FINAL PRELIMINARY ASSESSMENT REPORT FORMER WALKER AIR FORCE BASE ATLAS "F" MISSILE SILO 9 LINCOLN COUNTY, NEW MEXICO PROPERTY NO. K06NM0487

Prepared for



U.S. Army Corps of Engineers Albuquerque District

Purchase Order No. 42236 QP

October 24, 2005

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ACRONYMS AND ABBREVIATIONS

amsl	above mean sea level
AOI	Area of Interest
BaP	benzo(a)pyrene
BD/DR	Building Demolition and Debris Removal
bgs	below ground surface
BMAT	Ballistic Missile Analyst Technician
CON/HTRW	Containerized Hazardous, Toxic, and Radioactive Waste
DCCC	Deputy Combat Crew Commander
DERP	Defense Environmental Restoration Program
DHEW	Department of Health, Education, and Welfare
DOD	Department of Defense
EPA	U.S. Environmental Protection Agency
EPPT	Electric Power Production Technician
°F	Degrees Fahrenheit
FUDS	Formerly Used Defense Site
GN ₂	gaseous nitrogen
GSA	General Services Administration
HGL	HydroGeoLogic, Inc.
HTRW	Hazardous, Toxic, and Radioactive Waste
LCC	Launch Control Center
LN_2	liquid nitrogen
LO ₂	liquid oxygen
LP	launch platform
MAMS	Missile Assembly and Maintenance Service
MEK	methyl ethyl ketone
MFT	Missile Facility Technician
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MMRP	Military Munitions Response Program
NMED	New Mexico Environment Department
NMOSE	New Mexico Office of the State Engineer
PA	Preliminary Assessment
PAH	polynuclear aromatic hydrocarbons
PRP	Potentially Responsible Party
Shaw	Shaw Environmental, Inc.
silo	underground missile silo
site	Former Walker Air Force Base Atlas "F" Missile Silo 9
SMS	Strategic Missile Squadron
SVOCs	semi-volatile organic compound
TAL	target analyte list
TCE	trichloroethene

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ACRONYMS AND ABBREVIATIONS (continued)

TDL	target distance limit
TIC	tentatively identified compound
USACE	U.S. Army Corps of Engineers
USAF	United States Air Force
UST	underground storage tank
VOCs	volatile organic compound
WAFB	Former Walker Air Force Base

FINAL PRELIMINARY ASSESSMENT REPORT FORMER WALKER AIR FORCE BASE ATLAS "F" MISSILE SILO 9 LINCOLN COUNTY, NEW MEXICO PROPERTY NO. K06NM0487

1.0 INTRODUCTION

On July 16, 2004, HydroGeoLogic, Inc. (HGL) received Purchase Order No. 42236 QP from Shaw Environmental, Inc. (Shaw) to conduct a preliminary assessment (PA) for the former Walker Air Force Base (WAFB) Atlas "F" Missile Silo 9 (site) under the authority of the Comprehensive Environmental Response, Compensation and Liability Act, as amended by the Superfund Amendments and Reauthorization Act of 1986. This work is being conducted on behalf of the U.S. Army Corps of Engineers (USACE), Albuquerque District. The site is located in the eastern portion of Lincoln County, New Mexico, and has been assigned Formerly Used Defense Site (FUDS) Property Identification Number K06NM0487 (Figure 1). The site is located in New Mexico's 2nd Congressional District.

This PA was conducted in accordance with U.S. Environmental Protection Agency (EPA) Guidance Document EPA/540/G-91/013 to determine if an immediate or potential threat to human health and the environment exists as a result of Department of Defense (DOD) activities at the site and to determine if further action is warranted. The scope of work included performing a review of the DOD activities within the 500-foot by 500-foot alert area of the silo property (area of interest or AOI), identifying potential restoration projects to be accomplished under the Defense Environmental Restoration Program (DERP)-FUDS program, and identifying post-DOD activities at the site. Tasks performed in conducting this PA included: on-site and off-site reconnaissance, archival and regulatory research; interviews; title research; aerial photographic analysis; and comprehensive pathway and target research.

In 1990, the USACE made an evaluation of potential projects at the site. As part of this scope of work, HGL was tasked to identify any other potential projects not previously identified by the USACE based on the analysis of material obtained through the PA. The types of projects to be evaluated include: Hazardous, Toxic, and Radioactive Waste (HTRW), Containerized/HTRW (CON/HTRW), Military Munitions Response Program (MMRP), Building Demolition and Debris Removal (BD/DR), and Potentially Responsible Party (PRP).

Section 2.0 below describes the site location and physical characteristics, explains the DOD's activities at the site, and identifies the post-DOD owner. Section 3 provides details on the pathways of concern and potential targets. Projects are addressed in Sections 4, 5, 6, 7, and 8 for HTRW and CON/HTRW, MMRP, Petroleum Storage Tank (CON/HTRW), BD/DR, and PRP, respectively. Section 9 contains a summary of findings from the PA. Appendices A through D are HGL's field logbook, photograph log, historical aerial photograph analysis report, and references, respectively. Appendix D appears as a separate volume.

2.0 SITE DESCRIPTION AND OPERATIONAL HISTORY

2.1 SITE LOCATION

The site consists of 333.28 acres in eastern Lincoln County, New Mexico and is located in Township 11 South, Range 19 East, Sections 14 and 15 (Ref. 1, pp. 9, 14). The geographical coordinates for the AOI are approximately E 326,939 and N 857,318 (Ref. 2, p. 31). The site is located 30 miles west of Roswell, New Mexico along U.S. Highway 380 and sits at an elevation of approximately 5,135 feet above mean sea level (amsl) (Ref. 3, p. 2; Ref. 4). The land adjacent to the site is used for cattle ranching.

The regional climate for the site is mild. From March 1980 to September 2004, the average total annual precipitation in the region was 15.8 inches, with most of the precipitation occurring in May through October. The average total annual snowfall for the same period is 15.4 inches, with most of the snowfall occurring November through February. June, July, and August are the hottest months with average daily high temperatures of 88 degrees Fahrenheit (° F). December, January, and February are the coldest months with temperatures ranging from an average daily low of 24° F to 27° F (Ref. 5).

2.2 SITE DESCRIPTION

The DOD acquired the site property in 1960 through the following means: 5.48 acres were acquired in fee simple by condemnation, 234 acres were withdrawn from the public domain by Public Land Order 2749, and 93.80 acres were acquired through easements. The site was 1 of 12 locations purchased by the DOD in the vicinity of WAFB to construct an Atlas "F" missile launching facility (Ref. 1, p. 14).

A joint venture consisting of Macco Corporation, Raymond International, Inc., The Kaiser Co., and Puget Sound Bridge and Dry Dock Co. was awarded the contract to build the missile launching facilities (Ref. 6, p. 20). Construction on the site began in June 1960 and was completed on October 30, 1961 (Ref. 6, pp. 20, 42). Features constructed at the site included an underground missile silo (silo) and launch control center (LCC), water wells, water treatment building, two Quonset huts, septic system, and underground storage tanks for fuel and water (Ref. 1, p. 14). All of these features are within the AOI except the Quonset huts.

On May 16, 1964, the DOD announced that the Atlas "F" missile program was to be phased-out, and on February 4, 1965 the last Atlas "F" missile was removed from alert readiness (Ref. 7, p. 10). On July 2, 1965, the site was declared excess to the General Services Administration (GSA) (Ref. 8, p. 2). On March 18, 1968, GSA conveyed by quitclaim deed the 5.48 acres fee simple and 41.09 acres of the public domain land to Bonham Farms, Inc. (Ref. 1, pp. 9-14). On January 3, 1967, the remaining 192.91 acres of public domain were relinquished to the Bureau of Land Management by Public Land Order 4137. On July 1, 1966, the remaining easements expired following non-use for a period exceeding one year as stipulated in the acquisition documents (Ref. 1, pp. 9, 14). Bonham Farms, Inc. is the current owner of the AOI.

2.3 SITE PHYSICAL CHARACTERISTICS

The silo complex consisted of above and belowground structures within the AOI. Figure 2 depicts the typical surface and underground features of a silo complex, and Figure 3 illustrates the layout of the underground silo complex. Typical aboveground features included: two silo doors, silo air intake, silo air exhaust, fill and vent shaft, silo sump discharge, the LCC entrance, LCC sewer vent, LCC air exhaust, LCC escape hatch, LCC air intake, tile field for LCC sump, three communication boxes, two blast detection optical sensors, collimator site tube opening, RP-1 fuel manual shut off valve, dirty lube oil drain line, clean oil fill line, and horizontal crib locks. Fill stubs and vents were located above the ground for gaseous nitrogen (GN_2), liquid nitrogen (LN_2), liquid oxygen (LO_2), helium, and RP-1 (Ref. 9, pp. 3-7).

The AOI also contained a water treatment building, a cooling water tower for the diesel generators, a raw water storage tank, and a processed water storage tank. The water treatment building contained two water wells and pumps, and demineralization, filtration, and softening equipment (Ref. 9, pp. 3-7; Ref. 7, p. 2). Figure 4 depicts the layout of the site.

Wastewater from the LCC sump was pumped to a septic tank and leachfield located southwest of the silo (Ref. 6, p. 60; Ref. 9, p. 17; Ref. 2, p. 16). Wastewater from the sump at the bottom of the silo was pumped to the surface and disposed of through a 6-inch pipe into a drainage ditch. The outfall for the silo sump was located directly south of the silo (Ref. 6, p. 60; Ref. 9, pp. 3, 7; Ref. 2, p. 16).

Belowground features within the AOI included: the LCC; the missile silo; a 15,300-gallon diesel underground storage tank (UST) and a 15,000-gallon catchment tank, both typically residing east of the silo; and four utility water tanks with a 91,000-gallon combined capacity (Ref. 9, pp. 3-7). An Atlas "F" missile and the launch platform (LP) for the missile resided within the silo. Descriptions of the LCC, silo, LP, and missile are detailed below along with associated equipment and/or components.

The LCC was approximately 27 feet in height and 40 feet in diameter (Ref. 10, p. 17). Entrance into the LCC was through a stairway that began at ground level. The stairway shaft contained an entrapment area, two blast doors, connecting tunnel, a stairwell to the LCC levels and a utility tunnel that connected the LCC to the missile silo (Ref. 9, p. 10).

The LCC was a suspended, two-story steel structure (Ref. 9, p. 10). The suspension system was designed to absorb the ground shock of a near nuclear blast through four air cylinder spring supports (Ref. 10, p. 17; Ref. 11, p. 2). The air cylinder spring supports were attached from the ceiling of the structure to the first floor level and four level-detecting devices mounted between the second floor level and the concrete base (Ref. 11, p. 2). The upper floor of the LCC (Level 1) contained the ready room and storage area, janitor room, latrine and shower room, kitchen and dining area, heat-vent and air conditioning room, and medical supply room. The lower floor of the LCC (Level 2) was the work area that contained the missile launch console and associated equipment. Rooms contained on Level 2 included the launch control room, office, battery room, and communications and equipment room (Ref. 9, p. 10). Figure 5 provides an illustration of the monitoring, electrical, and launch equipment installed on Level 2 of the LCC (Ref. 11, p. 3).

Outside the stairwell entrance to the lower level of the LCC was a utility tunnel that connected to the missile silo. The tunnel was approximately 54 feet in length and 8 feet in diameter and provided personnel access to the silo and also served as a conduit for electrical and communications cabling (Ref. 10, p. 10).

The silo, which housed the missile and most of the equipment needed for its maintenance and launching, was a concrete cylindrical hole 52 feet in diameter and approximately 174 feet in depth (Ref. 10, p. 10; Ref. 12, p. 3). The concrete walls of the silo were 2 feet, 6 inches thick up to 55 feet below ground surface (bgs), at which point the thickness flared out to a total thickness of 9 feet (Ref. 13, p. 2). In the silo roof, which is flush with ground level, was a square opening sealed by two blast-resistant silo doors (Ref. 10, p. 13). The missile was installed, raised, and lowered into the silo through these doors via the LP.

Inside the silo was an octagonal structural steel crib. The crib was suspended from the silo walls on spring-loaded shock struts designed to cushion the crib and its contents against the shock of a near nuclear blast (Figure 6). Within the crib were two square shafts of different dimensions. The larger shaft was for the LP. The smaller shaft contained a utility elevator (Ref. 10, p. 13).

The crib contained eight levels which housed the equipment necessary to launch the missile and maintain the missile support systems, which included heating, ventilation, and air conditioning equipment (Ref. 12, p. 3). Figures 7 to 14 layout the configuration of each silo level and also list the equipment on each level. Additional information on specific equipment listed in the figures is provided below by silo level.

Silo Level 1: contained a 345-gallon demineralized water tank (Ref. 9, p. 21).

<u>Silo Level 2</u>: contained a hydraulic pump and 275-gallon hydraulic oil reservoir unit, a 30 KVA transformer, and eight accumulators and five GN_2 bottles mounted in a support rack (Ref. 9, p. 25-26; Ref. 14, pp. 2-3).

<u>Silo Level 3</u>: had a 30 KVA transformer, a transformer rectifier, an MD-2 motor generator, and an emergency missile power battery backup unit that consisted of 21 nickel-cadmium alkaline cells (Ref. 9, pp. 33-34).

<u>Silo Level 5</u>: contained a 348-gallon dirty lube oil tank, a 348-gallon clean lube oil tank, and a 665-gallon diesel fuel storage tank. The diesel fuel storage tank was kept full through a continuous topping process from the 15,300-gallon diesel UST. A model 40, heavy duty, vertical, multi-cylinder, solid injection full diesel generator was supplied fuel and oil from this equipment. The dirty lube oil from the diesel generator was pumped into the dirty lube oil tank (Ref. 9, p. 38).

<u>Silo Level 6</u>: contained a model 40, heavy duty, vertical, multi-cylinder, solid injection full diesel generator and a dirty lube oil pump. The dirty lube oil pump transferred dirty lube oil from the diesel generators on Levels 5 and 6 to the dirty lube oil tank on Level 5, and from there it was transferred to the top of the silo through a drain line when the tank was pumped-out. The pump had a capacity of 20 gallons per minute (Ref. 9, pp. 4, 42).

<u>Silo Level 7</u>: contained components for the propellant loading system and vapor detection equipment (Ref. 9, pp. 47-49).

<u>Silo Level 8</u>: contained a fuel loading prefab unit with a storage capacity of 630-gallon for RP-1, two 1,870-gallon tanks used to store high pressure helium, a 4,000-gallon LN₂ storage tank, a 3,600-gallon LO₂ topping tank, a 23,000-gallon LO₂ storage tank, three 13,000-gallon combined GN₂ storage tanks. The level also contained an evaporator tank for any overflow of GN₂ and LN₂ from the LN₂/helium shrouds during countdown (Ref. 9, pp. 52-55; Ref. 12, p. 8).

Beneath Level 8 at the bottom of the silo was the sump level, which contained a sump with two explosion-proof submersion 7.5-horsepower pumps with a capacity of 100 gallons per minute. Liquids that were discharged from the sump were routed up the silo wall through a discharge line. The discharge line was routed up to Level 2 where the liquids were released through a 6-inch line into a catch basin outside the silo at grade level (Ref. 9, p. 7, 57).

The LP was an open cage-type, four-level elevator on which the missile was lowered into and raised out of the silo. The platform was 16 feet square and 49 feet high (Ref. 10, p. 15).

The first level of the LP, which was aboveground when the platform was raised, contained the missile launcher and flame deflector. The second level held the launcher platform locking system, which anchored the platform to the silo walls when it was raised and to the crib structure when it was lowered. The third and fourth levels contained equipment for servicing the missile while the LP was rising during a countdown (Ref. 10, p. 15-16). Figure 15 details the equipment on the LP.

The Atlas "F" missile was 75 feet long, and had a 10-foot diameter that flared to 16 feet at the nacelles (Ref. 15, p. 2). The missile could be fitted with one of two different nuclear warheads (Ref. 7, p. 2). The main shaft of the missile was made of thousandths of an inch stainless steel, which was molded into a cylindrical tank structure that had no supporting framework. Rigidity of the missile was maintained through constant application of pneumatic pressure to the interior of the two missile propellant tanks. Missile pressure was maintained during transportation and standby using gaseous nitrogen. When the missile was in flight, helium was used to maintain pressure (Ref. 15, p. 2). Electrical, instrumentation, flight control, and guidance equipment were mounted on the outside of the missile (Ref. 15, p. 4). Figure 16 illustrates the components of the missile.

The missile contained a LO_2 tank with a capacity of 18,725 gallons, but 18,500 gallons of LO_2 was loaded into the tank during launch or propellant loading exercises. The RP-1 tank on the missile had a capacity of 11,653 gallons, but only 11,200 gallons of RP-1 fuel was stored inside the tank (Ref. 15, pp. 4-5).

During a 1990 site visit, the USACE noted that one of three water wells at the site appeared to be in use, evaporative ponds were well-vegetated, and manholes and two silo vents were open and collecting water. The entry to the LCC was also open. The USACE noted a depression east of the silo, which was believed to be the former location of the diesel tank. (Ref. 16, p. l). According to the property owner, the LCC entry had been welded shut, but trespassers and

vandals have used cutting torches to re-open it. The main silo doors were still closed (Ref. 17, p. 2).

2.4 SITE OPERATIONAL HISTORY

2.4.1 DOD Operations

The majority of information regarding DOD operations at the missile silos was obtained from interviews with six former Atlas "F" missile crewmen and maintenance personnel of the 579th Strategic Missile Squadron (SMS) stationed at WAFB. Formal interviews were conducted with these individuals regarding their knowledge of operations and maintenance activities in the AOI. With the exception of one individual, the interviewees were stationed with the 579th SMS during the entire activation period of the Atlas "F" missile program. It should be noted that the interviewees referred to the liquid oxygen at the silos as "LOX." Since the historical site documents use the acronym LO₂ for liquid oxygen, LO₂ will be used instead of LOX for standardization purposes.

All the interviewees reported to duty in late 1961 or 1962 while the silos were being constructed (Ref. 18, pp. 4, 9, 12, 16, 18). The Site Activation Task Force, under the Air Force Systems Command, was charged with overseeing the construction contractors. The USACE was also involved in the construction of the silos (Ref. 18, p. 12). During the construction phase, the interviewees worked out of the 579th SMS headquarters at WAFB. Several of the interviewees were sent to missile school where they received instruction on missile operations and the maintenance of the silos and support equipment (Ref. 18, pp. 9, 12, 18).

Once the U.S. Air Force (USAF) took custody of the silos, an inventory of the silo equipment was conducted. The missiles were then transferred to the silos, and the silos went to alert status (Ref. 18, p. 4).

The missile crew at each silo consisted of five crewmen. The crew included the Combat Crew Commander, Deputy Combat Crew Commander (DCCC), Ballistic Missile Analyst Technician (BMAT), Missile Facility Technician (MFT), and the Electric Power Production Technician (EPPT) (Ref. 18, pp. 6, 9). Both Crew Commanders had to have a rank of Captain or higher, and each wore the launch code for the missile in a sealed, plastic case around their necks. The launch code changed frequently, even during the course of a shift. Both Crew Commanders also carried a firearm to protect the launch code (Ref. 18, pp. 6, 12). In addition, two guards were stationed on top of the silo at all times (Ref. 18, p. 9). The missile crew worked a 24-hour shift and had 2- or 3-day break between shifts. During the course of a shift, crew members conducted about two or three inspections within the silo. The crewmen would record instrument readings and verify that the instrument lights in the silo were green, indicating that everything was operational (Ref. 18, p. 16).

Strategic Air Command required the crewmen to become certified prior to being assigned to a missile crew. This certification involved performing drills associated with missile operations. Approximately once a year, the crewmen had to be recertified, which typically involved conducting propellant loading exercises (Ref. 18, p. 6). It should be noted that during propellant

loading exercises, the nuclear warhead was removed from the missile and replaced with a dummy warhead of the same weight (Ref. 18, p. 10).

Each silo had a library containing about 10 to 12 feet of books, including technical orders and prints, referred to as "Tucker Prints," depicting the electrical and plumbing lines throughout the silo. The maintenance shops in the Missile Assembly and Maintenance Service (MAMS) building at WAFB also had a library containing similar material (Ref. 18, pp. 10, 18).

Silo operations relied on diesel generator power during normal operations, but commercial power was also available. The diesel generators were relied on totally during missile exercises (Ref. 18, pp. 16, 18). The silo contained two diesel generators. Diesel fuel was pumped from the UST into a "day tank" inside the silo. The "day tank" contained a day's worth of diesel to operate the generators. The generators also had cooling towers at the silos (Ref. 18, pp. 10, 13).

In addition to diesel fuel, other material stored on-site included LO₂, RP-1 fuel, LN₂, helium, and hydraulic fluid. LO₂, one of the fuel sources for the missile, was stored in large amounts in an oxidizing tank inside the silo. The LO₂ was loaded into the missile during launch or propellant loading exercises. After the exercise, the LO₂ was vented off the missile into the atmosphere. RP-1, a high-grade form of kerosene, was stored in a fuel tank on the missile (Ref. 18, pp. 5, 7, 10, 13). While the LO₂ was vented off the missile after an exercise, the RP-1 stayed on the missile and did not need to be replenished (Ref. 18, pp. 5, 10, 13).

Other material located in the silo included helium and hydraulic fluid. The hydraulic fluid was used to operate the silo doors, crib locks, and elevators. Because the hydraulic fluid was under great pressure, it had to be occasionally refilled due to leaks. A small tank was present inside the silo to store extra hydraulic fluid (Ref. 18, pp. 5, 13). Two gallons of hydraulic fluid were stored at the silo for back-up purposes (Ref. 18, p. 5).

Each interviewee was asked about general solvent use at the silos. The Maintenance Control Officer, who was responsible for overall maintenance operations at the silos, stated that small amounts of methyl ethyl ketone (MEK) may have been used at the silos to clean parts and remove grease. However, he did not believe trichloroethene (TCE) was used in the silos for maintenance or cleaning operations (Ref. 18, p. 5). Another interviewee, a DCCC, suggested that TCE may have been used (Ref. 18, p. 13). It is noted, however, that the DCCC did not oversee or conduct maintenance activities in the silos; rather, during maintenance operations, the DCCC remained in the LCC to monitor the support systems (Ref. 18, p. 10). Other interviewees did not know of any solvent use on the silo property. One interviewee stated that hydrocarbon solvents were incompatible with LO_2 , and the USAF was reluctant to use hydrocarbon solvents in the silos (Ref. 18, pp. 7, 11, 13, 16, 18).

The maintenance squadron for the 579th SMS, located in the MAMS building at WAFB, performed the majority of the maintenance at the silo (Ref. 18, pp. 7, 13, 16, 18). Interviewees stated that the maintenance crew was out at the silo on a daily basis performing scheduled maintenance or responding to maintenance requests. Scheduled maintenance, which included tasks such as replacing filters, was performed at the silo every 30, 60, 90, and 120 days, as well as annually (Ref. 18, pp. 4, 10).

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According to historical documents, the maintenance squadron was responsible for the following maintenance tasks on the missiles and support equipment: pre-launch, daily, and storage inspections; routine launch site servicing and preventive maintenance; removal and replacement of specific components; bench maintenance; assembly of missiles; periodic inspections; recycle maintenance; technical order compliance; and reclamation and repair of components and parts (Ref. 19, p. 3). Bench maintenance was performed at the squadron maintenance area, located at the MAMS building (Ref. 19, p. 6). Maintenance on the weapon system that was beyond the capability of the maintenance squadron was performed at contractor facilities, "AMAs", or at the squadron with Air Material Command mobile maintenance teams (Ref. 19, p. 7).¹ Depending on the level of service required, maintenance on the missile and support equipment would be conducted within the launch complex, WAFB, AMAs, or contractor facilities (Ref. 19, pp. 5-7). An interviewee recalled that any maintenance on the Atlas "F" warhead was conducted at WAFB (Ref. 18, p. 16).

Maintenance activities within the silo generally involved components of the support equipment, such as vacuum pumps, valves, and motors (Ref. 18, pp. 6-7). The Maintenance Control Officer described typical maintenance issues within the silo as malfunctioning equipment, door problems and facility problems. He added that much of the maintenance involved "R & R," also known as "Remove & Replace" (Ref. 18, p. 4). According to two members of the maintenance squadron, maintenance on the diesel generators occurred on a regular basis because the generators occasionally dripped fluid and were located above the LO_2 tanks. To resolve the potential hazard of the fluid coming into contact with the LO_2 , a 4-inch-deep drip pan was placed beneath the generators (Ref. 18, pp. 4, 18).

A MFT and another crewman were always in the silo to observe the maintenance crew's activities (Ref. 18, pp. 7, 10). According to one Maintenance Squadron personnel, the maintenance crew strictly adhered to the technical orders when conducting any silo maintenance or cleaning (Ref. 18, p. 18). Occasionally, maintenance inside the LCC occurred and typically involved electronic issues (Ref. 18, p. 4).

The missile crew performed minor adjustments to silo equipment during its "walk around." This maintenance entailed adjusting equipment to keep the temperature within a certain range, adding oil to the vacuum pumps, and wiping down equipment (Ref. 18, p. 7). According to historical documents, the missile crew was responsible for performing preventive maintenance on the launcher, ground support equipment, facilities, and communications and ground guidance equipment within the launch enclosure (Ref. 19, p. 4).

The interviewees did not recall if the LO_2 lines were flushed while out at the silo; however, one of these interviewees recalled that the LO_2 had to be replaced once and, as part of that process, a non-hydrocarbon cleaner was use to clean out the line. The LO_2 lines were extremely sanitary and remained sealed at all times (Ref. 18, pp. 7, 13). A technical manual stated that the cleaning of components and systems of the Atlas F weapon system was to be conducted in the MAMS building, and indicated that the propellant loading system was cleaned with nitrogen gas (Ref. 20, pp. 2-5).

¹ Although the referenced document does not define "AMA," the acronym is believed to stand for Air Material Area.

Very little material was stored at the silo itself. The maintenance crew brought any necessary material needed to conduct repairs or perform maintenance checks with them from WAFB (Ref. 18, p. 5). The maintenance squadron was also responsible for supplying diesel fuel and hydraulic fluid to the silos. A tanker delivered diesel to the silos once a month (Ref. 18, p. 5). The crewmen interviewed recalled that spills or leaks in the silos mostly involved hydraulic fluid, diesel, and occasionally lubricating oil (Ref. 18, pp. 7, 11, 13). Typically, the leaks involved mostly seepage and did not constitute large spills. If a larger leak of diesel occurred, it usually resulted from personnel forgetting to turn off the switch when filling the "day tank" on the generator (Ref. 18, p. 13).

Water frequently leaked into the silos and collected in the sumps at the bottom of the silos (Ref. 18, p. 7). Hydraulic oil that had leaked would occasionally flow into the sump as well (Ref. 18, p. 11).

The deactivation of the missile silos was conducted in three phases. Phase one included removing the missile, re-entry vehicle, and classified components, removing mobile equipment and equipment for reutilization, and disposing of missile propellants and gases. The second phase included protection and preservation of equipment, removal of organizational material and equipment, communications-electronics-meteorological equipment, and real property installed equipment. Phase three consisted of reporting the site as excess to the GSA and providing care and custody of the sites (Ref. 21, p. 2).

After removal from the sites, the missiles were transported to Norton Air Force Base and stored near Mira Loma (Ref. 21, pp. 3-4). Between the time when the sites were deactivated and when the equipment was dismantled and removed, the DOD took measures to preserve and maintain equipment in optimum condition for later reutilization (Ref. 21, pp. 5-6).

The USAF determined what equipment it could reutilize from the silos, and then other services and federal agencies were allowed to request remaining equipment. The USAF marked 42% of the equipment in the silos for reutilization (Ref. 21, pp. 7-9). General dismantling began after July 31, 1965 (Ref. 21, p. 13). The diesel generators and air conditioning units were removed from the silos and distributed within the USAF (Ref. 21, pp. 10-12). As part of the equipment removal procedure, the diesel fuel was drained from the generators prior to removal, the silo hydraulic system was drained, and GN_2 and helium were vented off. The diesel generators were removed from the silo along with equipment on Levels 1 through 8, including all the storage containers. The launch platform was used as an elevator for the removal. The launch platform and its drive mechanisms were then removed (Ref. 14, p. 4).

The remaining dismantling work was managed through service and salvage contracts where the contractor removed all required equipment and was granted the salvage rights to the residual equipment and material (Ref. 21, pp. 13-14). Open bidding on the service and salvage contracts began in August 1965 (Ref. 21, p. 16). On July 2, 1965, the site was declared excess to the GSA (Ref. 8, p. 2). On March 18, 1968, GSA conveyed by quitclaim deed the 5.48 acres fee simple and 41.09 acres of the public domain land to Bonham Farms, Inc. (Ref. 1, pp. 9-14).

Although not within the AOI, information on the Quonset huts was researched to determine their purpose. None of the interviewees had direct knowledge of the purpose of or the activities conducted in the Quonset huts, and their accounts varied on whether the huts were taken down when the construction phase was completed. One interviewee believed that the huts contained various shops, possibly plumbing and electrical shops. Other interviewees suggested that equipment and spare parts were stored in the huts (Ref. 18, pp. 5, 7, 10, 14, 17, 19).

Historical DOD documents indicated that one Quonset hut was for administration and the other was a warehouse (Ref. 7, p. 2; Ref. 8, p. 3). No site related documents specifically listed what was stored in the Quonset huts or described the activities conducted inside the huts. A missile phaseout document listed Atlas "F" maintenance ground equipment and distinguished what equipment was kept in the MAMS building at WAFB. Given the distinction of what equipment was kept in the MAMS, it is likely that the other equipment was stored at the site in the Quonset huts. Equipment that may have been stored in the huts included: "MAPCHE" checkout equipment, re-entry vehicle checkout equipment, guidance maintenance equipment, communications equipment, gas and propellant servicing equipment, work platforms (Ref. 22).²

2.4.2 Post-DOD Operations

On March 18, 1968, the GSA conveyed by quitclaim deed the 5.48 acres fee simple and 41.09 acres of the public domain land to Bonham Farms, Inc. (Ref. 1, pp. 9-14). Bonham Farms, Inc. is the current owner of the AOI. There is one active water well on the property that is used for livestock (Ref. 1, p. 23; Ref. 2, pp. 16-17). The site is not used for any other purpose.

3.0 PHYSIOGRAPHIC AND ENVIRONMENTAL SETTING

3.1 GROUNDWATER PATHWAYS

3.1.1 Hydrogeologic Setting

The site is located in the northwestern part of the Roswell Artesian Basin. Several aquifers exist within the Roswell Artesian Basin. Two distinct, but closely related, water systems within the upper carbonate-evaporite member of the San Andres Formation lie within the Roswell Artesian Basin. The first is a shallow aquifer, composed in part from alluvial fill, and the second is an artesian aquifer. Quaternary unconsolidated gravel, sand, silt, and clay form alluvium that lies unconformably above the Permian rocks in the Roswell Artesian Basin. The artesian aquifer occurs beneath an aquitard formed by the Queen Formation in faulted eastward-dipping rocks at the northwestern edge of a large depositional basin of Permian age. It is believed that the on-site wells were drilled to the San Andres Formation. In general, groundwater flows in a southeasterly direction across the basin (Ref. 2, pp. 19-20).

The logs for two wells drilled during construction of the site were located at the New Mexico Office of the State Engineer (NMOSE). One well was drilled to 650 feet and the other to 850

² Although the referenced document does not define "MAPCHE," the acronym is believed to stand for mobile automatic programmed checkout equipment.

feet. The drilling logs for both wells had no information regarding the location of groundwater zones, but did indicate between 80 to 95 feet of very-low-permeability strata between the ground surface and the depth of the wells (Ref. 23). During recent environmental work at the site, a borehole was advanced to 250 bgs and groundwater was not encountered (Ref. 2, p. 44). The site has one active well located at the pump house northwest of the LCC that is used for livestock (Ref. 2, p. 16-17).

3.1.2 Hydrogeologic Targets

Based on information from the NMOSE W.A.T.E.R.S. database, there are no municipal wells within a four-mile radius of the Silo 9 site, but there are 16 registered domestic wells. Information from the database was sorted to identify the domestic wells within the following target distance limits from the AOI: 0 to ¹/₄ mile, ¹/₄ to ¹/₂ mile, ¹/₂ to one mile, one mile to two miles, two miles to three miles, and three miles to four miles. The search identified 16 registered domestic wells within each target distance limit (TDL) was determined by multiplying the number of domestic wells within each TDL by 2.34, the average number of people per household in Lincoln County, according to the 2000 Census (Ref. 25, p. 2). Figure 17 identifies the domestic wells within each TDL. Table 1 shows the number of domestic and municipal drinking water wells and receptors within each TDL.

3.2 SURFACE WATER PATHWAYS

3.2.1 Hydrology Setting

The site lies in the Pecos River Basin. Approximately 1.6 miles south of the site, on the south side of U.S. Highway 70/380, is the Rio Hondo (Ref. 4; Ref. 26). The Rio Hondo is the only surface water within two miles of the site. According to the NMOSE, the Rio Hondo becomes intermittent at Riverside, New Mexico, which is approximately 2 miles southwest of the site and 1.4 miles upstream of the potential point of entry (PPE) for surface water runoff from the site (Ref. 27). Figure 18 depicts the location of the Rio Hondo within the two-mile TDL of the site and 15 miles downstream of the site.

3.2.2 Surface Water Targets

There are no wetlands within 15 miles downstream from the site, and the site is not in a flood zone (Ref. 28). There are no surface water intakes for domestic use within 15 miles downstream from the site (Ref. 29).

3.3 SOIL EXPOSURE AND AIR PATHWAYS

3.3.1 Physical Conditions

The site is located in the Pecos River Valley, a north-south trending topographic feature situated along the southwestern boundary of the Great Plains physiographic province. The geologic setting for the site is the Roswell Artesian Basin north of the western edge of the Guadalupian

reef complex of the Permian Basin. The Roswell Artesian Basin is bounded by the Capitan, Sacramento, and Guadalupe Mountains to the west, the Seven Rivers Hills to the south, and the scarp of the east bank of the Pecos River to the east. The northern boundary of the basin is indefinite, but probably coincides with the main stem of Arroyo del Macho. Regional stratigraphy consists of quaternary valley-fill alluvium overlying Permian marine clastic, carbonate, and evaporite rocks (Ref. 2, p. 19).

In a borehole recently drilled in the former UST area of the site, fill material was present to 10 feet bgs. Beneath the fill material, well-graded sand with gravel and rock fragments was deposited in contact with the top of the competent limestone present at approximately 12 feet bgs. The limestone exhibited alternating zones of less competent weathered sequences with thinly-bedded finer material. The limestone was very competent between 200 and 250 feet bgs, the total depth of the borehole (Ref. 2, pp. 31, 39-40).

Primary vegetation at the site is salt cedar and native grasses.

3.3.2 Soil and Air Targets

On the average, approximately 13 people live within the one-mile TDL of the site and 211 people live within the four-mile TDL. To calculate receptor information, the population within the one-mile and four-mile TDLs was calculated by multiplying the population per square mile of Lincoln County by the number of square miles within each TDL. The number of square miles of Lincoln County within each TDL was determined using ESRI ArcMapTM. Data from the 2000 U.S. Census was used for the total population of Lincoln County (Ref. 25, p.1). However, physical observations made during a site visit do not support this population density data. The closest resident to the AOI is located approximately two miles north-northeast of the site. The resident was located using a United States Geological Survey (USGS) digital orthophoto quadrangle image taken between 1996 and 1998. Distance from the AOI was determined using ESRI ArcMapTM.

Lincoln County encompasses 4,831 square miles and has a total population of 20,322 (20,322/4,831 = 4.2 people/square mile) (Ref. 25, p. 2). There are 3.14 square miles of Lincoln County within the one-mile TDL (4.2 people x 3.14 square miles = 13 people). There are 50.20 square miles of Lincoln County within the four-mile TDL (4.2 people x 50.20 square miles = 211 people). Table 2 shows the population tabulations for each TDL.

No schools or daycare centers are located within 200 feet of the site. Terrestrial habitat for endangered or threatened species does not exist on or near the site.

4.0 HTRW AND CON/HTRW PROJECTS

4.1 PRIOR AREAS INVESTIGATED FOR POTENTIAL PROJECTS

During initial investigation of the site in 1990 and 1995, the USACE identified four sources of potential hazardous or toxic waste contamination at the site: the area where the diesel fuel UST was located; the evaporative ponds associated with the water treatment system; the main missile

silo; and the septic system and leach field (Ref. 1, p. 3). Program policies prohibited any projects at the site since the site owner did not wish to participate (Ref. 1, p. 4).

In 2003, the USACE proposed a site investigation to include soil and groundwater sampling to address potential HTRW contamination (Ref. 1, pp. 24-25). The USACE is currently performing an investigation at the site. The areas being investigated and preliminary sampling results are detailed below.

Soil samples taken during the site investigation were analyzed for volatile organic compounds (VOC) (EPA 8260B), semi-volatile organic compounds (SVOC) (EPA 8270C), polynuclear aromatic hydrocarbons (PAH) (EPA 8270C-modified for low level PAH), and target analyte list metals (TAL) (EPA 6010B/6020/7470A/7471A). The laboratory also performed searches of mass spectra library files and reported the top 10 tentatively identified compounds (TICs) for each VOC and SVOC analysis (Ref. 2, p. 32). The soil sample results were compared against the more conservative levels of either the New Mexico Environment Department (NMED) Soil Screening Levels or the EPA, Region 6, Human Health Medium-Specific Screening Levels for residential exposure (Ref. 2, p. 33). Groundwater was not encountered during drilling activities within the study boundary (250 feet bgs) (Ref. 2, p. 44).

4.1.1 Septic Leachfield

Four soil borings were advanced to 4 to 7 feet bgs just beyond and downslope of the presumed boundary of the septic leachfield at the site. Soil samples were collected from the bottom of each soil boring (Ref. 2, p. 30). The analytical results from the soil samples did not exceed the evaluation criteria (Ref. 2, p. 35). The following TICs were identified in two of the soil samples and one field duplicate: heptadecane; 4-ethyl-octane; 5-ethyl-2,2,3-trimethyl-heptane; and 1h-indole-3-ethanamine. In accordance with the site investigation quality assurance plan, no further action was necessary regarding the TICs (Ref. 2, pp. 35-38).

4.1.2 Sump Outfall

A total of eight soil samples were collected in the vicinity of the sump outfall pipe and associated French drain. After the removal of cobbles in the French drain area, a total of four samples were collected from immediately below the drip edge of the outfall pipe and then downslope of the pipe at distances of 5, 10, and 20 feet. After these samples were collected, a trench was dug from the outfall pipe extending downslope approximately 20 feet. Four more samples were collected at an average depth of 3.5 feet bgs along the side wall of the trench at the same distances from the outfall pipe as the first four samples (Ref. 2, p. 30).

Organic vapors were not detected in any of the sump outfall samples, and none of the analytical results exceeded the evaluation criteria (Ref. 2, pp. 30, 35).

4.1.3 Former UST Area

One sample of limestone rock flour material was collected approximately 240 to 250 feet bgs in the former UST area at the site. Organic vapors were not detected with field-screening methods

and no visible evidence of contamination was observed from this deep borehole (Ref. 2, pp. 30, 32).

The analytical results from the sample did not exceed the evaluation criteria (Ref. 2, p. 35). The TIC eicosane was identified in the sample, and 10-methyl-nonadecane was identified in its field duplicate. In accordance with the site investigation quality assurance plan, no further action was necessary regarding the TIC (Ref. 2, pp. 35-38).

4.2 **PROPOSED PROJECTS**

No additional HTRW and CON/HTRW projects are proposed.

5.0 MMRP PROJECTS

5.1 PRIOR AREAS INVESTIGATED FOR POTENTIAL PROJECTS

No prior MMRP projects have been identified.

5.2 **PROPOSED PROJECTS**

No MMRP projects are proposed.

6.0 PETROLEUM STORAGE TANKS (CON/HTRW)

6.1 PRIOR AREAS INVESTIGATED FOR POTENTIAL PROJECTS

No prior CON/HTRW projects associated with petroleum storage tanks have been identified.

6.2 **PROPOSED PROJECTS**

No CON/HTRW projects associated with petroleum storage tanks are proposed.

7.0 **BD/DR PROJECTS**

7.1 PRIOR AREAS INVESTIGATED FOR POTENTIAL PROJECTS

During initial investigation of the site in 1990 and 1995, the USACE determined that former DOD structures remained on the site that could be hazardous. These structures included the main silo, silo vents, LCC, several manholes, and smaller underground structures. The USACE did not propose a BD/DR project for the site since policy did not permit BD/DR projects at sites that have been owned since DOD usage by one or more private interests, unless the title transfer documents specifically required the U.S. Government to restore the site (Ref. 1, p. 2, 16, 20). A review of the USACE's *Environmental Formerly Used Defense Site (FUDS) Program Policy, ER 200-3-1, May 2004* showed this policy is still in effect.

It is further noted that the conveyance to the current property contained a hold harmless clause to protect the DOD from liability. The clause released the United States from liability for claims of personal injury or property damage resulting from the government's use of the land (Ref. 1, pp. 10, 12, 14).

7.2 **PROPOSED PROJECTS**

No BD/DR projects are proposed.

8.0 PRP PROJECTS

8.1 PRIOR AREAS INVESTIGATED FOR POTENTIAL PROJECTS

No prior PRP projects have been identified.

8.2 **PROPOSED PROJECTS**

No PRP projects are proposed.

9.0 SUMMARY AND CONCLUSIONS

9.1 SUMMARY OF OPERATIONS

In 1960, the DOD acquired 333.28 acres in eastern Lincoln County, New Mexico to construct an Atlas "F" Missile Silo 9. Silo construction was completed by the fall of 1961, and the silo was placed on alert status in 1962. The underground silo complex consisted of the LCC and the silo, where the Atlas "F" missile and its support equipment was located. The silo complex included water wells, water treatment building, two Quonset huts, septic system, and underground storage tanks for fuel and water.

In May 1964, the DOD announced plans to phase-out the Atlas "F" missile program. In 1965, Silo 9 was declared excess to the GSA. The GSA conveyed the AOI to Bonham Farms, Inc. in March 1968. Bonham Farms, Inc. acquired the property to obtain the associated water rights, and is the current owner of the property.

9.2 SUMMARY OF AREAS PREVIOUSLY INVESTIGATED

Areas in which the USACE conducted prior investigations include the following HTRW projects:

- Septic Leachfield
- Sump Outfall
- Former UST Area

9.3 **PROPOSED PROJECTS**

Based on a review of historical DOD operations at the site, a site reconnaissance trip, analysis of migration pathways and receptors, and a review of environmental work performed at the site, no projects are recommended for the site.

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LEVEL 2

- 1 HYDRAULIC PUMP AND RESERVOIR
- 2 HYDRAULIC ACCUMULATOR AND
- GASEOUS NITROGEN PRESSURE TANKS 3 INTERCONNECTING JUNCTION BOX
- 4 LIGHTING PANEL LA
- 5 LIGHTING PANEL LD
- 6 30 KVA TRANSFORMER
- 7 LOCAL CONTROL HYDRAULIC PANEL
- 8 NONESSENTIAL MOTOR CONTROL CENTER
- 9 COMPRESSED AIR SYSTEM REGULATOR PANEL
- 10 ESSENTIAL MOTOR CONTROL CENTER
- 11 EXHAUST FAN BLAST CLOSURE AIR COMPRESSOR
- 12 SILO EXHAUST FAN AND PLENUM
- 13 GASEOUS OXYGEN VENT
- 14 WORK PLATFORM 1
- 15 LAUNCH PLATFORM COUNTERWEIGHT
- 16 MANIFOLD ASSEMBLY WORK PLATFORMS CRIB LOCKS SILO OVERHEAD DOORS
- 17 FILTERS

X:\Phoenix\Graphics\Atlas (SHA002)\ Figures\Silo9\2.3-Figures-9.cdr Created: CLimoges 04/01/05 Revised: CLimoges 10/21/05 Source: Ref. 9, p. 24

Geologia



VIEW A

Figure 8 Silo Level 2 Equipment Location Diagram


















Final Preliminary Assessment Report—Former WAFB Atlas "F" Missile Silo 9, Property No. K06NM0487

> Figure 17 Location of Known **Private Domestic** Wells Within a 4-Mile **Target Distance Limit**

2

Miles

 \bigcirc

Legend Former WAFB Atlas "F" Missile Silo 9 **Domestic Wells**

1/4-1/2-1- to 4-Mile Target **Distance** Limits

Filename: X:/Phoenix/Graphics/Atlas (SHA002)/ Maps/Silo 9 Final Draft/Fig 17-9-Wells.mxd Project: SHA002 Created: C. Limoges 11/2004 Revised: C. Limoges 10/24/05 Map Source: NM-OSE, RGIS, USGS 7.5 Minute Quad Map 1974



Final Preliminary Assessment Report—Former WAFB Atlas "F" Missile Silo 9, Property No. K06NM0487



Potential Point of Entry for Surface Water Runoff

Perennial Stream Flow

Intermittent Stream Flow

Filename: X:/Phoenix/Graphics/Atlas (SHA002)/Maps/ Silo 9 Final Draft/Fig 18-Silo 9 Surface-H2O-Analysis.mxd Project: SHA002 Created: CLimoges 05/03/05 Revised: CLimoges 10/24/05 Map Source: NM-OSE, USGS, RGIS

Target Distance Limits (TDL)	Location	Area (Miles Sq.)	Average Population/Mile Sq.	Total
1-Mile TDL				
	Lincoln County	3.14	4.2	13
	Total			13
	· · · · · · · · · · · · · · · · · · ·	· · · · · · · · · · · · · · · · · · ·	· · · · · · · · · · · · · · · · · · ·	
4-Mile TDL				
	Lincoln County	50.20	4.2	211
1	Total			224

Table 2 - Population Tabulation

*Actual Population based on 2000 U.S. Census data

Appendix A

APPENDIX A FIELD LOGBOOK

FINAL PRELIMINARY ASSESSMENT REPORT FORMER WALKER AIR FORCE BASE ATLAS "F" MISSILE SILO 9 LINCOLN COUNTY, NEW MEXICO PROPERTY NO. K06NM0487



8/2/2004 Silo 11 - Sile Vinit <u>9:40</u> Am. - cbservation from property permeter - pee range cattle - heilthy regetation - spent still casing observel on the ground - closut house = N 1.7 miles - Mr. Farat owns Sile 11____ - Silo 11 is located v 8.5 miles from interchange of Interstate 285 7 Havy 70, - Buin Jola sail all copration prode Jun sile to another had the song relative demensions, however they had to get the topography of the side 812/2004 10:30 Als 12 - Sele Visit AM. Mr. Hendley is the curle . He has a legal hepresentative since he us an ambassado

Photo of Selo 12 - Jung east from woodway 2 water tasks av present from Helix Oil Helex Oil owned the sate come tence 11:44 Silol - Mr. Zigler property - No evaporation prod-per & NWly directic - Mr. Zigler lives on the property - Brian sail this one of the selos that blew up. 11:55 Silo 2 - Sito Minit owner is Deckawitz (spelling) -Helin Oil unce to pump water a the set lih 8/2/04

8/2/04 12:00 Silo 3 - Site Vusit Photo taken in northerby luction - silo owned by Mis. Boke, dunced - Bruin sail Mi Baker constructor towers on the property for project with Los Alamo - he also sail there are no evaporation prode on the property - the seld got water pom team - Report House - is Elking road located about 0.7 miles 12:15 Silo 2 -Owner lives on-site Photo taken frieng south Observed Brenteal tenke. Iwo tanks are associated Heles al perations, Brian del nat prove what the 3rd tank was used for Obered trules / camper back hoe tuctor

Bigo indicated that Ails 2 also plew up. Also, the elevata in rula flew to the ground and pulled about Spenglo 812 All 4 - ste visit 12:40 pm. - owned by Mr. Baken -nement revelence is located of Hung 350 about 5 mile cast of seld. - Observed dulling apentions - due nother site - several - due nother site - several - dulling rigs are present -Brian mil evaporation - pondo an located SW of Allo pod. Photo I - tench field facing Nath Photo 2 - water treatment pd Jacing SW Photo 3 - cutfall from sild pring NSly direction - observed 5-mich day pipe

filo 4 - observed 2 access vents - abserved big pole Nog silo pol used for water UST - MW present on-site - USACE install - antenes tower was installed by Mr. Baker Jo dos Alemon - project Silo 5 8/2 This sets also blew up. Brian neil the sele property also has USAUE MW. 1:05 p.m. Pherto Joing north - closest residence is 2.7 mile west grib Photo 2-5- anteloje in spril pal - dut pile that was bug out for the minute Photo 6 - toten in NEly durtin provodside

.8/2 Ale 7 - fite Vint 2:02 pm V Jack for lichsploy Joine used for dienie full hlendeng Trailer W/resident con-site -opserved pite of barrels in the lot. Barrels laying houghtar Photos 1 - laund antal Photo 2 - barrelo Photo 3 - barrelo - Phento 4 - all ASTS > - taken faring due Moth Owner will not allow USAIE access Silo bite Viel -owner Wendel Petri 2:15 pm Photo I taken provod facing Photo 2 - taken freings ruth - Closest résédence és 8 miles

2:51 Silo & - City of Lake Arthur owne it - brught it to get water NI 115 ____p, m.____ - very good water in this area - under artesian pressur - residence on the property - 3 people including young chilf -Burnach USALE has completed Photo I - silo pad foring NEley Photo 2- Jones DOD water treatment hly & current locate of city wells Photo 3- Brain engineering ______ master prece " Brin soil fames DOD wells are now the citig's dunking water wells - use salt for chlainsten chlaination - 4MW locations - 2 well locations has 2 wells - Muc untalled in July 2004

Jilo 8 - evaporation ponds are nothe of treatment feality-enclosed in find - Observed 2 sewer montreles - least field is located to the west of the selo pad Slolo Site Vinit 4:03 pim. Photo taken frem N. - dors of silo temens open - repert referre um HWY 380 west of rela about 5 miles away. 445 Ado 9 Site Visit pm McCreis Ranch Brukom Faime lines property to get water wells. DOD wells as no longer

Als 9 - doest residence is I mile - Exportin ports are northing the set -Brun Sied leach pullo was sampled & all work @ Selo dre. Photo I water treatment Bldg pd - SW questa Photo2 - Frackfield NE Photo3 - reach field NE No MW @ this location 2 UST 170 Janks I larger UST HO Jonk well - 792 25 GPM Dyallon per menute 2/2004-

8/3 Met with Gang Baker over dennar 2:00pm - notes from meeting SAC - SIMS - cuil engeneering man - leth Berospace Engineering Squadra-possible source of info on Atlas - NARA DC Cartisgraphie Brand tos film on Rowell - Bid packet for Atlas solo. Getting the following DATION F. TO 2) Bed Packages for sulos 344 from OLA 3) "As Bult" 4.) master list of Tos for Atlas F" 5) Prints from NARA () Unit Hesting stuff fin maxwell Day said Solving Intract # FFR# may he defe of conveyonce to property

Hay Baker provides form of Silo 4 200 \$ silo. 8/3 - He also provides accesso He made file 9 tas a beg water tank because deft to SW is v 800' fumper about 25 gal menute - Gay said other silos hod 600 closes to surface. 2004 3

8/4 2004 -spate w/ Allere 10 Am o micropeitre - 1987-1999 ocemptiter - 5/1998 to present o bocho Computer - con look & index from 1987 to present - docs on computer 1999 to present Docs. pre-1999 annicipiete 8/4 spile à Pan B & County Assessois Office, Alleene suggested using local - Litte company for research. - Lawyers Litte 622-4331 Fordmark Title Licensed b 622-5340

13 Plat nops-veymap must be deel op - mayor pe rece certain date ter zed by publ Organ 9 tin " ca a 1/2/104) Sex th De Dony S

8/4/2004 Lary Baker 4-pm-8pm Bouy provided ies seme details about the Atla"F" program - 4 comparies worked together to build all the relos Prince Contractor - Convair (orignally) Senerel Degramics bought out Convair - became GDA DAwas the prime contractor of everything including mesule and site construction -- the 4 companies are brick and mortor ' Ko (lech 2/4/04) contractors w/ 6DA. The USACE referred. (Ich 8/4/04) referred between GDA of the 4 contractor derectly with the USACE Western Development Deverin went to Bechtel to design Atlas "IFI"

Wolfed W/Semin Prymod of TRW - on engineer -He was a USAF Ballistic Division man TRW - did system development for mensele. It dereited USAF to Beachtel to commension construction. 5) Vetech & Black mode the sete-specific punto - Hary freed to contact for "As - Builts" Hero, Sila II owner called Beachtel Buchtel- USAF saip build Atla 'F" at Vanderberg (OSTF) amilting at" (leh 5/4/04) Schielen Atlas 550 SMS Juncoln Atlas 551 SMS Abulano Atlas 575 SMS mart apart Lo Maentenance Les Hayles - was enlected guy, He was talked into joining AF. He went into electricat school.

10 Les Haylas - When he went to th minile squadron, te pren nothing about it when he got them the is very throw ledge Mainteriore Facility Jednica Mh. Ziegler = Section Maintenary = 14e was also Chief Warrant Office = He may not desclose classifies upo MAMS - Maintenance Assemply Maintenance Squadin 579th HQ - Officer (Hangards? <u>E WAFB</u> (n 13th minute -had space for another messile in some brea Bechtel did unitary prints, which are broken down by site the

Bob Kaplain - curator og Son Diego Aeronautical Museum All Atlas misicle wele built in San Diego. <u> 54 —</u> ZA Destrict of USACE start Atlas = Bullistic Missile Construction 12 Budigien General Wellington was appointed. Albuqueregne Pertiet handle by July 1941 He Rosevell sile = Area in effect Engineer was in charge A Jer He Rowell rite 5?) Le General of Program - General Schweis collection is C. Texas A & M. TRW = Zengeneers out of Aughes formed this company blc they could not be the prime contractor. ela-

Aerospice Corp Engeneers -- may have information -- non-projet Organization Sel2/ contaminated - 1992 1994 1997 sampleny activity - post-DOD operations letely caused the contomination, - 1st site to blow up ' - Accedent occurred in July 1912 - 1963 - et tad heen in operation for 10 months. Liquis Oxyge Plant in Hanga (Hangar 853) - generated 102 Mr. Baker showed us a photograph f - can abserved ZOX off-gassing @ the top RPI- drit work LO2 mixing with RPI

Gudaree pod - Destinguisker structure for Atlas F Site 11 ptoto= phil more ha whole set of photos 37th Mandenance (ch p/4/04) 37th Munitines Maintenance. Squadue were responsible for the upperposed feals · specialized training & LOWREY · Heywere clean of He crop enlerted men Hod deagnostic fool & nite for missile work 1 Doas of the mlos weighed about 07 Song has no contact for 3-9 th muniter Maintenance Synadra. at WAFB 4 He Surrellance & Inspection Belg was used for Atles wachend maintenance. - building designe 1) a this.

Selo/ Sile Laccident - fre kuned fra week - He missile dropped - ZO feet drun - the door hlow of 150° an each derection fild ha always for a wate proten since it was hult Saugnie there were 4 sogget sites _ Siles 12, 7, 8, 9 - For Silo 1, underground - niver runs benealth the here Mar New Also, Cropy braw of river meanly <u>Sils 1 Owens</u> - milially Wicksham oured it - from TX - Hen Rechard Oore lun 8/4/04 ·····

N Phil More was Deputy Crew Commander for the site (Sile) and the Commander was Jim Bloodworth Harry said the had copies of all site property or ones prior to DOD ownership - A 24-hour shift was really 36 hours. Misale enew mitally go to the MAMS bldg. at WAFB. 1f -go te the building - get a debriefing - get 100% on Hests - Is to silo - do shift @ silo - then debrief new minsile new for next shift Joseph Conrod - Lod atter duties Billy? C. H. MAMS blog did the checkrat of equipment. He was the KO who Conducted a lot of tests on the equipment. If the was a proplem of 20X Joading the AF may have called GDA to pigt

Sumps-went ato outfall. Sou drent pileive the material Contained any waste products, There was no chemical waste clarifier associated w/the outfull. Cumlite the Istan missile) Sub2 Phil More Ampenel to Sub 2 - This sile was the third sete to blow up on 3/1964. Harland Crew -Atark Board Crew - go through a check w/ 5 enstructors averlooping eocufting for 24 hours The Stone Board Crew - althe in oversight tole they have no more experience or knowledge than the standard Crew, In Standard Crew may even have "handson experience while the Stand Board crewhord may

<u>Assue-</u> Who gives orders when an incident occurs while Atom Brow Crew is there. ·4 Bill Burgleon - Sile 2 - Section Maintenine Officer for filos 1, 2 7 3 Siloz accident The missile gres up 3'7 won't go up or down. The Stand Brack Commande gives an oder (Combat Gew) Commander). The standard Crew Commande Jim Bloodworth sail "No, not according to TO" Jock Neves theid to go into sile three utility furnel-the wan't able to open the blast door due to the pressure. The minite caught fort guardo on 6-hr shifts Call Ime.

Selo 2 explosion Phil to only key to gate to get off of selo progenty Clatte was lead-packed material Lot air pocho - lower level hegan to gill up w/smoke. The people put the pick on to get out of smoke fills area He accelent reports are topenecoded for Ailon. Here uports are Q Kiltland AFB blackwas the safety office to the AF. Al Keng - win @ Silo 5 when it blew. He is an engineer from Frema, Hisrolo (b) Allo 5 1s as, MFT. Day dremit thent the sels es Contaminated & files Ail 2 and 12 were the last siles owned by Helin Out

Helex Oil also owned Siloll t sell it to John Freret. Freret is amorie due to "Di Doo letter" 4 "Mak" -Bob Laszan is a prestof John Nelex Oil orld pilos: Silv 6 - Wildel 5 - Jep Herth 11 - John Freiet 12 - Jenhlen 2 - Dirtewestz - also owned fild 10 & sold to ile 4 - Heles Oil, then Phase 3 Corp Julo 7 - City of Hagerman Julo 8 - City of Bake Arthue 4 Auizail wanteart. How Left 2/4/04 storge Bery was the foreman 8/4/ay leh
Ailo 2 was lift absolved for several years. When water stortage, Sergerale Despendity worked on it & bought 3/2002 - starter his un Destewitz lives on the site 8/4/04

2 8/6/04 4:30 pm. Interview w/ Sary Bake Selo3- SATEC- site Actuation Jack Face Command Solory Kos - Say Wants Here docs: ~ IFB # ~ Solory Contract # DIA-may he a source for these docs) > # may be present in the deal of conveyonce of the property. -runs is projecte until palvage is completel The solvage process may take 2 years to completo Silo 3 - was the last poly of site - 4/8/1967

Silo 3 Louis Angelo was the » Bes # · Solvage # Dary would lehe the list "Defend & Deter" - a brok that May have info Atlas Flis Where did the reach Issue-& manual go after the base closel? PAE /V esthical Research resench boly 579M · When he went to Maxwell any aly asked about ny in 1 ett

Stolog (contened - How Boken) Black & Vetech - Kannas let MO. BMD-Ballestic Missile Devent - Were they arriene hy AF Systems Command Bedtel - to they have does WSIG7-HI- reference to drowing w/the Sensail that there is neg -Sumpericle the rile that collected a lot of stuff -another sewer sump in hallway 2 Unit Hertnies - I is small and abbreviated _ I is larger version w/dates of events included, Ult-antence come in & a later A date & is not references -SAC antenne

Diesels & Catalment Janks PAD Chief - NCO who dealt W/ surface operations Current Hut - Lod bathroom Cerspool on suiface put of site - no septie tarks dø3 Feater on kenel 5 Dor tank Civil Ergenening Manual-may proce Stating having for metor, Lalong Contrator kal to take bond as goat, sign bond & put I up Dougs question - Who inspected salvage effort & signed of on the

 \mathcal{G} GSA - salvze material How got USA does for Silos 3 94 from DARA-Derver - hop a 2rd tourch console - hop douple communicatu - may electrical wires Silo height - 185 feet - two top to battom of sump. A 3 stes for double sumps in them, including Sate Silo 2 - the elevator would take of to different floors

de 7 = UFO sitergs = manuveurs that were not W/i our plane's apphility Also sow grosts a some silos -grosts were mostly lodean Julo 2 - Phil Mone was Deputy Gew Commande when it blew up. Silo 3 Arrie Angeles sold to Lynn men I month later Drue also had the Dalvage l'ontrat for this sild. contract for the selo JUX 8/0/04

filo3 nda tgip Phase 3 comp - went definite V John At Woodworth Jama estre So Say Baker elix del Lynn Meer Invertment Corp Phase > Solk. Bong B he

le 5 Hely Ort - only operation - Lol until mil 1980s (?) A bankrupty Ed Payto Billy Wilcon erginger out Alarka loi 6 Helen al - sign whochet in sport Werlell \$1500 - selo has no stars of no - ton good I vande lorm by kids no other operatory

<u>ک</u>رک Sela. 1 City of Hagerman Negrus Valley Reffring liver in trailer on - no te is deal new Ray Bell - is very wealthy Pegnes? Valley Refining is a tank form -Has left contamination per Darigs fords who worked there G crieg Sutterland Theypert lead in gasoline Tanta cost more Han other - It was deaper for the company to put leal in petroloum than some also dreng it or buying gas w/ lead in it. Ray Bell - IRS & ElA and after demi -penny punchan

Sell 7 How theips file 7 is on the EPA list - CERCUS -depend company mayte go after officers Nowater wells in Selos 1, 3, 4, \$5 City installed water line to Nike installation ne an Battombers Late - put in T & sent line to siloy - Water went thru. treatment system & sent to file 5 - deneneralized water - nome plate Silo 2 sho has water freatmant septem 4" pepe goes to delos! and 2 Julijotos

3 - 2 wells + water freatment -facility <u>Sile 12 - Zwells + water</u> treatment facility -large evaparties ponds Silo10 water reatment faulity that fits I tank only. Silo7 - has a very large tank, but can't see it due to barrels C the site' Water treatment facility varies C every site. <u>Ales - et is proveled water</u> - ne will - City of Hagerman - <u>proved</u> Ho vat - <u>proved</u> Ho vat - <u>Program Rever</u>

Selot - same story - no well - Hagerman fed worten pron Peypsus Risen - Sour skil this site. may now have bell Ashetos - clay pipelere from City of Hagenran 100 Silas 1. 27 and Jile 4 Separate contraits existed for communication luis and water lues A too miles of renderground Cable. MAMS Plant & Lot Plant Siles 8 - always owned ky Sale Arthur Enty like 2405 like ech 8-14/04 814/04

8 - only wells + water freatme 10 plant 11 12 filo 8 lig - lowner - ne operations provide H20 to ranchers - owns pecan ranch Jelo 10 Helex Oil backed out of buying the sets. Wulfor got it on the rebid - 89 acres - Wulpm got He rele, Hen went Ahrough divorce, - (Carrie-infi-Wulpon teard about sele of silo through rades. Wulpin's wife Carrie got the sile. - a couple of dead changes occurred. 104

filo 10 -Starlete operated the - had a patalle septie ton Starlete lessel landfim Carrie in 1999 to Conduct a Carershow Starkte dedat make good Day thought Here may on property due to Starlete not paying. Heles Oil Ed Payton (a Pada) sold it to Jahn Fairet. in 1997/1998

41 Sils Z Helez Oil Destelivetz -operations incolier the sale of H2O (Mi Bench) George Bench (MBenge) - Heliz Oil sold H20 altho not under Company though Silo 12 Further - no fature activity (echs/clos) Jelo 2 - no justher actual Sold on the courthouse Sold on the courthouse steps to back toxes g liens - or Zeegler bought if <u>filo 2 - Ifoky heard Dinpeliets</u> <u>raesel sitle wars A</u> <u>Mushcoms in the sito</u> met)

Although file 1 hod a lat was prought in. P 6/04

to leh 8/7/04 8/7/04 - Vusit State Engeneers Office research water wells - after 1933 - need to file Silo 6 7145 R271= 524-24 = \$ V T145 R28E S1-5,7-34 = K = 1 (leh, 8/1/04) NW 4 SE 4 327 - Jonuary 1940, Digth of well - 240' Sample Log O" T145 R29E 57, 17-20, 29-33 - Iwell Section 7 - 1999 = use = Stock well. Total # of wells = 2

1 th Selo7 T135 R27E 7135 RZUE 95 wells 145 RZYE TI4S RATE T 155 R27E TI4S RALE - SI-3, 10-15, 22-27, 35,36 1) Shallow well - W/2 W/3 KINW oz SI = 1954 2) Shallow well NWK4, NWK4 of S.2. 1959, Use: Oil Section 2 3) un: Dom/Atock 1985 4) Shallow well - SE Ky, SW Ky, SW Yz, Sec 2 1962 - Use: Demestic 51) Shallow well - 1959 use ilmigation Le.) Spallow - 19101 lese: ail

a3 7.) SW14, SF14, SD 1947 use: oil 8.) Stallow - SW14 SE14 S10 1944 Use: ? 9) well - Sw1/4 SF= 1/4, S10 1946 use = ? 10.) Shollow well - NW 1/4 NW 1/4 SE 1/4 SID 1959 - Use dementic 11.) Section 10 - Artescañ well 1905 - Use: menicipal. 12) Shallow - N'2, SW 1/4 ST= 1/4 of SIL 1957 use: domester 13) Shallow - NE Ky SW Ky SE Ky SIO 1952 une: ? 14) Shallow - SEV4, SEV4, SEV4, SID 1950 une - Domentic 15) Shallow well SIL 1962 une: Domenter

10) Shallow - SW14, SE14, NE% SI2 1940 17) Shallow - SW14, SE1/4, SW14, S12 1950 SW14, SW14, SE14, SI2 191 Shallow - SW14, SW14, SE 14, S12 20) Well - NEVY NW/4, 513 hallow- 513 2) well - sw 1/4, NW 1/4, NW 1/4, S14 23) Shallow - SW 14, NW 14, NW 14, 514 1948 24) well - Sw 14, NW 14, NW 14, Sty 1938

25) Shallow - NW 14 NW 14, 314 1960 use: urrigation 310 26) Shellow 1952 2 SW14, SW14, NW14, SI 27) Shollow Sw14, Sw14, NW14, S14 1958 12 28) Shellow - Swi4 gwi4 NW14, 514 1934 Lere: Unigation 29) SI4-NW14 SW14, S14 30) Shallow - SW14, NW14, NW14 Sig Stallow - E 12 Sw 14 SI4 1965 - use, vrigation 31) 14 32) Jest well - W1/2, SW1/4, 514 (74 1964

33) Shellow - W/2 NE 1/4, SW/4, S14 1965 uni-inigation 34) Shallow - Swily, SE 1/4 Swil4, Sk 1963 use - unigation 35) SW14 NW14, SE14, SI4 36) NW14, SE14 SE14, S14 934 Shallow - NW14, SE14, SE14, SF4 37 1952 SW14 SE14, SE14, SI4 38) 1952 ine; - inigat Shallow - Sw 14, 51= 14 ST= 14, ST= 14, ST 29. 1943

40) SIS - 1957 Use prinertie 14 41) Shallow - NW14, NE14 515 1955 use, domestic 514 42) W12 W12 NW14 NE 14, 515 43) SW14 NW14 NE 14 SIS 1963 use : verrigotin 44) NW14, SW14, NE 14, S15 514 45) Shellow - NW14 SW14, NE14 SI 1972 Use: wingotion Shallow - NW 14 SE, 14, 515 46) 1970 une-inigota 4,514 47) Shallow - Sw'ly, Sw'ly, SIE 14, SIS 1955 une unigoten

48) Artesian NE 1/4, NE 1/4, SE1/4 SI5 1978 use, vrigaten 49.) SW14, NW14, NE14, 522 1936 cese: vrigotion 50) Shallow - Sw14, NW14, NE14, 522 522 1954 rese-inigation 52) Shallow - N/2, NE Yy, SW 14, 522 1910 Use: dimenters $53) = Y_2, S = V_4, S = 22$ 1907 54) Shallow - Sw 14, NE 1/4, SIE 1/4, 522 958 use: dimester

55) Shallow SW 14 NE 14 SE 14 SD2 1955 usé amestic 515 56) Shallow SW /4 NIE 14 SIE 14 922 1960 Use dementie 57) Shallow NW14 SW14 NW14 SD: 1952 522 58.) Shallow - NW14, SW14, NW14, S23 1955 59.) Shallow NW14 SW14 NW14 SZ 19101 Lese: cirigation 22 60) SE 1/4 NW14 523 61) NW14 NE14 823 (2) SW14, NE 1/4 SZ3 1941 use inigation 63) SE 1/4, NE 1/4, S23 22 1946

(4) Shallow SE 1/4, NE 1/4, S23 1970 use: migotion (5) Shellow - SIE 1/4 NIE 1/4 523 1970 use: migation (6) Shollow _ SE 1/4, NE 1/4, S23 7) <u>SE 1/4</u> NE 1/4, <u>S23</u> 1981 use insigntion 68) SE 14 NE 14 523 1953 (9) Shallow SE 14, NE 14 523 1966 Lese unigotion 70) Shullow NE 1/4, 5W14, SW14 823 $NE^{1/4}, Su^{1/4}, Su^{1/4}, S^{23}$ 1957 ese: unigation

72) Shallow - NE 1/4, Sw 1/4, Sw 1/4, 523 1959 use vrigation 73) Shallow - W/2, SE 14, SW14, S23 1944 74) Stallow - NE 14 SE 14 SW 14 SZ: 1974 - use exploratory inight 75) NE 14, NE 14, SE 14, S23 1957 Lese: Somertie 76) NE 14, NE 14, SE 14, S3 1941 use: domestic 77) NW1/4 SE1/4, SE1/4 SZZ 1915 use supplemented 23 78) Shallow - NE 1/4, SW14, SZY 79.) Shallow - NE 1/4, SW14 SZY 1923 use wrighten

80) Shallow - Say 19109 use - inigation 3) NW14, SW14, NE14, 524 1954 lese-deme 52) SEV4 NEV4, 525 1930 use: Amerti 83) SE14 SE14 NE14 525 1988 weidemestre SU) SE 1/4, SE 1/4, SE 1/4, S25 2003 Userdment 85) Shallow - NW'ly NW'ly NE 1/4 Ich 817104

55 8/2/04 TI35 R27E 527-35 Shallow See 28 1954 use Imestic 1956 · u 3.e. ... Sw14, NW14, S34 2) 1959 -use: ail T135 RICE S25, 35, 36 T155 R27E 83-6 145R27E 51-35 Shallow N/2, SW/4, 54 1/4 use stock 19/08 SW1/4, SE1/4, SF 2

3) Shallow - Center 510 1971 Cesi-stock 4) Log of oil or go well - SIS 1962 5) SW14 NE14, SI7 1/1960 Lese: exploratory Le SELY, NW14, SIJ lese-domestic 7.) Shallow - W1/2 522 1965 - in- domented Si) Shallow - NW14 NW14 SW14, S30 1964 - ustistact

Silo & TLYS RJGE TISS RAGE 7155 R25E 199 well TILS RabE 7165 R27E T155 R27E 1) Shallow NW14 NE 14, SE 14, SE 2001 Une: amestic 2) Shallow SW 1/4, SE 1/4, SE 1/4, S32 1955 Lese: domentic 3) NW14, SW14 533 1911 use - domestic 4) Shollow NW14 5W14, 533 1/4 1953 Si) Shallow 533 1935

6) SE 1/4, NE 1/4, SE 1/4 833 1978 cere: domestic 7.) SE 1/4, NE 1/4 SE 1/4, S33 1974 Use: domestic 8.) S1/2, NW1/4, S34 1929 9) w1/2, NW14, SW14, S34 1989 Use amertie artock ET4, NE 1/4, SW 1/4, 51/2 534 1991 cese: domestic 51/2, Sw1/4, Sw1/4, S34 1977 aperdomente

59 125 NW1/4, SE 1/4, 534 8/7/04 19 2002 use: dome. leh 13) N'12 SE 14 534 1982 use: domestic/stock 4) W12, W12, SW14, S35 2002 use emestic/stock 15) Shellow SE1/4, SE1/4 SW1/4, 1955 rela 16) S1/2, NE 1/4, 5w 1/4, 535 34 1979 Use Imesti 17) SE14 535 1981 Use- domestic

T155 R26E 51-36 DNW14, SW14 SI 1955 2) SW14, SW14 SI 1941 3) NE14, SW14, NW/4 SZ 1987 lese domestes 4) NW114 NW114 53 1996 uni domentie / stoch Swlly, Swlly, NWlly, S3 1981 we domented Istoch G) EV/2 NW14 S4 19?

2.) Artesian Swilly NE 1/4 Nov 1/4 52 965 en inigation 3.) NE 1/4, 5w1/4, 54 9.) Atto NE 1/4, NW 1/4, S5 1937 10.) SW14, SW14, NE14, S5 1995 we: domenteilstock 1) SE 14, SW14 SS 1987 unisrepair - deepen stoch / dmeste 12) NW 14, SW 14, SG 938 3) Shallow NW14, NW14, SW14, Sb 1945
14, NW14, NW14, S7 1938 uni oil 15) Nusila Nusila, Nusila SZ 1937 14) NW14 NW14, ST 1909 17) Shallow NE 14 57 and 8 18) NW14 NEV4 S7 1910 19 11/2, NW 1/4 SW14 S7 1942 Shallow MU/4 SS 20 1973 un domestic

21) Shallow NW14, NW14, NW1452 1946 22) NE 1/4, NE 1/4, S8 1910 23) N'12, 51/2 NE 14 58 1978 use domentic/stock 24) NW14 SW14 SW14 S8 1909 25) NE 14, Sw 14, S8 1979 une domestic SE 1/4, SW 14, 58 20 1986 use: domestic Stollow Sw 14, SE 14, Sw 14 58 1969 cere domentic

28) Centar 1/4, NW14, NW14, SE1/4 1943 29) NULLY, NWILY, SELVY, SE 30) Shallow NE14, NW14, SE14, SR 31) NW14, SE14, S8 1977 use-errigation 32) Shallow N'2, 51=1/4, 58 1979 ese-irization 33) NW 14, NW 14, S9 34) Artesian NW14 5W14 59 1955

35) Artesian Navily, Novily, Swily, Sg 1451 36) Domestic NW14, NW14, 570 1954 Leve-demester Shallow SE 14 NE 14, DO NW14 NW14, 510 ht 192 1973 une-ungete 38) NE "4, NW "4, NW "4, SIO 1974 une-inigetion 39) NW14, NE14 NW4 SIO 1943 Stollow NW14, NE 14 NW 44, SIO 1950 41) Shallow NW 14 NE 114, NW 14 510 1955 une: inigotion

42) SIO 77 une inizatio 43) SW1/4, NW1/4, SIO 1978 un inigation 44) SEVY, SEVY, SID use - out 45) NW 14, SW 14, STO 511 (luh 5/7/04) 1910 use-domentes-SWILY, SE 1/4 SII 1982 use- livestock 2) Antesian NW14, NE14, NW14 S13 1955 Anterian NW14, NE 14 NW14 SIZ 1909

49) Arterian Norly NE 44, NE 1/4 SK 1965 une-inigetien 53) NE comen 513 1960 un enigotion SI) NWILY, NWILY, NWILY SIT 1945 52) NE 1/4, NW 1/4 SIF 53) NE 1/4, NW 1/4, SI7 1909 54D Shollow NW14, NW14 NE14, SIZ 1942 13 55) NW14, NW14, NE14, 517 SIR un - migation

, G 56) Stollow Sw14, SE14 Sw14 517 1967 un: domestic / stoch 5 SIX 1948 58) Stallow NW14, NW14 SIS 59 Shallow NW14, NW14, SIS Shallow NW14, NW14 518 60 1941 un enizo Shallow NW14 NW14 NW14 S18 1948 use domestic Intescan w12, E12, NW14, 518 (2) 1941 unijuigation

63) Artesian NE 14, NE 14, NILY SI 17 ~/ 64) Arterian NE 1/4, NE 1/4, NW 1/4 SIJ 1448 65) Shallow Swily Novie SIP 1961 en ingotion 66) NW 14, NW 14, NE 14, 518 1908 67) NW 114, NE 14, SW 14, S18 1908 Artesian Swilyde 1/4, 518 1965 une dimestri 69) Stollow - SE 1/4, SW 14, SIS-2003 use - Amestic

70) Shallow 51/2, NE 1/4, SE 1/4 518 71) Domestic Newly, Nw 14, 519 1959 usi-dimesti 72) NW 14, NW 14, 519 1906 73) SE 14, NE 14, NE 14, 519 1984 use-domesteilstoch 74) Shallow GW - NE 1/4 SIG 75) Shallow NW14, NE14, NE14, 519 1953

76) NE 1/4, NE 1/4, NE 1/4 519 :18 2001 ese - Amertie Stock 77) NW14, SE 14, Sw14, S 19 1929 Spaller NW 14, SW 14, SW 14, SI; 78) 1470 un inigotion 79) SE 14, 500/4, 519 1906 80) Artesian Nov14 SIE14, South SIE 1974 une intgation 81) Stollow Sw14, NE 14, NW14 SZO 1960 use-enigation

82) Shallow - NE 1/4, NW 1/4, S20 1943 83) Shallow NE¹¹4, NW14 520 1994 en domestic 84) Hallow NW14 NE14, SW14 520 1954 une municipal 85) Arteria Sw¹/4, Nw¹/4, NE¹/4 S21 1960 use - domentie 84) Swiy, Nwily, NElly, SZI USACIE well - (Site 4 #5) 87) Artesian S2) 1960 - public waks, santary 88) Artenin 521 1960 - public works & santary

89) Domestic NW14 NW14 SW14 5 1961 un amesti 90) Shallow NW14, SE14, 523 2003 une- jurgation 9D Shollow NEILY, NEILY, NEILY 522 20 1952 92) Shollow 55= 1/4, 5E 1/4 52= 1978 en domentie 93) Hollow - SE14, SE14, 525 1966 use-exploratory ton 94) NW14, NW14, S26 1943

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10 Stallow - STE NIU 529 1961 ene-inighton 11) NW, SW, S29 1959 unigation 12) Shallow NW, NE, SW 529 1961 une-domente 13) NW, SW, SW S29 1959 else America 14) Stallan Sw NE SE Stallan Sw NE SE Staloy S 30 1982 une migate 15) leh 8/2/04

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E/1/04 - Song Baker Silo 1-12 - State of NM en lispute w/ USA w/ water rights - legations GSA water righto then state for insues whit -10 9-10 Helez Oil acquires 8 of 10 siles - who hil of 10 ntos (backel out of 2 sites) Hagerman bought site from Sila 10 - 89 acres - why so much land Site 4 - taken from state

<u>filo3 - net from state</u> 600' wile & 1,200' long Siles 97E10 ISA let Helex out of Contract for buying it. Bonhom Wolvern 10 ruhil 9 nd de 10 service salvage contract -l'anguage (I-linear) agreenent _ 30-day period to remove / longe He then selo 3, 4, 55 were originally alternate since they were setes 10, 11, 12 - during construction

Sile 3 - Song theiles a well is located near store @ east NE of site filo 3, b, 9 - Lod nunway A Still collection get inder - get collection If find plotos get double prints for Dary filos 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 was open land - - hod a lot of - proplem during construct. - w/blasting - pit rock - blasting - pit rock - blasting - pit rock - of neighboring well Set Silos 3 all - real estate map

Appendix B

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APPENDIX B PHOTOGRAPH LOG

FINAL PRELIMINARY ASSESSMENT REPORT FORMER WALKER AIR FORCE BASE ATLAS "F" MISSILE SILO 9 LINCOLN COUNTY, NEW MEXICO PROPERTY NO. K06NM0487

APPENDIX B PHOTOGRAPH LOG

FINAL PRELIMINARY ASSESSMENT REPORT FORMER WALKER AIR FORCE BASE ATLAS "F" MISSILE SILO 9 LINCOLN COUNTY, NEW MEXICO PROPERTY NO. K06NM0487

INTRODUCTION

HydroGeoLogic, Inc. (HGL) prepared this photograph log as part of a preliminary assessment of the former Walker Air Force Base Atlas "F" Missile Silo 9 (site). HGL is performing the PA for the U.S. Army Corps of Engineers, Albuquerque District, through a subcontract with Shaw Environmental, Inc. This log contains photographs taken by HGL during site reconnaissance on August 2, 2004. The site is located in Lincoln County, New Mexico and has been assigned Formerly Used Defense Site (FUDS) Property Identification Number K06NM0487.

Photog	raph Number:
	1
Date:	
•	August 2, 2004
Time:	
•	4:23 p.m.
Directi	on:
٠	Unknown
Weath	er:
•	Cloudy
Photog	rapher:
•	HydroGeoLogic, Inc.
Locatio	on:
•	Vegetation Surrounding Silo
	Property



Description: The property adjacent to the silo contains dense vegetation.

Photog	raph Number:
•	2
Date:	
•	August 2, 2004
Time:	
•	4:27 p.m.
Directi	on:
•	Southwest
Weath	er:
•	Partly Cloudy
Photog	rapher:
•	HydroGeoLogic, Inc.
Locatio	on:
•	Pad for Water Treatment
	Building



Description:

Foundations for the former Water Treatment Building and water storage tank are visible.

Photograph Number: . 3 Date: • August 2, 2004 Time: 4:27 p.m. • **Direction:** • Northeast Weather: • Cloudy Photographer: • HydroGeoLogic, Inc. Location: Leachfield .



Description:

Leachfield associated with the septic tank for the LCC sump. Dense vegetation and several vents are visible. The entry to the launch control center is visible in the background.

