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Sputnik 3: An IGY Orbiting Research Laboratory

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Introduction

During the six months following the launch of the Soviet Union's second satellite, Sputnik 2, public attention was focused on American efforts to catch up by whatever means available. By the end of April 1958, the ABMA (Army Ballistic Missile Agency) had orbited two satellites in three attempts while America's "official" satellite program, Project Vanguard, had managed to get only one small test payload into orbit after four tries. While these satellites, with a total mass of only 29.5 kilograms (64.9 pounds), were dwarfed by the 592 kilograms (1,303 pounds) of useful payload orbited by the Soviets, they still made some important discoveries including that of the Earth's Van Allen radiation belt. But while leaders in the United States debated the Soviet's capabilities, the danger they might pose, and America's response, everyone wondered when the next Soviet satellite would be orbited and what surprises it would bring.

Unknown to everyone in the West at the time, engineers and scientists associated with OKB-1 (Experimental Design Bureau-1) under Sergei Korolev were quite busy during this hiatus in Soviet satellite launches. After the launch of the first two Sputniks using stripped down versions of the R-7 rocket known as 8K71PS (also designated as SL-1 in the West), development flights of the 8K71 ICBM version of the R-7 (designated the SS-6 or Sapwood by NATO) continued with launches on January 30, March 29, and April 4 of 1958. While none of these tests were completely successful, the experience gained with each flight lead to incremental improvements in the performance and reliability of this giant machine.

By the spring of 1958 the first R-7 rocket specifically designed to launch satellites, known as the 8A91 (or the SL-2 in the West), was nearly ready to fly. The payload for this new launch vehicle would be the Object D satellite developed by a team headed by Mikhail Tikhonravov at OKB-1. Originally meant to be the first Soviet satellite when Korolev's proposal was authorized by the Soviet government on January 30, 1956, development of Object D and its 8A91 launch vehicle dragged on almost a year longer than originally anticipated. But finally everything was ready for launch.

As with the launch of Sputnik 2, the timing of the third Soviet satellite launch would be set by Soviet Premier Nikita Khrushchev's political agenda. Thanks to Korolev and his team at OKB-1, the quick development and launch of the first two relatively simple Sputniks was able to secure an early lead in the Space Race for the Soviet Union. But Khrushchev, who took full advantage of the propaganda value of this lead, wanted more space spectaculars to further improve Soviet communism's image abroad and deter Western aggression.

While there were a range of projects under development that could supply Khrushchev with another important space first, none would be ready until at least the summer of 1958. The only hardware at hand was the nearly completed Object D and its launch vehicle. But to Khrushchev, who was not interested in science for its own sake, the launching of just another satellite would hardly be spectacular. As a result, Khrushchev's enthusiasm for this project was lukewarm at best. But with nothing else available, the launch of Object D was set to occur before the upcoming Italian parliamentary elections in the hope of influencing its results. An 8A91 rocket and an Object D satellite, along with a backup to insure a successful flight, were prepared for launch.

An Orbiting Research Laboratory

While Khrushchev could care less, Object D promised to make the most comprehensive geophysical survey of the environment above Earth's

atmosphere for the IGY (International Geophysical Year). Object D was roughly conical shaped with a height of 3.57 meters (11.7 feet) and a base diameter of 1.73 meters (5.68 feet). To help cut development time and simplify the design, it was decided that Object D would not be outfitted with an attitude control system and would be left to drift instead. Like its predecessors, Object D would be powered by a bank of silver-zinc batteries. With a total mass of about 1.3 metric tons (2,900 pounds), Object D was more than twice as massive all the other Soviet and American satellites combined.

