

# **The Adventure of Working For Space Technology Laboratories in Florida**

## **The (Relatively) Early Days**

**By**

**Harry Charles**

After the end of the second world war and after I was discharged from the Navy I taught First Year Physics at Howard College in Birmingham, Alabama. In fact 5 of us returned and taught almost 20% of the courses for a year. But that is another story.

In the class was Colonel Richard Kalman Jacobson, an ex Air Force Bomber Pilot, who became a good friend until he finally died in 2001.

After this I received my masters degree from Ohio State University. In early 1950 I saw a 4 x 6 index card on the bulletin board in the Mathematics Department describing job openings at the U.S. Naval Ordnance Test Station, Inyokern, California. My land lady had a son working there and she had shown me a Life Magazine article on the "Secret City" After inquiring about the openings I accepted a job there in March of 1950 and spent 8 years testing small rockets and missiles fired air-to-air and air-to-ground. I developed the mathematical theory of fire control systems, became relatively expert in obtaining and evaluating photographic data, but above all became an experienced test engineer.

The Thor IRBM and the Atlas and Titan ICBMs were being developed for the U.S. Air Force. Nobody had ever built a long range missile before these developments and the problems to be solved seemed never ending. The Air Force contracted with Ramo Wooldridge for the unique role of Systems Engineering and Technical Direction, SETD. RW actually issued program direction to the many contractors.

By 1957 Colonel Jacobson was working for General Bernard Schriever and he urged me to apply for a job at Ramo Wooldridge. After an interview with James Dunlap RW sent me to Florida for an interview with George Cherniak, John Blake and Mike Ross and then offered me a job at my choice of Edwards or at Cape Canaveral. After 8 years in the California desert the idea of a move to Florida seemed preferable because it represented a total change and so I arrived in Cocoa Beach in March 1958 to work on the Atlas Missile Program.

Cocoa Beach was truly different. There was essentially no housing available and people were commuting from Orlando and other cities. Fortunately for me, Convair, the builder of the Atlas and the integrating contractor, had contracted for the construction of 80 houses in Cocoa Beach. They overestimated the local contractors and the houses

were completed a year late after the Convair employees had somehow found other housing. I bought one of the first of the houses for about \$17,000, an affordable price because RW (by then Space Technology Laboratories, or STL) paid me well. At China Lake my salary was \$8,645 a year but STL offered me \$12,000 plus, much to my surprise, 15% extra hardship pay.

Just imagine arriving in Cocoa Beach with a wife, two very young children, two cars, and no place to live. STL had bought a motel in south Cocoa Beach and rented me a large room for an exorbitant \$60 a day.. Within three days I had closed on a house that I had previously decided on, had moved in and then waited for furniture. The house had three bedrooms and two baths and had a central gas heater. No pipes to distribute the heat but just a stand alone gas heater. The house did not have air conditioning so after a short time I installed a large window AC in the living room. There was noticeable temperature variation from room to room but the AC was wonderful to have.

There was little shopping available in Cocoa Beach but the beach was wonderful. Then there were the mosquitos! They were partly controlled by a truck that sprayed the area every day. Later a crop duster type of airplane sprayed every day.

Starting to work at Cape Canaveral was almost breath taking. The Atlas missile was huge and produced an enormous amount of energy from the two booster engines and single sustainer engine.. The people in the Atlas office were superbly smart and knowledgeable. Frank Koen and Tim Hanrahan taught me how the rockets and the rocket engines worked. Gene Thatcher was the guidance expert and the teller of the stories of escaping from Cuba. The most interesting member was John Thomas Blake, one of the very few true geniuses I have known. He and I worked together on data evaluation and in monitoring countdowns.

The Air Force officers were selected by combing the Air Force for the most competent officers and then assigning them to the missile programs. The Atlas officers in Florida included Col. Mike Meyer, Major Roger Lengnick, Captain Rae, and a young Lieutenant Bob Borland. These officers were well educated, were intelligent and were excellent managers, all in all superb people to work with.

The role of STL in Florida was to monitor all the missile operations at Cape Canaveral and Patrick Air Force Base and to work with and advise the Air Force. Convair considered that they were perfectly competent to run the operations without STL and there was a great deal of resentment at the management level. Nevertheless we all worked together smoothly at the working level. The STL people were able to see any test records they wished to see and could talk with any of the Convair people. If STL proposed any technical change there would be a meeting and Convair would bring in 6 specialists in the technical area, generally to refute the recommendation. We learned to do our homework thoroughly and to be certain that we were technically correct in any recommendations. On the other hand I remember searching all the test records for the

mercury manometer propellant utilization system on one missile with complete cooperation of Convair engineers, even though this system was developed and championed by Convair. I wrote a 16 page TWX on these test results and sent it to STL in Redondo Beach, California.

