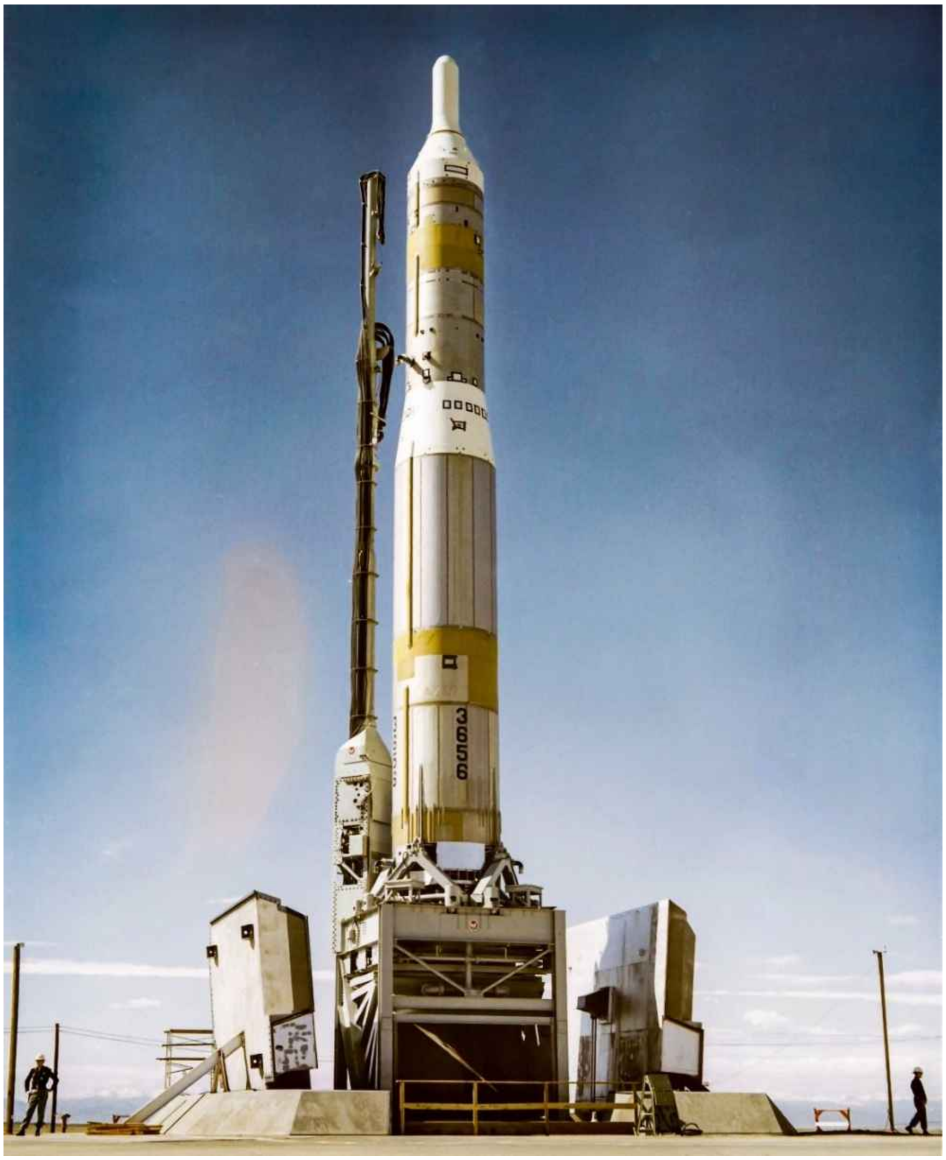
Titan I ICBM Activation at Lowry Air Force Base

Remembrances by Bill Bollendonk,
Martin Marietta Activation Team



Bill Bollendonk

December 2022

Editor's note

This document was drafted in 2007. The manuscript was lightly edited, formatted, and images were added in December 2022.

January 27, 2023

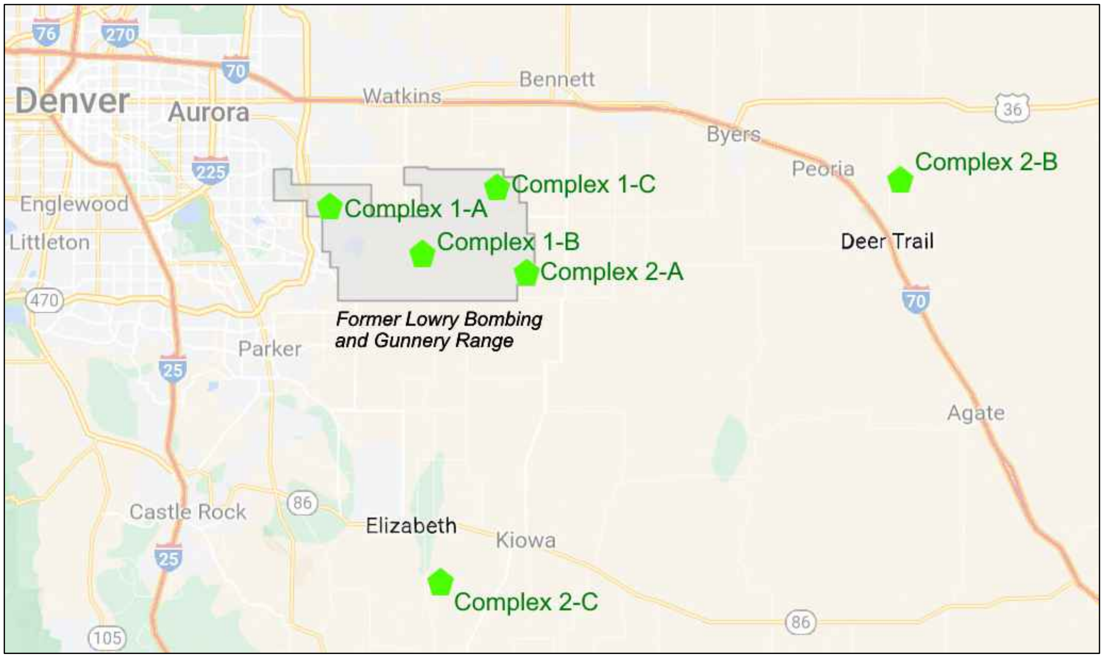
Titan I ICBM Activation at Lowry Air Force Base

