



The First Race to the Moon

by Andrew J. LePage
August 1998

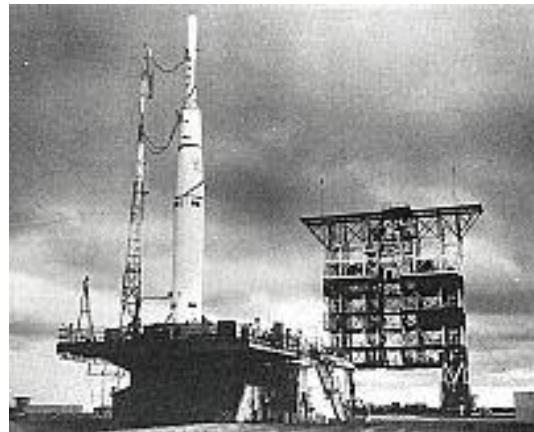
Introduction

By the beginning of August 1958 both the United States and the Soviet Union were hurrying preparations to launch their first probes to the Moon. In a bid to get the United States to the Moon first, ARPA (Advanced Research Projects Agency) had funded Operation Mona which went by the cover name "Pioneer" (see **Operation Mona: America's First Moon Program** in the April 1998 issue of *SpaceViews*). According to the plan, the U.S. Air Force (USAF) would make the first three Pioneer launches while the Army Ballistic Missile Agency (ABMA) would take responsibility for the last pair. For their first mission, the USAF prepared a Thor-Able rocket to launch a 38.1 kilogram (83.8 pound) probe from the Atlantic Missile Range (AMR) in Florida that would enter lunar orbit.

A quarter of the way around the planet, engineers at the Soviet design bureau OKB-1, under Sergei Korolev, were busy preparing their first E-1 lunar probe in the hopes of beating the Americans (see **The Soviets Reach for the Moon** in the June 1998 issue of *SpaceViews*). Erected on its pad at the NIIP-5 Test Range in Soviet Kazakhstan was the first 8K72 launch vehicle serial number B1-3. Based on the Soviet's R-7 ICBM, the goal of this three-stage variant was to hurl a payload of about 360 kilograms (790 pounds) towards a lunar impact. But unresolved problems encountered during development flights and static firings of new versions of the RD-107/108 engines used by the basic R-7 troubled Korolev's engineers. Despite this, the imminent launch of the first Pioneer and pressure from superiors to beat the Americans forced Korolev to attempt a launch anyway. A neck-and-neck race to be first to the Moon had developed.

The First Launches

Celestial mechanics and trajectory requirements dictated that the USAF Pioneer launch would be first. On August 17, 1958 at 8:18 AM EDT, Thor 127 lifted off from Pad 17A at AMR and into a clear Florida sky. For the first time in the history of our species, mankind was attempting to reach the Moon. All seemed to be going as planned as the Thor-Able accelerated towards space. But as the quickly rising rocket passed the altitude of 15 kilometers (50,000 feet) 77 seconds after launch, it exploded. Transmissions from the still active Pioneer probe were received until it plummeted into the Atlantic Ocean 123 seconds later. The first ARPA-sponsored Pioneer mission had failed. Based on an analysis of the wreckage recovered by divers, it was determined that the loss was caused by a failure in a bearing in the turbopump that supplied fuel to the Thor's MB-3 engine.



The Thor-Able launch vehicle before the launch of the first USAF Pioneer lunar probe on August 17, 1958. (Photo courtesy of NASA)

Back in the Soviet Union preparations to launch the first E-1 probe early on August 18 were falling behind. Frustrated by a series of malfunctions on the

pad, Korolev finally called off the launch after hearing of the Pioneer failure. The uncooperative 8K72 rocket was removed from the pad and returned to the MIK assembly building in hopes of making another launch attempt in a month. But for this September launch, Korolev's team would have the stage to themselves. Not knowing how close the Soviet Union was to launching their first lunar probe, USAF officials diverted the Thor-Able rocket scheduled for use in a September 14, 1958 Pioneer launch to "Project Bravo". The purpose of this program was to determine the feasibility of using the Thor-Able as an ICBM. While being first to the Moon was important, national security was more so.

On September 23, 1958, 8K72 B1-3 was back on its pad ready to try for the Moon again. The unproven rocket smoothly lifted off during its brief launch window and accelerated towards its target. But as the propellant tanks of the core and strap-on boosters emptied, longitudinal resonance vibrations (an effect called "pogo") appeared. Pogo had been encountered in some earlier flights of the R-7 and Korolev's engineers thought they had understood and corrected for its cause. The reappearance of this problem would finally doom the flight 93 seconds after launch when the strap-on boosters broke loose. The now free flying collection of rockets with the E-1 No. 1 probe still attached tumbled to the ground and exploded on impact. The Soviet's first attempt to reach the Moon ended as ingloriously as the American's. But unlike the American attempt, this failure was kept quiet firmly establishing the Soviet government's policy of keeping launch failures secret.

