DYESS AIR FORCE BASE, ATLAS F MISSILE SITE S-8
Approximately 3 miles east of Winters,
500 feet southwest of Highway 1770
Vicinity of Winters
Runnels County
Texas

HAER No. TX-25

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

REDUCED COPIES OF MEASURED DRAWINGS

HISTORIC AMERICAN ENGINEERING RECORD
Southwest System Support Office
National Park Service
P.O. Box 728
Santa Fe, New Mexico 87504

HISTORIC AMERICAN ENGINEERING RECORD

DYESS AIR FORCE BASE, ATLAS F MISSILE SITE S-8
Approximately 3 miles east of Winters,
500 feet southwest of Highway 1770
Vicinity of Winters
Runnels County
Texas

HAER No. TX-25

UTM:

Date of Construction: 1962

Engineer: U.S. Army Corps of Engineers

Builder: U.S. Army Corps of Engineers, H.B. Zachary and Brown & Root, Inc.

Present Owner:

Present Use:

Significance: The threat posed by intercontinental ballistic missiles (ICBMs) lay at the heart of nearly all foreign policy decisions during the Cold War Era. The Atlas program produced the United States' first operational intercontinental ballistic missile and served as the template for the technological and organizational aspects of later ICBM programs. The Atlas F missile represents the culmination of this pioneering effort and the Atlas F Missile Site S-8 at Winters, Texas is a representative example of one of the first operational ICBM launch complexes in the United States

Report Prepared by: Sheila McCarthy, Roy McCullough, James Gorski,
Tri-Services Cultural Resources Research Center
U.S. Army Construction Engineering Research Laboratories
2902 Newmark Drive
Champaign, Illinois 61826

Date: February 1996

1. HISTORICAL OVERVIEW

1.1 The Origins of Dyess Air Force Base

On 24 September 1953, just west of the central Texas city of Abilene, the first ceremonial shovelfuls of dirt were spaded to begin construction of the military installation known as Dyess Air Force Base (AFB). Located in Runnels County, Texas, Dyess AFB is the last in a series of military installations constructed in the region, the earliest dating from the mid-nineteenth century.

In 1851 the United States army established a lonely bastion on the Clear Fork of the Brazos River known as Fort Phantom Hill. Located about 14 miles north of where Abilene now stands, Fort Phantom Hill was one of many frontier garrisons established to protect the increasing number of white settlements from the Comanches, upon whose territory they were encroaching. The Army occupied the fort for only three years before abandoning it in 1854.[1] After this brief initial encounter, however, the area that would become Taylor County had little contact with the military for nearly a century. It was during this period that the city of Abilene was founded (1880).

With the outbreak of World War Two (WWII) came renewed interest in the region. By 1940, direct United States involvement in the war seemed likely. That summer, several members of the Abilene Chamber of Commerce formed a Military Affairs Committee, headed by W. P. Wright. This committee hoped to convince the War Department that the west Texas region was an ideal training spot for both ground and air components of the U.S. Armed Forces. After much intense lobbying, and several trips by some of its members to Washington, the Committee

[1]For a discussion of Fort Phantom Hill see John Henry Hatcher, "Seminar Report on the Military Background of the Abilene Country: Abilene and Taylor County, 1852-1952" (Hardin-Simmons University, TX, 1963). The same author's thesis, "A History of Dyess Air Force Base In Its First Decade: A Study in Community Relations" (M.A. thesis., Hardin-Simmons University, TX 1963) also includes a brief discussion of the fort.

succeeded. As a result, in December 1940, construction began on Camp Barkeley, an infantry basic training camp to be located 11 miles southwest of the city of Abilene.[2]

At the same time, the Committee was investigating the possibility of bringing the Army Air Force to Abilene. They argued that, because of the region's climate and topography, Taylor County was an ideal location for Army Air Force operations and training activity. The temperate climate provided good flying weather on a year-round basis while the terrain possessed the particular necessary characteristics deemed essential for air installation and runway planning.[3] The Committee suggested three possible sites for the establishment of tactical air unit training facilities and promised Washington "paved highways, railroad trackage, electric lines, water and gas mains, telephone and bus service will be furnished by the city . . . to the boundary lines of the site selected."[4] These arguments were convincing and in late 1942 the Army Air Force established a fighter pilot training base just outside of Abilene. Runways were completed in the spring of 1943 and the field was officially dedicated that June.

The original mission of the Abilene Army Air Field was to provide final training for P-47 Thunderbolt and P-51 Mustang fighter pilots prior to their entering combat. It was also designated as the regional headquarters for a network of other bases and air strips.[5] Both as a training facility and as a regional headquarters Abilene Army Air Field performed well enough

---

[2]Named after Private David Barkeley, an 18 year-old San Antonian killed two days before the end of World War I. Barkeley was the only Texan to win the Congressional Medal of Honor in that war. See Hatcher, "A History of Dyess Air Force Base," 55.

[3]Hatcher, "Seminar Report," 6, note #16. See also pp 12-16 of this work and Appendix V of Hatcher's "A History of Dyess Air Force Base" for detailed meteorological data compiled ten years later by the Abilene Chamber of Commerce in support of their request for the establishment of a Strategic Air Command base in the region.

[4]Hatcher, "Seminar Report," 57-58.

[5]These included: Alamo Field (San Antonio); Brownwood Army Air Field (Brownwood); Cox Army Air Field (Paris); Hereford (Hereford, Arizona); Temple Army Air Field (Temple); Palacios Army Air Field (Palacios); Gainesville Army Air Field (Gainesville) and Moskogee Army Air Field (Moskogee, Oklahoma). Avenger Army Air Field at Sweetwater, Texas was eventually placed under the joint command of the commander of Abilene Army Air Field. See Hatcher, "Seminar Report," 65.

to prompt one historian to assert the Air Field "made a vital contribution to the winning of World War Two."[6] After the war, however, both Camp Barkeley and the Abilene Army Air Field were closed.[7]

Deprived of the economic stimulation provided by the two military installations, the citizens of Abilene feared that their city was doomed to become a "ghost town".[8] The industrious members of the Abilene Chamber of Commerce, however, were determined not to let Washington forget about their city. In 1950, shortly after the outbreak of the Korean War, members of the National Defense Committee of the Abilene Chamber of Commerce reminded Washington that Abilene possessed a military installation in a good state of preservation that could contribute to the national defense effort. After receiving little response from Washington, the Committee began contacting members of the various major air commands directly.[9]

Their efforts were aided by emergency legislation passed in the summer of 1950, a response to the North Korean attack on South Korea that June. This legislation allowed the Air Force to expand from the 48-wing organization existing before the Korean War, to an 88-wing organization. President Truman subsequently requested a further expansion, asking Congress to authorize a 143-wing Air Force, consisting of 126 combat wings and 17 troop carrier wings. As a compromise, Congress voted to expand the Air Force to 120 wings.[10]

An obvious result of this dramatic increase in force strength was the need to establish a number of new military installations and training facilities. Consequently, Abilene became a focus of renewed attention. In 1952, Curtis LeMay, the Commander-in-Chief of Strategic Air

---

[6]Hatcher, "Seminar Report," 63.

[7]The Abilene Army Air Field was inactivated on 13 January 1947. During its period of inactivity (January 1947-October 1953) the installation became popularly known as 'Tye Air Field' since it was, in reality, located much closer to Tye, Texas than to Abilene. Hatcher, "A History of Dyess Air Force Base," 74.

[8]Hatcher, "Seminar Report," 104.

[9]Hatcher, "A History of Dyess Air Force Base," 71-72.

[10]The 143-wing Air Force would involve a total of 1,000,000 men and 25,000 aircraft. Ibid., 77, note 15.

Command (SAC), became convinced that the establishment of a SAC base in the area would be advantageous and on 3 July 1952 Congress authorized appropriations in excess of $32,000,000 for the first phase in the construction of a new SAC base on the site of the former Abilene Army Field.[11]

On 1 January 1955, the 4021st Air Base Squadron became the first unit to be activated at the new installation.[12] On 14 April 1956, in accordance with an air base memorialization program initiated by the Department of the Air Force, it was announced that the new installation would henceforth be known as Dyess Air Force Base, in honor of Lieutenant Colonel William Edwin Dyess.[13]

1.2 The "Cold War"

On 5 March 1946, Winston Churchill delivered a speech before a large crowd in Fulton, Missouri. "A shadow has fallen upon the scenes so lately lighted by the Allied victory," Churchill proclaimed, "From Stettin in the Baltic to Trieste in the Adriatic, an iron curtain has

---

[11]Hatcher, "A History of Dyess Air Force Base," 88. The total cost of construction at Dyess would exceed $70,000,000 while in 1963 the base was estimated to represent a Department of Defense investment of more than $350,000,000. Hatcher, "Seminar Report," 118.

