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Vanguard: America's Answer to Sputnik

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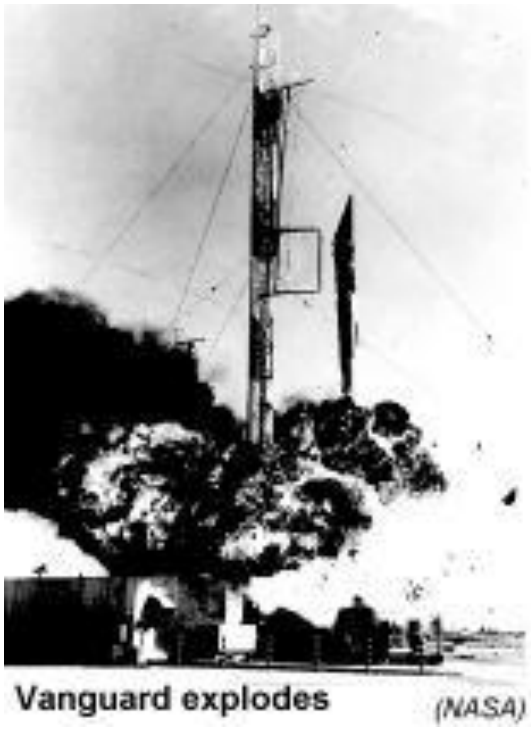
Vanguard explodes (NASA)

Introduction

The launching of the first two Sputniks was a terrible blow to America's self-image of technical preeminence that developed in the post-war years. With the onset of the Cold War, America also developed a keen sense of paranoia about Communism in general and the secretive Soviet Union in particular. The Sputnik launches, and their military implications, just fed this paranoia. Set against this backdrop was the infamous failure of the first Vanguard satellite launch attempt 40 years ago this December 6. Unfortunately this flight was touted by some as America's response to the Sputniks. Being at the focus of world attention for what was initially suppose to be a simple test flight was the last thing the Vanguard program participants wanted. This public relations disaster marked America's low point in what was quickly developing into a Space Race.

The Vanguard program had its roots in the mid-1940's in a collection of U.S. Naval Research Laboratory (NRL) sounding rocket programs. The 1946, the NRL sponsored the development of the Viking and Aerobee sounding rockets both of which served as upper atmospheric research tools. Viking was, for the day, a relatively large rocket built by the Glenn L. Martin Company (one of the corporate ancestors of today's aerospace giant, Lockheed Martin). Starting in October 1947 Reaction Motors Inc. began testing Viking's rocket motor which developed 89 kilonewtons (20,000 pounds) of thrust by burning a combination of alcohol and liquid oxygen. The Phase I version of the Viking weighed around 3,600 kilograms (8,000 pounds), was 81.3 centimeters (2.7 feet) in diameter and stood 12.8 to 14.6 meters (42 to 48 feet) tall depending on its payload. No two Vikings were exactly the same owing to the experimental nature of rocket technology at the time.

In its first flight on May 3, 1949, Viking 1 carried a 211 kilogram (464 pound) payload to the edge of space at a height of 80 kilometers (50 miles). Six additional Phase I flights over the next two years were, with one exception, all successful. These flights lifted payloads as heavy as 436 kilograms (959 pounds) and reached altitudes as great as 219 kilometers (136 miles). The NRL-Martin team then spent the first half of 1952 upgrading the Viking to fly higher with heavy payloads. These upgrades included increasing the diameter of the stage to 114.3 centimeters (3.75 feet) which allowed more fuel to be carried and permitted longer burn times. While the first Phase II Viking, Viking 8, broke loose during static testing on June 6, 1952, the four following

flights launched to the end of the basic program in February 1955 were resounding successes.

The Aerobee was a much smaller sounding rocket designed to carry more modest payloads to high altitude. This rocket was originally designed and built by the Aerojet Engineering Corporation under the guidance of the Applied Physics Laboratory at Johns Hopkins University. The name of the rocket was selected by Dr. James A. Van Allen who directed its planning. The initial design called for a two-stage vehicle weighing 540 kilograms (1,190 pounds) capable of hurling a 60 kilogram (130 pound) payload to an altitude of 125 kilometers (78 miles). The basic Aerobee was powered by a 12 kilonewton (2,600 pound) liquid propellant engine burning nitric acid and aniline. It was 5.74 meters (18.8 feet) long and 38 centimeters (15 inches) in diameter. It used a solid propellant booster stage at lift off to provide 93 kilonewtons (21,000 pounds) of thrust for 2.5 seconds. The first batch of 20 rockets was so successful that in 1952 the Air Force and Navy requested the development of an improved version initially designated Aerobee-Hi (and later called the Aerobee 150) that could send a 68 kilogram (150 pound) payload to a height of 275 kilometers (170 miles).

