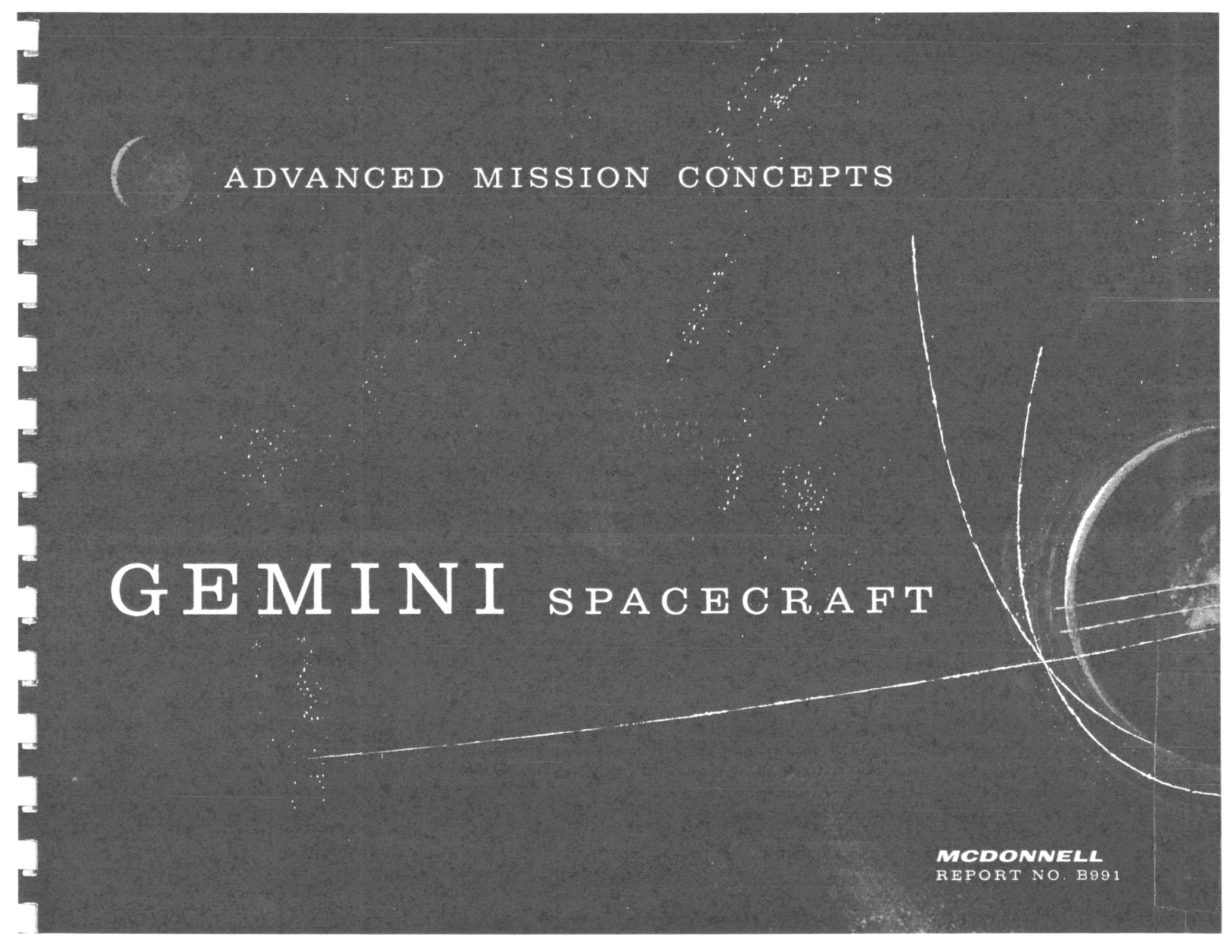




ADVANCED MISSION CONCEPTS

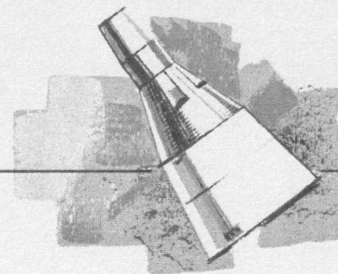
GEMINI SPACECRAFT

MCDONNELL
REPORT NO. B991

GEMINI
SPACECRAFT

ADVANCED
MISSION
CONCEPTS

REPORT NO. B991
1 SEPTEMBER 1965



MCDONNELL

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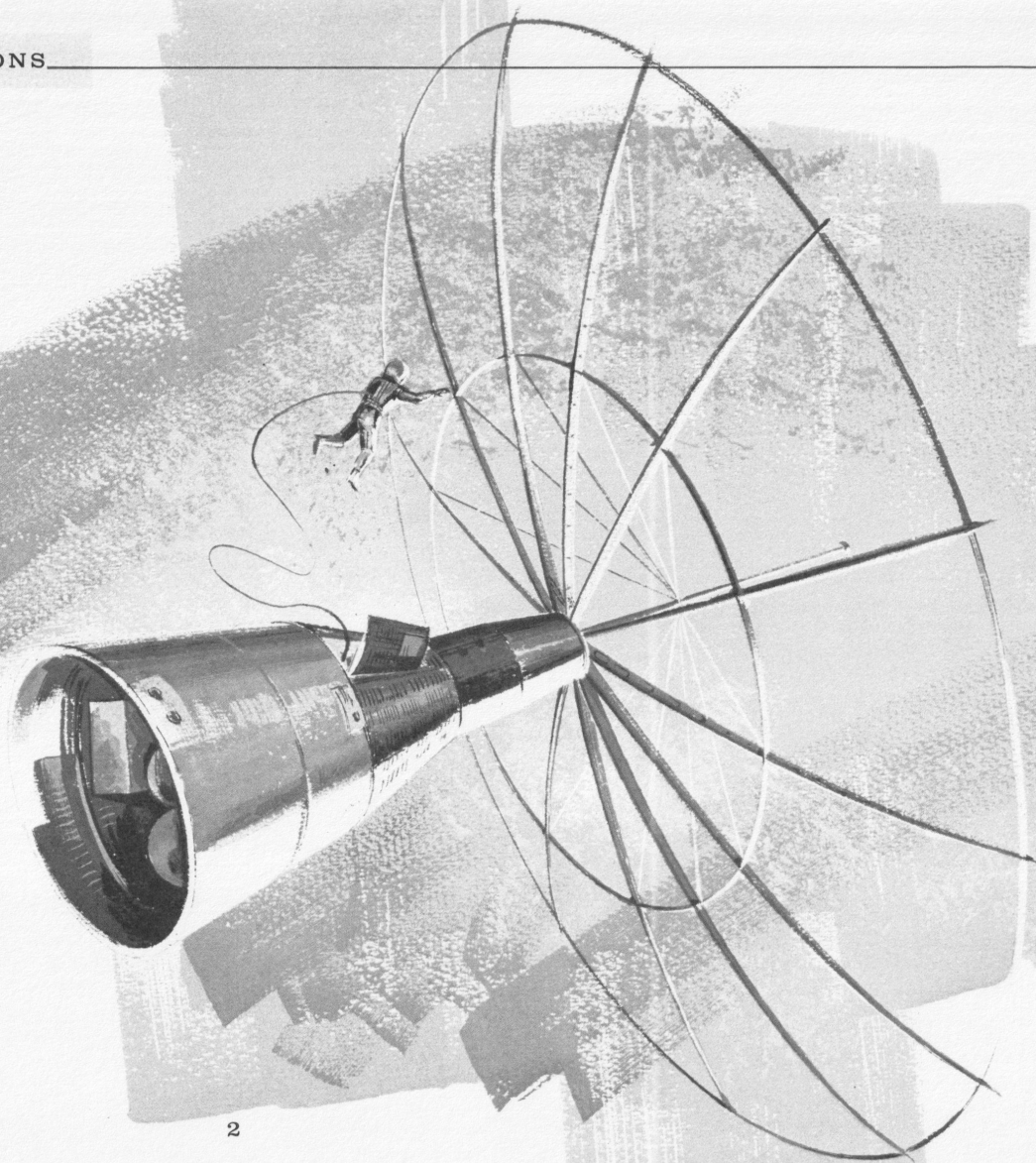
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INTRODUCTION

Through the Gemini Program, the United States has developed an operational manned space capability and a technology which forms the basis for future extended missions. The flight qualified Gemini spacecraft, with its designed-in versatility, represents a significant National Asset capable of further utilization in the Nation's expanding space program.

The series of concepts presented in this booklet illustrate missions utilizing this inherent Gemini capability and suggest the merit of further employment. Direct adaptations of Gemini hardware and Gemini technology have been considered. Each mission concept has received sufficient engineering study to validate critical technical aspects. The results of these studies are contained in McDonnell Reports B766 and B803.



