Five Days in October:
"Tracking" Sputnik I at Redstone Arsenal
By John Sevier Gibson

This is a brief firsthand account and commentary on Redstone Arsenal's virtually unknown official involvement in tracking and monitoring Sputnik I. It is written in the context of what was known at the time. Specifically it is based on the author's recollections, notes, local newspaper clippings [1], and a short Redstone report [2] which documents some of the technical aspects of the activity.

In late November, 1956, I reported for duty at the Army's Redstone Arsenal at Huntsville, Alabama. Huntsville was still a small southern town, just beginning to live up to its motto of "Rocket City USA". I was a recently commissioned 2nd Lieutenant, fresh from the Ordnance Corps school at Aberdeen Proving Grounds, Maryland. My assignment was to be a project officer in the Research Laboratories, a part of the Ordnance Missile Laboratories of the Army's Rocket and Guided Missile Agency (ARGMA). This was the development part of Redstone that was separate from the then recently formed Army Ballistic Missile Agency (ABMA), which several years later became NASA's Marshall Space Flight Center (MSFC). The lesser known ARGMA was very busy working on the Army's smaller rockets and missile systems as well as supporting ABMA in certain cases. My work at the Research Lab fell into the latter category as I was involved primarily in a project to develop high velocity, high temperature experimental facilities for simulated reentry testing of ballistic missile nose cone materials. A civilian, Dr. T.A. Barr, was in charge of the project. The entire lab staff was an unusual but very effective mix of civilian employees, Army officers and enlisted men.

The environment at Redstone in those days was one of hectic activity and growth. Morale was high and attitudes were very positive. This was the center of the new rocket and missile world. Virtually everyone there felt like he or she was a member of a great American team which was on the leading edge of science and technology. Those really were the "good old days"!

Friday, October 4, 1957 had been a normal workday at the lab. I went home that evening thinking of what to do over the upcoming weekend; did not hear or see any news reports and went to bed at a reasonable hour. At dawn on Saturday the 5th, I was awakened by a phone call from Dr. Barr. He wanted to know if I could go out to the lab and help set up a tracking station to pick up the radio signals of the Russian satellite. My first reaction was "what Russian satellite"? After a brief account of the world's first artificial satellite in orbit by Dr. Barr, I said that indeed I would be at the lab as soon as possible. I dressed, ate a quick breakfast, scanned the morning paper to see what was known about the satellite and rushed out to the lab at the north end of the Arsenal complex.

The four or five of us who had arrived pooled our knowledge of the newspaper [1], radio and a few TV accounts. These <u>initial news reports</u> said that a "185 pound, 23 inch diameter satellite had been launched the day before in an orbit with a 65 degree inclination to the equator, was about 560 miles up (we assumed this meant apogee height) and was making one orbit every 95 minutes". It was said to have "two radio transmitters on wavelengths of 7.5 and 15 meters". Further, the satellite's transmitters were said to be "sending a continuously alternating or telegraph-like signal with pulses being about 0.3 of a second apart". One report stated that this sounded like a "deep beep, beep, beep… as received on a short-wave radio". Later in the morning, someone telephoned in the exact transmitter frequencies of 20.005 MHz and 40.002 MHz.

In the first few days, the term "Sputnik" was not widely used. The typical news terminology, and our own, was "Russian satellite" or simply "the satellite". Some news accounts called it a "baby moon". Satellite location and some orbital parameters were updated frequently by way of news releases. For example, a new orbital time of 96.2 minutes was given in the afternoon newpapers[1] that same day, referencing a broadcast from Radio Moscow.

Our satellite group quickly inventoried the available lab instrumentation and equipment that could potentially be of use for the tracking or monitoring station. We found two communication receivers, a national HRO-60 and a Hallicrafters SX-62A. We also located loudspeakers, headphones, a two channel oscilloscope, an industrial Polaroid camera with scope attachment, an audio tape recorder, several rolls of number 14 copper wire, and a chalkboard. A small unused office was found which seemed about the right size for our needs.

