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GEMINI PROGRAM MISSION PLANNING REPORT (U)

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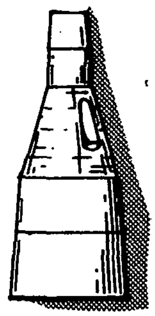

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER
Houston, Texas

January 6, 1965

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NASA PROGRAM GEMINI WORKING PAPER NO. 5019

GEMINI PROGRAM MISSION PLANNING REPORT

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TABLE OF CONTENTS

LIST OF TABLES

ABBREVIATIONS

ATV	Agena Target Vehicle
DOD	Department of Defense
ECS	Environmental Control System
ELSS	Extravehicular Life Support System
GLV	Gemini Launch Vehicle
GT-( )	Gemini Mission
GTA-( )	Gemini-Agena Mission
LEM	Lunar Excursion Module
MDS	Malfunction Detection System
MMU	Modular Maneuvering Unit
MSFEB	Manned Space Flight Experiments Board
OAMS	Orbit Attitude and Maneuver System
Psia	Pounds per square inch - absolute
R and R	Rendezvous and Recovery
RCS	Reentry Control System
REP	Rendezvous Evaluation Pod
SC	Spacecraft
SLV	Standard Launch Vehicle (Atlas)

1.0 INTRODUCTION

1.1 General

This report defines the Gemini Program objectives and presents guidelines for the individual Gemini missions. It provides general space vehicle configuration data, and descriptions of planned missions. Contingency mission requirements and extravehicular operations to be performed during specific missions are described in the last two sections of the basic document. Data on spacecraft weights and Gemini Launch Vehicle performance capabilities are provided in Appendix A, while Appendix B provides descriptions of onboard experiments to be conducted during Gemini missions.

1.2 Document Revisions

Revisions will be made to this document on a monthly basis and in accordance with Chapter 25.1.3 of the NASA-MSC Management Manual. Those organizations proposing revisions or wishing further mission information should contact the Gemini Program Mission Planning Office, Code GV5, Building 2, NASA Manned Spacecraft Center, Houston, Texas.

1.3 Mission Planning Documents

Gemini mission planning is documented in the following publications:

a. Mission Assignments.- Gemini flight missions are assigned by the NASA Office of Manned Space Flight, Washington, D. C. Current assignments are contained in "Gemini Flight Mission Assignments," M-D MGS 1300, dated June 9, 1964.

b. Mission Planning Information.- Current mission planning information will be provided by this document.

c. Detailed Mission Information and Direction.- A mission directive will be prepared for each flight which in turn will authorize subordinate mission oriented documents. The mission directive for each flight will be published approximately six months prior to the scheduled launch date and will be published as a Program Gemini Working Paper.

d. Working Documents and Other Documentation Containing Mission Information.- Preliminary studies showing alternate missions or procedures as applicable to the Gemini Program should reference this document as containing current approved mission planning information. Changes to this document should be proposed as necessary. When mission descriptions are included in other documents concerned with the Gemini Program, they should be consistent with mission information contained in this Gemini Program Mission Planning Report.

2.0 GEMINI PROGRAM OBJECTIVES

The general objectives of the Gemini Program are to further develop an operational capability in space and to investigate the problems of working and living in space. The Gemini Program consists primarily of development flights, long-duration flights, and rendezvous development flights. The National Aeronautics and Space Administration has assigned certain specific objectives to the Gemini Program. These objectives are as follows:

a. Subject two men and their supporting equipment to long-duration flights of up to two weeks in space.

b. Achieve rendezvous and docking with another orbiting vehicle, and develop efficient and reliable rendezvous techniques.

c. Maneuver the spacecraft in space after docking using the target vehicle propulsion system.

d. Perform extravehicular activities requiring the astronauts to climb out of the spacecraft for short periods of time while in orbit, and develop the capability and techniques for extravehicular operations in free space.

e. Provide a controlled reentry whereby the spacecraft is brought to a specific landing area.

f. Provide training for the astronauts who will fly in the Apollo program.

g. Carry appropriate engineering and scientific experiments in support of the national space program.

3.0 GEMINI MISSIONS

3.1 Gemini Mission One (GT-1)

The first Gemini mission was an unmanned orbital flight to test the Gemini Launch Vehicle (GLV) performance and the spacecraft and GLV exit environment.

3.1.1 Configuration.- The spacecraft (SC-1) used on the GT-1 Mission was the first production Gemini spacecraft. The spacecraft was unmanned for this mission, and was equipped with instrumentation designed to obtain data on exit heating, structural loads, temperatures, vibrations, and pressures to be telemetered to ground tracking stations. Some of the systems used in the spacecraft were simulated by dummy equipment or ballast. For this mission the combined second stage and spacecraft were inserted into orbit. The GLV was essentially the same configuration as will be flown on all Gemini missions, except for modifications made necessary by the unmanned spacecraft configuration.

3.1.2 Mission Objectives.- Following is a list of the primary objectives of this mission:

a. Demonstrate GLV performance and flight qualify GLV subsystems.

b. Determine exit heating conditions on the spacecraft and launch vehicle.

c. Demonstrate structural integrity and compatibility of the GLV and spacecraft through insertion.

d. Demonstrate accurate orbital insertion.

e. Demonstrate switchover if flight anomalies occur and demonstrate operation of the malfunction detection system (MDS).

Detailed information, including all mission objectives for the GT-1 Mission, is contained in NASA Program Gemini Working Paper No. 5005, "Mission Directive for Gemini-Titan II Mission I (GT-1)."

3.1.3 Mission Description.- The GT-1 Mission was successfully launched on April 8, 1964, and all mission objectives were met. The unmanned orbital flight was launched on an azimuth of 72.0°. The azimuth was chosen to be the same as the azimuth for the first manned flight (GT-3). The vehicle was inserted into a 86.6 - 173.0 nautical-mile elliptical orbit as compared to the Gemini reference 87-161 nautical-mile ellipse. The combined spacecraft and GLV second stage orbited for a period of 4.25 days. The vehicle then reentered due to atmospheric drag. A complete evaluation of the GT-1 mission is contained in the "Gemini Program Mission Report for Gemini-Titan I (GT-1)," MSC-R-G-64-1, dated May 1964.

3.2 Gemini Mission Two (GT-2)

The second Gemini mission will be an unmanned ballistic flight to qualify the spacecraft reentry heat protection and test the major Gemini systems required for manned orbital flight.

3.2.1 Configuration.- The spacecraft (SC-2) is a production configuration of all systems and structure needed for the launch, retrograde, reentry, and recovery phases of the mission. The thickness of the Spacecraft 2 heat shield is less than that of heat shields to be used on manned missions in order that data on the bonding of ablative material to the heat shield may be obtained. Crewman simulators will be installed on the ejection seats to perform the sequential functions normally performed by the astronauts. The Gemini Launch Vehicle (GLV-2) used will be the standard configuration used on all Gemini flights.

The loading of spacecraft consumables for the GT-2 mission is shown in table 3-I. The estimated usage rates of these consumables during the mission are defined in the Flight Plan for the GT-2 Mission.

3.2.2 Mission Objectives.- Following is a list of the primary objectives for the GT-2 Mission:

a. Demonstrate the adequacy of the spacecraft heat protection equipment during a maximum heating rate reentry.

b. Demonstrate spacecraft separation from the launch vehicle and separation of the equipment and retrograde adapter sections.

c. Qualify all spacecraft and launch vehicle systems as required for manned orbital flight.

d. Demonstrate combined spacecraft and launch vehicle checkout and launch procedures.

e. Demonstrate spacecraft recovery systems and recover the spacecraft.

Detailed mission objectives and information for the GT-2 Mission are contained in the NASA Program Gemini Working Paper No. 5013, "GT-2 Mission Directive."