GEMINI MISSION CONCEPTS

Nine Gemini mission concepts are presented in this section. The missions are based upon utilization of Gemini spacecraft and launch vehicles with minimum modification. The objectives of these missions are to:

- Develop information contributing to the Apollo and AES Programs with sufficient lead time to support critical system and sub-systems design decisions.
- Provide mission capability for the generation of scientific data.

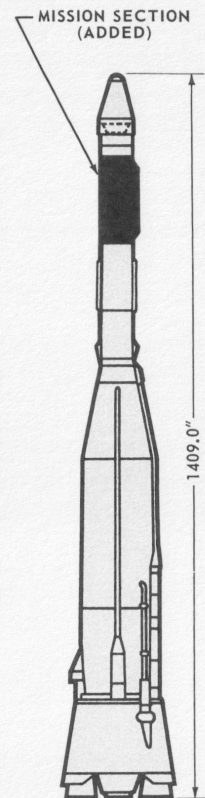
EXTENDED DURATION MISSION

Early evaluation of the effect of extended stay times in orbit upon men and spacecraft systems is fundamental to future mission planning where significant duration is a factor.

The practicality of carrying out 30 to 45 day manned flights in the 1967-68 time period employing Gemini spacecraft systems and launch vehicles yields a capability of entering the Apollo and AES mission era with increased confidence.

A configuration providing over 400 cubic feet of pressurized volume for crew mobility and experimentation for such a mission is illustrated at right.

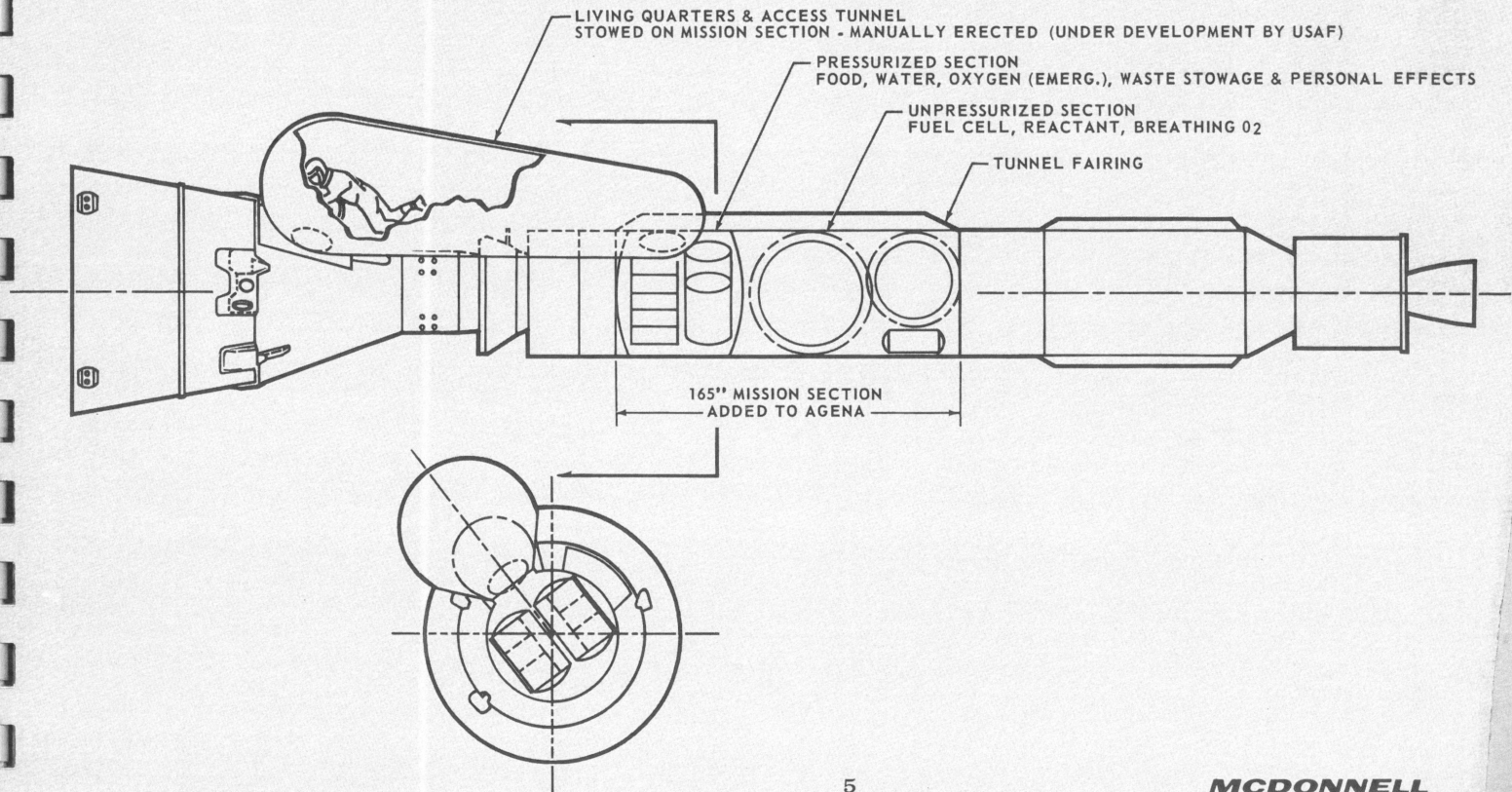
The mission is accomplished with a GLV-launched Gemini which effects a rendezvous with a modified Agena launched by an Atlas. Agena modification consists of a 165 inch mission section addition. An inflatable tunnel, carried aboard the Agena, is positioned by the astronaut after rendezvous and provides sheltered access from the Gemini spacecraft to the Agena mission module in a continuous pressurized volume.



AGENA LAUNCH
CONFIGURATION

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EXTENDED DURATION CONFIGURATION



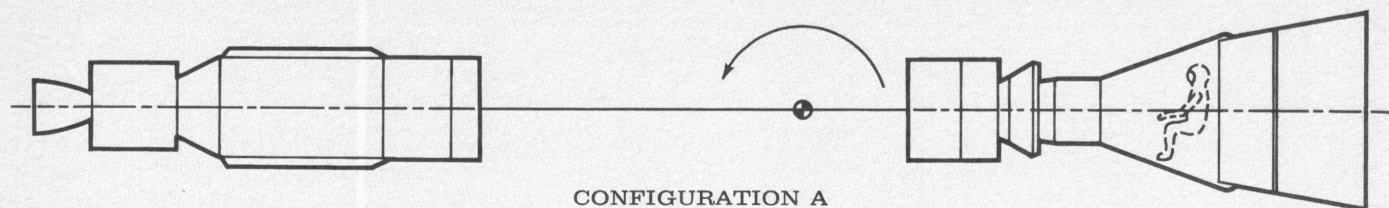
ARTIFICIAL GRAVITY

The requirements for a gravitational force to produce normal reaction and well-being over long periods of time is still a subject with many unknowns. Experimentation with an artificially induced gravitational vector is a means for quantitative assessment of the medical and behavioral aspects of the matter.

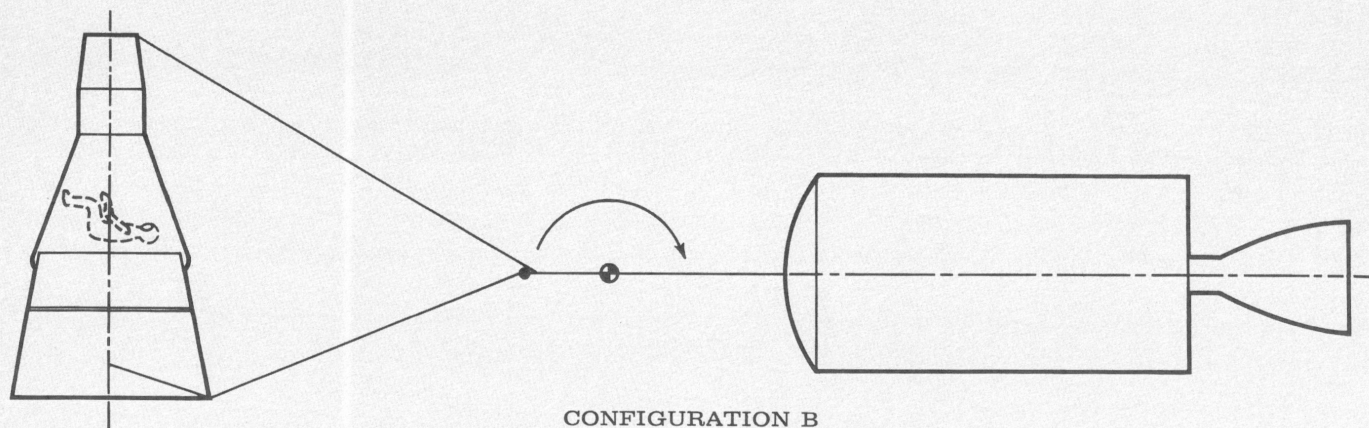
Several modes of induced gravity can be employed. Two are illustrated at right.