In addition to being the largest satellite ever launched up to this point, Object D would be the most sophisticated scientific satellite ever orbited. A commission of scientists and engineers established by the Soviet Academy of Sciences headed by Korolev's ally, Academician Mstislav V. Keldysh, with Korolev and Tikhonravov as his deputies decided what instruments Object D would carry. In the end they chose a dozen experiments that investigated virtually every area of interest to IGY scientists around the world. These included direct measurements of the density, pressure, and composition of the Earth's upper atmosphere. Measurements of the concentration of charged particles, cosmic rays, solar radiation, terrestrial magnetic and electrostatic fields, as well as the flux of micrometeorites would also be made. To round out the investigations, radio propagation studies would be performed using the satellite's transmitters that operated at frequencies of 20 and 40 MHz. All together 968 kilograms (2,130 pounds) of instrumentation and power supplies would be carried inside the pressurized interior of Object D.

The Sputnik 3 satellite.

To support all this instrumentation, Object D was equipped with a sophisticated high speed telemetry system called Tral D that would handle the flow of data. A tape recorder was also included in the system to store all of the instruments' observations when the satellite was not in contact with its controllers. Its contents could be downloaded via radio when the satellite was in sight of one of the new Soviet tracking stations.

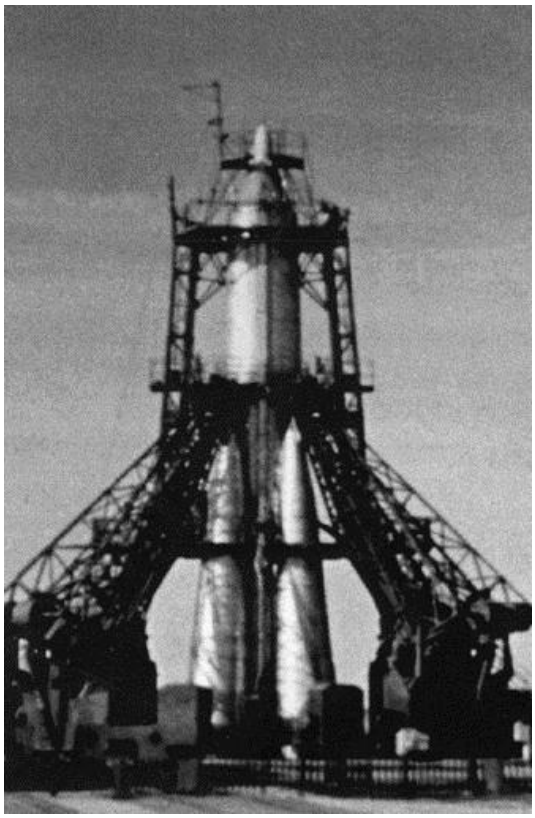
In order to maximize the scientific return of the mission, it was decided to place Object D in an elliptical orbit with a apogee of at least 1,500 kilometers (930 miles). Combined with the impressive array of instruments and the tape recorder, this orbit would allow the radiation belts first observed by the American Explorer 1 satellite to be systematically mapped in detail by a large array of instruments for the first time.

The first launch of the 8A91, with Object D mounted beneath an conical aerodynamic fairing on the nose, took place from the NIIP-5 Test Range in Soviet Kazakhstan on April 27, 1958. The 8A91, serial number B1-2, lifted off smoothly and all seemed to be going well at first. But as the rocket ascended, longitudinal resonance vibrations (an effect called "pogo") in the strap-on boosters increased in intensity as the propellant tanks emptied. The launch vehicle finally shook itself apart 88 seconds after launch. The debris reached a peak altitude of 13 to 15 kilometers (43,000 to 49,000 feet) and fell to the ground some distance downrange. The remains of the top secret Object D were subsequently recovered after a low profile search to keep it away from prying eyes. While the flight was a total loss, the ruggedness of the payload was aptly demonstrated when some of the would-be satellite's instruments continued to operate despite the explosively short ride. Unlike the American satellite program, the Soviet government made every effort to conceal the failure.

Sputnik 3 is Launched

After this first Soviet satellite launch failure, the backup 8A91 launch vehicle, serial number B1-1, was quickly prepared to launch a spare Object D. But while prelaunch checks of the payload's instruments showed everything to be in order, there were indications that the tape recorder was not operating properly. The engineer in charge of the telemetry system and recorder, Chief Designer Alexei F. Bogomolov of OKB MEI, did not want to be the one to hold up this important launch. Bogomolov insisted that the errant signals from the recorder were the result of electromagnetic interference from other sources in the testing room and that the unit was actually working properly. With increasing pressure from the Kremlin to launch, Korolev accepted Bogomolov's explanation despite the protests of the other engineers and preparations to launch the second Object D proceeded.

