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The Sleeping Giant: The Effects of Housing Titan II Missiles in Arkansas and Kansas from 1962 to 1987

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The Sleeping Giant:
The Effects of Housing Titan II Missiles in Arkansas and Kansas from 1962 to 1987

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ABSTRACT

During the Cold War, thirty-six sites across Kansas and Arkansas were selected to house Titan II intercontinental missiles. These devices could strike enemy targets 8,000 nautical miles away all while hitting inside an area of one square mile. These technological marvels quickly became an indispensable part of President Kennedy and Defense Secretary McNamara's 'flexible defense' strategy. While many authors have studied the ramifications of these devices on American foreign policy, few have researched the domestic implications of the missiles. This work looks to fill this void by investigating the Titan II missile program in Arkansas and Kansas from its construction in 1962 to its deactivation in 1987. More specifically, the work researches worker protection, civilian safety, and environmental damage to accurately determine the impact of the missile program in these two states. By looking at the program over the entirety of its twenty-five-year lifespan, the work argues that U.S. officials put the American public at increased risk for a variety of reasons. Officials understood the potential consequences of living near a missile silo but refused to properly inform citizens and workers of these hazards. The long-term ramifications of this are still being properly calculated.

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I also want to thank David Stumpf and Eric Schlosser who helped lay the frameworks for Titan II research. Most of the sources I found for this project were going off of leads they had originally uncovered. Gary Lay, Ralph Parish, and countless other Americans impacted by these facilities also need to be thanked for their bravery and willingness to recall their stories. Most of these accounts are alarming and were doubtlessly painful to recollect.

Lastly, I must give a huge thanks to the archivists at the University of Arkansas' Special Collections who were always extremely polite and willing to help in any way possible. The number of photocopies and time they allotted me go far beyond any thanks I can provide in this section. Similarly, I must thank the libraries at Ouachita beyond any thanks I can provide in this section. Similarly, I must thank the libraries at Ouachita Baptist and Kansas State University. Librarians at both provided me with direction through their collection.

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PROLOGUE:

"Why did all those men get killed and I didn't…why me…I don't know?" -Gary Lay[1]

Gary Lay began working at Nuclear Launch Complex 373-4 near Searcy, Arkansas as a way to save money for college. Lay, going into his senior year of high school, had aspirations to play football at the University of Arkansas in Fayetteville. When applying for the job at the missile silo, Lay confessed he knew little of what would be expected of him on a day-to-day basis.[2] His main motivation for seeking the job was simply that it was inside and therefore cooler than other summer jobs he had previously experienced.[3] In the best shape of his life, the teenager was confident he could handle anything the job would throw at him. He was initially very excited when the purpose of the launch complex was explained to him. The idea of working around a military defense system and huge rockets excited the seventeen-year-old. That is, until his first day on the job where he watched the monotonously narrated "*You and the Titan II*, a two-hour film" and learned how to use a mask with a filter.[4] Lay was told his duties around the complex would be mopping, cleaning, and just doing odd-jobs to help assist anywhere he could. The complex was in a re-modification stage at that point and was therefore swamped with various carpenters, painters, and electricians. Lay's job would be to help these men and clean up after them wherever possible. The job which had seemed so exciting the week before had regressed back to that of any other for the teenager.

[1] Linda Hicks, "Silo Fire Survivor tells his Story," *Searcy Daily Citizen*, May 7, 2000.
[2] Ibid.
[3] Jeannie Roberts, "Survivor recalls 1965 missile silo fire that killed 53," *The Washington Times,* August 16, 2015.
[4] Ibid.

On the morning of Monday, August 9, 1965, Lay entered into the silo for what would be his first true day on the job. The morning was largely uneventful as he worked on the bottom floor (of the nine-story silo) cleaning some wall panels. Around noon every day, most of the silo employees stopped working and grabbed an hour lunch. Lay had lunch with five other men around 11:30 a.m. and recalled some of the security escorts playing gin towards the end of their break.[5] After lunch, the fifty-five men all piled back into the silo to continue their various jobs, by 1:10 p.m., fifty-three of the men would be dead.

Lay had begun mopping on Level three at around 1:00 p.m. He recalled his back was to the missile when he heard what "sounded like whoosh, kind of like when a gas stove lights."[6] He felt intense levels of heat on his back, but before he could even turn around to assess the situation, the lights in the silo went out. The fifty-five men across nine stories were now in complete darkness as smoke began to pile into the complex. Suddenly, a second flash as a huge fire broke out near the location of the missile.[7] Lay recalled men shrieking as they funneled towards the emergency exits. Lay, perhaps more shocked than the rest of the men, did not move as quickly. By the time he reached the emergency ladder nearest him, dozens of men were already clawing at each other in front of him to be the first to get up. Lay, realizing he had no chance at survival that way, decided to run the opposite way: "my first instinct was just to get away from the fire. I think God told me, 'Hey, you're going the wrong way.'"[8] As Klaxons all across the silo shrieked, Lay crawled under the smoke towards the direction of the fire. He was able to feel his way to a secondary exit on the floor which took him to the underground control

[5] Linda Hicks, "Silo Fire Survivor tells his Story," *Searcy Daily Citizen*, May 7, 2000.
[6] Ibid.
[7] David K. Stumpf, *Titan II: A History of a Cold War Missile Program,* (Fayetteville: The University of Arkansas Press, 2000), 217.
[8] Jeannie Roberts, "Survivor recalls 1965 missile silo fire that killed 53," The Washington Times, August 16, 2015.

center.[9] In the control center, he found Hubert Saunders, who was also in shock. The two were quickly rushed to Searcy hospital for treatment of their considerable burns. At the hospital, they were informed they were the sole survivors from inside the missile bay.

[9] Stumpf, 218.

INTRODUCTION:

The Soviet Union's successful thermonuclear detonation in 1953 increased already high tensions in the Cold War. The United States, which had devoted little time towards improving its own nuclear capabilities since the successful drops on Hiroshima and Nagasaki, now perceived a need to upgrade its military technology to stay one step ahead of the Soviets. By 1949, the U.S. had proven through seismic reports that the Soviets had nuclear capabilities, but most nuclear scientists believed a successful above-ground test would be impossible until the early-1960s.[10] The surprising seismology reports of 1953 proved these estimates to be incorrect and led to panic amongst U.S. military officials who realized their country had lost its lead in the nuclear arms race. These findings lead to the swift organization of the Atlas Program in 1954. The program shifted American military focus from the development of stronger nuclear weapons to devices with longer strike capabilities.[11] ICBMs (Intercontinental Ballistic Missiles) were the ultimate creation of this program. These missiles claimed to have ranges of up to 3,000 nautical miles and were successfully tested by the U.S. Air Force in December 1958.

These first-generation HGM-25A missiles, better known as Titan I missiles, would be carefully studied throughout the late-1950s. The missiles were able to hit within an area of three square miles reliably from 2,500 nautical miles away.[12] The main problem with these early devices was that they did not allow for storable liquid-propellants. To generate propulsion in any ballistic missile, the device must have two things: a fuel source and an oxidizer to ignite the fuel.

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[10] Pavel Podvig, *Russian Strategic Nuclear Forces, (*Cambridge, MA: MIT Press, 2001), 14-15.
[11] Department of Defense, U.S. Air Force. *On Alert: An Operational History of the United States Air Force Intercontinental Ballistic Missile (ICBM) Program, 1945-2011 - Atlas, Titan, Minuteman, Peacekeeper MX, Minuteman III, Nuclear Warhead*, 2017, 8-10.
[12] A nautical mile is a measurement used to help calculate distance around a sphere. One nautical mile is equal to one minute of arc around the sphere of Earth. It is slightly longer than a conventional mile.

The drawback with the Titan I was that the early forms of the oxidizer used, liquid oxygen, did not permit safe storage inside the device itself.[13] This meant that before a device could be launched, it had to be pumped full of propellants, a task that took around twenty minutes to complete.[14] On top of this, not having propellants permanently stored inside the missile allowed only for strictly above-ground launches. These two problems (time restrictions, and above-ground launches) meant the Titan I could reliably only be used as an attacking weapon.[15] Attempting to use the Titan I for retaliatory strike purposes was deemed too risky by the Department of Defense in 1959.[16] They argued that the ICBMs ran the risk of being too easy of a target for a preemptive strike by the Soviets which severely hindered its ability to function as a defensive weapon.

The problems associated with the Titan I program were alleviated by the LGM-25C in January 1962. The device, better known as the Titan II missile, was the natural successor to the Titan I. The Titan II improved on the original device in almost every way. It could launch with a bigger nuclear warhead, strike over greater nautical distances, and hit targets with more accuracy all in far less time than its predecessor. The Titan II missile was also able to store its propellant inside the rocket itself. By switching to aerozine-50 and dinitrogen tetroxide as the fuel and oxidizer, the device could permanently store the propellant that would be used for propulsion. This ultimately meant the time to launch this new generation of ICBMs was cut down from twenty minutes to less than forty-five seconds. Also, the creation of storable propellants meant

[13] Figure 1 in the Appendix helps illustrate a Titan 1 Launch. The illustration was taken from Maduro Dive's website, written by its staff on January 23, 2015.
[14] David K. Stumpf, *Titan II: A History of a Cold War Missile Program,* (Fayetteville: The University of Arkansas Press, 2000), 69.
[15] Department of Defense, U.S. Air Force. *On Alert: An Operational History of the United States Air Force Intercontinental Ballistic Missile (ICBM) Program, 1945-2011 - Atlas, Titan, Minuteman, Peacekeeper MX, Minuteman III, Nuclear Warhead*, 2017, 12-15.
[16] Ibid.

the launch of the missile could occur completely from inside the silo. The only real inadequacy of the Titan II missile over the Titan I was the hypergolic nature of the stored propellant.[17] Naturally, for the oxidizer and fuel to successfully work together, they have to spontaneously ignite upon contact. This meant, however, that any leak/incident that allowed the two components to inadvertently come into contact could have catastrophic implications. Still, the significance of having an underground device that could launch quickly outweighed this potential drawback.

The first successful test of these new ICBMs was carried out on March 16, 1962. The test demonstrated that the device could successfully transport a W-53 warhead (weighing over eight megatons) 8,500 nautical miles, all while hitting inside a target area of one square mile.[18] Three additional tests spanning across September and October of that year proved the device to be both functional and efficient. The success of these tests allowed the Department of Defense to formally green-light federal construction for silos to house the new ICBMs. The Department of Defense requested funding for fifty-four Titan II silos in December 1962. The goal was to have these launch complexes fully operational by October 1963.

The development of Titan II missiles throughout 1962 lead to the obvious problem of determining where to house such dangerous devices. The Titan II missiles were ultimately placed in California, Arizona, Kansas, and Arkansas.[19] The missiles were installed in each state in 1962 and would remain there until around 1987. Historians have long debated why these states were selected to hold the launch complexes. The general consensus now suggests that Arkansas and

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[17] Ibid, fifty-four.

[18] Ibid, 73.

[19] Figure 2 in the Appendix shows the 4 Air Bases selected on a national map to help give perspective. Image was taken from the 'Walks through History' tour. Titan II ICBM Launch Complex 374-7 Site Southside (Van Buren County).

Kansas, being closer to the center of the country, were selected because they provided excellent defense bases for the U.S. military. At this point in the Cold War, the military was unsure whether an attack across the Pacific or Atlantic was more probable, so placing silos in the center of the country was the best way to keep them safe from preemptive strikes.[20] In other words, Arkansas and Kansas have been theorized to be the main defense bases for the Cold War with the Soviet Union. They were difficult to reach from either coast and were therefore the United States' best chance for a retaliatory strike if the Soviets attempted any type of proactive strike. Arizona and California, on the other hand, were most likely offensive in nature. Placing them near the Pacific afforded them the best location for an offensive strike by the U.S. if deemed necessary.

By the early-1960s, ballistic missiles had become a crucial part of the United States' Cold War strategy against the Soviet Union. ICBMs, along with submarine-launched ballistic missile (SLBMs) and strategic bombers formed the foundation of the so-called 'nuclear triad' under the Kennedy Administration. Kennedy and his defense secretary, Robert McNamara, argued this strategic triad made it impossible for the Soviet Union to impose intolerable damage to U.S. nuclear capabilities.[21] This meant that the Soviets could not risk attacking any part of the United States' nuclear arsenal because any attack would surely be reciprocated by another part of the triad. Without this three-winged nuclear strategy, Kennedy and McNamara's defense strategies of 'flexible response' and 'mutually-assured destruction' would not have held the same weight in the international community. Arkansas and Kansas, being the likely locations of these retaliatory

[20] Thomas Garwin and John Steinbruner, "Strategic Vulnerability: The Balance between Prudence and Paranoia," *International Security*, Vol. 1, No. 1, Summer, 1976.
[21] Michael Samuel, *Rebalancing the Nuclear Triad,* (BiblioScholar, 2012), 1-6.

strike, were therefore critical to the success of Kennedy and McNamara's defense strategy throughout the 1960s.

Many historians have examined the wide-reaching implications of ICBMs on diplomatic relations with the Soviets, but few have studied the effects of the program domestically. *Strategic Vulnerability: The Balance between Prudence and Paranoia,* written in 1976 by John Steinbruner and Thomas Garwin, was the first to truly question the necessity of nuclear devices from a domestic standpoint. The authors ultimately contend that the Titan II was an effective part of the American defense strategy but concede that it likely meant an abridgement of civilian and worker safety for those close to the devices.[22] The main criticism with *Strategic Vulnerability* was that it did not investigate these safety concerns, but instead merely suggested they were likely.

David Stumpf in his 2002 work, *Titan II: A History of a Cold War Missile Program*, investigates these safety concerns in far greater detail by looking almost exclusively at the domestic side of the Titan II program. Stumpf's work examines the entire history of the Titan II program from its foundations in 1945 to the deactivation of the devices in 1987. All of this research on the Titan II program leads Stumpf to conclude the devices were unbelievably reliable. Stumpf argues that in every accident associated with the device "human error was the cause of the fatality, not a hidden flaw of the missile, its subsystems, or the launch complex."[23] Stumpf briefly discusses each fatality associated with the missiles and demonstrates how they were, in fact, human error. Stumpf's book undeniably offers the most in-depth look at the Titan

[22] John D. Steinbruner and Thomas M. Garwin, "Strategic Vulnerability: The Balance between Prudence and Paranoia," (*International Security*, Vol. 1, No. 1, Summer, 1976), 157.
[23] David K. Stumpf, *Titan II: A History of a Cold War Missile Program,* (Fayetteville: The University of Arkansas Press, 2002), 215.

II program. It fails, as does the work before it, in its lack of reference to the citizens living and working near the missile site. Stumpf concentrates too heavily on the engineering side of the devices and leaves out their cultural impact. Stumpf is also far too quick to dismiss legitimate safety concerns linked with the devices. He blames all major accidents on human error (which was not always the case) and does not discuss the impact these accidents had on those living around them (especially oxidizer leaks throughout the 1970s). Nevertheless, his work provided the first comprehensive study of the program from start to finish and helped to build off of *Strategic Vulnerabilities* before it.

Eric Schlosser in his 2013 work, *Command and Control,* looks at the 1980 Damascus accident as a case study for what he calls the 'illusion of safety' in America during the Cold War in terms of nuclear weapons. His research "explores the precarious balance between the need for nuclear weapon safety and the need to defend the United States from attack."[24] Schlosser argues that Americans had little grasp of the great risk they were accepting living next to the devices.[25] Schlosser briefly discusses the Cold War strategy of the devices, agreeing with Garwin, Steinbruner, and Stumpf that the devices were pivotal to Cold War policies.[26] Unlike his predecessors, however, Schlosser provides a far more cynical view of the US military and government in their decision-making. He claims U.S. officials knowingly put citizens at risks while simultaneously assuring them of a safety they could never truly substantiate. Others works have established the government was hesitant to inform citizens of all risks involved with

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[24] Eric Schlosser, *Command and Control: Nuclear Weapons, the Damascus Accident, and the Illusion of Safety*, (New York: Penguin, 2013), 1.
[25] Ibid, 12.
[26] Ibid, 2.

devices.[27] Schlosser, however, pushes this idea even further, contending not only did officials not inform citizens of all risks, they actively provided them with false evidence of their safety.[28]

Schlosser's work on ICBMs helps explain the risks associated with housing the devices for workers and, to a lesser extent, civilians. His work directly challenges Stumpf's notion that silos were never mechanically unsafe. Schlosser helps to prove that the silos constantly had problems with hazardous gas leaks, unnecessary and slow concrete doors, and faulty alarm systems. While Schlosser concedes many of the major accidents occurred from human error, many smaller complications were mechanically based and could have been equally as destructive. The main criticism of Schlosser's work is he focuses too heavily on Damascus and the 1980s in his work. While Damascus was ultimately the biggest safety threat to Americans, it was not the only one. By not looking at all of the threats to domestic safety associated with the Titan II program, Schlosser misses the opportunity to truly prove there was an 'illusion of safety' prevalent in the U.S. in relation to nuclear weapon safety.

To fully investigate the domestic safety concerns associated with the Titan II program, it is essential to comprehensively examine the program in its entirety from 1962 to 1987. By carefully studying the program over this time period, it becomes much easier to make larger assertions about domestic safety. By studying the launch complexes in Kansas and Arkansas over this twenty-five year period, this work intends to demonstrate that nuclear safety was not strictly progressive or regressive in nature as Stumpf and Schlosser argue, but curiously more of

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[27] Mark A. Harwell and Thomas C. Hutchinson, *Environmental Consequences of Nuclear War Volume II-Ecological and Agricultural Effects*, (Scientific Committee on Problems of the Environment, 1986).
[28] Eric Schlosser, *Command and Control: Nuclear Weapons, the Damascus Accident, and the Illusion of Safety*, (New York: Penguin, 2013, 6.

a parabolic curve.[29] The initial increase in safety concerns was because the Titan II program was undoubtedly rushed throughout the 1960s. Getting the devices fully operational was the chief concern of the U.S. military and this lead to a dangerous three or four years for workers and civilians alike. Nuclear safety stabilizes around 1966 and continues to be stable until around 1975. During this time, the devices produce no fatalities and no major incidents occur. Most of the kinks had been worked out in the first few years and proper funding kept the devices safe. The easing of tensions with the Soviets and the progression of ICBM technology led directly to a lack of motivation to continue properly funding the Titan program. For this reason, safety concerns noticeably resurface around 1975. Fewer ballistic experts are employed at the silos and proper materials to keep leaks from occurring are not as well-funded. All of this leads to a return to poor safety conditions from 1975 until the retirement of the devices in the mid-1980s.