Configuration A utilizes the Agena rendezvous vehicle extended by cable and rotated. "Eyeballs-in" forces are provided.

Configuration B retains the burned-out second stage of the GLV with the Gemini centerline aligned normal to the radius of rotation. Induced gravity forces are oriented along the spine, approximating earth conditions.



CONFIGURATION A



CONFIGURATION B

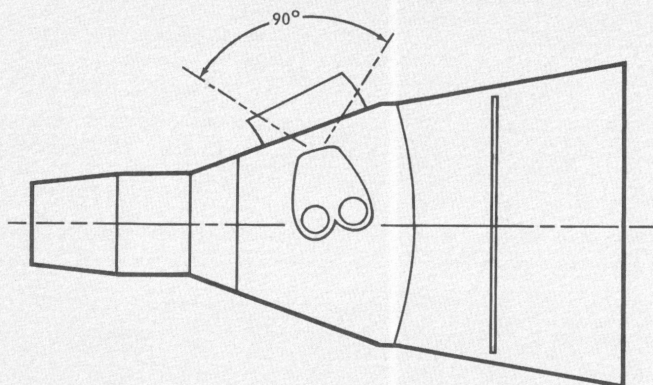
EARTH SURFACE OBSERVATION/MAPPING

The quality of the photographs taken during Gemini flights clearly demonstrates the potential of earth surface observation from orbit. Though these photographs were taken with a hand-held camera through the triple paned Gemini window, resolution and extent of detail are remarkable. Earth surface photography and geological, oceanographic, hydrological, and meteorological observation of a scientific order of quality can now be considered.

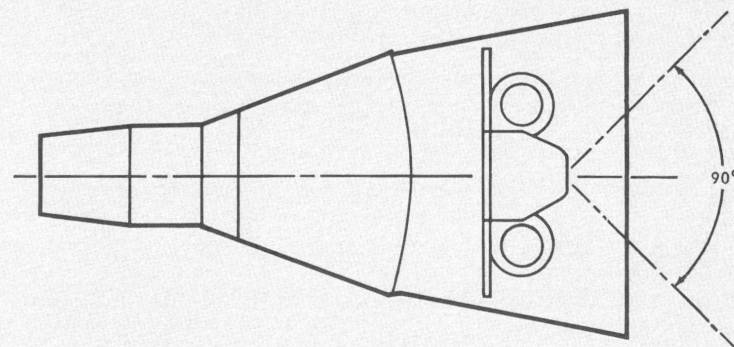
Two photographic configurations of Gemini are illustrated with placement of camera (A) in place of the right hand crewman and seat, and (B) placement of cameras in the adapter. The slight additional modifications to the basic Gemini configuration in the (B) version offers greater film footage. The film is retrieved from the adapter either by extravehicular activity or by a special film track leading into the pressurized cabin.

For illustration, from a 120 n.m. 35° inclination orbit, stereographic photographs can be obtained with nadir resolution of 22.5 ft. for 2:1 contrast and estimated mapping accuracies of better than 1000 feet. Film is provided for an area of 14.3 million square nautical miles. Complete coverage with 50% overlap at the equator, between 45° lateral swathwidths on successive days, can be completed in a seven day mission.

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CONFIGURATION A



CONFIGURATION B

CAMERAS INSTALLED	13 in. Focal Length f/3.5 Panoramic (2) 52 mm Focal Length f/3.5 Color (2) 10 in. Focal Length f/10 Horizon Recording	13 in. Focal Length f/3.5 Panoramic (2) 52 mm Focal Length f/3.5 Color (2) 10 in. Focal Length f/10 Horizon Recording
FILM CARRIED (FT.- ALL 70 MM)	12,500 - (Panoramic Cameras) 850 - (Color Cameras) 1550 - (Horizon Camera)	16,500 - (Panoramic Cameras) 1100 - (Color Cameras) 2050 - (Horizon Camera)
RE-ENTRY MODULE MODIFICATIONS	Removal of Right Hand Seat Removal of Right Hand Wing Instrument Panel Addition of Mission Equipment Addition of Pressure Wall Right Hand Hatch Modified for Automatic Control	Removal of Right Hand Seat Modified Pressure Bulkhead Structure
ADAPTER MODIFICATIONS	None	Addition of Mission Equipment Standard Equipment Re-Arranged

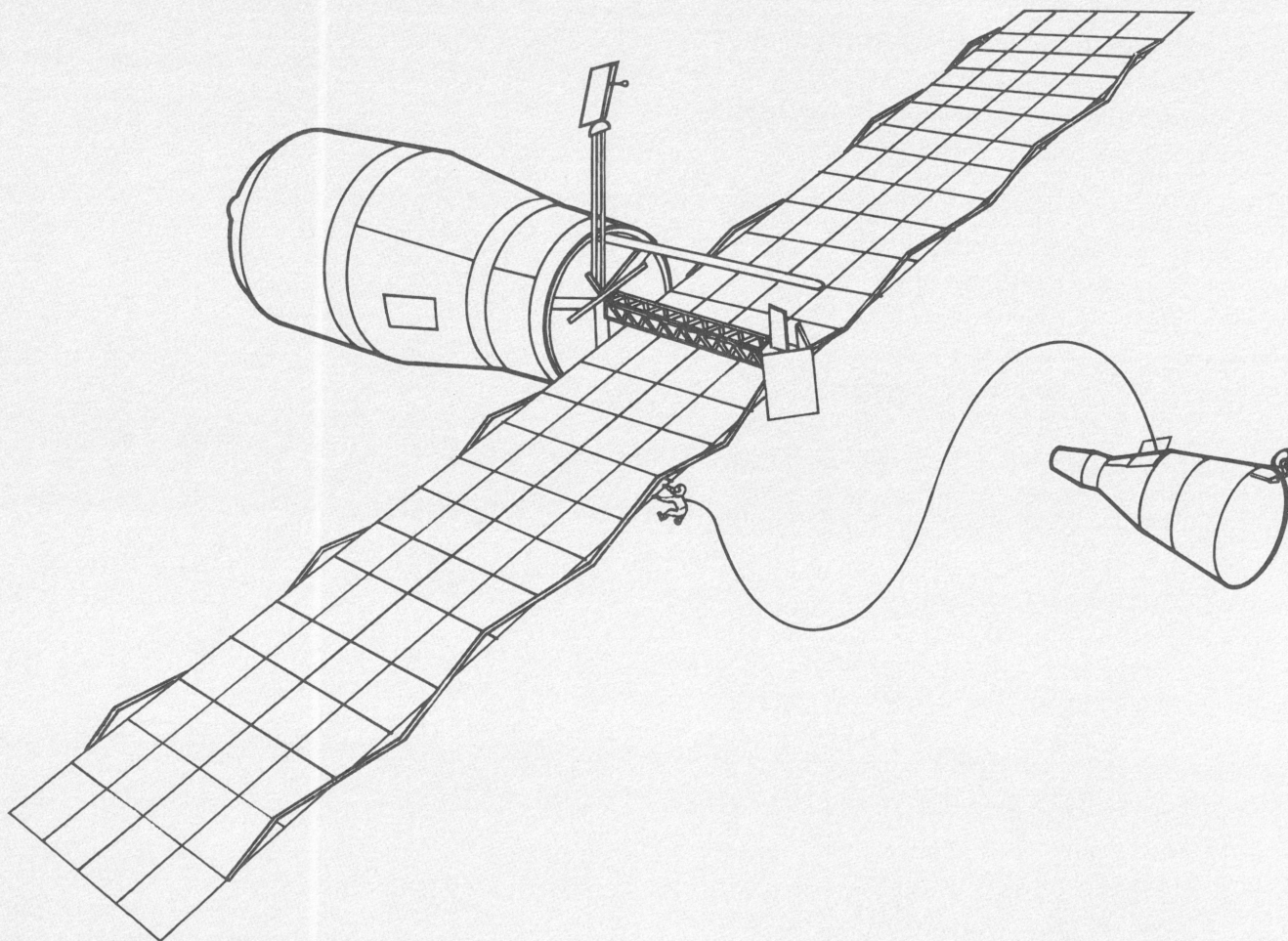
RENDEZVOUS WITH UNMANNED SATELLITE

Observation of orbiting objects and the return of all or a portion of a satellite for analysis is a desirable means for evaluating prolonged exposure of spacecraft and systems to the space environment.