[12] In its brief eight-year existence eleven major organizations and military establishments have existed at Dyess. These include: 4021st Air Base Squadron; 341st Bomb Wing; 341st Air Base Group; 819th Air Division; 819th Air Base Group; 96th Bomb Wing; 96th Combat Support Group; 64th Troop Carrier Wing; 516th Troop Carrier Wing; 5th Missile Battalion (U.S. Army); Site Activation Task Force. Hatcher, "A History of Dyess Air Force Base," 16, note #3.

[13]Biographical note: Lieutenant Colonel William Edwin Dyess commanded the 21st Pursuit Squadron and served with distinction in the Philippines. On 2 December 1943, during training exercises near Burbank, California, Lieutenant Colonel Dyess' P-38 Lightning caught fire over a heavily populated area. Rather than parachute to safety, Lieutenant Colonel Dyess guided the doomed aircraft onto a vacant lot where it crashed. By sacrificing his own life, Lieutenant Colonel Dyess saved the lives of many others. Lieutenant Colonel Dyess' life and exploits are recounted in his memoirs, The Dyess Story: The Eyewitness Account of the Death March From Bataan and the Narrative of Experiences in Japanese Prison Camps and of Eventual Escape (New York: G. P. Putnam's Sons, 1944).

descended across the Continent."[14] This famous speech, delivered in response to a particularly bellicose presentation by Stalin less than one month earlier, is usually presented as a convenient signpost by which to mark the beginnings of the Cold War. In fact, tensions between the United States and the Soviet Union had been steadily increasing for some time prior to Churchill's famous "Iron Curtain" speech. Fundamental ideological differences and, more specifically, disputes over the post-war political configuration of Europe made it inevitable that these former allies, the only two superpowers to emerge from the carnage of World War II, would eventually become adversaries.

In 1947 President Truman appeared before Congress in an effort to persuade them to authorize economic assistance for Turkey and Greece, two countries viewed as being threatened, albeit in different ways, by communist expansion. In the course of his speech Truman articulated a new foreign policy doctrine that publicized the concept of a global, ideological struggle between the United States and the Soviet Union and portrayed the latter as a dangerous, aggressive nation whose expansionist tendencies must be checked. To that end, Truman asserted that "it must be the policy of the United States to support free peoples who are resisting attempted subjugation by armed minorities or by outside pressures . . . [W]e must assist free peoples to work out their own destinies in their own way."[15] The "Truman Doctrine," as this policy came to be called, would form the cornerstone of American foreign policy for the next two decades.

The next two years were trying times for the Truman administration. In February 1948 the communists gained control in Czechoslovakia. In June of that same year Stalin seized control of the highways and railroads providing access to West Berlin. Truman's response was immediate and forceful. He initiated a massive airlift that lasted 324 days and delivered an

---

[14]Winston Churchill, speech delivered at Fulton, Missouri, 5 March 1946. The text of this famous speech is reproduced in Norman A. Graebner, Cold War Diplomacy, 1945-1960 (New York: D. Van Nostrand Company, Inc., 1962), 144-148.

[15]The text of this momentous speech is reproduced in Graebner, 149-52.

average of 13,000 tons of supplies per day.[16] In July, he transferred to England two groups of B-29 bombers, the plane designated to carry atomic bombs. Truman assured his close advisors that, although he prayed the bomb would not have to be used, "if it became necessary, no one need have a misgiving but that he would do so."[17]

The year 1949 subjected the Truman administration, and the American nation, to a number of severe shocks. In August of that year it was announced that Chang Kai-shek's Nationalist government in China had fled to Formosa and that China was now in the hands of the communists. Just forty-nine days after this announcement, on 23 September, it was announced that the Soviets had exploded their first atomic weapon. This was years earlier than anyone had thought possible. Most American scientists had predicted 1952 as the earliest possible date for the Soviets to perfect the weapon, with some not expecting them to succeed before 1955.[18] One scientist admitted he was "flattened" by the announcement, and commented, "There is only one thing worse than one nation having the atomic bomb, [and] that's two nations having it."[19]

These troubling developments abroad, along with mounting political pressures at home, prompted Truman to initiate a thorough review of American foreign policy. The result was the National Security Council report commonly known as NSC-68. Issued in April 1950, NSC-68 laid out, in no uncertain terms, the assumptions that would provide the basis for the future relationship between the United States and the Soviet Union. Commenting on the recent changes in the global balance of power, the report asserted, "What is new, what makes the continuing crisis, is the polarization of power which inescapably confronts the slave society with the free." "[U]nlike previous aspirants to hegemony," the report continued, this "slave society" that was the Soviet Union was "animated by a new fanatic faith, antithetical to our own and seeks to impose

---

[16]Walter LaFeber, America, Russia, and the Cold War, 1945-1984 (New York: Alfred A. Knopf, 1985), 77.

[17]Ibid.

[18]Eric F. Goldman, The Crucial Decade-and After: America, 1945-1960 (Vintage Books: New York, 1960), 100.

[19]Ibid.

its absolute authority" in areas under its control. The Soviet leadership was determined to eliminate any opposition to their authority, asserted the authors of the report, and "To that end Soviet efforts are now directed toward the domination of the Eurasian land mass."[20] To prevent future Soviet expansion and to reverse previous Soviet successes, NSC-68 called for a major expansion of American military power, including the development of hydrogen bombs to offset the possibility of the Soviets developing an atomic arsenal.

The uncompromising nature of NSC-68 did not sit well with all of the President's advisors. The two top State Department experts on Russia, George Kennan and Charles Bohlen, protested against the harsh phraseology contained in the report, arguing that, in fact, Stalin had no grand designs for world conquest.[21] Even the Secretary of Defense, Louis Johnson, objected, arguing that the policies suggested in the report would bankrupt the country.[22] These objections, however, were rendered largely immaterial when two months later, on 24 June 1950, North Korean military units poured across the 38th parallel, precipitating the first serious conflict of the post-war period to involve the United States.

The invasion of South Korea seemed to validate American fears concerning the dangers of communist expansion. The subsequent frustrations experienced during the course of the war by American's conventional forces, and perhaps more important, the considerable costs of their support, suggested the desirability of developing an alternative method of countering communist aggression around the globe short of a massive deployment of combat troops. Nuclear weapons seemed to combine the benefits of deterrence with those of cost-efficiency. This new increased emphasis on nuclear weapons is most evident in the early years of the Eisenhower administration. In his State of the Union address of 1953, President Eisenhower stated his belief that "To amass military power without regard to our own economic capacity would be to defend ourselves

---

[20]Cited in LaFeber, 96.

[21]LaFeber, 96.

[22]Ibid.

against one kind of disaster by inviting another."[23] By 1954, Eisenhower had managed to slash his predecessor's military budget by one-third while at the same time doubling the nation's nuclear stockpile.[24] In the early 1950s this stockpile consisted solely of weapons delivered to their targets by bombers, particularly the massive B-52 bomber. By the time of the Eisenhower presidency, however, research was already well under way for the development of a radically different method of delivering such weapons to their targets. One of the defining characteristics of the 1950s was the race to develop an operational ballistic missile system.

1.3 The Development of United States Ballistic Missile Programs

On 3 October 1942, a German V-2 missile successfully completed a flight test of 120 miles, thus becoming the world's first long-range ballistic missile. Less than two years later the missile made its combat debut when the Germans launched several against London. By the end of March 1945, the Germans had launched more than 3,700 V-2 missiles, 1,100 of them directed against targets in England.[25] With the German V-1 and V-2 missiles terrorizing London, the United States initiated a research program aimed at matching the enemy's technology.

In 1945 and 1946, the Army Air Forces negotiated a number of contracts with industry for a variety of missiles. These contracts fell into four categories: air-to-air, air-to-surface, surface-to-air, and surface-to-surface.[26] Contracts were subsequently awarded to Northrop Aircraft, Incorporated for a study and research project on both a subsonic (the "Snark") and a supersonic (the "Boojum") medium to long-range (1500-5,000 miles) surface-to-surface missile, and to North American Aviation, Incorporated for a surface-to-surface missile with a range of

---

[23]Cited in Edgar M. Bottome, The Missile Gap: A Study of the Formulation of Military and Political Policy (Rutherford: Farleigh Dickinson University Press, 1971), 22.

[24]LaFeber, 155.

