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19 October 1964
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PERFORMANCE AND DESIGN REQUIREMENTS
FOR THE
MANNED ORBITING LABORATORY (MOL) SYSTEM

Prepared for
COMMANDER SPACE SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
LOS ANGELES AIR FORCE STATION
Los Angeles, California

AIR FORCE / AEROSPACE
EYES ONLY
SENSITIVE MATERIAL

AEROSPACE CORPORATION

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Specification No: (3rd Coordination Copy)
Dated: 19 October 1964

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PERFORMANCE AND DESIGN REQUIREMENTS
FOR THE
MANNED ORBITING LABORATORY (MOL) SYSTEM,
GENERAL SPECIFICATIONS FOR

AIR FORCE / AEROSPACE
EYES ONLY
SENSITIVE MATERIAL

Approved by: ____________________
(Preparing Activity)

Approved by: ____________________
(System Program Director)

Date: ____________________

Date: ____________________

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MOL SYSTEM PERFORMANCE/DESIGN REQUIREMENTS
GENERAL SPECIFICATION

INDEX

MOL SYSTEM PERFORMANCE/DESIGN REQUIREMENTS
GENERAL SPECIFICATION

1.0 Scope

This specification establishes the performance, design, development and test requirements for the Manned Orbiting Laboratory (MOL) System. All elements and contract end-items of the MOL System shall conform to the requirements delineated herein.

1.1 Descriptive Title

The descriptive title for the total system shall be the "Manned Orbiting Laboratory System" (or "MOL System").

1.2 Purpose

The primary objective of the MOL program is to provide an in-space testing capability which will qualitatively and quantitatively assess the military usefulness of man in space.

In order to accomplish this objective it has been necessary to define possible military tasks in space and to define a set of experiments which will qualitatively and quantitatively evaluate man's value in the accomplishment of these tasks. The mission of the MOL program is to supply the necessary means, - the plan, the system hardware, the operational flights, and the evaluation, - to determine what the role of man should be, through carrying out these experiments. Man's unique capabilities can then be integrated into military space systems of the future.

This primary objective shall be accomplished as early as possible, with minimum cost, and with careful attention to safety aspects. Minimizing cost and time for development and test, as well as enhancing safety and reliability, implies a minimum of innovations to be introduced or developed. Proven vehicle and ground hardware, procedures, and facilities, resulting from prior DOD and NASA programs, are to be employed as the rule. Exceptions must be completely justified.

A secondary objective is the accomplishment of experiments and tasks less directly associated with potential military applications, - those which increase knowledge of the space environment, investigate longer range military problems for man in space, and improve operational capabilities in space. Such tasks shall not interfere with the primary objective, but may utilize payload allotments or time on orbit not otherwise required.

2.0 Applicable Documents

As listed in Appendix A, military specifications, standards, exhibits, manuals, regulations, publications, bulletins, pamphlets, and other documents are specified as appropriate to obtain first tier compliance for the MOL system. Only specifications affecting either the entire system or the whole of a system segment are included in this Specification and then are only applicable to the extent provided in the section in which they are called out.

3.0 Requirements

The Manned Orbiting Laboratory (MOL) Program centers around an orbiting vehicle in which men will carry out military and scientific experimental programs for durations of thirty days. The orbiting system consists of a Laboratory, a modified Gemini spacecraft (Gemini B), and the transtage of Titan III. This will be launched by Titan III-C from Cape Kennedy. During the ascent to orbit the space crew will be in the Gemini B, transfer to the Laboratory for accomplishing the on-orbit tasks as programmed, and will return to earth in the Gemini B. The remaining portions of the orbiting system will be left in a decaying orbit.

The Manned Orbiting Laboratory System is specified in terms of eight system segments, as defined in Section 3.1.2.2.

The basic MOL design will include the capability for in-space rendezvous. The rendezvous missions, to be conducted in the latter part of the program, shall use essentially the same integrally launched orbiting vehicle configuration with additional equipment to permit tail-to-tail docking of the two orbiting vehicles. The objectives of the rendezvous and docking mission shall be to provide for re-supply, a larger in-space testing capability, and to extend the duration up to 60 days.

3.1 Performance

The MOL flights shall be conducted from the Titan III launch complex at Cape Kennedy. Upon achieving orbit, the flight crew who, during launch and insertion into orbit, are located in the Gemini B, will prepare to transfer to the laboratory vehicle by conducting a checkout of the essential laboratory subsystems from the Gemini B and by activation of those laboratory subsystems which must be in operation during the transfer. Upon entering the laboratory, the flight crew will proceed to activate the remaining laboratory subsystems and place the laboratory vehicle in a full-operating condition. The crew will be the primary source of on-orbit flight decisions.

Orbiting Vehicle operations involving orbital abort, attitude control, translational control, transtage engine manuevers, rendezvous, docking, separation of vehicle elements, retrofire, and re-entry shall be conducted with pilot control as the primary operational mode. All system designs and trade-offs shall reflect this primary mode of operation.

Flight crew functions will include performance of prescribed experiments, observations, physiological and psychological testing, and the monitoring, controlling, and maintenance of vehicle and experiment subsystems. Status of subsystems in the Gemini B essential to safe return will be monitored. Data from experiments, as well as telemetry of orbiting vehicle condition and space crew physiological functions, will be transmitted from the orbiting vehicle to ground stations and/or recorded on board as appropriate for transfer to the Gemini B and return to earth.

Communication with the on-orbit crew and mission control functions will be controlled from a mission control center. A network of tracking and data acquisition stations will provide world-wide communication coverage. Experiment data management and certain experiment functions will be accomplished by an on-board central general purpose digital computer. Over-all control of the various experiments will remain a crew function. Certain analyses shall be made during orbital flights, both on-board and on the ground; the remainder will be accomplished after recovery.

For the rendezvous flights, the chaser vehicle will be launched 15 to 30 days after the target vehicle. The chaser will be launched in an elliptical catch-up orbit and, at the appropriate time, will be injected into the orbit of the target vehicle by means of the transtage. Rendezvous will be effected by means of a Gemini radar. Docking will be manual control and visual reference. Interchange of one crew member between chaser and target will be accomplished and the one Gemini B returned to earth. The chaser vehicle and the Laboratory from the target will remain on orbit an additional full mission period.

3.1.1.1.1 Prelaunch
Ascent & On-Orbit

Upon completion of the mission, the flight crew will perform final checks of the condition of the Gemini capsule and activate those systems required for crew transfer. They will then don their space suits, deactivate certain subsystems in the laboratory, and return to the capsule for separation and re-entry. Upon return of the crew to the capsule, checkout of subsystems associated with life support, separation, control, and re-entry will again be made and verified by the ground network.

Upon completion of all systems checkout and verification, separation will be effected and de-orbit and re-entry will be accomplished. Following re-entry into the atmosphere the Gemini spacecraft will deploy a parachute for descent to a water recovery site. A ship/plane recovery force will recover the crew, spacecraft, and experiment data in a primary recovery area in the Atlantic Ocean or in the event of an emergency a secondary recovery area in the Pacific Ocean.

3.1.1 Performance Characteristics

Performance characteristics of the MOL system are defined in terms of System Characteristics, Logistics, and Personnel and Training.

3.1.1.1 System Characteristics

The significant system characteristics are defined in terms of the various operational phases ranging from pre-launch through mission evaluation, the operating location at which these will be accomplished, and the responsibilities for the various portions of the mission.

3.1.1.1.1 Pre-launch Preparation

This phase covers the period from arrival of systems at Cape Kennedy to the "T-" count on the launch pad. Pre-launch preparation will follow normal Titan III ITL procedures, with assembly of the Orbiting Vehicle to the launch vehicle and checkout in the VIB and subsequent transport through the SMAB to the launch pad for final countdown.

3.1.1.1.2 Launch

This phase covers the period from initiation of "T -" count on the launch pad through lift-off. The launch countdown shall be initiated and conducted so as to provide the optimum opportunity for recovery in the event of a malfunction during ascent.

3.1.1.1.2.1 Crew launch Occupancy

The time to launch a MOL system after astronaut insertion in the Gemini B capsule shall be as short as possible, not exceeding 120 minutes, including scheduled automatic countdown sequence holds.

3.1.1.1.2.2 Hold Time

The system shall be capable of sustaining a three-hour unscheduled hold in addition to the maximum 120 minute countdown time after the crew enters the spacecraft.

3.1.1.1.2.3 Crew Escape

Prior to lift-off, escape from the spacecraft in the event of an emergency shall be by egress from the crew hatch or by means of the escape system.

3.1.1.1.3 Ascent

This phase covers the period from lift-off through final orbit insertion.

3.1.1.1.3.1 Azimuth

The system shall be capable of launching a mission from ETR on any azimuth from 90° to 108°.

3.1.1.1.3.2 Trajectory Safety

The ascent trajectory shall be such that in the event of mission abort at any time, the spacecraft will not exceed safe conditions for re-entry and recovery.

3.1.1.1.3.3 Insertion Elements

Initial orbit shall be approximately 80 n.mi. perigee and 160 n.mile apogee, then circularized at 160 n.mi. Nominal orbit inclination shall be 32°.

3.1.1.1.3.4 Communication

The system shall provide communication between the crew in the spacecraft and the mission control center during all portions of powered ascent.

3.1.1.1.3.5 Crew Escape

A crew escape system shall be provided which will allow safe escape and recovery if any catastrophic malfunction occurs during the ascent phase.

3.1.1.1.4 On-Orbit

This phase covers the period from final insertion into orbit until separation of Gemini B from the Laboratory prior to re-entry

3.1.1.1.4.1 Duration

The nominal MOL System Orbiting Vehicle duration shall be 30 days following the injection into a 160 n. mi. circular orbit. Duration of the rendezvous mission will range up to 60 days.

3.1.1.1.4.2 Normal Vehicle Orientation

The Vehicle shall be oriented such that the longitudinal axis lies in the orbital plane, perpendicular to the local vertical.

3.1.1.1.4.3 Orbital Decay

The orbital altitude shall be no less than 140 n. mi. throughout the mission.

3.1.1.1.4.4 Abort

The system shall be capable of retrieving the MOL crew from an on-orbit mission abort and of returning them to pre-selected water landing sites. The abort procedure shall be initiated and accomplished by the flight crew. The Gemini B shall be capable of sustaining the crew for 14 hours on-orbit after separation from the Laboratory.

3.1.1.1.4.5 Checkout and Monitoring

The Orbiting Vehicle System shall be capable of providing functional subsystems information to the ground and the flight crew for purpose of checkout of those parameters critical to crew safety, mission status, and system status. Crew safety parameters shall be available to the crew prior to the activation and occupancy of the Laboratory; conversely the Gemini B status shall be available to the crew during the on-orbit phase and prior to occupancy for mission termination.

3.1.1.1.4.6 Flight Crew Transfer

Passage of the crew members between the Gemini B and the Laboratory shall normally be accomplished within a pressurized tunnel which provides protection from the space environment. Capability for extra-vehicular crew transfer, involving only the protection afforded by pressure suits will be used as a back-up mode for transfer operation.

3.1.1.1.4.7 Mission Experiment Operations

The experiment equipment shall be operable by the crew members in conjunction with the Experiments Information System.

3.1.1.1.4.8 Maneuvering

The Orbiting Vehicle shall be capable of executing controlled maneuvers with six degrees for freedom. A capability for an on-orbit velocity increment of 500 feet per second is required, in a total of not less than ten thrusting periods. The velocity increment will be imparted by both of the transtage main propulsion engines.

3.1.1.1.5 Re-entry

Re-entry is defined as the period from separation of Gemini B from the laboratory through landing.

3.1.1.1.5.1 Separation

The Gemini B shall be capable of separation from the Laboratory Vehicle only by crew initiation.

3.1.1.1.5.2 Alignment Reference

Alignment of the spacecraft for retrofire shall normally be accomplished by use of a horizon sensor reference and gyro-compassing of the IMU as a primary mode. The secondary mode shall be through visual alignment by the crew.

3.1.1.1.5.3 Retrofire Orientation

Re-entry and de-boost data shall be provided the Gemini B crew for proper retrograde attitude and timing of manually-initiated ignition.

3.1.1.1.5.4 Return Maneuver Capability

During re-entry the Gemini B shall have a minimum capability for maneuvering cross-range 40 nautical miles, and downrange 400 nautical miles relative to the nominal touchdown point.

3.1.1.1.5.5 Communications

During descent, recovery aids, including a beacon, shall be provided in the Gemini B to facilitate tracking and impact prediction. A voice communication link shall be provided.

3.1.1.1.6 Recovery
Rendezvous and
Docking

3.1.1.1.6 Recovery

Recovery is the period from landing through safe return of crew, data, and spacecraft to points designated by the Mission Director.

3.1.1.1.6.1 Flotation

Following water impact, the Gemini B shall float in a command-astronaut hatch-up position. Provisions for additional flotation gear to be manually secured to the Gemini B by recovery force personnel shall be provided.

3.1.1.1.6.2 Recovery Support

Recovery forces consisting of sea and air units equipped with proper gear to facilitate astronaut, capsule, and data recovery shall be provided.

3.1.1.1.7 Rendezvous and Docking

3.1.1.1.7.1 General

The objectives of the rendezvous and docking mission shall be the operation of a representative set of experiments for up to 60 days, and the extension of crew on-orbit duration up to 60 days. The MOL system shall have the capability of rendezvous and tail to tail docking of two Orbiting Vehicles. The MOL configuration for rendezvous and docking shall be composed of two vehicles, namely a target and chase vehicles, that are minimum modifications of the basic integral launch configuration. Occupancy of both laboratories shall be possible after rendezvous.

3.1.1.1.7.2 Launch Preparations

Preparations for launch of a mission intended to rendezvous with a vehicle already in orbit shall be completed within 15 days after the target launch.

3.1.1.1.7.3 Maneuvers

The chase vehicle will acquire the target by radar. Following acquisition, a series of fine maneuvers will be made to place the target and chaser vehicles in the appropriate relative position for commencement of docking maneuvers. Final docking maneuvers shall be by manual control using visual observations.

3.1.1.1.8 Evaluation of Performance

Mission evaluation shall include:

Evaluation of astronaut performance

Evaluation of on-orbit equipment, both vehicle and experimental

Evaluation of over-all mission operation.

3.1.1.1.9 Operating Locations

3.1.1.1.9.1 Segment Acceptance Tests

Each system segment of the vehicle will be assembled and acceptance tested at the respective responsible contractor's facilities prior to shipment to either the CKAFS or to the Orbiting Vehicle contractor's facility as appropriate. Those system segments of the Orbiting Vehicle which are supplied to the Orbiting Vehicle contractor as GFE, will be assembled at the Contractor's facility in the on-orbit verification tests, the Orbiting Vehicle will be disassembled as required for transport and shipped to CKAFS.

3.1.1.1.9.2 Pre-Launch Integration, Checkout, and Launch

Final assembly of the MOL system flight vehicle will be completed in the VIB, checked out, transported to the launch pad, and launched at the Titan III ITL complex at CKAFS.

3.1.1.1.9.3 Mission Operations

3.1.1.1.9.3.1 Mission Control Center

The Mission Control Center shall be at CKAFS. Primary mission evaluation during flight will be performed at the MCC.

3.1.1.1.9.3.2 Tracking and Communication Sites

Tracking and communication network stations are designated by the phase of the mission profile during which they operate. Subject to negotiations with the appropriate agency the stations tentatively chosen for each phase are as follows:

3.1.1.1.9.3.2.1 Ascent

CKAFS
Grand Bahama Island
Grand Turk
Bermuda
Grand Canary Island
Antigua
Ascension
Pretoria
NRD Ships

3.1.1.1.9.3.2.2 Circularization and Early Orbit

Carnarvon
Hawaii
Vandenberg/Arguello
CKAFS
Antigua
Okinawa
Ascension
Pretoria
Grand Bahama
Bermuda
NRD Ships

3.1.1.1.9.3.2.3 On-Orbit

Okinawa
Hawaii
Vandenberg/Arguello
CKAFS
Antigua
Carnarvon
Voice Stations

3.1.1.1.9.4 Recovery Forces

Primary recovery forces shall consist of U. S. Air Force aircraft and Navy, MSTS or specially assigned ships and aircraft suitably deployed.

3.1.1.1.9.4.1 Initial and Early Orbit

During the first day there will be recovery provisions for each orbit.

3.1.1.1.9.4.2 On-Orbit and Return

After the first day there will be a limited number of recovery areas. The location and number of vehicles remain to be determined.

3.1.1.1.10 Mission Responsibilities

3.1.1.1.10.1 Over-all Responsibility

Over-all responsibility for design, development, and operation of the MOL System is assigned to the Space Systems Division, AFSC.

3.1.1.1.10.2 Launch Operations

Launch operations are the responsibility of the Space Systems Division, AFSC, supported by the DOD manager for Manned Space Flight Support and the National Range Division, AFSC.

3.1.1.1.10.3 On-Orbit Operations

On-orbit operations of the orbiting vehicles and the crew shall be the responsibility of the Space Systems Division, AFSC. Operation of the worldwide tracking net and communications net are the responsibility of the DOD Manager for Manned Space Flight Support and the National Range Division. The Mission Control Center shall be operated by the Space Systems Division and supported by NRD.

3.1.1.1.10.4 Experiment Operations

Experimental equipment, developmental simulators, procedures, and data analysis, shall be supplied by the Space Systems Division, AFSC, supported by the Navy and the Aerospace Medical Division and Research and Technology Division of AFSC. The Aerospace Corporation is responsible for providing general systems engineering and technical direction for Space Systems Division Contractors, as well as for the coordination and integration task. Hardware integration of the experiments into the Laboratory System Segment shall be performed by the Laboratory Contractor under the direction of SSD/Aerospace. The on-board central data management system shall provide those computer and data processing functions to support the experiments and is the responsibility of the Space Systems Division/AFSC.