For example, a rendezvous with the Pegasus satellite, photographing the meteoroid penetration panels, and removal, by EVA, of a section of one of the panels for return to earth would permit direct examination of meteoroid damage.

The basic flight plan would be to (1) inject into a low-earth orbit coplanar with the Pegasus orbit for gross catch-up, (2) transfer open loop to a slow catch-up orbit slightly lower than Pegasus, then (3) perform a closed-loop rendezvous.

Little modification to Gemini hardware and systems is required to support the mission, with the exception of acquisition radar needed to accomplish rendezvous with the non-cooperative Pegasus satellite. Either a 13 inch diameter radar antenna in the nose section or a fold-out antenna in the adapter would be required.



ONE-MAN GEMINI WITH ASTRONOMICAL TELESCOPE

Early space operations for astronomical observation and direct return of film to earth can be accomplished with a one-man Gemini as illustrated.

Two designs are considered: (A) a 16 inch telescope mounted in the right hand seat location and (B) a 26 inch telescope mounted in the adapter with access through a Gemini B type heatshield hatch.

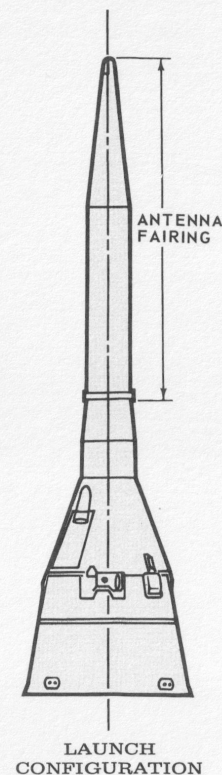
The mission would demonstrate the ability to make astronomical measurements with a pointing accuracy of 0.1 arc seconds for periods of over 10 minutes and would lead to the development of a capability of orbiting observatories capable of 0.04 arc second accuracy required for faint star observation.

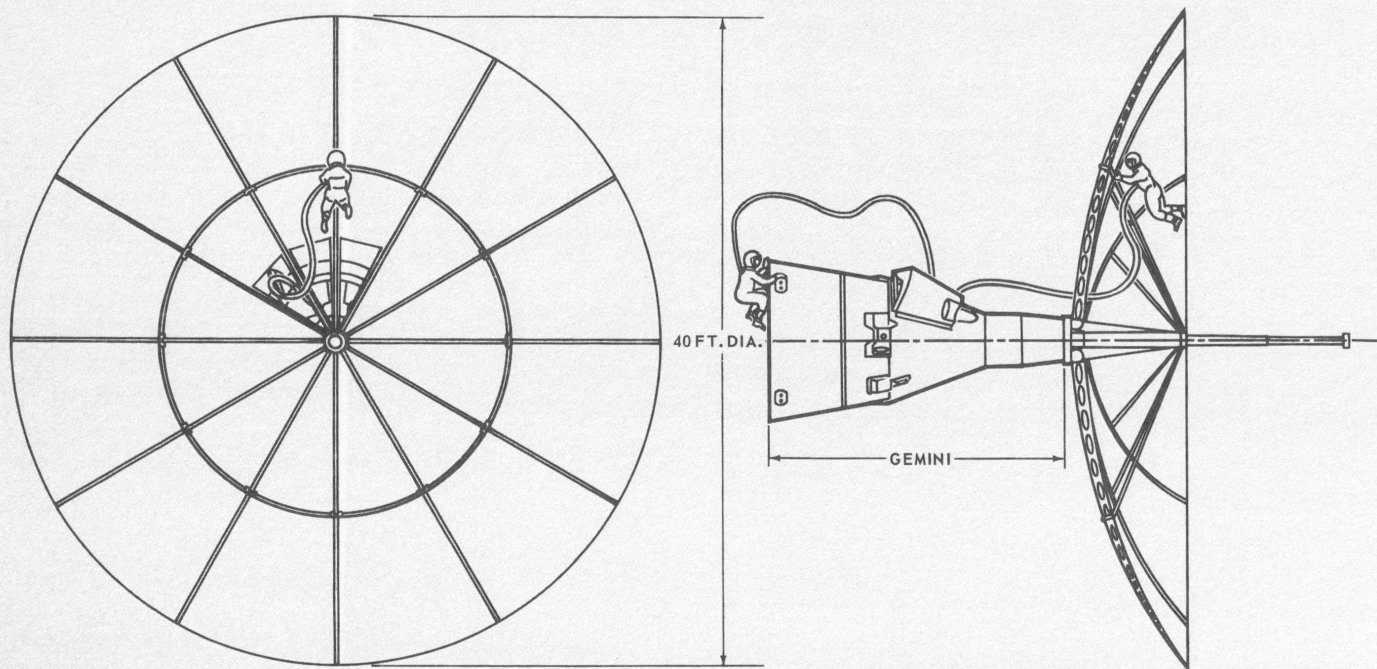
STRUCTURAL ASSEMBLY IN ORBIT

The development of techniques for assembly of space structures or station components by EVA will be requisite for advanced orbital missions. Typical functions, in addition to assembly, will be maintenance, inspection, alignment of radiators, sensors, antennas and propulsion systems.

A mission has been conceived to provide two experiments for early exploration of the problems of orbital assembly wherein:

- (1) a collapsed 40' diameter parabolic antenna would be launched aboard Gemini and assembled in orbit
- (2) one of the 100# OAMS thrust chamber assemblies would be removed and returned to earth for analysis





SIMULATION OF LEM RENDEZVOUS

The rendezvous of the Lunar Excursion Module of the Apollo spacecraft with the Command Module in lunar orbit is one of the critical elements of the return phase of the Apollo lunar mission. Therefore, an early earth-orbit test of the LEM rendezvous equipment and technique would be highly desirable. However, the LEM does not possess a re-entry or launch vehicle escape capability so a manned launch would entail risk. Automating the LEM probably would not provide satisfactory simulation since in the actual lunar orbit rendezvous, reliance is made on manual methods and human capabilities.

A Gemini spacecraft, with its inherent re-entry and escape capability, could be used as a test bed for early simulation of the LEM lunar orbit (rendezvous) technique. Such a test flight would involve fitting a Gemini Spacecraft with LEM equipment to perform computations and radar observations, or modifying Gemini equipment in order to simulate the LEM rendezvous operations. A rendezvous target with actual Apollo equipment or equivalent hardware would either be launched separately or carried into orbit aboard the Gemini.

ALTERNATIVE A - Use of Gemini Guidance and Computer with LEM Equations.

- Gemini assumes role of LEM vehicle
- Apollo command module simulated by Agena or smaller target launched with Gemini
- Velocity change computations by Gemini computer
- Maneuver & rendezvous executed with Gemini propulsion system

ALTERNATIVE B - Use of Apollo Guidance and Computer Installed in Gemini

- Gemini assumes LEM vehicle role with LEM computer, IMU, and radar
- Apollo command module transponder in target vehicle
- Maneuver and rendezvous by Gemini propulsion

ALTERNATIVE C - Limited Availability of Apollo Hardware

- Apollo systems used as available complemented by Gemini systems

PROPELLANT TRANSFER

Many advanced missions beyond earth-orbital operations involve either the rendezvous with other propulsion stages or the refilling of propulsion tankage for escape or maneuver propulsion.

