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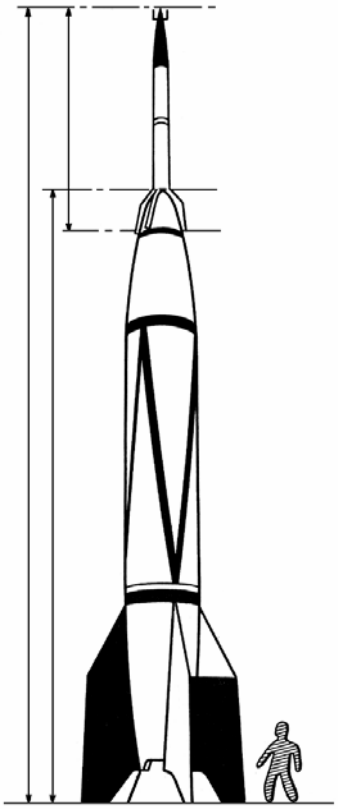

S. Starr
Chief Engineer
Dynacs Inc.
Kennedy Space Center, Florida

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Stanley O. Starr
Chief Engineer
Dynacs, Inc.
Kennedy Space Center, FL 32899
stanley.starr-1@ksc.nasa.gov

ABSTRACT

On July 24, 1950, Bumper 8 was launched from a small concrete launch pad north of the Cape Canaveral lighthouse, becoming the first launch from the Long Range Proving Ground. The Bumper missiles, six launched from White Sands and two from Cape Canaveral, were a combination of a German V-2 first stage and a WAC Corporal unguided, liquid fuel rocket as a second stage. The Bumper missions achieved great advances in altitude and velocity, demonstrated the first successful ignition of a second stage liquid rocket, and explored the boundaries of aerodynamic heating and complex missile control systems. They also engaged public interest during a time when weapons developments were largely secret. The fledgling Long Range Proving Ground had just embarked on a multiyear program to build a thousand mile, over ocean missile range when it was tasked with supporting the complex launching and tracking requirements of the last two Bumper launches. The LRPG quickly created facilities to support the Bumper launches, under harsh environmental conditions and with a hastily assembled team, and successfully met the Bumper launch schedule. Although announced to the press and widely remembered as successful, the two Bumper launches did not meet their technical objectives.

THE V2 MISSILE

the Germans under the technical leadership of Dr. Wernher von Braun during WWII produced a series of missiles of increasing size and complexity, culminating in the A-4. This was later renamed the V2 (for Vengeance) and put into mass production. At 46 feet in length with a lift-off weight of over 14 tons, it could deliver a one ton warhead to a target 160 to 200 miles from the launch site. The V-2 missile was a technical marvel in its time. Its rocket engine had a thrust of 28 tons[1], exceeding by a factor of 25 any other country's engines at the time. The development of the V-2 also required extensive advancements in aerodynamics, control systems, structures, manufacturing, and ground support systems. Some 5,000 A-4 missiles were fabricated and 3500 were launched under difficult wartime conditions. Construction of the missiles took place at an underground factory and slave labor camp where as many as 18,000 workers died building them[2].

As Germany collapsed, the then Colonel Holgar N. Toftoy of US Army Ordnance boldly seized the initiative to capture leading German rocket scientists and parts for a hundred V-2's from the concentration camp and underground factory at Mittelwerk[3]. At the war's end, some hundreds of box cars of V-2 parts along with tons of technical records and nearly 120 engineers were shipped to the US. Toftoy installed von Braun and the German engineers at Fort Bliss, Texas near the newly established White Sands Proving Ground.

Toftoy then faced the difficult problem of how to best use the talents of the Germans in a way that considered the sensibilities of the military in the post victory era and built upon the considerable accomplishments of American rocket engineers. In order to create valuable weapons systems, needed by the USA's projected war fighting needs, such as antiaircraft missiles and precision ballistic missiles, he would need to advance the state of the art beyond the level achieved by von Braun and create a government/industry infrastructure capable of building and operating such future weapons.

The captured V-2 parts were turned over to the General Electric Company (GE) to be assembled and fired under the Army Ordnance's Project Hermes. The goals of Hermes were to obtain experience in the handling and firing of large

missiles, to develop more advanced missile technology, and to provide platforms for upper atmospheric research. General Electric certainly faced a major challenge in salvaging the miscellaneous collection of parts into working missiles. Many of the parts were damaged or otherwise unusable. No detailed assembly and checkout plans existed although considerable assistance was provided by the nearby Germans and by documents developed under Operation Backfire, a British project to document and demonstrate the V-2. With advice from the nearby Germans, test labs were established at White Sands for component testing including hydraulic testing of rocket engine systems using water and full scale firing stands. In spite of these preparations, the Hermes team experienced a 50% failure rate of the missiles launched[4], well below reliability values quoted for German launches during the war. In many ways it would prove easier for engineers to build a missile from scratch, where each component could be controlled, from mining the metal, through fabrication, to final acceptance testing. The Hermes project illustrated to the Americans just how difficult it would be to design and build reliable missiles with so many critical components.