Photog	raph Number:	
•	4	
Date:		
•	August 2, 2004	
Time:		
•	4:29 p.m.	
Directi	on:	1
•	South	
Weath	er:	
•	Cloudy	
Photog	grapher:	
•	HydroGeoLogic, Inc.	
Locatio	on:	
•	Silo Pad	



Description:

The silo pad remains intact with small cracks evident. This photograph depicts the silo doors that cover the underground silo complex. The area surrounding the silo pad is heavily vegetated. Rain from a recent storm is pooling on portions of the silo pad.
Appendix C

APPENDIX C HISTORICAL AERIAL PHOTOGRAPH ANALYSIS REPORT

FINAL PRELIMINARY ASSESSMENT REPORT FORMER WALKER AIR FORCE BASE ATLAS "F" MISSILE SILO 9 LINCOLN COUNTY, NEW MEXICO PROPERTY NO. K06NM0487

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APPENDIX C HISTORICAL AERIAL PHOTOGRAPH ANALYSIS REPORT

FINAL PRELIMINARY ASSESSMENT REPORT FORMER WALKER AIR FORCE BASE ATLAS "F" MISSILE SILO 9 LINCOLN COUNTY, NEW MEXICO PROPERTY NO. K06NM0487

1.0 INTRODUCTION

HydroGeoLogic, Inc. (HGL) performed this aerial photograph review and analysis as part of its preliminary assessment of the former Walker Air Force Base Atlas "F" Missile Silo 9 (site), located in Lincoln County, New Mexico. Shaw Environmental, Inc., under contract to the U.S. Army Corps of Engineers (USACE), Albuquerque District, requested this analysis to assist in the determination of the nature and extent of responsibility that the USACE may have in the investigation and cleanup of potential contamination at the site. This site has been assigned Formerly Used Defense Site (FUDS) Property Identification Number K06NM0487.

Aerial photography of the site was obtained for 1959 and 1981. These photographs were examined to characterize long-term physical changes and environmentally significant features at the site. Black-and-white photography from 1959 and color photography from 1981 were used for this analysis. Significant findings from these years are annotated on the photographs and are discussed in the text of this report in chronological order. HGL attempted to locate aerial photograph coverage during the period that Site 9 was operational or immediately thereafter through its public and private sources. One source, the U.S. Department of Agriculture (USDA), Agricultural Stabilization and Conservation Service, appeared to have coverage during site operations; however, upon the USDA's review of HGL's photograph request, the department determined that the site was not in the area of coverage for that year. Subsequent photography at scales acceptable for aerial photograph analysis was not available until 1981.

The purpose of the analysis is to document historical activity at the site and its chronological development, and to identify any major visible features that may indicate the location of potential disposal areas and other relevant features. The findings from the analysis of aerial photography include buildings, areas of disturbed ground, mounded material, and unidentifiable objects that may be of environmental significance.

C-1

2.0 METHODOLOGY

HGL conducted a search of government and commercial sources to obtain the best available aerial photography of the site spanning the representative period. A list of the aerial photography used during the analysis of this site is provided in Table 1.

Date of Photograph	Source	Scale	Туре
9/21/1959	USGS	1:20,000	Black and White
4/19/1981	BLM	1:24,000	Color

Table 1List of Aerial Photographs Analyzed

USGS: United States Geological Survey

BLM: Bureau of Land Management

Two sets of aerial stereo-photographic pairs were analyzed. The analysis was performed viewing black-and-white and color aerial stereo-photographic pairs under magnification through a mirror stereoscope. Stereoscopic viewing creates a perceived three-dimensional effect, which enables the analyst to identify characteristics associated with features and environmental conditions. Visual characteristics include depth, height, tone, shadow, texture, size, shape, pattern, and association, which allow a specific object or condition to be recognized on aerial photography.

Scale and resolution precluded the ability to make a positive identification of some features; consequently, these features could not be characterized. Each one of these features was classified as an unidentifiable object (UO). This unique identification permits the reader to observe areas of interest (AOIs) without being led to any inaccurate conclusions.

The terms "possible" and "probable" are used to indicate the degree of certainty of feature identification. "Possible" is used when only a few characteristics are recognizable or the characteristics are not unique to a feature or environmental condition. "Probable" is used when more characteristics are recognizable. No qualifying terms are used when characteristics of a feature or environmental condition allow for a definite identification.

The aerial stereo-photographs were analyzed to identify features with potential environmental significance. The focus of this analysis was on the 500 feet by 500 feet alert area of the silo property as well as the Quonset huts constructed in conjunction with silo operations. Features of interest are labeled on the site photographs, illustrated in Figures 1 and 2, and are described in detail in Section 4.0 of this report. The description system begins in the northwestern-most AOI progressing from left to right and southward, by row, like reading a book. Features are annotated from their first appearance until they are no longer visible. Features have been numbered for the convenience of the reader. Site boundaries or areas used in this analysis were determined from

observations made from the aerial photography in conjunction with selected collateral information and do not denote legal property lines or ownership.

A 1964 operation manual and a construction status report site plan provide information about the property including the buildings, as well as the roads and miscellaneous structures.

3.0 ANNOTATION ABBREVIATIONS

The figures, which accompany the narrative in Section 4.0, were initially scanned from the aerial photographs, with features added to successive figures as changes were observed over time. In this analysis of the site, a "bullet" system combined with a textual description has been used for identifying significant features. A simple system of abbreviations is utilized to illustrate items described in the text and identified in the figures as areas of interest.

В	Building
DG	Disturbed Ground
MM	Mounded Material
UO	Unknown Object

Once identified, the same label is used to identify the object in subsequent years of analysis if the feature remains visible. If the feature is no longer visible or deemed irrelevant to further discussion, it is not included on subsequent figures.

4.0 AERIAL PHOTOGRAPH SITE ANALYSIS

For each year of coverage, a general description of the site as depicted in the photograph is provided. Site features are presented for the photograph, using the "bullet" system and the textual description discussed above.

4.1 SEPTEMBER 21, 1959 PHOTOGRAPH

General Description:

This photograph year is before construction of the site. The region is mostly desert, and vegetation is sporadic. See Figure 1 for the 1959 photograph.

Site Features:

No features of interest were identified on the 1959 photograph.



4.2 APRIL 19, 1981 PHOTOGRAPH

General Description:

Analysis of the 1981 photograph indicates that the silo is out of commission. Most of the buildings, structures and objects historically installed at an Atlas "F" missile silo has been removed, and only foundations remain. AOIs adjacent to the site were documented if they appeared to be related to possible activities or if they encroached upon the site. Please refer to the outline below for AOI descriptions. See Figure 2 for the 1981 photograph.

Site Features:

Features identified include the following:

UO-1 A circular unidentifiable object exists. It could be a foundation for a former structure. LCC An object is observed that could be the entrance to the Launch Control Center (LCC). **B-1** A light-toned object appears to be the foundation of a former building. Silo Pad The silo pad is located immediately west of the silo. It is a rectangular-type structure. Silo The circular area appears to be the silo and its outer doors. It is located near the center of the site. **B-2** The foundation remains at this location where a building once existed. UO-2 A dark-toned, unidentifiable object is observed outside of the site boundary. It is located near the southern entrance to the site. A large area of disturbed ground exists outside of the site boundary. It is noted DG-1 because of the AOIs proximity to the former Quonset hut locations. MM-1 A semi-rectangular-shaped area of mounded material exists. It is located west of The AOI has dark, medium, and light-toned the removed Quonset huts. characteristics. This feature is outside of the site boundary. **B-3** A foundation remains where one of the two Quonset huts existed. It is located approximately 1,000 feet south of the site boundary. **B-4** A foundation remains where one of the two Quonset huts existed. It is located approximately 1,100 feet south of the site boundary.



5.0 SUMMARY OF OBSERVATIONS

Table 2 presents a list of significant features noted at the subject site for the years of 1959 and 1981.

Feature Designation	1957	1981
B-1		×
B-2		×
B-3		× *
B-4		×
DG-1		×
LCC		×
MM-1		×
Silo Pad		×
Silo		×
UO-1		×
UO-2		×

Table 2
Summary of Aerial Photograph Observations

Appendix D

APPENDIX D REFERENCES

DRAFT FINAL PRELIMINARY ASSESSMENT REPORT FORMER WALKER AIR FORCE BASE ATLAS "F" MISSILE SILO 9 LINCOLN COUNTY, NEW MEXICO PROPERTY NO. K06NM0487

REFERENCE 1



DEPARTMENT OF THE ARMY SOUTHWESTERN DIVISION. CORPS OF ENGINEERS 1114 COMMERCE STREET

DALLAS, TEXAS 75242-0216

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CESWD-PMM (200-1c)

MEMORANDUM FOR CDR, USACE, ATTN: CEMP-R, WASH DC 20314-1000

SUBJECT: DERP-FUDS Inventory Project Report (INPR) for Site No. KO6NM048700) WAFB Facility Site #9 (Atlas Missile Site), NM

1. I am forwarding, for appropriate action, the INPR for the subject FUDS site which has been determined to be eligible under the DERP-FUDS program. This INPR has been reviewed by the Office of Counsel.

2. Although the CON/HTRW Project No. K06NM048701 is eligible under this program, I recommend that no further action be taken at this time. The current land owner does not wish to pursue further activities at this site. A BD/DR Project No. K06NM048702 is also included; however, due to policy consideration this site is not recommended.

onel mmanding

Encl

CF: ICESWA-ED-GH CEHND-PM-EP

PROJECT SUMMARY SHEET FOR DERP-FUDS BD/DR PROJECT NO. K06NM048702 BONHAM FARMS, INC., WATER WELL SITE SITE NO. K06NM048700 May 22, 1990

PROJECT DESCRIPTION. Several former Department of Defense (DOD) structures remaining on this site are considered hazardous. These include the main silo, silo vents, launch control center, several manholes and various other smaller underground structures. Due to the nature of the site, trespassers are a constant problem and safety concern for the current owner. Removal of all existing structural hazards was considered as a project for this site.

PROJECT ELIGIBILITY. These structures were built and utilized by DOD and currently present a clear danger of serious injury.

POLICY CONSIDERATIONS. Current policy does not permit the proposal of BD/DR projects at sites which have been owned since DOD usage by one or more private interests unless the title transfer document which conveyed the site from DOD or General Services Administration (GSA) specifically requires the Government to restore the site. This site is currently owned by a private interest and the title transfer document has no mention of Government restoration responsibilities. Therefore, this project cannot be proposed.

PROPOSED PROJECT. Permanent closure of all means of accessing the major underground facilities and removal of the smaller hazardous structures would render this site safe. The project would include demolition of selected above-ground structures and placement of fill in all minor below grade structures, accessways and manholes. The main silo and launch control center would remain intact, however, all means of access would be permanently closed. As described above, this project cannot be proposed due to policy considerations.

DD FORM 1391: Attached.

DISTRICT POC: David Gregory, DERP-FUDS coordinator, Albuquerque District, 505-766-1773, (FTS 474-1773).

PROJECT SUMMARY SHEET FOR DERP-FUDS HTW PROJECT NO. KO6NM048701 BONHAM FARMS, INC., WATER WELL SITE SITE NO. KO6NM048700 May 22, 1990

PROJECT DESCRIPTION. Several sources of potential HTW contamination exist at this site. A brief description of each follows:

a. An underground diesel fuel storage tank was installed at this site. During the site visit, a depression was noticed in the area where these tanks were typically installed. Also, these tanks are known to have been removed at similar sites in this area. For these reasons, it is believed that the tank at this site has also been removed. No obvious signs of contamination were noticed in the depression or the surrounding area, however, the former presence of the tank does pose as a potential source. This tank was in place for approximately 5 years.

b. The water supply system installed at this site included water wells, a water treatment system and several evaporation ponds. Treatment methods required and used by the Department of Defense (DOD) at the site are not known, however, it is believed that wastewater generated by backflushing the system was discharged into the evaporation ponds. None of the DOD installed treatment equipment remains and the evaporation ponds are currently dry. Plant growth in the evaporation ponds does not appear to be different from that in the surrounding area, however, the potential for contamination exists.

c. The main silo at this site is suspected to contain water. Equipment originally installed, and possibly remaining, in the silo is considered a potential source for contamination of any water in the silo. Direct access to the silo is now closed so it was not possible to confirm whether or not there actually is water in the silo. However, two of the three silo vents were open and water was found in both. The south silo vent had water at approximately 20 feet below ground level and the north vent contained water at 30 feet below ground level. The depth of water was not determined in either case.

d. A septic system and leach field installed by DOD at this site is another potential source of contamination. The septic tanks were located and one was found to contain water. The septic tank water is approximately 4 feet below ground level and of unknown depth. No odors were noticed and no samples were taken. Plant growth in the septic tank and leach field area did not appear to be different from that in the surrounding area.

PROJECT ELIGIBILITY. The facilities mentioned above were installed and utilized by DOD.

0003

POLICY CONSIDERATIONS. The current owner does not want to pursue further program activities at this site. Program policy indicates that a project may not be proposed when the current site owner does not wish to participate.

PROPOSED ACTIVITY. A site investigation to determine the existence and extent of possible HTW contamination in the above mentioned areas was considered. However, as described above, this activity cannot be proposed.

EPA FORM 2070-12: Attached.

DISTRICT POC: David Gregory, DERP-FUDS coordinator, Albuquerque District, 505-766-1773, (FTS 474-1773).

POTENTIAL HAZARDOUS WASTE SITE PRELIMINARY ASSESSMENT (EPA Form 2070-12)

I. IDENTIFICATION: DERP-FUDS HTW Project No. K06NM048701 (DERP-FUDS Site No. K06NM048700, Bonham Farms, Inc., Water Well Site.)

II. HAZARDOUS CONDITIONS AND INCIDENTS:

01. A. GROUNDWATER CONTAMINATION

02. Potential

03. Population Potentially Affected: less than 10

04. Description: Potential for groundwater contamination from silo water, former UST, septic tanks and evaporation ponds exists.

01. B. SURFACE WATER CONTAMINATION

02. Potential

03. Population Potentially Affected: less than 10

04. Description: Potential for contamination of surface runoff from the evaporation ponds exists.

01. C. CONTAMINATION OF AIR-Not Noted

01. D. FIRE/EXPLOSIVE CONDITIONS-Not Noted

01. E. DIRECT CONTACT-Not Noted

01. F. CONTAMINATION OF SOIL

02. Potential

03. Area Potentially Affected: less than 5 acres

04. Description: Potential soil contamination from the former UST, evaporation ponds and leach field exists.

01. G. DRINKING WATER CONTAMINATION-Not Noted

01. H. WORKER EXPOSURE/INJURY-Not Noted

01. I. POPULATION EXPOSURE/INJURY-Not Noted

01. J. DAMAGE TO FLORA-Not Noted

01. K. DAMAGE TO FAUNA-Not Noted

01. L. CONTAMINATION OF FOOD CHAIN-Not Noted

01. M. UNSTABLE CONTAINMENT OF WASTES-Not Noted

01. N. DAMAGE TO OFFSITE PROPERTY-Not Noted

01. O. CONTAMINATION OF SEWERS, STORM DRAINS, WWTPs-Not Noted

01. P. ILLEGAL/UNAUTHORIZED DUMPING-Not Noted

(EPA Form 2070-12 cont.)

05. Description of Any Other Known, Potential, or Alleged Hazards: Debris and structural hazards exist at this site.



SITE MAP

DERP-FUDS SITE NO. K06NM048700 ATLAS MISSILE SITE NO. 9



DERA, WALKER AFB, ATLAS MISSILE SITE # 9, Project No. K06NM05300

PROPERTY FURMERLY USED BY DOD

DOD AGENCY: Department of Air Force	
DOD POINT OF CONTACT (POC):	
SITE NAME WHEN USED BY DOD: Walker AFB, AF Facility S-9, NM	
FURMER USE BY DOD: Construction and operation of an ATLAS missile site	
LOCATION (CITY/COUNTY/STATE): Chaves County, NM	
LATITUDE/LONGITUDE: T. 11 S., R. 19 E., Sec 14 & 15.	
PROPERTY FORMERLY USED BY DOD CURRENTLY CONTROLLED BY:	
CURRENT SITE NAME:	L PRO
ALIAS SITE NAME:	Duc
CATEGORY OF HAZARD: None known (Debris, Unexploded Ordnance, Toxic/Hazardous Waste, Other)	
DESCRIPTION OF PROBLEM: None Known	
CURRENT OWNER POC (NAME/ADDRESS/PHONE):	
	•
OTHER RELEVANT INFORMATION: Project was under the control of DOD from 1960 thr (Photographs, Haps, Drawings, Property Use by Current Owners, Evidence of Discharge, etc.) This project consisted of 333.28 acres: 5.48 acres fee 1.52 acres acquired by Civil Action #4458, D/T filed 24 Ma amd 3.96 acres acquired by Civil Action 4773, D/T filed 18 May 1961. Both parcels were acquired from the State of New Mexico. The 5.48 acres fee we conveyed to Bonham Farms, Inc., Roswell, NM, by QCD dated 18 Mar 1968. 234.00 acres publid domain withdrawn by PLO 2749 dated 8 Aug 1962. 192.91 acr public domain were returned to BLM by PLO 4137 dated 3 Jan 1967. 41.09 acres of public domain were conveyed to Bonham Farms, Inc., Roswell, NM by QCD of 93.80 acres easement purchased from State of New Mexico 6 Jun 1962, and expin 1 Jul 1966 by terms of the acquisition document for non-use for a period of the security of the acquisition document for non-use for a period of the security of the acquisition document for non-use for a period of	ough 1967. y 1960. h ere ces of cres dated 18Mar red

one year.

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REPRODUCED AT GOVERGED THE SPECIA

DERA, WALKER AFB, ATLAS MISSILE SITE # 9, Project No. K06NM0530

The QCD to Bonham Farms, Inc., contains a "hold harmless" clause to protect the Government from liability.

Cost to the Government : \$2,619,135.00

Property sold for \$2,510.00

DERA, WALKER AFB, ATLAS MISSILE SITE # 9, Project No. K06NM0530

27 be 9

CUITCLAIM DEED

ENON ALL MEN BY THESE PRESENTS, That the UNITED STATES OF AMERICA, acting by and through the Administrator of General Services, under and pursuant to the powers and authority contained in the provisions of the Federal Property and Administrative Services Act of 1949, approved June 30, 1949 (63 Stat. 377), as amended, and applicable rules, regulations and orders promulgated thersunder, Grantor, hereby sells and quitclaims to BONHAM FARMS, INC., Foute 1, Box 243, Roswell, New Mexico 38201, Crantee, for the sum of Two Thousand Five Hundred Ten and No/100 Dollars (\$2,510.00), receipt of which is hereby acknowledged, all of its right, title and interest in the following described property in the County of Lincoln, State of New Mexico, to-vit:

A. A tract of land situate in the SWANN's of Section 14, Township 11 South, Range 19 East of the New Mexico Principal Meridian, more particularly described as follows:

Beginning at a point that bears East, a distance of 293.06 feet from the quarter (b) corner cormon to Sections 14 and 15, Township 11 South, Range 19 East, NMPM, thence North, a distance of 110.26 feet to a point; thence East, a distance of 600.00 feet to a point; thence South, a distance of 110.26 feet to a point; thence Veat, a distance of 600.00 feet to the point of beginning, containing 1.52 Acres, more or less.

B. A tract of land situate in the SWNN's of Section 14, Township 11 South, Range 19 East of the New Mexico Principal Meridian, more particularly described as follows:

Berinning at a noise that have been

and material and the closure gates closed and sealed. The door leading from the launch control center to the silo has been closed and sealed.

The Grantee covenants and agrees for itself, its successors and assigns, to assume all risk of claims for personal injuries and property damage srising out of ownership, maintenance, use and operation of the property and/or the existence of the underground and related facilities, and the Grantee further covenants and agrees to indemnify and save harmless the United States of America, its agents, officers and employees against any and all lisbility claims, causes of action or suits due to, arising out of, or resulting from inmediately or remotely: (1) the existence of the underground and related facilities; (2) ownership of the property; (3) use and/or operation of the property; and (4) occupation or presence of Grantee or any other party upon the property, lawfully or otherwise.

IN WIINESS MEREOF, the United States of America has caused these presents

to be executed as of the 18th day of March. 1968.

UNITED STATES OF AMERICA Acting by and through Administrator of General Services

Ev /s/ G.E.McNamara

G. E. MCNAMURA Regional Administrator, Region 8 Ceneral Services Administration

STATE OF COLORADO)) 65. COUNTY OF JEFFERSON)

On the 18th day of March, 1963, personally appeared before we. G. E.

SWD FORM 521 (#) Jan 65 Page 01 SUBJECT Atlas # 9 COMPUTATION FILE NO. DATE CHECKED BY_ COMPUTED BY DATE T | 1 5, R19E Sec. 14 Parcels 1-1.52 ac. 2-3.96 ac. 3-41.09 ac. 11.12 Sold off to Bonham Farms, Inc. 14 70-780 0013

ATCOEA

DEFENSE ENVIRONMENTAL RESTORATION PROGRAM FORMERLY USED DEFENSE SITES FINDINGS AND DETERMINATION OF ELIGIBILITY

BONHAM FARMS, INC. WATER WELL SITE SITE NO. K06NM048700

FINDINGS OF FACT

1. This site consists of 333.28 acres of land in eastern Lincoln County, NM, acquired by the Department of Defense (DOD) in the early 1960's. Of the total, 5.48 acres were acquired in fee by condemnation, 234.00 acres were withdrawn from the public domain by Public Land Order 2749, dated 8 August 1962, and 93.80 acres were acquired through easements.

2. The site was developed and operated by the U.S. Air Force as an Atlas "F" Missile launching facility and designated Atlas Missile Site #9, Walker AFB, NM. Structures built on the site by DOD included an underground missile silo, launch control center, two Quonset huts, water wells, a water treatment building, and other support facilities, such as water/fuel storage tanks and a septic system. The area was never under other than DOD's control during the period of DOD use.

3. The site and improvements were reported as excess to the General Services Administration in 1965. The 5.48 acres fee, 41.09 acres of public domain and all improvements were sold to a private owner by Quit Claim Deed, dated 18 March 1968. The remaining 192.91 acres of public domain were relinquished to the Bureau of Land Management by PLO 4137, dated 3 January 1967. The remaining easements expired 1 July 1966, due to nonuse for a period exceeding one year, as stipulated in the acquisition documents.

4. The deed conveying ownership of the fee land to the private owner contains a hold harmless clause, which releases the United States from liability for claims of personal injury or property damage resulting from the Government occupancy and use of the land. The deed further indicates that the underground facilities were stripped of all usable equipment and material and that the closure gates were closed and sealed. There is no specific mention of restoration responsibilities in the deed. The current owner of the fee property is Bonham Farms, Inc. of Roswell, New Mexico.

DEFENSE ENVIRONMENTAL RESTORATION PROGRAM FORMERLY USED DEFENSE SITES FINDINGS AND DETERMINATION OF ELIGIBILITY

Bonham Farms, Inc. Water Well Site Site No. K06NM048700

DETERMINATION

Based on the foregoing Findings of Fact, the site has been determined to be formerly used by DOD. It is, therefore, eligible for the Defense Environmental Restoration Program -Formerly Used Defense Sites established under 10 USC 2701 et seq.

5/10/95

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SITE SURVEY SUMMARY SHEET FOR DERP-FUDS SITE NO. K06NM048700 BONHAM FARMS, INC. WATER WELL SITE (Revised 7 February 1995)

SITE NAME: Bonham Farms, Inc. Water Well Site, formerly Atlas "F" Missile Site #9, Walker Air Force Base, New Mexico.

LOCATION: The site is located approximately 28 miles west of Roswell, NM, along US Highway 70-380. Location and site maps are included.

SITE HISTORY: In 1960, the Department of Defense acquired numerous parcels of land near Roswell, NM, for establishing a complex of Atlas "F" Missile launching facilities. The complex consisted of 12 individual sites, which were manned by personnel from former Walker Air Force Base, NM. These sites were completed in the early 1960's. This was referred to as Site #9 and consisted of an underground missile silo, launch control center and support facilities, such as a water supply system, including two wells and treatment equipment, fuel storage tanks, a septic system and two aboveground administrative office buildings. This site was excessed to the General Services Administration in 1965. The current owner of the site is Bonham Farms, Inc. of Roswell, NM. One of the DOD wells is currently being used for livestock watering.

SITE VISIT: The site was visited on 18 April 1990, by Richard Barnitz, CESWA-ED.

CATEGORY OF HAZARD: BD/DR and CON/HTRW.

PROJECT DESCRIPTION: Several areas, initially identified as potential projects, were subsequently investigated during the site visit. A brief description of each, by category of hazard, follows:

a. BD/DR. Several former DOD structures remaining on this site are considered hazardous. These include the main silo, silo vents, launch control center, several manholes and various other smaller underground structures. Removal of the dangerous conditions and hazards existing at this site was considered as a potential BD/DR project; however, policy considerations do not allow proposal of this type of project at this site; therefore, no further action is required.

0016

SITE SURVEY SUMMARY SHEET FOR DERP-FUDS SITE NO. K06NM048700 BONHAM FARMS, INC. WATER WELL SITE (Revised 7 February 1995)

b. CON/HTRW. Facilities installed by DOD, at this site, included fuel storage tanks, water treatment equipment and a septic system. No obvious evidence of HTRW contamination (i.e., leachate, unvegetated areas, etc.) was noticed. A site investigation was considered as a potential project; however, the current owner does not wish to pursue further activities at this site. Policy consideration will not allow proposal of a project at this site. Further action is not considered necessary.

AVAILABLE STUDIES AND REPORTS: A reduced copy of various views of a typical site is included.

PA POC: David Gregory, DERP-FUDS coordinator, Albuquerque District, phone number: 505 766-1773.

PROJECT SUMMARY SHEET FOR DERP-FUDS HTRW PROJECT NO. K06NM048701 BONHAM FARMS, INC. WATER WELL SITE SITE NO. K06NM048700 (Revised 7 February 1995)

PROJECT DESCRIPTION: Several sources of potential HTRW contamination exist at this site. A brief description of each follows:

a. An underground diesel fuel storage tank was installed at this site. During the site visit, a depression was noticed in the area where these tanks were typically installed. Also, these tanks are known to have been removed at similar sites in this area. For these reasons, it is believed that the tank at this site has also been removed. No obvious signs of contamination were noticed in the depression or the surrounding area; however, the former presence of the tank poses as a potential source. This tank was in place for approximately 5 years.

b. The water supply system installed at this site included water wells, a water treatment system and several evaporation ponds. Treatment methods required and used by DOD at the site are not known; however, it is believed that wastewater generated by backflushing the system was discharged into the evaporation ponds. None of the DOD installed treatment equipment remains and the evaporation ponds are currently dry. Plant growth in the evaporation ponds does not appear to be different from that in the surrounding area; however, the potential for contamination exists.

c. The main silo at this site is suspected to contain water. Equipment originally installed, and possibly remaining, in the silo is considered a potential source for contamination of any water in the silo. Direct access to the silo is now closed, so it was not possible to confirm if there actually is water in the silo. Two of the three silo vents were open and water was found in both. The south silo vent had water at approximately 20 feet below ground level and the north vent contained water at 30 feet below ground level. The depth of water was not determined in either case.

d. A septic system and leach field installed by DOD at this site is another potential source of contamination. The septic tanks were located and one was found to contain water. The septic tank water is approximately 4 feet below ground level and of unknown depth. No odors were noticed and no samples were taken.

PROJECT SUMMARY SHEET FOR DERP-FUDS HTRW PROJECT NO. K06NM048701 BONHAM FARMS, INC. WATER WELL SITE SITE NO. K06NM048700 (Revised 7 February 1995)

Plant growth in the septic tank and leach field area did not appear to be different from that in the surrounding area.

PROJECT ELIGIBILITY: The facilities mentioned above were installed and utilized by DOD.

POLICY CONSIDERATIONS: The current owner does not want to pursue further program activities at this site. Program policy indicates that a project may not be proposed when the current site owner does not wish to participate.

PROPOSED ACTIVITY: A site investigation to determine the existence and extent of possible HTRW contamination in this area was considered. However, as described above, this activity cannot be proposed.

EPA FORM 2070-12: Included.

DISTRICT POC: David Gregory, DERP-FUDS coordinator, Albuquerque District, phone number: 505 766-1773.

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PROJECT SUMMARY SHEET FOR DERP-FUDS BD/DR PROJECT NO. K06NM048702 BONHAM FARMS, INC. WATER WELL SITE SITE NO. K06NM048700 (Revised 7 February 1995)

PROJECT DESCRIPTION: Several former Department of Defense (DOD) structures remaining on this site are considered hazardous. These include the main silo, silo vents, launch control center, several manholes and various other smaller underground structures. Due to the nature of the site, trespassers are a constant problem and safety concern for the current owner. Removal of all existing structural hazards was considered as a project for this site.

PROJECT ELIGIBILITY: These structures were built and utilized by DOD and currently present a clear danger of serious injury.

POLICY CONSIDERATIONS: Current policy does not permit the proposal of BD/DR projects at sites which have been owned since DOD usage by one or more private interests unless the title transfer document that conveyed the site from DOD or General Services Administration (GSA) specifically requires the Government to restore the site. This site is currently owned by a private interest and the title transfer document has no mention of Government restoration responsibilities; therefore, this project cannot be proposed.

PROPOSED PROJECT: Permanent closure of all means of accessing the major underground facilities and removal of the smaller hazardous structures would render this site safe. The project would include demolition of selected aboveground structures and placement of fill in all minor below grade structures, accessways and manholes. The main silo and launch control center would remain intact; however, all means of access would be permanently closed. As described above, this project cannot be proposed due to policy considerations.

DD FORM 1391: Included.

DISTRICT POC: David Gregory, DERP-FUDS coordinator, Albuquerque District, phone number: 505 766-1773.

POTENTIAL HAZARDOUS WASTE SITE PRELIMINARY ASSESSMENT (EPA Form 2070-12)

I. IDENTIFICATION: DERP-FUDS HTRW Project No. K06NM048701 (DERP-FUDS Site No. K06NM048700, Bonham Farms, Inc. Water Well Site)

II. HAZARDOUS CONDITIONS AND INCIDENTS:

01. A. GROUNDWATER CONTAMINATION

02. Potential

03. Population Potentially Affected: less than 10

04. Description: Potential for groundwater contamination from silo water, former UST, septic tanks and evaporation ponds exists.

01. B. SURFACE WATER CONTAMINATION

02. Potential

03. Population Potentially Affected: less than 10

04. Description: Potential for contamination of surface runoff from the evaporation ponds exists.

01. C. CONTAMINATION OF AIR-Not Noted

01. D. FIRE/EXPLOSIVE CONDITIONS-Not Noted

01. E. DIRECT CONTACT-Not Noted

01. F. CONTAMINATION OF SOIL

02. Potential

03. Area Potentially Affected: less than 5 acres

04. Description: Potential soil contamination from the former

UST, evaporation ponds and leach field exists.

01. G. DRINKING WATER CONTAMINATION -Not Noted

01. H. WORKER EXPOSURE/INJURY - Not Noted

01. I. POPULATION EXPOSURE/INJURY-Not Noted

01. J. DAMAGE TO FLORA-Not Noted

01. K. DAMAGE TO FAUNA-Not Noted

01. L. CONTAMINATION OF FOOD CHAIN-Not Noted

01. M. UNSTABLE CONTAINMENT OF WASTES-Not Noted

01. N. DAMAGE TO OFFSITE PROPERTY-Not Noted

01. O. CONTAMINATION OF SEWERS, STORM DRAINS, WWTPs-Not Noted (EPA Form 2070-12 cont.)

01. P. ILLEGAL/UNAUTHORIZED DUMPING-Not Noted

05. Description of Any Other Known, Potential, or Alleged Hazards: Debris and structural hazards exist at this site.
SUPPLEMENTAL INPR SITE SURVERY SUMMARY SHEET FOR WALKER AIR FORCE BASE (ATLAS MISSILE SILO NO. 9) PROPERTY NO. K06NM048700

SITE NAME: Formerly, Atlas Missile Site No. 9, Walker Air Force Base, New Mexico

LOCATION: Lincoln County, New Mexico, approximately 28 miles west of Roswell, New Mexico. The property can be accessed from U.S. Highway 70-380.

Property History: In 1960, the Department of Defense (DOD) acquired numerous parcels of land near Roswell, New Mexico, to establish a network of twelve Atlas "F" Missile launching facilities. All twelve sites, including this site, were manned and operated by personnel from Walker Air Force Base (WAFB), New Mexico. Construction of these sites was completed in the early 1960s. This site was referred to Atlas Missile Silo No. 9 or Site No. 9, and its facilities structurally resemble the other eleven Atlas "F" Missile launching sites. Two central features of the site are the hardened missile silo, used to house the Atlas "F" Series, and the launch control center (LCC), with a tunnel connecting the LCC to the silo. Support facilities at the site include a water supply system, with well and treatment equipment, fuel storage tanks, a septic system, an administration building, a guardhouse and perimeter fencing. This site was excessed to the General Services Administration in 1965. The current owner is Bonham Farms, Inc., Roswell, New Mexico. One of the DOD wells is currently being used for livestock watering.

PROPERTY VISIT: Richard Barnitz conducted a site visit on 18 April 1990.

CATEGORY OF HAZARD (S): HTRW

PROJECT DESCRIPTION: Facilities installed by SOS, at this site, included fuel storage tanks, water treatment equipment and a septic system. No obvious evidence of HTRW contamination (i.e., leachate, unvegetated areas, etc.) was noticed. A site investigation was considered as a potential project; however, the current owner does not wish to pursue further activities at this site. Policy considerations will not allow proposal of a project at this site. Further action is not considered necessary.

AVAILABLE STUDIES AND REPORTS: A reduced copy of various views of a typical site is included.

POINT OF CONTACT: David Henry, Army Corps of Engineers Albuquerque district office, (505) 342-3193.

Walker Air Force Base K06NM048700 Supplemental INPR April 2003

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HTRW PROJECT SUMMARY SHEET FOR WALKER AIR FORCE BASE (ATLAS MISSILE SILO NO. 9) PROJECT NO. K06NM048700

<u>PROJECT DESCRIPTION</u>: Several sources of potential HTRW contamination exist at this site. A brief description of each follows:

- a. An underground diesel fuel storage tank was installed at this site. During the site visit, a depression was noticed in the area where these tanks were typically installed. Also, these tanks are know to have been removed at similar sites in this area. For these reasons, it is believed that the tank at this site has also been removed. No obvious signs of contamination were noticed in the depression or the surrounding area; however, the former presence of the tank poses as a potential source. This tank was in place for approximately 5 years.
- b. The water supply system installed at this site included water wells, a water treatment system and several evaporation ponds. Treatment methods required and used by DOD at the site are not known; however, it is believed that wastewater generated by back flushing the system was discharged into the evaporation ponds. None of the DOD installed treatment equipment remains and the evaporation ponds are currently dry. Plant growth in the evaporation ponds does not appear to be different from that in the surrounding area; however, the potential for contamination exists.
- c. The main silo at this site is suspected to contain water. Equipment originally installed, and possibly remaining, in the silo is considered a potential source for contamination of any water in the silo. Direct access to the silo is now closed, so it was not possible to confirm if there actually is water in the silo. Two of the three silo vents were open and water was found in both. The south silo vent had water at approximately 20 feet below ground level and the north vent contained water at 30 feet below ground level. The depth of water was not determined in either case.
- d. A septic system and leach field installed by DOD at this site is another potential source of contamination. The septic tanks were located and one was found to contain water. The septic tank water is approximately 4 feet below ground level and of unknown depth. No odors were noticed and no samples were taken. Plant growth in the septic tank and leach field area did not appear to be different from that in the surrounding area.

<u>PROJECT ELIGIBILITY</u>: The property was constructed and operated by the U.S. Air Force on DOD owned property. No known subsequent use of the property included activities that would have generated conditions hazardous to human health and the environment.

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<u>POLICY CONSIDERATIONS</u>: There are no known policy considerations that would preclude this project from being eligible for DERP-FUDS.

PROPOSED PROJECT: An SI is proposed to include drilling soil borings, installing monitoring wells, sampling and analyzing soil and groundwater and compiling an investigative report. Additional investigations may be necessary if environmental contamination is detected.

POINT OF CONTACT: David Henry, Army Corps of Engineers Albuquerque district office, (505) 342-3193.

Walker Air Force Base K06NM048700 Supplemental INPR April 2003

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REFERENCE 2

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ENVIRONMENTAL SITE INVESTIGATION REPORT Former Atlas Missile Silo Sites 8 and 9 Roswell, New Mexico FUDS Project ID Nos. K06NM048602 (Site 8) and K06NM048701 (Site 9)

Contract No. DACW05-96-D-0011 CTO-15, WAD 2

Document Control Number ACE15-085-S Revision C

Draft Final—April 2005

Prepared for: U.S. Army Corps of Engineers Albuquerque District 4101 Jefferson Plaza, NE Albuquerque, New Mexico 87109

Prepared by: Shaw Environmental, Inc. 5301 Central Avenue NE, Suite 700 Albuquerque, New Mexico 87108

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Acronyms and Abbreviations

ADR	Automated Data Review
amsl	above mean sea level
AVM	AVM Environmental Services, Inc.
BaP	benzo(a)pyrene
bgs	below ground surface
CAR	corrective action request
CD	compact disc
СТО	Contract Task Order
DERP	Defense Environmental Restoration Program
DOD	U.S. Department of Defense
DQO	data quality objective
DRO	Diesel Range Organics
EDD	electronic data deliverable
EDMS	Environmental Data Management System
EPA	U.S. Environmental Protection Agency
ESI	Environmental Site Investigation
°F	Degrees Fahrenheit
FORMS	Field Operations and Records Management System
FUDS	Formerly Used Defense Site
FWV	Field Work Variance
GPS	Global Positioning System
GRO	Gasoline Range Organics
ID	Identification
IDW	investigation-derived waste
kg	kilogram
LCC	Launch Control Center
MDL	method detection limit
μg	microgram(s)
mg/kg	milligram(s) per kilogram
mg/L	milligram(s) per liter
MQO	measurement quality objective
NAD	North American Datum
NMED	New Mexico Environment Department
NMAC	New Mexico Administrative Code
NMWQCC	New Mexico Water Quality Control Commission
PAH	polynuclear aromatic hydrocarbons
PDF	portable document format
ppm	part(s) per million
PVC	polyvinyl chloride
QAPP	Quality Assurance Program Plan
QC	quality control
RPD	relative percent difference
SARA	Superfund Amendments and Reauthorization Act

Acronyms and Abbreviations (continued)

Shaw	Shaw Environmental, Inc.
SPCS	State Plane Coordinate System
SVOC	semivolatile organic compound
TAL	Target Analyte List
TCLP	Toxicity Characteristic Leaching Procedure
TDS	total dissolved solids
TIC	tentatively identified compound
USACE	U.S. Army Corps of Engineers
UST	underground storage tank
VOC	volatile organic compound
WAD	Work Authorization Directive

1.0 Introduction

1.1 Purpose

This report describes the activities and presents the detailed results of the Environmental Site Investigation (ESI) performed at the Former Atlas Missile Silo Sites 8 and 9, located near Roswell, New Mexico (Figure 1-1). The ESI was conducted for the U.S. Army Corps of Engineers (USACE), Albuquerque District, under Contract Number DACW05-96-D-0011, Contract Task Order 15, Work Authorization Directive (WAD) 2 to the Sacramento Total Environmental Restoration Contract II. The ESI followed specifications in the *Final Work Plan*, *Environmental Site Investigation, Former Atlas Missile Silo Sites 8 and 9, Roswell, New Mexico, Formerly Used Defense Site (FUDS) Project Identification (ID) Nos K06NM048602 (Site 8) and K06NM048701 (Site 9)* (Shaw, 2004) and approved field work variances. The investigation activities, performed between May 24 and October 13, 2004, included surveys of site features, collection of surface and subsurface soil samples, installation of BARCADTM monitoring wells, collection of groundwater and standing silo water samples, and site restoration.

The investigations performed at Silo Sites 8 and 9 were accomplished in accordance with the Superfund Amendments and Reauthorization Act (SARA) of 1986, which amended the Comprehensive Environmental Response, Compensation, and Liability Act of 1980. Upon the passage of SARA, the Defense Environmental Restoration Program (DERP) was established (EPA, 2002). DERP assigns the Secretary of Defense the responsibility to carry out response actions at FUDS. The Department of Defense's executing agent for implementation of the FUDS program is the USACE. In general, regulatory oversight of FUDS activities is delegated by respective U.S. Environmental Protection Agency (EPA) regions to states within those regions. For this investigation, the New Mexico Environment Department (NMED) is responsible for regulatory oversight of activities conducted at the Atlas F Missile Silo Sites in New Mexico.

Background site descriptions and historical information for Silo Sites 8 and 9 are provided in Chapter 2.0 of this report. Chapter 3.0 presents regional characteristics. The investigation activities of soil assessment, groundwater and silo water assessment, survey, and site restoration are discussed in Chapters 4.0, 5.0, 6.0, and 7.0, respectively. Management of investigationderived waste (IDW) is discussed in Chapter 8.0 and quality assurance and quality control (QC) procedures are presented in Chapter 9.0. Chapters 10.0 and 11.0 provide the summary and recommendations and references, respectively. Included at the end of this report are the following appendices:



Figure 1-1 Site Location Map, Former Atlas Missile Silo Sites 8 and 9 Roswell, New Mexico

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- Appendix A, Field Documentation
- Appendix B, Analytical Result Tables
- Appendix C, Soil Boring Logs
- Appendix D, BARCADTM Monitoring Well Completion Diagrams
- Appendix E, Survey Data
- Appendix F, Laboratory Data Reports
- Appendix G, Automated Data Review
- Appendix H, Environmental Data Management System
- Appendix I, Field Work Variances and Corrective Action Requests
- Appendix J, Geochemical Evaluation of Soil and Groundwater Samples

1.2 Sampling Objectives

The following sampling objectives for the ESI at the Former Atlas Missile Silo Sites 8 and 9 are based upon the following Data Quality Objectives (DQO) developed during the technical project planning meeting held on September 30, 2003:

- Determine whether or not previous U.S. Department of Defense (DOD) activities at the Former Atlas Missile Silo Sites resulted in the presence of chemicals at concentrations that may impact human health and the environment.
- Identify potentially hazardous constituents that may have migrated from the Former Atlas Missile Silo Sites to the surrounding soil and/or groundwater, and determine whether any detectable constituents present at concentrations above evaluation criteria can be attributed to past DOD activities.
- Determine the presence of potentially hazardous constituents at three potential source areas at each silo site. Potential contaminant source areas include soil and groundwater surrounding the silo to a depth of approximately 250 feet below ground surface (bgs) (including standing water within the silo), the septic tank leachfields, and the silo sump outfall areas for silo sump discharge.

These objectives are consistent with the work plan developed for the ESI at Former Atlas Missile Silo Sites 8 and 9 (Shaw, 2004).

1.3 Activities

The ESI at Silo Sites 8 and 9 included the following activities:

- Conducted a survey of surface features at Silo Sites 8 and 9 using a global positioning system (GPS) to generate a site-specific layout.
- Advanced three deep boreholes at Silo Site 8 and one deep borehole at Silo Site 9.
- Collected subsurface soil samples within the deep boreholes for analysis of specific hazardous constituents.
- Completed the deep boreholes at Silo Site 8 as BARCADTM monitoring wells.
- Collected groundwater samples for analysis of specific hazardous constituents from the installed BARCADTM monitoring wells at Silo Site 8.
- Collected samples of standing water from the top and bottom of the water column inside the silo at Silo Site 8 for analysis of specific hazardous constituents.
- Advanced four shallow soil borings and collected subsurface soil samples from the leachfield area at both Silo Sites 8 and 9 for analysis of specific hazardous constituents.
- Collected surface and shallow subsurface soil samples from the sump outfall area at both Silo Sites 8 and 9 for analysis of specific hazardous constituents.
- Conducted a civil survey at Silo Sites 8 and 9 to accurately locate monitoring wells, soil borings, and surface soil sample points.
- Performed site restoration at Silo Sites 8 and 9.

2.0 Background

In the early 1960s, the DOD constructed a complex of 12 Atlas "F" Missile launching facilities within an approximate 50-mile radius of Roswell, New Mexico. Each site consisted of an underground missile silo and launch control center (LCC). The sites also included typical features such as a septic system and associated leachfield, a silo sump pump system, one or two Quonset-style buildings, underground fuel and water storage tanks, water treatment system, and a nearby evaporation pond. Aboveground water-treatment facilities included a diesel generator cooling tower, filtration shed, well pump house shed, and small water storage tanks.

The Atlas "F" Missile, an advanced version of the Atlas intercontinental ballistic missile, was stored vertically in the underground concrete and steel silo. The missiles were fueled with RP-1 (kerosene) liquid fuel when placed on alert, and fueled with liquid oxygen if a decision was made to launch. The Atlas "F" Missiles were phased out, and all the silo sites were permanently closed in 1965. By 1966, the silos and LCCs had been sealed, and all usable equipment and material had been salvaged; therefore, most of the site features mentioned above no longer exist at the silo sites.

Background information specific to Silo Sites 8 and 9 are summarized in the following sections. The site descriptions provided are based upon current site features observed and surveyed in May 2004. Survey activities and methods are discussed in Chapter 6.0.

2.1 Site Description

2.1.1 Silo Site 8

Former Atlas Missile Silo Site 8, approximately 30 miles southeast of Roswell, New Mexico, is located approximately 5 miles east of U.S. Highway 285, and approximately ½-mile east of New Mexico State Highway 2, near the town of Lake Arthur, New Mexico. Elevation at the site is approximately 3,375 feet above mean sea level (amsl).

Features surveyed at Silo Site 8 are presented in Figure 2-1. The original construction and layout of the silo sites are similar at each site. Modifications by subsequent property owners, vandalism, and weathering may have uniquely altered the features at any individual site. The original 70-foot-diameter concrete silo pad at Silo Site 8 remains intact while the surrounding 170-foot-square asphalt area has been heavily weathered and overgrown with native vegetation. Concrete foundations from the former water treatment facility, including a pump house and 100



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two water tanks, are located northeast of the silo pad. Active wells supplying drinking water to the town of Lake Arthur are present on the former water treatment facility pad. A small shed located just southwest of the pad houses the chlorine treatment system for the municipal water supply. The active water line runs underground relatively parallel to the northern site fence line. The silo doors remain welded shut, and vent openings adjacent to the paved area are currently cemented shut; however, the silo currently contains water. The stairwell entrance to the LCC and underground structures, located northwest of the silo pad, has been rendered inaccessible and is currently covered by an earthen berm. At the beginning of the ESI at Silo Site 8, a depression was present to the east of the silo pad where the underground storage tank (UST) was formerly located. Remnant debris related to the tank tie-downs were partially exposed within the depression area. Broken and unearthed remnants of the septic system are visible on the site west of the silo pad. A partial perimeter of earthen berm and salt cedar vegetation delineates the former location of the evaporation pond to the northeast of the silo.

ESI activities resulted in minor changes to site features. The former UST depression has been backfilled and leveled in order to accommodate drilling equipment. Buried remnants of a clay pipe, used for silo sump discharge, were unearthed during the ESI and have since been backfilled and leveled. All disturbed areas resulting from clearing and leveling have been reseeded with native vegetation (see Chapter 7.0 for site restoration details).

2.1.2 Silo Site 9

Former Atlas Missile Silo Site 9 is located approximately 30 miles west of Roswell, New Mexico, along U.S. Highway 70/380. Elevation of the site is approximately 5,130 feet amsl.

Current site features of Silo Site 9 are provided in Figure 2-2. The silo doors remain welded shut; however, the LCC door and some of the ventilation shaft grates are damaged. A ground depression, east of the silo pad, indicates the former location of a UST. Remnants of the former septic system appeared undisturbed and in their original locations. An exposed clay drainage pipe and French drain area for the silo sump discharge were discovered in an apparent original configuration during the site survey. Three-tiered evaporation ponds are delineated by earthen berms. The original concrete pad foundations for the water tanks and water treatment facility remain relatively intact. The former water treatment facility pad has a hole from an abandoned production well that is partially obstructed with debris. Two heavily weathered concrete pads indicate the former location of Quonset huts. An active well and water pump are located on the site in the small metal pump house, west of the LCC entrance. Two active water lines run through the site and are delineated by linear earthen mounds from 1 to 2 feet high.

During the ESI activities, the former UST depression was backfilled and leveled. The original condition of the sump outfall French drain was altered by trenching and backfilling. The disturbed areas have been reseeded with native vegetation.



Figure 2-2 Site Map Former Atlas Missile Silo Site 9, Roswell, New Mexico

2-4

2.2 Site History

2.2.1 Silo Site 8

Of the approximately 250 acres acquired by the DOD for the development of Silo Site 8, the actual missile facility occupied approximately six acres including a road easement. The current owner, the Lake Arthur Water Conservation Cooperative, obtained the property from the U.S. Government General Services Administration on September 26, 1966. According to well records obtained from the New Mexico State Engineers Office, the DOD originally installed four deep wells at Silo Site 8. All four wells were drilled to a depth of 1,110 feet bgs and were under artesian conditions. The City of Lake Arthur Water Conservation Cooperative currently uses two of these wells to supply water to the Lake Arthur community. The well records obtained from the State Engineers Office are included in Appendix A7.

2.2.2 Silo Site 9

The U.S. Government acquired multiple tracts of land for the development of Silo Site 9 from the State of New Mexico between May 24, 1960, and August 8, 1962. Silo Site 9 and its adjacent evaporation pond-area, each occupied approximately six acres. An aviation landing strip of unknown size was also associated with Silo Site 9 during operational years. Bonham Farms, Inc. purchased the property from the General Services Administration on March 18, 1968. Three wells have been observed at Silo Site 9. One active well located at the pump house (Figure 2-2) is currently being used as a stock well. Two inactive production wells are located within the concrete pad of the former water treatment facility. According to well records obtained from the New Mexico State Engineers Office, the three wells had total depths of 850, 750, and 650 feet bgs. The records indicate that the 850-foot well was cleaned out in 1986 and is likely the stock well located in the pump house. The depth to water in these wells ranged from 545 to 712 feet bgs at the time of completion. The well records obtained from the State Engineers Office are included in Appendix A7.

2.3 **Previous Investigations**

A soil-vapor survey conducted at some of the Former Atlas Missile Silo Sites in 1992 included Silo Site 8. The vapor from the vadose zone was analyzed for those aromatic volatile hydrocarbons and other petroleum vapors commonly associated with refined fuel products as well as halogenated volatile hydrocarbon vapor, specifically trichloroethene. No significant concentrations of soil vapors of concern were found at any of the sites, and the data produced were inconclusive as to the potential impacts of DOD activities on the environment (USACE, 1993).

Both Silo Sites 8 and 9 were included in site investigations conducted by the USACE between 1994 and 1997. The data collected during the site investigations were compiled into an ESI report (IT, 2001). However, the analytical laboratory contracted for the investigation

became involved in potentially fraudulent practices, which compromised the data. The USACE considers the previous analytical results unusable; therefore, the data cannot be used to determine the potential impact of DOD activities on the environment.

3.0 Regional Characteristics

3.1 Regional Geology and Structure

Silo Sites 8 and 9 are located in the Pecos River Valley, a north-south-trending topographic feature situated along the southwestern boundary of the Great Plains physiographic province (Havenor, 1968). The geologic setting for Silo Sites 8 and 9 is the Roswell Artesian Basin, north of the western edge of the Guadalupian reef complex of the Permian Basin (Havenor, 1968). Physiographically, the Roswell Artesian Basin is bounded by the Capitan, Sacramento, and Guadalupe Mountains to the west, the Seven Rivers Hills to the south, and the scarp of the east bank of the Pecos River to the east (Kinney et al., 1968). The northern boundary of the basin is indefinite, but probably coincides with the main stem of Arroyo del Macho (Kinney et al., 1968). The northern part of the Roswell Artesian Basin exhibits an east-southeast regional dip of about 50 feet per mile (Havenor, 1968). At least three major structural zones traverse the northern part of the basin, including the Border Hill, Six Mile, and Y-O Faults (Havenor, 1968). The Six Mile Fault occurs between the Border Hill Fault, which is the westernmost, and the Y-O Fault, which is the easternmost (Havenor, 1968). The City of Roswell lies above the Roswell block, which is formed by the Six Mile and Y-O Faults (Havenor, 1968). Silo Site 8 is located in the southern part of the Roswell Artesian Basin, 1 mile west of the Pecos River, south of the Y-O Fault, and north of the Sever Rivers Hills. Silo Site 9 is located north of the Borders Hills Fault in the northwestern part of the Roswell Artesian Basin. The Queen Formation, which forms the aquitard on the Orchard Park block, is the area southeast of the Y-O Fault and is absent throughout both the Roswell block west of the Pecos River and most of the Six Mile Fault. The Queen Formation is composed of very fine-grained red sandstone and siltstone containing abundant quartz grains with red siltstone and gray anhydrite commonly interbedded with dark red sandy or silty shale. Regional stratigraphy consists of quaternary valley-fill alluvium, overlying Permian marine clastic, carbonate, and evaporite rocks that dip gently to the eastsoutheast. The uppermost Permian rock unit is the San Andres Formation, which varies in thickness from 1,200 to 1,400 feet (Havenor, 1968). On the Roswell block, the San Andres Formation is deeply eroded (Havenor, 1968) and ranges in thickness from 550 to 600 feet. The lithology of the San Andres Formation varies within the basin, but is generally limestone with varying amounts of calcite, dolomite, anhydrite, halite, shale, and varying degrees of porosity and permeability (Kinney et al., 1968). The San Andres Formation is underlain by the Glorieta Sandstone, which varies in thickness from 0 to 750 feet (Havenor, 1968). The Glorieta Sandstone is a fine-grained to very fine-grained, moderately well-cemented, well-sorted, clean quartz sandstone that is generally gray to white or buff to yellow in color (Havenor, 1968). It yields less water than the San Andres Formation, but is the principal aquifer in the extreme western part of the Roswell Artesian Basin (Kinney et al., 1968). Presumably, the water supply

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wells drilled at the Former Atlas Missile Silo Sites are completed in the San Andres formation (USACE, 1993).

3.2 Regional Hydrogeology

Several aquifers exist within the Roswell Artesian Basin; they generally coincide with the structural regions previously described. Two distinct but closely related water systems within the upper carbonate-evaporite member of the San Andres Formation lie within the Roswell Artesian Basin. The first is a shallow aquifer, composed in part from alluvial fill, and the second is an artesian aquifer. Quaternary unconsolidated gravel, sand, silt, and clay form alluvium that lies unconformably above the Permian Rocks in the Roswell Artesian Basin. The quaternary alluvium sequence is thinner on the north side of the Y-O Fault. An artesian aquifer occurs beneath an aquitard, formed by the Queen Formation, in faulted eastward-dipping rocks at the northwestern edge of a large depositional basin of Permian age. In general, groundwater flows in a southeasterly direction across the basin. The Glorieta Sandstone is considered one of the primary transport (recharge) units for the artesian aquifer (Havenor, 1968).

3.3 Meteorology

The region has a generally temperate climate. During the summer, from June through September, rather frequent showers and thunderstorms deliver more than half of the annual precipitation. The relative humidity ranges from 70 percent in early morning to 30 percent in the mid-afternoon. Temperatures can be quite warm with readings of 100 degrees Fahrenheit (°F) or higher on an average of 10 days per year. In July, temperatures range from 63 to 96°F. Conditions in the fall consist of decreased rainfall, slight winds, and mostly clear skies. Cool nights turn into warm days and the relative humidity is low. In October, temperatures range from 41 to 75°F. Winter is marked by cold nights and temperate days. Zero or lower temperatures occur only one day during an average winter. Winter is the season of least precipitation. In January, temperatures range from 21 to 57°F. The spring is the driest season of the year with respect to relative humidity. Winds increase in the spring, particularly from the plateau areas of the west. On average, wind speed averages 25 miles per hour or more 60 days per year; the majority of these days occur from February to May. In April, temperatures range from 40 to 79°F (NWS, 1998).

3.4 Demographics and Land Use

Roswell is the largest city in the vicinity of Silo Sites 8 and 9. According to the 2000 U.S. Census (Census, 2000), 45,293 people reside in the City of Roswell, comprising approximately 2.5 percent of New Mexico's population. Chaves County has 61,382 residents according to the 2000 U.S. Census. The City of Roswell, which is the county seat of Chaves County, accounts for 74 percent of the county's population. Some of the top employers in the area include the Roswell Independent School District, Eastern New Mexico Medical Center, and

the City of Roswell. Land use adjacent to the City of Roswell consists of dairy farming, cattle ranching, and agricultural production (Census, 2000).

Silo Site 9 is situated just west of the Chaves County line, within Lincoln County. Approximately 19,411 people reside in Lincoln County according to the 2000 U.S. Census. Land use within this county consists primarily of cattle ranching and agricultural production (Census, 2000).

4.0 Soil Assessment

The soil assessment activities at Silo Sites 8 and 9 were designed to investigate potential releases of hazardous constituents from the following potential source areas:

- Septic System and Associated Leachfield; herein after referred to as Septic Leachfield
- Sump Outfall
- Former UST Area

Soil assessment activities also included:

- Deep Soil Boring
- Background Soil Sampling

The soil assessment activities implemented to characterize each potential source area at Silo Sites 8 and 9 are presented in Sections 4.1 and 4.2, respectively; analytical parameters are presented in Section 4.3; soil sample procedures are summarized in Section 4.4; soil sample results are documented in Section 4.5; and subsurface geology is described in Section 4.6. A summary of soil samples collected during the ESI at Silo Sites 8 and 9 is presented in Table 4-1.

4.1 Source Area Characterization Activities Silo Site 8

4.1.1 Septic Leachfield

Four shallow leachfield soil borings (AHL8-1, AHL8-2, AHL8-3, and AHL8-4) were advanced to approximately 9 to 14 feet bgs using hollow-stem auger drilling methods. Soil samples were collected from the bottom of each soil boring (Photo 1). Soil boring locations were chosen along a line parallel to the four clay vent pipes, as shown in Figure 4-1, and placed such that the soil boring locations lie within the leachfield. This configuration was chosen to provide a representative sampling scheme across the slope of the leachfield. Soil samples were collected with a 2-inch, stainless-steel split-spoon sampler driven ahead of the 3.25-inch-diameter augers (Photos 2 and 3) (Table 4-1). In order to characterize potentially hazardous constituents that may have migrated into the subsurface, each sample was collected from the native material directly beneath the leachfield. The soil samples were then collected from the brown native silt beneath the chalky-white silt that comprises the leachfield. No organic vapors were detected with field-screening methods, and no discolored soil was observed in the drill cuttings.

4.1.2 Sump Outfall

The termination of the clay outfall pipe for the Silo Site 8 sump system was located approximately 80 feet south of the silo. A backhoe was used to unearth the sump outfall pipe,

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Location ID	Sample Number	Sample Date	Sample Type	Sample Depth (ft bgs)	Analytical Methods ^a				
	····		Silo Site 8						
	Deep Borehole Samples								
BH8-1	BH8-1-1	6/18/2004	Environmental Soil	45	VOC (EPA 8260B)				
	DBD8-1-1	6/18/2004	Duplicate Soil of BH8-1-1	45	SVOC (EPA 8270C) PAH (EPA 8270C-Modified for Low Level PAH)s				
BH8-2	BH8-2-1	6/21/2004	Environmental Soil	45	TAL Metals (EPA 6010B/6020/7470A/7471A)				
	DBT8-2-2	6/21/2004	USACE Split of BH8-2-1 Soil ^b	45					
•••···	EBD8-1	6/21/2004	Equipment Rinsate after BH8-2-1	N/A					
BH8-3	BH8-3-2	6/22/2004	Environmental Soil	45					
	BH8-3-2	6/22/2004	MS/MSD Soil	45					
	·		Septic Leachfield Sa	amples					
AHL8	AHL8-1	6/28/2004	Environmental Soil	9.5–12	VOC (EPA 8260B)				
	AHL8-2	6/28/2004	Environmental Soil	10.5–13	SVOC (EPA 8270C) PAH (EPA 8270C-Modified for Low Level PAH)s				
	AHL8-2	6/28/2004	MS/MSD Soil	10.5–13	TAL Metals (EPA 6010B/6020/7470A/7471A)				
	AHL8-3	6/28/2004	Environmental Soil	11–14					
	AHD8-1-1	6/28/2004	Duplicate Soil of AHL8-3	11-14					
	AHT8-1-2	6/28/2004	USACE Split of AHL8-3 Soilb	11–14					
	EBL8-2	6/28/2004	Equipment Rinsate after AHL8-3	N/A					
	AHL8-4	6/28/2004	Environmental Soil	9–12					

Location ID	Sample Number	Sample Date	Sample Type	Sample Depth (ft bgs)	Analytical Methods ^a
			Sump Outfall	Samples	
OFT8	OFT8-1	5/25/2004	Environmental Soil	1.0	VOC (EPA 8260B)
	OFT8-2	5/25/2004	Environmental Soil	1.0	SVOC (EPA 8270C) PAH (EPA 8270C-Modified for Low Level PAH) [©]
	OFD8-1-1	5/25/2004	Duplicate Soil of OFT8-2	1.0	TAL Metals (EPA 6010B/6020/7470A/7471A)
	OFT8-1-2	5/25/2004	USACE Split of OFT8-2 Soilb	1.0	
	OFT8-3	5/25/2004	Environmental Soil	1.0	
	OFT8-5	5/25/2004	Environmental Soil	4.0]
	OFT8-6	5/25/2004	Environmental Soil	4.0	
	OFT8-6	5/25/2004	MS/MSD Soil	4.0	
	OFT8-7	5/25/2004	Environmental Soil	4.0	
	OFT8-8	5/25/2004	Environmental Soil	4.0	
			Background	Samples	
S8-BK1	S8-SS-BK-1	7/26/2004	Environmental Soil	0-0.25	TAL Metals (EPA 6010B/6020/7471A)
S8-BK2	S8-SS-BK-2	7/26/2004	Environmental Soil	0-0.25	
	S8-SS-BK-2	7/26/2004	MS/MSD Soil	0-0.25	
	BKD8-2	7/26/2004	Duplicate Soil of S8-SS-BK2	0-0.25	

BKT8-2

S8-SS-BK-3

7/26/2004

7/26/2004

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S8-BK3

0-0.25

0-0.25

USACE Split of S8-SS-BK2 Soilb

Environmental Soil

Location ID	Sample Number	Sample Date	Sample Type	Sample Depth (ft bgs)	Analytical Methods ^a		
Silo Site 9							
	••••••••••••••••••••••••••••••••••••••		Deep Borehole Sa	mples			
BH9-1	BH9-1-1	7/2/2004	Environmental Soil	245-250	VOC (EPA 8260B)		
	DBD9-1-1	7/2/2004	Duplicate Soil of BH9-1-1	245-250	SVOC (EPA 8270C) PAH (EPA 8270C, Modified for Low Level PAH):		
	DBT9-1-2	7/2/2004	USACE Split of BH9-1-1 Soilb	245-250	TAL Metals (EPA 6010B/6020/7470A/7471A)		
	•						
AHL9	AHL9-1	6/28/2004	Environmental Soil	46	VOC (EPA 8260B)		
	AHD9-1-1	6/28/2004	Duplicate Soil of AHL9-1	46	SVOC (EPA 8270C)		
	AHT9-1-2	6/28/2004	USACE Split of AHL9-1 Soilb	4-6	TAL Metals (EPA 6010B/6020/7470A/7471A)		
	AHL9-2	6/28/2004	Environmental Soil	4-7			
	AHL9-2	6/28/2004	MS/MSD Soil	4-7			
	AHL9-3	6/28/2004 Environmental Soil 4–6					
	EBL9-2	6/28/2004	Equipment Rinsate after AHL9-3				
	AHL9-4	6/28/2004	Environmental Soil	4–6			

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Location ID	Sample Number	Sample Date	Sample Type	Sample Depth (ft bgs)	Analytical Methods ^a				
Sump Outfall Samples									
OFT9	OFT9-1	5/26/2004	Environmental Soil	0–0.5	VOC (EPA 8260B)				
	OFT9-2	5/26/2004	Environmental Soil	0–0.5	SVOC (EPA 8270C) PAH (EPA 8270C-Modified for Low Level PAH)				
	OFD9-1-1	5/26/2004	Duplicate Soil of OFT9-2	0-0.5	TAL Metals (EPA 6010B/6020/7470A/7471A)				
	OFT9-1-2	5/26/2004	USACE Split of OFT9-2 Soilb	0-0.5					
	OFT9-3	5/26/2004	Environmental Soil	0-0.5					
	OFT9-4	5/26/2004	Environmental Soil	0-0.5					
	OFT9-5	5/26/2004	Environmental Soil	3.5					
	OFT9-6	5/26/2004	Environmental Soil	3					
	OFT9-6	5/26/2004	MS/MSD Soil	3					
	OFT9-7	5/26/2004	Environmental Soil	2.5					
	OFT9-8	5/26/2004	Environmental Soil	2					
			Bealessund	0					

Background Samples

S9-BK1	S9-SS-BK-1	7/26/2004	Environmental Soil	0–0.25	TAL Metals (EPA 6010B/6020/7471A)
S9-BK2	S9-SS-BK-2	7/26/2004	Environmental Soil	0–0.25	
S9-BK3	S9-SS-BK-3	7/26/2004	Environmental Soil	0-0.25	

Location ID	Sample Number	Sample Date	Sample Type	Sample Depth (ft bgs)	Analytical Methods ^a				
Investigation-Derived Waste (Silo Sites 8 and 9)									
Composite BH8-1 BH8-2 BH8-3	IDW-1	6/23/2004	Investigation-Derived Waste	10–108	TCLP VOC (EPA 1311/8260B) TCLP SVOC (EPA 1311/8270C) TCLP Metals (EPA 1311/6010B/7470A)				
BH9-1	IDW-2	7/2/2004	Investigation-Derived Waste	10–250					
BH8-4	IDW-3	7/11/2004	Investigation-Derived Waste	10–247	TCLP VOC (EPA 1311/8260B) TCLP SVOC (EPA 1311/8270C) TCLP Metals (EPA 1311/6010B/7470A) Diesel Range Organics (EPA 8015 TPH/DRO) Gasoline Range Organics (EPA 8015 TPH/GRO)				

eU.S. Environmental Protection Agency (EPA), 1986, "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," SW-846, 3rd ed., U.S. Environmental Protection Agency, Washington, D.C.

^bUSACE Split Samples shipped to the U.S. Army Corps of Engineers Omaha Laboratory, Omaha, Nebraska.

*Kemron Environmental Services, 2003, "Standard Operating Procedure for the Analysis of Organic Analytes, Method 8270C for Low Level PAHs, SOP MSS03," Kemron Environmental Services, Marietta, Ohio.

bgs = Below ground surface.

DRO = Diesel Range Organics.

- EPA = U.S. Environmental Protection Agency.
- ft = Foot (feet).
- GRO = Gasoline Range Organics.
- ID = Identification.
- MS/MSD = Matrix spike/matrix spike duplicate.
- N/A = Not applicable.

- PAH = Polynuclear aromatic hydrocarbons.
- SVOC = Semivolatile organic compound.
- TAL = Target Analyte List.
- TCLP = Toxicity Characteristic Leaching Procedure.
- TPH = Total petroleum hydrocarbons.
- USACE = U.S. Army Corps of Engineers.
- VOC = Volatile organic compound.





Figure 4-1 Soil Boring and Soil Sample Location Map Former Atlas Missile Silo Site 8 Roswell, New Mexico

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which was covered with approximately 1 foot of soil and cobbles. Once the sump outfall pipe was exposed, a 16-square-foot area downgradient of the sump outfall was excavated so that the surrounding soil horizon was approximately the same elevation as the bottom of the pipe. Three soil samples (OFT8-1, OFT8-2, and OFT8-3) were collected from this soil horizon: one sample from directly below the pipe, a second sample at approximately 1 foot downgradient of the pipe, and a third sample from organic-rich soil material inside the clay pipe (Photo 4) (Table 4-1). The area downgradient of the pipe was then excavated to 4 feet bgs and four soil samples (OFT8-5, OFT8-6, OFT8-7, and OFT8-8) were collected from a deeper soil horizon (Photo 5) to determine whether potentially hazardous constituents have migrated into subsurface soil downslope of the sump outfall. No organic vapors were detected at outfall soil sample locations.

4.1.3 Former UST Area

In order to characterize potential impacts to subsurface soil from the former UST, a deep borehole (BH8-1) was advanced through the former UST area, and a soil sample was collected at 45 feet bgs (Table 4-1). Soil samples were collected from 2-inch, stainless-steel split spoons driven into native soil (Photo 6). No organic vapors were detected with field-screening of the soil samples.

4.1.4 Additional Deep Borehole Soil Sampling

Two additional deep boreholes (BH8-2, BH8-3) were advanced at Silo Site 8. One soil sample was collected from each borehole from the vadose zone above the first encountered groundwater at 45 feet bgs, in order to determine whether potentially hazardous constituents are present. The soil samples were collected from a 2-inch, stainless-steel split spoon driven into native soil (Photo 6). No organic vapors were detected with field-screening of the soil samples. A fourth deep borehole (BH8-4) was advanced north of BH8-1; however, due to the drilling method required (mud rotary), a representative soil sample was not collected from BH8-4. The locations of the boreholes advanced at Silo Site 8 are shown in Figure 4-1.

4.1.5 Background Soil Sampling

Background soil samples were collected for trace metal analysis to support geochemical evaluations of metals in soil. Specifically, background soil samples were used for geochemical modeling to aid in determining whether a detected trace metal is a contaminant or a naturally occurring constituent. Background soil samples were collected within the boundary of the silo site away from any of the potential contaminant source areas. The three sample locations (BKG8-1, BKG8-2, and BKG8-3) are shown in Figure 4-1. At each sample location, a composite sample was collected that consisted of five grab samples within an approximate 4-foot-square area. Each grab sample (S8-SS-BK-1, S8-SS-BK-2, and S8-SS-BK-3) was collected from 0 to 3 inches bgs (Table 4-1). The grab samples from each location were passed

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through a No. 4 sieve to remove coarse material, homogenized in a stainless-steel bowl, and transferred into a 4-ounce jar.

4.2 Source Area Characterization Activities for Silo Site 9

4.2.1 Septic Leachfield

Shallow leachfield soil boring locations (AHL9-1, AHL9-2, AHL9-3, and AHL9-4) were selected to provide representative samples of the Silo Site 9 leachfield, while maintaining the integrity of the leachfield components, which remain in their original locations. The four soil borings, advanced 4 to 7 feet bgs, were placed just beyond and downslope of the presumed boundary of the leachfield. Two of the soil borings were completed immediately south of the leachfield boundary while the other two were completed parallel to the long axis, down-slope, and west of the leachfield (Photo 7). Soil samples were collected from a 2-inch, stainless-steel split-spoon sampler driven ahead of the 3.25-inch-diameter auger. Figure 4-2 presents the sample locations relative to the leachfield.

4.2.2 Sump Outfall

The termination of the clay outfall pipe for the Silo Site 9 sump system was located approximately 50 feet south of the silo (Figure 4-2). The sump outfall pipe and associated cobbled French drain were discovered in their original configuration (not buried as these were at Silo Site 8), gently sloping from the outfall pipe towards the south (Figure 4-2) (Photo 8). Approximately 6 inches of cobbles on the surface of the French drain area were removed, exposing the soil below for sample collection. Outfall soil samples (OFT9-1, OFT9-2, OFT9-3, and OFT9-4) were collected from immediately below the drip edge of the clay outfall pipe (Photo 9), and downslope, beyond the edge of the pipe at distances of 5, 10, and 20 feet, respectively. Upon collection of the first four samples, a backhoe was used to excavate a trench from the clay outfall pipe extending southward approximately 20 feet (Photo 10). During trenching activities, limestone bedrock was encountered at approximately 2 to 4 feet bgs. Outfall soil samples (OFT9-5, OFT9-6, OFT9-7, and OFT9-8) were collected at the same distances from the outfall pipe as the first four samples (0, 5, 10, and 20 feet), but at an average depth of approximately 3.5 feet bgs along the side wall of the trench. Organic vapors were not detected in outfall soil samples collected at Silo Site 9.

4.2.3 Former UST Area

The lithology, shallow bedrock, at Deep Borehole BH9-1 did not permit the collection of soil samples at multiple intervals as planned. One sample of limestone rock flour material (BH9-1-1) was collected from approximately 240 to 250 feet bgs at BH9-1, directly from the cyclone into a stainless-steel bowl. The sample material was homogenized, and a representative





sample was collected in an 8-ounce jar. EnCore[®] sample collection was not favorable at this location due to the lithology. No organic vapors were detected with field-screening methods, and no visible evidence of contamination was observed from this deep borehole.

4.2.4 Background Soil Sampling

Background soil samples were collected within the boundary of the silo site, away from any of the potential source areas identified in the ESI. The three sample locations (BKG9-1, BKG9-2, and BKG9-3) are shown in Figure 4-2. At each location, a composite sample was collected that consisted of five grab samples within an approximate 4-foot-square area. Each grab sample (S9-SS-BK-1, S9-SS-BK-2, and S9-SS-BK-3) was collected from 0 to 3 inches bgs (Table 4-1). The grab samples from each location were passed through a No. 4 sieve, homogenized in a stainless-steel bowl, and a representative sample was collected in a 4-ounce jar. Figure 4-2 provides the locations of Silo Site 9 background samples.

4.3 Analytical Parameters

Analytical procedures from EPA SW-846 (EPA, 1986) were used for the chemical analyses of soil samples. Soil samples and field QC samples were submitted to Kemron Environmental Services, Inc. (Kemron) in Marietta, Ohio, for laboratory analysis. The following analyses were performed on all soil samples collected at both Silo Sites 8 and 9, with the exception of background soil samples, which were analyzed for Target Analyte List (TAL) metals only.

- Volatile organic compounds (VOC) by EPA Method 8260B
- Semivolatile organic compounds (SVOC) by EPA Method 8270C
- Polynuclear aromatic hydrocarbons (PAH) by EPA Method 8270C-Modified for Low Level PAH
- TAL metals by EPA Methods 6010B/6020/7470A/7471A
- The laboratory also performed searches of mass spectra library files and reported the top 10 tentatively identified compounds (TIC) for each VOC and SVOC analysis.

4.4 Sample Procedures and Documentation

EnCore[®] samplers were used to collect soil samples for VOC analysis where applicable. Both 4- and 8-ounce glass, wide-mouth jars were used for the collection of soil samples for analysis of the other parameters (SVOCs, PAH, and TAL Metals). All sample containers were provided by Kemron.

Sampling tools such as stainless-steel bowls, split-spoon samplers, and sieves were decontaminated between sample locations and depths using a solution of tap water and
Alconox[®], followed by a final deionized water rinse. Sterile, disposable scoops were used during soil homogenizing to reduce the risk of cross-contamination.

Upon filling each sample container, the sample was immediately placed into a laboratoryprovided cooler with ice. Shaw Environmental Inc. (Shaw) maintained custody of the samples at all times until relinquished to Federal Express for priority overnight shipment to the laboratory.

Chain-of-custody documentation was electronically generated in the field using the EPA software program, FORMS [Field Operations and Records Management System] II Lite, Version 5.1 (DynCorp, 2002) and placed in each cooler to accompany samples to Kemron.

Table 4-1 provides a summary of all soil samples collected during the ESI at Silo Sites 8 and 9. Field documentation, including Field Activity Daily Logs, Soil Sample Collection Logs, Calibrations Logs, and Chains-of-Custody Records are included in Appendix A of this report.

4.5 Soil Sample Results and Evaluation

To aid in the identification of potential hazardous constituents, soil sample results were compared to previously determined evaluation criteria. The evaluation criteria were chosen as the most conservative of either the NMED Soil Screening Levels (NMED, 2004), or the EPA Region 6 Human Health Medium-Specific Screening Levels for residential exposure (EPA, 2003). The evaluation criteria for soil samples are presented in Appendix B1. Table 4-2 summarizes the potentially hazardous constituents detected above evaluation criteria in the soil samples collected at Silo Sites 8 and 9, which are discussed in the following sections. A table of detected analytes in soil samples is included in Appendix B2, which presents the constituent concentrations detected in soil samples collected during the ESI, as well as laboratory reporting detection limits, method detection limits (MDL), laboratory and final data validation qualifiers. Complete soil sample analytical results are available within the laboratory data reports in Appendix F. Background soil sample results for Silo Sites 8 and 9 have been incorporated into a Geochemical Evaluation, which is included in Appendix J.

4.5.1 Silo Site 8 Soil Sample Results

4.5.1.1 Former UST Area and Additional Deep Boreholes

Arsenic was detected at a concentration of 13.4 milligram(s) per kilogram (mg/kg) in the soil sample collected from the 45-foot depth at Deep Borehole BH8-3 (BH8-3-2) (Table 4-2). No other TAL metals, VOCs, or SVOCs were detected above evaluation criteria in soil samples collected from any of the other deep boreholes.

Table 4-2Soil Analytical Results Exceeding Evaluation CriteriaEnvironmental Site Investigation: Former Atlas Missile Silo Sites 8 and 9Roswell, New Mexico

Sample Number	Sample Depth (ft bgs)	Analytical Methodª	Analyte	Result	Units	Final Qualifier	Evaluation Criteria ^ь	Reporting Limit	Laboratory MDL
	·····			Silo Site 8			۰ 		
			De	ep Borehole Sa	amples				
BH8-3-2	45	6020	Arsenic	13.4	mg/kg		3.9	0.756	0.378
			Sep	otic Leachfield S	Samples				<i>P</i>
AHL8-4	9–12	6020	Arsenic	4.71	mg/kg		3.9	0.597	0.298
			S	ump Outfall Sa	mples				
OFD8-1-1°	1	8270C-MODd	Benzo(a)pyrene	63.0	μg/kg	J	62	67.4	33.7

*U.S. Environmental Protection Agency (EPA), 1986, "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," SW-846, 3rd ed., U.S. Environmental Protection Agency, Washington, D.C.

^bEvaluation criteria are found in Appendix B1. Evaluation criteria were selected from either 1) New Mexico Environment Department (NMED), 2004, "Technical Background Document for Development of Soil Screening Levels," Revision 2.0, Hazardous Waste Bureau, New Mexico Environment Department, Santa Fe, New Mexico, 2) U.S. Environmental Protection Agency (EPA), 2003, "EPA Region 6 Human Health Medium-Specific Screening Levels," electronic database maintained by Region 6, U.S. Environmental Protection Agency, Dallas, Texas, or 3) OHM Remediation Services Corporation (OHM), 1997, "Final Background Soil Sampling Report, Former Walker Air Force Base (WAFB)," prepared for U.S. Army Corps of Engineers, Tulsa District, TERC No. DACA-56-94-D-0020, Tulsa, Oklahoma.

°Field QC duplicate sample. Concentration in the primary sample did not exceed evaluation criteria.

^dModified for Low Level PAH.

- bgs = Below ground surface.
- ft = Foot (feet).
- J = The result is either an estimated quantity less than the reporting limit but greater than the method detection limit or considered an estimate because of some problem with associated quality control measures. The result is still usable.
- µg/kg = Microgram(s) per kilogram.
- MDL = Method detection limit.
- mg/kg = Milligram(s) per kilogram.
- PAH = Polynuclear aromatic hydrocarbons.
- QC = Quality control.

4.5.1.2 Septic Leachfield

The sample collected from the 9- to 12-foot bgs depth interval (AHL8-4) had an arsenic concentration of 4.71 mg/kg, exceeding the evaluation criteria of 3.9 mg/kg (Table 4-2). No other TAL metals, VOCs, or SVOCs were detected above evaluation criteria in soil samples collected at the Silo Site 8 septic leachfield.

4.5.1.3 Sump Outfall

Benzo(a)pyrene (BaP) was detected at an estimated concentration of 63 micrograms $(\mu g)/kilogram (kg)$ in one soil sample, collected from the outfall pipe (OFD8-1-1), exceeding the evaluation criteria of 62 $\mu g/kg$ (Table 4-2). This result was from a field QC duplicate. The primary sample did not contain a BaP concentration above the evaluation criteria. VOCs and metals were not detected above evaluation criteria in soil samples collected at the Silo Site 8 sump outfall.

4.5.2 Silo Site 9 Soil Sample Results

No analytical results exceeded evaluation criteria for soil samples collected from the Silo Site 9 septic leachfield, sump outfall, or deep borehole. Appendix B2 lists all analytes detected above laboratory MDLs.

4.5.3 Tentatively Identified Compounds in Soil Samples

Kemron performed mass-spectra library searches during all VOC and SVOC analyses in an attempt to identify nontarget compounds that may be present in the samples. Nontarget compounds were identified in order to assess the presence of unanticipated, unknown, or exotic compounds in soil at Silo Sites 8 and 9 in accordance with Section 3.2 and Table 3-1 of the Quality Assurance Project Plan (Shaw, 2004, Appendix A, Part II). The identified, nontarget compounds, referred to as TIC, for soil samples are listed along with estimated concentrations in Table 4-3.

