by President John F. Kennedy following the Cuban Missile Crisis as his "ace in the hole."[iv] This was also the title of Roy Neal's 1962 history that chronicled the development of the Minuteman missile.

Development of Solid-Fuel Intercontinental Ballistic Missiles

The development of solid fuel for ICBMs occurred simultaneously with the deployment of the Atlas and Titan ICBMs. The liquid fuel that powered these rockets added weight to the missile reducing its range, while the extreme volatility of liquid fuels made them dangerous to work with. Solid fuels promised to allow for smaller and cheaper missiles with greater effective range, while simultaneously eliminating the need for a problematic liquid-fuel system.[v]

By 1955 missiles propelled with solid fuel proved practical for shorter flights and two years later solid-fuel technology had progressed sufficiently for scientists to recommend large-scale development of a solid-fuel ICBM. Buoyed by these results, the Air Force authorized a series of studies that same year to develop a solid-fuel ICBM that was smaller than either the Atlas or Titan. Contracts to study solid-fuel missiles were finalized in 1956, and, rather than being completed in-house by the WDD, the work was awarded to the Wright Air Development Center (WADC), a private corporation contracted by the Air Force for missile development. The WADC directed the work of companies such as Aerojet-General, Thiokol, and Phillips Companies as they proceeded with solid-fuel feasibility studies.[vi] General Bernard Shriever, who headed the Air Force Ballistic Missile Division (the WDD prior to renaming in 1957) during the first years of the Minuteman program, felt that the transition from liquid to solid fuel, with its more powerful engines, greater range, and increased safety, was the most significant advancement in ICBM development, allowing the United States to jump ahead of the Soviets in missile technology.[vii]

Minuteman I

Development

The Minuteman grew from this massive effort, and a further illumination of the role played by its principal designers in the early years of development offers valuable insights into the Minuteman's initial design. While WADC oversaw its solid-fuel studies, Lieutenant Colonel Edward (Ed) Hall of the Ballistic Missile Division (BMD) had been transferred from the faltering Thor Intermediate Range Ballistic Missile program to his own office within the BMD. General Shriever gave Hall the freedom to design a solid-fuel missile, designated at that time Weapons System Q. Hall distilled the growing mass of information produced by the variety of contracted studies on solid fuel and other missile technologies. Hall generally worked alone, at first without even an administrative assistant. The one person Hall collaborated with regularly was Barney Adelman of Ramo-Wooldridge. Hall and Adelman worked to produce a design for a solid-fuel missile.[viii]

Hall ultimately incorporated technologies developed by a series of recent Air Force studies, including new swivel nozzles to control missile direction and an accurate method of shutting off the engines. In addition, he used previous studies to calculate warhead size and weight and research on solid fuel to determine the distance the missile could travel. Hall's final feasibility study, produced in 1957, outlined a series of missiles powered by the new fuel technology he named the "Minuteman" as a symbolic reminder of the country's military past and to reflect the quick response time of the missile system. Minuteman was designed to be an efficient, reliable weapon that could be mass-produced, stand unattended for long periods, be operated and maintained by small crews, stored and launched from underground silos, and automatically monitored for condition and combat readiness. It offered, in short, the solution to the troubling missile gap.[ix]

The Air Force accepted Hall's design–retaining the name Minuteman–in March of 1958, and began planning for funding and developing a Minuteman force.[x] The Pentagon initially planned to deploy one hundred Minuteman missiles by 1964 and another four hundred by 1965.[xi] Delays and budget troubles plagued the early development of the Minuteman, however. Though the Air Force positioned itself solidly behind the development of the Minuteman, the Joint Chiefs of Staff (JCS) did not share their enthusiasm for the Minuteman program, preferring other strategic defense options, such as the Intermediate Range Ballistic Missiles, Thor and Jupiter. Rumors of stalling tactics on the part of the JCS began to circulate. The Air Force Ballistic Missile Committee and the Office of the Secretary of Defense backed the Minuteman development, but a request for $150 million for fiscal year 1959 was initially reduced to $50 million.[xii] Without those extra funds, the Minuteman's supporters warned, the missile would not be ready for operational deployment by the early 1960s.

Funds were not forthcoming until the BMD and the Air Force persuaded General Sam Anderson, commander of Air Research and Development Command (ARDC), Chief of Staff General Thomas D. White, Vice Chief of Staff General Curtis LeMay, and Secretary of the Air Force James Douglas of the viability of the Minuteman.[xiii] General Schriever asserted to these men that there were no problems with either the concept or design of the new missiles and he asked for flexibility in carrying out the first part of a development program. He stated that he could prove his point within six months, if given the funding.[xiv]

After the general finished convincing his immediate superiors of the viability and utility of the program, he turned his attention to the three men who would make the final decision on Air Force program funding– Secretary of Defense Neil McElroy, Assistant Secretary of Defense William Holaday, and Deputy Assistant Secretary of Defense Donald Quarles. General Schriever arranged a deal whereby the BMD received $50 million for the first six months of 1959. If in that time the BMD could prove the efficacy of the Minuteman, the remaining $100 million would be released for Minuteman development.[xv]

By 7 January 1959, the Air Force established an operational schedule for the Minuteman. The first flight test was to take place in December 1960 with an operational weapon system in place by 1963. This ambitious schedule generated a great deal of skepticism on the part of outside scientists and government officials, but Schriever and his team were certain that the program could succeed. To close the "missile gap," and more importantly to prove that they were the best service to do so, the Air Force needed the Minuteman, and in a hurry.[xvi]