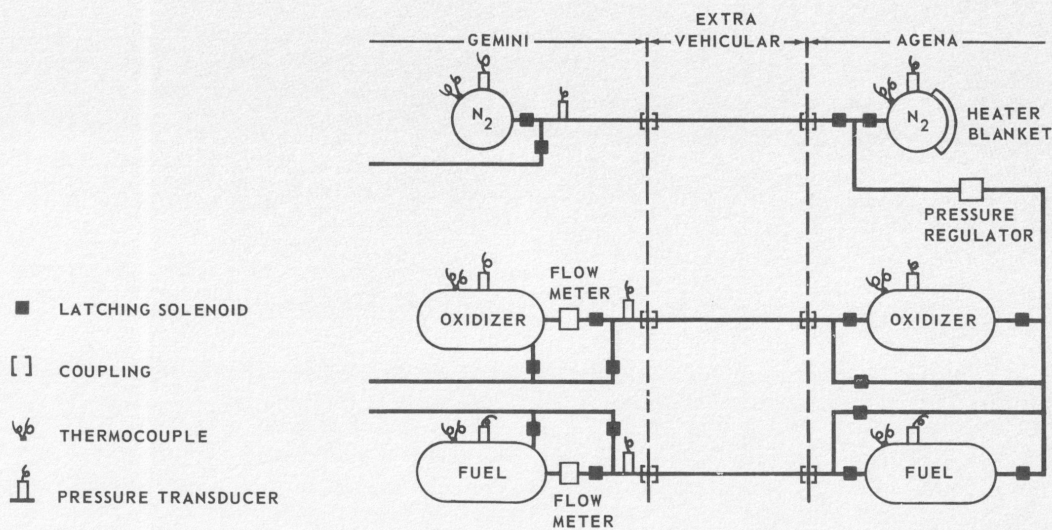
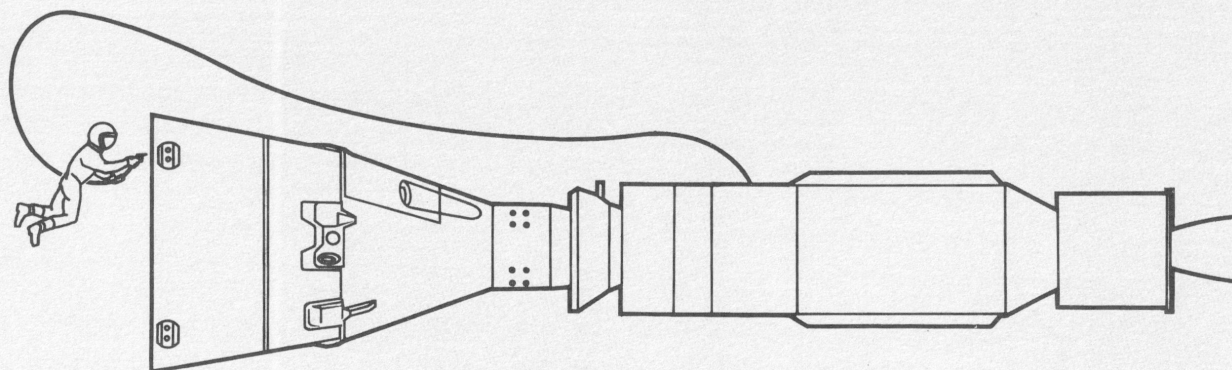
Examinations of problems arising in propellant transfer can be evaluated with useful lead time in the Gemini Program.

The Gemini is of the rendezvous configuration. It is equipped with additional tankage to receive the propellant to be transferred from the Agena. These tanks, located in the adapter equipment section of the spacecraft, contain centrifugal separators which part the liquid from the vapor. The Agena is modified to accommodate the propellant supply tankage. These tanks have propellant collection or retention devices. The transfer lines are brought forward and connected by extravehicular (EVA) activity. Following transfer, the propellants are discarded with the adapter equipment section when it is jettisoned.

The accomplishment of this task will provide the following technical benefits for future space missions:

- (A) Develop the EVA capability to accomplish the transfer line assembly and hook-up
- (B) Develop the capability to adapt to the use of special tools required for this assembly while in the EVA environment
- (C) Evaluate the effectiveness of propellant separation devices (gas/fluid separator in receiving tank)
- (D) Evaluate the effectiveness of propellant retention devices (fluid retention in the supply tank)
- (E) Establish methods for quantity monitoring of fluid (propellant) remaining in the supply tanks and fluid accepted by the receiving tanks

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LAND LANDING

A practical means of controlled land landing at a preselected site remains one of the objectives in mission planning and spacecraft design. Tests of the parasail-landing rocket system are now in progress.

Consideration has been given to other methods for providing a land landing capability, should an alternative to the present parasail landing system prove desirable. Two alternative approaches are:

- (A) The landing rockets for the parasail could be suspended from the parasail bridle.
- (B) The parasail-landing rocket configuration could be replaced with a coverleaf parachute which could decrease the descent velocity to 10 fps prior to impact. Ten feet per second is the allowable impact velocity for the present spacecraft structure.

Some other landing schemes considered are:

Installation of Impact Bags between Heat-Shield and large pressure bulkhead, plus the installation of a toroidal shaped impact bag around the recovery section.

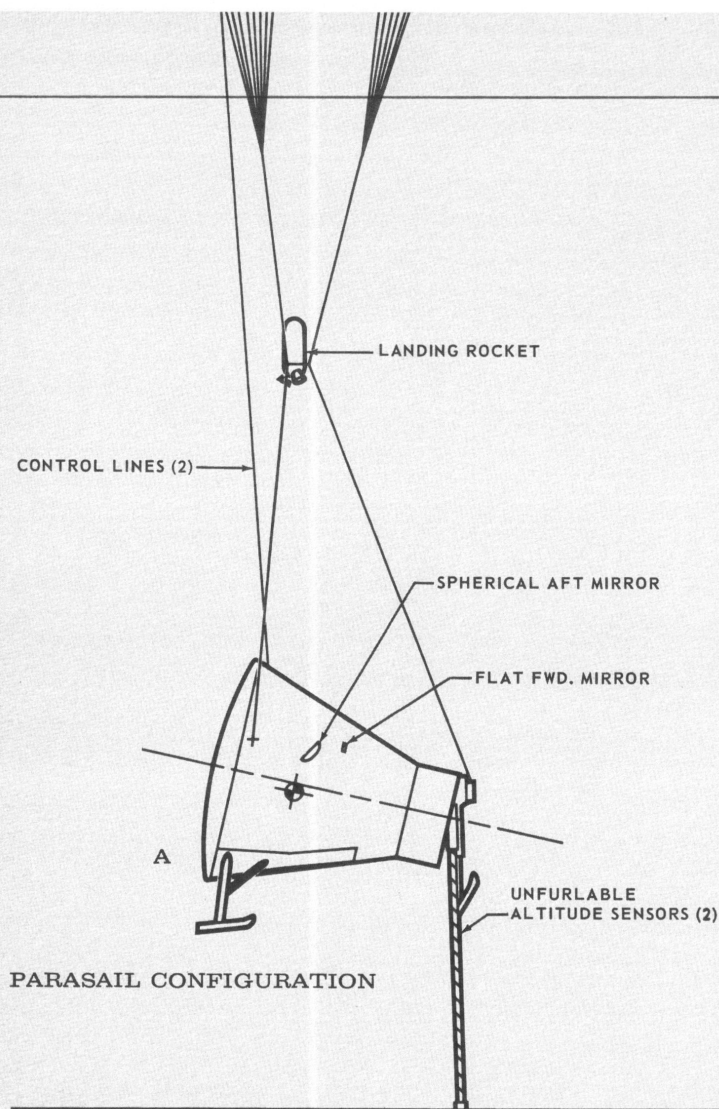
Installation of cable-spike arrangement in conjunction with an impact bag, an extendable heat-shield, or vertical landing rockets and utilizing heat-shield deformation for energy absorption.

Horizontal and vertical landing rockets

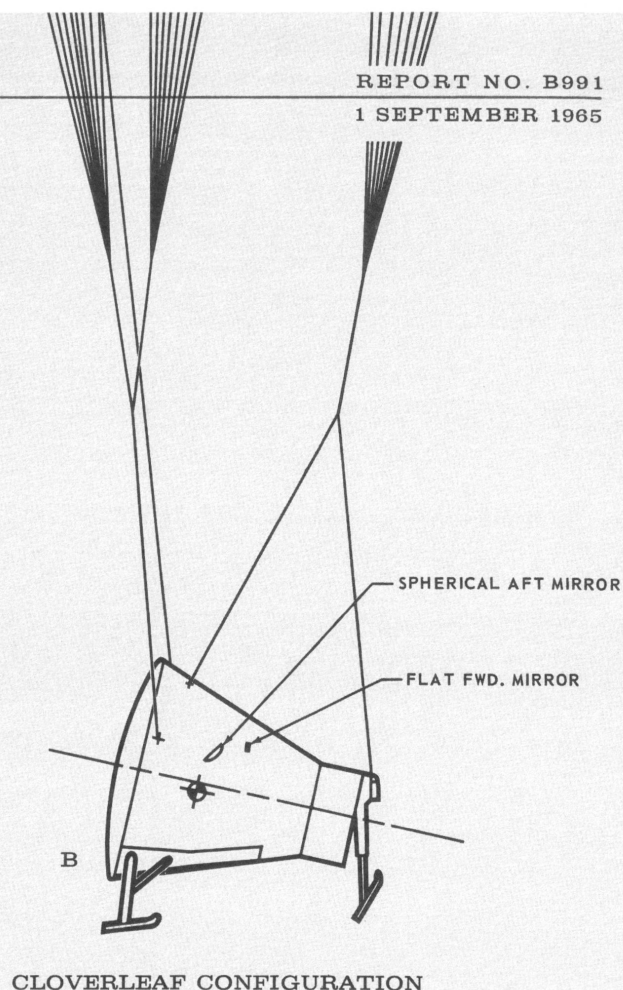
Larger landing gear (increased stroke and strength)

Gemini missions evaluating selected land landing techniques are possible with minimum modifications to Gemini hardware and systems.