3.2.3 Mission Description.- The second Gemini mission will be an unmanned flight and will be launched on a ballistic trajectory. The flight path angle at spacecraft separation from the launch vehicle will be approximately -2.404°. The ballistic trajectory was chosen because it provides the required maximum heating rate reentry conditions with a minimum of equipment modifications to automatically control the spacecraft during flight. Also, the ballistic trajectory provides minimum dispersions in the landing location and high reliability of spacecraft recovery when compared with an orbital flight. The center of gravity of this spacecraft is offset as part of the Gemini design, but the effect of the lifting vector will be cancelled by a 15°/sec spacecraft roll rate during reentry; therefore, the spacecraft reentry will closely follow a ballistic trajectory.

The launch azimuth for this flight will be 105.0°. This azimuth was selected to meet tracking and recovery requirements. The total range to the touchdown point will be approximately 1850 nautical miles, and the maximum altitude of 91.5 nautical miles will occur about 320 seconds after lift-off. Total flight time for the mission will be 1136 seconds. The landing will be made by parachute. Location and recovery of the spacecraft is expected to occur within approximately 2- and 4-hours after landing, respectively. Spacecraft recovery is mandatory for this mission to be considered a complete success.

3.3 Gemini Mission Three (GT-3)

The third Gemini mission is the first manned orbital mission, and will have a duration of three orbits. This flight will further qualify the spacecraft systems for long-duration missions.

3.3.1. Configuration.- The spacecraft (SC-3) will have the basic Gemini long-duration flight configuration, although a short-duration environmental control system (ECS) will be installed. All operational objectives of the flight can be met by a three-orbit (4.5 hr) flight; therefore, the flight plan has been operationally limited to three orbits. Since the Gemini fuel cell will not be installed on this spacecraft, power will be supplied by batteries. The Gemini Launch Vehicle No. 3 (GLV-3) is the standard configuration for use on all Gemini flights.

The loading of spacecraft consumables for the GT-3 mission is shown in table 3-I The estimated usage rates of these consumables during the mission are defined in the GT-3 Mission Flight Plan.

3.3.2 Mission Objectives.- Following is a list of the objectives for this mission:

a. Demonstrate manned orbital flight in the Gemini spacecraft and further qualify the spacecraft for long-duration missions.

b. Evaluate the two-man Gemini design and its effect on crew performance capabilities for the mission period.

c. Perform maneuvers to exercise the orbit attitude and maneuver system (OAMS).

d. Evaluate controlled flight path reentry by controlling the spacecraft roll rate to utilize the lifting vector caused by an offset in the spacecraft center of gravity.

e. Perform experiments as assigned by NASA Office of Manned Space Flight.

3.3.3 Mission Description.- The spacecraft will be placed into an 87-161 nautical mile elliptical orbit by the GLV. Separation from the GLV second stage will be accomplished using the aft-firing thrusters of the OAMS. The launch azimuth will be 72.0° in order to effectively use the Manned Spaceflight Network which was designed for three-orbit Project Mercury missions. Spacecraft retrograde and reentry will be initiated by the astronauts and the reentry flight path will be flown using the spacecraft onboard computer to reach a preselected landing area. A water landing will be accomplished using a drogue parachute and a main parachute. Manned spacecraft recovery procedures will be followed.

A "fail-safe" flight plan has been adopted for this mission to provide normal decay reentry for the spacecraft in the event of adapter separation failure and/or retrofire failure. The flight plan is approximately as follows:

a. Insert 87-161 nautical mile ellipse.

b. After one orbit at approximately first perigee perform a 60 foot-per-second maneuver to change the orbit into an 87-90 nautical mile ellipse.

c. After completion of two orbits at approximately second perigee perform an 88 foot-per-second maneuver to change the orbit into an 87-41 nautical mile ellipse.

A more detailed description of the mission and its objectives, as well as information concerning the methods of accomplishing the objectives is contained in Program Gemini Working Paper No. 5017, "GT-3 Mission Directive."

3.4 Gemini Mission Four (GT-4)

The fourth Gemini mission will be the first long-duration flight, and will have a duration of four days.

3.4.1 Configuration.- The spacecraft (SC-4) consists of the long-duration configuration modified to carry a battery power unit in place of the fuel cell. The spacecraft OAMS will be off-loaded approximately 160 pounds, since full spacecraft maneuver capability is not required for this mission. The spacecraft computer will use an interim set of guidance equations designated "Math Flow 3 Mod II." The Gemini Launch Vehicle (GLV-4) has the standard configuration for use on all Gemini flights.

The loading of spacecraft consumables for the GT-4 mission is shown in table 3-I. The estimated usage rates of these consumables during the mission will be defined in the Flight Plan for the GT-4 Mission.

3.4.2 Mission Objectives.- The GT-4 mission objectives are as follows:

a. Accomplish a long-duration manned flight.

b. Evaluate the effects of extended spaceflight on crew performance and physical condition.

c. Perform experiments as assigned by NASA Office of Manned Space Flight.

3.4.3 Mission Description.- The spacecraft will be launched on an azimuth of 90° into an 87-161 nautical mile elliptical orbit. During the flight, in-plane and out-of-plane maneuvers will be performed which will result in raising the perigee to approximately 135 nautical miles, and lowering the apogee to approximately 150 nautical miles.

Several onboard experiments will be performed during this flight.

This mission will further qualify the spacecraft for longer duration missions. The flight duration is limited to four days because of medical requirements. The spacecraft reentry sequence will be initiated by the astronauts. A controlled reentry and water landing are planned.

3.5 Gemini Mission Five (GT-5)

The fifth Gemini mission will be a seven-day long-duration flight using the Gemini fuel cell for spacecraft power.

3.5.1 Configuration.- The spacecraft (SC-5) will carry the standard long-duration equipment based on the 14-day configuration although the mission duration has been limited to seven days by medical requirements. The spacecraft will carry the rendezvous radar. The rendezvous evaluation pod (REP) will be used for evaluating rendezvous practice maneuvers. The Gemini Launch Vehicle (GLV-5) will have the standard configuration for use on all Gemini flights.

The loading of spacecraft consumables for the GT-5 mission is shown in table 3-I. The estimated usage rates of the consumables during the mission will be defined in the Flight Plan for the GT-5 mission.

3.5.2 Mission Objectives.- The mission objectives are given below:

a. Accomplish a long-duration flight up to seven days duration.

b. Open the spacecraft hatches in space.

c. Perform rendezvous exercises with the ejected rendezvous evaluation pod.

d. Further evaluate the effects of extended spaceflight on crew performance and physical condition.

e. Perform experiments as assigned by NASA Office of Manned Space Flight.

3.5.3 Mission Description.- The spacecraft will be launched on an azimuth of 90° into an 87-150 nautical mile ellipse by the GLV. After completion of the initial spacecraft checks, the spacecraft propulsion system (OAMS) will be used to raise the orbit perigee.

Rendezvous with an Agena will be simulated using the rendezvous evaluation pod. After the spacecraft perigee has been raised as discussed above, the REP will be ejected from the equipment section of the adapter. The OAMS will be used to separate the spacecraft a sufficient distance from the ejected pod. Maximum separation should be attained within two orbits after the REP is ejected. When sufficient separation has been achieved, the spacecraft will begin simulated Agena rendezvous maneuvers to achieve a very close approach to the REP, as well as match the spacecraft velocity to that of the REP. Once this objective is achieved, further spacecraft maneuvers may be attempted, if sufficient OAMS fuel is available. In addition, the initial extravehicular activities are planned for this mission, and will consist of opening and closing of the spacecraft right-hand hatch as well as the pilot standing up during periods when the hatch is open. Section 5.0 describes the extravehicular activities and equipment planned for this and future Gemini Program missions.

3.6 Gemini-Agena Mission Six (GTA-6)

The sixth Gemini mission is the first Agena rendezvous mission.

3.6.1 Configuration.- The spacecraft (SC-6) will be configured for the 2-day rendezvous mission. The spacecraft electrical power will be furnished by a battery module.

Although Gemini Launch Vehicle (GLV-6) will be the standard configuration for use on all Gemini flights, some minor changes will be made as part of the GLV weight reduction and performance improvement program.