[25]Jacob Neufeld, Ballistic Missiles in the United States Air Force, 1945-1960 (Washington, D.C.: Office of Air Force History, 1990), 41.

[26]These categories were first suggested in 1945 by engineers at Wright Field, Ohio. Ibid., 8.

175-500 miles. In April, Bell Aircraft Corporation was awarded a contract to conduct a research and design study for a 100-mile range, subsonic, air-to-surface missile called the "Rascal." That same month the Army Air Forces awarded a research and study contract to the Consolidated Vultee Aircraft Corporation (Convair) for a 1500-5,000 mile-range, surface-to-surface missile, in both a subsonic and supersonic version. This last program, designated Project MX-774B, laid the groundwork for the eventual development of the Atlas Intercontinental Ballistic Missile (ICBM).[27] All told, there were no less than twenty-six guided missile programs initiated in 1946.[28]

Despite this initial flurry of activity, however, the ballistic missile development program was given a relatively low level of priority until 1950. This was the result of a number of factors, including a notable lack of enthusiasm among key, conservative-minded individuals.[29] A sense of complacency prevailed among many officials, engendered by the belief that the United States enjoyed a clear military advantage over the Soviet Union.[30] In addition, certain technological problems cast doubt upon the utility of such weapons. Of particular concern were the inability to mount an attractive payload, in terms of weight versus yield, and the need to devise an effective way to protect this payload from the intense heat generated upon re-entry into the atmosphere. This combination of complacency and skepticism resulted in a drastic reduction in funds earmarked for the missile development program. In 1947 this forced the cancellation

---

[27]Headquarters of the Strategic Air Command, Office of the Historian, SAC Missile Chronology, 1939-1988 (Nebraska: Offutt Air Force Base, 1990). See also the charts in Neufeld, 28-33.

[28]Ernest Schweibert, A History of the U.S. Air Force Ballistic Missiles (New York: Frederick Praeger Publishers, 1965), 52.

[29]Ibid., 40-41.

[30]A U.S. intelligence report of November 1945 analyzed the military weaknesses of the Soviet Union and concluded that Stalin was unlikely to risk a major armed conflict for at least fifteen years. See also Admiral William Leahy's statement of August 19, 1945, broadcast on national radio, in which he asserted that the United States possessed a more powerful navy than any other two fleets in existence, the best equipped ground force in the world, the "largest and most efficient air force," and "with our British allies, the secret of the world's most fearsome weapon." Cited in LaFeber, 26-28.

of many missile research and study contracts and in June 1947 the "Operational Requirements for Guided Missiles" placed long-range surface-to-surface missiles at the "fourth level of effort", putting them below defensive missiles and missiles used to increase the striking power of bombers and fighters.[31]

The progress of missile development was further hampered by serious inter-service rivalries. The Army regarded missiles as evolutionary extensions of artillery and sought to separate the production of missiles and aircraft. The Army Air Force, on the other hand, claimed that missiles were simply advances in aircraft technology with control and guidance equipment replacing the pilot.[32] In 1946, the Army asked for operational control over all surface-launched missiles, but the Army Air Force was willing to concede only short-range, or close support missiles.[33] On 26 July 1947, President Truman signed the National Security Act that, by creating a National Military Establishment, abolished the War Department and replaced it with two separate departments: the Department of the Army and the Department of the Air Force.[34] With this new organizational setup it now became imperative that specific responsibilities for the missile programs be determined. On 15 September 1947, the "Army-Air Force Agreements as to the Initial Implementation of the National Security Act of 1947" gave the Air Force control over all surface-to-surface "pilotless aircraft" and "strategic missiles" with the latter defined as missiles "employed against targets whose destruction would not directly affect Army tactical operations." The Army was given control of all tactical missiles, or those used in support of land operations.[35]

---

[31]Ibid., 45.

[32]Neufeld, 17. It should be noted that a somewhat less intense rivalry also existed between the Army Air Forces and the Navy. Ibid., 21-22.

[33]Ibid., 23.

[34]Ibid., 52.

[35]Ibid.

Despite this initial agreement, however, operational responsibility for United States missile forces remained a contentious issue. In March 1949, the quarrel erupted again when the Army proposed that it should control all surface-launched missiles, while the Navy controlled all ship-launched missiles, and the Air Force controlled all air-launched missiles.[36] Secretary of Defense Louis A. Johnson referred the matter to the Joint Chiefs of Staff. This body recommended a plan that would "1) assign to the Army and Navy all surface-to-air missiles that extended the range of antiaircraft artillery; 2) assign to the Air Force and Navy all surface-to-air missiles that supplemented interceptor aircraft; and 3) assign to the Army and Navy all short-range surface-to-surface missiles, which replaced field artillery." Long-range surface-to-surface missiles were not mentioned in this recommendation but it was understood that since the Air Force retained responsibility for strategic bombardment such missiles would logically fall under their operational control.[37]

As a result, it was the Air Force and not the Army who, in January 1951, established another study project with Convair, known as project MX-1593. This project was devoted to the development of an intercontinental rocket-powered missile with a minimum range of 5,500 nautical miles,[38] a minimum speed of Mach 6 over the target, a Circular Error of Probable (CEP) of 1500 feet,[39] and the capability of carrying an 8,000-pound nuclear warhead. In September of that year Convair produced a design for a missile that would be 160 feet long and 12 feet in diameter. This missile was expected to require as many as seven rocket engines to generate the necessary thrust.[40]

---

[36]Ibid., 53.

[37]Ibid.

[38]A nautical mile equals a distance of 6080.2 feet.

[39]Neufeld, 54. A Circular Error of Probable is the radius of a circle within which half of all the weapons targeted can be expected to land.

[40]Ibid., 65-66.

An important breakthrough in the missile program was achieved on 1 November 1952 when the first experimental hydrogen fusion device was detonated at Eniwetok in the Pacific Ocean. Designated the "Mike" shot, this event was of great significance for the future development of intercontinental ballistic missiles. Before Eniwetok, lighter warheads entailed lower yields that, in turn, translated into greater accuracy requirements for the missile guidance system. The promise of lighter, but still powerful warheads, meant that less accurate missiles could be designed. One month after Eniwetok, as a result of "the anticipated developments in atomic warheads . . . which should permit the carrying of larger payloads," a committee established by the Air Force Scientific Advisory Board recommended that certain of the characteristics be modified.[41] In 1953, it was determined that the Atlas missile, as it was now called, would be 110 feet long, 12 feet in diameter, weigh 440,000 pounds (409,000 pounds of which would be propellants) and carry a 3,000 pound warhead. The range and CEP of this new design remained unchanged (1500 feet CEP, range of 5,500 nautical miles). The missile would require 4 first-stage engines (each generating 133,200 pounds of thrust) and a central sustainer rocket (generating 123,3000 pounds of thrust.)[42]

On 1 March 1954, the "Bravo" test explosion in the Marshall islands provided positive evidence that lighter, more powerful warheads were indeed possible.[43] These achievements "revolutionized the ballistic missile program" and resulted in some fundamental changes in basic missile requirements. Thus, in January 1955, the missile design was modified once again. The new configuration, designated the XSM-65, would be a 240,000 pound vehicle, powered by two engines (each delivering 135,000-pounds of thrust) and a sustainer engine capable of generating

---

[41]"Report of the USAF Scientific Advisory Board's Ad Hoc Committee on Project Atlas," 30 December 1952, records of the Office of the Chief of Ordnance (hereafter RG 156), carton #12, "Records Relating to the Army Guided Missiles Program, 1940-1962," Folder GM 224, "USAF Long Range Rocket Program." Unless otherwise noted, references are to materials deposited at the Federal Records Center in Suitland, Maryland.

[42]Neufeld, 66, 78.

[43]Ibid., 98.

60,000-pounds of thrust. The CEP of the new missile would be five nautical miles.[44] The first operational version of the Atlas missile was designed according to these specifications.[45]

The rapid growth and increased importance of the United States ballistic missile program necessitated the establishment of a number of new organizations to oversee its progress. In 1953, the Department of Defense asked Trevor Gardner, then Special Assistant for Research and Development to the Secretary of the Air Force, to form a committee to review and evaluate the Air Force missile programs. Gardner gathered together 11 prominent scientists to serve on this committee, officially known as the Strategic Missiles Evaluation Committee but more popularly referred to as the 'Teapot Committee'.[46] Thoroughly aware of the implications of Eniwetok this committee, in February 1954, recommended that a special Air Force organization be established to accelerate the ICBM program and to "simplify the normal controls and channels of coordination within the Air Force."[47] In making this recommendation the committee undoubtedly had in mind the conclusions, eight years earlier, of Theodore von Karman, then Director of the California Institute of Technology's Guggenheim Aeronautical Laboratory and the Army Air Force Scientific Advisory Group. In 1945, Karman, at the request of the President, conducted a survey of the achievements in science and technology by all nations, with a special emphasis on the German V-1 and V-2 missiles. Among his many other findings, published in a monumental thirty-three volume report entitled Toward New Horizons, Karman concluded the success of the German operation lay primarily in the fact that they had organized "under a single leadership...experts in aerodynamics, structural design, electronics, servomechanisms, gyros and

---

[44]Ibid., 125. To avoid the possibility of failure to ignite the second stage, all engines would ignite at lift-off. For this reason, the Atlas is known as a 1 1/2-stage rocket.