TIC were identified in one deep borehole soil sample (BH8-1-1) and two sump outfall soil samples (OFT8-1 and OFT8-6) at Silo Site 8. TIC were identified in one deep borehole soil sample and its field duplicate, two septic leachfield soil samples, and one leachfield field duplicate at Silo Site 9. Standard chemical reference volumes were consulted to determine the possible sources for the TIC. Possible TIC sources, with references footnoted, are also shown in Table 4-3. Generally, the TIC shown are likely weathered, degraded fuel, other refined hydrocarbons, or pesticide components. No evaluation criteria for the TIC were listed, and comparison against the TIC estimated concentrations could not be made. The greatest estimated concentrations for the TIC were in the low part(s)-per-million (ppm) range with most TIC

Table 4-3

Tentatively Identified Compounds In Soil Samples Environmental Site Investigation: Former Atlas Missile Silo Sites 8 and 9 Roswell, New Mexico

Sample Number	Analytical Methodª	CAS Number	Tentatively Identified Compound	Estimated Concentration (ppm)	Chromatograph Retention Time (minutes)	Possible Source for TIC
		Silo Site		8		
			Deep Borehole	Samples		
BH8-1-1	8260B	141-78-6	ETHYL ACETATE	0.0432	7.454	Industrial solvent but also naturally occurs from the fermentation of plant sugars ^b
			Sump Outfall S	amples		
OFT8-1	8270C	3179-47-3	2-PROPENOIC ACID, 2-METHYL-, DECYL	8.30	13.8	Degradation product of propenoic acid-based
		142-90-5	2-PROPENOIC ACID, 2-METHYL-, DODEC	3.76	14.81	pesticides ^{c,d}
		142-90-5	2-PROPENOIC ACID, 2-METHYL-, DODEC	6.60	15.7	
OFT8-6	8270C	205-82-3	BENZO[J]FLUORANTHENE	0.292	19.84	Primary alkane component of kerosene, diesel, fuel oil, and other refined oil products ^e

Table 4-3 (Continued) Tentatively Identified Compounds In Soil Samples Environmental Site Investigation: Former Atlas Missile Silo Sites 8 and 9 Roswell, New Mexico

Sample Number	Analytical Methodª	CAS Number	CAS Tentatively Identified Number Compound		Chromatograph Retention Time (minutes)	Possible Source for TIC
			Silo Site	9	· · · · · · · · · · · · · · · · · · ·	
		Deep Borehole	Samples			
BH9-1-1	8270C	112-95-8	EICOSANE	0.213	19.58	Primary alkane component of
DBD9-1-1 (duplicate of BH9-1-1)	8270C	56862-62-5	10-METHYLNONADECANE	0.221	19.58	kerosene, diesel, fuel oil, and other refined oil products ^e
			Septic Leachfield	I Samples		·
AHL9-1	8260B	629-78-7	HEPTADECANE	0.012	15.05	Primary alkane component of
		62199-06-8	HEPTANE, 5-ETHYL-2,2,3- TRIMETHYL-	0.015	15.38	kerosene, diesel, tuel oil, and other refined oil products ^e
AHD9-1-1 (duplicate of AHL9-1)	8260B	15869-86-0	OCTANE, 4-ETHYL-	0.009	15.05	
•		62199-06-8	HEPTANE, 5-ETHYL-2,2,3- TRIMETHYL-	0.012	15.37	
AHL9-4	8270C	61-54-1	1H-INDOLE-3-ETHANAMINE	2.990	15.13	Degradation product of ethanamine-based pesticides ^{d,g}

*U.S. Environmental Protection Agency (EPA), 1986, "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," SW-846, 3rd ed., U.S. Environmental Protection Agency, Washington, D.C.

*Bisesi, M.S. Esters, 1994, In: Patty's Industrial Hygiene and Toxicology. 4th ed. Vol. II. Toxicology. Part D. John Wiley & Sons, Inc., 1994. p. 2967-2971, 2977-2984.

Montgomery, J. H., 1991, Groundwater Chemicals Desk Reference Volume 2, Lewis Publishers, Chelsea, Michigan.

"Wood, A, 2004, Compendium of Pesticide Common Names (http://www.alanwood.net/pesticides/index.html).

*Murphy, B. L. and R. D. Morrison, 2002, Introduction to Environmental Forensics, Academic Press, New York.

Table 4-3 (Continued)Tentatively Identified Compounds In Soil SamplesEnvironmental Site Investigation: Former Atlas Missile Silo Sites 8 and 9Roswell, New Mexico

¹Orme, S. and S. Kegley, 2004, PAN Pesticide Database, Pesticide Action Network, San Francisco, CA. < http://www.pesticideinfo.org>. ⁹Oxford Dictionary of Chemistry 3rd Edition; Oxford University Press, 1996.

CAS = Chemical Abstracts Service.

ppm = Part(s) per million.

TIC = Tentatively identified compound.

concentrations estimated at less than 1 ppm. In accordance with decision rules established in Table 4-3 of the Quality Assurance Project Plan (Shaw, 2004), no further action regarding the TIC is necessary.

4.6 Site-Specific Geology

4.6.1 Silo Site 8

Shallow subsurface geology consists of unconsolidated silty sand and fill from ground surface to a depth of approximately 8 to 15 feet bgs. A reddish-brown to brown silty sand containing occasional angular quartites and anhydrite nodules was observed in all deep boreholes underlying the silty sand.

Underlying the silty sand in BH8-1, a red silty clay with moderate plasticity was present to 45 feet bgs. Evaporite deposits with weathered quartz conglomerate were encountered from 45 to 70 feet bgs. A dark-red silty clay was encountered from 70 to 96 feet bgs with a 3-foot-thick limestone bed from 90 to 93 feet bgs.

A grey to red clay with varying amounts of quartz conglomerate was encountered from 32 to 105 feet bgs in Deep Boreholes BH8-2 and BH8-3. A limestone unit of unknown thickness was encountered in Deep Boreholes BH8-2 and BH8-3 at depths of 105 and 102 feet bgs, respectively.

Deep Borehole BH8-4 included silty sands and clays with occasional cobbles from 15 to 100 feet bgs. Anhydrite with thinly bedded clay and limestone were encountered to 247 feet bgs, the total depth of the borehole. Two limestone beds were encountered within the upper portion of the anhydrite (100 to 120 feet bgs and 130 to 140 feet bgs, respectively). Deep borehole logs for Silo Site 8 are included in Appendix C.

4.6.2 Silo Site 9

The geology beneath Silo Site 9 is based upon interpretation of Deep Borehole BH9-1. In the vicinity of BH9-1 (former UST area), fill material exists in the top 10 feet. A 2-foot-thick well-graded sand with gravel and rock fragments is deposited in contact with the top of the competent limestone that was encountered at approximately 12 feet bgs.

The limestone exhibited alternating zones of less competent weathered sequences with thinlybedded finer material. At 200 feet bgs, the limestone becomes very competent, as evidenced by slow drill rates, to 250 feet bgs, the total depth of the borehole. The soil boring log for BH9-1 is included in Appendix C. Road cuts along US Highway 70/380, within a few miles of Silo Site 9, reveal numerous faults, extensive folding, and deformation of the limestone in this region. Thin, (1 to 3 feet thick) interbedded zones of silts and various soils can be seen within the limestone unit at a majority of the road cuts.

5.0 Groundwater and Silo Water Assessment

The ESI at former Atlas Missile Silo Sites 8 and 9 was performed to determine whether previous DOD activities at the silo sites resulted in the release of potentially hazardous constituents in groundwater. To accomplish this, BARCADTM monitoring wells were installed in the deep boreholes, and groundwater samples were collected and analyzed for hazardous constituents. Groundwater was not encountered during drilling activities to the study boundary (250 feet bgs) at Silo Site 9 (BH9-1); therefore, site investigation activities described in this section apply only to Silo Site 8. Two nested BARCADTM wells were installed in a deep borehole at the location of the former UST area. Two more BARCADTM monitoring wells were installed in deep boreholes located northwest and southwest of the UST area in a triangular orientation, in order to determine groundwater flow direction. A fourth deep borehole was advanced to 250 feet bgs in order to satisfy the established study boundary. The following sections present the borehole advancement techniques employed, BARCADTM installation activities, BARCADTM sampling and field collection methods, and results of the BARCADTM monitoring well sampling. Table 5-1 provides a summary of groundwater samples collected during the ESI at Silo Site 8.

5.1 Borehole Advancement Techniques

5.1.1 Silo Site 8

Prior to commencement of drilling activities, limited surface preparation activities were performed at Silo Site 8 to accommodate the drill rig and support vehicles. Preparation activities included brush clearing, followed by fill and leveling activities with clean fill material transported from an off-site source. Photo 11 shows the cleared area leading to and surrounding deep borehole location BH8-3.

Three deep boreholes, identified as Borehole 8-1 (BH8-1), Borehole 8-2 (BH8-2), and Borehole 8-3 (BH8-3), were advanced to total depths ranging from 95 to 108 feet bgs (Figure 4-1). Deep Borehole 8-4 (BH8-4) was advanced to a total depth of 247 feet bgs. The selected drilling methods used to advance the deep boreholes were modified, based upon subsurface geologic conditions encountered during advancement. Revised methods were approved by USACE oversight, prior to implementation, and documented in a Field Work Variance (FWV) (Appendix I).

BH8-1, located east of the silo in the former UST area, was advanced using a Stratex[®] drill bit with 9[%]-inch temporary steel casing to approximately 95 feet bgs (Figure 4-1). A perched groundwater unit was encountered at 40 to 45 feet bgs, and a deeper groundwater unit was encountered at the bedrock interface at 92 feet bgs.

Table 5-1

Groundwater Sample Summary Environmental Site Investigation: Former Atlas Missile Silo Sites 8 and 9

Roswell, New Mexico

					Analytic	al Methodsª	
Well ID	Sample Number	Sample Date	Sample Type	Sample Depth (ft bgs)	VOC (EPA 8260B) SVOC (EPA 8270C) PAH (EPA 8270C-MOD) ^b Unfiltered TAL Metals (EPA 6010B/6020/7470A)	Filtered TAL Metals (EPA 6010B/6020/ 7470A)	Total Dissolved Solids (EPA 160.1)
S8-MW1-A	S8-MW1-A-1	8/30/2004	Environmental Groundwater	56.25-57.25	Х		
	S8-MW1-A-2	8/30/2004	Environmental Groundwater			Х	
S8-MW1-B	S8-MW1-B-1	8/30/2004	Environmental Groundwater	89.75-92.25	Х		
	S8-MW1-B-2	8/30/2004	Environmental Groundwater			x	
S8-MW2	S8-MW2-1	8/31/2004	Environmental Groundwater	100.33-102.83	Х		
	S8-MW2-1	8/31/2004	MS/MSD Groundwater		X		
	S8-MW2-2	8/31/2004	Environmental Groundwater			x	
	S8-MW2-2	8/31/2004	MS/MSD Groundwater			x	
·	S8-MWD1-A-1	8/31/2004	Duplicate Groundwater of S8-MW2-1		X		
	S8-MWT1-A-2	8/31/2004	USACE Split of S8-MW2-1 Groundwater		X		
S8-MW3	S8-MW3-1	8/30/2004	Environmental Groundwater	102.50-105.00	X		
	S8-MW3-2	8/30/2004	Environmental Groundwater			Х	
S8-MW4-A	S8-MW4-A-1	8/30/2004	Environmental Groundwater	142.00-144.50	X		Х
	S8-MW4-A-2	8/30/2004	Environmental Groundwater			Х	

Table 5-1 (Continued) **Groundwater Sample Summary** Environmental Site Investigation: Former Atlas Missile Silo Sites 8 and 9 **Roswell, New Mexico**

<u>.</u>					Analytic	al Methods ^a	
Well 1D	Sample Number	Sample Date	Sample Type	Sample Depth (ft bgs)	VOC (EPA 8260B) SVOC (EPA 8270C) PAH (EPA 8270C-MOD) ^b Unfiltered TAL Metals (EPA 6010B/6020/7470A)	Filtered TAL Metals (EPA 6010B/6020/ 7470A)	Total Dissolved Solids (EPA 160.1)
S8-MW4-B	S8-MW4-B-1	9/9/2004	Environmental Groundwater	239.80-242.30	Х		Х
	S8-MW4-B-2	9/9/2004	Environmental Groundwater			х	
Sila 8	S8-SW1-1	8/31/2004	Standing Silo Water	150	X		Х
Top 15 ft column	S8-SW1-2	8/31/2004	Standing Silo Water			Х	
Silo 8 Bottom	S8-SW2-1	8/31/2004	Standing Silo Water	165–170	X		X
15 ft column	S8-SW2-2	8/31/2004	Standing Silo Water			Х	
Silo Site 8	TownWellNorth-1	01010004	Water Supply	200 ^d	X		
Town Well North T	TownWellNorth-2	9/9/2004				X	
	TownWellNorth-3	10/13/2004					Х

*U.S. Environmental Protection Agency (EPA), 1986, "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," SW-846, 3rd ed., U.S. Environmental Protection Agency, Washington, D.C.

^bModified for Low Level PAH.

^cUSACE split samples shipped to the U.S. Army Corps of Engineers Omaha Laboratory, Omaha, Nebraska.

^aDepth based upon approximate pump intake depth provided by the Lake Arthur Water Co-Op via phone conversation on October 11, 2004. Screened interval is unknown.

bgs = Below ground surface.

= Foot (feet).

MS/MSD = Matrix spike/matrix spike duplicate.

USACE = U.S. Army Corps of Engineers. = Volatile organic compound.

VOC

EPA = U.S. Environmental Protection Agency.

- PAH SVOC
- = Polynuclear aromatic hydrocarbons. = Semivolatile organic compound.

ID = Identification TAL = Target Analyte List.

ft

BH8-2 and BH8-3 were placed northwest and southwest of the silo (Figure 4-1), respectively, in order to determine groundwater flow direction. The deep boreholes were advanced using airrotary methods, with a roller bit and 9⁵/₈-inch temporary steel casing driven to 85 feet bgs. Beyond 85 feet bgs, the deep boreholes were drilled as open holes, utilizing the 8.5-inch roller bit to 108 and 107 feet bgs, respectively. Photos 12 and 13 show the typical drill rig and setup for the drilling activities. Groundwater was encountered at the bedrock interface in both BH8-2 and BH8-3.

A fourth deep borehole (BH8-4), located north of BH8-1, was advanced adjacent to the former UST area to the study boundary of 250 feet bgs. Mud-rotary drilling methods were used to install 9%-inch permanent steel casing to 105 feet bgs. The steel casing was advanced 5 feet into shallow bedrock and cemented in place, which sealed off both the perched and bedrock interface groundwater units. The remainder of the deep borehole was advanced, uncased to 247 feet bgs, through competent rock, with an 8.5-inch roller bit. A third groundwater unit was encountered in the shallow bedrock between 120 and 185 feet bgs. Water production was reduced significantly through a clay layer observed from 185 to 190 feet bgs, then increased again below 190 feet bgs, which suggests a possible fourth groundwater unit within the deep bedrock.

5.1.2 Silo Site 9

Limited surface preparation activities were performed in the vicinity of the planned deep borehole location, at the former UST area, in order to accommodate the drill rig and support vehicles (Photo 14). Surface preparation activities included brush clearing, followed by fill and grading, with clean fill material delivered to the site.

One deep borehole (BH9-1) was advanced to the study boundary of 250 feet bgs at the former UST area, east of the silo (Figure 4-2). The Stratex[®] drilling method was used in an initial attempt to drill BH9-1. The Stratex[®] proved unsuccessful in the shallow limestone bedrock conditions; therefore, a second attempt was made a few feet north. This deep borehole was advanced as an uncased open hole through competent limestone using an 8.5-inch roller bit, following the installation of temporary casing to 15 feet bgs. Groundwater was not encountered within the study boundary (250 feet bgs), and the deep borehole was abandoned by backfilling with a cement grout.

5.2 BARCAD[™] Monitoring Well Installation

A total of six BARCAD[™] monitoring wells (S8-MW1-A, S8-MW1-B, S8-MW2, S8-MW3, S8-MW4-A, and S8-MW4-B) were installed among four deep boreholes (BH8-1, BH8-2, BH8-3, and BH8-4) at Silo Site 8 (Figure 5-1).



Figure 5-1 Monitoring Well and Silo Water Sample Location Map Former Atlas Missile Silo Site 8 Roswell, New Mexico

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The six BARCAD[™] monitoring wells were completed at depths within the four potential water bearing zones encountered during borehole advancement, as follows:

- Deep Borehole BH8-1 (nested BARCAD[™] monitoring wells):
 - S8-MW1-A completed at 57 feet bgs within the perched groundwater unit
 - S8-MW1-B completed at 92 feet bgs within the bedrock interface groundwater unit
- Deep Borehole BH8-2:
 - S8-MW2 completed at 103 feet bgs within the interface groundwater unit
- Deep Borehole BH8-3:
 - S8-MW3 completed at 105 feet bgs within the bedrock interface groundwater unit
- Deep Borehole BH8-4 (nested BARCAD[™] monitoring wells):
 - S8-MW4-A completed at 145 feet bgs within the shallow bedrock unit
 - S8-MW4-B completed at 242 feet bgs within the deep bedrock unit

Photo 15 shows a nested pair of BARCADTM monitoring wells prior to wellhead completion. Figure 5-1 shows the location of BARCADTM monitoring wells installed at Silo Site 8, and Table 5-2 summarizes BARCADTM monitoring well specifications, including groundwater elevations. Appendix D contains BARCADTM monitoring well completion diagrams.

The BARCADTM monitoring wells were installed under the supervision of AVM Environmental Services, Inc. (AVM) of Grants, New Mexico. AVM was subcontracted by Shaw to supply the BARCADTM monitoring well materials and supervise WDC Exploration and Wells, Inc. during installation. With the exception of one BARCADTM monitoring well (S8-MW-1A) completed with a 1-foot porous section, the remaining BARCADTM monitoring wells were completed with 2.5-foot-long porous sections. Photo 16 shows a 2.5-foot-long porous section prior to installation. Above the porous section, 1-inch Schedule 80 polyvinyl chloride (PVC) riser pipe extended to the ground surface. The quantities and types of materials used for BARCADTM monitoring well completion are not consistent for each BARCADTM monitoring well and were selected based upon subsurface conditions. Typical completion materials consisted of No. 60 silica sand filter pack, ³/₄-inch bentonite chips placed above the filterpack for seal material, and a bentonite grout mix placed above the seal to ground surface. For BARCADTM Monitoring Wells S8-MW1-A and -B, nested within BH8-1, Nos. 8 to 12 silica sand was placed above the No. 60 sand for stability. In the nested BARCADTM monitoring wells within BH8-1 and BH8-4, sufficient seal material was placed to ensure no hydraulic communication between groundwater

Table 5-2 BARCAD[™] Monitoring Well Location and Completion Information Environmental Site Investigation: Former Atlas Missile Silo Sites 8 and 9 Roswell, New Mexico

Silo Site 8 Borehole ID	Well ID	Date of Installation	Completion Zone	Northingª	Easting ^a	Top of Riser Elevation (ft amsl)	Depth to Groundwater ft btor (Gauged 8/30/04)	Groundwater Elevation (ft amsl)	BARCAD™ Interval (ft bgs)	Total Borehole Depth (ft bgs)
	S8-MW1-A	6/20/04-	Perched	729138.60	539555.30	3381.28	40.56	3340.72	56.25-57.25	04.75
БП0-1	S8-MW1-B	6/21/04	Interface	729138.40	539555.24	3380.80	48.07	3332.73	89.75-92.25	94.75
BH8-2	S8-MW2	6/21/04	Interface	729235.40	539261.92	3379.27	45.92	3333.35	100.33– 102.83	107
BH8-3	S8-MW3	6/23/04	Interface	729070.43	539257.94	3377.71	44.57	3333.14	102.50 105.00	107
	S8-MW4-A	7/12/04-	Shallow Bedrock	729196.70	539578.02	3385.27	51.23	3334.04	142.00– 144.50	247
ЫПО-4	S8-MW4-B	7/14/04	Deep Bedrock	729196.62	539578.21	3385.17	61.09	3324.08	239.80– 242.30	241

^aState Plane Coordinate System, New Mexico East, NAD 83.

amsi = Above mean sea level.

bgs = Below ground surface.

btor = Below top of riser.

ft = Foot (feet).

ID = Identification.

NAD = North American Datum.

units. The BARCAD[™] monitoring well riser pipes were completed aboveground within locking, protective steel casings (Photo 17). Appendix D presents BARCAD[™] monitoring well completion diagrams for the two single (S8-MW2 and S8-MW3) and two nested BARCAD[™] (S8-MW1-A and -B and S8-MW4-A and -B) monitoring wells.

Following installation, the BARCADTM monitoring wells were tested to ensure that they were operating correctly. Each of the six BARCADTM monitoring wells functioned properly after installation.

5.3 Site-Specific Hydrogeology at Silo Site 8

Four possible groundwater units were encountered during drilling activities at Silo Site 8. The depths and hydrogeologic setting of each unit are described as follows:

- A perched groundwater unit producing significant amounts of water during drilling was encountered within the basin-fill deposits, ranging from 40 to 55 feet bgs in all deep boreholes.
- A second groundwater unit ranging from 89 to 105 feet bgs was encountered at the interface of the basin fill deposits and bedrock.
- Two additional groundwater units were observed within the bedrock. A shallow bedrock groundwater unit was encountered at 120 feet bgs and possibly the second deeper bedrock groundwater unit was encountered at approximately 190 feet bgs. The two bedrock groundwater units were separated by a red clay unit from 185 to 190 feet bgs. It is uncertain whether the shallow and deep borehole groundwater units are separate units.

Based upon well records, the town of Lake Arthur's two water supply wells at Silo Site 8 were drilled to depths ranging from 1,020 to 1,069 feet bgs, with pumps set at 200 feet bgs. Information regarding perforated intervals for the Lake Arthur Town Wells was not available.

A groundwater elevation map was constructed for the interface unit in three deep boreholes (Figure 5-2). Groundwater flow direction in the interface unit is to the southeast, and groundwater gradient across the site is approximately 0.0025 feet/foot. Table 5-2 summarizes groundwater elevations, completion zones, and depth to water measurements collected during the groundwater sampling activities.

5.4 Groundwater and Silo Water Sampling Activities and Methods

5.4.1 Well Gauging

Approximately one month after the BARCAD[™] well sampling systems were installed, and immediately prior to sample collection activities, Shaw gauged the depth to groundwater at each BARCAD[™] monitoring well to the nearest 0.01 feet using a well-sounder tape. The



Figure 5-2 Groundwater Elevation Contour Map Interface Zone Former Atlas Missile Silo Site 8 Roswell, New Mexico

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measurements were used to estimate the volume of water in the BARCAD[™] riser pipe. Table 5-2 presents the groundwater elevation data collected at Silo Site 8 during these activities.

5.4.2 BARCAD™ Monitoring Well Sampling Methodology

Groundwater analytical samples were collected from the six newly installed BARCADTM monitoring wells at Silo Site 8. Figure 5-1 shows each sampling location. The BARCADTM monitoring wells were sampled using a dedicated ¼-inch tube inserted into the 1-inch PVC riser pipe, down to a depth within a few inches above the porous section. Compressed nitrogen gas was applied through a ½-inch air line to the 1-inch well riser pipe with the control of a regulator. Application of the compressed gas closed the check valve, located above the porous section, which pushed the water column in the riser pipe to the surface through the ¼-inch discharge tubing. Once one volume of water was purged, the nitrogen gas was turned off, opening the check valve so that groundwater could recharge the riser pipe. Samples were collected directly from the ¼-inch discharge tubing into the sample containers. Filtered water samples were also collected by placing a 0.45-micron filter in line with the ¼-inch tubing. Photo 18 shows the sampling setup at one of the wells.

5.4.3 Silo Water Sampling Activities

Under subcontract to Shaw, Albuquerque Concrete Coring, Inc. cored through the silo door at Silo Site 8 for access to the silo interior for gauging and sampling activities. Several attempts to core through the door were unsuccessful due to imbedded hardened steel plates and 1¼-inch-diameter steel reinforcing bars. The 32-inch-thick reinforced concrete door was cored with a diamond-impregnated, hollow-core barrel. Once the door was successfully cored, gauging and sampling activities within the silo interior commenced.

AVM installed a temporary BARCADTM monitoring well assembly within the silo water column (Photo 19). The temporary assembly included a ¼-inch air line in place of the typical 1-inch PVC riser pipe. The BARCADTM assembly was lowered into the silo with a safety rope to within the top 15 feet of the silo water column. Once the BARCADTM assembly was secured, the ¼-inch tubing waterline was purged using compressed nitrogen, and silo water samples were collected. After sampling the upper 15 feet of the silo water column. After securing the BARCADTM assembly was lowered into the bottom 15 feet of the silo water column. After securing the BARCADTM assembly at this location, the water line was purged, and samples were collected (Photo 20). The entire BARCADTM assembly was then removed from the silo and the holes in the silo door were patched flush to the surface with nonshrink grout, prior to leaving Silo Site 8.

5.4.4 Lake Arthur Water Supply Well Sampling

At the direction of the USACE, samples were collected from one of the two water supply wells in the town of Lake Arthur, located at Silo Site 8. Water is pumped from these two wells to an adjacent chlorine treatment system; however, the samples were collected directly from the wellhead prior to chlorination. While the pump was in operation, water was collected from a brass sample port attached to a PVC union on the wellhead of the well, identified as Town Well North. The Town Well North pump had been operating for at least 20 minutes prior to sample collection. The sample flow was controlled to allow low flow through a short piece of dedicated tubing directly into the sample container. The town well was sampled twice, at an approximate one-month interval. Groundwater quality parameters were measured during the second sampling event.

5.4.5 Field Procedures and Methods

Groundwater quality measurements (pH, specific conductivity, turbidity, dissolved oxygen, temperature, and oxidation-reduction potential) were collected during BARCAD[™] monitoring. Water quality readings were obtained from sensors in a closed, flow-through cell using a Horiba[™] U-22 water quality meter. The instrument sensors were checked, calibrated, and documented to be operational prior to purging activities (Appendix A4). Table 5-3 provides the groundwater quality measurements from BARCAD[™] monitoring wells at Silo Site 8.

All groundwater samples were collected by filling the laboratory-provided sample bottles. The filtered fraction sample for TAL metals was passed through a 0.45-micron, disposable filter cartridge directly into sample containers. Upon filling each container, the sample was immediately placed into a laboratory-provided cooler with ice. Shaw maintained custody of the samples at all times, until relinquished to Federal Express for overnight shipment to the laboratory.

Chain-of-custody documentation was electronically generated in the field, using the EPA software program "FORMS II Lite, Version 5.1" (DynCorp, 2002), and placed in each cooler to accompany samples to the laboratory. Sample collection logs were completed for each collected sample (Appendix A4).

5.5 Analytical Parameters

Analytical procedures from EPA SW-846 (EPA, 1986) were used for the chemical analyses of parameters in the groundwater samples collected. Water samples were submitted to Kemron for the following analyses.

- VOCs by EPA Method 8260B
- SVOCs by EPA Method 8270C
- PAH by EPA Method 8270C-Modified for Low Level PAH

Table 5-3Water Quality Field MeasurementsEnvironmental Site Investigation: Former Atlas Missile Silo Sites 8 and 9Roswell, New Mexico

Silo Site 8 Location ID	Measurement Date	Purge Volume (liters)	Dissolved Oxygen (mg/L)	ORP (mV)	рН	Specific Conductance (mS/cm)	Temperature (°C)	Turbidity (NTU)	Comment
S8-MW1-A	08/30/2004	1.2	4.04	112	7.81	3.60	20.82	7.5	N/A
S8-MW1-B	08/30/2004	5.5	1.62	104	7.58	3.10	20.01	0	N/A
S8-MW2	08/31/2004	6.0	1.06	194	6.88	3.29	18.98	0	N/A
S8-MW3	08/30/2004	7.1	1.49	102	7.60	3.37	19.70	28.7	N/A
S8-MW4-A	08/30/2004	8.8	0.26	73	7.46	22.2	20.74	9.4	N/A
S8-MW4-B	08/30/2004	21.31	1.84	119	7.88	31.4	20.10	3.1	N/A
Upper 15-foot silo water column	08/31/2004	2.750	0.75	-203	9.19	28.2	21.99	0	Strong hydrocarbon odor, slight sheen
Bottom 15-foot silo water column	08/31/2004	2.9	1.78	-287	9.43	32.4	21.17	5.6	Strong hydrocarbon odor, slight sheen
TownWellNorth-3	10/13/2004	N/A	0.32	-74	7.25	1.06	23.9	3.3	Clear

= Degrees Celsius.

ID = Identification.

mg/L = Milligram(s) per liter.

mS/cm = Millisiemens per centimeter.

mV = Millivolts.

°C

N/A = Not applicable.

NTU = Nephelometric turbidity unit.

ORP = Oxidation Reduction Potential.

- TAL metals by EPA Methods 6010B/6020/7470A (filtered and unfiltered)
- The laboratory performed searches for mass spectra library files and reported the top 10 TICs for each VOC and SVOC analysis.
- Additional analyses were performed for total dissolved solids (Method 160.1) for four samples.

5.6 Groundwater and Silo Water Sample Results and Evaluation

To aid in the identification of potential hazardous constituents, selected evaluation criteria were established representing the more conservative standard of either the New Mexico Water Quality Control Commission (NMWQCC) groundwater standards (NMWQCC, 2002), or the EPA's National Primary and Secondary Drinking Water Regulations Maximum Contaminant Levels (EPA, 2001). Appendix B1 lists the evaluation criteria used for groundwater results. The following sections discuss the groundwater and silo water sample results that exceeded evaluation criteria.

5.6.1 Groundwater Sample Results

BARCADTM Monitoring Well S8-MW1-A, completed in the perched unit at 56 feet bgs, had concentrations of lead (0.0503 milligram(s) per liter [mg/L]) and antimony (0.0585 mg/L) in the unfiltered sample exceeding evaluation criteria of 0.015 and 0.006 mg/L, respectively. Lead and antimony did not exceed evaluation criteria in the filtered groundwater sample. VOCs, SVOCs, and PAH were not detected above evaluation criteria in any groundwater sample collected from Silo Site 8.

Manganese and aluminum were detected above evaluation criteria in all groundwater samples collected at Silo Site 8. The maximum manganese and aluminum concentrations were detected in BARCAD[™] Monitoring Well S8-MW1-A at 0.531 and 32.8 mg/L, respectively. Evaluation criteria of 0.05 mg/L for manganese and aluminum are secondary EPA drinking water standards and are not enforceable.

Various other metal concentrations detected in groundwater samples from BARCADTM Monitoring Wells S8-MW4-A and S8-MW4-B exceeded evaluation criteria. BARCADTM Monitoring Wells S8-MW4-A and S8-MW4-B are completed at 142 and 239 feet bgs, respectively. Results for total dissolved solids (TDS) samples collected from BARCADTM Monitoring Wells S8-MW4-A and S8-MW4-B were 98,200 and 34,100 mg/L, respectively. According to the NMWQCC Regulations (Section 20.6.2 New Mexico Administration Code [NMAC]), standards for groundwater do not apply to groundwater with TDS concentrations greater than 10,000 ppm; therefore, metal results from these BARCADTM monitoring wells are not discussed. Table 5-4 lists analyte concentrations in excess of evaluation criteria.

Table 5-4

Groundwater and Silo Water Results Exceeding Evaluation Criteria Environmental Site Investigation: Former Atlas Missile Silo Sites 8 and 9 Roswell, New Mexico

Sample Number	Sample Depth (ft bgs)	Analytical Parameters ^a	Total or Dissolved Sample ^b	Analyte	Result	Units	Evaluation Criteria ^c	Reporting Limit	Laboratory MDL
				Si	lo Site 8				
				BARCAD™ Mo	nitoring Well Samples				
S8-MW1-A-1	56.25-	6010B	Total	Aluminum	32.8	mg/L	0.05	0.100	0.05
	57.25			Iron	21.2	mg/L	0.3	0.0400	0.02
				Lead	0.0503	mg/L	0.015	0.00500	0.0025
				Manganese	0.531	mg/L	0.05	0.0100	0.001
		6020		Antimony	0.0585	mg/L	0.006	0.00100	0.0005
S8-MW1-A-2		6010B	Dissolved	Aluminum	0.173	mg/L	0.05	0.100	0.05
				Manganese	0.0996	mg/L	0.05	0.0100	0.001
S8-MW1-B-1	89.75-	6010B	Total	Aluminum	0.223	mg/L	0.05	0.100	0.05
	92.25			Manganese	0.107	mg/L	0.05	0.0100	0.001
S8-MW1-B-2		6010B	Dissolved	Aluminum	0.153	mg/L	0.05	0.100	0.05
·				Manganese	0.106	mg/L	0.05	0.0100	0.001

Table 5-4 (Continued)

Groundwater and Silo Water Results Exceeding Evaluation Criteria Environmental Site Investigation: Former Atlas Missile Silo Sites 8 and 9 Roswell, New Mexico

Sample Number	Sample Depth (ft bgs)	Analytical Parameters ^a	Total or Dissolved Sample⁵	Analyte	Result	Units	Evaluation Criteria⁰	Reporting Limit	Laboratory MDL
			BAR	CAD™ Monitorin	g Well Samples (Contin	ued)			
S8-MW2-1	100.33-	6010B	Total	Aluminum	0.142	mg/L	0.05	0.100	0.05
	102.83			Manganese	0.102	mg/L	0.05	0.0100	0.001
S8-MWD1-A-1		6010B	Total	Aluminum	0.149	mg/L	0.05	0.100	0.05
(Duplicate of S8-MW2-1)				Manganese	0.105	mg/L	0.05	0.0100	0.001
S8-MW2-2		6010B	Dissolved	Aluminum	0.156	mg/L	0.05	0.100	0.05
				Manganese	0.0953	mg/L	0.05	0.0100	0.001
S8-MW3-1	102.50-	6010B	Total	Aluminum	0.760	mg/L	0.05	0.100	0.05
	105.00			Manganese	0.197	mg/L	0.05	0.0100	0.001
S8-MW3-2		6010B	Dissolved	Aluminum	0.201	mg/L	0.05	0.100	0.05
				Manganese	0.179	mg/L	0.05	0.0100	0.001

Table 5-4 (Continued)

Groundwater and Silo Water Results Exceeding Evaluation Criteria Environmental Site Investigation: Former Atlas Missile Silo Sites 8 and 9 Roswell, New Mexico

Sample Number	Sample Depth (ft bgs)	Analytical Parameters≉	Total or Dissolved Sample⁵	Analyte	Result	Units	Evaluation Criteriaº	Reporting Limit	Laboratory MDL
			BARC	CAD™ Monitorin	g Well Samples (Contin	ued)			
S8-MW4-A-1	142.00-	6010B	Total	Aluminum	286	mg/L	0.05	0.100	0.05
	144.50			Arsenic	0.175	mg/L	0.05	0.00400	0.002
				Iron	42.3	mg/L	0.3	0.0400	0.02
				Lead	0.0399	mg/L	0.015	0.00500	0.0025
				Manganese	1.07	mg/L	0.05	0.0100	0.001
		6020		Antimony	0.105	mg/L	0.006	0.00100	0.0005
	-			Selenium	0.0550	mg/L	0.05	0.0100	0.005
		160.1		TDS	98,200	mg/L	10,000	1000	500
S8-MW4-A-2		6010B	Dissolved	Aluminum	1.85	mg/L	0.05	0.100	0.05
				Arsenic	0.149	mg/L	0.05	0.00400	0.002
				Manganese	0.476	mg/L	0.05	0.0100	0.001
		6020		Selenium	0.0645	mg/L	0.05	0.0100	0.005
S8-MW4-B-1	239.80-	6010B	Total	Aluminum	1.28	mg/L	0.05	0.500	0.25
	242.30			Manganese	0.462	mg/L	0.05	0.0100	0.001
		160.1		TDS	34,100	mg/L	10,000	1000	500
S8-MW4-B-2]	6010B	Dissolved	Aluminum	0.596	mg/L	0.05	0.100	0.05
				Manganese	0.417	mg/L	0.05	0.0100	0.001

Table 5-4 (Continued)

Groundwater and Silo Water Results Exceeding Evaluation Criteria Environmental Site Investigation: Former Atlas Missile Silo Sites 8 and 9 Roswell, New Mexico

Sample Number	Sample Depth (ft bgs)	Analytical Parametersª	Total or Dissolved Sample⁵	Analyte	Result	Units	Evaluation Criteria ^c	Reporting Limit	Laboratory MDL
				Silo V	/ater Samples	· · ·			
S8-SW1-1	150	6010B	Total	Aluminum	0.288	mg/L	0.05	0.100	0.05
				Manganese	0.153	mg/L	0.05	0.0100	0.001
		160.1]	TDS	16,900	mg/L	10,000	200	100
S8-SW1-2	1	6010B	Dissolved	Aluminum	0.241	mg/L	0.05	0.100	0.05
				Manganese	0.100	mg/L	0.05	0.0100	0.001
S8-SW2-1	165-170	6010B	Total	Aluminum	0.383	mg/L	0.05	0.100	0.05
				Manganese	0.244	mg/L	0.05	0.0100	0.001
		160.1		TDS	20,100	mg/L	10,000	1000	500
S8-SW2-2]	6010B	Dissolved	Aluminum	0.272	mg/L	0.05	0.100	0.05
				Manganese	0.236	mg/L	0.05	0.0100	0.001

*U.S. Environmental Protection Agency (EPA), 1986, "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," SW-846, 3rd ed., U.S. Environmental Protection Agency, Washington, D.C.

^bTotal = Unfiltered samples.

^cEvaluation Criteria are found in Appendix B1. Evaluation criteria were selected from either 1) U.S. Environmental Protection Agency (EPA), 2001, "National Primary Drinking Water Regulations," Office of Water, U.S. Environmental Protection Agency, Washington, D.C. or 2) New Mexico Water Quality Control Commission (NMWQCC), 2002, "New Mexico Water Quality Control Commission Regulation," Section 20.6.2 of the New Mexico Administrative Code, New Mexico Water Quality Control Commission, Santa Fe, New Mexico.

bgs = Below ground surface .

Dissolved = Samples collected through a 0.45 micron filter.

ft = Foot (feet).

- MDL = Method detection limit.
- mg/L = Milligram(s) per liter.
- TDS = Total dissolved solids.

Appendix B2 presents all detected compounds in groundwater samples, and Appendix F2 contains complete analytical laboratory reports.

5.6.2 Silo Water Sample Results

The established evaluation criteria are not applicable to the standing water in the silo; however, the silo water sample results are compared to the evaluation criteria here for discussion purposes only. VOCs, SVOCs, and PAH were not detected above evaluation criteria in silo water samples. Manganese and aluminum concentrations were detected above evaluation criteria in silo water samples at maximum concentrations of 0.244 and 0.383 mg/L, respectively. TDS results for both unfiltered silo water samples (S8-SW1-1 and S8-SW2-1) were 16,900 and 20,100 mg/L, respectively. Silo water is not considered a domestic water supply and will not be considered for domestic supply in the future; therefore, no further action is necessary.

6.0 Survey Activities

6.1 GPS Survey

Two levels of surveying were conducted at Silo Sites 8 and 9. An overall site survey was conducted prior to commencement of drilling and sampling activities in order to locate and identify site features, as they currently exist. Locations of site features, such as small concrete structures or debris, were mapped as point coordinates. Linear data were mapped for features such as the outline of the evaporation ponds, circular water tank pads, and the rough outline of the former UST excavation depression. Point coordinates and linear definitions of site features were surveyed with a Trimble Pro XRS GPS unit that recorded horizontal coordinates in latitude and longitude, referenced to the North American Datum (NAD) of 1927 (Photo 21). Horizontal and vertical data were corrected in three-dimensional real time, at the time of mapping from base station correction signals. GPS data were converted to the State Plane Coordinate System (SPCS) New Mexico East Zone, (NAD 83), with Trimble Pathfinder Office Software. Results of the GPS Survey are presented in Figures 4-1 and 4-2.

6.2 Civil Survey

Upon completion of BARCAD[™] monitoring well installation and sample collection activities, a civil survey was conducted by Landmark Surveying, a licensed New Mexico surveyor, to accurately locate BARCAD[™] monitoring wells, soil borings, and soil sample locations. The civil survey was performed with a Rascal[®] 8-Channel Real Time Kinematic Surveying System and a Zeiss[®] Automatic Level. Horizontal coordinates were recorded in the SPCS New Mexico, East Zone, referenced to the NAD 83. Vertical elevations were referenced to the U.S. Coast and Geodetic Survey's 1988 National Geodetic Vertical Datum. Elevations, in feet amsl, for BARCAD[™] monitoring wells were measured to the top of the PVC riser pipe and at ground surface. Surveyed points were tied to a known benchmark at each silo site. Civil survey data for the BARCAD[™] monitoring wells, deep boreholes/soil borings, and soil sample locations are incorporated in Figures 4-1 and 4-2. Table 5-2 presents the BARCAD[™] monitoring well survey data.

The objectives of the ESI are as follows:

- Determine whether or not previous DOD activities at the Former Atlas Missile Silo Sites resulted in the presence of chemicals at concentrations that may impact human health and the environment
- Identify potentially hazardous constituents that may have migrated from the Former Atlas Missile Silo Sites to the surrounding soil and/or groundwater, and determine whether any detectable constituents present at concentrations above evaluation criteria can be attributed to past DOD activities.
- Determine the presence of potentially hazardous constituents at three potential source areas, at each silo site. Potential contaminant source areas include soil and groundwater surrounding the silo to a depth of approximately 250 feet bgs (including standing water within the silo), the septic tank leachfields, and the silo sump outfall areas for silo sump discharge.

To accomplish these objectives, soil and groundwater samples were collected and analyzed for potentially hazardous constituents. This section presents a summary of the soil and groundwater assessments and provides recommendations based upon these findings.

10.1 Summary

10.1.1 Silo Site 8

Soil Assessment Summary

The soil assessment investigated potential releases of hazardous constituents to surface and subsurface soil from the following potential contaminant source areas:

- Septic Leachfield
- Sump Outfall
- Former UST Area

Arsenic concentrations exceeded evaluation criteria (3.9 mg/kg) in samples collected from Deep Borehole BH8-3 (45 feet bgs) and the septic leachfield soil boring AHL8-4 (9 to 12 feet bgs) at concentrations of 13.4 and 4.71 mg/kg, respectively. BaP was detected at an estimated concentration of 63 μ g/kg, slightly exceeding the evaluation criteria of 62 μ g/kg, in the duplicate soil sample collected from material in the sump outfall pipe; however, the primary sample result for BaP was below evaluation criteria. No analytes were detected above the evaluation criteria in the soil sample collected from the deep borehole (BH8-1) advanced through the former UST

area. No other VOCs, SVOCs, or PAH, were detected at concentrations exceeding evaluation criteria in soil samples collected during the ESI at Silo Site 8.

Given the geologic setting of Silo Site 8, where basin fill deposits overlay evaporates (anhydrite and limestone), it is not uncommon to find naturally occurring arsenic levels at slightly elevated concentrations. To demonstrate that arsenic levels detected during the ESI are naturally occurring, a geochemical evaluation was performed on soil samples collected at Silo Site 8. The geochemical evaluation of arsenic in soil involved correlating detectable concentrations of arsenic to iron. Soil samples with higher arsenic concentrations also contained higher iron concentrations, indicating naturally occurring conditions. Appendix J discusses arsenic in soil and the geochemical methods used in the evaluation.

Based upon soil sample results, there have been no impacts to soil from the potential source areas at Silo Site 8.

Groundwater Assessment

Four potential groundwater units were encountered during deep borehole advancement at Silo Site 8 as follows:

- A perched groundwater unit encountered within the basin fill deposits ranging from 40 to 55 feet bgs
- A second groundwater unit at the interface of the basin fill deposits and bedrock ranging from 89 to 105 feet bgs
- A shallow bedrock groundwater unit encountered at 120 feet bgs
- A potential deep bedrock groundwater unit encountered at 190 feet bgs

Based upon recharge rates during sampling and observations made during drilling, the deep bedrock groundwater unit produces less water than the other three identified groundwater units. Groundwater flow direction in the interface groundwater unit is to the southeast.

In order to determine whether groundwater has been impacted, BARCAD[™] monitoring wells were completed in each of the groundwater units. Both filtered and unfiltered samples were collected. Lead (0.0503 mg/L) and antimony (0.0585 mg/L) were detected at concentrations exceeding evaluation criteria (0.015 and 0.006 mg/L, respectively) in the unfiltered groundwater sample collected from BARCAD[™] Monitoring Well S8-MW-1A, completed in the perched unit. The NMWQCC Regulations, Section 20.6.2.3103, state that standards shall apply to the dissolved portion of the contaminant. Therefore, based upon the filtered sample results (dissolved), lead and antimony concentrations were below evaluation criteria. Manganese and aluminum were detected above evaluation criteria (0.05 and 0.05 mg/L) in all groundwater units at Silo Site 8. The maximum manganese and aluminum concentrations were detected in BARCADTM Monitoring Well S8-MW1-A at 0.531 and 32.8 mg/L, respectively. Evaluation criteria for these metals are unenforceable secondary standards and no further action is recommended, in accordance with the established DQOs (Shaw, 2004). Various other metals were detected above evaluation criteria in groundwater samples collected from the shallow bedrock groundwater unit (S8-MW-4A) and deep bedrock groundwater unit (S8-MW-4B). TDS results for these BARCADTM monitoring wells were well above the NMWQCC standard of 10,000 mg/L; therefore, groundwater standards are not applicable, and no further action is recommended in accordance with the established DQOs (Shaw, 2004).

TDS results for both unfiltered silo water samples (S8-SW1-1 and S8-SW2-1) were 16,900 and 20,100 mg/L, respectively. Silo water is not considered a domestic water supply and will not be considered for domestic supply in the future; therefore, no further action is necessary.

10.1.2 Silo Site 9

There were no analytes detected in the soil samples collected at Silo Site 9 exceeding evaluation criteria. Groundwater was not encountered at Silo Site 9 within the study boundary (250 feet bgs). No further action is recommended in accordance with the established DQOs (Shaw, 2004).

10.2 Recommendations

Based upon the results of field activities and a review of the ESI analytical data, the following recommendations are proposed for each silo site.

10.2.1 Silo Site 8

Metals detected in soil samples at concentrations exceeding evaluation criteria were determined to be naturally occurring and not indicative of contamination. Metals in groundwater samples from the perched groundwater unit exceeding evaluation criteria, are not indicative of contamination, and most likely represent natural conditions. TDS in the bedrock groundwater units and silo water indicate that they are not a potable water source, and will not be used as a potable water source in the future; therefore, no further action is recommended for Silo Site 8 in accordance with the established DQOs (Shaw, 2004).

10.2.2 Silo Site 9

No analytes were detected in soil samples at Silo Site 9 exceeding evaluation criteria. Groundwater was not encountered at Silo Site 9 to the study boundary of 250 feet bgs. Subsurface conditions consisted of limestone bedrock to 250 feet, making migration of any potential contaminants to the groundwater table unlikely; therefore, no further action is recommended for Silo Site 9 in accordance with the established DQOs (Shaw, 2004).

REFERENCE 3

Final Environmental Site Investigation Report Atlas Missile Silo Nos. 2, 3, 4, 5, 6, 8, 9, 10, 11, and 12 Roswell, New Mexico

Contract No. DACA47-97-D-0021 Delivery Order No. 0003

PREPARED FOR: United States Army Corps of Engineers Albuquerque, New Mexico

PREPARED BY: IT Corporation 5301 Central Avenue NE, Suite 700 Albuquerque, New Mexico 87108

17/01 (raig) Approved by: _ Date: IT QC/Manager Approved by: und Date: IT Delivery Order Manager Approved by: Date: IT Project Manager

January 2001

8.0 Silo No. 9

8.1 Site Background

8.1.1 Site Description

The Silo No. 9 site is located 30 miles west of Roswell, New Mexico, along Highway 380. Vegetation is sparse across the site. The LCC door and some vents appear damaged. No monitoring well was located at the site (IT, 1999). The current layout and features of Silo No. 9 are shown on Figure 7.

8.1.2 Site History

No site history is available for Silo No. 9.

8.1.3 Summary of Field Investigations

The following field activities took place at Silo No. 9.

- September 26, 1996—Drilling of four test borings was initiated and soil samples were collected.
- October 14, 1996—Drilling of the deep soil boring was initiated.
- October 23, 1996—Deep soil boring was abandoned.

8.2 Study Area Investigations

8.2.1 Contaminant Source Investigations (Local)

Contaminant source investigations at Silo No. 9 included sample collection at locations where contamination could potentially exist, based on known activities at the site. Potential contaminant source areas at Silo No. 9 include the former location of the diesel UST, a septic system (septic tank and leachfield), and the silo or a source inside the silo. Section 8.4 discusses the results of the contaminant investigations.

8.2.2 Soil and Vadose Zone Investigations

Shallow test borings were advanced in the vicinity of Silo No. 9 in order to investigate soil and vadose zone contamination. The test borings were drilled with hollow-stem auger methods by a CME 75 mounted on a 2-wheel drive truck. All drilling equipment, including the drill rig, augers, and drill rod, were decontaminated prior to borehole advancement (Corps, 1999a).

Soil samples were obtained either with a 5-foot continuous sampler or with a 2-inch diameter split-spoon sampler. The continuous sampler was attached to rods inside the auger flights and was advanced ahead of the lead auger to collect an undisturbed soil sample 3 inches in diameter and 5 feet in length. The split-spoon sampler was used only when friction caused high temperatures inside the continuous sampler. The split-spoon sampler was driven 18 inches into the soil ahead of the lead auger to obtain undisturbed soil samples (Corps, 1999a).

8.2.2.1 Test Borings

In September 1996 four shallow test borings were advanced at Silo No. 9 using the methods described above. Two soil samples were collected from Test Borings 1 and 2 at 1.5 feet bgs and at 14 feet and 6.5 feet, respectively. The soil samples from Test Borings 3 and 4 were collected at 0.8 and 7 feet bgs, respectively (Corps, 1999b). A surface soil sample was collected in November 1996 from the 0- to 5-foot bgs depth interval. The location of the four test borings and the surface soil sample are not known.

8.2.2.2 Soil Sampling and Analysis

Soil samples collected from the shallow test borings were analyzed for SVOCs using EPA Method 8270; for pesticides and PCBs using EPA Method 8080; for metals using EPA Method 6010/7000; and for TPH using EPA Method 8100m. The surface soil sample was analyzed for pesticides and PCBs using EPA Method 8080. The dates, depths, analytical parameters, and laboratories for soil samples collected at Silo No. 9 are summarized in Table 1.

8.2.2.3 Test Boring Abandonment

The test borings were abandoned immediately after sampling by backfilling with drill cuttings. Headspace measurements with a PID were used to screen excess soil samples and cuttings. Any soil material exceeding 5 parts per million on the PID was returned to the test boring; the remainder of uncontaminated cuttings were spread evenly around the borehole.

8.2.3 Groundwater/Silo Water Investigations

A deep soil boring was advanced to 250 feet, intended for completion as a monitoring well. No groundwater was encountered, and the soil boring was abandoned by backfilling with grout.

8.3 Physical Characteristics of the Site

8.3.1 Surface Features

The construction and layout of the silo pad are similar at each silo and are shown in Figure 2. The silo pad consists of a paved area approximately 170 feet square with a 70-foot outside diameter silo in the center. A covered stairwell entrance to the LCC and the underground structure is at the northwest corner and a UST for diesel fuel was typically located off the eastern edge of the pad. The LCCs are 33 feet deep and 44 feet in diameter. The missile silos are 174 feet deep with an inside diameter of 52 feet. Other features of the silo include septic systems, evaporation ponds, and concrete building pads (Corps, 1993) (Figure 2). Current features at Silo No. 9 are shown on Figure 7.

8.3.2 Geology

The lithologic logs for the four test borings and the deep soil boring were not available for inclusion in this report, therefore, no interpretation of subsurface geologic conditions could be made.

8.3.3 Hydrogeology

8.3.3.1 Depth to Water

No groundwater was encountered to 250 feet bgs at Silo No. 9. It is unknown whether standing water exists in the silo.

8.3.3.2 Monitoring Well Construction

A deep monitoring well borehole was drilled and intended for completion as a monitoring well. Because no groundwater was encountered during drilling of the soil boring, the soil boring was abandoned.

8.3.3.3 Well Abandonment

Abandonment of the deep soil boring was performed in October 1996 by backfilling with grout and EnviroplugTM (Corps, 1999a).

8.3.4 Land Use

The area adjacent to the site is primarily used for cattle ranching.

8.4 Nature and Extent of Contamination

The Corps provided laboratory reports containing analytical results from soil samples that were collected at Silo No. 9. No groundwater or silo water samples were collected at Silo No. 9. The data from each report were reviewed for completeness against validation checklists (see Appendix C), including the name of the analytical laboratory, the laboratory batch number, and the quality control methods used by the laboratory. The results were then compiled into summary tables (Appendix B).

This section discusses the results of site characterization in terms of contaminants and contaminant distribution for soil samples from Silo No. 9.

8.4.1 Contaminant Distribution Map

Based on the types of contaminants found in soil samples at Silo No. 9, a contaminant distribution map was not applicable to this silo (see Section 8.5).

8.4.2 Soil Contaminant Summary

Arsenic was detected above the EPA Region 6 residential screening level of 0.39 mg/kg at a concentration of 7.4 mg/kg in the soil sample from Test Boring 2 at 6.5 feet bgs. No other analytes exceeded EPA Region 6 residential screening levels for soil samples collected at Silo No. 9. Extractable petroleum hydrocarbons (EPH) were detected below the NMEDUSTB standard (100,000 μ g/kg) at a concentration of 43,000 μ g/kg in the soil sample collected from Test Boring 2 at the 1.5-foot depth. The location of this test boring is not known. Table 8 summarizes analytes detected in soil samples collected at Silo No. 9 and Appendix Tables B1.7.1 through B1.7.4 contain complete soil sample results for Silo No. 9.

8.4.3 Groundwater/Silo Water Contaminant Summary

No groundwater or silo water samples were collected at Silo No. 9.

8.5 Conclusions and Data Gaps

With the exception of arsenic in one soil sample collected from Test Boring 2, no other EPA Region 6 residential screening levels were exceeded in soil samples from Silo No. 9. The arsenic result is likely due to naturally high background levels of arsenic in soils at Silo No. 9. TPH was detected below the NMEDUSTB standard in Test Boring 2 at the 1.5-foot depth. The location of this test boring is not known.

8-4

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Groundwater was not encountered to 250 feet and silo water (if present) was not sampled at Silo No. 9. As a result, the extent of any groundwater contamination from DoD activities could not be determined. Additionally, any potential impacts from silo water contamination could not be assessed because of the lack of information. Before Silo No. 9 can be ruled out as a source of contamination, silo water must be collected and analyzed or the lack of silo water must be documented. This information will fill the data gap represented by the lack of silo water or groundwater analytical results.

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REFERENCE 4



REFERENCE 5

PICACHO 2 WSW, NEW MEXICO (296804)

Period of Record Monthly Climate Summary

Period of Record : 3/ 1/1980 to 9/30/2004

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	56.6	60.1	65.9	73.8	81.6	89.1	89.3	86.1	82.2	74.2	63.6	55.8	73.2
Average Min. Temperature (F)	24.9	27.3	31.9	38.9	47.9	55.5	59.5	58.8	51.6	41.1	31.1	24.1	41.1
Average Total Precipitation (in.)	0.46	0.34	0.46	0.65	1.02	2.07	2.20	3.79	2.38	1.13	0.60	0.69	15.81
Average Total SnowFall (in.)	3.9	1.8	1.0	0.6	0.0	0.0	0.0	0.0	0.0	0.6	1.9	5.7	15.4
Average Snow Depth (in.)	0	0	0	0	0 0	0	0 0	0	0	0	0	0	0
Percent of possible observ Max. Temp.: 98.3% Min.	vations : Temp.:	for perie 97.8%	od of re Precipi	cord. tation:	98.9% :	Snowfa	11: 99.49	% Snov	v Depth	: 99%			

Check <u>Station Metadata or Metadata graphics</u> for more detail about data completeness.

Western Regional Climate Center, wrcc@dri.edu

REFERENCE 6

XVIII-20-10

HISTORY

OF

CORPS OF ENGINEERS

BALLISTIC MISSILE CONSTRUCTION OFFICE

CONSTRUCTION AND CONTRACT

ACTIVITIES

AT

WALKER AIR FORCE BASE ROSWELL, NEW MEXICO

JUNE 1960 - JUNE 1962

"FOR OFFICIAL USE ONLY"

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Stanford I. POLONSKX

Lt. Col., CE Area Engineer

ATCOEO

UNITED STATES ARMY CORPS OF ENGINEERS BALLISTIC MISSILE CONSTRUCTION OFFICE LOS ANGELES, CALIFORNIA

WS-107A-1 MISSILE LAUNCH COMPLEXES WALKER AIR FORCE BASE ROSWELL, NEW MEXICO

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INTRODUCTION

Presented herewith is a complete and factual summary report of construction and contract activities associated with the construction of the Walker Air Force Base Atlas F Ballistic Missile Launching Facilities.

The scope of the report includes activities in connection with construction of twelve launching complexes and support facilities. It does not include installation of missiles and controls which is being accomplished by separate contract directly under the administration of the Site Activation Task Force of the Air Force.

The report is prepared and submitted in accordance with instructions contained in Corps of Engineers Ballistic Missile Construction Office Circular Number 61-74, issued 27 October 1961, subject: "Historical Summary Report of Major ICBM Construction".

PART I

ADMINISTRATICN

ESTABLISHMENT AND FUNCTION: CORPS OF ENGINEERS BALLISTIC MISSILE CONSTRUCTION OFFICE (CEBMCO)

The U. S. Army Engineers established the Ballistic Missile Construction Office in Los Angeles on 1 August 1960. The office was established to further streamline, strengthen, and expedite ICBM site construction. ICBM construction consists of Atlas, Titan, and Minuteman squadron sites at various bases, as well as certain testing facilities at Vandenburg AFB, California and Cape Canavarel, Florida.

The Corps of Engineers Ballistic Missile Construction Office (CEBMCO) is commanded by Colonel E. E. Wilhoyt, Jr.

CEBMCO, through various Construction Directorates, controls the overall missile site construction program and supplies to the Area Offices any guidance required of them, ie: Construction, Electrical, Mechanical, Engineering, Propellant Loading System (PLS), Administration, etc.

Inasmuch as the Atlas F Areas were quite a distance from CEBMCO, numerous visits were made by CEBMCO Representatives to the different Area Offices, thereby assuring CEBMCO of the currency of events occurring in the field.

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The Organization Chart (Fig. 1) shows the five ICBM Directorates under CEBMCO, with a further breakdown of the Atlas "F" Directorate, together with its six area offices.

)RGANIZATION CHART

CORPS OF ENGINEERS BALLISTIC MISSILE CONST. OFFICE U S ARMY LOS ANGELES, CAL.

CORPS BALLISTIC MI	OF ENGINEER ISSILE CONST. OFFICE
Colonel E. E. Wilh	Commanding hoyt, Jr. Officer
MIN. MAN CONST. DIRECT.	ATLAS F CONSTRUCTION DIRECTORATE
	Col. W. W. Wilson Director
TITAN I CONST. DIRECT.	ADMINISTRATION BRANCH
	CONTRACT ADMINISTRATION BRANCH
	CONSTRUCTION BRANCH
TITAN II CONST. DIRECT.	ENGINEERING BRANCH
	LIAISON GROUP
ATLAS D&E CONST. DIRECT.	
	AREA OFFICES ALIUS AIR FORCE BASE
	DYESS AIR FORCE BASE
	LINCOLN AIR FORCE BASE
	COUTLETING AIR FURCE BASE
	WALKER AIR FORCE BASE

Figure 1

ESTABLISHMENT AND FUNCTION: WALKER AREA OFFICE

The decision to construct Atlas Missile Launching Facilities in this area was reached in early January 1960, at which time the Albuquerque District Office was requested to perform certain soils investigations, et cetera, to determine whether or not the geological conditions in this area would support the proposed installation. This investigation was accomplished by the Spencer J. Buchanan Co., and by Gordon Herkenhoff and Associates with favorable results.

Design was initiated in early March 1960 after completion of the investigation.

The Walker (Roswell) Area Office was established 15 May 1960 by District Order #231 under the Albuquerque District, to handle supervision, inspection and contract administration for construction of 12 Atlas Missile Sites in the vicinity of Roswell, New Mexico.

The facility was advertised for bids on 16 May 1960 and a total of six bids were received. Bids were opened on 15 June 1960.

Successful bidder was the Macco Corporation, Raymond International, Inc., The Kaiser Co., Puget Sound Bridge and Dry Dock Co., a Joint Venture. The contract was awarded 16 June 1960 and the Notice to Proceed issued 20 June. Work started on 23 June 1960.

Although, as indicated previously, a Ballistic Missile Construction Office was established with Headquarters in Los Angeles on 1 August 1960, it was not until 22 November 1960, by means of General Order 37, that the transfer of construction responsibility from the Albuquerque District Office to CEBMCO was accomplished. By this means the Walker Area Office came under the jurisdiction of CEBMCO and was

removed from the control of the Albuquerque District. Effective that date, a Civilian Personnel Administration agreement was entered into by CEBMCO and the Support District. Extensive recruiting efforts were continued.

The mission of the Walker Area Office was to perform those portions of Contract Administration which were delegated from the Atlas F Directorate of CEBMCO to the Area Office. The contracts to which this mission applied were those under which twelve Atlas F ICBM Launch Base Complexes and their related support facilities were constructed. Administrative and logistical support was provided the Area by CEBMCO and the Albuquerque District to the extent indicated in the document entitled "Division of Responsibilities, Administrative and Logistical Support, Walker Area Office".

The Walker Area Engineer's Office was organized with four primary branches and two offices (Safety and Counsel), each reporting directly to the Area Engineer. Organization Chart Fig. 2 shows the organization at approximately peak strength in July 1961. Organization Chart Fig. 3 shows the organization on 1 January 1962, at which time construction progress permitted the assignment of one project engineer to two or sometimes three missile sites, depending on the status of completion of each site. As the construction phase neared completion, personnel phase-cuts were increasingly evident. Displacement of personnel was accomplished almost entirely by attrition, and spirited efforts were made by the Area Engineer's staff to assist these individuals in securing positions in other agencies, particularly within CEEMCO. A great deal of cooperative spirit prevailed also in the rotation of individuals to saccomplish needed tasks, which often became necessary due to the selection and loss of individuals for new assignments within the Corps and to other agencies.

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The relatively high percentage of professional engineers comprising the Area Office was a major factor in the accomplishment of construction efforts. It is considered noteworthy that at one time (when the organization was approximately at peak strength) 92% of all Area Office personnel were qualified professional engineers.

Project Engineers, responsible to the Construction Branch, were selected for each of the 12 sites to inspect and supervise contract construction. The Propellant Loading System (FLS) functions were also accomplished under the immediate responsibility of the Construction Branch.

The functions of the branches and offices of the Walker Area Office were as follows:

AREA ENGINEER: The Area Engineer supervised assigned construction contracts, represented the Contracting Officer and enforced contract provisions as well as providing direction and coordination of the area's organization activities.

DEPUTY AREA ENGINEER: The Deputy assisted the Area Engineer and acted as Area Engineer during his absence. He provided direction to the technical, advisory, and administrative in all matters of a technical nature.

EXECUTIVE OFFICER: He assisted the Area Engineer and the Deputy in a staff capacity in delegated matters not requiring the immediate or personal attention of those officials. His duties included the coordination, review or approval of matters delegated by the Area Engineer or his Deputy, serving as focal point in all matters relating to the Administrative and Advisory staff. He supervised Military Personnel Admin-

istration as directed, and performed numerous additional duties as specifically assigned.

ADMINISTRATION BRANCH: Furnished administrative services to all elements of the Area Office, including each of the twelve missile construction sites. Furnished instruction to clerical personnel and provided stenographic and typist assistance. Provided office services including: supply, communication, custodial services, reproduction, transportation, mail distribution, records, purchasing and procurement. Directed civilian personnel actions and maintained records to include: time and attendance, leave, cost and pay. Received and approved for funds all obligating documents other than Construction Contracts and Modifications.

ENGINEERING AND TECHNICAL BRANCH: Provided engineering and technical assistance to area personnel. Reviewed plans and specifications and furnished comments to CEBMCO. Resolved conflicts and design inadequacies in plans and specifications and instituted change order action. Furnished contract plans and specifications for use by other branches. Maintained set of all contract plans and specifications and files of all approved material and shop drawings. Provided Administration Branch with documents (shop drawings, catalogues, etc.) required by using service. Prepared as-built drawings. Performed technical and engineering approvals of soils, concrete, and other materials and equipment. Performed engineering inspections of construction to insure adequate construction standards and compliance with design criteria. Maintained liaison with Architect-Engineer, USAF AMC/EMD Field Office,

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CEBMCO, KCDO, and other Corps of Engineer Districts on engineering and technical matters.

CONTRACT ADMINISTRATION BRANCH: Advised area personnel on contractual matters. Received progress schedules from contractors, reviewed same, and initiated action for revision or approval. Furnished Engineering Branch with comments for addendum changes on plans and specifications. Prepared Government Construction Cost Estimates for Change Orders. Branch Chief represented Area Engineer on SATAF Change Order Board. Monitored proposed change orders within Area Office and initiated change order action with contractors. Conducted modification negotiations and prepared and distributed modification documents. Investigated and determined validity of claims. Initiated action and followup on government furnished equipment until arrival at job site or railhead. Expedited construction materials. Maintained and reported status of modifications and claims. Reported work stoppages to CEBMCO. Processed documents on transfer of completed work to Air Force.

CONSTRUCTION BRANCH: Supervised and conducted continuous inspections of construction activities. Directed the job-level Engineer Trainee Program. Reported to the Engineering Branch conflicts and design inadequacies occuring in the plans and specifications. Reviewed proposed changes for construction feasibility and time impact. Provided Contract Administration with information for progress reports. Insured maintenance of a set of contract prints showing as-built conditions. Provided Contract Administration Branch with data for ENG Form 290 and other transfer documents. Established and furnished construc-

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tion completion and acceptance dates to Contract Administration Branch. Reported work stoppages to Contract Administration Branch and prepared formal work stoppage reports. Directly supervised the Project Engineers.

SAFETY OFFICE: Assisted the Area Engineer in administering the Corps of Engineers' Safety Program within the Area.

Provided for frequent safety inspections at all work sites.

Advised the Area Engineer of potential safety hazards on all sites which he was unable to have corrected.

Prescribed and coordinated a balanced program of Safety activities. Assured prompt reporting of accidents.

Prepared formal reports of findings with recommended corrective action on all accidents and serious hazards which hampered efficient uninterrupted construction progress.

OFFICE OF COUNSEL: Assisted and advised the Area Engineer and his supporting elements on legal matters except Real Estate.

Rendered staff advise in the negotiation and preparation of contractual documents and reviewed all contract actions for legal sufficiency.

Reviewed actions concerning all contractual and non-contractual claims initiated by Contract Administration Branch.

Processed settlement of contractual documents as delegated by the Office of Counsel, CEBMCO.

Reviewed actions initiated by Contract Administration Branch on appeals made by contractors to decisions made by the Contracting Officer or Contracting Officer's Representative.



Prepared litigation reports as required.

Performed labor relations functions, assuring enforcement of contract labor standards and promoted good working relationships between the Corps of Engineers, organized labor and contractors.

Received, reviewed, and initiated necessary action on all contractor's payrolls.

ADMINISTRATIVE PROBLEMS:

The question of re-employment rights for CEBMCO employees created a great deal of confusion in the minds of most of the people assigned to the Area Office. Higher headquarters must have anticipated the problems which would result upon completion of the work at the different ICBM bases when individuals became available for a new assignment and/or wished to exercise re-employment rights. A letter published by the Office of the Chief of Engineers dated 13 December 1960, Symbol ENGEP-CE, established Civilian Personnel policies to provide re-employment rights for certain categories of CEBMCO employees. One basis for confusion or misunderstanding was the fact that so-called "absolute" re-employment rights were apparently granted to individuals assigned to Headquarters, CEBMCO, whereas so-called "administrative" re-employment rights, only, were granted to persons assigned to the different field offices. In addition, these administrative re-employment rights granted to field employees applied only to individuals who had reported for assignment to a field (Area) office directly from another Corps of Engineers Office. As a result, many individuals, assigned to the Area Office as recent graduate engineers or from government offices other than the Corps of Engineers,

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were not entitled to re-employment rights. In a number of cases, too, individuals were assigned to the Area Office from a Corps of Engineer District at a much later date than other individuals not formerly connected with the Corps. This inequality was particularly applicable to young engineer trainees who were recruited from college and who, during phase-out, did not have re-employment rights with the Corps even though they were, in many cases, among our most desirable employees from the standpoint of insuring their retention in CEBMCO. Over twenty (20) engineer trainees were thus affected. Although a number of these individuals subsequently received assignment to other newly activated Area Offices, many of them accepted assignment in other federal agencies or with private industry and their services were thus lost to CEBMCO.

Further complicating this problem was the fact that re-employment rights were based on the grade held by the individual at the time he departed a District Office. Upon exercising these re-employment rights, the affected individual competed with other District Office employees at their <u>current grade</u> while his rights were based on the grade held at the time of his departure from the District.

It is recommended that further study be made of the civilian personnel re-employment policy to afford more uniform treatment of individuals in like circumstances.

PART II

CONSTRUCTION

ORIGIN AND MISSION:

Prime responsibility for Atlas "F" Weapon System Development rests with the United States Air Force. Six geographical locations in the United States were selected to house the construction of Atlas "F" Operational Base Missile Launch Complexes, each consisting of twelve unitary Silo Launch Complexes and Support Facilities. This is the history of the construction at Walker Air Force Base, Roswell, New Mexico. The United States Air Force, through its Ballistic Missile Division, established a Site Activation Task Force to accomplish this mission at Roswell, New Mexico. The United States Army Corps of Engineers was selected as the construction agency to perform construction for the Site Activation Task Force. This is solely a report of the work encountered by the United States Army Corps of Engineers element of the SATAF organization.

The decision to build the Atlas "F" Launch Facilities in the Roswell, New Mexico, area was reached in early January 1960, at which time the Albuquerque District of the United States Army Corps of Engineers was requested to perform soil investigation to determine if the geological conditions in this area would support the proposed installation.

This investigation was accomplished by Spencer J. Buchanan and Associates and Gordon Herkenhoff and Associates with favorable results. Design was assigned in early March 1960 to the Bechtel Corporation.

The proposed construction was advertised for bids on 16 May 1960, bids were opened on 15 June 1960, and the basic construction contract in the amount of \$22,115,828 was awarded to a joint venture consisting of the Macco Corporation, Raymond International, Inc., The Kaiser Company, and Puget Sound Bridge and Drydock Company on 16 June 1960. Notice to proceed was issued on 20 June 1960 and the work was initiated on 23 June 1960. The Roswell Area Office of the United States Army Corps of Engineers was activated on 15 May 1960 with a nucleus of people that was expanded to eight officers and 168 civilians at the peak of activity. (See organizational chart, Part I)

Lt. Colonel Joseph G. Kimble was selected as the Area Engineer and was the Officer-in-Charge throughout the construction. DESCRIPTION OF THE PROJECT:

Basically the project consists of a silo, having a twenty-six feet minimum inside radius by an inside height of 165 feet, and a launch control center, forty feet inside diameter by twenty-seven feet clear height. The launch silo consists of two feet six inch thick concrete walls up to a point approximately fifty feet below the top of the silo at which point the wall flares to a total thickness of nine feet. It has a concrete cap nine feet thick. Concrete floors normally are six inches thick, but are five feet thick where ground water causes excessive hydrostatic pressure. The launch control center has two feet six inch thick walls with a three feet six inch floor and a three foot roof. In the interior of the sile is a steel crib which is suspended by four shock absorbing hengers, contains eight levels, and supports all the facilities inside the silo. The launch control

center has two suspended floors on which all the equipment is mounted. Descriptive sketches of silo and LCG appear on Figures 4, 5 and 6. The LCC and silo are connected by an underground tunnel. The silo and LCC represent the basic construction unit. Twelve such units are distributed within a forty mile radius in concentric arrangement around Walker Air Force Base. Distances vary from 21.4 and 42.4 road miles from Walker Air Force Base (See Vicinity Plan, Figure 7). In addition, maintenance and support facilities, consisting of a Re-Entry Vehicle Facility, a Missile Assembly Building, a Liquid Oxygen Generator Plant, and Water Supply Systems for the Missile Launch Complexes, were constructed.

TOPOGRAPHY:

The sites are located in the majority of cases on gently rolling terrain adjacent to the Pecos River Valley. Site 5 lies actually in the valley fill area. Sites 6 and 7, near the foot of the Sacramento Mountains, lie on somewhat rougher ground. Elevations average about 3500 feet above sea level. Vegetation is scant, consisting of semidesert type grasses and shrubs.

GEOLOGY AND GROUND WATER CONDITIONS:

All sites are located in what is known as the Roswell Artesian Basin. This title is misleading. Artesian water production does occur in the vicinity of the City of Roswell. Some years ago there were large flowing wells in that area but the flowo have ceased as a result of over-pumping of the artesian aquifer.

Geological formations are of Permian, Triassic and Quaternary ages. They consist of the Chupadera, Chalk Bluff and Dockum formations

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overlain by a mantle of Quaternary overburden. The Chupadera formation is made up of the Yeso member at its base and the San Andres limestone member at its top. The San Andres has very recently been further subdivided, with the lower portion being known as the Glorieta formation and the upper part as the San Andres limestone. The Chalk Bluff formation overlies the San Andres and the Dockum formation overlies the Chalk Bluff. The formations generally dip eastward approximately one degree. The San Andres formation is exposed in the westward portion of the sites area near the foot of the Sacramento Mountains, the Chalk Bluff through the central portion, and the Dockum at the eastern limits.

The Artesian condition is brought about by the presence of the permeable San Andres limestone on the surface in the Sacramento Mountains, an area of fairly good annual rainfall, and by the slope of the San Andres to the east at fifty to sixty feet per mile, a slope greater than the surface. The relatively impermeable red beds of the Chalk Bluff formation tend to hold water in the permeable San Andres under pressure, although this is highly variable with local conditions since the formations are interconnected and leakage from fractures and improperly constructed wells locally modifies conditions.

Subsurface exploratory investigations were made prior to issuing plans and specifications for bid. Core hole and seismic investigations were made by Spencer Buchanan and Associates of Bryan, Texas. Ground water explorations were performed by Gordon Herkenhoff and Associates of Albuquerque, New Mexico. Findings of the investigations and the reports received thereof are the basis of most of this geological

report. Results of the investigation were presented in log form on contract drawings. Descriptive logs and notes on water encountered are extracted from the drawings and exhibited as Figures 8 through 12.

Consistently, the material encountered in excavation was as shown on the logs, although there were some variations in thickness of strata across the width of silo excavations. Some unexpected difficulties in the way of more water than expected was encountered. Sites 3, 6, 7, 8, 9, 11 and 12 were dry holes. Site 10 had water in the shaft in negligible emounts. Considerable water was encountered at Sites 1, 2, 4, and 5, leading to claims by the contractor.

Generally, the valley area west of the Pecos River contains ground water in almost unlimited quantities and of fair quality. The thickness of the San Andres diminishes to the west and production tends to be less than in the valley fill area. Massive salt beds to the east, and particularly east of the Pecos river where wells were drilled in the Chalk Bluff formation, contained water with so many salts as to be unusable without special treatment. All water from the San Andres is hard and requires treatment if Public Health Standards are to be met.