The Atlas/Agena configuration is standard for all Gemini rendezvous flights. The Atlas launch vehicle will be the standardized Space Launch Vehicle SLV-3B. The Agena Target Vehicle (ATV) will be the Agena D Vehicle modified to Gemini requirements. Gemini equipment will be identical on all Agena vehicles. Agena D vehicle modifications will be incorporated as available to the Agena D vehicles. Vehicles for the first Gemini rendezvous mission are Atlas-1 and Agena Target Vehicle 5002 (ATV-5002).

The loading of spacecraft consumables for the GTA-6 mission is shown in table 3-I. The estimated usage rates of these consumables during the mission will be defined in the Flight Plan for the GTA-6 mission.

3.6.2 Mission Objectives.- The mission objectives for GTA-6 are as follows:

a. Achieve rendezvous and docking of the Gemini spacecraft with the Agena Target Vehicle, using both the spacecraft and Agena capabilities, as required.

b. Complete rendezvous using the radar-computer closed-loop orbital mechanics rendezvous mode.

c. Perform predocking Agena maneuvers, as required, using the Agena propulsion system.

d. Perform Agena vehicle checkout, determine its safety status, and test the Agena attitude maneuver capability while the vehicles are docked.

e. Evaluate the Agena maneuver capability after the vehicles are separated. Also evaluate the capability to command Agena maneuvers from the spacecraft and from the ground.

f. Conduct extravehicular operations. (See Section 5.0.)

g. Perform experiments as assigned by NASA Office of Manned Space Flight.

3.6.3 Mission Description.- The Atlas/Agena vehicle will be launched into a 161 nautical mile circular orbit on an 83.88° launch azimuth. The launch azimuth is selected to provide an orbital inclination of 28.87°. This orbital inclination and the 161 nautical mile orbital altitude provides spacecraft launch windows over a five-day period. A simultaneous countdown of both the GLV and Atlas/Agena has been adopted to provide maximum launch reliability of the GLV at the time the Atlas/Agena is launched. The first opportunity for GLV launch exists one-orbit or approximately 102 minutes after Atlas/Agena launch.

Launch azimuth for the GLV will be a function of the time of launch to provide launch as near as possible into the Agena Target Vehicle plane. The launch azimuth will range from 82.0 to 105.0°. Variable launch azimuth is accomplished by a variable roll maneuver before vehicle pitch-over.

For the first rendezvous mission, a concentric orbit method of rendezvous has been selected. In this method, the spacecraft will be launched into an 87-140 nautical mile ellipse. After one or more orbits, the spacecraft orbit will be circularized at 140 nautical miles. The lower spacecraft orbital altitude provides a catch-up rate with the target vehicle. A two-impulse transfer will be used to bring the spacecraft into the Agena 161 nautical mile orbit.

The rendezvous guidance mode for this mission is specified as the radar-computer mode. This mode provides a minimum fuel consumption when compared with the radar-optical or the optical rendezvous modes. In the event of computer or radar failure, the mission can proceed using ground data and the radar-optical or the optical rendezvous guidance modes.

After docking with the Agena, commands will be given to the Agena over the spacecraft-Agena hardline link. Attitude commands will be given to test the command system. The Agena secondary propulsion system may be activated to perform a small combined vehicle maneuver. At the present, it is not planned to use the main propulsion system on this flight while the vehicles are docked, as studies are still in progress on the stability and safety of Agena main engine burns while the two vehicles are docked.

It is planned to dock and separate the vehicles several times to provide experience with the docking mechanism. After final separation from the Agena, the spacecraft radar link will be used to transmit attitude commands to the Agena. These standoff commands will provide data on Agena visability at different attitudes and separation distances. After completion of the above Gemini-Agena requirements, the spacecraft will retrograde, reenter, and land in a preselected landing area.

Ground commands will be used to perform various Agena exercises after the Gemini-Agena requirements are completed. These exercises will be designed to test Agena command and control, and maneuver capability. They may continue until the Agena no longer responds to commands or the Agena may be commanded so as to reenter. No provisions for Agena recovery have been made as the Agena is expected to be destroyed by the reentry.

3.7 Gemini Mission Seven (GT-7)

The seventh Gemini mission is the Gemini 14-day long-duration mission and the fuel cell will supply spacecraft power.

3.7.1 Configuration.- The spacecraft (SC-7) will be configured for the 14-day long-duration mission. The Gemini Launch Vehicle (GLV-7) will have the standard configuration for use on all Gemini flights.

The loading of spacecraft consumable for the GT-7 mission is shown in table 3-I. The estimated usage rates of these consumables during the mission will be defined in the Flight Plan for the GT-7 mission.

3.7.2 Mission Objectives.- The GT-7 Mission objectives are as follows:

a. Provide flight data on the physiological effects of long-duration space flight.

b. Monitor and evaluate the effects of long-duration space flight on crew performance and physical condition.

c. Perform extravehicular standup maneuver required to retrieve experiment package from outer skin of adapter section.

d. Develop flight and ground operational techniques for extended duration space missions.

e. Perform experiments as assigned by NASA Office of Manned Space Flight.

3.7.3 Mission Description.- The spacecraft will be launched at an azimuth of 90° into an 87-161 nautical-mile ellipse. At first apogee, the spacecraft propulsion system will be used to circularize the orbit to 161 nautical miles.

Extravehicular activities, observation, and experiments will be conducted during the flight. The flight crew will initiate spacecraft reentry and a controlled reentry will be provided as on all manned Gemini flights. A water landing is planned. The spacecraft capability has been designed for a maximum of 14 days. Actual flight duration will depend on experience gained from earlier flights as well as progress of this mission.

3.8 Gemini-Agena Mission Eight (GTA-8)

The eighth Gemini mission is the second Gemini rendezvous mission.

3.8.1 Configuration.- The spacecraft (SC-8) will be configured for the 2-day rendezvous mission. The Gemini Launch Vehicle (GLV-8) will have the standard configuration used on all Gemini launches. The Agena Target Vehicle (ATV-5003) and Atlas Launch Vehicle (Atlas-2) have standard rendezvous configurations.

The loading of spacecraft consumables for the GTA-8 mission is shown in table 3-I. The estimated usage rates of these consumables during the mission will be defined in the Flight Plan for the GTA-8 mission.

3.8.2 Mission Objectives.- The GTA-8 Mission objectives are as follows:

a. Achieve rendezvous and docking using the radar-optical mode of rendezvous guidance.

b. Perform predocking Agena maneuvers, if required.

c. Checkout and fire the Agena main engine while the vehicles are docked. (The capability to perform combined vehicle maneuvers will be evaluated at a later date.)

d. Conduct further Agena maneuvers after spacecraft separation. These maneuvers may be commanded from the spacecraft or from the ground.

e. Further develop rendezvous techniques and accomplish rendezvous earlier than planned on GTA-6.

f. Perform experiments as assigned by NASA Office of Manned Space Flight.

3.8.3 Mission Description.- Some operational procedures will be changed for this mission depending on the experience gained from the first rendezvous mission. This mission is designed to develop quick, efficient rendezvous, and will use the radar-optical rendezvous mode. The basic mission to be flown, however, will be similar to that described for GTA-6, in Section 3.6 of this report. Experiments will be conducted as described in Appendix B.

3.9 Gemini-Agena Mission Nine (GTA-9)

The ninth Gemini mission is the third rendezvous mission.

3.9.1 Configuration.- No changes from the GTA-8 configuration are planned. The vehicles used will be: SC-9, GLV-9, Atlas-3, and ATV-5004.

The loading of spacecraft consumables for the GTA-9 mission is shown in table 3-I. The estimated usage rates of these consumables during the mission will be defined in the Flight Plan for the GTA-9 mission.