– Remembrances by Bill Bollendonk, Martin Marietta Activation Team

From mid-1960 through 1964, I was assigned to the Titan I ICBM activation and technical support to the 451st Strategic Missile Wing at Lowry AFB near Denver, Colorado. The following are some of my many experiences during those years, that for the most part, have been forgotten. These are some personal experiences gained through my very close contact with the Titan I ICBM and the exceptionally dedicated engineers, technicians and Air Force personnel that provided our country with a major deterrent force.
– Bill Bollendonk, December 2022

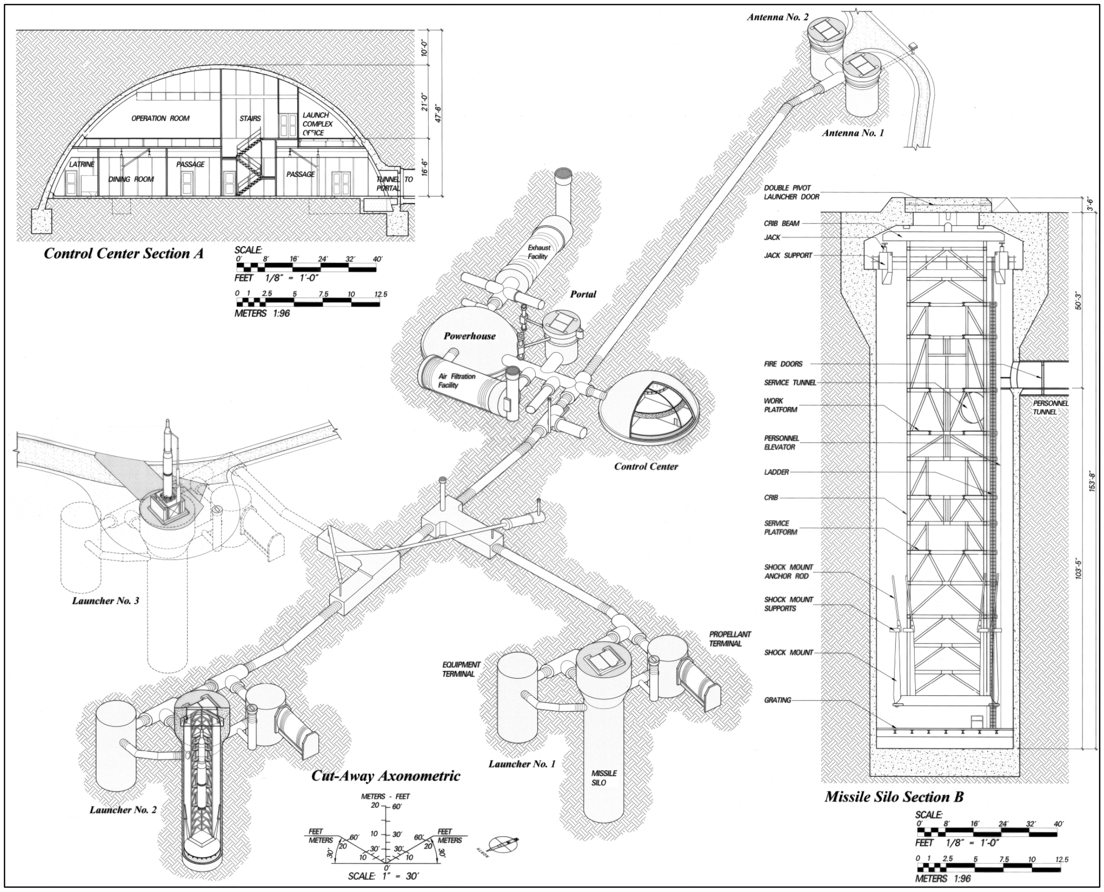
The Titan I program began development in 1955 as a backup option in case the Atlas program failed. It would become the second Intercontinental Ballistic Missile (ICBM) deployed by the U.S. Air Force. The Titan I was the first multi-stage ICBM put on operational alert. At their peak, 54 Titan I weapon system missiles were operational from 1961 until 1965. 18 Titan I operational missiles were installed east of Denver. Four of the 451st Strategic Missile Wing launch complexes (1A, 1B, 1C, and 2A) were constructed on Former Lowry Bombing and Gunnery Range. The other two Colorado complexes were located near the towns of Deer Trail (2B) and Elizabeth (2C).

The construction contracts of the underground silos, control center, powerhouse and antenna silos had been awarded earlier and construction was underway when Martin Marietta was awarded the systems integration contract that would pull all the pieces into an operational weapon system. After several years of missile tests and hot firings at the engineering and manufacturing facility southwest of Denver, I had been reassigned to the Martin Marietta activation team responsible for installation, checkout and sell off the missile ground control equipment. During the following months I helped assemble the ground equipment activation team and start the training process for them. Many were from the design groups, but most were new hires and they required clearances and training for the subsystems they would be responsible for. While all the hiring, planning and training was taking place, I was allowed access to the Range to monitor the construction under way by the Corps of Engineers and subcontractors, and report issues identified during the hardware installation.



Six Titan I missile complexes East of Denver; each missile complex had three operational missiles.

The Titan I missile was stored in an underground silo, raised to the surface, and then launched. The guidance antenna was raised at the same time and the guidance locked on to the missile just before launch. The 15-minute countdown that preceded the raising of the launcher to the surface included loading the liquid oxygen into both stages at the same time, while a full checkout of all subsystems was automatically sequenced. Once the process was started, it was under the control of the sequencer, with no further commands by the launch crew. The process could be aborted at any time by the launch officer. The RP-1 fuel was stored in the missile tanks and was only offloaded when a missile had to be removed for maintenance. The underground facility included a 24,000-gallon liquid oxygen (LOX) dewar, one for each of the three silos in a complex. The dewar was able to keep oxygen in liquid form for about a week, before it had to be topped, due to boil off. The operational system was very complex and hard for the military to maintain and became the reason the Titan I was replaced later with the more advanced Titan II missile. Titan II was launched from underground silo once the overhead blast door was open, unlike Titan I which required the missile to be brought to the surface for launch. Titan II also had a great advantage, as it was fueled by storable propellants that provided a much faster launch sequence. Titan II carried a larger payload and required considerably less ground support equipment.



Cut-away view of Titan I missile complex East of Denver. The entire 34-acre Launch Complex is buried underground with hardened access doors for entry, utilities, and silos.
From Historic American Engineering Record, “Titan One Missile Complex 2A”. HAER CO-89.