Vanguard is Born

The Navy wanted to improve its stable of sounding rockets to hurl payloads to higher velocities. In part this was so that higher altitudes could be reached but also so that nose cones could be tested under high-speed reentry conditions. This latter reason was to support the development of warheads for the long range missiles then being designed. One obvious choice was to lash together the two sounding rockets that were presently available: The Viking and Aerobee.

It was quickly recognized that optimizing the sizes of the Viking-Aerobee combination and adding a third stage would allow the launching of an Earth-orbiting satellite. Work through 1954 and 1955 ultimately resulted in a classified joint NRL-Martin feasibility study called simply "A Scientific Satellite Study". One proposal would use an improved Viking as a first stage and two solid rocket upper stages to place an 18-kilogram (40 pound) instrument-laden nose cone into a circular 347 kilometer (215 mile) orbit. The other would use a Viking first stage, an enlarged Aerobee for a second stage and a newly designed solid propellant third stage to place a 9-kilogram nose cone into a 488 kilometer (303 mile) orbit. The NRL was confident they could orbit a satellite within two years of a go-ahead.

The NRL study was only the latest in a long series of satellite proposals that had been completed during the previous few years. And like all the rest, the NRL study would have languished were it not for the International Geophysical Year (IGY). The IGY grew out of talks in international science circles for a Third International Polar Year. But by 1954 more scientific disciplines got involved and the scope broadened greatly resulting in the IGY which would run from July 1957 to December 1958. On October 4, 1954 the Committee of the IGY met in Rome to consider the launching of small satellites as part of the program. On March 14, 1955 the National Committee of the IGY endorsed the Rome directive. Finally on July 29, 1955, President Dwight Eisenhower announced that the United States would launch a small satellite as part of their contribution to the IGY.

While the United States had committed to launching a satellite, it was not necessarily going to be the one proposed by the NRL. In September of 1954 Project Orbiter, a joint Army Ordinance Corps-Office of Naval Research (NRL's parent organization) concept developed by Wernher von Braun's team, was submitted to Assistant Secretary of Defense Donald A. Quarles for consideration. By January of 1955, Quarles invited the U.S. Air Force to submit its own proposal to use an Atlas ICBM to launch a satellite. Quarles then deferred the decision on the satellite proposals to an Advisory Group on Special Capabilities. On July 5, 1955 the NRL formally submitted their satellite proposal to Quarles' Advisory Group as an all-Navy alternative to the others.

This last minute gamble paid off handsomely for the NRL. On September 9, 1955 the Advisory Group on Special Capabilities voted seven to one for the NRL Viking-Aerobee satellite proposal. The NRL proposal had two things going for it: First, the proposal, while made by the Navy, made use of non-military rockets thus satisfying President Eisenhower's intent that the American IGY satellite program be a "civilian" (or at least a non-military in appearance) program. Second, the development of the NRL satellite launch vehicle would not interfere with the Army's Redstone or the Air Force's Atlas development programs which were considered vital for national defense. On the day the Advisory Group made their selection, the Department of Defense (DoD) wrote a letter to the Secretary of the Navy

authorizing the Navy to proceed with the NRL proposal to launch a satellite during the IGY.

Vanguard Gets Started

While the NRL was responsible for the design of the rocket, a Technical Panel, headed by Richard W. Porter, under the National Academy of Science's IGY committee was charged with selecting the instruments for the NRL satellites. This panel recommended that instead of carrying a nose cone into orbit, a 76-centimeter (30-inch) sphere should be orbited to facilitate studies of upper atmospheric density. In the end a compromise was reached and the NRL satellite would now be a 51-centimeter (20-inch) sphere. This fundamental change in satellite design, along with other problems encountered early in the launch vehicle's development, required a redesign of Vanguard in the fall of 1955 to accommodate this physically larger payload. This change would also cost the project much time and money.

By March of 1956, not only was the redesign completed, but the program's management structure and mission was settled. Considering the size of the program, it was felt that one of the regular divisions of the NRL was not capable of taking on such a task. Instead a special group was formed with the NRL's John P. Hagen as the program manager and Milton Rosen, from the Viking program, as the technical director. In fact it was Rosen's wife, Josephine, who suggested the name "Vanguard" for the program which was officially adopted later on September 16, 1956. In the spring of 1956 the new management team defined exactly what Vanguard was: It was to be a complete system for space exploration. In the end this is why Vanguard is the only American satellite program to apply the same name to its rocket and satellite payload.

The first stage of the Vanguard rocket would consist of an lengthened Phase II Viking rocket to be built by the Martin Company. This new rocket would be powered by a General Electric X-405 engine based on the one used in the Army's Hermes rocket program. The new engine would burn kerosene and liquid oxygen to produce 125 kilonewtons (28,000 pounds) of thrust. Unfortunately problems with this stage's development were encountered almost immediately. The Navy had assumed that the original Viking development team at Martin would be available for Vanguard. Unknown to the Navy at the time the letter of intent was signed, Martin's Viking team had been broken up and most of its members were reassigned to work on the development of the Air Force's new Titan ICBM. Since the development of Vanguard was in to no way to interfere with any military rocket program, the NRL had to make do with the experience of the NRL Vanguard group and the remnants of the Martin team.