3.1.1.1.10.5 Recovery Operations

Primary support in the area of recovery operations shall be provided by the DOD Manager for Manned Space Flight Support.

3.1.1.2 Logistics
Personnel & Training

3.1.1.2 Logistics

3.1.1.2.1 Supply Support

3.1.1.2.1.1 Spare parts support for the Laboratory Vehicle, Gemini B, Experiments, Crew Equipment, T-IIIC and attendant AGE shall be provided in accordance with AFSSD Exhibit 63-14. Spare parts requirements shall be based on a concept of minimum maintenance at launch site consisting primarily of component replacement. Spare parts support planning shall consider the requirement for prestocking and control of "Critical to Launch" spares. Spares kits shall be developed as required to support the crew capability for "In Flight" or "On Orbit" maintenance.

3.1.1.2.1.2 Spare parts for the VIB, ITL, MCC, Range Stations, Recovery Forces, and attendant facilities and AGE shall be provided as required from contracts under which such services and/or facilities maintenance are provided.

3.1.1.2.2 Maintenance Support

3.1.1.2.2.1 Applicable documents for Maintenance Support are listed in Appendix A with the prefix letter MS.

3.1.1.2.2.2 The repair program shall be based on return of components to home plant and/or to associate, sub-contractors or vendors plants for repair and return. Prime Contractors shall not duplicate repair capabilities existing at associate, sub-contractors or vendors plants. Repaired components must meet the serviceability and reliability requirements established for acceptance of newly fabricated articles.

3.1.1.2.2.3 Maintenance of the VIB, ITL, MCC, Range, Recovery Forces and attendant facilities and AGE shall be provided from contracts under which such services are provided.

3.1.1.3 Personnel and Training

Personnel associated with the total MOL system fall into two basic categories: Space Crew and ground personnel. These are treated separately in this specification and throughout the program.

The Space Crew, their flight equipment, and training requirements are described in Section 3.3.5. Ground personnel only are specified in the requirements of this section.

3.1.1.3.1 Operational Personnel

There are no Operational Personnel for MOL in the general military context except as included in the support functions. Support personnel associated with flight operations will be assigned and coordinated by the MOL Test Operations Office of SSD. Personnel required for the assembly checkout, maintenance, launch, and operations support shall be supplied by contractors concerned with the various system segments.

3.1.1.3.1.1 Personnel Specification

The contractors shall specify to SSD the number, type, skill, and training requirements of personnel required for assembly, checkout, maintenance, launch, and operations support.

3.1.2 System Definition

3.1.2.1 System Engineering Documentation

3.1.2.1.1 System Level Functional Schematics (Figure 3.1.2.1.1)

3.1.2.1.2 Functional Flow Diagrams

3.1.2.1.2.1 MOL System Top Level Functional Flow Diagram (Figure 3.1.2.1.2.1)

3.1.2.1.2.2 MOL System First Level Functional Flow Diagram "Perform MOL Evaluation" (Figure 3.1.2.1.2.2)

3.1.2.1.2.3 MOL System First Level Functional Flow Diagram

a. "Perform MOL Mission and Recovery Operations" (Figure 3.1.2.1.2.3 a)

b. "Perform MOL Rendezvous Mission and Recovery Op-operations" (Figure 3.1.2.1.2.3 b)

3.1.2.1.2.4 MOL System First Level Functional Flow Diagram "Perform MOL Launch Operations" (Figure 3.1.2.1.2.4)

3.1.2.1.2.5 MOL System First Level Function Flow Diagram "Perform System Integration and Pre-Launch Operations" (Figure 3.1.2.1.2.5)

3.1.2.1.2.6 MOL System First Level Functional Flow Diagram "Perform Acceptance of Vehicle System Segments" (Figure 3.1.2.1.2.6)

3.1.2.1.2.7 MOL System First Level Functional Flow Diagram "Perform Simulation System Development and Accomplish Simulation Objectives" (Figure 3.1.2.1.2.7)

3.1.2.1.2.8 MOL System First Level Functional Flow Diagram "Design, Develop and Test MOL Vehicle System Segments" (Figure 3.1.2.1.2.8)

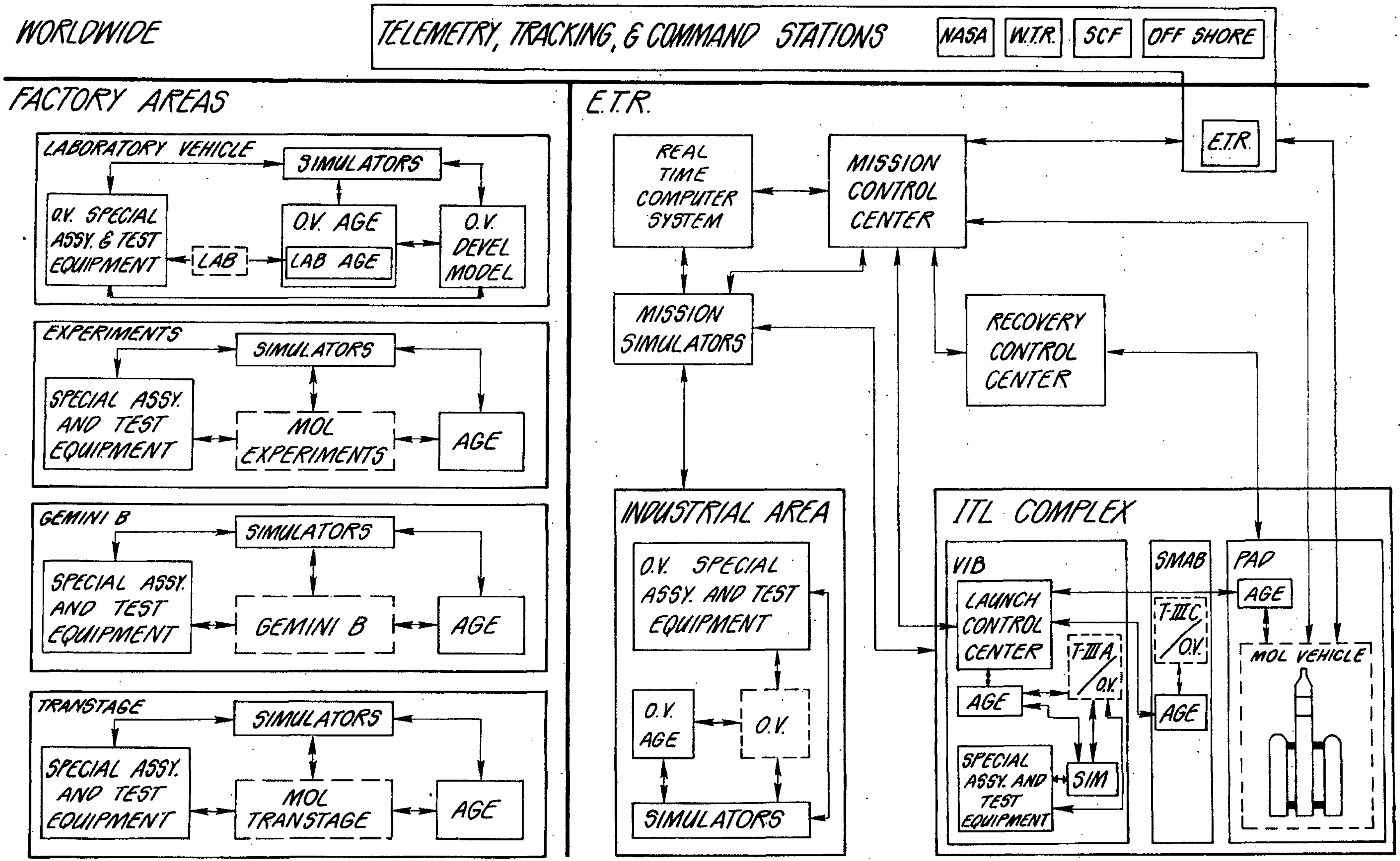
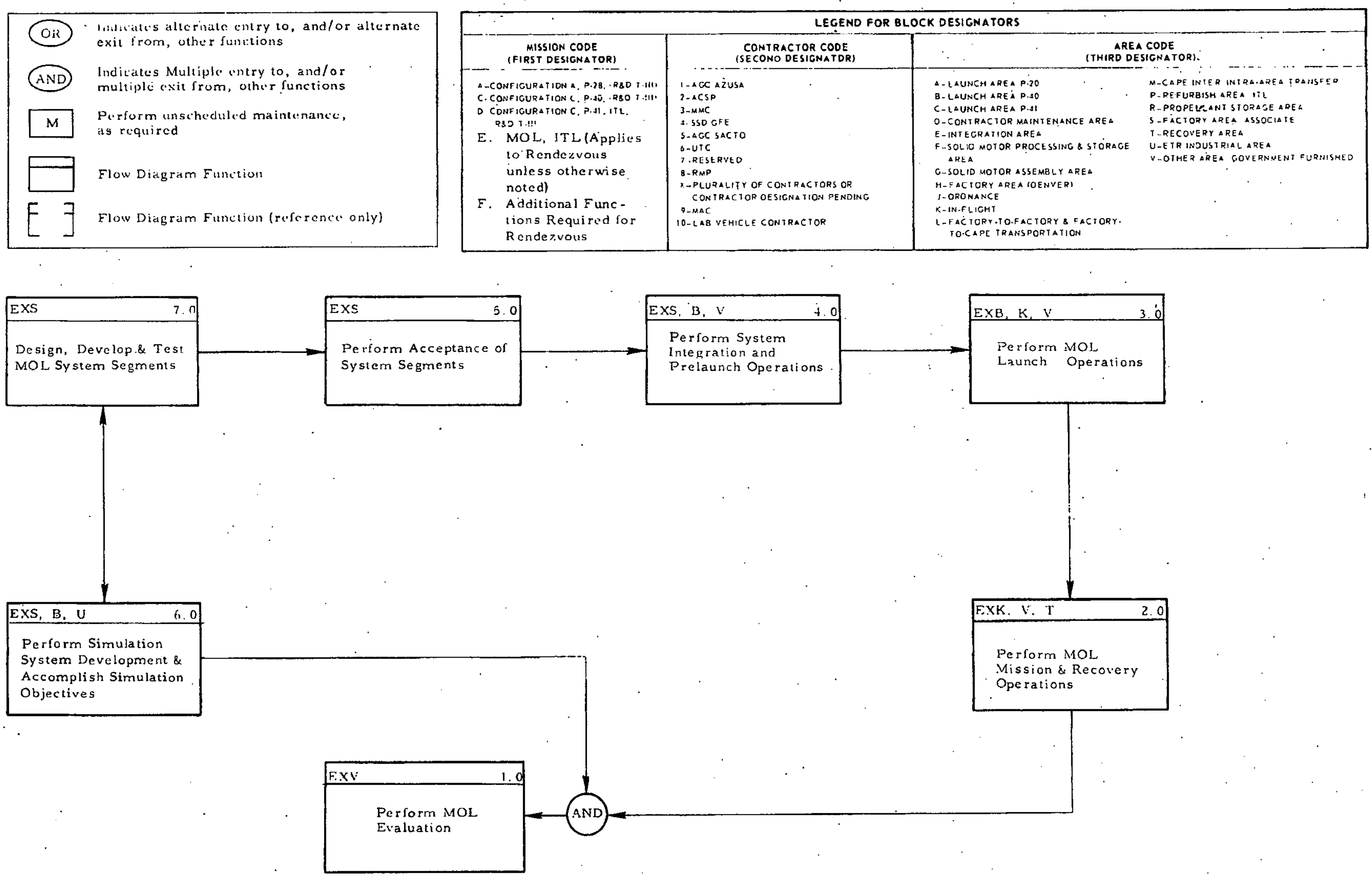


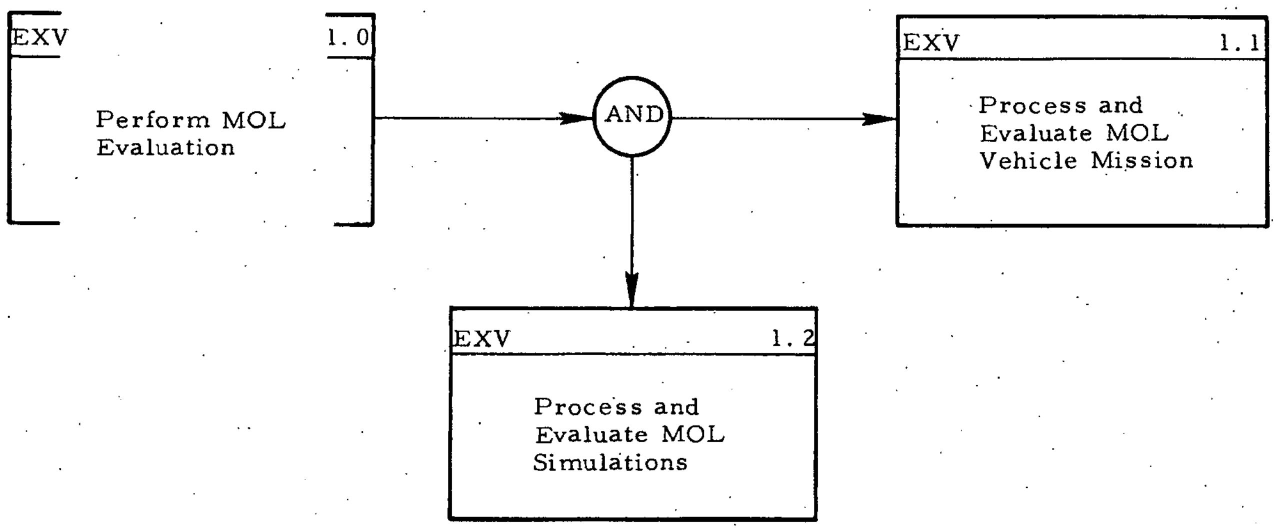
FIGURE 3.1.2.1.1- MOL SYSTEM SCHEMATIC DIAGRAM



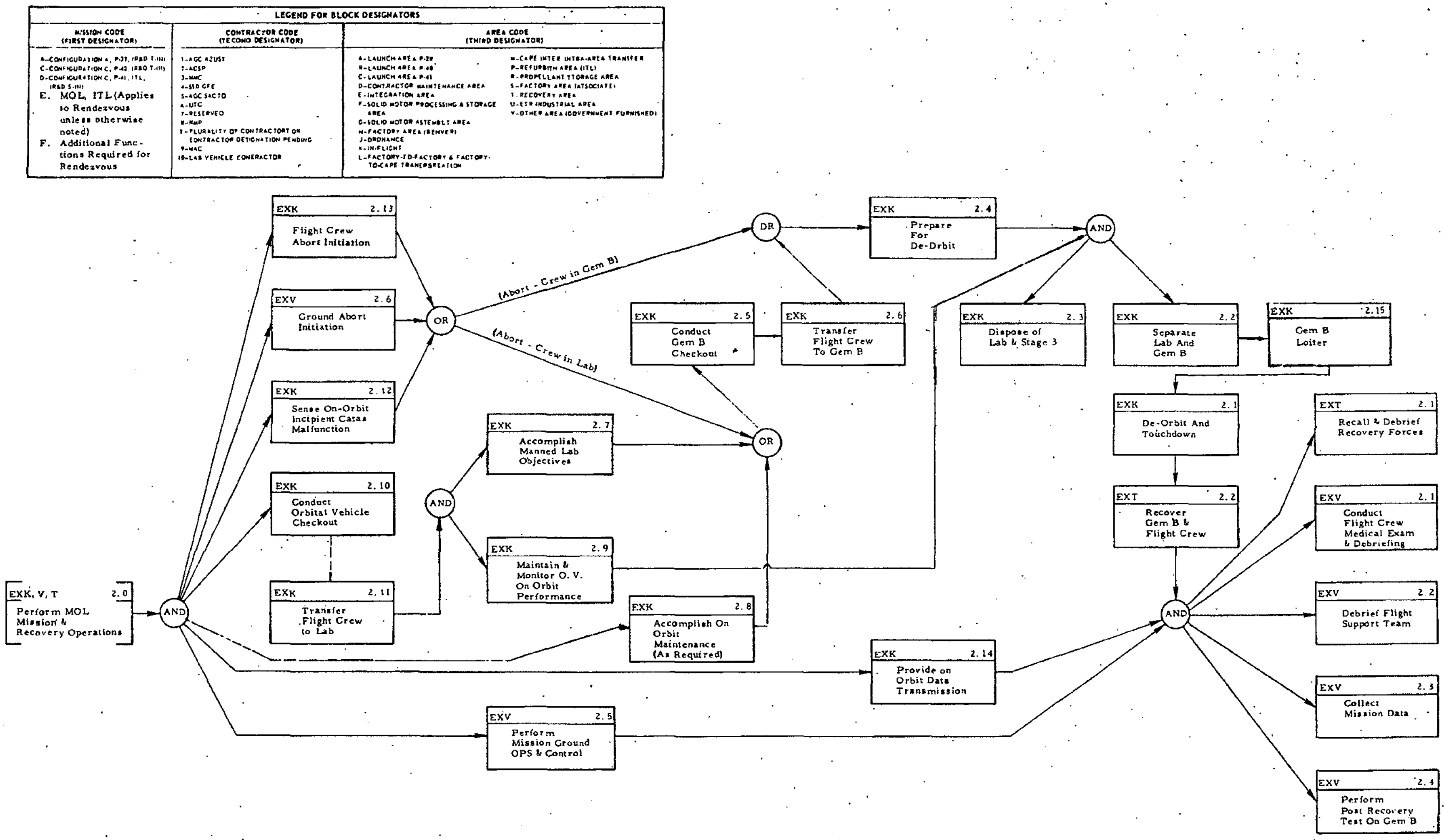
3.1.2.1.2.1 MOL SYSTEM TOP LEVEL FUNCTIONAL FLOW DIAGRAM