Disaster at Complex 1A Silo 1

There are many things that stand out about my time during activation of the operational Titan I ICBM system on the Lowry Bombing Range, just east of Denver, Colorado. Without doubt, the more horrific was the loss of life from an accident involving the silo overhead doors in August 1961. The two doors were controlled by very large hydraulic cylinders that both opened and closed them. During opening, the doors were rotated on hinges to the vertical position and then restrained as they went over center to the open, locked position. On closing, the reverse took place, till the doors were again on the large, flat, reinforced concrete surfaces. The doors weighed much more than 50 tons each and were opened by hydraulic cylinders. When open during the silo construction phase, the doors were held in the open position by massive strong backs bolted to both the door and the silo structure.

On August 7, 1961, I drove onto the complex at the start of the shift, before “sunrise service” (Site manager’s morning status meeting) and just as I passed through the guard gate, I saw one of the doors on Silo 1 rotate over center and fall at very high speed to the closed position. As I parked, almost everyone above ground was running toward the silo and it was then I realized things were not normal. The scene was very confused. Men near the silo were shouting, crying and vomiting. I remember standing and watching, not knowing the door had fallen on several workers. The on-site ambulance drove by me with the siren blaring, followed by several large trucks. By this time those with presence of mind were cordoning off the area, allowing no one to enter. Dick Lee, the Martin Activation Director, came on the address system and announced all Martin personnel were to return to Lowry for the rest of the shift. The next day the area around Silo 1 was fenced off and guards were keeping all away, as the incident team started their investigation. In Lee’s trailer that morning the mood was extremely sober, as the happening of the day before were told. For still unknown reasons, one of the doors closed. The door strong backs were not yet connected to the door and the hydraulic system released pressure that kept the door against the open stop. No one should have been near the door, so why they were there was still unknown. The door was opened that afternoon and the remains of several of the workers removed. I am glad I never saw the accident pictures, as I was told they were really graphic and caused immediate emotional impact. The area was back in operation within a week, but it took several weeks before the somber mood at Complex 1A returned to pre door incident levels. And even then, most workers wanted to get 1A behind them.

Fixing LOX Umbilical Disconnect Design

By the late summer of 1961, the pressure of getting the ground hardware installed was lifted from my shoulders, as I was asked by my manager to pass off that job to one of my team and to concentrate on solving some of the design problems that had been left open by the systems design engineers at the Martin Waterton plant. There were several real showstoppers that if left uncorrected, would prevent turnover to the Air Force on schedule. The propellant transfer system that moved liquid oxygen from the storage 24,000-gallon dewar to the missile had many problems, including the critical interface between the ground half and the missile half of the retractable umbilical. LOX was loaded into the missile tanks via a retractable 8-inch diameter umbilical line that had to move away from the missile when the launcher started to rise. The timing for the retract sequence was critical, as the boom that held the line had to move rapidly to avoid being struck by the launcher structure during the raising sequence. Both stages had the same problem, although the stage 2 umbilical boom was even more of a problem, as it was longer and had a greater travel time. I was given permission by my manager and Dick Lee to pick anyone I wanted to help with the process of finding a design solution. With that agreement, I pulled Bill Van Dyke from the propulsion mechanical design group at the Martin Waterton facility to help redesign the LOX interface system to the missile. We convinced Dick Lee to allow Bill and myself to witness the separation problem from the silo, something that was strictly forbidden, as no one was allowed beyond the silo blast doors during LOX loading. I am sure Dick made the decision on his own, as later no one believed we had actually been in the silo during loading. Dressed in LOX splash suits, we stood on the platform behind the umbilical boom, Bill on one side and me on the other while the retract command was given. The problem was easily understood, but was not easily correctable, as the boom interface was much too bulky and had freeze-up problems due to the LOX that was always left between the two halves of the disconnect. The design people at the plant were really not happy with what Bill and I came up with, but the fix was simple and we re-engineered it as an as-built within a week. The design Bill worked out replaced the boom with an 8" flex line that was pulled away from the missile rapidly by a counterweight when the launcher moved. The fix replaced several dozen parts that had been the source of many of the problems associated with test failures during the prior months. The new design worked very well for the rest of the Titan activation program and throughout the operational use by the Air Force.

Measuring LOX Fluid Level

One of the most perplexing problems associated with the propellant system was the liquid level sensors placed in the LOX tanks to sense the tank was full and to send a signal to stop the fill pumps. The sensors were placed inside the upper end of both LOX tanks and when covered with liquid, would complete a bridge circuit and provide a signal to the ground equipment. The design was marginal, as one leg of the bridge was subjected to LOX temperatures at minus 260 degrees F and the other three were at room temperature. Adjusting the ground part of the bridge required knowledge of the ambient temperature of the silo when the sensor was to operate. That was never the same, as the temperature in the silo dropped rapidly when the LOX tanks were being filled and was never the same from one loading to the next. During the checkout of the missile loading system at Site 1A, it became apparent the level sensors were not reliable as they required too much attention prior to every tanking. The system would be very difficult for the Air Force to maintain and a replacement level sensor would have to be developed. The timing was many months away, so the Bouge LOX Level Sensor System would have to work for the demonstration and sell off of the missile silos on the Lowry Bombing Range. The process was to determine how best to set up the sensors for loading and to train the techs on the process. After lots of trial-and-error testing, a scheme was devised that put the tank sensor in a bucket of liquid nitrogen with the ground side of the sensor bridge next to the bucket, allowing the cold gas to overflow the bucket onto the platform, thereby putting the bridge in a cold environment, while accomplishing final adjustments. The setup method worked well and was used by a small group of technicians that became a roving team supporting the tanking operations. That worked for a while, but after the turnover to the Air Force, they had major difficulty keeping teams trained and in my next assignment, I would be up to my ears in the issue again.