On May 15, 1958 the second 8A91 rocket lifted off from its pad in the Kazakh steppes for the fourth Soviet satellite launch attempt. This time the rocket operated perfectly placing its 1,327 kilogram (2,922 pound) payload, now called Sputnik 3, into a 230 by 1,880 kilometer (143 by 1,168 mile) orbit inclined 65.2 degrees to the equator. Once in orbit, Sputnik 3 separated from the spent core of its launch vehicle to start its mission. While this flight did not give the Soviets any new space firsts, the immense size of the satellite was a shock to the West and provided leaders with more evidence that the Soviet Union possessed an viable ICBM capability.



An 8A91 launch vehicle being prepared for launch.(NASA)

But as the Soviet propaganda machine hailed their latest space success, in reality all was not well with the new satellite. Much to the chagrin of everyone involved in the project, the suspect tape recorder failed to operate once in orbit. Because of the secrecy associated with the project, Soviet authorities did not share with the rest of the world the information needed to receive and decode Sputnik's signals thus losing the opportunity to recover data gathered over the most of the globe. This limited the new Sputnik's measurements to the times it was over Soviet territory. Since Sputnik 3 was near the perigee of its orbit during these periods, it could only make observations up to an altitude of about 1,000 kilometers (600 miles). While extremely useful data could still be gathered, project scientists would be unable to make the systematic series of measurements they hoped to make.

It was only after the scientific results of the first American and Soviet satellites were studied in detail was it was realized how the loss of the tape recorder prevented Soviet scientists from making an important scientific find. After the discovery in late 1958 by American scientists that the Van Allen radiation belt is in fact composed of distinct inner and outer portions, Soviet physicist Sergei Vernov realized that Sputnik 3 had returned the first measurements from the outer belt. But because of the loss of the tape recorder, he and his colleagues were unable to place their spotty data into the broader context required to recognize the significance of their observations.

With hindsight, Soviet authorities claimed on March 6, 1959 that Vernov had discovered the outer belt and that this result had actually been reported at an IGY meeting the previous August - long before the American's announcement of their discovery. Unfortunately the Soviet claim was rejected since such a statement was not explicitly made in their August 1958 report and there was no way to unambiguously identify the outer belt from the Soviet data published up until that time. Still, a popular Russian joke at the time proposed that the Van Allen belt be renamed the "Van Allen-Vernov Belt".

Aftermath of the Mission

While many of the more power hungry instruments finished their observations in the first few weeks of flight, Sputnik 3 continued to return useful data until its orbit finally decayed and the satellite burned up on May 6, 1960. Despite the fact that the mission was largely successful, there was no support in the Soviet government for follow-up missions. Khrushchev was far more interested in space spectaculars than the systematic exploration of space. This combined with limited resources at OKB-1 and its network of other design bureaus resulted in continual reassessments of project priorities during 1958.

In the end, three nearly-completed scientific satellites in the shops at OKB-1 that were to follow Sputnik 3 into Earth orbit were never launched. Development of oriented versions of the Object D and other proposed satellites that would use the 1.5 metric ton (3,300 pound) payload capability of the 8A91 launch vehicle were also eventually scrapped. Since the next

round of missions would require launch vehicles with much greater payload capabilities, the 8A91 was quietly retired after only two launches.

Experience gained from the 8A91 flights was not wasted and helped Korolev's engineers iron out problems with the development of the R-7 ICBM and its derivatives. In the mean time the basic 8K71 would be modified to carry larger payloads into space in support of the next round of space spectaculars. With the relatively "easy" space firsts achieved, Khrushchev charged Korolev and his team with attaining the next goal: The first probes to the Moon.

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