Between May 1946 and September 1952, 73 V-2's were launched at White Sands[5], first by General Electric and later by the First Guided Missile Battalion. These V-2 launches were of great significance in the development of America's missile know-how. They established a team of Americans with the capability to launch large rockets, required the development of critical components, and established a cadre of scientists dedicated to space and upper atmosphere studies.

When the V-2's arrived at White Sands, a tall triangular tower was already there, constructed in the summer of 1945 for the launch of a small sounding rocket known as the WAC Corporal. The WAC and V-2 shared Launch Complex 33 for the next two years and would later be married to form the first two-stage liquid fueled rocket, the Bumper WAC.

JPL AND THE WAC CORPORAL

In 1943, the Army Air Corps asked Dr. Theodore von Karman to review British intelligence reports of a "large caliber" German rocket under development. His group at the Guggenheim Aeronautical Laboratory of the California Institute of Technology (GALCIT) had made major advances in rocket propulsion under a 1939 Army Air Force contract to study rocket assisted take off for aircraft (jet assisted take off or JATO for short)[6]. Von Karman, noting that current American rocket technology was inadequate to develop rockets with a 200-mile range, proposed a progressive development program based on the JATO motors[7]. The Air Corps turned him down but the Ordnance Department did not. A contract called ORDCIT would develop tactical rockets of increasing size and complexity, from the small solid fueled Private to the large self-guided Corporal. One might guess that by the time a missile called General was developed, it would be pretty good!

The Private was essentially a solid fuel JATO unit with a pointed nose and tail fins. The 92 inch long, 10 inch diameter rocket was successful in teaching the ORDCIT team aerodynamics and in solving problems associated with launching. When the Private project was complete, ORDCIT was to move on to the Corporal missile, a fully self-guided tactical weapon. The Jet Propulsion Laboratory (JPL), GALCIT's rocketry spin-off, did not yet have the required knowledge in missile controls. Frank Malina, at this time Technical Director of JPL, credits himself[6] with conceiving and selling the concept of developing an unguided sounding rocket to buy time while continuing engine and airframe development. Army Ordnance established such a requirement in December 1944[8].

The WAC Corporal was a 0.4 scale unguided version of the envisioned Corporal, intended to reach an altitude of 100,000 feet with a 25 pound payload to study the upper atmosphere. JPL would launch it from a 100-foot tower using a booster rocket to reach initial speeds of 400 feet per second, fast enough that the three tail fins would provide stability. The WAC without booster was only 12 inches in diameter and 12.5 feet long. The WAC engine would burn red fuming nitric acid and aniline and use compressed air to push the propellants to the rocket chamber. An inertia valve would start compressed air flow upon reaching a certain acceleration, eliminating the need for complex controls. Malina stated that WAC stood for "without active control," but in the rampant sexism of the day, it may well have stood for Women's Army Corps as Corporal's little sister.

The WAC A was a successful sounding rocket, first launching in late 1945 and reaching to over 37 miles[5]. JPL engineers incorporated a series of improvements into the WAC B version, first

launched in December 1946. The WAC demonstrated several new technologies including a nose cone that could separate from the vehicle and a parachute for recovery of the instruments. The last WAC B was launched on June 12, 1947.

BUMPER WAC

History is muddy on the origin of the idea for a V-2/WAC combination rocket. Malina claims that Martin Summerfield of JPL proposed the match[6]. The theoretical concept of multi-step rockets and their advantages in reaching high velocities and even achieving earth orbit was by now quite old. While the concept of multistage liquid fueled rockets had long been around, the Army was now in possession of the people and hardware needed to make it happen. According to official project histories[8], the idea was put forth by General Toftoy during a meeting on June 13, 1946 between Army Ordnance, General Electric and JPL. While the General may have been advised by his scientists on potential program options, the Bumper concept is consistent with the missile policy he enunciated that same month in Washington, "More progress will result from stressing basic research and component development for the next five years or so, than by hurrying into large scale production improving existing missiles or early models of promising new weapons"[9]. This project would not result in a new practical missile design, in fact far from it. But it would require collaboration between all of his key contributors, would demonstrate the benefits of multistage rockets in achieving higher ranges, and explore aerodynamics in regions beyond the capabilities of wind tunnels then under construction.

It would also provide a major public relations boost to American missile work. One of the benefits to working with the V-2 missiles was that they were generally un-classified; the public was even notified of their scheduled launches. This allowed for public engagement in an otherwise very secretive program. Missile altitudes at White Sands had become a focus of public attention and the potentially attainable altitudes of the Bumper would demonstrate the tremendous advances being made and boost public confidence.