Testing

The BMD successfully launched a "tethered" Minuteman I prototype on 15 September 1959. This test showed that the Minuteman could be fired directly from an underground silo, prompting the Air Force to fast-track the program in the hopes of having the first Minuteman I on duty by 1962.[xvii] The production of the first operational Minuteman I force was approved in March 1960 and consisted of 150 missiles assigned to a single missile wing at Malmstrom Air Force Base in Montana. The wing had three squadrons with fifty missiles each. Construction on the operational facility to house the missile wing at Malmstrom began in March 1961.[xviii] The previous month at Cape Canaveral, the first full test of a Minuteman I proved successful–the missile deposited its warhead 4,600 miles from the launch site.[xix] During these tests the missiles did not employ armed atomic warheads. *TIME* magazine reported that an awed observer murmured "Brother, there goes the missile gap" and described the successful test flight as follows, "Even for sophisticated missile watchers, the men who have marked the flight of so many of Cape Canaveral's great fire-breathing birds, last week's show was a dazzling spectacle. The blast-off was swift and sure; there was none of that heart stopping hover of other tests when liquid-fueled monsters seemed to balance in uncertain equilibrium before they picked up the momentum of flight."[xx]

Secretary of Defense Robert McNamara, a longtime advocate of a strong strategic defense and the elimination of the missile gap, became a leading advocate, within the new Kennedy Administration, of the Minuteman program following a March 1961 visit to the BMD. During this visit scientists demonstrated their advances in solid-fuel technology. McNamara walked away from this meeting more convinced than ever of the need, and of the value, of the new Minuteman missile system.[xxi] The production of the Minuteman I proved successful, and by 1964 McNamara determined the Minuteman missile force would consist of one thousand missiles. As with any program of this size (and expense), his determination of this number was reached only after lengthy consultations with the JCS, the National Security Council, the White House, think tanks such as RAND, and congressional leaders. By June 1965 the Air Force was on the way to meeting this target, with an operational force of eight hundred Minuteman I missiles located at Malmstrom Air Force Base, Ellsworth Air Force Base in South Dakota, Minot Air Force Base in North Dakota, Whiteman Air Force Base in Missouri, and F.E. Warren Air Force Base in Wyoming.[xxii]

Design

Minuteman I was designed to be a "highly reliable, three-stage, solid-propellant weapon" that could endure long periods in storage and travel over five thousand miles to reach its target.[xxiii] This was further than any of the earlier generations of ICBMs. Yet the Air Force required more than simply a new missile to make the Minuteman system work.

Launch Facilities (LFs) and other support structures had to be designed in order for the Minuteman to prove an effective deterrent to Soviet aggression.

The initial Minuteman I force was divided into five missile wings of either three or four missile squadrons per wing. Fifty missiles made up a squadron, and each squadron was further divided into five flights of ten missiles. A flight had its own Launch Control Center (LCC) that monitored ten LFs. To reduce its vulnerability to enemy attack, each flight was dispersed across several miles, with the LCC located a minimum of three miles from any missile and the missiles similarly distanced from each other.[xxiv]

In Minuteman I wings I and II electrical and environmental support equipment were initially located aboveground in the Launch Control Facility (LCF) support building. The missile system was constructed during a time when the doctrine of “massive retaliation” directed strategic planning–the military expected to launch the entire Minuteman I force in retaliation for a Soviet attack, and though a grim prospect, post-attack survivability of more than several hours for the crew was consequently not considered an essential feature of the design.[xxv] This strategy changed with the construction of Minuteman I wings III to V, and LCC support equipment moved underground as part of the new “controlled response” strategy, which called not only for the possibility of a limited or controlled American nuclear response, but also consequently for post-attack missile survivability. No one thing prompted this change in American strategic thinking. Rather, “controlled response” developed organically by the close of the 1950s as a potential answer to the limitations of “massive retaliation,” most specifically the way an all-or-nothing nuclear response to potential superpower conflicts threatened to too severely limit the options available to policymakers engaged in a crisis. By developing the ability to strike with limited components of their nuclear arsenal, American policymakers hoped to achieve not only greater flexibility in the international arena, but also greater success as well, as “controlled response” led to the Kennedy Administration’s famed “flexible response” policies, which called for non-nuclear and even irregular (such as the Special Forces) applications of military might. Not every crisis warranted a full-scale nuclear response, after all, and by the 1960s, American leaders demanded the tools necessary to meet the changing needs of a Cold War fought increasingly in the global periphery.[xxvi]

Contractors

Boeing received the original contract for the design, assembly, and testing of Minuteman I in October 1958 and later contracted to develop hardware and electronics and check operational facilities.[xxvii] Other associate contractors for the Minuteman system included AVCO and General Electric for reentry vehicles designed to deliver nuclear warheads to their targets, Autonetics Division of North American Rockwell for guidance systems, and Bell Aerosystems for post-boost control and a navigation system for the reentry vehicle. The post-boost controls served the critical function of controlling the reentry vehicle after it had separated from the missile and began to descend to its target. Sylvania won the contract for the ground electronics system and TRW Systems headed up systems engineering and technical direction.[xxviii]

Three contractors were chosen to develop the three solid-propellant stages for Minuteman I. Each of these three stages performed specific functions. The first stage launched the missile, the second stage provided additional thrust as the missile traveled towards the target, and the third stage propelled the reentry vehicle with its nuclear payload back into the atmosphere and to its designated target.[xxix]

The Thiokol Chemical Company built the first stage–the M55 motor. The M55 produced two hundred thousand pounds of thrust using a combination of Thiokol synthetic rubber, powdered aluminum, and ammonium perchlorate (AP). Its steel casing utilized four small, swiveling nozzles for propulsion and navigation. Aerojet-General constructed the sixty thousand-pound thrust second-stage engine, which was fueled by polyurethane and AP, while also employing swiveling nozzles and a steel casing. Aerojet-General replaced the steel casing initially employed in its engine with lighter and stronger titanium in 1962. The third stage was constructed by Hercules and consisted of a thirty-five thousand pound thrust motor with a composite AP propellant and a technologically advanced glass-fiber filament-wound casing.[xxx] By employing so many contractors for the Minuteman I project, the Pentagon managed to spread earnings from the lucrative missile program throughout the American aerospace industry, providing jobs for thousands of workers and profits for even more investors, and pleasing politicians with companies in their home districts. The variety of contractors also ensured the wide-spread dissemination of advanced technologies and procedures throughout the industry, in what was effectively a Pentagon-sponsored investment in the education and research of its most vital defense firms.