[45]Schweibert, 60.

[46]The members of this important committee were John von Neumann, who served as Chair, Simon Ramo, Dean Woolridge, Clark Millikan, Charles Lauritsen, Louis Dunn, Hendrick Bode, Allen Puckett, George Kistiakowski, Jerome Wiesner, Lawrence Hyland. Colonel Bernard A. Schriever served as the committee's military representative. Neufeld, 99.

[47]Schweibert, 73.

control devices, propulsion, in fact, every group required for the development of a complete missile."[48] It was exactly this kind of centralized control the 'Teapot Committee' recommended. If this was done, and if the missile program was given increased priority and "limited only by technical progress and not by funding," the committee believed an operational ICBM could be achieved within six to eight years.[49] In response to these recommendations, the Air Research and Development Command (ARDC) established the Western Development Division (WDD) in Inglewood, California. Brigadier General Bernard Schriever was placed in command of WDD and this organization was made directly responsible for the Atlas ICBM development program.

In January of 1955, the Western Development Division-Special Aircraft Projects Office board, in cooperation with the Air Material Command-Air Research Development Command board at Wright-Patterson Air Force Base in Ohio, evaluated potential contractors for the major ICBM subsystems of the Atlas. Convair was awarded the contract for the airframe. North American received the contract for the propulsion system. The nose cone re-entry vehicle contract was awarded to General Electric. Burroughs was responsible for the computer system. Two different guidance systems were contracted: General Electric was responsible for developing a radio-inertial guidance system, while A. C. Spark Plug examined the possibilities for an all-inertial guidance system.[50]

One month after these contracts were awarded the Technological Capabilities Panel of the Science Advisory Committee, Office of Defense Management, issued the report known as the Killian Report, named after the Chairman of the Committee, James R. Killian, Jr., President of the Massachusetts Institute of Technology. The purpose of the report was to present an analysis of the comparative progress of ballistic missile programs in the United States and the Soviet Union. While the report acknowledged the current superiority enjoyed by the United States, it expressed concern over an alarming potential disparity in missile forces that could develop as

---

[48]Ibid., 43.

[49]The full text of this report can be found in Neufeld, Appendix I.

[50]Ibid., 132.

early as 1959 unless the United States took immediate steps to fill certain "gaps" in its missile program.[51] Fear of this "missile gap" prompted the committee to recommend that the United States ICBM program should become "a nationally supported effort of the highest priority."[52] Both the National Security Council and the Joint Chiefs of Staff agreed with this recommendation and, in September 1955, President Eisenhower issued a directive assigning the highest national priority to the ICBM research and development programs.

The supposed missile gap remained a constant concern for United States officials and citizens alike. This concern became outright anxiety when, on 4 October 1957, the Soviet Union successfully launched "Sputnik", the world's first artificial satellite. More significant than the satellite itself, however, was the powerful rocket booster that lifted Sputnik into orbit, for this indicated that the Soviets possessed the capability of delivering a powerful weapon to targets within a 4,000 mile radius.[53] In response to the launching of Sputnik strategic air force units were dispersed and placed on alert and short-range Jupiter missiles were installed in Turkey and Italy to offset the long-range Soviet weapons. The general state of anxiety caused by Sputnik led to other 'gaps' being "suddenly discovered in everything from missile production to the teaching of arithmetic at the pre-school level."[54]

Perhaps most important, the launching of Sputnik created an increased sense of urgency within the United States ballistic missile program. Money was poured into the program and meticulously plotted timetables were severely compressed. A concept of "concurrency" was adopted in which missile development and the construction of launch support facilities were

---

[51]Bottome, 29.

[52]Ibid. Intermediate Range Ballistic Missile (IRBM) programs were also initiated, resulting in the Thor and Jupiter programs.

[53]LaFeber, 195.

[54]Ibid.

conducted simultaneously, which, as one might expect, resulted in a number of problems.[55] These dramatic new measures were not without results. On 31 October 1959, the first American ICBM equipped with a nuclear warhead, an Atlas D, went on alert at Vandenberg Air Force Base, California.

1.4 Development of the Atlas

On 9 September 1959, following the first successful launch of an Atlas D series missile at Vandenberg Air Force Base, California, General Thomas S. Power, Commander-in-Chief, Strategic Air Command, declared the Atlas intercontinental ballistic missile to be operational. Events proceeded quickly and by the summer of 1962, there were 11 operational missile sites and seven operational Atlas missile squadrons.[56]

This remarkable achievement was facilitated by the award of separate contracts for the design and development of each of the major subsystems of the Atlas. These associate contractors included Rocketdyne (engines), General Electric Company and the Burroughs Corporation (radio-inertial guidance), American Bosch Arma Corporation (all-inertial guidance system), the A. D. Little company (propellant loading), and the Kellog Switchboard and Supply Company (communications). Convair was designated the "systems integrator" for the Atlas missile project as a whole and was also responsible for the design and development of the missile's air frame, autopilot system and numerous other components. In addition, Convair was responsible for missile assembly, the conduct of captive and flight tests for the Air Force, and the activation of new Atlas bases under the direction of the Air Force Ballistic Missile Division.

The establishment, and rapid expansion of the United States ICBM force was the product of a complex, yet very rapid, program of research and development that witnessed a number of

---

[55]A more detailed discussion of these problems is provided in the section of this report dealing with the construction of launch facilities.

[56]Three at Francis E. Warren AFB, Wyoming, one at Forbes AFB, Kansas, one at Offutt AFB, Nebraska, one at Fairchild AFB, Washington, and one at Vandenberg AFB, California. Hatcher, "A History of Dyess Air Force Base," 166.

innovations in both the technological and the organizational spheres. One of the more problematic issues confronting scientists in their efforts to design an airframe for intercontinental ballistic missiles was the question of weight. The greater the weight of the missile, the more limited its range and the greater its propellant requirement for liftoff. This increase in the propellant requirement, of course, added to the total weight of the missile. It has been estimated that at liftoff, six out of every ten pounds of propellant were consumed for no purpose other than to lift the propellant itself.[57]

The most significant innovations regarding the problem of missile weight were suggested in 1946 by Karel Bossart, a structural engineer and project manager of Convair's Project MX-774, one of the earliest ballistic missile projects. Improving upon the design used for the German V-2, Bossart eliminated the double wall arrangement of the fuel tanks and instead stored the propellant in two individual metal enclosures mounted inside the missile. This system had the dual benefit of increasing the missile's fuel capacity while also eliminating the internal fuel tanks, as the walls of the new tanks would themselves now form the outer wall of the fuselage. "What emerged," says one author, "was a sort of flying propellant tank with a power plant in the rear and an instrumentation package up front."[58] Bossart's second major improvement over the V-2 design was in suggesting only the warhead itself be protected against the heat of reentry. The German missile had been designed so the entire missile could withstand the considerable heat generated upon reentry into the atmosphere. A considerable savings in weight could be effected by protecting only the nose cone. In addition, this selective protection would also reduce the drag on the missile, improving its range and accuracy.[59] Finally, Bossart removed the internal metal stiffening rods used in the V-2. The missile obtained the necessary structural rigidity through the use of nitrogen gas pressure. Nitrogen gas served a dual purpose in that it was also

---

[57]John Chapman, Atlas: The Story of a Missile (New York: Harper and Brothers, 1960), 19.

[58]Neufeld, 47.

[59]Ibid.

used to force the liquid oxygen and alcohol fuel out of their tanks.[60] Bossart's innovations improved upon the V-2's airframe-to-propellant weight ratio by a factor of three.[61] Further weight savings were obtained by fashioning the propellant tanks from tough, lightweight stainless steel, thinner than a dime. These tanks, as has already been noted, also formed the outer metal skin of the Atlas airframe and were kept under constant pressure or in a stretch condition to prevent them from collapsing of their own weight. Skin gauges varied throughout the structure, but the heaviest gauge was less than .04 of an inch.