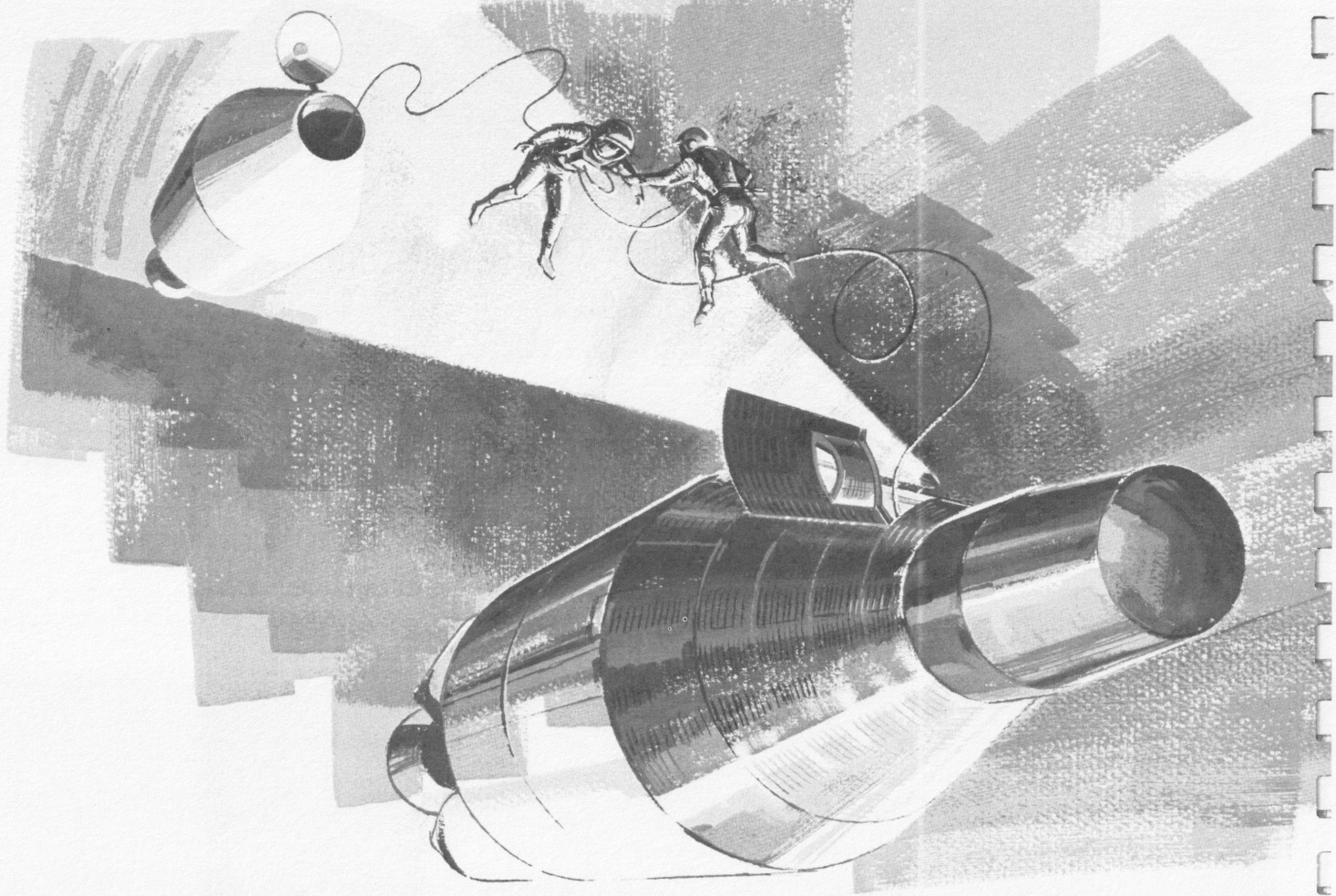
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PARASAIL CONFIGURATION



CLOVERLEAF CONFIGURATION



EXTENDED CAPABILITY SPACECRAFT

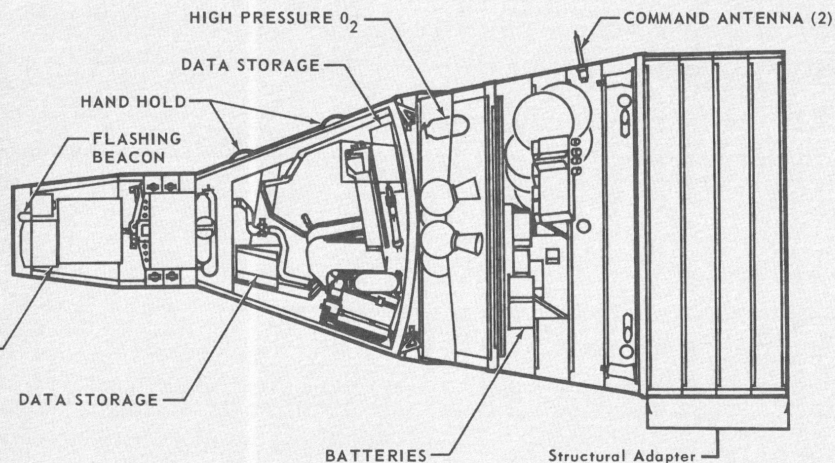
The foregoing missions entail utilization of Gemini spacecraft with little or no change. In the ensuing pages consideration is given to spacecraft versions which are:

- Gemini structure and systems technology
- Oriented towards near-earth orbit missions
- Enlarged structure for additional pressurized volume and experiment capability
- Compatible with GLV, Saturn IB and Titan IIIC launch vehicle capability

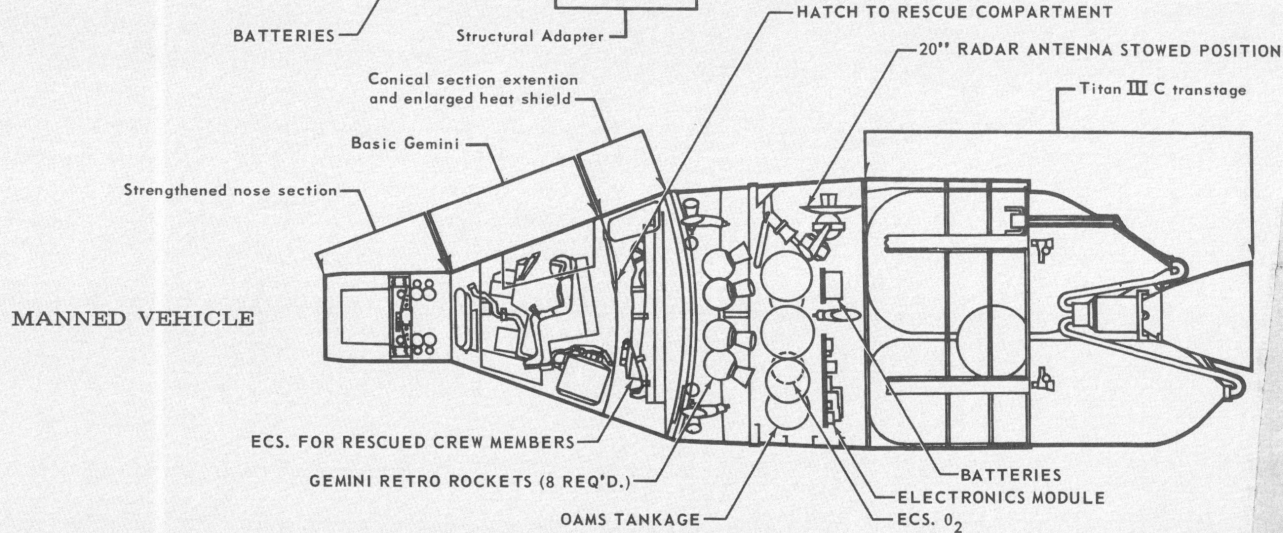
GEMINI RESCUE SPACECRAFT

As space mission traffic and the duration of missions are extended, the possibility of disabling incidents is statistically increased. Measures now being taken with respect to operational safety for space crew personnel are oriented towards reliability of systems and redundancy in critical areas. The fact remains, however, that the prospect of a disabling failure can never be completely removed. Nor can the possibility of a disablement or sudden illness of a crew member be completely discounted. A rescue capability, therefore, should be considered, at the least, as a potential operational requirement.