For my first Atlas countdown and launch George and John said they planned to be at the launch site at 5:30 a.m. but that I did not need to come before 7:30 or 8:00. I was there at 5:30, instantly making a good impression on them. I went with them to inspect the Atlas missile from top to bottom and then to go into the blockhouse. During the first countdowns I studied the control consoles and the data recorders in the blockhouse. Initially there was a long pre-count and then approximately a 3-hour countdown and launch - that is if everything went well. The countdown was run by the Convair test conductor, and launch decisions were made by three people - the test conductor, the Air Force officer, and George Cherniak for STL.

During the next 3 years I was in the blockhouses of Launch Sites 11, 12, 13 and 14 for totals of 100 countdowns and 60 Atlas launches. The STL people sat in the back row of the blockhouse, in front of the visitor observation room, and monitored the consoles, the data recorders and the communication channels available on the head sets. I developed my role into that of integrating the system information available from watching the consoles and the data recorders. I was the only person independently integrating all this information.

The first launches were really trial and error. We would launch a missile, identify the malfunctions and then fix the problems. On the first A-series launch, a few months before I arrived, there was no heat shield above the booster engines and the missile suffered fatal fire and heat damage. This missile was flown without a sustainer engine.

One of my failures in the block house came about on the first launch of a new propellant utilization system, used to ensure that the liquid oxygen (LO<sub>2</sub> or Lox) and fuel were used up at nearly the same time. There were three indications that something was wrong. Two measurements from the PU system, one the error demodulation voltage, were different from what they had been in a practice countdown. Also the reading of the load cell output, indicating the weight of the missile system, was oscillating. I reported this as indications of a problem which I could not identify. However the decision was made to launch and we had a spectacular failure. The LO<sub>2</sub> fill and drain valve was not closed and immediately upon liftoff a huge stream of LO<sub>2</sub> poured out from the open valve. The thrust from the adjacent booster engine was 40% low and the missile lifted a few feet, remained vertical, drifted toward the beach and then blew up. The LO<sub>2</sub> fill and drain valve was recovered and the shaft was found to be broken. It was never determined whether it was broken from the beginning or whether the explosion broke it. By coincidence I immediately asked the LO<sub>2</sub> panel operator whether he had closed the valve, because I had failed to notice, and he said that he had. Later there was some question about this.

There were about 80-100 telemetry measurements from the missile systems, which were recorded at Telemetry Station 2, TEL 2. They were also recorded in telemetry trailers. STL received telemetry records from TEL 2 and displayed them on tables so they and the Air Force could examine them. Early in my career there I invented (and I am sure many other people invented) plastic overlays on which we could identify the measurements and indicate the scale for each recorded measurement. Thus we could estimate numbers immediately, such as the 40% reduction in thrust mentioned above.

Three hours after an FRF (Flight Readiness Firing) or a launch, Convair displayed all the telemetry recordings in Hanger J at Cape Canaveral together with about an 80 page preliminary report. Each of a large number of specialists wrote one or two pages in a predetermined format. Air Force people and STL people started at the beginning of the 3-hour report, worked our ways through the entire report, and made comments directly on the report.

John Blake and I examined the records from one late A-series Atlas launch and finally deduced that the system driving the LO2 and fuel pumps had suddenly lost the pump load. This was based entirely on one measurement of RPM that almost instantaneously turned up and disappeared from the telemetry record. We then reviewed the same RPM measurement from earlier A flights and found the same failure on two of them. As far as I know this does not appear in any written history of the Atlas flights. The failure was that a quill shaft had broken. The pumping system had been adapted from one used by German fire departments but then we had "improved" it because LO2 and fuel had to be pumped at two different rates. The quill shaft was redesigned to solve the problem for future missiles.

We became accustomed to flying a missile, determining what problems occurred on the flight, and then making the necessary redesigns to fix them. When we had a successful flight we almost felt that the flight had been wasted because there must still be missile problems and we would have to discover them on a later flight. I remember only one occasion when we failed to understand and solve a problem. During a test on the ground we discovered a problem with the control of the vernier engines. We could not discover the cause of the problem. We reran the ground test about 20 times and the problem did not recur. The decision was made to fly the missile. The problem did recur during flight and we failed to achieve all the test objectives. Because we could not diagnose the problem the logic for controlling the vernier engines was redesigned for subsequent missiles.