Bossart was also responsible for a major innovation in engine design, namely, the gimballed, or swivelling, engine. Prior to this development, flight was controlled by the insertion of movable vanes in the exhaust system. This had the drawback, however, of interfering with the exhaust flow, significantly reducing the thrust. The gimballed engines, provided a better means of control over the flight of the missile, and also resulted in a more efficient performance. The first demonstrated use of gimballed engines was the launching of the first of three rocket research test vehicles constructed by the Convair Corporation on 13 July 1948.

The propellant used in the Atlas F missile was a mixture of liquid oxygen, or 'LOX,' and RP-1, a kerosene-based fuel. The bottom of the two tanks within the missile was filled with 12,000 gallons of RP-1 while the upper tank was filled with 18,600 gallons of LOX.[62] The need for a rapid response to an enemy attack required that the fueling process be accomplished as quickly as possible. The liquid oxygen was pumped into the tank during countdown at a rate of 5,000 gallons per minute.[63] The volatile properties of LOX, however, made the propellant loading process somewhat hazardous. LOX does not burn by itself but it does support and

---

[60]Chapman, 32.

[61]Neufeld, 47.

[62]Congress, Senate, Preparedness Investigating Subcommittee of the Committee on Armed Services, Series of Explosions of Air Force's Atlas F Intercontinental Ballistic Missiles. 88th Cong., 2nd sess., 1964, 6.

[63]Congress, Senate, Preparedness Investigating Subcommittee of the Committee on Armed Services, Construction Cost of Air Force Atlas and Titan Missile Sites. 87th Cong., 2nd sess., 1962, 4.

rapidly accelerate the combustion of all flammable materials. Therefore, the mixture of LOX with any hydrocarbon substance creates a potential 'fire-and-explosion' hazard. An explosive gel forms when substances high in hydrocarbon content, such as grease and lubricants, come into contact with LOX. This gel can be ignited by static electricity, mechanical and fluid friction or shock waves. This resulted in a very hazardous situation because of the many moving mechanisms within the missile facility that required lubricants. Several launch complexes were destroyed by explosions resulting from errors in judgment or mechanical malfunctions during the propellant loading process.[64]

The most significant development in the guidance system of the Atlas missile was the switch from the 'radio-inertial' guidance system, employed on the Atlas D series missiles, to the 'all-inertial' guidance system used on the Atlas E and F series. The radio-inertial system employed a Doppler radar consisting of a ground transmitter and a network of four receiving stations, laid out in the pattern of a cross. Tracking radar could not be used during the initial stages of the missile's ascent, however, due to reflections from the ground. During this brief period the missile was guided by a gyro-stabilized autopilot. In contrast, the all-inertial guidance system, as its name suggests, was an entirely independent system. The system was completely contained within the missile itself. There were a number of advantages and disadvantages to both of these guidance systems. For example, the radio-inertial, or 'command', guidance system had a degree of accuracy estimated at somewhere between three and ten times greater than the all-inertial system; the size and weight of the airborne equipment was considerably less than that required for an all-inertial system; and the missiles were deemed more reliable, the result of continuous ground control. On the other hand, the extensive antenna facilities required for the command guidance system required a particular kind of terrain and made those missile sites

---

[64]On 1 June 1963, Atlas F launch complex 579-1 of the 6th Strategic Aerospace Wing at Walker AFB, New Mexico, was destroyed by such an explosion during a propellant loading exercise. On 13 February 1964, launch complex 579-5 was destroyed in a similar explosion as was launch complex 579-2 on 9 March 1964. On 14 May 1964, Atlas F launch complex 577-6 of the 11th Strategic Aerospace Wing at Altus AFB was destroyed. For details see U.S. Senate, Preparedness Investigating Subcommittee on Armed Services, Series of Explosions of Air Force's Atlas F Intercontinental Ballistic Missiles, 88th Congress, 2nd Sess., 1964.

difficult, if not impossible, to protect, or 'harden' effectively. The antenna structures also made radio-controlled missiles less adaptable to mobile launching platforms, an idea seriously considered at the time. In addition, enemy jamming of inertial guided missiles was, as far as was known at the time, impossible. The all-inertial guidance system also permitted a salvo capability that was not possible in situations where each missile had to be individually controlled.[65] Finally, the need for extensive antenna installations for ground control in the command guidance system required launchers to be grouped around central control facilities that, in turn, increased their vulnerability to enemy attack. The switch to the all-inertial system, accomplished by 1959, allowed launchers to be individually sited and dispersed.

The research and development of the various components and subsystem of the Atlas missile resulted in several groundbreaking achievements in missile technology: the thin-skin construction of the air frame, permitting heavier payloads and longer ranges; the identification and examination of problems inherent in the staging process; the use of gimballed engines to aid in directing the missile; and the use, in the Atlas F, of an all-inertial guidance system are just a few of the innovations realized in the Atlas program. In addition, there were numerous advances in several support areas. Perhaps most important were the significant improvements in the handling of liquid oxygen. The propellant loading process was made much more rapid and the containment control LOX systems improved, as a direct result of the Atlas program, to the point where hydrocarbons could be detected down to the presence of two micrograms of hydrocarbons per milliliter.[66]

In the course of this research, a series of prototype missiles were developed to test the various components and subsystems that would go into the final operational version of the missile. The first operational Atlas missile, the series D, was preceded by the Atlas A, Atlas B,

---

[65]For good discussions of the relative merits of the two guidance systems see Philip Klass, "How Command Guidance Controls Atlas," Aviation Week, 28 April 1958, 74-77 and Klass, "ICBM Guidance Techniques Compared," Aviation Week, 2 May 1960, 159-160.

[66]Alexander 1963, 54-56.

and Atlas C. Subsequent modifications in the missile launch and control facilities resulted in the production of the Atlas E and Atlas F.

The series A was designed to test the basic design concepts of the missile, including the overall performance and compatibility of the booster engines, the autopilot system, the airframe, and the pneumatic, hydraulic and electrical systems. The first wholly successful test flight occurred on 17 December 1957. There were a total of eight test flights of the series A between 11 June 1957 and 3 June 1958. Four of these flights were rated as 'successes' and the four others were rated 'partial successes'.[67]

The series B missile carried practically all the airborne systems intended for use on the initial operational weapon system, including the complete propulsion system (designed by Rocketdyne Division of North American Aviation) and the guidance system (designed by General Electric-Burroughs). The basic objectives of the series B were to test the performance of the three-engine propulsion system and the staging of the booster engines, to evaluate the nose-cone separation mechanism, and to determine the performance of the radio-command guidance system. The first successful launch of a series B missile, which also marked the first successful staging of any missile, occurred at Cape Canaveral Air Force Base, Florida, on 2 August 1958. Four months later, the first full-range flight test of a series B was successfully performed at the base. Between 14 July 1958 and 2 February 1959 there were a total of ten test flights of the series B, six classified as successes, two as partial successes and two as failures.[68]

The first series C Atlas ICBM was launched from Cape Canaveral on 23 December 1958. This series incorporated a number of systems and components improved or redesigned as a result of the A and B-series experiences. These improvements included the use of a lighter gage airframe skin (.020-.040-inches), as well as a number of upgrades in the propulsion system. Two of the major objectives of this series were to test the accuracy and reliability of the General

---

[67]A flight that achieved 75% or more or more of its test objectives was considered successful, 25% to 75% was considered a partial success, below 25% was considered a failure. George Alexander, "Atlas Accuracy Improves as Test Program is Completed," Aviation Week and Space Technology, 25 February 1963, 60.; Chapman, 119.

[68]Alexander 1963, 67.

Electric Mod-3 radio-inertial guidance system and the reliability and adequacy of range safety procedures and equipment. Of the six series C test flights, three were classified as successes, two as partial successes, and only one as a failure.[69]

The first successful launch of a series D Atlas, the series the Air Force intended to deploy operationally, occurred at Cape Canaveral AFB on 28 July 1959. The success of this and a subsequent flight, on 11 August, prompted the Air Force to schedule a test launching conducted by a Strategic Air Command crew at Vandenberg Air Force Base, California. This launch was successful and, on 9 September 1959, General Thomas S. Power, Commander-in-Chief, Strategic Air Command the Air Force, declared the Atlas ICBM to be operational. The results of the Atlas D series tests were twenty-seven successes, two partial successes and three failures.[70]

The first successful launch of a series E Atlas took place on 24 February 1961 at Cape Canaveral. This series incorporated innovations in the booster engines and in the autopilot system. The main difference between this and earlier missiles was the method of emplacement: series E missiles were stored horizontally in semi-hardened rectangular "coffins" and were raised to a vertical position and fueled before launching. The first successful launch of an Atlas E from this kind of launcher took place on 28 February 1962.[71] The overall results of the Atlas E series testing were ten successes, six partial successes, and two failures.[72]

The Atlas F series was almost identical to the E series but differed in the method of emplacement. The F series missiles were stored in underground 'hardened' silos and were raised to the surface by elevator for launching. The first successful launch of an Atlas F series missile

---

[69]Ibid., 69.

