Chapter 4: Delta-01 and Delta-09 (1960s–80s)

Overview of the Complex

The Minuteman missile is a technological wonder. Designed to launch at a moment's notice, it is capable of achieving speeds exceeding fifteen thousand miles per hour and then striking its target half a world away. Though created to deter war, its destructive capabilities exceeded anything known to previous generations. This force waited beneath the ground, in silos buried eighty feet beneath the surface, directed by operators housed miles away beneath unimposing buildings that dotted the windswept plains. Untold numbers of unsuspecting travelers passed Minuteman installations as they drove across the region's highways and roads. Those on a pilgrimage to such popular destinations as Mount Rushmore, Badlands National Park, Wall Drug, and the Sturgis Motorcycle Rally, or those just traveling home or to a new life across America, passed a portion of the nation's nuclear arsenal. This chapter explores the physical layout and features of the Launch Control Facility (LCF) and Launch Facility (LF), the structures that comprise Minuteman Missile National Historic Site.

Delta-01 and Delta-09 are located in rural South Dakota about fifty miles east-southeast of Rapid City, South Dakota. Built in accordance with the Air Force's dispersal strategy, the LCF and the LF lie approximately ten miles apart. The two facilities were originally linked by a system of blast-proof underground cables and a radio communications network, known as the Hardened Intersite Cable System (HICS). On active duty from 1963 until 1991, the LCF and LF were part of an operational unit, collectively known as Delta Flight, consisting of one LCF and ten missile LFs. Delta Flight was one of five flights assigned to the 66th Strategic Missile Squadron (SMS) of the 44th Strategic Missile Wing (SMW), headquartered at Ellsworth Air Force Base, near Rapid City.

Delta-01 and Delta-09 were turned over to the Strategic Air Command (SAC) on 1 November 1963, making them among the first Minuteman sites to be activated at Ellsworth. With the introduction of modifications to the Minuteman missile, the Ellsworth missile field, including Delta-01 and Delta-09, was upgraded to a Minuteman II installation in the early 1970s. No major structural modifications were necessary for this conversion, and over the years, these facilities were subject to limited new construction and remodeling. In September 1991 all 450 of the nation's Minuteman II missiles were taken off alert. Delta-01 and Delta-09 were deactivated in early 1993 and placed on "caretaker status." Deactivation included the removal of the Minuteman II missile and warhead from Delta-09 and the removal of classified electronic equipment, hazardous materials, environmentally sensitive materials, and equipment saved for use at other sites from both Delta-01 and Delta-09. To the greatest extent possible, the facilities were left to appear as they had when they were first taken off alert.

In 1993 the United States Air Force and the Rocky Mountain Regional Office of the National Park Service initiated studies to determine whether Delta-01 and Delta-09 could be preserved as a unit of the National Park Service. In 1999 Congress designated Delta-01 and Delta-09 as a National Historic Site and the bill was signed into law by

President Bill Clinton. The facilities, including all cultural materials of the sites such as furnishings and objects, have been transferred to the National Park Service. The buildings, structures, and landscapes are all important features of Minuteman Missile National Historic Site. The following pages offer a description of these facilities.[i]

Launch Control Facility Delta-01

Delta-01 occupies an open, grassy tract of land on the west side of Jackson County Road CS 23A, approximately one-half mile north of Interstate 90's Exit 127. Delta-01 occupies approximately 6.4 acres of the South Dakota landscape with approximately 1.85 acres located within the security fence. Approaching the site from the Interstate, it looks like a lone ranch house in the open grassland. Over the years, most travelers on the nearby Interstate probably did not give the site a second look or even know what military capabilities lay within the South Dakota plains.

The area surrounding the site, outside of the security fence, is open grassland with a few small privately owned agricultural buildings located several hundred feet to the northwest. Terrain at the site rises gradually toward the north. A chain-link security fence, topped with strands of barbed wire, encloses the site's buildings and structures. Access to the site is provided by a gently curving gravel driveway on the west side of the county road. The driveway passes over a steel cattle guard and through a remote-controlled, chain-link, sliding gate in the security fence. The LCF support building and the vehicle storage building are located just inside the security fence, with an asphalt drive and parking area to their front. The Launch Control Center (LCC), accessed from the LCF support building, is located below ground and is not visible. Even though Interstate 90 is visible to the south of the site, it has a largely isolated feeling, with the wind whipping across the plains frequently serving as the only companionship.

The remaining area encompassed by the security fence is covered with native grass that was routinely mowed by the Air Force. The area inside the security fence includes a variety of electronic, mechanical, and recreational features designed to support operations and provide diversion for crew assigned to the facility. These features include a volleyball court, horseshoe pit, underground diesel storage tank, aboveground diesel storage tank, water well, gas pump, basketball hoop, flagpole, and utility poles. A code burner, used to destroy security codes, consisting of an open metal drum mounted on metal legs, is located near the volleyball court. Larger-scale resources within the security fence include the hardened high frequency (HF) transmit antenna, hardened HF receive antenna, hardened ultrahigh frequency (UHF) antenna, survivable low-frequency communication system antenna, Intercontinental Ballistic Missile (ICBM) super-high-frequency satellite terminal antenna, television satellite dish, and HICS. A concrete helicopter pad, two sewage lagoons, and the cathodic protection rectifier are located outside of the security fence to the south. A barbed-wire fence with wooden posts surrounds the lagoons.

Launch Control Facility Support Building

The LCF support building is the most prominent surface feature at the site. Located inside the sliding security gate, the support building provided accommodations for Air Force personnel, served as a security control center for the entire flight, and housed environmental, mechanical, and electrical systems for the underground LCC. The support building is an unpretentious, one-story, ranch-form structure with its principal facade facing southeast. It is built of conventional wood-frame construction, and has a low-pitched, side-gabled roof. The main portion of the building is rectangular in plan, measuring approximately thirty-three feet wide and 128 feet long. The southeast wall projects forward near the northeast end to form a wide bay for the installation's security center. A gabled-roof, one-story mechanical wing extends from the building's northeast side, measuring approximately twenty-one feet deep and thirty-four feet wide.

The support building rests atop a concrete-slab foundation. The outer walls are sheathed with wide-lap, steel, clapboard-style siding embossed with a wood-grain pattern. Painted tan, the siding was installed between the mid-1970s and early 1980s to replace the original cement asbestos siding. The roof has minimal overhangs, and is covered with brown, asphalt, T-lock shingles.[ii] Large sheet-metal ventilator hoods are located on the roof and back wall of the mechanical wing, and several smaller ventilator hoods project from the roof of the main building above the kitchen and utility room areas. There are steel, ogee-profile gutters at the eaves. Fascia boards, gutters, and verge rafters are painted dark brown.

Windows in the support building are one-over-one, double-hung, sash fitted with white combination storm/screen units. These windows were installed in 1976 to replace the building's original wood sash windows. Although most of the windows are arranged in groups of two or three, the security center windows are placed closely together, forming a nearly continuous band that extends across the southeast wall and wraps around both sides of the bay, providing the security controllers a clear view of the security gate and entrance road.

The southeast side of the LCF support building has a communication equipment room, water treatment room, and boiler room that are accessed through exterior doors. The boiler room can also be entered from the interior of the building. The rear of the support building has an attached very-high-frequency (VHF) antenna and an air conditioner.

The support building's main entrance is located on the main facade, adjacent to the security bay. A doorway on the northeast side of the main entrance hall opens directly into the security control center. This room served as headquarters for the Air Force security police who maintained a constant vigil over the facilities of Delta Flight. Positioned beneath the windows inside the center is a desk-like console containing telephone and radio equipment. Guards seated at this console could observe the main entrance, operate the entrance gate, check the credentials of visitors to the site, and monitor radio transmissions. An expanded-metal cage set into one corner of the room provided storage space for weapons. A small enclosed vestibule behind the security center served as the sole access point to the underground LCC.

The support building includes both residential spaces, such as the day room, bedrooms, exercise room, and kitchen, and operational and mechanical spaces, such as the security control center, water treatment room, diesel generator room, and boiler room. The interior finishes of the residential spaces at Delta-01 largely date to the late 1980s. Interior spaces in Ellsworth's LCF support buildings were decorated and furnished by the people who occupied them. As part of an ongoing "self help" program, the base supplied materials such as paint, tile, and wall paneling, and Delta Flight personnel supplied the labor required to put the materials into place.