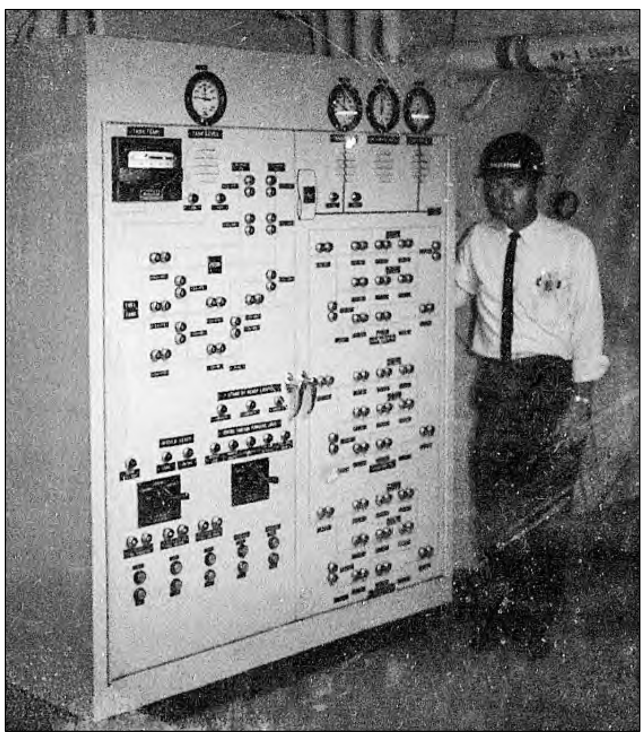
During the activation and turnover of the Titan I weapon system at the three wings located in Colorado, California and Washington, the design and flight testing of Titan II was well under way. The test stands at the Waterton facility south of Denver were already being modified to test Titan II. A controversy arose about whether the Titan II missile could survive the overpressures caused by silo launch. The design team for Titan II countered the concern of Thompson Ramo Wooldridge (TRW), suggesting a demonstration at Vandenberg Air Force Base in California, where a Titan I would be launched from the underground silo and destroyed over the Pacific Ocean. The Silo Launch Test Facility (SLTF) was quickly constructed and a Titan I was diverted from the line for the test at Vandenberg. Some of the later Titan I operational ground systems were also installed in SLTF and I was asked to go there to help with the installation and checkout and to acquire firsthand knowledge of systems operation that would apply to the operational installations.

Things at the sites on the Range were moving along well with the demonstrations and turnover approaching. There were still many problems to be resolved, but most of the equipment was installed and some systems test started. The Corps of Engineers was still in trouble with much of the Real Property Installed Equipment (RPIE) that was many months late. The main diesel generators in the powerhouse at Complex 1A were undergoing the final inspections prior to starting the demonstrations for acceptance. They had been online producing the power required by the launchers to raise a loaded missile, but some of the support systems required to have all 4 generators online at the same time were yet to be installed and tested. RPIE became the single biggest problem for the complexes on the Lowry Bombing Range and for that matter, all the silos at all three Titan I operational sites. The equipment was constantly breaking down, with very limited spares and later, when I was very involved with the silos after turnover to the Air Force, it was clear the technical data the Air Force would need to maintain the weapon system was totally inadequate, or nonexistent. Titan I was to be on alert as a deterrent force for three years and then replaced by Titan II. I would soon find out how really bad things were.

Achieving Single Point Ground

For the next year I spent most of my time solving ground equipment installation problems and learning all the secrets of equipment operation that was not apparent until the subsystems operated as a system. One of the major glitches was the single point silo grounding design, that I spent weeks trying to sort out. The design was a mess, as it had not been properly thought through. In defense of the design, there was really no way to adequately test the design until all the interfacing ground equipment was installed and operating. I was once again able to convince Dick

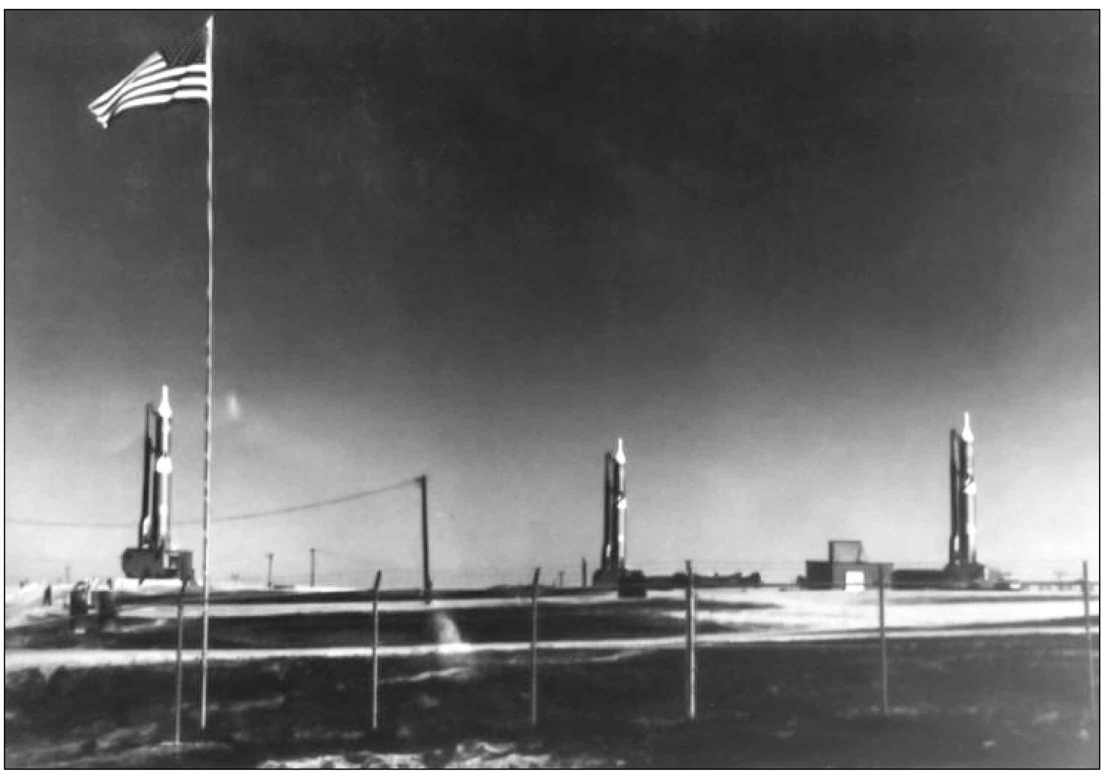
Lee that I needed to have a free hand in a silo and to be able to disconnect much of the interfacing cablings, if a solution was to be found. With a team of engineers and techs, a several week process was started to make an “as built” drawing of the grounding system and modify the design as required. Much of the engineering was reworked as the first complexes were activated. With several of the Waterton engineering design staff assigned to the group and the authority to make and sign off changes on site, things got moving. That really helped the turnaround time for required changes, though it did not integrate the field people with the engineering home departments. I spent almost 24 hours a day for several days trying to get a handle on the grounding problem. Things were not going well and late one night, Dick Lee, the Martin Activation Manager, came into the equipment terminal to find most of the racks open and much of the cables disconnected. He shook his head, turned around and walked out. At the next morning sunrise service, he did not ask what the situation in the terminal was. That was good, as I would not have had an answer. I remember the solution to the single point grounding system came within a few hours, once the as-built drawing was available. The changes required to make the system work were easily implemented and the equipment wiring changes were completed within a few days. After that, all of the silos were modified during the installation process.



