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Operation Mona: America's First Moon Program

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Introduction

During the opening months of the Space Age, the American space program was in total disarray as a wide range of civilian and military interests vied for control. In the hopes of quickly unifying the military's research projects and securing a major share of the nation's future space program for the Department of Defense (DoD), Secretary of Defense Neil H. McElroy established the Advanced Research Projects Agency (ARPA) on February 7, 1958. ARPA was charged with coordinating all the DoD's advanced research, including their space projects, to help eliminate duplicate efforts. Since the entire space program at this time was connected in some way to the military, by default ARPA would be in charge of the American space program until Congress and the Administration made other arrangements.

On March 27, 1958 President Eisenhower approved McElroy's plan for ARPA to undertake its first series of space missions. The most ambitious of these was labeled "Operation Mona" which called for the launching of five probes to the Moon. Three of these would be lofted by the U.S. Air Force (USAF) Ballistic Missile Division while the Army Ballistic Missile Agency (ABMA) would be responsible for the last two. ARPA believed that a successful military lunar mission would not only help the United States leap frog ahead of the Soviet Union in the space race but also add credibility to the military presence in space. It was felt by some that these missions could help prevent any civilian space agency that Congress might create from taking an important share of the space program from the DoD. In addition, the long-distance guidance and tracking experience gained in the project would be useful for future scientific and weapons programs.

USAF Moon Probe

The USAF would have the first shot at the Moon with the more ambitious of the two sets of ARPA probes. For these missions the USAF planned to use their new Thor-Able rocket as the basis of a launch vehicle. The two-stage Thor-Able 0 had been cobbled together from existing rocket components to perform reentry tests of the Atlas ICBM warhead design. USAF planners felt the Thor-Able 0 could be modified with relative ease into the three-stage Thor-Able I Space Carrier for their lunar mission.

The first stage of this rocket was the Thor intermediate-range ballistic missile (IRBM) with a range of 2,600 kilometers (1,600 miles). The Thor, built by the Douglas Aircraft Company (which became McDonnell-Douglas and much later merged with Boeing) for the USAF, was about 18.6 meters (61 feet) long and 2.4 meters (8 feet) in diameter at the base. The Thor DM1812-6 variant used for the Thor-Able I incorporated a Rocketdyne MB-3 powerplant burning kerosene and liquid oxygen (LOX) to produce 668 kilonewtons (150,000 pounds) of thrust.

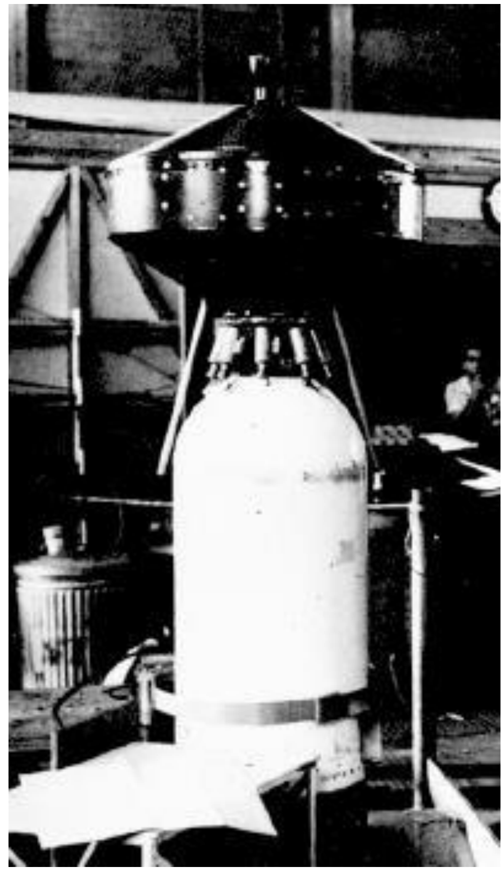
In the Thor-Able configuration, Thor's nuclear warhead was replaced with an adapter upon which the upper stages were mounted. These stages were modified versions of the ones originally developed for the Navy's Vanguard program. The second stage was modified by STL (Space Technology Laboratory - a division of TRW) for Douglas Aircraft for the Thor-Able program. In the Able configuration, the second stage retained its original 0.85 meter (2.8 foot) diameter but it was shortened to 5.8 meters (19 feet) to optimize its size for the Thor-Able mission. The second stage's original Aerojet General AJ10-37 liquid propellant rocket engine was replaced with the substantially improved AJ10-41 engine for the Thor-Able I.