The LCF's main entrance hall leads into the spacious day room area. The day room provided dining and recreational space for topside support personnel. Furnishings include three couches, a television, and both dining tables and booths. The day room walls are covered with wainscoting of pre-finished hardboard or varnished wood. The east wall of the day room is decorated with a large mural depicting a woodland scene. The day room and other rooms in the residential area have suspended acoustical tile ceilings with recessed fluorescent lighting fixtures. A dedication plaque, dating to November 1966, is located inside the day room and reads "as a tribute to the goodwill and mutual understanding between the citizens of this community and the Air Force." A kitchen and pantry are located off the day room. The kitchen and pantry feature metal cabinets and industrial kitchen appliances. The wall of the pantry retains a menu and price list of food items available for purchase by the staff. The kitchen walls are covered with melamine panels and the floors are vinyl.

A doorway off of the day room opens into a long central hallway flanked by seven bedrooms, men's and women's latrines, a boiler room, and a utility closet. The women's latrine was added in the mid-1980s, when the Air Force began to assign women to the duty roster at Minuteman sites. The bedrooms feature carpeted floors, walls finished with fabric-covered sound board, and suspended acoustical ceiling tiles with recessed fluorescent lighting fixtures. The bedrooms were furnished with beds or bunk beds, a desk, and freestanding wardrobe closets. The facility manager was the only personnel to receive his or her own bedrooms. The VIP bedroom has two bunk beds and could sleep four. The two bedrooms assigned to security personnel were outfitted with blackened windows and were provided with sound insulation to allow for daytime sleeping as security alert team personnel and flight security controllers rotated twelve-
hour shifts on their three-day alert. One of the bedrooms for security personnel also includes a locker for weapons and a rifle clearing barrel or a secured can to dummy fire weapons into to verify that they are unloaded.

The wing on the east end of the support building originally contained a single-stall garage and two mechanical equipment rooms. The garage was enclosed in 1975 and converted into an exercise room for staff. The equipment rooms contain a diesel-fueled generator for emergency power, as well as air conditioning and filtration equipment for the LCC.

Launch Control Center

Buried approximately thirty-two feet below ground, the LCC is entered from the LCF support building through a ten-foot-square, reinforced-concrete access shaft that descends from a small vestibule at the back

of the security center. This structure served as the command post for the ten dispersed missiles of Delta Flight. Its entry shaft contains a small elevator and a steel-rung ladder surrounded by an open safety cage. The base of the shaft opens into a low-ceilinged vestibule that provides room for a bank of lockers and swing space for an eight-ton, steel-and-concrete blast door that seals the entrance to the control center. One wall of the vestibule is painted with art work depicting a missile labeled "USAF" blasting through the tattered flag of the former Soviet Union.

A small sign on the wall of the vestibule and a yellow line painted across the floor demarcate the beginning of the control center's high-security "no-lone zone, two-man concept mandatory." Any person entering the restricted area had to be accompanied or observed by a second person who was trained to detect erratic behavior, improper activity, or sabotage attempts. Launch control officers carried sidearms to protect the nuclear resources controlled from within the "no-lone zone," and use of "deadly force" was authorized. A piece of art work on the blast door serves as a darkly humorous reminder of the LCC's defining purpose. Emblazoned on the door's outer face is a crudely painted depiction of a red, white, and blue pizza delivery box, labeled "Minuteman II." A hand-lettered legend framing the illustration reads: "World-wide delivery in 30 minutes or less, or your next one is free."[iii] Decoration of the blast door and the area outside LCCs was common. Another Ellsworth LCF site, Oscar-01, featured a portrait of *Sesame Street's* Oscar the Grouch with missiles in his paws painted on the wall.

The blast door is secured by twelve hydraulically operated latchpins placed around its perimeter. Emergency procedures allowed for the door to be opened by the facility manager from outside the LCC, but this would take about fifty minutes. When these pins retract, the door swings open on massive roller-bearing hinges to reveal a low, tunnel-like passageway leading to the LCC. Approaching the LCC, one passes the enormous blast door, crouches down to pass under a header of the tunnel, crosses a narrow walk between the outer and inner shell of the capsule, and then through an opening into the control center.

The LCC itself consists of two separate structural elements, nestled one inside the other. On the outside is a protective shell, shaped like an enormous gelatin capsule, that measures twenty-nine feet in diameter and fifty-four feet in length (outside dimensions). It is constructed of heavily reinforced concrete, with walls three to four feet thick, and is lined on the interior with a quarter-inch-thick steel plate. Suspended inside the shell is a box-like acoustical enclosure containing the launch control consoles, communications equipment, missile monitoring equipment, and spartan accommodations for the two-person Air Force launch crew. The acoustical enclosure is rectangular in plan, measuring approximately twelve feet wide and twenty-eight feet long. It rests atop a twelve-foot-by-thirty-two-foot, steel-framed platform. The corners of the platform are suspended by a large pneumatic cylinder called a "shock isolator." Hung from heavy chains attached to the ceiling of the shell, the isolators are designed to let the enclosure bounce as much as two feet in any direction without major damage. An articulated, steel-plate bridge spans the gap between the platform and the access tunnel. The floor of

the acoustical enclosure is made of removable steel plates covered with sheet vinyl. A strip of light brown carpet lies over the floor plates.

Compartments beneath the floor contain survival equipment, emergency batteries, and a motor generator. The walls and ceilings of the enclosure are made of hollow-walled, perforated-steel panels filled with sound-absorbing material. One early visitor to the Ellsworth facilities, Richard B. Stolley, reported that the noise inside the LCC was "almost overwhelming–a high electrical whine. It was comforting proof that all equipment was working, but my ears rang for hours after I left the capsule."[iv] A beige fabric headliner is attached to the ceiling framework with Velcro. The headliner was installed in 1990 to help reduce noise levels inside the enclosure, which had previously disturbed crewmembers. Four recessed fluorescent lighting fixtures centered in the ceiling illuminate the enclosure's interior. Emergency task lighting is provided by adjustable spotlights mounted on the ceiling. Virtually every surface inside the enclosure is painted pale green. "It's a color we've learned to detest," observed one Ellsworth missile crew member in 1964.[v]

Upon entering the LCC, one feels that he or she may have stepped back in time or onto a movie set as the communication and computer equipment within largely dates to its installation in the 1960s. The equipment appears "ancient" by today's standards, but continued to be fully functional into the early 1990s when the site was deactivated. The LCC contains two desk-like consoles placed about twelve feet apart. Positioned in front of each console is a swiveling, high-backed, aircraft seat fitted with seat belts and a shoulder harness. The launch control (commander's) console is located at the east end of the acoustical enclosure, directly opposite the entrance. It has an illuminated panel that allowed the commander to continually monitor the operational and security status of each of the ten missiles and launchers in Delta Flight. The communications control (deputy commander's) console is centered against the south wall of the enclosure. It contains an array of radio and telephone equipment that enabled the crew to communicate with other LCFs, base headquarters, and SAC. At the side of each console is a small panel containing a spring-loaded, key-operated launch switch. The keys to these switches were kept in a double-padlocked, red steel box mounted above the deputy commander's console. If crew members had received an order to launch their missiles, they first would have unlocked their padlock (placed on the box at the beginning of their shift) on the red steel box and removed the launch keys and preset authenticators. Then, if the Emergency War Order (EWO) had been determined to be authentic, the missile combat crew members would have inserted the codes they had received into the enabling panel, inserted the keys into the switches, and turned them in unison. If their launch command was verified by a second LCC, one to ten Minuteman missiles would have blasted out of their silos and streaked toward preassigned targets halfway around the world. This system was designed to make it impossible for a single individual or crew to launch the flight's missiles.

Lining the walls of the acoustical enclosure are heavy aluminum electronic racks containing computer equipment, radio transmitters and receivers, a telephone relay system, and a power control panel. The acoustical enclosure is also equipped with a stainless steel latrine, a small refrigerator/microwave oven unit, and a curtained sleeping

compartment. Installed in 1991, the sleeping compartment replaced a military cot that had occupied the same space. Virtually everything in the LCC was strapped down or permanently mounted, including the coffee pot and seat belts for the combat crew seats.