Water for use at the sites was developed by wells at Sites 2, 5, 6, 7, 8, and 9. Water for Sites 1 and 10 is transmitted by pipe line from Site 2. Water for sites 3 and 4 is obtained from the nearby village of Hagerman via pump station and pipe line and for Sites 11 and 12 from the City of Roswell. All waters were too highly mineralized for intended usage. Special domineralization and softening processes were provided.

ite No. 2 Site No. 10 LCC Silo LCC DOCKUM FORMATION (TRIASSIC) ONE RBURDEN QUATERNARY OVERBURDEN QUATERNARY CALICHE, brown & white, very soft Ss SM SAND, rod, silty, soft CLAY, light reddish brown, soft, CLAY red, silty CL CLAY, brown, sandy, silty CL 10 sandy with coliche nodules to t in size Grodes to It be with CALICHE, white weathered red sittstone seams SANDSTONE, brown, fine-grained Ċo Ss 20 DOCKUM FORMATION (TRIASSIC SHALE, red and grow, dayiey. DOCKUM FORMATION (IRIASSIA) CLAY, dork red, sondy, soft, with Sh CL CL stracks of green sondy clay SANDSTONE, red, silty, massive, 30 SANDSTONE, red, mod hard very fine-provined, weathered, soft groy-green, siltu fine-provined, angillaceous of top soft, red micoceous below 34 3' Occosion sandstane becomes firm, unstreats of red silly shake 40 weathered al hairline seam of rad shake SANDSTONE, dark red. hard. Ss Ss fine-grained with spots and Ss bands of dark red silly day 50 Si with green streaks. Seams of shale and silty clay 62.5-64.0' 60 MUDSTONE, red, firm but crush-Sandstone becomes conglomer-atic with shale & limestone@66 ed, weakened 70 slickensided BORING COMPLETED 2-6-60 BORING COMPLETED 2-19-80 AT A DEPTH OF 73.0 FEET AT A DEPTH OF 773 FEET Ms CONTINUOUS 6-INCH CORE 80 CONTINUOUS 6-INCH CORE. Ss 90 SANDSTONE & SILTSTONE 100 red and growish, firm to very firm NOTE 1: A static water level was 110 measured 128 teet below the ground NOTE 1: The drilling water in the surface in the deep boring upon rebecoming brown sandstane w deep boring was boiled out upon comcovery from total dewatering by boiling. The bailing rate was less than ш pletion of drilling at a bailing rate of 120 4 less than 20 q.p.m. No recovery 15 q.p.m. water level was reported after bailz 2 ing the test hole. 130 gray sandstone Ss 56 x dark gray sandstone with -6 à 140 calcoreous stringers at 140' w 0 Si 150 changing to light green sandstone with interbedded green shale, interbedded cost at K3' 5 160 light grow sandstone with 3-in. 170 layer of limestone at 170' gray sandstone with interbadded light green shale 180 sandstone, dark gray 190 SHALE red shale (mudstone), slickensided 200 Sh red and green shale, slicken-Contract No. DA-29-005-ENG-2598 sided Walker AFB-Roswell, New Mexico BORING LOGS-NORTHEAST GROUP BORING COMPLETED 2.20-60 AT A DEPTH OF 225.0 FEET SITES 1, 2 AND 10 (Extracted from Contract Drawings) CONTINUOUS 6-INCH DIA CORE FIGURE 8. · · · · · · ·

			,		Si	te	e No. 2
Silo	Site	e No	•	LCC	Silo		LCC
		T		OUE DRUDDEN (QUATE DNARY)	DOCKUM FORMATION (TRIASSIC)		DOCKUM FORMATION (TRIASSIC)
RDEN IQUATERNARY	' ci		CI	CLAY red silty.	SANDSTONE, red, friable, very	Ss	Calliche brown & white, very soft
gravel			-	Bed fine sand 100'-104'	fine grained		CL CLAY, brown, sandy, silty
LUFF FORMATION PERMA	when	1		CHALK BLUFF FORMATION (PERMIAN)			
I groy & pink some grovel	Gų		104	GYPSUM, gray			. Ss SANUSTUNE, brown, fine grained
rk red, very soft, contain	S CL			GYPSIM MAN	CLAY, red, sondy, base, with gray	СГ	CL CLAY, dark red, sandy, saft with streaks of oreen sandy clay
1 orau and pink	Gu	1 -	- 04		gionnior gauconi		aroy areen, silty
· · · · · · · · · · · · · · · · · · ·	04	ļ	<u><u> </u></u>	CLAY red. shaky, augsum particles	soft had Al'-AP']	soft, red
1, silty, trace of anovel	CL		Gų	GYPSUM, gray Lost water circulation at 45.5	Juli ded ti te		SANDSTONE, dark red hard.
1, with traces of red clay	Gy			CLAY & CYDSIAA			Ss The ordined with spots and bonds of dork red silty day
d, sandy, trace of quare!	CL	-	CL	Alternating byers of gray gup	SILTSTONE, red, firm	Si	i with green streaks.
M, gray and pink	Gu		Gų	sum and red clay. Gypsum tragments in clay.			
or rea cuy os to do					SANDSTONE, red, fine-grained.		
		4		Gray gypsum at bottom.	The Die, Thinking Charge		
ed, silty		-		BORING COMPLETED 2.7.60			BORING COMPLETED 2-6-'60 AT A DEPTH OF 77.3 FEET
M. gray, with streaks o	f Gu		•	CONTINUOUS 6-INCH CORE	sandstone is dark red, tine- orained with dK.red, silty clay.	ł	CONTINUOUS 6-INCH CORE
silty clay and grave.	- I '		· •	n en	jointra & air slakes sandstone is gray and green,	Ss	s
ed, very proken, slick- ded at many angles.	CL	1			fine-anned, aupsiterous 06-90 Highly crushed	1	
M. alternating in layers CLAY red, slickensided	CL	(h					
M. orau							
ch layer of clay			NOTE	1: A static water level was			NOTE 1: A static water level was
bed rad mottled aray clay	4 G		mea. surfe	ace upon completion of drilling	sandstone is dark red, fine-		surface in the deep boring upon re
		'	Th e dru	by bailing at approximately 15	grained		ing The bailing rate was less than
ch layer of red, silty, tiri '	77)		q.p.r.	n. for four hours. However, the	Charles with such county		15 g.p.m.
			the	deep boring was totally dry	nf dwk red siltu cloy & our	14	4
DRITE, gray, with thin mertinas	A	n			SHALE, dark gray, sitty, and air stakes	Sh _	8
IM. gray, with scattered	1				SANDSTONE		
es of giay anhydrife and in bed of clay at 148 H.	0	4			gray, fine-grained		
					i li har a fina anniord		
red and gray mottled, wi 1 lavers of gypsum, firm	n.				· scattered large lumps of very	Ss	5
					soft, green, silty cloy	1	
144 brown donte we	<i>"</i>				dark red, fine-grained		
ed fractures in all direction	G G	4			gray-green, fine-grained, with		
red soft to firm with 94	<i>p</i> -	4					
Guntum hed	h				CHALK BLUFF FORMATION IPL KIMP	1	
Οφρουπ τευ		(CLAY, red, silty, soft, with oup	•	
					qupsum	a	2
		1					
Current had					rea soft, silty, with ausum		
Gypson web					streaks and horigonial, gupsum filled cracks		
G COMPLETED 2-4-6	50	<u>_</u>			BORING COMPLETED 2.5.60	-	
DEPTH OF 225.0 FEE	7 -				CONTINUOUS 6-INCH CORE		
INCOUS & INCH CORE	•						se da se
							0029


arre No. 4	4	No.	Site
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LCC

LCC OVERBURDEN QUATERNARY OVERBURDEN QUATERNARY OVERBURDEN (QUATERNARY) CLAY H. brown, sandy, some CL coliche, bodky disturbed SILT, ned, sondy, with coliche ML SILT, red, clayey, with fine sand, caliche above 15, somewhat Ŵ mottled red and awy 134' 150' CHALK BLUFF FORMATION PERMAN ML calcareous and moist below CHILK BLUFF FORMATION (PERMIN) SHALE, dark red to red, soft, very Sh 20 clowey with soft plastic city. CLAY, light brown to brown silty 342 queson frequests broken stiff to very stiff, some oup sum Limestone pebbles at 30 bry Ms CHALK BLUFF FORMATION (PERMIAN) 20 LAI ren, shely, hard, very Histic some pupium, coliche SILTSTONE, red, fine sondy, soft saules and gravel to & size. CH CL 40 CLAY, red silty, generally soft some gravel 40-45, moist below 45' 50 SC Smill, 100, Sure coursed alles limestone fragments 55'-60' clay is dark red, shaky, with friable sand and grovel to cab 34 **90** ble size, some quasum. SC U CAY rea sorry very stir CL SC SAND red. of grained, chayey SANDSTONE, red, very frishle, Ss 70 thinly bedded w/silty cby. BORING COMPLETED C.6-60 AT A DEPTH OF THO FEET CONTINUENTS STREET BORING COMPLETED 2-10-50 ę AT A DEPTH OF 75.0 FEET 80 CONTINUOUS 6-INCH CORE limestone grovel 90'-95' 90 lost drilling mud GYPSUM & CLAK in alternating NOTE I. A Statis with and mes m D" Layers Red clay 102 - 104 100 established bi fest telew the ground NOTE 1: A static water level was Surface in the deep boring account Gy measured 23 feet below the ground . stay & hours after boiling, CL surface in the deep boring after bail by mater supply test well y sked mat-er at the rate of some = 91.51 110 ing. Bailing at a rate of approximately 20 q.p.m. lowered the water level from CL with only moderate drow xown. 23 feet to a depth of 60 feet. لما V 120 The test well exterior to a 4 dy depth of 105 leet, por writed GYPSUM, grou 5 z from Breet to Preet with some annudrite 185-131 130 with thin layers of black shale and red clay 131.4 - 136.4 r last drilling mud 125'-135' à. 140 gypsum is interbedded with LL I brown and red day O 150 gypsum is gray, massive 160 interbedded with soft red shake 64 170 quipsum is gray, massive inter bedded w/soft, gwy shake Gy 180 broken gypsum and anhydrite 190 in brown clay matrix. 200 gray gypsum 1 anhydrite Contract No. DA-29-005-ENG-2598 24 alternating layers of gypsum, Walker AFB-Roswell, New Mexico clay, and anhydrite BORING LOGS-SOUTH GROUP BORING COMPLETED 2-8-60 AT A DEPTH OF 225.0 FLET SITES 3, 4 AND 5 (Extracted from Contract Drawings)

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Site No. 5

CONTINUOUS 6 INCH CORE

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FIGURE 9

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Site No. 3 Site No. 4 Silo LCC SI10 LCC 3URCEN (QUATERNARY) OVERBURDEN QUATERNARY, OVERBURDEN IQUATERNARY OVERBURDEN QUATERNARY SM red, silty, with coinche CLAY, red, loose, silty, with SAND, red, silty, with coliche CLAY H. brown sandy, some α CL caliche. bodky disturbed broken pieces of caliche M FORMATION (TRIASSIC DOCKUM FORMATION (TRIASSIC SANDSTONE & SILTSTONE CHALK OLUFF FORMATION (PERMAN) CHALK BLUFF FORMATION OF RMIAN Red, fine to very fine-grained STONE & SILTSTONE. calcareous, friable Few bed SHALE dork red to red, soft, very Sh 1, fine-grained, very weakly MUDSTONE, reddish, crushed, of dark red, hard, sandy chu. clowey with soft plastic cion. nented, friable, some calcorslickensided planes all directions queson frequerits, broken strength of stiff clay, secondary Ĵs oupsum veins. Ms I.A. ren, shew, hard, very s lastic some gypsum, coliche S CH .coules and gravel to f size. 55 * raveling during drilling 8 SC Shirl, 100, Sine conned a liger SAND, red, madium grained, clar SANDSTONE, red, fine grained ey, calcareous and very truste SC. CL CAY rea, somy very site Bed of dark red sandy clay 71.0'- 71.7' gravelly of base. SC SAND red. xf grained, chycy SORING COMPLETED 2.6.60 BORING COMPLETED C-6-60 AT A DEPTH OF 75.0 FEET AT A DEPTH OF THE FEET CONTINUENTS STITCH CORS CONTINUOUS 6-INCH CORE CLAY, red, silty, soft, with linestone ownel. NOTE 1. No moter mus encountered Chy is red, silly to sondy, firm to soft, small(f) green clay NOTE I. A Statis with and meas BLUFF FORMATION (PERMIAN CL in the deep boring and the nearby established bi feet below the ground water supply test well. surface in the deep boring approximreg silty talls, carbonaceous atoky 24 hours after bailing CL TQNE red mottled with by noter supply test well yielded mut-er at the rate of some of grad Si it gray granular gypsum, 92.0 with only moderate draw somm. Jerately firm Clay contains angular pebbles of yellow mudstone and rounded The test will extering to a pebbles of quartzite, with sandy depth of 105 test in rated lime and green clay fragments. red, silty, firm, mottled from Bfeet to Preet n lenses of gypsum and CL iy chay Clated and weakly recemented GYPSUM. massive UM. massive, broker and 30 CLAY red silvy GYPSUM CLAY red and green, sulty ted with day along textures. ĈL GY=SUM Collapse breccia broken, with red and green Chay in stactures 1615-1722 IM breccia in matrix of red, silly chay proy-preen tractured siltstone ΰų 172.2' - 173.6' Gy massive qupsum 183'-193' soft, sillty chy 197'-199' D' of soft shi of 205' CONTINUOUS 6-INCH CORE ANHYORITE & GYPSUM È massive with sna 'solution * HOLE DEEPENED 2-11-30 Massive with little Ha covities. 34 TO A DEPTH OF 276.5 FT. CHU ALL MASSIVE ROCH SALT BED WITH MINOR RED CLAY MPLETED 2-4-60 BORING COMPLETED 2 6-3. AT A DEPTH OF 2655 FEET 6.50 EPTH OF 2250 FEET IMPURITY CONTINUOUS 6-INCH : O-E

Site No. 3 Silo LCC SI16 OVERBURCEN QUATERNARY) OVERBURDEN QUATERNARY, OVERBURDEN KOUATERNAK SM SAND, red, silty, with coliche SAND, red, silty, with caliche CLAY, red, base, silty, with broken pieces of caliche 10 DOCKUM FORMATION (TRIASSIC DOCKUM FORMATION (TRIASSIC SANDSTONE & SILTSTONE CHALK BLUFF FORMATION/PERM 20 Red, fine to very fine-quained, calcareous, friable Few beds SANDSTONE & SILTSTONE, red, fine-grained, very weakly MUDSTONE, reddish, crushed, of dark red, hard, sandy chy. 30 cemented, frisble, some calcorslickensided planes all direct. COUS strength of shiff clay secon ĴS oupsum veins. b 40 Si Ss 50 Hole raveling during drilling 8 60 S, SAND, ned, medium-grained, c. SANDSTONE, red, fine grained ey, calcareous and very frie gravely at base. 70 Ss Bed of dark red sondy clay 71.0 - 71.7 80 BORING COMPLETED 2-6-60 AT A DEPTH OF 75.0 FEET CONTINUOUS 6-INCH CORE CLAY, red, silty, soft, with lin 90 stone general. 100 NOTE 1: No mater was encountered Clay is not, silly to sondy, fi to soft, small() green clay in the deep boring and the nearby CHALK BLUFF FORMATION (PERMAN CL 110 water supply test well. CLAY red siltu talls, carbonoceous. . L SILTSTONE, red, mottled with W 120 Si ٤. light gray, granular gypsum; Clay contains angular pebbl moderately firm Z of yellow mudstone and roun 130 pebbles of quartzite, with se lime and green clay fragmer r CLAY, red, silty, firm, mottled F.a. with lenses of quasum and 140 CL ш gray clay Ó Brecciated and weakly recemented 150 GYPSUM. massive SYPSUM, massive, broker and CLAY red silty GYPSUM CLAY red and green, silty jointed with clay along factures. 160 GY. 2SUM Collapse breccia ---170 brokan, with red and green clay in fractures 1615-1722 GYPSUM, breccia in matrix of firm red, silty clay. groy green fractured siltsta Gy 180 172.2' - 173.6 massive qupsum 183'-193' 190 200 soft, silty cby 197'-199' D' of soft chil of 205' 210 CONTINUOUS 6-INCH CORE ANHYDRITE & GYPSUM massive with so all solution 220 HALITE, massive with little # HOLE DEEPENED 2-11-60 Ha covities. TO A DEPTH OF 276.5 FT. red clay ALL MASSIVE ROCK SALT BED WITH MINOR RED CLAY BORING COMPLETED 2-4-60 BORING COMPLETED 2.6.5 AT A DEPTH OF 2255 FEET AT A DEPTH OF 225.0 FEET IMPURITY. CONTINUOUS 6 INCH JOHE 0033

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Silo	Lie	NO.	1	LCC				÷
<u>D AND ALTERED ZON</u> <u>'ÉCENT)</u> white, firm	E Co	1	Ca	WEATHERED AND ALTERED ZON [RECENT] CALICHE white firm	न		7	
S FORMATION (PERMIA)			Ls	SAN ANDRES FORMATION (DERMIA			1	
IE. light grou, finely crup wrd, broken, with wold and fractures.	ş.		CL	LIMESTONE, while, two tured w/ yellow clay in factures, (LAY, yellow and ten, silty, with timestone from the hand		30		
e is broken, porous and recemented with calc- 15 feet.				LIMESTONE, gray, fractured, with some silt and chy fill-		40		
ly crystalline, scattered Ned wys			Ls	ing in the Hochures.		50		.
						60		
f dark groy, angular lime- ments in gray lime stone 71' to 72'				BORING COMPLETED 2-8-60		70		
is groy, porous, with groy chert 70' 83'			Ĉ	CONTINUOUS GINCH CORE				
ery hard 90-92						90		
tred vugs to i"dia.						100		•
' is dork gr ee nish-grou, crystailine, with janes 'n, vuqqy limestone	Ls	NO.	TE I. Pr w	No oppreciable inflow of		110	F	• • •
		this as a	ls in orei deter	the San Andres limestone of o lie below a depth of 500 ft, mined by the nearby test well.		120	NFE	
		.'		- <u>-</u>		:30	Ŧ	
porous limestone very dense, very finely				•		140	DEPT	•
limestone with skylolikes						150		
						160		
						170		
						180		
					╏┼	190		
finely crystalline 'es also pronounced Tures filled with gouge					+	200		
s gray, hard to mea- iry porcus								
PLETED 1-27-60 1 OF 2250 FEET 6-INCH SORE								
	~							

Contract No. DA-29-005-ENG-2598 Walker AFB-Roswell, New Mexico BORING LOGS-WEST GROUP SITES 6 AND 7 (Extracted from Contract Drawings) FIGURE 10

60 Site No. 7 LCC Silo LCC SAN ANDRES FORMATION (PERMIAN) WEATHERED AND ALTERED ZONE WEATHERED AND ALTERED ZONE LIMESTONE, gray, hard with horizontal fracture seams CENT (RECENT) Co Ca CALICHE, white, firm CALICHE, white firm. 10 containing silt and clay. Caliche above 10' SAN ANDRES FORMATION (PERMIAN SAN ANDRES FORMATION (PERMIAN Ls 20 CL LIMESTONE white, textured, wi LIMESTONE, light groy, finely crysyellow cloy in fractures. talline, hard, broken, with void CLAY, yellow and ton. silty with pockets and tractures. 30 limestone frequents, hard .5 Limestone is broken, porous and portiolly recemented with calc-ite to 145 feet. LIMESTONE, gray, fractured, with some silt and clay fill-40 Damp clay at 43' ing in the fractures. Ls Gray, finally crystalline, scattered 50 cakine filled was 60 Breccia of dark gray, angular lime 70 stone Frequents in gray lime stone 71' to 72' BORING COMPLETED 2-9-60 BORING COMPLETED 2-8-60 AT A DEPTH OF 75.0 FEET AT A DEPTH OF 750 FEET 80 CONTINUOUS 6-INCH CORE Limestone is gray, porous, with dark gray chert 70'-83' CONTINUOUS GINCH CORE 90 Hard to very hard 90' 92' Light gray to light tan, very porous, scattered vugs to I due TE 1: The CES-foot boring was 100 during drilling. The water levels in Limestone is dark greenish-gray very hard crystailine, with games limestone of the orea are believed ie below 500 feet. 110 of light tan, vuqqy limestone NOTE 1: No appreciable inflow of water will occur at this site as maker Ls í. levels in the San Andres limestone of ш 120 14 this area lie below a depth of 500 ft. as determined by the nearby test well. z 130 x ۵ 140 LLI I Hard, gray, porous limestone Ο grading to very dense, very finely crustalline limestone with skyblikes 150 160 170 180 190 200 Gray, dense, finely crystalline. with stylolites also pronounced vertical fractures filled with calcite as a gouge Contra Walks Limestone is gray, hard to medium hard, very porous BORING COMPLETED 1-27-60 AT A DEPTH OF 2250 FEET (Extrac CONTINUOUS 6.INCH CORE 0035

					1. 7
	• 	· · ·	Site No	0.6	Site No.
an an the second s	1		5110	LCC	Silo
		10	SAN AMORES FORMATION (PERMAN) LIMESTOME Grow, hard, with 5-10% solu- tion was lined with askits crustels, accasional clay seams 45° 60° and vertical joints	SAW AMORES FORMATION (PERMIAN) LIMESTONE, gray, hard with horizontal fracture seams containing silt and clay. Cal- iche above 10.	WEATHERED AND ALTERED ZONE IRECENT CALICHE white firm SAN ANDRES FORMATION (PERMIAN LINAE STONE LIDAT ADDITION (PERMIAN
			Gray, dense, hand, with hand, red clay seams, catile lenses. Dark gray, with pink catile and red clay seams.	Ls Domp clay at 43'	talline, hard, broken, with void pockets and fractures. Limestone is broken, porous and portially recemented with calc- ite to 145 feet. Gray, finely crystalline, scattered
		• 0 70 • 0	Medium to light group, dense. hard, fine to very fine crustel- kine with calcine seems. Massive between 70'and 75'	BORING COMPLETED 2-9-60	Calcite filled waps Breccia of dark gray, angular time- stone hagments in gany timestone 71' to 72'
	ET	90	Brownish-gray, hard fine gravined, I" rugs lined with calcite, harizontal fractures with red calcareous clay.	NOTE 1: The 225-foot boring was try during drilling. The water levels in the limestone of the orea are believed to lie below 500 feet.	Limestone is gray, parous, with dark gray chert 70'03' Hard to very hard 90'92' Light gray to light tan, very por- ous, scattered vugs to l'dua. Limestone is dark greenish-gray, very hard crystalline, with jones of light can vibou limestone
	EPTH IN FE	120 130 140	Greenist grou, sense, ir regular Fractines, small, red clay sams between 1195 and 1285		Ls man kre this as i
	Ð	180	Dark gray, massive, highly fractured, factures filled with cakite and clay. Sincken- sides at MS within I'clay, which may be gauge. Water seep 158-3-1526 in breccia.		Hard gray, porous limestone grading to very dense, very finely crystalline limestone with skyblikes
		170	ian, sing, woony recrumed, eso crystalline, fectured, wet at 162'. Mottled gray and kan. sandy also gray, platy limestone. Some raveling.		
		190 ·	dings (\$7 of red, ten, buff, clayey limestone. Fossill ferous. Locally sandy and clayey lime- stone 175' to 103.		Gray, dense, finely crystalline
		210 220	Dork gray, hard, dease, harizontal fractures lined whed clayd calcile		with styloutes, also pronounced vertical fractures filled with calcite 3: J gouge Limestone is gray, hard to med- ium hard, very porcus
			BORING COMPLETED 1-31-60 AT A DEPTH OF EESI FLET CONTINUOUS 6-INCH CORE	0036	BORING COMPLETED 1-27-60 AT A DEPTH OF 2250 FLET CONTINUOUS 6-INCH CORE



Silo I.CC OVERBURDEN COUNTERNARY 10 OVERBURDEN COUNTERNARY I de colspan="2">OVERBURDEN COUNTERNARY I de colspan="2">OVERBURDEN COUNTERNARY I de colspan="2">I de colspan="2">OVERBURDEN COUNTERNARY I de colspan="2">I de colspan="2" I de colspan="2"	SILO <u>OVERBURDEN (QUATERNARY)</u> SM SM OVERE HALK BLUFF FORMATION (PERMIAN With
10 OVERBURDEN (QUATERNARY) SUE with onliche CHALL BURT RAMATION (PERMIAN) L3 CL AY, red, sithy, with coboreaus nodules.	OVERBURDEN (QUATERNARY) SM SM OVERE HALK BLUFF FORMATION (PERMIAN) CHULK, With
	With
20 GYPSUM, grow, massive, with lew church server N-13 GYPSUM, grow, massive, with lew church server N-13 GYPSUM, grow and SHALL, grow, hard, grow immestone. Gy in alternating layers.	SANDSTONE, reddish and tan. fine-grained, moderately soft, mostly friedle, with clovey beds
λέ [and gypsiterous partings
40 Gypsum is reddish groy to dit groy GYPSUM, groy	Soft, filleo
• Gray gypson	
To Larthy, porous limestone. 6" of 64.5'	
Very colcoroous, ton clay. Nº-75 BORING COMPLETED 2-18-60 AT A DEPTH OF 74.9 FEET	BORING
CONTINUOUS 6-INCH CORE 1 greenish, clovey, limestane 2 brittle, cakareous claystone	CONTIN
100 : LIMESTONE, gray, porous, thech ured, light gray, calcoreous filt-	35
LS NOTE 1: The mater level was measured after bailing at a depth of 106 ket	NOTE 1: The c the deep too
180 Below the graund surface in the deep boring. This maker level represents a Sight artesion hand, as no maker mas encountered in the deep boring above	19.3 Feet below prior to o bail bailing, the re
140 Linnestone is gray, hard (14) CLAXSTONE homon cohomony	rearby test n
190	
160 SHALE group, hard, cabareous, Sh tractured.	
170 LIMESTONE, group, porous, partiel- ly decomposed, fractured and	
100 poorly recemented. Ls	
SHALE & LIMESTONE, shake is Sh light to dark owny, clayey to silty, fractored.	PSUM, gray, massive Gy
EIO CLAY, silty, moist CL	INYORITE gray massive An
280 SHALE, CON & ANHYDRITE LISA SHALE, turning to light group por Sh	
BORING COMPLETED 2-9-60 AT A DEPTH OF 22:50 FEET CONTINUOUS 6-INCH CORE	RATING COMPLETED 1-31- 60 RA GEPTH OF 2250 TEET ONTINUOUS 6-INCH CHEL 0038

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Contract No. DA-29-005-ENG-2598 Walker AFE-Roswell, New Mexico BORING LOGS-EAST GROUP SITES 11 AND 12 (Extracted from Contract Drawings) FIGURE 12

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	Silo,	Site No	LCC	Silo Silo	te	No .	.12	· · ·
	OVERBURDEN OWATERNAH SAND red, fine, silfu with calicity DOCKUM FORMATION (TRIASS SHALE & SANDSTONE	KU Sh	CL OVERBURGEN GLATERMARY) CLAY derk reasoner silty Sh DOCKUM FORMETION TRASSIC	OVERBURDEN B UATERNARY) SAND, red. with coliche & grovel	sp.		SH	OVERE SAND (and
	red, bodly broken, jointed a weathered above 17' becom firmer below	od & inp Ss	Ss SHALE & SANDSTONE, red, bod- ly broker, jointed and weathered SANDSTONE, red fine around, Ss Mod How E, red fine around,	DOCKUM_FORMATION(TRIASSIC) SILTSTONE, red, massive, firm, bro- ken, jointed, cokareous coment	Si			DOCKUN MUDST
	SANUSTONE, red, firm, fine the medium-grained, 45° joint fro 335' to 3	s Ss	greenish; gray near base. SILTSTONE, MUDSTONE; &	MUDSTONE, red and gray, joinhed, weak to firm, slickensided	Ms		Ms	Red a whe
	SILTSTONE, MUDSTONE, AND SANDSTONE, inter bedded, mod ately firm to firm, 60°-90° joints throughout	p gr.	Si crately firm to firm. Ms Ss	MUDSTONE & SILTSTONE red with green mottling fine- grained, massive, firm		i	ŝi	sided.
	crushed, with ir regular , slick ensides: 475'-405', 520-540 560-580', 755-760'	5) Ms 35	St SANDSTONE and for any	Jointed w/seams and deposits of oupsum and limestone, (slickensided)				plane jointe Slicke
			BORING COMPLETED 2-8-60 AT A DEPTH OF 76.9 FEET CONTINUOUS 6-INCH CORE		Ms			SORING NTA DEL CONTINU
	SANDSTONE, red, fine-grained, locally consomeritic with claystone peobles, generally firm but becoming soft wher extremely broken, some cross bedding.	r Gr A Ss A	NOTE 1: The deep boring was dry o the maximum depth of exploration. The nearby water supply test hole was dry to a depth of +35 fret.		& Si	NO Ma the Wa Vir	TE I s dru s dry tuolk	The 2 y upon c rby was to a a y no pun
				Jointed with calcareous sooms and deposits				
	SILTSTONE, SANDSTONE, AN, MUDSTONE, about 4.4.2, red h locally gray, highly jointed throughout, firm to maderate	D . Si	•	SANDSTONE, red to greenish, fine-grained, some crass-bed- ding, calcareous cement. w/inner formation conglomer- ate of sendstone and shale	51			
	ly firm except for crushed 30nes Kil-161.5'; K70'-1671': and Kil-194'(gyps:ferous) which are soft CHALK BLUFF FORMATION (PERMAN)	Ss M:		1638 - 165.8' and 175.0'- 1778' MUESTONE & SILTSTONE red and gray, massive, firm	Ms B Si		•	
	GYPSUM AND SHALE, gypsum in massive bads to 3" thick, shale shot through with secondary gypsum plus some primary gypsum nodules. Belo 200 gypsum teds show Jay- filled solution joints. Shale is moderately soft to moderat- ely firm.	Gy 58		SANDSTONE, red, with some horizontal shear planes Sondstone is red and gray w/seam of red shale 214.5'-215.7'	Ss		•	
	BORING COMPLETED C-3-60 AT A DEPTH OF C273 FEET CONTINUOUS 6-INCH CORE		0040	SHALE red and gray BORING COMPLETED 2-10-60 AT A DEPTH OF 225.0 FEET CONTINUOUS 6-INCH DIA. CORE	<u>5</u>			

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SITE ACTIVATION TASK FORCE

Walker AFB, New Mexico



FIGURE 13

6 January 1962, fifty-seven days later than originally scheduled. The contract contained a completion schedule listing 25 August 1961 as completion date for the first site with others following at one week intervals. A sequence of construction starting dates by sites, was scheduled in early stages. However, due to differences in conditions met, progress did not develop at the same rate for each site and sequences changed several times. In addition, time extensions were granted in varying amounts by sites but averaging sixty days. Following is a tabulation of original contract completion dates by site sequence and a second tabulation of actual completion dates by Site Numbers:

Contract Schedule

Actual Completion

Site Sequence	Completion Date	Site Number	Completion Date
1	25 Aug 61	10	24 Oct 61
2	1 Sep 61	9	30 Oct 61
3	8 Sep 61	1	δ Nov 61
4	15 Sep 61	8	13 Nov 61
5	22 Sep 61	3	19 Nov 61
6	29 Sep 61	12	27 Nov 61
7	6 Oct 61	11	5 Dec 61
8	13 Oct 61	6	18 Dec 61
9	20 Oct 61	2	22 Dec 61
10	27 Oct 61	7	25 Dec 61
11	3 Nov 61	5	5 Jan 62
12	10 Nov 61	4	6 Jan 62

The above actual completion dates coincide with scheduled completion dates revised to include time extensions. Final inspections on or before those dates revealed each site substantially complete. No liquidated damages were assessed. Support facilities contracts were awarded and completed within the period of custody by the basic prime contractor.

CONSTRUCTION FEATURES AND OPERATIONS:

MASS EXCAVATION: Mass excevation from ground to reference elevation 960 feet first commenced at site number 1 on 2 July 1960, upon completion of the clearing and grubbing operations. This particular phase of work was subcontracted by the prime contractor to Anderson Brothers, an earth moving corporation located in Albuquerque, New Mexico. This portion of the work progressed rapidly after two ten hour shifts were established on 12 July 1960. Some sites were excavated to reference elevation 960 feet in the short time of five days using three twenty yard Tournapulls, two D-8 bulldozers with rippers, one D-6 angle ditcher, a motor grader for dressing slopes and a service truck for serving field equipment. The amount of mass excevation at the various sites was approximately forty-eight to fifty thousand cubic yards, excavated, hauled and stock piled on individual site easement areas. On complex numbers 1, 2, 6, 7 and 8, drilling and blasting was necessary during the mass excavation operations and progress was considerably less on these sites. Caliche rock from one foot to three feet in thickness was encountered at sites 11 and 12. The site contractor was able to break up the rock utilizing heavy rippers on the D-8 caterpillar tractors and complete the mass excavation at these sites without resorting to drilling and blasting. Mass excavation was completed at the final site, Site No. 6, 12 October 1960.

SHAFTING: Shafting for silos for site numbers 1 and 2 commenced on 25 July 1960 and on 30 July 1960 for site number 10. This operation was completed on 22 November 1960 at site complex number 4 which was the wettest site complex of the twelve. Water was encountered during

2-8

excavation at four of the twelve silos. The average time for shafting of the dry holes from reference elevation 960 feet to 820 feet was fifty-five days. This averaged 2.5 feet per day. The wet hole, complex number 4, was shafted in fifty-five calendar days, being shafted as rapidly as possible under very adverse conditions. Most of the material encountered was saturated sand, silt, and clay, all of which produced various amounts of water. Silo number 4 encountered anhydrite strata requiring drilling and blasting for the last ten feet of excavation. Extra silo ring beams and vertical supports were required. The vertical supports consisted of angle irons welded between ring beams to obtain a cage effect for mutual support against slopping pressure behind the lagging.

The wet hole at silo complex number 5 was shafted in eightyone days, the longest time utilized in any shafting operation. An attempt to intercept the 150 to 200 gallons per minute was unsuccessful and shafting below reference elevation 930 feet was conducted in a vertical rain of water. Slowness of shafting was directly attributal to the unstable nature of the material and to the necessity of reducing blasting to a minimum amount for any one blasting operation. Discomfort of the miners working constantly in the falling water also contributed to the slow rate of progress. As in the instance of site number 4, extra silo wall support ring beams and angle iron vertical stiffeners were provided. Although the contractor started operations behind schedule he was able to increase progress and actually completed silo shafting some ten days ahead of schedule.

WATER CONTROL: At site complex number 1, a seep of water was en-

countered at a depth of nineteen feet with increasing amounts as the mass excavation progressed. Pumping was necessary from the mass excavation area and started on 25 July 1960. Shafting of the silo commenced on 29 September 1960 and increasing increments of water were encountered with additional depth for about fifty to sixty feet. Weep pipes were installed at numerous places through ringbeam lagging, and a system of sheet metal troughs was devised to intercept infiltrating water and decrease the amount falling on operations below. Pumping was continued from bottom of excavation as it progressed and from the air shaft excavation adjacent to the silo throughout silo shaft excavation and shaft wall concrete placement and was not discontinued until backfill operations started on 27 February 1961. Grouting was necessary, particularly in the area around the fill and vent shaft. Portland cement and pozzolan were used.

At site complex number 2, water was encountered at silo shaft excavation depth of 126 feet reference elevation 834 on 27 August 1960. Pumping started and the inflow increased with additional depth reaching a maximum of 270 gpm. It was necessary to change the type of foundation to an alternate type because of the water inflow and unstable conditions encountered at the bottom of shaft excavation. The contractor elected to provide a second sump for dewatering purposes in addition to the sump required by the contract drawings. Consequently, the shaft was excavated below the originally required level to provide space for filter material and the 5'6" thick base. A 6" electric driven turbine pump was installed in the temporary sump and effectively removed the water during silo

2-10

floor and wall concrete placement. After the silo walls were completed, grouting was performed in the lower area of the silo through grout pipes installed prior to concrete placement.

Core logs indicated that water would be found in excavation for site complex number 4 at about sixty feet below original ground surface. The contractor test-pumped a test well located about 200' from the silo and found that as much as 150 gpm could be pumped from the 105' deep 6" test well with a twelve foot drawdown. Stang Corporation (Engineering Dewatering Specialists) was called in 29 July 1960 to make a study of the underground water, soil conditions and to recommend dewatering treatment. A 16" dia. test well was drilled about 150 feet from the 6" test well to a depth of 195 feet, cased and perforated and a core hole was drilled 100 feet from the original 6" test well in line with 16" well and center of the silo. Stang Corporation representative and the contractor installed pumps, pumped for several days making numerous measurements on drawdown and volume of water pumped.

Stang Corporation's report stated that as much as 400 to 500 gpm inflow could be expected in the silo excavation and that a peripheral treatment was recommended.

Halliburton Company (an oil well grouting specialist firm) was called in on 22 August 1960, and drilled holes and installed 2" grout pipes at five foot centers just inside the concrete ring beam collar support to a depth of sixty-one feet. These 2" diameter grout pipes were grouted in place with standard Portland cement with two per cent calcium chloride. Over 900 sacks of cement were used for an

2-11

average of about fifteen sacks for each of the sixty-one grout pipes installed.

Chemical grouting started on 1 September 1960, using formalin and urea to form a synthetic resin belonging to the group of aminoaldehyde resins. The chemical was pumped at a rate of 1 to 2 gpm under pressures of 80 to 100 psi through perforations in the 2" grout pipe. Approximately eighty gallons of solution were pumped through each two feet increment of perforated pipe. The perforations in the pipe were made utilizing a shaped charge made by Jet Research Center and lowered into the pipe by a small cable and then detonated. A few areas took the grout so fast that pressures could not be built up and consequently some Howcogel (grained bentonite) was mixed with the chemical grout. All water for chemical grouting operations was hauled in from Artesia due to the fact that water available on the site was so salty that it affected the chemical reactions.

After placing some 17,000 gallons of this type of chemical grout, a rotary drill rig was brought in and cores were taken in the grouted area. Very little of the grout was found and as a result, operations with the resin chemical were discontinued on 17 September 1960. On 24 September, a shipment of PWG was received and some 7,100 gallons of this plastic type chemical grout were pumped in the ground by 28 September 1960. The grout used was polymerized water gel with additives that allowed control of time of set to as quickly as five minutes. Additional core boring was performed and very little of the PWG was found in the cores. Halliburton Company moved out 30 September 1960.

2-12

The contractor then drilled ten wells, eighty foot deep around the perimeter of the silo in the mass excavation area. These were 20" diameter gravel packed wells with 3" pump inside perforated. The first well was completed and pump installed on 6 October casing. 1960. Drilling of the dewatering wells and shaft excavation was performed concurrently until shaft excavation reached about fifty foot depth at which time the inflow into the shaft increased considerably, and pumping had to be accomplished from the silo shaft excavation The water inflow was sixty gpm at a fifty-five foot depth and bottom. increased proportionately with additional depth to a 350 gpm inflow on 16 November 1960 at a depth of 130 feet at which time the ten dewatering wells stopped producing water. Shaft excavation was completed on 26 November 1960 and a 5'6" slab was placed 17 December 1960. Pumping was continued until after the fourth wall lift of concrete was placed.

Any evaluation of the effectiveness of the chemical grouting is pure speculation as it is not known what the conditions would have been without the grouting. However, it is the general consensus of opinion among the engineers working with the water problem at site number 4 that the chemical grouting was ineffective due to the fact that the movement or flow of the underground water was fast enough to dilute and wash the grout away before it could set.

At complex number 5, mass excavation was started on 13 August 1960 and water was encountered before reaching the bottom on 18 August. A collection trench was dug around the perimeter of the mass excavation area from eight to fourteen feet deep, draining

to a sump on the northwest side and was backfilled with gravel. An electric turbine pump was then installed in the sump. Silo shafting started on 26 August 1960 with dewatering being accomplished by means of electric and air sump pumps operating from the bottom of the shaft excavation. Water inflow increased with depth from about 20 gpm at twenty foot depth to a maximum of 200 gpm at 60 to 100 foot depth. Serious sloughing of material behind the ring beams and lagging occurred, making it necessary to suspend shaft excavation on several occasions. Lean concrete and grout was placed in the voids behind the lagging and additional ring beams and vertical stiffeners were installed. Rock (anhydrite) was encountered at the sixty foot level in the shaft and drilling and blasting were necessary for the balance of the shaft excavation. Layers of clay sandwiched between layers of rock made dewatering and excavation difficult. At the time the shaft was at the sixty-five foot depth, two dewatering wells were drilled from the bottom of the mass excavation area, one on the north side and one on the south. Pumps were installed but insufficient water entered the wells to make any appreciable change in the volume of water entering the silo excavation. The water did not travel in any particular strata, but seeped through the clay and made sloughing a real Shafting was completed on 17 November 1960 and metal plates problem. were welded to the ring beams from elevation 887 to 903 and grout pipes were installed at frequent intervals. Grouting started on 7 February 1961 after the silo concrete walls were placed and continued intermittently until 14 April 1960, effectively sealing off all but a few minor seeps.

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<u>CONCRETE OPERATIONS</u>: Concrete placement started on 25 September 1960, about five days behind schedule and proceeded slowly at a rate considerably less than the scheduled rate. This was due in part to the rate of delivery and in part to the inability of the contractor to get forms ready for succeeding pours.

Conventional type forming was selected because of the Type V (Sulphate resistant) cement specified for use. Time of set for this type cement was known to be much longer than Type I standard Portland cement. Tests were made on the time of set of the Type V cement at the Corps of Engineers Southwest Division Laboratory, and initial set was found to be approximately seven hours at 50°F.

The contractor started silo wall concrete placement with three sets of forms thirty foot in heighth for the portion below reference elevation 962, and two sets of forms for use from reference elevation 962 to 991. Early in November 1960, the Area Engineer directed the contractor to construct a fourth set of lower wall forms. The contractor complied and also constructed a third set of upper wall forms.

Reinforcing steel forming and placement was subcontracted to Cobusco-Salyer, a joint venture consisting of Colorado Builders Supply Company and Ira Salyer of California. All bending and forming was performed on several sites and hauled to others. About 12,000 tons of reinforcing steel was placed in the twelve silos and launch control centers in sizes from number two through number eighteen bars. The reinforcing steel ironworkers worked two ten hour shifts per day throughout most of the construction period and were able, in most

2-15

instances, to keep ahead of forming and placement by use of several ingenious jigs and slings that allowed placement of a score or more bars with a single crane operation. The number eighteen bars in the silo cap and doors were required to be butt-welded by either the exothermic or shielded arc methods. The contractor elected to make the welds manually, using a low hydrogen rod by the shielded arc welding process with certified welders. After the joints were butt-welded, radiographic films were made of ten per cent of the welds by Western Industrial X-Ray Corporation of Lubbock and Houston, Texas, using an iridium isotape. A few questionable welds were found, cut out, rewelded and additional radiographs taken.

All concrete was furnished by the F. M. Reeves Company of Roswell. The aggregates were produced from Reeves pit southwest of Roswell, except that about twenty-five per cent of sand from the Acme pit, twenty miles northeast of Roswell was blended with sand from the Reeves pit to improve gradation. Originally, the concrete was drybatched into two batch truck-trailers, hauling two six yard batches to five transfer hoppers located near the midpoints of two and three site complex groupings. At the hoppers the dry-batched concrete and water hauled from Roswell was transferred to truck mixers for mixing and transporting to the various sites. During cool weather it was possible to supplement the twelve batch trucks with truck mixers hauling direct from the batch plant to the sites. In cold weather the mixing water was heated by steam at the batch plant supplemented by additional heating from liquid petroleum gas burners in the water tanks of the dry batch trucks. During the hot summer weather of 1961,

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all concrete was hauled by the dry batch trucks to the transfer hoppers, at which point ice was added in lieu of mixing water in amounts up to 300 pounds per six yard batch. In addition, the major portion of concrete placement was scheduled for night placement in order to take advantage of the lower night time temperatures.

Winter concrete protection met minimum requirements through the use of tarpaulins and various types of heating devices. No frozen concrete was experienced, and all placing temperatures were 50° F or higher.

Concrete quality control was very good. Adequate tests were made on aggregates and compression tests on the finished product. One set of compression test cylinders was made from each approximate eighty cubic yards of concrete placed. Engineer control personnel were continuously present on a twenty-four hour basis at the (1) batch plant, (2) the transfer hopper points, (3) the work site for receiving, running slumps and making cylinders and (4) for proper placement and vibration. Further, in consideration of the hour experience factor of Corps of Engineers field personnel, during two of the three daily shifts, the Construction Branch assigned two coordinators to the concrete operation, one to swing shift and one to the graveyard shift. In this manner, the Roswell area deviated from normal practice of assigning coordinators to groupings of complex sites and assigned coordinators to specific construction operations over the entire twelve sites to provide a high degree of continuity of control.

Compression cylinders made on the sites were hauled to the contractor's fog curing room located at his Roswell shop and yards

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area, and then transferred to the Corps of Engineers field testing laboratory, located on Walker Air Force Base as the break dates fell due. Average cylinder breaks on Class AA concrete were approximately 500 psi above the 3750 psi required and on Class AAA concrete were well above the 5000 psi requirement.

Most milestones for silo wall concrete placement were met except that the last four silos slipped four to seven days because of unusually severe storms in December. All milestones for silo cap and door concrete placement were reached ahead of schedule. Concrete placement rates for LCC and silo concrete (except caps) were less than forty cubic yards per hour on a twenty-four hour basis, although the forty yard per hour rate was exceeded for short periods of time. The slow rate was caused by the inability of the supplier to transport concrete from the central batch plant to the various sites. Truck breakdowns, tire trouble, slick highways, delayed deliveries of cement (also truck transported) all added up to a slow rate of placement. On the silo cap pours, it was determined that a minimum rate of fifty cubic yards per hour would be necessary because of a modified Type V cement with faster time of set proposed for use and because of higher summertime temperatures. The supplier was able to place his equipment in such condition that the fifty yard per hour rate was exceeded at all sites and no cold joints were experienced.

The finished concrete product at all sites is considered excellent and well above average in appearance, soundness and structural stability.

CRIB STEEL: An interesting phase of construction was the erec-

tion of the steel structure inside the concrete silo known as crib steel. After the completion of the concrete walls of the silo, the necessary progressive task was the erection of the crib steel. This operation consisted of erecting the equivalent of an eighteen story fifty foot by fifty foot building, built of high strength structural steel, inside of the silo. Approximately 500 tons of steel went into each silo, enough to build a first class railroad for a length of two and one half miles. The eighteen story steel frame structure is an eight sided structure with a 22.5-foot vertical opening near the east side of the silo which was to later become the Missile Inclosure. The steel structure thus built around the Missile Inclosure contains eight floor levels. Level eight, the lowest, is at elevation 840, fourteen feet above the silo floor. Level one, the highest, is at elevation 979'-6", approximately eleven feet below the silo cap. At each floor, steel grating and checkered plate was placed and utilized as a base to set the numerous Propellant Loading System, heating, air conditioning, ventilation and electrical equipment. The erection of crib steel commenced from the bottom of the silo on temporary column extensions resting on concrete pads. There are eight exterior columns and two interior. The crib structure is hung from four compression spring type shock hangers with suspensions points at Level 5. A peripheral truss between Levels 5 and 4 transfers loads to the suspension points. The two interior columns are supported by trusses between Levels 4 and 3. Columns are in tension below trusses and compression above. At the lower portion of the Missile Inclosure are two frames composed of box girders and box hangers which are located one each at

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the north and south sides of the inclosure. The box hangers serve to hold the Missile in true position while in the silo and are correlated with lock brackets placed at the silo cap to hold the top of the Missile in alignment with the bottom of the Missile. The box hangers have Korfund springs at the top and bottom pre-compressed to 70,000 pounds. The purpose of these springs is to give the Missile a vertical flexible movement. All structural members were designed with high strength bolted connections and conformed to the AISC specifications for structural steel joints utilizing ASTM A-325 bolts. Fabrication of the steel was performed by Mosher Steel Company of Dallas, Texas. After the crib steel had been erected from the silo floor through level three, suspension assembly systems consisting of high strength steel rods and pre-tension springs were installed. These assemblies were known as the shock hangers. Shock hangers consisted of hanger rods and a series of compression springs which were shipped in an un-compressed state. The springs were compressed at the site, utilizing a hydraulic jack, to approximately seventeen inches less length than in the shipping state. Stanchions were then placed at the assembly base to hold the springs in a compressed state until such time as they were supporting the entire silo crib load. The assemblies were then attached by their upper ends to steel plates previously embedded in the silo concrete wall and to the crib structure at their lower ends. At this point in time the crib steel had been erected through the third level.

At this time it was necessary to vertically jack the crib steel approximately two inches to allow eight inch threaded nuts to be

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fastened to the base of the shock hanger assembly rods. This was accomplished through the use of eight hydraulic jacks placed under the eight exterior columns. During this operation the contractor had to be exceptionally careful in order to meet critical design criteria of the final position of the crib structure. The crib steel structure at the fifth level, elevation 915 feet 10.5 inches, had to be placed within a quarter inch vertical of reference elevation and 1/16 inch of a true north, south, east and west position. The shock hanger assemblies were positioned to within a quarter inch plumbness, top to bottom. When this task was accomplished the hydraulic jacks and jack pads were removed from the base of the eight exterior columns and the crib structure was left suspended on the shock hanger assemblies fastened to the concrete silo walls. With the crib structure suspended from four sides to the silo walls, a gentle but measurable swaying motion was in effect at all time. This lateral and vertical sway which is comparable to the gentle rocking of the baby crib, led to the naming of the crib structure. This motion, combined with the position hanger Korfund spring motion, will enable the Missile to remain in a slightly flexible position through its tenure inside the silo. At the suspension of the crib structure the erection of the crib through level one was completed.

LAUNCH CONTROL CENTER: The Launch Control Center, better known as the LCC, is a two story cylindrical structure of reinforced concrete set six feet below ground level, wherein operating personnel for the Atlas Launch Complex will be housed. The first or top level has kitchen, first aid, toilet and living accommodations as modern and

complete as the average new home. The second level houses the remote control and communications equipment, and is the nerve center of the Launch Complex. The bulk of the control and communications equipment will be installed by others (not under CE contract) during the second phase of construction.

A reinforced concrete stairway and entry tunnel leads from grade level down two flights of stairs, through a pair of electrically locked entrapment doors, past a surveillance TV camera and into a vestibule adjoining the LCC. Stairwell affords the sole means for personnel entrance to the LCC and Launching Silo. The LCC in turn is connected to the Launching Silo by an eight-foot diameter steel tunnel, thirty-five foot below grade, leading from the LCC stairwell to the silo vestibule. Two pairs of heavy steel blast doors located in the entry tunnel and silo vestibule seal off the LCC from ground level and the Launching Silo.

The LCC as stated before is a cylindrical structure, 44'-6" in diameter and 33'-6" high outside, having walls 2'-3" thick, a 3'-6" base slab and a 3'-0" roof slab, all of reinforced concrete amounting to 875 c.y. A center column 4'-0" in diameter with a 12'-0" diameter cone base and capital extending from the base slab to roof slab is the lone interior support member for the roof slab.

Concrete was placed in three lifts, base, walls, and roof slab, with the stairwell placed monolithically with the LCC. The entrance stairway and vestibule were treated as separate structures and concrete placed accordingly. Ninety-six tons of steel were placed in the concrete as reinforcing, varying in size from # 4 to # 10 bars and

in certain locations constituted such a dense maze that it was all but impossible to place concrete.

Within this concrete shell, a structural steel frame or "crib" was erected as the framing structure for the two levels and the various rooms. The entire crib is suspended from the concrete roof slab by four air cylinder spring supports and is free to move independently of the concrete shell, providing protection for personnel and equipment from external shock waves. Four floor leveling devices sense the level of the crib in respect to the concrete base slab and supply or bleed off compressed air to their respective air cylinders as necessary to maintain the crib level and at the proper height regardless of the load distribution within the L.C.C. Crib members range in size from light angles and channels up to 21" wide flanged beams 30'-6" long.

It would appear that since the crib is suspended from the concrete roof slab that steel erection would precede roof concrete placement. Yet, because of the monolithic placement requirements resulting in restricted access for hoisting heavy and bulky materials into the L.C.C. (down the Launching Silo and through the connecting tunnel, for pieces longer than 10°-0" could not negotiate the corners or narrow doorways in the entry stairway and vestibule passage) it became necessary to erect the crib before placing the roof slab. However, the crib being designed for suspension at the upper level, it could not be used as the sole support of the roof forms. The lighter members designed for tension only would, in compression, be subject to over-stressing. The contractor did erect steel on one site after

placing the roof slab, but found the experiment costly and time consuming. Thereafter crib erection preceded concrete placement. The crib was solidly blocked up from the base slab, shored between levels with 4" x 4" study approximately $3^{*}-4^{"}$ on centers set on the main floor members, and the top level decked over with $3^{"} - 12^{"}$ planking. Steel forming scaffolds were then set on the planking to support the roof forms. The planking was field cut so as to distribute the load to the shored framing members. Prior to shoring, crib erection including steel decking was completed.

Construction through completion of concreting was accomplished in the open excavation area simultaneously with silo concreting and crib steel erection. Subsequent to concreting, work by the various crafts within the L.C.C. was completed during backfill operations of the open excavation.

The contractor did not prosecute work on the L.C.C. as a separate entity. Instead, he elected to work the L.C.C. simultaneously with each phase of construction in the Launching Silo. Thus, while completion of the L.C.C.'s was delayed in a sense, waiting for the larger silo structure to catch up before entering another phase of construction, it proved advantageous in that the L.C.C. provided the means to correct organizational inefficiencies and to shake out crews. Certainly then the L.C.C.'s absorbed much of the "learning curve" inherent to large construction, particularly where so much of the work is consolidated within a single narrow structure and yet so widely dispersed over a large geographical area.

MECHANICAL WORK:

1. <u>Utility and Domestic Water</u>: The utility water system is installed with a hydropneumatic pressure booster system which is located in the silo. The system consists of one turbine type utility water pump and one certrifugal fog spray pump, a hydro-pneumatic tank, with all necessary valves, fittings, and controls attached thereto. The domestic water is used for human consumption and is so piped to all facilities used by the occupants. Utility water is classified as water used for fire protection equipment and make up water for the other systems.

2. <u>Hydro-Pneumatic Tank</u>: This tank is the center of all water systems with the exclusion of hot and chilled water used for air conditioning systems. This tank supplies the pressure and the make up for the water systems.

3. <u>Sump Water Disposal System</u>: This system is so constructed as to dispose of all water used for human consumption. The water is disposed of by the use of two pumps and is so piped into a drainage field outside of the silo. Other waste water is disposed of by another set of pumps which pipe the water to grade and so to drainage ditches.

4. <u>Condenser Water Supply and Return System</u>: The purpose of this system is to remove heat from the diesel generator and the water chillers. This water is in turn piped to a cooling tower at grade for cooling and then returned to diesel generators and chillers for the removal of heat.

5. <u>Chilled and Hot Water Systems</u>: These are two separate systems which work in conjunction in the heating and air conditioning systems. Two refrigeration plants keep the chilled water at its proper temperature. The hot water system gets its source of heat from the exhaust of the diesel generator and is so controled to keep the water temperature at desired conditions.

6. <u>Heating</u>, Ventilating and Air Conditioning Systems: Both of these systems are complex in nature and gigantic in size. The purpose of both systems is to keep a constant temperature as required by the various locations within the complex itself. Outside air is taken in and purified by a dust collector before it is available for use in the silo. A combination of fans, supply and exhaust the air at the complex so as to maintain enough fresh air for consumption.

7. <u>Compressed Air System</u>: This system supplies air pressure to the air cylinder supports, blast closures and the hydro-pneumatic tank. The Air cylinder spring supports suspend the floor at the Launch Control Center in four columns of air within the cylinders so as to have a floating floor. The blast closures when closed will isolate the complex from the outside atmosphere.

8. <u>General</u>: All the systems are fully automatic. The many automatic controls that operate these systems are so wired as to reflect any malfunction in the systems on an indicating lights cabinet. The supply of water for the systems is obtained from four underground storage tanks. All piping is rigidly supported to the floating crib steel and is identified as to the type of liquid being carried by it.

ELECTRICAL WORK:

1. <u>Site Work</u>: The electrical features at grade include gate controls, communications, remote power receptacles for support equipment, personnel audio and visual warning alarms, lighting of work areas and a cooling tower which automatically cools condenser water from major units located in the silo.

Rough-in work has been accomplished to provide means for future commercial power, heat and shock sensing devices and communication manholes for intersite communications system.

2. Security Control: The entry tunnel is equipped with an entrapment area for security control. Entry to the entrapment area is remotely controlled from the L.C.C. A pushbatton, when operated, warns the operator in the L.C.C. that entry into the entrapment area is desired. The first entrapment area door latch is released by the L.C.C. operator for entry. When inside the entrapment area, a television camera, which is connected to a monitor set in the L.C.C. provides the means for proper recognition of the party desiring entry. Communication with the party and the L.C.C. operator is maintained through a speaker-mike set installed in the proximity of the entrapment area. The second entrapment area door latch is also remotely controlled from the L.C.C. by the operator. Once past the entrepment erea, access to the L.C.C. and silo is gained through a series of blast doors. All doors encountered are equipped with limit switches to alarm the L.C.C. personnel of activity taking place and location. Each door limit switch is identified at the monitor station, Facility Remote Control Penel.

3. <u>Steirwell</u>: The stairwell is equipped with an electrically controlled pneumatically operated blast closure. The blast closure operates under blast conditions and seals off the flow of air to and from the stairwell. Emergency light units provide limited lighting during a power failure. Communication means, public address and telephone, are provided at various locations.

4. Launch Control Center - First Level: The first, upper, level of the L.C.C. includes two blast closures which are electrically controlled and pneumatically operated. The mechanical room and kitchen are equipped with surge panels to protect the direct burial cables from surges due to lightning end/or overload conditions. The panels are equipped with lightning arrestors. This level is also equipped with telephone outlets, public address system outlets, fire alarm detector, audible and visual alarms. The four air-spring cylinder supports for the L.C.C. crib are equipped with solenoid valves which cause the cylinders to raise and lower the crib. The solenoid valves are energized by the operation of the floor leveling devices installed in four respective locations at the second level of the L.C.C. The floor leveling devices are mechanically controlled which in turn operate limit switches. Electrical power is provided for the range, refrigerator, water cooler, garbage grinder, hot water heater and lighting.

5. Launch Control Center, Second Level: The L.C.C. second, lower, level includes the main power panel, lighting distribution transformer and various lighting and communications distribution panels. There is a diesel general remote control panel to start, stop, parallel

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and transfer load at the diesel generators in the silo fifth and sixth levels respectively. The Facility Remote Control Panel located in the Launch Control room contains audible and visual alarms for critical circuits. The indicator panel visually indicates equipment normal operating conditions. In the event a failure occurs, the visual and audible alarms operate simultaneously. This is to provide immediate action to clear systems of faults or break down. The fire alarm system power supply and annunciators located by the Facility Remote Control Panel provides immediate audible and visual fire alarms from designated zones throughout the Launch Control Center and Silo.

6. <u>Utility Tunnel</u>: The utility tunnel, which provides access from the L.C.C. to the silo includes various cable trays which carry the control, power and signal cables. Provisions have been made for communications, public address system and emergency lighting at the utility tunnel.

7. Launching Silo: The Launching Silo is equipped with two 500 kilowatt diesel generators, one of which is normally in operation. Power is supplied to hundreds of relays, solenoid valves, limit switches and motors through miles of wiring and cables. Dry-type transformers were installed for all lighting and convenience receptacles. Interconnecting wiring and cabling was accomplished through numerous conduits, cable trays and wire-ways.

Various panels, cabinets and boxes have been provided to house relays, breakers, motor starters, terminal blocks, fuses, future telephone and public address system and motor disconnect switches.

In the missile enclosed area the receptacles, lighting, public address and telephone outlets and conduits are explosion-proof types. This is an explosion-proof area and rigid requirements are set forth to confine an electrical explosion within the explosion-proof fixtures.

An electrically operated personnel elevator was installed to provide immediate access to desired floor levels.

8. <u>Grounding</u>: Hundreds of bare stranded copper leads were installed throughout the Site, Launch Control Genter and the Launching Silo. This was to reduce the noise, stray and static electrical current flow which otherwise would interfere with the missile critical operational electronic equipment.

9. Tests: All electrically operated equipment was subjected to tests to insure that desirable results were met.

PROPELLANT LOADING SYSTEM: The propellant loading system, or PLS, consists of facilities to store and transfer liquid propellant fuels with auxiliary fluids and gases from supply sources to the missile. Propellants used are liquid oxygen and RP-1 fuel. Auxiliary systems contain liquid nitrogen, gaseous nitrogen, gaseous oxygen, and gaseous helium.

Idquid oxygen is maintained at $-297^{\circ}F$ and liquid nitrogen at $-320^{\circ}F$. Piping systems for those liquids are heavily insulated and storage vessels are, in effect, giant thermos bottles, having inner and outer shells separated by a vacuumed annular space.

Gaseous oxygen, nitrogen and helium are confined in their systems under high pressure.
Storage vessels were fabricated and installed as a part of the prime contract. All piping and equipment were fabricated and installed by Paul Hardeman, Inc. under a separate contract administered by the Ft. Worth District. The installation portion of Hardeman's contract was assigned to the prime contractor with the status of a subcontractor. Piping was fabricated as spools and equipment assembled on six prefabricated skids as follows:

Skid

Silo Location

Liquid Oxygen Control Prefeb	Level 7
Liquid Oxygen Fill Prefab	Level 7
Liquid Nitrogen Prefab	Level 7
Pressurization Prefab	Level 7
Instrument Air Prefab	Level 7
Fuel Loading Prefab	Level 8

During the first few months of silo construction, plans were being made to meet the new challenge of installing and testing a complex Propellant Loading System, in which the Walker Aren Office had almost no one trained and very few with past experience. The magnitude of importance could be measured by the strict and almost unbelievable cleanliness criteria. Specifications stated that the Contractor must install and maintain a system with no particulate matter in excess of 150 microns in size. There were other criteria, of course, but the greatest problem remained with developing techniques to minimize airborne and man-made particulate contamination during system installation. This phase was considered by many as the determining factor, whether or not the using agency could setiafactorily Launch or bave

to abort a missile. It was imperative that a program be instituted to familiarize all of Engineering personnel concerning the intricacies of PLS.

In the Fall of 1960, a Propellant Loading Service Systems Orientation Course was conducted in Denver, Colorado by United Testing Laboratories' personnel, under the auspices of CEBMCO. It was realized that this course would be instrumental in establishing a basic and common understanding of Propellant Loading Service Systems and to standardize installation and acceptance testing procedures. During the latter part of the year, more than fifty of the Walker Area Engineers, including the Chief of Military Construction Branch and his staff, attended this course.

The 15th day of March 1961, PLS installations commenced in the Walker Area. At the inception of the PLS installation stage, an indoctrination course was set up at the Area level for all Engineering personnel who had not attended the course in Denver. A serious attempt was made to duplicate the Denver material in order to give one and all a common background. In addition, intensified training was given in the techniques involved in connecting spools to maintain the highest degree of cleanliness possible. Cleanliness of the Area, personnel, tools, and using of the proper inspection aids, such as blacklight, white light, and Wipe Test, were stressed.

To attain the highest degree of confidence possible with the using agencies, Air Force and General Dynamics/Astronautics, a compact Propellant Loading Systems Indoctrination Course was offered to them. It was the belief that in this way the agencies involved would benefit

from the same information and also would be useful as a sounding board for differences of opinion. During the months of May and June, approximately eighty GD/A and Air Force personnel attended lectures designed to acquaint the customer with the Area Office's dedicated interest of giving them a system that would be functionally sound.

During the installation of PLS at the up-stream sites, the PLS section, consisting of a staff of approximately six engineers, devoted themselves to constantly roving the sites in a attempt to standardize our procedures and techniques. Wherever possible, spools were connected together top-side within the confines of a more than adequate spool make-up enclosure. The wall interiors were covered with polyethylene, a vacuum intake was located in the enclosure, strict uniform requirements were maintained, all lines being connected were under constant, adequate, gaseous nitrogen purge, a window was placed in each enclosure for observation of spool hook-ups by staff members, to again insure our strict techniques were being followed.

From their arrival, all prefabs and vessels were daily monitored to insure adequate, positive pressure was maintained at all times. Periodic spot checks were taken to establish correct dewpoint maintenance.

To further assist its staff, Corps of Engineers transferred personnel from up-stream bases, giving the Area invaluable knowledge and experience to further develop its PLS capability. During this time, preparations were being made to establish a program of standardization for acceptance testing. Specifications were reviewed meticulously for these requirements, sample testing forms were developed, and again,

a course in acceptance testing was begun. Night after night each system was reviewed to a select group of test engineers, so that one and all would understand not only the systems individually, but as they relate to one another. The slogan "Be one step ahead of the Contractor" was instituted and was the ultimate goal of all.

Approximately the first of August, PLS testing commenced with the lead site, Site 10. It was realized that all decisions made at this time would pattern effectiveness of down-stream sites. Continuous surveillance by the PLS section was maintained. It was at this site that Modification #94, which concerned the blowing down of the gaseous nitrogen and gaseous oxygen A. O. Smith vessels, contenced. Techniques developed at this lead site saved many man-hours in accomplishing this modification down-stream. The gaseous nitrogen bottle in particular was most troublesome. Approximately one hundred blowdowns were required before obtaining an acceptable blowdown pad. During PLS acceptance testing at this site, refinements of the test procedures were made, accounting for sizeable savings in time and money. During this period, a PIS bulletin was developed and distributed to all sites. Each problem as it arose was studied, and final resolution was dissiminated to all. A policy was established to insure that the down-stream sites would be in a position to take full advantage of the experience gained at the lead site.

Approximately one million gallons of liquid nitrogen was used in checkout and testing of the PLS system. The majority of this liquid was converted to high pressure gas for pressurization and blowdown of the systems. Liquid nitrogen was also used for cold

flow tests on the liquid systems in place of the more hazardous liquid oxygen. In addition, 900,000 standard cubic feet of helium and 10,000 gallons of RP-1 were used.

LAYOUTS AND SURVEYS: The Atlas "F" Launching Silos and their contents were constructed under unusually close tolerance requirements. In fact, it is believed that many of the requirements were something new in the heavy construction industry. To accomplish the degree of accuracy required by the contract documents it was necessary to establish special survey controls and procedures.

The launching silo design and construction was measured and located from three axis lines. Two horizontal axes, 90° apart, were centered on a vertical axis which constituted the rotational center line of the truly cylindrical shape of the silo concrete structure. The X-X axis was oriented parallel to a true East-West direction, the Y-Y axis parallel to true North-South, and the Z-Z axis was plumb. Vertically, the structure was controlled by measurements above specified data surfaces. Each silo structure was referenced to an exact elevation above mean sea level datum. For uniformity of plans all silos were detailed, vertically, to a reference datum 1000.00 feet below the finished top surface of the concrete cap.

Because of the high degree of accuracy required to be established in locating the silos horizontally and vertically, the United States Coast and Geodetic Survey was called on to establish base line control markers. Prior to issuance of plans and specifications the Coast and Geodetic Survey established a base line at each site with brass cap monuments. It provided the exact length and true bearing

of each base line which it terminated at each end with a brass cap monument showing grid locations and elevation above mean sea level. At a later date, and before start of construction it provided similar brass cap monuments on the X-X and Y-Y axes of each silo.

During excavation and concreting operations the Corps of Engineers survey crews, equipped with highly accurate instruments, set brass cap markers on the X-X and Y-Y axes adjacent to or on the structures as work progressed. They first set markers at ground surface near the lip of the open cut excavation, then on the concrete collar at beginning of shaft excavation, later in the silo concrete floor, and finally in the silo concrete walls.

For control of crib steel erection the survey crews installed four vertical wire cables on the X-X and Y-Y axes, one at each silo wall. The ironworkers were thus able to locate the axes by attaching horizontal string lines to the cables across the silo at any floor elevation. For vertical control during crib steel erection the survey crews provided a rigidly attached high-grade calibrated steel tape from top to bottom of the silo, located on the silo wall.

Many construction features required highly accurate setting to unusually close tolerances. The contractor's surveyors located the items first and were followed by the Corps of Engineers in a careful check. Principal of the items thus installed, together with tolerance setting requirements, were as follows:

1. Silo wall form panels - plus or minus 1 inch tolerance horizontally from the Z-Z axis.

2. Special steel wall form panel with collimator plate insert-maximum 3/8 inch from Y-Y axis and plus or minus 1 inch from the Z-Z axis.

3. Imbedded items in silo wall concrete-variable tolerances.

4. Site tube - 3/8 inch tolerance horizontally and $\frac{1}{4}$ inch vertically.

5. Shock hanger wall bracket concrete inserts, approximately 10 feet wide by 12 feet high and 9000 pounds each - 1 inch tolerance, all directions and elevations.

6. Crib steel - 1/8 inch tolerance at each floor level, horizontally and vertically.

7. Launch platform counterweights and drive base assemblies - 1/8 inch tolerance.

8. Silo cap door - 1/16 inch tolerances.

Propellant loading system flanged interface connections 1/16 inch tolerances.

A part of the final setting accuracy checks was participation by General Dynamics/Astronautics surveillance teams. Their interest was in verifying accuracies required for their later installation of the missile and control systems.

PHOTOS: Photos of construction features and operations are contained in Appendix A.

DESIGN CHANGES: There were no major design changes after construction started, but there were a multitude of small ones. An outstanding example is in silo crib steel drawings. In the interest of

interchangibility of parts and operating and maintenance personnel the Using Service established the policy that plans and specifications for all six Atlas "F" missile base projects must be identical. Contract documents contained normal engineering drawings of the silo crib steel structure, but the concept of uniformity was carried further to structural details. A provision in the specifications stated that supplemental structural steel detail drawings would be issued after award of contract. Normally, such detail drawings are prepared for the contractor by its structural steel febricator, and their accuracy are thus a contractor responsibility. The supplemental detail drawings, as later provided, were subsequently found to contain many errors and deviations from the contract drawings. These led to loss of time and extra work on the part of the contractor; and, since he was not responsible for the accuracy of detail drawings, he was able to recover costs incurred.

The contract drawings were revised a number of times during construction. The revisions were not major in scope but so numerous in number that they caused unusual confusion, delays and loss of effort in tearing out and replacing work.

A list of modifications and allied claims resulting from design changes is contained in the MAJOR MODIFICATIONS AND CLAIMS section, Part III, of this report.

ENGINEERING AND TECHNICAL BRANCH:

With the establishment of the Roswell Area Office, the Engineering and Technical Branch came into being. It was staffed with three engineers and six engineer trainees.

The design architect-engineers contracted to the Air Force and were to perform design on all changes to the standard package. After the issuance of the first eleven modifications, subsequent modifications totaling one hundred and twenty-five were designed and contract documents revised by E and T Branch engineers and draftsment. The Walker Area Office was the only one under the Atlas "F" Directorate that revised the contract drawings to reflect all changes. The modifications varied from simple to very complex and in numerous cases required revisions to hundreds of reproducible drawings. Over one thousand three hundred contract drawings were revised by E and T Branch personnel.

The file room in the E and T Branch contained over ninethousand seven hundred shop and contract drawings. Approximately five thousand shop drawings were reviewed and approved by personnel of the E and T Branch. A drawing log was maintained constantly to show all information about each drawing and its whereabouts. Drawings were processed at the rate of eighteen per day and were reviewed and approved at the rate of nine per day.

A large percentage of time of the higher level engineers in the E and T Branch was spent in liaison between the Area Office and Air Force (SATAF), higher authority (CEBMCO), General Dynamics/ Astronautics (GD/A), Inspecting Districts, and Districts responsible for the seventeen Assigned Services Contracts. Much of their time was spent advising the Air Force of construction progress feasibility of proposed changes, estimating costs of changes and in determining that changes were mandatory.

LABOR RELATIONS: Relations between contractors and labor at the Walker Area were excellent. There were some disputes which resulted in six walkouts or strikes by certain trades for periods of two to six days as follows:

Strikes and/or Work Stoppages

Start		End	Union	Cause	Man Days Lost
23 Aug	; 60	26 Aug 60	Carpenters	Work Assignment	66
31 Aug	; 60	5 Sept 60	Laborers	Safety Factors	2231
4 Apr	61	5 Apr 61	Electricians	Discharge of Workers	32
8 Jun	e 61	9 June 61	Electricians	High Time Pay	68
9 Jun	e 61	12 June 61	Plumbers	Ice Water	75
20 Jun	e 61	21 June 61	Ironworkers	Work Assignment	40
				Total	2512

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PART III

CONTRACT ADMINISTRATION

<u>GENERAL</u>: The construction of the Walker Air Force Base Atlas "F" Ballistic Missile launching facilities was accomplished under five prime contracts - a basic contract for the twelve missile launch complexes consisting of silo, LCC and immediate site work and four support facilities contracts.

Because of an atmosphere of urgency, plans and specifications were prepared hurriedly and issued for bids with full knowledge that revisions would be required to fit requirements of the missile which was still in the development stage. This understanding became known as a "concept of concurrency." Because of this condition many changes were made to plans and specifications during construction. In many instances, changes were made upon changes, quite often resulting in the necessity to tear out construction work already accomplished. A total of 177 modifications in the aggregate amount of \$16,240,500.00 were negotiated and processed for the basic construction contract. Approximately half of the dollar volume of this amount resulted from directed changes and the remaining half from claims found valid.

In the early stages of construction the impetus of urgency continued. The Contractor was in constant reminder that there would be no alternative but to complete the job on schedule; to include changes and additions by modifications. A close watch was kept on progress as reported versus a progress schedule established at the beginning of the job. When it began to appear that progress was lagging behind

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that schedule the contractor was prodded by GC-5 letters to get back on schedule. In February 1961, the "big push" was relaxed by directive. All GC-5 letters were rescinded with the exception of those on cryogenic vessel fabrication which were known to be the most critical features of the job. Nevertheless, situations had been created which resulted in large claims.

Another aspect of the job which led to large claims was the number of people on the sites other than contractor and normal inspection forces. The Air Force, being vitally concerned that the finished product be compatible with the needs and requirements of its missile, placed a surveillance crew by its missile contract at each site. In addition, personnel from the various branches and departments of the Air Force's Site Activation Task Force and related Ballistic Missiles Division made frequent and periodic visits. This, coupled with the limited work space in silos, led to claims of unusual and astronomic proportions.

A total of 241 claims were received from the basic contractor. Of these, 197 were denied or withdrawn, thirty-eight were approved and successfully negotiated, and six remain outstanding. The contractor has signed a release from all claims as negotiated. A part of the release is a stipulation placing dollar value limitations on the six outstanding claims, thus limiting the dollar value of the contract.

CONSTRUCTION PRIME CONTRACTS:

LAUNCH COMPLEXES: The basic construction prime contract was Contract No. DA-29-005-ENG-2598, WS-107A-1 Operational Base Missile

Launch Complexes, awarded to a joint venture composed of the Macco Corporation, Raymond International, The Kaiser Company, and Puget Sound Bridge and Dry Dock Company. The Macco Corporation, as sponsors, administered the project from its home office at Paramount, California. The original contract, in the amount of \$22,115,828.00 was awarded 20 June 1960. Work was accepted as substantially completed 6 January 1962 with all minor deficiencies corrected as of 8 February 1962. Because of the great number of changes, "concept of concurrency," limited working spaces and other unusual conditions there were a great many modifications and an abnormal number of claims. As a result of 177 modifications and 241 claims, thirty-eight of which were recognized, the contract was finally settled at \$38,356,329.42, with time extensions granted averaging sixty days per site. There were no liquidated damages. The final settlement is subject to six claims exceptions which are stipulated in a release signed by the contractor not to exceed \$274,000.00.

The contractor's performance has been rated above average in quality of work performed and satisfactory in all other respects.

LIQUID OXYGEN PLANT: Contract No. DA -29-005-ENG-2654, 25 Ton Liquid Oxygen Plant, was awarded to S.I.P., Inc., of Houston, Texas, 31 October 1960, in the amount of \$383,893.00. It consisted of central storage and handling facilities for liquid oxygen and liquid nitrogen, located at Walker Air Force Base. The contract was completed on 18 August 1961, ahead of contract schedule and with no time extensions. There were ten modifications, all minor in nature. The contract was closed at a total cost of \$385,088.00.

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The contractor's performance is rated average on evidence of ingenuity and economy, excellent in effectiveness of safety program, and above average in all other factors.

<u>RE-ENTRY VEHICLE FACILITIES</u>: Contract No. DA-29-005-ENG-2656, Re-Entry Vehicle Facilities, was awarded to Earl F. Puckett, of Roswell, New Mexico, 4 November 1960, in the amount of \$118,254.00. It consisted of a vehicle maintenance building addition, office and toilet additions to an existing storage building, and a mounded concrete igloo storage magazine. All are located at Walker Air Force Base. The basic contract was completed 3 months ahead of schedule on 9 June 1961, with no time extensions and with five modifications. All additional work was completed by 12 September 1961. The contract was closed at a total cost of \$123,830.32.

The contractor's performance rating has been established as excellent in quality of work, effectiveness of safety program, and cooperative attitude and above average in all other respects.

<u>SHOPS, MISSILE ASSEMBLY AND MAINTENANCE, AND TECHNICAL SUPPLY</u> <u>BUILDING</u>: Contract No. DA-29-005-ENG-2697, Shops, Missile Assembly and Maintenance, and Technical Supply Building, wasawarded to Arvol D. Hays, Lubbock, Texas, 25 November 1960, in the amount of \$536,883.00. It was a building job, as titled, at Walker Air Force Base. The contract was completed 30 September 1961, on schedule and with no time extensions. Eighteen minor modifications were issued, bringing the total cost of the job to \$536,658.02 at closing.

The contractor's performance rating: Effectiveness of Safety Program - Excellent; Quality of work and Cooperative Attitude - Above

Average Meeting Schedules, Ingenuity and Economy, Organizational Ability and Efficiency, and Adherence to Security Regulation - Average; Effective Use of Materials, Equipment, Manpower and Facilities - Satisfactory; Effectiveness of Supervision - Unsatisfactory. The last rating resulted from the condition that supervision with authority to act for the contractor was available on an indeterminate, part-time basis only.

WATER SUPPLY FOR 12 SITES: Contract No. DA-29-005-ENG-2801, Water Supply for 12 Sites, was issued to Brown-Olds Plumbing and Heating Corporation, El Paso, Texas, 18 January 1961, in the amount of \$814,253.70. It provided domestic and service water for the sites and consisted of wells, raw water storage, demineralization and softening treatment, treated water storage, pump stations and transmission pipelines. Sixteen modifications have been negotiated and processed in amounts ranging from a \$35,911.05 decrease to a \$19,218.25 increase, bringing the total cost of the contract to \$854,893.44. Nine claims have been received, of which four have been recognized and processed as modifications, three have been withdrawn, and two are outstanding as of this date. The contract was physically completed 9 March 1962 on schedule as revised by time extension granted by reason of added work and excusable delays.

The contractor's performance rating: above average for adherence to security regulations and effectiveness of safety program; average in quality of work, ingenuity and economy, and cooperative attitude; and satisfactory in all other factors.

<u>PRINCIPAL SUBCONTRACTS</u>: The basic construction contractorawarded nine major subcontracts as follows:

MASS EXCAVATION: Anderson Brothers of Albuquerque, New Mexico. Open cut excavation to a level at the bottom of the LCC structure, about 35 feet of depth.

<u>REINFORCING STEEL</u>: Cobusco-Salyer Company of Denver, Colorado. Furnish and install concrete reinforcing steel in LCC's and silos.

<u>CRIB STEEL ERECTION:</u> Owl Trucking and Construction Company of Compton, California. Erection of crib steel at the last seven sites. The prime contractor performed crib steel erection with its own crew at the first five sites.

<u>MECHANICAL</u>: The Stanley-Carter Company of Detroit, Michigan. Furnish and install plumbing, heating, ventilating and air conditioning systems in LCC's and silos.

ELECTRICAL: Clarkson-Douglass Electric Company of El Paso, Texas. Furnish and install electrical work in LCC's and Silos.

<u>PERSONNEL ELEVATORS</u>: Otis Elevator Company of New York City, New York. Installation of personnel elevators in silos. Otis had a separate contract with the Government for fabrication and installation of the elevators. In accordance with terms of their contracts, the installation portion was assigned to the prime contractor, thus Otis effectively became a subcontractor.

<u>PROPELLANT LOADING SYSTEM</u>: Paul Hardeman, Inc., of Stanton, California. Installation of missile fuel propellant systems, including piping and equipment. Hardeman also had a separate contract with the Government for fabrication and installation. The installation portion was assigned to the prime contractor.

<u>PAINTING</u>: Eric Lundeen of Los Angeles, California. All painting work. <u>ROADS AND PARKING AREAS</u>: Floyd Haake of Roswell, New Mexico. Paving and graveling of access roads and parking areas.

Data on cost to the prime contractor of the above subcontracts are not available. Efficiencies of the subcontractors have not been analyzed and thus cannot be included. There were no major subcontracts under the Support Facilities prime contracts.

MAJOR MODIFICATIONS AND CLAIMS: In connection with the basic prime Contract No. DA-29-005-ENG-2598, Launch Complexes, there were twentytwo major contract modifications negotiated for amounts in excess of \$100,000.00. Of these, four formally assigned seventeen Assigned Service Contracts to the prime contractor in the aggregate amount of \$4,142,193.90. Assignment was in accordance with contract provisions of both prime and Assigned Service contractors. The prime contract contained an estimate of the value of the ASC contracts as \$4,774,000.00. However, this amount was not included in the prime contractor's original contract amount. The assigned amount, therefore, actually constitutes a reduction of about \$630,000.00 in the anticipated dollar volume of the prime contract. Eight more of the twenty-two major modifications were for changes or additions and ten resulted from recognized claims. Six claims remain unsettled but are limited in maximum amounts by stipulations contained in a release signed by the Contractor. The above are listed as follows:

Modi N	fication lumber	Description	Amount
	<u>A - Ass</u>	igned Service Contract Assignment Modification	5
	40	PLS Subcontract	\$1,702,000.48
	41	Overhead Door Hinge Assembly Subcontract	239,199.75
	42	Electric Switchgear, etc., Subcontract	166,669.61
	46	Remaining ASC Subcontracts	2,034,173.45
	<mark>B -</mark> Maj	or Modifications Due to Changes	
	11 .	Major Mechanical and Structural Changes	\$1,215,000.00
	13	Provide for a Continuous Electromagnetic Screen	112,592.55
	57	Struc., Mech. and Elec. Changes & Revisions	111,500.00
	77	Mechanical & Electrical Changes & Additions	135,800.00
	87	Add Hangars & Pipe Supports	137,000,00
	100	Supplemental Design Drawings - Changes	308,000.00
	106	Operate Diesel Generator for Power	388,000.00
	108	Mech., Elec., & Painting Changes & Additions	157,800.00
	C - Maj	or Modifications Due to Recognized Claims	
	155	Struc. Steel - Field Correction Memoranda	\$ 129,000.00
	157	Silo Slip Forms vs., Conventional Forms	932,100.00
	158	Additional Modif. Overhead for Time Extensions	525,000.00
	159	Crib Steel Erection Tolerances	277,000.00
	161	Joint Occupancy & Multiple Inspection	1,250,000.00
	162	Validation Procedures	244,000.00
	163	Acceleration	3,499,950.00
	171	Jt. Occup. & Mult. Insp., Elec. Sub.	296,122.00

Modification <u>Number</u>	Description	Amount
172	Valid. Procedures - Elec. Sub.	114,838.00
176	Acceleration - Elec. Subcontractor	643,539.00

Copies of memoranda describing claims resulting in the above modifications are contained in Appendix B.

D - Unsettled Claims with Stipulated Maximum Amounts

Claim Number	Description	Amount
C-20	Crane Accident at Site 2	\$ 25,000.00
C-24	Delayed Delivery, PLS Vessels, Yuba Industries	53,000.00
C-26	Concrete Supplier - Davis-Bacon Wages	17,000.00
C-40	Delayed Delivery, PLS Vessels, Taylor-Forge	30,000.00
C-32 & 131	Delayed Delivery, PLS Vessels, GAT Co.	149,000.00
· · · · · · · · · · · · · · · · · · ·	Total Stipulation	\$ 274,000.00

There were no major modifications or claims in connection with the Support Facilities contracts.

PART IV

MISCELLANEOUS

ACCIDENTS:

The Walker Area suffered three major accidents involving eight fatalities as follows:

1. Laborer electrocuted while guiding a corrugated culvert section suspended from a crane boom when the crane boom contacted a power line. The accident occured 29 August 1960. It resulted in one fatality and two temporary total disabilities. Corrective action: Contractor was issued strict instruction that no equipment with the capability of contacting high voltage lines would be operated, maneuvered, or in any manner positioned in close proximity to high voltage lines until compliance with the provisions of Section 18-10 of General Safety Requirements had been satisfied.

2. Oiler-driver of truck crane started truck engine as ironworkers removed outriggers and wheel chocks. Truck was in reverse gear and backed into silo. This accident occured 16 February 1961. It resulted in six fatalities, one permanent disability, eighteen temporary disabling injuries and \$149,000.00 damage. Action taken: Backfill to be kept eighteen inches below top of silo parapet walls. Braking systems to be checked periodically. Shaped wheel chock blocks to be provided. Recommendation that truck cranes used near silos be equipped with "fail safe" braking systems.

3. Ironworker, while attempting to tighten bolts between Levels 4 and 5, leaned over and grasped a tie rod which was loose at one end.

The spring action of the tie rod threw him against the silo wall and he fell to the bottom. The accident occurred 1 May 1961 and resulted in one fatality. Action taken: Contractor directed to properly secure all structural members immediately at time of installation in silo. Nets to be installed to afford protection in rattle spaces as well as in shafts.

The Walker Area accident experience data was as follows:

Man-hours Worked	3,971,189
Disabling Injuries	74
Fatalities	8
Days Lost	51,086
Frequency Rate	18.63
Severity Rate	12.89

VISITS:

Because of the nature of the project there were many visitors to the Area Office and the job sites. A list of visits, as extracted from the Area Daily Log and Register, is contained in Appendix C.

CEREMONIES:

There were two formal ceremonies during the construction work.

The Liquid Oxygen Plant was turned over to Walker Air Force Base 28 April 1962.

Site 10 was turned over to the Air Force 31 October 1961 in a ceremony wherein the keynote speech was made by New Mexicos' Governor Mechem.

Photos and newspaper articles appear in Appendix C.

RELATIONS WITH SATAF:

Key personnel heading the Site Activation Task Force are shown on Figure 13.

Relations with SATAF were generally excellent. However, the quality of personnel initially employed by General Dynamics Astronautics, which is a part of the SATAF organization, was extremely marginal. This Area was staffed with 92% graduate or professional engineers. GD/A surveillance personnel were composed of sirplane factory quality control types of personnel, similar in quality with inspection type personnel in the GS-5 to GS-7 grade range. They lacked basic comprehension of their tasks and were not familiar with construction practices. As the job progressed and GD/A personnel became available from "up-stream" bases, the situation improved in direct relationship to influx of qualified engineers employed by GD/A on the sites.

CONCLUSIONS:

a. The program as constituted was generally properly organized and controlled by CEBMCO in Los Angeles, California.

b. The plans and specifications for the work, while requiring many changes due to the "concept of concurrency", were generally satisfactory.

RECOMMENDATION:

It is recommended that:

a. Information from "up-stream" bases should have been more promptly relayed to down-stream bases.

b. The lump-sum fixed price control not be utilized for

construction involving concurrency. A fixed price incentive type contract would appear to be more appropriate.

c. The installation and checkout phase of the work should have been under the direction of the construction contracting officer in order to facilitate better control of the quality and cost of the work.

REFERENCE 7

The following is a verbatim transcript of a report written by The founding trustee of the National Aerospace trust. Any personal comments of mine will be italicized. Les Hayles

The report:

ATLAS F (SM-65F/HGM-16F)

Intercontinental Ballistic Missile (ICBM)

United States Air Force (USAF)

Strategic Air Command (SAC)

Walker Air Force Base, Roswell, New Mexico

HQ 6th (Heavy) Bomb Wing/6th Strategic Aerospace Wing

579th Strategic Missile Squadron (579th SMS)

Atlas Series F was designed and developed to counter the threat of strategic and/or tactical threat signature(s) to the economic (business/trade) interests of the United States of America. To be maintained as emergency capable, and if required, be used as emergency force against weak or undefended industrial and urban targets. Further, as primary force-capable projection in counter-economic/counter-value warfare towards destruction of hostile industry or urban centers. Finally, for the execution of hostage centers

Squadron force configuration was 12 remote launch sites (minimum 7 mile separation between complexes) located in a circular pattern around a host airbase (remote site support facilities).

Each remote launch site layout consisted of a missile silo and launch control center (*LCC*). All essential ground/system support equipment was stored in silo on an 8 level shockmounted crib structure. Offset within the crib structure was a launcher platform elevator shaftway (also known as the missile enclosure area [*MEA*]).

Unlike later systems, <u>Atlas F WAS NOT in-silo launched</u>. The missile was raised to the surface for launching.

The missile silo and launch control center were connected by a blast lock (2 blast lock doors), a very short utility tunnel, and a post construction-installed blast debris door.

Entrance to the underground facility was via a surface door, down a two-tier personnel stairway, elbow corridor into a two-door entrapment area (with TV camera view point), short corridor to a blast lock (2 blast doors) and down into a vestibule stairwell to bi-level LCC doorway entrances and personnel utility tunnel entrance (at bottom of vestibule stairwell).

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Above ground site surface features were a quonset style administration and storage buildings, water cooling tower (*diesel generator cooling*), water filtration shed(s), well pumphouse shed(s), small water storage tanks(s), gatehouse sentry shed, sewage stabilization pond(s), discage communications antenna, and an access road to/from county or state highway/road. During Operation Red Heat updating (1963-64), the discage communications antenna was repositioned nearby, within easement, to make room for a periscopic high frequency communication antenna (silo) and a ultra- high frequency cone-shaped communications antenna concrete hardstand.