The Vanguard rocket (NASA)

As a result of the larger diameter Vanguard satellite design, the original Aerobee was now too skinny for use as a second stage. A new larger-diameter stage designed by Aerojet-General would be have to be used instead. It incorporated an AJ-10 rocket engine that developed 33 kilonewtons (7,500 pounds) of thrust using the storable propellants inhibited white fuming nitric acid and symmetrical dimethyl hydrazine. The guidance system, which was mounted on the second stage, would be developed by Minneapolis Honeywell Company.

The third stage, which weighed about 230 kilogram (500 pounds), required a real leap in solid rocket motor technology. As a result of the risks, two companies were selected to develop this stage in parallel. The Grand Central Rocket Company would develop a solid rocket motor employing a metal case similar to those used in earlier motor designs. A more novel approach was proposed by the Allegheny Ballistic Laboratory, which was a subsidiary of the Navy operated by the Hercules Powder Company. This design, called X-248, would use a much lighter fiberglass casing. The X-248 was a bit more risky to develop but it promised to allow heavier payloads to

be orbited by Vanguard. When completed, Vanguard would stand 22 meters (72 feet) tall and weigh about 22,600 pounds (10,300 kilograms) and liftoff. Even today it is one of the smallest satellite launchers ever built.

There was also the question of where the rocket would be launched. Most of the Viking rockets were launched from White Sands, New Mexico but the proximity of populated areas to where Vanguard's rocket stages would fall ruled out this site. Eventually Cape Canaveral, Florida, whose limited facilities were just being expanded for large ballistic missile test flights, was chosen. While the NRL hoped to use or share existing assets, in the end they were forced to build their own launch facility at the Cape as well as establish tracking facilities downrange so that it would not interfere with military missile development. Bendix Corporation received the contract to develop, construct, and install tracking devices. The system, called "Minitrack", was eventually used by many early American satellites. A network of optical and radio ground stations were also setup to track the satellite and receive data once in orbit.

Test Flights Begin

By the end of 1956, Project Vanguard was well underway and the first test launches were being prepared. The first test flight, TV-0, used the leftover Viking 13 rocket. It was successfully launched on December 8, 1956 and carried a payload of equipment to check the tracking and telemetry systems at Cape Canaveral. The next test flight on May 1, 1957, designated TV-1, used the Viking 14 rocket to test the Grand Central Rocket Company-built third stage. It successfully tested the solid rocket, its spin table, and other systems with a flight that reached a peak altitude of 193 kilometers (120 miles) and traveled 724 kilometers (450 miles) down range.

The first true Vanguard test flight, TV-2, was a test of Vanguard's first stage with dummy upper stages mounted above. TV-2 successfully flew on October 23, 1957 just a couple of weeks after the launch of Sputnik 1. The balance of the test program called for four additional test flights to be followed by seven "operational" flights. These initial test flights would not carry the 10 kilogram-class satellite intended for the operational flights. Originally a simple nose cone was to be carried but in July of 1957 it was decided that a small 1.47 kilogram (3.25 pound) test satellite would be used instead to exercise the tracking stations.

This test satellite would consist of a simple 16 centimeter (6.4 inch) polished aluminum alloy sphere equipped with two transmitters (one battery-powered and the other solar-powered) operating at frequencies around 108 MHz. While this test object did not carry any instruments, tracking it would provide information on atmospheric density, the shape of the Earth's geoid as well as confirm that orbit had been achieved.

The Vanguard satellite (NASA)

After the launch of Sputnik 1, William M. Holaday (who was responsible for guided missile development in the Office of the Secretary of Defense) and John Hagen briefed President Eisenhower on the status of Vanguard and the plans for the TV-3 flight. It was stressed that TV-3 was a test flight with the remote possibility of a satellite reaching orbit. Future plans for Vanguard would depend on the results of this test. On October 11, 1957 the White House released a statement that Project Vanguard would launch a satellite in the near future. Immediately the press went overboard and billed the TV-3 test flight as a satellite launch. Despite its experimental status, the Vanguard TV-3 test flight was the de facto American response to Sputnik.

On December 6, 1957 the first stage of TV-3 ignited and began to lift itself off. Only a meter (yard) off the pad and two seconds into the flight, the GE X-405 engine lost thrust. As if in slow motion, TV-3 settled back onto its launch pad, toppled over and exploded. The tiny grapefruit-sized test satellite rolled across the pad to safety and continued to transmit as TV-3 burned. The failure of what was suppose to be a test flight struck America to its core. Immediately Vanguard was dubbed "Kaputnik" and "Flopnik" by an unforgiving press. American leaders and the public lost faith in the program. While the next test flight, TV-3BU (for "TV-3 Back Up"), would fly

within the next couple of months, the DoD and White House needed more options before this public relations disaster turned into a political and military one. Von Braun's team would get their chance to launch a satellite.

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