Independent studies of mating the WAC to the V-2 were conducted by the German engineers at Fort Bliss, General Electric, and JPL. While the studies were underway, in October 1946, the Bumper Project was added to General Electric's Hermes contract and to the ORDCIT project. The program that emerged is described in the official records[8]:

> "The BUMPER was a test vehicle to investigate the feasibility of separation at high velocity of a two-stage missile; to obtain missile velocities and altitudes higher than those attainable by other means; and to conduct limited investigations of high speed, high altitude phenomena such as missile skin temperature rise."

The Fort Bliss Bumper design study was coauthored by von Braun and identified several key problems including keeping the V-2 stable in flight, cleanly launching the WAC and the flight stability of the WAC in the nearly airless upper atmosphere. JPL carried out trajectory analyses for different mission profiles including nearly vertical ones to reach maximum altitudes and flat trajectories to reach maximum speeds (and thus maximum aerodynamic pressure and temperature).

The aerodynamic instability of the Bumper was solved by submerging the WAC tail into the nose of the V-2. This moved both the Bumper center of gravity back and covered the WAC fins thus increasing stability by moving the vehicle's center of drag behind its center of mass. The WAC's flight stability concern was resolved by both increasing the number of fins from three to four, and by spinning the WAC just after separation by firing two small solid rocket motors. Successfully launching the WAC from the moving platform of the V-2 was a very difficult problem. Particular concern revolved around the effect of the WAC's rocket blast on the V-2 while they were still attached and the need to keep the WAC's liquid propellants pushed into the bottom of their tanks. The liquids would be kept in place by igniting the WAC while the V-2 was still firing at a reduced thrust. The WAC would be nested into 4 short flexible rails attached to the V-2 nose. Small wheels mounted on the WAC body would guide the small rocket out of its cocoon straight along the V-2 axis. Two blast doors in the V-2 nose would pop open at WAC ignition to vent the hot exhaust away. Douglas Aircraft was hired to fabricate the flight kits including the modified WAC B vehicles while GE installed the modifications onto the V-2's.

Considerable laboratory work was required to verify that the WAC could be made to work at high altitudes while rapidly spinning. One test involved emptying a clear tank of propellant while spinning to photograph the meniscus and verify that most of

the fluid would come out before the compressed air reached the outlet. Perhaps the most challenging test involved spinning the WAC motor while firing to ensure that the centrifugal forces did not adversely affect the impingement of the fuel and oxidizer jets in the combustion chamber. These tests showed that spinning the WAC would not significantly affect its performance[10].

JPL's calculations indicated that because the WAC was unguided, it would have a large potential impact area. Vertical flights could be accomplished safely at White Sands but for parabolic flights[8] "the danger area around the expected impact point would be so large that it appeared necessary to *consider an over-water firing range* for such a missile" (author's italics). Any trajectory other than nearly straight up, would require a test facility which did not exist in 1946.

The WAC would carry a 50 pound payload consisting of a Doppler receiver/transmitter for speed and position of the missile, and a rudimentary telemetry system which would provide missile nose cone temperature and operational data from the V-2 and WAC. This would allow scientists to measure height, speed, acceleration, and to infer aerodynamic drag by measuring how quickly it slowed down in free flight. The nose temperature would indicate the severity of aerodynamic heating, a major unknown in hypersonic flight.

The first six Bumper flights were conducted from White Sands in May and August of 1948. The first two launches used a solid rocket motor in place of the WAC to test the stage separation. The first was a success but in the second, the V-2 engine cut off after only 33.5 seconds (normal burn time was about 65 seconds). The third and fourth "rounds" carried WAC-B's with reduced fuel load in September and November of 1948. Both failed, the third due to explosion of the second stage motor during ignition which resulted in the WAC propellants streaming down the sides of the V-2 and enveloping it in flame. The WAC motor was recovered and showed the banana peel marks of a chamber explosion. For some reason, the motor had not started smoothly at altitude and considerable propellant had built up before ignition. As Herman Bank, Project Engineer for the WAC recently stated, "...we had made some tests that were on the ground with a small vacuum container over the end of the rocket to simulate high-altitude ignition. But unfortunately it wasn't big enough to simulate the upper stage actual conditions. So when we fired the first one, we blew up the motor. We recognized afterwards that it wasn't an adequate test. We put a diaphragm over the end of the exhaust nozzle and it worked fine."[11]

The fourth Bumper flight failed when the V-2 engine shut down. The WAC then separated from the V-2 (due to its higher mass to drag ratio). Surprisingly, the V-2 engine restarted and passed the WAC in flight. Bumper 6 would also fail, again due to the V-2, but with the fifth round, the Bumper WAC program hit pay dirt.