The complex was hardened to 150-200 psi (although system deficiencies would rate the sites at 30-50 psi during operational lifespan).

Missile silo was 179 ft deep (including 4 ft deep sump well) and 52 ft in (inside) diameter. Launch control center was 40 ft in (inside) diameer, with a floor-to-ceiling height of 27 ft, and a concrete support column (4 ft in diameter) in center of LCC structure. The launch control center had two levels. Both floors were hung from the ceiling on an air suspension system (4 cylinders) as shockmounting.

System Designer/Manufacturer: General Dynamics; Convair Division, San Diego, California.

Missile Length: 82 ft, 6in (MK-IV RV & OW-38 M1 warhead or MK-III & OW-49M4

warhead combinations)

Missile Diameter: 10 ft (tank stage), and/or 16 ft (booster) (engines)

Missile Weight: 268,448 pds (minimum w/ MK-III RV/OW-49M4)

: 270,100 " (maximum w/ MK-IV RV/OW-38 M1)

Missile Thrust: 390,000 pds

Missile Range: Strategic Operational Requirements (SOR):

3,450 miles (minimum)

6,325 Miles (SOR Nominal) with MK-IV RV/OW-38M1 warhead or

alternate payload MK-III RV/OW-49M4 warhead

Missile Range; Maximums:

+8,760 miles maximum with MK-IV Mod-3A RV/OW-38M1

warhead with no penetration aids

+8,085 miles maximum with MK-IV Mod-5B-3 RV/OW-38M1/Mod-1A

Penetration Aid Mod

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+9,042 miles maximum with alternate payload; MK-III Mod-2B RV &

OW- 49M4 warhead (348 pound RV/1,732 pd warhead/369 pounds of subsystems)

Re-entry vehicle (RV) (primary) Weight/Dimensions; MK-IV:

225 pds, 11 ft 3 in length and 2 ft 7 1/2 in diameter (4 ft 0 in at adapter)

(alternate) Weight/Dimensions; MK-III:

348 pds, 11 ft 10 in length and 2 ft 0 in diameter (4 ft 0 in at adapter)

Warhead/War Reserve (WR) Weight: 3,309 pds (OW-38M1)

[3,000 pds XW-38 prototype weight]

: 1,732 pds (OW-49M4) (alternate)

[1,500 pds XW-49 prototype weight]

Yield Values (primary test): 3.50 - 3.75 Megatons

(alternate test): 1.40 - 2.50 Megatons

SOR/WR Yield Value: 2.35 Megatons (minimum value)

4.50 Megatons (nominal value)

6.70 Megatons (maximum value)

Emergency Yield Values: OW-38M1; 4.70 - 6.70 Megatons (select high)

OW-49M4; 2.35 - 3.35 Megatons (select low)

WR/RV Subsystems Weight: 368 pds (alternate RV; MK-III)

The word Provisionals is penned in here. 291 pds (primary RV; MK-IV Mod 3A)

426 pds (primary RV; MK-IV Mod 3A with

Mod 1A Penetration Aid Pods)

Penetration Aids/Decoys: 3 loads (Mod-1A, Mod-2B, and Mod-4), plus Atlas F aeroframe

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The word Provisionals is penned in here. tank fragmentation.

<u>Note:</u> Penetration aids and decoys were incorporated into the MK-IV RVs to increase mid-course (free-space) and terminal (atmospheric) penetration by the re-entry vehicle into a hostile airspace to degrade and counter defensive detection systems (radars) down to 150,000 ft.

The MK-IV re-entry vehicle mounted a primary penetration aid pod, plus a secondary decoy payload ejection mechanism (DECPEM) pod.

The Mod-1A primary deception pod contained 5 vacuume (*spell?*) (free-space) inflatable aluminized mylar balloons shaped like the MK-IV RV. When disperced (1.1 - 2.0 seconds after RV separation from aeroframe) deployment was designated for a 65-mile diameter dispersion. The secondary DECPEM contained 5 high intensity flares.

To offset any potential aim point by hostile detection, fire control and acquisition radars, an openloop tank fragmentation destruct sequence was built into the Atlas F aeroframe.

Further, a spin stabilization system was mounted in the MK-IV RV to increase speed (by generating non-RV oriented rotation of over 100 rpm) over the target area.

Finally, the MK-IV RV was coated with a "glove" of ablative material to reduce radar cross section and reduce wake ionization.

All decoys utilized either enhancement or reduction features to counter infrared detection and ultraviolet detection.

Total Payload Weight: 2,448 pds (alternate; MK-III Mod 2B/OW-49M4)

Penned In : 3,825 pds (primary; MK-IV Mod-3A)

4,100 pd citation 3,960 pds (primary; MK-IV Mod-5B with Mod-1A Penetration Aid Pod)

Target Selection: 2

Targets Allotted Per Force: 4 - 5 (2 - 3 missiles each target)

Detonation Points: 8,400 - 16,800 ft (airburst)

2,640 - 5,280 ft (near-surface burst)

0 ft (ground impact burst "failsafe")

Fuzing Options: 2 (airburst or near-surface burst)

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Circle Error Probability (CEP) [area 50% of targetted warheads will detonate in]:

2.2 miles from target (1963)

1.6 miles from target (1964, after upgrading)

Launch site Reaction Time: 10 - 12 minutes (SOR: - 8 minutes)

NOTE: During Operation Long Reach (24 July, 1963), Walker AFB remote launch sites achieved a simulated launch average of 14 min 35 sec (only 7 of 15 simulated launch attempts declared successful). Of those successful (7), five had an average simulated launch time of 10 min 54 sec.

The following are Operation Long Reach results respecting Walker AFB remote site simulated Operational Readiness Testing (ORT) EWO full-cycling drills. Ratios cited are launch attempts versus launch success. As follows:

579-1 Destroyed by fire, explosions, and burnout

579-2 Maintenance/Training

579-3 3/1

579-4 Maintenance/Training

579-5 1/1

579-6 2/1

579-7 Maintenance/Training

579-8 Maintenance/Training

579-9 1/1

579-10 4/1

579-11 1/1

579-12 3/1

Fuel Fill Time: Stored aboard missile (<u>except</u> RP-1 levelling/topping insertion prior to launcher/elevator lift to surface)

Propellant (oxidizer) Fill Time: 4 minutes 50 seconds, or less

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Emergency War Order (EWO) Static (raised) Hold Time: 2 minutes Emergency War Order (EWO) Static (in-silo) Hold Time: 60 minutes

EWO Silo Lift Time (raise missile): 1 min 20 sec

Time To Lower Missile: 8 - 20 min (at select descent speeds)

Blast Door Reaction Time (to open doors): 25 sec

Blast Door Weight: 75 tons

Launch Crew: 5 (combat crew rotation every 24 hours)

On-site Security Crew: 2 (rotation every 4 hours)

Launch Site Sufficiency (hold-out period): 10 days

Reserve Missiles: 1

Reserve Warheads: 1 - 2

Reserve RVs: 6

Training RVs: 6

Recycle of Propellant Tank Supply: Every 10 - 12 days

Recycle of Fuel Tank Supply: Every 180 days

Missile Squadron Force Load: Missiles Ready: 67% minimum

80% maximum

Missile System Relabilty: 1962; 53%

1963; 59%

1964; 37%

1965; 36%

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Atlas F Silo Propellant Tank Volumes:

Liquid Oxygen (Lox) Storage Tank: 23,000 gal. capacity

" " " " : 21,850 gal. nominal load

" " Topping Tank: 3,629 gal. capacity

""" ": 3,420 gal. nominal load

Atlas F Fuel Tank Volumes:

RP-1 (kerosene-type) Fuel Catchment Tank: 15,000 gal. capacity

RP-1 (kerosene type) Fuel Catchment Tank: 12,000 - 13,850 gal. nominal loads

" Levelling/Topping Tank (in silo): 630 gal. capacity

" " " " " " : 580 gal. nominal load

Note: Topping Tanks (LOX and RP-1) were used for "topping off"; filling up the Atlas F aeroframe tank immediately prior to launch.

CONSTRUCTION HISTORY

Directive given, 6 January, 1960, from the U.S. Army Corps of Engineers (USACOE), Albuquerque District for establishing of a 12 - Atlas Series F intercontinental ballistic missile (ICBM) squadron around Walker AFB (Roswell), New Mexico.

On 15 May, 1960, USACOE establishes Walker (Roswell) Area Office.

Authority to advertise for construction bids given, 16 May, 1960. Six (6) bids received by end date. Lowest bid accepted.

Successful bidder is a joint venture of Macco Corporation, Raymond International, Inc., The Kaiser Company, and Puget Sound Bridge and Dry Dock Company with a bid of \$22,115,828.00.

Contract is awarded 16 June, 1969, and Notice to Proceed issued 20 June, 1960.

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Work begins 23 June, 1960. Initial efforts are site excavation down to base level of 35 ft below grade.

Missile silo shafting began 25 July, 1960. Shortest time to shaft 60 ft in diameter down to a depth of 180-185 ft achieved at Site 579-3 (Elkins) in 55 days (2.5 ft per day). Longest time to shaft required 81 days at Site 579-8 (Lake Arthur). due to water infiltration difficultied (150-300 gal per minute).

Concreting construction began at Site 579-3, 25 September, 1960 (5 days behind schedule). Site completion dates are as follows:

Site 579-3 24 Oct, 1961

" 579-12 30 Oct, 1961

" 579-1 06 Nov, 1961

" 579-11 13 Nov, 1961

" 579-4 19 Nov, 1961

" 579-7 27 Nov, 1961

" 579-6 05 Dec, 1961

" 579-9 18 Dec, 1961

" 579-2 22 Dec, 1961

" 579-10 25 Dec, 1961

" 579-8 05 Jan, 1962

" 579-6 06 Jan, 1962

On October 31, 1961, Site 579-3 (Elkins) became the first Walker AFB auxillery (remote) site to be turned over to the USAF Site Activation Task Force (SATAF) for essential ground support equipment installation.

On February 8, 1962, Site 579-5 became the final Walker AFB auxillary (remote) site to be turned over to USAF SATAF.

Total cost of primary construction contract: \$38,356,329.42, and with additional contracts and post-construction claims awarded, the final affixed sum was \$59,441,277.84.

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CONSTRUCTION ACCIDENTS

29 August, 1960 Laborer fatally electrocuted while guiding a corrugated culvert section

suspended from a crane boom, when crane boom made contact with a

power line.

16 February, 1961 Oil-driver of truck crane started truck engine as iron workers removed outriggers and chocks. Truck gears in reverse. Truck crane backs over

silo edge into silo, falling 174 ft to silo bottom, resulting in 6 fatalities, 1

permanent disability, and 18 temporary disabilities.

1 May, 1961 Ironworker, while attempting to tighten bolts (between Silo Levels 4 and 5) leans over and grasps a tie rod which is loose at one end. The spring action of the tie rod throws worker against silo wall and worker falls 129 ft to silo bottom, fatally injuring.

During construction activity (3,971,189 manhours) there were 74 disabling injuries, and 8 fatalities.

The quality of construction by workers at Walker AFB (support sites) and auxillary (remote) ICBM sites was rated as excellent by the U. S. Army Corps of Engineers and the United States Air Force.

Site costs to maintain per year: \$330,000 per year.

579th Strategic Missile Squadron Milestones

01 September, 1961: Organized/Acitvated

30 November, 1962: Turnover of final completed site to Strategic Air Command. Atlas F ICBMs

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and Ready Crews declared fully operational. Squadron at Defense Condition 2 (DEFCON 2), due to the Cuban Missile Crisis. Retraction

to DEFCON 5 was set by May 1963.

01 June, 1963 Site 579-1 silo destroyed by fire and explosion.

13 February, 1964: Site 579-5 silo destroyed by fire and explosions.

09 March, 1964: Site 579-2 silo destroyed by fire and explosions.

16 May, 1964: Secretary of Defense Robert S. McNamara declares Atlas F to be phased-out by end of June 1968.

19 November, 1964: Accelerated phase-out of Atlas F system, sites and squadrons announced by Secretary of Defense Robert S. McNamara to be completed by end of June 1964.

05 January, 1965: First Atlas F removed from alert readiness.

04 February, 1965: Last Atlas F removed from alert readiness.

09 February, 1965: Last Atlas F departs Walker AFB for storage.

25 March, 1965: 579th Strategic Missle Squadron is Inactivated.

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The total cost for a 13 Atlas F missile force assigned to Walker AFB, from the beginning of site surveys (1959), site construction, site equipment installation, maintained operational status, until the conclusion of phase-out (1965) was \$439,923,070.00.

The total cost for the Atlas program was \$6,518,310,000.00.

The Atlas F was phased-out due primarily to economic considerations. It proved too costly to maintain, with exremely complex, highly flammable non-storable propellent/fuel loading aspects. The Atlas F also suffered from degrading reliability factors.

The advent of the more reliable, accurate, cost-effective, and quick reaction Minuteman I and Titan II ICBMs promised far reaching improvements over the Atlas F.

Minuteman I and Titan II had reaction times of 10 seconds and 48 seconds, respectively, versus Atlas F at 600 - 720 seconds.

Minuteman I was a smaller ICBM with solid propellent fuels, mounted a smaller 880 pd OR-56M2 warhead (1.3 megaton yield value), and had a CEP of 1,822 ft. Titan II had liquid storable propellent/fuel, "hard target" (the high probability of incapacitating a hardened target) capability, and a larger thermonuclear yield warhead (rate 9.4 - 13.4 megatons), versus Atlas F with a non-storable propellent (LOX), an <u>EXTREMELY DELICATE</u> propellent loading system (PLS), and half the thermonuclear yield (4.7 - 6.7 megatons).

Titan II had a CEP of 4,858 ft., versus Atlas F which obtained an improved CEP (in November 1964) of 8,500 ft.

Both the Minuteman I and the Titan II were in-silo launched. Further, it required 10 men to sevice the Minuteman, while it required over 80 to service the Atlas F.

These factors, plus more (political/strategic trade-off), accellerated the decision for phase-out. Due to forecast reliability problems with Atlas F (which surfaced very early in flight testing), phase-out was proposed by USAF Chief of Staff, General Curtis LeMay, only months after the final squadron of Atlas F sites (assigned to Plattsburgh AFB, New York) became operational!

Of the four (4) 1st-Generation ICBM systems (Atlas D, E, F, and TitanI), the Atlas F was the most troublesome. One major design flaw was mounting diesel generators directly above the propellent loading system (PLS).

During Operation "Long Reach" Force Operational Readiness Inspection evaluations at Walker AFB (1963), it was discovered that from a total 15 simulated EWO countdown - launch commit drills, <u>only</u> 7 were rated successful, and 8 were failures.

This implied that if, under a war footing, a launch order was directed (1963), <u>only</u> four Atlas F ICBMs would have launched. Of those launched, <u>only</u> one Atlas F was expected to neutralize the

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target. This figure did not include the force riding out thermonuclear subjegation and postdetonation environment. Include it and not one Atlas F was expected to be mission capable.

Atlas F sites, although rated to withstand thermonuclear overpressure of 150 - 200 pounds per square inch (PSI) proved (due to a very delicate propellent loading system) capable of withstanding only 30 - 50 psi. Not much greater than the horizontally-stored Atlas E system and "coffin" configured sites, which were rated at 25 psi.

By 1964 the Atlas F system and site was predicted to be completely vulnerable to Soviet "first Strike" attack. Even if inaccurate, Soviet warhead detonations (2 - 25 megatons) could incapacitate Atlas F, due to PLS design flaws, and launch site air intake/exhaust vent weakness (where post-detonation deposition was concerned).

The Atlas F's primary threats were the new Soviet ICBMs, designated SS-7 Saddler, SS-8 Sasin (mounting 5 - 10 megaton warheads), and the huge SS-9 Scarp (mounting a 20 - 25 megaton warhwad).

After phase-out of the Atlas F the mainframes/aeroframes were shipped to storage, and were later used to transport orbital/suborbital payloads into space. The mainframes/aeroframes were exhausted by September 8, 1981.

The warheads were dismantled and fissile elements reconstituted into national stockpile.

Currently, all sites are privately owned, and in most cases, are abandoned. All sites should be considered <u>EXTREMELY DANGEROUS</u>, due to uncovered fill vent shaft (depth of 85 feet), air intake and exhaust vent shafts (depths of 35 feet and 45 feet, respectively), and the missle silo. The primary danger in the silo is the entrance via the personnel utility tunnel(blast lock blast doors).

There is very little threshold beyond the final blast door. Further, if the silo has been salvaged, then there is a direct fall into deep water or an empty silo. Where water was observed, a fall of about 45 - 75 feet can be expected. Where a dry silo was observed, a fall of 145 feet can be expected. Survival is remote at best.

Finally, there is high methane levels, and a distinct "dead air" factor (lack of proper oxygen content, due to confined deep spaces and poor air circulation).

WALKER AFB ACCIDENTS

01 June, 1963; Site 579-1, First propellent loading exercise (*PLX*) since ORI acceptance (9 months in operation). Propellent filter failure, fire, explosion, and further burnout (19 1/2 hours). Silo destroyed. No warhead mounted. As follows:

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First accident occurred during a propellent loading exercise (PLX) at Site 579-1.

Ready operational crew RO-22 conducted exercise. Crew was declared qualified as a result of successful completion of a standardization board check on 17 April, 1963, and had conducted, prior to the accident, three (3) PLX's. A standboard check had been performed (check of crew's proficiency; performed by a team of highly qualified personnel.

579-1 was approaching completion of Operation "Long Reach" Operational Readiness Inspection (ORI) cerification; with site slightly ahead of schedule. Successful conclusion of scheduled PLX on 1 June, 1963, which required loading of liquid oxygen (LOX) and countdown through "Launch Commit" sequence (to "hold point" at 10 seconds to main engine ignition) would certify site as ready capable for emergency use.

On 1 June, 1963, 579-1 completed preparations for the acceptance PLX. In launch control center (LCC) were five-man ready operational crew, sector commander, safety technician, additional electrical power production technician, three-man mobile calibration and maintenance crew and four "Long Reach" engineers.

The PLX was scheduled for 10:00 AM, but thunderstorms in local area precluded any attempt, until unstable weather activity moved out of area. <u>Note:</u> SYSTEM VULNERABILITY TO INCLEMENT WEATHER PATTERNS!

PLX rescheduled for 5:30 PM. Ten minutes prior to PLX, sector commander proceeded to silo cap area to visually check the area sky for thunderstorm activity. After favorable observation, the command post at Walker AFB was notified that conditions were suitable for conducting the PLX. A "Long Reach" Phase III message was initiated by the commandpost.

However, a brief delay occurred when it was noticed that the diesel generators were putting out excessive current. A power factor adjustment was made in the electrical power production equipment, which improved situation, yet notably, current output was still slightly high.

PLX started at 5:44 PM and the RO crew initiated countdown. PLX was declared successful and abort sequence (term used to identify a button on missile combat crew commander's launch control console) started. Abort means ''recovery'' of missile from raised position, down into silo. Abort occurred at 5:57 PM. At 6:05 PM missile is in full down position.

At 6:06 (50) PM the LOX drain indication is noted. During the LOX drain, at 6:17PM, the drain valve indication changed from fully closed to intermediate (not fully open or closed).

Note: During the LOX loading sequence and drain sequence, the following sequences occur.

LOX is loaded aboard the Atlas F through two valves and a filter.

During drain, flow is accomplished from the missile LOX tank through a drain valve back into the LOX storage tank. The LOX drain sequence is automatically begun when the missile launch/elevatorplatform is down and locked. Drain is initiated by the opening of the airborne drain valve and the opening of the LOX line drain valve. LOX drain is accomplished by gravity flow. To insure that all LOX is offloaded, and to allow time for missile and oxygen line warmup, a

timer was installed in the propellent loading system (PLS) which kept the missile drain and line drain valves open for 45 minutes.

As it was, then, at 579-1, the safety technicians were instructed to enter the silo and determine the nature of malfunction. However, before the technicians entered the silo, at 6:22 PM, the valve indication changed to fully open. The malfunction determination team was recalled back to the LCC, and LOX drain offloading continued. Such was proper procedure, since all weapon system indicators were visually normal.

At 6:24 PM the valve indicator again changed to intermediate (not fully open or closed). Again, the safety technicians proceeded to the silo to detemine the malfunction. After exit from LCC Level 2, down a few stairsteps to blast/debris door, (installed during post-construction SATAF contract) and through the very short utility tunnel, the team reached the silo area blast doors)2 blast forming the silo area blast lock).

At 6:26 PM the team was in the blast lock ready to open final blast door to enter the silo. Upon authorization to enter the silo, at 6:27 PM, the team encountered abnormal resistence to open the blast door. It was determined that the door was being held closed by overpressure within the silo.

One of six television monitors in the launch control center (LCC) began showing visual evidence of sparks and flashes on silo level 8 (lowest misile crib level).

Fire alert alarms were initiated at silo Level 7 and 8, and evacuation alarms sounded. Missile silo water fog spray system was actuated. Safety technicians were ordered to return immediately to safety of LCC, and after securing the blast and debris doors in the utility tunnel, arrived safely at 6:28 PM.

Concurrent with safety team's arrival, television monitors for silo Level 6A camera manifested flames rising from a lower level. (All silo level designated 'A' were inside the Missile Enclosure Area (MEA.)

At 6:28(32) PM all electrical power (provided by diesel generators on silo levels 5 and 6) failed. An explosion then occurred within the silo, with fires of varying intensity which would burn for about 19 1/2 hours. Flames were observed at heights estimated to be over 500 ft above the silo cap area. As the fires burned minor explosions and detonations were heard within the silo conflagration

In the LCC, smoke and dust filled the two levels. Visibility was severely limited even with emegency lighting. Contact was made by field phone with observers in the fallback area (2,000 ft. from silo). Observers related extent of fire and that flames were obscuring the emergency exit and the security fence on the north site boundary. However, observers determined the personnel entrance was clear of flames.

LCC personnel donned emergency breathing apparatus, evacuated via the personnel entranceway and scaled the security fence on the north side of the launch complex. Exsept for a few minor cuts and bruises, there were no injuries.

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<u>Note:</u> Liquid oxygen (LOX) is compresed air, distilled into a pale blue liquid state, which constantly boils at -297 degrees F (EXTREMELY COLD). LOX does not burn by itself, but it supports and rapidly accelerates the combustion of all flammable materials.

The mixture of LOX with any hydrocarbon substance causes a potential fire and explosion hazard, A hydrocarbon is an organic compound. Grease and lubricants are high in hydrocarbon content, and an explosive gel, resulting from LOX in contact with a hydrocarbon source, can be ignited by static electricity, mechanical and fluid friction and shock waves introduced by impact.

LOX fill and drain transfer system mandated hydrocarbons at no greated than 200 parts per million. A figure which exceeds the cleanliness of a hospital operating room!

During the post-accident inquiry of 579-1 fire and explosion it was determined that the LOX filter showed evidence of two holes burned through the bottom of the filter housing an either side of the mounting pedestal. Evidence of burning similar to that normally experienced from a cutting torch was found in the filter base plate.

When LOX is loaded, flow is accomplished through two valves and a filter to the missile.During offload LOX flow is accomplished through the drain valve with LOX going to, but not through the filter.

The LOX filter was removed and analyzed. Analysis showed that fracture had occurred to one of the J bolts which holds the filter element inside the filter housing.

The investigation board concluded that an oxygen/steel fire had been initiated within the filter housing while LOX was flowing from the missile through the drain valve end of the housing.

It was concluded that the fracture of the J bolt was caused by the opening and closing of the LOX line drain valve. With the valve cycling, as it was, it was possible that the pressure surges of the LOX flowing, then not flowing again, could have fractured the J bolt. When the J bolt fractured, the filter element was then permitted to shake and rattle within the housing case. It was possible that the filter shaking action was enough to ignite the LOX by friction, thus starting an oxygen/metal fire.

Once the fire started with a large quantity of LOX present, the fire intensity was enough to burn holes through the sides of the filter case. LOX was permitted to escape through the holes and flow in around the filter on Level 7, as well as dropping to Level 8.

The large quantity of gaseous oxygen (GOX) released by the cascading LOX (GOX is derived from evaporating LOX) from the burned-through filter case was ignited by the burning filter. Flames progressed rapidly upward through the crib structure and burned through into the missile enclosure area (MEA), where the Atlas F rests on its launcher/elevator platform. (*The TV monitor on Level 6A [inside the MEA] showed flames rising from below, indicating fire was there already.*)

The missile enclosure area walls are covered with an aluminum coated spun glass and wool insulation material. The burning enclosure walls subjected the Atlas F aero/mainframe skin (less than the thickness of a dime) to excessive temperatures. (*The Atlas skin was/is .040 inches thick - 40 thousandths of an inch.*)

Failure occurred in the missile tank, venting the LOX to zero (Atlas D, E, and F aero/mainframes must be constantly inflated by internal pressure!). Loss of internal pressure resulted instructural collapse, dropping the MK-IV inert training re-entry vehicle (no special physics munitions mounted during any PLX) down through aero/mainframe, rupturing the tanking bulkhead between the LOX tank and the RP-1 fuel tank, mixing the LOX remaining in the tank. Explosion was inevitable.

Another consideration for a prime suspect to the accident was the LOX filter gasket which could have been contaminated by hydrocarbon from a source external to the filter. It was possible through leaks or spills, hydrocarbon could have gotten into the gasket and then, through a wicking action, be transferred from the outside of the gasket to the inside of the gasket. The presence of hydrocarbon within the filter could have been responsible for the high intensity of the fire.

Presence too of hydrocarbon on Levels 7 and 8 could have contributed in a compounding manner to fire intensity once LOX spilled through and out of the filter case. Be *(that)* as it may, the primary source of the fire was inside the filter case.

Besides destroying the inside of the silo, the force of the initial explosion blew one 70-ton silo cap door 99 ft. to the west, and the other 70-ton silo cap door 109 ft. to the east. Such was the force of the explosion. Entry to investigate silo interior damage was not attempted for four days. Even then, the interior had not cooled sufficiently, until two days more days.

13 February, 1964; Site 575-5. First propellant loading exercise since ORI acceptance (14 months in operation). Launcher/elevator fuel line disconnect failure, combined with vapor ignition in diesel exhaust ducts (electric wire fire) and silo fire. Missile in raised position explodes. Silo destroyed. No warhead mounted. As follows:

Second accident occurred (like 579-1 accident) after a successful propellent loading exercise (PLX), ar Site 579-5.

The inspector general for Headquarters, Strategic Air Command, Omaha, Nebraska, was at Walker AFB at the time conducting an operational readiness inspection (ORI). Site 579-5 was the last of five Atlas F sites to be exercised.

Ready operational crew RO-60, and standardization crew S-03 were scheduled for the exercise. Both crews were alert ready qualified. Crew S-03 had just completed a standardization check on 6 February 1963. The exercise to be conducted on 13 February, 1964, was a normal quarterly recheck of RO-60. Prior to this date S-03 had accomplished 10 PLXs and RO-60 had completed 3.

579-5 was declared ready for a PLX and the exercise order sent from Walker AFB command post. Countdown was initiated at 10:10 am.

Approximately 4 minutes into the countdown, a silo 19% oxygen indication alarm was noted,

indicating a less than normal oxygen content. This was considered noncritical and the countdown was continued.

The Atlas was fully loaded with LOX and commit sequence initiated and progressed normally until launcher/elevator lift began.

As the launcher/elevator platform rose off the disconnects, fuel spillage was detected on the silo Level 8 television camera monitor located in the launch control center (LCC). The spillage appeared to be emanating from the launcher/elevator platform portion of the disconnect. Visual evidence estimated the spill to be between 5 and 50 gallons. An abort, or recovery sequence was not required for the situation.

Fuel spillage occurred at launcher/elevator rise when the fuel line demated. The portion of the line, which is attached to the launcher/elevator, disconnects from the portion immediately under the launcher/elevator platform. The fuel line is approximately 40 feet in length. Any fuel remaining in the line or any leak of the missile fuel-fill valve will gravity collect in the fuel line. Should the quantity be sufficient to fill the line up to or above the point of the launcher/alevator platform disconnect, a spillage of the amount collected, above the disconnect will occur at launcher/elevator rise.

As it was, the exercise was not delayed due to the noncritical condition. Therefore, the Atlas F was raised. The missile was up and locked at 10:20(47) am.

At 10:21(42) am, the ORI was concluded and declared successful.

Abort sequence was delayed for a visual inspection for fuel spillage. At 10:24 am, personnel proceeded to the silo cap to inspect the missile.

Topside inspection showed no indication of leaks and personnel returned to the LCC at 10:29 am. Then, members of the ORI inspection team left the site.

A 10:31 am, upon the recommendation of the standboard crew, the squadron commander ordered the nonessential bus be shut down to remove power from the electrical outlets in the silo. This was done as a safety precaution because of the fuel spillage on silo Level 8.

NOTE: The term "nonessential" is a misnomer, since shutting down nonessential power turns off power to many of the silo facilities. The more significant were: (1) Pumps, which circulate condensor water to the diesel generators; (2) the main silo exhaust fan; and (3) the fire fog system pump. The bus is called nonessential since it may be turned off for a short period during a combat is operating. It was done to reduce the electrical load so that one generator can provide sufficient power to raise the launcher/elevator platform with a fully loaded Atlas F missile.

The most vital equipment affected by the nonessential bus, at least as far as the accident was concerned, was the diesel cooling capability and the silo exhaust fan. Keeping the two vital systems inoperative for a prolonged period resulted in diesel overheating and hot exhaust gases being trapped in the exhaust plenum.

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Overheating was indicated at 10:50(52) am when the operating diesel indicated high temperature.

With the missile in the raised up position - above ground - there was no way to control the pressure within the fuel-and LOX tanks unless an item of equipment known as the pneumatics test set is connected to the missile. At 10:38 am, a call to the fallback area was made requesting the pneumatic test-set operator to proceed to the silo cap area for pneumatic test-set hookup. The pneumatic test-set operator was in the process of connecting to the missile when he heard a noise that sounded like a "pop" and noticed gaseous oxygen (GOX) in he pneumatic test stand and on the ground. He looked outside and saw LOX spraying out of the main LOX fill-line disconnect on the launcher/elevator platform. He reported the information immediately to the LCC.

Underground in the LCC, monitors for television camers located on silo Levels 2, 6A, and 8 were obscured by what was determined to be GOX vapors. The television camera on the silo cap area also displayed vapor at ground level.

At 11:00(03) am loss of power occurred in the LCC. Nine seconds later alternating current was lost, and at 11:11 am, explosions in the silo of first, a low-order nature, then high order both in the silo and the Atlas F in the raised position at silo cap. The high-order explosion was a massive detonation and conflagration.

The post-accident investigation concluded that the primary cause of the accident was due to an error in judgement by the squadron commander. It was also concluded that vapor from the spilled fuel from the missile enclosure area (MEA) at silo Level 8 travelled through the exhaust duct to the exhaust plenum on Level 2. The vapor then mixed with the hot diesel exhaust gas and ultimately exploded.

A fire then ensued which burned the cables controlling the missile LOX drain valve. The cables were exposed to possible fire or explosion damage at several locations where the cables enter under the floor plating and pass within 1 o 2 inches from the exploded exhaust duct.

Located on silo Level 3 are units called logic racks, which are merely cabinets that have the control wiring and panels that go up to control the missile, and the harness, the wiring that goes up to the missile, is near the exhaust duct where the first low-order explosion occurred.

It was believed that when the fire started at silo Level 3, which was an RP-1 fuel vapor and hot diesel exhaust fire, the explosion then damaged the wires nearby, and sent a signal up to open the LOX fill and drain valve on the launcher/elevator platform.

When this occurred, LOX dropped into the silo, and with a fire already burning and mixing with the spilled RP-1 fuel no the bottom a low-order explosion occurred and a greater fire ensued, which burned for 10 minutes in the silo, until pressure support systems failed and the pressurized Atlas F aero/mainframe lost structural integrity.

The missile LOX drain valve was recovered from the missile wreckage and analyzed. The analysis showed that the valve had been driven open electrically.

It was further concuded that the signal that opened the airborne valve was the result of a shorting of the tanking panel wires which were damaged at one or more locations.

After this event occurred, the accident was inevitable: LOX spilled to the missile enclosure area floor on silo Level 8, which suffered cryogenic fracturing, and dropped to the bottom of the silo. LOX and RP-1 fuel formed a gel on silo Level 8 and silo foundation floor and detonated, resulting in a powerful pressure pulse to travel up the MEA shaftway to the underside of the launcher/elevator platfrom, ejecting the column of gaseous oxygen (GOX) that was observed by personnel at the fallback position (2,000 feet from the missile silo).

The explosion produced fires in the silo from hydraulic systems and from the diesel engine fuel supply lines. The Atlas F missile withstood the effects of the explosion and fire for 10 minutes before the missile LOX tank lost pressure and sructural failure occurred to the aero/mainframe.

This failure caused a LOX/RP-1 fuel detonation at or near the missile intermediate bulkhead. The MK-V inert training re-entry vehicle dropped almost straight down through the remaining missile fuel tank section and came to rest node down on the launcher/elevator platform in the sustainer engine space. With the fire raging in the silo and then the 12,000 gallons of RP-1 fuel and 19,000 gallons mixing on the surface, the missile's explosion was absolutely horrific!

09 March, 1964; Site 579-2. First propellant loading exercise since ORI acceptance (15 months in operation). Propellant (LOX) gaseous vapor venting freezes and fractures launcher/elevator cables. Launcher/elevator falls 3 feet and seizes. Support systems failure to maintain tank pressure in missile, causes tank failure, resulting in the collapse of the aeroframe. The inert "dummy" MK-IV RVfalls down through missile rupturing missile's LOX/RP-1 (Propellant/Fuel) tanking bulkhead. Explosion. Silo destroyed. No warhead mounted. As follows:

Third accident occurred during a propellant loading exercise (PLX0, at Site 579-2.

It was a routine PLX an was conducted by standardization crew S-02 and ready operational vrew RO-27. Both crews were alert ready qualified, and had previously conducte 13 and 2 PLX's respectively.

Countdown was started at 1:00pm, and was running normal until 1:12pm, when the commit sequence was initiated. After rising off the LOX disconnect panels the launcher/elevator stopped after rising 3 feet up. Seconds later, a 25% silo-oxygen alarm sounded indicating a possible LOX spill.

The abort; "recovery" sequence was immediately initiated, in an effort to return the launcher/elevator platform to a full down position. The sequence started but the launcher/elevator platform would not lower. It is not known, nor will it ever be, why the lift failed to raise or lower. Damage from the accident made such a determination impossible.

At 1:26pm, the crew started the emergency procedure checklist. Prior to launcher/elevator platform up-run, the LOX tank is pressurized to flight pressure of 26 pounds per square inch. The emergency procedure required that the LOX-tank pressure be reduced to a pressure of 7 pounds per square inch by opening the boiloff valve if the launcher/elevator platform has stopped.

<u>NOTE</u>: LOX, because of its very low temperature, is continually boiling. If left in a closed container gaseous oxygen (GOX) will raise the pressure within the container. The emergency procedure checklist stipulated opening of the boiloff valve so that pressure within the container,

the Atlas F missile LOX tank, could be temporarily relieved of pressure.

The standboard missile combat-crew commander (MCCC) omitted depressing the emergency pushbutton which enables the boiloff valve to open. The step was intentionally omitted due to concern for the high-oxygen content already indicated and a desire not to further enrich the silo area with the addition of GOX. Therefore, troubleshooting the launcher/elevator platform was initiated, and qualified personnel were sent into the silo.

Personnel proceeded from LCC Level 2 to the silo, entering at silo Level 2. Due to the fire risk, personnel had to disregard the use of the personnel elevator, and descend by way of spiral stairway to silo Level 7, where they descended further to silo Level 8 via vertical ladder.

NOTE: With the boiloff valve closed, and the LOX contained within the LOX tank continually boiling off, GOX at high pressure is forced into suspension with the LOX. Under such conditions, when the boiloff valve is opened, the GOX escapes, reducing the pressure within the LOX tank. Since the GOX is suspended throughout the LOX, a large amount of LOX is also forced out of the boiloff valve.

A simple example of the phenomenon is shaking a can or bottle container of soda, then open it.

In 579-2 silo the missle tank pressure remained normal for an hour and then the LOX tank pressure began to rise. The system design provided an automatic switch to emergency at 30 pounds per square inch pressure in the LOX tank.

At 2:39pm the LOX tank pressure had built up to emergency release pressure levels. The system automatically switched to emergency which enabled the boiloff valve to open. Opening the boiloff valve, after having been closed for an extended period of time, resulted in the rapid expulsion of LOX.

Seconds later, a high and increasing oxygen content was measured by the safety technician in the silo. He, along with other technicians (who were trying to fix the lift system in the silo), noticing the increasing GOX levels, evacuated the silo immediately. After securing the two blast doors in the blast lock, the blast/debris door in the utility tunnel, the team returned to the LCC.

On one of the LCC monitors GOX was observed coming out of the missile enclosure area (MEA) into the non-explosive-proof area of the silo Level 2.

By 2;47PM the LOX tank pressure had dropped to normal pressure so the pressurization system was returned to automatic mode.

At 2:47(30)pm white smoke was seen coming out of the silo exhaust system by personnel at the fallback position (2,000 feet from the silo) and was observed on the television monitor in the LCC.

At 2:48pm the white smoke had turned grey and at 2:49pm, the smoke became black. The fire fog water spray system was initiated

At 2:51(30)pm electrical power was lost, and at 2:53pm the first of two high-order explosions occurred. At 2:54pm the Atlas F missile exploded, destroying the missle and heavily damaging the silo.

Like the two previous accidents, there were no appreciable injuries and LCC crews were able to evacuate to the fallback position.

The post-accident investigation concluded that the LOX on the LOX tank was ejected through the boiloff valve and sprayed all over the missle enclosure area (MEA). It was further concluded the LOX being ejected from the boiloff valve struck the wire rope cables that are on each side of the MEA that lift the launcher/elevator platform.

When the cables were struck by the -297 degree F LOX, the cables experienced cryogenic fracturing; cold fracturing of the cables. When the cables broke the launcher/elevator platform suddenly dropped down to silo Level 8 (a fall of 3 feet) onto the downlocks. The impact would have been sufficient to cause bulkhead reversal and rupture the intermediate bulkhead between the missle LOX tank and RP-1 fuel tank, *(allowing LOX and fuel to)* mix together and explode.

Primary cause of the accident was an error in judgement, in that the standboard missi

le combat crew commander (MCCC) directed a deviation from the current technical order checklist which resulted in the missle boiloff valve remaining closed for an extended period of time.

NOTE: The MCCC faced two serious problems. One was a launcher/elevator platform which had seized and stuck with fully loaded tanks, and the other was a high GOX level within the silo. He did not want to further enrich the high GOX content, so he decided to leave the boiloff valve closed and attempt to correct the launcher/elevator platform lift and lower the platform down to drain points so that detanking could be done. His plan was overtakenby time when the boiloff valve opened in the emergency mode.

Also, the original cause was that the missle lift system failed to successfully drive up or down after stopping.

It was concluded that the wire rope cables connected between the tension equalizer, launcher/elevator platform, and launcher lift drive system were failed by impingement of LOX or GOX from the boiloff valve.

If the boiloff valve had been opened immediately as stipulated in emergency procedures, then the pressure within the LOX tank would have been relieved down to levels allowing the extended time required to troubleshoot the lift, and forecast to fix same before an emergency situation involving venting was required. An error in judgement was made when the boiloff valve was left closed by the decision of the missile combat crew commander (MCCC).

Another factor which contributed to the MCCC being unable to clear the GOX content in the silo was the lack of purge fan(s) on site during the PLX.

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NOTE: ALL PROPELLANT LOADING EXERCISES WERE FAILURES AT 579-2!

<u>NOTE:</u> There was a very serious launcher/elevator problem at 579-2 (8 consecutive unsuccessful missile lifts, before catastophic accident).

NOTE: The 579th Strategic Missile Squadron had the highest success rating regarding propellant loading exercises (PLX) amongst all Atlas F squadrons during "Operation Red Heat" updating (1963-1964). At the latest date of accident, 36 Atlas F missiles and silo sites had completed "Red Heat" updating throughout the United States.

SITE # MISSLE # MISSILE DISPOSITION

579-1 61-2563 (77F) Destroyed in silo by explosions, 01 June, 1963.

579-2 62-12126 (90F) Destroyed at silo by fire and explosions, 09 March, 1964.

579-3 61-2530 (44F) Launched 03 December, 1969, for Advanced Ballistic

Re-Entry Systems (ABRES) program.

579-4 62-12131 (95F) Launched 03 May, 1968, ABRES.

579-5 61-2574 (88F) Destroyed in silo by fire and explosion, 13 February, 1964.

579-6 61-2565 (79F) Salvaged for spare parts ABRES.

579-7 62-12128 (92F) Launched 09 June, 1979 ABRES.

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579-8 62-12139 (103F) Launched 29 June, 1971 ABRES.

579-9 61-2562 (76F) Launched 06 August, 1971, for Orbital Vehicle (OV) program. Made flight as OV-1.

579-10 61-2571 (85F) Launched 05 April, 1971, ABRES.

579-11 62-12138 (102F) Vandenberg AFB, California. Was modified for Space Test Program.

579-12 61-2560 (74F) Launched 01 September, 1971, ABRES.

* 62-12135 (99F) Launched 25 September, 1971, ABRES.

* Missile Assembly and Maintenance Site (MAMS). An Atlas F was stored as a spare missile mainframe/aeroframe at Walker AFB.

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REFERENCE 8

U. S. ARM ENGINEER DISTRICT, ALBUG ERQUE

CORPS OF ENGINEERS FEDERAL BUILDING, 517 GOLD AVENUE, S. W. ALBUQUERQUE, NEW MEXICO 87103

IN REPLY REFER TO SWARE Atlas "F" Missile Site No. 9, Walker AFB, NMex

2 July 1965

General Services Administration Region 8 Denver Federal Center Denver, Colorado

Gentlemen:

Inclosed is preliminary Report of Excess Real Property covering the Atlas "F" Missile Site No. 9, Walker Air Force Base, New Mexico, Holding Agency No. Albuquerque-149.

Sincerely yours,

I Incl (trip)
SF-II8 w/rpt & map attchd

H. K. SHADEL Chief, Real Estate Division



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STANDARD FORM 118 DECEMBER 1953 PRESCRIBED BY GENERAL	F EXCESS		1. HO	Uquer que=149	DATE RI	ECEIVED (GSA use only					
SERVICES ADMINISTRATION REGULATION 2-IV-201.00 118-102		REA	L PR	OPERTY	2. DATE OF REPORT GSA CONTROL NO. (GSA use 2 July 1965 Only)						
3. TO (Furnish address of General Servic Region 8, Den	<i>GSA regional</i> es Admin ver Fede	offices) istratio ral Cent	n er		4. FROM (Name and address of holding agency) U.S. Army Engineer District, Albuquerque P. O. Box 1538						
Denver, Color	5 1 km	Albuque	erque	e, New Mexic	0 87103						
5. NAME AND ADDRESS OF R H. K. Shadel, P. O. Box 153 Albuquerque,	ACTED ate [6. NAME AND Command Headqua (SAC) U Walker	addres der arter JSAF Air	s of custodian s, 6th Stra Force Base,	tegic Ae New Mex	rospace Wing ico					
7. PROPERTY IDENTIFICATIO Atlas "F" Mis Walker Air Fo	8. PROPERTY A Site IC Roswell Highway	ADDRES Cate , Ne s No.	s (Give full location ed approxima ew Mexico an 380 and 70	n) tely 30 d north	miles west of of U. S.						
9.		S	PACE DA	TA		-		10.	LAND		
USE	NUMBER OF FLOOR AREA NUMBER BUILDINGS (Sq. ft.) FLOORS		NUMBER OF FLOORS (3)	FLOOR LC CAPACIT (4)	AD Y	CLEAR HEADROOM (5)	(From SF 118b)	ACRE ON SALVARE REER			
A. OFFICE	1	4,00	00	1				A. FEE	5,48		
B. STORAGE		4,00	00	1				B. LEASED			
C. OTHER (See 9 F)	4	13,24	+1	12				C. OTHER	296.02		
D. TOTAL (From SF 118a)	6	21,24	-	E OFFICIEV H	OTHER LIGE CH			D. TOTAL	301.50		
(1) OWNER (2) TENANT	. 6	21,24	-1	Missi	le Launch	Fac	ility.				
11. C	OST TO GOVER	NMENT			12. LEA	SEHOLD)(S) DATA (Use separ	ate sheet if ne	ecessary)		
ITEM		SCHEDULE		COST	A. TOTAL ANNU	JAL REN	TAL		\$		
A. BUILDINGS, STRUCTURES, AND MISCELLANEOUS FACI	UTILITIES, LITIES	A (Co1 d)	(Col d) \$2,666,318			B. ANNUAL RENT PER SQ. FT. OR ACRE C. DATE LEASE EXPIRES					
B. LAND		B (Col. f)		- 481	D. NOTICE REQUIRED FOR RENEWAL						
C. RELATED PERSONAL PROPE	ERTY	C (Col. h)			E. TERMINAL DATE OF RENEWAL RIGHTS						
D. TOTAL (Sum of 11A, 11B,	and 11C)	TE COST (O	\$2,	666,799	F. ANNUAL RENEWAL RENT PER SQ. FT. OR ACRE \$						
Ieased) \$12,000	J MAINIENANC	LE CUSI (Gove	rnmen	r-owned or	G. TERMINATIO	N RIGH	GOV	FRNMENT			
13. DISPOSITION OF PROCEED Miscellaneous	s Receipts				14. TYPE OF CO Reinfor	nstruc	concrete, c	orrugate	d iron.		
15. HOLDING AGENCY USE Missile Launch	Complex	(Inacti	ve)		16. RANGE OF POSSIBLE USES Fuel and water storage;						
		^	•		Salvage	e .					
17. NAMES AND ADDRESSES OF Portales, New Me Bartlesville, Ok Las Cruces, New	F INTERESTED xico; Hi lahoma; Mexico.	federal agen gh lands Farmers	CIES AN Un i ve Coop	D OTHER INTE Prsity, L , Hagern	rested parties .as Vegas, nan, New N	Eas New lexic	stern New Mes Mexico; Ci co; New Mexi	xico Uni ties Ser co State	versity, vice Oil Co., University,		
18. REMARKS The prop Atlas "F" Missil The surrounding farms. The inst	erty was e C omple: land area allation	acquire x locate as consis was scre	d for d in st mo eeneo	the con the vici ostly of against	nity of M livestock known mi	alke ran lita	peration and or Air Force ches and sca ry needs, w	mainten Base, N attered ith nega	ance of the ew Mexico. irrigated tive results.		
19. REPORT AUTHORIZED BY							-				
NAME					SIGNATURE						

H. K. SHADEL

Chief, Real Estate Division

SIGNATURE

HKSladel

U. S. GOVERNMENT PRINTING OFFICE 16-69840-2

STAND DECEM PRESC SERVIC REGUL	ARD FORM 1 IBER 1953 RIBED BY GE ZES ADMINIST ATION 2-IV-20	18-A NERAL RATION DLOO BUILDINGS, STRU MISCELLA	CTURES, U Neous fac	TILITIES, AI ILITIES	AD	118 202	1. HOLE	adenci querque	- 149 GS	PAGE 1 OF 4 PAGES OF THIS SCHEDULE A CONTROL NO. (GSA use Iy)
		SCHEDULE A-SUPPLEMENT TO	D REPORT OF	EXCESS REAL	L PROPERTY	110-202	3. ANNU	AL RENTAL		
LINE NO.	HOLDING AGENCY BUILDING NO.	DESCRIPTION	ESTIMATED	OUTSIDE DIMENSIONS	FLOOR AREA (Sq. ft.)	NO. OF FLOORS	CLEAR HEAD- ROOM	FLOOR LOAD RANGE	REST	RICTIONS ON USE R TRANSFER OF RNMENT INTEREST
1	(-)	Buildings:	(d) \$	(e)	(f)*	(g)*	(h)*	(i)*		(j)
3	11413	Warehouse, Quonset Hut Corrugated iron siding and frame,	14,609	40'×100'	4,000()] ()			
5 6		Completed: 1962.	José				-			
7 8 9	11414	Admin-Quonset Hut Corrugated iron siding and frame.	JM 18,543	40'×100'	4,000(a	a) (á	1)			
10 11 12		concrete slab floor and foundation Completed: 1962.								
13 14 15	11400	Water Supply Treatment Plant Butler type corrugated iron buildin concrete slab floor and foundation	14,967 19, (40)	32'x48'	1,536(0	:) (d	:)			
16 17	11100	2 ea. wells. Completed 1961. Structures:	0							
18 19	11406	G/M Launch Control Center Underground circular reinforced	291,901	40' 1D 27' Depti	2,512(0	2(0	.)			
1 22 23		concrete with membrane waterproofin covered with 7'6" earth compacted fill. Completed: 1961.	ıg ,							
24 25	11407	Missile Launch Facility Constructed of reinforced concrete	2,025,338	52' ID 165' dep†1	9,126(0) 8(c)			
26 27 28		Completed: 1962		top door t base level	•					
29 30 31										
32		TOTAL	2,365,358		21,174					

Frenx ngures with symbols to denote type of space, as follows: (a) for office; (b) for storage; (c) for other.

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STANI DECEN PRESC SERVI REGU	DARD FORM 1 MBER 1953 CRIBED BY GE ICES ADMINIST LATION 2-IV-20	18-A NERAL RATION 100 SCHEDULE A-SUPPLEMENT TO	i. Hole Albuq 3. annu	1. HOLDING AGENCY NO. 2. PAGE 2 OF 4 PAGES Albuquerque-149 OF THIS SCHEDULE GSA control NO. (GSA use only) 3. ANNUAL RENTAL					
	HOLDING	Γ	FOTUNTED	T		<u> </u>			······································
LINE NO.	AGENCY	DESCRIPTION	COST		FLOOR AREA	NO. OF	CLEAR HEAD-	FLOOR LOAD	RESTRICTIONS ON USE OR TRANSFER OF
(a)	(b)	(c)	(a)	(e)	(Sq. ft.) (f)*	FLOORS	ROOM	RANGE	GOVERNMENT INTEREST
1	11415	Tunnel	85 300	81/101/15	(1)		(n)*	<u>(</u>)*	(j)
2		Connects Silo and LCC, constructed	0,500		0/(0)	1(0)			:
3		of reinforced concrete with steel			<u> </u>			······	
· .		concrete floor.							
5		Completed: 1962.	1		······································				
6						·		······································	
7	148	Pad, Hard Antenna – UHF	600	10' dia.		<u> </u>			
8		Concrete construction - 9 S.Y.	1	3' dept	<u></u>				
9		Completed: 1964.							· · · · · · · · · · · · · · · · · · ·
10									
11	11419	Silo, Hard Antenna - HF	33,170	8'dia,		<u> </u>			
12		Underground - concrete encased		27 depth				—. <u></u>	
13		with steel liner.				<u> </u>			
14		Completed: 1964.							
15	11405	Ph							
16	11405	Fence, Boundary - 5720 LF.	11,056						
		constructed of 5 strands of barbed							
		wire on 4' high wooden posts.							
19		Completed: 1961.							
20	11410	F							
1 <u>22</u>	11410	rence, Security - 1960 LF.	21,698						
23		Construction: / chain link, sur-							
24		supported on steel posts with an	ire						7
25		electrical operated cate of tubula							
26		steel frame construction							
27		Completed: 1962							
28									
29									-
30									
31						-in			
32									
						200200000000000000000000000000000000000			
<u> </u>		TOTAL	\$151,824		67				
*1	Profix fidure		·						

Prefix figures with symbols to denote type of space, as follows: (a) for office; (b) for storage; (c) for other.

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STAN DECE PRESC SERVI REGU	DARD FORM 1 MBER 1953 CRIBED BY GE CES ADMINIST LATION 2-IV-20	18-A NERAL RATION DI.00 SCHEDULE A-SUPPLEMENT T	1. HOLDING AGENCY NO. 2. PAGE 3 OF 4 PAGES OF THIS SCHEDULE Albuquerque-149 GSA CONTROL NO. (GSA use only) 3. ANNUAL RENTAL								
LINE	HOLDING	ESTIMATED									
NO.	BUILDING	DESCRIPTION	COST	OUTSIDE DIMENSIONS	AREA	OF	HEAD-		RESTRICTIONS ON USE OR TRANSFER OF		
(a)	(b)	(c)	(d)	(e)	(50.11.) (f)*	(g)*	(h)*	(i)*	GOVERNMENT INTEREST		
1	11412	Telephone Duct Facilities	1.829		1			(-)			
2		buried 1-1/2" and 4" conduit,									
3		207 LF - Completed 1962.									
_ 											
6	<u></u>			· · · · · · · · · · · · · · · · · · ·					· · · · · · · · · · · · · · · · · · ·		
7	11402	Water Storage Tank	15.055								
8		Steel, 6,000 gal cap	15,955	·				····			
9		Completed: 1961.									
10	· · · · · · · · · · · · · · · · · · ·							· · · · · · · · · · · · · · · · · · ·			
11	11408	Water Storage Tank	45.010								
12		Steel, 93,000 gal, cap.	49,919								
13		Completed: 1962.			· · · · · · · · · · · · · · · · · · ·						
14							·				
15	11409	Diesel Storage Tank	6.929	·····	+						
16		Steel, 364 bbl cap.			<u> </u>						
17		Completed: 1962.									
18											
19	11403	Water Mains	3,695				-				
20		3" and 4" transite, 80 & 100 PSI.									
t		Completed: 1961.	· · ·						······································		
22	11404										
23	11404	Sanitary Sewage Mains	18,948			+		······			
24		4" and 8" CI & VC pipe, 512 LF.									
25		Completed: 1961.			······						
26	11/20										
27	11420	Ind. Waste Mains	23,800					***			
28	·····	Completed 1051			· · · · · · · · · · · · · · · · · · ·						
30		compteted: 1901.									
31											
32											
			1	No.					;		
		TOTAL	\$117.075								
1					L	1					

*Prefix figures with symbols to denote type of space, as follows: (a) for office; (b) for storage; (c) for other.

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STANI DECEI PRESC SERVI REGU	DARD FORM 1 MBER 1953 CRIBED BY GEI CES ADMINIST LATION 2-IV-20	RETAL RETAL RATION MISCELLA	118-202	ı. ногр Albu	1. HOLDING AGENCY NO. 2. PAGE 4 OF 4 PAGE OF THIS SCHEDULE GSA CONTROL NO. (GSA to only)				
	r	SCHEDULE A-SUPPLEMENT	O REPORT OF	EXCESS REAL	PROPERT	Y	3. ANNU	AL RENTAL	
LINE NO.	HOLDING AGENCY BUILDING NO.	DESCRIPTION	ESTIMATED cost	OUTSIDE DIMENSIONS	FLOOR AREA (Sq. ft.)	NO. OF FLOORS	CLEAR HEAD- ROOM	FLOOR LOAD RANGE	RESTRICTIONS ON USE OR TRANSFER OF GOVERNMENT INTEREST
(a)	(b)	(c)	(d)	(e)	(f)*	(g)*	(h)*	(i)*	(j)
2		Overhead 900 LE	54						
3	· · · · · · · · · · · · · · · · · · ·	Completed: 1961							
- <u>-</u>		Sompteted: 1901				ļ			
5	······································	Miscellaneous			••••••••••••••••••••••••••••••••••••••				
6	11411	Road (Asphalt)	27,552						
7		Constructed of 6" crushed stone,		· · · · · · · · · · · · · · · · · · ·					
8		double bituminous, 18' width,			***-*				
9		<u>2777 LF - 5447 S.Y.</u>							
10		Completed: 1962.							
12	11401	Park Vohiclo Non One							:
13		Hard surfaced gravel 1253 S V	4,455						
14		Completed: 1961							
15							····		
16				·					
17									
18									
19									
20								······································	
72									
23		1 							
24									
25	· · · · · · · · · · · · · · · · · · ·				·				
26		······································							
27					·····				
28									
29						<u> </u> −−−−−			
30					· · · · · · · · · · · · · · · · · · ·				
32									
<u> </u>				-					
*F	*Prefix figures with symbols to depute to								

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refix figures with symbols to denote type of space, as follows: (a) for office; (b) for storage; (c) for other.

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STAN	STANDARD FORM 118-B								
DECE	MBER 1953 CRIBED BY G	ENERAL		_					A LEVEN AGENCY NO. 2. PAGE OF PAGES
SERV	ICES ADMINIS	TRATION		LAN	D				A DUQUER QUE- 149 B OF THIS SCHEDULE
REGU	LATION 2-IV-	201.00							LEASE LICENSE USE ONLY
		SCHEDULE	B-SUPPLEME	T TO REPO	ORT OF EXC	ESS REAL PROF	ERTY		
	118-302								
LINE	TRACT	NAME OF FORMER		TRACT	1	EXCESS REAL PROPER	ГҮ	1	
NO.	NO.	NAME OF FORMER	OWNER OR LESSOR	ACQUIRED	ACRES OR-		ANNUAL	TYPE OF	RESTRICTIONS ON USE OR TRANSFER OF
				eq.ft.)	SQUARE FEET	COST	RENTAL	ACQUISITION	GOVERNMENT INTEREST
(a)	(b)	(c	:)	(d)	(e)	(f)	(g)	(h)	
1		WALKER AFB N	MISSILE LAUN	ICH COMPL	EX - SIT	E NO. 9	1		(1)
2								-	
-	Total	Reported on F	Previous						
	Sch	edule:		333.28	2333.28	\$936.00		-	
5									
6		Deletions							
7									
8	<u> </u>	ept of The I	nterior (BL	M) (2.49)	Part				
9	D	11 11 13	11 11	(209,97)	Part				
.10	5-9-F	11 11 12	11 11	(0.22)	Part				
- 11	<u>S-9-G</u>	11 11 11	11 11	(5.63)	Part				
13			Sub-Total	(192.91				
14									
15		The delet	ion covers	all Publ	ic Domai	n_at			
10		the installa	tion less L	o <u>t 5, Se</u>	c. 14, T	IS,			
1/		Range 9 Eas	t, N.M.P.M.	The ab	ove land				
10		excepted fro	m the delet	ion_is_t	he only I	ublic			
<u> </u> − <u>1</u> 3		Domain land	to be dispo	sed_of_p	ursuant ·	to			
		regulations c	of the Gener	al Servi	ces_Admiı	istration			
22		except_	manene	Kar 918	, con	alneng	41,09	acres ,	n fel
23		· · · · · · · · · · · · · · · · · · ·			ľ	/			
24						<i>v</i>			
25					- And a co	10 Atra	·		
26					- Vale	8 / 3 /20 / 5 M - 2 - 2 - 2 - 2 - 2 - 2 - 2 - 2 - 2 -			
27							A g		
28							1		
29							ļ		
30									
31									
32			· · · · · · · · · · · · · · · · · · ·						
L				777 0			L		
			TOTAL	553.28	140.37	\$936.00			
				I					

U.S. GOVERNMENT PRINTING OFFICE : 1963-0-673279

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STANI DECEI PRESC SERVI REGUI	DARD FORM (MBER 1953 CRIBED BY G CES ADMINIS LATION 2-IV-	I18-B ENERAL TRATION 201.00		1. HOLDING AGENCY NO. 2. Albuquerque-149A PAGE 1 OF 1 PAGES OF THIS SCHEDULE 3. GOVERNMENT INTEREST GSA CONTROL NO. (GSA use only)				
		SCHEDULE B-SUPPLEMEN	X PERMIT X EASEMENT					
			TRACT	E	XCESS REAL PROPERT	Y		
LINE NO.	TRACT NO.	NAME OF FORMER OWNER OR LESSOR AND ADDRESS	ACQUIRED	ACRES ORXX	COST	ANNUAL RENTAL	TYPE OF ACQUISITION	RESTRICTIONS ON USE OR TRANSFER OF GOVERNMENT INTEREST
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
1	Totals	on Previous Schedule	301.50	301,50	\$ 481	**		
2	1		•					
3		Increase in Acreage and/						
		or Acquisition Cost						
5								
6	A	Dept. of Interior	(6.74)	(6.74)	(0)* /		Transfer PL	0 2749 dtd. 8 Aug. 1962 Acquisition
7					325.		Cost.	
. 8					(325)			
9								
10	100	State of New Mexico	(1.52)	(1.52)	(100)/~		Fee (Condmn)	
11					25			Acquisition Cost added
12					(125)			Correct Acquisition Cost
13								
14	101-1	State of New Mexico	(3.96)	(3.96)	(198)*		Fee (Condmn)
15					40 √			Acquisition Cost added
16				· · · · · · · · · · · · · · · · · · ·	(238)		-	Correct Acquisition Cost
17								
18	<u>100-</u> Е	State of New Mexico	(62.02)	* (62.02)* (93)*		Easement	
19			31.78	31.78	65 N			Acreage & Acquisition Cost added
			(93.80)	(93.80	(158)			Correct Acquisition Cost
		1 						
22								
23								
24								
25								
26		<u>* Acreage and/or Acquisi</u>	tion Cos	<u>Shown</u>	on Previous	Report.	dtd. 2 July	1965.
27				· · · · · ·	· · · · · · ·	a a la ser de la ser		р. а
28								
29								
30								
31	· · · · · · · · · · · · · · · · · · ·							
32		L	·				· · · · ·	
		TOTAL	333.28	333.28	936			

U.S. GOVERNMENT PRINTING OFFICE : 1963-0-673279

·						· .		K. C. Constant of -16-65		
STAN	DARD FORM MBER 1953	118–B						1. HOLDING AGENCY NO. 2.		
PRESC	CRIBED BY G	ENERAL	I AN	n				Albuquerque-149 PAGE OF PAGES OF THIS SCHEDULE		
REGU	LATION 2-IV-	-201.00	LAN	U				3. GOVERNMENT INTEREST GSA CONTROL NO. (GSA		
		SCHEDULE B-SUPPLEMEN	T TO REPO	ORT OF EXC	ESS REAL PROP	ERTY		PERMIT		
		· · · · · · · · · · · · · · · · · · ·	TRACT	Г <u> </u>	YCESS PEAL PROPERT	· · ·	118-302	FEE AGREEMENT		
LINE	TRACT	NAME OF FORMER OWNER OR LESSOR	ACQUIRED	and a constraint of the second s	ACLOS ALAL PROPERT	[TYPE OF	RESTRICTIONS ON USE OR TRANSFER OF		
NU.	NO.	AND ADDRESS	(Acres.or	SQUARE FEET	COST	ANNUAL	ACQUISITION	GOVERNMENT INTEREST		
(a)	(b)	(c)	(d)	(e)	(f)	(9)	(b)			
1	А	Dept. of Interior	6.74	6.74		(6/		(i)		
2	B	Dept. of Interior	2.49	2.49	· · · · · · · · · · · · · · · · · · ·	•••• and	Iranster	1L0 2749, dated 8 Aug 1962.		
٦	C	Dept. of Interior	8.26	8 26	\			Insert the answerse state of the state of th		
						·		2749 for most into PLO		
5	100	State of N. M.	1.52	1.52	100		Condemn.	41+2 FOR RESTRICTED area.		
6	101-P	NM State Hwy Comm					Permit			
7	101-1	State of N. M.	3.96	3.96	198		Condma			
8		Dept_of_Interior	209,97	209,97	Cophradro Hongila	Silimutation	Transfor	PLO 2749 dated 8 Aug 1000		
9	100-E	State of N. M.	62,02	62.02	93		Fasement	1962		
10	<u> - 9-F</u>	<u> </u>	0.22	0.22	gen an approximation of the dimensional states	ېزې دا مېښې د. د او د د د د د د د د د د د د د د د د د د	Transfer	PL0 2749 d5tot 9 Aug 1000		
	5-9-E	Dept of Interior	0.69	0,69		444 1 ⁵⁴	11	1 LO 2/42, Udieu o Aug. 1962		
12	<u>5-9-100</u>	-E-2 Robt O. Anderson	(0.16)	(0.16)	90		Fasement	Acreage included in Tr 1005		
- 13	<u>5-9-100</u>	-E-3 Robt O. Anderson	(0.18)	(0.18)	*		11			
14	<u>S-9-100</u>	-E-4 Robt O. Anderson	(0.0008)	(0.0008)	*		11	11 11 11 II		
15	3-9-6	Dept.oterior	<u> </u>	5.63	i destructions de la companya de la	and the second	Transfer	PLO 2749, dated 8 Aug 1962.		
10		* Opent install to m			· .					
19		No So 100 F 2								
19		NO. J=J=100-E-Z				· · · · · · · · · · · · · · · · · · ·		All land acquired subject to		
- 13								oil, gas and mineral interests re-		
†								served to former owners and/or less		
22								Land items are to be retained		
23					· · · · · · · · · · · · · · · · · · ·			until final disposal has been		
24					· · · · · · · · · · · · · · · · · · ·			accomplished on all Government-		
25		· · · · · · · · · · · · · · · · · · ·			· · · · · · · · · · · · · · · · · · ·	· · · · · · · · · · · · · · · · · · ·		owned property located thereon.		
26					·					
27					· · · · · · · · · · · · · · · · · · ·					
28						<u>-</u>				
29					······································			· · · · · · · · · · · · · · · · · · ·		
30			· · · · · · · · · · · · · · · · · · ·							
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32			33370	2,22.2	V 431	· · · · · · · · · · · · · · · · · · ·				
		7074	301.50	301 50	-\$-481-			1		
		IOTAL			Ψ T UI					

U.S. GOVERNMENT PRINTING OFFICE : 1963-0-673279

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Compliments of The Larimer County Abstract Company, 151 West Mountain, Phone HUnter 2-1208

REFERENCE 9

579th Strategic Missile Squadron 6th Strategic Aerospace Wing (SAC) UNITED STATES AIR FORCE Walker AFB, New Mexico

OPERATIONAL READINESS TRAINING

ATLAS "F"

TASK 200

SILO FAMILIARIZATION (REVISED)

(This Guide replaces Silo Famiarlization Guide dated July 1962 and changes 1 Aug 62 and 1 Sep 62 thereto. Previous editions should be destroyed)

FOR INSTRUCTIONAL PURPOSES ONLY

SEPT 1962

FLUID LINE CODE

NAME	FUNCTION	NAME	FUNCTION
		Ing a	Town Isouid Iowel Common
AHE -	Air Supply=Valves & Controllers	NML1-	Lower Llouid Level Sensor,
APC =	Air Supply-LCC Air Cylinders		Heat Exchanger
APD -	Air Supply-PDU	NML2⇒	Lower Liquid Level Sensor,
APU =	Air Supply-PCU Valves and		Liquid Nitrogen Storage
	Controllers	NMU1-	Upper Liquid Level Sensor,
aus -	Air Supply-Blast Closures,		Heat Exchanger
	Diesel Air Tank	NMU2-	Upper Liquid Level Sensor,
FFM -	Fuel Fill Line-Missile	!	LN2 Stee,
FFP -	Fuel Fill Line-Prefab	NOD -	Equalize Pressure-Drain OFM
HAS1-	Helium Supply-PDU-Airborne Spheres	NOP -	GN2 Supply-Pressurization
HAS2-	Helium Supply-PDU-Airborne Spheres	Į	Prefab to Press LOX Tanks
HCS 🛥	Helium Supply-HCU	NOT1-	GN2 Press-LOX Storage Tank
HCX1-	Missile LOX Tank Exhaust	NOT2-	GN2 Press-LOX Topping Tank
HCX2-	Missile Fuel Tank Exhaust	NPC -	GN2 Supply-PDU-Missile Press
HES -	Helium Emerg. Supply to PCU	NPM -	GN2 Purge-Mobile SFC. Unit(L/P)
HEX -	Helium Exhaust from HCU	NPP -	GN2 Re-supply from Press 'n
HFD -	Helium Charge Line-Inflight Tanks	1	Prefab
HFP -	Fuel Tank Pressure Checkout	NPS1-	LN2 Storage Tank Press Line
HFS -	Fuel Tank Ullage Sensor (L/P)	NPS2-	LN2 Storage Tank Vent Line
ਸਸਨ _	Helium-Heat Exchanger for Airborne	NPS -	Heat Exchanger Vent Line
	Saheres	NRM -	GN2 - Retraction Mech. (L/P)
HOP -	IOX Tank Pressure Checkaut	NSD -	GN2 - PDU
HOS -	LOX Tank III are Sensor (I/P)	NSU1-	(N2 Supply-Raised Launch Plat-
HMC =	Helium_Missile Controls		Form
HNS -	Helium Normal Supply-PCU	NSU2-	GN2 Supply-Launch Platform
HRS -	Refrigerated Helium-Airborne	NTP -	M2 Supply Press 'n Frefab
11100 -	Soberea	NIIS -	GN2 Press=APCHE Maits (L/P)
HSM -	Heltum Supplie Missile from $HCII(1./P)$	NYP _	Fuel Leveling Tank Vent
NDP -	Fouslize Pressure-Drain FFM	DAF -	All Supply-GN2 Tanks (4400 B)
NEY _	Vent IN2 Tank & Relief Values an	OFC -	LOX Supply Storage Tank
TATAV =	TNO Dwatten Wither Tailor Varves with	OFM _	In Subol, source tain
សភាព	(NO Sunniv_Consund Dragenna Panis/(2008)	OFP -	IOX Supply Line Fill Prefab
NFF =	Tonalize Pressure Tessure Tank (300)	OFS -	LOX Supply Line Tenning Tenk
MED	CNO Champe I for few Fuel Duetch	OFT -	IOX Fill Ling-Cantrol Drafsh
wrf 🗢	Guidan Custor ruer rreido		Lawar Linnid Laval Saman
RTLEA	CNO Change Idne for Dockeylds	OUDT	TOX Stanses
iv⊓A ⇔	ADDATE FILE TOL UNIGHTIC	CM112_	linner Tignid Terral Sensor
17173	ACCUMULATOR'S	01:02.2	LOY TEADING
	INC Duck from Wersha Chandel (L/F)	0ST	TOT TARANSAR ISAA MIREILA
- للسلام معرو	LNZ Drain from Missile Onrouns(L/M)		Nor Inhottle PTIC= 129116
NLF -	LNZ QOAXIAL LINE-AIRDORNE DONERES	0VU -	ACUT TTUE TLOW CETTER ATAG
NLSI-	LINZ SUPPLY=LINZ Freiad	OTTE	On LUA CONCIOL FREIGO
NLS2-	LNZ SUPPLY IFOM LNZ Storage Tank	UV1 =	VENU LINE (TOM NEILE! VALVOS
NLS3-	LNZ Supply to Heat Exchanger	1177	On LUA FILL Freiad
		UVY -	Vent Line Irom LUX Tanks
		IPUX -	HUU MINAUST IFOR Meiler Valves



SILO CAP AREA

1. Silo Air Intake: Goes to air wash dust collectors on Quad 3 level #1 of the crib.

2. Silo Air Exhaust: Exits from the Silo wall at level 2, Quad 2.

3. Fill and Vent Shaft:

a. <u>GN2 and GOX Vent (OVP)</u>: To pressurization pre-fab to vent LOX storage tank through N-5 and topping tank through N-4.

b. <u>Helium Fill</u>: To Missile LOX tank from pneumatic check-out vehicle (PCV) (During MAPCHE checkout only) (HOF)

c. <u>Helium Fill (HFP)</u>: To RP-1 tank from PCV (During MAPCHE checkout only)

d. <u>LN2 Fill (NLS)</u>: Through LN2 pre-fab to LN2 storage tank and LN2 heat exchanger.

e. <u>Helium Vent</u>: (HCX-1) Missile LOX tank pressure exhaust through PCU valve 112.

f. <u>GN2 Vent (NEX)</u>: LN2 vent from LN2 heat exchanger & storage tank through LN2 pre-fab.

g. LOX Fill: (OFP) Stub up L20 through LOX fill pre-fab valves L-7 & L-6 to LOX storage & topping tanks.

h. <u>Helium Fill (HFD)</u>: 6,000 PSI helium through PDU to both inflight helium bottles. Manual valve 23 for IF #1. Manual valve 24 for IF#2.

j. <u>GN2 Fill (NPP)</u>: 4,000 PSI GN2 fill to single 500 cubic foot bottle.

k. GN2 Fill (OAF): 4,000 PSI GN2 fill to 2 ea 625 cubic foot bottles.

1. <u>GN2 Fill (NFD)</u>: To 6,000 PSI GN2 bottle (Gnd Pressurization * Routine use) through valve 25 in the PDU.

4. A. Manual Valve F-16: From missile to catchment tank.

B. Valve F-15: Missile fill stub up. (RPI)

<u>C.</u> Dirty Lube Oil Drain Line: From tank on level 5 and pump on level 6.

D. Clean Lube Oil Fill Line: To tank on level 5.

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I When West (MULTIC Missile fuel tank pressure exhaust through FUU value fint

F. GNA vent: Vent from fuel loading pre-fab (fuel leveling tank) located on level 8. (NVP)

5. <u>Demineralized Mater Fill</u>: To demineralized water tank on level #1 (may not be used),

5. Catchment Tanke Access & vent (15000 gal cap).

7. A. F-17: RP-1 fill stub up.

B. F-20: One way check value to RP-1 catchment tank.

C. F-18: RP-1 manual shut off valve located between F-19 and F-20.

D. F-19: Catchment tank fill stub up.

8. Diesel Fuel Tank Fill: To diesel storage tank (15,300 gallon cap).

9. Diesel Fuel Tank Vent:

10. <u>Cooling Water Tower</u>: Cools condenser water to maintain return water temp at 90°F. Receives 8 GPM make up water from the utility water system through a chemical pot feeder on level 1. Cools Diesels, Water Chiller Units and Instrument Air Pre-fab.

11. <u>Collimator Sight Tube Opening</u>: Used to orientate the collimator to true North.

12. <u>Utility Water Tanks and Vents</u>: 4 ea tanks 6¹/₂ feet under surface. Total capacity 91,000 gallons. 1-16,000 gallon, 3 ea 25,000 gallon. High level alarm 89,450 gallons, low level alarm at 79,300 gallons.

13. LCC Entrance:

14. <u>LCC Sewer Vent</u>: Blast closure closes automatically in event of nuclear blast for 20 seconds, then opens.

15. <u>LCC Air Exhaust</u>: 16" blast closure closes automatically in event of nuclear blast for 30 minutes, then opens.

16. <u>LCC Escape Hatch</u>: Shaft contains 4 tons of sand which empties into level 1 of LCC when trap door is opened.

17. <u>LCC Air Intake</u>: 16" blast closure closes automatically in event of nuclear blast for 30 minutes, then opens.

18. <u>Blast Detection Optical Sensors (2 ea)</u>: Converts the light radiation of a nuclear blast to an electrical pulse which is sent to the Muclear Blast Detector Unit on level 2 of the LCC. The same mast has an optical test light which simulates the light of a Muclear Blast.

- NOTE: Used in conjunction with the optical sensers are 3 ea buried loop anntennae to detect ground shock. Each antenna consists of a 2 foot diameter loop, 10 feet underground and a matched test antenna.
- 19. Raw Water Storage Tank: Contains Unprocessed water.
- 20. Water Plant Building Containing:
 - A. #1 Well and Pump.
 - B. #2 Well and Pump (may be in seperate pump house).
 - C. Deminerialization, Filtration and Softening Equipment.
- 21. Processed (Product) Water Storage Tank:

NOTE: Location and makeup equipment (19,20,21) varies from site to site.

- 22. Electrical Stub-ups: 480 VAC power from NEMCC
 - A. Helium Compressor Elect Connection, 75KW
 - B. Oxygen recharger electrical connection, 75KW
 - C. MAPCHE check-out vehicle electrical connection. MAPCHE contains electronic equipment for rapid automatic checkout of the various missile systems.
 - D. Ground connection.
 - E. DMU electrical connection. Now called PTS (Pneumatic test set), Set supplies pressure to the missile during installation and removal and during MAPCHE checkout. 50KW
 - F. GN2/LN2 recharger electrical connection, 130KW
 - G. Engine service trailer stubup. 25KW
 - H. 110V AC 30 general purpose outlet.
- 23. Comm Box (3) (Areas 3.4 and 11)
- 24. Electrical Connection: For fuel (RP-1) purification unit,
- 25. <u>Personal Warning Light and Horns</u>: Located above LCC actuated from FRCP, Level 2 of LCC.

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- 26. <u>Silo Doors</u>: 2 ea. 150,000 lbs, 16³ 8ⁿ X 22³ X 2³ 6ⁿ thick with a 14ⁿ overlap, Designed to withstand over-pressure of 100 PSI. Each door opens to 95^o in 19 seconds. West door opens 6 seconds after start of east door. Total door opening time 25 seconds.
- 27. <u>Breakaway Cylinders</u>: 2 each door assists main door actuators. Has 4" stroke with 37,500 lbs lifting capacity.
- 28. <u>Main Door Actuators</u>: One for each door. Has snubbing action from 90 to 95 degrees of upward travel.
- 29. Horizontal Crib Locks: (3 each) 120 degrees apart, (NW-NE-S)
- 30. <u>Uplock Strikers</u>: (For Launcher Platform) 4 each. Used to lock the launcher platform to the silo cap when the launcher platform is in the raised position.
- 31. Comm "J" Boxes

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- 32. P.A. Alert Button
- 33. Silo Sump Pump Discharge on to Ground Through 6" Pipe. Location may Vary.
- 34. <u>Catch Basin</u>: Receives waste water discharge from water processing plant when equipment is back-flushed. Location may vary.
- 35. Tile Field: Receives discharge from LCC sump pumps.





T. O.

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Section

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1-13

CENTER

Introduction: fne launch Control Center (LCC) is a cylindrical structure 40 feet in diameter, by feet below grade, and contains a 2 story steel structure called a hung floor. This hung floor hangs from the ceiling of the concrete structure by a suspension system that is air cushinned to abcord ground shock.

The entranceway to the ECC consists of a stairway down from grade level, entrapment area, two blast doors, connecting tunnel and a stairwell for the ECC levels and to the silo connecting tunnel.

The upper floor (level 1) of the LCC is divided into various rooms: Ready room and storage area, fanitor room, latrine and shower room, kitchen and dining area, heat, vent and air conditioning room, and medical supplies room.

The lower floor (level 2) of the LCC is also divided into various rooms in which the actual launch equipment is located: Launch Control Room, office, battery room and communications and equipment room. The tunnel to the silo connects LCC level 2 and sile level 2.

The utility tunnel which connects the LGC with the silo is approximately 50 feet long with an inside diameter of 8 feet. Two blast doors are presently located at the silo end of the tunnel together with two blast plates. These blast plates are permanently bolted to the concrete walls (one on the inside wall of the silo and the other in the tunnel) and have numerous $2\frac{1}{2}$ inch holes used for routing cables between the LCC and silo. A third blast door is to be installed at the LCC end of the tunnel.

Entranceway to LCC

- 1. Grade entry door and micro switch
- 2. Stairway down
- 3. Telephone
- 4. Bull horns (5 ea)
- 5. Entrapment area door warning buzzer
- 6. Entrapment area = two doors and micro switches
- 7. T.V. monitor camera
- 8. Blast'doors (2) and micro switches

9. LCC Stairwell air exhaust vent

10. LCC Stairwell blast closure - 10"

- 11. Energency lighting
- 12. Sewer Drain
- 13. Sewer Vent

LEVEL QUE LEC.