LEGEND FOR BLOCK DESIGNATORS

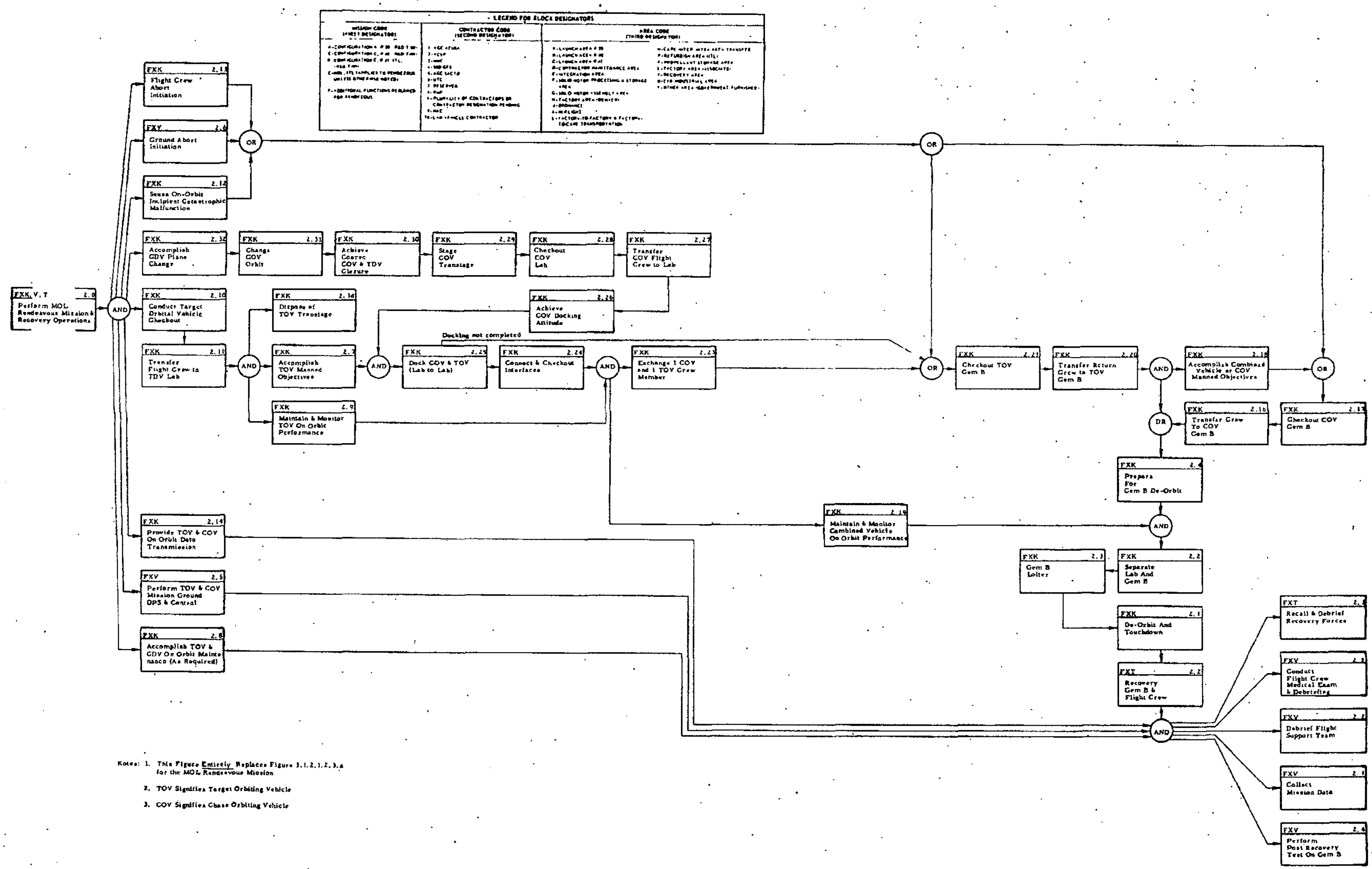
MISSION CODE (FIRST DESIGNATOR)	CONTRACTOR CODE (SECOND DESIGNATOR)	AREA CODE (THIRD DESIGNATOR)	
A–CONFIGURATION A, P-20, (R&D T-III)	1–AGC AZUSA	A–LAUNCH AREA P-20	M–CAPE INTER INTRA-AREA TRANSFER
C–CONFIGURATION C, P-40, (R&D T-III)	2–ACSP	B–LAUNCH AREA P-40	P–REFURBISH AREA (ITL)
D–CDNFIGURATION C, P-41, ITL, (R&D T-III)	3–MMC	C–LAUNCH AREA P-41	R–PROPELLANT STORAGE AREA
E. MOL, ITL (Applies to Rendezvous unless otherwise noted)	4–SSD GFE	D–CONTRACTOR MAINTENANCE AREA	S–FACTORY AREA (ASSOCIATE)
F. Additional Functions Required for Rendezvous	5–AGC SACTO	E–INTEGRATION AREA	T–RECOVERY AREA
	6–UTC	F–SOLID MOTOR PROCESSING & STORAGE AREA	U–ETR INDUSTRIAL AREA
	7–RESERVED	G–SOLID MOTOR ASSEMBLY AREA	V–OTHER AREA (GOVERNMENT FURNISHED)
	8–RMP	H–FACTORY AREA (DENVER)	
	X–PLURALITY OF CONTRACTORS OR CONTRACTOR DESIGNATION PENDING	J–ORDNANCE	
	9–MAC	K–IN-FLIGHT	
	10–LAB VEHICLE CONTRACTOR	L–FACTORY-TO-FACTORY & FACTORY-TO-CAPE TRANSPORTATION	



3.1.2.1.2.2 **MOL SYSTEM FIRST LEVEL FUNCTIONAL FLOW DIAGRAM "Perform MOL Evaluation"**



3.1.2.1.2.3.a MOL SYSTEM FIRST LEVEL FUNCTIONAL FLOW DIAGRAM
"Perform MOL Mission & Recovery Operations"
(Not Applicable to Rendezvous Mission - See 3.1.2.1.2.3.b)

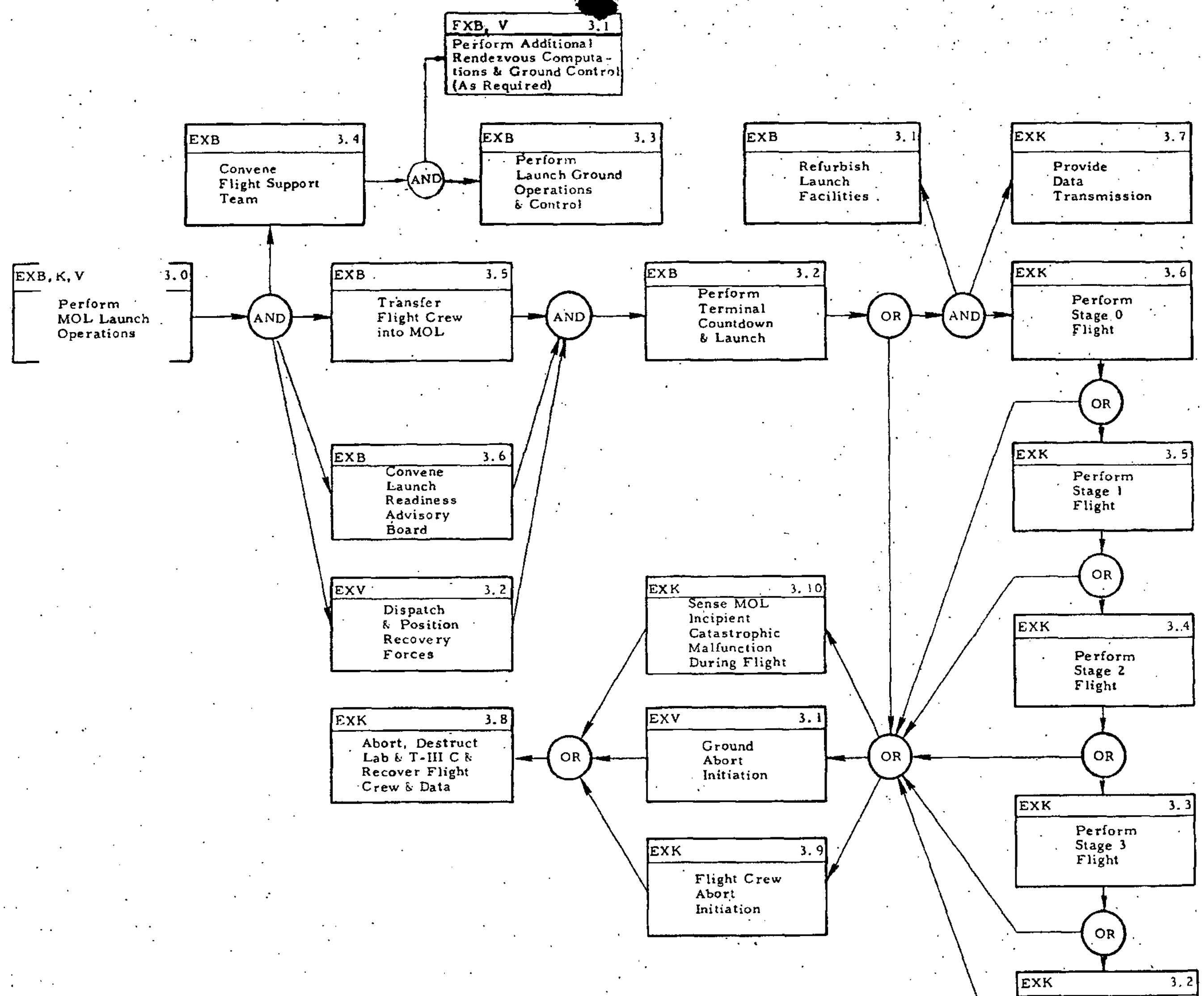


Notes: 1. This Figure **Entirely** Replaces Figure 3.1.2.1.2.3.a for the MOL Rendezvous Mission

2. TOV Signifies Target Orbiting Vehicle

3. COV Signifies Chase Orbiting Vehicle

3.1.2.1.2.3.b MOL SYSTEM FIRST LEVEL FUNCTIONAL FLOW DIAGRAM
"Perform MOL Rendezvous Mission & Recovery Operations"

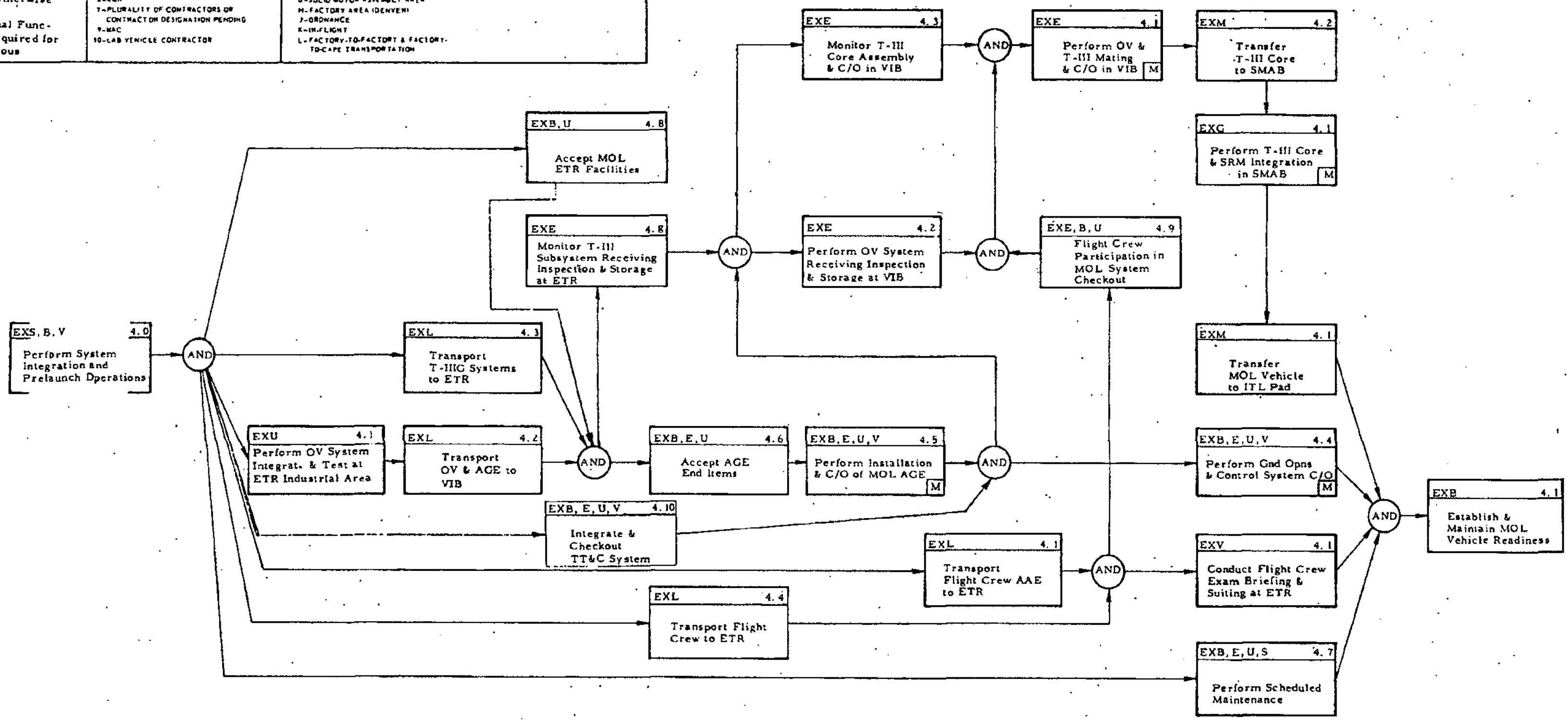


LEGEND FOR BLOCK DESIGNATORS

MISSION CODE (FIRST DESIGNATOR)	CONTRACTOR CODE (SECOND DESIGNATOR)	AREA CODE (THIRD DESIGNATOR)	
A–CONFIGURATION A, P-20, (R&D T-III)	1–AGC AZUSA	A–LAUNCH AREA P-20	M–CAPE INTER INTRA-AREA TRANSFER
C–CONFIGURATION C, P-40, R&D T-III	2–ACSP	B–LAUNCH AREA P-40	P–REFURBISH AREA (ITL)
D–CONFIGURATION C, P-41, ITL, (R&D T-III)	3–MMC	C–LAUNCH AREA P-41	R–PROPELLANT STORAGE AREA
E. MOL, ITL (Applies to Rendezvous unless otherwise noted)	4–SSD GFE	D–CONTRACTOR MAINTENANCE AREA	S–FACTORY AREA (ASSOCIATE
F. Additional Functions Required for Rendezvous	5–AGC SACTO	E–INTEGRATION AREA	T–RECOVERY AREA
	6–UTC	F–SOLID MOTOR PROCESSING & STORAGE AREA	U–ETR INDUSTRIAL AREA
	7–RESERVED	G–SOLID MOTOR ASSEMBLY AREA	V–OTHER AREA GOVERNMENT FURNISHED
	8–RMP	H–FACTORY AREA (DENVER)	
	X–PLURALITY OF CONTRACTORS OR CONTRACTOR DESIGNATION PENDING	J–ORDNANCE	
	9–MAC	K–IN-FLIGHT	
	10–LAB VEHICLE CONTRACTOR	L–FACTORY-TO-FACTORY & FACTORY-TO-CAPE TRANSPORTATION	