- (A) An unmanned spacecraft using an essentially unchanged Gemini with a structural adapter added to accommodate Titan III C launch vehicle.
- (B) A manned spacecraft using a Gemini reentry module with an extended conical section and strengthened nose section for docking. Launch vehicle is Titan III C with transtage used for maneuver.



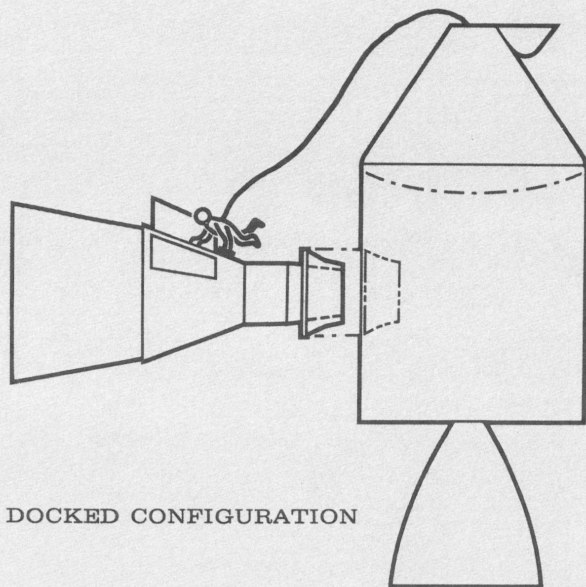
UNMANNED VEHICLE



MANNED VEHICLE

RESCUE SPACECRAFT

(Continued)



DOCKED CONFIGURATION

UNMANNED DESIGN CRITERIA

- Use of Gemini spacecraft with minimum modification
- Titan IIIC launch vehicle
- ETR or WTR launch
- Rescue accomplished within 24 hr. period
- On-orbit maneuver with transtage and Gemini thrusters
- 250 na mi/40° mission spacecraft orbit
- Rendezvous and docking guidance
 - Gemini and Titan inertial system
 - Radar tracking
 - Visual
 - RF command link
- Gemini nose docking provisions on mission spacecraft
- Two crewmembers capable of extravehicular transfer

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MANNED DESIGN CRITERIA

Single rescue spacecraft pilot

ETR or WTR launch

Titan IIIC launch vehicle

24 hour rescue mission

On-orbit maneuvering with transtage and

Gemini thrusters

250 na mi/40° mission spacecraft orbit

Rendezvous guidance

Gemini and Titan inertial systems

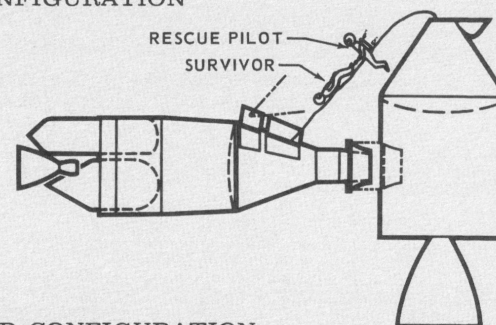
Direct sensing radar

Visual

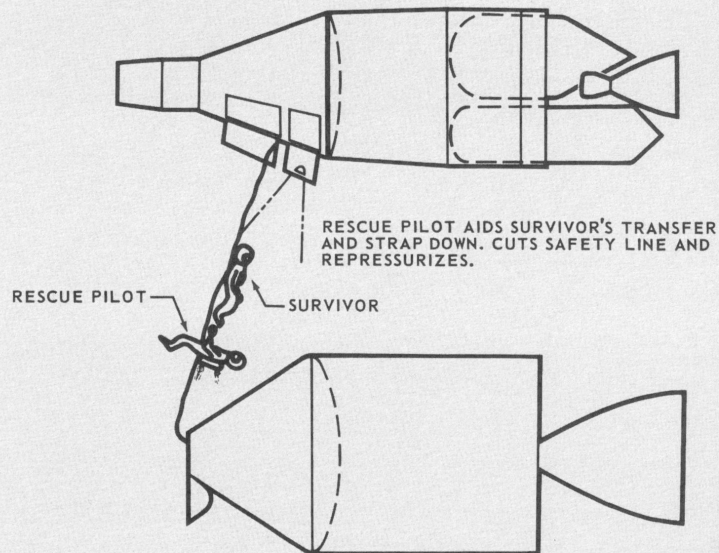
Mission spacecraft can not actively contribute
to rescue operations

Three crewmembers rescued

DOCKED CONFIGURATION



NON-DOCKED CONFIGURATION



LOGISTICS SPACECRAFT

Projected near-earth orbital missions require orbital stay times of 30, 60, 90 days and longer; the principal constraint on mission duration being expendables and crew stamina. Resupply and crew member rotation by a specially configured spacecraft has been viewed as a necessary element in mission planning.

Concepts for logistics vehicles employing the Gemini spacecraft and evolving from Gemini technology have been studied and are presented on the following pages.

Configuration (A) utilizes an unchanged Gemini re-entry vehicle and adapter and adds a logistics module between adapter and launch vehicle mating points.

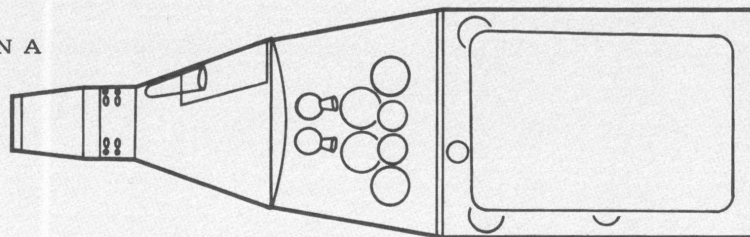
Transfer of supplies is by EVA.

Configuration (B) employs the heat-shield hatch and adapter tunnel, being developed for Gemini B, permitting access to the supply module. Logistic transfer may be carried out by EVA or through a pressurized tunnel connected to the cargo module.

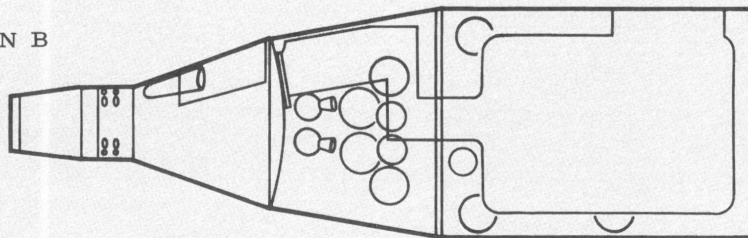
Configuration (C) is rear-docked. The crew and supply transfer is performed through a rear supply module bulkhead hatch.

Launch vehicles for all configurations are Titan III C or Saturn IB.