On February 24, 1949 Bumper 5 reached 5,000 miles per hour and climbed to 244 miles, more than double the 110 miles reached by a V-2 on December 17, 1946. As Malina later stated, "Thus the WAC became the first recorded man-made object to enter extra-terrestrial space, and the "space age" could be said to have been opened in the U.S.A. in 1949"[6]. Out of four true Bumper WAC's fired, only one was successful, but it accomplished most of the program's goals to achieve high altitude, high velocities and demonstrate the launching of one liquid fueled rocket from another in flight. In addition, Bumper 5 showed that radio communication could be sustained through the ionosphere. Because of high winds aloft, the WAC went far off course. Its parts were discovered accidentally seven months later by a cowboy named Kennedy. Bob Droz, a JPL technician, was sent out to recover the parts which showed the effects of melting of the magnesium spin rocket cases and considerable melting on the leading edges of the fins[11].

Now it was time for the program to move to an over-water range to try for high speeds in the lower atmosphere.

THE CAPE

When the Army established the White Sands Proving Ground in 1945, they knew that it would be inadequate to test some of the long range missiles then being conceived. Each military service was actively scouting for longer test ranges. In October 1946, a committee to study the feasibility of establishing a long range proving ground for testing guided missiles was established under the Joint Research and Development Board. This board was established during the time of plummeting Truman military budgets to eliminate duplication[12]. This was a confusing period of competition between the services and departments involving conflicts over future roles and shrinking budgets. Missile programs had been initiated by the

Army Air Corps, Army Ordnance, Navy Bureau of Ordnance and Navy Bureau of Aeronautics[13]. Each service jostled for position and tried to have various committees give it the mandate for various weapon systems. At this time, the Air Force's desired approach to guided missiles involved descendants of the German V-1, jet powered unmanned airplanes with ranges into the thousands of miles.

General William L. Richardson of the Army Air Force headed the Committee on the Long Range Proving Ground. Richardson had led the IXth Air Defense Command during the war which was responsible for the air defense of Antwerp during its major bombardment by the Germans using V-1's and V-2's[14]. After the war, Richardson was named to head the Air Force Guided Missile Group; there he was a key player in promoting Air Force interests in guided missiles. The Long Range Proving Ground Committee would have equal service representation but would be led by the Air Force whose flying missiles would have the longest range.

The committee first assessed the requirement for such a range by reviewing current and projected missile development and training needs. Finding the need urgent they proceeded directly to site selection. The committee established criteria for a range location including an existing base area with supporting facilities within the continental United States, a range at least 3,000 miles long with observation stations for the first 500 miles, and a climate allowing for year round operations. Among the more detailed criteria was, "Since electronic devices are important in down range instrumentation, the regions of natural electronic disturbances must be avoided"[15]. An interesting note, considering the final selection is that Central Florida has been called the lightning capital of the world.

The committee submitted its report in June of 1947 giving as its first choice an area extending south from El Centro, California, along the Gulf of California and as their second choice was a range from Cocoa, Florida extending southeastward along the Bahama Island chain[12]. An errant Hermes missile from White Sands that crashed next to a cemetery in Juarez, Mexico on May, 29 1947, and the resulting uproar, convinced the military of the immediacy of the problem and may have laid the ground work for a report the following January stating that, "the political climate in Mexico precluded the possibility of obtaining permission from the Mexican government" for the military's first choice for a range location. In that same month, conversations with the British indicated a willingness to establish range stations on Bahamian islands. Originally the second choice, politics promoted the Cape into the lead.

The site chosen for the Joint Long Range Proving Ground (JLRPG) included a launching area at the remote Cape Canaveral, midway down the east coast of Florida, along with a recently decommissioned Navy air base 17 miles to the south. During World War II, the Banana River Naval Air Station provided anti-submarine aircraft search capability for the central Florida coast. The many merchant ships torpedoed in Florida waters during WWII attests to the importance of this Station. In August 1947, after completing major upgrades to the runways and other facilities, the station was inactivated and placed in caretaker status.

In August 1948, the base was transferred to the Air Force to provide a base of operation for the Joint Long Range Proving Ground[12] although the project had yet to be approved by Congress and was kept secret from the American public. The JLRPG was administered from Washington D.C. by a committee representing Army, Air Force, and Navy and chaired by Richardson. He was also able to recruit Col. Harold Turner, who had been the first base commander for the White Sands Proving Ground, to represent the Army and act as his deputy. In August 1948, fifteen airmen from Eglin Air Force Base in Florida's panhandle arrived to provide security and fire protection, the first residents of the JLRPG.

While the Air Force would manage the overall operations of the proving ground, including launch operations and flight safety, other services would play major roles. The Army Corps of Engineers would provide for construction of the facilities in the U.S. while the Navy Bureau of Yards and Docks would plan and construct the downrange monitoring sites. The Army Signal Corps would be responsible for communications systems including radio and telephone links to the island stations. Instrumentation would be provided by a "working group" consisting of Watson Laboratories (Air Force) and the Signal Corps Engineering Laboratories (Army) next door at Fort Monmouth, New Jersey, and Ballistic Research Laboratories in Maryland. These labs had built up the instrumentation at White Sands and had greatly

extended work started by the Germans on missile tracking using optical telescopes and radio tracking using the Doppler effect.