3.1.2.1.2.4 MOL SYSTEM FIRST LEVEL FUNCTIONAL FLOW DIAGRAM
"Perform MOL Launch Operations"

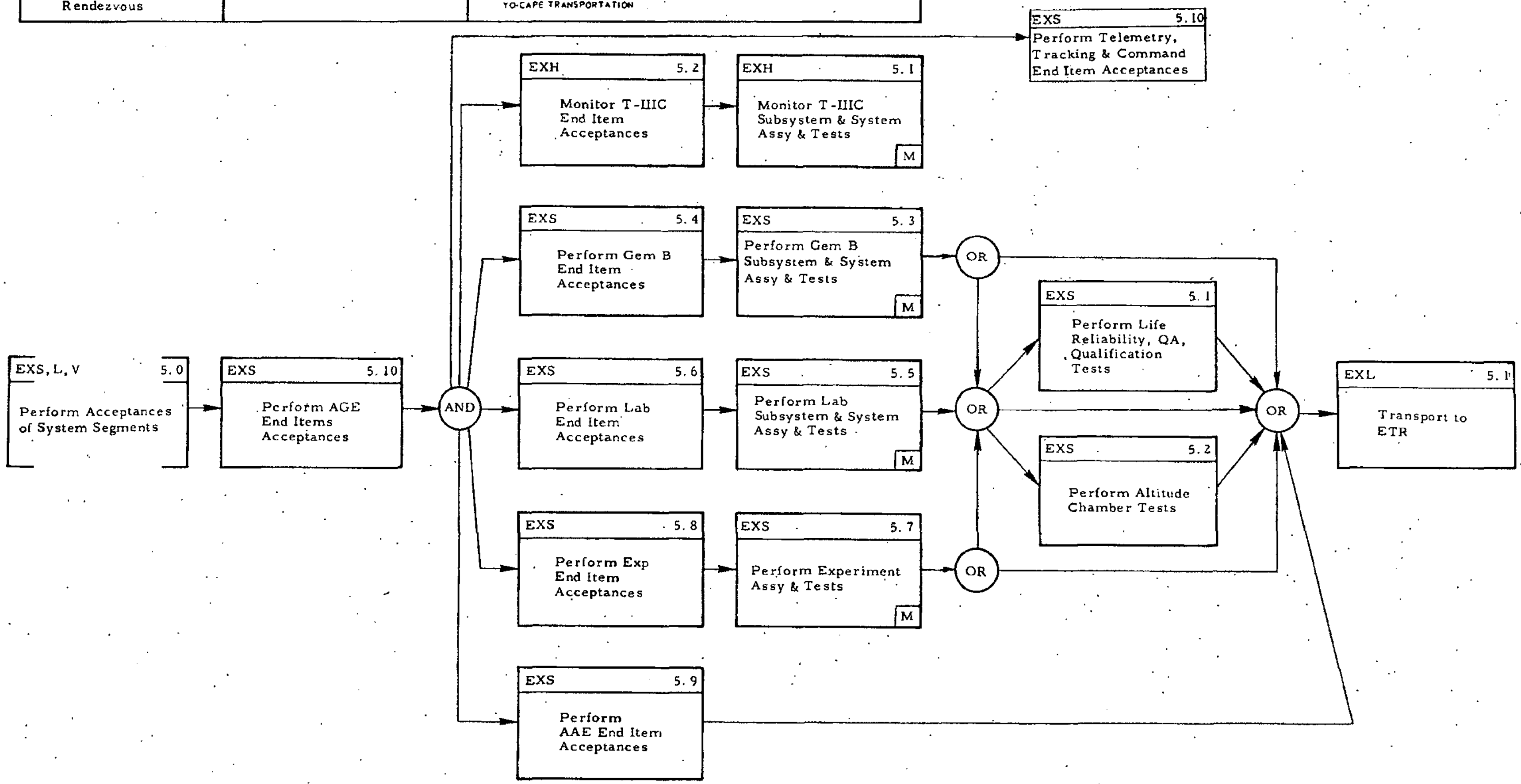
LEGEND FOR BLOCK DESIGNATORS		
MISSION CODE (FIRST DESIGNATOR)	CONTRACTOR CODE (SECOND DESIGNATOR)	AREA CODE (THIRD DESIGNATOR)
A-CONFIGURATION A, P-20, (R&D T-III) C-CONFIGURATION C, P-40, (R&D T-III) D-CONFIGURATION C, P-41, ITL, (R&D T-III) E. MOL, ITL (Applies to Rendezvous unless otherwise noted) F. Additional Functions Required for Rendezvous	1-ACC AZUSA 2-ACSP 3-MMC 4-SSD GFE 5-ACC SACTO 6-UTC 7-RESERVED 8-RMN Y-PLURALITY OF CONTRACTORS OR CONTRACTOR DESIGNATION PENDING 9-MAC 10-LAB VEHICLE CONTRACTOR	A-LAUNCH AREA P 20 B-LAUNCH AREA P-40 C-LAUNCH AREA P-41 D-CONTRACTOR MAINTENANCE AREA E-INTEGRATION AREA F-SOLID MOTOR PROCESSING & STORAGE AREA G-SOLID MOTOR ASSEMBLY AREA H-FACTORY AREA (DENVER) J-ORDNANCE K-IN-FLIGHT L-FACTORY-TO-FACTORY & FACTORY-TO-CAPE TRANSPORTATION M-CAPE INTER (INTRA-AREA TRANSFER) P-REFURBISH AREA (ITL) R-PROPELLANT STORAGE AREA S-FACTORY AREA (ASSOCIATE) T-RECOVERY AREA U-ETR INDUSTRIAL AREA V-OTHER AREA (GOVERNMENT FURNISHED)



3.1.2.1.2.5 MOL SYSTEM FIRST LEVEL FUNCTIONAL FLOW DIAGRAM
"Perform System Integration and Prelaunch Operations"

LEGEND FOR BLOCK DESIGNATORS

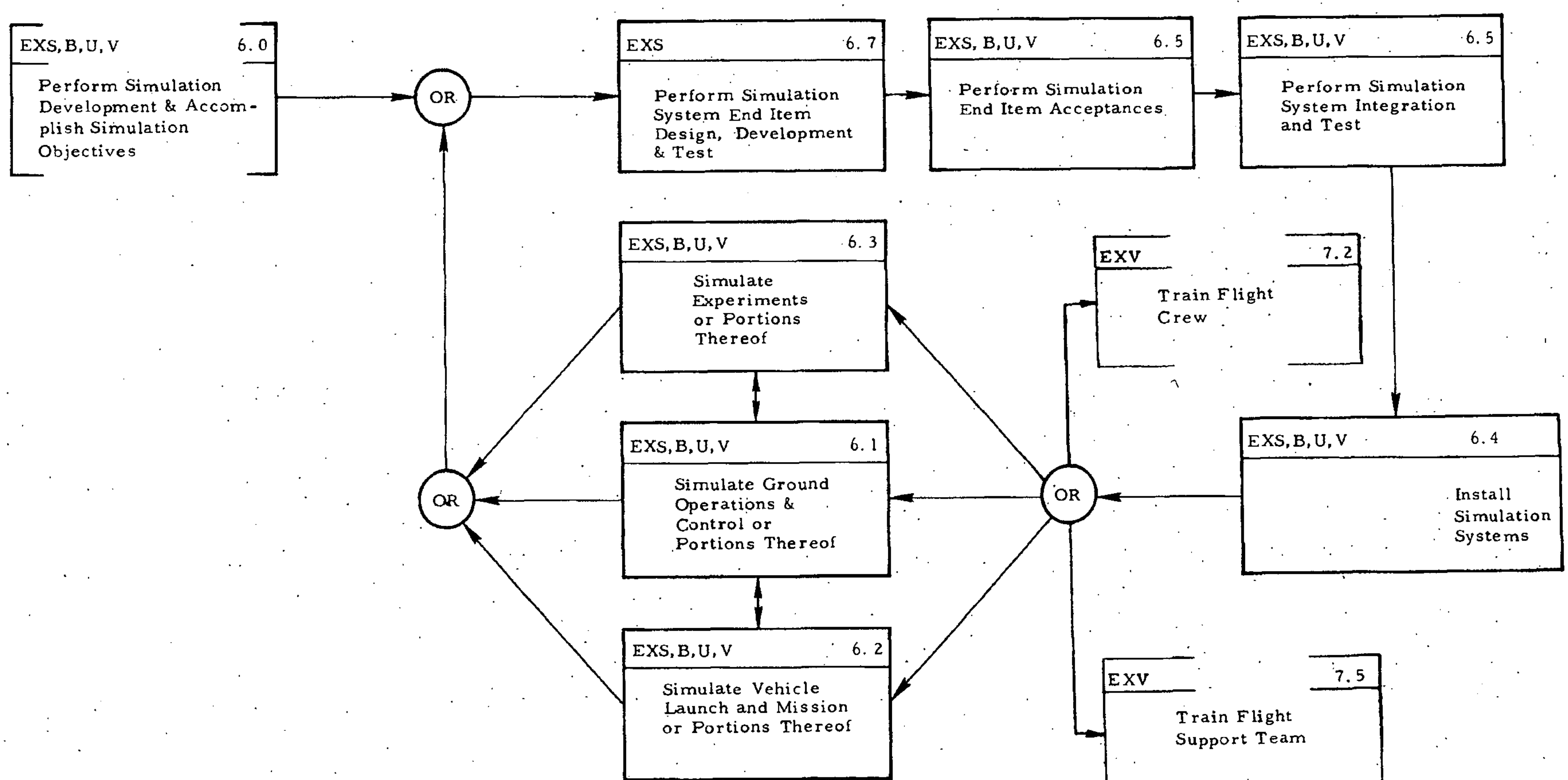
MISSION CODE (FIRST DESIGNATOR)	CONTRACTOR CODE (SECOND DESIGNATOR)	AREA CODE (THIRD DESIGNATOR)	
A-CONFIGURATION A, P-20, (R&D T-III) C-CONFIGURATION C, P-40, (R&D T-III) D-CONFIGURATION C, P-41, ITL, (R&D T-III) E. MOL, ITL (Applies to Rendezvous unless otherwise noted) F. Additional Functions Required for Rendezvous	1-AGC AZUSA 2-ACSP 3-MMC 4-SSD GFE 5-AGC SACTO 6-UTC 7-RESERVED 8-RMP X-PLURALITY OF CONTRACTORS OR CONTRACTOR DESIGNATION PENDING 9-MAC 10-LAB VEHICLE CONTRACTOR	A-LAUNCH AREA P-20 B-LAUNCH AREA P-40 C-LAUNCH AREA P-41 D-CONTRACTOR MAINTENANCE AREA E-INTEGRATION AREA F-SOLID MOTOR PROCESSING & STORAGE AREA G-SOLID MOTOR ASSEMBLY AREA H-FACTORY AREA (DENVER) J-ORDNANCE K-IN-FLIGHT L-FACTORY-TO-FACTORY & FACTORY-TO-CAPE TRANSPORTATION	M-CAPE INTER INTRA-AREA TRANSFER P-REFURBISH AREA (ITL) R-PROPELLANT STORAGE AREA S-FACTORY AREA (ASSOCIATE) T-RECOVERY AREA U-ETR INDUSTRIAL AREA V-OTHER AREA (GOVERNMENT FURNISHED)



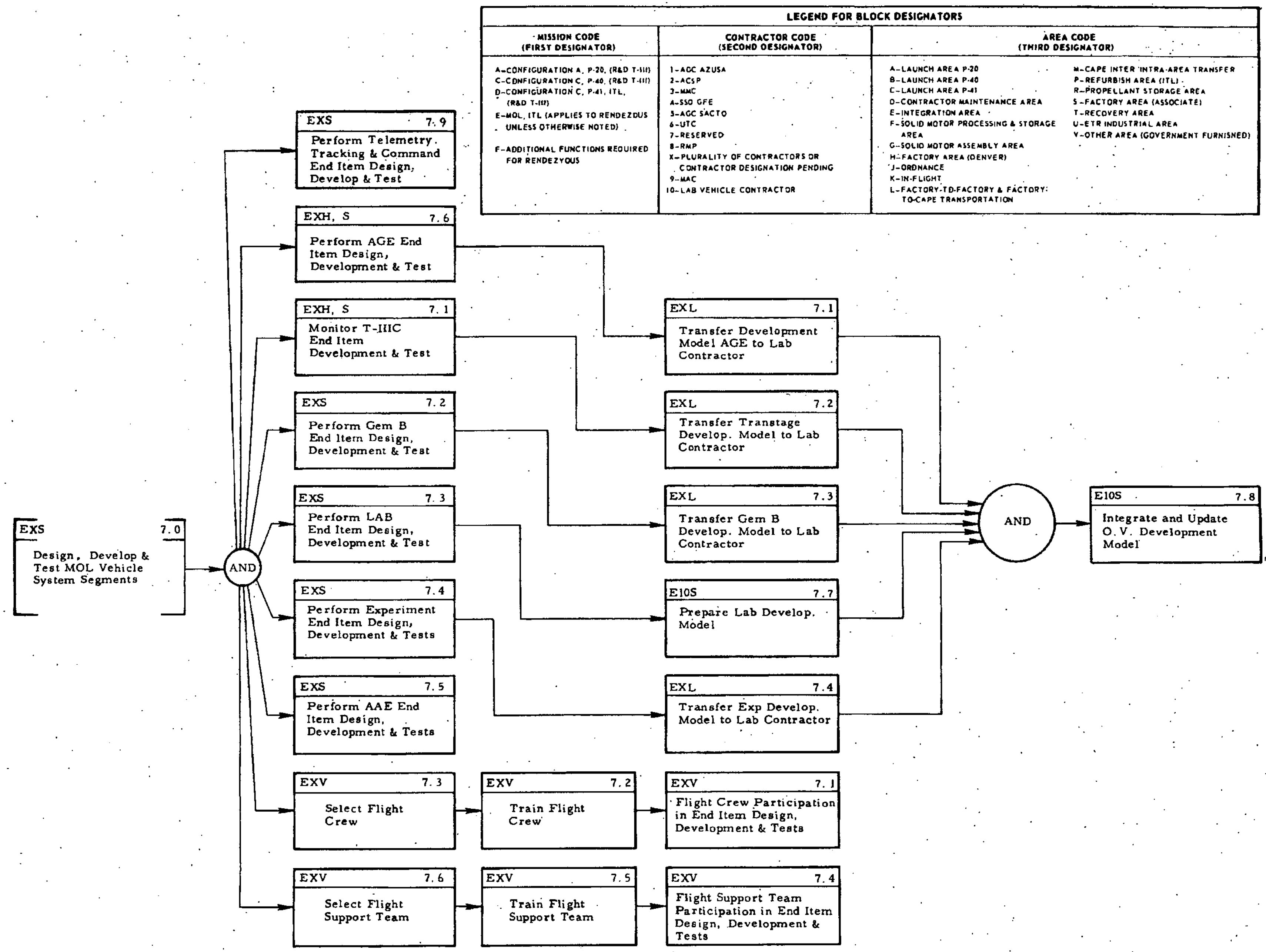
3.1.2.1.2.6 MOL SYSTEM FIRST LEVEL FUNCTIONAL FLOW DIAGRAM
"Perform Acceptances of Vehicle System Segments"

LEGEND FOR BLOCK DESIGNATORS

MISSION CODE (FIRST DESIGNATOR)	CONTRACTOR CODE (SECOND DESIGNATOR)	AREA CODE (THIRD DESIGNATOR)	
A-CONFIGURATION A, P-20, (R&D T-III) C-CONFIGURATION C, P-40, (R&D T-III) D-CONFIGURATION C, P-41, ITL, E. MOL, ITL (Applies to Rendezvous unless otherwise noted) F. Additional Functions Required for Rendezvous	1-AGC AZUSA 2-ACSP 3-MMC 4-SSD GFE 5-AGC SACTD 6-UTC 7-RESERVED 8-RMP X-PLURALITY OF CONTRACTORS OR CONTRACTOR DESIGNATION PENDING 9-MAC 10-LAB VEHICLE CONTRACTOR	A-LAUNCH AREA P-20 B-LAUNCH AREA P-40 C-LAUNCH AREA P-41 D-CONTRACTOR MAINTENANCE AREA E-INTEGRATION AREA F-SOLID MOTOR PROCESSING & STORAGE AREA G-SOLID MOTOR ASSEMBLY AREA H-FACTORY AREA (DENVER) J-ORDNANCE K-IN-FLIGHT L-FACTORY-TO-FACTORY & FACTORY-TO-CAPE TRANSPORTATION	M-CAPE INTER INTRA-AREA TRANSFER P-REFURBISH AREA (ITL) R-PROPELLANT STORAGE AREA S-FACTORY AREA (ASSOCIATE) T-RECOVERY AREA U-ETR INDUSTRIAL AREA V-OTHER AREA (GOVERNMENT FURNISHED)



3.1.2.1.2.7 MOL SYSTEM FIRST LEVEL FUNCTIONAL FLOW DIAGRAM
"Perform Simulation System Development & Accomplish Simulation Objectives"



3.1.2.1.2.8 MOL SYSTEM FIRST LEVEL FUNCTIONAL FLOW DIAGRAM
"Design, Develop & Test MOL Vehicle System Segments"

3.1.2.2 System Segment List

The following eight system segments for MOL are identified. Necessary ground equipment, simulators, "soft-ware," and other segment determined material and activities are included under the appropriate segment.

3.1.2.2.1 Orbiting Vehicle System Segment

This constitutes all segments and parts of segments which are in orbit.

3.1.2.2.2 Laboratory System Segment

3.1.2.2.3 Gemini B System Segment

3.1.2.2.4 Experiments System Segment

This consists of a number of independent or inter-related experimental programs, each of which may be considered a sub-segment. Developmental simulators are included under each experiment.

3.1.2.2.5 Flight Crew and Crew Equipment System Segment

The complete mission simulator and certain other training simulators are included.

3.1.2.2.6 Titan III-C System Segment

This segment includes the operation of the ITL.

3.1.2.2.7 Test Operations System Segment

The following sub-segments are involved:

Test Support System
Mission Control System
Recovery System

3.1.2.2.8 Facilities Segment

This segment consists of new facilities and major modifications to be obtained from USAF MCP funds.

3.1.2.3 Contract End Item List

The list, given in Appendix B, calls out only the principal system CEI's. Reference will be made on the principal CEI's to other CEI lists covering the minor CEI's.

3.1.3 Operability
Effectiveness
System Segment List

3.1.2.4 Interfaces

Interfaces between the various segments and their interfacing components are delineated in Appendix C. Interface Control Documents requirements shall be stated as needed in the outline format given.

3.1.3 Operability

3.1.3.1 Effectiveness

The goal of the MOL Program is the acquisition of experimental results; the reliability emphasis must, therefore, be in terms of mission accomplishment. In addition, since men are involved in the mission, specific attention must be paid to safety.

3.1.3.1.1 The methods by which the mission effectiveness can be increased include:

a. Low Failure Rates
Increased MTBF attained primarily through basic design, and through selection and qualification of components and parts shall be accomplished.

b. Redundancy
Where adequate reliability cannot be attained by means of a single path or component, redundancy must be provided along with a highly reliable means of transferring to the alternate.

c. Maintenance
Although emphasis should be placed on inherent reliability for the entire mission time, the fact that a crew is on-orbit permits maintainability of certain elements. This is only possible if appropriate design measures have been taken for checkout, access, and replacement. Determination of the extent to which manned maintenance can contribute to reliable space operations is a significant goal of the program. The design shall be such that maintenance capabilities learned on one flight can be instituted as planned, but not necessarily scheduled procedures for similar elements on the next flight. However, maintenance tasks should not intefer with time allotments for experimental tasks.

d. Alternate Mode Flexibility

It will be essential to minimize the over-all effects of single failures on mission accomplishments. Obtaining a significant amount of mission data in spite of failures should be a prime consideration in task and time allotments.