To substantiate this, nuclear safety in Arkansas and Kansas will be examined through three lenses: worker protection, civilian safety, and environmental ramifications. These three emphases will often overlap and are by no means mutually exclusive but separating them as much as possible affords the clearest investigation into the overall domestic safety concerns from 1962 to 1987. Chapters one through three will investigate worker conditions inside silos. More specifically, chapter one will study the hurried construction of Titan II facilities and analyze the impact this rush had on worker safety. Chapter two will look at the stabilization of safety from 1966 to 1975 and discuss why these safe conditions eventually eroded. Chapter three will look at the most dangerous time period for worker safety inside silos, 1978 to 1987. All five worker fatalities in Arkansas/Kansas' silos will be investigated to demonstrate not only the irrefutable

[29] A Parabolic Curve is a symmetrical 'U-Shaped' Curve. It is helpful in describing the progression of nuclear safety in America because it begins and ends at a high (or low) point while rounding out somewhere in the middle. Nuclear Safety follows a similar path throughout the time studied by beginning and ending dangerously while being relatively safe in the middle.

risk to workers, but also how the issues were resolved for future safety. In addition, several non-fatal incidents that are not as well-known will be reviewed to demonstrate the daily hazards present to workers inside Titan II complexes.

From here, the work will shift to civilian safety and the dangers of living close to a nuclear silo. Chapter four will use personal testimonies, court documents, and government reports to establish the safety threats to citizens living near the launch complexes. The chapter will also provide evidence revealing the lack of concern by U.S. officials to properly investigate these fears. Ultimately, the U.S. government will be shown to have failed American citizens by not taking necessary steps to make the devices as safe as possible for the public. They operated under an 'illusion of safety' with the devices that was misleading and were extremely lucky that a major civilian accident (worse than Damascus) did not occur.

The final chapter will research the environmental impact of Titan II missiles. The environmental ramifications of nuclear silos are the hardest of these three lenses to properly analyze as there is not yet enough source material to evaluate. Nevertheless, it is possible to demonstrate that basing options in the early-1960s gave little forethought as to how much ecological damage would occur with certain silo placements. The building of the fifty-four launch complexes were commonly put in areas that caused massive damage to the environment. The oxidizers and jet fuels used as missile propellants will also be carefully studied to determine the theoretical ramifications caused by countless missile leaks across the 1970s and 1980s. These leaks in the short-term likely caused changes in sunlight and precipitation across much of Arkansas. Long-term effects (assuming multiple exposures) could have impacted climate and temperature in the areas. This would have no doubt influenced agriculture in the state. The only way to truly gauge the environmental impact of these leaks is to know how many leaks actually occurred, which is unfortunately difficult to verify at this point. Only by properly investigating through all three of these lenses: worker protection, civilian safety, and environmental ramifications across the entire lifespan of the Titan II program, can larger assumptions finally be made. By examining these three components, it can be accurately substantiated that domestic safety concerns followed a parabolic curve with both 'high/dangerous' ends being the fault of the U.S. government, although for largely different reasons at each end.

CHAPTER ONE: WORKING CONDITIONS IN EARLY SILO OPERATION (1962-1966)

"*Unfortunately, nothing is perfect in this world; while it would be most desirable that a third criterion - safety - be met, it is quite obvious that in missile system components, safety comes in a poor third, if at all.*" –Edward Robles, Lead Systems Engineer, at the 1962 USAF symposium discussing worker safety around ballistic missiles.[30]

The primary objective of the United States' Atlas Program was to increase national security through superior military systems. Unfortunately, this meant that the safety of workers tasked with operating and maintaining these devices was often of subordinate concern. Still, throughout the short lifespan of the Titan I, no major accidents occurred. The independent placement of the propellants and the requirement of above-ground launches made the devices slower, but also far safer for workers. The Titan II missile, while unquestionably more efficient militarily, called for in-silo launches as well as the permanent storage of hypergolic fuels. These new conditions for workers made their safety much harder to guarantee. Additionally, the Titan II was so pivotal to national security that the complexes that housed them were severely rushed and not properly inspected before becoming operational. This rushed construction lead to severe defects in the silos' ventilation system which put workers at increased risk. For these reasons, the first four years of the program, 1962 to 1966, were extremely hazardous to workers inside the silo. During these early years of silo operation, worker safety was often a second or third concern behind national security and public safety.

[30] United States Air Force, *Sanitary and Industrial Hygiene Engineering Symposium,* 9-12 October 1962, symposium convened at 392d Aerospace Medical Group (Vandenberg Air Force Base, California), 125 military and civilian personnel from Air Force bases across the U.S. were in attendance, quote is found on page 108.

Each of the fifty-four Titan II complexes in the U.S. were around ten-stories deep and contained a 100-foot missile filled to the brim with exceedingly volatile components. When properly readied, each Titan II had atop itself a W-53 warhead which contained three times the strength of all the bombs used in WWII (including both atomic bombs). It is somewhat astonishing then, that during the twenty-five-year lifespan of the Titan II, only five fatal accidents involving the devices occurred and that none involved a nuclear explosion. While these five tragedies took the lives of fifty-eight workers across Kansas and Arkansas, they still do not properly express the immense risk workers inside the silo faced both in the short as well as the long-term. By briefly studying these five accidents as well as several non-fatal incidents it becomes clear the extreme threat the Titan II silo posed to the average worker inside.

Examining these conditions inside the silos was first addressed by John Womack in his 1997 work *Titan Tales: Diary of a Titan II Missile Crew Commander.* Womack commanded launch crews inside of silos in both Arkansas and California during the first ten years of the Titan II program. Womack explains that the program was hurried in its construction and that workers were not always properly prepared for the jobs they would be doing.[31] Nevertheless, the program was extremely well-funded, and this often meant the 'best and the brightest' system engineers worked for the program. Womack suggests that only due to the intelligence and resilience of these workers were several tragedies averted during these early years of operation. False alarms were particularly unnerving with things as simple as a flock of birds commonly setting off alarms with the warning of incoming missiles.[32] Womack's account helps set the scene for these early years of the Titan II program when silo operation was being rushed, but still

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[31] John Womack, *Titan Tales: Diary of a Titan II Missile Crew Commander, (*Soliloquy Press: 1997), 12-13.
[32] Ibid, 17.

well-funded. Even with his work cutting off in the mid-1970s when he leaves the program, it helps demonstrate how a lack of federal concern and funding led to many of the best systems engineers and commanders (such as himself) leaving the program.

Womack's account remains the best primary text featuring worker safety from inside the silo, but because it only documents his own recollections it fails to accurately investigate the hazards faced by workers at other silos. Nevertheless, his testimony helps demonstrate how dangerous even the best launch complex was in the early years of operation.[33] Researchers such as Stine, Mackenzie, and Schlosser have agreed with Womack that rushed construction likely put these workers at increased risk but none have properly investigated these claims.[34] Stumpf, who has done perhaps the most in-depth secondary research on worker safety, is the only researcher who suggests the Titan II silo was not excessively hazardous for workers. Stumpf does concede that working around nuclear weapons systems put workers at an increased risk but argues that all injuries and accidents associated with the Titan II were because of worker error not due to rushed construction. Reviewing the fifty-eight fatalities associated with the Titan II program, Stumpf goes as far as to argue "in each case, human error was the cause of the fatality, not a hidden flaw of the missile, its subsystems, or the launch complex."[35] To examine the validity of Stumpf's argument and to properly gauge whether rushed construction put workers at increased risk, it is

[33] Under Womack's command, his launch crew won multiple awards given by the Strategic Air Command wing of the Department of Defense for best operating silo in the 1960s and 1970s. Even with these awards, Womack concedes there were many hazardous times inside his silo.
[34] Listed are the secondary works that have touched on worker safety in Titan II silos. Harry Stine, *ICBM: The Making of the Weapon That Changed the World,* (Crown Publishing: 1991). Donald Mackenzie, *Inventing Accuracy: A Historical Sociology of Nuclear Missile Guidance,* (MIT Press: 1993). David Stumpf, *Titan II: A History of a Cold War Missile Program*, (University of Arkansas Press: 2002). Eric Schlosser, *Command and Control: Nuclear Weapons, the Damascus Accident, and the Illusion of Safety,* (Penguin Books: 2013).
[35] Stumpf, 235.

necessary to briefly look at each of the five major accidents of the Titan II program as well as some minor incidents.

While all of the fifty-four Titan II silos were to be fully operational by the summer of 1963, some complexes in California were functional by early 1962. On May 24, 1962 the first major incident occurred at complex 4C in Chico, California. An explosion and subsequent fire occurred destroying much of the inner silo. The investigation team found that a blocked vent was the major causes of the fire damage.[36] At the point of the explosion, no workers were inside the internal part of the silo where the fire took place.[37] While this bit of fortune saved these workers, the lack of a genuine follow-up investigation would mean no major changes to silo complexes to fix the poor ventilation system. The lack of modifications after an incident which featured no fatalities would be an ongoing theme during the entire lifespan of the Titan II. The inadequate examination into the ventilation problems in Chico would foreshadow the worst American industrial accident at a nuclear silo just three years later.

The 1965 Searcy Fire was the first fatal accident to occur at a Titan II facility.[38] The incident occurred on August 9, 1965. The huge $4.7 million silo had fifty-five men working in the missile bay at the time of the disaster.[39] Most had just returned from their lunch break at 12:30 p.m., by 1:15 p.m., fifty-three of the men were dead.[40] The accident occurred when a

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[36] Department of Defense, U.S. Air Force. *On Alert: An Operational History of the United States Air Force Intercontinental Ballistic Missile (ICBM) Program, 1945-2011 - Atlas, Titan, Minuteman, Peacekeeper MX, Minuteman III, Nuclear Warhead*, 2017, 19-22.
[37] Figure 4 in the Appendix illustrates an operating silo complex. Taken from 'Walks through History' tour. Titan II ICBM Launch Complex 374-7 Site Southside (Van Buren County).
[38] Figure 3 in the Appendix provides a map of the 18 silo locations in Arkansas. It also lists the 3 locations of fatal accidents in these silos. It was taken from the Arkansas Democratic-Gazette.
[39] Figure 4 in the Appendix provides an illustration of what an average Titan II Missile Silo was like. Notice the silo is broken into 3 parts, with the Control Center being located very far from the actual missile. The only survivors of the Searcy fire made their way through to the control center rather than exiting to ground level from the missile bay.
[40] The 53 Fatalities at the Searcy Silo make the incident one of the worst industrial accidents in U.S. history and the worst inside a nuclear or energy facility.

welder purportedly nicked a hydraulic line on level two of the silo shaft causing a swift fire inside the 78% oxygen tank.[41] This was made worse by the 750-ton slab of concrete ceiling that was closed for the day. With the roof closed, the smoke had nowhere to escape and quickly asphyxiated the silo workers within a matter of minutes. The fifty-three fatalities were dispersed through the entire missile area. fourteen were on level two, twenty-five on level three, six on level four, one on level five, four on level six and three on level seven.[42] David Yount, the commander of the silo, would immediately start the emergency checklist for such an occasion, "giving the [evacuation] order three times over the public address system," but would be largely unable to save any of the men trapped outside the control center, in the silo itself.[43] By 2:20 p.m., the Missile Potential Hazard Team arrived with helicopters and ambulances to assess the situation and damage.[44] They found that fifty-three men were indeed missing, but the smoke was still too heavy to attempt safe entry into the silo. Only at 8:15 p.m. were the men able to successfully enter the silo and remove the bodies, most of which were grouped around ladders at various exits.[45] Gary Lay (whose testimony starts this work) and Hubert Saunders were the sole survivors from inside the bay.

The next day, August 10, 1965, the Air Force Aerospace Safety Missile Accident Investigation Team quarantined the silo to conduct an investigation. In a report delivered later in Washington D.C., the team found that "a welder caused a flexible high-pressure line containing

[41] Orval Eugene Faubus Papers, MS/F27/301/FAUBUS, Series 12, (Records Pertaining to Non-Government and Inter- Government Organizations, 1955-1966), Box 444, folder 2. Special Collections, University of Arkansas Libraries, Fayetteville.
[42] Faubus Papers, Box 444, Folder 3.
[43] Linda Hicks, "Silo Fire Survivor tells his Story," Searcy Daily Citizen, May 7, 2000.
[44] Faubus Papers, Box 444, Folder 3.
[45] Faubus Papers, Box 444, Folder 4.

flammable hydraulic fluid to rupture by accidentally striking it with a welding rod."[46] They affirmed that they found no reason to believe it was caused by anything other than the personal fault of the welder.[47] Lastly, the team found the missile was surprisingly undamaged from the fire and was not carrying nuclear devices at the time, which were being held separately in Jacksonville, AR.[48] These reports, however, only demonstrated the positive side of the accident. By stating that the fire was the personal fault of the welder and was not a notable risk to the general public, the report was able to assuage the danger of the silos and devices.

While this was good for keeping public opinion unchanged on the issue of ICBMs and their housing near civilians, it did not change the fact that the accident had exposed clear safety concerns to investigators. The missile accident team determined twenty-six problems had influenced the large number of lives lost. These were not small problems but glaring oversights due to the swift development of the silos. Some of the larger problems included: not having proper ventilation to rid smoke from the silo quickly, having awkward silo roofs that did not retract quickly or reliably, not having elevators that could be used during emergency situations in which all power was lost, poorly positioned emergency exits which were hard to find in the dark and not adequate for dealing with an emergency such as a fire, air masks given to silo workers that did not help shield them from fire smoke, and first responders having no understanding of the inner silo layouts which were still top secret at that point.[49] These issues were not brought forward in the report given to Washington, but were later added in 'Project Yard Fence' as

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[46] 1965 Searcy Accident Report Delivered to Congress. Air Force Research Agency, Maxwell Air Force Base, Montgomery, Alabama.
[47] Ibid.
[48] Ibid.
[49] John McClellan Papers, S: 134, Box 470, Dates: 1963-1965, Military—Department of Defense A-R 1963-1965, Folders 3-4. Special Collections, Riley-Hickingbotham Library, Ouachita Baptist University

immediate changes to silos in use.[50] Project Yard Fence were the large-scale modifications issued by the government for all Titan II silos in 1965. While this does demonstrate a concern for safety inside the silos, it shows the US government were furthering the 'illusion of safety' Schlosser details in his work. By issuing a statement saying the welder alone caused the accident and no real public risk ever occurred, the silos were able to maintain their safe reputation to the public as well as its workers. By not bringing to the public eye the twenty-six changes which needed to occur to make the facilities safer, they were able to fix the problems without answering public criticism about the shoddy development of the silos in the first place.

Even with the accident team finding twenty-six problems, the investigation was not nearly conclusive enough. A full investigation of the Searcy accident would not occur until 2000, which seems to display that they were more concerned with getting the silo back into operation than properly inspecting its overall safety. This is made abundantly clear by the fact that thirteen-months later (September 1966), the silo was restored to 'alert' status and back to business as usual, even with charred walls still remaining to haunt the workers.[51] The 2000 investigation exposed even more cause for concern. The investigation found that the lack of safety measures went far beyond the problems supposedly fixed with Project Yard Fence. These concerns expounded on the earlier investigation stating "hydraulic flushing lines were haphazardly draped, welding blanks and standby fire extinguishers were lacking, cigarettes and lighters and other prohibited articles were found on the workers or within the work areas. Hand tools in the launch duct were not tied to the personnel or support beams to prevent them from falling and striking

[50] Ibid.
[51] Ibid.

the missile."[52] The last of these is a particularly disconcerting find, in that the Damascus accident occurred when a socket (not tied down) was dropped and hit a fuel line in 1980.

The two investigations into the 1965 Searcy fire help to illustrate the safety concerns inside and outside the silos. The first report issued directly after the accident, demonstrated that the silos had been built too quickly and were not truly safe for the workers inside. The clear ventilation oversights (which had been foreshadowed by the Chico Incident) would prove costly once another fire broke out in a silo with workers present. The report later given to Washington would help to couch these twenty-six problems in the hopes of shifting blame back on to individuals instead of rushed construction. By doing this, the government was able to implicitly argue that the complexes were still safe, but workers had to be safer to avoid industrial accidents. David Stumpf has echoed these sentiments in his research on Titan II worker safety, in suggesting that worker errors were to blame for all fatalities. This is clearly unfair, however, as the disaster would not have been fatal for all the workers inside the silo if not for several safety omissions caused by rushed construction. While the worker undoubtedly started the accident, the swift building of the silos is what made it lethal. With proper ventilation, reliably retractable silo roofs, air masks that could filter smoke, and better emergency exits, the accident would have likely only killed the original welder. Instead, it took the lives of fifty-two others.

Examining the report delivered to Washington, there is no concession of liability by the U.S. government. Accident investigators on-scene did not fully understand the safety concerns associated with these devices. The 2000 report would help to show the original investigation was carried out with speed rather than accuracy as the major goal. The later report helped to disprove

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[52] David K. Stumpf, *Titan II: A History of a Cold War Missile Program*, (University of Arkansas Press, July 1, 2002), 218-219.

the government's argument that the only danger found was inside the silo, not to the general public. Unobserved problems, namely not having hand tools tied to workers inside the silo, would almost prove costly on a global stage. The 1980 Damascus accident, which occurred when a six-pound socket was dropped eighty-feet and struck the rocket's fuel tank, could have been avoided if a more complete investigation in 1965 had taken place.[53] The Titan II at that time of the 1980 accident *was* carrying a nuclear device, which was the major justification in the 1965 Searcy accident report for why public safety was never a real issue. Essentially, the US had a fortunate break in 1965 when the disaster was held inside the facility due to no nuclear possibility. By not undertaking a proper investigation following the Searcy disaster, U.S. officials allowed several preventable safety concerns to pass unnoticed. One of these concerns (tying down tools so they could not fall great heights) could have had severe global ramifications. Only a last-measure safety feature stopped the nuclear device from releasing radioactive material and being far worse for civilians and workers alike.[54]

The U.S. Air Force was fortunate no other large fires inside a Titan II silo occurred. While Project Yard Fence purported to address all known safety concerns inside the silo, it still did not offer a remedy for the ventilation system inside the missile bay. To completely fix the ventilation system inside the silos would have been a mammoth undertaking that would have required a large amount of federal funding. Instead, silo roofs were made to open quicker and more reliably. Officials believed that since smoke would simply escape if the 750-ton door retracted, all they needed to do was have several safety features in place that made sure the door

[53] Schlosser, 2.
[54] Schlosser, 5.

would reliably open in the event of a fire. In addition to this, new air masks for workers were required that could properly filter smoke from a fire.

Fortunately, no large-scale fires broke out inside a Titan II missile silo, so the new safety features were never actually put to the test. More than likely, the new safety measures would have prevented a similar accident from occurring as they did seem to fix the issue of asphyxiation from fire smoke. The drawback to these new measures were that they did not fix the crucial problem - proper ventilation for the entire missile bay. Officials failed to realize there might be a need to ventilate something besides simply smoke. When the program had proper funding, this was not a major concern since no other kind of ventilation was needed. When the program stopped being properly funded, however, it ran into the problem of oxidizer and hydraulic fluid leaks becoming a daily issue. Since some of the compounds used to propel missiles are heavier than air (they will not escape vertically through a roof opening), not having a proper ventilation system would become a potentially deadly problem yet again.