Minuteman Production Board

Boeing and a group of other associate contractors managed the design and building of the Minuteman I missiles. Because of the large number of contractors involved in the project, contract management for Minuteman production became quite cumbersome and in 1962 Major General Thomas Gerrity, head of the Ballistic Systems Division of the BMD, brought the associate contractors together to seek a more efficient production program in order to ensure a timely completion.[xxxi] Representatives from Boeing, Thiokol, Hercules, Aerojet-General, AVCO, Space Technology Laboratories, and Autonetics were invited to the meeting, which ultimately established the Minuteman Production Board. This group of associate contractors had unprecedented direct participation in assembling the Minuteman system. Each associate contractor had a member on the board. Board members also had the authority to commit to corrective measures to address any production problems that arose.[xxxii] By putting their reputations on the line, and by simultaneously providing each contractor with the flexibility and opportunity to solve any unforeseen problems in their own product, Gerrity’s production board managed the Minuteman program with impressive efficiency.

Capabilities

The missile the Air Force and contractors produced was a marvel for its time. Minuteman I stood 55.9 feet long and, when fueled and armed, weighed sixty-five thousand pounds with a maximum speed exceeding fifteen thousand miles per hour. The first Minuteman I, model IA, could travel approximately 4,300 miles, which fell short of the expected range of five thousand miles due to a problem with the swivel nozzles that controlled the missile's propulsion. The Air Force subsequently produced the Minuteman IB, which had an improved second-stage motor housing made of titanium. The new housing improved on the steel housing used for the Minuteman IA, lightening the missile and increasing its range over the Minuteman IA.[xxxiii] The Minuteman IB traveled approximately six thousand miles to its target. Both missiles featured an inertial guidance system designed to deliver a single warhead to a preprogrammed target halfway around the world in less than half an hour after launch.[xxxiv]

National Site Selection

The Air Force went through a rigorous process of selecting sites to house its Minuteman missiles. During the early stages of Minuteman I deployment, the site location was restricted by the maximum flight distance of the Minuteman IA. This range led the Air Force to search for sites in the northern United States, bringing the missiles within closer range of the Soviet Union.[xxxv]

Other factors restricted site selection for the new Minuteman. For example, sites had to be within the continental United States lest foreign states argue that the housing of missiles on their territory gave them a say in their use. In the early days of the Cold War, for instance, the Truman and Eisenhower administrations encountered the British government's insistence that nuclear weapons aboard American bombers based in the United Kingdom could only be used with London's approval.[xxxvi] Additionally, the Air Force required that Minuteman I ICBMs be spaced far enough apart to be considered separate targets, so that one Soviet strike would not debilitate a significant number of American missiles. The missiles also had to be far enough inland to be outside the range of sea-launched Soviet missiles, yet still within effective range of identified enemy targets. To reduce the expense of deploying Minuteman I, the Air Force located the command and support facilities for the new Minuteman weapon system at existing Strategic Air Command (SAC) bases.[xxxvii] (For a discussion of SAC, see Section II, Chapter 2: U.S. Air Force, Strategic Air Command, and Ellsworth Air Force Base). By using existing bases, the Air Force took advantage of existing infrastructure, and avoided the need to develop a site from the ground up.

Army Corps of Engineers

The Army Corps of Engineers (Army Corps) held the responsibility for construction administration and construction of the Minuteman LFs and LCFs. Once the support bases were identified by the Air Force, the Army Corps, the BMD, and SAC Headquarters at Offutt Air Force Base in Nebraska sited the individual silo sites. The team worked together, conducting soil analyses and topographical and geographical surveys to help locate the specific locations for the missile silos.[xxxviii] By 1960 decisions on site locations had been made and the construction of the Minuteman I LFs and LCFs was well under way.[xxxix]

Given the location of most Minuteman sites on the upper plains, the Omaha District of the Army Corps of Engineers (Omaha District) oversaw the construction of the Minuteman LFs and LCFs. The construction of the LFs was, in the words of historian Ernest Schwiebert, "the largest financial outlay of the ballistic missile program."[xl] However, the construction of the facilities for Minuteman I at Minot Air Force Base in North Dakota in the early 1960s were estimated by the Army Corps to cost $400,000 per silo, which was significantly cheaper than the cost of the earlier Atlas and Titan systems in the late 1950s and early 1960s at $2 million per silo. The special fueling facilities required for the liquid-fuel ICBMs and smaller size of the Minuteman I resulted in this difference in price, further proof of the Air Force's claim that the Minuteman would save money while providing a more powerful nuclear deterrent.[xli]

Typically, the Omaha District supervised the Minuteman installations and planned for their specific location, and then hired private contractors to build the facilities. Omaha's Peter Kiewit Company won the right to serve as prime contractor for construction at many of the missile sites. The Omaha District provided design services and contract management for construction of Minuteman's ground facilities at F.E. Warren Air Force Base in Wyoming, for example, as well as Ellsworth Air Force Base in South Dakota, Minot Air Force Base in North Dakota, and Grand Forks Air Force Base in North Dakota.[xlii] The construction at Minot Air Force Base displays the scope of the effort required to construct the LFs and LCFs for the Minuteman missile. The Minot site demanded construction of 150 silos and fifteen LCFs in a twelve thousand-square-mile area. During peak construction, Kiewit and its subcontractors employed six thousand workers, 1,100 vehicles, and 115 cranes to keep construction on pace to meet the aggressive project schedule.[xliii]

By December 1962 Minuteman IA had been deployed at Malmstrom Air Force Base in Montana. The Air Force also deployed the upgraded Minuteman IB with a titanium second-stage engine case at Ellsworth Air Force Base, Minot Air Force Base, F.E. Warren Air Force Base, and Whiteman Air Force Base in Missouri. The Minuteman I missiles at these bases were clustered around former Atlas complexes. By June 1965, eight hundred silos across the country housed the new Minuteman I ICBMs.[xliv] The complete installation of the Minuteman I LFs eventually took ten years and faced a range of challenges dependent on the specific conditions at each site. Adverse conditions varied from particularly trying winters to soil conditions that required special engineering techniques to construct structurally sound missile silos and underground LFs.[xlv]

