Aerospace Medicine and Project Mercury

Navy Participation

CAPTAIN ASHTON GRAYBIEL, MC, USN

THE UNITED STATES Navy was a proud participant in the vast preparation and the far-flung operational activities which, in bold exhibitions of professional skill, culminated in our first manned space flights. In terms of magnitude, this represented the largest concentrated effort the Navy has ever put forth in a peaceful enterprise. In terms of sacrifice, many important tasks were temporarily set aside, many persons altered their plans, and one man, Seaman Donald W. Robinson, lost his life.* In terms of individual accomplishment, Navy Astronaut Shepard was the second man in space and the first to make a suborbital flight; Marine Astronaut Glenn was the fifth man in space and the third to orbit the earth; Navy Astronaut Carpenter is poised to make the next orbital flight and Navy Astronaut Schirra is his back-up.†

Although it is my task to highlight Navy participation in Project Mercury, such a report would be out of balance without summarizing what the National Aeronautics and Space Administration has done for the Navy. NASA has funded or helped fund most of the studies carried out by the Navy and, vastly more important, it has provided the Navy with an opportunity to play a glorious role in man's first attempts to conquer space. The sacrifices the Navy has made will soon be forgotten, but the heroism of its astronauts and the services it rendered will find a permanent place in the record of today's achievements. As long as histories of this Conquest are written, at points however distant in time, they must all begin with the brilliant successes of Project Mercury.

In such a major undertaking as Project Mercury, with its numerous tremendous ramifications, it is not difficult to lose sight of some of the medical aspects of the program which, although relatively small in magnitude, were essential to success both of a particular flight and to the advancement of the science and art of manned space flight. Broadly considered, the medical aspects fall into such well-known categories as Selection of the Astronaut, Indoctrination in Life Support Systems, Medical Care, and Periodic Re-evaluation. However, in Project Mercury there were unusual problems to take into account. These stemmed from the: (1) small number of astronauts, (2) small payload, (3) characteristics of the flight profile, (4) hostility of the environment aloft, and (5) landing on water. The problems generated by these factors centered around: (1) close interrelationships between medical and professional fitness of the astronauts, (2) need for continuous monitoring of physiological responses and environmental conditions during flight, (3) medical logistics of "recovery," and (4) maximal exploitation of the flight for scientific purposes. The Medical Department of the U. S. Navy participated to some degree in the solution of all of these problems, making available with an open hand the facilities of its laboratories, the services of its physicians and scientists, and the benefit

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From the U. S. Naval School of Aviation Medicine, Pensacola, Florida.

Opinions or conclusions contained in this report are those of the author and do not necessarily reflect the views or endorsement of the Navy Department.

Report presented under the sponsorship of the Office of Life Science Programs, National Aeronautics and Space Administration.

Presented at the Aerospace Medical Association Meeting, Atlantic City, April 12, 1962.

*Seaman Robinson was lost overboard the *USS Chuckawan* during refueling preparations at a mid-Atlantic location on January 15, 1962.

†Since preparation of this report, Navy Astronaut Carpenter successfully completed an orbital flight on May 24, 1962, and Navy Astronaut Schirra followed with an equally successful orbital flight on October 3, 1962.

of its accumulated experience in flight medicine. There is time to mention only some of the many contributions.

The Navy centrifuge at Johnsville was used in five Project Mercury simulation programs, requiring 233 days of centrifuge operation, in which the accelerative profiles of the Redstone and Atlas booster missions were simulated.[1] The primary purposes of these simulations were to test the efficiency of the various types of equipment to be used in actual flight, to establish physiological limits of acceleration stress, to ascertain performance characteristics under stress, and to train the astronauts for various flight control conditions which would be encountered in the boost and re-entry phase of space flight.

The chief objective of this first program initiated in August, 1959, was to determine some realistic stress limits which the astronaut could endure and still reliably perform various tracking tasks, with particular attention being given to recording and evaluating of biomedical measurements. In general, this first study translated into design equipment of the Mercury spacecraft demonstrated that, with the expected acceleration patterns, the restraint equipment would be suitable with certain modifications. This study also indicated that certain improvements should be made in the side arm controller, that a minor change should be made in the position of the contour couch, and the sequential programing of events on the telelight panel should be changed. The data obtained in this first project were used by McDonnel engineers in designing improved models of the Mercury capsule.