[70]Ibid., 75.

[71]Headquarters of the Strategic Air Command 1990. The first fully successful launch of a series E from a standard gantry-type launcher had taken place on 24 February 1961. George Alexander, "Atlas Accuracy Improves as Test Program is Completed," Aviation Week and Space Technology. 25 February 1963, 78.

[72]Ibid.

from an operational-type silo test facility took place at Vandenberg Air Force Base on 1 August 1961.[73]

The different emplacement strategies of the Atlas E and Atlas F missiles were the product of a new and innovative approach to the organization of the research effort as a whole. Brigadier General Harry E. Goldsworthy, then Director of Production and Programming, Deputy Chief of Staff, Systems and Logistics, Headquarters, United States Air Force, outlined this new approach in his testimony before a subcommittee of the Senate Committee on Armed Services. The research effort was being carried out according to the concept of "concurrency." This approach, said General Goldsworthy, represented "a departure from the time proven sequence of development, test, and then production through a drastic compression of that cycle so that the basic steps in weapon system acquisition were done concurrently rather than sequentially." The Atlas project, therefore, was "pioneering not only a new weapon system, but also a completely new means of acquiring that system." This same concept of concurrency also determined the approach to the construction of launch facilities. In practice, this meant their construction "had to be initiated before the first missiles had ever reached the test pads."[74]

As might be expected, this approach resulted in a number of difficulties for the construction engineers. Since the concept of concurrency "calls for the design and development of system support equipment and facilities in parallel with that of the missile" this meant the engineers often were "designing at best for an unproven element and at worst for an unknown element." As Goldsworthy pointed out, the engineers may, for example, "have to design and build a blockhouse before the quantity or configuration of the equipment that will have to go onto it is known."[75] As a result, the engineers were constantly required to change their construction plans to correspond with new developments in missile technology. For example,

---

[73]Ibid. The first successful launch of an Atlas F from a standard gantry-type launcher had occurred on 8 August 1961.

[74]U.S. Congress, Senate 1964, 4.

[75]Michael Yaffee, "Missile Support Becomes Prime Cost Item," Aviation Week, 4 April 1960, 65-70.

at Lincoln Air Force Base, Nebraska, 312 of the original 476 pages of specifications were changed. No less than 1,214 new drawings were issued (compared with the 355 originals) and the number of special connections per site increased from 184 to 1,506. 68% of structural steel work was affected by these changes as was 77% of the mechanical piping.[76] In August 1960, the major contractors presented a report to Thomas Gates, then Secretary of Defense, outlining their "Suggestions Regarding the Ballistic Missile Program." The primary focus of this report were problems created by the concept of "concurrency" and, specifically, "the deplorable conditions surrounding change orders" which significantly increased construction costs and required the extension of construction deadlines. A second focus of the report was the need to undertake a reevaluation of the manner in which responsibilities were allocated among the various organizations and to better define the relationship between the various civilian and the military agencies and to delineate more precisely their respective roles in the construction process.[77]

1.5 Construction of Launch Facilities

The new ICBM force required substantial organizational changes in the Air Force hierarchy including the creation of new organizations responsible for the design and construction of launch facilities. On 1 April 1961, the Air Force Systems Command was established and made responsible for "the research, development, production and procurement actions required to acquire complete aerospace weapon and support systems needed to accomplish the Air Force mission."[78] There were seven divisions within the Air Force Systems Command, including the

---

[76]Congress, House, Subcommittee on Military Construction of the Committee on Appropriations, Air Force Intercontinental Ballistic Missile Base Construction Program. 87th Cong., 1st sess., 1961, 80.

[77]"Suggestions Regarding the Ballistic Missile Program," records of the Office of the Chief Engineers (hereafter RG 77), Acc. # 64A-2125, carton #10, "Military Construction Project Files, 1959-1961," Folder 285/53 "CEBMCO, Letters, CY 60."

[78]This Command was made up of elements of two former commands: the Air Research and Development Command (ARDC) and the Air Material Command (AMC). Hatcher, "A History of Dyess Air Force Base," 251.

Ballistic Systems Division (BSD).[79] BSD was responsible for "developing concepts and criteria for technical facilities, designing and constructing those facilities, and monitoring construction to ensure compatibility with the weapon systems."[80] To help meet these responsibilities, BSD supervised eighteen Site Activation Task Forces (SATAF) for the Atlas, Titan and Minuteman ICBMs.[81]

The Army, through its Corps of Engineers Construction Agency, was assigned to administer and manage site construction, although the actual construction was carried out by civilian contractors.[82] For this purpose, at the end of July 1960, the Corps of Engineers Ballistic Missile Construction Agency (CEBMCO) was established.[83] Headquartered in Los Angeles and placed under the command of Brigadier General Alvin C. Welling, this agency was responsible for the initial "brick and mortar" phase of construction. Once this phase was completed, the Ballistic Missile Systems Division and Convair would begin the installation of operational equipment.

Several factors were considered in the selection of potential ICBM sites. Most basic was the accessibility to targets within the 7,000 mile range of the operational Atlas missiles. In addition, it was necessary that the soil conditions be suitable for the sinking of missile silos. Finally, wherever possible, sites were selected to take advantage of existing SAC base support

---

[79]The other six divisions were: Space Systems Division; Aeronautical Systems Division, Electronic Systems Division; Aerospace Medical Division; Foreign Technology Division and the Research and Technology Division. Ibid., 254-258.

[80]Neufeld, 201.

[81]For a breakdown of BSD organization, see the very useful, "Ballistic Systems Division Organization and Functions Chartbook" found in RG 77, Acc. #64A-2125, carton #13.

[82]A good description of the relationship between the COE and civilian contractors in the base construction process can be found in "Statement of Chief of Engineers on ICBM Program", September (?) 1960, RG 77, Acc. # 64A-2125, carton #12, Folder 285/51 #12, "Organization and Functions, CY 1961."

[83]An organization breakdown is given in "Construction Policy and Procedures: U. S. Air Force Ballistic Missile and Related Programs," 30 September 1959, RG 77, Acc. #64A-2125, carton #12, Folder 285/53 "Military Construction, ICBM General, July-December 1959".

facilities (such as at Dyess) and thus avoid the expense of building new facilities exclusively for ICBM bases. In addition, this arrangement ensured the accessibility to roads, rail heads and other logistical requirements would be available.[84]

Just as the specifications of the missile evolved over time, so did the design and configuration of the ICBM launch facilities. In the first Atlas squadron, activated at Vandenberg Air Force Base, the operational missile was kept in an exposed vertical position at all times and was serviced by a gantry. The second squadron, at Warren Air Force Base, was laid out in the so-called "1 x 6" configuration, with six missiles clustered in a horizontal position around one launch complex. The third and fourth squadrons, activated at Warren AFB and Offut AFB were in a "3 x 3" configuration, with three launch complexes controlling three missiles each. The next three squadrons at Fairchild AFB, Forbes AFB, and Warren AFB were in a "1 x 9" configuration, with individual launch centers for each of the nine missiles in the squadron. The number of missiles in later squadrons was increased to twelve and, as a result, the next six squadrons, the "heart of the Atlas program", were in a "1 x 12" configuration.[85] This trend towards decentralized control stemmed from concerns over the consequences of a successful enemy missile strike. The dispersal of the missiles made it unlikely that one successful missile strike would incapacitate the entire squadron. This dispersion was made possible only after the switch to an all-inertial guidance system that did not require the construction of an extensive antenna network, as it would not have been economically feasible to construct an individual antenna network for each missile complex.

In addition to changes in the configuration of the squadrons, changes were made in the housing of the missiles themselves with the intention of providing greater degrees of protection in the case of an enemy strike. The launch facilities for the initial Atlas squadrons were labelled "soft" installations, in that they provided no additional protection for the missile. Most of the missiles used in this type of installation, those of the Atlas D and E series, were positioned on

---

[84]Richard Sweeney, "Atlas' Flexibility Permits Varied Bases," Aviation Week, 25 May 1959, 103.