LCC LEVEL 1

- 1. Hulity Room
- 2, <u>Electric Mater Heater</u>
- 3. Utility Sink
- 4. <u>Air Support Cylinders (4)</u>: The LCC contains a 2 story steel structure. This steel structure hangs from the concrete roof by a suspension system that is air cushioned by 4 supporting and leveling cylinders with approximately 350 ± 15 PSI instrument air supplied to them. The 4 cylinders provide air suspension and absorb ground shock. The support cylinders are individually and automatically controlled to maintain the structure level under normal operating conditions.
- 5. Latrine and Shower Room
- 6. <u>Kitchen and Dining Area</u>: The kintchen and dining room has all equipment necessary for a ten day isolation of the launch crew. This equipment consists of a stove, sink with disposal, refrigerator freezer, tables and chairs. Enough food will be stored in the kitchen area to feed the launch crew during a possible ten day isolation period.
- 7. Facilities Electrical Cabinet
- 8. Center Column with Canvas Enclosure
- 9. Heating, Ventilation and Air Conditioning Room: Equipment in this room is capable of supplying approximately 5550 CFM of clean refrigerated (or heated) and dehumidified air to the LCC. Air is drawn thru the above ground air intake duct, a 16" blast closure and filters (including a CBR filter) by a 7½ hp motor and supply fan (S-1). This same fan then forces the air thru a chilled water coil and a heated water coil and thru ducting to both levels of the LCC and the silo tunnel. Normally, approximately 3800 CFM of the 5550 CFM is recirculated air and 1750 CFM is fresh "outside" air. The LCC exhaust fan (E-1) draws approximately 1100 CFM of air from the communications emergency battery room, the kitchen and latrine and forces this air thru a 16" blast closure and out an above ground exhaust vent. In addition to the "recirculated" air and the "exhausted" air, approximately 650 CFM of air flows from the LCC thru the LCC stairwell 16" blast closure and vents into the LCC entranceway tunnel.
- 10. Air Intake Blast Closure 16"
- 11. Medical Supplies Room
- 12. Escape Hatch and Ladder. Filled with 4 tons dry sand
- 13. Air Regeiver Tank
- 14. 300 PSI Lines for 4 Blast Closures
- 15. <u>Five 500 PSI Lines</u>: L to R,1 ea. supply line to reciver tank and 4 ea. supply lines to LCC support cylinder regulators.
- 16. Electrical Cabinet
- 17. Air Exhaust Blast Closure 16"
- 18. Electrical Cabinet
- 19. Sewer Vent Blast Closure
- 20. LCC Stairwell Blast Closure 16"
- 21. Comm Box (Sta 35)
- 22. Speakers
- 23. Emergency Light (6VDC)



LCC LEVEL TVO

- 1. <u>Launch Control Console</u>: Monitors standby and countdown status of weapon system with light and pressure gage indications. Has controls to start countdown, commit and abort sequences.
- 2. <u>Facilities Remote Control Panel</u>: Monitors RPIE. Can control blast closures and missile enclosure fog system.
- 3. <u>Power Remote Control Panel</u>: Monitors and partially remotaly controls the diesel generators.
- 4. T.V. Monitor & Controls: More than one system may be installed.
- 5. <u>Gate and Door Control</u>: The gate and door control panel contains 3 buttons and 3 indicator lights. The gate control button and light are for entrance through the perimeter gage (this may or may not be installed). The No. 1 entrapment area, after identification by T.V. The No. 2 button and light will permit entrance through the second security door. Both security doors are electrically un-locked and locked.
- 6. <u>Blast Detection Console</u>: Detect nuclear blast, closes blast closures and causes guidance to go on memory.
- 7. <u>Fire Alarm Panel and Rectifier (12VDC)</u>: Provides fire alarm and monitor system. (See "note" for Fire Detector Zones and Locations.)
- 8. Fire Alarm Batteries (12VDC)
- 9. Blast Detection Terminal Cabinet
- 10. <u>Battery Bank (Comm)(48VDC)</u>
- 11. <u>Comm Cable Dryer</u>
- 12. Battery Charger for Communications Battery Bank and Telephone Fingers
- 13. <u>Distribution Transformer 440 V (45KVA)</u>
- 14. Lighting Panel "D" : Provide controlling Ckt. Eks for light system
- 15. <u>Launch Control Center Motor Control Center</u>: 480 V 60 cycle power through breakers for LCC.
- 16. <u>Telephone Terminal Cabinet</u>
- 17. P.A. Terminal Cabinet
- 18. <u>Central Distribution Frame</u>

- 19. <u>Power Distribution Service Cabinet (120/208 Volts 60 Cycle)</u>: For inter-site telephone carrier. Has 130V and 48V breakers.
- 20. Lighting Panel 'C': For communications.
- 21. Launch Enable System
- 22. <u>P.A. System</u>: Controls, amplifier (6 ea) and pre-amplifiers.
- 23. Emergency Lights (6VDC)
- 24. <u>Alarm Annunciator</u>: Visual and audible alarm or communications malfunction.
- 25. Switch for Air Conditioning Unit (Ref #31)
- 26. Floer Access Doors
- 27. Access, Leveling Devices
- 28. LCC Lighting Panel "A":
- 29. Alarm Annunciator and Comm Override Lock Switch
- 30. Water Plant Panel
- 31. Communications Room Air Conditioning Unit Chilled Water Only

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- 32. <u>Sewage Pumps (2)</u>: From LCC to septic tank and tile field.
- 33. <u>Control Station Manual Operating Level</u> (new location) Manual Operation of AMF.
- 34. Speakers
- 35. <u>Telephone (Sta 39)</u>
- 36. Circuit Breaker for LES
- 37. Circuit Breaker Cabinet for Bell Ringers and Communications Battery (48V) Chargers.
- 38. Fuse Box (slow-blow type): For bell ringers.
- 39. Switch for Fan Coil Unit-(FC-1)

- 40, <u>staral Back for Site Comm Boxes</u>
- 41. Central Rack for Direct Lines (C.P., ACP etc) and Explosion Proof (E.P.) Corm Ecxes
- 42. Dial Telephone Cable Carrier Maye Equipment
- 43. Telephone Patch Panel to Each Site and MAMS and Cable Carrier Wave Equip
- 44. Power Supply Panel for Carrier Wave Equipment

	Manual repo ance to Fac	orting stations on Levels 2, 4, 6 and 8 at ent cility Elevator.)r=
	8	LCC	
	7	MEA Levels 6, 7 and 8	
,	6	MEA Levels 2, 3 and 4	
	5	Silo Levels 7 and 8	
. '	4	Silo Level 6	
	3	Silo Level 5	
	2	Silo Levels 3 and 4	
	1	Silo Levels 1 and 2	
	ZONE	LOCATION	
NOTE:	FIRE DETECTOR	R ZONES AND LOCATIONS	

QUAD. II

QUAD. I



III · QUAD.

SILO - Level 1

- 1. <u>Facility Elevator</u>: Combination freight and passenger elevator for interlevel service from level 1 to level 8, 6000 lb capacity, electrically operated.
- 2. <u>Facility Elevator Drive and Control</u>: Electric motor incorporating reduction drive and sheaves and pulleys providing motive force to raise and lower facility elevator.
- 3. <u>Launcher Platform Drive</u>: Elevates and lowers the launcher platform, between stowed and launch positions, under all load conditions. Direct machanical actuation is supplied by either one of two 125 hp electric motors operating through a power transmission that rotates the two drive sheaves. Five cables for each of the two drive sheaves are attached to the crib structure at one end, and pass under the sheaves at the top of the counterweights, rise and reeve about the drive traction sheaves, undersling the launcher platform sheaves, and are anchored at the top of the crib structure through tension equalizers.
 - A. Low Speed Motor
 - B. Aux Speed Decreaser
 - C. Clutch (Shaft Coupling)
 - D. Main Speed Decreaser
 - E. Brake
 - F. High Speed Motor
 - G. and H. Drive Sheaves
- 4. <u>Launcher Platform Guide Rails</u>: Located on three sides of the launcher platform serve to guide launcher platform as it is lowered and raised within the silo. These rails minimize lateral movement, or tilting of the launcher platform and provide a smooth vertical track for the launcher platform travel, The rails are of I-beam construction with flanges to provide a smooth bearing surface.
- 5. <u>Spray Pumps (P20 & 21)</u>: Consist of two water pumps, each with a capacity of 280 gpm flow. The pumps are connected in parallel, as one pump is in continuous operation and the other pump is on standby. Water is pumped to the sprayers in the dust collectors and then recirculated by the operating pump. Water losses are supplied by the makeup tank, item 12.
- 6. <u>Circular Stairs</u>: An all steel circular stairway, 5 ft in diameter, goes from level 1 to level 7, thereon a vertical ladder is used to level 8.
- 7. <u>Air Conditioning Ducts</u>: Distributes air throughout the crib and is routed to the 8th level.

- 5 <u>Lust indicates (DCPO & 21)</u>: Cylindrical, wet impingement type air washes -bust collector units. Cleans supply air prior to distribution.
- <u>Supply Fass (SF 20 & 21)</u>. Draws the air from the dust collectors and distributes to the air ducting. Alternately used when outside temperature below 60°F.
 - a. Direct driven axialvane inlet fan
 - b. 20 hp 1750 rpm, 440v, 3 phase, 60 cps

c. Water agitator equipped sump

- 10. <u>Air Intake Plenum</u>: Provides intake air chamber to the dust collector units.
- 11. <u>Sand Settling Tank</u>: In series with dust collectors, provides trap to allow impurities washed from conditioned air to precipitate out. 1 amp to sump.
- 12. <u>Air Wash Water Makeup Tank</u>: In series with sile air conditioning system.
- 13. <u>Chilled Water Tank</u>: In series with main water chilling system located on fourth crib level. This tank acts as a header or expansion tank. App 30 gpm.
- 14. Launcher Platform Motor Control Center: Contains controls that provide power for the two electric motors that in turn afford power to raise and lower missile. The 125 hp motors operate from 480v, 60 cps, 3 phase current. Also furnishes power to amf logic racks, hydraulic power pack and launch platform drive control.
- 15. <u>Launcher Platform Drive Control</u>: Both motors are controlled from a common saturable-reactor type control network. Motor speed is controlled by tachometer feedback control.
- 16. Logic AMF Racks (4): Controls the automatic and proper sequencing of mechanisms for raising the missile for launch and then return platform to hard state. Provides checkout and test of this lifting mechanism and locates malfunctions.
- 17. <u>Demineralized Water Tank</u>: Capacity 345 gal. Furnishes make-up water to chilled water system, hot water system, and diesel engine closed loop cooling system.
- 18. Demineralized Water Pump (P-90): Transfers water from demineralized water tank through a one way check value to systems listed in para. 17. Pump is automatically controlled by liquid level control values in the chilled and hot water systems. Manual operation is from FTC #2, silo level 2.

- by. <u>Classed For Feeder</u>: Softins 8 gpm utility water for use in the concensor water system.
- 20. Intake Vents and Blast Closures: Two 46 in. outside diameter pipes allow the intake air to the silo air conditioning system. It will automatically close upon detection of thermonuclear radiation. Elect heaters and dampers being installed.
- 21. Emergency Lights (6 Volts)
- 22. Comm Box
- 23. Loud Speakers (2 Each)
- 24. <u>Control Manual Operating Level (Manual Operation of AFM System)</u> Quad II (old location)
- 25. Missile Lift Junction Box
- 26. <u>GN2 Pressure Guage (GN2 to Silo Doors Actuators for Cushion)</u>
- 27. Fire Extinguisher
- 28. <u>Warning Horn</u>
- 29, NCU Connect: GN2 to NCU when L/P is up and locked,
- 30. Safety Platform & Elevator Entrance (Performent for the former
- 31. Diesel Fuel Storage Tank Shutoff Valve
- 32. <u>Overspeed Control Box</u>: This unit provides a means of checking the operation of the overspeed sensor and contains an annunciator to indicate that an emergency stop has been initiated by the overspeed sensor.

QUADI



QUAD IN

Level 2

QUAD II

27



LEVEL 2

VIEW A

- 1 HYDRAULIC PUMP AND RESERVOIR
- 2 HYDRAULIC ACCUMULATOR AND
- GASEOUS NITROGEN PRESSURE TANKS
- **3** INTERCONNECTING JUNCTION BOX
- **4 LIGHTING PANEL LA**
- **5 LIGHTING PANEL LD** 6 30 KVA TRANSFORMER
- 7 LOCAL CONTROL HYDRAULIC PANEL
- 8 NONESSENTIAL MOTOR CONTROL CENTER 9 COMPRESSED AIR SYSTEM REGULATOR PANEL
- 10 ESSENTIAL MOTOR CONTROL CENTER
- 11 EXHAUST FAN BLAST CLOSURE AIR COMPRESSOR
- 12 SILO EXHAUST FAN AND PLENUM 13 GASEOUS OXYGEN VENT
- 14 WORK PLATFORM 1
- 15 LAUNCH PLATFORM COUNTERWEIGHT
- 16 MANIFOLD ASSEMBLY WORK PLATFORMS CRIB LOCKS SILO OVERHEAD DOORS
- 17 FILTERS

40. 10-116A

Figure 1-24. Silo Level 2 Equipment Location

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SILO LEVEL 2

- 1. Facility Elevator
- 2. <u>Facility Elevator Counterweights</u>: Consist of iron slabs which are guided by rails and lower to the 8th level. Has chain attached to bottom to compensate for cable weight changes.
- 5. <u>Launcher Platform Counterweight</u>: This slab unit comprises 26 cast iron and three steel slabs bolted together to form a 541,000 lb counterweight. The counterweight minimizes the power requirement to raise and lower the launcher platform together with a fully load ed missile and all AGE on the platform. The V-shaped groove in each vertical end of the counterweight accomodates a guide rail. The counterweight weighs approximately 6000 pound more than the launch platform.
- 4. Launch Platform Guide Rails
- 5. <u>AC Outlets</u>: Three full size ac outlets provide receptacles for use of 115V and 208V.
- 6. <u>Spiral Staircase</u>
- 7. Air Conditioning Duct
- 8. <u>Hydraulic Reservoir and Pump Unit (Hyd Power Pack)</u>: Contains a 275 gal reservoir, a 1 hp 5 gpm electric driven hydraulic pump with 200 psi output, a 40 hp 20 gpm pump with 3000 psi output, one accumulator and necessary filters and valves. Pumps receive power from M/L MCC and provide power to horizontal and vertical crib locks, doors, launch platform brakes, drive complings and the work platforms.
- 9. Launcher Platform Fan Coil Unit (FC-40): Provides positive circulation of conditioned air throughout launch platform contained units.
- 10. <u>Accumulator Rack</u>: Eight accumulators and 5 GN2 bottles are mounted in a support rack. The hydraulic fluid is pressurized by 3700 psi nitregen gas. Six accumulators and 2 GN2 bottles are used to operate the silo doors and the remaining two accumulators and 3 bottles operate the other systems.

NOTE: Sile Air Conditioning	Specifications
Areas	Temperatures
Launch Platform Enclosure Collimator Control Cabinets Remainder of Silo	70°F ± 5° 65% RH 70°F ± 3° 65% RH 70°F ± 3° 65% RH 50°F to 100°F

- <u>intrative Control Pasel</u>: Provides (1) a means of pinpointing trouble areas. (2) ranual control of the main and standby hydraulic pumps and (3) control of nitrogen cylinder recharging.
- 13. <u>Sand Settling Tank</u>: Allows solid impurities washed from conditioned air to precipitate out. 1 GPM to sump.
- 30 KVA Lighting Transformer: Input of 440 volts is reduced to 120/208 V, 3 phase power through panel LD to the lighting panels LA and LB for illumination of the crib and launch platform. (100 Amp with 70 A Breaker)
- 15. <u>Lighting Panel LA</u>: Provides 120VAC 60 cycle, single phase to silo lighting at silo levels 1,2,3 and grade.
- 16. Distribution Panel LD: Receiver 120/208VAC from the 30DVA lighting transformer on level 2 and distributes it to lighting panel LA on level 2, lighting panel LB on level 4, RP-1, diesel fuel and GOX detectors on level 7, and to the 6V emergency lighting chargers and relays on all levels.
- 17. <u>Nonessential Motor Control Center (10 Units)</u>: Controls main air supply fans (2-20 hp each), lower silo supply fan (3 hp), hot water heater, (1 hp), main exhaust fan (15 hp), exhaust vent bent blast closures, waste water pump (10 hp), standby spray pump, spray pump, LO2 vacuum pump, LO2 vacuum pump subcooler, LN2 vacuum pump, water condensate return pump, missile fuel drain pump, fog system pump, water chiller pump, dirty lube oil pump air compressors (2-15 hp), utility water pump, defueling pump, condenser water pumps, hot water pump, hot water pump standby, launch platform purge exhaust fan, launch platform exhaust fan, launch platform fan control unit, 30 KVA transformer silo level 2 and detector units silo level 7. This bus is de-enterized at commit as these items are not necessary for launch.
- 18. Exhaust Duct for Level 6

- 19. <u>Essential Motor Control Center (Six Units)</u>: 30KVA transformer, silo level 3, DC power supply unit, pod air conditioning control cabinet for air handling, air handling fan, control cabinet fan coils, thrust section heating blower, thrust section heating element, hydraulic pumping unit, 400 cps motor generator and distribution system, 48 vdc battery rectifier, water chiller unit, chilled water pump, emergency water pump. Contains motor controllers protective circuit devices and pilot controls for equipment required for standby and countdown.
- 20. <u>Air Compressor</u>: Supplies compressed air for electro-pneumatic panel.
- 21. Exhaust Plenum: Collects silo air conditioning exhaust and diesel exhaust into common plenum which vents gases to the atmosphere.
- 22. Main Exhaust Fan (EF-30): Provides impetus to used silo air, diesel exhaust and RP-1 vapors, with draws accumulated waster from plenum and forces it to vent to atmosphere at ground level. Draws air from silo levels 2 and 5.

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- 23, <u>Telephone Terminal Cabinet</u>: Provides switching center to facilitate routing of telephone communication between silo and LCC.
- 24. Fire Alarm Bell
- 25. Fire Alarm Cabinet
- 26. <u>Diesel Exhaust:</u> Exhaust gases carried toward exhaust plenum from diesel engines located on levels 5 and 6.
- 27. Exhaust Vents and Closures: Two 46 in. outside diameter pipes provide exit of contaminated air into the exhaust tunnel and shaft. Blast closure doors will automatically close upon detection of thermonuclear radiation.
- 28. Emergency Lights, 6 Volts:
- 29, Fire Manual Alarm
- 30. FTC #1
- 31. Comm Box
- 32. Test Switch for Upper Silo Exhaust Fan
- 33. Hydraulic Manifold
 - A. Hydraulic doors manifold (2 each).
 - B. Crib Locks, and launch platform locks.
 - C. Work Platforms.
 - D. Launch Platform drive brake.
- 34. <u>Missile Enclosure Air Exhaust</u>: Air into missile enclosure area on level 7.
- 35. Hydraulic Manifold J Box
- 36. Portable Fire Extinguisher
- 37. GOX Vent: Mechanically extended and retracted (see P26, par 38)
- 38. <u>Sump Pump Discharge</u>
- 39. Condenser Water Supply (From cooling tower)
- 40. Condenser Water Return (To cooling tower)
- 41. <u>Electro-Pneumatic Panel</u>: Contains controls for electro-pneumatic valve system operation in the water and air conditioning systems.
- 42. FTC #2: Contains controls and indicators for EMCC and NEMCC equipment. The fact that it is physically a part of the NEMCC is insignificant.
- 43. Missile Enclosure Area Makeup Air Input



PASTALIT TERMINAL CABINET #2

	Water Chiller Unit WCU-51 - "High Pressure" light.
·.*	Water Chiller Unit WCU-51 - "Chilled Water Warm" light.
3.	Water Chiller Unit WCU-51 - "Oil Pressure Low" light.
ي د نه	Blank
- ș,	Launch Platform Exhaust Fan EF-40 - "Run" light,
- 6.	Launch Platform Purge Exhaust Fan EF-41 - "Run" light.
- 7.	Lower Silo Supply Fan SF-22 - "Run" light.
3.	Blank
- 9.	Launch Platform Purge Supply Fan SF-41 - "Run" light.
10,	Water Chiller Unit WCU=50 - "High Pressure" light,
11.	Water Chiller Unit WCU-50 - "Chilled Water Warm" light.
12;	Water Chiller Unit WCU-50 - "Oil Pressure Low" light.
13.	Thrust Section Pressure Fan PF-70 - "Run" light; Start and Stop switch.
- 14,	Thrust Section Heating Coil EC-71 - "On" light.
15.	Launch Platform Fan Coil Unit FC-40 - "Run" light; Start and Stop switch.
16,	Main Exhaust Fan EF-30 - "Run" light and Hand-Off-Automatic switch.
17.	Oxygen Purge Reset - Reset Oxygen Detector Before Resetting Purge Cycle - Reset Button and Green Light.
18.	Hot Water Pump P-60 & P-61 - P-61 "Run" light, P-60 "Run" light and "P-60 - Off - P-61" selector switch.
19.	Spray Pump P-20 & P-21, P-21 "Run" light, PS-20 "Run" light; "P-20-0ff- P-21" selector switch.
20,	Supply Fan SF-20 & SF-21 - SF-21 "Run" light, SF-20 "Run" light and "SF-20=Off-SF-21" selector switch.
21,	Condenser Water Pump P-30 & P-31 - "Run" light and "Hand-Off-Automatic" selector switch.

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QUAD IV



LEVEL 3

- RE-ENTRY VEHICLE PRELAUNCH MONITOR AND CONTROL UNIT
 COUNTDOWN GROUP
 LIGHTING PANEL
 LIGHTING PANEL

- 4 FACILITIES INTERFACE CABINET 5 CONTROL MONITOR GROUP

- 1 OF 4 AND 2 OF 4 6 480-VOLT 30-KVA TRANSFORMER
- 7 LAUNCH CONTROL POWER PANEL 8 CONTROL MONITOR GROUP

- 8 CONTROL MONITOR GROUP
 3 OF 4 AND 4 OF 4
 9 28 VDC BATTERY
 10 400 CYCLE SKID MOUNTED MOTOR-GENERATOR TYPE MD-2
 11 DISTRIBUTION BOX
 12 POWER SUPPLY DISTRIBUTION SET

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Figure 1-43. Silo Level Three Equipment Location

SILO LEVEL 3

- -- Facility Elevator
- 2. Facilaty Elevator Counterweights
- 3. Launch Platform Counterweights
- 4. Launch Platform Guide Rails
- 5. <u>G.E. Pre-launch Monitor</u>: Capable of continuous and periodic monitoring of the mated re-entry vehicle. MK3 or MK4 can set R/V for ground or air burst.
- 6. Circular Staircase
- 7. Air Conditioning Ducts
- 8. <u>ARMA 1A1, 1A2 Racks</u>: Two racks provide the continuous hold of the inertial guidance alignment system and includes confidence checks on the system. Controls and monitors the guidance system during C/D,
- 9.
- 10. Telephone Cabinet: Terminal board for all telephone cabling in the silo,
- 11. <u>Pod Cooling J Box</u>: All three units receive electric power, 440, 3
 12. <u>Hydraulic Pump J Box</u>: Center and from these three function boxes electric power is routed to the cableloop assembly,
- 13. Launch Platform J Box: crib to launcher.
- 14. Facility Interface Cabinet: Junction box for providing electric power to the following prefabs: liquid oxygen, fuel and pressurization.
- 15 and 16. <u>Control Monitor Group 1 & 2</u>: Two units contain necessary relays, computers, comparators, and mircuitry to sequentially send actuation signals to the missile and AGE during countdown. They obtain feedback information from these actuations, compute and compare these signals and present results of this analysis as GO/NO=GO signal at the launch control console.
- 17 and 18. <u>Control Monitor Group 3 & 4</u>: Two units designed to simulate signals that are normally produced by the missileborne and ground support equipment when stimulated by the two logic units. The feedback of signals from the simulated system of the LSR is computed and compared by the logic units and results are indicated as GO/NO=GO signals on the launch control console. Primary purpose of the LSR is to checkout the operation of the logic units and the launch control console and identify any malfunctions of these units.

6.3

- A solution of the lower Supply Panel: Distributes 120/208 volts, 3 phase, ab epo to the logic units, LSR units, GE pre-launch monitor and the ARMA gaidance units.
- 20. <u>30 KVA Transformer</u>: Reduces 440 volts, 3 phase, 60 cycles to 120/208 volts and this power is routed to the launch control power supply panel, item 19.
- 31. <u>50 Cycle and 400 Cycle AC Distribution Panel</u>: Receives 120/208 volts, 3 phase, 400 cycles from the motor generator and directs it to the logic units, LSR units and ARMA guidance units. Motor generator requires 440 volts, 3 phase 60 cycle input from the motor control center. Voltage regulation is controlled electrically and frequency regulation is controlled by the 60 cycles power to the synchronous drive motor. Has SPGG and engine valve heater indicators.
- 22. <u>28 VDC Power Supply Switch</u>: 60 amp, unfused safety switch for AC power input into the 28 vdc power supply unit.
- 23. <u>Motor Generator Disconnect Switch</u>: 30 amp, unfused safety switch for the AC power input into the motor generator unit.
- 24. Spare J Box
- 25. Drinking Fountain
- 26. MD-2 Motor Generator (400 Cycle)
- 27. <u>Control Cabinet Fan Coil Unit</u>: Contains three electric heating coils, one chilled water coil, and a 2 hp electric fan motor. Furnishes condioned air to launch control cabinets, checkeut equipment (LSR), ARMA - racks, and collimater equipment. Manually controlled from FTC #2, silo level #2.
- 28. <u>Plenum</u>: Air shamber for the control cabinet air conditioning system.
- 29. Emergency Missile Power Battery: This equipment supplements the normal 28 vdc power supply and distribution unit during countdown. Provides an emergency source of 28 vdc shutdown power in event normal 90 power supply as a malfunction or an AC input voltage failure. Battery unit consists of 21 nickle-cadium alkaline cells mounted on wood travs. Each cell has an amp-hr rating of 240 amp-hr at the 8 hr rate to a cell voltage of 1.14 volts. Trickle charge from the main power supply (rectifier) will maintain the charging of the batteries. A test panel with a voltmeter, cell selector switch and a press-to-read switch will enable to check each individual cell.
- 30. Diesel Exhaust: Exhaust piping from levels 5 and 6.

32. Comm Box

- 33. Portable Fire Extinguisher
- 34. Fire Detector Head
- 35. P.A. Speaker
- 36. Emergency Lights
- 37. Fire Detector Head
- 38. <u>GOX Vent Blast Closure</u>: GOX from the missile boiloff valve through the duct on level 2 exhausts through the fan and 24" blast closure into the bottom of the fill and vent shaft.
- 39. <u>Transformer Rectifier (28 VDC)</u>: Power supply component consists of a transformer rectifier assembly with required power input of 440 AC volts, 3 phase, 60 cycle. The output is 28 DC volts, 600 amp. A power distribution panel is mounted to the power supply unit. It contains the relays and terminals to switch and distribute rectified 28 vde and/ or battery DC to the ground support equipment and to the missile.
- 40. Main Utility Water Shutoff Valve Located on Silo Wall
- 41. Commerical Power Cable Entrance Throught Silo Wall
- 42, <u>Telephone Terminal Cabinet</u>
- 43. GOX Vent Blast Closure "J" Box
- 44. Cable Loop to Cap: Ref #22, page 1
- 45. AMF "J" Box: For work Platforms.
- 46. Filter for Utility Water to Airwash Duct Collectors



Level 4





LEVEL 5

1	480-VOLT SWITCHGEAR		7 CLEAN LUBE OIL TANK
2	INSTRUMENTATION BOXES (OSTF-2)		B HEAT RECOVERY SILENCER
3	SURGE PROTECTION PANEL (EXCEPT OSTF-2)		9 WATER HEATER (OSTF-2)
4	DIRTY LUBE OIL TANK	1	D DIESEL DAY TANK
5	500 KW DIESEL GENERATOR	1	1 WORK PLATFORM 2
6	AIR RECEIVER (OSTF-2)		

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Figure 1-25. Silo Level 5 Equipment Location

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SILO LEVEL 5

- L. Facility Elevator
- 2. Facility Elevator Counterweights
- 3. Launcher Platform Counterweights
- 4 Laumener Platform Guide Rails
- 5. <u>480V Diesel Switchgear</u>: This unit receives the 440 vac, 3 phase, 60 cycle produced by the diesel generators. From the circuit breakers, which have protective trip breakers for undervoltage or overcurrent loads, the electrical power is distributed to the essential motor control center, nonessential motor control center, missile lift (L/P) motor control center and the launch control center. Operation of this switchgear can be locally controlled or partially remotely controlled from the launch control center.
- 6. <u>Circular Stairs</u>
- 7. <u>Air Conditioning Ducts</u>
- 8. Cpening Grating
- 9. <u>Dirty Lube Oil Tank (Overhead</u>): Dirty lube oil from the two diesel generators is pumped into this tank. The tank capacity is 348 gal, size is 3 ft diameter by 7 ft length.
- 10. <u>Diesel Generator (#60)</u>: The diesel engine is a model 40, manufactured by White Diesel Engine Division, Springfield, Ohio. It is a heavy duty, vertical, multicylinder, solid injection full diesel type: The electrical power unit is a roller bearing synchronous generator, manufactured by the Ideal Electric and Manufacturing Company. Specifications are: kw 440, dva 550, volts 480/277, amp 662, rom 720, temperature 50°C, continuous duty, 3 phase, 4 wire, 60 cycles.
- 11. <u>Diesel Fuel Storage Tank (Overhead)</u>: Stores adequate diesel fuel for one day operation. Capacity is 665 gal. Fuel oil from external underground tank of 15,300 gal is drawn continuously in a topping process to maintain the silo storage tank in a full capacity.
- 12. <u>Clean Lube Oil Tank (Overhead)</u>: Provides clean lube oil to the two diesel generators. Capacity is 348 gal, size is 3 ft diameter by 7 ft length.
- 13. <u>Heat Recovery Silencer</u>: Designed as a muffler silencer for the diesel exhaust gases and also has a heat recovery unit. The heat recovery unit has coils in the silencer for heating of demineralized water which is circulated to the launch control center, thrust section heat coil and the air conditioning units.

- <u> Brinking Pater</u>
- Diesel Exhast
- 16. Comm Boy
- 17. Emergency Light (6 Volts)
- 13. Commercial Power Circ Breaker
- 19. Electric Hot Mater Heater Circuit Breakers
- 20. Exhaust Section Temperature
- 21. <u>Vertical Crib Locks (4 Ea)</u>: Locks the crib to the silo wall by removing the spring tension on each odd numbered suspension spring. See page 66, item B and diagram on page 63.
- 22. Work Platform Key Switch
- 23, Fog System Control Valve
- 24. Fog Nozzles (4 Each)
 - NOTE: Water Fog System pressure supplied by the fog system pump on level 4. Pump rated at 500 GPM. Fog System turned on manually at the FRCP in the LCC.
- 25. Telephone Terminal Cabinet
- 26. Ladder to Work Platform #2
- 27. Fire Detector Head
- 28. P.A. Speaker

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Level 8

LEVEL 6

1 48-VOLT DC DISTRIBUTION PANEL

2 48-VOLT BATTERY RACK

3 48-VOLT BATTERY CHARGER 5 500 KW DIESEL GENERATOR

6 AIR RECEIVER

7 WATER HEATER

3 ALIGNMENT GROUP SIGHT TUBE 4 INTERCONNECTING JUNCTION BOX (VAFB) 9 WORK PLATFORM



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Figure 1-27. Silo Level 6 Equipment Location (Typical)

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- 2. Facility Elevator Counterweights
- 3. Launcher Platform Counterweights
- 4. Launcher Platform Guide Rails
- 5. <u>4.3 VDC Station Battery</u>: Provides 48 vdc power to the 480v diesel switchgear to trip the air circuit breakers and to operate the diesel engine controls. Battery is a 24 cell, wet, NICAD type, rated as 80 Amp/hr.
- 6. Circular Stairs
- 7. Air Conditioning Duct
- 8. <u>48 VDC Battery Charger</u>: Transformer rectifier to charge the 48 vdc station battery. Receives electrical power 440 vac from the essential motor control center.
- 9. Manual Fire Alarm
- 10. <u>Diesel Generator (#61)</u>: Same as Item 10, level 5.
- 11. <u>Dirty Lube Oil Pump (#62)</u>: The pump will transfer the dirty lube oil from the lube oil sump of the two diesel engines to the dirty lube oil storage tank. The pump will also transfer dirty lube oil from the storage tank to a discharge at the top of the silo. Pump design is a rotary gear type with a capacity of 20 gpm.
- 12. <u>Motor Operation Damper Below Grating</u>: Grating opening is 36 by 36 in. square with air outlet capacity of 17,500 cfm. Damper is controlled by pneumatic motor operation through the air conditioning system.
- 13. <u>Air Start Tank (Overhead)</u>: Provides air pressure for starting of the two diesel engines. Air pressure of 300 psi is supplied by the instrument air prefab. The air start tank is 2 ft in diameter by 7¹/₂ ft length.
- 14. <u>Heat Recovery Silencer</u>: Same as item 13, level 5.
- 15. <u>Collimator Housing and Platform</u>: The collimator enclosure is an insulated room which houses the collimator, collumator support platform, and bench mark supports (Fig 19). This room is fastened to the silo between the sixth and seventh levels and houses the operational and maintenance personnel for the collimator system. The enclosure is provided with a positive-action, self-closing door and is caulked and insulated to maintain a constant internal temperature level. A handrail is provided around the collimator platform for personnel and equipment safety.

Let i show the level 7 of the cost of the second safe and the sub-state of the enclosure.

The collicator support platform is a 3 ft 6 in. diameter plate which supports in. collimator rigidly. The supporting structure of the platiorn fastens to a steel plate mounted on the wall of the silo. Two beach mark supports are housed in the collimator enclosure. The supporting structures fasten to facility-furnished steel plates mounted on the wall of the silo.

12. <u>Collimator</u>: The collimator sight tube provides an optically unobstructed path for a beam of light to transmit data from the collimator to the missile. The tube is constructed of 10.75 in. diameter aluminum tubing coated on the inside to reduce light diffraction. Neoprene boots and sleeve joints are installed at each end of the tube. These boots and joints preserve alignment adjoining structures. The tube is constructed in two section; one section is fixed, the other is movable. The fixed section is fastened to the crib structure with two adjustable fittings, These fittings allow minor adjustments in alignment. One end of the fixed section is provided with an adjustable, flexible connection with the collimator enclosure. The other end of this section mates with the hinged end of the movable section of the tube.

The movable section is fastened to the structure by a hinge. A seal fitting on the lower end of the movable section mates with a similar fitting on the fixed section when the tube is in operating position. The upper end of the movable section is coupled to the missile through a sleeve coupling, newprene boot, and another sleeve coupling. This upper sleeve has a $\frac{1}{2}$ in. thick neoprene gasket that mates and provides a soft contact with the skin of the B2 pod. The upper sleeve is also provided with a bar that acts as a window-hook fastener to keep the tube locked to the B2 pod.

The collimator sight tube retraction mechanism consists of a 190 lb counterweight. Upward movement of the missile causes the windowhook fastener to release and the movable section of the tube to swing upward through an arc of approximately 64 degrees to stowed possition. In stowed position there is a 2 in. minimum clearance between the sight tube and the launcher platform. A detent equipped with a neoprene bumper provides shock absorption and prevents tube rebound from the stowed position. This arrangement allows one man manual extension of the collimator tube to operating position.

Signal devices consisting of 28 vdc microswitches signal the position of the movable section of the collimator tube to the missile launcher lift control.

In order to align the collimator in reference to the polaris star, a sight tube is necessary. From level 904 ft 3 in. a 10 in. outside diameter pipe is inserted in the silo wall at a 4^c degree angle. This piping extends in a straight line to the surface, approximately 100 ft, where the top end is **protected** by a manhole type cover. At the top and bottom of this pipe, glass plates are installed and sealed, and a vacuum is induced in order to prevent refraction effects on the collimator.

- 17. <u>Collimator Air Conditioning</u>: One 6 in. air conditioning duct which is insulated, tees off at the bottom of collimator housing and enters into the bottom of the housing at two ports. The temperature in the collimator must be maintained at 70° F \pm 3°, 65% relative humidity maximum.
- 18. AIG Hoist and Rail
- 19. Telephone Terminal Cabinet
- 20. Hot Water Heater
- 21. Diesel Fuel Detector
- 22. Emergency Lights (6 Volt)
- 23, P.A. Speaker
- 24. Exhaust Temperature Indicator (Stack)
- 25. Collimator Sight Tube to Missile
- 26. Fog Nozzles (8 Each)
- 27. <u>Panel DC</u>: 48VDC distribution vanel contains 4 ea circuit breakers; diesel #60, diesel #61, 480 V switchgear and spare.
- 28. Horizontal Dampers (4 ea)
- 29. Comm Box
- 30. Fire Detector Head



Level 7



- 1 LO₂ TOPPING CONTROL UNIT 2 INSTRUMENTATION BOXES (OSTF-2)
- 3 LN₂ PREFAB
- 4 GASEOUS OXYGEN DETECTOR
- 5 LO2 CONTROL PREFAB
- 6 GASEOUS OXYGEN DETECTOR
- 7 LO2 FILL PREFAB

- 8 INSTRUMENT AIR PREFAB
- **9** PRESSURIZATION PREFAB
- 10 ALIGNMENT GROUP ENCLOSURE ALIGNMENT GROUP BENCH MARKS
- 11 FIRE X CONTROL PANEL (VAFB)
- 12 DIESEL FUEL VAPOR DETECTOR
- 13 RP-1 DETECTOR

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Figure 1-34. Silo Level 7 Equipment Location

- الميا المناحة المتعاد المتنار
- 2. Sevator Counterweights
- 3. Launcher Platform Counterweights
- L. Loucher Platform Guide Bails
- 5. <u>Marille Photosure Area Air Conditioning Return Duct</u>: Acts as an air return to the plassic order area from the fan coil unit FC-40 on silo level 2 for recirculation to the pussile enclosure area.
- 6. Circular Steirs: End of the circular stairs at this level.
- 7. Air Conditioning Duct
- 8. Ladder: Vertical ladder extending downward to level 8.
- 9. Liquid Nitrogen Prefab: Unit contains the necessary sequence valves which are manually controlled to fill the liquid nitrogen storage tank and heat exchanger. During countdown, liquid nitrogen is directed through auto valves into the prefab to flow in the coax pipe (PN2/He) in order to maintain a cold temperature of the helium flow and to fill the LN2/He shrounds on the missile.
- 10. <u>Liquid Oxygen Control Prefab</u>: Unit contains the necessary valves and components to filter and control the flow of liquid oxygen from the storage tank to the missile. It contains the valves to provide rabid and fine loading of the missile during countdown. It also has the control of flow for draining the missile.
- 11. <u>Gaseous Oxygen Detector Cabinet</u>: Detector Contains the necessary electronic equipment and oxygen-analyzer to detect the oxygen atmosphere in the crib and launch platform areas. When the oxygen content goes below 19% or above 25% by volume, the detector unit will initiate audible and visible alarms in the silo area and to the facilities remote control panel in the launch control center.
- 12. Lower Sile Supply Fan (Overhead)SF22: Electric driven fan directs 17,500 cfm of air from diesel generator area on the 6th level to lower part of sile. Open grating between level 5 and 6 allow air to be drawn from level 5. Operates in conjunction with SF20 and SF21. Shuts off automatically when diesel vapor reaches 10% LEL.
- 13. <u>Instrument Air Prefab</u>: The unit contains two air compressors with catacity of 15 SCFM flow, 1500 psig output. The unit has a 65 SCFM spherical air receiver and contains the necessary valves, filters and air dryers. Purpose of the unit is to compress, store and deliver clean

A lines to restatically operated values, contconstant the sile and LOG. An alarm indication on the second coll ender when receiver tank pressure drops to cyll offer any LCC suspension, diesel star and plast chosores,

- Liquid Oxygen Fill Prefab: A unit that contains necessary values to control, during resupply, the flow of liquid oxygen to the storage tank and topping tank in the crib assembly.
- 15. <u>Prescurization Prefab</u>: A unit which controls and distributes gaseous nitrogen to the following subsystems:
 - a. Resupply of nitrogen and charging of the three gaseous nitrogen storage tanks. (4000 PSI)
 - b. Liquid oxygen storage tank and topping tank for transfer flow to the missile.
 - c. Nitrogen control unit on the launch platform.
 - d. Pneumatic distribution unit. (PDU)
 - e. GN2 storage bottle in the fuel prefab for fuel transfer to the missive. (4000 PSI)
- 16. <u>RP-1 Detector Cabinet</u>: Storing missile fuel (RP-1) in the missile tank makes the area inside the missile enclosure hazardous when contaminated by fuel fumes. An explosive vapor detection system initiates audible and visible alarms in the missile enclosure area and at the FRCP panel in the LCC when predetermined lower limit explosive levels are reached. High rate air purging at the 20% fume concentration level is automatic and continues until 40% LEL is reached. When 40% LEL is reached the purge cycle stops and the water for system is manually activated. At 20% LEL the sile telephone system is deenergized to reduce explosion hazards. The 20% and 40% LEL alarm indications are located on the trouble section of the FRCP and on the RP-1 detector unit. For system "ON" "OFF" push buttons and indicator lights are located on the control section of the FRCP.
- 17. <u>Diesel Fuel Dectector Cabinet</u>: Contains electronic equipment and hydrocarbon-analyzer for detecting concentration of diesel fuel vapors. When a 10% concentration of diesel fuel vapor is indicated at the detector unit, circuitry will stop lewer sile supply fan SF=22, close volume damper VD=21 (ceiling of sile level 7), and open volume damper VD=31 on main sile exhaust fan EF=30 (sile level 2). At 20% concentation of diesel vapors the above purge cycle continues and an audible and visual alarm will be initiated at the FRCP in the LCC.

18. Speaker

- 19. Fire Hose
- 20. <u>Air Conditioning Exhaust Duct</u>: A 28 in, duct, routing exhaust air from the launch platform area at level 8 to the exhaust plenum chamber at level 2,
- 21. Emergency Shower and Eye Wash
- 22. Collimator Housing: Described in item 15, level 6.
- 23. Emergency Light (6 Volts)
- 24. GOX Detector Heads
- 25. Communications Panel for Fueling/Defueling: Sta 36 (E.P.)
- 26. Comm Box
- 27. P.A. Speaker
- 28. LOX Topping Control Unit: Controls the rate of LOX topping during countdown. Also performs LOX line drain.
- 29. Fire Extinguisher
- 30. For Nozzles (4 Each)
- 31. Alert Button
- 32. Telephone Terminal Cabinet


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LADDER TO LEVEL 7
 INFLIGHT HELIUM SUPPLY TANK NO. 1
 INFLIGHT HELIUM SUPPLY TANK NO. 2
 GROUND PRESSURIZATION SUPPLY TANK
 VACUUM PUMP
 LN2 STORAGE TANK AND HEAT EXCHANGER
 LO2 TOPPING TANK
 LO2 STORAGE TANK

LEVEL 8

- **9 GASEOUS NITROGEN TANKS**
- 10 PNEUMATIC SYSTEM MANIFOLD REGULATOR 11 COLD DISCONNECT PANEL
- 12 LN₂ EVAPORATOR 13 FUEL PREFAB
- 14 HOT DISCONNECT PANEL 15 PRESSURE SYSTEM CONTROL
- 16 THRUST SECTION HEATER

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Figure 1-32. Silo Level 8 Equipment Location

SILO LEVEL 8

1, Facility Elevator

2. <u>Air Conditioning Ducting</u>: Ducting for intake and exhaust air distribution is routed at the bottom of the crib, and also inter-connected to the enclosed launch platform area.

3. Facility Elevator Counterweight

- 4. <u>Fuel Loading Prefab</u>: Loading, topping and unloading the missile fuel tank is controlled by the prefab. It is an enclosed unit, having a fuel storage tank with capacity of 630 gal, gaseous nitrogen supply pressure tank, filter and necessary valves. Included is a 10 hp fuel pump used for draining the missile fuel tank.
- 5. <u>Pressure System Manifold Regulator (Pressurization Distribution Unit)</u>: Remotely and Semiautomatically controls and flow of helium and gaseous nitrogen and inst. air from storage vessels to other AGE equipment within the sile. The unit provides stable regulated pressure under both static and dynamic pressure conditions. It consists of the following system; helium flow control and regulating, helium emergency, helium charge, gaseous nitrogen pressurization and emergency instrument air. During standby provides GN2 to PCU for missile tank pressure. During C/D it provides He for missile tank pressure.
- 6. <u>Air Conditioning Duct To Launch Platform</u>: A rectangular ducting, which has a quick disconnect at the launch platform, is then routed downward to go underneath level 8 flooring and into the main air exhaust duct. The complete ducting, until connected to main air exhaust ducting, is insulated against heat loss. This ducting carries the heated exhaust air from the pod air conditioning unit.
- 7. <u>Cold Disconnect Panel</u>: Contains the lower half of riseoff connections which supply the following services to the launch platform; missile LO2 and fuel tank pressurization, helium pressurization line to one unshrouded sphere, helium to HCH and GN2 to NCU when L/P is down and locked.
- 8. <u>Liquid Nitrogen Overflew Evaporator</u>: The evaporator is a tank which collects the overflow of liquid nitrogen or gaseous nitrogen from the LN2/helium shrouds during countdown. Thereon, the liquid nitrogen boils off into a gaseous state and vents into sile level 8, quad III, Vapors are picked up and exhausted by exhaust fan EF41 in sump. The evaporator tank is fabricated of aluminum alley.
- 9. <u>Het Disconnect Panel</u>: Contains the lower half of riseoff connections which supplies RP-1 fuel and the thrust section heat to the laurch platform.

- 10. <u>Pressurization Control Unit (PCU)</u>: The PCU automatically and manually controls the pressures in the probellant tanks of the missile during all phases of operation. During standby, the PCU will maintain pressurization of missile tanks with gaseous nitrogen. This unit also has an emergency system for backup in maintaining missile pressurization.
 - NOTE: When PCU is in emergency, missile tank pressures can be maintained only from the LCC by means of the raise/lower buttons on the launch officers console.
- 11. Thrust Section Heater: This unit provides hot air, 145°F to 200°F into the thrust section of the missile during loading procedures of liquid oxygen and liquid nitrogen. The heater receives hot water from the two diesel heat recovery silencers and also an electric heat coil is used to heat the air to be blown through the ducting into the thrust section. The complete unit is insulated in order to maintain temperature control in the launch platform area.
 - 12. <u>Ladder (down from level 8)</u>: Vertical ladder from level 8 to the bottom of the silo,
 - 13, Telephone Cabinet
 - 14. <u>Ladder (up to level 7)</u>: Vertical ladder with cage from level 8 to level 7.
 - 15. <u>Thrust Section Pressure Fan</u>: Electric Operated fan (blower) to force ambient air through the heating coil section, where the air is heated and forced into the thrust section of missile. Capacity of the fan is 1000 cfm.
 - 16. Inflight Helium I
 - 17. Inflight Helium II: Two high pressure helium storage tanks are manifolded, so that either tank can be selected to provide pressurization. These tanks furnish helium for the spheres on the missile, to the missile propellant tanks during countdown, and for emergency pressurization of missile tanks during standby or countdown. Gapacity per tank is 250 cu ft water volume, storing 163,000 sef of helium at 6000 psi.
 - 18. <u>Ground Pressurization Nitrogen (6000 PSI)</u>: Consists of one high pressure gaseous nitrogen storage tank. Provides nitrogen to the pressurization control unit for maintaining pressurization of the missile propellant tanks during standby status. It also provides nitrogen to the pneumatic distribution unit for pressurizing the hydraulic accumulator rack for opening the silo doors. Guad III

Local energy in this exchange Local energy in liquid nitrogen. Local energy is to the loop is 70 ft long and the Local Local Loop is 70 ft long and the Local Local Local Loop is coasial type with Charles and the coasial bibling is coasial type with Charles and the coasial pibling is routed by liquid nitr-Local Local Local Local Local Dibling is routed by liquid nitr-Local Local Local Local Dibling is routed to the missile Should and spheres. The liquid nitrogen unit is a crygonic constr-House vessel, with a capacity of 600 gal. It is mounted above the liqhous integer storage tank,

- 12 <u>312 329 Tark Selow</u>. This tank provides liquid nitrogen to the Coaxia: pipics and thereon into the missile shrouds. The storage tank is vertically installed and it has a capacity of 4600 gal.
- 20. Ladder and Cage: Vertical ladder mounted to the LN2 storage tank extending to the top of the LN2/He heat exchanger. A work platform is provided at the top of the LN2 storage tank.
- 21. LO2 Topping Tank: During countdown, this tank will top off the missile oxidizer tank due to LO2 boiloff losses and for losses during hold periods. It is installed in a vertical position. It is a crygonic type vessel, with water volume capacity of 3600 gal. The normal 102 capacity is 3420 gal which allows for ullage.
- 22. Emergency Shower
- 23. Eye Mash
- 24. <u>LO2 Storage Tank</u>: It is the main liquid oxygen storage tank for servicing the missile oxidizer tank and is installed in a vertical position. It is a crygonic type vessel, with a water volume of 23,000 gal. The normal LO2 capacity is 21,850 gal which allows for ullage.
- 25. <u>Gaseous Nitrogen Storage Tanks</u>: Stores adaquate supply of gaseous nitrogen to pressure transfer LO2 and LM2 to the Missile, Consists of three vertical mounted vissels. The two 625 set tanks are used for the liquid oxygen transfer system. The remaining 500 set tank is used to provide liquid nitrogen transfer pressure to LM2 storage tank and GN2 pressure to the nitrogen control unit on the launch platform. This tank also provides backup pressure for the instrument air prefacerstem. The tanks have 1750 cubic feet of water volume total with pressurization at 4,000 PST.
- 26. <u>Air Conditioning Exhaust Duct</u>: A 28 inch air exhaust duct into which two fan motors remove air from the launch platform area, route it threough the exhaust duct to level 2, and force it into the exhaust statt,
- 27. Fire Hose
- 28. Oxygen Masks

- and Brei Persetor
- 32. Arning dorn
- 33. Fire Alarm Box
- 24 IM Storage Tant: & Heat Exchanger Vacuum Pump: Located on floor.
- 35. LOX Tooping Tank Vacuum Pump: Located on top of tank.

- 36. LOX Storage Tank Vacuum Pump: Located on top of tank.
- 37. Switches for Items 34. 35 and 36
- 33. Test Switch for SF-41 Supply Fan Purge Cycle
- 34. Supply Fan Purge Cycle SF=41: Purge supply fan will draw air from the silo area into the launcher platform enclosed area when the gas detector denotes there are hazardous air conditions in the shaftway. Also operates during a four minute purge cycle at start of C/D. Air flow is 10,000 CFM.
- 40. Test Switch for Thrust Section Heater Supply Fan
- 41. Emergency Light (6 Volts)
- 42. Comm Box
- 43. Automatic Fire Dectector
- 44. GOX Alarm Bell and Light





11 J. STMP

Such Market in the Silo Sumo, Each pump is rated at 7.5 hp and has a capacity of 100 GPM. Electrical power for the pumps is 480 VAC 3 phase correct. The pumps are automatic in operation and are rotated in usage by means of a magnetic alternator to provide equal running time for each pump. Normally one pump will operate alone.

When the liquid level of the sump rises to 3' from the grating the first pump will start. When the liquid level rises to 1' 8" from the grating the second pump will cut in. If a malfunction occurs and the liquid level rises to within 1' 2" of the grating a high level alarm signal will be sent to the trouble section of the FRCP "Silo Sump Hi Level". All liquids discharged by the sump pumps are routed up the silo wall through the discharge line. The discharge line exits the silo through the concrete wall at crib level 2 and is routed to a catch basia outside the silo at grade level.

- 2. Comm Box: Explosion proof.
- 3. Ladder
- 4. Sump Pump Controis
- 5. EF-40 and EF-41 Test Switches
- EF-41 Launcher Platform Purge Exhaust Fan: Exhaust fan EF-41 is electrically innerlocked with EF-40. EF-41 is normally deenergized. It will be energized to operate during the following conditions:
 - A. RP-1 vapor concentration 20% LEL.
 - B. At start of countdown (signal start of LN2 fill). EF=41 is powered by a 7.5 hp electric motor operating on 480 VAC 60 cycle 3 phase current. EF=41 has capacity of 13,000 CFM which is exhausted up through the main exhaust fan (EF=30) on level 2 and out of the sile. Operation of EF=41 opens Volume Damper VD=42 which signals the FRCP of the ourse condition ("RP=1 fire for system damper open" = Fed Light).
- 7. EF-40 Launcher Platform Exhaust Fan: Exhaust fan EF-40 is electricailly innerlocked with EF-41. Only one fan will operate at a time. EF-40 will operate normally exhausting air from the launcher wistform area at a rate of 3,000 CFM. The fan motor is rated at 2 hm and operates on 480 VAC 60 cycle 3 phase current. Air is exhausted identically as EF-41.
 - NOTE: A fire thermostat (FST=41) is located at the inlet side of the two exhaust fans and senses inlet temperature. Then in let temp. exceeds 125°F. Each fan will be deenergized,

- . Less Massire anter
- . They Elevator Area
- 10. Air Conditioning Duck



lst Level - Elevation 1015 ft 4 in.

Launcher Platform Equipment Location (Level 1)

L/P LEVEL 1

- 1. Fiel fill and Drain: The fuel fill-and-drain line is a 4 in, bibing routed from the hot disconnect panel (level 4) to a ground fuel-anddrain valve located on the launcher pedestal in quad I.
- 2. <u>Missile Alignment Pin and Latch Assembly</u>: Four alignment bins are installed on a box housing support mounted to the launcher pedestal. The pins have length of approximately 2 3/8 in. protruding into the female connector of the missile. Two of the round pins have souared off sides mounted in quads I and II. The standard round bins are mounted in quads III and IV. The four latches have a hook design which slides into the slots of the four main lognerons of the missile booster section. They are used to clamp down the missile to the launcher when the missile is not fueled. During normal standby with the missile fueled, these latches are removed.
- 3. <u>Launcher Pedestal Frame:</u> The frame assembly consisting of two welded structures, is mounted with one structure in quads I and II and the other in quads III and IV. The structures consist of welded, 8 in steel piping in a rigid, vertical and tripon framework. Another steel box framework is mounted on top of this assembly. This framework contains the riseoff disconnect banels, alignment pins, and latches. The pedestal support in quad IV contains the one inch rise-off switch (MOS Switch).
- 4. <u>IO2 Fill-and-Drain Assembly</u>: The ground LO2 fill-and-drain value is mounted in quad III. It mates with the other half of the disconnect value on the crib when the launcher platform is in the lowered position. The LO2 inlet piping is 10 in. in diameter until it connects to the probe that enters the missile. This probe has a diameter of 8 in. The probe unit is mounted in a swivel unit at the lower section, which is pneumatically actuated to move outboard 28 degrees upon riseoff of the Missile.
- 5. <u>LO2 Topping Line Assembly</u>: The LO2 topping line assembly provides liquid oxygen to the propulsion assembly prior to engine start. The piping is 3.5 in diameter.
- 6. Comm Box
- 7. <u>Riscoff Disconnect Panels</u>: Two panels provide automatic cutoff of servicing of fluids at missile riscoff. The two panels on the pedestals are the lower half disconnects, which contain the female couplings.

provide the second of and if contain the following outlet provide the following outlet

Le contra pressurization to ambient spheres in missile (1)

- 2. Led to shroyas (1)
- 3. Fuel tank pressurization line (1)
- 4. Endraulic pressure lines to booster and sustainer/vernier engines (2)
- 5. Hydraulic return lines from the engines (2)

The other panel, located at quads III and IV, has the following outlet ports.

- 1. LO2 tank pressurization (1)
- 2. LO2 topping (1)
- 3. LN2 to shrouds (1)
- 4. Helium pressurization to the shrouded spheres
- 8. <u>LN2 Drain Assembly</u>: During countdown, liquid nitrogen is directed into the missile shrouds for cooling the helium gas. The LN2 overflow and its boileff gases are routed through the drain piping assembly and from there into the LN2 evaporator unit. This line assembly on the launch pedestal is divided into two sections and then coverges into one main drain line. The drain line at quad II is 4 in. diameter steel turing routed across to quad III. It tees into the main drain line, which is 8 in. diameter aluminum alloy material.
- 9. <u>Missile Umbilical Cables</u>: The six missile umbilical cables are routed from the umbilical J box on level 2, to vertical racks, to level 1, and from there to the missile. B2 pod.
- 10. Pod Air Conditioning Duct (Quad III): Cooled air is routed from the pod air conditioning unit on level 4 through a rectangular duct (in-side dimension of 2 in. X 15 in.) to level 1, and from there it is routed in a tubular duct of 8 in. diameter. This tubular duct is clamped to a vertical support, and in the proximity of B-2 pod, it is divided into three separate flexible tubes that are then connected to the B-2 pod.
- 11. <u>LN2/He Coaxial Disconnect Panel</u>: The upper half of the quick-disconnect unit is mounted at the corner of quad III. This unit contains the female half of the quick disconnect. The mating unit, the rale half, is mounted on the crib structure. The unit has spearate quick-disconnect valve for helium and for liquid nitrogen. The liquid nitrogen tees into the helium line and at this tee connection a coaxial tubing is

connected for helium to flow internal with liquid nitrogen surrounding it. This coaxial tubing is routed to the riseoff disconnect panel in quads III and IV.

- 12. <u>Ped Air Duct and Umbilical Support Assembly</u>: The ped air duct and umbilical support assembly is a tubular support of appreximately 6.5 in. diameter by 12.5 ft length. It provides the support for clamping the ped air conditioning duct and the six missile umbilical cables. All of these cables are connected to the B-2 ped.
- 13. <u>Thrust Air Heat Ducting</u>: Heated air is routed from the thrust section heater on level 8 of the crib, through the het disconnect panel of the launcher platform (level 4), upward to level 1 and into quad II of the launcher pedestal and missile. The duct is 8 in. in diameter and is insulated against heat less.

14. Engine Compartment Access Platforms:



2nd Level - Elevation 997 ft 4 3/4 in.

Launcher Platform Equipment Location (Level 2)

75

L/P

Subject of of of the fact scenes of this level has a hydraulic actuator where a second first locking the launcher platform to the crib structback of the cap. The lock and of the actuator has an attached guide coller assembly. This assembly consists of two rollers mounted in vertload plates. The upper roller follows an arc of the tapered rail mounbed to the crib and pulls the lower roller into locking position as it hats the upper and lower striker plate. The four lock actuators are to be the rigid locked position within 5 sec after the platform is in "ultransed or full-lowered position.

- 2. Interlock of Locking Assembly: Above each actuator locking assembly, there is at 90 degrees an additional mounted hydraulic actuator unit. The rod end is attached to a wedge. When the locking assembly piston rod has moved out to the rigid locked position, this interlock unit positions its wedge in down movement and locks the main biston rod from retracting. The interlock unit positions its wedge lock within l sec.
- 3. <u>Hydraulic Manifold</u>: The hydraulic manifold receives its main source of hydraulic pressure from the crib hydraulic equipment. By electric solenoid valves it distributes hydraulic pressure to the locking and interlock assemblies for locking or unlocking the launcher platform to the crib.
- 4. <u>Hydraulic Tubing Installation</u>: Stainless steel tubing is routed from the hydraulic manifold to the proximity of the locking actuators. From there, flexible hoses are attached from the tubing to the locking assemblies.
- 5. <u>Access Area</u>: An access area with a vertical ladder is provided to level 3.
- 6. Comm Box
- 7. <u>Guide Rollers</u>: On this level there is one large guide roller assembly, As the launcher platform rises to the full-up position, the rollers will rise over a small length rail tapered to an oversize I beam mounted to the silo cap. The tapered I beam is wedged between the rollers and aligns the launch platform to the sile.
- 8. <u>Tubing and Piping Supports</u>: Propellant gases, hydraulies, and heated air routed from level 4 to level 1 and into the missile. Reading from left to right the indentification of lines is:
 - 1. LN2 drain from missils shrouds (1)
 - 2. Helium pressurization of scheres in missile (3)
 - 3. LO2 topping to missile (1)

ing issembly of launcher blacform (2)

We HP - Whi to missive or diata (1)

ala se se se se se se se trades de la des

- Apprendic pressure/return to posser and sustainer/vernier engines
 (4)
- Inhibited (Box (A junction points for missile umbilical cables & inhibited control cables). This umbilical 5 box provides circuitry to the missile juring standby and countdown from the AGE on the crib and the launth control center. During LSR checkout, it disconnects the missile and reroutes the circuitry to the in the LSR and the logic units. When performing APCHE checkout of the missile, this unit provides ac and do power to the missile power control unit. (APCHE) (item 14, Fig 15). Cable connections at this J box are plug-in types for rapid replacement. The unit also homes an Arma (guidance) amplifier. The box enclosure is provided with cooling air from the pod air conditioning unit. The dimensions of this unit are 66 in. wide, 24 in. deep, and 80 in. high.
- 10. <u>MA-3 Valve Control Box</u>: The MA-3 valve control box receives 28 vdc power from the crib power distribution unit and command signals from the auto-pilot and signal control unit. Through relays, circuitry is directed when necessary to the booster, sustainer, and vernier engines for cut-off control.
- 11. <u>Cable Duct</u>: The cable duct is a ladder design on which electric cables are secured and supported. These cables are routed to various junction boxes and to the ground support equipment.
- 12. J Box (APCHE): This unit provides an interface for the MAPCHE trailer. It connects the trailer circuitry to the missile umbilical J box (item 9, Fig 15). Also dist power to MAPCHE, control monitors, PIS (DMM) and checkoat equipment NOT incl. emer. 24VDC.
- 13. <u>Pod Air Conditioning Duct</u>: The pod air conditioning duct is insulated ducting that comes from the pod air conditioning unit on the fourth level and is routed to the missile.
- 14. Missile Power Control Unit (APCHE): This power control unit provides the necessary relays and receptacles for distribution of 400 cps and 28 vdc power to the missile and APCHE during APCHE checkout mode. Its power source is the power distribution boxes on level 3 of the crib assembly. Power is routed through the cable loop system to this unit. The dimensions are 24 in. long. 20 in. high. and 8 in. wide.





Launcher Platform Equipment Location (Level 3)

L/P LEVEL 3

- 1. <u>Hydraulic Pumping Unit</u>: The hydraulic pumping unit contains two independent hydraulic pumping systems in one common cabinet. The first stage system services the booster engine hydraulic system, and the second stage system services the sustainer/vernier engine hydraulic system. Each stage independently supports its system in the fill-and-bleed function and provides hydraulic pressure to its system. The first and second stages use a 20 gal common reservoir. Each hydraulic system contains a hydraulic pump with a capacity output of 3000 psig and 8 gpm flow, driven by a 30 hp, 400v, 3 phase electric motor. Standard components, such as filters, sight tubes, oil cooler, electric and hand-operated valves, restrictors. indicators, and relief valves, are in each system. The dimensions of the unit are: width, 5 ft; height, 5 ft; length, 6 ft; and weight, approximately 2,500 lb.
- 2. <u>Hydraulic Tubing</u>: Two hydraulic pressure and two return lines (one pair for booster and the other pair for the sustainer/vernier systems) are routed from the hydraulic pumping unit to the riseoff disconnect panels at level 1.
- 3. <u>Nitrogen Control Unit (NCU)</u>: The NCU is an enclosed unit with necessary valves, regulators, and gages to regulate all nitrogen gas distribution to the missile and ecuipment on the launcher platform. Primarily, the unit is manually operated. Gaseous nitrogen is received from the crib storage and distribution units at an inlet pressure of 1200 to 4000 psig. It is then pressure regulated and distributed to the following:
 - 1. 1000 psig to engine service unit (checkout)
 - 2, 1000 psig to hydraulic pumping unit, item No. 1
 - 3. 0.1 psig to the J box (APCHE)
 - 4. 0.1 psig to the pod air conditioning unit

Four additional outlets are provided, with each outlet having attached to it a 45 ft length of flexible hose. The hoses are mounted on reels in the unit. They are used for ground servicing in charging and nurging the missile and launcher components. The dimensions of the NCD are: length, 4 ft; height, 5 ft; width, 3 ft; and weight, 1,500 lb.

4. <u>Guide Rollers</u>: Two large guide roller assemblies ride on a 17 in, wide I beam, with the beam positioned between the rollers. The guide rail and rollers minimize the lateral or tilting movement of the launcher platform. The rollers are 3.75 in, wide and 10.5 in, in diameter. The roller shaft is mounted in a roller bearing.

- 5. Tubing and Piping Supports (Item 8, level 2) L/F
- 6. Access Area
- 7. Cable Loop Assembly (Item 9, level 4) (L/P)
- 8. <u>Helium Charge Unit</u>: When the launcher platform rises during tactical launch, this helium charge unit provides and continues the required pressurization of the missile. Two storage spheres are contained in this unit: One is a high-pressure sphere (6000 psi), and its controls maintain or relieve the required pressurization of the missile storage spheres during launching procedures. This sphere also provides emergency pressurization of the missile RP-1 tank. The second sphere, the low-pressure sphere (1000 psi), and its controls operate unit controllers in this assembly and sense variables of pressures. The unit is 60 in, square and weighs approximately 500 lb.
- 9. Comma Box
- 10. <u>Pod Air Conditioning Duct</u>: This is continuous duction from the missile and is routed underneath the level decking and into the bod air cond= itioning unit.





Launcher Platform Equipment Location

L/P EVEL

 $r_{\rm experient}$ is and enclosed in the unit area defundation of the second of the unit area of the second of the missile control of the major components and circuit area defundations are control of the second of the second

2. <u>Hot Disconnect Panel</u>: The hot disconnect panel is the top half of the quick-disconnect panel. It makes to the lower half panel located on level 8 of the crib structure. The following subsystems are routed through this disconnect panel, reading the outlet ports right to left:

1. RP-1 fuel (1)

2. Thrust air heating line (1)

The unit is 22 in. wide by 33.5 in. long.

- 4. <u>Guide Roller Assembly</u>: One small guide roller assembly rides on an I beam (10 in, wide with the beam positioned in between the rollers), The rollers are 2.5 in, wide and 7.5 in, in diameter, with their shaft mounted in a roller bearing.
- 5. Guide Roller, Assembly (Same as item 4. level 3(L/P)
- 6. Elevator Door Level 75
- 7. <u>Access Area</u> (An access area with a vertical ladder to the obtion of the crib, level 8)
- 8. <u>LN2 Evaporator Piping</u>: This piping routes the overflow of liquid nitrogen and its gases from the shrouds in the missile to a couling located directly under the level decking. From there it is routed to the LN2 evaporator tank located on the crib, level 8.
- 9. <u>Cable Loop Assembly</u>. This cable loop assembly provides the necessary continuous circuitry and hydraulic pressure from the crib equipment to the launch platform equipment and missile. The cable consists of 63 electrical cables, 2 chilled water lines and 3 hydraulic lines secured and supported on 2 mount brackets. As they are routed upward in the launcher, the cables and lines are directed to their "sepective units for power and control,

- 1

This is the top half of the quick-disconnect over half banel located on level 8 of the concated on level 8 of the concated on level 8 of the panel, creating one outlet ports left to right:

2, 102 and fuel pressurization to missile lines (2)

- b. GN2 to NCO when launcher platform is down and locked
- c. Helium missile controlline (1)
- d. Helium to HCU

This panel is 27.5 in. wide and 45 in. long.

12. <u>NCU Disconnect (Upper)</u>: This is one-half of a quick-disconnect for receiving gaseous nitrogen from the crib storage equipment. The gaseous nitrogen pressurization is disconnected from the launcher to the crib on raising of the launcher at the cold disconnect panel. At the full-raised position, the upper NCU disconnect unit is connected to the other lower-half disconnect, which is mounted on the crib approximately 3 ft below crib level 1.

- CRIB LOCKING AND SUSPENSION SYSTEMS



THE STREET STREE

4. <u>Orib is mension System Assembly</u>: The crib suspension assembly provides for isolation of the srib and configment, launcher platform and missive to minimize damage from ground shock. The suspension shock atomis are mounted on the sile wall 90° apart at level 2 and are attatched to the crib at level 6. Each strut is 64' 22" long and has 7 decks of springs, 3 sets of springs per deck. The suspension system will allow 1,45" of vertical travel.

B. Lock and Damper System Assembles:

1. A single vertical struct lock is mounted on the bottom of the 7th spring on each odd numbered suspension strut, Each lock consists of a hydraulic cylinder and fork lock that neutralizes the spring action of the strut and levels the crib,

2. Three horizontal crib locks are located 120° apart on the top level of the crib. Each lock has a hydraulic piston that exerts a force against a striker plate mounted to the sile cap and positions the crib center line. To the center line of the sile cap.

3. There are four friction type horizontal strut dampers, one mounted on the bottom of each shock strut assembly pair. The dampers exert a damping force of 200 lbs and allow 4" of horizontal crib travel.

- C. <u>Platforms:</u> Missile Work Platforms are provided at four silo levels (2,5,54 & 6). In addition, a safety platform is located at silo level 1 and an engine compartment access platform is located on the launcher platform (at silo level 7 with the L/P down). These platforms are located so as to permit access to the missile for limited maintenance and service to support and house the missile stretch mechanism.
 - 1. Work Platforms: Work platforms (w/p) 1,2,3 are hydraulically retractable. Work platform 4 is mechanically linked to W/P 3. Hyd. pressure is supplied by the 40 hp motor driven pump, (Hyd. power pack) on crib level 2. The pump is started from either the Hyd. control panel on level 2 or the control station manual operating level panel on level 1. The W/P can be stopped and retracted ed at any point during the extend cycle, but they cannot be stopped or re-extended in the retract cycle until fully retracted.

A system of limit switches is utilized with the work platforms. These switches permit current flow to a light on the applicable level key switch panel to indicate that the platform on that level is extended, and by means of an interlock system to prevent motion of the L/P if any W/P is not fully retracted. Conversely, the interlock system prevents the extension of the work platforms when interference with the launcher platform would occur. The work platforms can be operated only when the L/P is in the fully down and locked position.

- (a) which we see the sections provide access for attachnulls. It liss these the stretch mechanism.
- (b) <u>4/P2</u> Silo level 5. (Three feet above silo level 5). One section provides access to the upper section of the B=2 pod, containing the retro=rockects, missile inverter, exication transformer (U=4 Pkg), programmer (U=3 Pkg), filter servo amplifier (U=2 Pkg), programmer (U=3 Pkg), power changer over SW, rocket engine relay box, missile battery and proo-ellant utilization system.
- (c) <u>W/P3</u> Silo Level 5A. (Eight feet above silo level 6). Five sections provide access to the vernier engines, B=1 pod and to the lower section of the B=2 pod, which contains the umbilical connections and the AIG platform, control and computer.
- (d) <u>W/P4</u> Silo level 6. Three sections provide access to the booster engine nacelles. Mechanically linked to W/P3.
- 2. <u>Safety Platform</u>: The safety platform is located at sild level 1. Equipment can be lowered down through the sile cap and received at this platform. The safety platform is accessable from the facility elevator and is the largest of the platforms (132' long X 8' wide). It is pneudraulically operated. 300 psi air pressure charges a hydraulic accumulator which supplies pressure to the "up" side of apair of actuators. These actuators retract the platform through pulley and cable linkages. The platform slowly free-fails to the extended position as hydraulic fluid is forced back into the de-pressurized accumulator through orfices. A Hyd, hand pump is provided for use in the event that air pressure fails.
- 3. Engine Compartment Access Platforms: The right and left engine compartment access platforms are each 15 ft long and 5 ft wide and are located directly under the missile engines. The platforms are fixed to the L/P and are actuated by 2 hp motors and gear boxes. The access ladder and electric motors control station are on level 1 of the L/P.

D. Stretch Mechanism:

(a) <u>Functional Description</u>: The function of the mechanisms is to supply two upward acting forces at diametrically opposite sides of the missile skin rendering the thin-walled cylinder section of the skin safe from collapsing under its weight in case the cylinder loses its internal pressure.

When loss of pressure occurs the stretch mechanism will be positioned in its operating position and locked. The support pin is manually moved forward and the pin insert is introduced into the opening provided for it in the skin of the missile cone.



2nd. W./ P. 918'11"



WORK PLATFORM IN SILO CRIB

:

the support nin is the distriction load in turn is the platform load in turn is the static structure.

- (b) Physical Rescription: The stretch mechanism is stored horizontally within a space envelope approximately ó in. X 18 in. Y 40 in. It is hinged into the No. 1 work platform along its lifting arm extends about 18 in. beyond the 18 in. envelope width to reach the missile. The mechanism has two main moving parts, or links contained between two outer side plates. Pins or shafts supported by the side plates pass through one end of each link allowing it to rotate about that end. One link is a hydraulic cylinder, the other a missile stretching arm. In operation, the cylinder presses upward on the lifting or stretching arm. The Top side plate is flush with the work platform deck when stored. There are two equivalent mechanism.
- (c) <u>Operation</u>: The stretch mechanism is so designed that it may be manually positioned, pumped to operating pressure and manually locked in place within 10 min. by two men. The stretch mechanism is divided into a left hand mechanism assembly which is located in platform 1D and a right hand mechanism assembly which is located in platform 1B. Each mechanism assembly consists of a housing assembly, a support pin housing and a hydraulic actuator.

Either the right hand or the left hand mechanism may be erected first. The mechanisms are similar and the same erection and operating sequence is used with each mechanism. The steps of the sequence are as follows:

- 1. Unlatch and lift the left hand stretch mechanism assembly out of work platform 10.
- 2. Lock in the upright position by allowing the lock block at the rear of the housing to drop into the locking slot.
- 3. Lift the support oin housing out of the mechanism housing and place it so that it is supported by its pivot and by the hydraulic stretch actuator.
- 4. Remove the tee handle from the clip on top of the pin housing and insert in the hole provided in the support pin.
- 5. Slide the support pin forward and insert the pin in the missile nose cone adapter bearing.
- 6. Repeat sleps 1 through 5 with the right-hand mechanism assembly.

- a. E. S. Sirvell, pressure into both stretch mechanism actsuccess or parcelly supping the hand sums which is located an platform 1.
- 8. When the desired stretch has been achieved, lock each actuator mechanically by retating the locking collar until it is jammed against the actuator cap.
- 9. The hydraulic pressure may then be relieved until it is necessary to remove the stretch mechanism from the missile.
- 10. When it is desired to relieve the stretch, again pump pressure into the actuators until the pressure is relieved on the locking collar.
- 11. Turn the locking collar (on the actuator) down so that the actuator can be retracted.
- 12. Relieve hydraulic pressure by opening valve on the hand pump.
- 13. Slide the support pin back into the pin housing until the ball lock in the housing drops into the detent in the slide and holds the slide in place.
- 14. Replace the tee handle in the clip on top of the pin housing.
- 15. Fold the pin housing and the actuator and replace in the mechanism housing.
- 16. Unlock the mechanism by pulling the cable handle to lift the lock block out of the locking slot.

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17. Stow the stretch mechanism in the platform.



LEVEL 4

- 1 JUNCTION BOX ASSY IR56 SILO CHECKS (576 AND OSTF-2)
- 2 INSTRUMENTATION CABINET (OSTF-2)
- **3 INSTRUMENTATION CABINET (OSTF-2)**
- 4 LIGHTING PANEL LB
- **5 LIGHTING PANEL LB**
- 6 CONDENSER, WATER CHILLER, AND REFRIGERATIONN COMPRESSOR
- 7 CHILLED WATER PUMP P-51 (P-50 FOR OSTF-2)
- 8 CHILLED WATER PUMP P-50 (P-51 FOR OSTF-2)
- 9 EMERGENCY WATER PUMP P-32
- 10 CONDENSER, WATER CHILLER, AND REFRIGERATION COMPRESSOR

- 11 CONDENSER WATER PUMP P-31
- 12 HYDROPNEUMATIC UTILITY WATER TANK 50
- 13 CONDENSER WATER PUMP P-30
- 14 AIR TANK (OSTF-2)
- 15 WATER PUMP P-80
- 16 UTILITY WATER PUMP P-81
- 17 HOT WATER PUMP P-61
- **18 HOT WATER EXPANSION TANK 63**
- 19 HOT WATER PUMP P-60

40.10-117

Figure 1-17. Silo Level 4 Equipment Location

SILO LEVEL 4

- Fastin Elevator
- 2. Facility Elevator Counterweights
- 3. Launcher Platform Counterweights
- 4. Launcher Platform Guide Rails
- 5. <u>Water Chiller Units 50 and 51</u>: To provide chilled water to the following:
 - A. Launch Control Center Fan Coil Unit,
 - B. Control Cabinet fan soil unit.
 - C. Launch Platform enclosure fan coil unit.
 - D. Pod air conditioner on the launch platform.
- 6. <u>Circular Stairs</u>

4

- 7. Air Conditioning Ducts
- 8. <u>Chilled Water Pumps P50 and P51</u>: Two 15 hp chilled water pumps, one pump for normal and the other is for standby. Water is circulated by these pumps to water chiller units then directed to air conditioning cooling coils throughout the silo, launch control center and returned to the pumps in a closed loop system.
- 9. Emergency Water Pump (P-32): Provides emergency backup for the condenser water pumps. It is started by a signal received from the blast detection system. Provides a 50 GPM flow of hard water from the utility water system. This water flows from the pump to the water chiller units, to diesel generators water jacket heat exchangers, inst, air pre-fab and to drain in the sump.
- <u>Condenser Water Pumps (P-30 & P-31)</u>: The two condenser water pumps provide normal circulation of cooling water from the cooling tower to water chiller units, diesel generator's heat exchangers and instrument air prefab.
- 11. <u>Hot Water Pumps (P=60 & P=61)</u>: Circulates hot water in a closed loop system from the heat recovery silencers of the diesel generators to the thrust section heating coil, fan coil unit FC=40 on crib level 2 and fan coil unit FC=1 on level 1 of the LCC.
- 12. Hot Water Expansion Tank (TK-63): A 30 gallon capacity tank which serves dual purpose:

(A) An expansion vessel for the system.

from the deminstrized water system.

- Itility Water Tank (TK20): Primary function is to maintain a head presoure on the utility water system. The tank is pressurized with air of 85 psig from the instrument air prefab. As the water level drops, the air pressure will be simulataneously reduced, and at 63 psig the utility water pump will start operation to replenish the water supply and stop operation at 85 psig. When tank pressure drops to 48 psig a low level alarm indication will be registered on the FRCP in the LCC.
- 14. Fog System Pump (P-80): Pump is centrifugal type with a capacity of 500 GPM. This pump supplies water for the fog nozzles, emergency showers, eye wash fixtures, fire hose stations, air washer emergency supply and condenser water emergency supply. Operates in conjunction with the utility water pump. Starts when the utility water tank pressure drops to 55 psig and stops when pressure reaches 74 psig.
- 15. Utility Mater Pump (P-81): The 30 GPM capacity utility water pump is sized to supply the normal demand for drinking water, domestic water, cooling tower make-up (8 GPM) and air wash system make-up (2 GPM). Operation of the pump is controlled by pressure switches located in the utility water tank. Pump starts when utility water tank pressure drops to 63 psig and stops when pressure reaches 85 psig.
- 16. Diesel Exhaust Ducts
- 17. Telephone Terminal Cabinet
- 18. <u>Lighting Panel LB</u>: Power to lights and reciptacles on levels 4,5,6,7, 8 and sumps.
- 19. Fire Detector Head
- 20. Comm Box
- 21. Emergency Lights (6 Volts)
- 22. Hand Fire Extinguisher
- 23. P.A. Speaker

Sever Exhaust Fan EF-31 - "Run" light and "Hand-Off-Automatic" selector switch.

- 3. Gooling Tower Electric Heater EH-30 "On" light.
- ... Chilled Water Pump P-50 & P-51 P-51 "Run" light, P-50 "Run" light and "F-50-Off-P-51" selector switch.
- Control Cabinet Fan Coil Unit FC-10 "Run" light and Start-Stop switch.
- 36. Control Cabinet Electric Heating Coil EC-101 "On" light.
- 27. Demineralized Water Pump P-90 "On" light and Hand-Off-Automatic selector switch.
- 28. Emergency Water Pump P-32 "Run" light, Start Button and Stop Button.
- 29. Chilled Mater P-50 Start and Step Buttens, no light.

REFERENCE 10

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REPORT NO. 600-200

GENERAL DYNAMICS ASTRONAUTICS, A DIVISION OF GENERAL DYNAMICS CORPORATION



ATGBAK

REPORT NO. 600-200

INTEGRATING CONTRACTOR'S BASE ACTIVATION PROJECT MANUAL

ATLAS WS 107A-1 SERIES F SILO BASES

Prepared by

GENERAL DYNAMICS | ASTRONAUTICS A DIVISION OF GENERAL DYNAMICS CORPORATION San Diego, California

MARCH 1961

IV. BASE DEPLOYMENT AND DESIGN
BASE DEPLOYMENT

Currently authorized Atlas missile bases are deployed in the general pattern shown on the opposite page. The distances between bases and Base Activation headquarters in San Diego are natural deterrents to good communication. Total compliance with the detailed means and methods of the Project Control Plan provides maximum effectiveness of communication, coordination and control.



BASE DEPLOYMENT

BASE DESIGN PHILOSOPHY

Each silo base consists of 12 launch sites deployed as shown on the accompanying map of Plattsburgh Air Force Base, New York. The first consideration in locating the sites is maximum dispersal for protection against enemy action. Other major considerations are local topographical and geological conditions. Each launch site is operationally independent. All 12 sites are dependent for logistic support on a common Squadron Maintenance Area, and are controlled from a central administration area.



MILES FROM PLATTSBURGH		POPULATION	10	<u>20</u> T
SITE	PLATTSBURGH	19,000	SCALE OF	MILES
1 30 MI.		1,505		
2	38 МІ.	1,400		
3	52 MI.	1,400		
4	30 MI.	1,000		
5	26 МІ.	1,650		
6	34 MI.	300 -		
7	32 MI.	300		
8	27 MI.	500		
9	33 MI.	500		
10	28 МІ.	100		
11	36 МІ.	100		
12	39 MI.	100		

SILO BASE LAYOUT

A typical Series F silo squadron is shown on the opposite page. In the launch-ready configuration, all structures and equipment at a launch complex will be below ground, as at complexes 2 through 12 in the illustration. Only during maintenance operations will equipment be dispersed as shown at Complex 1. The mobile ground support equipment shown is based at the Squadron Maintenance Area and delivered to a launch complex as required.



TYPICAL SILO BASE LAYOUT -

TYPICAL LAUNCH COMPLEX

A typical launch complex is shown in cutaway on the opposite page. Essentially, the complex consists of two concrete cylinders closed at both ends. Both cylinders are completely below ground level. The larger cylinder, the silo, is over 174 ft. deep and has an inside diameter of about 52 ft. The silo contains an Atlas missile, plus most of the structures, facilities and equipment needed to launch it. The other cylinder, called the launch control center, is approximately 27 ft. deep and is about 40 ft. in diameter. The launch control center contains living quarters and facilities for the launch crew, plus the equipment to monitor the operational readiness of the silo and launch its missile.

The silo and launch control center are connected by a cylindrical tunnel about 54 ft. long and about 8 ft. in diameter. This tunnel serves as a conduit for the launch control cabling, and provides access to the silo. Together, the silo and launch control center form a self-contained combat unit, with food, water and power. In the launch-ready configuration the ground level opening in the silo roof is sealed by blast-proof concrete doors. During a missile launch these doors are opened and the missile is lifted to ground level.



TYPICAL LAUNCH COMPLEX.

V. FACILITY AND GROUND SUPPORT EQUIPMENT

The silo (see opposite page) is an 11-story building situated completely below ground. Its floor, walls and roof, which are of reinforced concrete, form a cylinder measuring over 174 ft. long and about 52 ft. in diameter. Inside this cylinder is a structural steel crib. The crib, which is octagonal in cross-section, contains eight floor levels. On these levels are mounted the storage tanks, machinery, control cabinets and other items of support equipment needed for the Atlas missile that is stored in and launched from the silo. Passing vertically through the levels of the crib are two square shafts. The larger shaft is for the launcher platform, on which the missile is lowered into the silo for storage and raised above ground level for launching. The smaller shaft contains a utility elevator for maintenance personnel and equipment movement. The crib is suspended from the silo walls on spring-loaded shock struts designed to cushion the crib and its contents against the shock of a nuclear blast. In the silo roof, which is flush with ground level, is a square opening sealed by blast-resistant doors. Through this opening, which is aligned with the launcher platform shaft, the missile is lowered into and raised out of the silo. Access to the silo for personnel is through a cylindrical concrete tunnel connected to the launch control center. Except during maintenance, operation of the equipment in the silo is remotely controlled and monitored from the launch control center.

SILO



SILO

LAUNCHER PLATFORM

The launcher platform is an open cage-type, multiple-level elevator on which a missile is lowered into and raised out of the silo. The platform is 16 ft. square and 49 ft. high, and weighs approximately 171,500 lb.