3.9.2 Mission Objectives.- The mission objectives are as follows:

a. Further develop rendezvous techniques.

b. Investigate rendezvous in elliptical orbits.

c. Accomplish rendezvous with a minimum of Agena predocking maneuvers.

d. Conduct simple maneuvers with the Gemini-Agena combined vehicle after docking.

e. Conduct extravehicular operations. (See Section 5.0.)

f. Perform experiments as assigned by NASA Office of Manned Space Flight.

3.9.3 Mission Description.- Detailed plans for this mission will be developed to investigate other rendezvous techniques. The Agena will be launched into a 102-165 nautical-mile orbit (preliminary altitude numbers only). This Agena orbit will have an orientation such that one orbit after launch, the spacecraft can be launched at the Agena orbit perigee. If on-time launch is accomplished, rendezvous can occur within one orbit of insertion. Catch up maneuvers may be performed with either the Agena or the spacecraft. If spacecraft launch is delayed beyond the same-day launch window, Agena prephasing maneuvers will be required to normalize the rendezvous problem. The experiments to be conducted on this mission are described in Appendix B.

3.10 Gemini-Agena Mission Ten (GTA-10)

The tenth Gemini mission will be designed to develop direct-ascent rendezvous techniques.

3.10.1 Configuration.- No changes from the GTA-8 configuration are planned other than the incorporation of onboard experiments. The vehicles used will be SC-10, GLV-10, Atlas-4, and ATV-5005.

The loading of spacecraft consumables for the GTA-10 mission is shown in table 3-I. The estimated usage rates of these consumables during the mission will be defined in the Flight Plan for the GTA-10 mission.

3.10.2 Mission Objectives.- Following is a list of the objectives for this mission:

a. Develop direct-ascent rendezvous techniques.

b. Conduct a Gemini-Agena combined vehicle mission while docked.

c. Develop onboard rendezvous navigation techniques.

d. Perform experiments as assigned by NASA Office of Manned Space Flight.

3.10.3 Mission Description.- This flight will be designed to thoroughly investigate direct rendezvous with the Agena Target Vehicle.

Nominally, the Gemini spacecraft will be launched one orbit after Agena launch. Out-of-plane velocity and apogee altitude will be corrected at insertion, and radar closed-loop guidance will commence as soon as possible. Further studies of required techniques are continuing.

The Agena will be inserted into a circular or elliptical orbit, depending on the results of studies and earlier rendezvous flights. Spacecraft steering to rendezvous will begin immediately at insertion. With nominal insertion, rendezvous and docking is possible using optical or radar-optical techniques. The experiments to be performed on this mission are described in Appendix B.

3.11 Gemini-Agena Mission Eleven (GTA-11)

The eleventh Gemini mission will be designed to simulate an Apollo Program Lunar Excursion Module (LEM) rendezvous.

3.11.1 Configuration.- No changes from the GTA-8 configuration are presently planned. The vehicles used will be SC-11, GLV-11, Atlas-5, and ATV-5006.

The loading of spacecraft consumables for the GTA-11 mission is shown in table 3-I. The estimated usage rates of these consumables during the mission will be defined in the Flight Plan for GTA-11 mission.

3.11.2 Mission Objectives.- The following is a list of the primary objectives for this mission:

a. Conduct an earth orbit simulation of the Apollo LEM lunar-orbit rendezvous.

b. Conduct a Gemini-Agena combined vehicle mission in support of simulation and training for Apollo missions.

c. Perform experiments as assigned by NASA Office of Manned Space Flight.

3.11.3 Mission Description.- The operations and procedures for this flight will simulate Apollo LEM maneuvers, where possible. Orbits and maneuvers will be planned to support studies of LEM rendezvous from lunar ascent. Combined vehicle maneuvers after docking will also be conducted for this purpose.

After separation from the Agena, further maneuvers may be made to investigate docking with an unstabilized target. Experiments to be conducted are described in Appendix B.

3.12 Gemini-Agena Mission Twelve (GTA-12)

This flight will be used to conduct an Apollo LEM abort simulation.

3.12.1 Configuration.- No changes from the GTA-8 configuration are presently planned. The vehicles to be used are: SC-12, GLV-12, Atlas-6, and ATV-5007.

The loading of spacecraft consumables for the GTA-12 mission is shown in table 3-I. The estimated usage rates of the consumables during the mission will be defined in the Flight Plan for the GTA-12 mission.

3.12.2 Mission Objectives.- Following are the primary objectives for this mission:

a. Conduct an earth orbit simulation of lunar orbit maneuvers and operations pertaining to LEM abort from lunar descent.

b. Conduct a Gemini-Agena combined vehicle mission after docking.

c. Perform experiments as assigned by NASA Office of Manned Space Flight.

3.12.3 Mission Description.- Operations and procedures for this mission will simulate Apollo procedures, wherever possible. Apollo LEM abort from lunar orbit will be investigated and simulated, as closely as possible, to provide a representation of operational problems and to provide astronaut training.

Alternate missions are also being studied for this flight.

Experiments which will be conducted are described in Appendix B.

TABLE 3-I.- MISSION CONSUMABLES LOADINGS

	GT-3	GT-4	GT-5	GTA-6	GT-7	GTA-8	GTA-9	GTA-10	GTA-11	GTA-12
OAMS										
Fuel	120	120*	160	311	135	311	311	311	311	311
Oxidizer	246	139*	230	379	215	379	379	379	379	379
Pressurization gas	2.0	2	2	4	2	4	4	4	4	4
Environmental Control										
Lithium Hydroxide	32	62	62	32	89	32	32	32	32	32
Oxygen (Primary)	16	52	75	54	106	54	54	54	54	54
Oxygen (Secondary).	14	14	14	14	14	14	14	14	14	14
Drinking Water.										
Adapter Section	16	61	44	30	0	0	0	0	0	0
Reentry Module.	16	16	16	16	16	16	16	16	16	16
Food	2.6	10	18	5	36	5	5	5	5	5
Electrical Power System										
Batteries										
Adapter Batteries	352	703	0	236	0	0	0	0	0	0
Fuel Cell	0	0	138	0	138	138	138	138	138	138
Fuel Cell Reactants	0	0	105	0	202	52	52	52	52	52
Reentry Control System										
RCS propellants	72	72	72	72	72	72	72	72	72	72

*These OAMS loadings reflect 52 pounds more propellant based on more recent information than that contained in the "Gemini Spacecraft Weight and GLV Payload Capability" report of December 1, 1964.

4.0 CONTINGENCY MISSIONS

4.1 Requirements

Contingency missions are required to provide workable plans in the event of hardware development problems and to take advantage of knowledge gained on earlier Gemini flights.

4.2 Plans

4.2.1 Unmanned Flights.- In the event that all mission objectives are not met by the GT-2 flight, an evaluation will be made to determine if the mission should be reflown. The primary consideration in this determination will be astronaut safety. The GLV was qualified by the GT-1 Mission. Many systems will be qualified through ground testing. The GT-2 Mission will qualify the spacecraft afterbody heat protection and the spacecraft retrograde and reentry control systems. If another unmanned flight is required, it will follow the GT-2 flight plan.

4.2.2 Long-Duration Flights.- The long-duration flights extend from the three-orbit manned flight to a 14-day spacecraft design capability. Backup flight capability consists primarily of the capability to extend or shorten flight duration based on equipment availability and flight experience. A rendezvous flight was placed between the 7-day and 14-day flights to provide full evaluation of the 7-day flight before the 14-day flight is attempted. The spacecraft long-duration configuration is designed for 14-days whether used or not.

4.2.3 Rendezvous Flights.- Failure of the Atlas/Agena would cause cancellation of the Gemini launch. Acceptable orbits for a rendezvous mission are well within Agena capability, but some Agena equipment failures would limit the mission. The spacecraft would be launched if rendezvous could be accomplished, even if docking were not possible. All rendezvous spacecraft and target vehicles have identical equipment capability in order to provide an interchange of mission objectives where necessary.