The third stage was the fiberglass-cased X-248 Altair solid motor built by Allegheny Ballistic Laboratory. This innovative lightweight motor had been developed by the Navy as a backup for the more conventional motor developed by the Grand Central Rocket Company for Vanguard. The X-248 was later incorporated into several other rocket designs including a high performance version of the Vanguard. All together, the Thor-Able I was 27 meters (88 feet) tall from its base to the top of its hemispherical "mushroom cap" payload fairing.

Since the Able stages were essentially the same as those used by Vanguard, they unfortunately shared many of its problems. By the end of the summer of 1958, malfunctions in the second stage of the Vanguard were responsible for four of Vanguard's five failures. During this period the upper stages of the Vanguard operated correctly only once to place Vanguard 1 into Earth orbit on March 17, 1958 (see **Vanguard 1: The Little Satellite That Could** in the March 1998 issue of *SpaceViews*).

The Thor-Able 0 reentry tests were the only additional successes for this upper-stage design during this time. The first Thor-Able 0 was launched on April 23, 1958 but blew up 146 seconds into the flight because of a turbopump failure in the Thor No. 116 first stage. While the payloads were not recovered, the Thor-Able 0 itself operated successfully on the flights launched on July 9 and 23 of 1958. Theoretically, the Thor-Able I could place 160 kilograms (350 pounds) of payload into a 480-kilometer (300-mile) high orbit or 39 kilograms (85 pounds) into a direct ascent escape trajectory.

Only months after the launch of the first Earth satellites, the USAF planned to send its three Moon probes into lunar orbit. Under contract by the USAF, STL built three 38-kilogram (84-pound) spin-stabilized probes each carrying 18 kilograms (39 pounds) of scientific instruments. The orbiter consisted of a wide cylindrical belt joining two flattened fiberglass cones. At the end of the bottom cone was a ring of eight vernier solid rockets which could be fired to correct the probe's trajectory. At the other end of the probe was a single Thiokol Falcon solid rocket motor that would be fired 65 hours after launch by to slow the probe into lunar orbit. Removable black and white stripes applied to the probe's exterior before launch were used for passive thermal control.



A USAF lunar orbiter attached to the final stage of its Thor-Able launch vehicle (NASA)

The probe's wide belt carried the control systems, batteries, radio, and scientific instruments to measure magnetic fields, radiation, and micrometeorites. The USAF probe also carried a simple camera in the hopes of obtaining the first close-up images of the Moon. This camera weighed only 400 grams (14 ounces) and consisted of a small parabolic mirror that focused infrared radiation received from the Moon onto a special cell. One line of the image would be obtained for each revolution of the spinning probe. The scene could then be slowly built up one line at a time as the probe moved in relation to the Moon. On the remote chance that the probe should accidentally impact the Moon, the spacecraft was decontaminated to minimize the chances that organisms from Earth would corrupt any future biological investigations on the Moon. The original plan called for all three USAF probes to be launched during the summer of 1958.

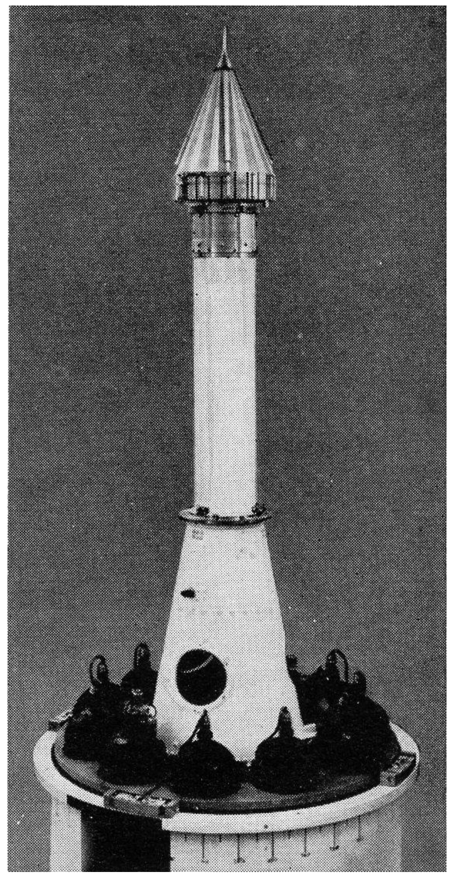
The ABMA Moon Probe

After the USAF launched their three probes, the ABMA was authorized to proceed with theirs. The ABMA Moon project had its origins in an early-1956 proposal with the Jet Propulsion Laboratory (JPL) to use a modified ABMA-developed Jupiter IRBM to launch two deep space probes during the IGY. With ARPA's approval, Wernher von Braun and his team set out to build the launch vehicle that they needed for the mission: The Juno 2. This new launch vehicle consisted of a modified Jupiter IRBM topped with an improved version of the JPL solid rocket cluster used on the Juno 1 launch vehicle (see **Project Orbiter: Prelude to America's First Satellite** in the January 1998 issue of *SpaceViews*).