In April, 1960, the second simulation program was begun at the Navy centrifuge starting with the full pressure suit added to the configuration. By this time a more realistic flight profile was available for both Redstone and Atlas booster vehicles. The major points of interest in this program were the effects of the full pressure suit and 100% oxygen when combined with acceleration. The centrifuge gondola was evacuated to 5 psi, and "exit" and "re-entry" sequences were simulated. Considerable effort was required in perfecting an acceptable system for obtaining biomedical data on subjects wearing full pressure suits. Various types of bioinstrumentation systems were evaluated during this program.

With the integration of these flight and bioenvironmental data, it was then possible to introduce training simulations for the first time on the centrifuge. Repetition of runs increased the astronaut's ability to master both the control and monitor tasks. Characteristics of the simulated flight profile and the dynamic responses of the control system were varied in order to determine what stability limits would be needed if the astronaut were required to operate controls during re-entry. Emergency abort escape situations were simulated, and the astronauts were given training in controlling or damping the violent oscillations that would probably occur under these conditions. There were simulations of both the manual and automatic systems of the capsule during this program.

A much improved full pressure suit was available for the third Mercury simulation program. A new helmet was added and the suit itself was modified to provide much more comfort. The problem of bioinstrumentation had been solved, and in this program a complete dress rehearsal for an actual flight was carried out for both the Redstone and Atlas missions.

The fourth program was a specific study of the Redstone flight profile with Astronauts Shepard, Grissom, and Glenn as subjects, and it took place a few weeks prior to the first suborbital flight. Centrifuge simulations followed the exact real-time event sequences which had been predetermined for launch through re-entry, with the complete run lasting fifteen minutes. In this study emphasis was placed on the effects of acceleration and their influence on post-run task performance. This entire program was specifically directed toward preparing for the first manned suborbital flight.

The fifth, and most recent, Project Mercury centrifuge simulation was completed in September, 1961. It was similar to the fourth program with the difference that it simulated an Atlas mission.

The time required to complete an entire Redstone or Atlas simulation was used to establish an operational schedule for the actual flight. The information obtained during the centrifuge simulation programs provided a baseline for comparing the actual inflight performance characteristics as well as physiological data. The importance of these programs was best expressed by Shepard who stated he felt it to be the second most important training procedure.

A second major effort took place at the Navy Aircrew Equipment Laboratory in Philadelphia where, at the invitation of NASA, they were asked to develop and construct a full pressure suit as part of the life support system of the Mercury spacecraft.[2] The requirements were established in a general specification, and work was initiated to modify the basic Navy Mark IV suit to include those design features unique to the Mercury application. The results revealed that the Navy suit system was adequate with regard to burst pressure limits, ventilation system resistance, and weight but that the thermal protective performance of the suit system was inadequate. At an early date NASA selected the complete Navy suit and helmet for use and requested the Navy Equipment Laboratory to improve the thermal performance.

After extensive investigation, which consisted of many heat pulse tests, mobility tests, and over-all resistance to flow test, a satisfactory suit ventilation-insulation configuration for adequate thermal performance was devised and integrated with the spacecraft at McDonnel Aircraft Corporation.

A program of suit indoctrination followed wherein the astronauts were exposed to simulated altitude, thermal heat pulse and mobility tests. The findings indicated areas of compromised mobility and led to improvements later incorporated into the actual flight suits.

When the anticipated thermal profile of the Mercury mission was received, a further improvement in thermal protection was required. Therefore, the Navy Equipment Laboratory simulated the complete mission profile with respect to altitude, wall temperature, dry bulb cabin air temperature, and to the quantity, temperature, and moisture content of the suit ventilation and breathing gas. Simulations included "on pad," "launch," "orbit," "re-entry," and "ground stand-by" conditions. The experimental findings resulted in a series of modifications which culminated in a satisfactory thermal performance of the suit.[2]

During November, 1960, an environmental simulator was delivered to the Navy Equipment Laboratory. The astronauts were trained in this simulator and the various mission modes of operation were conducted.