3.1.3.1.2 Program Effectiveness

In order to insure attainment of experimental results, it is essential that basic experiments be scheduled on at least two flights and that programming of tasks on-orbit be timed to maximize the data obtained. Data readout to ground stations should be planned not only to provide monitoring as a basis for decision by the mission control center, but also to record information which might be lost due to subsequent malfunctions.

3.1.3.1.3 Specific Mission Effectiveness

Over-all program effectiveness shall be defined in terms of probabilities for mission success of individual flights. These shall be further identified in terms of required success probabilities for each system segment and the principal subsystems thereof.

3.1.3.1.4 Data shall be developed to support a detailed apportionment of effectiveness to the various system segments.

3.1.3.1.5 For each system segment, a plan shall be developed to show how substantial compliance of the effectiveness allocations will be demonstrated prior to acceptance.

3.1.3.1.6 For each system segment, a plan shall be developed to show how actual compliance to the effectiveness allocations is judged based on the performance, as applicable, during mission events such as assembly, launch, flight, and recovery.

3.1.3.2 Maintainability
Environment
Transport & Handling
Human Performance

3.1.3.2 Maintainability

3.1.3.2.1 Maintenance Requirements

3.1.3.2.1.1 Ground Maintenance Requirements

Maintainability of launch vehicle AGE and flight systems shall conform to the requirements of MIL-M-26512C with the exceptions as specified in Attachment 1 to SSD Exhibit 62-126.

The design of the OV AGE shall use MIL-M-26512C as a guideline for maintainability purposes. Maintenance at the launch site shall be restricted to major module/component removal and replacement. Module and component repair will be accomplished at the point of manufacture. Spare modules will be stocked at the launch site as required based on detailed maintenance analysis.

The AGE shall be designed such that ease of maintainability can be incorporated to minimize equipment down time in order that launch schedules may be adhered to. AGE will be designed to have self-contained fault isolation and detection provisions. Preventative maintenance in terms of routine pre-planned tasks such as inspection, lubrication, and minor adjustment shall be included in all AGE designs to enable minimum equipment down time due to critical component malfunctions.

3.1.3.2.1.2 On-orbit Maintenance Requirements

The scope of on-orbit scheduled and unscheduled maintenance and repair shall be established as a result of design optimization studies and tradeoffs. Quantitative maintainability requirements shall be established consistent with allowable element down times. Adequate accessibility shall be provided for the maintainable items.

3.1.3.3 Useful Life

This paragraph is not applicable in the weapon system sense to the MOL Program.

3.1.3.4 Environment - Natural and Induced

The environments applicable to the MOL Program are divided into the following general classifications:

a. Prelaunch - (applicable to all segments)
b. Launch/ascent - (applicable to Airborne Vehicle and pad)
c. On-orbit - (applicable to Orbiting Vehicle)
d. Descent and Recovery - (Applicable to Gemini B)

3.1.3.4.1 SSD Exhibit 64- , "Environmental Criteria Specification for the MOL System", which contains all details on the applicable environments other than launch and early ascent.

3.1.3.4.2 SSD Exhibit 62-116A, "Environmental Requirements Specification, Program 624A", Revision A, 1 July 1964, which covers the launch and early ascent phases.

3.1.3.5 Transportability and Handling

3.1.3.5.1 General

Existing transportation and handling equipment from military or commercial sources will be used in preference to the design of new equipment. Equipment shall conform to the requirements of MIL-S-8512 and MIL-M-8090C as well as to the environmental requirements of this specification.

3.1.3.5.2 Transportability

Transportation planning for all components of the MOL System shall be by air in accordance with Space Systems Division Exhibit 63-3 and MIL-A-8421B. However, other modes of transportation may be utilized.

3.1.3.5.3 Handling

The handling of ground equipment shall be in accordance with the general requirements of MIL-S-8512B. To facilitate the handling of ground equipment, the design shall incorporate the safety measures prescribed in AFSC Manual 80-5.

Instrumentation or other indicators shall be affixed to all transport assemblies, as required, to record or indicate any out of tolerance environments which have been encountered during transport or handling of sensitive assemblies or components.

3.1.3.6 Human Performance

For this program the Flight Crew has been functionally separated from the Ground Crew and is treated in the Flight Crew and Crew Equipment System Segment, Section 3.3.5. All Ground Crew will be treated within their associated segments.

Documents governing system development fall into two categories: (1) Those applicable or partially applicable for use as governing documents and (2) Those usually concerned with operational system development which may be used primarily for guidance as they are not totally applicable. The documents concerned with human performance (both Flight Crew and Ground Crew) are listed in Appendix A with these prefixes:

Applicable or partially applicable	Prefix HP
Guidance	Prefix GP

3.1.3.7 Safety
3.2 Design & Const Stds

3.1.3.7 Safety

3.1.3.7.1 Applicable Documents for Safety are listed in Appendix A with the prefix letters SF.

3.1.3.7.2 Mission Safety Criteria

3.1.3.7.2.1 The equipment design shall, in general, include sufficient redundancy so that no single equipment failure shall cause the necessity for an abort.

3.1.3.7.2.2 The equipment design shall, in general, include such features that no single equipment failure shall be cause of a fatality.

3.1.3.7.2.3 Adequate design measures shall be taken to either avoid the use of toxic fluids in manned segments or to prevent their coming in contact with personnel during normal breakdown modes.

3.1.3.7.3 General

The safety requirements specified under this paragraph shall include all equipment and areas which the crew may be expected to contact, or be in the immediate vicinity of; incorporating design features to preclude all forms of chemical and physical injury.

3.1.3.8 Dangerous Materials and Components

a. Acceptable concentrations of toxic compounds shall be determined both for short term and for continuous exposure. The primary exposure problem is related to toxic materials encountered by fuel handlers. However, to the extent that these materials are diffused into the atmosphere, there is a problem of exposure of persons not in the immediate area of the fuel handling operation, including civilian populations.

b. Techniques and equipments shall be selected to ascertain that safe exposure levels are not exceeded. Storage containers and methods of handling toxic materials shall be specified. An investigation of available and appropriate types of protective clothing (impermeable, impregnated, etc.), and respiratory masks (including those which permit the inhalation of outside air after filtration and those which contain a portable oxygen supply) shall be made.

c. Special attention is required for problems concerning the OV and on-orbit operations. This should include materials failures or developed toxicity (due to outgasing, embrittlement, etc.) promulgated by radiation and/or high vacuum or low temperature condition exposure.

3.1.3.9 Noise and Vibration

(See Section 3.1.3.4)

3.1.3.10 Life Support

(See Section 3.3.5)

3.2 System Design and Construction Standards

The System Design and Construction Standards contained herein shall be applicable to the performance, design, development and test of the system equipment, as well as to the Design Disciplines, such as Mechanical, Electrical, etc. Design requirements of this type shall be imposed by specifying the incorporation of the established military standards and specifications as applicable in the individual contract and item specifications. The documents listed in Appendix A with the prefix DG shall be used as general guides in the design and construction of the MOL Program equipment.

3.2.1 General Design and Construction Requirements

Requirements specified herein shall apply to the design and construction of all system equipment. Those documents listed in Appendix A with the prefix letters DR form a part of this requirement.

3.2.1.1 Selection of Specifications and Standards

3.2.1.1.1 The selection of specifications and standards for the identification, control and procurement of the commodities required to design and fabricate the equipment under contract shall be in accordance with MIL-STD-143 and the requirements of this specification. Only those military documents listed in ANA Bulletin 400 and/or the DOD Index of Specifications and Standards shall be interpreted as being "I" documents as defined in MIL-STD-143. Specifications and Standards of Governmental Agencies other than DOD (e.g. NASA, FAA, etc.) shall be interpreted as being Group III documents as defined in MIL-STD-143.

3.2.1.1.2 Specification control and/or source control drawing as defined in MIL-D-70327 shall be used to modify or augment the requirements and quality assurance provisions of the documents available to the contractor from Group I through IV inclusive of MIL-STD-143. In order of precedence this method is desired over the use of Group V documents. Any Group III documents selected for use shall automatically necessitate the preparation of a specification control drawing and shall be so drafted to establish the specific document being referenced, its date of issue, and contractor control responsibility for its use.

3.2.1.1.3 Military Standards shall be employed to the maximum extent. (AFSSD Exhibit 61=81, Compliance Specification.)

3.2.1.1.4 All standards or specifications other than those established and approved for use by the Air Force must be approved by the procuring agency prior to incorporation into the system specification.

3.2.1.2 Materials, Parts and Processes

Materials, parts and processes selected for this system shall be selected with attention being given to the stringent requirements of temperature, temperature gradients, thermal conductivity, vibration, shock, loads, pressure, light weight construction, and simplicity of manufacture. To insure compliance with optimum utilization of procedures, processes, methods, etc., the following shall be adhered to:

3.2.1.2.1 Attention shall be directed to prevent unnecessary use of strategic and/or critical materials. A strategic and critical materials list can be obtained from the procuring agency.

3.2.1.2.2 The use of non-standard materials, parts and processes shall be justified as to the reason for their use in lieu of standards as well as substantiation of their suitability for the intended application by submittal of engineering analysis, test reports, etc. to demonstrate that the replacement has satisfactory performance characteristics.

3.2.1.2.3 Those documents listed in Appendix A with the prefix letters MP apply to the Materials, Parts, and Processes requirements.

3.2.1.3 Standards and Commercial Parts

MIL-HDB-300 shall be used to insure the use of standard and commercial parts and parts listed in MIL-S-38000 Qualified Parts Lists. To comply with the requirements, the following definitions and procedures are offered:

3.2.1.3.1 Military Specified Parts, Military Standard Parts, and MIL-Spec Parts are interpreted as those parts controlled by, and procurable under the documents classed as Group I in MIL-STD-143.

3.2.1.3.2 Government Standard Parts are defined as those parts controlled by and procurable under the documents classed as Group II and III in MIL-STD-143.

3.2.1.3.3 Industry Standard Parts shall be understood to be those parts controlled by and procurable under the documents classed as Group IV in MIL-STD-143.

3.2.1.3.4 Design Activity Standard Parts, Company Standard Parts and Commercial Parts shall be understood to be those parts controlled by and procurable under the documents classed as Group V in MIL-STD-143.

3.2.1.3.5 Full utilization shall be made of IDEP.

3.2.1.4 <u>Moisture and Fungus Resistance</u>

Materials shall be used which will resist damage from moisture and fungus. Protective coatings will not be acceptable as moisture and fungus preventatives on parts which will lose the coatings during the normal course of inspection, maintenance, and periodic testing. "Moisture" shall be considered as containing salt from marine atmosphere (MIL-STD-210, Climatic Extremes for Military Equipment). The tests necessary to satisfy this requirement are specified under MIL-STD-810 and MIL-E-5272C.

3.2.1.5 <u>Corrosion of Metal Parts</u>

3.2.1.5.1 <u>Electrolytic Corrosion of Metal Parts</u>

The use of dissimilar metals in immediate contact which will tend to accelerate electrolytic corrosion in the presence of moisture shall be avoided - as defined in MS 33586A. Where the use of such metals in immediate contact cannot be avoided, proper protection or insulation of such parts shall be provided. Care should be taken to prevent equipment corrosion in the laboratory due to moisture under zero g conditions. The moist salt atmosphere created by man's presence may increase such electrolytic problems.

3.2.1.5.2 Stress Corrosion

Materials techniques and processes shall be selected and employed with regard to heat treatment procedures, corrosion protection, finish and assembly and installation such that sustained/residual surface tensile stresses, stress concentrations and the hazard of stress corrosion, cracking and hydrogen embrittlement are minimized.

3.2.1.5.3 Protective Methods

Protective methods and materials for cleaning, surface treatment, and application of finishes and protective coatings shall be accomplished in accordance with MIL-F-7179.

3.2.1.6 Interchangeability and Replaceability

3.2.1.6.1 Interchangeability and Replaceability in Terms of In-Flight Maintenance Requirements

Insofar as possible, the design and manufacture of all MOL subsystem and experimental equipment shall not preclude the using of common parts such as valves; or electronic components such as transistors, capacitors, or printed circuit modules; or equipment in which one unit or component can be utilized for several functions in many items of the same or different equipments. Connectors, fasteners, small tubing and piping, etc., should be designed such that satisfactory interchangeability can be accomplished for many of these common items in order to alleviate spare part requirements and variety of types of special tools required for interchangeable, or non-interchangeable but replaceable, parts of a common nature. Therefore, appropriate attention should be given towards obtaining maximum usage of common devices and component parts insofar as possible on all MOL subsystems and experimental equipment in the Orbiting Vehicle. Applicable documents are listed in Appendix A with the prefix letters IC.

3.2.1.7 Workmanship

The equipment, including all AVE and AGE parts and accessories, shall be constructed and finished in accordance with the detail requirements specified in the documents listed in Appendix A with the prefix letters WK. The workmanship requirements of MIL-E-5400F, Paragraph 3.5, shall be implemented with the aid of written standards for workmanship.

3.2.1.7.1 Quality Assurance

This section covers the quality assurance requirements that must be implemented during the design and manufacturing phases to assure the timely implementation of adequate and appropriate controls in accordance with MIL-Q-9858A and USAF Specification Bulletin No. 515 to ensure that the materials, workmanship and performance are to specified standards; and components have been manufactured and tested to approved drawings and specifications; and the reliability and quality assurance requirements of SSD Exhibit 62-117 have been met.

3.2.1.7.2 Inspection and Test Equipment Selection

Equipment required for performance of the necessary inspections and tests shall be determined. Planning shall include the calibration system requirements to conform to MIL-C-45662A.

3.2.1.7.3 Material Review Engineering and Quality Assurance

At the earliest practical point, the material review representatives shall be determined. The material review procedures shall be reviewed for conformance to USAF Specification Bulletin No. 515.

3.2.1.7.4 Vendor and Subcontractor Selection and Control

The Contractor shall have a system for supplier selection and control. The system shall provide for continued assessment of suppliers. Provisions shall exist for requiring quality control systems in the plants of suppliers and lower tier subcontractors in accordance with MIL-Q-9858A or MIL-I-45208A as appropriate. Specification control drawings shall be generated in accordance with MIL-D-70327.

3.2.1.8 Electromagnetic Interference

The General Design and Construction Requirements for this subject have been prepared under SSD Exhibit 64- titled, Electromagnetic Interference Control Specification for Manned Orbiting Laboratory. Applicable Military Specifications are listed in Appendix A with the prefix letters EI.

3.2.1.9 Identification and Marking

Equipment, assemblies and parts shall be marked for identification in accordance with SSD Exhibit 62-181. Specific identification requirements include such conditions as:

3.2.1.9.1 Equipment which may be damaged by operation in excess of the rated duty cycle shall be so marked.

3.2.1.9.2 Items with limited operating lifetime or shelf life shall be so marked and a log maintained which is attached to the subject item.

3.2.1.9.3 Critical components, as defined by AFSCM 375-1 shall bear a high visibility and unique marker, plaque or decal which will immediately identify these components. This identification shall not be used on any other type item, other than those classified as critical.

3.2.1.9.4 Applicable documents relating to Specification and Marking are listed in Appendix A with the prefix letters IM.

3.2.1.10 Storage

The system shall be designed to minimize the degrading effects of storage environments. In the event unwarranted system, weight, bulk, environmental limitations, etc. are involved in achieving storage protection, special protective containers, covers, etc., may be used. Special design attention shall be devoted to critical items - per AFSCM 375-1. System design criteria relative to the in-orbit storage of maintenance items needed during the orbital mission shall be established by design activities. This criteria shall be incorporated into CEI specification and critical component specifications. Applicable documents relating to Storage listed in Appendix A are preceded with the prefix letters ST.

3.2.2 Design Disciplines

The design criteria requirements listed shall be limited to specific design disciplines and/or types of equipment:

3.2.2.1 Electrical

The electrical design discipline requirements have been prepared under SSD Exhibit 64- , titled, General Specification, Wiring Harness. The applicable documents for this subject are listed in Appendix A with the prefix letters EE.

3.2.2.2 Mechanical

Mechanical equipment design disciplines shall be applied to AVE, MGE and OGE and shall reference such documents as AFM 88-2, Definitive Designs for Air Force Structures.

3.2.2.3 Hydraulic and Pneumatic

Applicable Hydraulic and Pneumatic reference documents are listed in Appendix A with the prefix letters HP.

3.2.2.4 Civil

Applicable civil reference documents are listed in Appendix A with the prefix letters CV.

3.3.1 Orbiting Vehicle

3.3 Performance Allocations

3.3.1 Orbiting Vehicle System Segment

The Orbiting Vehicle (OV) shall be composed of the following system segments: the Gemini B; the Laboratory; the Experiments; and the Titan III Transtages and flight crew and crew equipment. The rendezvous and docking aspect of the segment is treated in Paragraph 3.3.1.2.12.

3.3.1.1 Allocated Performance and Design Requirements

3.3.1.1.1 Mass Parameters

3.3.1.1.1.1 Weight Breakdown

The gross weight of the Orbiting Vehicle shall be approximately 19,700 pounds, excluding the Transtage.

3.3.1.1.1.1.1 Laboratory

The Laboratory segment weight shall not exceed 9800 pounds.

3.3.1.1.1.1.2 Gemini B

The allocated weight of the Gemini B segment shall not exceed 6300 pounds, including crew and flight equipment.

3.3.1.1.1.1.3 Experiments

The allocated weight of the Experiments segment shall not be less than 3600 pounds for a 30-day mission integral launch mission.

3.3.1.1.1.1.4 Transtage

The Transtage dry weight shall not exceed 5250 pounds.

3.3.1.1.1.2 Center of Gravity

The center of gravity shall be established and controlled such that requirements for on-orbit attitude control, and Titan IIIC launch phase control are not compromised.

3.3.1.1.2 Electrical Power

3.3.1.1.2.1 Orbiting Vehicle

The Laboratory central power system (CPS) shall provide the total Orbiting Vehicle power requirement while on orbit. The power over the entire 30 days is 1.8 KW with a peak of 3.6 KW. Peak requirements for each segment are identified in the appropriate segment sections.