Once activated, the Minuteman missile was always in a state of readiness requiring less maintenance than earlier missiles and this impact was described by Lt. Col. George V. Leffler, commander of the 100th Strategic Missile Squadron, "The Minuteman is like getting a new car and not getting the keys. You can't drive it. You have no sense of ownership. With a liquid missile, you can run it up out of the silo on the elevator, fuel it, go into the countdown. We can't touch a thing."[xlvi]

Minuteman II

Development and Design

Even as the Air Force began deploying Minuteman I missiles in 1962, research and development into the Minuteman II had already begun. The new Minuteman was created to improve on the missile guidance systems, payload capacity, and anti-missile defenses of the Minuteman I. Minuteman II facilities offered survivability more in line with the Kennedy administration's "controlled response" doctrine. The first test launch of Minuteman II occurred at Cape Canaveral in 1964 and the first operational launch occurred one year later. As part of the Force Modernization Program begun in 1966 to modernize the Air Force missiles, the Minuteman II ICBMs eventually replaced the entire fleet of Minuteman I ICBMs. In 1968, just three years after the first test launches, 350 Minuteman II ICBMs were in the ground. Between 1969 and 1975, the program replaced the Minuteman I with Minuteman II missiles, and upgraded LCFs and silos to accommodate the more sophisticated missile.[xlvii]

Capabilities

The second generation of the Minuteman missile, Minuteman II, differed from its predecessor in several important ways. It was a larger missile designed to accommodate increased engine and warhead size, measuring 57.6 feet long and weighing seventy thousand pounds. As with its predecessor, Minuteman II was capable of reaching speeds in excess of fifteen thousand miles per hour. Minuteman II offered an improved second-stage engine manufactured by Aerojet-General, improved targeting system, extended range, electronic autopilot, all-inertial guidance system, and an Avco Mark IIC reentry body with a one- to two-megaton nuclear warhead.[xlviii] These improvements allowed the Minuteman II to strike targets from a greater distance with greater precision. New anti-missile technology increased the chances of the missile avoiding an enemy’s defenses and delivering its warhead. The missile gap had become a thing of the past by the mid-1960s, as American intelligence proved beyond doubt the superiority of American missiles over their Soviet counterparts. However, this fact did not keep the Air Force from continuing to improve its product.[xlix]

National Site Conversion

Much of the work for site selection had already been completed with Minuteman I. When Minuteman II was ready for deployment, the Air Force established priorities for replacement of the Minuteman I missiles, and the first Minuteman II was deployed at Grand Forks Air Force Base, North Dakota, in August 1965. The first operational Minuteman II squadron, the 447th Strategic Missile Squadron, went on alert at Grand Forks Air Force Base in 1966. Minuteman II ICBMs eventually went in the ground at another five SAC bases (Malmstrom Air Force Base, Ellsworth Air Force Base, Minot Air Force Base, F.E. Warren Air Force Base, and Whiteman Air Force Base). Malmstrom Air Force Base was also selected as the location for an additional Minuteman squadron, and LFs and LCFs were consequently constructed at this base.[l]

Minuteman III and the Next Generation

In July 1965, after the entire Minuteman I force was declared operational and prior to Minuteman II deployment, the Air Force contracted with Boeing for research and development for the next phase of Minuteman, Minuteman III.[li] Minuteman III represented a change in the United States’ strategic planning, and consequently resulted in additional advancements in missile technology. Minuteman I was designed based on the theory of “massive retaliation” which required the missiles to launch at one time in retaliation to an attack. Minuteman II was designed based on the theory of “controlled response” which required some of the missile fleet to survive a nuclear attack. Minuteman III was designed under a theory of “flexible response” which required the missile to be able to fire independently and target multiple potential aggressors.[lii] Like the earlier Minuteman missiles, Minuteman III underwent rapid development. Five hundred fifty Minuteman IIIs were in the ground by 1977 and Minuteman III sites were later located in Colorado, Nebraska, Wyoming, Montana, and North Dakota. Four hundred fifty Minuteman II and fifty-four Titan II ICBMs remained on alert at this time, after retirement of Atlas and Titan I.[liii]

Capabilities

Minuteman III stands 59.8 feet long and weighs 76,000 pounds. The new generation of Minuteman employed an upgraded third-stage engine, post-boost navigation control of the reentry vehicle, and an MK12 reentry vehicle possessing three nuclear warheads that could be independently delivered to multiple targets. The upgraded engine and the greater navigation control enabled the weapon to reach multiple targets more quickly and accurately than the previous generations of Minuteman. Previous Minuteman missiles carried a single nuclear warhead and therefore could only strike a single target.[liv]

Advancements in Missile Technology and the Cold War

Much of the research and development effort to improve missile technology in the later part of the twentieth century centered on increasing the sophistication of the Minuteman III system. Efforts to increase the accuracy of Minuteman reentry vehicles and to design these vehicles to be less detectable by radar were ongoing in the 1970s[lv] Today the Minuteman system is commonly thought of as part of a “triad” defense system involving land-based missiles, submarine-launched ICBMs (known as SLBMs) controlled by the Navy, and Air Force manned nuclear bombers. When analysts use the term triad, they refer to these three independently operated nuclear systems (land-, air-, and sea-based), reasoning that three such disparate systems would collectively prove less vulnerable to enemy attack than any solitary system might be.[lvi]

The purpose of America’s nuclear program was, at its most basic, one of deterrence. With the ability to launch unprecedented destruction, American strategists reasoned that no foreign foe would dare strike at Western vital interests. Throughout the Cold War, none did. The superpowers fought bitter and brutal wars on the Cold War’s periphery, through proxy states and powers. Korea, Vietnam, and Angola provided stark examples of Cold War geopolitics played out on a local stage, often with deadly results. Minuteman was never designed for such conflicts; it was instead a product built and deployed for one purpose: to deter a direct Soviet strike at Europe or at the United States itself. Its was a global mission.