A third simulation and indoctrination program was initiated at the Naval School of Aviation Medicine which dealt with capsule egress and survival at sea.[3] It was demonstrated that a number of hazards existed whether the astronaut remained in the spacecraft or attempted to egress. These centered around flotation of the spacecraft in case of capsule leakage or an open side hatch; the hazards incidental to egress, suit flotation, and capsizing of life raft; and survival on the open sea. These problems were studied systematically,[4-6] and a decision reached to devise and test a flotation collar for quick attachment to the spacecraft.[7] It was demonstrated that such a raft rendered the Mercury spacecraft unsinkable.[8]

Following the adoption of the Auxiliary Flotation Collar for both primary and contingency area recovery, pararescue personnel of the USAF Air Rescue Service and divers of Atlantic Fleet Units were trained in its deployment and use at NAS Pensacola.[9]

Additional training, indoctrination, and assistance were provided at the Naval School of Aviation Medicine in orientation and disorientation,[10] and at the Naval Medical Research Institute in the physiology of temperature control and bodily reactions to heat stress and vibration stress. The Navy played an important role in the establishment of monitoring and communication stations at sea[11] and assisted directly and indirectly in the debriefing sessions after each of the astronaut missions.[12-15]

By far the largest Navy assignment in Project Mercury was the responsibility for recovery at sea. This is pointed up by the fact the primary and eight planned impact areas had an average width of 33 miles and a combined length of 2,747 nautical miles, only a little less than the distance from Florida to Africa, and totaled approximately 80,000 square miles. In the first orbital flight, 24 ships including three carriers were deployed, 13 Marine helicopters, over 60 Navy aircraft and 15,000 Navy personnel were involved in the recovery operation.[16]

The medical aspects of this large undertaking consisted of two phases, namely "planning" and "operation." Toward the end of December,1959, NASA requested tentative plans for the medical care and handling of the astronaut following impact. The following June, after a series of interim communications, a final report was submitted by the Naval School of Aviation Medicine.[17] This report summarized a fairly exhaustive analysis of the medical problems followed by specific recommendations. The analysis was divided into four major sections. The first dealt with certain probabilities in the technical aspects of the flight which would affect the location and condition of the astronaut at impact. The second was a consideration of the environmental stresses and of other factors which might result in injury. The third and fourth dealt with the important variables, "elapsed time until treatment could be instituted," and "the extent or level of this treatment." This was followed by a synthesis of an operational medical recovery program which was summarized in charts and diagrams. The recommendations, logically deduced from the available facts, were initially regarded by some as "rather ideal." However, subsequent decisions and events have generally endorsed these recommendations.

During recovery operations the guiding policy was that recovery of the spacecraft was only an essential prerequisite to recovery of the astronaut.[18-20] It would be incorrect to say the recovery operations were conducted without expressions of "individualism" which are inseparable from human nature. Nevertheless, these operations stand forth as a notable example of smoothly coordinated effort both within and between the agencies involved.

The spirit displayed by the recovery teams may be illustrated by preparations aboard the destroyer *Noa* in connection with MA-6.[21] Remember, the *Noa* had been at sea for much longer than expected, and, where stationed, there was only an outside chance that it would participate in the recovery of Astronaut Glenn. I quote from their report, "When it was announced that the third orbit had been started we had the chest containing the medical examination equipment and the astronaut's personal gear brought up to the Commodore's cabin. All hands not on watch turned to topside in sparkling clean whites, which the laundry had worked all night to wash, starch, and press." It was only a fortuitous sequence of events which suddenly thrust on the *Noa* the task of retrieving the spacecraft; not only were they found ready and on the alert (shipboard recovery time 39 minutes) but also they were *en parade*.

In conclusion, let me say that this is the spirit in which we will continue our support of Project Mercury.

ACKNOWLEDGMENTS

The author gratefully acknowledges the assistance provided in the preparation of this report by Cdr. B. F. Burgess, Jr., Capt. R. A. Bosee, Capt. F. K. Smith, Cdr. D. P. Morris, Dr. D. E. Stullken, and Mrs. Catherine Kasparek.

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11. NAVAL MEDICAL MONITORS:

Captains (MC): E. L. Beckman, V. G. Benson, C. E. Pruett

Commander (MC): F. H. Austin

Lieutenant Commanders (MC): L. H. Blackburn, J. Gordon, G. F. Kelly

Lieutenants (MC): E. P. Jacobs, G. Lucchina

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    Captains: G. C. Clark, J. R. Connelly, A. Graybiel, H. D. Warden
    Commanders: R. C. Laning, M. J. Trummer
    Lieutenant Commanders: R. D. Belser, R. A. Brown, R. D. Cordier, E. P. Ellis, Jr., J. L. Glass, T. C. Hartney, M. E. Henderson, W. D. Hoofer, R. H. Hux, W. M. Johnson, J. S. Maughon, R. L. Mullin, R. C. Thomas
    Lieutenants: A. E. Gilbert, J. H. Modell, S. Mucha, B. E. Smith
    HMCA: J. P. Galt
    HM-2: B. A. Aiton, E. Y. Gill, J. A. Hines, D. P. Hisoire
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