[85]Congress, House 1961, 221.

an erector within a rectangular enclosure with a hydraulically activated movable roof. This configuration facilitated maintenance and service work on the missile while it was in a horizontal position.[86] The "1 x 9" squadrons were "semi-hard" which meant that they were enclosed in a coffin-type launcher either underground or covered over with dirt. Such emplacements were rated as being capable of withstanding 25 pounds per square inch (psi) of overpressure that could be generated by a warhead detonation. The "1 x 12" squadrons, the configuration used for the Atlas F missile, were "fully hardened", meaning they were emplaced in underground silos capable of withstanding 100 psi of overpressure.[87]

One of the major questions that arose with regard to the silo configuration was whether the missile should be fired from within the silo itself or raised to the surface for firing.[88] The use of an elevator system was decided upon when it became apparent that the acoustic vibrations generated by a launch from within the silo could potentially damage the fragile components and systems of the missile. It was decided that the best course of action would be to avoid this problem altogether by raising the missile to the surface for firing. Of course, the addition of an elevator created new problems. According to one estimate the elevator, being a very complex piece of equipment, contained over 300,000 working parts and weighed over 500,000 pounds.[89]

Besides the additional protection afforded by the underground silo and the shock-mounted crib assembly, the Atlas F had another, very significant, advantage over its predecessors. The Atlas, mounted vertically, with the RP-1 fuel stored aboard the missile and most of the liquid oxygen loading performed in the silo,[90] could be fired in less than ten minutes, with only a minute or so required in the vulnerable position above ground for engine start. By comparison,

---

[86]Aviation Week, 20 June 1960, 104-109.

[87]U.S. Congress, House 1961, 221.

[88]Richard Sweeney, "Ground Support Stresses Silos, Hard Site," Aviation Week, 7 March 1960, 135-139.

[89]U.S. Congress, Senate 1962, 5.

[90]Ninety tons of LOX were stored in one tank at the bottom of the silo. U.S. Congress, Senate 1962, 4.

Atlas missiles in the "soft", horizontal installations had to be raised into an exposed vertical position above ground for propellant loading, final checkout and firing configuration, a process that required approximately twenty minutes.[91] Plans were made for the construction of six Atlas F complexes. These were to be located at Schilling Air Force Base, Kansas; Lincoln Air Force Base, Nebraska; Plattsburg Air Force Base, New York; Altus Air Force Base, Oklahoma; Walker Air Force Base, New Mexico; and Dyess Air Force Base, Texas.

1.6 The Atlas at Dyess Air Force Base

In September 1959, a joint decision was made by Strategic Air Command, the Ballistic Missiles Division and Headquarters, United States Air Force to investigate the possibilities of establishing an Atlas missile squadron at Dyess Air Force Base. Following this decision, events moved relatively quickly. A preliminary investigation and selection of potential launching sites was undertaken in October with subsurface investigations beginning in January of the following year. That same month the Site Activation Task Force received approval for the establishment of an Atlas missile squadron in the area.[92] The squadron would be incorporated into the 96th Strategic Aerospace Wing, already stationed at Dyess since September 1957.[93]

Contracts for the construction of the twelve missile launch sites were advertised to bidders on 29 April 1960. These sites, located in a roughly circular pattern around Abilene, were located near small cities or communities, from which they derived their names.[94] Bids were opened at

---

[91]"USAF Plans Six Hardened Atlas Sites," Aviation Week, 20 February 1960, 54.

[92]Hatcher, "A History of Dyess Air Force Base," 264.

[93]The decision to bring an Atlas missile squadron to Dyess, which brought approximately 2,000 men to the installation, mitigated much of the negative economic impact caused by the earlier decisions to inactivate the 341st Bombardment Wing and the 4th Strategic Support Squadron, resulting in the loss of approximately 2,300 men. Hatcher, "A History of Dyess Air Force Base," 294.

[94]The twelve sites were located in a roughly circular pattern around Abilene. Sites were at Baird, Denton, Oplin, Lawn, Bradshaw, Winters, Shep, Nolan, Anson, Corinth West, Phantom Lake, and Albany.

Abilene on 26 May 1960. The low bid of $20,075,000 was advanced by H. B. Zachary and Brown & Root, Inc., against a government estimate of $22,584,544.

Construction began on 7 June 1960 at the site of the future Baird missile complex.[95] Compared with construction at other Atlas F ICBM bases, the operation at Dyess proceeded with relatively few problems. A progress report of July 1960 announced that "Operations have begun at all twelve sites. The contractor is working aggressively and so far has been able to keep up with his very optimistic construction schedule." The report concluded that the Dyess site "appears to be the best organized and best equipped in the program from the standpoint of excavation operations."[96] Only four months later, it was reported that silo excavation had been completed at all sites, while silo wall concrete had been poured at five of the twelve sites. Delivery of the cryogenic tanks that would be emplaced at the bottom of the silo for the storage of liquid nitrogen, was running about two months behind schedule.[97] By June 1961, it was estimated that construction at Dyess was 89.3% completed, against a scheduled 94.0%. Everything having been completed except the installation of the cryogenic tanks.[98] Things were proceeding so well, in fact, that at a 1961 congressional hearing on the subject of missile base construction, to which all of the six major contractors had been invited, only the Dyess contractors were unrepresented. They sent word to the subcommittee members that they had

---

[95]Leroy Ecklund and John Lee, History of the Dyess Area Office, 18 April 1960 to 28 April 1962 (Corps of Engineers Ballistic Missile Construction Office: 1962), 15-17.

[96]"Progress Report-July 1960," RG 77, Acc. # 64A-2125, carton #10, "Military Construction Project Files, 1959-1961," Folder 285/53 "CEBMCO, Letters, CY 60."

[97]"Progress Report - November 1960," RG 77, Acc. # 64A-2125, carton #10, "Military Construction Project Files, 1959-1961," Folder 285/53 "CEBMCO, Letters, CY 60."

[98]"Atlas 'F' Projects: Summary of Progress as of 15 June 1961," RG 77, Acc. # 64A-2125, carton #13, "Military Construction Project Files, 1960-1961," Folder 285/53 "Atlas F Summary Reports, CY 61."

decided not to attend because they "had nothing to complain about."[99] Turnover ceremonies to mark the completion of construction were held at Dyess on 3 November, 1961.[100]

On 1 July 1962, the 578th Strategic Missile Squadron (SMS) was activated at Dyess. The squadron was turned over to the Strategic Air Command on 4 November and two weeks later, on 15 November, the 578th SMS was declared operational. With the exception of the Cuban Missile Crisis in October 1962, when the squadron was ordered to place all twelve missiles on alert, the history of the 578th SMS at Dyess was uneventful. On 1 December 1964, as part of a general phaseout of all "first-generation" ICBMs, the first Atlas missile was taken off alert at Dyess. Two months later the last Atlas ICBM at Dyess was taken off alert and, on 25 March 1965, the 578th SMS was inactivated.[101]

As the experience at Dyess suggests, the Atlas intercontinental ballistic missile had a relatively short-lived operational existence, from 1959 to 1965. This was primarily the result of the increasing reliance upon the solid-fueled Minuteman ICBM. Economic considerations, however, also played a key role in the decision to deactivate the liquid-fueled ICBMs of the first generation. As early as 1963, an air staff study group recommended the retirement of the Atlas D and E, as well as the Titan I. The original schedule was for the Atlas D to be retired in 1964, the Atlas E in 1966 and the Titan I in 1968. After the elections of 1964, however, Secretary of State Robert McNamara announced "Project Added Effort" which called for the retirement of all first-generation ICBMs in 1965. It was estimated that this early phaseout would save $117 million. The Air Force, recognizing that the Minuteman and Titan II ICBMs, represented a safer and more flexible system than either the Atlas or the Titan I, made no effort to appeal the decision. As one analyst observed, Strategic Air Command "evinced little nostalgia at their passing. These complex systems, fueled by volatile liquid oxygen, and in relatively soft

---

[99]U.S. Congress, House 1961, 256.

[100]Letter to Lt. General W. K. Wilson, Jr. (8 December 1961), RG 77, Acc. # 65A-3184, carton #12, "Military Construction Project Files, 1961-1962," Folder 285/53 "CEBMCO, Letters, CY 61."

[101]The important dates can be found in the SAC Missile Chronology, 1939-1988, 46-47.

configuration, had been difficult and expensive to maintain on alert."[102] The deactivation proceeded quickly and by July 1964, in the entire SAC inventory of 821 missiles, there remained only 113 Atlas missiles (18 Atlas D, 27 Atlas E, and 68 Atlas F) as against 600 Minuteman ICBMs.[103] On 12 April 1965, the last Atlas ICBM, an Atlas F based at Lincoln AFB, was removed from alert status.