Ultimately, the Cold War system that spawned Minuteman and the doctrine of mutual assured destruction through nuclear deterrents came to an end. The details of the Cold War’s final chapters will be discussed in greater depth in later sections. For now, it is important to note that the Minuteman II system lasted through the end of the Cold War, but not long after. The international system experienced dramatic changes throughout the 1980s. Renewed American military spending following the pain of Vietnam, initiated by the Carter Administration but later taken to new heights by President Ronald Reagan, helped exacerbate East-West tensions following the period of relative détente of the 1970s. Simultaneously, Communist leaders behind Europe’s Iron Curtain faced a new spirit of change and reform. Such calls for reform were prompted in part by outside forces (such as Reagan's vitriolic anti-communist rhetoric, improved access to Western media including television broadcasts, and calls for change from prominent human-rights advocates such as Pope John Paul II), but found their greatest expression in domestic reform movements such as Poland's Solidarity. The tide of discontent, when coupled with a growing awareness of their country's inability to match American military spending (and technological advancement more broadly) prompted dramatic changes in the Soviet system by a group of political reformers led by Mikhail Gorbachev. As we shall see, Gorbachev prompted political, economic, and social reforms at home, and helped create a new atmosphere of East-West cooperation, in particular following Reagan's departure from office. The Cold War informally ended in 1989, when West and East Germans spontaneously gathered in Berlin to tear down the hated wall that had divided them for a half-century. It formally ended two years later, when a failed coup attempt in Moscow led ultimately to the dissolution of the Soviet empire in favor of a democratic regime headed by Russia's first post-Cold War president, Boris Yeltsin.

Whether the threat of nuclear annihilation had safeguarded superpower relations during the Cold War, keeping them from mutual assured destruction, can never be fully known or determined. What is clear is that deterrence worked, in the sense that the two sides never came to direct nuclear blows (though as we shall see, they came close), in no small part because of the fear of widespread nuclear war. Minuteman was one such deterrent….against global communism. As we shall see, it was a weapon that came to shape the American landscape, leaving a mark on the men and women who operated it.

Plate 9. Minuteman test launch, Vandenberg Air Force Base, 1963 *("Site Activation Chronology, Minuteman Project, Ellsworth Air Force Base, South Dakota, July 1963-October 1963," K243.012-40, in USAF Collection, AFHRA)*

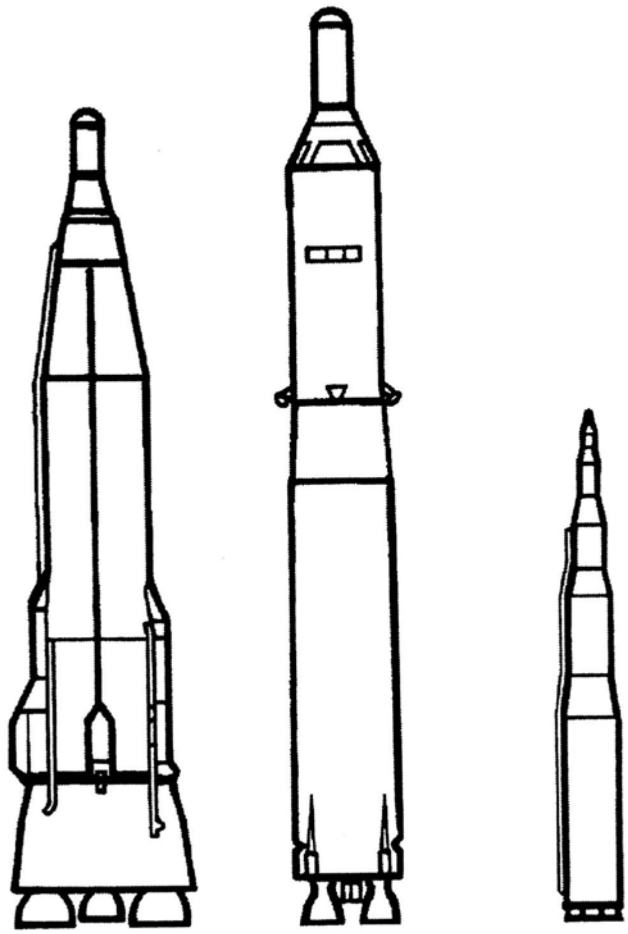

Plate 10. From left to right, scale drawings of Atlas, Titan I, and Minuteman I ICBMs *(John C. Lonnquest and David F. Winkler, To Defend and Deter: The Legacy of the United States Cold War Missile Program, 65)*

Plate 11. Full-scale test of Minuteman I missile, Edwards Air Force Base, California, 1960 *(Photograph No. B-08-018-1, "Guided Missiles – Boeing SM-80," U.S. Air Force Photo, Record Group 342, National Archives,, College Park, Md.)*