In May 1949, a bill creating the Joint Long Range Proving Ground and appropriating 75 million dollars over three years was signed by President Truman. The public only then learned of the military's plan to establish a proving ground at the Cape. It was announced that the range would initially operate out to 500 miles but could be extended to 5,000 miles[17]. Now that funding and other approvals were official, activation of the facility, which had been quietly underway, increased to a high tempo.

Colonel Turner assumed provisional command in October 1949 as personnel began pouring into the area. His biggest problems turned out to be housing and mosquitoes. In October there were 457 people working on the range already and by the end of December the number had risen to 820[12].

Norris Gray was one of sixteen personnel transferred from Anniston Ordnance Depot in Alabama where he had become an expert in ordnance handling after the war. He had served in the 9th Infantry Division as chief of section artillery and fought in campaigns from North Africa to Germany including one operation where V-2 missiles were captured intact. He was glad to return to Florida as he and his bride had been raised in Tampa. He transferred to Banana River in October of 1949[17]. He found the base in very poor condition when he arrived: "I was going to move in the second house south of the Officers Club, which was called Silver Beach at that time. So we started to open the front door. Well the front door fell off and the back door fell off. Go in and look over and the commode had fallen over. One of the Navy guys finally came up and said, 'Sir, you've got big problems.' I said, 'I sure have.' He said, 'Rapid oxidation's got you.' And from then on we knew it was rust!"

Elizabeth Bain was a recently divorced mother working as a senior clerk in personnel at Watson Labs recruiting personnel to work at the Cape. Her group was to be transferred to Rome, New York and she vehemently resisted the transfer. Her supervisor suggested that she consider moving to the Cape herself and support the staffing. She discussed this with her two daughters and they agreed. Fortunately for her, an engineer named Bill Wrye had purchased a house in the area and offered it to her. In the beginning of 1950, Liz and her two daughters, aged 11 and 12 drove down to a place called Cocoa Beach. She had great trouble adjusting partly due to unfriendly neighbors and a bout of rheumatic fever[18].

Dick Jones, a veteran of the Italian campaign, was part of the Fort Monmouth communications group at White Sands when he received the call to move to the Cape. As he recently related[19], "They said we want you to stop here and we want you to go over to a place called Cape Canaveral. So we all grabbed for a road map of Florida to see where that was. A whole bunch of us took off in Army vehicles with as much communications equipment as we could pack in them and headed for the Cape. I remember getting into Cocoa and I asked somebody where Cape Canaveral was and they said you go across this wooden bridge and when you come to the ocean, hang a left. I said something about the Naval Air Station and they said well then you got to take a right when you get to the ocean and you go through a little town called Cocoa beach. There' a little fish and chips place there called Fishers, when you see that you keep going south and then you'll hit the base."

The mosquitoes were terrible. The second aircraft received by the base was dedicated to mosquito control. Experiments on different methods of mosquito control were officially started in mid-1949 and turned into a minor industry. Harvey Huntington received a check for $125 for developing a new mosquito fog generator that used less than half the chemicals of previous systems and produced a much better fog[20]. Other wildlife, especially rattle snakes, raised great concerns for those working in the launching area. The base motor pool initiated a policy requiring all drivers dispatched to the Cape to "take enough snake bite kits to care for any passengers who might be bitten"[12].

Land acquisition and improvement at the launch site was a top priority. The Coast Guard allowed the Range to use two and a half square miles of property around the Cape Canaveral lighthouse while the base took legal action to obtain another 12,000 acres (at an average of $100 per acre). This would displace only some 60 residents[12].

BUMPER PREPARATIONS

The original plans were for the Range to be partially operational in late 1951 but various programs were clamoring for support. Army Ordnance wanted to complete the Bumper project so that personnel could be reallocated to pressing

weapons development projects such as Corporal. In June of 1949 the JLRPG accepted the Bumper project in expectations that quick release of funds would permit the construction of a suitable launch facility by January of 1950. Naturally, the needed funds were delayed.

The two Bumpers would explore a range of high speed flow outside the capabilities of wind tunnels and existing missile data (generally up to Mach 4). The V-2 would launch in a vertical trajectory then heel over to an inclination of only 20 degrees before releasing the WAC. This was expected to result in velocities exceeding Mach 5 at much higher atmospheric pressure than experienced by Bumper 5. The purpose of these flights was to verify theoretical models of high speed aerodynamic conditions including those put forward by von Karman. In addition to measuring temperature and pressure, small models were to be installed on the tip of the WAC and lift measured. To protect the nose cone instruments a special teflon covering was developed by General Electric. JPL had developed an insulating covering for the WAC body and fins. According to JPL technician Bob Droz this consisted of perlite, a clear granular mineral powder insulation, mixed with sodium silicate also called "water glass"[21].