With the program properly funded, expert supervision kept the missiles from leaking such compounds. This federal support meant from 1966 to 1975, no major accidents inside a Titan II missile silo occurred.[55] The rushed construction of the Titan II silos had left it with several small design flaws, but the only one of fatal proportions seemed to be that of the poorly designed ventilation system. Project Yard Fence helped to alleviate this problem with its new roof design and filtrated air masks for workers. Proper federal funding helped keep the best systems engineers employed in the fifty-four silos and these workers kept the devices well-

[55] A second fatal accident occurred on January 24, 1968. Eugene Bugge was cleaning the top level of a silo in White County, AR. He was originally wearing a two-point safety harness but removed it to reach an unknown fluid on the ground below him. He slipped and fell nearly 90-feet to his death. This incident is of no real importance to the discussion on worker safety, as the worker voluntarily removed his safety harness.

maintained. During this ten-year period, the devices and complexes that housed them were reasonably safe for workers and civilians alike. The Titan II program matured into this stable period and it is hard to find any sign of unreasonable risk to workers or civilians.

CHAPTER TWO: FOREIGN POLICY ERODES SAFE CONDITIONS (1966-1978)

"Others perceived us as a bit of a wild bunch. I knew several security policemen at Davis Monthan who rated PTS [Propellant Transfer System] *troops in the same category of crazy as the explosive ordnance disposal (EOD) guys. What I can tell you is that we were one of the few career fields (along with EOD, pararescue, and tactical air combat controllers) to receive hazardous duty pay for the work we did. Fewer than 5,000 people in the entire Air Force qualified to receive haz pay and even firefighters didn't have it until 2005…We were damn proud of what we did and our "bad boy" reputation was just a part of that."* -Lynne Scott Discussing the Hazard Pay PTS workers started receiving in the mid-1970s.[56]

The stable decade of silo safety slowly eroded in the mid-1970s. It is difficult to precisely understand why this erosion occurred. Likely, it was initiated because of the foreign policy of Richard Nixon. In an attempt to avoid nuclear annihilation, Nixon had moved to ease the tensions between the U.S. and Soviet Union. This increased dialogue between the two governments signaled the earliest signs of détente.[57] Strategic Arms Limitation Talks (SALT) were the ultimate objective of these discussions and eventually terms were agreed upon by both nations on May 26, 1972. Henry Kissinger, the National Security Advisor, during these talks unsuccessfully attempted to retire all Titan II missiles for similar concessions from the Soviets.[58] These public negotiations likely led many U.S. officials to stop considering Titan II silos and missiles as absolutely necessary to national defense. Determining the cause for the reduction of funds to Titan II silos would require a more comprehensive study into U.S. foreign policy during

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[56] Lynne Scott, "One of the Most Dangerous Jobs in the Air Force," Liquid Reality Studios, November 2013.
[57] John Lewis Gaddis, *The Cold War: A New History,* (Penguin Books: 2006), 180-185.
[58] Gaddis, 200-203.

the time. No matter the cause, however, the effects of this reduced funding greatly impacted the working conditions at the fifty-four launch complexes across the country. Many of the country's best system engineers and crew commanders began leaving the program for the newer Minuteman facilities where they could receive better pay.[59]

The lack of federal funding and attention given to Titan II missile complexes severely deteriorated in the mid-1970s. Kissinger's willingness to retire all Titan II missiles from service signaled their outdated technology. The Titan II had initially been designed to operate for only ten years from 1962 to 1972. The U.S. Air Force had already begun moving towards safer solid-fueled Minuteman missiles due to the hypergolic nature of liquid-propelled missiles. Even with these technological shifts, however, the Titan II missiles remained operational until 1987.[60] As a result, the Titan II remained in the U.S. arsenal for fifteen years longer than it should have all while receiving less and less expert attention and funding. Naturally, this meant an increase in safety concerns at these silos for civilians and workers alike. Around 1975, the timeworn Titan II missiles started to regularly leak highly volatile oxidizers and jet fuels. Fatalities and incidents began popping up all across the country, most notably in Arkansas and Kansas, where the least amount of attention was given.

Missile leaks became frighteningly common after 1975. The Air Force found that between 1975 and 1979, 126 leaking incidents had been reported in Arkansas and Kansas alone.[61] Before 1975, less than ten such leaking accidents had occurred since the start of the

[59] John Womack, Gary Conine, and Chuck Penson all speak on this in their works.
[60] This reluctance to retire the Titan II missiles may have been because of their unsuccessful usage in SALT I talks. Kissinger hoped to receive some kind of concession from the Soviets before he retired all fifty-four silos.
[61] Department of Defense, U.S. Air Force. *On Alert: An Operational History of the United States Air Force Intercontinental Ballistic Missile (ICBM) Program, 1945-2011 - Atlas, Titan, Minuteman, Peacekeeper MX, Minuteman III, Nuclear Warhead*, 2017, 27.

program. The Titan II missiles were simply not built to house such corrosive compounds for as long as the silos had been in use. Unsurprisingly, fatal incidents began to arise because of these constant leaks. This surge in worker safety concerns marked the end of the stable period of the Titan II missile program. The U.S. government's refusal to simply retire the missiles or at least provide them proper funding were the direct causes of this escalation.

The first fatal accident to occur after this stable period (and the third fatal accident overall) occurred at launch complex 374-7 in Damascus, Arkansas. The silo, located around fifty miles north of Little Rock, is perhaps best known for the later 1980 incident. On October 8, 1976 a small team was assigned to clean up leaking hydraulic fluid that had gotten all over the missile. Properly cleaning hydraulic fluid is difficult because it is primarily oil-based, so simply using water will not work to clean it. Workers instead were given Freon-113 soaked towels to scrub the missile as the compound would help mitigate the oiliness of the fluid and allow water to remove the rest.[62] The workers did not know what to do with the soaked towels, so they simply dropped them to the silo floor for later gathering. Once the missile had been successfully cleaned, workers went to collect the rags on the silo floor. Several workers, including the crew commander Larry Woods, began feeling dizzy and nauseous and hurriedly exited the silo bay.[63]

The Freon-soaked towels needed to be removed from the silo bay, so Sargent Mark Davis volunteered to return and quickly collect them. He attempted to hold his breath while retrieving them, believing that as long as the Freon did not enter his lungs he would be fine. As he bent over, the close proximity to the Freon gas caused him to vomit.[64] As Davis returned to the others,

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[62] *History of the 308th Strategic Missile Wing, Little Rock AFB, Arkansas, October-December 1976*, 308-HI-Vol.1, Exhibit 11.
[63] Ibid.
[64] "AF Sargent, 24, Died from Exposure to Freon-113 Vapors," *Arkansas Gazette,* April 1, 1977.

Sargent Larry South offered to follow Davis and continue collecting the towels. South also became ill and attempted to return to the control center but collapsed in the silo equipment room. South was rushed to the base medical center but was announced dead-on-arrival.[65]

The problem was that Freon-113 gas does not rise above air. While a majority of gases are lighter than air, Freon-113 is one of the few that is heavier. By dropping towels soaked in the gas all the way to the silo floor, the gas lingered at the bottom of the bay with nowhere to escape since it could not push past the air in the bay. When Davis and South entered the bottom floor, the area was likely anoxic (without any oxygen). Coming into contact with an area so concentrated in Freon-113 is lethal for even small periods of time. Sgt. Davis was fortunate not to have suffered a similar fate as Sgt. South.

The lack of ventilation and air circulation found in the earlier incidents at silos was again the major cause of the fatality in 1976. The investigation team found that only sixty cubic feet per minute of air was cycled by the ventilation system, meaning that when South and Davis entered the silo floor they were likely entering an area seven-foot deep of primarily toxic gas (above the height of both men).[66] Also, the more they bent down to collect towels, the more concentrated the fumes they were coming into contact with. David Stumpf, on reviewing the 1976 fatality, has suggested, "this was a case of small oversights compiling into a fatal accident."[67] While there truly was a weird amalgamation of freak coincidences that led to the fatal accident, it is unfair to attribute the death on 'small oversights.' Incidents at Chico and Searcy had revealed these air circulation problems over ten years earlier, but no remedy of the

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[65] Ibid.
[66] *History of the 308th Strategic Missile Wing, Little Rock AFB, Arkansas, October-December 1976*, 308-HI-Vol.1, Exhibit 11.
[67] David Stumpf, *Titan II: A History of a Cold War Missile Program,* (Fayetteville: University of Arkansas Press, 2002), 224.

system had occurred. On top of this, the missiles should have been better maintained so as to not be leaking hydraulic fluid in the first place.

Sargent Larry South's death from Freon-113 exposure revealed the critical ventilation problem in the Titan II silo. Incidents in Chico and Searcy had initially demonstrated this to U.S. officials, but their unwillingness to provide federal funding to modify all fifty-four silos meant accidents were likely to keep reoccurring. Changing the silo roof design and providing better air masks just buried the actual problem. While this would have probably worked in the event of fire smoke, it had no effect on Freon-113. U.S. officials were one step behind the accident they were trying to prevent. Instead of fixing the underlying problem that made silos dangerous, they responded to the accident after it occurred. They incorrectly believed that ventilation would only be necessary in the event of smoke from fires after Searcy. Going off this notion, they installed modifications (roof and masks) that only helped ventilate gases lighter than air. At Damascus, this notion was shown to be wrong as having a reliably retractable roof did not help in the slightest when faced with a gas that lingered under air. Only a proper ventilation system that could circulate all gases from air would have solved the problem in 1976. The only change made after Sgt. South's death was that crew commanders were now made to document the amount of gas used to clean the missile, and to routinely check air concentration levels. No modification to the air circulation in the bay was suggested.

Missile leaks only became more and more common as each Titan II aged. These leaks were undoubtedly the most hazardous part of the job for workers around the devices. The hydraulic fluid leak in 1976 was slightly dangerous as it was toxic to eyes and skin but was nothing compared to that of jet fuel or oxidizer leaks. Obviously leaky jet fuel runs the risk of igniting if put around any type of spark. Even with that risk, the most dangerous leak for workers was still that of the oxidizer. The oxidizer used in the Titan II propulsion, nitrogen tetroxide, is a highly corrosive compound. The NFPA Hazard Identification System classifies Nitrogen Tetroxide as a three in its diamond system for health.[68] This means the compound can quickly cause permanent injury upon contact. More specifically, after coming into contact with N_2O_4 "pulmonary edema gradually develops, causing fatigue, restlessness, coughing, difficulty in breathing, frothy expectoration, mental confusion, lethargy, bluish skin, and weak, rapid pulse."[69] Furthermore, if the oxidizer were to inadvertently come into contact with the jet fuel under the right circumstances, a gigantic explosion would occur.

The lethalness of N_2O_4 meant even small leaks of the compound were to be taken very seriously. While accurate information on Titan II oxidizer leaks is still concealed from the public (which will be discussed further in the next chapter), it is possible to learn about such leaks through major accidents. The only fatal accident to occur due directly to an oxidizer leak occurred at launch complex 533-7 in Rock, Kansas on August 24, 1978. The accident occurred when a refueling of oxidizer was needed for missile B-57 at the silo. Sporadically, missiles would be drained of their oxidizers or jet fuels if certain cleaning or maintenance was needed. By removing the compounds before completing the task, the job was much safer. On this occasion, the maintenance went as intended and workers were tasked with refilling the oxidizer tank when finished. The refueling went as planned as all of the N_2O_4 made its way back into the missile. The fatal problem occurred when they attempted to remove the fuel pump from the missile and

[68] The National Fire Protection Association assigns a number between 0-4 for Health, Flammability, and Instability for each chemical in its database. The NFPA works with the *CAMEO Chemicals Database*, National Oceanic and Atmospheric Administration website, U.S. Department of Commerce.
[69] Details about Nitrogen Tetroxide were found at *cameochemicals.noaa.gov/chemical/4075*.

the quick-disconnect valve failed to clamp properly.[70] As a result, nearly all 14,000 gallons of the toxic compound came quickly spewing out of the missile.

N_2O_4 vapor is brown and the huge leak made it nearly impossible for anyone in the silo bay to see clearly. The leak scared workers who began screaming and ran out of the inner silo as fast as possible. Fortunately, the men closest to the leak were wearing proper clothing made to prevent the toxic gases from reaching them. Unfortunately, the toxic vapors dispersed quickly to the outer silo where workers did not have on such clothing. Most of the workers were able to access the top level of the silo or the control center through blast doors to avoid the fumes. The huge amount of people trying to leave at the same time perplexed the blast door system, however, and one of the blast doors became confused and would not open properly.[71] Workers Erby Hepstall, Carl Malinger, Charles Frost, and Robert Thomas were all trapped in this dangerous area behind the blast door. All four men were fortunate enough to have safety clothing on that purportedly helped mitigate the fumes. Even with the clothing, however, the effects of the gas were still being felt and Sgt. Thomas soon collapsed from the exposure. Eventually, the three workers managed to get open the blast door and pulled the unconscious Thomas topside. Upon reaching level two of the silo, Thomas still appeared to be alive. Hepstall removed his suit to attempt resuscitation, but after several moments, it became clear that Thomas was dead. The three remaining workers made the difficult choice of leaving Thomas to save themselves.

The three successfully evacuated the complex and were hosed down upon reaching the surface. A voluntary group of workers went back down to retrieve Thomas' body. The workers found Thomas and carried his body up seven flights of stairs from level three to topside.

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[70] "Report of Missile Accident Investigation, Major Missile Accident, Titan II Complex 533-7, 22 September to 10 October 1978," Vol. 1, p 1-12, Titan Missile Museum National Historic Landmark Archives. Accessed via email.
[71] Ibid.

Originally, it seemed as though only Thomas' injuries were fatal. Upon arriving at the hospital, twenty-five workers were treated with various injuries from the exposure to the oxidizer. Malinger and Hepstall, who had been closest to the leak, had the most severe injuries upon arrival to the medical center. Malinger suffered permanent damage to his vocal cords and lungs, and had full paralysis in his left arm, but managed to survive the incident. Hepstall, was not so fortunate, and died days later on September 3, 1978. The exposure to the fumes had caused lung and kidney failure. It is likely that removing his suit to give Thomas mouth-to-mouth played a huge part in his death.

The investigation team took control of the silo the next day and released their findings on October 10, 1978. The team found that a faulty 'O' ring had caused the huge leak of oxidizer. The 'O' ring, which was supposed to close the valve once the oxidizer had been fully pumped, jammed open and could not be fixed quickly. The leak could have been avoided if they had unscrewed the valve slowly to inspect if such a leak was occurring. If such a leak did occur, they could have put the hose back and found a different way to jam the opening before removing the pump. By unscrewing the valve too quickly, they had no chance to stop the leak once the fuel pump was fully removed. The investigation team was quick to blame the workers for not following proper procedure by slowly unscrewing the Teflon ring.

While, yet again, the initial accident was predominately the fault of the worker (and a faulty 'O' ring), the reason for all the fatalities was that of the poorly designed safety features inside the silo. The accident investigation team found that "Thomas died due to an unforeseen flaw in the design of the RFHCO" (Rocket Fuel Handler's Coverall Outfit).[72] The suit was

[72] Figure 5 in the Appendix shows an RFHCO on display at the Air Force Armament Museum at Eglin Air Force Base in Florida.

shockingly not designed to allow direct contact with liquid oxidizer. Thomas was therefore found to have died because, at the time of the leak, he attempted to use his gloved hand to stymie the 14,000 gallons of oxidizer.[73] The compound easily overpowered him, tearing through his suit filling his clothing and encompassing his body in a dense cloud of poisonous vapor.[74] While this flaw in the RFHCO may have been defensible, the fact that Malinger and Frost had such severe injuries was not. Hepstall removed his mask to attempt resuscitation on Thomas, so his suit could not be blamed, but Malinger and Frost had uncontaminated suits and were still severely injured by the oxidizer. Upon further inspection, it was found that the RFHCO suits "offered only marginal protection to prolonged exposure to liquid oxidizer."[75] Essentially, the only safety clothing given to the men to prevent oxidizer leaks did not offer protection for an extended period of time (more than five minutes).

The reason the four men had been exposed to the oxidizer for such a long time was because of the faulty blast doors. The investigation team found that "the RTMN (Radio-Type Maintenance Network) was not working properly since too many people were trying to use it at once."[76] Upon further testing, it was found that the system could only handle five requests to open doors at a time. So, if an accident occurred and many workers were trying to use the system at the same time, the system would crash and not work properly for the sixth request. This sixth request happened to be for the four men closest to the leak, and in the most danger. As Stumpf has said for the 1976 incident, this was again several small problems developing into a much

[73] "Report of Missile Accident Investigation, Major Missile Accident, Titan II Complex 533-7, 22 September to 10 October 1978," Vol. 1, p 1-12, Titan Missile Museum National Historic Landmark Archives. Accessed via email.
[74] Ibid.
[75] Ibid.
[76] Stumpf, *Titan II,* 226.

bigger problem. The faulty 'O' ring, inadequate RFHCO suits, flawed blast doors, and human error all played a significant role in the two fatalities and twenty-five injuries.

It is too easy to suggest, as Stumpf has, that accidents such as these were simply going to happen around something as dangerous as nuclear missiles. For one, during no other lifespan of a similar missile system (whether Atlas, Titan I, Minuteman, Peacekeeper MX, or Minuteman II and III), have nearly as many accidents occurred.[77] Stumpf suggests that both accidents in 1976 and 1978 had many small parts come together to form a much bigger incident that was harder to anticipate. The problem with this assessment is that it also means that fixing even one of these smaller issues would have avoided the bigger issue entirely. For example, in the 1978 disaster, four distinct problems merged together to make the incident fatal. If any one of the four problems: 1) the 'O' ring not malfunctioning 2) the suits not being susceptible to the oxidizer they were meant to repel 3) the blast doors not working or 4) the workers not following proper precaution, had been addressed, the accident would not have been fatal.

Stumpf is indisputably correct is asserting that accidents and incidents are going to happen somewhere as dangerous as a nuclear missile silo, especially over a twenty-five-year period. But, this is exactly why it is essential that proper safety features are applied beforehand. Well-designed facilities with proper safety gear mitigates the risk to workers when these inevitable accidents do occur. The Titan II was clearly rushed in its initial construction, which helps explain the faulty blast door system. These problems were compounded by poor funding and the old-age of the devices (the 'O' ring was over a decade old and the suits were not nearly adequate for protection). All that was needed was the last part of the equation, human error, for

[77] Department of Defense, U.S. Air Force. *On Alert: An Operational History of the United States Air Force Intercontinental Ballistic Missile (ICBM) Program, 1945-2011 - Atlas, Titan, Minuteman, Peacekeeper MX, Minuteman III, Nuclear Warhead*, 2017.

these dormant problems to become fatal. Suggesting that all these fatalities were human error is clearly unfair. Human error was simply the spark point for many other issues.