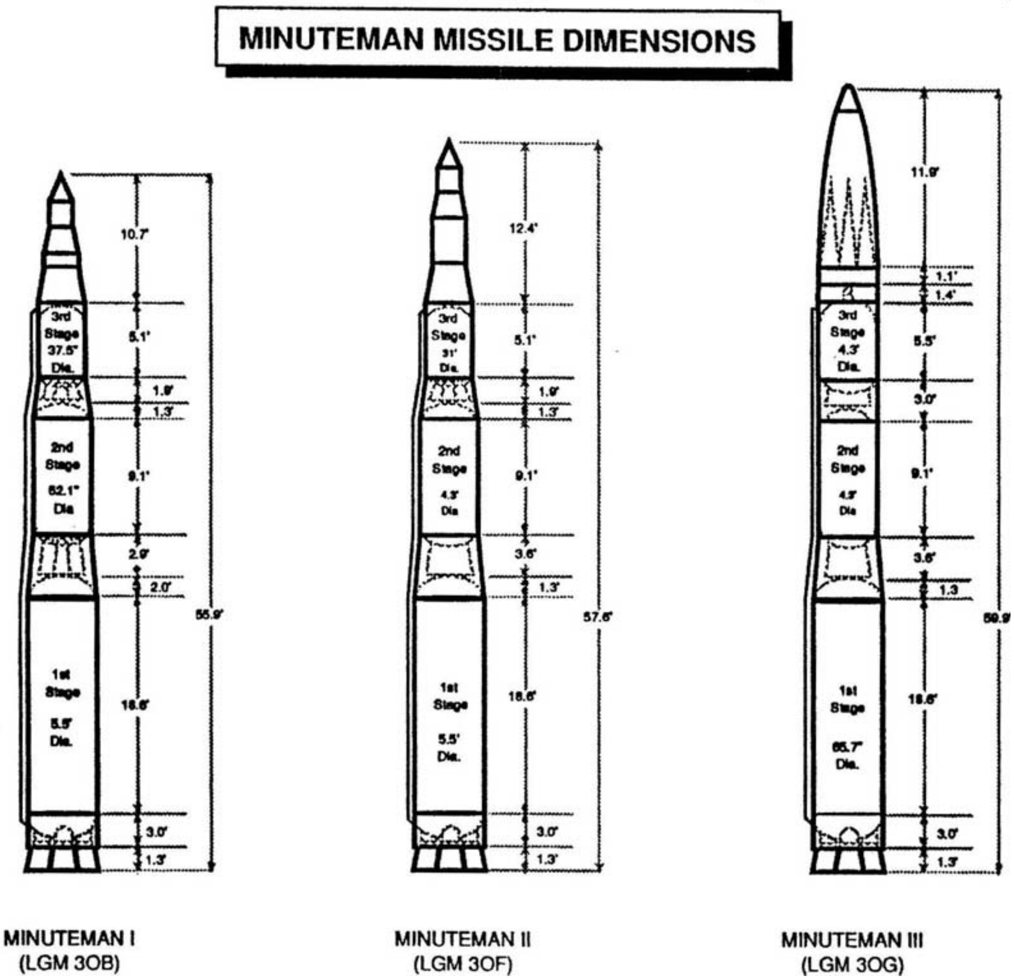

Plate 12. Line drawings showing the evolution of the Minuteman ICBM
(Lonnquest and Winkler, To Defend and Deter: The Legacy of the United States Cold War Missile Program, 243)

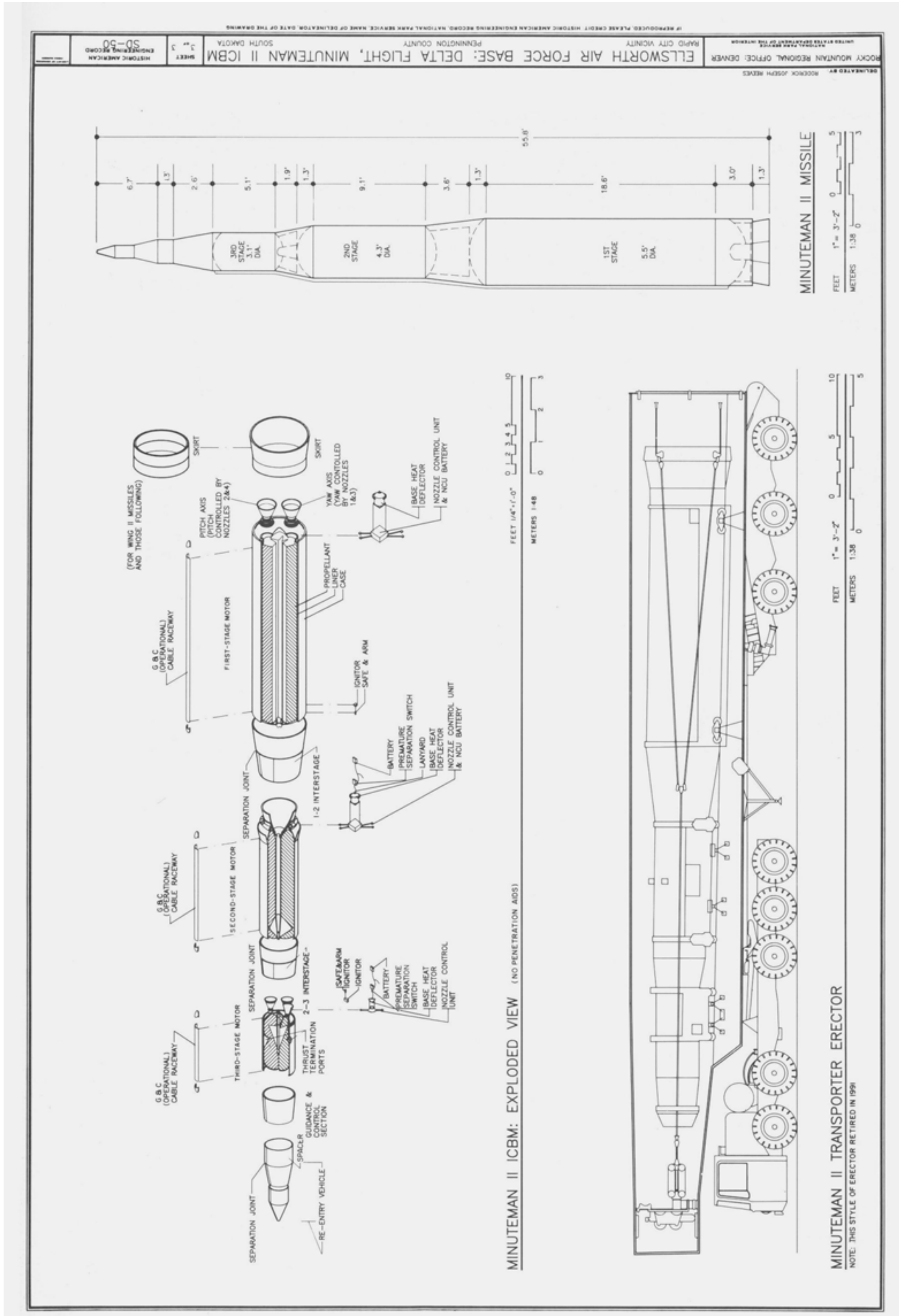

Plate 13. Line drawing showing an exploded view of Minuteman II and the Minuteman II Transporter Erector *(Library of Congress, Prints & Photographs Division, HAER SD-50-sheet 3)*