Many organizations were involved in the firings. The Long Range Proving Ground provided facilities, overall support, and coordination. Colonel Turner would be responsible for flight safety while Lt. Colonel Thomas L. Mann was assigned as chief of the launching branch. Orchestration of all participants including writing the countdown procedure fell to Major Robert H. Offley, Jr. General Electric had overall responsibility for preparing and launching the vehicle with the assistance of the 1st Guided Missile Battalion from White Sands. Douglas Aircraft and JPL prepared the WAC. The Navy provided two tracking ships, the *USS Sarsfield* and the *USS Foss* from Key West. Fort Monmouth provided all communications systems including telephones, telemetry recording, and interference control. The Ballistic Research Laboratory provided range measurement instrumentation.

It was expected that a paved road connecting the north terminus of A1A to the launch area would be finished by the time of the launches. It would need to have the bearing strength to withstand the 15 ton gross weight of the liquid oxygen trailer and be straight enough for the German-made Meilerwagen, used to transport and erect the V-2[22].

A blockhouse made from reinforced concrete and providing 500 square feet of working space was to be in place 500 feet from the launch pad.

Personnel from the Cape, including Norris Gray, went to White Sands in October to review their procedures and facilities. Upon their return they trained other personnel in the details of launch operations. The launch dates were slipped to July 19th and 26th for Bumpers 7 and 8 respectively.

Funding was finally released in May when a contract for $258,000 was let with Duval Engineering Company to build a concrete launching pad and provide a paved road four and seven tenths miles in length from A1A to the launch site. Another contract for $80,000 was let to Ingram Plumbing for installation of potable and fire fighting water systems in the launch area[23]. The decision had been made to forgo the sophisticated blockhouse and instead install a temporary command shelter due to lack of time. The pad, at least, would be quite sophisticated. The 100 foot square structure covered a system of access tunnels and hatches so that equipment could be placed below pad level. The pad surface was bounded by a lip several inches high and sloped east, toward the beach. The fire fighting water system was connected to a series of small nozzles along the western side used to flood the pad before launch to protect the concrete surface and to wash away chemical spills. The pad tunnels led to a buried cable tray allowing cables to be routed to the new blockhouse when built. For Bumper, cables were simply laid in a rough wooden cable tray along the ground. The pad and the water system were the only permanent facilities used to support the Bumper tests. Electronic gear was housed in truck trailers, tents and temporary wooden structures. As General Richardson said, the launches "will be held on a 'picnic' or rough and ready basis"[24].

Concern over the extensive communications systems required in the launch area drove Fort Monmouth to cobble together a Provisional Communications Detachment from available personnel who were sent down to the Cape in February. Ed Belcher had served in the South Pacific during the war and had just completed a tour shipping horses and mules to Selonica and Athens and was eligible for reassignment[25]. "So they said we got a place for you, we're going to ship you to Florida and I thought that was nice...I like Miami." His group of 43 was shipped down on a C-54 transport in heavy winter gear.

Unfortunately, they had not been cleared to land at Banana River and had to land at the small airport in Titusville. They were paid with checks and had no place to cash them. The trip was a mess but they were eventually housed at an old Navy barracks next to Hanger 751 where the Bumper equipment was kept. Ed's unit set about installing telephone poles, cables and switchboards throughout the launch area.

The V-2 was to be launched due east with separation of the WAC to occur about 50 miles out over the Atlantic. The *USS Sarsfield* would be positioned almost directly under the separation point and be equipped with a tracking telescope to observe and film the separation. A Doppler transmitter system would be located near the lighthouse just south of the launch site. Its transmitted signals would be received by the WAC and retransmitted to four ground based receivers. There were also two locations of Askania tracking telescopes. The data from these instruments would be used to reconstruct the trajectory of the Bumpers and not only provide insight into possible failures but also estimate aerodynamic drag. The *USS Foss* would be used to help clear the range and position itself 200 miles from the launch site, hopefully to locate the impact site of the WAC[26].

On June 18, a convoy arrived with the V-2 missiles and the WAC's arrived by aircraft. Two days later the construction crews completed the shell roads, blockhouse, and pad. Paving of the road was delayed until after the Bumper tests. On June 30 the gantry scaffolding was completed along with the umbilical pole. The gantry consisted of two sections of 12 level painters' scaffolding on castor wheels. These could be rolled up and sandwiched around the missile in minutes providing access to all levels for loading of propellants, installation of batteries, parts replacement and other access needs. Three days later the cables had been routed between the umbilical disconnects and the "block house." The only protection the wood frame blockhouse came from its position behind a high sand berm. A large periscope made from a thick mirror and sheet of aluminum allowed the command center a good view of the missile area.