5.0 GEMINI EXTRAVEHICULAR OPERATION

5.1 Implementation

As a primary program objective, the capability for extravehicular operation will be phased into the Gemini missions as early as practicable. Thereafter, extravehicular operation will be used as necessary to accomplish other mission tasks.

5.2 Extravehicular Equipment

Following is a brief summary of the special equipment for extravehicular operation.

5.2.1 Extravehicular Life Support System.- The extravehicular life support system (ELSS) will consist of a chest pack containing a semi-open loop oxygen supply system and a reserve oxygen tank. Normal oxygen will be supplied by a high pressure umbilical line connected to the spacecraft environmental control system. The reserve tank in the ELSS will contain 2.15 pounds of oxygen at 7500 psia. This reserve oxygen will permit return to the spacecraft and ingress without the umbilical.

5.2.2 Spacesuit.- The G4C spacesuit to be used for extravehicular operation will be a modified version of the G3C spacesuit developed for the first manned Gemini flights. The primary modifications include an overvisor for visual and physical protection, a redundant pressure closure seal, and thermal and meteoroid protection integrated in the outer cover layer. The basic characteristics of the suit will remain unchanged.

5.2.3 Spacecraft Provisions.- Spacecraft provisions for extravehicular operation will include a cockpit connection for the oxygen umbilical, and external handrails on the spacecraft adapter sections. The spacecraft hatches are designed to be opened and closed in space.

5.3 Extravehicular Development

The objectives of Gemini extravehicular operation are as follows:

a. Develop the capability to perform extravehicular operation in free space.

b. Employ extravehicular operation to augment the basic capability of the Gemini spacecraft.

c. Develop operational techniques and evaluate advanced extravehicular equipment in support of the national space effort.

5.4 Mission Planning for Extravehicular Operations

Mission planning is based on a step-by-step progression from the simplest to the more difficult extravehicular tasks. The tasks proposed for each mission are as follows:

a. GT-5 - Open the hatch and stand up, demonstrate hatch closure and repressurization techniques.

b. GTA-6 - Egress to the vicinity of the hatch, evaluate hand holds, demonstrate ingress techniques.

c. GT-7 - The ELSS chest pack will not be carried on this flight because of required storage for expendables. An open hatch and standup maneuver is planned to retrieve experiment package from outer skin of adapter section.

d. GTA-8 - Egress and proceed to the interior of the equipment adapter section. Retrieve experimental equipment and data packages, evaluate space tools, evaluate tether dynamics, evaluate displays for the astronaut maneuvering unit.

e. GTA-9 - Retrieve the astronaut maneuvering unit from the adapter equipment section, evaluate the astronaut maneuvering unit (DOD Experiment D-12).

f. GTA-10 through GTA-12 - Retrieve equipment from the spacecraft adapter equipment section and the Agena Target Vehicle, evaluate advanced life support system and extravehicular equipment, continue evaluation of the astronaut maneuvering unit (DOD Experiment D-12).

GEMINI PROGRAM

MISSION PLANNING REPORT

APPENDIX A

SPACECRAFT WEIGHT AND GEMINI LAUNCH

VEHICLE PAYLOAD CAPABILITY (U)

A-1.0 WEIGHTS

Individual spacecraft weights are determined monthly by the Gemini Program Office. The current spacecraft weight as included in table A-I includes all definitely committed experiments listed in table A-II.

A-2.0 GLV PAYLOAD

Payload capability is determined monthly based on information available and the following mission requirements:

a. Payload capability for GT-1 and GT-3 through GT-12 is based on a 3-sigma insertion probability into an 87-161 nautical mile orbit.

b. Payload capability for GT-2 is based on a special trajectory to obtain a maximum reentry heating rate. Insertion into this trajectory is at 87 nautical miles with launch at an azimuth of 105°.

c. Payload capability minimum is based on a launch hold time or launch window of 3.5 hours for GT-1 through GT-7 and 2.5 hours for GT-8 through GT-12.

d. Azimuth requirements for the missions are:

GT-2, 105°; GT-1 and GT-3, 72.0°; GT-4, GT-5, and GT-7, 90°; GT-6 and GT-8 through GT-12, 82 to 105°.

TABLE A-I. - GEMINI SPACECRAFT WEIGHT AND GLV PERFORMANCE

Mission		Current* S/C Weight	GLV** Payload Capability	Margin
GT-1	Unmanned Orbital	7029	7665	----
GT-2	Unmanned Ballistic	6890	7249	359
GT-3	Manned 3 Orbit Battery Power	7098	7601	503
GT-4	Manned 4-day Battery Power	7589	7739	150
GT-5	Manned 7-day REP, fuel cell	7737	7743	6
GTA-6	2-day Rendezvous Battery Power	7687	7746	59
GT-7	Long Duration 14-day fuel cell	7576	7793	217
GTA-8	2-day Rendezvous fuel cell	7800	7828	28
GTA-9	2-day Rendezvous fuel cell	7836	7836	0
GTA-10	2-day Rendezvous fuel cell	7672	7836	164
GTA-11	2-day Rendezvous fuel cell	7744	7836	92
GTA-12	2-day Rendezvous fuel cell	7836	7836	0

*Gemini Program Office Weight Status Jan. 1965

**Minus 3-sigma capability – see text.

TABLE A-II. - GEMINI EXPERIMENTS STATUS*

SEPTEMBER 1964

Status \ S/C No.	3	4	5	6
Definitely Committed	S-2,4 (4) T-1 (65) M-2 (0)	D-1,8 (25) D-6,9 (6) M-2,3,4,6 (0.5) MSC-1,2,3,10 (43) S-5,6 (5.8)	S-1,5,6,7,8 (16.4) D-1,2,4,6,7,13 (174.5) M-1,2,3,4,5,6,9 (8.5)	D-1,2,6,8 (22) M-1,2,3,4,5,6 (8) MSC-2,3 (33.3) S-5,6,12 (17.2)
Probable Commitment				
Total Weight	(69)	(80.3)	(202.4)	(80.5)

*Refer to Appendix B for experiment descriptions

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TABLE A-II. - GEMINI EXPERIMENTS STATUS* (Concluded)

SEPTEMBER 1964

S/C No. / Status	7	8	9	10	11	12
Definitely Committed	M-3,9 (1) D-4,7 (159) MSC-2,3 (33.3) S-8 (3.6)	D-14,15,16 (174)	D-12,14 (230) S-12 (11.4)	D-5,10 (44.5) S-12 (11.4)	D-5,8,14 (134.5) M-2,4,5 (3.5) S-9,11,13 (23)	D-8,10,12,16 (275) M-2,4,5,6 (3.5) MSC-3,6,7,8 (51) S-5,6,7,11,13 (17.8)
Probable Commitment	M-1,2,4,5,6,7,8 (10.3) D-5,9,13 (11) MSC-4 (10) S-5,6,9 (22.8)	M-1,2,4,5,6 (7.5) S-1,3,7,9 (30)	M-2,4,5,6,7,8 (6.3) S-1,11 (19.4)	M-2,4,5,6 (3.5) MSC-3,4,5,6,7,8 (66) S-1,5,6,13 (23.2)		
Total Weight	(251)	(211.5)	(255.7)	(137.2)	(161)	(347.3)

*Refer to Appendix B for experiment descriptions

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GEMINI PROGRAM

MISSION PLANNING REPORT

APPENDIX B

GEMINI ONBOARD EXPERIMENTS

B-1.0 GENERAL

Gemini onboard experiments included in this appendix to the "Gemini Program Mission Planning Report" have been recommended by the Manned Space Flight Experiments Board contingent upon a determination that each experiment is feasible and will have no adverse impact on Gemini schedules or primary objectives. Where continuing studies indicate that experiments tentatively programed for specific missions are not feasible, revisions to this appendix will be furnished as this information becomes available.

B-2.0 ASSIGNED EXPERIMENTS

Experiments assigned to mission GT-3 through GTA-12 are indicated in table B-I. Table B-I will be updated as needed when experiments are reassigned, added, or deleted.