There was a lot of discussion about the receiving antenna situation. With our limited assets, we had no way to devise hi-gain tracking antennas and felt that some sort of omni-directional antenna concept was the best option. It was decided that separate long wires, of approximately 200 feet in length, would be used on each frequency. The two long wire antennas, made from the rolls of copper wire, were mounted above the lab building's flat rectangular roof. Each antenna was in a horizontal "L" shape, going along tow adjacent sides of the roof, but in opposite directions. It was thought that such antennas, while relatively crude, would be essentially omni-directional and should pick up sufficient satellite radio energy to work with the two receivers. The HRO-60 was set to pick up the 20 MHz signal and the SX-62A was set for the other signal at 40 MHz.

By late morning everything was ready and we started listening. The dual beam oscilloscope, with Polaroid camera attached, was fed by the audio output of each receiver. The single channel tape recorder could be switched to the output of either receiver. Each receiver had its own loudspeaker and headset. The chalkboard was set up on a wall for plotting orbits and calculating expected radio reception times.

For the first hour or so, no identifiable sounds were heard. We wondered if we were on the right frequencies. We discussed the likelihood of being close enough to the satellite's path. We worried about our makeshift antennas. Then at 12:35 p.m., a weak periodic radio signal was heard on the 40 MHz receiver [2]. The receiver's audio tone (BF0 circuit) was adjusted to make the signal clearer. This signal had the characteristic telegraphic sounding "beep, beep, beep" and the pulse repetition rate was about three tenths of a second. It was the satellite! We could hardly believe our ears. In about four and a half hours, our hastily assembled task force had met, developed a plan, gathered and set up the equipment, and made our first contact with the satellite. Quite a feat we thought at the time. After all, this was Redstone Arsenal's first operational satellite project! Of course we knew that many others in this country and around the world were doing the same sort of thing, but that didn't dampen our enthusiasm one bit. We realized that we were involved in the beginning of the space age. We felt like were "electronic pioneers"!

Figure 1. The Sputnik I radio monitoring station at Redstone Arsenal. Lt. J.S. Gibson in the foreground is adjusting the oscilloscope and Mr. E. E. Johnson in the background is logging reception times and signal strengths. This photograph was taken on October 9, 1957, the last full day of monitoring activity.

It was on a later satellite pass that evening that we took the first of many photographs of images of the satellite's received radio signals. The oscilloscope was adjusted for a single manual sweep so that we could trigger the scope and the camera at the same time. By keeping the camera lens open for an entire sweep of several seconds, numbers of clear photographs were made which showed the image of the periodic pulses and the spaces as well as the shape of an individual pulse and the overall signal envelope of a series of pulses.

The task force was augmented to ten [3] and, by taking shifts of two people each for several hours, monitored around the clock. In the early morning hours on the 6th, the first really clear simultaneous reception of both transmitters was accomplished. The two transmitters alternated in sending so that a pulse from one corresponded to a space from the other. Just after noon on the 6th, the 20 MHz signals sounded strange and had the appearance of some sort of strong, irregular low frequency modulation on each pulse. Sometimes the spaces disappeared altogether and a continuous signal was heard. In the very early morning hours on the 7th, similar irregularities and continuous transmissions were noted on 40 MHz.