It is suspended on 10 cables within the silo crib. The platform structure consists of four levels. On the first level, which is above ground when the platform is raised, are the missile launcher and flame deflector. The second level holds the launcher platform locking system, which anchors the platform to the silo walls when it is raised, and to the crib structure when it is lowered. The third and fourth levels contain equipment for servicing the missile while the launcher platform is rising during a countdown.



LAUNCHER PLATFORM

LAUNCH CONTROL CENTER

The launch control center is a cylindrical chamber of reinforced concrete about 27 ft. high and about 40 ft. in inside diameter. Built completely below ground, the chamber contains two floor levels supported by an air-cushioned suspension system designed to cushion against the ground shock of a nuclear blast. The rooms on the lower level contain the facility and launch control equipment used by the operating crew of a single launching silo. The rooms on the upper level contain living quarters and facilities for the crew. The launch control center is connected to its silo by a cylindrical concrete tunnel some 54 ft. long and about 8 ft. in inside diameter. Access from ground level to both the launch control center and the tunnel is through a blast-resistant concrete stairwell. Emergency exit can be made through an escape hatch in the launch control center roof.



LAUNCH CONTROL CENTER

AREA KEY

FIRST LEVEL

- A READY ROOM & STORAGE
- B JANITOR'S ROOM
- C MEDICAL SUPPLY ROOM
- D TOILET
- E KITCHEN & MESS
- G HALL
- SECOND LEVEL
- H BATTERY ROOM
- J OFFICE
- K COMMUNICATIONS
- EQUIPMENT ROOM
- L LAUNCH CONTROL ROOM

- 1 ALTERNATE COMMAND CONSOLE
- (ONE PER SQUADRON)
- 2 POWER PLANT REMOTE CONTROL PANEL 15 MISCELLANEOUS TRUNK BAY
- 3 LAUNCH CONTROL CONSOLE
- **4 TV MONITOR**
- **5 OFFICE EQUIPMENT**
- F POWER DISTRIBUTION ROOM 6 LIGHTING DISTRIBUTION TRANSFORMER
 - 7 FIRE ALARM PANEL **EXIT & EMERGENCY LIGHTING PANEL** NORMAL LIGHTING PANEL LIGHTING DISTRIBUTION PANEL
 - **8 BATTERIES & RACK**
 - 9 TELEPHONE TERMINAL CABINET
 - 10 CHARGER BAY
 - 11 COMMUNICATION POWER DIST. PANEL
 - 12 PA SYSTEM CABINET

- 13 COMMUNICATION EQUIP. PANEL "B" 14 MAIN DISTRIBUTION FRAME
- (DIRECT LINES)
- 16 MOTOR CONTROL CENTER
- 17 FINDER CONNECTOR BAY
- 18 POWER BOARD

EQUIPMENT KEY

- 19 MISCELLANEOUS RELAY RACK
- 20 SELECTOR BAY
- 21 X-TIME CLOCK BAY
- . 22 REGISTER BAY 23 TRANSLATOR BAY
 - 24 FACILITY REMOTE CONTROL PANEL
 - 25 SASS BAY

LAUNCH CONTROL CENTER

LUBE OIL AND FUEL OIL SYSTEM

This system stores and distributes the fuel and lubricant required by the two diesel generators that supply facility electrical power for both the silo and the launch control center. The amount of oil stored in this system is a primary determinant of the length of time a launch complex can remain operationally independent.







LUBE OIL AND FUEL OIL SYSTEM

HEATING, VENTILATING AND AIR-CONDITIONING SYSTEM

This system continuously pumps a supply of fresh, washed air into the silo, heats or cools the air as required, and distributes it throughout the silo. Part of the system maintains constant temperature inside the shaft that encloses the launcher platform. The system also continuously expels stale air, fumes and vapors from the silo.



HEATING, VENTILATING AND AIR-CONDITIONING SYSTEM

UTILITY WATER SYSTEM

The utility water system provides the water for personnel, fire protection, and the air-conditioning system in both the silo and the launch control center.

UTILITY WATER SYSTEM



DETECTION SYSTEMS

There are five detection systems at each launch complex: the fire alarm system, which detects and provides alarm signals in the event of fire: the gaseous oxygen detection system and the diesel fuel vapor detection system. These systems give both a visual and an audible warning if they detect critical concentrations of gaseous oxygen or diesel fuel vapor in the silo. Another detection system senses the presence of missile fuel vapor in the silo, gives a visual and audible warning, and causes the release of water fog which suppresses the vapor. Fifth is the blast detection system: this system consists primarily of a light-sensitive detector, mounted above ground level at the launch complex, which is sensitive only to high-intensity light, such as the flash of a nuclear explosion. Upon sensing such a flash, the detector sends a signal to a cabinet in the launch control center. This signal closes blast protection doors in the ventilator ducts, and at other passages with openings at ground level, before the blast forces of the explosion.



DETECTION SYSTEMS

COMMUNICATION SYSTEMS

Each launch complex has a telephone system and a public address system. The telephone system interconnects the launch control center with all entrances to the launch complex and with the eight levels in the silo. Calls can be placed, via the launch control officer's console, from one silo level to another. Public address system inputs from the launch control center reach all areas of the launch complex.



SILO

COMMUNICATION SYSTEMS --

SILO CRIB SUSPENSION SYSTEM

The major components of this system are four wall brackets and four pairs of springloaded shock struts. The wall brackets are mounted 90° apart on the silo wall, above the second level of the crib. The upper ends of each pair of shock struts are attached to a wall bracket, and the lower ends are attached to the crib at a point between the fifth and sixth levels. Each shock strut is 60 ft. long and consists of from 5 to 7 sets of concentric springs mounted on a central rod. Spring retainers on the rod transfer equal crib loads of each spring on the strut. The entire weight of the crib structure and its contents, including the launcher platform and missile, is suspended on the struts. Total weight is more than 1,500 tons. The system cushions the missile and its support equipment against the ground shock of a near-miss nuclear blast. Hydraulically actuated locks in the system anchor the crib structure to the silo walls during launcher platform operation.



SILO CRIB SUSPENSION SYSTEM .--

LAUNCHER PLATFORM DRIVE SYSTEM

The launcher platform drive system raises and lowers the launcher platform along a set of guide rails attached to the inner sides of the launcher platform shaft structure. The drive system includes a drive mechanism, a launcher platform counterweight, 10 wire ropes, and a tension equalizer. The drive mechanism consists principally of two 125-hp electric motors, two reduction gears and two traction sheaves. The launcher platform counterweight, which has its own shaft and guide rails, is a stack of iron and steel slabs surmounted by two sheaves. The counterweight weighs 536,000 lb. The wire ropes are grouped in two sets of five ropes anchored to crib structure directly below the drive mechanism located on crib level No. 1. The opposite ends are attached to the tension equalizer, a teeter bar assembly anchored to crib structure above level No. 1. This assembly equalizes the tension between the sets of wire ropes.



LAUNCHER PLATFORM DRIVE SYSTEM

PROPELLANT LOADING SYSTEM

The propellant loading system consists of the silo-mounted storage tanks, control units and tubing which supply fuel and liquid oxygen to the missile (see illustration on opposite page). Fuel is loaded aboard the missile through fill lines connected to a tank truck above ground. The fuel then remains aboard the missile until the missile is launched or replaced. Two Dewar-type tanks in the system store liquid oxygen, which is transferred to the missile during countdown operations.



PROPELLANT LOADING SYSTEM

PNEUMATIC SYSTEM

The pneumatic system includes the silo-mounted equipment used in the storage, control and transfer of gases. (See illustration on opposite page.) Gaseous nitrogen handled is used in missile propellant transfer, silo hydraulic equipment operation, and missile maintenance. Helium is used for missile tank pressurization.



PNEUMATIC SYSTEM

HYDRAULIC SYSTEM

The hydraulic system consists of the silo-mounted control units, reservoirs, pumps, accumulators, lines and actuators needed for operating hydraulically powered equipment. (See illustration on opposite page.) This equipment includes the crib locks, the work platforms, the launcher platform locking mechanism, and the silo overhead doors. Also included is the hydraulic pumping unit on the launcher platform. This unit supplies hydraulic power to the missile during countdown and checkout operations.



HYDRAULIC SYSTEM

SILO ELECTRICAL EQUIPMENT

This equipment includes the generators, transformers, rectifiers, batteries, switchgear and cabling needed to make the entire launch complex electrically self-sufficient. Two diesel generators in the silo are the basic source of all electrical power for both the silo and the launch control center. The generators produce 480v 3-phase 60cycle alternating current. Power is distributed through switchgear to the launch control center and to 480v operating equipment in the silo. This equipment includes pumps and motors, 120/208v transformers, 48v and 28v d-c rectifiers, and a 400cycle 117v motor generator. Two sets of batteries, charged by rectifiers powered by the diesel generators, provide emergency 48v and 28v d-c power.


SILO ELECTRICAL EQUIPMENT

LAUNCH CONTROL CENTER ELECTRICAL EQUIPMENT

The 440v 3-phase 60-cycle a-c power supply for the launch control center is routed through the utility tunnel that connects the launch control center to the silo. Within the launch control center the power is routed to the 440v equipment, and to a 120/208v transformer. The 120/208v power is routed throughout the launch control center. Emergency power is provided by batteries.



- A SUPPLIES
- B READY ROOM & STORAGE AREA
- C KITCHEN & MESS
- D TOILET
- E JANITOR
- F HEATING, VENTILATING & AIR CONDITIONING EQUIPMENT ROOM
- G BAT. ROOM
- H OFFICE
- J LAUNCH CONTROL ROOM

LAUNCH CONTROL CENTER ELECTRICAL EQUIPMENT

GUIDANCE SYSTEM GSE

The guidance system GSE includes a collimator room and two sight tubes. The collimator room, an insulated light-tight chamber, is mounted on the north side of the silo wall at crib level No. 6. Inside the chamber are a collimator assembly and two bench marks. A sight tube leads from ground level down to the north side of the collimator room providing a light path between the collimator and the star Polaris. Periodic fixes made on Polaris and the two bench marks keep the collimator in alignment. The other sight tube leads upward from the opposite side of the collimator room to the missile guidance pod. This tube provides a path for an orienting light beam sent from the collimator to the inertial guidance reference platform aboard the missile. The portion of the tube which extends into the launcher platform enclosure is hinged, and swings out of the way when the missile is raised.



GUIDANCE SYSTEM GSE

RE-ENTRY VEHICLE GSE

The re-entry vehicle GSE consists of the cabinet shown in the accompanying illustration. The logic units in this cabinet simulate the re-entry vehicle during checkout operations and monitor it during standby and countdown activities.



RE-ENTRY VEHICLE GSE --

MOBILE GSE

The mobile ground support equipment used at a launch complex consists of the trucks, trailers and handling equipment shown on the opposite page. This equipment is stored at the Squadron Maintenance Area when not in use at the launch complex.



MOBILE GSE

MISSILE SYSTEMS CHECKOUT AT LAUNCH SITE

Checkouts of the systems aboard a silo-based missile can be performed at the launch complex without removing the missile from the launcher platform. Checkouts are performed using equipment housed in two trailers, which are brought to the launch complex from the Squadron Maintenance Area. One of the trailers, the pneumatic checkout vehicle, contains tanks and other equipment which simulate both normal and abnormal missile tank pressures. The electrical checkout vehicle contains automatic programed checkout equipment which controls and monitors both the pneumatic checkout vehicle and the missileborne systems under test.



MISSILE SYSTEMS CHECKOUT AT LAUNCH SITE

LAUNCH CONTROL SYSTEM

The launch control system consists of control cabinets and cabling in the silo, and a launch control console in the launch control center. This system continuously monitors the countdown readiness of the missile and its ground support equipment and controls and monitors their operation during a countdown.



32 RELAY LOGIC UNIT NO. 2

33 PLATFORM SENSING ALIGNMENT GROUP

MISSILE SILO

LAUNCH CONTROL SYSTEM

LAUNCH CONTROL CONSOLE

The launch control officer monitors and operates the missile and its ground support equipment from the launch control console located on the lower level of the Launch Control Center (see opposite page). The indicators and controls on the panel show the countdown-ready status of missileborne and silo-mounted systems; pushbuttons are provided for the emergency control of missile tank pressures. In the upper left corner of the panel are guidance system indicators and controls. At the top center of the panel is a digital clock. During a countdown, this clock indicates the time remaining before missile launch. When the ready-for-countdown indicator is green, a countdown can be started by depressing the start button below it. Indicators to the right of this button show the progress of the countdown. When the ready-for-commit indicator turns green, depressing the button to the right of that indicator causes the missile to be raised out of the silo and launched. If a malfunction occurs during a countdown, the sequence can be reversed to the ready-for-countdown point by depressing the start abort button to the right of the precommit indicators. Other controls on the panel include buttons for the launch complex telephone and public address systems.



LAUNCH CONTROL CONSOLE

MISSILE ERECTION SYSTEM

The missile erection system consists of a trailer-mounted erector and four trailer alignment rails. The erector essentially is a walking beam actuated by an electrically driven jackscrew. Before missile erection or removal, the trailer alignment rails are anchored in pairs to steel plates, which are embedded in the silo cap at opposite sides of the launcher platform opening. The missile handling trailer is backed onto one pair of alignment rails, and the erector trailer is backed onto the other pair. With the launcher platform raised to the proper height above ground, one side of the missile thrust section is attached to pivots on the launcher; the other side is attached to a hinged fitting on the walking beam of the erector. Then the erector's jackscrew either retracts the beam for missile erection or extends it for missile removal.



MISSILE ERECTION SYSTEM.

VI. GLOSSARY

GLOSSARY

Terms used in this manual are defined below in the sense in which they apply to base activation.

AMC --Air Material Command of the U.S. Air Force, the logistic service agency, which controls the purchase of weapons and other property for the Air Force.

ARDC--The Air Research and Development Command of the U.S. Air Force. The service agency directing the development of Air Force weapon systems.

ASSOCIATE CONTRACTOR--A civilian contracting organization working with Astronautics in the activation of a complete missile base.

BMD--The Ballistic Missile Division of the U.S. Air Force. The service agency directly responsible for and in charge of the Ballistic Missile Program, including the Atlas Program, for which BMD is the Project Office.

BOD (Beneficial Occupancy Date) -- The date on which the facility is accepted by the Air Force at which time Astronautics and its associate contractors and subcontractors can commence installing ground support and other equipment.

COMPLEX--A complex is comprised of a silo, launch control center, paving, fences, underground storage tanks, etc., necessary to the protection maintenance and launching of single Atlas Series F missile.

CONFIGURATION--The physical sum of all the component structures, equipment instrumentation, and other property which comprises a complete weapon system.

COORDINATION--The synchronization of two or more parallel but independent actions all of which are needed to accomplish a single thing.

EID--A four-digit numerical representation of the work description of an end item configuration.

END ITEM--A final combination of parts, assemblies and installations comprising a product which is ready for its intended use, either along or in conjunction with other end items.

FACILITY--The structures, machinery, instruments, and equipment built, provided, and installed by the Corps of Engineers' contractors in accordance with architect and engineer drawings and specifications.

FUNCTION--A Base Activation term which is used to define a grouping of components used principally for the same purpose and validated as an individual operational entity. It may define a complete system or only part of a system.

GSE (Ground Support Equipment) --All mobile or installed equipment, instruments, and the like, employed in the weapon system which is neither facility nor missile. (See severable items.)

INSTALLATION & CHECKOUT (I&C) SCHEDULE -- A schedule chart showing flow and span time of GSE installation, validation and integration tasks necessary to activate an Atlas missile launch complex.

INSTALLATION--The placement and securing of the item. It does not necessarily mean that the item will be completely hooked up mechanically and electrically unless the planning card so describes it.

INTEGRATION--The action necessary to interconnect two or more functions and check out the resulting configuration.

INTEGRATED FACILITY ITEMS--Facility items which are included in activation functions.

INTERFACE--Within silo systems, any point where facility and GSE installations meet.

ITEM--An incremental collection of work tasks that will be accomplished in a given period of time. In most cases in activation, an item corresponds to an OIL.

JOD (Joint Occupancy Date) --A date (prior to BOD) agreed upon by Astronautics BMD and Corps of Engineers. It allows certain I&C tasks to commence before the facility is completed and accepted by the Air Force.

OIL (Operations Inspection Log) --A document produced by IBM data processing methods, compiling the identifying numbers of the planning cards related to a particular group of work, usually an item.

PLANNING CARD--The paper form used to spell out in detail the operations to be accomplished during activation. References to procedures, drawings, etc., are included.

SEVERABLE ITEMS--Items of property which may be readily moved from one location to another. Examples: desks, hand tools, motor vehicles, laboratory equipment, calibration instruments.

SPECIFICATIONS--The detailed book of specifications prepared under the Corps of Engineers for Facility protions of each base.

SURVEILLANCE PLAN--An instrument wherewith men and material are provided and deployed in such manner as to ensure complex and continuing observation of all phases of work involved in activating an Atlas missile silo launch base.

TAB CARD--A special-paper IBM card with perforations corresponding to coded numbers and letters representing status data, which is extracted from the card by electronic data processing machines. The accumulated data from all cards in a "run" is printed out by the machines in any desired, predetermined form of summation or analysis of project status.

VALIDATION--The action of determining that a system or other prescribed portion of the base can and will serve the purpose for which it was created.

WEAPON SYSTEM CONTRACTOR -- The agency accepting over-all responsibility for production of the weapon system. Design criteria, surveillance, coordination, quality control and final selloff are facets of this task. Astronautics is the weapon system contractor for the Atlas weapon system.

REFERENCE 11

T. O. 21M-HGM16F-1SS-4-

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SAFETY SUPPLEMENT

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OPERATION MANUAL

USAF SERIES

MISSILE

THIS PUBLICATION SUPPLEMENTS T.O. 21M-HGM16F-1 DATED 1 APRIL 1964 (PRE-HEAT AND RED HEAT) AND REPLACES INTERIM SAFETY SUPPLEMENTS T.O. 21M-HGM16F-1SS-3 DATED 19 JULY 1964 AND T.O. 21M-HGM16F-1SS-4 DATED 29 JULY 1964. Reference to this supplement will be made on the title page of the basic publication by personnel responsible for maintaining the publication in current status.

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29 JULY 1964

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Ss

Ss

Ss

Ss

During a PLX or maintenance countdown using LN2 in place of LO2 and the STORAGE AREA OXYGEN 19 PER CENT indicator on the FRCP illuminates red from "START COUNTDOWN" to MISSILE LIFT UP AND LOCKED INDICATOR AMBER", and a TV camera is positioned on Level Seven to scan all LO2 transfer lines and valves on Level Seven outside the MEA, the countdown may be continued at the discretion of the MCCC, only if it can be determined by visual observation and by logic and pressure indications that there is no evidence of LN2 leakage or spillage. If leakage or spillage is evident, MCCC shall initiate abort in accordance with Table 4-2, Item 6C If the countdown is continued, the following procedures shall apply:

1. After MISSILE LIFT UP AND LOCKED indicator illuminates green and ABORT INDICATOR illuminates red, perform ACTION 1, Step 1 of Table 4-2, Item 6C.

2. After ABORT EXTERNAL INDICATOR illuminates amber, perform steps 2 through 6, Table 4-2, Item 6C.

SAFETY SUPPLEN

ATGBAK

AF SBAMA AUG 64 3.300

T.O. 21M-HGM16F-1

Paragraph 1-7 to 1-13

1-7. LAUNCH CONTROL CENTER.

1-8. The launch control center (figures 1-4 and 1-5) consists of two floor levels (crib) that are suspended from the ceiling of a concrete structure and air-cushioned to absorb ground shocks. The suspension system is composed of four air cylinder spring supports attached from the ceiling of the structure to the first floor level and four level-detecting devices mounted between the second floor level and the concrete base. Should the floor level lower or tilt, the level detecting devices sense the change. Solenoid-operated valves are then actuated to allow compressed air to enter or to bleed air from the respective air cylinders. (See figure 1-6.) The first level (upper floor) contains a medical supply room; rest room; heating, ventilation, and air conditioning equipment room; and a training-briefing room. The second level (lower floor) containing the launch control center is divided into four main rooms; a battery room, office, communications equipment room, and a launch control room. Entrance to the launch control center is gained through a blast door and stairway. An escape hatch is also provided for emergency exit. The launch control room contains the equipment to monitor and control countdown and launch of the missile and equipment to monitor power, hazardous conditions, and facility status. Controls and monitoring equipment consistof panels, consoles, and television. The television monitors missiles condition within the silo or may also be connected to external (above ground) cameras.

1-9. LAUNCH CONTROL CONSOLE.

1-10. The launch control console is located on the second level of the launch control center in the launch control room. A panel on the console (figure 1-7) contains the controls and indicators necessary for the missile combat crew commander (MCCC) to initiate a countdown and launch the missile. Arranged in various functional platches, the indicators display the summary status of the acrospace ground equipment (AGE) and missile systems at standby and during a countdown. The information displayed enables the MCCC to monitor the progress of a countdown, maintain a safe missile condition, and make the required decisions in the event of a subsystem malfunction. A communications subpanel provides the various telephone line connections required by the MCCC.

1-11. During countdown, all relay logic subsystems are remotely controlled from the launch control console. Signals from the console energize circuits in the countdown panels (figure 1-8) of the countdown control system. The countdown control system, in turn, energizes and controls circuits in the other relay logic systems. Signals from the control-monitor group 1 and 2 of 4 then actuate and control the airborne and AGE systems. The responses are interlocked in the relay logic unit as required for comparison and further sequencing. Certain critical status responses are displayed on the front panels of the control-monitor group 1 and 2 of 4 to provide information for fault isolation and local control operations. Control-monitor group 1 and 2 of 4 send summary status signals to the launch control console for display.

1-11A. PNEUMATIC LOCAL CONTROL PANEL.

1-11B. The pneumatic local control panel (PLCP), located on the left side of the launch control console, contains the controls and indicators to sequence the pneumatics end-to-end (PETE) test, (See figure 1-100.) The PETE test is conducted periodically and verifies the functional integrity of missile pneumatic and pressurization systems, both ground and airborne. Indicators on the panel display the operation and sequencing of missile system valves, pressure switches, and regulators while the PETE test is being performed.

1-12. GROUND COMMUNICATIONS.

1-13. The ground communications systems available at the launch complex include the following: the direct line telephone, the research and development system (OSTF-2), the administrative dial telephone, the missile flight safety system (Vandenberg AFB), the public address (PA), and the launch maintenance conference network. (See figure 1-9.) The direct line communications system is the primary mode of communication used during missile countdown and launch. It provides direct communication between consoles and from consoles to other specific stations, with no switchboard intervening. Depressing a line selected pushbutton on a console connects the attendant's headset to the direct line station selected. The command post and the alternate command post console operators can, by depressing

Section I

T.O. 21M-HGM16F-1



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Figure 1-4. Launch Control Center (Typical)

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Figure 1-22. Guided Missile Silo Launcher Platform

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T.O. 21M-HGM16F-1



LEVEL 1

- 1 FRESH AIR DUST COLLECTOR, PUMP, AND WASHER

- WASHER
 2 DUST COLLECTOR WATER MAKEUP TANK
 3 OVERSPEED CONTROL BOX
 4 CHILLED WATER EXPANSION TANK
 5 INTERCONNECTING JUNCTION BOX
 6 ELECTRICAL MISSILE LIFTING CONTROL CVSTEM SYSTEM

- 7 MISSILE LIFT SYSTEM MOTOR CONTROL CENTER
 8 LAUNCH PLATFORM MISSILE LIFTING DRIVE ASSEMBLY CABINETS
 9 DEMINERALIZED WATER STORAGE TANK AND PUMP P-90
 10 FACULER STORAGE TANK AND
- 10 FACILITY ELEVATOR DRIVE 11 MISSILE LIFTING LAUNCH PLATFORM DRIVE ASSEMBLY

40.10-60 (600) A

Figure 1-65. Silo Level 1 Equipment Location

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REFERENCE 12



PREFACE

ALTOS AND FORCE BALC SITE "G - CRETA

This manual has been prepared for information of base activation personnel, to serve as a reference guide for a general description of the fundamental structural and functional items associated with a typical Atlas missile silo launching complex. The information contained within is basic only and is not to be used as contractual or authoritative data.

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GENERAL

The silo concept of a missile launcher permits the missile to be maintained in a partially serviced condition, in the hard state while under nuclear attack, without preventing prompt execution of the mission of a strategic squadron.

The silo is a cylindrical hole, 52 ft. in diameter and 174 ft. in depth with a concrete wall varying in thickness from 2 ft. to 9 ft. Within the silo an octagonal structural steel crib divided into eight levels is suspended by a system of mechanical springs. Mounted within the crib are the numerous systems necessary to launch the missile, as well as a spiral staircase and a personnel freight elevator. The silo also contains electric generating and associated auxiliary and control equipment, heating, ventilation, and air-conditioning equipment necessary for proper functioning of the missile support system. Located within the crib is a 21-ft. square enclosed, insulated vertical shaftway containing a launcher platform weighing approximately 270,000 lb. The launcher platform is suspended by a cable system and serves as the elevator to lift the missile to launch position. It is divided into four levels which contain the equipment to service the missile up to the riseoff period. Retractable work platforms are located within the shaftway for access to the missile. The total suspended weight of the crib and launch platform with equipment is over 1,500 tons.

Located approximately 100 ft. away, also underground, is the launch control center (LCC). The LCC is a reinforced, concrete, cylindrical-shaped room approximately 44 ft. in diameter and 33 ft. high, containing a steel crib, divided into two levels, which is supported by an air-cushioned suspension system. The LCC contains missile launch control equipment, facility control equipment, communication facilities and batteries for their operation. It also contains an operational office, ready room, storage area, heat, ventilating and air-conditioning equipment, kitchen, messing and sanitary facilities for the operating personnel. The LCC houses a normal launch crew of three and in emergen-



CRIB & LAUNCH PLATFORM

cies, there are provisions for support of twenty men and continuous complex operation for up to ten days after complete isolation. A tunnel with a blast resistant closure, protects the crew in the LCC from any explosions that may occur within the silo. Personnel access to the complex is through an opening at ground level to descending staircase equipped with blast door. Except for command communication, each unitary silo is operationally independent of the other silos of the squadron.

Reinforced concrete silo cap doors approximately 30 in. thick provide adequate protection for the missile and permit safe personnel access to the silo after a near miss by a nuclear weapon. Blast closures operated by a blast light sensing device located above ground, cover the air intakes, air exhausts, and theodolite sight tube, also furnishing protection. The silo complex is protected from intruders by a fence with a remote controlled gate, floodlights and surveillance TV cameras. Personnel safety during servicing and maintenance of the missile is provided by emergency showers, eyewash fountains, alarm systems and so on. The LCC is provided with a sand-filled emergency escape hatch through which escape may be made after the releasing of the sand.

The crib and launch platform are designed for "stick"-type construction. Individual beams will be cut to length and predrilled before being shipped to the site. The beams will be bolted together in the silo starting with the eighth or bottom level, which is constructed upon temporary shoring. The structural members are mated and facility equipment installed before the seventh level is constructed. This procedure is followed through the construction of the fifth level after which equipment may be installed when the crib structure is completed.

The launch platform is erected in two sep-

arate sections on pads adjacent to the silo. The GSE components will be installed and the plumbing interconnects will be made before placing the launch platform into the silo. The lower half will be first lowered into the silo and set on temporary shoring. The upper section will then be lowered and the sections joined at the splice area.

To further comply with the prefabrication concept, all piping shall be detailed. In the area of tubing runs where this concept may not be the most expeditious for a particular run, production samples will be developed. These production samples will be derived from the full-scale mockup article. The mock-up is also used as an engineering check tool for details. This prefabricated plumbing as well as electrical interconnecting assembly approach, calls for the establishment of an accurate foot print and interface pattern. The facilities interface are to be designed to permit quick connection of GSE components. Because of cleaning problems, minimum working area and tight construction schedules, welding of pipe or tubing is to be kept to a minimum in the silo. Welding of brackets and other small non-critical items, is permitted. Spooling pieces are used in runs of large rigid pipes where it is mandatory to insure a proper fit. The crib is suspended within the silo shell



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by a system of shock mounts attaching at the top to inserts embedded in the silo wall. The suspension system is fastened to the crib at the lower end. The system consists of four wall brackets and eight shock struts, paired into four pairs spaced around the periphery of the crib. Each strut consists of a centered spring capsule, made up of regular mechanical springs, with 5-in. dia. centered strut rod at each end. An 18 in. rattle space is provided between the crib and the silo shell. including top and bottom, to allow for the displacement of crib structure when ground shock is experienced. Horizontal and vertical dampers are provided to damp out motion between crib and silo. Prior to operation of the launch platform, it is necessary to lock the suspended crib structure to prevent its , moving out of line. The locking system is remote controlled from the LCC and is a part of the countdown procedure. The launch platform is roller mounted on three vertical guide rails and is supported by a series of cables, tension equalizers, rollers and sheaves. A series of counter weights weighing approximately 565,000 lb. are installed to assist in the launch platform vertical movement. Positive locking provisions are provided for locking of the launch platform in both the fully extended and retracted positions.

SILO CRIB

This section is devoted to the listing of major GSE and facility installed equipment with a brief functional description of each.

LEVEL No.8

LO₂ TANK (FACILITY)

Storage of missile liquid oxygen supply until tanking period, during countdown.

LO2 TOPPING FACILITY

Supplies top off LO_2 to missile to replenish boil-off losses during extended hold periods. LN_2HE STORAGE AND

HEAT EXCHANGER (FACILITY)

Chills helium gas to missile storage bottles and supplies the helium bottle shrouds in missile with LN_2 refrigerant to maintain low helium temperature in bottles during countdown.

THRUST SECTION HEATER (FACILITY)

Supplies heated air during countdown to maintain components and small hydraulic lines at proper operating temperature in the presence of LO_2 and LN_2 .

HE GROUND PRESSURIZATION TANK (FACILITY) Pressurize missile tanks for launch (including hold period) de-tanking, etc., after an abort.
SILO CRIB

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This section is devoted to the listing of major GSE and facility installed equipment with a brief functional description of each.

LEVEL No. 8

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LO2 TANK (FACILITY)

Storage of missile liquid oxygen supply until tanking period, during countdown.

LO2 TOPPING FACILITY

Supplies top off LO_2 to missile to replenish boil-off losses during extended hold periods. LN_2HE STORAGE AND

HEAT EXCHANGER (FACILITY)

Chills helium gas to missile storage bottles and supplies the helium bottle shrouds in missile with LN_2 refrigerant to maintain low helium temperature in bottles during countdown.

THRUST SECTION HEATER (FACILITY)

Supplies heated air during countdown to maintain components and small hydraulic lines at proper operating temperature in the presence of LO_2 and LN_2 .

HE GROUND PRESSURIZATION TANK (FACILITY) Pressurize missile tanks for launch (including hold period) de-tanking, etc., after an abort. HE INFLIGHT NO. 1 (FACILITY) One load inflight requirement, high pressure checkout to DCU, emergency pressurization system.

HE INFLIGHT NO. 2 (FACILITY)

One load inflight requirement. Checkout missile pneumatic system.

PRESSURIZATION CONTROL UNIT (GSE)

Maintains required missile tank pressures during all phases of operation, before switch over to internal pressurization at L/P rise. PNEUMATIC DISTRIBUTION UNIT (GSE) Controls gas flow to PCU, HCU and chilled helium fill system.

LN₂ EVAPORATOR TANK (GSE)

Evaporator tank for warmed up LN_2 already passed through the shrouds on lines and bottles.

COLD DISCONNECT PANEL (GSE)

Contains fuel and LO_2 tanks, pressure lines, He charge line, GN_2 to NCU, GN_2 to slug unit, GO_2 vent from slug unit and LO_2 to slug unit disconnects.

HOT DISCONNECT PANEL (GSE)

Contains thrust section heater disconnect, water inlet and return for pod cooling disconnect, and fuel fill disconnect. FUEL LOAD PREFAB (GSE)

Unit contains necessary valves, lines, etc., for

monitoring the transfer of hydrocarbon fuel to missile.







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LEVEL No. 7

LO₂ CONTROL PREFAB (FACILITY)

Monitors, controls servicing of missile with LO_2 . Controls venting of LO_2 storage tank. LO_2 FILL PREFAB (FACILITY)

Monitors, controls filling of LO_2 storage vessels; controls venting of topping tank during standby.

PRESSURIZATION PREFAB (FACILITY)

Controls filling of gaseous nitrogen storage, distribution of gaseous nitrogen to the LO_2 storage, topping and slug tanks, to the fuel prefab, NDU and various other components as required.

LN₂ PREFAB (FACILITY)

Monitors, controls the fill and transfer operations in the LN_2 units.

INSTRUMENT AIR PREFAB (FACILITY)

Compressed air system for complex instrument air, diesel engine starting air, and operating of blast closure mechanism.

RP-1 DETECTOR (FACILITY)

System shall be capable of sampling, analyzing and actuating the specified alarms when concentrations of RP-1 excess vapors are present in the areas serviced by the sampling stations.

DIESEL FUEL VAPOR DETECTOR (FACILITY) Same function as RP-1 detector, for diesel vapors.

OXYGEN DETECTOR (FACILITY)

Same function as RP-1 detector, for excessive oxygen.

LEVEL No. 6

DIESEL GENERATOR (FACILITY)

Facility a-c power requirement is provided by diesel driven synchronous generators (one is located on Level 5). Only one will be operaating during ready condition. The standby generator is remotely controlled from the LCC as required, by failure of the operating generator or for periodic maintenance. Both will be operating during countdown.

AIR START TANK (FACILITY)

Compressed air storage tank for engine starting air.

48 V BATTERY (FACILITY)

Used with constantly operated electrical equipment, switch gear, LCC control, etc. Also supplies current for emergency light if generators fail.

48 V CHARGER (FACILITY)

Charger provides for normal current drain, plus a rapid recharge after use.

HEAT RECOVERY SILENCER (FACILITY)

Engine cooling and waste heat recovery system for space heating of launcher, silo and LCC.

AIG SYSTEM COLLIMATOR AND BENCH MARKS

Optical alignment equipment utilized in orienting the sensing platform to the selected target azimuth. The bench mark supports, collimator support platform and collimator is housed in a special room, attached to the silo wall between the sixth and seventh levels. The self closing light tight door to the room is located approximately eight feet above crib level and is reached by a special ladder.

LEVEL No. 5

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DIESEL GENERATOR (FACILITY) Explained with Level, No. 6. HEAT RECOVERY SILENCER (FACILITY) Explained with Level No. 6. LUBE OIL TANK (FACILITY)

Lube oil storage tanks, one for clean oil and one for dirty oil transferred from the sump. FUEL OIL DAY TANK (FACILITY)

Tank capacity is sufficient for 24 hr. and is maintained by a continuous topping operation from underground storage.

480 v switch gear (facility)

Contains synchronization and control equipment for diesel generator sets, as well as main circuit breakers for the 480 v bus power from switch gear supports 480 v motor control center of silo and LCC.

LEVEL No. 4

UTILITY WATER PUMP (FACILITY)

The utility water supply system consists of a turbine type utility water pump, a centrifugal fog spray pump and a hydropneumatic tank with necessary valves, fittings, etc. Used for fire protection etc.

UTILITY WATER TANK (FACILITY)

Hydropneumatic tank for above system. WATER CHILLER UNIT (FACILITY)

Reciprocating type water chiller, consisting of hermetic reciprocating compressors and motors, control system, and other necessary equipment to furnish chilled air to the air wash in the air-conditioning system and pod air cooler.

HOT WATER EXPANSION TANK AND PUMPS (FACILITY)

Hot water in a closed loop is pumped to the heat recovery silencers where it is re-heated and circulated to thrust section heater, launch platform heat coil, and the LCC.

CHILLED WATER PUMP (FACILITY)

Electrically driven, single stage, enclosed impeller type water pumps, for circulating the chilled water.

COOLING TOWER PUMP (FACILITY)

Condenser water pumps circulate cooling water from cooling tower to the diesel generators, condenser units and instrument air prefab and returns to cooling tower. FOG PUMP (FACILITY) Supplements the utility water pump when large demand drops the pressure in the hydropneumatic tank.

LEVEL NO. 3

3

400 A-C MOTOR GENERATOR SET (GSE) Supplies 400 cps, 120/208v 3 phase power to launch control GSE.

28V D-C BATTERY (GSE)

Emergency 28v d-c in the event of 20v d-c power supply unit failure.

28V D-C SUPPLY (GSE)

Supplies 28v d-c to launch control GSE.

L/C LOGIC RACKS (GSE)

The relay logic units contain the relays, comparators, delay devices, and wiring to perform operations required for a missile launching. SIGNAL RESPONDER (GSE)

The responders contain the relays, simulators, delay devices, and wiring to simulate the circuitry of the missile and associated GSE.

ARMA CONTROL RACK (GSE)

Guidance system checkout equipment to test the inertial guidance system.

GE LAUNCH MONITOR (GSE)

Re-entry vehicle, pre-launch monitor and control group.

30 KVA TRANSFORMER (FACILITY) (ALSO ON LEVEL NO. 2)

One transformer supplies 120/208 v, 3 phase power to energize 120/208v distribution panel which supports the launch control 60 cps power supply panel.

LEVEL No. 2

HYDRAULIC POWER PACK (GSE)

Hydraulic system consists of reservoir, pump assembly, accumulators, GN2 bottles, and control panel and is source of power to operate door closures, platforms, locks, etc. COUNTER WEIGHT (GSE)

Series of counter weights contributing to launch platform vertical movement.

AIR HANDLING UNIT (FACILITY)

Silo exhaust fan and plenum for controlling the ventilation within the silo structure. ESSENTIAL MOTOR CONTROL CENTER (GSE) Electrical power from the 440v MCC essential bus is necessary to support the instrument air system, air compressor, 30 kva transformers, d-c power supply unit, missile pod refrigeration equipment, thrust section heater, HPU, 400 cps motor generator and distribution system, 48v d-c battery rectifier (charger) water chiller unit and chilled water pumps, gas detectors and emergency water pump.

NON-ESSENTIAL MOTOR CONTROL CENTER (GSE)

Non-essential power is necessary to support main air and silo supply fans, hot water heater, main exhaust fan, exhaust vent blast closures, sump pump, spray pumps, LO2 vacuum pumps, and so on.

LEVEL No. 1

L/P DRIVE MECHANISM (GSE)

Mechanism consists of two identical 125 hp electric motors. One motor is used for highspeed hoisting; the other for low-speed hoisting. With the necessary gearing, clutch assembly, brace assembly, sheaves, etc., to perform their required function.

L/P DRIVE CONTROL CABINET (GSE)

Cabinets containing control circuitry amplifiers, transformer, reactors and resistors for controlling the drive mechanism. AMF LOGIC RACK (GSE)

Contains relays, comparators, delay devices and circuitry to control and sequence; the launch platform locks, launch platform rise, and silo doors, prior to launching.

AIR WASH DUST COLLECTOR UNIT (FACILITY) Supply air entering the silo is passed through an air washer and wet impingement type dust collector.

FACILITY ELEVATOR DRIVE MECHANISM (FACILITY)

Contains controls, cables, sheaves, etc., for operating the freight and personnel elevator.

LAUNCH PLATFORM





L/P LEVEL NO. 4

POD AIR-CONDITIONER (GSE)

Provides cooling air to missile equipment pod while in the silo. To dissipate heat buildup due to electronic equipment operation. $LO_2 SLUG TANK (GSE)$

Provides final slug of subcooled LO_2 to propulsion system to prevent pump cavitation at engine start and maintain full LO_2 supply in missile during elevator rise.

SLUG PRESSURE TANK (GSE)

Supports the slug tank with pressure.

DISCONNECT PANELS (GSE)

Missileborne hydraulic, pneumatic, liquid oxygen and nitrogen supply disconnects.

L/P LEVEL No. 3

HELIUM CHARGE UNIT (GSE) Controls helium source to missile spheres during platform rise. NITROGEN CONTROL UNIT (GSE) Regulates and controls nitrogen for charging, testing and purging operation.

HYDRAULIC PUMPING UNIT (GSE)

Provides an oil supply for filling and bleeding hydraulic system and provides hydraulic power for missile hydraulic system or autopilot system C/O and for missile requirements during active countdown, until the time airborne equipment over-rides and takes over.



SMA

SQUADRON MAINTENANCE AREA The SMA provides the necessary facilities for support maintenance requirements of the missile squadron. The SMA is composed of three separate buildings supporting the various operations.

A missile assembly building (MAB) with missile maintenance area and adjacent shop areas for system and component checkout and repair. These areas include: engine maintenance area, inertial guidance system area, hydraulic - pneumatic area, electrical - electronic area, instrument area, component area, power room and supplementary work shops and tool cribs.

A munition section strategic missile squadron (MSSMS), provides facilities for maintenance, repair and checkout of re-entry vehicles, hypergols, explosives, etc., required to support the weapon system.

An administration and storage building (ASB) will be located adjacent to the MAB. The squadron command headquarters housed in the ASB has the capability to activate the launch capability of any or all of the launchers, (alternate command post is also established in one of the complex LCC). The ASB also provides storage facilities for administration and space for weapon system maintenance and service supplies.

ALTUS AFB: SITES 6, 7, + 8 CHIEF COMPLEX ERRMAN CLIFF SITE G SUP the NHXON ACT. ENG STONE 4 DWIGHT AAFB OPERATION LEF: JACK CHAPIN ECT. MOORE - E. BRANDENBURG JUOD SPECT. FERGUSON SWEENEY DATAE JIM DEATING SITE G ASSIST. SUP - CHEFRICHADDS CH. SHOP SUP - GILLIAM FEARL JURY (L|P)ENGINEERS SITE 6: REED HUME, FRANK P.L.S. (AIR-COUD) P.L.S SURIANEK. KILGORE IOM KHOADES, 461 MAPCHE ELECT. M.L.S. ELECT. DES. LAISON ICIC AUSTIN. DRANNAGAN ELDON DESIGN LAISON L/C SHILS ELECT AGER JARDER KOBERTS

NOTES

ALTUS AIRFORCE BASE SITE # 1: LONE WOLF, OKLA. SITE # 2: SNYDER, OKLA. SHE #3: CACHE , " SITE #4: FREDRICK, " SITE # S: FARGO, TEXAS SITE # 6: CRETA, OKLA. SITE #7: HOLLIS, " STE#8: ROSSEL, " SITE #9! WILLOW, " SITE #10: HOBART, " SITE #11: MANITOU, " SITE #12: GRANITE, "



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REFERENCE 13

ATLAS MISSLE SITE TOUR

0900 — 1200

24 MARCH 1962

INFORMATION BULLETIN

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HISTORY

The decision to build the Atlas Launching Facilities in this area was reached in early January 1960 at which time the Albuquerque District Office was requested to perform soils investigation to determine whether or not the geological conditions in this area would support the proposed installation. This investigation was accomplished by the Spencer J. Buchanan Company and by Gordon Herkenhoff & Associates with favorable results.

Design was initiated in early March after completion of the investigation, and the facility was advertised for bids on 16 May 1960, and bids were opened on 15 June 1960. The construction contract, in the amount of \$22,115,828.00, was awarded to a Joint Venture consisting of Macco Corporation, Raymond International, Inc., The Kaiser Company, and Puget bound Bridge & Drydock Company on 16 June 1960. Notice to Proceed was issued on 20 June 1960, and work was initiated on 23 June 1960.

The Roswell Area Office was activated on 15 May 1960 with a nucleus of people and has been expanded to a strength of 8 Officers and 165 Civilians.

CONSTRUCTION FEATURES

The Launching Facility consists of a launching silo which has a 26 ft. 1 in. inside radius and is 178 ft. deep, and a Launch Control Center which has a 40 ft. inside diameter and a 27 ft. clear height. The launching silo has 2 ft. - 6 in. thick concrete walls up to a point approximately 55 ft. below the top of the silo at which point the wall flares out to a total thickness of 9 ft. The LCC also has 2 ft. - 6 in. thick walls with 3 ft. -6 in. floor and a 3 ft. - roof.

On the interior of the silo is a steel crib which is suspended from four shock mounts and supports all of the facilities inside the silo. The Launch Control Center has two suspended floors on which all equipment, etc. is mounted. The LCC and silo are connected by an underground tunnel.

There is a total of six Atlas "F" launching facilities being constructed nationwide, and a determination was made that all of these facilities would be identical insofar as practical. To accomplish this, and to assure delivery of critical material in sufficient time, the Government entered into contracts for fabrication of what is known as the standardized equipment. This equipment consists of the Propellant Loading System prefabs and interconnecting piping, the shock hangers, the door actuating mechanisms, the shock suspension systems, heating, ventilating, and air conditioning systems, and blast door closures.

These contracts have been assigned to the prime contractors, and they are responsible for the delivery and installation of these items of equipment. One of the critical features of construction of these facilities is the cleanliness requirements for the Propellant Loading System. The systems are subject to temperature variations from a minus 308° F. to 120° F. and pressures exceeding 3500 lbs. per square inch. All portions of the Propellant Loading System and its component parts must be absolutely cleansed of all foreign particles and hydrocarbon larger than 150 microns as the presence of foreign substances, particularly hydrocarbons, can result in violent explosion and void the function of the facility.

The facility is a hardened facility designed to withstand nearby atomic detonations and still retain its effectiveness. It has a capability of sustaining operations for a period of up to ten days without outside support. This "button-up" period is principally for periods of inclement weather that would preclude normal delivery.

The construction is being accomplished under the philosophy of "concurrency", i.e., concurrent with the development of the weapons system.

SEQUENCE OF CONSTRUCTION

The construction of the Atlas Launching Facilities at Walker Air Force Base was accomplished under the supervision of the Area Engineer of the U. S. Army Corps of Engineers acting as the construction agent for the U. S. Air Force.

EXCAVATION: Open cut for mass excavation to a depth of approximately 38 feet was of the open pit type, large enough for silo and launch control center construction, work space, and a ramp leading down to this area. Solid material was broken up by dynamite placed in drilled holes and lighter material was ripped by bulldozer. Haulage to a waste area was by conventional powered scrapers. After this open mass excavation was completed, the silo shaft was excavated to a depth of 178' below original ground surface. The method employed was to drill blast holes to depths of 12', loading these holes with dynamite and break up about 10' to 15' of material at one time. This material was then removed by means of 45-55 ton cranes using a clam shell bucket on the first 35-40' and thereafter the contractor utilized a large muck bucket and dump trucks. It was necessary to lower and raise a front end loading tractor weighing about 22 tons into the shaft for each 15' of excavation. Concurrent with shafting was the placement of a series of steel ring beams spaced at 5' vertically. Containment of the silo well surface area was by means of wire mesh and gunite concrete. Wood lagging was used on silos with heavy water scepage when considered necessary.

<u>CONCRETE PLACEMENT</u>: (Approximately 6,000 Cu Yds per Site). The major placement consisted of silo concrete which started on 6 September 1960 at Site #2 and was completed on 15 February 1961 at Site #7, with exception of the silo cap. The secondary concrete placement was for the Launch Control

- 2 -

Center and miscellaneous smaller pours continued until the completion date of 15 March 1962. The above 3 items were dovetailed together as the construction progressed. The last large pour was the silo cap which was actually completed after the silo crib steel was in place. Above ground surface pours were formed on both the inside and cutside. Only a 1" plus or minus tolerance was allowable on the interior surface of the silo concrete. This tolerance applied to an 178' overall plumb height and a 52' 2" diameter. Concrete was placed by cranes using a 2 Cu Yd buckets. Tremies were used within the forms. Pneumatic vibrators were used to consolidate the type #V concrete. Heated water was required in the concrete batch in the winter and ice added in the hot summer months to control the temperature of the concrete at placement. The top 40' of construction was heavily re-inforced including $2\frac{1}{4}$ " ribbed bers closely spaced in both horizontal and vertical planes.

CRIB STEEL: Erection of structural crib steel was one of the major tasks urder the direction of the Corps of Engineers. Macco Corporation erected all of the Launch Control Center cribs and 5 of the silo cribs. Owl Transportation and Trucking Company erected 7 of the silo cribs. Methods of erection was to pre-assemble the long columns into bents on the ground surface and then lower the complete unit into the silo. These units were connected by individual beams and braces as the work progressed. Installation of cryogenic, high pressure vessels and diesel generators proceeded con-currently with erection of Crib Steel. Delays in delivery of some of the above vessels caused extra work due to difficulty of drifting and placing these units after a major portion of the crib steel was in position. Grating, handrails ard other miscellaneous iron were added per schedule. When the crib steel was erected through the 3rd level it was swung from its supports onto the shock strut hangers located at four points on the silo wall. Tolerances on the silo crib steel were extremely close. The tolerances required was 1/8" on alignment and 1/4" on elevations for each level. Backfill of the Mass Excavation proceeded con-currently with the erection of crib steel.

<u>MECHANICAL AND EXECTRICAL</u>: Installation of piping, pumps and related equipment proceeded after the initial erection of crib steel. Pre-assembled piping and units were connected together, controls added, the units pressure tested, and in the final stages these units were validated for operating efficiency. The Electrical installation for use on the support facilities was con-currently constructed with the mechanical units which included the air conditioning system. Very close co-ordination was required by all crafts and trades to construct the interior of the silo. Good cooperation was the normal attitude and only minor interferences were noted. Improvements were made in plans as the work progressed and these changes in turn needed to be incorporated into the finished product.

The propellant loading system (PLS) was constructed con-currently with the other systems. As previously noted this feature required meticulous care due to close tolerances and requirements of the contract.

- 3 -

In summation, and to lend some idea of the magnitude of the construction effort that is reflected in the construction of one Atlas "F" sile are the following: Approximately 48,000 cubic yards of material was excavated by open cut method. This was followed by approximately 24,000 oubic yards of material excavated by silo shafting. The sum total of those two, 72,000 cubic yards, was used during backfill operations. A total of approximately 6,000 cubic yards of portland cement concrete has been placed. The crib steel alone weighs approximately 600 tons, and when suspended and balanced on the eight suspension springs the weight of the crib steel, the various fueling vessels, motor generators, propellant loading skids, etc., the total weight accumulates to approximately 1,800,000 pounds. Using average job figures, the direct payroll paid to skilled and semi-skilled workmen employed at this site is in the magnitude of 3/4 million dollars. This does not include the salaries of the professional personnel, and workers at various fabricating factories. It reflects only the salaries of the workmen actually employed at Complex No. 4. The construction phase is complete and the site now passes to the second phase that of installation and checkout. Many more items of hardware will be placed within the silo and the Launch Control Center. Many more manhours of effort will be expended prior to the time when the missile is actually housed in the silo.

Any individual questions concerning the construction effort will be answered in detail during the morning tour of the site,

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ILLUSTRATION OF AN ATLAS-F MISSILE COMPLEX.



REFERENCE 14

SBAMA

EQUIPMENT REMOVAL PLAN ATLAS " F "SERIES SILO REPORT NO. 692 - 02 - 65 - 8 DATED: 5 MARCH 1965

CONTRACT NO. AF04 (607) - 9649



BLOCK NUMBER: 24

PLOCK TITLE: Drain MIS hydraulic system

GENERAL DESCRIPTION OF BLOCK ACTION:

This block defines a method of draining the MIS hydraulic system of hydraulic fluid and establishes a sequence for dismantling the various elements of the hydraulic system.

TIME REQUIRED: 5 days

MANPOWER REQUIRED:

- a. 1 electrician
- 3 hydraulic technicians ъ.

SPECIAL TOOLS AND EQUIPMENT REQUIRED:

- a. Six 55 gallon drums
- b. K rottle and 15 feet of hose (FSN 4730-80 37666, MS28741-4-1800 or equivalent)
- c. Four 10 gallon cans

TASK DETAILS:

- CAUTION -

Do not flame or torch cut any hydraulic lines. Feilure to comply may result in fire or explosion and injury or death to personnel.

- A. Verify the following conditions.
 - 1. L/P down
 - 2. Inching tool installed (MIS)
 - 3. Manual brake release cystem installed
 - L. L/P locks retracted
 - 5. Herizontal and vertical locks retracted
 - ε. Stanchions installed
 - 7. Sile doors open and secured
 - 8. All work platforms retracted
 - 9. All electrical power to MIS off. Insure that both blocks 1C and 15 have been completed.

SYMBOL

9. All elect have been	rical power to completed.	MIS off. I:	nsure that both	h blocks l	C and 15	REVISION		
JENERAL DYNAMICS ASTRONAUTICS SAN DIEGO, CALIFORNIA	CODE IDENT NO.	SIZE DRA	WING NO. 692-	-02-65-8		_	KAGE NO.	02
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### TASK DETAILS, BLOCK NO. 24 (Continued)

### B. Initial Drain

- 1. Verify that all pressure gages on the Local Control Hydraulic Panel indicate O psig.
- 2. Verify hydraulic reservoir level is below "MAX DRAIN IEVEL".
- 3. Open drain values VM-143, VM-154, and VM-135 located on the HPU and reservoir.
- 4. Remove the following components from the hydraulic accumulator and GN2 pressure tank rack: Filters FR-501, FR-503, and FR-505; Valves VA-951, VA-965, and VA959; and Check Valves CK-982, CK-984, and CK-983.
- NCTE: As hydraulic components are removed from the system, all ports should be capped with suitable protective closures.
- 5. Hook up pneumatic hose (FSN 1720 80 37666 or equivalent) from K bottle to the open line on the sir side of each accumulator rack and apply 50 psig pneumatic pressure. Hold pressure until the reservoir oil level stabilizes.
- 6. Remove pneumatic charge and disconnect K bottle and hose. Cap air side of each accumulator assembly.
- 7. Open VM-404 on hydraulic reservoir and drair reservoir into a suitable container.

MOTE: As much as 200 gallons of hydraulic oil can be expected.

- 8. Open drain value on FP-109 filter asserbly and drain filter housing.
- 9. Remove calibration plug above GA-122 on ICHP and install hose from port into suitable container.
- 10. On the LCHP, open W-172 and W-173 to connect gage circuit.
- 11. Remove two bleed valves on rod end of door cylinders.
- C. L/P and Umbilical Drain
  - 1. Remove spreader bar located nearest to the bottom of the umbilical loop.

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SYMBOL

EVISION :

2. Position 55 gallon drums under the lowest point in each of the hydraulic hoses and shrond hoses with plastic sheets to control oil spray.

3. Cut the bottom side of each hose and drain.

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SAN DIEGO, CALIFORNIA	CODE IDENT NO. SIZE DRAWING NO.						o	
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#### INTRODUCTION

#### SBAMA EQUIPMENT REMOVAL PLAN - ATLAS "F" SERIES SILO

### SCOPE

This plan provides a controlling sequence of operations, and procedures for these operations, to remove all equipment from an Atlas "F" Series sile site, except the crib steel, facility elevator, sump pumps, and lights.

The entire package includes a flow chart, a procedure for each block on the flow chart, an equipment and materials list, and a cumulative list of manpower and material requirements. The plan has been designed, as requested, to suit existing USAF capabilities as much as practicable.

#### GENERAL EXPLANATION OF FLOW CHART

The flow chart shows the earliest time at which given operations may be performed safely. The principal flow is as follows:

The site is verified to be inactivated (1) according to the plan proofed at SAC Site 5, Altus AFB. If this has not been accomplished, it must be done (2). However, installation of vinyl covering and dessicants need not be accomplished as equipment will be removed from the silo.) Subject to the limitations called out in the individual block procedures, the following actions may then proceed simultaneously: Prepare Diesels for removal (3), drain fuel loading prefab (4), open and secure silo doors (5), bleed down GN2 and helium (3), prepare LCC and tunn#] equipment for removal (7), dismantle cooling tower (11).

An important sequence following (4) and (5) is to drive the launch platform inter the uplocks (9), modify the top of the launch platform as a staging platform (13), install horizontal crib shoring (14), and drive the L/P down to level 7 (16). Then the L/P is prepared for drive-up using the inching tool (17), (19), (23). Counterweight shoring can be installed (20), and the uplock area can be cleared (21) at this time. All Level 7 equipment is disconnected and removed (18) to the L/P staging platform for crane lift-out of the sile. Meanwhile, the sile hydraulic system is drained (24), the umbilicals (25), and MLS controls (48) are removed. The L/P is moved to Level 6 (28) and Level 6 equipment (27), (29), (49), except the Diesel D-61, is removed. This general operation proceeds through Levels 5,4,3,2, and 1 (30 thru 37).

Heavy rigging operations begin with door cylinder removal (39), and continue through dismantling, and removal of the L/P (38), L/P drive mechanisms (40), (41), (42); missile enclosure area equipment from Level 8 (43); Diesels from Levels 5 and 6 (50); storage vessels from Level 8 (44).

Finally, the silo is secured (46), and the silo doors are closed, leaving the crib steel and minimum electrical circuits for pumps, facility elevator, and some lights.

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EVISION SYMBOL

# **REFERENCE 15**

# AIR TRAINING COMMAND

ALL F SERIES COURSES.

# INTRODUCTION TO WE ROTAL

Jamen 1962

FOR INSTRUCTIONAL PURPOSES ONLY

ATGBAK

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SM=65F_SERIES

TECHNICALITRAINING

5 7/ 300 A7LAS STUDENT STUDY GUIDE and the British used them against Fort McHenry, Maryland, in the War of 1812. Our National Anthem mentions the rockets.

The first significant American contribution to rocketry came from Dr. Robert H. Goddard, who built and flew his own liquid propellant rocket near Roswell, N. M., in the 1920's.

Hitler, looking for a super weapon, took the rocket and developed the V-2 with the help of such noted scientists as Christoph Geisler and Werner von Braun. This was the first long range rocket in history, and it was from this vehicle that the lagging Russians and Americans launched their military rocket development.

Missiles have come a long way since World War II. The progress made can be attributed mostly to the independent research and development accomplished in such fields as electronics, rocketry, jet propulsion and aerodynamics. The future outlook for missiles, although presenting many obstacles to be overcome, is that they will be the main weapon of war.

### ATLAS DESCRIPTION

Atlas, the SM-65 Missile (Figure 1-1) is the first operational intercontinental ballistic missile (ICBM) in the arsenal of the Strategic Air Command. Comparable in size and weight to a diesel locomotive, Atlas is the nucleus of the organization of men, missiles, and machines that constitutes the SM-65F (silo) Missile Weapon System.

Designed as a deterrant to hostile enemy action, the SM-65F missile can place a thermonuclear warhead into a ballistic trajectory that will intersect a target more than 5500 nautical miles away. Effective retaliatory capability requires immediate operational readiness of the weapon system. It is therefore maintained with fuel stored in the missile tank during standby. In this status, the missile is ready for launching as soon as liquid oxygen has been loaded and the various countdown sequences have occurred.

The Atlas is 75 feet long, and its 10 foot diameter flares to 16 feet at the nacelles. In contrast to such impressive size, the skin thickness of the Atlas is measured in thousandths of an inch. This tough, lightweight stainless steel skin is fabricated into a cylindrical tank structure containing no internal supporting framework. Rigidity is maintained through constant application of pneumatic pressure to the interior of the two missile propellant tanks. While being transported, and during standby, the tanks are pressurized with gaseous nitrogen. During flight, helium is used. Equipment pods, containing electronic and electrical equipment, are attached to the tank section skin. Electrical, instrumentation, flight control, and guidance equipment is contained in these equipment pods.

The Atlas system, with its unique one-and-one-half staging, differs from other modern missiles in that it has several engines but only one propellant tank structure. This permits igniting all engines, including the upper stage (sustainer) engine, on the ground. There is no risk that the missile will abort through failure to achieve ignition of a second stage many miles in the air. Missile reliability is remarkably improved. Movable thrust chambers mounted on gimbals provide directional control from commands from the flight control system. Vernier engines are used to obtain precise velocity and attitude adjustments just prior to re-entry vehicle separation.

Atlas is propelled by five rocket engines. The booster engines, which provide the greatest amount of thrust (330,000 lbs), consist of two thrust chambers, fuel and interconnecting piping. The sustainer engine with a single thrust chamber and related pumps, pipes and valves, develops a thrust of 57,000 pounds. Two small vernier engines, individually gimbaled and supplied with fuel and oxidizer by the sustainer pumping system, each develop 1,000 pounds of thrust.

After the missile has been lifted into the first part of its trajectory, a substantial portion of the fuel has been consumed and the missile, greatly reduced in weight, is in thin air high above the earth. The booster engines have then performed their function in boosting the missile to high altitude, and the entire booster section, including pumps, thrust chambers, and the housing for these parts, is jettisoned. Thrust from the sustainer and vernier engines is then sufficient to continue accelerating the missile to the desired final velocity. (See Figure 1-2.)

### SM-65F STRATEGIC MISSILE SQUADRON CONFIGURATION

A typical "F" series missile weapon system base consists of twelve launch  $\infty$  mplexes surrounding a centrally located Squadron Maintenance Area (SMA). (See Figure 1-3.) The separation between launch complexes is in the order of 15 to 25 miles and a distance from the SMA to any launch complex varies from 25 to 60 miles. This configuration is referred to as the 12 x 1 unitary Strategic Squadron.

There are four separate buildings in the Squadron Maintenance Area (Figure 1-4); the Missile Assembly Building (MAB); the Surveillance and Inspection Building (S & I); the Administration and Storage Building (ASB) and the Paint and Combustable Storage Building.

### **RE-ENTRY VEHICLE ADAPTER**

Starting at the forward end of the tank section is the first component to be discussed. It is the re-entry vehicle adapter. It is as its name implies, the structure that joins or adapts the re-entry vehicle to the tank section. It is fabricated of aluminum sheet in the shape of a frustum. It is connected to the tank section at airframe station 502.00. (Figure 3-2)

### TANK SECTION

Following the re-entry vehicle adapter is the tank section proper. It is primarily designed as a propellant container. The tank section is used to support the following: the re-entry vehicle, equipment pods, sustainer engine and booster section. It may be described as a large, cylindrical, metal balloon. As air pressure is used to shape a balloon, gas pressure (nitrogen and helium) is used to maintain the shape of the tank section. There will be times, as you shall learn, when the tank section is stretched to either supplement or replace this gas pressurization. This pressurization and/or stretch is required to maintain the structural integrity of the tank skins. The tank section is of pure monocoque-type construction; that is, there is no internal framework to support the tank on the ground or to counteract accelerative and aerodynamic loads in flight.

The material most extensively used in constructing the tank section is stainless steel. The most common abbreviation used for it is CRES, which stands for corrosion resistant steel. The main quality that this material possesses is its high strength to low weight ratio. This allows tank skins to be very thin yet very strong when under pressure. The minimum tank skin thickness is 0.011 in. and the maximum thickness is 0.038 in.

### Liquid Oxygen Tank

The forward part of the tank section makes up the liquid oxygen tank. The tank has a maximum capacity of 18,725 gallons. About 18,500 gallons of liquid oxygen is loaded into this tank. Within the liquid oxygen tank there is a 200 lbaluminum structure. It is called the antisloshing structure. Its primary purpose is to stop any large degree of sloshing of liquid oxygen. If it were not there, the liquid oxygen might slosh severly enough to unbalance the missile to the point where it would be impossible for the gimbaling thrust chambers to control it.

### Fuel Tank

The after part of the tank section is the RP-1 or fuel tank. It has a maximum capacity of 11,653 gallons. Into this tank is loaded about 11,200 gallons of RP-1. Within the RP-1 tank are 2 components. One is the vernier RP-1 tank, which is a propulsion system component. The other is a thin sheet of perforated aluminum, which is mounted across the tank at airframe station 1133. It is called the antivortexing membrane bulkhead. Its function is to prevent the vortexing action of RP-1. Vortexing is that action of a liquid similar to the swiveling effect created as water is drained from the sink or bathtub. Without the antivortexing membrane bulkhead it is possible that the vortexing could be severe enough to produce propellant pump cavitation and, therefore, premature burnout during flight.

### Other Bulkheads of the Tank Section

In addition to the antivortexing membrane bulkhead there are 4 other bulkheads that can be mentioned here.

1. Forward Bulkhead

This is ellipsoidal in shape and forms the roof of the liquid oxygen tank. It contains an access door, which permits entry into the liquid oxygen tank. The access door also provides the mounting for the pneumatically operated liquid oxygen boiloff valve.

2. Intermediate Bulkhead

This is located at about airframe station 960. It is ellipsoidal in shape and forms the floor of the liquid oxygen tank.

3. Aft Conical Bulkhead

2

This is located at the aft end of the tank section and is made of stainless steel. It is the floor of the RP-1 tank. Part of its structure is a forged-aluminum piece called the thrust cone. It is bolted to the bulkhead and supports the sustainer engine gimbal. Its removal allows access to the inside of the RP-1 tank.

# **REFERENCE 16**

Site Visit Summary Atlas #9

Current Owner: Bonham Farms, Roswell, NM. P.O.C. William Bonham, 623-2299, (Roswell NM)

Site visit was made 4-19-90 by Richard Barnitz.

This site apparently had 3 wells, # A small pumpt well house (with tin building remaining) was at this site in addition to the usual large pump house. One well appeared to still be in use.

Evap. ponds were well vegetated. Septic area was located west of silo. Manholes were open and one tank had water init, =4'BGL of unknown depth. Other tank was dry and = 7' deep. Splitter box was dry.

2. Silo vents were open, the North and south one. South one had water at = 20' BGL., = 6.5x6.5' opening. North vent had water at = 30' B.t.L. Depth of water in either was not known. Apparently, these vents were just welded shut and never capped with concrete. Lccentry was open. Door was welded shut and never concreted over. A depression east of silo is thought to be where n diesel tank was.

There is potential BD/DR work and HTW investigation (septic tanks, silowoter) at this site.

## **REFERENCE 17**

Contacted William Bonham (623-2299) Roswell, N. current owner of Atlas # 9. His wife said the entry to the control room had been welded shut, but was opened by Mr. Bonham and later welded shut again. Trespassers have since re-opened the control room Using cutting torches. The main silo is still closed. Mr. Bonham Knew of no HTW hazards

at the site and expressed no concerns regarding remediation work. He said the sites are a nuisance because they attrac. trespassers & vandals. He said he has installed fences & signs and requested state Police watch the site to deter trespassers. He said this has done little good. He says people will go to extreme effort (i.e. cutting torches) to open these sites. Mr. Bon ham granted permission to make a site visit.

4-18-90 Contacted Mr. Bonham to inform him I intended to visit the site on 4-19-90. I also invited him to accompany me if he wished, but he declined to go.
Atlas#9 623-2299

wife (control Room) dogs sealed shut cutopen later ord-went in rewelded reopened by vandals. (trespassers). 5 ilo still sealed.

Mr. Bomham - no real concerns - has had signs up, told 5 toto Police, to watch - can't keep people off the site - has liability insurance on it I keeple will go to extreme effort to open these sites

They to dechitout

## **REFERENCE 18**

## **INTERVIEW SUMMARIES**

## PRELIMINARY ASSESSMENTS OF 12 FORMER ATLAS "F" MISSILE SILOS

## 579th SMS, WALKER AIR FORCE BASE ROSWELL, NEW MEXICO

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Shaw Environmental, Inc.
i

## INTERVIEW SUMMARIES PRELIMINARY ASSESSMENT INVESTIGATION

## FORMER ATLAS "F" MISSILE SILOS 579th STRATEGIC MISSILE SQUADRON WALKER AIR FORCE BASE ROSWELL, NEW MEXICO

### **1.0 INTRODUCTION**

HydroGeoLogic, Inc. (HGL) received Purchase Order No. 42236 QP from Shaw Environmental, Inc. to conduct preliminary assessments of twelve former Atlas "F" missile silos associated with the 579th Strategic Missile Squadron (SMS), Walker Air Force Base (WAFB), Roswell, New Mexico. As part of its preliminary assessment investigation, HGL located six former missile crewmen and maintenance officers of the 579th SMS, and conducted formal interviews with these individuals regarding their knowledge of operations and maintenance activities in the Atlas "F" missile silos. In addition, these individuals were asked about their knowledge of the events surrounding the accidents at three of the Atlas "F" missile silos. A list of individuals interviewed and their positions with the 579th SMS are presented in Table 1. Refer to Section 2.0 for the interview summaries.

## Table 1List of Interviewees

Interviewee	Position	Time Period of Involvement
Orville L. Doughty, Lt.	Maintenance Control Officer, Maintenance	1962-1963
Col., USAF Ret.	Squadron	
Gene Lamb	Deputy Combat Crew Command	1961-1965
Jack Lundgard	Deputy Combat Crew Command	1961-1965
Phil Moore	Deputy Combat Crew Command	1961-1965
Jerry Nelson	Deputy Combat Crew Command	1962-1965
George Ziegler	Section Maintenance Officer, Maintenance	1962-1965
	Control Unit	

### 2.0 INTERVIEW SUMMARIES

### Orville Doughty Lt. Colonel, USAF Ret. 9186 E. Placita Arroyo Seco Tucson, AZ 85710 (520) 733-3603 Oldmmd@cox.net

On January 7, 2005, Lisa Contreras-Hendler and Stephanie Hester of HGL interviewed Orville Doughty, Lieutenant Colonel, U.S. Air Force (USAF), Retired, in person at the Titan Missile Museum in Tucson, Arizona, regarding his knowledge of the Atlas "F" missile silos (Atlas silos) associated with the 579th Strategic Missile Squadron (SMS), which was attached to Walker Air Force Base (WAFB), Roswell, New Mexico.

Mr. Doughty was stationed with the 579th SMS at WAFB from approximately January 3, 1962 to July 1963. Mr. Doughty was the Maintenance Control Officer for the 579th SMS. His office was located in the Missile Assembly and Maintenance Services (MAMS) building at WAFB. While at WAFB, he supervised the maintenance staff, including George Ziegler.

When he reported to duty in January 1962, four Atlas silos had already been installed. The remaining eight missile silos were installed while he was stationed with the 579th SMS. Mr. Doughty said once the contractor turned over the silos to the USAF, he was responsible for conducting an inventory of the equipment in the silos, including documenting the equipment's serial numbers. After the USAF took custody of the silos, it put the warhead onto the missiles and installed the guidance and target systems. The silos went into the alert status soon thereafter.

Mr. Doughty provided details on the maintenance of the silos. Scheduled maintenance was performed every 30, 60, 90, and 120 days, plus annually. In addition to the scheduled maintenance, the maintenance crew was sent out to the silos when items broke. He was responsible for dispatching the maintenance crew to the silos. Mr. Doughty said the typical problems at the silos included issues with the malfunctioning of equipment, door problems, and facility problems. He said the work involved a lot of "R & R," also known as "Remove & Replace."

Mr. Doughty recalled the largest problem at the silos dealt with the diesel generators, which dripped occasionally. These generators were located one level above the liquid oxygen (LOX) tanks. To resolve the potential hazard of the fluid coming into contact with the LOX, the maintenance crew placed a 4-inch deep drip pan beneath the diesel generators. Any diesel problems occurred in the silo itself, while any electronic issues that arose usually occurred in the Launch Control Center (LCC).

The maintenance department was in charge of supplying diesel fuel to the Atlas silos. Mr. Doughty recalled sending a tanker out to the silos once every month. This department also supplied the hydraulic oil, which was used for the elevators within the silos. Mr. Doughty was asked if he could recall other substances used in the Atlas silos. He believed that "MEK" (also known as methyl ethyl ketone) may have been used on the silo property to clean parts and remove grease. If MEK was used, Mr. Doughty said that it would have been in relatively small amounts. He also mentioned the LOX, which was an oxidizer, and the RP1 fuel, which was a crude kerosene product. He does not think that "Tric" was used at the silos, but it was used at WAFB. Mr. Doughty confirmed that his definition of "Tric" was trichloroethene. A hazardous management manual listed the chemicals that were used in the silos.

Regarding storage of material on silo property, Mr. Doughty said that very little material was stored at the silo. The maintenance crews brought any material it needed to do a repair or maintenance check out to the silo with them. The diesel was stored on-site, but he did not recall the size of the tanks. He recalled that two gallons of hydraulic fluid was stored on-site as back-up. The Atlas silos typically operated on diesel during normal operations instead of being electrically powered. Diesel power was relied upon totally during missile exercises. LOX was replenished after any missile exercises since it was vented during the exercise, but the RP1 fuel typically did not require refilling.

Mr. Doughty was asked about the Quonset huts on the silo property. He said these huts were removed once the contractors left. Although he did not go into the Quonset huts, he believed that the huts contained various shops, possibly plumbing and electrical shops. The huts were government-owned and he suggested contacting the Civil Engineering Department of the USAF for further details.

Mr. Doughty stated that he was the first person from the 579th Maintenance Section to arrive at Silo 1, the site of the first silo explosion. The doors of the silo had been blown off, and USAF staff was unable to get into the silo until the following day due to the fire. Mr. Doughty recalled seeing soot everywhere within the silo, but the LCC remained clean. He recalled seeing a 1/2-cup of coffee in the LCC that was not even disturbed. Mr. Doughty was asked if he was able to describe any hazardous conditions in the silo following the accident. He said the biggest hazard was the physical damage to the equipment in the silo. He added that polychlorinated biphenyls (PCB) were not present in oil at this time so this contamination did not exist.

Regarding overall operations of the silos, Mr. Doughty could not think of any operations that occurred at the silos that would cause an environmental problem.

After leaving WAFB, Mr. Doughty was assigned to the Strategic Air Command headquarters in Omaha, Nebraska, and continued to work in the capacity of missile maintenance. He subsequently became MAMS Commander for the missile squadron assigned to Davis-Monthan Air Force Base. Mr. Doughty remained in the USAF for 34 years and retired with the rank of Lieutenant Colonel.

### Gene Lamb 3313 N. Glenhaven Midwest City, OK 73110 (405) 737-2471 dlamb4@cox. net

On October 1, 2004, Lisa Contreras-Hendler and Stephanie Hester of HGL interviewed Mr. Gene Lamb via telephone regarding his knowledge of the Atlas "F" missile silos (Atlas silos) associated with the 579th Strategic Missile Squadron (SMS), which was attached to Walker Air Force Base (WAFB), Roswell, New Mexico.

Mr. Lamb, a 1st Lieutenant in the Air Force, was the Deputy Crew Commander for Silos 1 and 5. His primary assignment was at Silo 1, but he worked at other silos when additional crewmen were needed. Generally, the composition of the missile crew changed as individuals went into and out of military service. Each silo had two crew commanders, and each crew commander had to have the rank of Captain or higher. Congress required that a non-commissioned officer or NCO was stationed on every crew because the crew had access to sensitive documents that could launch the missiles. In addition to the Crew Commander and Deputy Crew Commander, other missile crewmen included the Ballistic Missile Analyst Technician (BMAT), Missile Facility Technician (MFT), and the Electric Power Production Technician (EPPT).

By September 1961, none of the silos associated with the 579th SMS were in operation, but the site activation task force was in place. The silos had been dug and the military was in the process of installing equipment. During this period, Mr. Lamb was stationed at the squadron headquarters at WAFB, assembling training folders.

The crew in a silo was called the "Stand Board" crew. The Strategic Air Command (SAC) required the crewmen to initially become certified prior to being assigned to the missile crew. This certification process involved performing drills associated with missile operations. Periodically, about once per year, the crewmen had to be recertified. The part of the recertification process involved conducting the propellant loading exercises. For an average shift, Mr. Lamb's crew would report to duty, walk the silo with the prior crew, settle into the operations, and then conduct tests that the SAC had given the crew. His crew name was "Skybird."

Both Crew Commanders at the silo wore the launch code in a sealed, plastic case around their necks and a firearm to protect the launch code. The code changed frequently, even during the course of a shift. Each Crew Commander had to separately de-code the messages, and then switch with each other and come to an agreement on the messages. Mr. Lamb noted it was difficult to open the plastic container containing the launch code.

Maintenance activities at the silos were on-going. Mr. Lamb explained that the silo was filled with motors and valves, which not only made the silo a very noisy place to be, but also always provided something to fix. Generally, maintenance issues dealt with support equipment. Much of the maintenance involved vacuum pumps that were used for silo operations and the launch

vehicles. Silo equipment, referred to as Real Property Installed Equipment or "RPIE," requiring repairs included valves, motors, and hand equipment. Maintenance efforts also addressed computer failures.

The missile crew during its "walk around" was able to perform some manual and/or minor adjustments on the support equipment. A crewman, for example, can adjust the equipment to keep the temperature within a certain range. The crew also added oil to vacuum pumps when the crew looked through the "sight glass" and noticed that the oil was getting low. More extensive maintenance was conducted by personnel out of WAFB. Mr. Lamb thought this maintenance crew was part of the maintenance squadron of the 579th SMS. This maintenance crew conducted both scheduled maintenance and addressed problems as they arose. Most of the maintenance work occurred in the silo instead of the launch control center (LCC). The missile crew always had two crewmen in the silo to observe the activities of the maintenance crew.

Two diesel generators were located in the silos. Mr. Lamb did not recall many problems with these generators. Diesel was stored in underground storage tanks with a grating covering it. Mr. Lamb believed that the diesel was pumped into the silos, but he did not know if a smaller tank was located in the silo.

Regarding the use of chemicals or spills in the silo, Mr. Lamb recalled oil spills, specifically hydraulic fluid, from machines and pumps. Occasionally during maintenance activities, lubricating oil from a motor or the vacuum pump would spill. Mr. Lamb also remembered that the silo had water leaks, which would collect in the sump at the bottom of the silo. The sump would then be pumped out.

RP1 fuel, a kerosene-based material, was always stored on the Atlas missile. The LOX was stored outside of the missile, and was loaded onto the missile during a launch or a propellant loading exercise. After an exercise, the LOX was then unloaded off the missile. Occasionally, the Atlas missile itself had to be replaced as part of routine maintenance. When this event occurred, Mr. Lamb thought that the RP-1 fuel had to be removed from the missile prior to moving it. He suspected that the RP-1 fuel may have been traded out when this event occurred.

Mr. Lamb did not recall the flushing of lines in the silos. However, he did remember changing out the LOX once and using a non-hydrocarbon cleaner to clean out the line. He thought trichloroethylene may have been used. Mr. Lamb suggested that HGL contact a MFT regarding the use of solvents in the silos as this crewman would have observed the activities of the maintenance personnel out of WAFB. He recommended Don Hajek, a MFT who used to live in Colorado Springs, Colorado, as a potential interview candidate. Mr. Lamb thought that small cans or bottles of solvents might have been used in the silos, but he did not recall any spills or the names of any solvents.

Mr. Lamb recalled that the silo complexes had two Quonset huts, which he believed were used for equipment storage. He did not recall observing any activity associated with these huts.

He provided a description of the events surrounding the explosion at Silo 1. The missile exploded while it was still in the silo. The LOX fire that caused the explosion was started in the

fill line that led from the LOX storage tank into the missile. According to Mr. Lamb, an internal fire was started and burned through the valve, causing the LOX to spill onto the floor of the silo and catch on fire as well. Silo 1 was shut down after the explosion.

Regarding the Silo 5 explosion, Mr. Lamb recalled that his missile crew was preparing for the propellant loading exercise at Silo 5. They encountered some problems and had to fix it before the exercise. During the course of drilling for the exercise, his crew's shift ended and they had to return to WAFB to be debriefed while the replacement crew was put in place to execute the propellant loading exercise. He recalled driving back to the Silo 5 in his personal car to watch the exercise. During the exercise, the LOX started to spill out and fall into the silo, causing the fire. He subsequently read that the LOX valve was partially open, which caused the LOX to start dripping into the silo. He drove about two or three miles from the silo and stopped traffic. The missile exploded and he recalled feeling a concussion on his chest. The missile crew in Silo 5 stayed in the LCC during the exercise. He thinks that the guards were also in the LCC during the exercise. Silo 5 also ceased operations after the explosion.

Mr. Lamb did not recall any activities, operations or events at the silos that would be environmentally significant other than the explosions at the silos.

Mr. Lamb left WAFB when the Atlas silos were being shut down in 1965. He left the military, but was re-called back into service after two years and went to Germany. He remained in the military for 22 years.

Regarding research avenues, Mr. Lamb did not have any documentation available although he suggested the following individuals as a potential source of information:

- Pete Cummins Crew Commander at WAFB, possibly residing in Las Vegas, Nevada.
- Jack Lundgard Crew Commander stationed at Silo 3, Command Control.
- Don Hajek MFT who was living in Colorado Springs, Colorado.
- Professor Terry Isaacs Professor at South Plains College, Loveland, Texas. According to Mr. Lamb, Professor Isaacs said that the military wanted to get the Atlas "F" ready because the Jupiter missile was going out of commission.
- Phil Moore Former missile crewman, who subsequently went to Cape Canaveral to launch missiles.
- Linda Irvine Compiled a list of 579th SMS personnel for reunion purposes. Mr. Lamb will e-mail Ms. Irvine about HGL's research.

### Jack Lundgard 2200 West 33rd Street Panama City, Florida 32045 (850) 769-6913 jacklundgard@aol.com

On October 7, 2004, Lisa Contreras-Hendler and Stephanie Hester of HGL interviewed Mr. Jack Lundgard via telephone regarding his knowledge of the Atlas "F" missile silos (Atlas silos) associated with the 579th Strategic Missile Squadron (SMS), which was attached to Walker Air Force Base (WAFB), Roswell, New Mexico.

Mr. Lundgard was one of the first officers to report to duty to the 579th SMS. He arrived in Roswell in October 1961 and was a member of the site acceptance team. This team worked with the silo construction team, and his responsibilities included observing the construction crew's activities. By late 1961, most of the silo sites had been completed. The silos associated with WAFB had 12 missiles. He mentioned that the Atlas silos at the New York location only had 11 silos.

Shortly after arriving at WAFB, Mr. Lundgard was sent to missile or "ORT" school at Vandenberg Air Force Base (AFB) where he received instruction on how to launch the missiles. He was also taught about the maintenance of the silos and support equipment. He completed the school and returned to WAFB in the Spring 1962.