The LCC ordinarily used commercial electrical power to run its motor generator, and drew its clean and cool air supply from air-conditioning equipment located aboveground in the LCF support building. However, the center was also capable of operating for sustained periods of time without any support from topside. In the event of a nuclear attack or higher state of readiness, an automatic blast valve system was designed to seal the capsule off from the surface. For extended periods of time crew members would then activate a hand-pumped oxygen regeneration unit to obtain breathable air. The storage batteries and motor generator beneath the floor would provide emergency electrical power and an emergency air-conditioning unit would prevent vital electronic equipment from overheating. Crew members trapped in the capsule after an attack could theoretically reach the surface through a three-foot-diameter, corrugated-steel escape tube that angles upward from the east end of the LCC. To maintain rigidity, the tube is sand-filled and plugged at its lower end. To make their exit, crew members would have removed the plug, dug out the sand, and climbed up the tube to ground level.

Heated Vehicle Storage Building

A large vehicle storage building, erected in 1968 to provide heated parking for vehicles, stands near the northwest corner of the LCF support building. It is a one-story, three-stall, wood-frame garage with a low-pitched, front-gabled roof. Resting on a concrete slab, the building is rectangular in plan, measuring approximately thirty-two feet by forty feet. Its outer walls are sheathed with wide-lap steel, clapboard-style siding embossed with a wood-grain texture and painted tan. The roof has slight overhangs and brown asphalt T-lock shingles. The main facade includes a large central garage door flanked by two slightly smaller openings. Each of the three openings contains an insulated-steel, overhead door with horizontal flush panels.

The building was constructed to accommodate a front end loader used for snow removal, among other vehicles. Its interior walls are sheathed with hardboard panels. The ceiling is insulated but unfinished. Steel pipe columns between the bays provide additional structural support for the roof. A small enclosed furnace room is in the building’s west corner. An enclosed tool storage room, built c.1986, adjoins the rear wall.

Communication Antennae

Delta-01 includes numerous antennae. A blast-hardened, HF transmit antenna, constructed in 1963 and deactivated in the early-1970s, stands near the east side of the compound, about 140 feet due south of the access road. This structure consists of an underground, reinforced-concrete cylinder, approximately twenty-one feet in diameter and fifty feet deep (outside dimensions). The well of the cylinder contains a telescoping, four-sided radio antenna originally capable of extending to a maximum height of 120 feet.

A hardened HF receive antenna is set into the ground about 160 feet south-southeast of the LCF support building. Built in 1963, this

structure consists of a reinforced-concrete cylinder covered by a concrete cap and measuring approximately sixteen feet in diameter and thirty-seven feet deep (outside dimensions). Distributed evenly around the perimeter of the structure are five small ports. Each port contained a slender, ballistically actuated, steel, monopole antenna. This antenna system was deactivated c.1987-88.[vi] When it was still in use, one monopole extended from the cylinder at all times. If the exposed antenna were to have been damaged during an attack, a replacement could have been quickly deployed through the detonation of an explosive squib in an adjacent port.

A hardened UHF antenna stands near the southwest corner of the LCF support building. It was installed by the Motorola Company in 1976 to provide "unprecedented reliability to radio communications between the base and the missile field."[vii] The hardened UHF antenna consists of a massive, cast-steel frustum, bolted to a thick, reinforced-concrete slab sixteen feet square. Surmounting the frustum is a conical, white fiberglass weather dome.

The survivable low-frequency communication system (SLFCS) antenna is buried in the ground about 140 feet east of the LCF support building and is not visible from the surface. Installed in 1968, the SLFCS is part of the facility's EWO communication system. The ICBM super-high-frequency satellite terminal
antenna was installed at the rear of the LCF support building c.1992, at the same time missile sites were being deactivated in Ellsworth's 67th Strategic Missile Squadron (SMS).

Other structures associated with Delta-01 include the cathodic protection rectifier, television satellite dish, and HICS. An electronic device installed in 1963 to protect underground features such as fuel tanks from corrosion, the rectifier is located just outside the security fence on the north side of the access road. Its aboveground portion consists of a white-painted steel electrical box mounted on a wood pole, while the below ground portion consists of a well approximately 220 feet deep, containing eleven graphite anodes. A television satellite dish installed in 1987-88 sits in the grassy area in front of the LCF support building.[viii] The HICS was an underground communications link that connected the LCC at Delta-01 with all ten Delta-Flight LFs, including Delta-09 and the rest of the LCFs and LFs of the 66th SMS. The system employed a double-walled cable, pneumatically pressurized so that ruptures could be readily identified. In accordance with the Treaty Between the United States of America and the Union of the Soviet Socialist Republics on Reduction and Limitation of Strategic Offensive Arms (START Treaty), the HICS link was permanently disabled. To demonstrate compliance with the START Treaty, the HICS cable was severed and portions were removed.

A concrete helicopter pad and two sewage lagoons are located outside of the security fence to the south. The two large sewage lagoons used for treating waste materials lie approximately 240 feet southeast of the LCF support building. The original sewage lagoon, constructed in 1963, is an open settling basin, 118 feet square, surrounded by an eight-foot-high earthen berm. In 1970-71, an additional lagoon was appended to the southeast corner of the original structure. The new overflow lagoon is irregular in plan and is considerably larger than the earlier basin. Built in 1970-71, the large helicopter pad provided a safe

landing area for the helicopters that were used to transport personnel and equipment between the LCF and Ellsworth Air Force. The helicopter pad consists of a flat concrete slab fifty feet square, surrounded on all sides by a wide shoulder of gravel and asphalt.

Launch Facility Delta-09

Delta-09 is located approximately ten miles west-northwest of LCF Delta-01. It occupies part of an open, grassy tract of land straddling Pennington County Road T512, about 0.6 miles west and south of Interstate 90, Exit 116. Although the Interstate is visible in the distance, the site is in a rural area without other development around it. Historically under Air Force ownership, Delta-09 occupied ninety acres: eighty acres of concurrent use and ten acres of exclusive use, with one acre located within the security fence. Delta-09 is surrounded on the north, west, and south sides by the open land of Buffalo Gap National Grassland, under ownership of the United States Forest Service. In the distance are geological formations similar to those found in Badlands National Park. The launch structures are concentrated inside a rectangular area surrounded by a chain-link security fence. A double gate is located on the east side of the security fence. A gravel access drive leads from the double gate to the nearby county road.

The area inside the enclosure has been graded to form a level, earthen platform that is elevated a few feet above the surrounding terrain. The platform has a gravel surface, and was specifically planned to provide maneuver space for the truck-like transporter-erector vehicles that hauled and emplaced the Minuteman missiles. The missile launcher and LF support building are located near the southern end of the maneuver space platform, with most of their structural elements underground. A smaller rectangular area at the north end of the platform outlined by four, low, small concrete corner pylons served as a landing pad for helicopters. Floodlights mounted atop two wooden utility poles at opposite corners of the maneuver space provided illumination for nighttime maintenance activities at the site. Two remnants of the concrete-base pad from the earlier outer zone security system antennas remain at the site: a square
concrete pad with four reflector mount pedestals is located to the southwest (rear) of the missile launcher and a clutter monument and footing of the antenna pedestal are located to the rear (south) of the launch support building.

Missile Launcher

The missile launcher was designed to serve as a temperature- and humidity-controlled, long-term storage container, protective enclosure, support facility, and launch pad for a Minuteman ICBM. The launcher consists of an underground launch tube (silo), surrounded by a cylindrical equipment room and covered by a hardened, ballistically actuated closure door. A heavily secured hatchway connected to the equipment room allowed Air Force personnel to enter the launcher and step down a metal rung ladder into the upper and lower equipment rooms surrounding the missile to conduct routine maintenance activities.

The launch tube is essentially a reinforced-concrete cylinder lined with a quarter-inch steel plate. It measures twenty-five feet in diameter (inside dimension) and approximately eighty feet deep. The

tube rests atop a four-foot-thick, reinforced-concrete foundation, with its lower forty-six feet encased in approximately ten inches of heavily reinforced concrete. A two-inch-thick steel plate on the floor of the tube serves as a blast deflector for the missile's exhaust.[ix]

Welded to the walls of the launch tube, about twenty-one feet above the floor, are pulley blocks for the three-point suspension system that supported the installation's Minuteman missile. The suspension system consists of a free-floating, steel missile-support ring attached to three wire cables. The cables pass over the pulley blocks and fasten to large, coil spring-type shock absorbers fixed to the base of the silo.

