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Gemini: The first approaches to exploring and working in space

Project Gemini’s start actually came about because of Apollo. The first approach for getting to the Moon was a direct ascent technique, in which a gigantic rocket, the Nova, would launch an assembled vehicle that would travel to the Moon, land there, and return to Earth. A competing approach, use of lunar orbit rendezvous to permit only a small vehicle to land on the Moon, promised considerable weight savings and a shorter and less risky development time—less risky, that is, if the techniques of rendezvous and docking could be quickly and safely demonstrated. As stated in the Preface to On the Shoulders of Titans: A History of Project Gemini: “Gemini was first and foremost a project to develop and prove equipment and techniques for rendezvous.”

It is uncertain how an EVA would have been accommodated on the Gemini vehicle if there had not been the decision to discard the escape tower approach used on Mercury and planned for Apollo. The escape tower was an externally mounted rocket motor that would lift the manned crew compartment free of the launch vehicle in the event of catastrophic failure. During a normal launch sequence, the tower would be jettisoned after the period of maximum risk had passed. Discarding the escape tower meant that several hundred pounds of weight and many troublesome failure modes were eliminated.

An ejection seat approach was selected as the means for effecting crew escape during a launch vehicle failure. The large door opening required to accommodate the ejection seat technique paved the way for an EVA, since it offered a “free” doorway to space; however, it was not until July 1961 that the spacecraft was officially changed from a single-occupant to a two-crewmember vehicle called “Mercury Mark II”. The name was officially changed to “Project Gemini” in January 1962. Two crewmembers offered not only a number of advantages in spreading out tasks for longer missions, but also allowed the opportunity for EVAs.

EVA was not a high-priority Gemini objective, although it had been in the planning stages since 1962. The Gemini Support Office in MSC’s Crew Systems
Division (CSD) was formed by 1964 to formally carry out the development of hardware for a Gemini EVA; however, initial planning had gone on prior to the office formation in order to set in motion the processes to develop the spacesuit and associated life support system. In April 1964, Gemini EVA planning called for an EVA to commence on Gemini IV. The EVA program was to be phased, with EVAs on Gemini IV and V comprising Phase 1; those on VI, VII, and VIII were to make up Phase 2; and IX and subsequent missions, Phase 3. Maneuvering units were envisioned, as was an advanced life support backpack, called the portable environmental control system (PECS), then under early development with AiResearch (now Honeywell). This system would be used on a joint-funded NASA/Air Force mission called Gemini 14C. The PECS would feature, among other things, an Apollo program concept (discussed in Section 6.5) of liquid transport for rejecting metabolic heat—a design that would ultimately find its way into all U.S. spacesuits.

The requirements for the Gemini EVA program were threefold: (a) develop the capability for an EVA in free space; (b) use EVA to increase the basic capability of the Gemini spacecraft; and (c) develop operational techniques and evaluate advanced equipment in support of EVAs for future programs.

5.1 EARLY SAFETY WARNINGS

Much of the early concern for astronaut safety focused on the extremely critical and potentially dangerous launch sequence. The liquid oxygen and kerosene mixtures used for earlier flights were replaced by the Titan’s hydrazine/nitrogen tetroxide combination, which ignited upon mixing. A primary Gemini concern was ejection through a fireball resulting from a launchpad explosion. Naturally, concerns for suit pressure retention as well as thermal control during an EVA were paramount in the minds of suit designers and builders. As future events would show, another and more insidious danger was inherent in all spacecraft then under design: the use of a 5 psia (34.5 kPa) pure oxygen atmosphere for orbital operations.

Although Mercury had operated at 5 psia (34.5 kPa) with no apparent problems, there was concern in the medical community for crewmember exposure for extended periods of time to elevated oxygen pressure. It was not until early July 1962 that a decision was made between a 7 psi (48.2 kPa) mixture—3.5 psia (24.1 kPa) oxygen/3.5 psia nitrogen—and a 5 psia (34.5 kPa) pure oxygen atmosphere for Apollo. The decision made was to use 5 psia for Apollo. Gemini had never really seriously considered any other pressure.

Studies related to 5 psia pure oxygen atmospheres were carried out by NASA to investigate the human effects over 14 days, and two of these studies suffered near catastrophic results due to factors other than those of physiology.

In late August 1962, in a collaborative test effort between NASA and the Air Force’s School of Aerospace Medicine at Brooks Air Force Base in San Antonio, Texas, two Air Force officers were outfitted with pressure suits featuring removable arm and leg sections, in addition to having helmet faceplates that could be opened.