The missile design problems were difficult enough but we discovered a few cases of attempted sabotage. We had a Rough Combustion Control (RCC) system designed to detect rocket ignition problems during an FRF and to shut the engines down. There were two modes of unstable burning in the rocket nozzle which might occur. One would display a chugging burning that would not immediately become too serious. The other

would be like a blow torch revolving at high frequency in the throat of the engine and at worst could cut through the engine. We found one instance in which the RCC setting was so high that the engines would not be shut down even if a problem occurred. Another time we found the RCC setting to be zero so that the engines might be shut down even with no abnormal burning. Once we happened to find a long 2 x 4 in the lox tank. Another time we found a glob of grease in a lox line. It was obvious that someone had put the grease on a finger and then rubbed it off inside the lox line. This had the potential for burning and causing a problem.

There was one double failure. Nearly always the failures on a flight were initiated by one failure that then lead to the others. On an FRF an experimental Sundstrand Auxiliary Power Unit (APU) was installed. It quickly overheated and was being destroyed. The engines were automatically shut down. During post test inspection we discovered that about 40% of the lox injectors in the booster engines were plugged by desiccant, and would have caused major problems very quickly if the engines had not been shut down. Convair had an extremely competent quality control engineer, name was Goldinger, who went to San Diego to review procedural changes to ensure that desiccant bags would never again be left in the system. He was assured that it could not happen again. Mr Goldinger then borrowed a flashlight and he discovered a desiccant bag in a missile on the factory floor. Back to the drawing board on the procedures.

The missile programs had the highest priorities in the country. The result was that the work on each missile went on 24-hours a day. When something could be done the right people were there to do the work. This made life particularly difficult for the people working on the programs and even more difficult for the families. The only social life was with other families in their homes or at the Officers' Club at Patrick Air Force Base. Commonly a planned get together had to be cancelled because one or the other husband had to work.

One slow hour at the Cape we figured out that not one of the 35 or so STL Atlas people was married to his or her original spouse. This included a few people who had never married and a few who had divorced previous to the Cape but very many families dissolved because of the pressure of work conditions. The husbands were proud of the work they were doing but the mothers took the brunt of it.

Most families had young children. My own son and daughter, Harry and Stephanie, still remember with affection that many times I would arrive home from the Cape during the late night hours and that we would all have hot chocolate together. They were 3 and 5 when we arrived in Cocoa Beach in 1958, and 6 and 8 when we moved to California in 1961. Fortunately we were all in good health because medical facilities were limited. We had two local doctors and had a hospital in Cocoa. In fact our move away was complicated because Harry had to have a tonsillectomy the very week we were scheduled to move. My wife, Marian, and I stayed a few extra days and then drove

away to transfer to STL in Redondo Beach, California.

We also went to the famous local restaurants to eat out. There was Ramon's, the Surf, and the River's Edge. Ramon's is gone, the Surf was recently sold, and the River's Edge is now the Lobster Shanty. Ramon's was famous for Caesar Salad and for the cheese dip and then for the sea food. The Surf was famous for the enormous menu, including whale meat and bear meat, and for the elaborate relish tray. The River's Edge had good food, welcomed children, and furnished coloring books for the children.

One example of a "simple" problem was that of filling the LO<sub>2</sub> tank with liquid oxygen. At one point the program office decided to try to fill the tank to capacity by pumping LO<sub>2</sub> into the tank very slowly after it was almost full until the LO<sub>2</sub> appeared at the LO<sub>2</sub> valve. Observers from the various offices were present to observe and ensure that there was no problem. This procedure probably took an hour and it was completed satisfactorily. After doing this a number of times over a period of months we simply pumped LO<sub>2</sub> until a solid stream poured from the LO<sub>2</sub> valve. One unanticipated result was that the oxygen stimulated the mosquitoes into a frenzy.

We had a leak from a liquid nitrogen truck one day and we learned something else. The liquid nitrogen leaking onto the concrete road caused the concrete to spall and it created a hole in the concrete 4"-6" deep. A trivial comment: I never understood why the liquid nitrogen trucks carried a prominent warning "No Smoking Within 50 Feet". Nitrogen is not flammable.

Then came Hurricane DONNA in 1960. For the first time we had Atlas missiles erected on all four launch sites and were preparing them for launch. What were we to do with them? The mathematicians concluded that the missiles would be OK if we moved the work platforms away from them. However the prudent decision was made to take the missiles down and move them back to the hangers. After the hurricane we had to erect all four missiles again and to decide the extent of the retests to be performed to prepare them for launch.