Encircling the upper portion of the launch tube is a cylindrical, two-level equipment room, built of heavily reinforced concrete with a steel liner. The equipment room is about twenty-five feet by fifteen feet and twenty-eight feet deep, with a four-foot-thick slab foundation, and walls two feet thick. A six-inch-wide "rattle space" between the equipment room and the launch tube allows the two structures to move independently.

The lower level of the equipment room contains a motor generator and supports for twelve large storage batteries. The batteries themselves were removed from the missile launcher during deactivation in 1993. An electrical surge arrestor room is located on the southeast exterior wall of the lower level. The numerous surge arrestors inside were designed to prevent electronic equipment inside the launcher from being damaged by electromagnetic pulses resulting from nuclear explosions. On the south side of the lower level, the cylindrical ballistic actuator that opens the launcher closure door during the launch sequence stands upright and extends through the upper level floor.

The upper level of the equipment room consists of a steel-framed platform covered with a rolled-steel deck plate. Cast into the east outer wall is a narrow, steel-faced bench, calibrated with compass bearings. Part of a complex optical alignment system, the bench originally supported an "autocollimator" (no longer in place) that was used to align the missile's guidance system. Directly above the bench is a canted cylindrical porthole (sight tube) glazed with bulletproof glass that is now permanently welded shut. This sight tube is aligned so as to point through the open access hatch, which allowed guidance technicians to establish visual references to a pair of azimuth markers (surveyors' benchmarks) located on the surface outside of the security fence.[x]

The northwest one-third of the upper-level floor is suspended from a series of coil-spring shock struts attached to the ceiling. Attached to the shock-mounted floor are racks of electronic equipment used to monitor and troubleshoot the missile, communicate with the LCC, and conduct the countdown. Mounted on the wall adjacent to the equipment racks are two cylindrical, stainless-steel chemical tanks. These tanks originally contained a sodium chromate solution for cooling the Minuteman missile's guidance system. Maintenance workers could gain access to the missile and the bottom of the silo by removing the hatch plates from the side of the launch tube, lowering the access door or "diving board," and installing a motorized cage. The two-person work cage could reach the circumference of the launch tube and also could

lower workers sixty feet to the bottom of the silo.

The underground launch tube and equipment room are covered by a massive, reinforced-concrete roof slab, known as the launcher closure. The top of the slab is level with the surface of the maneuver area. The roof slab is roughly teardrop-shaped in plan, with its apex pointing toward the northwest. The reinforced-concrete closure door is three and one-half feet thick and weighs more than ninety tons. If a missile had been fired the launch enclosure would have been blown open with great force. A concrete approach apron on the north side of the launcher closure with steel transporter erector pylons and transporter erector jack pads was used to align and support the transporter erector while the missile was emplaced. Transporter erector landing gear pads are also located just north of the apron.

The area directly south of the missile launcher is approximately three and one-half feet lower than the gravel maneuver area, exposing the south edge of the roof slab. Cast into the southern edge of the roof slab is a pocket-like opening for the launcher's horizontally sliding closure door. A low, buttressed concrete wing wall on each side of the door opening separates the maneuver area from the ground below. A concrete track apron is directly behind the launcher closure with a center track rail and side closure or maintenance tracks. The launcher closure rolls open on two wide steel tracks mounted atop deep reinforced-concrete beams cantilevered out from the launcher. The closure door's steel-sheathed leading edge is shaped like the cowcatcher on a steam locomotive and is designed to clear debris from the tracks when the ballistic actuator flings the door aside. The grade slopes slightly south from the apron to provide drainage away from the launcher. If the missile or one of its major components had to be removed or replaced, maintenance workers would use a hydraulic pipe pusher mounted on a cogged rail in the middle of the track apron to jack the closure door open.

For more routine maintenance activities, workers entered the silo through the personnel access hatch in the northeast corner of the roof slab. The access hatch is a heavily reinforced, steel-and-concrete vault door, operated by two hydraulic cylinders. The door opens into a cylindrical shaft that descends to the lower level of the equipment room. Fitted into the shaft is the "B-plug," a piston-like, steel security door operated by an electro-mechanical actuator. The silo cannot be entered until the B-plug is retracted.

Slight modifications have been made to Delta-09 to prepare it for interpretation as a static display. The launcher closure has been permanently fixated in a partially open position, in agreement with the START Treaty, and a glass and aluminum viewing enclosure was installed over the opening in 2001. A deactivated training missile was installed in the launch tube in 2001. The glass viewing enclosure allows visitors to see into the launcher to view the training missile. (For further discussion of Delta-09 modifications see Section III, Chapter 3: Minuteman Missile National Historic Site)

Launch Facility Support Building

Located adjacent to the missile launcher on the southeast is the 1963 LF support building, which contains an array of mechanical, electrical, and environmental equipment. This box-like underground structure has

its roof about one foot above ground level. Constructed entirely of reinforced concrete, the building is rectangular in plan, measuring roughly sixteen feet wide, twenty-five feet long, and eleven feet deep. At the north end of the structure is a narrow rectangular areaway, covered with steel grating and a steel entry hatch. A ladder mounted on the interior wall provides access through the hatch down into the building.
Two removable steel hatches in the middle of the roof of the support building allowed maintenance crews to quickly install large pieces of equipment or remove them for repairs.

The support building contains electrical distribution equipment; a diesel-fueled emergency generator that supplied electrical power when the commercial source was unavailable; a brine chiller unit that provided cold water to the launch equipment room air handler, which in turn, provided the electronic racks and launcher with temperature and humidity-controlled air; a hydraulic pump for the personnel access hatch; a temperature control air compressor; and various panels for mechanical, security, and communications systems.

Associated Structures
Delta-09 includes five structures historically associated with the launcher, two of which are antennae. The improved minuteman physical security system (IMPSS) antenna, a white fiberglass monopole, rises from the base of the roof slab on the east side of the closure-door opening. This antenna is part of the IMPSS that was installed at the launch site in 1989. IMPSS is a microprocessor-based surveillance system designed to detect outer zone intruders. It replaced troublesome older security systems so sensitive that they could be set off by “elk, rabbits, [or] even high-jumping grasshoppers.”[xi] A hardened UHF antenna, installed c.1968 to link the LF with the SAC’s airborne launch control center, is located a few feet to the northwest of the silo opening. It rests atop a thirteen-foot-diameter, reinforced-concrete base, shaped like an inverted saucer. The antenna itself is housed inside a cast-steel frustum capped with a conical, gray fiberglass weather dome.

Three other structures are located at Delta-09 outside the security fence. A cathodic protection rectifier installed in 1982-83 is located on the south side of the access drive, approximately 160 feet east of the security fence. Its aboveground portion consists of a galvanized steel electrical box mounted on a wood pole protected with a small fence. The below ground portion consists of a well approximately 220 feet deep, containing eleven graphite anodes. Two azimuth markers, used in conjunction with the autocollimator to align the Minuteman guidance system, are each located approximately one thousand feet from the launcher–one to the north-northwest and the other to the north-northeast. Each azimuth marker consists of a cylindrical concrete pylon, three feet in diameter and eight feet deep, set vertically into the ground. The visible portion of each pylon is approximately eighteen inches in diameter and four feet high. A disc-shaped aluminum alloy survey plate is set into the top of each pylon. Two HICS marker posts are located to the south of the chain link security fence. The wooden posts are about twelve feet tall with orange bands around the top and directional arrows to mark the location of the underground HICS.

Conversion to Minuteman II

Between 1971 and 1973, facilities at both the Delta-01 and Delta-09 sites were modified slightly when Ellsworth replaced its arsenal of Minuteman I missiles with the more advanced Minuteman II. The most important changes associated with this conversion were contained within the missiles themselves, since Minuteman II featured a more powerful propulsion system and a more accurate guidance system than its predecessor. Changes included installation of new electronic ground-support equipment in existing racks at both the LCF and the LF; and the installation of electronic filters, seals, and circuit-breaking equipment at both sites to protect the facilities against damage from the electromagnetic pulses released by atomic blasts. Because the Minuteman II was slightly longer than the Minuteman I, the missile support ring inside the LF silo was lowered by lengthening suspension cables. The optical alignment system was adapted to work with the new missile by welding stops to the autocollimator bench to limit the instrument's range of motion. The retractor mechanism for the umbilical cable was relocated, and several other cables and fluid lines within the Missile Launcher were rerouted. No structural changes were required at either the LF or the LCF to accommodate the new missile.[xii]

After conversion to Minuteman II, Delta Flight experienced only minor modifications as it continued to fulfill its mission. Changes at the LCF support building included new steel siding and replacement windows, the addition of a women's latrine, air conditioning, and interior redecorating. Alterations to the LCC included the installation of carpet, Velcro-attached fabric acoustical ceiling panels, a curtained sleeping compartment (called a modular bed storage unit), an updated latrine, and a new privacy curtain to accommodate mixed gender crews.