TABLE B-I.- GEMINI EXPERIMENTS

Assigned Experiments		Missions									
Number	Department of Defense Technological Experiments	GT-3	GT-4	GT-5	GTA-6	GT-7	GTA-8	GTA-9	GTA-10	GTA-11	GTA-12
D-1	Visual Definition of Objects in Space		X	X	X						
D-2	Visual Definition of Objects in Near Proximity in Space			X	X						
D-3	Mass Determination										
D-4	Radiometer Measurements			X		X					
D-5	Star Occultation					X			X	X	
D-6	Visual Definition of Terrestrial Features		X	X	X						
D-7	Radiometric Observation of Objects in Space			X		X					
D-8	Radiation		X		X					X	X
D-9	Simple Navigation		X			X					
D-10	Navigation								X		X
D-12	Modular Maneuvering Unit							X			X
D-13	Astronaut Visability			X		X					
D-14	UHF, VHF Polarization Measurements						X	X			
D-15	Low Light Level Television						X			X	
D-16	Power Tool Evaluation						X				X

TABLE B-1.- GEMINI EXPERIMENTS - (Continued)

Assigned Experiments		Missions									
Number	Scientific Experiments	GT-3	GT-4	GT-5	GTA-6	GT-7	GTA-8	GTA-9	GTA-10	GTA-11	GTA-12
S-1	Zodiacal Light Photography			X			X	X	X		
S-2	Sea Urchin Egg Growth	X									
S-3	Frog Egg Growth						X				
S-4	Radiation and Zero g Effects on Blood	X									
S-5	Synoptic Terrain Photography		X	X	X	X			X		X
S-6	Synoptic Weather Photography		X	X	X	X			X		X
S-7	Cloud Top Altitude Spectrometer			X			X				X
S-8	Visual Acuity			X		X					
S-9	Nuclear Emulsion					X	X			X	
S-11	Airglow Horizon Photography							X		X	X
S-12	Micrometeorite Collection				X			X	X		
S-13	Astronomical Camera								X	X	X

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TABLE B-I.- GEMINI EXPERIMENTS - (Continued)

	Assigned Experiments	Missions									
Number	Medical Experiments	GT-3	GT-4	GT-5	GTA-6	GT-7	GTA-8	GTA-9	GTA-10	GTA-11	GTA-12
M-1	Cardiovascular Reflex			X	X	X	X				
M-2	Cardiovascular Effects		X	X	X	X	X	X	X	X	X
M-3	Inflight Exerciser		X	X	X	X					
M-4	Inflight Phonocardiogram		X	X	X	X	X	X	X	X	X
M-5	Biochemical Analysis of Body Fluids			X	X	X	X	X	X	X	X
M-6	Bone Demineralization		X	X	X	X	X	X	X		X
M-7	Gemini Calcium Balance Study					X		X			
M-8	Inflight Electroencephalogram					X		X			
M-9	Vestibular Effects			X		X					

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TABLE B-I. - GEMINI EXPERIMENTS - (Concluded)

Assigned Experiments		Missions									
Number	Technological Experiments	GT-3	GT-4	GT-5	GTA-6	GT-7	GTA-8	GTA-9	GTA-10	GTA-11	GTA-12
T-1	Reentry Communications	X									
	Center Engineering Experiments										
MSC-1	Electrostatic Charge		X								
MSC-2	Proton-Electron Spectrometer		X		X	X					
MSC-3	Tri-Axis Magnetometer		X		X	X			X		X
MSC-4	Optical Communications					X			X		
MSC-5	Ultraviolet Reflection from Lunar Surface								X		
MSC-6	Beta Spectrometer								X		X
MSC-7	Bremsstralung Spectrometer								X		X
MSC-8	Color Patch Photography								X		X
MSC-10	Two-Color Earth's Limb Photographs		X								

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B-3.0 EXPERIMENT DESCRIPTIONS

Brief descriptions of the experiments listed in table B-I are given in the following paragraphs. More detailed information concerning the experiments to be conducted in conjunction with the GT-3 mission may be found in NASA Program Gemini Working Paper No. 5014, "Experiments for GT-3 Mission," September 22, 1964.

B-3.1 Department of Defense Technological Experiments

B-3.1.1 Experiment D-1 (Visual Definition of Objects in Space).- In conducting this experiment, the astronauts will employ elaborate photo-optical equipment to investigate the technical problems associated with observing, evaluating, and photographing objects in space. These objects include the launch vehicle, rendezvous evaluation pod, Agena Target Vehicle, and natural celestial bodies such as the moon. Data from this experiment will be used to evaluate the astronauts' ability to view and track objects, and to maintain object-camera orientation by maneuvering the spacecraft.

B-3.1.2 Experiment D-2 (Visual Definition of Objects in Near Proximity in Space).- This experiment will be conducted to gather information about the astronauts' capability to maneuver the spacecraft in relation to nearby objects in space using the same photo-optical equipment as in experiment D-1.

B-3.1.3 Experiment D-3 (Mass Determination).- This experiment will be performed to investigate the feasibility of determining the mass of an orbiting vehicle by direct contact. When the spacecraft and the Agena Target Vehicle have been docked and rigidized, the configuration will be thrusted for approximately 25 seconds. The average acceleration will be determined for the last seven seconds of this period. The mass of the target vehicle will then be determined by the astronaut, using onboard instrumentation, and by the ground control station using telemetry data. The results obtained will be compared with the known mass of the target vehicle.

B-3.1.4 Experiment D-4 (Radiometric Measurements).- For this experiment, the spacecraft will be equipped with devices capable of measuring radiant intensity from the ultraviolet through the infrared. The spacecraft will be manually oriented toward regions of interest to record such spectral data, with possible visual correlation by photography.

B-3.1.5 Experiment D-5 (Star Occultation Measurements).- In performing this experiment, an astronaut will employ a photoelectric occultation telescope to make time and intensity measurements as stars are occulted by the edge of the earth's atmosphere. The primary application of the results of this experiment will be to develop a simple, accurate, self-contained orbital navigation capability.

B-3.1.6 Experiment D-6 (Visual Definition of Terrestrial Features).- This experiment will investigate the technical problems associated with an astronaut's ability to acquire, track, and photograph terrestrial objects from a spacecraft with more elaborate photo-optical equipment than that used previously. The astronaut will photograph selected series of objects during day-side and night-side intervals of the flight using specified lens-film combinations. The resulting data will be used to evaluate the astronauts' ability to maintain object-camera orientation by maneuvering the spacecraft.

B-3.1.7 Experiment D-7 (Radiometric Observations of Objects in Space).- This is an extension of experiment D-4 to measure the radiometric intensity of space objects, such as the rendezvous evaluation pod or the Agena Target Vehicle. The spacecraft will be manually oriented toward the object while spectral data is recorded. If possible, photographs will be taken for visual correlation.

B-3.1.8 Experiment D-8 (Radiation).- Data from this experiment will be used to supplement external radiation measurements in studying the dose levels within the spacecraft resulting from passes through regions of varying radiation intensity. Two tissue-equivalent, current-mode ionization chambers will be used to measure the variation of absorbed dose-rate inside the spacecraft, while a plastic scintillator dosimeter will be used to measure total accumulated dose. Five small packets containing radiation detection and measurement devices will be placed at various locations in the cabin to ascertain their suitability as convenient dosimeters of space radiation.

B-3.1.9 Experiment D-9 (Simple Navigation).- This experiment is designed to develop and test navigation procedures which employ simple stadimetric devices to make sightings and measurements in space using the horizon and stars as references. Data from sightings will be used in computations to determine orbital parameters. These results will be compared with actual parameters to determine the accuracy of the procedures.

B-3.1.10 Experiment D-10 (Navigation).- The purpose of this experiment is to investigate autonomous orbital navigation techniques. Primary emphasis will be placed on determining precise vehicle attitude relative to the local vertical and orbital plane. This information is required for effective position determination using stellar references and for orbital change maneuvering.

