Preparation of the Astronaut

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THE NASA's Project Mercury pilots began their preparation for orbital flight shortly after their selection in March 1959. At this time their training program was instituted.[1, 2, 3]

Briefly, this training included as exact simulation of the entire space environment as could be accomplished on the ground. It included such experiences as duplication of the launch and re-entry acceleration profiles on a centrifuge; exposure to predicted heat profiles; survival experiences on water and on land; disorientation training on a variety of devices; and exposure to brief periods of weightlessness in jet aircraft. The more definitive preparations for any given flight, however, began several weeks or months before the flight. The pilot of the Mercury Atlas-6 flight, for example, moved to Cape Canaveral in December 1961. His flight did not take place until February 20, 1962. During this lengthy period, the pilot was occupied with the many intricate details of checking out his spacecraft, the launch vehicle, and in participation in flight simulations which exercised the world-wide tracking network. Particular attention was paid to his physical fitness during this period by increasing the pace of his physical fitness program; by giving careful attention to his diet; and by exerting a special effort to obtain an adequate amount of rest each night. It had been his habit for many years to run about two miles a day. During the few weeks prior to the launch this distance was increased to about five miles a day. During the last two weeks prior to the flight, he reduced this distance to two miles again, and during the two-day period immediately preceding the flight took only brief exercises and short walks.

The actual preparation of the pilot began about three days before the flight when he was placed on a low residue diet. About two weeks before the flight he started taking his meals, prepared under the supervision of a trained dietician, in the special dining facility provided on Cape Canaveral. The meals preceding the low residue diet were nutritious and of a conventional nature. They were prepared under carefully supervised conditions and samples were retained under refrigeration for at least 48 hours. This retention of sample meals is a simple and well known epidemiological measure. If the pilot had developed a gastrointestinal illness, the source of the infection could have been determined by analysis of the sample meals. The conventional meals served no other purpose than to assure that the pilot was in a good state of nutrition and had a minimum of exposure to possible enteric infections. At about this same time, some effort was made to minimize his contacts with the general population. This is, again, a simple preventive medicine measure, and the provision of a private dining area facilitated this effort. It was recognized that the pilot could not be placed in absolute confinement during his preparatory period but it was felt that all reasonable precautions must be taken to prevent exposure to infection.

The palatable low residue diet, which was started three days prior to the launch, was developed through the ingenuity of Miss Beatrice Finkelstein of the USAF Aeromedical Laboratory, who also supervised the preparation and serving of the meal. The diet was designed to provide foods which will be completely absorbed by the gastrointestinal tract; thus leaving little or no bulk for the formation of feces. To accomplish this, a high protein diet based on such items as meat, rice, eggs, sugar and beverages was required. Foods prohibited included coarse or whole grain breads and cereals, cheese, rich desserts, fruits (except strained fruit juice and canned peeled fruit such as peaches or pears), tough cuts of meats, and vegetables (except strained vegetables such as tomatoes, peas, carrots and baked or boiled potatoes). The necessity for maintaining a minimum of residue in the lower gastrointestinal tract is obvious. A satisfactory urine collection device was developed and worn on the MA-6 flight, but no method has yet been devised which will permit defecation without removal of the pressure unit; an obvious impossibility in the Mercury spacecraft. Prolonged ingestion of the low residue diet did not prove to be deleterious. Due to delays in the launch schedule, the pilot remained on the low residue diet for a period of nine days, interrupted on the sixth day by three normal meals. During this period, the frequency of defecation diminished and the quantity of any individual movement diminished. None of the symptoms generally associated with constipation were experienced.

Becauses of the wide scope of the pre-flight physical examination, it was conducted in two parts. The first half was scheduled to be performed two days prior to the flight and the second half on flight morning. The many delays and cancellations of MA-6 required deviation from this plan.

The first half of the examination consisted of those procedures which were not felt to be time critical. It is admitted that changes in the human organism can take place in a two-day period, but the magnitude of the examination does not permit it to be performed in its entirety just prior to the flight. Even with every effort being made to minimize procedures in the pre-launch period a total of seven hours and 27 minutes elapsed between the time the pilot was awakened and liftoff. In order to accomplish all of the immediate pre-flight procedures and be ready for an 0700 launch, it was necessary to awaken the pilot at 0220 on the morning of the launch. The launch did not take place

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until 0947, but all delays occurred after the pilot had been inserted into the spacecraft, and could not be foreseen.

During the first half of the physical examination, the pilot was seen by specialists in neurology, ophthalmology, aviation medicine, psychiatry and radiology. A standard twelve-lead electrocardiogram was taken, as was an electroencephalogram and an audiogram. Blood samples were drawn for bio-chemical studies and for cross-matching with prepositioned blood obtained from donors located at Patrick Air Force Base.

Several days before the flight, special labyrinthine studies developed by Capt. Ashton Graybiel, MC, USN were performed.[4] These studies consisted of requiring the pilot to walk a series of wooden rails elevated two inches above the floor level. Each rail was slightly more narrow than its predecessor and a numerical score is obtained based upon the distance walked in a specified period of time. This is referred to as the Ataxia Test. Following the Ataxia Test, the pilot's external auditory canals were irrigated with warm water maintained at a carefully controlled temperature one or two degrees below body temperature. In this modified caloric test, the temperature at which fine nystagmus is first detected is considered the end-point and is recorded as the threshold temperature.