Bill Bollendonk with Fuel Transfer Panel near Tunnel Junction 12. The panel was outside the fuel terminal located a short way down the launcher tunnels, before the blast door locks.

Launch Complex Countdown Demonstration

By spring of 1962, the first Titan complex was ready for final demonstration and turnover to the 451st SMW. I was at the complex for the turnover demonstration, and it was something to remember. The wing had been training launch teams during the flight tests in Florida and at the complex during the final test phase prior to turnover, so a wing launch team was at the consoles in the underground command center, while the Martin test conductor monitored the count on the net. Only Air Force and Martin test personnel were allowed in the complex, so all others had to view the count from several miles away. The count started and within the required times all three missiles were above ground, through the launch sequence and stopped at T minus something. What a sight to see three Titan missiles, successfully through a launch count with no apparent problems. After the missiles were returned to their underground silos, unloaded, and pronounced safe, we were allowed back into the complex to review the instrumentation. As I recall, there were several problems with the demonstration, but none would keep the turnover from happening within a short time. The first Titan I complex was turned over to the Air Force on 12 April 1962 during a ceremony at the Lowry Wing Headquarters. Little did I realize my life was again about to change in a dramatic way.



Three Titan I missiles in launch position during readiness test demonstration.
From: wikipedia.org/wiki/File:724_SMS_3_Titan_I_Missiles_Site_A_1962.jpg

Complex Integration

Dave Levine, then director of the Titan I program for Martin, was at the turnover and said he would like to discuss something with me in his office at the plant the next morning and would I be there early. No other comments made. I was sitting outside of Dave's office at the Waterton facility the next morning when he arrived. His secretary was not yet in the office, so he unlocked his office and asked me to sit at the conference table. Until the day before, I had not met Dave. He was an icon of sorts among the staff, as he had been instrumental in getting the Titan I program through many very bad times, especially at the Cape during the flight test program, when things were reeling under several major flight failures. Dave had a very direct way about him and just from the stories I had heard, I knew we would get along. I made a friend that morning and Dave became one of my supporters during the next ten years at Martin. Dave asked what my thoughts were on the condition of the complex that had been turned over the day before and what I thought about the capability of the Air Force to operate the Titan Weapon System. I remember thinking, why is he asking me these questions; shouldn't they be asked of people of much higher pay grade than me? I gave him an assessment from my position in the trenches. I told him I was certain the system would not be on alert for very long after the Air Force was given the operating and maintenance job. Further, I told him something he guessed, but was not spoken about outside of the senior management of the Company; that was the likelihood of a major incident during planned operational exercises that would be accomplished with a nuclear warhead atop the Titan I missile. He said he was very worried about the same thing and that was why I was in his office. He went on to say Strategic Air Command (SAC) Headquarters, in Omaha, Nebraska, had requested, through The Martin Company's senior management in Baltimore, consideration for putting a team of highly qualified engineer level personnel at the disposal of the 451st SMW. Further, they had requested this team be assigned ASAP. Dave asked if I would take on the task of assembling such a team and lead it for the near term. Before I could answer, he indicated it would carry a responsibility far beyond what he should be asking me to undertake, but he was sure I could handle the job. I told Dave I would do my best, but I would need support from the staff at the plant whenever a problem came up that was beyond the team's capability. He assured me that was understood and that he would answer my calls personally. He asked me to start putting together the team that day and to have it in place at the Wing HQ within the week, if not sooner. As I left Dave's office, he smiled, said thanks and I would be seeing a significant change in labor grade.

The next few days were very wild. I made a list of 20 of the best people from all of the subsystem disciplines and started the rounds asking for them. As expected, since all were of the caliber needed for my team, they were also the best of each of the groups that I was pulling them from and by the end of the first day, I had struck out on all but 2. Not a good start. I called Dave and explained the problem and he asked for the list. I read it to his secretary and within hours had my team. I did not make a lot of friends in the process, but I was already worried about the responsibility Dave had alluded to and I was beginning to wonder what that really meant, so getting the best people must be the right start.

Failed Operational Readiness Inspection Recovery

The first ORI (Operational Readiness Inspection) at the 451st SMW was not something to be proud of. As I remember, only one of the missiles reached the launch abort point. Also, I think only half of the Titans were on alert at the start of the ORI. Of course, the Inspector General (IG) team knew the alert status before they left Omaha, as the status of all SAC systems were constantly monitored in the underground at SAC HQ. The ORI lasted several days, during which time each of the Wing areas were reviewed and briefed on the IG team findings. The team left after briefing Colonel Julius Pickoff, the 451st Wing commander, the Wing had failed the ORI. Colonel Robert “Bob” Cummings, the DCM (Deputy Commander for Maintenance), called me to his office the next day and briefed me on the maintenance areas that received failing grades. Needless to say, the total Wing was in a state of shock. I personally found the whole process overwhelming. I remember saying to Bob there was no way the Wing could have received a passing grade with all the maintenance issues confronting them. The first Titan I ORI was to prove the entire Air Force maintenance concept would have to change and, in the long run, it would be a good thing the issue had been brought to the surface early in the life of the Titan I. I wondered how Bob would fare with such a devastating performance of the system. Looking back on that first ORI, I think the whole thing had been planned to show the condition of the system and Col. Pickoff was a party to the plan.

Martin management in Baltimore quickly got the classified data from the ORI and was on the phone to Dave Levine for clarification. My knowledge of the ORI results was limited to the actual missile performance, but of course that was reason the failing grade was given. I went to the plant to brief Dave on what I knew and what Bob had told me. Asked whether I thought there could have been any other outcome of the ORI, I said there could not have due to the condition of the facilities and the many problems with missile systems due to the failure to have, and install, the modification kits provided by the Logistics Command at Ogden, Utah. Ogden was far behind the curve with the several dozen missile changes in the pipeline and had very little handle on the RPIE issues that caused many of the support failures. Dave indicated he understood the problem and would do what he could to get things moving within the Logistics Command. We discussed what my team might be able to do to help put the Wing in a position to pass the next ORI would surely come within three months. Many of the missiles had malfunctioned due to a Helium tank overpressure caused by a sensor that was to be replaced through modification direction from Ogden. The modification kit was several months behind schedule and would not be installed within what was thought to be the next ORI visit. Dave asked what I would do to correct the problem before the next ORI if the kits could not be delivered in time. I said I could correct the problem. The meeting was over and as I left, he said, now you know why when you took the job, I said it carried a heavy responsibility. Yes, I was beginning to understand.