Delta-01 and Delta-09 were among the remote facilities where the men and women of Ellsworth lived and worked. They were designed for security and functionality. They were designed, in the final analysis, for a function each hoped would never be needed. Let us now turn to those men and women, to their duties and their lives, and to the culture of the missileers and the missile crews.

Plate 37. Aerial view of Delta-01 *(Library of Congress, Prints and Photographs Division, Historic American Engineering Record, Reproduction Number HAER SD-50-A-2)*

Plate 38. Aerial view of Delta-01 highlighting the aboveground buildings used by missile crews *(Library of Congress, Prints and Photographs Division, Historic American Engineering Record, Reproduction Number HAER SD-50-A-1)*

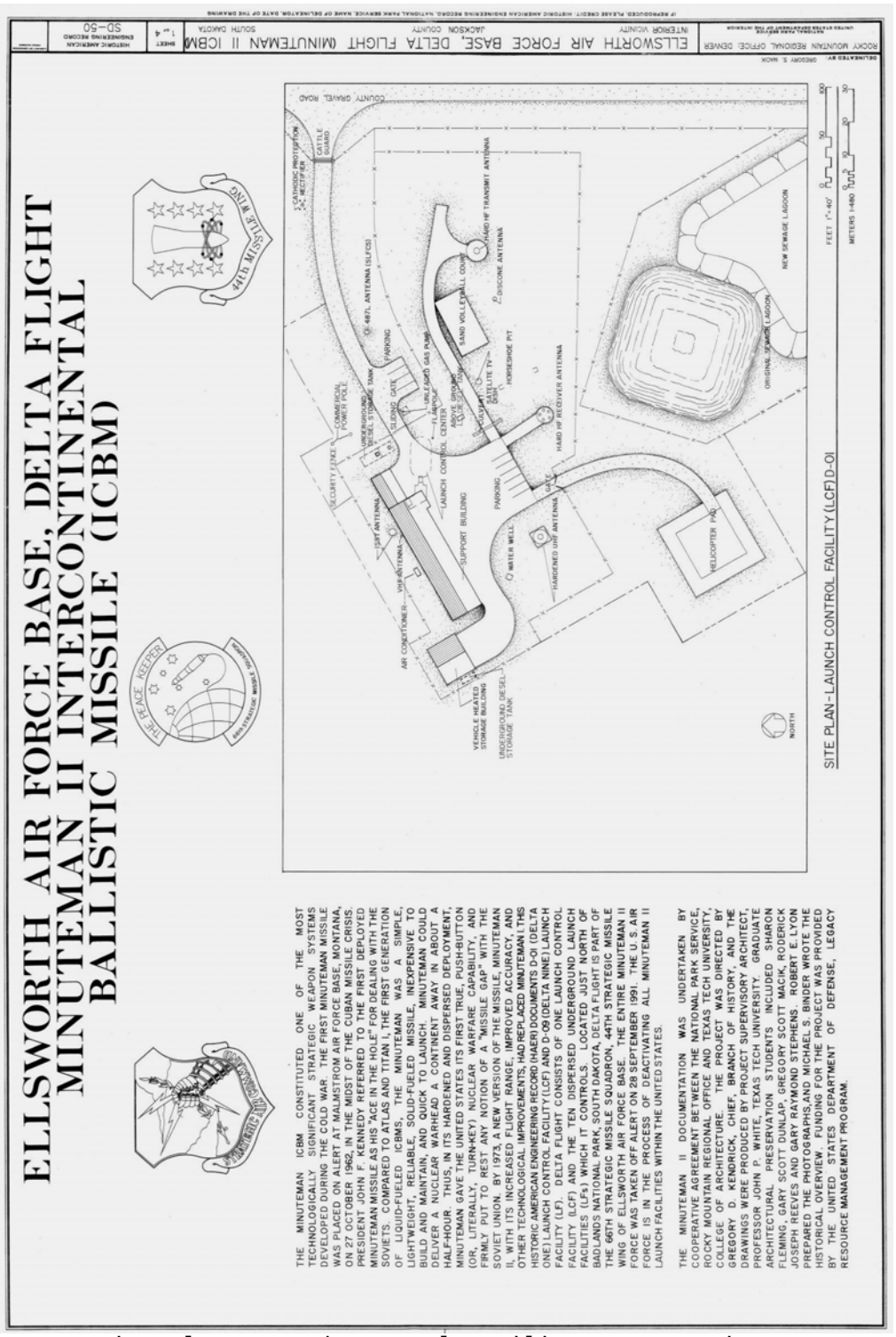


Plate 39. Site plan, Launch Control Facility - correction to text: the Minuteman II system was taken off alert on 27 September 1991 *(Library of Congress, Prints and Photographs Division, Historic American Engineering Record, Reproduction Number HAER SD-50-sheet 1)*

Plate 40. View of Launch Control Facility Support Building, Delta-01
(Photograph by Mead & Hunt)

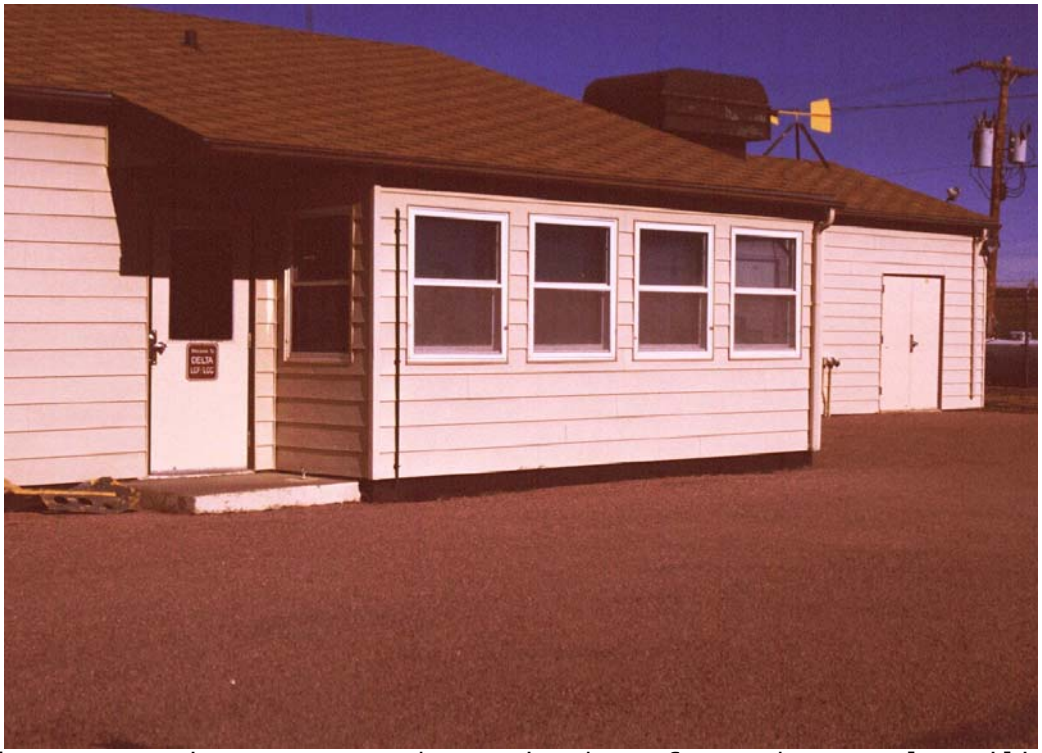


Plate 41. Main entrance and security bay of Launch Control Facility Support Building, Delta-01
(Photograph by Mead & Hunt)