3.3.1.1.2.2 Gemini B

Electrical power allocation to the Gemini B shall be 200 watts average.

Power system monitoring functions of the Gemini B local power supply shall be located both within the Gemini B and the Laboratory. The total abort and re-entry power system requirements shall be provided by the local Gemini B power supply.

3.3.1.1.2.3 Laboratory

The Laboratory shall be allocated an average power of 1.35 KW for its functions during all phases of the mission after transfer to internal power.

3.3.1.1.2.4 Experiments

The Experiment System Segment shall be provided an average power of 250 watts from the CPS. Experiments peculiarly incompatible with the CPS shall be supplied from an Experiment-peculiar power supply.

3.3.1.1.2.5 Transtage

The average power required from the Orbiting Vehicle for on-orbit operation of the Transtage shall be included in the power allocation for the Laboratory Segment. This allocation is 50 watts average power.

3.3.1.1.3 Leak Rate

The leak rate on orbit, with all system segments normally pressurized, shall not exceed approximately 4.5 lb/day, of which approximately 2.5 lb/day shall be allocated to the Gemini B (and transfer tunnel) and approximately 2.0 lb/day shall be allocated to the Laboratory.

3.3.1.1.4 Effectiveness

3.3.1.2 Peculiar Performance and Design Parameters

Certain Orbiting Vehicle requirements will be unique to particular flights. The following requirements are those which are common to all flight configurations.

3.3.1.2.1 Communication and Control

3.3.1.2.1.1 General

The Communication and Control Systems located in the segments shall be capable of independent operation. Electromagnetic compatibility shall be demonstrated when systems located in the different segments are activated simultaneously.

3.3.1.2.1.2 Command System

Isolation shall be provided between the Gemini B Command System and the Laboratory Command System to prevent inadvertent activation of either Command System.

3.3.1.2.1.3 Data Transmission System

Sufficient isolation shall be provided between the Gemini B, Titan III and Laboratory Vehicle Data Transmission Systems to prevent interference between those systems when operating simultaneously.

3.3.1.2.2 Orbit Attitude Maneuvering System (OAMS)

3.3.1.2.2.1 Operational Modes

The on-orbit attitude control shall be provided by the Laboratory. The OV shall be capable of on-orbit operation with or without the transtage attached.

3.3.1.2.2.2 Orientation

Maneuver capability to any attitude and the maintenance of this attitude in either inertial orientation or in a local vertical orientation shall be provided. Generation of disturbance torques by venting of stored material and by starting and stopping of rotating machinery shall be minimized.

3.3.1.2.2.3 Remote Activation and Control

Capability to control the transtage main propulsion engine ignition, thrust termination and gimbal system from the Laboratory shall be provided. The interface between the transtage propulsion system and the Laboratory control system shall be at the gimbal servo valve and the propellant valve inputs.

3.3.1.2.2.4 Maneuvering

On orbit maneuvers requiring addition of velocities in excess of approximately 10 feet per second shall be accomplished with Transtage Propulsion. Maneuvers requiring lesser velocity additions shall be accomplished with the Laboratory propulsion system.

3.3.1.2.3 Structural Design Requirements

3.3.1.2.3.1 General

Sufficient strength and rigidity shall be provided to meet the maximum loading and/or environmental conditions within the envelope of missions requirements. The Orbiting Vehicle shall be compatible in terms of load transmission capability and mating at the interfaces with the Gemini B, with Titan IIIC Transtage, and with the experiments.

3.3.1.2.3.2 Separation

The capability shall be provided for separation on orbit between the Gemini B and Laboratory System Segments and between the Orbiting Vehicle and Titan IIIC Transtage.

3.3.1.2.3.3 Thermostructural

The Orbiting Vehicle shall not adversely deform as a result of structural temperature gradients.

3.3.1.2.3.4 Aeroelasticity

Flutter or other related dynamic instability shall be prevented on the orbiting vehicle system.

3.3.1.2.4 Crew Transfer

3.3.1.2.4.1 Normal Mode

An internal pressurized tunnel through the heat shield shall be provided to transfer the crew between Gemini B and the Laboratory. Movement through the hatches and tunnel shall be in vented pressure suits; however, emergency inflation of the suit shall not cause trapping in the tunnel. The Gemini B heat shield and pressure hatch shall remain open at all times when both crew members are not in the Gemini B.

For the initial transfer to the Laboratory, one crewman shall transfer into the smaller Laboratory compartment prior to beginning transfer of the other. For final transfer from Laboratory to Gemini B, the first crewman shall verify that all Gemini B systems are operating satisfactorily prior to transfer of the second.

3.3.1.2.4.2 Emergency Mode

Provision shall be made for extravehicular egress/ingress and transfer of crew members between the Gemini B and the Laboratory vehicles.

Extravehicular egress/ingress to Gemini B shall be via the regular Gemini B hatches and to the Laboratory through the extravehicular hatches.

Emergency transfer capability shall be provided from all Laboratory Vehicle compartments to space for extravehicular transfer to Gemini B.

The Laboratory vehicle shall provide umbilical lines and a one hour supply of metabolic oxygen for two crew members. Back-up emergency Environmental Control shall be provided by the portable system specified as part of Experiment P-6. (Ref. section 3.3.4.)

3.3.1.2.4.3 Number of Transfers

Several return trips may be made to the Gemini B during the mission.

3.3.1.2.4.4 Parcel Transfer

Small packages shall be required to be manually transferred between the Laboratory and Gemini B.

3.3.1.2.5 Experiment Provisions

3.3.1.2.5.1 General

Data packages containing film, magnetic tape, bio samples and other material shall be transferred to the Gemini B for return.

3.3.1.2.5.2 Modification Group List per Flight

Modifications to the Orbiting Vehicle for each flight mission and the experiment payload configuration, with its allocated performance characteristics and requirements, shall be defined, in accordance with Appendix B.

3.3.1.2.6 Orbital Operations

3.3.1.2.6.1 Laboratory Activation

The orbit will be circularized at the operational altitude within the range of a ground tracking station, followed by laboratory segment subsystems activation and checkout. Pre-transfer actions shall be accomplished in such a manner that the first astronaut commences transfer to the Laboratory while the orbiting vehicle is within range of communication stations. Upon completion of laboratory activation, the second astronaut will begin the Gemini B shutdown and transfer to the Laboratory within range of a communication station. Upon completion of Laboratory activation tasks, the Laboratory orbital configuration will be verified and a shirt-sleeve environment utilized.

3.3.1.2.6.2 Experiment Operation

The orbiting vehicle and mission requirements for the on-orbit operation of the experiments, such as jettisonable covers, sensor deployment, antenna erection, air locks, extravehicular activity, [redacted] human factors, bioastronautic measurements, and observation locations are specified.

Upon completion of the on-orbit test phase the Gemini B shall be checked out and activated and the crew transferred in sequence with data such as film, magnetic tape, bio and other test samples. The Laboratory shall be de-activated and separated in preparation for de-orbit and re-entry of the Gemini B.

3.3.1.2.7 Aerospace Ground Equipment (AGE)

The OV AGE shall include all the integrated Gemini B, Laboratory and Experiments AGE which is necessary to transport, handle, mate, integrate, verify interfaces, calibrate, check out, isolate faults, monitor, record, service and control the OV as an independent system and the OV as a system mated with the Titan IIIC booster. This AGE shall be capable of providing a means of (1) verifying the proper operation of the OV systems during checkout, countdown and launch, (2) determining whether the fully assembled system is operable within the prescribed limits of each segment, (3) assuring that all interfaces (electrical, mechanical, and human) between OV segments or with external surfaces are proper, and (4) identifying to the segment (or in critical systems the sub-segment) level areas of failure or operation outside of prescribed operating limits. The OV AGE shall be designed for compatibility with the Titan IIIC AGE and the ITL facilities. The OV AGE in the ITL system and located at the launch pad and/or in the Vertical Integration Building (VIB) shall provide capability for checkout of the integrated OV in any cell of the VIB and for launch from either pad of the ITL system with a minimum of facility down-time and duplication of equipment. The OV AGE to be utilized at the Integrating Contractor's facility shall be functionally identical to the AGE utilized at the ITL. Provisions for OV AGE self-check and verification shall be provided.

3.3.1.2.8 On-Orbit Monitoring and Checkout

Both ground telemetry data and in-flight monitoring panels shall be utilized for on-orbit monitoring and checkout. The parameters requiring checkout and the frequency of performing monitoring functions shall be specified for each orbiting vehicle subsystem. Orbiting vehicle checkout shall be performed prior to activation or initiation of any new phase of the mission, and during the first few orbits, to establish performance parameters of each subsystem. Functions shall be visually and audibly presented for critical subsystem malfunctions.

3.3.1.2.9 On-Orbit Maintenance

Design for maintainability shall be incorporated for those components or system elements where tradeoff studies show that crew safety, mission completion, and/or design adequacy will be best improved by the provision of a maintenance capability. Where design for ground maintainability, which includes accessibility and ease of removal and replacement of selected modules or components, does not degrade in-flight capabilities, it shall be incorporated into the design. Maintenance shall normally be limited to the interior of the Laboratory or Gemini B.

3.3.1.2.10 Rendezvous and Docking Missions - Orbiting Vehicle

3.3.1.2.10.1 Payload Allocation

3.3.1.2.10.1.1 The minimum experimental payload for the target vehicle shall be 3000 pounds.

3.3.1.2.10.1.2 The maximum experimental payload in the chase vehicle shall be provided which will not compromise the rendezvous mission.

3.3.1.2.10.2 Rendezvous Operations Requirements

3.3.1.2.10.2.1 Pre-Docking

3.3.1.2.10.2.1.1 The Gemini B rendezvous radar, computer, and displays shall provide the gross rendezvous guidance and control capability.

3.3.1.2.10.2.1.2 Sufficient fuel to permit maneuvers of approximately 500 fps shall be provided in the transtage system of the chase vehicle.

3.3.1.2.10.2.1.3 A velocity of approximately 50 fps shall be provided in the chase vehicle OAMS to permit terminal rendezvous and final docking.

3.3.1.2.10.2.2. Post-Docking

3.3.1.2.10.2.2.1 The environmental control and life support system of the target and chase vehicles shall operate as independent systems. It shall be possible to transfer environmental replenishment gases from one vehicle to the other. It shall be possible to transfer food and water between the two vehicles.

3.3.1.2.10.2.2.2 After docking, the electrical power systems of the two vehicles shall be joined to permit power to be shared in a reasonable manner between the two vehicles.

3.3.1.2.10.2.2.3 The OAMS of either the chaser or the target shall operate the completely docked configuration.

3.3.1.2.10.2.2.4 The Laboratory communication systems shall be operable independently, but not simultaneously.

3.3.1.2.11 Laboratory Requirements

3.3.1.2.11.1 The Laboratory shall provide structural, electro/mechanical, and space for the fitting of the rendezvous mission equipment.

3.3.1.2.11.2 The target vehicle shall contain: a crew transfer tunnel assembly which connects the vehicle pressurized compartment to a mating face on the docking plane between the target and chase vehicles, a crew access hatch to be installed on the pressure compartment side of the tunnel, a compatible docking mechanism assembly located at the aft end which is exposed for operation following transtage ejection, and an umbilical assembly capable of effecting electrical power, signal flow, and some fluid transfer between docked vehicles.

3.3.1.2.11.3 The chase vehicle structure shall contain: a crew transfer tunnel assembly which connects the vehicle pressurized compartment to the mating face of the target vehicle at the docking plane, a crew access hatch to be installed on the pressure compartment side of the tunnel, a compatible docking mechanism assembly located at the aft end which is exposed for operation following transtage ejection, some additional electrical power system capability and tankage required for 60 day operation, and an umbilical assembly capable of effecting electrical power, signal flow, and gas transfer between the docked vehicles.

3.3.1.2.11.4 The target vehicle, (including subsystems), and the target experimental payload shall be qualified for a minimum of 60 days.

3.3. .2. .5 The chaser vehicle (including subsystems) and the chaser experimental payload shall be qualified for a minimum of 45 days.

3.3.1.2.11.6 The target vehicle shall incorporate radar transponder compatible with the Gemini B rendezvous radar.

3.3.1.2.11.7 Power Supply

The power supply shall have the capability of an in-space shut-down after completion of the launch, rendezvous, and docking mission phases. It shall be capable of an in-space start after 15 days of on-orbit storage in the shut-down mode.

3.3.1.2.12 Gemini B Requirements

3.3.1.2.12.1 The Gemini B shall be capable of storage on-orbit for 45 days.

3.3.1.2.13 Transtage Requirements

Provision shall be made for full control of the transtage main propulsion unit from the Gemini B.

3.3.2 Laboratory Vehicle

3.3.2 Laboratory Vehicle System Segment

The Laboratory Vehicle shall consist of two sections, one pressurized and one unpressurized. The pressurized section shall consist of two compartments, for environmental control, life support, attitude control, power generation, communications, vehicle status monitoring, and Experiment operation.

3.3.2.1 Allocated Performance and Design Requirements

3.3.2.1.1 Volume

3.3.2.1.1.1 Pressurized

The Laboratory Vehicle shall provide a pressurized volume of approximately 1200 cubic feet, divided into two compartments which shall permit emergency egress (extra-vehicular).

3.3.2.1.1.2 Unpressurized

The Laboratory Vehicle shall provide a usable unpressurized volume of approximately 600 cubic feet.

3.3.2.1.2 Internal Arrangement

The equipment in the Pressurized section shall be arranged to afford maximum free volume for crew mobility. Provisions for crew personal requirements shall be integrated into a specific area of the Section, and all manually-operated control functions shall be related for functional efficiency. Equipment shall be packaged for minimum crew interference and injury. The over-all internal arrangement shall provide for convenient and simple management of the vehicle by the crew.

3.3.2.1.3 Crew Stay Time

The Laboratory Vehicle shall provide for a nominal on-orbit stay time for a two-man crew of 30 days, plus a reserve time of three days.

3.3.2.1.4 Launch Re-cycle Operations

The MOL System must be capable of re-cycle following a postponed launch so as to coincide with Titan IIIC requirements.

3.3.2.1.5 Effectiveness

Data shall be furnished to support a detailed apportionment of effectiveness to the Laboratory Vehicle Segment. A plan shall be developed to show how substantial compliance of this effectiveness allocation will be demonstrated prior to acceptance and how actual compliance to this effectiveness allocation is judged during each mission.

3.3.2.2 Peculiar Performance and Design Requirements

3.3.2.2.1 On-orbit Maintenance

Critical elements of the Laboratory shall be designed and arranged to facilitate on-orbit maintenance and repair operations.

3.3.2.2.2 On-orbit Technical Data

Technical data on each of the Orbiting Vehicle segments and their subsystems as required by the Flight Crew in the performance of their operational and maintenance functions shall be provided in a convenient and easily accessible form.

3.3.2.2.3 Docking Provisions

The external arrangement shall be such that docking to at least one end of the Laboratory shall be possible.

3.3.2.2.4 Outgassing and Venting

The Laboratory shall be designed so that neither normal venting nor normal leakage of the consumable stores shall impinge on the Transtage.

3.3.2.2.5 Communication and Data Handling Requirements

3.3.2.2.5.1 Command System

3.3.2.2.5.1.1 Scope

The ground-to-vehicle command link is required to transmit information which will control certain vehicle equipments or up-date subsystems such as the guidance subsystem or an on-board computer. A prime concern is that the command sent is received and translated into the proper command with maximum reliability and minimum error.

3.3.2.2.5.1.2 System Description

3.3.2.2.5.1.2.1 General

The MOL Command System shall consist of the ground equipment for sending the command, and the vehicle equipment for receiving and distributing the command. The command system will be from ground to vehicle (one way).

3.3.2.2.5.1.2.2 Receiving

Multiple receivers operating continuously in parallel will receive the RF signal from the antenna system interface. Each receiver will detect the carrier modulation information and provide this as an audio output to the decoder.

3.3.2.2.5.1.2.3 Decoder Type

The command decoder shall be of the digital type.

3.3.2.2.5.1.2.4 Bit Rate

The command system shall accommodate an information bit rate of 200 per second minimum.

3.3.2.2.5.1.2.5 Command Capacity

The basic capability for the laboratory vehicle shall be: one (1) Vehicle Address, one (1) Real Time System Address, and four (4) Stored Program System Addresses. Consideration should be given to expansion of Real Time System Addresses and Stored Program Addresses.

3.3.2.2.5.1.2.6 Number of RTC Channels

A minimum of 32 RTC output channels shall be provided.

3.3.2.2.5.1.2.7 Error Probability

The probability of the decoder accepting an invalid message shall be less than 1×10^{-6}. The probability of rejecting a valid message shall be less than 1×10^{-3}. Error detection codes may be considered as a means of trading RF bandwidths for lower probability of error.

3.3.2.2.5.1.2.8 Message Verification

At the completion of a valid command sequence, a verification signal shall be sent to the telemetry data link.

3.3.2.2.5.1.2.9 Invalid Message Reset

Detection of an invalid command/message shall cause the decoder to reset and await the repeated or reset command.

3.3.2.2.5.1.2.10 Stored Program Command (SPC) Transfer

Decoded SPC's will be stored in appropriate circuits and a ready pulse sent to the addressed system. Message transfer is accomplished on receipt of clock pulses to the decoder, reading out the message in the order received. New data will be inhibited until transfer of data or reset of the decoder. The decoder shall be reset after transfer of data or after an appropriate time interval has elapsed following message storage.

3.3.2.2.5.1.2.11 Power

Power leads shall be isolated from case ground. No false command execution outputs shall result from out-of-tolerance receiver operation, over-or-under voltage, or voltage transient conditions.