The weeks following the failed ORI were so busy that I hardly got home. Many times, I slept on site in one of the crew support rooms in the complex control center. My team did the same thing, as they were all engaged with the maintenance people, working off all the crab/action items assigned by the IG. Bob Cummings had the 451st Wing food people make sure there was food for all my team and all had access to required support from Maintenance Control. It was mid-winter and the winter of 1962-1963 was a very cold one, so Bob directed the people assigned to my TST (Technical Support Team) be allowed to park inside the complex security fence to prevent them from having to walk the quarter mile from the parking area to the guard gate and then to the complex entry portal. This presented a problem, as all personnel entering the complex had to first get a key and code at the base and that was only given to military personnel. Somehow, Bob got around the system by having Maintenance Control call security at the complex with the name of those of the team that would be entering, so all my people would need was their security badge. Worked slick.

Several weeks after the ORI, when things for the Wing and my team settled down, I was asked by Bob Cummings to accompany him to a meeting in Col. Pickoff's office. Julius Pickoff, "Pick", was a fine leader, admired by all of his staff and those under his command. Many of his first line commanders had come with him to the 451st when a major shakeup had occurred weeks before the first ORI. Most had served with him at one time or another in the B-36 bomber wings. Bob had told me of many experiences he had while flying with Pick's command and how, when Pick made a promise, it was always honored. I was surprised there were only the three of us in Pick's office, as from the way Bob had talked, I expected that it was a briefing to him by staff personnel. As usual, Pick got right to the point. The ORI failure was due to several factors that Bob and therefore my team would be concerned with. First, the facilities issues and second, the missile system failures. We discussed the facility problems and what had been accomplished to correct them and what still had to be resolved. Getting the facilities to a satisfactory state was basically one of getting repair parts and tech data to install them. Ogden had a team of support people on base accomplishing the maintenance, as they did not require the tech data. They were authorized to use the equipment manufacturers supplied data. Repair parts were short, but things were better than before the ORI, when no parts, or data were available. Pick's next asked what had been accomplished to assure the missile problems would not be the cause for failure next time. I am sure he already knew the answer, as Bob would have kept him informed about the slow mod kit deliveries from Ogden. He asked what kits were critical to getting to the planned launch abort point and I explained there were only a few, but they were critical, and I knew they were way behind schedule. Pick's next question got to the heart of the meeting. What could we do to get around the kit issue and could I do it? For a moment I did not understand the question, but after a few seconds of silence, Dave Levine's words about responsibilities came through, loud and clear. What could I do about it? So that was why there were just the three of us in the room. I told Pick all the modifications in the pipeline had been proven during testing on the test stands, or at the Cape during flight testing and some of the engineering changes I had actually been responsible for during the latter days of the activation. It was very clear what he wanted but would not directly ask. Could the changes be made by my team? I told Pick only a few of the changes required parts, most were rewiring, or sequencer programming changes. That was especially true in the Propellant Loading and Pressurization System (PLPS), where most of the shutdowns occurred. He then asked, would I take care of it? Before I could answer, he added, if you know you and the team can do it, I will tell you to do so. Wow! I cannot remember whether Bob said anything during the entire meeting, but he looked at me and grinned. I had been set up. Pick stood and extended his hand, saying, "You may get fired, but I will be court marshaled." Guts!

It only took a few hours for the team to gather all the changes considered critical. The wiring ones were easy to plan, as all they needed were simple hand tools. The most critical two required new parts and I had no thoughts on how to get them in the quantity required to modify all 18 missiles, but I knew who would. I called Dave Levine and said I needed the parts, and asked if he arrange for me to get them at the plant. Dave never asked why. He just said that I would receive a call the next day.

The call came, one of the team picked up the parts, each of my subsystem engineers got a counterpart assigned by Maintenance Control, a schedule was put in place and all the modifications were complete within two weeks. The word had been put out that no one was to say anything about what was going on, in fact, only the team knew the story, as the maintenance techs went along only for the ride and to help supply tools and hands as necessary. The one remaining problem was that there was no way to be sure all the mods had been installed correctly, as that could only be accomplished during a system test. The missiles were not off alert more than a few hours each as the modifications were being installed, so the reporting to SAC showed nothing more than the usual maintenance downtime. A more sensitive issue was to keep the Ogden people in the dark, as they would have blown the whistle loud and long. In fact, months later, when the mod kits finally arrived from Ogden, they were bought off by the maintenance people as installed and the parts were given to me to return to the plant.

Things proceeded well for the next few months with the usual problems associated with keeping missiles on alert and solving the many technical data problems that continued to haunt the operational program. During this time, I had a most unusual experience while viewing a movie in downtown Denver. My wife Jeanne and I were enjoying the movie, when across the bottom of the screen came a hand written note requesting Bill Bollendonk call his office immediately. We had told the babysitter where we would be, so when Maintenance Control called the house, she had given them the name of the theatre. The problem was associated with the Bouge LOX level sensors. A maintenance tanking at one of the sites had an indication of liquid coming from a missile vent and the duty officer had shut down the LOX transfer operation and called Maintenance Control, as that was beyond his technical data authority. He was smart enough to command the vents to remain open. I dropped Jeanne back at the house and headed to the site, as I recall it was 2C, near Elizabeth, the farthest from Lowry and off the Range. The travel time of one hour allowed the tank to boil off enough to be within the parameters for de-tanking. All went well after I got there and assured Bob Cummings everything was normal, and the data was capable of de-tanking from that point. A busy night, but all went well.

There was one addition to the technical data as a result of the failed ORI. The engineering people thought a new alert status check list should be developed as a final back out from the silo to assure all subsystems were in a “go” posture. That was already part of the data, but not as an independent checklist. An engineering manager from Waterton was assigned to convince me of the merit of a new checklist and he became a part of the team while it was developed. I cannot remember how the new checklist was presented and agreed to by Ogden, but I suspect they were embarrassed by the poor performance during the ORI and went along with anything suggested that would help ensure there would be no repeat of the failure.

