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Catching Up in the Moon Race

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Introduction

Before NASA was founded in October of 1958, the USAF had ambitous plans for space exploration. During the national debate that followed the launch of Sputnik, the USAF was trying to position itself so that it could dominate the nation's infant space program. Even after the Advanced Research Projects Agency (ARPA) was founded in February of 1958 and given the task of coordinating America's military space programs, USAF efforts and plans figured prominently.

The USAF's first step beyond the Earth orbit was a lunar exploration program approved by President Eisenhower as part Operation Mona on March 27, 1958 (see **Operation Mona: America's First Moon Program** in the April 1998 issue of *SpaceViews*). In conjunction with the builders of their first Moon probes, STL (Space Technology Laboratory - a division of TRW), the USAF also began to study follow on missions to lunar orbit and even to the planets with the closest, Venus, given priority. Little was known about Earth's near twin at this time and many believed Venus ranked with Mars as a likely abode for extraterrestrial life making it a desirable target for exploration.

But such missions would require a rocket larger than the Thor-Able used in the first USAF lunar orbiter missions. With more advanced upper stages still under development, a logical short term solution to the problem was to place the Able upper stages on a rocket larger than the Thor IRBM. In the end the USAF selected their Atlas ICBM and the Atlas-Able was born.

The Atlas-Able

The first stage of the Atlas-Able consisted of a modified Convair-built Atlas D ICBM. The Atlas program began in February of 1954 when it was recognized that an ICBM was a feasible weapon. The Atlas made use of an innovative stage-and-a-half design where a pair of booster engines were jettisoned after they were no longer needed during ascent. A sustainer engine would then push the payload towards its target feeding off of the remaining propellants in the missile's lightweight integral propellant tanks that used internal pressure to maintain the stiffness of the missile. The first model, Atlas A, only used the pair of booster engines to send the rocket on an abbreviated test flight. Atlas 4A made the first test flight on June 11, 1957 but failed. The first successful test, Atlas 12A, came on December 17 of that year.

The next model, the Atlas B, had a full complement of engines and would test the complete weapon system from launch to injecting a dummy warhead into an intercontinental trajectory. The first Atlas B was tested in July of 1958 but failed. The second flight, on August 2, did succeed and the Atlas finally flew at full range in November. On December 18, a stripped down, "hot-rod" version of the Atlas B was launched into Earth orbit carrying an experimental communication payload as part of ARPA's Project Score (see **The Talking Atlas** in the December 1998 issue of *SpaceViews*). By the end of the Atlas B program on February 4, 1959, ten Atlas B missiles had been launched with six successes.

The next model, the Atlas C, was used for additional testing and training of Strategic Air Command (SAC) missile crews. Eventually deployed in limited numbers, the Atlas C was armed with a General Electric (GE) Mk 2 warhead. During its test program, which ran from December 23, 1958 to August 24 the following year, only three Atlas C missiles met their objectives out of six attempts.

The Atlas D, deployed operationally in semi-hard coffin installations, was outfitted with a GE Mk 3 warhead. In addition to its role as an ICBM, the Atlas D was designated for use as the booster for USAF launch vehicles like the Atlas-Agena (see **Spy in the Sky** in the March 1, 1999 issue of *SpaceViews*). Eventually the Atlas D was also selected as the launch vehicle for NASA's Mercury orbital missions (see **Giving Mercury Wings** in the September 1, 1999 issue of *SpaceViews*). The first Atlas D test launch in April of 1959 failed as did the next three attempts. The first Atlas D to meet it goals finally flew on July 28. After another successful flight from the Pacific Missile Range in California on September 9, the Atlas D was declared "operational", if not yet very reliable.

Launch of Atlas-Able 4 carrying Pioneer P-3 on November 26, 1959. (NASA)

The upper stages of the Atlas-Able were nearly identical to those used in the not very successful Thor-Able. Major differences appeared in the second stage, which included lengthening it by 0.65 meters (2.1 feet) and substituting a lighter Aerojet AJ10-101 engine for the AJ10-42 used earlier. The X-248 solid rocket motor built by the Allegheny Ballistic Laboratory topped off the stack as it did on the Thor-Able.

By the fall of 1959, the Able combination along with its close relative, the Vanguard upper stages, had an abysmal record: The two out of three success record for the USAF Thor-Able entry tests of 1958 were the highlight of Able's career. Out of the five flights of the Thor-Able Space Carrier, only the launch of the 64-kilogram (142-pound) Explorer 6 on August 7, 1959 was completely successful (see **The Early Explorers** in the August 8, 1999 issue of *SpaceViews*). The upper stages were responsible for three of the four launch failures including the USAF's first attempts to reach the Moon as part of Operation Mona.

The upper stages of the Vanguard echoed Able's poor performance racking up only two additional successes since the launch of Vanguard 1 (see **Vanguard and Its Legacy** in the February 1, 1999 issue of *SpaceViews*). The upper stages were found responsible for six of the eight Vanguard launch failures. In total, Able and its relatives had flown successfully only six times out of sixteen opportunities. Combined with the less than stellar success record of the Atlas at that time, things were bound to go wrong with the Atlas-Able.

A Change of Plans

Once NASA came into being in October of 1958, all space science programs run by the military were transferred to the new civilian space agency. This included not only the remaining flights originally part of ARPA's Operation Mona, but also the follow-on probes the USAF was planning. In November of 1958 NASA essentailly adopted the existing USAF follow on program and started plans to launch a pair of 169 kilogram (373 pounds) Pioneer probes to Venus during the June 1959 launch window. After this a lunar orbiter mission was planned. But these plans were soon to change. After the successful launch of Luna 1 in January 1959 and the failure of the first four American Pioneer lunar probes (see **Shooting for the Moon** in the January 1, 1999 issue of *SpaceViews*), the near term goals of the Pioneer program were redirected: Instead of going to Venus, the new Pioneers would be sent to the Moon in hopes of beating the Soviet Union into lunar orbit.