3.3.2.2.5.2 Data Acquisition System

3.3.2.2.5.2.1 Scope

Data acquisition is part of the total communications and data handling system and must interface with voice transmission, command verification, and intercommunication requirements.

3.3.2.2.5.2.2 General

The Data Acquisition Subsystem shall:

1. Accept electrical signals from the flight crew and Experiments Information System.

2. Provide equipment for signal conditioning, coding and multiplexing the instrumentation signals for telemetry and recording.

3. Provides tape recorders/reproducing equipment.

4. Provide a video system for support of vehicle status reporting.

3.3.2.2.5.2.3 System Description

3.3.2.2.5.2.3.1 General

The major elements of the Data Acquisition System are the PCM telemeter, a large capacity magnetic tape recorder(s), and a wideband data system.

The same basic equipments shall be used for both manned and unmanned flights. VHF FM/FM telemetry may be used to accommodate high frequency vibration and similar requirements.

3.3.2.2.5.2.3.2 PCM Telemetry

The Laboratory Vehicle telemetry system shall be as separate and operationally independent of Gemini B spacecraft telemetry as possible consistent with the requirement for the capability of monitoring and transmitting critical Gemini B parameters remotely in the Laboratory Vehicle.

The PCM Telemetry must accept a variable mix of analog, digital, and discrete data inputs. Depending upon the particular flight mission and the mission phase, telemetry demands may vary. The system shall be sized for 350 input channels maximum and 64 channels minimum. The PCM telemetry shall allow for expansion of the number of channel inputs to 600-700 without major re-design. Analog inputs shall be both high level (0-5 watts) and low level (0-20 millivolts, approximately). The design must also provide for selection and format combination of a wide range of sampling rates. The system shall be capable of operating at a transmission rate of 51.2 kilobits/sec minimum. The PCM format shall be compatible with Gemini PCM ground station decommutation and data handling equipment.

An important aspect of the PCM telemetry system design is control integration with a compatible magnetic tape recorder(s). Continuous recording of a sub-frame(s) of vehicle and crew status data at a rate of approximately 5 kilobits/sec is required, which will be transmitted later at a high rate to primary MOL ground stations. Similarly and normally simultaneously, capability must be provided for recording of a sub-frame(s) of limited special vehicle and experimental data. Telemetry dump of the two sets of recorded data shall be independent. Channel inputs from both data sets shall be available for transmission via the Real Time Telemetry.

3.3.2.2.5.2.3.3 Magnetic Recording Equipment

3.3.2.2.5.2.3.3.1 Digital Recording

Vehicle and crew status data will be recorded on magnetic tape whenever the vehicle is out of range of an appropriate ground receiving station. High speed playback of the recorded data shall be provided upon receipt of a ground command, programmed signal, or decision by the crew. The tape recorder shall be sized to handle a data rate of approximately 5 kilobits status data and 5 kilobits other data for a duration of at least three hours. Playback will be based upon 100 minutes of telemetry dump per day.

It is anticipated that certain experiments will require data storage capability at recording rates independent of telemetry.

3.3.2.2.5.2.3.3.2 Video Recording

The capability for wide band recording of video data up to approximately 6 Mc shall be provided.

3.3.2.2.5.2.3.4 Wideband Data System

A potential requirement exists for a wideband data system capable of handling either high-speed digital data up to approximately 10 megabits per second, wideband analog transmission of TV pictures with 4 to 5 Mc video bandwidth, and 2 to 6 Mc/s bandwidth experimental data.

Some experiments may provide more than six hours of wideband data per 30-day mission. On-board editing of recorded wideband data will be required. Photographic and tape record of data is required for capsule return. RF transmission of edited data using the wideband or PCM telemetry links is required.

3.3.2.2.5.3 Data Transmission System

3.3.2.2.5.3.1 System Description

The telemetry transmitters shall consist of:

a. Real Time Transmitters
b. Standby Transmitters
c. Delayed Time Transmitters
d. Wideband Transmitters

The transmitter selected for the Laboratory Vehicle shall be compatible with the Ground Operational Support System Segment. This system shall be active prior to launch for Laboratory Vehicle checkout purposes and during ascent and orbital phases of the mission. The system shall be designed to be activated from ground command, an on-board programmer, or manually.

3.3.2.2.5.3.2 Transmitter Characteristics

The Real Time, Standby, and Delayed Time Transmitters shall operate on preassigned frequencies in the 225 to 260 mc/s VHF band and conform to IRIG performance standards. Solid-state components shall be used for all active elements.

The wideband link shall utilize direct analog wideband FM modulation of up to 5 megacycles bandwidth or binary PCM/PM of up to 10 megabits bandwidth depending on the application. The carrier frequency shall be between 2.2 to 2.3 kmc/s.

3.3.2.2.5.4 Tracking System

3.3.2.2.5.4.1 General

The Laboratory Vehicle Tracking System consists of the Radio Frequency Beacons required to assist the Ground Orbital Support Segment in determining vehicle ephemeris data by ground tracking techniques. This system shall consist of a transponder radar-type beacon compatible with the tracking radars located at the designated global tracking sites and a CW type beacon to aid the ground in vehicle acquisition. This system shall be activated by ground command, an on-board programmer, or manually, and will normally be used only on-orbit when tracking is required.

The radar transponder beacon shall operate on C-band and shall be compatible with the FPS-16 and FPQ-6 ground tracking radars. The VHF acquisition beacon shall operate between 215 to 260 Mc.

3.3.2.2.5.5 Voice System

3.3.2.2.5.5.1 Requirements

The voice communications subsystem must provide two-way communications between ground and crew and intercommunication between the flight crew during laboratory and transfer operations.

3.3.2.2.5.5.2 Equipment

The laboratory communications equipment shall be compatible with the Gemini B voice communication equipment.

3.3.2.2.5.5.2.1 Voice Control Center (VCC)

The VCC consists of both a HF and VHF voice network and a common control panel. The two networks shall be capable of operating simultaneously during all phases of the laboratory mission. Each network has two identical audio systems. The VCC provides a distribution and control center for the voice and audio systems and shall be located in the pressurized section.

Two identical audio systems shall be provided for each crewman. The audio system shall consist of a microphone amplifier, headset amplifier, voice-operated switching circuit, and an electrical matching and switching network to provide HF/VHF voice communications and intercommunications. A speaker shall be provided in the pressurized section to retain voice contact when helmets are removed.

A common control panel shall be provided for use by the crew. The panel shall have individual mode selection switches and volume controls for each crewman. The controls for transmitter-receiver selection, squelch and keying shall be common to the crew.

3.3.2.2.5.5.2.2 Remote Control Panels

The remote control panels shall be similar to the control panel, but located at points remote from the VCC. The remote control panel shall be electrically connected to the VCC and have the capability of permitting control of the voice networks from the remote positions.

3.3.2.2.5.5.2.3 HF and VHF Voice Transmitter-Receivers

The HF and VHF voice transmitter-receivers shall each consist of an AM voice transmitter and an AM receiver which provide two-way duplex crew-to-ground communication. Two HF and VHF transmitter-receivers shall be located in the laboratory.

3.3.2.2.5.6 Antenna System

3.3.2.2.5.6.1 General

The Laboratory Vehicle Antenna System shall consist of the components from the antenna to the Voice, Data Transmission, Command, and Tracking systems. The Antenna System will primarily be utilized when the Laboratory Vehicle is in orbit but design consideration shall be given to obtain antenna coverage during the ascent phase for the Data Transmission System.

3.3.2.2.5.6.2 General Requirements

The Antenna System shall normally be operational during the orbital phase of the mission.

The C-band, S-band (Wideband Data), and VHF (telemetry) antenna radiation pattern shall be essentially hemispherical.

The command, voice, and acquisition antennas shall provide near-spherical coverage such that their associated communications functions can be maintained with the ground during spacecraft maneuvers or non-nominal attitude conditions.

3.3.2.2.5.7 Security Subsystem

Capability shall be provided to encryptographically secure the VHF duplex voice and telemetry links. The non-secure or secure mode of operation for either service or both shall be an in-flight option. The voice encryption technique shall minimize vehicle/laboratory equipment size-weight-power and complexity. The telemetry security equipment shall be capable of operation with either the PCM telemetry or the wide band data link. The maximum data rate requirement for the secure telemetry is one megabit/sec.

3.3.2.2.6 Environmental Control and Life Support

3.3.2.2.6.1 Scope

The environmental control and life support system shall consist of the following functional areas:

a. Atmosphere Control
b. Thermal Control
c. Food Management
d. Water Management
e. Waste Management
f. Crew Hygiene

The specific requirements for each of the above subsystems are given below, together with the overall requirements for the complete system.

3.3.2.2.6.2 Atmosphere Control

3.3.2.2.6.2.1 General

The atmosphere control subsystem of the Laboratory shall maintain and control the pressure, composition, temperature and relative humidity of the atmosphere for the pressurized section. Provision shall be made for operation of the pressure suits. Means shall be provided to recharge the portable environmental control units used in extravehicular activities.

3.3.2.2.6.2.2 Atmosphere Pressure and Composition

The atmosphere control subsystem shall possess the inherent capability to operate in either a single or dual gas mode, and shall provide for such capability to be responsive to on-orbit decision. Operation of the single gas mode shall be assured by complete separability of the dilutent gas supply and control from the dual gas provisions. Pressure in the single gas mode shall be 5 psia. In the dual gas mode, pressure may be as much as 7.5 psia.

3.3.2.2.6.2.3 Pressure Control

Provisions shall be made to control the pressure and composition for either the single gas or dual gas operational modes.

3.3.2.2.6.2.3.1 Single Gas Pressure Control

A pressure regulation system shall control the total pressure for the single gas mode. Demand pressure regulation shall be provided to control the specified total pressure for pressure suit operation.

3.3.2.2.6.2.3.2 Dual Gas Pressure Control

The dual gas pressure system shall be designed to preclude flooding the pressure compartments with the dilutent gas and shall control oxygen based on total pressure.

3.3.2.2.6.2.4 Metabolic Gas Flux

The baseline caloric requirement of 2800 Kcal (based upon a 70 kg man) and composition noted in 3.3.5.2.6.2 leads to oxygen consumption of 1.87 lbs/(man)(day) and CO_2 production of 2.32 lbs./(man)(day). Variations of approximately $\pm$ 10 percent about these baseline quantitites are permitted.

3.3.2.2.6.2.5 Environmental Temperature and Humidity

The average temperature for the internal wall pressurized volume shall not significantly exceed the internal ambient atmosphere temperatures, nor be less than atmosphere dew point. Operating temperature for the vehicle atmosphere shall be $70^{\circ} \pm 5^{\circ}$F. Vehicle atmosphere humidity shall fall within the range of $50 \pm 10\%$. The specified limits shall be met under the worst combination of vehicle orientation, crew operational mode, atmosphere operational mode and equipment operation.

3.3.2.2.6.2.6 Atmospheric Storage Requirements

The atmospheric storage shall provide for the following requirements:

a. Oxygen to provide for crew metabolic requirements during Laboratory pressurized section occupancy, for Gemini B reactivation, and for extravehicular activities.

b. Oxygen to provide for leakage make-up for the Gemini B.

c. Oxygen and dilutent to provide for leakage make-up of the Laboratory pressurized section, one complete repressurization of the pressurized section, and a number of repressurizations of the pressurized section depending on the extravehicular experiment activity.

d. A 10% margin on oxygen and dilutent requirements, over and above those allowances made for any purge and leakage.

3.3.2.2.6.2.7 Oxygen Storage

Oxygen and dilutent storage shall be supercritical cryogenic. The storage system shall be capable of a minimum 48 hour non-vent standby time prior to launch. Design of the system shall be such that normal venting will not occur during orbital operation.

A measuring system shall provide a continuous measurement of cryogenic quantity remaining. Accuracy of measurement shall be within 2% of the full scale indication.

3.3.2.2.6.2.8 Carbon Dioxide Control

An absorber shall be used to remove carbon dioxide. A trade study shall establish whether it should be regenerable. The environmental control system shall maintain nominal CO_2 levels below 0.08 psia. The maximum permissible pressure for CO_2 shall be 0.15 psia.

3.3.2.2.6.2.9 Odor and Contaminant Control

Activated charcoal shall be utilized in series with the lithium hydroxide absorber to provide partial odor and tract gas control. A catalytic burner shall be provided for supplementary and emergency use.

Concentration limits for a preliminary set of possible contaminants shall be as specified in U.S. Navy Submarine Atmosphere Habitability Data Book, #250-649-1, Revision 1, Navy Bureau of Ships.

Positive control shall be exercised to identify contaminants, their sources, and to minimize their introduction into the laboratory atmosphere.

3.3.2.2.6.2.10 Minimum Pressure Maintenance

The oxygen for the pressurized volume shall be maintained above 3.50 psia for a minimum of 10 minutes, in the event of a cabin puncture equivalent to a 0.50 inch diameter hole. One compartment of the pressurized volume shall be capable of maintaining normal pressure in the event of a cabin puncture in the other.

3.3.2.2.6.2.11 Repressurization

Repressurization time for the complete pressurized volume shall not be minimized, but in no case shall exceed 1 hour. Repressurization time for each compartment of the pressurized volume shall be on a pro rata basis. Provision shall be made for the rapid dumping of the atmosphere in either compartment.

3.3.2.2.6.3 Thermal Control

3.3.2.2.6.3.1 General

The thermal control subsystem of the LV shall provide for heat transfer from the vehicle interior to the heat sink devices. Heat transfer shall be effected by means of air-to-liquid heat exchangers and cold plates, utilized in combination with a circulating heat transport fluid loop. Heat sink devices shall consist of a space radiator and water evaporator.

3.3.2.2.6.3.2 Space Radiator

The space radiator shall form part of the external vehicle surface and shall meet the meteoroid criteria. The space radiator shall be designed and controlled to avoid freezing of the transport fluid under all operational conditions, including Laboratory Vehicle pre-activation.

3.3.2.2.6.3.3 Water Evaporator

The fuel cell excess water and the collected atmospheric condensate shall be utilized with the water evaporator. The water evaporator shall provide for supplementary and emergency cooling on-orbit, and during the launch environment. This technique shall be used only when the expulsion of such material is not deleterious to the function of sensors located on the external surface of the Orbiting Vehicle. Consideration shall be given to minimizing disturbances of vehicle attitude due to the use of the water evaporator.

3.3.2.2.6.3.4 Vehicle Orientation

The thermal control system shall be capable of maintaining required temperature limits, with the vehicle in any orientation, for approximately one hour.

3.3.2.2.6.3.5 Wall Temperature

The temperature for the internal wall of the pressurized volume shall not exceed 120°F nor be less than atmosphere dew point when subject to the worst combination of vehicle orientation, crew operational mode, atmosphere operational mode and equipment operation.

3.3.2.2.6.4 Food Management

The food and feeding system shall be designed to maintain optimal nutrition and performance of the flight crew and shall emphasize simiplicity, palatability and minimum interference with on-orbit duties. Food storage shall be at nominal cabin temperature and shall be such as to protect the food supply from chemical and microbial spoilage. Surplus food residues and containers shall be collected and processed in the waste management system.

3.3.2.2.6.5 Water Management

Water management shall be provided for the efficient utilization of the water consumed and produced within the Laboratory Vehicle. The on-board source of potable water shall be the fuel cell electrical power system. Crew metabolic requirements shall be stored in a potable water tank. The excess fuel water shall be stored in a waste water tank, in which shall also be stored the collected atmospheric condensate. Waste water shall be utilized for thermal control purposes. The potable water shall be made available to the pressurized section at temperatures of 155°F and 55°F. Potability measurement shall be provided.

3.3.2.2.6.6 Waste Management

Waste management shall be provided for the collection, transfer and storage of all crew and cabin wastes. The crew waste collection devices shall be convenient and comfortable to use, and shall require minimum maintenance to avoid unsanitary conditions. The pressurized section atmosphere shall not be contaminated by the use of these devices and any atmosphere used in the crew waste collection process shall be decontaminated before return. Containers impermeable to solids, liquids, gases and bacteria shall be provided for waste storage. Proper purification control of collected waste shall be effected.

Provisions shall be made for the management of daily urine volumes of 1800 $\pm$ 700 ml per man to be collected as a total daily specimen. This volume (less a 50 ml aliquot for physiological tests) is to be delivered to and managed by the urine disposal system.

The daily fecal volumes of approximately 30 $\pm$ 30 ml shall be collected in a special bag for subsequent lyophilization.

3.3.2.2.6.7 Crew Hygiene

Solid debris, such as hair, nails, scuffings, food particles, etc., shall be trapped and processed into the waste management system.

3.3.2.2.6.8 Overall System Requirements

3.3.2.2.6.8.1 Prelaunch Operation

During the prelaunch phase, the system shall have checkout capability to verify required performance and operational parameters. Atmospheric conditioning of the pressurized volume shall be effected by purging and filling with the specified atmospheric composition at in excess of sea-level pressure. Ground cooling of the Laboratory shall be provided.

3.3.2.2.6.8.2 Launch Operation

During the launch phase, the system shall have the capability to furnish operational status determination via telemetry. The atmosphere of the pressurized section shall be relieved during ascent to maintain a pressure differential comparable to the specified orbital requirement. Cooling of the Laboratory Vehicle during ascent shall be provided by a water evaporator.

3.3.2.2.6.8.3 Monitoring and Control

Monitoring of the system shall be provided to furnish performance status and diagnostic data for on-orbit and ground control requirements. Control of the system shall be on-board.

3.3.2.2.6.8.4 Safety Features

All valves that connect the interior of the pressurized section to the space environment shall have manual closures and/or overides. Filters shall be provided to protect critical components such as pumps and compressors. Relief shall be provided to prevent overpressurization. Flow limiting devices shall be provided to prevent excessive use of gas supplies.