As expected, the IG landed at Lowry for an ORI within several months. This time the Wing passed, as most of the missiles were on alert and all but two reached the programmed abort. There were many smiles around Wing HQ and I got a call from Pick, just after the final debriefing, saying well done to the team. That was all that was ever said.

Challenges of Managing LOX

My activity on the Lowry Range continued, but in a different role. The Titan I Weapon System was programmed to go through a major upgrading, starting in the spring and I was asked to manage the engineering portion of the update. By this time the 451st was pretty much on their own, as the size of the TST had been cut back to about ten members and would be down to just a company representative by the start of the update program. The plan was to take one squadron off alert at a time, leaving the other, with nine missiles on alert. The Titan I update team, consisting of Martin personnel, associate contractors and the Corps of Engineers were already moving into the Lowry HQ building that had been mostly vacant since the end of WWII. All three Titan locations in Colorado, California and Washington would go through the update program sequentially and the teams would move to them in turn.

Within a week of my leaving the Wing, I had the most intense time experienced during my Titan I assignments. As I had told Dave Levine when he asked about the capability of the Air Force to take over the operation of the weapon system, my concern was the inexperience and training might result in an incident involving a nuclear warhead. The Air Force people were always willing to learn, follow directions, and in almost all cases put safety before anything else. There were only a few times I was involved with a situation the Wing Safety Officer and I had a different take on the proper actions to follow to back out of a potential serious problem. Most of the day-to-day issues would not lead to safety problems for personnel. There was only one that was a potential Broken Arrow (an unexpected nuclear incident) where the Wing Safety Officer and I had a very different position about the back out procedure. It started about 2 AM, when I received a call from Maintenance Control saying the oxygen level in one of the propellant terminals was reported to be over 30%. I asked the Maintenance Control officer if any other readings had been taken within the tunnel leading to the propellant terminal and he reported they were about to dispatch a team from the base to troubleshoot the problem. I suggested he have the team take along several LOX loading suits and several extra portable handheld oxygen sensors. The problem was in one of the silos close to the base and I was there within 40 minutes. Col. Cummings had arrived just before me and we entered the complex at the same time. The maintenance team was on site and preparing to open the first blast door leading to the missile silo, electrical terminal and propellant terminal. Each of the three areas also had blast doors at the entry points that isolated each from the other and the outside world. The safety officer had arrived and while the team was preparing to open the blast door, we discussed the technical data that covered high oxygen reading within the complex. The first task was to determine the source of the oxygen, the percent level, whether it was stable or rising, and how fast. What we were about to encounter was not covered by the data and most importantly, the approach to safely securing the weapon system.

When the first blast door was opened, the techs reported a 32% oxygen level. That should not be, as the first report indicated the level in the propellant terminal was 30%. The problem was not the difference from the propellant terminal, but there was anything above normal in the tunnel separated by the propellant terminal and the first blast door. That indicated the door from the propellant terminal was open, a condition that should never happen, but, in any case, should be shown on the complex alarm panel on the command console which was green. Col. Cummings had the safety people on the line at SAC HQ in Omaha, briefing them on the situation and current status. I suggested that I suit up and join one of the maintenance teams and proceed to the propellant terminal. All agreed, and with a handheld oxygen sensor, we opened and passed through the first blast door and started the long walk through the tunnel to the junction to the propellant terminal, about 50 feet further. As soon as we made the turn toward the propellant terminal it was obvious why there was a high level in the main tunnel. The propellant terminal blast door was open several inches and badly distorted. The blast door design was to protect the terminal from overpressure from the main tunnel so the structure was convex as seen from the main tunnel. To have distorted the door there had to be a very high overpressure from inside the terminal applied to the concave, inside of the door. We approached the door about the time that Command Center said that were seeing an oxygen level of 25% in the equipment terminal. We returned to the Control Center to review the problem. The technical data stated that under conditions where the oxygen level in the equipment terminal reached, or exceeded 30%, all power to the terminal was to be turned off. I suggested that I return to the propellant terminal, enter it and determine the source of the leak. That was within the data protocol, so safety and SAC agreed. The tech and I were back at the propellant terminal within a few minutes and managed to get the blast door open enough for us to pass through, but little more. The scene on the other side was amazing.

The terminal entry was at the second level and all I could see of the first level was LOX. It looked like the blue Caribbean with puffy clouds above. LOX, at minus 280 degrees is extremely cold, so the terminal was like stepping into space. The cloud of gas above the liquid was well into the second level and finding its way out through the partially open door. The PA came on announcing the level in the equipment terminal was 27%. All the equipment in the terminal was designed to be gaseous oxygen (GOX) compatible, with stainless steel grating, railings, explosion proof lighting and all of the piping and valves were also stainless steel. I crossed the propellant terminal to the entrance to the horizontal silo that housed the 24,000-gallon dewar and found the cause of the problem. The 24” main valve from the dewar to the lines and valves that led to the missile silo had parted at the flange between the dewar and the main outlet valve allowing the liquid from the dewar to flow onto the floor area under the dewar. The gap between the mating flanges of the valve and the dewar had opened at about the 2 o’clock position, allowing the pressure to stream LOX into the propellant terminal and into the area below the dewar. When the pressure dropped, the leak was then confined to only the dewar area. I do not know how much LOX had been in the dewar, but it was probably empty now. The propellant terminal had an exhaust tower to the surface, some 30 feet above the top of the terminal. The concrete tube, about 10 feet in diameter was separated from the main part of the terminal by several large diameter stainless plates that acted as blast valves. They remained open, unless an overpressure at the surface was detected, at which time they would slam closed. I could not see the valves, but I suspected they closed with the spike overpressure from the LOX spill. That sealed the terminal and the pressure buildup caused the terminal blast door to fail.

I returned to the propellant terminal door and with the tech pushed it closed as much as we could. I don't think I was in the terminal more than two minutes, as it was dangerously cold. We returned to the Control Center to brief Col. Cummings and the safety officer. The oxygen level sensor in the propellant terminal was still reading only 30% and had have failed, as the handheld sensor was pegged at 100% at the terminal blast door. The safety officer was very agitated and kept telling Col. Cummings that he must shut off power to the equipment terminal at once. The reading there was now close to mandatory 30% level in the tech data. I was really worried the level was much higher in all three areas, if the failure of the propellant terminal oxygen sensor was any indicator. The main power switching controls were located on the 4th, top level of the equipment terminal and they were explosion proof, as was all the switch equipment in the complex. The ground control equipment for the missile was located on the 3rd level of the equipment terminal and it was all solid-state circuit boards in several racks.