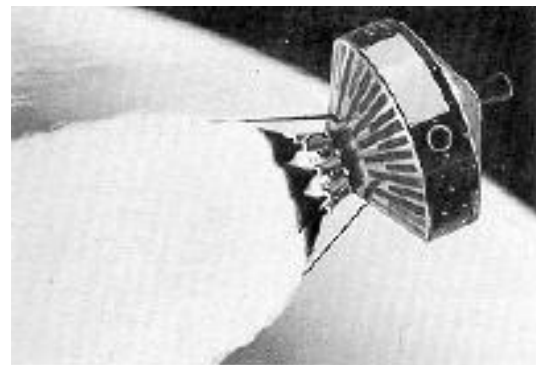
The Race Heats Up

Another 8K72, serial number B1-4, was hastily modified by Korolev's engineers for another clandestine launch attempt the next month. As in August, Korolev would have to race against the Americans who were preparing another Thor-Able to launch a 38.3 kilogram (84.4 pound) Pioneer probe towards lunar orbit. But unlike the August launch, ARPA was no longer in charge of the American effort. An act of Congress officially established the National Aeronautics and Space Administration (NASA) to run the United States' civilian space program starting on October 1, 1958. Much to the chagrin of those who wanted the U.S. Department of Defense (DoD) to run the show, President Dwight Eisenhower transferred most of the DoD's purely scientific space projects to the new agency including ARPA's Pioneer program. With ARPA and the USAF relegated to an advisory role, the next Pioneer

mission would be the first launch for the fledgling space agency.

As before, trajectory requirements allowed the United States to get off the pad first. On the morning of October 11, 1958 at 3:42:13 AM EST, Pioneer 1 was launched towards the Moon just seconds after the opening of its window. Unlike the previous attempt, the Thor first stage operated properly this time giving the high speed Able stages their chance to operate. The second stage fired followed by a nominal burn of the X-248 third stage. It seemed that the launch was a success and the probe would reach the Moon near midday on October 13.

Meanwhile in the Soviet Union, word arrived about the successful launch of Pioneer 1 as Korolev and his team pushed hard to make their launch window during the local morning of October 12. While Pioneer 1 was the first up, the faster trajectory of Korolev's E-1 No. 2 probe would allow it to reach the Moon a couple of hours before the American probe giving the Soviet Union another space first. After a night of hectic preparations, the second 8K72 lifted off its launch pad to chase after its American competitor. But despite the best efforts of Korolev and his team, the pogo effect that destroyed the first 8K72 launch vehicle reappeared in the new rocket as it climbed towards space. After a flight of 104 seconds, 8K72 B1-4 finally blew up under the stress. With this latest failure, future launch attempts were put on hold until the cause of the malfunction could be ascertained and a fix implemented.



Pioneer 1 firing its vernier rockets to boost its speed. (Photo courtesy of TRW)

Fortunately for Korolev and OKB-1, it was soon discovered that Pioneer 1 was not headed for the Moon after all. A programming error in the second stage timer caused it to shut down too early leaving the lunar probe travelling 152 meter per second (340 miles per hour) short of its intended final velocity of 10.744 kilometers (6.677 miles) per second. In

addition it was discovered that Pioneer 1 was pointed 2.1 degrees off course. Even after firing its vernier rockets to gain another 48 meters per second (107 miles per hour), Pioneer 1 would reach no higher than 114,000 kilometers (70,700 miles) before arcing back towards the Earth.

While reaching the Moon was out of the question, Pioneer 1 could still use its instruments to investigate this previously unexplored region of space. For the first time the full extent of the Van Allen radiation belt was probed. Pioneer 1 found that it extended to 8,000 to 11,000 kilometers (5,000 to 7,000 miles) above the equator before fading out at an altitude of 15,000 kilometers (9,300 miles). The Van Allen belt would not be a barrier to piloted missions beyond the Earth as some had begun to fear.

To continue gathering useful data, ground controllers came up with an alternate mission plan. They decided to ignite Pioneer's 13 kilonewton (3,000 pound) thrust solid retrorocket motor near apogee to raise the probe's perigee up to 32,000 kilometers (20,000 miles). Orbiting the Earth about every 60 hours, Pioneer 1 could observe the outer reaches of Earth's magnetosphere until its batteries ran out.