The missile crew consisted of the following five-man crew: Combat Crew Commander, Deputy Combat Crew Commander, Ballistic Missile Analyst Technician (BMAT), Missile Facility Technician (MFT), and the Electric Power Production Technician (EPPT). In addition, two guards were stationed on top of the silo at all times. Mr. Lundgard was the Deputy Missile Combat Crew Commander (DMCCC) and he worked out of Silo 2 and then finished up at WAFB at Silo 3. He believed that he may have also been located at Silo 5 for a period of time. He explained that Silo 3 was the Command Post for all the silos. It had VHF and UHF to allow for more communication to the outside world from the silo in the event of a wartime scenario. Although each silo had the ability to launch its own missile, Silo 3 had a relay to the other silos that could launch their missiles as well. The Atlas "F" missiles were five mega-ton weapons. Mr. Lundgard said that the military needed missiles with a large impact because the accuracy of the missiles during that era was poor; consequently, it needed a missile that took out more territory.

During the course of the 24-hour shift of the missile crew, the DMCC never went on topside because the DMCC held the top secret code for launching the missiles. The missiles had a decoy system, which Ford Motor Company made. He recalled one occasion when this company's technical representative came to the silo to repair the system.

Mr. Lundgard described certain features of the silo. The silo was equipped with an access tunnel that served as a doorway from the launch control center (LCC) to the silo. He said that there was a silo cap and a domed-object that was used for a retractable antenna. The silo had sensors that

popped up and detected a nuclear explosion. If an explosion was detected, the outlets to the exterior of the silo would be closed. The silo also had an escape hatch and a perimeter fence. The silo library contained about 10 to 12 feet of maintenance books. He said that the library contained "Tucker Prints," which depicted the electrical and plumbing lines throughout the silos. He did not know where the silo's water supply was located, but he suspected it came from a well on-site. Mr. Lundgard said that silo operations did not require the use of much water. The Quonset huts were used during the silo construction phase, but he did not know for what purpose. He believed the huts were removed once the silos became operational.

He recalled two diesel generators in the silos, and that the diesel was stored in tanks on top of the silo cap. Although he did not know if the diesel fuel storage was underground or aboveground, the diesel was piped from the storage tanks into holding tanks inside the silos. Mr. Lundgard suggested that the Dash-1 manual may provide details about the use and storage of diesel. Silo operations switched back and forth between commercial power and diesel power. The cooling towers at the silo were used for the two diesel generators. He said that diesel power was used as back-up and he did not know if these generators operated on a daily basis. He recalled, however, that the generators were very noisy.

Regular and continuous maintenance was performed on the silo equipment to ensure that the missile never went off "alert" status. Checklists were used for the maintenance process. Mr. Lundgard observed some minor maintenance tasks, such as the changing of a light bulb. The MFT oversaw major maintenance conducted by the maintenance crew out of WAFB. During major maintenance, he would be stationed inside of the LCC monitoring the system. The maintenance crew from WAFB was out at the silo on a daily basis, and they were part of the 579th SMS.

Mr. Lundgard identified the following materials associated with the Atlas "F" missile operations: liquid nitrogen, liquid oxygen (LOX), gaseous helium, and RP-1. The RP-1 is a hydrocarbonbased fuel that, along with the LOX, was used as a rocket propellant. He did not know if the RP-1 was ever recycled. It was a stable material, and it had microorganisms growing in it. He did not recall whether the RP-1 fuel required replenishment.

Mr. Lundgard provided a description of the launch procedures and the events that led to one silo explosion. The bottom half of the missile had RP-1 fuel in it and the top half of the missile contained instrument or pressurized air. Mr. Lundgard described the missile like an aluminum balloon. During launch procedures, the top half of the missile filled with LOX as the doors to the silo opened. When the hot sun beat down on the missile, its contents heated up causing the LOX to expand and burst a seam. The LOX caught a flicker and then exploded. All the missiles that exploded blew up during the propellant loading exercise (PLE). The military placed a warhead that weighed the same as the nuclear warhead on the missiles during the PLE. Mr. Lundgard recalled being in Silo 3 with the Inspector General when Silo 5 exploded. His crew turned the cameras on top of Silo 3 in the direction of Silo 5 and noticed a column of smoke. When asked if he knew of any environmental issues associated with any of the silo explosions, Mr. Lundgard said that he thought the accidents took out "everything" as they were catastrophic.

He said that the military tried to minimize any spills at the silos, but he thought that the hydraulic oil presented a bigger problem instead of the diesel. Mr. Lundgard said the hydraulic oil used inside of the silo would drip down to the sump at the bottom of the silo. The sump was pumped out, but Mr. Lundgard did not know whether the pumped material was put inside a container or pumped onto the ground or into a drainage ditch. He said that minimal amount of oil would drip into the sump. He did not recall any spills of diesel.

Mr. Lundgard did not know whether lines on missile were flushed or whether the missiles were washed down with any substance. He indicated that he did not think it was necessary for missiles to be washed down. He also did not know about any solvent use at the silos.

While he was still stationed at WAFB, he recalled seeing the missiles being pulled out the silos, but he did not know what occurred with the silos themselves. Mr. Lundgard left WAFB in the Fall 1965 and went into the military intelligence school. He worked in photo intelligence during the Vietnam War and then later worked on the SR-71 in Japan and in Germany. Mr. Lundgard retired as a Colonel in the U.S. Air Force and he was 70 years old on the date of this interview.

Regarding other information avenues, Mr. Lundgard said that he conducted an interview with a professor who later wrote a book about the Atlas "F" missile. He gave this individual his documents, including the Dash-1 and the checklist he used while in the LCC. He recalled that Richard Wade was an MFT. Mr. Wade's telephone numbers are (813) 996-1022 (home) and (813) 732-2784 (cell). Other potential information sources included the Air University at Maxwell AFB and Wright Patterson AFB.

### Phil Moore (321) 636-9843 moorepe@ix.netcom.com

On October 4, 2004, Lisa Contreras-Hendler and Stephanie Hester of HGL interviewed Mr. Phil Moore by telephone regarding his knowledge of the Atlas "F" missile silos (Atlas silos) associated with the 579th Strategic Missile Squadron (SMS), which was attached to Walker Air Force Base (WAFB), Roswell, New Mexico.

Mr. Moore was stationed with the 579th SMS, and he arrived at WAFB in October 1961 and departed 1965. He was the Deputy Crew Commander and his rank while there was 2nd and 1st Lieutenant. Later, Mr. Moore was promoted Major. Other crew men in the silo included three enlisted men, including a Sergeant and two Airmen. The Crew Commanders were either Captains or Majors.

In 1961, the Site Activation Task Force (SATF), under the Air Force Systems Command, oversaw the construction of the silos. He recalled the U.S. Army Corps of Engineers being involved. He never saw the silos under construction, but he recalled that while construction was occurring he was waiting for a slot to open at missile school. On February 2, 1962, he went to missile school.

Each silo had its own library which contained at least one copy of the technical orders. Mr. Moore did not think that crewmen had individual copies of the technical orders. The Dash-1 was a technical manual that was similar to an operator's manual that typically came with a car. The manual addressed how to operate the missile and its equipment, but it did not address how the systems were repaired or maintained. Mr. Moore thinks that most of the contents of the library were thrown away once the military left the silo properties. He recalled seeing a large number of manuals left in the silo libraries at the time of deactivation. He said that these manuals were not classified. Rather, the launch code and the procedures to go through to launch were the classified material.

He was assigned to Silo 1 until that silo exploded. Mr. Moore was on leave when the explosion at that silo occurred. He was then located at Silo 7, which he called his home site. Mr. Moore worked at other silos when they needed additional staffing. Specifically, he was on duty at Silo 2 when it exploded, but that was the only time he was assigned to this silo.

After the explosion in Silo 1, Mr. Moore recalled that the launch control center (LCC) had smoke damage and the rest of the silo was also damaged. The silo began to fill up with water. He said that this silo was located near an underground river that was located at a depth of six feet. A corrugated metal conduit was used to stop water from rising in the silo, and the silo hole was deepened to accommodate the conduit. The explosion blew open the conduit. He believed that another silo had an underground conduit associated with it, but he could not recall the specific silo.

As a Deputy Crew Commander of a missile crew, Mr. Moore was responsible for operating the silos. The crewmen did some maintenance, but personnel out of WAFB conducted most of the maintenance. His crewmen oversaw the WAFB maintenance crew as they performed their duties. He occasionally oversaw some maintenance activities because he was interested. He said that the squadron had a large number of maintenance personnel who specialized in certain areas. Mr. Moore described the silos as a busy place with many people there. He only recalled one or two occasions when there were no maintenance crews in the silos. Most of the maintenance issues in the silos dealt with support equipment, and did not involve the missiles themselves.

Mr. Moore did not know if the LOX lines on the missiles, which were made of stainless steel, had to be cleaned out. He said, however, that these lines were extremely sanitary and remained sealed at all the times. Some equipment had filters, which were pulled out and changed occasionally. Anything on the outside of the equipment was cleaned off immediately.

Material stored on-site included diesel fuel used to operate the diesel generator. Diesel was stored in a "day tank" inside the silo, which contained a day's worth of diesel to operate the generator. A larger diesel tank with associated piping was located aboveground. Liquid oxygen (LOX) was also stored in large amounts in an oxidizing tank inside the silo. He estimated that about 19,000 gallons of LOX was stored in the silo. The LOX was one of the missile's fuel supplies. RP1, a high-grade form of kerosene, was also stored in a fuel tank inside the silos. Mr. Moore said that 12,000 gallons of RP-1 fuel was stored, and he did not recall that this fuel had to be replenished. Other materials included helium gas and hydraulic fluid. The hydraulic fluid was used to operate the silo doors and crib locks. These locks had to be in place prior to a launch. The hydraulic fluid was under extremely high pressure, about 3,000 pounds per square inch. Mr. Moore said that the hydraulic fluid was occasionally refilled because of leaks. A small tank was located inside the silo to store extra hydraulic fluid. This fluid was a standard oil hydrocarbon.

Mr. Moore said there were many leaks in the silo. Types of leaks included diesel, hydraulic fluid, and water. A lot of diesel leaked from the generators, the lines, and joints. Typically, the leaks involved seepage and did not constitute large spills of diesel or hydraulic fluid. However, some of the leaks were larger and resulted from personnel forgetting to turn off the switch when filling the day tank. If an overspill occurred on the diesel fuel's day tank, the military had to be cautious resolving the problem since the LOX lines were located a few levels below the day tank.

He did not recall using solvents to clean any spills, but he said it was a possibility. Mr. Moore had worked in aircraft manufacturing, specifically Douglas Aircraft Company in Tulsa, Oklahoma, during the late 1950s and he recalled using a lot of TCE in that job. TCE could have been used in the silos for spill clean up since it was not a petroleum-based material and therefore was not incompatible with the LOX.

The Dash-1 manual (TO 21M-HGM-16F-1, Section 4, pg 4-15, 4.101-4.102) contained emergency procedures for spills. Based on visual inspection, if a spillage of RP-1, diesel, or hydraulic fluid is noted, the fan and the water were to be turned on. He said that the missile had a Fog system that involved a water spraying system, which needed to be cleaned up afterwards.

A sump pump was located at the bottom of the silo, which pumped the liquid out to the top. Mr. Moore did not know where this liquid went, but he suspected that the liquid was pumped onto the ground. He said the sump was greasy, stating it was the only thing in the silo that was not cleaned. If a gas spill occurred in the silo, the air conditioning unit would suck it up.

When each of the silos exploded, there was a huge amount of RP-1 fuel released. However, the explosions resulted in a fire that lasted for hours, and he believed that the fuel was probably burned away.

Mr. Moore believed that the alkaline water in the pipes of Silo 11 caused problems by creating residue in this silo's pipes. Acid was put into the pipes to eat out the residue. At Silo 11, he recalled that acid was poured into the cap, which caused a lot of damage to the electrical equipment. This event occurred at the end of the Atlas "F" program.

The LCC was relatively clean. The military conducted household-type of cleaning in the LCC and occasionally painted items using enamel paint. The floors were mopped and the kitchen scrubbed using normal household cleaners. Dust from the LCC control panels was wiped off with a damp cloth.

Regarding other areas associated with the silo property, Mr. Moore suspected that some spills or dumping might have occurred on the top surface, including spillage in the diesel tank area. He said that not many spills occurred in the LCC itself.

According to Mr. Moore, the Quonset huts were used to store spare parts. He said the huts were used during the construction phase as well as during the missile operations.

Mr. Moore described the events surrounding the explosion at Silo 2. He said that he had the accident report for this explosion. Silo 2 was under evaluation by the Standboard crew when it exploded. This silo always had problems with the missile lift system because it would always stick. Mr. Moore said the system was warped. The count down during the propellant launching exercise was completely normal. The missile rose to the top, but it became stuck and could not be lowered. Pressure was building up in the missile. This pressure was not released immediately because the Standboard crew conducting the evaluation would not allow the Standard crew on duty to do it. Mr. Moore said if this pressure was released at the right time, the missile would not have exploded. The missile tumbled down three levels and every gas in the silo was released, taking out all of the diesel and hydraulic lines. Mr. Moore said that the cable attached to the elevator froze from the LOX, became brittle, and the weight of the missile broke the cable and made it fall.

Mr. Moore later learned that the LOX and RP-1 fuel tanks fell to the bottom of the silo and started to fill up the ducts, which contained grease. The fire started in the ducts and went through the vent system. A power surge went through the LCC as a result of the burning, which blew out a monitor in the LCC. Flames from the ensuing explosion rose 200 feet high in the air, and the fire burned for hours.

Mr. Moore estimated about 18 individuals were inside the LCC when Silo 2 exploded, including one civil service employee and someone from the San Bernardino Air Material Command. They used the field phone to communicate outside of the LCC. When they were informed that it was safe to evacuate because no more flying debris was observed, they ran out of the silo as the fire burned. Mr. Moore had the only key to the perimeter gate, but the gate was already open. When the explosion occurred, it shook the LCC and knocked Mr. Moore down; however, the shock absorbers performed well and the LCC stayed intact. Smoke began to fill up the LCC though.

When the Atlas silos were deactivated, the RP-1 fuel was drained out of the tanks.

After leaving the 579th SMS, he was in the Vietnam War and continued to work with missiles.

Mr. Moore estimated that he had about two suitcases full of information regarding the Atlas program. He also suggested the following individuals as potential interviewees:

- Jerry Lundgard
- Wayne Peatley Mr. Peatley has Alzheimer's Disease
- Bob Pittman Mr. Pittman may not be interested in speaking with HGL.
- Bob Caplan Mr. Caplan worked in maintenance while stationed at WAFB. Mr. Caplan is involved in a Missile Talk Forum. His contact information is <u>bobcapl@pacbell.net</u>.
- Les Hayls
- Bill Bergelin Mr. Bergelin worked in maintenance while stationed at WAFB. His contact information is <u>wbergelin@compuserv.com</u>.
- George Ziegler Mr. Ziegler was assigned to the maintenance squadron.

### Jerry Nelson 4570 Ocean Beach Blvd Unit #46 Cocoa Beach, Florida 32931 (321) 784-2616

On September 21, 2004, Lisa Contreras-Hendler and Stephanie Hester of HGL interviewed Mr. Jerry Nelson via telephone regarding his knowledge of the Atlas "F" missile silos (Atlas silos) associated with the 579th Strategic Missile Squadron (SMS), which was attached to Walker Air Force Base (WAFB), Roswell, New Mexico.

Mr. Nelson was stationed with the 579th SMS from 1962 until the Atlas "F" missiles were decommissioned in 1965. He was a crew member at Silo 9 and the Deputy Crew Commander (DCC) for Silo 6. The DCC was the second in command of the five-man missile crew. It required two members of the missile crew to launch the nuclear weapons. Mr. Nelson explained that the missile crew worked a 24-hour shift and had a 2- to 3-day break between shifts. Two crewmen had to be awake at all times during the shift. The crewmen typically got about four hours of sleep during the 24-hour shift. During the course of a shift, crewmen made about two or three inspections within the silo. They would be responsible for recording instrument readings. If the silo's system light was green, everything was operational. If the system light was red, a malfunction occurred and the crewmen would call maintenance if they were unable to resolve the problem.

As a crewman, Mr. Nelson maintained the missile launch readiness and performed some minor maintenance, such as removing light bulbs in the launch control center (LCC). The maintenance crew out of WAFB performed any major maintenance at the silo. Mr. Nelson was not able to recall the type of major maintenance that occurred, but said it was conducted in the silos. Any maintenance on the Atlas "F" warhead was conducted at WAFB. The WAFB maintenance crew occasionally conducted modifications and maintenance in the LCC. He thought the maintenance crew came out to the silos on a relatively infrequent basis. Mr. Nelson added that scheduled maintenance at the silos also occurred.

Mr. Nelson was asked if trichloroethene (TCE) was used in the silos or the LCC. He did not recall using TCE in the LCC, but did not know whether it was used in the silos. Mr. Nelson did not know if any other chemicals were used in either the silo or the LCC. He mentioned that hydrocarbon solvent was incompatible with the liquid oxygen (LOX); consequently, the military was reluctant to use this type of substance in the silos.

Mr. Nelson stated that the diesel generators were located inside the silos, but he did not know where the diesel fuel was stored. The silos were equipped to use commercial power, but since the military wanted the silos to remain independent, diesel was mostly relied upon for silo operations.

Mr. Nelson did not know what the evaporation ponds were used for at the silos.

He did not know what activities occurred in the Quonset huts. Mr. Nelson said that the Quonset huts were used during the construction phase of the silos, and remained on-site after construction was completed. These buildings were not generally occupied while he was at the silos. Mr. Nelson explained that the personnel at the silo property consisted of the five-membered missile crew and two security guards located at the front gate.

Mr. Nelson did not know of any fuel spills or accidents at the silos to which he was assigned. However, explosions occurred at three other silos. For one of these explosions, the missile had been raised up and then became stuck. The missile exploded because it was unable to be lowered in order to drain off the LOX. Mr. Nelson did not know what occurred with the other two silo explosions. As a description of the standard process, he explained that the LOX is put into the missile during the last few minutes prior to raising the missile up. It took a few minutes to raise the Atlas "F" missile up to its launch position, and even a longer period of time to lower the missile.

After leaving WAFB, Mr. Nelson worked on the Saturn 5 fabrication in New Orleans and the Saturn 5 launch at Cape Canaveral. Later, he worked at Cape Cod inside another LCC.

Mr. Nelson provided suggestions on other research avenues. He recommended interviewing Chief Warrant Officer Ziegler. Mr. Ziegler worked in maintenance out of WAFB. He also suggested Gene Lamb, another missile crewman. Mr. Lamb organized the last reunion for the 579th SMS. Regarding document sources, Mr. Nelson said many documents, such as technical orders (TOs), were housed inside the LCC. These documents were classified and they described all the equipment contained in the LCC and silos. He had given Gary Baker a copy of the TO. HGL confirmed with Mr. Nelson that it was the same TO that Mr. Baker provided to HGL on a prior visit. Mr. Nelson did not know where HGL could locate "As-Built" drawings, but mentioned that General Dynamics may be one source to explore for these documents.

### George Ziegler 2001 W. Rudasill, Apt 9101 Tucson, AZ 85704 (520) 297-9384

On October 11, 2004, Lisa Contreras-Hendler and Stephanie Hester of HGL interviewed Mr. George Ziegler via telephone regarding his knowledge of the Atlas "F" missile silos (Atlas silos) associated with the 579th Strategic Missile Squadron (SMS), which was attached to Walker Air Force Base (WAFB), Roswell, New Mexico.

George Ziegler reported to duty to the 579th SMS at WAFB in March 1962. He was assigned to the Maintenance Control Unit, and he mostly worked out of WAFB. At the time of his arrival, the silos were still under construction. Mr. Ziegler remained at WAFB for three months, working in the Reports and Analysis Section. He then went to missile school and did not return to WAFB until December 1962. While in school, Mr. Ziegler went through general missile comprehension courses and learned about all missile operations.

Upon his return to the 579th SMS at WAFB, Mr. Ziegler supported plans and scheduling. He also worked in the Real Property Installed Equipment Section, which dealt with the water treatment facilities at the silos. He said every three silos had a water treatment facility.

Mr. Ziegler was asked if his responsibilities required him to go to the Atlas silo locations. He estimated that he went to the silos about once or twice a week for a period of time. He thought that he may have only visited about 4 or 5 of the 12 silos while stationed at WAFB. Mr. Ziegler indicated that the maintenance crew out of WAFB generally performed work on the silo equipment. Occasionally, maintenance was conducted on the missile itself. The maintenance crew ran scheduled diagnostic tests on different systems of the missile operations throughout the year.

Mr. Ziegler did not recall the specific types of maintenance conducted at the silos. He explained the missile system was so complex and it required several types of work. He recalled that the maintenance crew worked on the diesel generators on a regular basis. These generators were the primary source of energy for the silos. Mr. Ziegler thought that diesel fuel storage tanks were located on the same level as the diesel generators in the silo. Mr. Ziegler was unable to recall if any chemicals or cleaning agents were used within the silos, including specifically trichloroethene also referred to as TCE. He also did not know if the liquid oxygen (LOX) lines were cleaned at the silos or at some other location.

Technical orders (TOs) were used for the maintenance and cleaning that occurred in the silos. Mr. Ziegler said that the maintenance crew was in strict compliance with the TOs, but he did not know if the TOs addressed solvent usage. Each silo had its own library and he suspected that a similar library existed at WAFB. He knew that the maintenance shops at WAFB had copies of the relevant TOs. These shops were located in the (MAMS). The entire administration section of the 579th squadron was also located in the MAMS building.

When asked about Quonset huts on the silo properties, he recalled seeing these huts and he believed that these huts were used during the construction phase of the silos. He suspected that after construction ended, the huts were used for storage. Mr. Ziegler never went into the huts and did not know what they housed.

Mr. Ziegler did not have any knowledge of the accidents that occurred at three of the Atlas silos in New Mexico.

Mr. Ziegler remained with the 579th SMS at WAFB until approximately July 1965 when the Atlas "F" program became deactivated. When he left the U.S. Air Force, Mr. Ziegler's rank was Chief Warrant Officer (CWO-4).

## **REFERENCE 19**



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FROM: DEMC

31 Dec 58 Comment No. 2 Mr. Bousha/ehm/21137

The proposed SAC SM 66-2 does not appear applicable to installation 1. engineering functions. This staff memorandum is devoted to operational maintenance of the missile and missile system and does not involve maintenance of the real property items such as block house, launch pad, missile maintenance buildings.

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2. SAC SM 66-2 contains information which would be desired by field units and recommendation is made to publish this data as a SAC letter or regulation for wider coverage. an gala sa Contraction and the result of the second

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SAC SM 66-2

STAFF MEMORANDUM ) NUMBER 66-2 )

DRAFT

HEADQUARTERS STRATEGIC AIR COMMAND Offutt Air Force Base, Nebraska

#### MAINTENANCE - ENGINEERING

#### Strategic Missile Weapon Systems

1. PURPOSE. This memorandum:

a. Establishes Strategic Air Command policy for the maintenance of strategic missile weapon systems.

b. Provides guidance to all Strategic Air Command staff agencies for use in preparing planning documents for specific missile systems in accordance with AFR 5-57, i.e., operational, logistics, installation, technical, and crew training plans.

2. GENERAL. a. The strategic missile weapon systems presently include the SM-62, SM-65, SM-68, SM-73, SM-75, SM-78 and SM-80. Additional weapon systems will come under the purview of this regulation as their development progresses.

b. Strategic missile squadron launch sites may be located in an isolated area. Transportation will be required between the squadron launch sites and its supporting base, a distance no less than eighteen miles (see inclosure 1).

- (1) The supporting base will be an active military installation which will provide the maximum support within its capability. This support includes housekeeping, supply, and certain maintenance support to the assigned missile squadrons. Normally, the squadron RIM/MAB building and squadron/wing headquarters will be located on this base.
- (2) The geographical location of the missile squadrons, the operational requirements for multiple launching with a

* Supersedes SAC SM 66-2, 19 December 1956

d. Missiles will not be removed from the missile squadron/wing area except for depot/contractor level maintenance that cannot be performed at this area.

e. Development of missiles and support systems should support and not compromise the maintenance plan.

f. SAC missile maintenance procedures are established in SACM 66-9, Strategic Missile Maintenance Management Manual.

g. The maintenance structure of a strategic missile organization must be developed to insure maximum capability with the most efficient use of personnel. The current organizational maintenance structure for a strategic missile squadron is shown in SAC Manual 66-9, Strategic Missile Maintenance Management Manual.

4. MAINTENANCE DEFINITIONS. For a mutual understanding to terminology, a set of definitions specifically tailored to the systems concept of maintenance has been established. These definitions apply to hydraulic, electrical, mechanical, or electronic equipment. These definitions are shown in inclosure 2, using an autopilot system as an example, and again in inclosure 3 using an auxiliary power system as an example.

5. MAINTENANCE RESPONSIBILITIES.

a. The missile squadron/wing is responsible for all <u>organizational</u> and <u>field</u> levels of maintenance on missiles and support equipment. This responsibility includes normal squadron functions, such as pre-launch, daily, and storage inspections; routine launch site servicing and preventive maintenance; removal and replacement of specific components; bench maintenance; assembly of missiles; periodic inspections; recycle maintenance; technical order compliance; reclamation and repair of components and parts.

b. The Air Materiel Command is responsible for all depot level maintenance, both contract and USAF. This includes the provisions for mobile depot teams to assist using command at the site, if possible, to accomplish work beyond their resources and capability. This may include, but is not limited to, major

mudifications and repairs, mass assembly of missiles, major overhauls, and storm or explosive damage.

c. To assist in determination of items which can be repaired at organizational and field level, AMC, in collaboration with ARDC and SAC, will develop by missile type, master repair lists for strategic missiles. The authorized maintenance lists will be published by AMC in appropriate technical orders.

6. ORGANIZATIONAL AND FIELD LEVEL MAINTENANCE. Three functional areas, launch complex, periodic maintenance and bench repair, are interacting and interdependent at the organizational level.

a. Launch Complex Maintenance

- Launch complex maintenance is that maintenance performed on the missile, launcher facilities, GSE, and ground guidance station equipment and communications.
- (2) Launch complex maintenance consists of:
  - (a) Performing preventive maintenance and servicing of missile and each system while installed in the missile. Preventive maintenance on the launcher, ground support equipment, facilities, communications and ground guidance equipment within the launch enclosure will be the responsibility of the operation/maintenance personnel of the launch emplacement, augmented when necessary by specialists dispatched from the squadron maintenance area (SMA).
  - (b) Testing missile, ground guidance equipment, facilities, communications, and ground support equipment to determine if all minimum performance standards are met.
  - (c) Performing trouble shooting and isolating the malfunction to the smallest removable unit, replacing unit, and

interval basis to insure the operational readiness of the missile and ground support equipment. Periodic maintenance will be performed at the launch complex when practical. Other time interval inspections on the missile, ground support equipment, facilities and ground guidance station equipment will be accomplished at the launch complex by the operational/maintenance crews utilizing the installed checkout equipment. Specialists will be dispatched from the general maintenance building to assist the operation/ maintenance crews as required.

- (2) Periodic maintenance consists of:
  - (a) Performing maintenance on unit equipment at predetermined time intervals and upon initial receipt from depot or contractor.
  - (b) Scheduled inspection, cleaning, lubrication and preservation as necessary, thorough performance checks and alignment of the missile, installed systems and ground support equipment.
  - (c) Replacement of time-change proposals.
  - (d) Remating the missile on the launcher after periodic inspection. The periodic crew will be assisted in mating the missile stages by the operation/maintenance crew of the launch complex.
- (3) Periodic inspection and maintenance procedures will be developed through adaptation of the present planned inspection procedure (TO 00-20E-1 and other appropriate Technical Orders) to missile weapon systems.
- c. Bench Maintenance
  - (1) Bench maintenance is that maintenance performed in the checkout

and repair of components, assemblies, etc., submitted from the launch area. Bench maintenance will be accomplished in the squadron maintenance area. Bench maintenance will include initial inspection and serviceability checks as required on components received.

- (2) Bench maintenance consists of:
  - (a) Isolating malfunctions in components submitted from the launcher enclosure or periodic maintenance area to an assembly, subassembly, plug-in unit, detail part, etc., the repair of the malfunctioning assembly, subassembly, plug-in unit, detail part, etc., and the performing of any necessary alignments, adjustments, or calibrations required as a result of such repair, replacement or reconditioning.
  - (b) Performing calendar inspections and checkout of components using appropriate checkout test equipment to insure that the repaired, reconditioned or inspected components and assemblies meet established standards.
  - (c) Operating and maintaining all system maintenance test benches assigned to the squadron.
  - (d) Performing technical order compliances on components that are assigned to the squadron.
  - (e) Repairing and calibration of assigned peculiar (non AF standard) test equipment consistent with time, ability and tools available. (AFS test equipment repairing and calibration will be accomplished by the air base support unit in accordance with AFR 74-2 and SAC SUP-1 thereto.)
  - (f) Performing functional acceptance checks on equipment received

from depot facilities.

- (3) Bench maintenance will require special test benches and consoles and Air Force standard test equipment (scopes, signal generators, vacuum-tube voltmeters, spectrum analyzers, etc.). An adequate quantity of repair parts (bench stocks) must be maintained to repair components.
- (4) Bench maintenance repairmen will require a knowledge of theory, system function, circuit anlaysis, stage by stage, and a high degree of repair capability.
- (5) Technical data must be presented to the repairman in appropriate size (8¹/₂ x 11) technical manuals and will include detail component schematics, with necessary descriptive narrative to enable him to accomplish his job.

7. DEPOT LEVEL MAINTENANCE. Depot level maintenance is that maintenance beyond the capability of the missile squadron and falls into two categories; weapon system and non-weapon system support.

a. Depot level maintenance on weapon system items will be the responsibility of the logistic support manager and may be accomplished in contractor facilities, AMA's or at the squadron by means of mobile maintenance teams.

b. Depot level maintenance on non-weapon system items will be supported through the normal Air Force channels.

8. PROCEDURES. To preserve a high degree of support for missile units, it is necessary that the following supply and support procedures be implemented:

a. The missile squadron will be supported for maintenance items through a weapon system account located on the squadron site. This weapon system supply account will requisition direct from the logistic support manager, receive, process, inventory, and issue all items required to support the missile.

## **REFERENCE 20**

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T. O. 42C-1-11

## TECHNICAL MANUAL cleanliness standards

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# CLEANING AND INSPECTION PROCEDURES FOR BALLISTIC MISSILE SYSTEMS

F41608-80-D-A006

PUBLISHED UNDER AUTHORITY OF THE SECRETARY OF THE AIR FORCE

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## 15 JUNE 1965

CHANGE 10 - 15 JULY 1980

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## SECTION IV ATLAS, THOR, AND TITAN I WEAPON SYSTEMS

#### 4-1. GENERAL.

4-2. SCOPE. This section includes specific policies and procedures for cleaning all components and systems used in the Atlas. Thor, and Titan I weapon systems. General cleaning procedures are specified in Section III, General Cleaning Procedures.

4-3. RESPONSIBILITY. Prior to the start of and during the cleaning operation, the supervisor in charge will ensure that proper procedures and materials are being used as specified herein. The supervisor will obtain necessary coordination with appropriate base organizations to ensure use of safe practices (reference Sections II and III).

4-4. CLEANING FACILITIES. Typical Titan I and Atlas cleaning facility equipment layouts are shown in Figures 4-1 and 4-2, respectively. The cleaning area is divided into the pre-clean (or rough clean) area and the final cleaning area. The cleaning supervisor will ensure that cleanliness requirements are met. All tools used in the final cleaning area will be cleaned and maintained at the same standards as specified for the parts, components, or assemblies to be cleaned. When equipment is not available at the Base for the accomplishment of required precleaning or final cleaning tasks, the contaminated item shall be returned to the depot for processing.

#### 4-5. GENERAL CLEANING REQUIREMENTS.

4-6. PROCESSING COMPONENT PARTS. Instructions outlining the general processes for cleaning components are shown in Figures 3-2 through 3-9. Figure 3-1 has been included as a guide for selecting applicable cleaning procedures.



Use extreme caution when handling machined parts (seats, poppets, etc) and filter elements. Arrange items in such a manner as to prevent their striking one another, since any damage may be sufficient to render the part unserviceable.

#### 4-7. Component Parts -

4-8. Parts or tools shall never be laid on floors or on uncleaned surfaces. Lay parts on clean table top or on clean polyethylene sheet.

4-9. Never touch interior of components with bare hands. If it is necessary to wipe off flanges or interior of parts, wear alcohol or solvent-resistant polyvinyl gloves and use a clean line-free cloth (Federal Specification CCC-C-46 Type I) moistened with methylene chloride (Dichloromethane, Military Specification MIL-D-6998, Grade A).

4-10. Components shall be cleaned, dried, reassembled, inspected, and packaged in the final cleaning area only.

4-11. Corrosion Removal - Metal parts which are found to be corroded must be treated to remove the existing corrosion and to retard further corrosion prior to being taken into the clean room. Parts that have been plated or anodized, and which have been damaged to such an extent that the base metal has corroded, shall not be cleaned (with the exception of painted parts). Also, if the strength or function of a part will be impaired by the corrosion removal process, the part shall not be cleaned. For such unclean parts, the supervisor shall request disposition instructions from the responsible depot.

4-12. Painted Parts -

WARNING

Paint remover produces dangerous and noxious fumes. Avoid breathing the fumes over a protracted period of time or in confined spaces. Always provide for adequate ventilation. Wear alcohol or other solventresistant polyvinyl gloves during the cleaning process. As an added precaution, wear an approved face mask. Failure to take proper precautions can result in serious injury or death.

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LEGEND

- 1 Detergent/Rinse Tanks
- 2 Work Benches
- 3 Cabinets
- 4 Vapor Degreaser
- 5 Deionized H₂O Rinse
- 6 Solvent Reclaimer
- 7 Sonic Cleaner
- 8 Pass-thru Oven
- 9 Sink
- 10 Plastic Dip

- 11 Electric Oven
- 12 CTU Hose Rack
- 13 CTU
- 14 CTU Adapter Set
- 15 Cryogenic Test Stand ("D" Series)
- 16 Handling Cart
- 17 Smock Racks
- 18 Liquid Nitrogen Cart ("D" Series)

Figure 4-2. Typical Atlas Cleaning Facility Layout (MAMS)

Section IV Paragraphs 4-13 to 4-20

Painted parts, which require cleaning, shall have the paint completely removed by applying paint remover (Military Specification MIL-R-25134) with a long-handled, non-metallic brush to the painted surface until all paint has softened and lifted. Rinse thoroughly with filtered (10 micron, nominal) Solution I (Paragraph 3-30) and allow part to dry thoroughly. Continue the cleaning process per Section III.

#### 4-13. PROPELLANT LOADING SYSTEMS (PLS).

4-14. PLS CLEANLINESS STANDARDS AND IN-SPECTION. These cleanliness standards and inspection techniques are applicable to the systems and components of the missile and ground support system containing, or used in connection with RP-1 fuel, liquid oxygen, liquid nitrogen, and pneumatic gases.

4-15. Component Standards and Inspections - The contamination limits for the propellant and pneumatic subsystem components are shown in Figures 4-3 and 4-4. Cleanliness of components shall be determined by the procedures of Inspections No. 1, 2, 3, 4, 5, and 6, as applicable and as described in Paragraphs 9-12 through 9-35. Inspections No. 1 and 2 shall be utilized for checking test fluids and finalcleaning solvents. They shall also be used as a quality control technique for the verification of component cleaning process and where system maintenance manuals require a particle count for cleanliness certification of specific components. Inspections No. 3, 4, and 5 shall be utilized as the general methods for verification of component cleanliness. Inspection No. 6 shall be conducted as a referee inspection by the Depot or other qualified test agency where the level of hydrocarbon contamination is questioned after completion of Inspections No. 4 or 5. The results from Inspection No. 6 shall be final and binding when a significant difference exists in the interpretation of the results of other inspections. Only components of the liquid oxygen, nitrogen, and helium subsystems need to be certified as LOX clean (no hydrocarbons) by Inspections No. 4 and 5. Ultraviolet inspection of hydraulic and fuel system components is commonly used as a means of hydrocarbon detection; however, since these systems employ hydrocarbon-base fluids, the presence of hydrocarbons shall not be cause for rejection.

4-16. System Standards and Inspection - Propellant and gas systems shall be judged clean if the contamination limits specified in this section have not been exceeded. The liquids or gases used during cleanliness testing shall comply with the latest issue of applicable military or other cited specifications. All propellant liquids and gases used during cleanliness testing, except RP-1 fuel, shall be filtered through 10 micron nominal, or less, filter units. RP-1 fuel shall be passed through a 40 micron absolute, or less, filter/dewatering unit.

4-17. Liquid Oxygen, Liquid Nitrogen, Gaseous Nitrogen, and Helium Systems - Cleanliness is determined by gas blowdown test, Inspection No. 10. The contamination permitted entrapped on the filter pad of a blowhorn (or equal), during testing of a dry system, or in the test fluid effluent of a pressure bomb sample is shown in Figure 4-5. The filter pad will be inspected with black light. Fluorescence resulting from fibers and solid particles which do not exceed the maximum size criteria will not be cause for system recleaning. Fluorescence of filter pad stains or entrapped globules will be cause for recleaning the system.

#### 4-18. HYDRAULIC SYSTEMS.

4-19. HYDRAULIC SYSTEMS CLEANLINESS STANDARDS AND INSPECTIONS. Cleaning of hydraulic systems includes cleaning of components and piping for missile, ground facilities systems, and maintenance ground equipment. Hydraulic components and piping systems will be cleaned using the detailed processes and the applicable standards indicated in this manual, and in accordance with the detailed disassembly and reassembly procedures contained in the applicable weapons system technical manuals.

4-20. Titan I systems and Maintenance Ground Equipment (MGE) requiring component and piping cleaning are:

a. Missile hydraulic systems - Stage I and II.

b. Hydraulic pumping unit - Missile MGE.

#### 9-42. INSPECTION NO. 9-WATER CONTENT DETERMINATION, MINUTEMAN THRUST VECTOR CONTROL SYSTEM.

9-43. The maximum water content shall be 20 ppm (0.002% by wt.) when tested in accordance with the ASTM D1364 and ASTM D1533 methods (Reference Document Item 51, Section XI) as applicable (Karl Fischer reagent titration method).

#### 9-44. INSPECTION NO. 10-SERVICE FLUID SCREENING.

9-45. SERVICE FLUID SAMPLING FROM SYSTEMS. Samples of the service fluids used to certify system (subsystem, piping and skid units) cleanliness shall be obtained and tested. The service fluid used for the final rinse or purge shall be flowed through the system for a minimum of two minutes at maximum operational flow rates whenever possible. For gas blowdowns, nitrogen gas conforming to MIL-P-27401 or clean dry air with moisture and hydrocarbon content equivalent to limits established for nitrogen in MIL-P-27401 shall be introduced into the system. A two minute blowdown with a minimum of 100 ft/sec gas velocity in the largest diameter pipe section being sampled will be acceptable, except that the maximum velocity attainable through the permanently installed system and approved sampling device may be used where 100 ft/sec cannot be obtained. The sampled effluent shall be passed through a 50 mesh sieve (ASTM Designation E11-61, Fine Series #50); except for Titan I and Atlas, the effluent is passed through the filter pad of a blowhorn (or equal). After the test, the screen (filter pad) is carefully removed from the sampling unit and sealed in a clean polyethylene bag until it is examined.

#### 9-46. SERVICE FLUID SAMPLING FROM TANKS.

For storage, transport, and holding tanks, a fill and drain cleanliness inspection method can be used, although Inspection No. 10 is preferred when size permits. The sampler is installed in the drain line

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9-47. SERVICE FLUID SCREENING INSPECTION, The 50 mesh seive samples shall be inspected with a 10 power magnifying glass (FSN 6650-526-4239). If no particulate matter remains on the screen, the equipment shall be certified for use. If any particulate matter remains on the screen other than that specified in Section VI or VII as applicable, collect the contamination in an appropriate sampling fluid (Paragraph 9-15 - Reagent Fluid) using the Significant Surface Sampling technique specified in Paragraph 9-14 and perform a Total Filterable Solids Determination (Paragraph 9-22).

removed from the sampling unit and sealed in a clean polyethylene bag until it is examined.

#### 9-48. INSPECTION NO. 11-TANK VACUUM CLEANING.

9-49. Missile propellant tanks shall be visually inspected after final assembly is completed and prior to system checkout. Other tanks may be inspected by this method after the final cleaning and drying operations. Inspection shall consist of vacuum cleaning all places where contamination entrapment could occur. The vacuum cleaning operation shall in no way affect the structural or functional integrity of the tanks or any related component or subsystem. The debris vacuumed away shall be collected on a 100 mesh screen, and examined by the Service Fluid Screening Inspection (Paragraph 9-47). If the particulate matter does not exceed the applicable limits of Sections IV, V, VI and VIII the tanks shall be certified for use. If these limits are exceeded, repeat the cleaning and drying operations and the vacuum cleaning inspection. If re-entry into the tank is made subsequent to this inspection, the vacuum inspection shall be repeated.

## **REFERENCE 21**
FUR UPPRIME

## PHASE-OUT OF THE ATLAS E AND F AND TITAN I WEAPON SYSTEMS

November 1964 - June 1966

by WILBUR E. CLEMMER

Historical Research Division Air Force Logistics Command Wright-Patterson Air Force Base, Ohio

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October 1966

AFLC Historical Study No. 350

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working arrangements were left up to the two commands, with primary responsibility lodged in AFLC.

The two commands soon agreed as follows: The deactivation program would be accomplished in three phases. Phase I, the responsibility of SAC units, covered the removal and preparation for shipment of the re-entry vehicle; missile; classified components; excess mobile equipment; and SAC re-utilization save list, if any; and the disposal of missile propellants and gases. Custody of each site or complex was to be turned over to the air base group or squadron when Phase I tasks were completed. Phase II, under the direction of an AFIC appointed executive manager, included the turn-off of all unnecessary power, protection and preservation of equipment, and the maintenance of those systems that were to remain operable. It also involved the removal and disposition of organizational materiel and equipment, communications-electronicsmeteorological equipment and real property installed equipment. In Phase II the AFIC executive manager was to be responsible for controlling all disposal processes relating to organizational materiel, including RPIE. SAC was to furnish equipment and manpower to accomplish Phase II tasks. Phase III consisted of reporting sites to the General Services Administration as excess and providing care and custody of the sites. The host support base (SAC, ATC or TAC) was to provide the care and custody. Real property disposal actions in that phase were to be the responsibility of the Army Corps of Engineers and GSA. Phase III would

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were concerned with the disposition of Atlas and Titan I sites. One called for disposing of all Atlas E sites--sites that were too soft for any envisioned Air Force use; another, for disposing of Atlas F and Titan I sites adjacent to Larson, Lincoln, and Schilling AFB's--bases scheduled for early phase-out; and a third, for preserving and holding the remaining sites indefinitely--so Headquarters USAF could determine their potential for Air Force re-utilization purposes. Mr. Zuckert listed cost figures to support the recommended actions and asked for funds and manpower to accomplish them. (32)

On 15 January 1965 Secretary McNamara approved funds in the following amounts to carry out the plan: \$3.1 million for first year storage of the missiles; \$5.3 million for disposal of 26 Atlas E, 24 Atlas F, and 3 Titan I sites; and \$8.8 million for the preservation of the remaining sites. Concurrently he approved manpower spaces to carry out the plan. (90) Spaces approved for the over-all deactivation program were 3,058 military and 219 civilian. Twenty five hundred of these were for the equipment * disposal task and 558 for storage of 59 complexes.

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DTAF's most pressing tasks were to get the missiles to Norton and to store them at SBAMA and nearby Mira Loma. The first order of business, then, was to fund for those tasks. AFLC set up

* Ltr., Chief, Ops. Div., Dir., Prod. & Prog., Hq. USAF, to Chief, Hist. Liaison Office, Hq. USAF, 23 Nov. 1965.

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fund programs as follows: (167)

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Missile Deactivation	and Storage	\$ 303,300
Missile Transportati	on***	1,378,920
Travel and Per Diem		173,124
	Total	\$1,855,311

Budget estimates for fiscal 1966 were \$429,000 for missile deactivation and storage, \$258,740 for travel and per diem, and none for missile transportation. The latter task would be completed in FY 1965. (168)

On 16 June, after the missile movement was complete, the Site Deactivation Management Group at Norton reported to Headquarters DTAF on the cost of moving the 148 missiles which had been surface transported. Data for the report were obtained from the commerical carriers, who reported the actual charges they were billing the government. In sum, those changes amounted to \$1,122,996. This, however, cannot be regarded as a final figure. The charges had to be audited by the carriers and the Interstate Commerce Commission before they could be processed to the Army Finance Center for payment. And even after payment, they were still subject to change six months to a year later, after final audit by the General Accounting Office. (266)

* Interview with Mr. Atherton, 29 Sept. 1965.

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** Deactivation, as used here, refers to deactivating the missiles themselves, not to site deactivation.

*** Of this amount, \$71,125 was for reimbursing MATS' industrial fund for airlift of nine missiles [Budget Proj. No. P433 ASIF (MATS) 2220] and \$1,307,795 for over-the-road transportation of 149 missiles [Budget Proj. No. P433 Surface 2250 Transportation]. (Doc. 65)

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In this connection, the contributions of the SBAMA Deactivation Task Force at Norton AFB deserves special mention. Through careful transportation planning it had kept the operation ahead of schedule and within estimated costs. Through modification of commercial flatbeds to accomodate Titan I missiles, it had facilitated the movement of those missiles. And through competent and timely overhaul of each Atlas trailer after each trip from bases to Norton, it had assured expeditious movement of the Atlas E's and F's. (Doc. 147)

### Preservation of Installed Materiel

During the interval between the deactivation of Atlas E and F sites and Titan I complexes and the dismantlement and removal of equipment in silos and related structures, protective measures had to be taken to preserve and maintain that equipment in optimum condition for later re-utilization. Early in 1965, therefore, SBAMA engineers and technicians developed procedures and techniques for the preservation of that equipment. In developing those procedures and techniques, the technical people had to take into account the marked variations in temperature, humidity, airborne dust and dirt, and so forth, at widely dispersed missile sites and complexes. After prototyping the preservation techniques and related facilities were placed in a preservation status for an indefinite period.

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The principal preservation techniques included circulation of hot air through the silos to reduce moisture to an acceptable level, the relief of all high pressures from the various systems, the use of special preservative oil in the diesel generators, and the use of vinyl draping material to protect equipment from condensation and dust. The task of preserving the equipment was accomplished with personnel of the Strategic Air Command, the Tactical Air Command, and the Air Training Command. SBAMA DTAF teams made periodic inspections to determine the adequacy of preservation procedures and techniques.

The total cost of preserving materiel at all sites and complexes was \$642,820. (Doc. 147)

### Utilization of Facilities

On 28 September 1964, even before DOD's decision to phase-  $\stackrel{\times}{\times}$  out the Atlas E and F and the Titan I, General Gerrity created an Air Staff Study Group to study and evaluate potential Air Force uses for phase-out ICBM facilities. On 16 November the group recommended that 59 sites-44 Atlas F and 15 Titan I--should be retained in a preserved status while an evaluation was being made of  $\stackrel{\times}{\times}$   $\stackrel{\times}{\times}$ possible uses for the facilities. (Doc. 143)

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* Lieutenant General Thomas P. Gerrity, DCS/S&L, Hq. USAF.
 ** There was one launch facility for each Atlas F site and three launch facilities per Titan site, making a total of 89 launch facilities to be retained.

*** This document is Rpt. No. 3 (FINAL), Atlas E, F and Titan I Fac. Util. Proposals, by Air Staff Study Gp., 15 Sept. 1965. The supporting papers, TABS A through T, were not reproduced for this history. The entire report is filed in the AFLC Hist. Archives.

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recipients; however, obligated (save-list) items were to be removed prior to transfer of a site to any recipient.

As of 6 May 1966 five Titan I, two Atlas E, and three Atlas F sites were being retained by the Air Force. The General Services Administration had earmarked one Titan I, eleven Atlas E, and six Atlas F sites for non-Air Force use. Of the sites being retained by the Air Force, six were earmarked for future AF missions. One was scheduled to be loaned to a contractor to perform a metal research project for AFSC. After completion of the project, in approximately six months, that site was to revert back to SAC. Three sites, located within the confines of Vandenberg Air Force Base, were retained as integral parts of that base.

The chart opposite this page indicates disposition of the *
retained sites. It also provides unclassified information on **
utilization of the sites.

### Utilization of Equipment

Much of the equipment at Atlas E and F and Titan I sites was needed elsewhere within the Air Force and other government agencies. It was good equipment--like new, in most cases; and much of it was very expensive. Here was an opportunity to save

** Users of this history who have a "need to know" what utilization was to be made of the Chico "C" and 725C Titan sites may obtain that information from the Aerospace Division, Directorate of Supply, Headquarters AFIC.

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^{*} Background Summary: Deactivation and Phase-Out of the Atlas E and F and Titan I ICBM's and the Equipment Re-Utilization and Disposal Program, prep. by SBAMA and Hq. AFLC Offices of Information, 3 May 1966.

tax dollars on a grand scale and the Air Force was determined to take full advantage of it. Beginning in December 1964, the AMA's started screening available assets against Air Force operational requirements. In March 1965 other services and federal agencies began screening their requirements for materiel against brochures--catalogs describing available equipment--and sent their requisitions for needed equipment to SEAMA. For the most part the work was completed on target--31 July 1965. (Doc. 143) Some screening went beyond that date, as indicated at a later point in this study.

To help the Air Force and other agencies in their equipment screening, an Atlas F site near Lincoln, Nebraska, was dismantled and the equipment was displayed at Lincoln AFB. This will be discussed later under a separate topic heading.

For the most part, screening was done within a procedural framework developed by DTAF in cooperation with Headquarters USAF, GSA, and SAC. Large diesel generators and air conditioners, however, were handled in an exceptional manner. Those items, too, will be discussed at a later point.

Vehicles, also, were requisitioned and redistributed outside DTAF's screening and redistribution procedures. Since they were not considered part of the weapon system packages, their disposal was governed by the provisions of AFM 67-1, which required

* Brochures are discussed in greater detail later on in this study.

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the requester was Air Force, other DOD, or non-defense. Requisitions for components to satisfy firm programs were to be given precedence, however, over those for complete systems or subsystems to satisfy potential programs. (193, 227)

All screening was substantially completed by 31 July 1965. As of that date figures showed that the USAF had earmarked 42 per cent of surplus items from Atlas sites and 5.8 per cent from Titan I sites for re-utilization. Those figures, however, do not tell the whole story. Additionally, approximately 15,000 line items were being transferred to Base Supply and the AFSC Test Wing account at Vandenberg AFB in the Atlas booster program. Further, many Titan I site items were being retained for use in the Titan II program and were being transferred to the Titan II account. (287)

In August the Office of Assistant Secretary of Defense, Installations and Logistics, directed all agencies to take another look at the excesses, and DTAF accordingly extended the screening period to 15 October 1965. This OSD re-emphasis on screening and the extension of the screening period provided a more intensive, detailed second screening by DOD agencies, with greater assurance that all requirements would be considered. By 3 June 1966, as a result of this and previous screening, \$923.5 million worth of equipment, including missiles, was being re-utilized by and/or earmarked for USAF, Army, Navy, DSA, GSA, the National Aeronautics

* Removal of one or more components of a system or subsystem would make it functionally worthless.

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and Space Administration, and so forth. This represented 70 per * cent of the original cost of the equipment controlled by DTAF.

### Diesel Generators

Redistribution of large surplus diesel power generators was handled on an exceptional basis. They were placed under special distribution control by Headquarters USAF, with the Directorate of Civil Engineering given responsibility for redistributing them for use in Air Force and other construction programs over a period of approximately five years. Some were immediately required for Southeast Asian, European, and other destinations.

On 15 January 1965 the Directorate of Civil Engineering, USAF, announced that power generator units of 100 kilowatt-hour capacity and over were to be tested; disassembled; inspected; removed from sites; rehabilitated as required; temporarily stored, if necessary; and redistributed to Air Force and DOD activities. Division of labor for accomplishing the testing, teardown, shipment, storage, and redistribution tasks was as follows: Headquarters USAF was to direct, monitor, and control the program; specify what generators were to be shipped and where; and issue

Re-utilization of RPIE and CEM equipment was higher than AGE because those items were more easily applied to other programs and because most of them were standard commercial items. AGE, however, was peculiar to a particular missile and therefore was more difficult to adapt in follow-on programs. (Interview with R. L. Hunkeler and E. E. Wilson, 3 June 1966.)
 ** Actually, only generators of 500 kilowatt-hour capacity and greater were involved in the redistribution program.

**(**)

diesels by lifting them through the resulting hole. All four diesels at Larson AFB were removed in that manner.

A new, easier method for removing diesels from Titan I installations was subsequently developed, however, after it was decided that some of the diesels would be completely dismantled for overhaul. The diesels were dismantled into five major segments and brought to the surface through the elevator shaft by use of special cranes. This latter method was adopted for removal of the * remaining diesels at Titan installations.

Removal of generators from sites began at Complex A at Larson in June 1965. As of 2 August 36 generators had been removed: 4 from Larson, 12 from Warren, 18 from Dyess, and 2 from Lincoln. (285) By 3 June 1966 a total of 218 diesel generators ranging from 500 kilowatt-hour capacity to 1,020 kilowattcapacity had been declared excess and were available for redistribution. Of these, 196 had been removed from sites and complexes for shipment to various destinations--97 of which were earmarked ** for Southeast Asia.

### Large-Capacity Air Conditioners

Large air conditioners, as indicated previously, were also handled in an exceptional manner through Headquarters USAF. In all, there were thirty-six large-capacity units--twenty-four 150-ton units and twelve 250-ton units--all within Titan I complexes.

* Interview with R. L. Hunkeler and E. E. Wilson, 3 June 1966. ** Interview with R. L. Hunkeler and E. E. Wilson, 3 June 1966.

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As of 8 June 1966 the Directorate of Civil Engineering, Headquarters USAF, had directed DTAF to retain four of the 150-ton units at Titan I "retention" complexes and to distribute the remaining twenty to other Air Force activities. That organization had also directed DTAF to retain six of the twelve 250-ton units at Lowry AFB sites and to redistribute the remaining six-five to Kelly AFB, Texas, and one to the AF Aero Propulsion Laboratory, Research and Technology Division, Wright-Patterson AFB, Ohio.

Units under 100-ton capacity were distributed by SBAMA, through brochured requests. One hundred and forty-two 40-ton units at Atlas F sites were distributed to various Air Force bases for use in military construction projects. Smaller units, from Atlas E sites, went to the Army, Navy, Air Force, Atomic * Energy Commission, and to various donees.

### Site Dismantlement

The complexity of the sites, with most of the equipment deep in the silos, made it infeasible to permit each claimant to arrange for and remove the property he wanted. Permitting such removals could have resulted in inadvertent damage or destruction to property required by other claimants. Thus the decision was made that all claimant requirements had to be considered as a whole so that the removal of the property from each

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* Telephone interview with Mr. John A. Sowell, SBAMA ICBM Task Force, 8 June 1966.

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site would be accomplished as one removal action. Also, this would require less time, manpower, and money. (Doc. 46, Atch. 2)

Site dismantlement efforts are discussed below under two headings: (1) Lincoln AFB Prototype Dismantlement for Equipment Display and Data Development and (2) Dismantlement Plans and Contractual Instruments. As the title of the first topic implies, one purpose of the dismantlement effort at Lincoln was to provide prospective customers with an opportunity to look equipment over to determine what they could use. This was touched upon in the section above on "Screening." As indicated by the latter part of the title, however, this was not the sole purpose. A lot of information could be obtained as to how many man and machine hours were involved in dismantling given items of equipment, as to the order in which items should be removed, as to costs, and so forth. Such information is the basis of industrial engineering and it would be highly useful when general dismantling began after 31 July 1965.

The second topic is concerned with whether the work should be done organically or contracted out; and if contracted out, what instrument or instruments should be used. It is also concerned with testing out the principal type of contractual instrument selected to see if it was actually the best type to use.

### Lincoln AFB Prototype Dismantlement for Equipment Display and Data Development

Early in March 1965 SAC and AFLC jointly decided to dismantle equipment at a missile site near Lincoln, Nebraska, and

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it was concluded that DLSC would assume responsibility for contracting for services to dismantle the missile sites for property required by any authorized recipient. (Doc. 146, Atch. 3)

In March 1965 the AFLC ICBM Deactivation Task Force developed plans for dismantlement and removal of equipment at Atlas E and F and Titan I missile sites by contract. In developing those plans, DTAF took into consideration the fact that sites were of two categories--"retained" and "disposal." Retained sites were those earmarked for follow-on use. Disposal sites were those for which there was no follow-on requirement--those which would be turned over to the General Services Administration for disposition.

On 30 March Headquarters DTAF presented its plans to the Air Staff. Those plans envisioned three contractual arrangements for dismantling and removal of required equipment prior to the turn-over of those sites to follow-on users within the Government, to donee organizations, or to GSA for sale. The first contractual method proposed was by Service Contract wherein the contractor would be required to remove needed equipment from any given launch facility for a negotiated fee. The second proposed method was by Service and Salvage contract wherein the contractor would remove all required equipment and be granted salvage rights to the residual equipment and material. The government would retain title to the real property and take eventual disposal action through GSA. The contractor would pay the government a negotiated fee for salvage rights. The third was by Service and Real Estate

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contract, which would generally follow the guidelines of the Service and Salvage proposal, except that title to the real estate would also pass to the contractor.

DTAF recommended that the Service and Salvage type of contractual arrangement, with contracts administered by DLSC, should be the primary method used for dismantling and removal of the equipment at the "disposal" sites. That method would attract contractors whose primary concern was the acquisition and sale of % salvage material. Further, it would result in no "out-ofpocket" costs to the government--a highly important consideration in AFLC's drive to keep costs to the absolute minimum. (210, Doc. 147)

On 15 April 1965 the Air Staff formally approved DTAF's proposal, in writing, after having given oral approval on 31 March. In the interval DTAF had negotiated an agreement with DSA and GSA whereby those agencies would assume the necessary contract administration and sales functions. And as soon as the written approval was received the agreement was signed. (211, 231)

DSA, for its part, agreed that its Defense Logistics Services Center would administer the Service and Salvage contracts.

* The Service and Real Estate contract method held no special attraction to salvage contractors as their interests did not lie in the acquisition of real estate.

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[Hq. SAC] Hist. of Atlas & Titan I Phase-out, 1 June 1965, p. 92. Doc. not reproduced.

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For its part, GSA agreed to sell the remaining property and real estate. And for its part, the Air Force agreed to provide liaison for and technical assistance to DSA and GSA. Among other things, AFLC was to assist DLSC in the preparation of contractual work statements and Invitations for Bid.

DTAF felt that suitable sites should be selected to develop experience in the application of the Service and Salvage concept. AFLC recommended Sites 3 and 9 at Plattsburgh, New York, for that prototyping effort. Those sites were recommended for three reasons: First, water leakage at the sites made their further use questionable. Second, connection of commercial electric power to those sites, a prerequisite for continued retention, would be too expensive. And third, no agency had expressed an interest in utilizing either site. Experience gained would be applied to the follow-on program. (242)

On 14 May 1965 the Air Staff approved the prototyping effort at Plattsburgh. By 31 July the IFB's had been mailed out, with bid opening scheduled for 31 August. (283) During the ensuing months the prototype effort was carried out and other contracts were let. The last Service and Salvage contract--for removal of equipment from nine sites at Walker AFB, New Mexico-was expected to be awarded on 17 June 1966.

 * [Hq. SAC] Hist. of Atlas and Titan I Phase-out, 1 June 1965, pp. 92-93.
 * <u>The Norton Newscone</u>, 3 June 1966.

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## **REFERENCE 22**

٦ COORDINATION AND FILE COPY FILE DESIGNATION General 1 USAF Plan of Action for Phaseout of Atlas E, F and COORDINATION OFFICE LAST Titan I Weapon Systems SYMBOL - . 6 an 25 NAME energy . CINC vc CS DCS PRO POLAD DAS Mail/Rerd Pub1 D<u>CR</u> Admin Plans Budget Mgt Anlys Acct/Fin Sys/Svcs D<u>E</u> Dev Engr Ops DM3 Wesson DM4 Prove DM4 Settle DM6 Mint DM5 With Vets: Crutinin Nets: Crutinin Nets: Crutinin Hsg DI Air Est Tgt Mat Sys Div Tgts 544 ARTW DM Log Sup Wpn Mainy Trans / Proc ATW mark. DO PL CO CE OT RQ SD WE DP Off Amn Mil Svcs Civ DPP DPL Prog Plans M&0 CINCSACREF DXI Hist Сн IG IGI IGS JA ÓÀ TURN OFFICE SYMBOL ORIGINATOR'S NAME AND GRADE SU PHONE NO. TYPIST'S DATE TYPED 7: DAIL ADMIN SERVICES (For Dispatch) C < 1L eiven -458 ORM 964, JUN 64 PREVIOUS EDITION IS OBSOLETE. 0001

### ATLAS "F" EQUIPMENT/FACILITY BREAKOUT

1. Operational Missile Area Sub-System (Ground)

Included in this broad category are two basic subdivisions: The Operational Ground Equipment which must operate successfully with the missile during readiness, count down, and launch; and the Maintenance Ground Equipment which is required to receive, service, maintain and verify the missiles and related equipment.

a. Operational Ground Equipment (OGE)

Launch Control Equipment (Located in ICC) Missile List System

Hydraulic Supply System

Propellant Loading System

Pressurization Control System

Inertial Guidance System Checkout Equipment

Communications Equipment (Launch Essential)

Ground Power Equipment (Launch Essential)

b. Maintenance Ground Equipment (MGE)

MAPCHE: Checkout Equipment

Re-entry Vehicle Checkout Equipment

Propulsion System Checkout Equipment (In MAMS)

Missile Handling and Service Equipment (In MAMS)

Guidance Maintenance Equipment

Communications Equipment (non launch essential)

Gas and Propellant Servicing Equipment

Miscellaneous Tools and Test Equipment

Pneumatic Checkout Equipment

Calibration Equipment

Work Platforms

2. Communications

a. Support Communications: This system includes the base switching facility, the base nontactical radio service, off-base trunking facilities, the lines, fire, crash, maintenance expediting and all required navigational and meteorological aids.

b. Latra Complex Communications: This system consists of the conference networks, communications panels, TV Systems, direct line circuits and termination, which provide these communications functions necessary to erect, checkout and launch a missile including all circuits required for facilities and supporting operations during count down.

c. Inter-Complex Communications: These are the point-to-point systems that connect launch complexes with each other and with the support base. Systems may be government owned or commercially leased and consist of a cable or microwave radio or a combination of both:

3. RPIE Sub-Systems are identified as follows:

a. Air Conditioning, heating and ventilation.

b. Power generation and distribution.

c. Water pumping and distribution,

d. Utility air system,

TAB "C"

## **REFERENCE 23**

### Form WR-23

#### STATE ENGINEER OFFICE

### FIELD ENGR. LOG WELL RECORD

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the nearest district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1A and Section 5 need be completed.

Section 1	L		(A) Owner of well Gordon Herkehoff	& Assoc. In	G.
			Street and Number 302 Eighth NW City Albuquerque	State N.N	
			Well was drilled under Permit No.       H=408         NW       1/4         SW       1/4         of Section 14       1/4	Twp. 11S	s located in the Rge. <u>19E</u> ,
			 (B) Drilling Contractor	Licens	e No
			 City	State	~*************************************
			Drilling was commenced	January	1960
(I	Plat of 6	40 acres)	 Drilling was completed	January	1960

Elevation at top of casing in feet above sea level_____Total depth of well 650' State whether well is shallow or artesian______Depth to water upon completion______

Section 2

#### PRINCIPAL WATER-BEARING STRATA

No.	Depth in Feet         Thickness in From         Description of Water-Bearing Formation				
1					
2					
3					
4					
5		1		No. 1984	

Section 3	3			RECOR	D OF CAS	ING		*	
Dia Bounda		Threads	Dep	oth		m Ch	Perforations		
in.	ft.	in	Top	Bottom	reet	Type Snoe	From	To	
			1		- 1. at ¹ . a				
	1			n Anna Anna - Anna Anna Anna Anna - Ann	1000				
			1			6			
		+							

Section 4

### RECORD OF MUDDING AND CEMENTING

Depth From	in Feet To	Diameter Hole in in.	Tons Clay	No. Sacks of Cement	Methods Used
	·	<u> </u>	<u></u>		

Section 5	PLUGGING RECO	RD
Name of Plugging Contractor		License No.
Street and Number	City	State
Tons of Clay used		
Plugging method used		Date Plugged19
Plugging approved by:		Cement Plugs were placed as follows:
	a de la companya de l	Douth of Plug

	Pasin Supervisor	No.	From	To	No. of Sacks Used
	Dasmi Supervisor			1. 11 X 21 X	
FOR USE OF	STATE ENGINEER ONLY			76.5°	
Data Resoured	and the second			1.	
Date Received	· · · · · · · · · · · · · · · · · · ·		and the second sec		
		Lines	<u></u>	<del>کر میڈیڈر میں بروکر</del> نمبذید کرد میڈیڈر م	
a the second	an a		to the state	ning Baratan Karata	alan menerika yang bergeraka keringan meri
File No. H-4	08 Use Expl.			ocation No.	. 11.19.14.310

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ATNMSE

Section 6

LOG OF WELL

From	in Feet	Thickness	Color Type of Material Encountered
210111	То	in Feet	
	50		Limestone, light tan to brown to gray, dense, crystalline with
			occasional dark gray shale breaks.
0	60		Limestone, as above, tan and gray
100	80		Linestone, as above, tan, brown and gray
0	90	· · · · · · · · · · · · · · · · · · ·	limestone, as above, predominantly light gray
0	100	·	limestone, as above, tan, brown and gray
00	130		limestone, as above, light gray
50	180		limestone, se above, tan, brown and gray
180	190		limestone, dark brown silty
190	220		limestone, light to dark gray, some tan
220	230		limestone, brown and gray
230	240		limestone, as above and dark brown silty limestone
240	300		limestone, light gray to brown, silty
300	330		limestone, light gray to brown, crystalline iron stains
330	-350		limestone, light gray to brown, crystalline
350	360		limestone, light gray, crystalline
360	420		sandstone, white to light gray, very fine grained, well-sorted,
			locsely cemented, slightly liney
420	440		sanndstone as above, yellow to buff
440	460		limestons, dolomitic, tan to gray, dense, silty
460	510		limentone. tan. to gray, dense, slightly silty
510	540		limestone and shale, tan to buff
540	550		shale, reddiah tan
550	580		limestone, tan, dense, silty
580	620		shate, red, blue and gray
	630		limestone, desno, brown
620		1	

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described well.

Well Driller

Form WR-23

STATE ENGINEER OFFICE

### FIELD ENGR. LOG

WELL RECORD

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the nearest district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1A and Section 5 need be completed.

Section 1	The Come of Protocol Cito Mpt It
·····	(A) Owner of well USA corps of Angineer site 5
	Street and Number Federal Building
	City Albuquerque State N.M.
	Well was drilled under Permit No. <b>H-408</b> and is located in the <u>14 NW 14 SW 14 of Section 14 Twp. 11 S. Rge. 19 E.</u>
	(B) Drilling ContractorLicense No Street and Number
	City State
	Drilling was commenced 19
	Drilling was completed 19
(Plat of 640 acres)	

850' Elevation at top of casing in feet above sea level_____Total depth of well_____ State whether well is shallow or artesian_____Depth to water upon completion_____

Section 2	2
-----------	---

PRINCIPAL WATER-BEARING STRATA

Depth in Feet		in Feet	Thickness in	Description of Water-Bearing Formation
	From	To	Feet	
1				
2				
3				
4				
5				

Se	cti	on	3

#### **RECORD OF CASING**

Dia	Pounds	Threads	De	pth	-	<b>m m</b>	Perforations		
in.	ft.	in	Top	Bottom	Feet	Type Shoe	From	То	
10			0	740	740				
8			700	850			740	850	
	1		1						

Section 4

#### RECORD OF MUDDING AND CEMENTING

Depth in Feet		Diameter	Tons	No. Sacks of	Methods Used
From	То	Hole in in.	Clay	Cement	
	}				
	i				

Section 5	PLUGGING RECO	RD		
Name of Plugging Contractor.		I	icense No	
Street and Number	City	S	tate	
Tons of Clay used	Tons of Roughage used	Type of	roughage	
Plugging method used		Date Plugged		19
Plugging approved by:		Cement Plugs wer	e placed as follows:	
		Depth of Plug		

	Basin Supervisor	No.	Depth From	of Plug To	No. of Sacks Used
FOR USE OF STAT	E ENGINEER ONLY				
Date Received					
File No. <u>H</u> - 408	Use		I	location No	. 11. 19. 14. 310

## FIELD EI ... LOG

### SAMPLE LOG - SITE 6 (B)

"B" SITE A-408

0- 80	Limestone, gray, dense, crystalline
<b>8</b> 0- 90	Limestone, light tan to gray, dense, massive to crystalline
90~100	Limestone, as above, with black shale partings
100-120	Limestone, light tan to gray, dense, massive to crystalline
120-130	Limestone, as above, black shale partings, fossiliferous
130-190	Limestone, light tan to gray, dense, massive to crystalline, scattered gray to black shale nodules
190-220	Limestone, as above, no shale nodules
220-230	Limestone, as above, scattered gray to black shale nodules
230-240	Limestone, as above, no shale nodules
240-250	Limestone, light tan, shaly
250-330	Limestone, light gray to dark gray, silty, black shale partings, 290-300 fossiliferous
330 <b>-</b> 340	Limestone, tan to dark gray, black shale partings, trace of calcite
340-370	Limestone, as above, trace of very fine grained silty yellow sand
370-400	Limestone, as above, 30-40% quartz sandstone, medium grained, tight lime matrix
400-460	Sandstone, very fine to medium grained, tan to yellow, lime matrix, friable
460-470	Limestone, tan to gray, dense
470-480	Sandstone, light gray, very fine grained, friable lime matrix, silty
480-500	Limestone, tan to gray, dense, trace of calcite and sandstone as above
500-530	Limestone, tan to gray, dense
530-5 ¹ 40	Gravel, limestone, & very fine grained yellow silty sand.
540-580	Limestone, tan to gray, dense & very fine grained yellow silty sand
580-610	Shale, red, limy
610-620	Shale, red, gray, tan, limy

SAMPLE LOG - SITE 6 (B) (Con't.)

620-660 Shale, red, limy

660-680	Shale, red, tan & gray limestone
6 <b>8</b> 0-765	Limestone, tan to gray, dense, massive
765-790	Limestone, tan to black, dense, massive
790-850	Limestone, tan to gray, dense, massive

Total Depth - 850

10 Inch Casing 0-740'

8 Inch Casing 700' to 850

Perforated From 740' to 850'

### **REFERENCE 24**

## Data Origin: http://www.seo.state.nm.us/water-info/gis-data/ose-wells.zip Silo 9 Domestic Well Analysis Extracted Data Source: X:\Phoenix\Graphics\Atlas (SHA002)\Data\Shape\Atlas-Wells-02-05.shp Silo 9 Domestic Well Analysis

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OBJECTID	D	X COORD	Y COORD	DB FILE NB	USE	DIVERSION	POD REC NB	WELL NUMBE	TWS	RNG	SEC	QQ	)2 Q	3 ZON	X	Y EASTING	NORTHING	START DATE	FINISH DAT	DEPTH WELL	DEPTH WATE	Dup
46186	185031	493855	3687735	H 00146	DOM	3.00	185031	H 00146	115	19E	28	1	4			493905	3687532			0	0	
46308	109992	492136	3688052	H 00258	DOM	3.00	109992	H 00258	115	19E	29	1	2 3			492186	3687849	8/22/1957	8/26/1957	103	65	
46462	109531	496717	3690476	H 00408	DOM	6.00	109531	H 00408	115	19E	14	3	1			496767	3690273	4/19/1986	4/26/1986	850	712	
46464	178320	496717	3690476	H 00408	DOM	6.00	178320	H 00408 S	11S	19E	14	3	1		TI	496767	3690273			0	0	
46465	178321	496717	3690476	H 00408	DOM	6,00	178321	H 00408 S2	115	19E	14	3	1			496767	3690273			0	0	
46466	178322	496717	3690476	H 00408	DOM	6.00	178322	H 00408 \$3	115	19E	14	3	1			496767	3690273			0	0	
46470	178323	495490	3687728	H 00412	DOM	6.00	178323	H 00412	115	19E	27	1	4			495540	3687525			0	0	
46473	178324	495490	3687728	H 00415	DOM	6.00	178324	H 00415	11\$	19E	27	1	4			495540	3687525			0	0	
46505	109105	493054	3688522	H 00452	DOM	6.00	109105	H 00452	11\$	19E	20	4	4		П	493104	3688319	12/5/1960	12/17/1960	212	154	
46533	181570	494568	3688228	H 00473	DOM	3.00	181570	H 00473	115	19É	28	2	2 1			494618	3688025			0	0	
46537	181564	494357	3688225	H 00479	DOM	3.00	181564	H 00479	115	19E	28	2	1 2			494407	3688022			0	0	
46545	109971	492092	3687470	H 00489	DOM	3.00	109971	H 00489	11\$	19E	29	3	2 1			492142	3687267	7/21/1961	7/27/1961	200	65	
46596	110452	496313	3687707	H 00545	DOM	3,00	110452	H 00545	115	19E	27	2	4			496363	3687504	10/1/1963	10/15/1963	160	120	
46605	180923	492836	3689534	H 00560	DOM	3.00	180923	H 00560	115	19E	20	2	0			492886	3689331			0	0	
47620	178903	498298	3693377	H 01618	DOM	3.00	178903	H 01618	115	19E	1	3	3 1			498348	3693174		12/31/1919	400	0	
47622	186527	496816	3690375	H 01620	DOM	3.00	186527	H 01620	11\$	19E	14	3	1 4			496866	3690172			850	0	

## **REFERENCE 25**

State & County

### U.S. Census Bureau

10 Years on the Web **QuickFacts** 

# **New Mexico QuickFacts**

Go ÷

New Mexico counties - view map

Select a county

Place Search More New Mexico data sets

Lincoln County, New Mexico **O**Further information

Want more? Browse data sets for Lincoln County

	Lincoln	
People QuickFacts	County	New Mexico
Population, 2003 estimate	20,322	1,874,614
Population, percent change, April 1, 2000 to July 1, 2003	4.7%	3.1%
Population, 2000	19,411	1,819,046
Population, percent change, 1990 to 2000	58.9%	20.1%
Persons under 5 years old, percent, 2000	5.1%	7.2%
Persons under 18 years old, percent, 2000	22.7%	28.0%
Persons 65 years old and over, percent, 2000	17.9%	11.7%
Female persons, percent, 2000	51.0%	50.8%
White persons, percent, 2000 (a)	83.6%	66.8%
Black or African American persons, percent, 2000 (a)	0.4%	1.9%
American Indian and Alaska Native persons, percent, 2000 (a)	2.0%	9.5%
Asian persons, percent, 2000 (a)	0.3%	1.1%
Native Hawaiian and Other Pacific Islander, percent, 2000 (a)	0.1%	0.1%
Persons reporting some other race, percent, 2000 (a)	11.3%	17.0%
Persons reporting two or more races, percent, 2000	2.5%	3.6%
Persons of Hispanic or Latino origin, percent, 2000 (b)	25.6%	42.1%
White persons, not of Hispanic/Latino origin, percent, 2000	70.9%	44.7%
Living in same house in 1995 and 2000', pct age 5+, 2000	50.2%	54.4%
Foreign born persons, percent, 2000	6.1%	8.2%
Language other than English spoken at home, pct age 5+, 2000	20.7%	36.5%
High school graduates, percent of persons age 25+, 2000	84.5%	78.9%

http://quickfacts.census.gov/qfd/states/35/35027.html 1

Bachelor's degree or higher, pct of persons age 25+, 2000	22.8%	23.5%
Persons with a disability, age 5+, 2000	3,844	338,430
Mean travel time to work (minutes), workers age 16+, 2000	20.9	21.9
Housing units, 2002	15,787	805,293
Homeownership rate, 2000	77.2%	70.0%
Housing units in multi-unit structures, percent, 2000	8.6%	15.3%
Median value of owner-occupied housing units, 2000	\$108,400	\$108,100
Households, 2000	8,202	677,971
Persons per household, 2000	2.34	2.63
Median household income, 1999	\$33,886	\$34,133
Per capita money income, 1999	\$19,338	\$17,261
Persons below poverty, percent, 1999	14.9%	18.4%
	Lincoln	
Business QuickFacts	County	New Mexico
Private nonfarm establishments with paid employees, 2001	724	42,686
Private nonfarm employment, 2001	4,704	553,357
Private nonfarm employment, percent change 2000-2001	4.3%	0.7%
Nonemployer establishments, 2000	1,378	81,398
Manufacturers shipments, 1997 (\$1000)	NA	17,906,091
Retail sales, 1997 (\$1000)	149,077	14,984,454
Retail sales per capita, 1997	\$9,307	\$8,697
Minority-owned firms, percent of total, 1997	14.1%	28.5%
Women-owned firms, percent of total, 1997	20.6%	29.4%
Housing units authorized by building permits, 2002	184	12,066 ¹
Federal funds and grants, 2002 (\$1000)	100,681	17,477,521
	Lincoln	
Geography QuickFacts	County	New Mexico
Land area, 2000 (square miles)	4,831	121,356
Persons per square mile, 2000	4.0	15.0
👩 Metropolitan Area	None	
FIPS Code	027	35
1: Includes data not distributed by county.		

Download delimited tables | Download Excel tables

(a) Includes persons reporting only one race.

(b) Hispanics may be of any race, so also are included in applicable race categories.

FN: Footnote on this item for this area in place of data

NA: Not available

D: Suppressed to avoid disclosure of confidential information

X: Not applicable

S: Suppressed; does not meet publication standards

Z: Value greater than zero but less than half unit of measure shown

F: Fewer than 100 firms

Data Quality Statement What do you think of QuickFacts?

Source U.S. Census Bureau: State and County QuickFacts. Data derived from Population Estimates, 2000 Census of Population and Housing, 1990 Census of Population and Housing, Small Area Income and Poverty Estimates, County Business Patterns, 1997 Economic Census, Minority- and Women-Owned Business, Building Permits, Consolidated Federal Funds Report, 1997 Census of Governments

Last Revised: Friday, 09-Jul-2004 09:01:02 EDT

Census Bureau Links: Home · Census 2000 · Subjects A to Z · Search · Data Tools · Catalog · Quality · Privacy Policies · FOIA · Contact Us

### USCENSUSBUREAU Helping You Make Informed Decisions

### **REFERENCE 26**

Basins in New Mexico



## **BASINS IN NEW MEXICO**



### What is a Basin?

A large or small depression in the surface of the land, which may or may not drain into the ocean.

## **More Information About Basins**

.ttp://nm.water.usgs.gov/basins.htm

3/27/2005

## **REFERENCE 27**

### HydroGeoLogic, Inc. - Confirmation Notice Atlas Missile Silo Preliminary Assessment

Auto ROC ID# 185		Print Record				
🗌 Phone 🗌 Researc	h/Doc Collection 📋 Interview					
Name of Person Contacted	Title Position	Company/Agency	Name			
Stu Hanson	Water Master Hondo Basin	NM-OSE				
Street Address	City	State Zi	p Code			
Phone Number	Fax Number	E-Mail				
505-622-6521		shanson@ose.st	ate.nm.us			
Contact Made by		Date (s)				
Clark Limoges			5/4/2005			
Time	· · · · · · · · · · · · · · · · · · ·	· · · · · · · · · · · · · · · · · · ·				
9:30 AM	🗌 Contact Initia	nted 🛛 🗹 Contact F	Received			

### Summary

Mr. Hanson and Mr. Hernandez returned a previous call I made on Tuesday, the 3rd of May 2005. I started off the conversation telling them that we are doing a surface water analysis for a PA we are completing for the USACE. I stated that we had reason to believe the Rio Hondo river was intermittent around the vicinity of our Silo 9 (site) and continued to be intermittent downstream. However, we had no concrete evidence besides data from a gauging station that is 20 mile downstream.

Both Mr. Hanson and Hernandez agreed that the Rio Hondo is intermittent beginning at Riverside and continuing downstream to Border Hill. They even thought that the river may go sub-surface to recharge the San Andreas Aquifer.

I gave the gentlemen coordinates of our site as they said they would research the area to determine site's location in relation to the area where the Rio Hondo changed to intermittent, or if it submerged into the aquifer.

After a review of the site location, Mr. Hanson called back to say that the site was almost directly north of point where the Rio Hondo river changed to intermittent. He faxed a portion of a technical report that detailed the activities of the Rio Hondo in that region and a hydrology map displaying the site location in relation to the stream change from perennial to intermittent.

Mr. Hanson and Hernandez could not determine a specific location where the Rio Hondo river recharged the San Andreas aquifer.

### **U.S. Army Corps of Engineers-HTRW CX**


## **REFERENCE 28**



## **REFERENCE 29**

HydroGeoLogic, Inc. - Confirmation Notice Atlas Missile Silo Preliminary Assessment

Auto ROC ID#					
133			_	Print Record	d
🗸 Phone 🗌 Resear	ch/Doc Collectio	n 📋 Intervi	ew		
Name of Person Contacted	on	Company/Agency Name			
Lisa Brown			NM Drinking Water Bureau		
Street Address		City		State	Zip Code
		Roswell		NM	
Phone Number	Fax Number		E	-Mail	
505-762-3728			-		
Contact Made by				Date	(s)
Clark Limoges					1/18/2005
Time					
10:00 AM	ł	Contact In	itiated	🗌 Cont	act Received
Current and and					

Summary

Contacted Ms. Brown and asked her a few specific questions about drinking water intakes for surface water. I told her we were doing some research for USACE in Chaves and Lincoln counties and part of the research entailed locating any drinking water intakes 15 miles downstream from the potential point of entry. Ms. Brown told me that there are no public entities that are drawing from surface water in Chaves county or the east side of Lincoln county off the Rio Hondo (location of silo 9).

I asked Ms. Brown what criteria were set for a well being considered a public drinking water intake. Her response was that in order to be considered part of the public water system a well must service 15 connections or 25 people, and they must be connected at least 60 days out of the year.

**U.S. Army Corps of Engineers-HTRW CX**