The first half of the examination described above was performed first on January 22, 1962. The flight scheduled for January 24, 1962 was cancelled and rescheduled for February 14, 1962. The first half of the examination was repeated on February 12, 1962, but the flight was again postponed. At this point, it became necessary to carefully evaluate the requirement for performing these procedures a third time. All of the specialists were consulted and it was demonstrated that there were no significant differences between the results collected on January 22 and those of February 12, 1962. In deference to the pilot it was decided that there would be very little gained by repeating these lengthy procedures. It must be remembered that a very careful examination was performed on the flight morning. Valuable baseline data was accumulated at that time as well.

The day before the flight was spent in relative quiet. The pilot attempted to get as much rest as possible and most of the day was spent in peaceful relaxation. There were some requirements for briefing and last-minute preparations. These include last looks at the weather and minor changes in the plan for inflight activities. On February 19, 1962, the pilot finally retired at 2130. He obtained four hours and fifty minutes of light dozing sleep. Each Mercury pilot has known that mild sedatives were available to him, but none has asked for them. Each has slept without benefit of sedation.

At one time, consideration was given to gradually altering the pilot's diurnal cycle to permit eight full hours of sleep ending with awakening at about 0200. In order to accomplish this, the pilot would have had to approach this new schedule gradually over a period of several weeks. His own preflight duties are so intimately related to those of hundreds of others concerned with the flight that this approach was felt to be almost impossible. It would have meant, for example, that his breakfast would have occurred at 0400, lunch at 0800, supper at about 1400, and bedtime at 1800. This would, in effect, permit him to have only about 5 hours of time during the day which coincided with the normal work schedule of the support personnel at the launch site. This is not adequate to perform all the required tasks and duties.

Lt. Colonel Glenn was awakened at 0220 on the morning of February 20, 1962. He appeared refreshed, alert and well rested. He was permitted thirty minutes for his morning ablutions, and was served a breakfast consisting of filet mignon, eggs, toast, juice and milk at 0250 hours. Breakfast was consumed in about fifteen minutes and the physical examination was started at about 0305. This was the second half of the preflight examination and was conducted by three separate examiners. A general physical examination was performed by a Flight Surgeon. This was followed by an extensive examination by an internist with special emphasis on the cardiovascular system. A psychiatrist administered several short psychomotor tests and conducted a brief interview. This examination failed to reveal any significant abnormality. The pilot had no complaints, either specific or general. He was alert and eager to proceed with the flight. His weight was 171-7/16 pounds. Oral temperature was 98.2 F.; pulse was 68; respiration rate was 14; and the blood pressure was 118/80 in the left arm while sitting. The liver edge was just barely palpable at the right costal margin on deep inspiration. No other organs were palpated. The abdomen was well relaxed; there was no tenderness and no abnormal masses were palpated. The extremities were measured at the point of greatest circumference for comparison at the end of the flight.[5]

After the physical examination had been completed, the biological sensors were applied. The electrocardiogram in all Mercury flights was obtained by means of two separate leads. These required the placement of four electrodes. The early developmental ECG harness consisted of only three sensors, one of which was an electrode common to the two leads. This was soon abandoned when it became apparent that the loss of the common electrode would mean the loss of both leads. The electrodes were German silver screens imbedded inside a well formed in a rubber disc. The electrolyte was 10 per cent calcium chloride made into a thick paste by the addition of bentonite, a mineral powder similar to talc. The screen itself did not come in contact with the skin but was held about 3/32 inch away from the skin by its position in the rubber disc. The intervening space was filled with the electrolyte. The complete device was glued to the skin with an adhesive. The upper surface of the disc was covered with plastic tape to prevent evaporation of the electrolyte. The disc was then covered with a circle of moleskin to protect it from being disturbed when the suit was donned.[6]

Respiration was measured by means of a heated wire thermistor suspended from the microphone of the helmet.[6] The thermistor was so located as to be in the airstream of either the nostrils or the mouth. Respiration was measured by the cooling effect of the inhaled and exhaled air on the heated wire thermistor. Deep body

temperature was also measured with a thermistor imbedded in a soft rubber rectal probe.[6]

The blood pressure device was only recently developed and was used for the first time on the flight of MA-6.[7] It consisted of a modified blood pressure cuff which was applied to the pilot's left arm. This cuff was connected through the suit to a manual bulb located on the pilot's chest. At a pre-arranged time or when requested by the ground station, the pilot could inflate the cuff by about six compressions of the bulb. The pressure in the cuff bled off slowly through a small orifice. The pressure in the cuff was measured and telemetered to the ground where it appeared as a sloping line on a heated pen recorder. A microphone was located over the brachial artery at the distal edge of the cuff. The output from the microphone was superimposed on the pressure trace as it was recorded on the ground. With this system, the first blood pressure sound to come through to the microphone as the cuff deflated appeared as a deflection of the pressure curve on the recorder. This was read as the systolic pressure. The sound of each subsequent beat also appeared as a deflection of the slope. The last sound to be detected by the microphone was read as the diastolic pressure. As was the case for all of the biological measurements, the blood pressure was recorded on board the spacecraft as well as telemetered to the ground.