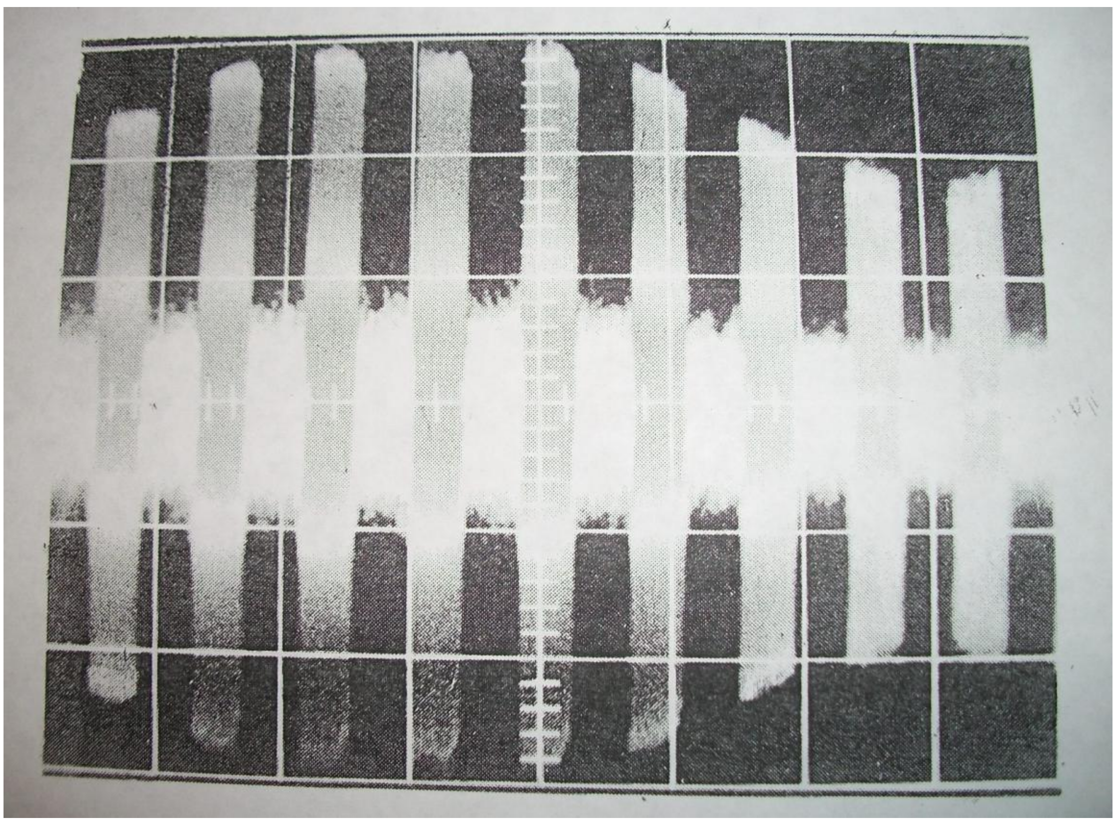

Figure 2. Photograph of a typical oscilloscope image of the 20 MHz radio signal from Sputnik I. The image is of a six second sweep, left to right, showing the radio signal pulses or "beeps" as vertical bars. This shows the normal pulse duration and space between pulses of about 0.3 second each. Close observation shows small modulations on individual pulses. Modulation of the entire pulse envelope can also be seen. Photo was made at 11:07 p.m., October 5, 1957.

A number of visitors dropped by at various times, mostly our military and civilian peers from various ARGMA and ABMA labs. A few Colonels showed up. We were hoping a General or one of the high level civilian scientists would come by, but that never happened. They were probably pretty busy discussing a possible Army satellite launch.

By the 9th, signal strengths were getting weak and the resulting photographs and tape recordings were of rather poor quality. Also nothing new in the signal characteristics was being noticed. For five days and nights we had logged all satellite receptions as to time, signal strength, unusual sounds, etc., made many tape recordings and took numerous scope image photographs. On the morning of the 10th we stopped. Over the next week or so, various ones of us would wander back to the monitoring room in hope of hearing something new or unusual, but little was heard. Even though the satellite was still transmitting, its declining signal strength and the limitations of our rather simple radio setup precluded any further meaningful reception.

What did we learn from our intensive five-day effort? We developed a crude form of satellite tracking so that we could predict approximately when the radio signals would be strongest at our location. We observed in the scope photographs what we thought were four different and distinguishable types of signal modulation - each of which could have corresponded to a different type of satellite information. These were: 1) variations in the length of time between pulses, 2) variations in the duration of the pulses themselves, 3) lower frequency modulations of individual pulses, and 4) very low frequency modulations of the entire signal envelope of a series of pulses. We were working in relative isolation and did not know at the time what some others did know; that the pulse and the space variations did correspond to changes in satellite pressure and temperature. We didn't pursue this matter much then as we thought that we would get into it in more detail later by analysis of the numerous audio tapes and photographs and discussions with others who were doing similar investigations.

A few of us did suspect that the individual pulse and envelope modulations could have been non-intentional. Some of the lower frequency modulations on individual pulses looked pretty ragged and could have been symptoms of overheating of the transmitter or the effect of fading capability of the assumed battery power source. The very low frequency modulation superimposed on the pulse pattern envelope could possibly have been caused by satellite rotation or ionospheric phenomena. In both cases, the modulations were sometimes there and sometimes not, thereby causing even more uncertainty as to their origin.