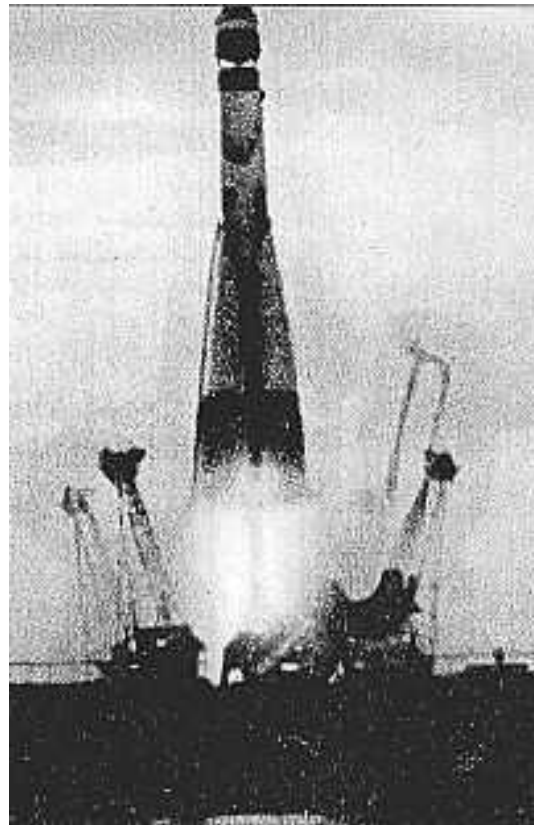
While this plan promised to salvage something out of the flight, bad luck would strike again. The launch aim error had left Pioneer 1 spinning at an unintended angle to the Sun. The probe's simple thermal control system could not adapt to the change and internal temperatures fell below freezing. When the command to ignite the retrorocket was given, it failed to fire because of the cold. Pioneer 1 was now forced to continue in its ballistic path which ended in a fiery reentry over the South Pacific Ocean 43.3 hours after launch. Even though Pioneer 1 did not reach the Moon, the record breaking flight still helped America's flagging morale.

More Launches... and Failures

While Korolev's efforts to get the Soviet Union to the Moon first got a reprieve with the failure of Pioneer 1, it was only a brief one. The last of the original ARPA Pioneer orbiters was immediately prepared for launch in the hopes of beating the Soviets. Unknown to everyone in the West, this time the American attempt would go unanswered as a commission of Soviet engineers and scientists continued to investigate the cause of the 8K72 launch failures.

But just as Korolev and his team was learning from their failures, Korolev's American counterparts learned from theirs. In order to avoid another

premature shutdown of the Thor-Able second stage, the guidance system was outfitted with a Doppler command system that would minimize trajectory errors and insure a more accurate course to the Moon. On November 7, 1958 at 2:30 EST in the morning the Thor-Able carrying the 39.6 kilogram (87.3 pound) Pioneer 2 blasted off. While the first and second stages operated perfectly this time, the third stage failed to ignite thus dooming the latest NASA Moon probe. Pioneer 2 reached a peak altitude of 1,550 kilometers (963 miles) before falling back to Earth 42.4 minutes after launch.



The launch of a Soviet 8K72 rocket carrying an E-1 lunar probe. (Photo from author's collection)

With this last Pioneer orbiter flight, NASA's lunar hopes turned to the pair of smaller ABMA-developed Pioneer flyby probes which would be ready to launch in December. But the different trajectory requirements of this probe dictated a launch window that opened two days after the next Soviet E-1 launch attempt. Fortunately the commission charged with finding the reason for the first two 8K72 launch failures were able to trace the source of the problem. While pogo had been largely eliminated from the two-stage R-7 variants, it was discovered that the addition of the new Blok E third stage raised the rocket's center of gravity in such a way to make the

problem reappear. A simple baffle was introduced in the boosters' oxidizer pipeline to eliminate the effect and Korolev's team was ready to try for the Moon again.

The next 8K72, serial number B1-5, lifted off on December 4, 1958 carrying E-1 No. 3. Unlike the first two flights, this time the rocket flew flawlessly through to the dropping of the four strap-on boosters. The pogo problem had finally been solved. But 245 seconds after launch as the core was still firing, thrust in its RD-108 engine dropped to 70% and then quit altogether. A failure in the engine's turbopump had brought the Soviet's third attempt to reach the Moon to a premature end.

While rumors of this and other launch failures circulated for years, details would remain secret until the fall of the Soviet Union 34 years later. In the mean time, engineers at OKB-1 would have to prepare another E-1 probe and 8K72 launch vehicle for a fourth attempt after the New Year. But before

then, NASA's Pioneer 3 would get its chance to reach the Moon first.

Bibliography

Kenneth Gatland, *Robot Explorers*, MacMillan Co., 1972

Andrew J. LePage, "The Great Moon Race: In the Beginning...", *EJASA*, Vol. 3, No. 10, May 1992

Yegor Lyssov, "Soviet Moon Probes" (Correspondence), *Spaceflight*, p. 318, Vol 34, No. 10, October 1992

Robert Reeves, *The Superpower Space Race*, Plenum Press, 1994

Timothy Varfolomeyev, "Soviet Rocketry that Conquered Space Part 3: Lunar Launches for Impact and Photography", *Spaceflight*, pp. 206-208, Vol. 38, No. 6, June 1996