B-3.1.11 Experiment D-12 (Modular Maneuvering Unit).- This experiment will demonstrate the use of a modular maneuvering unit (MMU) which is an extravehicular life support and maneuvering system. The system will consist of two basic units. The chest unit will be primarily a life support package, while the back unit will have life support and maneuver capability. The chest unit will permit an astronaut to leave the spacecraft cabin and move to the adapter assembly where the back unit will be stored. After donning the back unit, the astronaut will perform maneuvers in space to establish stability and control capabilities. The astronaut may also accomplish specified work tasks on the Agena Target Vehicle.

B-3.1.12 Experiment D-13 (Astronaut Visibility).- This experiment is designed to measure an astronaut's ability to identify ground objects subtending small visual angles. A prepared sequence of ground targets will be placed in a strip in line with the spacecraft's flight path. As the spacecraft passes over the ground targets, the astronaut will observe the target area under controlled conditions, and the astronaut's description of his observations will be recorded.

B-3.1.13 Experiment D-14 (UHF-VHF Polarization Measurements).- The purpose of this experiment is to obtain precise measurements of the electron content of the ionosphere using polarimeters developed by the Naval Research Laboratory. Data from this experiment will be used in the design of improved spacecraft communications and control systems.

B-3.1.14 Experiment D-15 (Low Light Level Television).- This experiment will investigate the use of a special image orthicon television camera system, employing an image intensifier, in observing earth terrain features under low light level conditions. The test picture will be recorded on film in the spacecraft and correlated with other data obtained during the flight to determine the geographical areas viewed.

B-3.1.15 Experiment D-16 (Power Tool Evaluation).- The objective of this experiment is to evaluate man's ability to perform useful maintenance tasks in free space, and to evaluate the performance of a minimum reaction power tool designed specifically to overcome the effects of reactive torques and forces experienced under zero gravity conditions. An astronaut will be required to egress the spacecraft cabin while in orbit and traverse to the retrograde section of the adapter. At the work site, he will attach himself to the spacecraft, remove the tool from a stowage compartment, and perform specified tasks on a prearranged work panel. Upon completing the tasks, the astronaut will secure the tool, detach himself, and return to the spacecraft cabin.

B-3.2 Scientific Experiments

B-3.2.1 Experiment S-1 (Zodiacal Light Photography).- The purpose of this experiment is to obtain color photographs of the zodiacal light and the horizon airglow phenomena. The spacecraft will be manually oriented at the proper times, and when the targets have been acquired the astronaut will initiate a series of electrically timed photographic exposures.

B-3.2.2 Experiment S-2 (Sea Urchin Egg Growth).- This experiment is designed to investigate zero gravity effects on sea urchin eggs during sensitive stages of their development. Fertilization of egg samples will be activated prior to launch and during flight to start the cell division and growth process. The growth of eggs in various stages of development will be fixed at prearranged times during the flight. A similar series of control samples will be fertilized and developed simultaneously on the ground. The growth of the eggs during zero gravity under controlled conditions will ascertain if any cell division effects exist due to zero gravity. If the results are positive, future experiments will be planned for further investigation. If the cells, as expected, do not demonstrate any zero gravity effects, the results of this experiment will be used as a control in studying the effects of zero gravity on cells which have demonstrated effects due to gravity changes.

B-3.2.3 Experiment S-3 (Frog Egg Growth).- This experiment will investigate zero gravity effects on frog eggs during sensitive stage of their development. The method used in conducting this experiment will be similar to that described for Experiment S-2 (paragraph B-3.2.2).

B-3.2.4 Experiment S-4 (Radiation and Zero g Effects on Blood).- The purpose of this experiment is to determine if a synergistic relationship exists between the effects of weightlessness and radiation on white blood cells. A series of human blood samples will be exposed to a known source of radiation in the spacecraft during the flight. For comparison, a series of control samples will be exposed simultaneously on the ground. The frequencies of various types of chromosomal aberrations due to the radiation will then be measured. An analysis will also be made of blood samples taken from the astronauts immediately before and after the flight. If unpredicted results are obtained, further experiments might be required.

B-3.2.5 Experiment S-5 (Synoptic Terrain Photography).- The objective of this experiment is to obtain high quality photographs of selected parts of the earth's surface. The spacecraft will be manually oriented from an orbit mode attitude to a moderately high camera depression angle attitude. After a series of photographs has been taken, the spacecraft will be reoriented to the orbit mode attitude. Four spacecraft orientation maneuvers will be required during which approximately 40 pictures will be taken over areas of the United States.

B-3.2.6 Experiment S-6 (Synoptic Weather Photography).- The objective of this experiment is to learn more about the earth's weather systems by obtaining high quality photographs of selected cloud formations. As in experiment S-5, the spacecraft will be oriented from an orbit mode attitude to a moderately high camera depression angle attitude. After a series of photographs has been taken, the spacecraft will be reoriented to the orbit mode attitude. Approximately 10 orientation maneuvers will be required during which approximately 40 pictures will be taken.

B-3.2.7 Experiment S-7 (Cloud Top Altitude Spectrometer).- Spectrograms of various types of cloud formations will be taken from the spacecraft during orbital flight. This experiment will provide quantitative information on atmospheric oxygen absorption to support a method under development for determining cloud top altitudes from orbiting meteorological satellites.

B-3.2.8 Experiment S-8 (Visual Acuity).- In conducting this experiment, the astronaut will view a known ground object, and report what he observes, with and without the aid of a telescope. This information will be correlated with the results of preflight laboratory experiments to investigate the limits of visual performance of the astronauts in detecting and recognizing objects on the earth's surface.

B-3.2.9 Experiment S-9 (Nuclear Emulsion).- The objective of this experiment is to obtain data to be used in studying galactic cosmic radiation and the trapped proton flux of the Van Allen belts. A nuclear emulsion stack will be secured to the outside of the spacecraft before launch. After a minimum 12-hour exposure in space, the emulsion will be recovered by an astronaut while the spacecraft is in orbit. The astronaut will place the emulsion in an insulated container onboard the spacecraft to protect it during reentry.

B-3.2.10 Experiment S-11 (Airglow Horizon Photography).- An astronaut will take a series of spectrograms of the horizon airglow at various times during the space flight to study the emission spectra of the airglow phenomenon on a global scale.

B-3.2.11 Experiment S-12 (Micrometeorite Collection).- The purpose of this experiment is to collect micrometeorites in space so that their physical and chemical nature can be studied. A collection apparatus capable of being opened or closed by remote control from inside the spacecraft will be fastened to the outside of the reentry module prior to launch. After the micrometeorite collection surfaces have been exposed in space for a minimum period of eight hours, while the spacecraft is in drifting flight, the apparatus will be recovered by an astronaut and stowed onboard the spacecraft to protect it during reentry into the earth's atmosphere.

B-3.2.12 Experiment S-13 (Astronomical Camera).- The purpose of this experiment is to test a technique for investigating ultraviolet stellar spectra under space vacuum conditions. This technique embodies the use of a special 35 mm camera and guiding apparatus to be attached to a bracket and operated by an astronaut while the spacecraft hatch is open.

B-3.3 Medical Experiments

B-3.3.1 Experiment M-1 (Cardiovascular Reflex).- The purpose of this experiment is to determine the effectiveness of pneumatic (Graveline) cuffs in preventing deterioration of an astronaut's blood distribution system induced by prolonged weightlessness. The cuffs are applied to the astronaut's thighs, and will be inflated automatically to a prescribed pressure at specified intervals during the flight.

B-3.3.2 Experiment M-2 (Cardiovascular Effects).- This experiment will be conducted to determine the extent of cardiovascular reflex deconditioning and changes in the total circulating blood volume of the astronauts. Comparisons will be made of the astronauts' preflight and postflight blood pressures, blood volumes, pulse rates, and electrocardiograms. These data will reveal cardiovascular and blood volume changes due to heat stress, prolonged confinement, dehydration, fatigue, and the possible effects of weightlessness. This experiment is part of a continuing study of the effects of space flight on the human body.