The Atlas was the United States' first operational intercontinental ballistic missile and, as such, provided the 'template' for later generations of ICBMs. This was certainly the case with regard to the scientific aspects of the program, with the Atlas program paving the way in the development of guidance systems, propulsion systems, and air frame construction. The program also had a profound impact on American industry. In addition to the considerable injection of capital into the industrial sector resulting from the numerous government contracts, the more exacting manufacturing and testing requirements of ballistic missile components required the construction of entirely new and specialized facilities.[104] Perhaps even more important, however, were the lessons learned concerning the manner in which such large-scale research and development programs should be organized and managed. In every respect, the development and production of the Atlas ICBM can truly be described as a pioneering achievement.

2. ARCHITECTURAL DESCRIPTION

2.1 General Description of the Atlas-F Missile Site S-8

---

[102]Cited in Neufeld, 237. For a detailed schedule of deactivations, see the SAC Missile Chronology, 1939-1988.

[103]Neufeld, 237.

[104]"Impact of the Ballistic Missile on Industry" in Lieutenant Colonel Kenneth F. Gantz (ed.), The United States Air Force Report on the Ballistic Missile: Its Technology, Logistics and Strategy. New York: Doubleday and Company, 1958), 156-157.

The launch complex is located approximately three miles from the town of Winters, and 500 feet southwest of Highway 1770. Surrounded by a chain link security fence topped with barbed wire, access to the complex is through a security gate at the northeastern end. Within the security perimeter, the site appears to be simply a flat, paved area, since nearly all structures are below grade. The only elements distinguishing the location of the two main facilities of the complex are the circular concrete "lid" of the hardened missile silo and the above-ground entrance to the Launch Control Center (LCC). A water cooling tower and water treatment building are the only other visible structures at the complex. Various support equipment, such as the water storage tanks and diesel fuel storage tank are all located below grade.

The launch complexes around Dyess AFB were in the "1 x 12" configuration, described earlier, in which the twelve launch facilities functioned independently of one another, with each facility provided with its own Launch Control Center. This configuration was adopted in an attempt to mitigate the damaging effects of an enemy missile strike. With the "1 x 12" configuration a successful enemy missile strike on an LCC would disable a single missile whereas, in earlier configurations, the destruction of an LCC had the potential to incapacitate several missiles. The typical dispersion area for an Atlas F missile squadron in this configuration was 50 miles x 55 miles. The dispersion of the Dyess squadron falls within a roughly comparable area.

The plans used for all twelve complexes were standard Air Force Ballistic Missile Division (AFBMD) plans, modified for the Dyess area by the firm Black and Veatch of Kansas City, Missouri. The original standard drawings were made for the Air Force by the Bechtel Corporation. The Dyess Site Activation Task Force (SATAF) included representatives from both corporations, in order to expedite the changes and revisions that would inevitably become necessary over the course of the project.

Each launch complex consisted of a Launch Facility, or silo, and a Launch Control Center (LCC). The standard plans called for a silo, constructed of reinforced concrete, varying from 2 feet 6 inches to 9 feet thick, 174 feet deep, and a diameter of 52 feet 2 inches. The silo housed 389 tons of structural steel, suspended from the silo walls from four points. This "crib" assembly

housed the missile and supporting equipment, acting as a "shock absorber" in the event of a ground blast. Each silo included two diesel generators, air conditioning units, various mechanical and electrical systems, and a Propellant Loading System.

The Launch Control Center was a two-story structure housing the necessary controls for missile monitoring and missile launch. Like the Launch Facility, the LCC was positioned within a suspended steel framework serving as a shock absorber in the event of a ground blast. The LCC was an underground facility, constructed of reinforced concrete, located 6 .5 feet below ground level.

3. BIBLIOGRAPHY

(Archival research was conducted at the Federal Records Center in Suitland, Maryland and in the Corps of Engineers, Office of History Military Files Holdings located at Fort Belvoir, Virginia.)

Alexander, George. "Atlas Accuracy Improves as Test Program is Completed." Aviation Week and Space Technology, 25 February 1963, 54-78.

Bottome, Edgar M. The Missile Gap: A Study of the Formulation of Military and Political Policy (Rutherford: Farleigh Dickinson University Press, 1971).

Chapman, John L. Atlas: The Story of a Missile. (New York: Harper and Brothers, 1960).

Department of Missile and Space Training. Missile Launch/Missile Officer Student Study Guide. Sheppard Air Force Base, Texas 1964.

Ecklund, Leroy and John Lee. History of the Dyess Area Office, 18 April 1960 to 28 April 1962. Corps of Engineers Ballistic Missile Construction Office: 1962.

Gantz, Lieutenant Colonel Kenneth F. The United States Air Force Report on the Ballistic Missile: Its Technology, Logistics and Strategy. (New York: Doubleday and Company, 1958).

Graebner, Norman A. Cold War Diplomacy, 1945-1960. (D. Van Nostrand Company, Inc.: New York, 1962).

Hansen, Bertrand L. "The Atlas F Operational Suitability Test Facility Number 2 (OSTF-2)." (Ohio State University, 1963).

Hatcher, John Henry. "Seminar Report on the Military Background of the Abilene Country: Abilene and Taylor County, 1852-1952." Hardin-Simmons University,Texas, 1963.

-- "A History of Dyess Air Force Base in its First Decade: A Study In Community Relations." M.A. thesis., Hardin-Simmons University,Texas, 1963.

Hayes, T. J. "ICBM Site Construction." The Military Engineer, no. 362 (November-December, 1962): 399-403.

Klass, Philip J. "How Command Guidance Controls Atlas." Aviation Week, 28 April 1958, 74-77.

-- "ICBM Guidance Techniques Compared." Aviation Week, 2 May 1960, 159-160.

LaFeber, Walter. America, Russia, and the Cold War, 1945-1984 (Alfred A. Knopf: New York, 1985).

Neufeld, Jacob. Ballistic Missiles in the United States Air Force, 1945-1960. Washington, D.C.: Office of Air Force History, 1990.

No author given. "USAF Plans Six Hardened Atlas Sites." Aviation Week, 22 February 1960, 54-55.

No author given. "SAC Shapes Missile Force for Survival, Fast Reaction." Aviation Week, 20 June 1960, 104-109.

No author given. "Air Force Group Prepares, Equips ICBM Sites." Aviation Week and Space Technology, 25 September 1961, 150-159.

Office of the Historian, Headquarters Strategic Air Command. SAC Missile Chronology 1939-1988. Nebraska, Offutt Air Force Base, 1990.

Schweibert, Ernest G. A History of the U.S. Air Force Ballistic Missiles. New York: Frederick A. Praeger, 1965.

Sweeney, Richard. "Atlas' Flexibility Permits Varied Bases." Aviation Week, 25 May 1959.

-- "Integrated Support Expedites Launching." Aviation Week, 1 June 1959.

-- "Ground Support Stresses Silos, Hard Site." Aviation Week, 7 March 1960.

U.S. Congress. House. Subcommittee of the Committee on Appropriations. The Ballistic Missile Program. 85th Cong., 1st Sess., 1958.

U.S. Congress. House. Subcommittee of the Committee on Government Operations. 86th Cong., 1st Sess., 1959.

U.S. Congress. House. Committee on Science and Astronautics. Progress of Atlas and Polaris Missiles. 86th Cong., 1st Sess., 1959.

U.S. Congress. House. Subcommittee on Military Construction of the Committee on Appropriations. Air Force Intercontinental Ballistic Missile Base Construction Program. 87th Cng., 1st Sess., 1961.

U.S. Congress. Senate. Preparedness Investigating Subcommittee of the Committee on Armed Services. Inquiry Into Satellite and Missile Programs. 3 vols., 85th Cong., 1st and 2nd Sess., 1958.

U.S. Congress. Senate. Preparedness Investigating Subcommittee of the Committee on Armed Services and the Committee on Aeronautical and Space Sciences. Missile and Space Activities. 86th Cong., 1st Sess., 1959.

U.S. Congress. Senate. Preparedness Investigating Subcommittee of the Committee on Armed Services. Construction Cost of Air Force Atlas and Titan Missile Sites. 87th Cong., 2nd Sess., 1962.

U.S. Congress. Senate. Preparedness Investigating Subcommittee of the Committee on Armed Services. Series of Explosions of Air Force's Atlas F Intercontinental Ballistic Missiles. 88th Cong., 2nd Sess., 1964.

Yaffee, Michael. "Missile Support Becomes Prime Cost Item." Aviation Week, 4 April 1960, 65-70.