Ideally agency officials would have wanted more time and resources to improve the reliability of the Atlas-Able by replacing the Able stages with improved versions from their Thor-Delta program (later known just as Delta). But budget limitations brought on by the spiraling costs of other NASA programs and the fear of what the next Soviet space achievement would bring did not allow it. The first launch was planned for the fall of 1959.

Despite the problems, the new Pioneer lunar orbiters were the most advanced American spacecraft to date. The new Pioneer was a spin stabilized sphere one meter (39 inches) in diameter weighing 169 kilograms (372 pounds). Attached to the exterior were four paddles covered with solar cells that would be deployed after separation from its launch vehicle. At each end of the probe was a small rocket engine: One to be used in bursts of up to four seconds for course corrections and the other to brake the probe into lunar orbit when it came within 8,000 kilometers (5,000 miles) of the Moon. The hydrazine propellant for these engines was kept in a 66-centimeter (26-inch) diameter sphere inside the probe. The hydrazine would spontaneously decompose inside the throat of the engines after it had passed over a bed of an aluminum oxide catalyst.

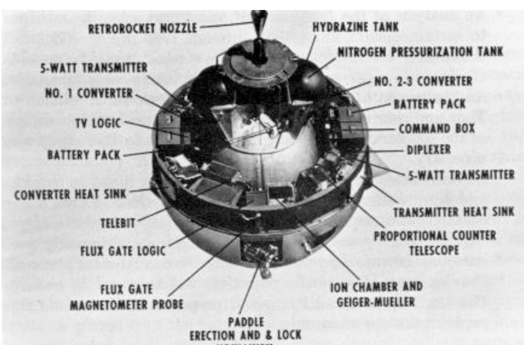

Diagram of the Pioneer lunar orbiter. (NASA)

Thermal control was provided by 50 four-blade blue and white butterfly fans controlled by bimetallic coils. As they heated and expanded, the butterfly fans would open, exposing more white and less blue to reflect heat. When cooled, the butterfly fans would close, exposing more blue to allow more heat to be absorbed. This complex thermal control system was required due to the amount of instrumentation carried and the more demanding thermal environment this mission would encounter.

Each probe carried a variety of instruments to measure the magnetic and radiation environment around the Moon. Instruments included two magnetometers, a high radiation counter, an ionization chamber, Geiger-Mueller counters, a low-energy radiation counter, a plasma probe, and a scintillation spectrometer to measure the energy of solar protons. In addition, a simple television scanner was carried to return the first images of the unseen lunar farside.

The Missions

One of the biggest difficulties for the new Pioneer Moon program was the availability of Atlas D missiles. The manufacturer's assembly lines simply could not keep up with the demand for the missile. While still important to national prestige, NASA's new Moon probes had lower priority than Defense programs and Project Mercury. In order to get their first new Pioneer launched in October 1959, officials decided to substitute a surplus Atlas C as the booster. But the program suffered its first set back on September 10, 1959 when Atlas-Able 1 caught fire and exploded on the launch pad during a static test firing of Atlas 9C, fortunately without the payload attached.

A Pioneer lunar orbiter being prepared for launch. (NASA)

For the next attempt, NASA diverted an Atlas D from its Mercury program. Atlas 20D was originally the backup launch vehicle for Mercury's successful Big Joe test flight and was no longer needed. On November 26, 1959 Atlas-Able 4 with a Pioneer orbiter designated P-3 as the payload lifted off from Pad 14 on the Atlantic Missile Range (AMR) in

Florida. All was going well until about 45 seconds into the flight when the bulbous fiberglass payload shroud ripped away under the aerodynamic loads destroying the third stage and probe.

By December 1959 (40 years ago this month) a shortage of Atlas D missiles, a lack of funding, and scheduling conflicts with other programs for the only two Atlas launch pads at the AMR forced NASA to delay the next Pioneer launch for almost a year. On September 26, 1960 Atlas-Able 5A, carrying Pioneer P-30 under a reinforced nose shroud, lifted off from Pad 12. Since the lunar farside had already been photographed by the Soviet Union 11 months earlier (see **Photographing Luna Incognita** in the October 15, 1999 issue of *SpaceViews*), the television camera on P-30 was replaced with more scientific equipment raising its total mass to 176 kilograms (387 pounds). While the Atlas 80D booster operated as intended, the oxidizer system in the second stage's engine malfunctioned forcing an early shut down. The payload was destroyed upon reentry over what is now South Africa 17 minutes after launch.

The last Pioneer orbiter, P-31, was launched on December 15, 1960 using Atlas-Able 5B. Like so many Atlas flights at that time, the Atlas 91D booster exploded at an altitude of 12,000 meters (40,000 feet) after only 68 seconds of powered flight. A salvage effort was started to retrieve the debris out of the 21-meter (70-foot) depths of the Atlantic off Florida to determine the cause of this latest Atlas D failure.

In the end, NASA's first probes to the Moon suffered the same fate as all but one of the original ARPA Moon missions: As debris scattered on the floor of the Atlantic or as fine dust in the upper atmosphere. While the Soviet Union suffered from their share of lunar failures, their successes were spectacular. In this first round of the race to the Moon, the Soviets had clearly won. The stage was now set for the next round in the race to reach the Moon - attempting a landing.

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