CHAPTER THREE: THE TITAN BECOMES A NATIONAL SAFETY CRISIS (1978-1987)

"How overworked they were, how understaffed they were, how bad the equipment was, how many failures they'd had in terms of leakage and other issues…They said if something is not done, someday, some time, one of these missiles is going to explode." Skip Rutherford, aide to Senator David Pryor, recalling what silo workers were routinely telling he and Pryor during the lead up to the Damascus explosion.[78]

The Titan II missile program reached its most dangerous period in the late-1970s and early-1980s. The lack of federal funding and increasing age of the fifty-four Titan missiles had made each silo an extremely dangerous place to work. Silo workers were acutely aware of these risks and began to push for silo-wide hazard pay for all workers employed by the Air Force.[79] Before this point, only PTS (Propellant Transfer System) troops had received hazard pay. Other workers argued, however, that the PTS troops were not the only ones accepting excessive risk. The 1978 oxidizer leak in Rock, Kansas had injured seventeen workers who were not PTS troops, workers who were not receiving any extra pay. Workers in Arkansas' silos began to voice these concerns to Senator David Pryor and his aide, Skip Rutherford, on a daily basis. While these concerns were disregarded for all of 1978 and much of 1979, nine minor incidents in Arkansas helped refocus the discussion back to safety concerns inside each silo. These smaller

[78] Skip Rutherford interview with reporter Winnie Wright, October 7, 2016. They were discussing an upcoming documentary about the Titan Missile Program in Arkansas.
[79] Hazard pay is defined by the U.S. Department of Labor as "additional pay for performing hazardous duty or work involving physical hardship. Work duty that causes extreme physical discomfort and distress which is not adequately alleviated by protective devices is deemed to impose a physical hardship." Found on the DOL website.

incidents would foreshadow the 1980 disaster in Damascus while shifting Pryor's focus back to civilian safety.

The nine incidents leading up to September 1980 involved issues such as oxidizer leaks, short-circuited wiring panels, jet fuel leaks, and faulty vapor detection systems.[80] The most dangerous of these nine incidents occurred in August 1979 at launch complex 373-3, which was located four miles from Heber Springs. During a routine check of emergency lighting in the facility, the crew commander turned off all power in the silo. The activation of emergency lights strangely caused a metal rod to slightly fall hitting a wiring panel, initiating a short-circuit.[81] A small fire started around the electrical wiring. Because the power had been turned off, no sprinklers were activated. Technicians evacuated the control center, unaware of the small fire. Eventually, the fire was discovered, and crewman came back to extinguish the blaze. The problem was that the oxidizer and fuel in the missile had begun to heat up, creating massive pressure inside the missile. By the time the fire was fully extinguished, the missile was found to be only minutes away from exploding thousands of gallons of oxidizer and jet fuel. According to a senior technician working that day, "only great skill kept that missile from exploding."[82]

Titan II silo locations were typically chosen for their distance away from civilian populations. Complex 373-3 was one of the few very close to thousands of civilians. Heber Springs, according to the 1980 census, had around 4,500 people who would have been directly impacted. Predictably, the public was not informed of the incident that had just occurred in their backyard. Still, the incident frightened Senator David Pryor, who got to work trying to make the

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[80] "Titan II Missile sites in Arkansas have been plagued," *Arkansas Gazette,* September 28, 1980.
[81] David Hampton Pryor Papers, MC 336, Group II, Series 5, subseries 10, Box 266, Folder 15 and 16 (Research on Titan II). Special Collections, University of Arkansas Libraries, Fayetteville.
[82] Walter Pincus, "Aging Titan II Was Time Bomb Ready to Go Off," *The Washington Post*, September 20, 1980.

silos in Arkansas safer for the general public. Senator Pryor wanted to get federal funding to install an alarm system that would warn civilians of a potential leak, fire, or similar safety concerns.[83] While this will be discussed more in the civilian safety chapter, it is important to understand how Pryor became directly involved in silo safety. Senator Pryor's alarm system idea was roundly opposed by the Strategic Air Command wing of U.S. Air Force. The SAC likely did not want to install such an alarm system as it would have meant acknowledging the danger of the missile silos to the public. To calm the Senator, the SAC agreed to an open study on the safety of the Titan silos in the state.

Senator Pryor was asked to participate in these safety studies. He talked to system engineers as well as crew commanders and even did a silo walkthrough in late-1979. It seems probable that the SAC was hoping to gain Senator Pryor's approval for the silos as he was admired by the Arkansas populace. Pryor, a trustworthy figure to most Arkansans, walked the launch complex to 'assess safety concerns,' but later admitted he had no idea what he was supposed to be looking for.[84] Remarkably, on the day Pryor went into one of the silos, the missile at another site was actually leaking oxidizer. On top of this, thirteen of the eighteen safety devices designed to record high levels of oxidizer gas in each of the Arkansas silos were not actually working.[85] While Pryor was not informed of this until after the 1980 Damascus accident, he *still* left the silos with an air of concern. Many of the engineers he spoke with had expressed concerns about the breakdown of missiles and daily leaks. One of the technicians he spoke with

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[83] David Hampton Pryor Papers, MC 336, Group II, Series 5, subseries 10, Box 267, Folder 11 and 12 (Titan II–Safety and Effectiveness). Special Collections, University of Arkansas Libraries, Fayetteville.
[84] Pryor Papers, Folder 12.
[85] Ibid.

said that he was having trouble keeping his engineers working on solving new problems as they were too busy fixing old problems.[86]

Even when silo workers spent their time addressing these old problems, the lack of federal funding meant they no longer had spare parts and "repairs had to be improvised."[87] A later report found that nineteen Titan II missiles of the fifty-four in the U.S. in 1979 had needed one or more tank patches because of corrosion. This evidence that the skin of each missile was weakening over time was disregarded by the SAC. The only hint that the SAC felt unnecessary risk was being put on silo workers was the addition of hazard pay for most silo workers in 1979. Pryor eventually released a public statement in late-1979 saying how important ICBMs were in keeping America safe, and how glad he was that Arkansas could play its part in national security. He finished the statement by asserting he 100% trusted workers at the site. Pryor was careful not to actually speak about the program as a whole, instead asserting he had faith in the Arkansas worker.

The Arkansas Gazette, writing later in September 1980 (after Damascus), criticized the inaction by Pryor and the Air Force asserting "Titan II missile sites in Arkansas have been plagued by nine accidents in the past 18 months…at least one had the potential to cause a similar blast to that of the recent Damascus explosion."[88] Pryor, disturbed by these criticisms, released all the information on the Heber Springs incident and the eight other incidents since March 1979 to demonstrate nothing was being concealed. These documents fueled news campaigns for weeks and led to the prevailing opinion that proper action could have prevented the Damascus accident

[86] Ibid.
[87] Ibid.
[88] "Titan II Missile sites in Arkansas have been plagued," *Arkansas Gazette,* September 28, 1980.

from occurring.[89] While it was true that the Damascus accident had many precursors, what those attacking Senator Pryor did not know was that he had spent most of the previous year lobbying for an alarm system to help keep the public safe.

The Damascus explosion occurred early in the early morning on September 19, 1980 at launch complex 374-7. A twenty-one-year-old missile technician, Dave Powell, was fixing a problem causing low pressure in one of the missile's fuel tanks at 6:30 p.m. the night before. Powell accidentally dropped a six lb. socket from a twenty-five lb. ratchet nearly ninety-feet directly into the rocket's stage-one fuel tank.[90] The force from the socket punctured the missile's fuel tank releasing a huge amount of aerozine-50 into the silo. Powell, hearing the hissing sound of gas escaping, could only utter 'uh-oh' to the worker next to him, Jeff Plumb.[91] The two quickly climbed topside and told commanders of their mistake. Because Aerozine-50 spontaneously ignites upon contact with the missile's oxidizer, N_2O_4, it was essential to keep the two compounds from interacting. Technicians, aware of this danger, called for a complete evacuation of the facility. The situation was made particularly dangerous because of the W-53 warhead sitting on top of the missile. The W-53 had a yield of nine megatons making it the most powerful weapon in the U.S. arsenal at that point. One W-53 warhead had the detonation power of all the bombs dropped in WWII including both atomic bombs. Detonation of the device (if airborne) would have resulted in a 3.5-mile fireball in diameter and would have been fatal to

[89] Examples of news sources like this include: "Titan II Missile sites in Arkansas have been plagued," *Arkansas Gazette,* September 28, 1980 and Walter Pincus', "Aging Titan II Was Time Bomb Ready to Go Off," *The Washington Post*, September 20, 1980
[90] Figure 6 in the Appendix provides a helpful illustration of a Titan II warhead to make the Damascus incident clearer. Taken from the *Gemini Design Certification Report* from February 1965
[91] Schlosser, *Command and Control,* 81.

90% of individuals within thirty-miles.[92] Likely, hundreds of thousands of Arkansans would have died, and most Americans. would have been affected.

Initially, it did not seem likely that the fuel would come into contact with the oxidizer. This assessment changed, however, when the stage-one fuel tank (located at the bottom of the missile) completely emptied. Technicians began to consider that the now empty chamber might collapse under the weight of the rest of the missile. Over the next few hours, several technicians attempted to fix the problem, but it became clear that if the missile collapsed a terrific explosion would likely occur. In the early hours of September 19, Senior Airmen David Livingston and Jeff Kennedy entered the silo to assess the situation. Detectors designed to identify volatile conditions found that the atmosphere was extremely explosive. The two were advised to vacate the silo but were not fortunate enough to leave the silo in time to get a safe distance away. As the two men were going topside, at about 3:00 a.m., the oxidizer and fuel inadvertently came into contact with each other and a massive explosion occurred. The blast sent the 750-ton silo roof 200-feet into the air where it landed some 600-feet away from the complex.[93] Kennedy, whose leg was immediately broken, was blown 150-feet away from the silo, but miraculously survived. Livingston was blown nearly the same distance but died from his injuries. Twenty-one other workers near the silo were directly injured from the explosion.

While it was clear no nuclear reaction had occurred, the missile and warhead were nowhere to be found. The entire missile complex was destroyed, but it was still apparent that the

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[92] Thomas Cochran and William Arkin, *Nuclear Weapons Databook: U.S. Nuclear Warhead Production,* (Ballinger Publishing Company: 1987), 41.

[93] David Hampton Pryor Papers, MC 336, Group II, Series 5, subseries 10, Box 267, Folder 10 (Titan Disaster, 1980). Special Collections, University of Arkansas Libraries, Fayetteville.

missile had exited the silo.[94] Confused reports of the situation reached Washington with Walter Mondale, the Vice President of the U.S., particularly annoyed screaming into his phone, “goddamn it, I’m the vice president of the United States! You should be able to tell me if there’s a nuclear warhead on this missile or not.”[95] Eventually, with the help of the rising sun, the missile and warhead were found in a ditch 200-feet from the complex. After testing, it was found that only a last-second safety feature had managed to prevent a nuclear explosion from occurring.

Eric Schlosser, the leading researcher on Damascus, explained that the U.S. military was not forthcoming about these findings. He found that “the Pentagon denied there was any possibility this warhead could have detonated and that was accepted by the media. It wasn’t until I really started researching this accident that I was able to do interviews and obtain documents that showed conclusively that this warhead was at risk of detonating accidentally.”[96] On top of this, the Pentagon claimed that the socket drop was a freak accident. Jeff Plumb, who was next to David Powell when he dropped the socket later recalled, “we had dropped tools numerous times. It wasn't the first time that we ever dropped a tool and watched it fall. It was common.”[97] Schlosser also corroborated this, as other technicians inside the silo remembered similar occasions of hand tools being dropped down the silo. Ironically, when directing the documentary to replicate the Damascus explosion, Schlosser’s cast actually dropped multiple sockets down the

[94] Figure 7 in the Appendix shows the silo directly after the explosion. Taken from the *Arkansas-Democratic Gazette*.
[95] Eric Schlosser, *Command and Control: Nuclear Weapons, The Damascus Accident, and the Illusion of Safety*, (Penguin Publishing: 2013), 115.
[96] Eric Schlosser interview with *Salon*. Article entitled “The night we almost lost Arkansas – a 1980 nuclear Armageddon that almost was,” by Andrew O’Hehir, September 14, 2016.
[97] Eric Schlosser, *Command and Control*.

fake silo shaft by accident.[98] Investigators after the 1965 Searcy fire recommended the need to tie down hand tools to prevent missile punctures, this was not an unidentified problem.

The cleanup to Damascus was estimated at $225,322,000 and was so costly that the Air Force decided to close the complex as it was not worth reopening. The investigation's report given to Congress found that the device was reliable, and that the last-second safety feature on the warhead successfully prevented a major accident from occurring. The only two alterations suggested was for a tracking device on the warhead in case it became lost and better logs on the location of the warhead at all times. As Schlosser has suggested, the media accepted this slanted view from the Pentagon. While they still criticized Pryor and the Air Force for inaction in the lead-up to Damascus, they did not get as irate as they should have. If not for the last-second safety measure, Arkansas likely would have been devastated. Media outlets focused too heavily on the incidents in 1979 to help demonstrate a recurring lack of safety. This is probably best explained because details on the entire Titan II program were not properly released until 2017. Pryor's release of the nine incidents leading up to Damascus in 1979 and 1980 was probably not sanctioned by the Air Force yet provided only a narrow view of Titan II safety.

The criticism given to Senator Pryor by Arkansas' media was largely unfair. Most seemed to question his concern for the average Arkansan's safety due to his inaction in the lead-up to Damascus. This was backwards. In actuality, Pryor's concern for the civilian is what put the state at more risk. After the Heber Springs incident, Pryor worked tirelessly for his alarm system to help alert civilians of possible hazards. Pryor, like the average Arkansan, did not seem to recognize that a major disaster could easily impact all of Arkansas, not just those close to the

[98] Schlosser interview with *Salon,* 2015.

silo. For this reason, Pryor did not accept the recommendations of silo experts throughout all of 1978 and 1979. If he had, he would have realized that keeping silos safe was essential to keeping the entire public safe – the two were largely inseparable. Instead, he seemed to believe that an accident inside a silo would be disastrous for only those workers, but not for the average citizen. So, instead of working day-and-night to solve problems inside the silo, Pryor worked to design a system to help civilians when these incidents occurred. Damascus helped demonstrate that this would not work. No matter how perfect the public alarm system was, the warhead would see to it that everyone suffered, not just the silo worker. In the end, the media was correct in stating the warning signs of Damascus were there. Clearly the two-years leading up to Damascus demonstrated a need for these missiles to be retired. They were wrong, however, in asserting that Pryor's inaction caused the problem to be worse. In truth, Pryor should have been criticized for the action he did take. He concentrated too heavily on his alarm system while not heeding the information he was receiving from silo-technicians of an impending disaster.

The U.S. military likely began deactivating Titan II missiles directly because of the accident in Damascus. While the program did not officially end until 1987, the missiles began to be retired slowly from 1982 to 1987, five years earlier than originally planned.[99] At that point, they were the oldest missiles still in use by the U.S. military. Solid-fuel missiles, such as Minuteman I and II, were far safer and produced far less accidents. The incidents in Arkansas (not including Damascus) had cost anywhere from $20 million to $50 million to cleanup. The incidents in Kansas had cost $15 million to $25 million. Adding in the $225 million from Damascus, the Titan II missile was becoming far too expensive to keep. The cost of upkeep, the

[99] Walter Pincus, "Aging Titan II Missiles to be Retired Five Years Early," *The Washington Post,* September 24, 1981.

obsoleteness of the devices, and the recurring accidents likely all played a role in this 'early retirement' for the Titan II.

The early retirement for the Titan II could not come soon enough for the average silo worker. Hazard pay was not worth the immediate risk and many workers even began to question possible long-term effects of being around so many oxidizer and jet fuel leaks. Initially, these long-term health effects were more of a joke for the average worker, but the last decade seems to hint that they may have been correct in their assumptions.[100] Several Titan II missile workers have come forward recently (after-2013) with claims that their recent cancers were from repeated exposure to fuels and oxidizers. The first of these cases, in 2014, claimed the worker (who worked in various silos from 1968 to 1992) experienced neurological issues for much of his life and eventually contracted colon cancer due to exposure. Judge Mainelli found "The Veteran's colon cancer was causally or etiologically due to service, to include exposure to hydrazine." [101] A similar case in 2015 found the Titan II Warhead caused ionizing radiation that caused thyroid cancer for a silo worker (who worked from 1962 to 1966). The warheads used at this time were found to be 'dirty bombs' which emitted radiation even at periods of rest. Repeated exposure to this radiation eventually caused his myelodysplastic syndrome and thyroid cancer.[102]

These recent cases have led one Titan II vet to establish a database for silo workers to log their symptoms and gain legal help if necessary. The site allows each worker to calculate their exposure to toxic chemicals and see if their ailments could be linked to repeated exposure to the

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[100] Josh Harkinson, "Hanging out with the Disgruntled Guys Who Babysit America's Aging Nuclear Missiles: And Hate Every Second of It," *Mother Jones*, November/December 2014 issue.

[101] *Edwards v. Oklahoma Department of Veterans Affairs*. Department of Veterans Affairs Regional Office in Muskogee, Oklahoma, adjudicated by T. Mainelli, acting Veterans Law Judge, January 23, 2014.

[102] *Schlickenmaier v. Florida Department of Veterans Affairs*. Department of Veterans Affairs Regional Office in St. Petersburg, Florida Adjudicated by Michael Lyon, acting Veterans Law Judge, April 6, 2015.

missile's oxidizer, N_2O_4. For most of these workers, calculating their exposure is not really necessary. The average Propellant Transfer System troop received around 150 times the allowed NIOSH (National Institute for Occupational Safety and Health) exposure to oxidizers *each month*. Even the average worker who did not directly transfer the compounds to the missile were found to be 9.3 times above the permitted limit. These cases are only looking at oxidizer exposure also. Aerozine-50, the jet fuel used in each Titan II, breakdowns into formaldehyde. Long-term exposures of formaldehyde have been associated with increased risks of lung and nasopharyngeal cancers. Properly analyzing these long-term effects will take several more years of research, but there does seem to be a strong link to certain types of cancer and repeated exposure to Titan II oxidizers and fuels. Workers are only now comprehending these risks and are fortunately receiving settlements for the hazards they faced to keep the country safer.

