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Mercury: America's First Spaceship

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The Contractor

As NASA started its first full calendar year of existence in 1959, groups of engineers and managers were busy starting up the various programs the newborn space agency was assigned. Perhaps the busiest of these groups was the Space Task Group (STG) under the direction of Robert R. Gilruth. Based at NASA's Langley Research Center, STG was charged with developing the country's first manned spacecraft for Project Mercury. The project's goal was to send a man into orbit using a USAF Atlas ICBM and safely return him to Earth. While Project Mercury would build on years of research conducted by the USAF, various aerospace contractors, as well as NASA's predecessor, the NACA (see **The Beginnings of America's Man in Space Program** in the October 1998 issue of *SpaceViews*), there was still an incredible amount of work to be done before the first flight. The fact that the Soviet Union was also likely developing a manned spacecraft only added to the sense of urgency that pervaded NASA (see **The Start of the Manned Space Race** in the November 1998 issue of *SpaceViews*).

All during late December of 1958, selected members of NASA management and STG were busy evaluating the bids they had received from 11 potential contractors to build the Mercury spacecraft. But even before NASA officially selected Mercury's prime contractor, it was already taken for granted by many that the McDonnell Aircraft Company would win. Starting in October of 1957 McDonnell had assigned 20 people to study manned spaceflight concepts as part of the USAF-sponsored Manned Ballistic Rocket Research System or MIS (Man In Space) program. This number swelled to 40 when work on the USAF Dyna-Soar aerospace glider project was added.

By June of 1958 the company had 70 people on their team. Many of these engineers worked closely with the NACA Langley group that was already laying the groundwork for what would become Project Mercury. Throughout the summer of 1958 McDonnell worked closely with NACA helping to define their manned ballistic capsule concept. This close relationship continued until the official call for proposals was released by NASA. Since the McDonnell proposal incorporated the vast majority of the elements STG desired in their manned spacecraft design, the company had a clear edge in the competition from the start.

A boilerplate model of the Mercury capsule undergoing water tests. (NASA)

After a lengthy evaluation process, the Source Selection Board officially recommended McDonnell as Mercury's contractor on January 9, 1959. NASA Administrator T. Keith Glennan accepted the board's recommendation and telephoned James S. McDonnell himself later that day with the good news. On February 6, 1959, a contract to procure a dozen capsules at an estimated cost of $18.3 million (plus a company fee of $1.5 million) was signed. While the actual costs would almost immediately start to spiral upwards, the focus moved to finalizing the new spaceship's design.

The Spacecraft

By the time McDonnell was officially on the project, STG engineers had already decided on all the important design elements of the Mercury capsule based on exhaustive research. It was the task of McDonnell's engineers to produce a working design from this research and start cutting metal to build it. But with the low Earth orbit payload capability of the Atlas estimated to be about 1.3 metric tons (2,900 pounds), the final capsule design would have to be the ultimate in efficient compact engineering.

The Mercury capsule was a truncated cone topped with a cylinder with a total height of 2.92 meters (115 inches). The tiny pressurized cockpit would occupy the largest portion of the capsule with most other systems packed throughout the cramped interior. Recovery systems and horizon sensors would be housed in the small cylindrical section at the top. At the base, where the heatshield was located, Mercury was 1.88 meters (74 inches) across. At this time a metal heatsink like those successfully used in the first ICBM reentry vehicles was in the lead for the heatshield design. A lighter weight but still experimental ablative heatshield where a ceramic coating would absorb heat, char, and break away in small pieces (thus carrying the heat of reentry away from the capsule) was also being actively developed. The structure of the capsule was primarily composed of titanium which was lighter than steel and remained strong even at high temperatures.

Mounted underneath the heatshield was a retrograde package consisting of three solid rocket motors. Each motor produced 4.45 kilonewtons (1,000 pounds) of thrust for about ten seconds. This package was ignited at the end of the orbital mission and would start the capsule's descent from orbit. Also mounted in this housing was a trio of smaller posigrade rockets producing only 1.78 kilonewtons (400 pounds) of thrust each for a second. The purpose of these smaller motors was to separate and move the capsule away from its Atlas booster once orbit had been achieved. After the retrograde package had completed its task at the end of orbital flight, it was discarded.

Mercury capsule with launch escape system attached. (NASA)

Mounted on top of the Mercury capsule was the launch escape tower. Standing 4.57 meters (15 feet) tall, the tower consisted of a light structural truss topped by a cylinder housing a pair of solid rocket motors. Conceived by Maxime A. Faget (who later became STG's Flight Systems Chief) and his team at Langley in July of 1958, this structure was designed to pull the capsule safely away from the Atlas booster in case of a catastrophic failure either on the pad or early during the ascent. To accomplish this, the larger motor produced 230 kilonewtons (52,000 pounds) of thrust for a second. The capsule would then execute a normal water landing by parachute some distance downrange. The second motor was designed to pull the escape tower away from the ascending spacecraft 150 seconds after launch with a 1.5 second burst of 3.6 kilonewtons (800 pounds) of thrust. For the rest of the powered ascent the retrograde rockets could safely pull the capsule away from the booster in case of an emergency.

McDonnell (as well as the USAF in the MIS program) originally preferred a pusher-rocket configuration for a launch escape system with large motors attached at the base of the capsule. Faget's tractor design had the benefit of being easily jettisoned during flight when the hardware was no longer needed. This increased the amount of usable hardware that could be orbited as well as exposing the astronaut to the hazards pyrotechnic devices for as short a period as possible.