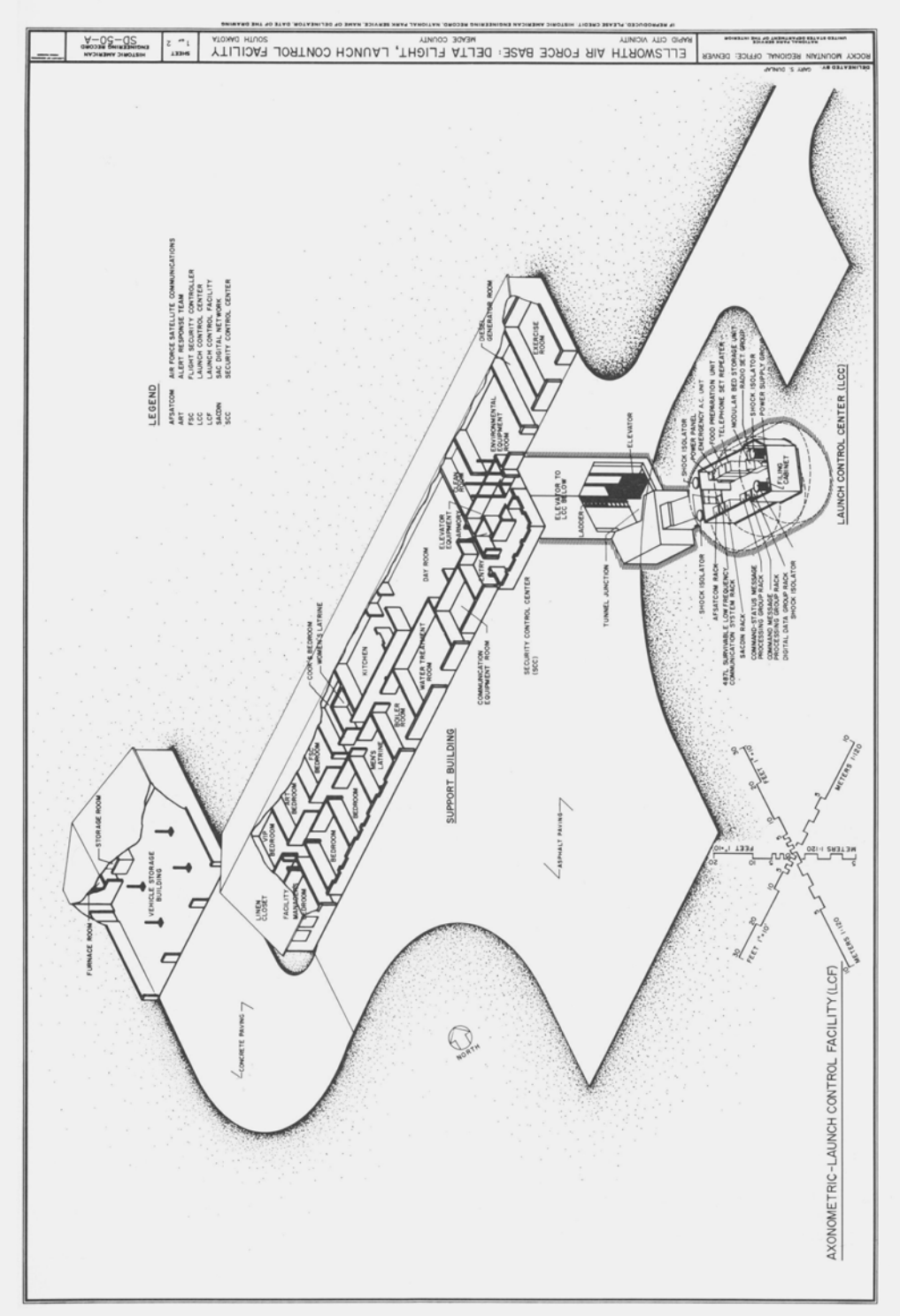


Plate 42. Interior plan view of Delta-01 *(Library of Congress, Prints and Photographs Division, Historic American Engineering Record, Reproduction Number HAER SD-50-A-sheet 1)*

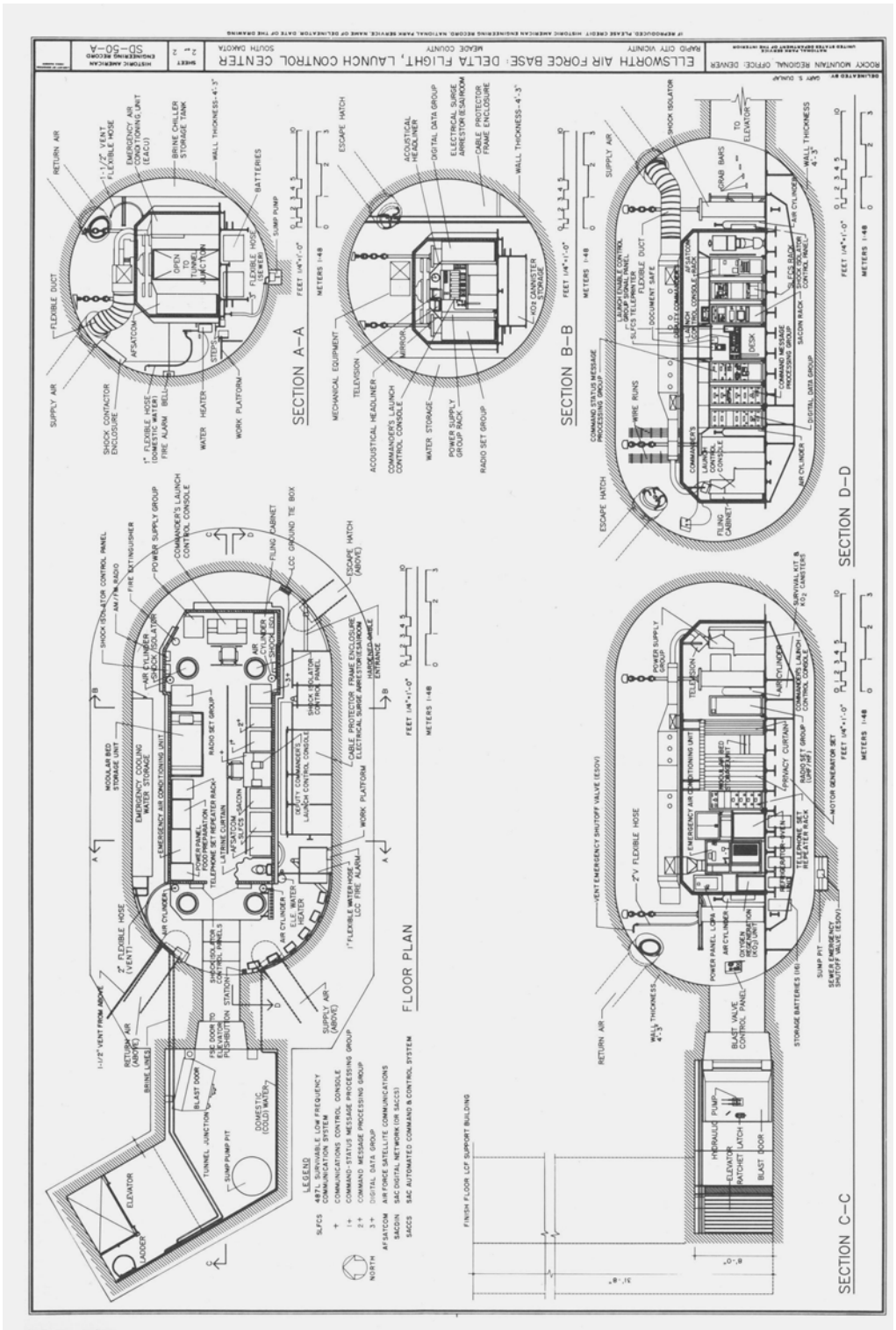
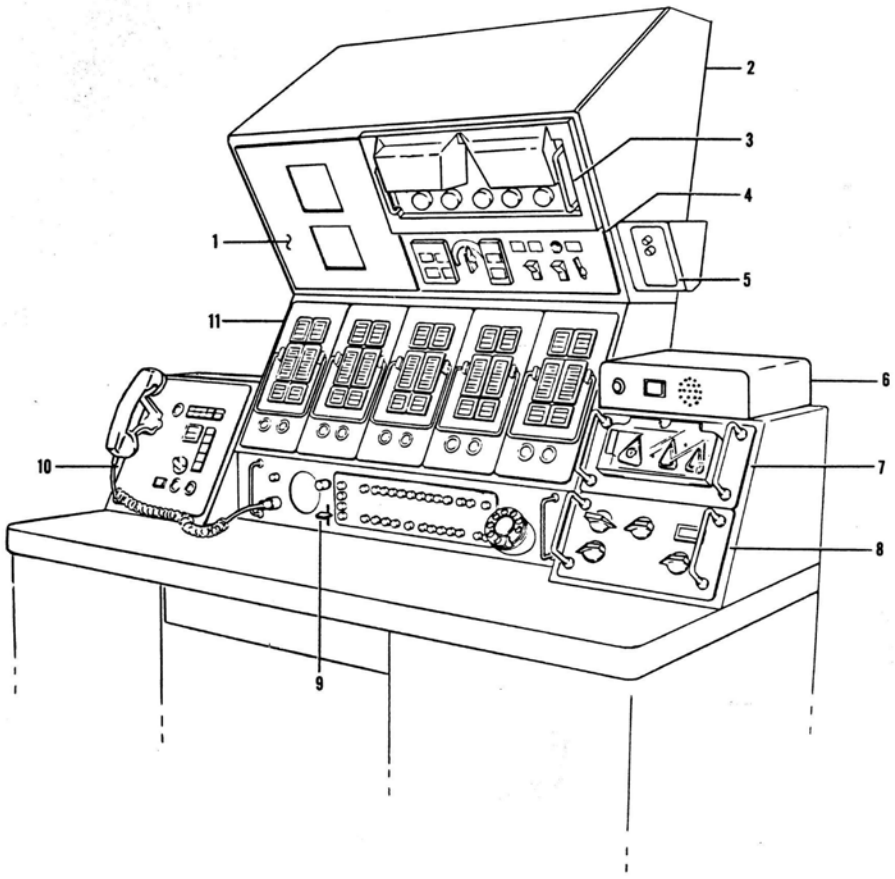