The Titan II silo was an immensely dangerous place to work. Immediate risks included fires, falls, leaks, and explosions. Long-term effects from radiation exposure, while still being calculated, likely led to cancer, extreme hearing loss, tooth decay, and stomach problems. These workers accepted these potential risks and commonly joked about being the 'bad boys' of the Air Force. Most of these workers were in their early-twenties and thirties, yet their grace under-pressure and quick-thinking were probably the main reason more catastrophes like Damascus were averted. The fifty-eight fatalities associated with the twenty-five-year lifespan of the Titan II program are by far the most of any Cold War U.S. missile program. Still, they do not adequately express the level of hazard involved. Liquid-based missiles like the Titan II work on the idea of containing huge amounts of extremely hypergolic fuels in close proximity to one another. It is astonishing more accidents like Damascus did not occur, especially considering how rushed the program was in its first few years. With the invention of solid-based fuels, the

Titan II should have been quickly phased out. Unsuccessful détente attempts lead to the postponement of the Titan's much-needed retirement. For nearly fifteen years after the devices should have been retired, silo workers were asked to accept increased risk as these already dangerous devices became corroded and leaky. U.S. officials put these workers and the citizens living around the silos at enormous risk all to keep a bargaining piece against the Soviets. The missiles were never even used in these SALT discussions, and as a result, the inevitable Damascus explosion occurred. Only after this clear sign of negligence did the U.S. began to phase out the Titan II and shift to using only solid-propellant based missiles.

CHAPTER FOUR: CIVILIAN SAFETY AROUND TITAN II COMPLEXES

"He was always easygoing, but right after the accident, he'd say things like, 'I'll knock your head off,' or, 'Pack your bag and get out.' He was taking a lot of medication for the pain. Even now, you can make him angry. Before the 1978 accident, nothing could."[103] -Beverly Stacks talking about changes to her husband after a 1978 oxidizer leak in Arkansas.

"I didn't want to say anything to my family about the burning sensation in my chest because I didn't want to alarm them…then later in the day, I did, and my son said, 'Dad, I didn't want to bring it up, but I feel the same way.'"[104] -Richard Kincaid, a citizen from Damascus, speaking after the 1980 Accident.

"To me, it was meant to be a defense for our country and not something against me. So, taking it out, unless they have something to replace it, I might feel as though I'm not as protected,"[105] -Barbara Watters, who lived next to a Titan II in Kansas, voicing her regret at losing Titan IIs in April 1985, even after all the incidents associated with them.

Workers in Titan II complexes understood most of the risks they were accepting on a daily basis. The same cannot be said for the average citizen living around the silos. Most civilians had little comprehension of what the silos held, or the potential risks associated with living near these devices. Recent historians have found that a 'Nuclear Taboo' did not reach average citizens until decades after the U.S. military. Nuclear Taboo is the idea that a stigma emerged after 1945 towards using nuclear weapons when other options were available (even

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103 Art Harris, "Titan II: A Plague on this Man's House," *Washington Post*, September 22, 1980.
104 Art Harris, "Illness strikes Five Miles from Titan II Explosion," *Washington Post,* September 26, 1980.
105 Antone Gonsalves, "Aging Missiles Pulled out of Kansas," *The Wichita Eagle,* June 24, 1984.

when U.S. had a nuclear monopoly and deterrence was not a factor).[106] While this reluctance to use nuclear weapons clearly did not stop the U.S. from stockpiling them, it demonstrates their awareness of the inherent danger of even being near the devices. Civilians did not have this same comprehension of nuclear weapons silos and were generally tolerant of having complexes and warheads near their families. U.S. officials often took advantage of this lack of understanding by civilians to help keep public support high for the otherwise dangerous facilities. Originally, the danger associated with these silos was not high. By the mid-1970s, however, the silos had become a public safety crisis. The U.S. government allowed the Titan II program to continue operation without properly informing these citizens of these health risks, some of which are still being properly examined.

Research on public safety around Titan II launch complexes is surprisingly small. Eric Schlosser has written the most on civilians living around Titan II silos. His 2013 work, *Command and Control,* looks primarily at the 1980 Damascus accident as a case study for what he calls the 'illusion of safety' prevalent in Cold War America. Schlosser argues that Americans had little grasp of the great risk they were accepting living next to the devices, and that the U.S. military was careful not to dispel this ignorance. Schlosser has gone as far as to claim, "the lies and obfuscations of the Air Force about nuclear accidents over the years reveal a military leadership smugly confident in its ability to determine, in secret, what is best for the nation."[107] Similarly, authors like Beard, Penson, and Pomeroy have alluded to this deceitfulness by the U.S. government on the issue of nuclear safety.[108] These works all provide good evidence for the

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[106] Nina Tannenwald, *The Nuclear Taboo: The United States and the Non-Use of Nuclear Weapons since 1945*, (New York: Cambridge University Press, 2007), 2-5.

[107] Eric Schlosser interview with *The American Prospect*. Article by Konstantin Kakaes, "Eric Schlosser, Bard of Folly," *The American Prospect,* October 2013.

[108] Listed is the research which has touched on public safety around Titan II silos. Edmund Beard, *Developing the ICBM: A Study in Bureaucratic Politics* (Columbia University Press, 1976). Chuck Penson, *The Tian II Handbook:*

government working in secret without informing the public of risk. The problem with these works are that they do not research the actual risks to civilians.

Works such as Gretchen Heefner's 2012 book *The Missile Next Door: The Minuteman in the American Heartland* have helped to demonstrate how the average civilian dealt with ICBMs close to their home. The work examines nearly one-thousand Minuteman ICBMs in Montana, Wyoming, South Dakota, North Dakota, Colorado, Nebraska, and Missouri during the late-Cold War. Heefner argues three main points in her work. First, the building of these Minuteman silos caused an intersection of local politics with national security that helped expose the negative response of ordinary citizens. Second, nuclear devices were much more than military weapons, they were also examples of psychological weaponry by demonstrating the embrace the average American had for the arms race as well as nuclear deterrence. Lastly, Heefner argues researching ICBMs helps to demonstrate how economics, namely a military-industrial complex model, led citizens to embrace the devices they had originally fought so ferociously against.[109]

Heefner's work is the only major scholarship to truly look at Cold War ICBMs from the perspective of the average civilian. The problem with her work is that it focuses only on the Minuteman missiles, and the civilian pushback to these. Titan II facilities in Arkansas and Kansas did not have the same civilian response for several reasons. First, most of the Minuteman missile facilities came after the original accidents in Arkansas and Kansas. Before these incidents occurred, citizens were less aware of safety concerns and thus less likely to oppose the silos

A Civilian's Guide to the Most Powerful ICBM America Ever Built, (Chuck Penson Publishing, 2008). Eric Schlosser, *Command and Control: Nuclear Weapons, the Damascus Accident, and the Illusion of Safety,* (Penguin Books, 2013). Steven Pomeroy, *An Untaken Road: Strategy, Technology, and the Hidden History of America's Mobile ICBMs,* (Naval Institute Pres, 2016).

[109] Gretchen Heefner, *The Missile Next Door: The Minuteman in the American Heartland,* (Cambridge: Harvard University Press, 2012), 8-12.

themselves. Secondly, Titan II facilities in Arkansas and Kansas did not bolster the economy of those areas in the same way they did for states that came later. This is likely because the U.S. government realized they had to pump money into these economies to get civilians to support the program as a whole. Either way, Arkansas and Kansas' civilians were clearly not embracing missile silos because it was financially beneficial to them. Essentially, the response by civilians in Arkansas and Kansas to Titan II facilities was far different than the response to Minuteman missiles in later states. Ironically, later states fought very hard to reject installation of their generally safe solid-propellant missiles, while Arkansas and Kansas were very accepting of the much more dangerous liquid-propelled missiles.

There were some precursors to the dangers of nuclear devices well before the installation of Titan IIs in the 1960s. Unfortunately, most civilians never heard these accounts. A study by the William J. Perry Project found that "a minimum of 1,200 U.S. nuclear weapons were involved in incidents between 1950 and 1968."[110] Most of these accidents were trivial, but some could have been devastating. On March 11, 1958 a B-47 bomber accidentally released an atomic bomb over South Carolina. The bomb landed on the Gregg family's chicken house, exploding (non-nuclear) and creating a crater fifty-feet wide and thirty-five-feet deep. On January 24, 1961 a B-52 bomber accidentally dropped two hydrogen bombs over a swamp in North Carolina, each could have had a full-scale nuclear detonation. Only the last of three safety features kept the bombs from going nuclear. One of the bombs still has not been successfully recovered.[111] Thirty-two other 'broken arrows' (significant accidents) had occurred in the U.S. before the push for ICBM technology. In many ways, ICBMs were the answer to these problems. By housing the

[110] William J. Perry Project, "Nuclear Accidents in the U.S.," 2013.
[111] James Oskins and Michael Maggelet, *Broken Arrow – The Declassified History of U.S. Nuclear Weapons Accidents,* (Lulu Publishing Company, 2008), 14-17.

missiles in-ground and not having them airborne twenty-four hours a day, the ICBM was seen as a progressive move in public safety. Still, the risk for citizens in Arkansas and Kansas was only increased by this new technology.

As early as 1962, Commander Bob Peurifoy was calling for greater safety measures inside of Titan II facilities. Peurifoy, who had helped design part of the new warhead, was shocked that the silos were storing the nuclear core with the bomb itself. Before the Titan II, the two were stored independently so that it was impossible for a device to accidentally go nuclear if detonated unintentionally. U.S. officials wanted the devices to be swift in case of the need for a retaliatory strike, so they pushed for having the devices 'live' at all times. Commander Peurifoy explained that this opened the door to short-circuits or small fires causing an accidental nuclear blast. In an interview with PBS, Peurifoy claimed that he lobbied the U.S. Air Force to implement new features that would ensure no accidental detonation could occur.[112] Officials rejected this because they were happier with a device being more likely to go off than chancing a 'dud' when actually needed.[113] When this idea was rejected, Peurifoy publicly maintained that silos were a "clear public safety hazard."[114] For the next twenty years, Peurifoy worked to install safety devices so that weapons housed in the U.S. would not accidentally detonate.

For the first few years of the Titan II program, the warhead sitting atop the missiles was 'live.' This was the major threat for civilians living around the device for the first decade of the program. While poor ventilation was plaguing workers' safety inside the silo, outside the complex, civilians were generally pretty safe. As explained earlier, the program was very well-

[112] Interview by Commander Robert Peurifoy to PBS for their documentary *Command and Control,* 2014.
[113] Ibid.
[114] Ibid.

funded and only the risk of accidental nuclear explosion was really going to impact citizens living in the area. This risk was relatively low, but as seen, accidents could happen. Fortunately, from 1962 to 1965, no such accidental detonation occurred. Finally, in 1965, Titan II facilities began to heed Commander Peurifoy's warning and began placing the nuclear core away from the bomb (although they did not install any new safety features to the warhead). This move added several minutes onto launch times for the missiles but made them impossible to detonate accidentally. Separating the nuclear core from the bomb made civilians even safer around launch complexes in the middle years of the Titan II program.

Much like that of workers, public safety reached a stable period for nearly ten years from around 1966 to 1975. That is, until the missiles began to age, and the program became poorly-funded. Following the same curve as worker safety, public safety reached its most dangerous period in the late-1970s. Although it was not as well-examined then, oxidizer leaks were understood to be dangerous by the NIOSH (National Institute for Occupational Safety and Health). Now, it is understood that Nitrogen Tetroxide is extremely dangerous for humans if exposure occurs for either long periods of time or intense short periods. While research is not conclusive on the long-term effects of oxidizers, there is strong evidence that repeated exposure can cause varying types of cancer. The question then is: how frequently was the public exposed to these leaks, and were the exposures enough to impact citizens' health?

Precise statistics on oxidizer leaks are impossible to acquire, having not been publicly released. Nevertheless, it is possible to get an estimation of how many leaks were occurring by looking at all available data. By 1976, silo leaks were clearly becoming commonplace across the country. A report from Washington found that seven of the eighteen missiles in Arkansas required tank patches to stave off corrosive leaks. The same report found that nineteen Titan II missiles across the fifty-four in the U.S. in 1979 had needed one or more tank patches because of deterioration.[115] This meant that, at the very least, around forty percent of missiles across the U.S. had experienced some leakage due to age. After the massive 1978 leak in Rock, Kansas, Representative Dan Glickman asked for a comprehensive study into the history of the Titan II sites in his state. The study conducted by the U.S. Air Force was by no means specific but found that "hundreds of minor oxidizer leaks had occurred since 1975" in Kansas alone.[116] A similar study prepared for Senator David Pryor in Arkansas found that a comparable number of minor leaks had occurred in his state.[117] When conducting these studies into oxidizer leaks, the Air Force appears to be purposefully ambiguous. They always classify the leaks as minor (with the exception of the Rock, Kansas leak) and only give the number of leaks as rounded numbers. Still, it is clear that hundreds of leaks were occurring after 1975.

Ralph Parish, who is currently a tour guide for the 'Walk through History' exhibit at ICBM launch complex 374-7 in Van Buren Country, has provided evidence for leaks occurring quite regularly at the complex near his house. Parish sold his land to the government in January 1961 for a launch complex to soon be constructed. He recalled not having any idea what the complex would be used for. Having never heard of ICBM technology, he thought it sounded like something out of a movie instead of real life.[118] He assumed the facilities would be safe, and he never had any plans to use the land for anything else, so he agreed to sell the area. From 1974-1977 (before any major leaks happened) Parish recalled he and his family being evacuated from

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[115] David Hampton Pryor Papers, MC 336, Group II, Series 5, subseries 10, Box 267, Folder 11 and 12 (Titan II–Safety and Effectiveness). Special Collections, University of Arkansas Libraries, Fayetteville.
[116] Congressional Papers of Dan Glickman, MS 97-05, Series 4, Box 159, Folder 22 (Titan II Report). Special Collections, Wichita State University, Wichita.
[117] "Assessment Report: Titan II LGM-25C, Weapon Condition and Safety," Senate Armed Services Committee, May 1980.
[118] Personal Interview with Ralph Parish, Tour Guide of the, 'Walks through History' exhibit. Titan II ICBM Launch Complex 374-7 Site Southside (Van Buren County).

their house on four different occasions. Finally, with the 1978 evacuation, they were told that the reason for their evacuation was an oxidizer leak at the complex. The evacuation in 1978 was no different from the four previous evacuations, which has lead Parish to assume that the previous evacuations were likely also from leaks in the silo. Because the four previous leaks were probably minor, Parish was evacuated but not informed. Either way, Parish's testimony helps to demonstrate how even these 'minor' leaks were still likely affecting local citizens.

The vague research complied by the Air Force makes it difficult to accurately quantify the health risk to the public from all these minor leaks. It is far easier to study the major leaks and calculate the health effects from these. The first major oxidizer leak was the 1978 leak in Rock, Kansas. Nearly 14,000 gallons of Nitrogen Tetroxide spilled out of the missile killing two workers and severely injuring twenty-five others. The crew tasked with cleaning up the accident found that the gas was not escaping the silo naturally, and that opening the silo roof was the best way to allow the gas to escape.[119] Experts realized that this posed a risk to civilians so they waited until a time the wind was blowing East so as to avoid as many citizens as possible.[120] When the silo door was retracted, toxic brownish-red vapor went 3,000 feet high and traveled East nearly four miles. Over "200 people were forced to leave their homes for several days because of the toxic cloud."[121] Jim Hodgson, a farmer who lived closest to the complex, recalled that silo personnel came running to his house screaming and pointing to the sky: "we didn't smell anything…but we saw past some trees a dark cloud coming…it was moving a little east of

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[119] Congressional Papers of Dan Glickman, MS 97-05, Series 4, Box 159, Folder 18 (Titan II Class A Mishap Report). Special Collections, Wichita State University, Wichita.
[120] Figure 8 in the Appendix provides a map of the locations of the 18 Titan II silos in Kansas. The Rock, Kansas complex is listed as 533-7. Notice why they would have wanted the oxidizer vapors to move East.
[121] Antone Gonsalves, "Aging Missiles Pulled out of Kansas," *The Wichita Eagle,* June 24, 1984.

our house, blowing just to the right of us."[122] Silo workers made the families quickly leave before suggesting they tear off their clothes and wash down with water a safe distance away.

For twelve hours after the accident, the N_2O_4 lingered slowly around 200-feet off the ground. Hundreds of residents began leaving their homes at the site of the cloud. Mabel Hodgson, age fifty-eight, asserted "all that vapor coming out, we didn't know what it was going to do to us."[123] After a few days, most residents were allowed back into their homes, but officials were unsure whether those living close to the silo could return anytime soon. U.S. officials hired several workers tasked with finding housing for those who lived nearby the silo. Civil Defense officials were already preparing for claims from these individuals. Captain Ken Schwetie, released a public statement asserting "if anybody has damages resulting from the accident, they can file claims at McConnell…if the damage is a result of this accident."[124] Unfortunately, many of these cases have not been released to the public. Several settlements were reached for these families forced to evacuate, but it is difficult to find evidence used in the cases or concessions given by the government.

The 1978 Rock, Kansas leak is the most well-known oxidizer leak because of the huge amount of vapor leaked. Still, the oxidizer leak that was actually the biggest health risk to the public occurred at complex 374-7 in Damascus, Arkansas (the site of the later 1980 accident). On January 27, 1978 an oxidizer leak inside the facility occurred while the silo door was retracted. The leak sent a cloud of vapor 2,500 feet high and 300 feet wide nearly two miles.[125] The reason this smaller leak was so potentially lethal was that the wind happened to carry the

[122] Stu Beitler, "Giant Missile Leaks Deadly Gas, Fumes Kill Man, Force Evacuation of Town," *United Press International*, August 1978.
[123] Ibid.
[124] Ibid.
[125] Figure 9 in the Appendix provides a picture of the toxic vapor hovering above the facility.

vapor across U.S. Highway-65.[126] An unnamed driver on the highway was quoted as saying people he knew “were heading to Branson and Harrison to get away from this…it’s such a nightmare and a blur…no one knows what is happening.”[127] The leak forced the evacuation of 1,400 citizens including 500 school children from two school districts. Most of the citizens in Van Buren County were understandably confused and upset.

John Stacks, who was twenty-five at the time, was up at 4:30 a.m. that morning milking his 200 Holstein cows. At around 7:00 a.m., the time of the leak, he smelled something similar to rotting eggs, but rationalized that it was probably just a neighbor’s brush fire. He continued working with the brown fumes hovering just above him for nearly four hours until a neighbor called to warn him that the area was being fully evacuated.[128] The Stacks, along with seven other families who lived within walking distance of the Damascus complex leisurely packed their things and left the area. Air Force officials landed in helicopters to assure residents no danger from radioactivity had occurred. This was clearly deceiving, as two local farmers were still being examined at a local hospital, their health effects unknown at that point.

Later that week, upon returning to his farm, John Stacks had sixteen cows die and forty-two more that needed to be put down (of his 200 total). While this was bad enough, customers hearing of this began to stop buying products from him. None of his local customers wanted anything to do with his farm, almost like it was cursed. Even when customers did want to buy a cow, “the bank in Weslie wouldn’t loan money to buy one.”[129] To gain trust back from his customers, Stacks had to start personally giving insurance on his cows, leading to him having “to

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[126] Figure 10 in the Appendix shows Highway 65 being shut down the entire day.
[127] David Hampton Pryor Papers, MC 336, Group II, Series 5, subseries 10, Box 267, Folder 11 and 12 (Titan II–Safety and Effectiveness). Special Collections, University of Arkansas Libraries, Fayetteville.
[128] Art Harris, “Titan II: A Plague on This Man’s House,” *The Washington Post*, September 22, 1980.
[129] Ibid.

give one man his $700 back when the cow [he] sold him soon died."[130] Stacks eventually had to sell off his small general store to pay off these debts.