One key concern was electromagnetic interference from vehicles during the test especially when the range safety ordnance was "live." Fort Monmouth provided a sophisticated radio interference van but the detachment was still woefully short of personnel. As Liz Bain recalls[18], "My boss, Colonel James, called me in and said you, you and you are going to work up at the Cape. To me that was one of the goofiest things I had ever heard of." She was assigned to work in the Radio Interference Van sitting on the north east corner of the pad, just feet from the missile. "The Army would pick us up at 2:00 or 3:00 in the morning and we would ride up to the Cape in the back of Army trucks...So we got up there and there was no place to eat, no place to get a drink of water, no nothing, no bathrooms, so what are we going to do... And it was so hot in there, imaging this time of year, it was just terrible. So these little GI's in this rinky dink van said ok we'll fix you up. So they hooked up a long extension cord and here I was sitting out by the missile, could almost put my feet up on the thing..."

On July 13 a full dress rehearsal was conducted of the range assets and procedures, the first of three such tests. Finally, on July 17, after range instrumentation and the road to the Pad were declared ready, Bumper 7 was transported out to the Cape. Using the Meilerwagen, the vehicle was erected onto its launch stand and rotated to its aim azimuth. The next day the final rehearsal, what would later be called a "plugs in" test of the vehicle and range, was conducted.

Cape Fire Chief Norris Gray provided personal memories[27]: "There wasn't much on the Cape in 1950, except the lighthouse and a few private homes...Wires leading from the blockhouse to the pad were in an open wooden trough. Because the fire department crews had to stay near the missile 24 hours a day we slept on the pad itself. I didn't get home for two weeks. Food was sent up daily from Patrick and we bathed in a nearby pond. We shaved about every third day. There were a million mosquitoes at the Cape then and they pestered us day and night. They were so thick, when I sprayed repellant on my arms they would get matted in my hair and my arms would look black."

"On the day of the first launch, all of the Cape residents were evacuated to safety. That is all except one. There was an old lady who lived about a half mile [north] of the missile site, and she refused to budge. When anyone approached her house, she aimed a double-barreled shotgun at them and they scrambled for cover. For some reason though, she would talk to me, and I finally convinced her to leave. She told me she didn't even know how to load that shotgun."

Surprisingly, all was ready for the scheduled launch on the 19th. The countdown had begun the

night before at midnight, with loading of the missile propellants, which in the case of the WAC, 32 gallon carboys were hand hoisted up the scaffold to be funneled into the rocket. Acid was spilled down the side of the missile and a delay occurred while it was inspected and washed.[26] The WAC spin rockets failed but it was decided to launch without replacing them. (Spinning the WAC was really unnecessary in these flights.) At "X" minus 4 hours the Doppler unit failed and was replaced. Later the Doppler reference transmitter failed causing an additional delay of 5 hours. The launch originally scheduled for 0800 was eventually slipped for these and other reasons until the firing command was given at 1720 hours.

As was reported in the *Florida Times Union* on July 20, "When they finally got around to pulling the firing switch on the giant device — it produced only a popping noise, hardly worthy of a champagne cork". The missile engine compartment was saturated with condensed moisture since the adjacent liquid oxygen tank had been full for 7 hours. A short in a fuel solenoid valve caused the failure[26]. This was probably fortunate since other short circuits would have likely occurred. The Cape had experienced its first on pad abort and fire, but this would not become the key anniversary date.

Five days later, on July 24, 1950 Bumper 8 was in its final countdown. The scheduled launch time of 0800 slipped to 0928 to replace a failed telemetry transmitter and a fuel cut off receiver. Norris Gray watched the launch with a small group of men inside the communications shed, a roofing felt covered wood frame building less than three hundred feet from the V-2. With him were "Pappy" White, launch director for General Electric, Lt. Colonel Tommy Mann, Chief of the Launching Branch, and several others[17]. Liz Bain and her truck had moved off the pad into the palmettos to watch from a safe distance[18]. Ed Belcher had worked a twelve-hour shift and decided to take a quick nap. He would sleep through the first launch from the Cape[25].

Seconds after launch the missile passed through a cloud layer at 20,000 feet and was obscured from view from the launch area but for a dark shadow of the contrail that raced across the cloud layer[28]. The first Cape launch appeared to onlookers to be a success but at 63 seconds the WAC separated, appeared to break-up and signal from the Doppler unit was lost. Colonel Turner had the range destruct package activated on the V-2 before it hit the water.

Analysis of tracking data showed that the missile had heeled over to only 10 degrees from horizontal when the planned trajectory angle was 22 degrees. The overall trajectory was much lower than planned. Camera footage from the *USS Sarsfield* indicated that the WAC nose had collapsed presumably due to aerodynamic pressure. The launch was announced to the press as a success. It was successful from the standpoint of the range, all tracking systems and safety systems worked properly, but no aerodynamic data was gathered.

JPL and Douglas engineers strengthened the nose for the WAC and included a dye pack to mark the impact point in the ocean for possible recovery of wreckage. Bumper 7 was loaded back on the Meilerwagen. Concern for morning tropical weather and its impact on optical coverage caused the launch time to be moved up to 0700. The count went even more rapidly than planned however, and the missile was fired at 0644. Again after lift off, it took a flatter lower altitude trajectory than planned. At 61 seconds, the V-2 engine dropped to 8 tons of thrust and sent the ignition signal to the WAC. The missile was almost 14 miles east of the pad at an altitude of 8.5 miles when WAC separation occurred[29]. The WAC fired for 40 seconds accelerating to only 3286 miles per hour, a little over half the target velocity.