Plate 43. Line drawings of interior of Delta-01 Launch Control Center
(Library of Congress, Prints and Photographs Division, Historic American Engineering Record, Reproduction Number HAER SD-50-A-sheet 2)

Plate 44. Interior side of blast door, Delta-01 *(Library of Congress, Prints and Photographs Division, Historic American Engineering Record, Reproduction Number HAER SD-50-A-56)*

Plate 45. Launch Control Center at Delta-01 *(Courtesy of the 28th Civil Engineering Squadron, Ellsworth Air Force Base)*

Plate 46. Delta-01 Missile Commander’s Launch Control Console *(Library of Congress, Prints and Photographs Division, Historic American Engineering Record, Reproduction Number HAER SD-50-A-69)*



1 PAS MONITOR PANEL
(SEE T.O. 21M-LGM30F-1-22)
2 RADIO SET CONTROL GROUP
3 HF TRANSCEIVER (SEE T.O. 21M-LGM30F-1-22)
4 RADIO SET CONTROL (SEE T.O. 21M-LGM30F-1-22)
5 ANTENNA CIRCUIT BREAKER PANEL
6 SCPs: AUDIBLE AND DISPLAY SIGNAL DEVICE - INOPERATIVE
7 LAUNCH CONTROL PANEL (SEE FIGURE 1-32)
8 PROGRAM CONTROL PANEL (SEE FIGURE 1-33)
9 TELEPHONE TRANSMITTER CONTROL (SEE FIGURE 1-45)
10 ALARM-MONITOR PANEL (SEE FIGURE 1-30)
11 MISSILE STATUS INDICATOR PANEL (SEE FIGURE 1-31)

Plate 47. Line drawing of a Launch Control Console *("Weapon System Operation Instructions," (U.S. Air Force, 10 March 1986, Available at the 28th Civil Engineer Squadron, Ellsworth Air Force Base, S.Dak.), 1-57)*

Plate 48. Aerial view of a completed Launch Facility in 1963 *("Site Activation Chronology, Minuteman Project, Ellsworth Air Force Base, South Dakota, July 1963-October 1963," K243.012-40, in USAF Collection, AFHRA)*

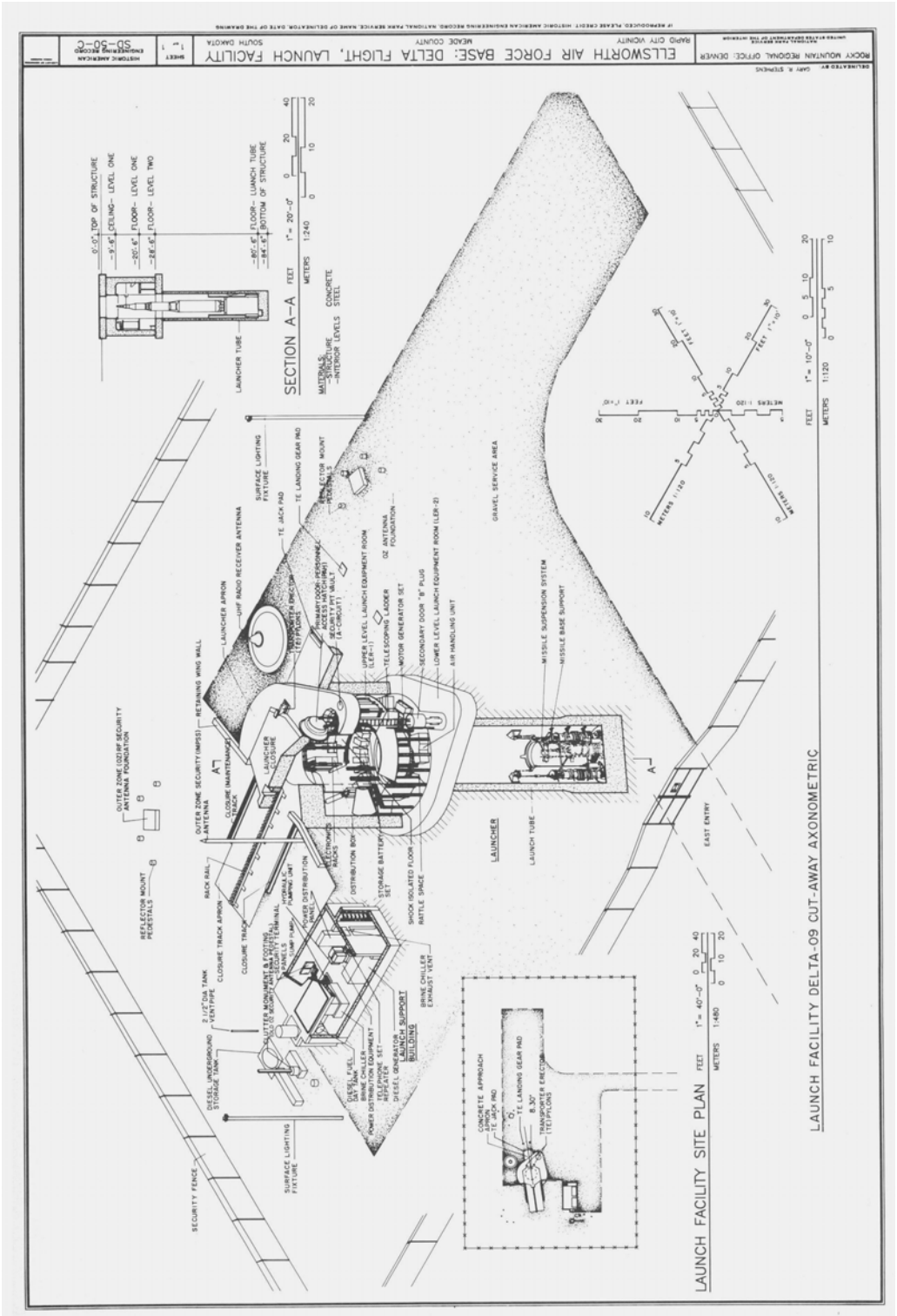


Plate 49. Site plan and cut-away view of Delta-09 Launch Facility
(Library of Congress, Prints and Photographs Division, Historic American Engineering Record, Reproduction Number HAER SD-50-C-sheet 1)

Plate 50. Topside view of Delta-09 Launch Facility with missile launcher and personnel access hatch *(Photograph by National Park Service)*

Plate 51. Personal access ladder into missile launcher, Delta-09
(Library of Congress, Prints and Photographs Division, Historic American Engineering Record, Reproduction Number HAER SD-50-C-24)