The financial losses from the 1978 leak were devastating to Stacks, but he was more worried about his families' health. Stacks claims to have experienced routine migraines ever since the leaks, driving to the hospital many times for pain shots into his spine. The pain got so bad that he even went to Washington D.C. to have neurological tests done. His wife has testified that his personality severely altered after the leaks over their home (her quote about this opens the chapter). In 1979, Stacks filed a $2.6 million lawsuit in federal court claiming that the government's faulty equipment had caused him financial as well as health complications. A neighbor of Stacks, Barton Williams (age forty-nine) filed a similar suit for $800,000.

During Stacks case, it was found during autopsies of the dead cattle that they had died from collapsed lungs. These autopsies essentially proved that the N_2O_4 vapor had clear health effects on Stacks, his cattle, and his family. Stacks won the case, but the specific details of the case are not publicly available. Winning the case provided little joy to Stacks or his family. He wanted to move directly after the case (before the 1980 accident), but said it was impossible to find a buyer for his 'cursed' farm. The family eventually moved after the 1980 accident but were unable to sell the farm until many years later.

The 1978 oxidizer leaks and the 1979 Heber Springs incident led Senator Pryor and his advisor, Skip Rutherford, to reevaluate public safety in their state. Arkansas officials had long believed that the silos were largely harmless and provided no ill-effects to local citizens. These events changed their mind. Rutherford began to privately assert after Heber Springs that if

[130] Ibid.

something was not soon changed "there is going to be a major disaster one day and innocent people are going to be hurt."[131] Pryor, clearly shaken by these sentiments, began working tirelessly on his new alarm system to better alert civilians of an incident inside a silo. He wanted to have a system in place that would call every house in the area, and blare public sirens, alerting citizens of a potential hazard. The SAC rejected this alarm system saying it would be expensive an unnecessary. In actuality, they probably opposed it because installing such a system would be conceding the missiles were dangerous to the public.

The alarm system might have been helpful in 1980 when the Damascus accident occurred. Pryor, the day after the accident, publicly stated it was “unbelievable that the Air Force has not installed an early warning system.”[132] Without the system, evacuation of the city took hours to complete. At the time of the incident most civilians had no clue what was happening. Herman Swafford stated, “the explosion shook our house like an earthquake even though we were seven miles from the silo...we grabbed a few blankets and some diapers for the baby… [the deputy] told us to get out as fast as we could, that there were toxic fumes in the air.”[133] Some citizens, like Grace McMackin, understood the situation, “we all figured that when we heard the explosion we knew exactly what had happened…our neighbors in the road practically ran over us trying to get out” they did not need to be told to evacuate.[134] Eventually, authorities were able to vacate an area of forty square miles just North of the silo. Nearly 5,000 citizens were evacuated by the 1980 disaster.

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[131] Letter from Rutherford to Pryor in May 1980 (months before Damascus). David Hampton Pryor Papers, MC 336, Group II, Series 5, subseries 10, Box 267, Folder 11 and 12 (Titan II–Safety and Effectiveness). Special Collections, University of Arkansas Libraries, Fayetteville.
[132] David Hampton Pryor Papers, MC 336, Group II, Series 5, subseries 10, Box 267, Folder 11 and 12 (Titan II–Safety and Effectiveness). Special Collections, University of Arkansas Libraries, Fayetteville.
[133] George C. Wilson, “Blast Kills 1, Injures 21 at Missile Silo,” *The Washington Post,* September 20th, 1980.
[134] Ibid.

The cleanup of the accident began in early-October 1980. Debris was gathered across 500 acres around the launch complex. The estimated cost for cleanup was $225,300,000. After things finally calmed down, citizens began to observe health problems. Twelve citizens within two weeks of the accident were hospitalized for "symptoms ranging from nausea and vomiting to stomach pains, fever, headaches, and shortness of breath."[135] All of these are typical signs of exposure to N_2O_4 vapor. Benny Mercer, the mayor of Guy, Arkansas recalls not being able to catch his breath for nearly a week after the accident. Dwayne, his ten-year old son, had to miss multiple days of school because he kept vomiting. Mercer recalls "when you took a whiff of air, it burned your nose down to your lungs...it spelled like ammonia."[136] Richard Kincaid, the fire chief in Guy, complained of similar problems (his quote starts this chapter). The base doctor who treated these individuals found that they all "showed symptoms of having been exposed to combustible material" attributing their symptoms likely to exposure of toxic fumes.[137]

Gerald Southall, director of the state's Office of Pollution Control, interviewed several other citizens after the 1980 accident. The department found that several citizens were experiencing similar symptoms after the blast. Initially, the department attributed these symptoms to mass hypochondria across the community, but several citizens treated had been isolated from other members of the community. The Sheriff of Van Buren county, Gus Anglin, was irritated by this lack of admission of responsibility by the U.S. government. Anglin had met directly with Sam Tatom, director of the state Department of Public Safety, after the 1980 incident. Tatom briefed the sheriff on the situation and assured him it was a freak accident that would not happen again. Anglin recalls not wanting to be 'suckered again' after experiencing

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[135] Art Harris, "Illness Strikes Five Miles from Titan II Explosion," *The Washington Post,* September 26, 1980.
[136] Ibid.
[137] Ibid.

similar events in 1978 and 1979. Anglin argued that the Air Force was, yet again, trying to limit their accountability in the 1980 disaster stating, "they acted as if they wanted to cover up the leak and were reluctant to let us order any type of evacuation."[138] Senator Bob Dole of Kansas asked for a federal investigation into public safety around Titan II facilities. Dole, having experienced similar incidents in his state, asserted "if it's not safe and effective, I don't know why you need it."[139]

Federal safety changes at the silos did not occur after the 1980 incident. Air Force official, Lew Allen Jr., downplayed the accident at Damascus saying, even "a safe system can have an accident."[140] The Air Force continued to maintain this line of reasoning for the lifespan of the Titan II. Declaring that the Titan II program was safe for the public, they refused to allow major safety changes to the device even as it aged, corroded, and became leaky. As discussed earlier, the program began to fade by the mid-1970s. The oxidizer leaks, particularly from 1977-1980, demonstrated to the government that there was an increased risk to the civilians living around the silos. This is evidenced by: the amount of settlements they have conceded, personal testimonies by those living around the silos, and from workers inside the silo recalling numerous leaks. The U.S. government would not openly admit to these public health problems but began swiftly retiring Titan IIs after the 1980 incident. By 1985, most of the missiles in Arkansas had been retired. Minor oxidizer leaks from 1980-1987 undoubtedly occurred (most notably at complex 374-3 in Conway County in 1983) but were never as severe as the leaks from 1977-1980. For those five years, a public safety crisis was occurring with most citizens unaware of how much danger they were actually in. The Air Force deliberately kept these citizens unaware

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[138] George C. Wilson, "Blast Kills 1, Injures 21 at Missile Silo," *The Washington Post,* September 20th, 1980.
[139] Congressional Papers of Dan Glickman, MS 97-05, Series 4, Box 159, Folder 18 (Titan II Class A Mishap Report). Special Collections, Wichita State University, Wichita.
[140] Ibid.

of the risks and have provided only vague statistics for researchers hoping to investigate the claims further.

CHAPTER FIVE: THE ENVIRONMENTAL IMPACT OF THE TITAN II MISSILE

Researching worker protection and civilian safety during the twenty-five-year lifespan of the Titan II missile program is far easier than quantifying the environmental ramifications of the devices. Serious scholarship into nuclear environmental concerns is a fairly recent field of study. As a result, no major work has touched on the ecological repercussions of the program in Arkansas and Kansas. This is largely because of the lack of firm statistics associated with the program, but also because the effects are still being properly understood. Still, looking at major incidents where the data is substantiated by the U.S. government, it becomes possible to estimate how much ecological damage occurred. This chapter will attempt to appraise this destruction.

Following a similar curve as previous chapters, environmental destruction began and ended in its most dangerous phase. The initial construction of the silos naturally meant altering large swaths of land, and the locations picked for the bases were often poor choices from an ecological standpoint. This destruction stabilized in the middle of the lifespan of the Titan II. This uneventful period ended with the increase of oxidizer leaks in the 1970s. These leaks will be looked at to determine just how hazardous they were to the ozone and atmosphere. Lastly, the cleanup of accidents and the deactivation of devices across the U.S. will be assessed. Combining all this research gives the best assessment possible of the environmental damage caused by the Titan II Missile Program.

Not until 1985 did a scientific work look to question the environmental impact of nuclear weapons. *Environmental Consequences of Nuclear War, Physical and Atmospheric Effects,* written in 1985, identified these threats. Before 1985, U.S. officials were more concerned with defending against an imminent nuclear attack from the Soviets, meaning the necessity of the devices outweighed all other concerns. The 1985 work, however, looked at the physical and atmospheric effects caused by the devices, devoid of the question of their necessity. The work addresses, in-depth, every environmental issue conceivable and the subsequent short and long-term consequences of a nuclear war. The authors theorized that just one nuclear detonation over the United States would likely cause short-term changes in sunlight and precipitation and long-term effects of climate change and temperature.[141]

The work was followed up with a second volume in 1986 entitled *Environmental Consequences of Nuclear War Volume II- Ecological and Agricultural Effects* by Mark A. Harwell and Thomas C. Hutchinson. This work looked to find the impact on humans caused by a nuclear war, not just on the environment. The work found that the climate change and atmospheric effects of a nuclear war would likely impact the agriculture of the U.S. the most from an everyday human standpoint. The authors found that food availability would be extremely diminished as most crops would be destroyed. Additionally, U.S. citizens would likely all settle in highly-populated areas away from fallout radiation, thus leading to vast food shortages.[142] Overall, volumes one and two of the *Environmental Consequences of Nuclear War* showed that the US was on the edge of a huge ecological disaster if they sparked a nuclear war or had an accidental detonation domestically. Not only would there be huge losses of lives at the time of the explosion, there would be long-term consequences that stretched years into the future.

The past decade of research has seen many scientists echo similar sentiments to those proposed by Harwell and Hutchinson. James McDonald with his 2017 piece, "The Environmental Impact of Nuclear War," went a step further and found that a nuclear blast would

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[141] A. B. Pittock, T. P. Ackerman, P. J. Crutzen, Michael C. MacCracken, C. S. Shapiro and R. P. Turco, *Environmental Consequences of Nuclear War, Physical and Atmospheric Effects,* (SCOPE Series, Volume 1, 1985).
[142] Mark A. Harwell and Thomas C. Hutchinson, *Environmental Consequences of Nuclear War Volume II-Ecological and Agricultural Effects*, (Scientific Committee on Problems of the Environment, 1986).

trigger more long-term effects than previous works had assumed. McDonald asserted that "to make matters worse… radiation lingers in soil, plants, and in food chains. Children in the Marshall Islands experienced thyroid problems long after nuclear tests…[certain] food chains are particularly vulnerable both to radiation and the disruptive effects of atmospheric soot."[143] Essentially, radiation has been found to remain in some plant life. So, even if Americans were able to successfully grow plants after a blast (which would be difficult), there is a chance the plants would still contain traces of radiation.

All of these works help to demonstrate the possible ecological ramifications of nuclear explosions, but do not speak specifically on accidental explosions of Titan II missiles. Other works help to slightly fill this void. The *Final Environmental Impact Statement, Peacekeeper in Minuteman Silos, FE Warren AFB, WY* released in 1984 was the first major federal work to investigate the environmental effects of a silo on the atmosphere. The work found that silos were largely safe and had few negative environmental impacts.[144] While this helps research the environmental impact of a solid-propellant missile, it does not help with research into Titan II silos.

On the fiftieth anniversary of ICBM technology, *The Associated Press* ran several stories detailing the history of the Atlas program. One of these, by Mead Gruver, serves as perhaps the best work on the environmental impact of ballistic missiles. The piece entitled, "Pollution an Enduring Legacy at Old Missile Sites," looks at TCE traces at abandoned missiles sites. TCE, or trichloroethylene, was used to clean missiles (after the fatal Freon-113 accident). While TCE was initially thought to be safe, it has since been found to harm drinking water. The chemical was

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[143] James McDonald, "The Environmental Impact of Nuclear War," *JSTOR Daily,* August 26, 2017.
[144] Defense Technical Information Center*, Final Jurisdictional Environmental Planning Technical Report. Peacekeeper in Minuteman Silos, 90th Strategic Missile Wing, F.E. Warren Air Force Base. Volume 3*, 1984.

first found in California's drinking water in the 1990s, making certain water supplies undrinkable. A new filtration system remedied the problem quickly, but civilians had probably been consuming traces of TCE for thirty years. Lenny Siegla, directory of the Center for Public Environmental Oversight, asserted the government does not "look too hard for new contamination because if they do, they have to tell people they have to clean it up."[145]

Gruver's work is the best study of environmental concerns from abandoned silos, but again does not look at the biggest questions of ecological impacts. Most of the historiography on environmental consequences look at theoretical incidents. It is pretty well-established that there would be immense short and long-term effects if a nuclear device exploded domestically, but since this never happened (at a Titan II facility), it is only theoretical. Instead of looking at hypothetical scenarios of atomic blasts, it is more useful to look at the realistic effects of silos across the country.

The easiest of these effects to study is in the original construction of the silos. Across Kansas and Arkansas, thirty-six silos were built around the Air Force Bases at Wichita and Little Rock. When deciding on the locations for these silos, it has been established that defense strategy was the main criterion.[146] Written in 1993, *ICBM Basing Options: A Summary of Major Studies to Define A Survivable Basing Concept for ICBMs*, helps to demonstrate how little thought the government gave to ecological concerns in their selection criteria. They largely sought areas away from the public that were secluded, flat, and the easiest to build on.[147] Fortunately, this often meant few trees were unnecessarily cut down for the construction.

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[145] Mead Gruver, "Pollution an Enduring Legacy at Old Missile Sites," *The Associated Press*, October 10, 2009.
[146] Art Hobson, "The ICBM Basing Question," *Science & Global Security,* Volume 2, 1991, 1fifty-four-155.
[147] Office of the Deputy Under Secretary of Defense for Research and Engineering, *ICBM Basing Options: A Summary of Major Studies to Define A Survivable Basing Concept for ICBMs*, August 31, 1993.

Unfortunately, it usually meant that flat farmland was the best place for the silos. As seen with TCE, many toxic chemicals can find their way into the soil from these silos. Because farmland was often chosen for these bases, the soil quality was often higher meaning that it absorbed chemicals far better than non-farmland. This meant that the locations selected for the silos often meant environmental impacts were amplified because of the fertility of the land. As seen in California, chemicals like TCE were probably absorbed into the ground at sites in Arkansas and Kansas. No full-scale government study on the impact of Titan IIs has been conducted so it is difficult to know for sure.

After the original construction of the silo facilities, there was little impact to the environment during the stable years of operation. Only a theoretical nuclear device going live would have negatively impacted the environment. As previously seen with worker and civilian safety, however, the late-1970s changed all of this.[148] Routine oxidizer leaks were undoubtedly hazardous to the environment, atmosphere, and ecosystem. One of the major pushes in the last decade by the EPA (Environmental Protection Agency) has been to “reduce the emissions of Nitrogen Oxides into the atmosphere.”[149] Both state and local governments were given targets by the EPA known as the National Ambient Air Quality Standard (NAAQS).

Typically, Nitrogen Oxides (NO_x) are released by the burning of a fuel. This means that most local governments are tackling the NAAQS goals by regulating the emissions of cars, trucks, and public transport. The problem with NO_x is that it naturally reacts with air to form ‘bad’ ozone. NO_x has been found to be 300 times more potent than CO_2 to the environment. The EPA writes that "bad ozone is not emitted directly into the air but is created by chemical

[148] The Environmental Protection Agency was founded in 1970.
[149] National Ambient Air Quality Standard, “Basic Information about Nitrogen Oxides,” Environmental Protection Agency, August 29, 2013.

reactions between oxides of nitrogen (NOx) and volatile organic compounds (VOC) in the presence of sunlight. Emissions from industrial facilities and electric utilities, motor vehicle exhaust, gasoline vapors, and chemical solvents are some of the major sources of NOx and VOC… [bad] ozone can have harmful effects on sensitive vegetation and ecosystems."[150] On top of this, NO_x has been found to interact with water in the atmosphere to form acid rain. While traces large enough to cause this would not have been possible from silo leaks, it is still worth understanding how dangerous NO_x are to the ecosystem.

The push for federal regulation into NO_x has been a fairly recent occurrence. This does not mean, however, that information on oxides was not available much earlier. As early as 1971, *The Green Book* was released by the EPA speaking on the need for new standards in oxide emissions across the U.S (a year after the agency was created). While this research was well-established in the 1970s, it was not until 1998 that federal regulations on NO_x emissions were finally implemented. State Implementation Plans (SIPs) were not available until the early-2000s. These plans monitor air quality, document it publicly, and provide approaches to reducing emissions.

As stated earlier, N_2O_4 was the oxidizer of choice for Titan II missiles. N_2O_4 is one of the most toxic Nitrogen Oxides in existence. In the defense of the U.S. government, scientific awareness of the dangers of N_2O_4 was not prevalent until the early-1970s. Since Titan II facilities were built in the early-1960s, it would be unfair to criticize the government for using N_2O_4 as its major oxidizing source (as NO_x were not considered ecological dangerous). The U.S. government can be criticized, however, for not properly funding the missile program in the

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[150] Ibid.

1970s when oxidizer leaks were becoming routine. Scientists understood the potential damage to the ozone that could occur from these leaks, yet officials did nothing to fix the aging Titans.

By studying modern emission standards, it is possible to research major leaks and identify the damage they likely did to the environment. As always, specific information on oxidizer leaks is not publicly available. Because of this, it is difficult to truly quantify the amount of damage done by NO_x (SIPs were not in place until nearly fifteen years after the retirement of the Titan II). Unfortunately, this means attempting to calculate the environmental impact of minor oxidizer leaks is largely impossible. It is possible, though, to calculate the damage to the environment from major leaks where the amount of oxidizer leaked has been disclosed.

The EPA's recommended allowed concentration of NO_x is currently ".12 parts per million (ppm) for a 1-hour exposure period…[and] .03 ppm for an annual exposure period."[151] During the January 1978 oxidizer leak in Damascus, 2,000 gallons of oxidizer leaked from the missile. The best way to calculate the concentration of gases is to have it expressed in pounds/cubic feet. Since there are around 8.3 pounds of weight for each liquid gallon (at room temperature), we can calculate that 2,000 gallons of N_2O_4 produced around 16,600 pounds of vapor that escaped the missile. The density of air is around .075 pounds per foot, so we have to multiply the 16,600 pounds of vapor by .075 to properly compare the N_2O_4 with air (16,600 x .075), giving us 1,245 pounds of vapor interacting with its environment.