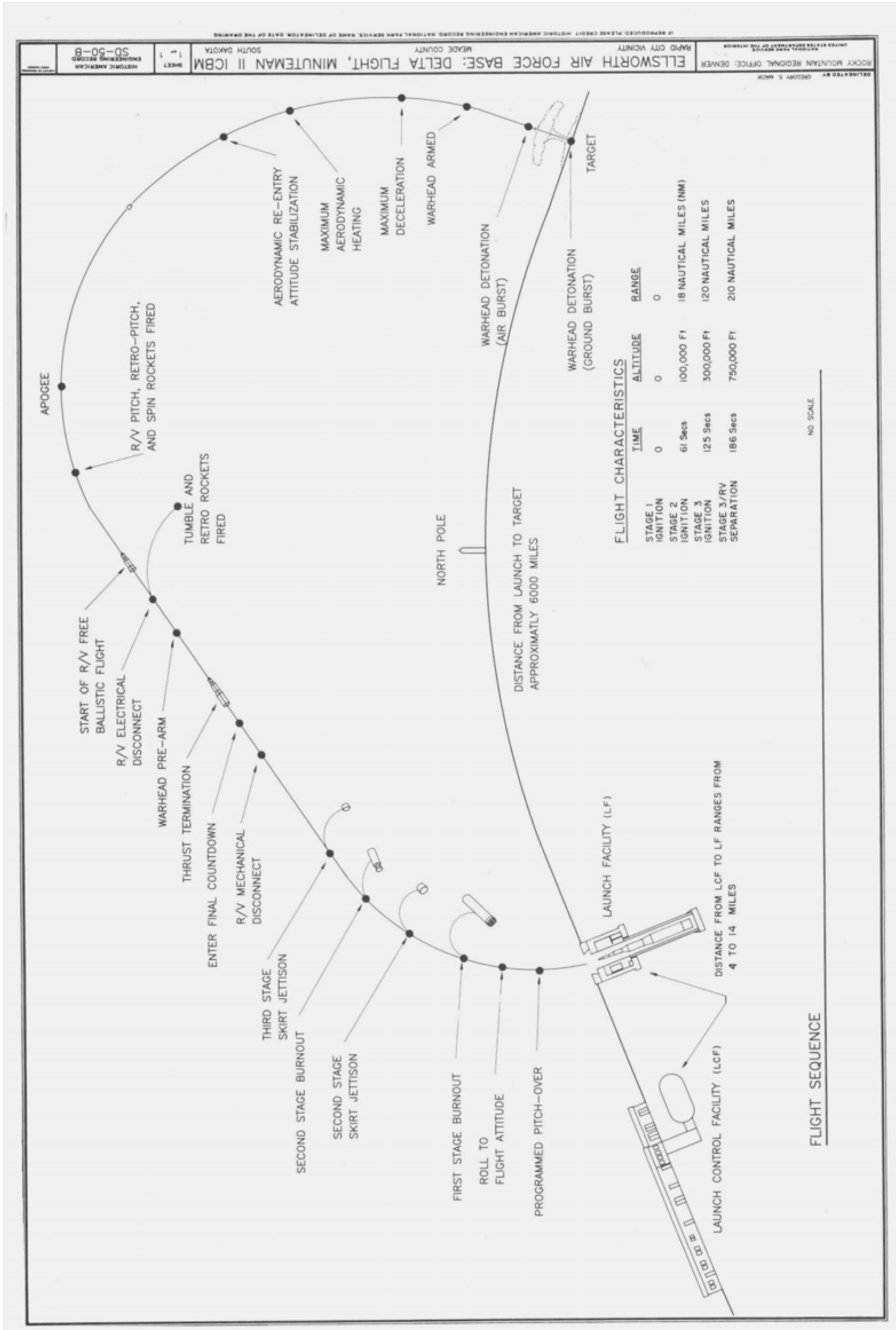

Plate 14. Flight sequence of Minuteman II ICBM
(Library of Congress, Prints & Photographs Division, HAER SD-50-sheet 4)

[i] William Leavitt, "Minuteman: Ten Years of Solid Performance," *Air Force Magazine* 54, no. 3 (March 1971): 24.
[ii] Roman, *Eisenhower and the Missile Gap*, 30-63. For Symington, see Roman, *Eisenhower and the Missile Gap*, 37.
[iii] Neufeld, *The Development of Ballistic Missiles in the United States Air Force, 1945-1960*, 229. Roman, *Eisenhower and the Missile Gap*, 192. For Eisenhower, see Roman, *Eisenhower and the Missile Gap*, 186.
[iv] Malmstrom Air Force Base's Alfa Flight was brought to alert status in conjunction with the origins of the Cuban Missile Crisis. Reportedly President Kennedy referred to Malmstrom's Alfa Flight as America's "First Ace in the Hole." The squadron used this as their motto. "10th Missile Squadron," http://www.globalsecurity.org/wmd/agency/10ms.htm (6 October 2003).
[v] Neufeld, *The Development of Ballistic Missiles in the United States Air Force, 1945-1960,* 186; Neal, *Ace in the Hole*, 28.
[vi] Neal, *Ace in the Hole,* 77.
[vii] General Bernard A. Schriever, interview by Major Lyn R. Officer and Dr. James C. Hasdorff, typed transcript, 20 June 1973, 8.
[viii] Neal, *Ace in the Hole,* 82-88.
[ix] Glasser, interview, 67; Neufeld, *The Development of Ballistic Missiles in the United States Air Force, 1945-1960,* 227; Leavitt, "Minuteman: Ten Years of Solid Performance," 26; Ogden Air Logistics Center, "Minuteman Weapon System History and Description," (Hill Air Force Base, Utah, 1990), 26.
[x] Neufeld, *The Development of Ballistic Missiles in the United States Air Force, 1945-1960,* 227; Neal, *Ace in the Hole,* 78.
[xi] Neufeld, *The Development of Ballistic Missiles in the United States Air Force, 1945-1960,* 227.
[xii] Neal, *Ace in the Hole,* 95-96.
[xiii] Neal, *Ace in the Hole,* 297; Neufeld, *The Development of Ballistic Missiles in the United States Air Force, 1945-1960,* 228-229.
[xiv] Neal, *Ace in the Hole,* 97.
[xv] Neal, *Ace in the Hole,* 97.
[xvi] Neal, *Ace in the Hole,* 103.
[xvii] Leavitt, "Minuteman: Ten Years of Solid Performance," 26.
[xviii] Ogden Air Logistics Center, "Minuteman Weapon System History and Description," 26.
[xix] Stine, *ICBM: The Making of the Weapon that Changed the World*, 239.
[xx] "Closing the Gap," *TIME* (10 February 1961), 16.
[xxi] Neufeld, *The Development of Ballistic Missiles in the United States Air Force, 1945-1960,* 186.
[xxii] Ogden Air Logistics Center, "Minuteman Weapon System History and Description," 26.
[xxiii] Ogden Air Logistics Center, "Minuteman Weapon System History and Description," 36.
[xxiv] Lonnquest and Winkler, *To Defend and Deter: The Legacy of the United States Cold War Missile Program*, 250.
[xxv] Ogden Air Logistics Center, "Minuteman Weapon System History and Description," 25.
[xxvi] For the evolution of American military strategy from Truman through Kennedy, David Alan Rosenberg, "The Origins of Overkill: Nuclear Weapons and American Strategy, 1945-1960, *International Security*, 7, no. 4 (Spring, 1983), 3-71. For "controlled response" and "flexible response," see Andrew Butfoy, "The Marginalisation of Nuclear Weapons in World Politics? The Case of Flexible Response," *Australian Journal*