B-3.3.3 Experiment M-3 (Inflight Exerciser).- The purpose of this experiment is to assess the astronauts' capacity to perform physical work under spaceflight conditions. Monitored exercise will be performed by the astronauts prior to the flight to establish control data. Isotonic exercises employing a bungee cord and involving the arms and legs will be taken prior to and after exercising. Pulse rate will be monitored continuously. The inflight data obtained will be compared with the control data to determine the capacity for work in space.

B-3.3.4 Experiment M-4 (Inflight Phonocardiogram).- The purpose of this experiment is to measure the fatigue-state of an astronaut's heart muscle during a long-duration flight. A microphone will be applied to an astronaut's chest wall at the cardiac apex. Heart sounds detected during the flight will be recorded on an onboard biomedical recorder. The sound trace will be compared to the waveform obtained from a simultaneous inflight electrocardiogram to determine the time interval between electrical activation of the heart muscle and the onset of ventricular systole.

B-3.3.5 Experiment M-5 (Biochemical Analysis of Body Fluids).- This experiment will be conducted to determine the astronauts' reaction to the stress requirements of spaceflight. Hormonal assays will be made from plasma samples obtained from the astronauts before and after the flight, and urine samples obtained before, during, and after the flight.

B-3.3.6 Experiment M-6 (Bone Demineralization).- The purpose of this experiment is to establish the occurrence and degree of bone demineralization resulting from prolonged weightlessness during spaceflight. Special X-rays will be taken of an astronaut's heel bone and the terminal bone of the fifth digit of the right hand. Three preflight and three postflight exposures will be taken of these two bones and compared to determine if any bone demineralization has occurred due to the spaceflight.

B-3.3.7 Experiment M-7 (Gemini Calcium Balance Study).- This experiment is designed to establish the rate and amount of calcium loss from the astronauts' bodies during a long-duration flight. The astronauts will be restricted to a controlled diet starting two weeks prior to the flight and continuing until two weeks after the flight. During this time, intake and output will be carefully recorded; and output specimens and blood samples will be analyzed.

B-3.3.8 Experiment M-8 (Inflight Electroencephalogram).- This experiment is designed to assess the state of alertness, level of consciousness, and depth of sleep of the astronauts while in space flight. The electrical activity of the astronauts' cerebral cortex will be monitored and recorded on a spacecraft biomedical tape recorder.

B-3.3.9 Experiment M-9 (Vestibular Effects).- In this experiment, changes in the astronauts' orientation capability under conditions of weightlessness and darkness are to be investigated by inducing and measuring ocular counter-rolling within a two week period prior to the flight and again immediately after the flight. In addition, visual location will be measured before, during and after the mission by means of special, lightproof goggles.

B-3.4 Technological Experiments

B-3.4.1 Experiment T-1 (Reentry Communications).- This experiment is designed to evaluate a technique for restoring communications with the spacecraft during reentry communications blackout. The technique consists of ejecting water from the spacecraft during reentry in an attempt to prevent ionization, thereby permitting the passage of radio frequency waves.

B-3.5 Manned Spacecraft Center Engineering Experiments

B-3.5.1 Experiment MSC-1 (Electrostatic Charge).- Before rendezvous missions are attempted, an investigation must be made of the possibility of inadvertent ignition of pyrotechnics and other detrimental effects due to discharge of electrostatic charge potentials during rendezvous. In this experiment, an electrostatic potential meter which protrudes through the wall of the spacecraft adapter assembly will be used to detect and measure any accumulated electrostatic charge that may be created on the surface of the spacecraft by ionization from engine exhaust. This data will be analyzed to determine if the charge is adequate to create a rendezvous hazard.

B-3.5.2 Experiment MSC-2 (Proton-Eelectron Spectrometer).- This experiment is designed to measure the quantity and energy of protons and electrons present immediately exterior to the orbiting spacecraft. This will be accomplished by means of a scintillating-crystal charged particle analyzer mounted on the adapter assembly of the spacecraft. Data from this experiment will be used to correlate radiation measurements made inside the spacecraft and to predict radiation levels on future space missions.

B-3.5.3 Experiment MSC-3 (Tri-Axis Magnetometer).- In this experiment, the direction and magnitude of the earth's magnetic field with respect to the spacecraft will be measured. A tri-axis fluxgate magnetometer mounted in the adapter assembly of the spacecraft will be used for this purpose. Data from this experiment will aid in the analysis of Experiment MSC-2.

B-3.5.4 Experiment MSC-4 (Optical Communications).- This experiment is designed to aid in determining the feasibility of using laser beams for spacecraft-to-earth communication. On a given signal, the spacecraft will be placed in the correct attitude and an astronaut will mount a portable laser transmitter in the operating position near a window. As the spacecraft approaches an optical receiver equipped ground station, the receiver system will be directed to the spacecraft by slaving with tracking radar. A laser beacon located at the ground receiver will have its output beam boresighted with the radar beam tracking the spacecraft. The astronaut will visually locate the laser beacon and keep its image centered on the cross hairs of a telescope mounted on the laser transmitter. While aiming the transmitter at the ground receiver, voice communication will be attempted by the astronaut speaking into his helmet microphone while depressing the laser transmit switch.

B-3.5.5 Experiment MSC-5 (Ultraviolet Reflection from Lunar Surface).- In designing the spacesuit to be used in the Apollo Program, it is necessary to know the total incident ultraviolet energy to which an astronaut's face will be exposed while he is on the lunar surface. An accurate value can be computed if the ultraviolet spectral reflectance of the lunar surface is known. This experiment is designed to provide this data. While the spacecraft is in orbit, one astronaut will aim and guide a spectrograph while the other astronaut keeps the spacecraft oriented toward the moon. Several spectrograms will be made of the solar radiation from the lunar surface.

B-3.5.6 Experiment MSC-6 (Beta Spectrometer).- In order to assess the degree of radiation hazard to astronauts on Apollo missions, Manned Spacecraft Center personnel intend to employ a computer which will predict the radiation dose to which the astronauts would be subjected. To make meaningful and reliable predictions, radiation dose measurements must be made on Gemini missions and compared with the predicted dose. A Beta Spectrometer, which measures secondary X-ray emission, will be mounted in the adapter equipment section of the spacecraft, and will be turned on and off by one of the astronauts at preselected times. A Bremsstralung Spectrometer, which measures X-rays produced by electrons impinging on the spacecraft, will also be carried. The Bremsstralung readings will be compared with the results of computer calculations to verify or adjust the computer code.

B-3.5.7 Experiment MSC-7 (Bremsstralung Spectrometer).- This experiment is to be flown in conjunction with the Beta Spectrometer (paragraph B-3.5.6, Experiment MSC-6) and is designed to measure the Bremsstralung flux near the spacecraft skin as the vehicle passes through a region of high free electron concentration. The Bremsstralung Spectrometer will be mounted on the inner wall of the pressurized cabin. An astronaut will turn it on and off at preselected times by flipping a switch on the instrument panel.

B-3.5.8 Experiment MSC-8 (Color Patch Photography).- Available data on the effect of the space environment on color photographs is not sufficient to insure correct color balance of photographs to be taken on Apollo missions. Additional data will be provided by Gemini flights. Photographs of color patches will be taken by an astronaut in free space.

These photographs will be compared with others taken under controlled conditions on the ground to determine the effect of ultraviolet energy upon the color.

B-3.5.9 Experiment MSC-10 (Two-Color Earth's Limb Photographs).- The astronaut will obtain photographs of the earth's limb using a hand-held camera, black and white film, and a special filter mosaic which will allow each picture to be taken partly through a red filter and partly through a blue filter. After the flight, the negative will be subjected to careful measurements, and the resulting data will be used in statistical analyses to evaluate the limb radiance. These studies will be used to determine if the sun-lit earth's limit can be reliably observed in the short visible, or near ultraviolet spectral region.