There was no open equipment anywhere in the equipment terminal, but I was not sure of the support equipment for the launcher. That would have been designed to be explosion proof, but I did not have personal knowledge to that effect. I suggested the command to open the propellant terminal vents be given to provide a path for the oxygen gas to get to the surface. The valves were opened with hydraulic pistons located inside the vent base and the reservoir was always charged. The valves opened and locked in the open position. I then recommended I take a team of techs to the propellant door and seal it as best we could, as that would reduce the flow of gas into the main tunnel. Thank goodness for Kotex and compatible tape. Poor design put the equipment terminal entry below the level of the propellant terminal blast door, so gases that got into the main tunnel would flow to both the missile silo and the equipment terminal. At the time I could not understand how gas was getting into the equipment terminal with the blast door closed. The SAC tech team headed to seal the propellant blast door, while I tried to calm the safety people in the Control Center and at SAC HQ. If anything caused an explosion in either of the terminals, or the missile silo, the potential of a nuclear release was very probable. Little danger of a nuclear explosion, but a radiation release was possible. With RP-1 fuel in both stages of the missile, any explosion would mix the oxygen gas with the fuel and the missile would probably be destroyed and drop the warhead into the explosion. That, by the book, would be a Broken Arrow. What we had before us then was a potential broken arrow and that was giving everyone nightmares.

Cummings was on the line to SAC HQ and had the conversation on the speaker phone. The voice on the other end was a general, as Cummings referred to him as such. Cummings had passed along my worries about shutting off power while the tech and I were in the propellant terminal, so the SAC safety people were considering the alternatives among themselves. The voice at the other end of the line asked, “Mr. Bollendonk, how sure are you that we might have a problem if power is turned off.” My answer was I was not positive we would, but leaving the system as it was, sealing off the propellant terminal and allowing the LOX to boil off, would be the safest approach. After a few moments of muffled conversation on the other end, the voice said “Bob, let’s go that way.” Within thirty minutes of getting the propellant door sealed and stuffing Kotex around all the cable tray openings into the equipment terminal, the oxygen level in the equipment terminal started to fall from the 30% level it had risen to during the crisis.

The conversation with SAC HQ ended and after over three hours things looked like they were under control. I stayed on at the complex for the rest of the night and following morning to witness the teams’ handheld sensor readings. The main tunnel was almost normal in 7-8 hours and the equipment terminal was slowly dropping. I remember getting some sleep in the ready room, but by noon the next day, when I left the complex, I was dead tired and I wondered how close my decisions had come to being a part of history.

I learned a few weeks later the cause of the LOX leak was due to not pre-cooling the dewar fill lines prior to pumping liquid oxygen into the dewar. The maintenance crew had come onto the complex at about 1 AM and were in a hurry to get the dewar topping completed, so they violated the tech data and started flowing liquid into the fill lines without the 20-minute cool down required. The gas created by the rapid LOX boil-off caused the dewar to shake violently on the shock mounts. The dewar displacement on the shocks, by design, was 24” in all direction, but visuals of the mounts during the repair process indicated the dewar had struck both stops in the vertical displacement. Sadly, within a year the same thing was to occur at the Elizabeth complex with very similar results.

Cuban Missile Crisis

One other event that happened during those few years with the 451st was during October of 1962, the first and only time that I am aware during the "Cold War" that US Military Forces raised the DEFCON (Defense Ready Condition), to level 2. DEFCON 2 meant the next command would be to launch air strikes and missile strikes in accordance with the Single Integrated Operational Plan (SIOP). The Cuban Missile Crisis had been the center of all news for several days and the Wing was already at DEFCON 2 due to the events unfolding. I received a call from Col. Pickoff’s office to report to his office immediately. There was quite a bit of activity at Wing HQ and Bob Cummings said, as I passed his office the DEFCON had just been raised to 2. I had a very short conversation with Pick. He said that he wanted my team to be ready to go to any site to help with a launch, if directed by Maintenance Control. He said if the order came to launch and go to DEFCON 1, that I would be sworn in as a Captain in the Air Force and the team would all be sworn in, in the NCO ranks. It was a very scary time in history and I was very relieved when the DEFCON returned to 3 about a week later.

Memorable Experiences

I was very fortunate to be a part of many military and space programs during my 34 years with Martin Marietta Aerospace, but none ever gave me the responsibility I was given during the short time spent on the Titan I ICBM program. Certainly, there are many stories that could be added to the foregoing, but most will be buried in the minds of those who were there. Unfortunately, many of the people referred to in the foregoing have passed this life and their stories no longer can be told. Perhaps sometime in the future, the history of this period of international conflict will be told to the generations that follow. I will always be proud of the minor part I played.

Hard hats of a missile site activation engineer.

About Bill Bollendonk

Bill is a New York City native glad to relocate to Colorado and study Electrical Engineering at CU Boulder. Bill joined the Glenn L. Martin Company in 1956 to work on the Titan I program. In addition to Titan I, Bill had a long aerospace career working on many development programs, including Titan II, Skylab EREP, Viking, Space Shuttle Caution & Warning and PIC, Peacekeeper, Manned Maneuvering Unit, and Tethered Satellite. Bill retired as a program director in 1990.

Additional Reading

Historic American Engineering Record, Creator, “Titan One Missile Complex 2A, .3 miles west of 129 Road and 1.5 miles north of County Line Road, Aurora, Adams County, CO”, HAER CO-89, https://www.loc.gov/item/co0919/

> Historic American Engineering Record, Creator, “Written Historical and Descriptive Data, Titan I Missile Complex 2A”, HAER C0-89, Daniel J. Hoisington, April 2006, https://memory.loc.gov/master/pnp/habshaer/co/co0900/co0919/data/co0919data.pdf

Historic American Engineering Record, Creator, “Glenn L. Martin Company, Titan Missile Test Facilities, Waterton Canyon Road & Colorado Highway 121, Lakewood, Jefferson County, CO”, HAER CO-75, https://www.loc.gov/item/co0348/

> Historic American Engineering Record, Creator, “Glenn L. Martin Company, Titan Missile Test Facilities - Written Historical and Descriptive Data”, HAER CO-75, John F. Lauber and Jeffrey A. Hess, December 1993, https://memory.loc.gov/master/pnp/habshaer/co/co0300/co0348/data/co0348data.pdf

--