of Political Science 28, no. 2 (1993): 271-289; and Francis J. Gavin, "The Myth of Flexible Response, United States Strategy in Europe During the 1960s," *International History Review* 23, no. 4 (2001): 847-875.

[xxvii] Stenvick, *The Agile Giant: A History of the Minuteman Production Board*, 48.

[xxviii] William, "Minuteman: Ten Years of Solid Performance," 25.

[xxix] Ogden Air Logistics Center, "Minuteman Weapon System History and Description," 18-19.

[xxx] Stine, *ICBM: The Making of the Weapon that Changed the World,* 239.

[xxxi] Stenvick, *The Agile Giant: A History of the Minuteman Production Board,* 32-33.

[xxxii] Stenvick, *The Agile Giant: A History of the Minuteman Production Board,* 32-33.

[xxxiii] Schwiebert, *A History of the U.S. Air Force Ballistic Missiles*, 246-247; Lonnquest and Winkler, *To Defend and Deter: The Legacy of the United States Cold War Missile Program,* 77.

[xxxiv] Leavitt, "Minuteman: Ten Years of Solid Performance," 25.

[xxxv] Lonnquest and Winkler, *To Defend and Deter: The Legacy of the United States Cold War Missile Program,* 77.

[xxxvi] For more detailed treatment of the Churchill-Truman understanding of this issue, see Alan P. Dobson, "Informally Special? The Churchill-Truman Talks of January 1952 and the State of Anglo-American Relations," *Review of International Studies* (vol. 23) 27-47.

[xxxvii] Lonnquest and Winkler, *To Defend and Deter: The Legacy of the United States Cold War Missile Program,* 78.

[xxxviii] Neufeld, *The Development of Ballistic Missiles in the United States Air Force, 1945-1960,* 201.

[xxxix] Neal, *Ace in the Hole,* 169.

[xl] Schwiebert, *A History of the U.S. Air Force Ballistic Missiles,* 139.

[xli] "The Federal Engineer - Damsites to Missile Sites: A History of the Omaha District, U.S. Army Corps of Engineers," (Omaha, Nebr.: U.S. Army Corps of Engineers, 1985), 193.

[xlii] "The Federal Engineer - Damsites to Missile Sites: A History of the Omaha District, U.S. Army Corps of Engineers," 193.

[xliii] "The Federal Engineer - Damsites to Missile Sites: A History of the Omaha District, U.S. Army Corps of Engineers," 193.

[xliv] Stine, *ICBM: The Making of the Weapon that Changed the World,* 240.

[xlv] "The Federal Engineer - Damsites to Missile Sites: A History of the Omaha District, U.S. Army Corps of Engineers," 194.

[xlvi] James Atwater, "How the Modern Minuteman Guards the Peace," *The Saturday Evening Post* (9 February 1963).

[xlvii] Ogden Air Logistics Center, "Minuteman Weapon System History and Description," 24, 26, 33.

[xlviii] Some Minuteman II missiles may have been upgraded to Mark 12 reentry body. Stine, *ICBM: The Making of the Weapon that Changed the World,* 240; Ogden Air Logistics Center, "Minuteman Weapon System History and Description," 31.

[xlix] Stine, *ICBM: The Making of the Weapon that Changed the World,* 240; Leavitt, "Minuteman: Ten Years of Solid Performance," 25.

[l] Ogden Air Logistics Center, "Minuteman Weapon System History and Description," 26, 33; Leavitt, William, "Minuteman: Ten Years of Solid Performance," 25.

[li] Ogden Air Logistics Center, "Minuteman Weapon System History and Description," 26.

[lii] Irving Stone, "Minuteman: The Best is Yet to Be," *Air Force Magazine* 54, no. 3 (March 1971): 29-30.

[liii] Stine, *ICBM: The Making of the Weapon that Changed the World,* 240.
[liv] Ogden Air Logistics Center, "Minuteman Weapon System History and Description," 26; Stone, "Minuteman: The Best is Yet to Be," 29.
[lv] Edgar Ulsamer, "Minuteman: First Among Equals," *Air Force Magazine* 54, no. 3 (March 1971): 35.
[lvi] Stone, "Minuteman: The Best is Yet to Be," 30; Ogden Air Logistics Center, "Minuteman Weapon System History and Description," 21.