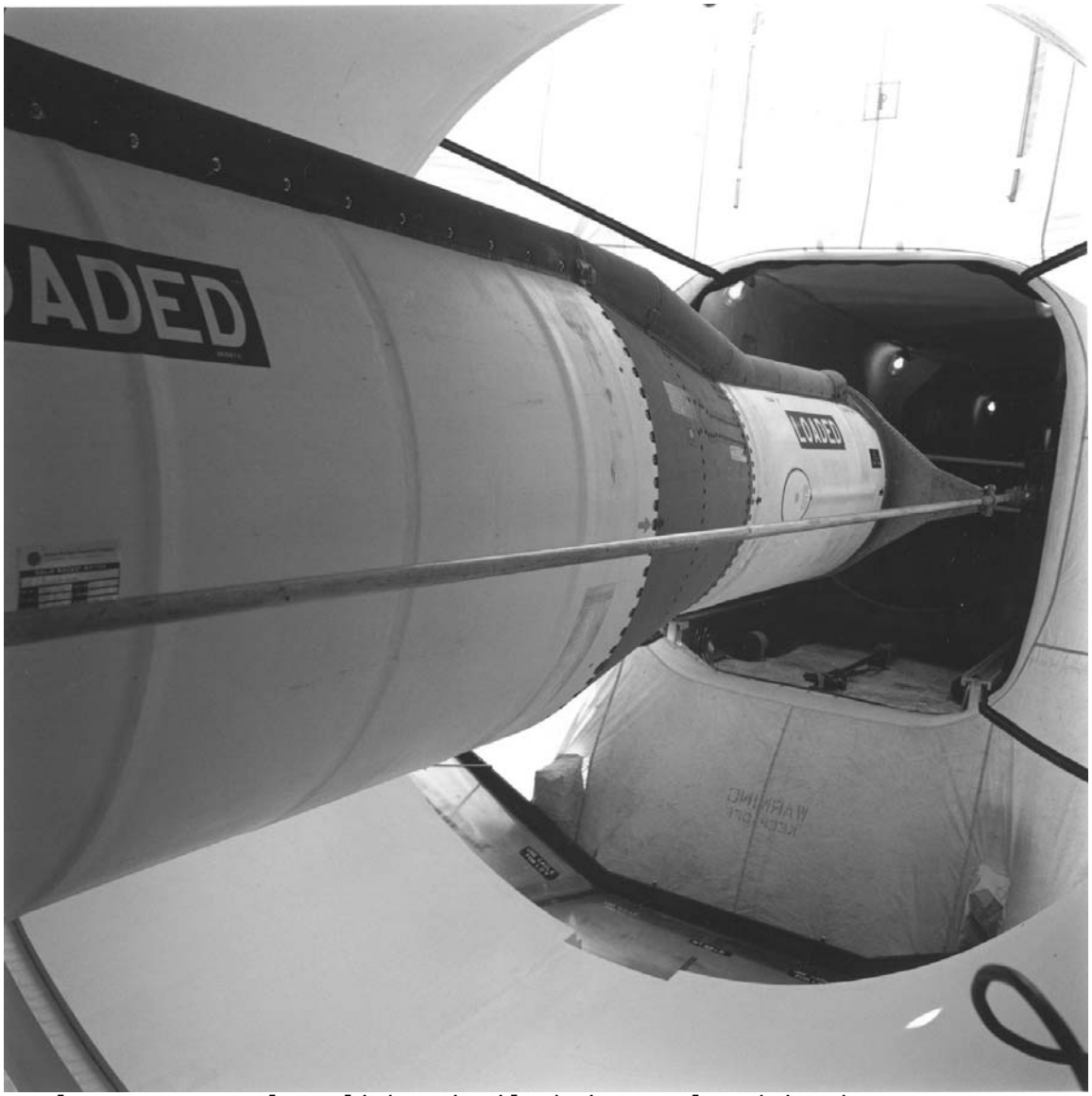


Plate 52. A Delta Flight missile being emplaced in the Transporter Erector *(Library of Congress, Prints and Photographs Division, Historic American Engineering Record, Reproduction Number HAER SD-50-C-18)*

Plate 53. Interior of Delta-09 silo showing launch tube encircled by electronic equipment

(Courtesy of National Park Service, Photograph by Richard M. Kohen)

Plate 54. One of two azimuth markers located outside the Delta-09 security fence used by guidance technicians to align the missile's guidance system *(Photograph by Mead & Hunt, Inc.)*

[i] The description of Delta-01 and Delta-09 is adapted from Jeffrey A. Hess and John F. Lauber, "Minuteman II ICBM Launch Control Facility D-1 and Launch Facility D-9, Ellsworth Air Force Base Draft National Historic Landmark Nomination," Prepared for the U.S. Air Force, 1996, conversations with Tim Pavek, 28th Civil Engineer Squadron, Ellsworth Air Force Base, and construction documents from the 28th Civil Engineer Squadron, Real Estate Office, Ellsworth Air Force Base.

[ii] Hess and Lauber, "Minuteman II ICBM Launch Control Facility D-1 and Launch Facility D-9, Ellsworth Air Force Base Draft National Historic Landmark Nomination." The draft National Historic Landmark Nomination cites the replacement of the siding in 1976, while project drawings date to 1983. Architectural drawings on file at the 28th Civil Engineering Squadron, Ellsworth Air Force Base, S.Dak., office of Tim Pavek, Environmental Engineer.

[iii] The illustration on the blast door was painted in 1991 by Tony Gatlin. See "Ellsworth Air Force Base, 44th Strategic Missile Wing, Blast Door Art," On file at the 28th Civil Engineering Squadron, Ellsworth Air Force Base, S.Dak., office of Tim Pavek, Environmental Engineer. This humorous artistic rendering is a play off of a contemporary popular advertisement for the Domino's Pizza home-delivery restaurant chain.

[iv] Richard B. Stolley, "How It Feels to Hold the Nuclear Trigger," *LIFE* 57 (6 November 1964): 38.

[v] Stolley, "How It Feels to Hold the Nuclear Trigger," 38.

[vi] Hess and Lauber, "Minuteman II ICBM Launch Control Facility D-1 and Launch Facility D-9, Ellsworth Air Force Base Draft National Historic Landmark Nomination."

[vii] "Chronology of the 44th Strategic Missile Wing, 1976," on file at the 44th Missile Wing History Office, Ellsworth Air Force Base, S.Dak. The 44th Strategic Missile Wing was inactivated in 1994, records from the 44th Missile Wing History Office have been sent to the Air Force Historical Research Agency at Maxwell Air Force Base, Montgomery, Ala.

[viii] The satellite dish may have been installed in the late 1980s or early 1990s. Hess and Lauber, "Minuteman II ICBM Launch Control Facility D-1 and Launch Facility D-9, Ellsworth Air Force Base Draft National Historic Landmark Nomination."

[ix] "Transfer of Construction," Launch Facility D-1.

[x] For a concise explanation of the autocollimator system, see C.M. Plattner, "First SAC Crews Controlling Minuteman," *Aviation Week and Space Technology*, 78 (7 January 1963): 62-63; and Rolf Winterfelt, "Minuteman System is 'Most Reliable,' " *Missiles and Rockets*, 8 (27 February 1961): 39, 53.

[xi] Stolley, "How It Feels to Hold the Nuclear Trigger," 38. The IMPSS system is described in Aida E. Roig-Coepton, "1991 Annual Brief History, 44th Missile Wing," 2, on file at the 44th Missile Wing History Office, 44th Strategic Missile Wing, Ellsworth Air Force Base, S.Dak. The 44th Strategic Missile Wing was inactivated in 1994, records from the 44th Missile Wing History Office have been sent to the Air Force Historical Research Agency at Maxwell Air Force Base, Montgomery, Ala.

[xii] The changes that would be required to convert the facilities from Minuteman I to Minuteman II are outlined in "What's 'Force Mod?,' " *Minuteman Service News*, 23 (November-December 1965): 11. In addition to the changes listed here, this article, written before the conversion began, also noted that large water tanks would be buried underground at all fifteen of Ellsworth's Launch Control Facilities to help cool the

environmental control systems. According to Ellsworth missile engineer Tim Pavek, however, the tanks were never installed. Tim Pavek, Conversation with Hess Roise, Inc., 29 October 1996.