As the first stage of the Juno 2, the kerosene and LOX tanks of the Jupiter retained their original 2.67 meter (8.75 foot) diameter but were lengthened by a total of 0.92 meters (3.0 feet) making the rocket 16.84 meters (55.24 feet) long. This prolonged the burn time of the 668 kilonewton (150,000 pounds) thrust Rocketdyne S3D engine by 20 seconds to a total of 182 seconds. Mounted on top of the first stage under an aerodynamic shroud was the instrument compartment and a JPL-developed, three-stage solid rocket cluster similar to that used by the ABMA Jupiter C and Juno 1 rockets. Modifications of this cluster from these earlier versions included filling the third and fourth stages with a higher performance propellant and changing the original stainless steel casing of the fourth stage to a lighter weight titanium casing.

The upper stage cluster of the Juno 2, when used with the Jupiter C and Juno 1 launch vehicle, was quite reliable if somewhat inaccurate due to the inconsistent performance of early solid rocket motors. The three Jupiter C flights were largely successful and two of the three Juno 1 failures were due to an upper stage malfunction. It operated successfully three times, orbiting Explorers 1, 3, and 4 (see **Explorer: America's First Satellite** in the February 1998 issue of *SpaceViews*). Theoretically, the Juno 2 could place 43 kilograms (95 pounds) of payload in a 480-kilometer (300-mile) high Earth orbit or up to 7 kilograms (15 pounds) of useful payload on a direct ascent escape trajectory.

On May 2, 1958 ABMA contracted the builder of the first Explorer satellites, JPL, to build a pair of tiny probes that the Juno 2 could launch towards the Moon. Weighing just 5.9 kilograms (13 pounds) each, the probes were essentially a 23-centimeter (9-inch) wide cone with a 8-centimeter (3-inch) spike antenna on the top. They were 51 centimeters (20 inches) long and constructed of gold-washed fiberglass. The exterior was gold plated and striped with paint for passive thermal control. The electrically conductive gold plating on the cone also served as an unsymmetrical dipole antenna element in conjunction with the spike antenna. At the squat cylindrical base of the probe was a despin mechanism consisting of two 1.5-meter (60-inch) long weighted wires. As the wires unwound, the payload's spin rate would decrease from 415 to 11 revolutions per minute. Located inside the probe was a 500-gram (1.1-pound) transmitter with an effective power of 180 milliwatts. The power supply for the transmitter and instruments consisted of a set of eighteen mercury cells.



A JPL/ABMA Moon probe attached to the upper stage cluster of its Juno 2 launch vehicle (NASA/JPL)

Originally these JPL-built Moon probes were to carry a tiny photographic package capable of obtaining a single photograph of the Moon's far side during a close flyby. A photoelectric triggering device would trip the camera's shutter when the Moon was in the detector's field of view and closer than 32,000 kilometers (20,000 miles). But with the discovery of the Van Allen radiation belts by the first Explorer satellites, the ABMA Moon probes' primary instrument was changed to a pair of Geiger-Mueller tubes to obtain data on the radiation environment between the Earth and Moon. The original photoelectric triggering device was retained as an engineering test for future systems.

With the new instrument, the mission of this probe was also changed. Instead of a close flyby, the probe was now destined to impact the surface of the Moon 33 hours and 45 minutes after launch. Given the inherent inaccuracy of direct ascent trajectories, the relatively crude nature of the Juno 2 solid rockets and guidance system, as well as the lack of any course correction capability, the ABMA Moon probe would be lucky to make it anywhere near the Moon never mind hit it. Nonetheless, at this early stage of space exploration a lunar flyby was just as valuable scientifically as a direct hit. Since the ABMA had to wait until after the USAF probe launches, September of 1958 was set as the tentative launch date for their first Moon shot. With luck the ARPA-sponsored Moon probes, in addition to providing valuable IGY data, would get America ahead of the Soviet Union in the Space Race.

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