One memorable missile launch was that of Atlas 10B in December of 1959. President Eisenhower wanted to fly a missile into orbit with a radio transmitting a Christmas message. Atlas 10B was selected and would require that the entire missile and sustainer engine would go into orbit. This would be by far the largest satellite sent up for a long time. The entire mission was highly secret. However John Blake and I determined that the anti-slosh baffles in the propellant tanks were larger than usual and we guessed that the missile would go into orbit. It turned out that the large baffles had nothing to do with the flight objective so our correct conclusion was derived from the wrong data. I integrated the flight trajectory by hand and concluded that the missile would exhaust the propellants prematurely. On a trip to California I reviewed this with the appropriate people and was completely brushed off.

It was necessary to test the radio and so it was turned on briefly one night about midnight. There was no report of anyone hearing the brief radio broadcast.

Three days before launch of 10B we encountered a hydraulics lock-up problem with the vernier engines used for small course corrections. The President gave us 48 hours to solve the problem or else the flight would be scrubbed. All the managers and the Convair technical people worked for 36 hours straight solving the problem. The flight objective was still secret and few people knew about it. During the launch countdown there was a point at which the GE guidance console engineer was to receive a certain signal indicating that the guidance system was GO but the signal would not automatically be generated because the flight objective required a change. A Convair engineer was in the basement of the block house during the countdown to flip a switch at the correct time to manually send the GO signal to the GE console engineer. The launch and flight were successful.

During the countdown and launch there was a man from Washington who waited beside an open telephone line to Washington, ready to report at a moments notice. He said his name was Sam Brown, an obvious pseudonym. We later found out that was his real name.

One should question why we developed both the Atlas and Titan ICBMs. This was an enormous example of redundancy. The Titan was obviously a more efficient missile than the Atlas because the sustainer engine would be ignited in space and would have the optimum expansion ratio for the space environment. The Atlas has all three engines ignited on the ground, conditions not optimum for the sustainer engine. The Atlas would not have been developed if we had known the answer to one question - Can a rocket engine using liquid propellants be ignited in the relative vacuum of space? The answer of course is YES but it could not be answered by test.

In those days most of the missiles were flown to Ascension Island. However there were no satellites to furnish precise locations of places on earth. When such data became available we found that Ascension Island was about a half mile from our previously determined location.

One missile was scheduled to fly with no instrumentation, but we succeeded in getting one accelerometer mounted on the top of the tank. The flight failed but I was able to integrate the acceleration, and the variations in it, to determine that the intermediate bulkhead separating the LO2 and fuel ruptured and allowed the LO2 to drop into the fuel creating an explosive and flammable mixture. This could be caused only by loss of pressure in the fuel tank and therefore a failure in the system maintaining the helium pressure which supported the LO2. We later converted the accelerometer data to the audio range and listened to the resulting sounds which sounded convincingly like rupturing metal.

One deep secret from those days concerned Aerospace Corporation. The Mercury program was to lead to manned flight. The Aerospace role on Mercury was somewhat similar to that of STL on Atlas. When the first Aerospace people arrived at Cape Canaveral they had to learn the details of the Atlas countdown. Several of us from the Atlas office joined the Aerospace people for flight readiness firings to teach them about the countdown. I am sure that STL management would not have approved of this.

We also were in the blockhouse when the first 7 astronauts were there. For several months the original 7 astronauts spent time in the Atlas blockhouse learning all they could. Most of them were rather distant but the big exception was Deke Slayton. He and I used to sit together in back of the blockhouse and discuss our respective backgrounds and careers and the Atlas program. I even told him about the time 12 years before when I had a run in with John Glenn. Glenn pounded the table and said that anybody who had anything to do with the MK 16 Aircraft Fire Control System should be investigated by Congress. I was the one who derived the mathematical theory for the Mk 16. But that is another story. By coincidence I had casually met Wally Schirra several years earlier when we were both at the U.S. Naval Ordnance Test Station, China Lake, California.

A trivial item of interest which is probably not in the histories is that Vogue Magazine somehow got permission to spend an afternoon photographing models posed near the launch stand and missile. They had no place convenient for changing the clothing they were modeling and so they changed in their cars. I suspect they never knew that there were 4 periscopes following their every move.

Arnold Anchordoguy, the STL Atlas Program Manager, visited us at Cape Canaveral and I met him there. Later I traveled to Los Angeles to Atlas headquarters on Arbor Vita Blvd. I met Arnold in the hallway and told him about the details of the Atlas failure analysis made from the single accelerometer. I believe that incident led him to offer me promotion to head of the Test Department, since Gene Noneman was to move from that job to another, and subsequently to that of Atlas Program Manager when Arnold moved on.