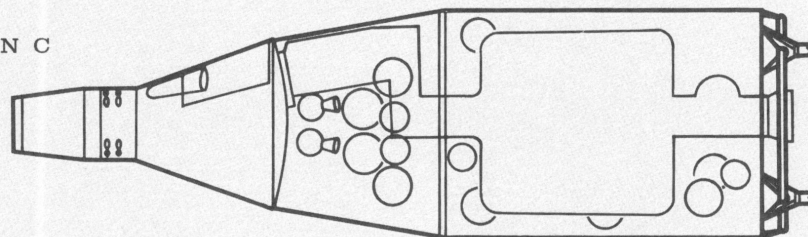
CONFIGURATION A



CONFIGURATION B

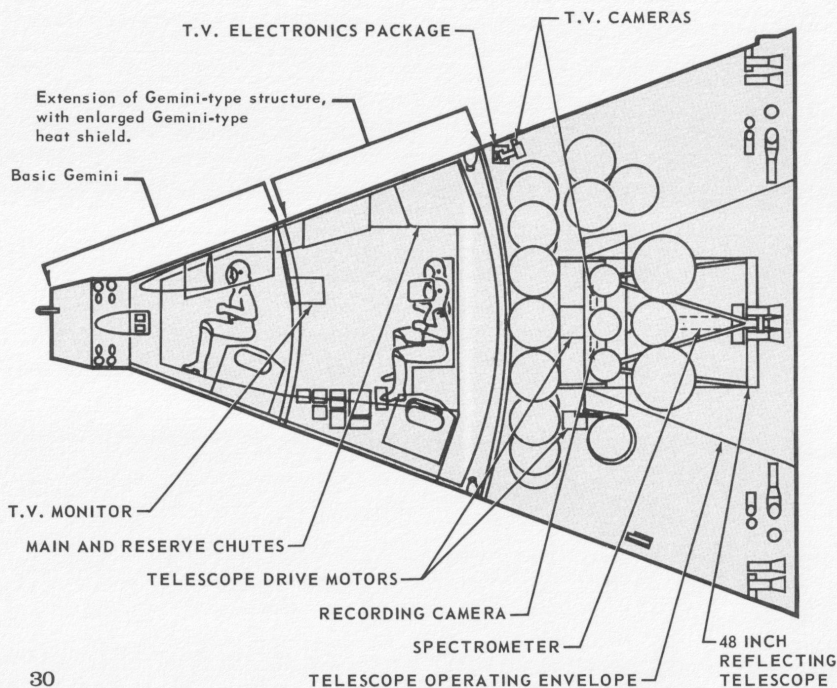


CONFIGURATION C



LARGE GEMINI

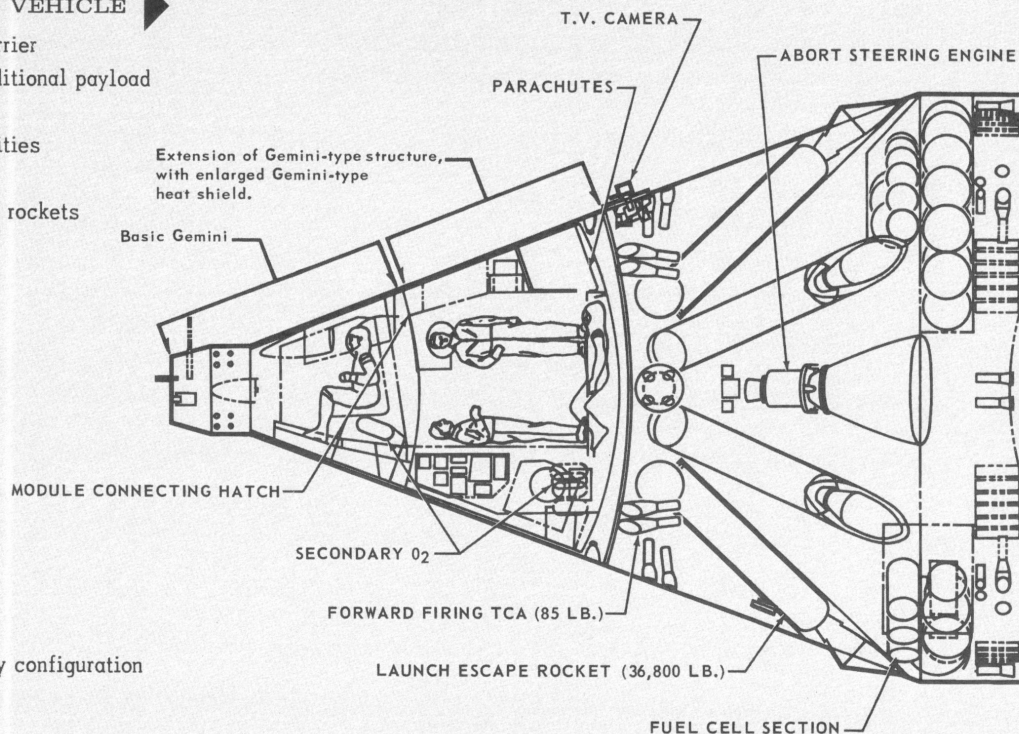
The configurations shown build upon Gemini systems and structure technology. Extension of the re-entry module conical section and adapter redesign yields a second generation Gemini spacecraft designed specifically for near-earth orbit operations with increased mission capability.



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GEMINI II LOGISTICS VEHICLE

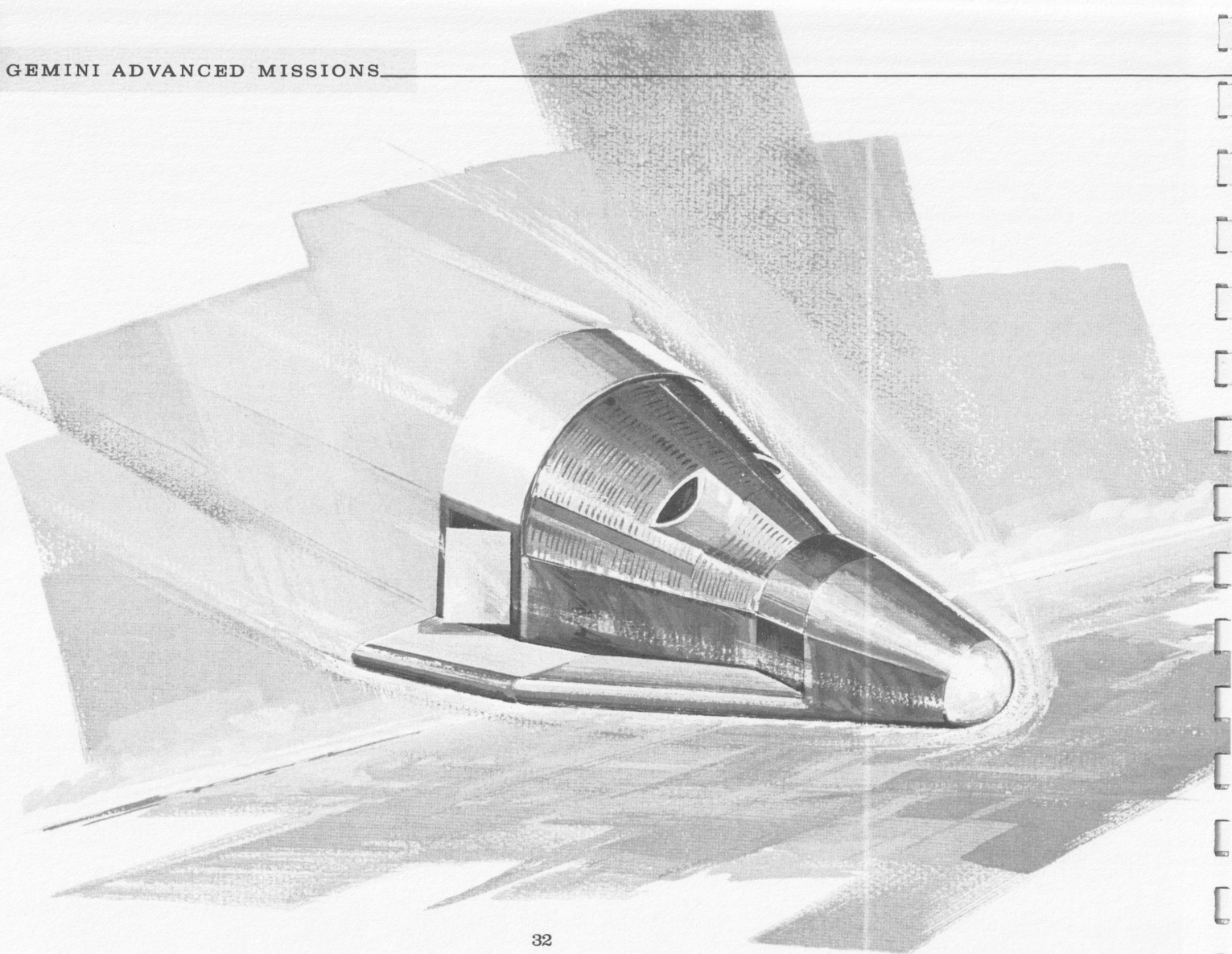
Personnel & equipment carrier
 Eight men plus 6500 lb additional payload
 Rendezvous capability
 Seven-day mission capabilities
 Saturn 1B launch
 Escape by adapter mounted rockets



GEMINI II LABORATORY

48 inch telescope in observatory configuration
 200 NM orbit
 5 man crew
 14 day mission capability
 Additional 9000 lb payload
 Saturn 1B launch
 Escape tower provided (not shown)

GEMINI ADVANCED MISSIONS





EXPERIMENTAL ADVANCED SPACECRAFT CONCEPTS

The concept presented in this section acknowledges the efforts being directed towards the development of maneuverable, horizontal-landing spacecraft. Scaled flight programs have produced valuable information on the aerodynamic and thermodynamic characteristics of lifting re-entry flight profiles. The subsonic manned flight tests being conducted at the Edwards Flight Research Center are permitting evaluation of the subsonic and landing characteristics of lifting shapes. A manned orbital flight program now remains as a next step.

LIFTING GEMINI

The installation of a separable fairing on the lower surface of the Gemini command module provides an experimental lifting configuration requiring little modification to the basic Gemini spacecraft. Thus, a manned flight program examining the hypersonic maneuver characteristics of lifting re-entry vehicles is a possibility at minimum cost and high mission reliability. Redundancy in re-entry capability is provided by separating the lifting surface and performing a normal Gemini re-entry.

CONFIGURATION CONCEPTS

- Use of existing pad facilities and man-rated launch vehicle (GLV)

- Utilizes Asset technology

- Maximum use of existing Gemini structure

- Major systems of Gemini retained

- Wing released prior to parachute deployment

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