GE would later find that the special gyro units built for these tests had what is known as a "sneak circuit." These units had both a gyro erection circuit to spin up the gyros before launch and a drive circuit to rotate the pitch gyro causing precession, in turn controlling the missile pitch to follow a desired trajectory. At lift off the erection circuit is supposed to be deactivated and the precession circuit activated. On Bumper 7 and 8, the erection circuit stayed active causing the gyros to over precess so the missiles followed a shallower than desired trajectory[4].

The story doesn't end there however. The launches were declared successes by the military and since the performance of the WAC portion of the missile was classified, they didn't need to reveal the failures. Over time a mythology grew that the shots were successful. Even the direct participants remember them as successes. In a post launch press conference Colonel Turner stated that the launch was[30], "a complete success in every way." The newspaper reported his other statements to the

effect that Bumper had achieved a speed of over 3600 miles per hour. While this is true it conceals the fact that the target velocity was much higher. Later reports, including an official publication from White Sands would state[31], "Not withstanding the error in trajectory, Bumper 7 attained a speed of Mach 9, the highest sustained speed that had ever been reached in the atmosphere." While technically the speed reached was the highest, if we discount Bumper 5 as having attained its high speed out of the atmosphere, it certainly represents a severe case of "spin doctoring."

The day after the Bumper 7, Colonel Turner was stricken with a cerebral hemorrhage and hospitalized[12]. He would recover although he left the service in November. Two days later, the Base was renamed after General Mason M. Patrick, leader of the Army Air Corps in WWI.

The Cape launch area was designated the Cape Canaveral Auxiliary Air Force Base in 1951, the first of five name changes[32]. From the Bumper launches through December 1999, the Cape would support 3182 launches[32], about the same number as the V2's launched by the Germans in WWII.

THE BEGINNING OF A NEW ERA

The year in question, 1950, was significant in rocketry for a number of reasons. The Korean War and the previous year's detonation of a nuclear device by Russia increased America's emphasis on rocket programs including the reinstatement of some that had been cancelled. It was also the year that von Braun's team was moved to Huntsville, Alabama. They formed the technical core of a project called Redstone that developed an upgraded V-2 type missile using American components and tooling. Members of von Braun's team, returned to the Cape in 1953 to begin flight tests of the Redstone and moved permanently in 1956 (14). A modified version of the Redstone, called Jupiter C, launched the first American satellite, Explorer 1, in January 1958. Von Braun's team evolved into the Marshall Space Flight Center and the Kennedy Space Center with German engineers assuming key management and technical positions in the expanding NASA organization.

In the meantime, JPL completed the fully controlled Corporal missile but slowly phased out of missile research preferring that industry perform engineering. Frank Malina left JPL to work for the United Nations then later, rich from stock in Aerojet Corporation, a spin off company that he, von Karman and other JPL pioneers started, he moved to Paris to become a somewhat successful artist. Aerojet and Douglas Aircraft evolved the WAC into a sounding rocket for the Navy called the Aerobee, which continued to be a very successful research tool until 1985 when the last round was fired from White Sands. JPL, under the leadership of Dr. William Pickering, again collaborated with the Redstone engineers on the Explorer 1, when JPL provided unguided upper stages including the satellite. JPL went on to become the world's premier builders of deep space probes.

Standing on the cracked and rust stained concrete of the Complex 3 launch pad, in the shadow of the modern Atlas launch gantry, it is difficult to imagine those days 50 years ago when men and women struggled against the elements and odds to launch two modern rockets here. In a few hot weeks in June and July, in the middle of this then barren palmetto scrub, they built a launch complex and launched two missiles. These missile shots are now all but forgotten footnotes in the long history of rocketry at the Cape. Later launches allowed the U.S. to surpass the Soviets in ballistic missiles, place artificial satellites in earth orbit, launch probes through out the solar system, and send humans to the Moon. Now the Cape, a Spaceport, delivers spacecraft into orbit that are so useful and pervasive that people hardly know they even exist.

Norris Gray stayed at the Cape, eventually joining and retiring from NASA. He is still active in space circles locally where he enjoys telling young people about the early days. Liz Bain continued to work for the Air Force and married an Air Force officer involved in the Snark program. She has retired to the local area. Ed Belcher met his future bride while on his short assignment at the Cape and after many more adventures retired back to the Melbourne, Florida area. Dick Jones stayed at the Cape, married Colonel Turner's secretary, and assumed a leadership role as a civil servant in range communications. He now works as a volunteer at the Space and Missile Museum on the Cape. Bob Droz went on to a successful career in the space business, first with JPL then later with TRW is retired in California. Herman Bank is active in a group of retired JPL space engineers who help develop medical technologies.

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