Next, we must calculate the area of air that was exposed to the vapor. In this case, the area was around five miles wide and five miles long (twenty-five square miles). Since, the atmosphere reaches 300 miles high, the volume of area (300x5x5) would be 7,500 cubic miles. It

[151] Ibid.

is common to calculate the ppm using pounds/cubic feet, so it is necessary to convert 7,500 cubic miles into cubic feet (7,500 x 5,280) to get a total of 39,600,000 cubic feet of air in the area the vapor was exposed. Now, all one has to do is divide the 1,245 pounds of vapor by the amount of air present, 39,600,000 cubic feet, to establish the concentration of the gas (.00003144). To put this into the standard parts per million, the number is multiplied by one million to find that there were 31.4 ppm of N_2O_4 vapor exposed to the atmosphere after the 1978 leak in Damascus. As established earlier, anything above .12 ppm in a one-hour timeframe is unacceptable. This means that after the 1978 leak, the atmosphere was exposed to N_2O_4 emissions that were around 262 times more than the permitted number.

The later 1978 Rock, Kansas leak was even worse for the ozone. While the earlier leak in Damascus only released 2,000 gallons of oxidizer, the Rock incident released nearly 14,000 gallons. Using the same math as before, 14,000 gallons leaked means 8,715 pounds of vapor interacted with the environment. The area of air exposed to the vapor was a little larger during the Rock disaster, closer to thirty-five square miles. This means that (35x300) the vapor was dispersed through 10,500 cubic miles of air or 55,440,000 cubic feet of air. With 8,715 pounds of vapor dispersed into 55,440,000 cubic feet, there was .0001572 of vapor present. In standard terms this would be expressed as 157.2 ppm of gas prevalent in the air. This means that after the 1978 Rock incident, the atmosphere was subjected to 1,310 times the permitted vapor.

These numbers, while estimations, demonstrate the immense damage done to the ozone and environment by just two of the known oxidizer leaks in the late-1970s. As established earlier, The U.S. Air Force found that between 1975 and 1979, 126 leaking incidents had been reported in Arkansas and Kansas alone.[152] Most of these leaks were probably minor, but they still released amounts of N_2O_4 vapor into the atmosphere that were above now-permitted levels. These leaks were by far the greatest risk to the environment not just of Arkansas and Kansas, but of the country and world.

The Damascus accident is the only other major accident (besides the two-1978 leaks) which has been properly documented so that its environmental ramifications can be understood. Most of the oxidizer in the missile tank spontaneously ignited with the aerozine-50 which is why the explosion occurred. This meant that most of the oxidizer was burned up and did not impact the environment. Still, traces of the vapor were still present when cleanup crews came in for inspection the next day.

The 1980 cleanup of Damascus helps demonstrate how poorly understood or appreciated the study of ecological ramifications were. During the cleanup, "100,000 gallons of contaminated water from the silo" were pumped out of the silo and released into the nearby soil.[153] This water likely contained radiation, so pumping it into the soil did nothing to stop the radiation from impacting the environment. In fact, releasing the contaminated water into the soil was one of the worst things cleanup crews could do as the soil would just absorb the radiation and keep it for long periods of time. Also, when the Air Force decided to ultimately close the complex, as it was deemed too costly to reopen, they just filled the silo with "soil, gravel, and

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[152] Department of Defense, U.S. Air Force. *On Alert: An Operational History of the United States Air Force Intercontinental Ballistic Missile (ICBM) Program, 1945-2011 - Atlas, Titan, Minuteman, Peacekeeper MX, Minuteman III, Nuclear Warhead*, 2017, 27.
[153] David Hampton Pryor Papers, MC 336, Group II, Series 5, subseries 10, Box 267, Folder 11 and 12 (Titan II–Safety and Effectiveness). Special Collections, University of Arkansas Libraries, Fayetteville.

small concrete debris."[154] While this was the cheapest option available, it was one of the worst for the environment.

By the mid-1980s, the U.S. government finally seemed to grasp the importance of the environment in making decisions about the silos. In 1987, as they were deactivating the last of the Titan IIs in the country, they finally commissioned federal research to find out the proper way to retire these silos. Unlike Damascus, where they just filled in the silo with whatever was lying around, they properly transported and disposed of all known contaminants. This federal study, *The Environmental Assessment for the Proposed Deactivation of Titan II Missiles*, found that the best way to dispose of these missiles was through a three-step process. The three steps: safe deactivation, identification and transportation of known contaminants, and proper destruction of these contaminants signaled the U.S. Air Force was finally beginning to understand the repercussions to the environment of their program.[155]

Properly quantifying the environmental ramifications of the Titan II missile program in Arkansas and Kansas is difficult because of the lack of firm statistics. By looking at established data from major accidents in 1978 and 1979, it becomes possible to estimate how much damage was occurring. This is not possible for the minor leaks. While many undoubtedly occurred, it is impossible to estimate the damage without some baseline of established data. Studying the two disasters in 1978 establish that damage did occur, but much more will probably be proven in the coming years of research. To its credit, the U.S. government did eventually learn from these mistakes. They began to turn away from all liquid-propelled missiles after the 1978 and 1980

[154] Ibid.
[155] Defense Technical Information Center, *The Environmental Assessment for the Proposed Deactivation of Titan II Missiles,* Department of Defense, 1986.

accidents. While this was probably down more to the risk to citizens and workers, it still helped prevent the environment from experiencing further destruction.

CONCLUSION:

Intercontinental Ballistic Missiles played a fundamental role in defending the United States during the Cold War. Seismology reports by 1953 confirmed the Soviets had narrowed the gap on nuclear technology. Creating a device that could strike accurately over continents was therefore essential to the U.S. keeping its lead in the global conflict. Titan I missiles demonstrated such a device was feasible but were too slow and unreliable to be trusted with national security. Titan II missiles improved on this by being able to launch with a bigger nuclear warhead, strike over greater nautical distances, and hit targets with more accuracy all in far less time than its predecessor. More specifically, these technological wonders could strike targets 8,500 nautical miles away while carrying an eight megaton W-53 warhead, eventually hitting a target area of one-square mile within minutes.

The missiles themselves were spectacles to behold. The Titan II was by far the largest ballistic missile ever commissioned by the U.S. government. Each missile reached nearly nine-stories high and transported the world's most powerful nuclear warhead. By 1961, Fifty-four of these missiles were produced by the U.S Air Force. Housing these giant missiles covertly was difficult. In 1962, California, Arizona, Arkansas, and Kansas were eventually chosen for distinct strategical reasons. eighteen silos were constructed in the western states to provide an offensive base if the U.S. decided upon a preemptive strike against the Soviets. Arkansas and Kansas were chosen due to their flatness, centrality in the country, and potential for retaliatory strikes. While only eighteen silos were built out West, thirty-six silos were split between the two central states, demonstrating that defense bases were more significant to U.S. strategy.

The underground arsenals housed in each of these states were indispensable to Kennedy and McNamara's overall defense strategies of 'flexible response' and 'mutually-assured destruction.’ ICBMs, SLBMs, and strategic bombers formed the backbone of their ‘nuclear triad,’ and made it theoretically impossible for the Soviets to stop a retaliatory strike. In this way, the nuclear triad claimed to keep Americans safe by always being able to impose damage back on the Soviets. ICBMs were particularly important to this. Housed in silos that were purportedly impenetrable by nuclear weapons, the devices were the ultimate retaliatory weapon of the era. Arkansas and Kansas, if called upon, were likely the silos that would have been asked to deliver a retaliatory strike if deemed necessary and were therefore critical to the nation’s defense strategy throughout the 1960s.

Investigations into the Cold War by historians such as John Lewis Gaddis, George Kennan, and Melvyn Leffler have all suggested that ICBM technology was critical to national security during the conflict. Both sides comprehended that an attack on the other would be fully reciprocated, so were unwilling to increase tensions through the use of nuclear weapons. While the devices were indisputably critical to the overall security of the country, they were not always safe for the public living around the facilities. Worker security, civilian safety, and environmental protection were all abridged in some way by the silos housed in their region.

The Titan II had the longest lifespan of any similar military device at around twenty-five years. From 1962 to 1987, the Titan II was a major domestic threat for the public living around it. The level of threat from these missiles and their silos fluctuated over time but largely followed a parabolic curve. Put another way, the level of threat was highest at the beginning and end of the lifespan of the Titan II.

Initially, this increased threat was due to the rushed construction at silos as officials wanted the facilities operational as soon as possible. Worker safety was abridged by this rushed construction because of a faulty ventilation system prevalent in all the silos. Silos were found to not filter or circulate air nearly well enough. When a fire broke out, as did in Chico 1962 and Searcy 1965, the air system was unable to filter smoke and workers died from preventable asphyxiation. Civilians were at increased danger early in the program because of the permanent storage of nuclear cores with the bombs themselves. U.S. officials wanted missiles to be as quick as possible, so they kept warheads 'live' at all times. This opened the door to potential domestic nuclear explosions and was criticized by several silo commanders at the time, calling it a public-safety crisis. Environmentally, the locations picked for silos destroyed good land. This land was often fertile and had nice soil. This meant chemicals that found their way out of the facility, such as TCE, had fertile soil which would absorb and house it for long periods of time.

The Titan II Missile program, from a public safety standpoint, rounded out during the middle years of the program. From 1966 to 1975, the program produced no fatalities and no major incidents occurred. At this time, the Titan II was still the major defense technology of the U.S. and was funded accordingly. U.S. officials realized the Titans were necessary to national security and the best system engineers and technicians worked inside the silos during this time. In the mid-1970s, however, solid-based propellant missiles like the Minuteman began to surpass the Titan II. The Minuteman was far smaller but could strike with similar precision and damage as the Titan II. On top of this, the Minuteman was propelled by solid fuels and oxidizers, which were far safer than its predecessor's liquid propellants.

The Titan II should have been quickly phased out in the mid-1970s with the creation of the Minuteman. The missiles had only been commissioned to serve until 1972, so it made sense to retire them in 1975. The metals used in the siding of the missiles were not designed to house corrosive compounds like aerozine-50 or Nitrogen Tetroxide for as long as it was being asked.

Inexplicably, though, the Titan II endured as a defense weapon of the U.S. for nearly fifteen more years after its original retirement date. Understanding why the Titan II was not retired requires a close look at foreign policy of the time. Boiled down, President Nixon had initiated détente talks as early as 1972, so many U.S. officials believed tensions with the Soviets were easing with the passage of SALT I. This meant they were less willing to provide federal funding to programs serving national security concerns. Since Minuteman missiles were promised as the future of ballistic technology, there was even less reason to give funding to the Titan Program. This does not explain properly, however, why the missiles were not just phased out altogether. Since they were still being somewhat federally funded, it seems as if it would have just been easier to close the program entirely. The reason this did not occur was actually because of SALT 1 talks in May 1972. Henry Kissinger, the National Security Advisor, had attempted during these discussions to concede Titan II missiles for similar concessions from the Soviets. When this did not occur, Kissinger was reluctant to just retire the missiles anyway as he probably hoped to use the missiles in foreign diplomacy before retiring them.

Whatever the reason, the Titan II continued serving the U.S. military throughout the late-1970s and early 1980s. During this time, the Titan II reached the end of its parabolic curve and was at its most dangerous point. The major reason for this increased risk was the sheer amount of oxidizer leaks occurring from the missiles. Missile leaks became frighteningly common after 1975. The Air Force found that between 1975 and 1979, 126 leaking incidents had been reported in Arkansas and Kansas alone. Before 1975, less than ten such leaking accidents had occurred. A later report found that nineteen Titan II missiles across the fifty-four in the U.S. in 1979 had needed one or more tank patches because of corrosion (nearly forty percent). These oxidizer leaks were extremely dangerous to workers, civilians, and the environment because of the compound used, Nitrogen Tetroxide. N_2O_4 is classified as a three-out-of-four health risk on the NIOSH meaning it is extremely dangerous for humans over short and long periods of exposure.

Oxidizer leaks were most dangerous to workers during the time. Propellant Transfer System teams asked to fill and drain the missiles of oxidizer were even given hazard pay by the U.S. Air Force (a bonus even firefighters employed by the USAF did not enjoy). From 1977 to 1980 incidents involving these leaks become frighteningly common. The 1978 Rock, Kansas fatalities helped demonstrate how dangerous these leaks were for workers, and how little protection there was against the compound. These short-term effects were bad enough, but recently it has been found that long-term diseases were likely caused by this exposure as well.

Civilians were also directly impacted by these oxidizer leaks. Major leaks at Rock and Damascus spewed thousands of gallons of N_2O_4 vapor into the air and undoubtedly impacted citizens living around the silos. Numerous farmers were hospitalized, and several had their livestock perish from symptoms attributed to exposure to the toxic vapor. While several settlements were reached for those most impacted by the leaks, innumerable amounts of citizens were probably affected without being aware. The U.S. Air Force was careful to not properly inform citizens of these threats. Until more publicized events like Damascus occurred, many civilians just inherently believed missile silos were safe.

The environmental ramifications of the oxidizer leaks of the 1970s are the hardest to quantify but were still clearly negative as a whole. Nitrogen Oxides (such as N_2O_4) are a major contributor to the deteriorating ozone. While vehicles are commonly blamed for these emissions, ICBMs leaking oxidizer also played a part. The 2,000 gallons leaked at Damascus and 14,000 gallons leaked at Rock went far beyond the allowed concentrations into the air. These major leaks (not including countless minor leaks) undoubtedly destroyed ozone in the atmosphere and likely had negative effects on weather and agriculture in both the short and long-term.

By the 1980s, the Titan II was finally deemed too dangerous to maintain. Massive phase outs of the twenty-year old missiles began in the early-1980s after the Damascus accident. The cost of upkeep, the obsoleteness of the devices, and the recurring accidents likely all played a role in this retirement for the Titan II. For those living around the silos, the retirement could not come soon enough. The effects of the Titan II program on workers, civilians, and the environment are still being properly quantified today. While the missiles were undoubtedly necessary for the defense of the U.S. during the Cold War, the effects experienced by those living closest to the devices were severely negative. Civilians, and to a less extent workers, were unaware of these dangers to their safety, implicitly trusting their government to protect them. The U.S. government failed the public by keeping the effects of Titan II silos secret. Only when all statistics on Titan II operations are publicly released can the overall effects of the devices on public safety be accurately calculated.

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APPENDIX

Figure 1:

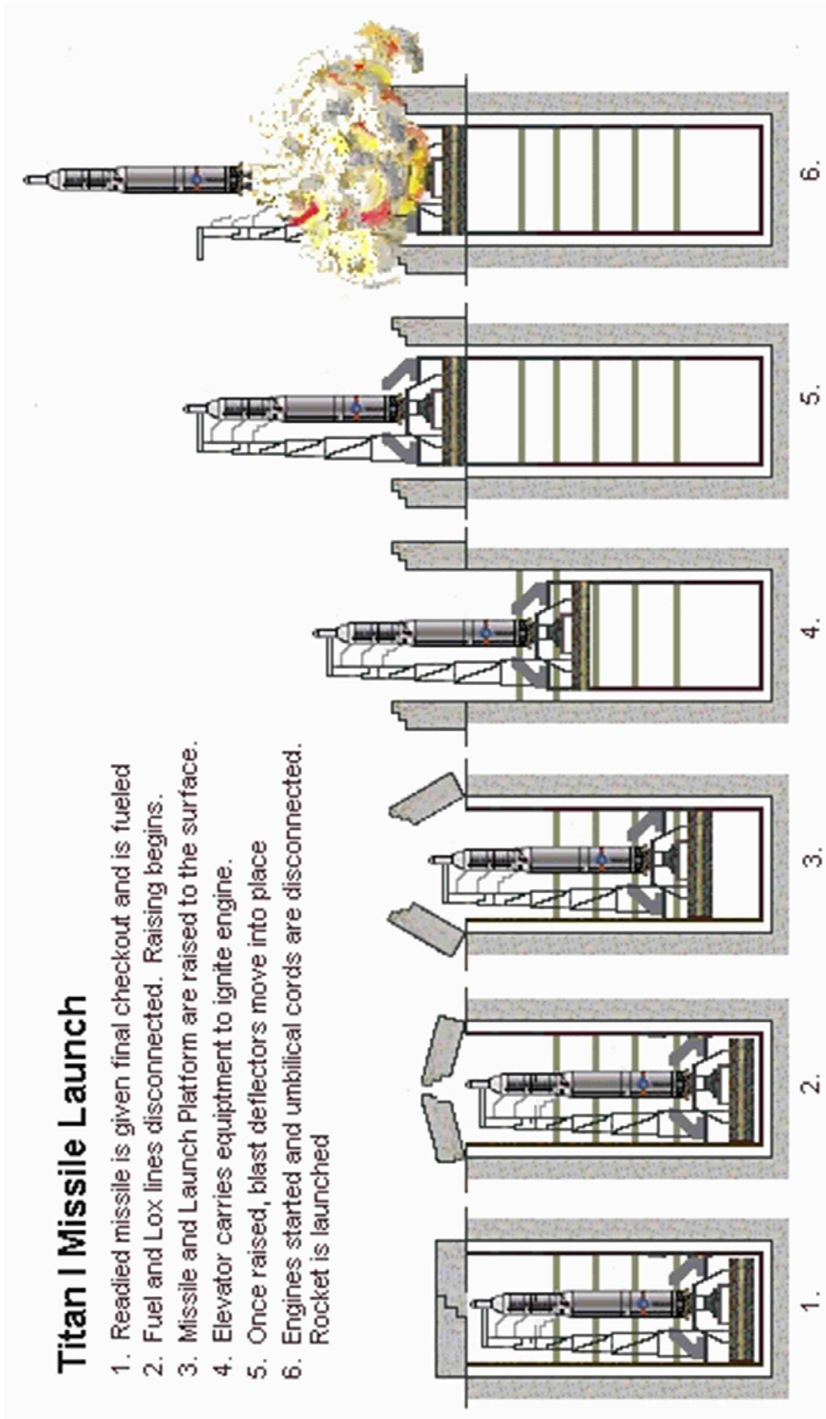

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Figure 2:

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Figure 3:

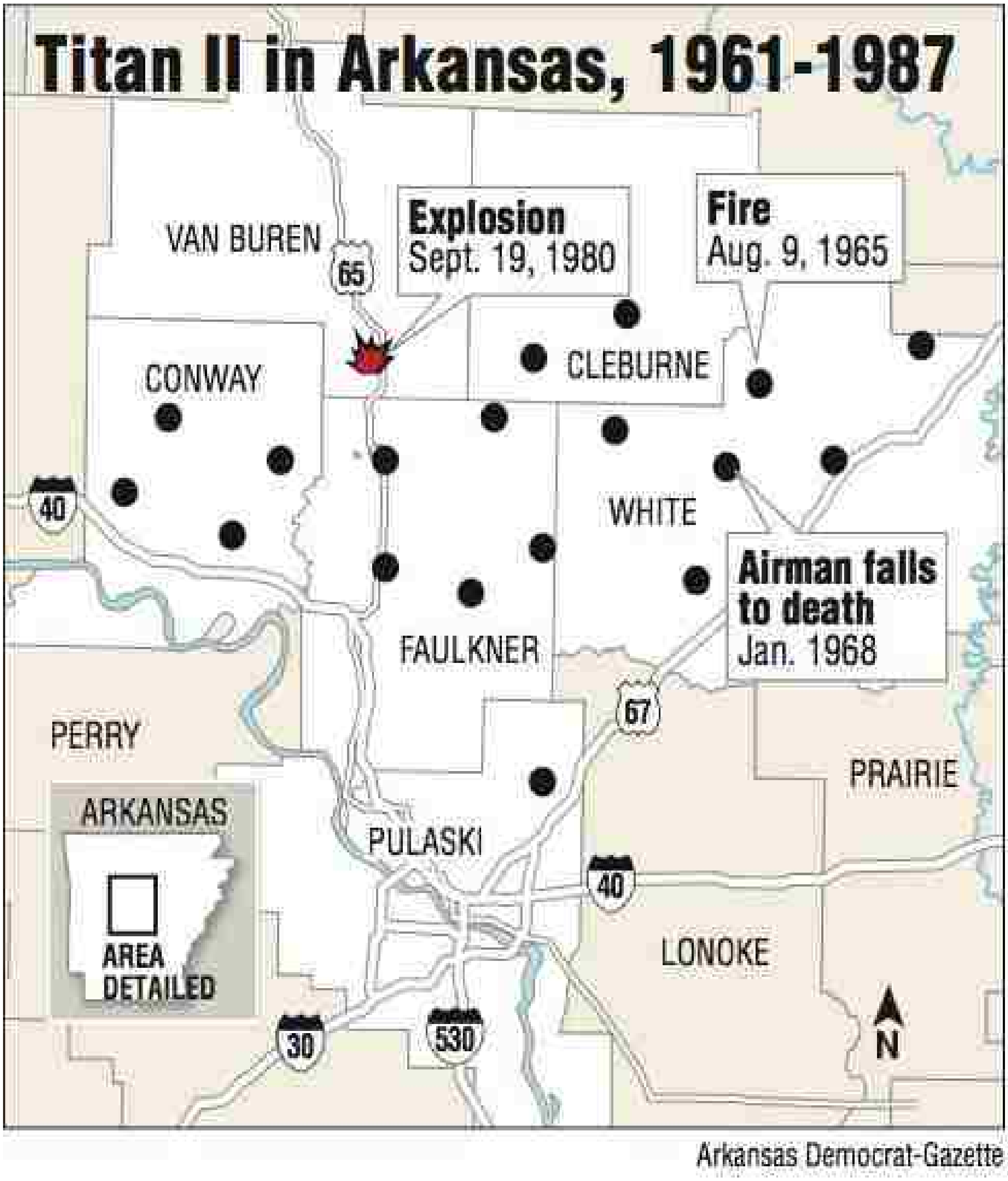

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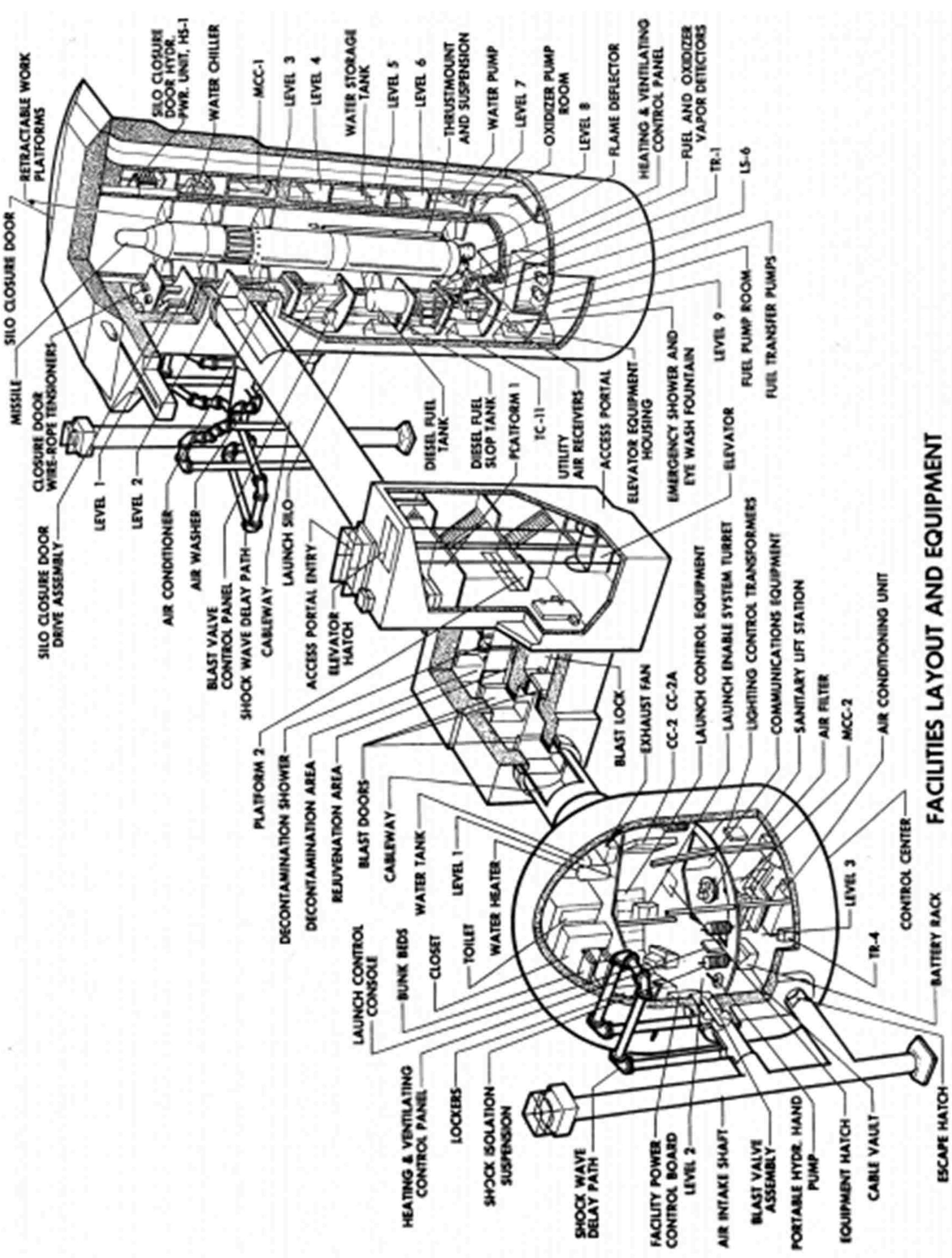
Figure 4:



Ibid.

Figure 5:

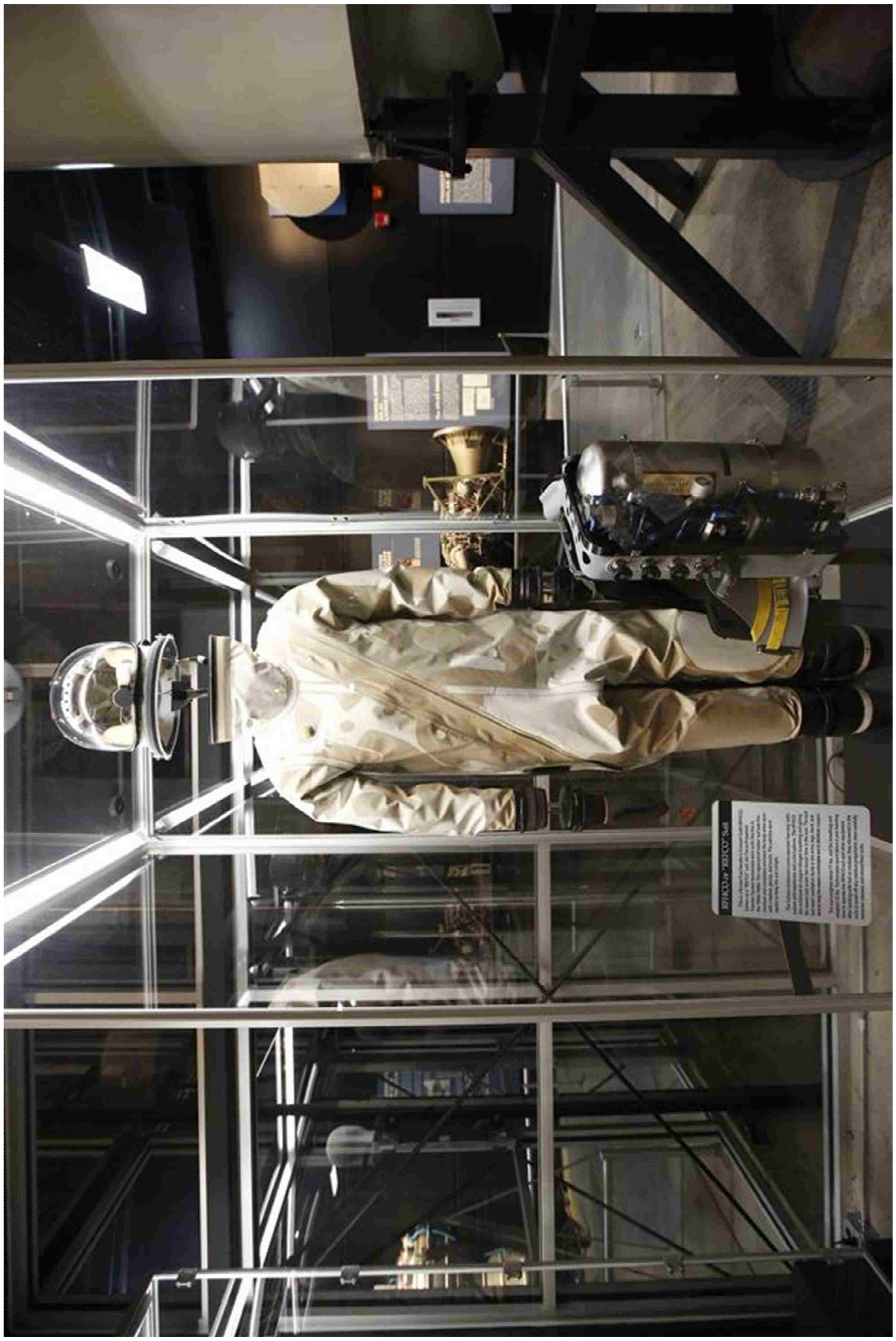


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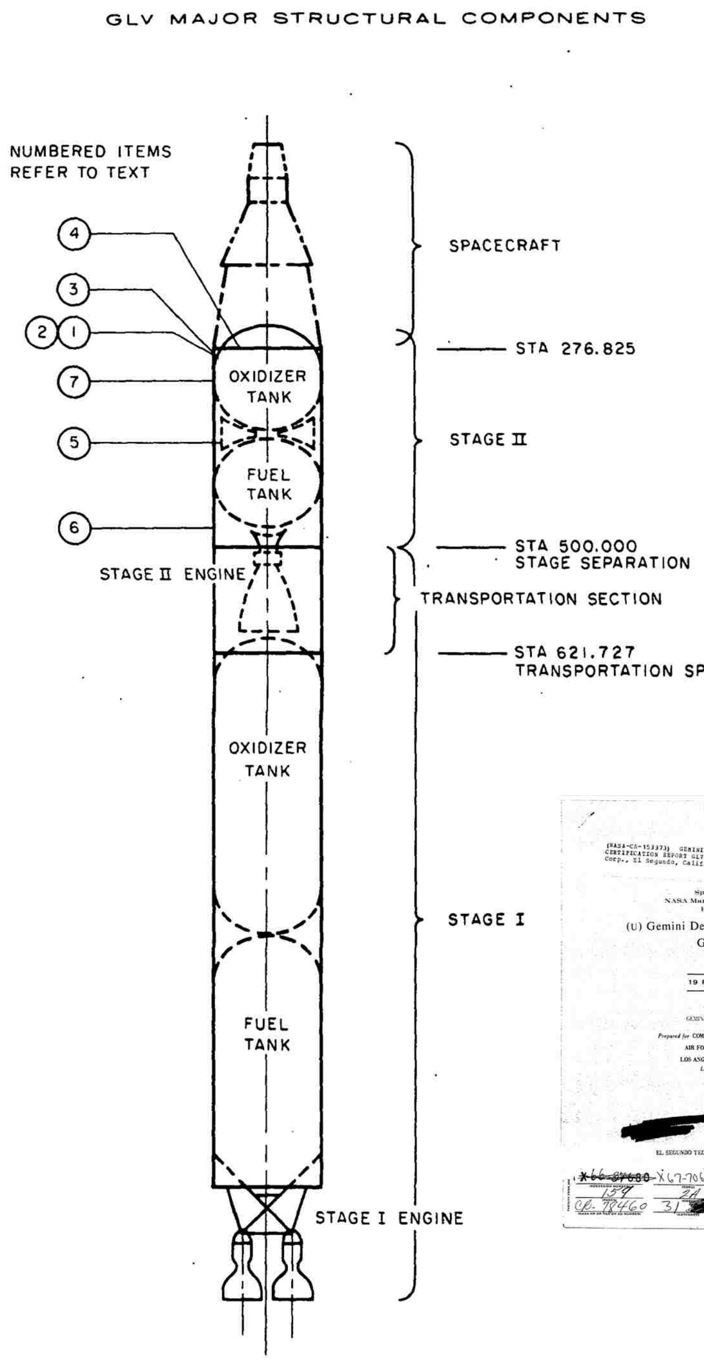
Figure 6:



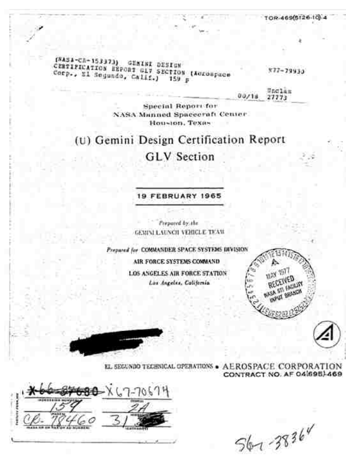

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Figure 7:

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Figure 8:

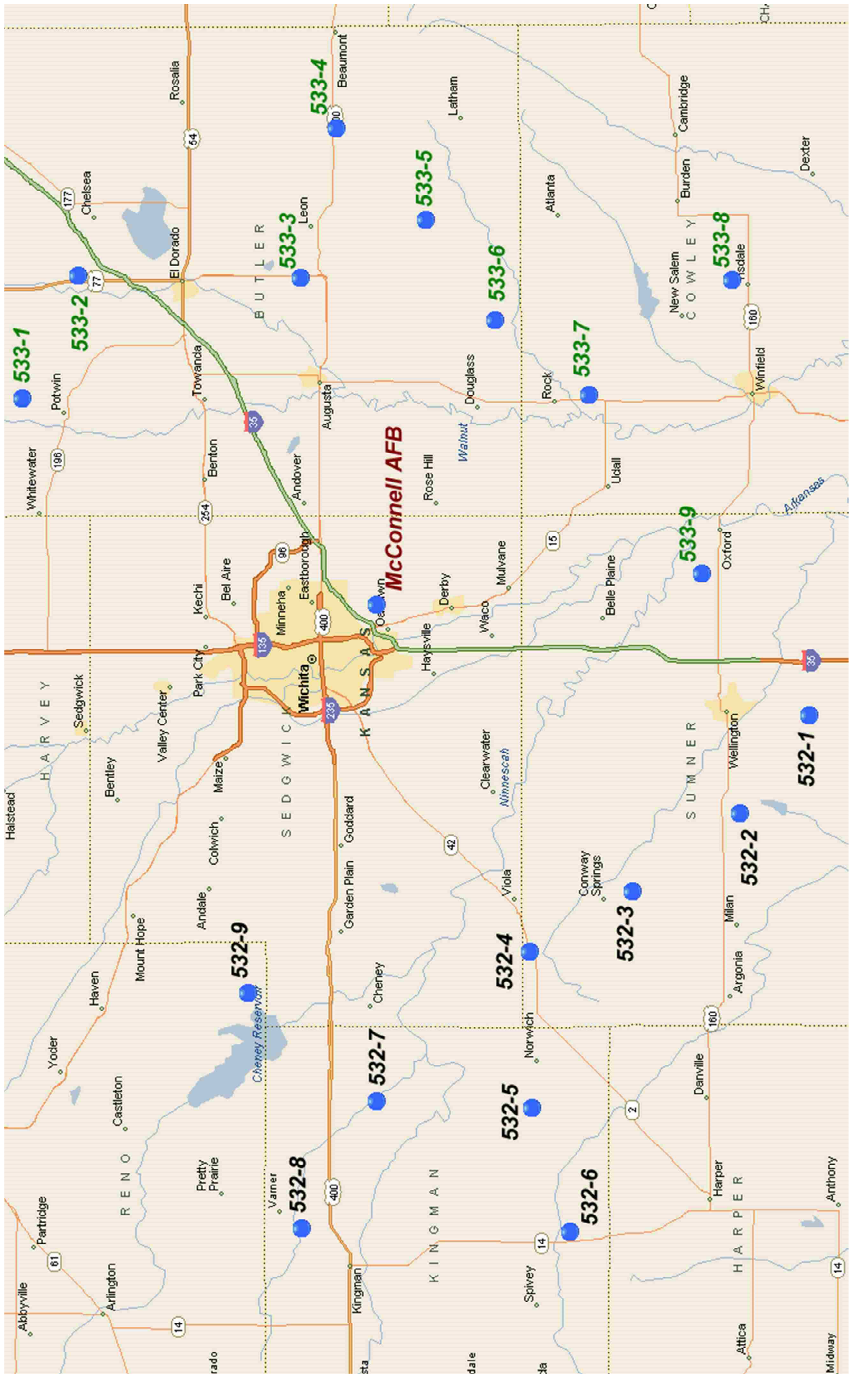

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Figure 9:

—Staff Photo by Gene Prescott

Air Force, State Police Block Highway to Site

Police and Air Force vehicles and an Air Force helicopter are stopped at the intersection of U.S. Highway 65 and state Highway 124 north of Damascus where authorities set up a roadblock to prevent persons from entering the area where toxic fumes leaked from a fuel tank at a Titan II missile silo Friday morning. Motorists were routed around the evacuated area. Two farmers who lived near the silo were hospitalized for examination.

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Figure 10:

Ibid.