There were many at Redstone on the evening of October 4th who were notified of the launch and successful orbit of the satellite. In fact the U.S. Secretary of Defense was visiting ABMA, along with others, including the Secretary of the Army and several of his senior staff. All of these high level visitors were attending a before dinner social gathering at Redstone's Officers Club along with the military and civilian leaders of ABMA. An ABMA representative suddenly ran in and announced that he USSR had put a satellite in orbit. The group was stunned!

It had been common knowledge that the Army had long wanted to put a satellite in orbit, and had the capability to do so. But Redstone had been told to hold off in favor of the U.S. "civilian" satellite project Vanguard which was to be launched as a part of the U.S. International Geophysical Year (IGY) program. Most people in the U.S. assumed that Vanguard would be first in space. There were rumors and press stories that the USSR was planning some sort of satellite launch, but they were largely discounted at the time.

Consequently the announcement of the successful USSR satellite really came as quite a shock to the group assembled at the Officers Club. It was said that one of the Washington visitors suddenly looked ill. ABMA's Werhner von Braun said something like "man has taken the first step towards Mars", fully realizing the implications of this first satellite. There was considerable discussion between von Braun and the visitors about Redstone's ability to launch a satellite very soon using existing rocket equipment.

The people of Huntsville generally were very disappointed that the Russians had beaten the Americans into space, but they followed every Russian development very closely. A very large number of Redstone's military and civilian employees lived in Huntsville, so the city as a whole was Redstone oriented. Consequently, Huntsville took on Redstone's successes and disappointments as it's own. By early November, the general depression was even more severe when the USSR launched the second satellite.

Later in November, when Redstone had finally been given the green light to launch an American satellite, the atmosphere at Redstone and in Huntsville brightened considerably. Soon people began to forget about the Russian satellites and were mainly talking about the upcoming American launch, to be based on Redstone's technology and expertise.

This preoccupation with the future launch also affected our Lab, even though we were not directly involved. The five days of Sputnik data we had accumulated were essentially shelved. A brief memorandum report [2] was written which is the only documentation of the operation. We had done our part in the scientific investigation of the Russian artificial Earth satellite. It was a small activity in the grand scheme of things at Redstone Arsenal. However, we knew we had participated in an important scientific first. Now it was over; our few days in the limelight were finished. Back to work with the mundane business of developing better nose cones, guidance systems, vacuum seals, rocket nozzle materials, etc.

Little did any of us know what a barrage of numbers and types of satellites would swiftly follow. After Sputnik II, next was our own Explorer I in January, 1958. The 1957-1958 International Geophysical Year (IGY) was in full motion and several more U.S. and other USSR scientific satellites went up. Sputnik proved to be the catalyst that really got the American space program going. In the following few years, U.S. and USSR satellite launches became commonplace. An unbelievable space age had been ushered in, beginning with Sputnik I.

Epilogue

In the years following Sputnik I, details slowly became available about the launch rocket, launch site, and the satellite itself. Such information was totally unknown to us in October, 1957. While the Sputnik I story is still not completely known, more of the story can be found in a number of excellent references today. For example, the best overall background on technical development, "chief designer" Korolev, political motivations, and launch activities can be found in James Oberg's 1978 article [4] and 1981 book [5]. Peter Smolders' 1974 book [6] has an interesting account of the launch as well as excellent photographs and drawings of the main (RD-108) and four booster (RD-107) rocket engines of the types used for Sputnik and several later projects. The 1990 book by Frank Winter [7] contains a fine overall description and drawing of the complete Sputnik I launch vehicle (R-7) configuration as well as more detail on the operational characteristics of the main and booster engines. M.K. Tikhonravov's 1973 paper [8] has many of the technical details of the satellite itself. This includes the overall design philosophy, structural and mechanical design, electrical and electronic design, operational characteristics, etc. More insight into Redstone Arsenal's history and reactions to Sputnik can be found in Frederick Ordway and Mitchell Sharpe's informative 1979 book [9]. Much recent information on the Soviet Union's space program, including Sputnik is available in James Harford's (1997) [10] and Helen Gavaghan's (1998) [11] excellent books.

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