Before the suit was put on, the integrity of all of the biological sensors was checked with an oscilloscope. A useful electrocardiogram and respiration trace was obtained on the oscilloscope, but the temperature and blood pressure devices could be checked only for circuit continuity.

The complete physical examination and application of sensors took nearly one and one-half hours, and at about 0430, the suit donning process was started. After the suit had been put on, the pilot was placed on a special test bench where the suit was inflated to a pressure of 5 psi and a gross determination of leak rate was made. Using this gross method, the suit leak rate was determined to be only about 360 cc per minute. After this suit leak check, the integrity of the suit was not again violated except for opening of the face piece. Prior to departure from the suiting area, the proper functioning of the sensors was again demonstrated.

At 0500 the Blockhouse Surgeon called the suiting area with the information that the countdown was proceeding and that it was time to depart for the launch area. A special trailer was provided for this trip. It contained all of the equipment necessary to completely change a suit if the flight article were to be damaged during the insertion process. The value of this expedient is well illustrated by the following experience which occurred during the insertion procedure. After the pilot had been placed in the spacecraft, it became necessary to reposition his microphones. While this was being attempted, one of the microphones broke loose from its mounting. A new mounting was obtained from the standby helmet in the transfer van at the base of the gantry and was substituted for the broken item. Had this extra equipment not been available, it would have been necessary to send back to the suit room in Hangar S for this item and much valuable time would have been lost. Extra sensor harnesses were also carried and electronic equipment was available to check the sensors should they have to be changed. Immediately upon his arrival at the transfer van, the pilot was placed in a reclining chair and his biosensor cable was connected to a recorder. A record of all his vital signs was started at that time. This record was interrupted only for a few minutes when he ascended the gantry and was inserted into the spacecraft. During the ride to the launch complex, the pilot received his final weather briefing by a meteorologist. Sample biological recordings were obtained and sent to the physicians in the Blockhouse and in Mercury Control Center for comparison with records obtained from the spacecraft after insertion of the pilot.

The ride from the suiting area in Hangar S to the launch complex took about 20 minutes. The pilot was held for about 40 minutes in the transfer van after his arrival at the base of the service structure. The van was equipped with complete communication facilities as well as living necessities for the personnel. These included a latrine, a drinking water supply, running water, a hot plate, and box lunches. The pilot was able to communicate through his helmet headset and microphone to the gantry, the Blockhouse and Mercury Control Center.

At about 0600 the pilot and the insertion team ascended the gantry and insertion into the spacecraft began at 0606. In this process, the pilot climbed into his contour couch through the side hatch of the spacecraft. The communications leads were attached and the hoses from the environmental control system connected. Finally, the restaint harness straps were placed in their proper position and fastened loosely. They were left loose to permit the pilot to move around as much as possible during the purging of the suit with 100 per cent oxygen which was the next step in the process. These movements were encouraged to facilitate washing out of any pockets of trapped ambient air within the suit during the purge. The purge took about five minutes, and when completed, a sample of gas was withdrawn from the environmental control system and analyzed for oxygen content on the spot. The launch rules required that this sample contain 95 per cent or more oxygen. In this case, the sample was nearly 100 per cent after corrections had been made for temperature. The restraint harness was then drawn up to a comfortably tight condition. Several persons, including a Flight Surgeon, made a final visual inspection of the interior of the spacecraft. On the morning of the MA-6 launch, this inspection revealed that the pilot presented a calm, yet eager, facies; he was not perspiring; his voice was steady; and his speech content was appropriate. He was well oriented and eager to proceed with the launch preparations.

After this final visual inspection of the pilot, the hatch was applied to the spacecraft and the interior was purged with 100 per cent oxygen. A sample was withdrawn and analyzed as with the environmental control system. Again, the purity must be over 95 per cent.

Throughout the course of the countdown, the pilot was monitored by physicians in the Blockhouse. His

electrocardiogram was recorded continuously as was his body temperature and his respiratory pattern. The blood pressure was measured at intervals and the physicians listened closely to his voice transmissions. The pilot's voice was considered the single most important montoring aid available to the physician. The mission rules called for cancellation of the flight only after more than one of any of the physiological parameters were lost due to technical reasons. On the other hand loss of voice transmission was considered adequate cause for cancellation of the flight. Once the spacecraft had been placed in orbit the mission rules permitted loss of all bioinstrumentation telemetry if the voice link remained intact.

After the cabin purge, the preparation of the pilot was considered complete. The gantry was withdrawn, the countdown proceeded to zero, and the spacecraft was launched.

SUMMARY

A chronological history of the preparation of the pilot of the Mercury Atlas-6 manned orbital flight has been presented.

A brief resume of his physical condition prior to the flight illustrates that he was in good physical and mental health.

The bioinstrumentation techniques and equipment are described.

The value of duplicate equipment and personnel is illustrated.

The mission rules insofar as bioinstrumentation was concerned are outlined.

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