The choice of the Atlas ICBM as Mercury's launch vehicle required that other special accommodations be made for the pilot. One of the reasons the USAF did not want to use the Atlas for MIS was because of the punishing G loads. While an astronaut could easily withstand the peak 6 G acceleration during a normal ascent, the rocket's flight profile was such that peak loads could reach as high as 20 G during a ballistic reentry after an abort. The USAF felt that anything higher than 12 G should not be allowed but Faget and his team came up with a solution. They designed a contoured couch fitted to each pilot. This couch design had been tested in July 1958 at the Navy Acceleration Laboratory in Johnsville, Pennsylvania and allowed test subjects to withstand loads in excess of 20 G without ill effects.

One of the important engineering decisions that had to be made early in the Mercury program dealt with the capsule's life support system. Ideally one would want to reproduce the Earth's atmosphere inside the capsule for its occupant - a two gas oxygen-nitrogen system operating at 1013 millibars (14.7 pounds per square inch or psi). Soviet engineers chose this route with their manned spacecraft design. But American research also suggested that a single-gas atmosphere of pure oxygen in the 200 to 460 millibar (2.9 to 6.7 psi) pressure range was also an option. This approach was initially championed by STG engineer Stanley C. White. A single-gas environmental system would be much simpler, lighter, and more reliable than a two-gas system. The lower pressure also allowed the capsule's pressurized cabin to be of lighter construction and would be less prone to leak.

White, who was working with the subcontractor of Mercury's environmental control system AiResearch Manufacturing, convinced their engineers that a one-gas system should be used. In the end a pure oxygen atmosphere at a pressure of 345 millibars (5 psi) was approved as being sufficient for astronaut life support and heat transfer requirements (to remove excess heat from the cabin). This atmosphere would become the standard for American manned spacecraft until the introduction of the Space Shuttle in 1981. The one major drawback of this standard, however, was the extreme fire hazard of a pure oxygen atmosphere - a fact that would be painfully demonstrated eight years later with the Apollo 1 tragedy.

The Astronauts

One of the most important components of the Mercury spacecraft (and the point behind the whole project) was its pilot. But with the significant number of unknowns associated with spaceflight, it was difficult to agree on a standard for selecting astronauts. In November of 1958 STG took on this formidable task and developed NASA's first astronaut selection criteria: Reflecting the chauvinism of the time, the candidate had to be a male between 25 and 40 years of age. In addition to being in excellent physical health, each sponsored candidate had to be shorter than 180 centimeters (71 inches) in order to fit into the cramped Mercury cockpit.

Initially it was felt that a strong background in the sciences would be of prime importance for an astronaut. STG required that candidates hold a degree in science or engineering and have at least three years of experience in the science, engineering or with aircraft, balloons or submarines. Alternatively the candidates could hold a Ph.D. or have six months of medical experience. The original STG plan called for gathering 150 candidates from open applications. From these applications, 36 would be called in for initial evaluations and of these a dozen would proceed to nine months of intense training. At the end of the process, six would be formally invited to become astronauts.

But by the end of 1958 this plan had been abandoned at the request of President Eisenhower who wanted the first astronauts to be jet pilots selected from the armed services test pilot schools. While arguments could be made that "flying" a ballistic capsule hardly required the skill of a top notch test pilot, a test pilot's ability could significantly increase the chances for a successful mission (or a successful abort!). In January 1959, NASA management set down a new set of criteria for astronauts. The physical and educational requirements stayed the same as did the desire to limit the final selection to six men. Now applicants would be required to have 1,500 hours of flying time in high performance jet aircraft.

The Department of Defense provided NASA with the records of 508 military pilots. White, Robert B. Voas and William S. Augerson selected five Marine, 47 Navy and 58 USAF pilots from the list. These 110 men were divided into three groups and brought to Washington for interviews and further screening starting on February 2, 1959. With 69 men from the first two groups passing the initial screening, the third group was excused to relieve the burden on the remainder of the selection process. Further evaluation narrowed the field to 36 pilots. Of these men, 32 volunteered to continue the process and undergo a series of exhaustive medical tests at the Lovelace Clinic in Albuquerque, New Mexico starting on February 7.

The original Mercury 7 astronauts. (NASA)

Tests at the clinic were followed by stress tests at the Wright Air Development Center starting February 15. Additional psychological testing and high-G rides in a centrifuge followed. In the end a list of 18 candidates was delivered to Langley for final consideration. It was found to be impossible to select only six finalist from the candidates so a list of seven names was ultimately passed up to NASA's upper management. Administrator Glennan approved the list on April 2, 1959 and on April 9 America's first seven astronauts were presented at a Washington press conference. Dubbed the "Mercury Seven" by the press, these first astronauts were Lt. M. Scott Carpenter (US Navy), Capt. L. Gordon Cooper, Jr. (USAF), Lt. Col. John H. Glenn, Jr. (US Marine Corps), Capt. Virgil I. Grissom (USAF), Lt. Cdr. Walter M. Schirra, Jr. (US Navy), Lt. Cdr. Alan B. Shepherd, Jr. (US Navy), and Capt. Donald K. Slayton (USAF). Only a half a year after being founded, NASA seemed to be making progress in the manned space race.

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