3.3.2.2.7 Orbital Attitude Maneuvering System (OAMS)

3.3.2.2.7.1 General

This system shall control the vehicle attitude and provide translational velocity change capability while on-orbit. An on-off reaction jet attitude control system located in the Laboratory shall control the vehicle attitude and generate small velocity changes. The transtage main propulsion system shall be utilized, in conjunction with the control electronics located in the Laboratory, for large velocity changes.

3.3.2.2.7.1.1 Operating Requirements

The control system shall be capable of continuous operation in any of the operating modes specified below for the entire mission. The translational modes must be available at any time during the mission.

3.3.2.2.7.1.2 Limit Cycle Dead Band

A fine limit cycle dead band of $\pm$ 0.2 degree and a coarse dead-band of $\pm$ 3.0 degree shall be provided.

3.3.2.2.7.1.3 Body Rates

Body axis rates shall be maintained below 0.01 degree/second during limit cycle operation. Vehicle attitude accuracy and translational requirements are presented below.

3.3.2.2.7.2 Operating Modes

The following operating modes are required to provide automatic and manual attitude hold and maneuver capabilities, and translational acceleration to meet the MOL mission requirements.

3.3.2.2.7.2.1 Horizon Scan Local Vertical

In this mode the vehicle attitude shall be automatically maintained with the longitudinal axis normal to the local vertical and in the orbit plan to within 0.4 degree about the local vertical and 0.7 degree about the orbit plane.

Displays of attitude errors relative to the reference system and body axis rates shall be available.

3.3.2.2.7.2.2 Rate Stabilization

The Rate Stabilization mode shall be used for manual maneuvers and for short term attitude hold. Maneuver rates shall be available up to 5.0 deg/sec.

The displays shall provide three Euler angles, which locate the body axis coordinate system relative to the local vertical and orbit plane (or to an alternate attitude to which, the body axis reference system has been aligned). The body axis rates and attitude errors shall also be displayed. The desired Euler angles (relative to the local vertical reference system) will be inserted into the control system by the astronaut.

3.3.2.2.7.2.3 Attitude Hold

Automatic attitude hold and maneuver shall be provided in this mode. Automatic maneuver rates shall be available.

3.3.2.2.7.2.4 Minimum Impulse

This mode will be used by the astronaut to provide precise open-loop attitude control. The attitude and rate accuracy shall be limited only by the fuel consumption and the minimum rate achievable from the reaction control system.

External-visual or attitude control system displays shall be used as the attitude reference in this mode.

Display requirements are identical to those of the Rate Stabilization mode.

3.3.2.2.7.2.5 Direct Control

This mode will be used as a back-up in case of control system failures or where high maneuver rates are required. The reaction jets shall be controlled directly by the astronaut through a minimum amount of electronics to provide high reliability.

The attitude reference in this mode shall be external-visual or attitude control displays.

Display requirements are the same as those of the Rate Stabilization mode.

3.3.2.2.7.2.6 Transtage Velocity Increment

Control of the transtage main propulsion system ignition and thrust termination shall be provided. The vehicle attitude shall be controlled through the use of the transtage main engine gimbal system while thrusting, and in the Attitude Hold mode before and after thrusting. The astronaut will be required to insert initial gimbal angles and ΔV requirements into the control system.

The transtage gimbal angles and the velocity-to-be gained shall be displayed to the astronaut.

3.3.2.2.7.2.7 Transtage Ullage

The mode provides the propellant settling for the main engine in the transtage. The astronaut will control this mode through the ΔV display panel.

3.3.2.2.7.2.8 Translation Control

The reaction jet system will be required to supply small velocity changes in six direction parallel to the vehicle control axes. Acceleration greater than 0.05 ft/sec^2 shall be required. Translational control shall be manual and the Attitude Hold mode will be utilized to maintain vehicle attitude.

3.3.2.2.7.3 Control Electronics

3.3.2.2.7.3.1 Reference System

This system shall contain the horizon sensors, integrating gyros, rate gyros, accelerometer, and Euler Angle Computer (EAC).

3.3.2.2.7.3.2 Displays

The displays shall include mode select, Euler angle set, deadband control, velocity control and reaction jet control panels. Euler angles, body axis rates and attitude errors shall also be displayed.

The mode select panel will allow any of the control system operating modes to be selected and indicate which mode is currently operating.

The Euler angle set panel shall permit the astronaut to insert the three Euler angles and the maneuver rate, as well as displaying the currently set valves.

Find and coarse deadband selection and the magnitude of the coarse deadband shall be controlled through the deadband control panel.

The velocity-to-be-gained shall be set in the velocity control panel, as well as the initial Transtage gimbal angles required to align the thrust vector through the vehicle center of mass.

The reaction jet control panel shall contain the malfunction detection system displays and the switching associated with the reaction jet system.

The Euler angles, body axis rates and attitude errors shall be displayed in a manner which is most efficient for the astronaut.

3.3.2.2.7.4 Propulsion System

The reaction jet propulsion subsystem consists of thrust chamber assemblies, mounted to give vehicle rotation and translation, and a propellant supply and distribution system. This subsystem responds to actuation commande from the control electronics. Redundancy shall be provided for jet or jet module failure.

3.3.2.2.7.4.1 Life

The Subsystem must be capable of a minimum of 3000 sec. operation at any time during the thirty-day on-orbit life of the orbiting vehicle system. Time periods of acceptance testing, pre-launch testing (e.g. on-pad checkout and loading) and all other durations of subsystem operation shall be considered in the total subsystem life.

3.3.2.2.7.4.2 Thermal Considerations

The subsystem design shall be consistent with requirements for temperature conditioning of the propellants and other components necessary to maintain subsystem or vehicle components within their operating temperature range.

High and low temperature strength along with thermal shock properties shall be considered in the choice of thrust chamber materials. The temperature encountered should range from space temperatures to the combustion temperature of the propellant(s).

3.3.2.2.7.4.3 Minimum Impulse Bit

The engine shall deliver a minimum impulse bit of less than 0.25 lb. sec. This minimum shall not vary by more than $\pm$0.05 lb. sec. The minimum impulse bit is defined as the area under the thrust time curve including buildup and decay transients.

3.3.2.2.7.4.4 Specific Impulse

Steady state (pulses greater than 1.0 sec.) specific impulse shall not be less than 250 seconds. Specific impulse for the minimum impulse bit shall not be less than 100 seconds. Specific impulse at small pulse widths (less than 1.0 sec) is defined as the impulse bit (lb. sec.) divided by the weight of propellant consumed per pulse (lb.).

3.3.2.2.7.4.5 Duty Cycle

The duty cycle will be composed mainly of:

a. Limit cycles which require short on periods (> 0.020 sec.)

b. Roll maneuvers which require on periods of approximately one to ten seconds at intervals of approximately sixty seconds.

c. Translation maneuvers which require on periods of approximately five to ninety seconds at intervals of approximately five to two hundred seconds.

3.3.2.2.7.4.6 Impulse Capability

The stored impulse capability of the subsystem shall be determined from the requirements. Consideration shall be given to expulsion efficiency, leakage, and off-performance operation.

3.3.2.2.7.4.7 Propellant Gaging

The subsystem shall include a method to measure and display to the astronaut the amount of propellant remaining in the subsystem.

3.3.2.2.7.4.8 Leakage and Permeation

Subsystem design shall include considerations to eliminate or minimize the leakage and/or permeation of fluid to other parts of the subsystem or to enclosed compartments, modules or sections of the Orbiting Vehicle.

3.3.2.2.7.4.9 Propellants

The propellants shall by hypergolic bipropellants which are space storable and shall be selected considering thermal environment and minimization of ignition over-pressure transients.

3.3.2.2.8 Electrical Power Supply

3.3.2.2.8.1 General Requirements

The Laboratory Vehicle Central Power System (CPS) shall provide the total laboratory subsystem power during launch and injection, lab activation, on-orbit, and emergency mission phases.

3.3.2.2.8.1.1 Type of Power Source

The generation of primary electrical power for the Lab CPS shall be accomplished with H_2-0_2 fuel cell modules arranged in parallel, with automatic and manually actuated interconnections.

3.3.2.2.8.1.2 Nominal Power

The Lab CPS shall be a nominal 28 volt dc power system utilizing established design practices for subsystem compatibility.

3.3.2.2.8.1.3 Overloads

During the 30-day on-orbit phase the Lab CPS shall accommodate transients, intermittent peaks of 3.6kw and shall remain within its performance specification. The maximum to average and maximum to minimum power ratios imposed upon the CPS are nominally 2:1 and 4:1 respectively.

3.3.2.2.8.2 Specific Requirements

3.3.2.2.8.2.1 Location

The fuel cell powerplant shall be located in the unpressurized compartment of the Laboratory Vehicle.

3.3.2.2.8.2.2 Life

The fuel cell powerplant shall have a minimum life capability of 1,000 hours and during this life shall remain within its performance specifications while providing the Laboratory CPS power requirements.

3.3.2.2.8.2.3 Fuel Cell Standby Capability

The Lab CPS shall have a minimum fuel cell 28 volt module standby capability of 40% of the modular configuration. The standby modules may be utilized from either a cold or operating status.

3.3.2.2.8.2.4 Parasitic Power

Parasitic power generated and required by the fuel cell powerplant may be delivered to the main dc bus, but it shall not be included as part of the 1.8 kw average power required to be delivered by the powerplant for the Lab CPS loads.

3.3.2.2.8.2.5 Emergency Power

Emergency battery power shall be readily available and capable of maintaining emergency load conditions of 1 kw for a duration adequate to determine criticality of malfunction, ground mission control center coordination, remedial action, or return to Gemini B.

3.3.2.2.8.2.6 Voltage

During the mission phases, and for all combinations of loading within the mission power profile, including emergencies, the powerplant shall maintain 25 - 30 volts at the bus.

3.3.2.2.8.2.7 Specific Reactant Consumption

The total quantity of reactants including purge requirements needed by the fuel cell powerplant to provide the required electrical power for the mission duration shall be no greater than 0.95 pounds per net kilowatt-hour.

3.3.2.2.8.2.8 Water Removal

The water transport system shall remove the product water from the fuel cell. The water shall be delivered to the life support interface as potable for human consumption.

3.3.2.2.8.2.9 Waste Heat

The waste heat generated by the fuel cells shall be removed by a coolant circulated through each fuel cell module. The coolant system shall be integrated with the EC/LS system and dissipate its accumulated heat through an external space radiator located on the surface of the Laboratory.

3.3.2.2.8.2.10 Power Source Failure

Power distribution from the fuel cell modules shall be designedso that the failure of any module or modules does not adversely affect the operation of the remaining modules. Switch-out of the failed modules, loading of the stand-by modules, or start up of the redundant modules shall be automatically controlled with a remote manual override capability. individual control of each module shall also allow selective grouping of any combination of fuel cell modules.

3.3.2.2.8.3 Power Control and Monitoring

Provisions shall be incorporated within the Laboratory for Monitoring and managing the CPS. Visual indications of electrical system events, conditions, outputs, and malfunctions shall be provided.

The power control unit shall provide a distribution point for the major electrical power within the Lab., a switching capability, circuit access for ground maintenance, and fault isolation and protection.

3.3.2.2.8.4 Power Conditioning

All laboratory equipment and experiments requiring power outside the characteristics of the fuel cell power plant shall provide individual power conditioning equipment operated from the main bus.

3.3.2.2.8.5 Reactant Supply System

The reactant supply shall be provided from a supercritical cryogenic storage system. A minimum of two tanks each shall be provided for the hydrogen and oxygen storage.

3.3.2.2.8.5.1 Capacity

The cryogenic storage system shall have adequate capacity to supply all of the reactants for the fuel cell power system to accomplish the 30-day on-orbit mission, plus 3 day margin, at an average net power level of 1.8kw.

3.3.2.2.8.5.2 Pressurization

The cryogenic storage system shall be capable of a minimum 48 hour non-vent standby time prior to launch. Design of the tankage system shall be such that venting will not occur during normal orbital operation. The heater duty cycle shall be minimized by utilizing excess heat from the Environmental Control System. An electrical resistance heater shall be included to provide additional heat for presurization during initial pressurization or periods of high fluid withdrawal.

3.3.2.2.8.5.3 Quantity Measurements

A quantity measuring system shall provide a continuous measurement of cryogenic quantity remaining. Accuracy of measurement shall be within 2 percent of the full scale indication.

3.3.2.2.8.6 Mission Phase Requirements

During the pre-launch phase the CPS shall have a check-out capability, so that performance parameters may be verified prior to launch. Performance parameters of the other Lab sub-systems are also excercised, and the CPS shall sustain their launch mode power requirements upon transfer to internal power.

During the launch and ascent phase, monitoring of the CPS shall be provided.

3.3.2.2.8.7 Laboratory Vehicle Equipment Power Requirements

3.3.2.2.8.7.1 Equipment Operating Voltage

Laboratory equipment shall give specified performance when operated with 23 - 31 volts at the equipment power terminals.

3.3.2.2.8.7.2 Under and Over-Voltage

Laboratory equipment shall withstand, without damage, voltages from 21 - 34 volts at its power terminals and shall immediately give specified performance upon return to the equipment operating voltage.

3.3.2.2.8.7.3 Transients

Laboratory equipment shall be capable of withstanding transients of $\pm$ 100 volts with respect to nominal bus voltage for durations up to 20 microseconds.

3.3.2.2.8.7.4 Electromagnetic Interference

Electromagnetic Interference (EMI) of the Laboratory Vehicle shall be minimized consistent with weight and performance constraints. The subsystems shall neither generate excessive interference, nor shall they be excessively susceptible to radiated and conducted noise.

3.3.2.2.8.7.5 Grounding

The Lab CPS shall incorporate a single point ground system, compatible grounding network with the Gemini B launch vehicle, and Experiments.

3.3.2.2.9 Structural Subsystem

3.3.2.2.9.1 Design Environment Criteria

The environmental criteria applicable to the Laboratory Vehicle structure are specified in SSD Exhibit 64-

3.3.2.2.9.2 Structural Design Criteria

The structural design criteria applicable to the Laboratory Vehicle are specified in SSD Exhibit 64-

3.3.2.2.9.3 Limit Load

Limit load is the maximum anticipated load, or combination of loads, which a structure may be expected to experience during the performance of specified missions in specified environments.

The structure shall be designed to have sufficient strength to withstand simultaneously the limit loads, applied temperature and other accompanying environmental phenomena for each design condition without experiencing excessive elastic or plastic deformation.

3.3.2.2.9.4 Factors of Safety

	Limit	Proof	Ultimate	Burst
a. Flight Loads				
Manned Payloads	1.00		1.40	
b. Non-Flight Loads				
(Other than Pressure				
Dangerous to Personnel	1.00		1.50	
Remote to Personnel	1.00		1.25	
c. Pressure Loads				
Main Propellant Tanks	1.00	*	1.40	1.40
Rocket Motor Cases	1.00	*	1.25	1.40
Pneumatic Vessels (Including Accumulators and Pressurization Bottles)	1.00	1.67	2.22	2.22
Manned Cabins	1.00	1.33	2.00	2.00

3.3.2.2.9.4 Factors of Safety (Cont'd)

	Limit	Proof	Ultimate	Burst
Hydraulic Vessels (Including Assumulators and Pressurization Bottles)	1.00	2.00	4.00	4.00
Hydraulic Vessels (Normally Under Oil Pressure Only)	1.00	1.50	2.00	2.00
Hydraulic and Pneumatic (Lines, Fittings and Hoses)	1.00	2.00	4.00	4.00
Main Propellant (Supply and Vent Components	1.00	1.50	1.88	1.88

3.3.2.2.9.5 Strength and Stiffness

3.3.2.2.9.5.1 Structural failure shall not be precipitated at loads less than ultimate.

3.3.2.2.9.5.2 The structure shall not experience deformations which impair functional performance at limit loads.

3.3.2.2.9.5.3 The structure shall not experience deformations which impair peformance of function at loads less than limits.

3.3.2.2.9.5.4 Structural deformations shall not precipitate structural failure at loads less than ultimate.

3.3.2.2.9.5.5 Flutter or other dynamic instability shall not occur on the Vehicle at any condition within the design envelope.

3.3.2.2.9.5.6 Structural materials utilized in the pressurized areas shall possess demonstrated crack resistance under the specified environments and operations, and shall be of conventional types.

3.3.2.2.10 Crew Accommodations

3.3.2.2.10.1 Furnishings and Equipment

The pressurized section shall provide furnishings and equipments in functional groups for maximum efficiency and crew safety.

3.3.2.2.10.2 Restraints

Restraint devices shall be incorporated to facilitate safe and efficient crew movement and performance of tasks.

3.3.2.2.10.3 Safety Devices

Safety guards, safety shields, and locking devices shall be provided on or over appropriate rotating machinery, controls, and display faces.

The interior of the laboratory shall be designed to contain collision protection on such furnishings and equipments where injury to crew could result from motion of the laboratory or crew activity.

3.3.2.2.10.4 Crew Transfer Provisions

3.3.2.2.10.4.1 Normal Transfer

The Laboratory Vehicle shall provide umbilical connections required for life support and communications under normal crew transfer operations. Such provisions shall be located in the immediate vicinity of ingress to the laboratory pressurized compartment.

3.3.2.2.10.4.2 Emergencies

Provisions shall be made for the storage of emergency transfer equipment, to be located adjacent to an extravehicular hatch. Such provisions shall consist of portable emergency oxygen packs, extravehicular restraint devices, and portable lamps.

3.3.2.2.10.5 Hatches

Pressure tight hatches, capable of actuation from either side, shall be provided at all ingress/egress portholes in the laboratory pressurized compartments.

3.3.2.2.10.6 Windows

Viewing windows, as appropriate, shall be provided in the laboratory pressurized compartment to permit earth and star field viewing by the crew. Provisions shall be included for manual control of solar radiation and direct light emission through window areas.

3.3.2.2.10.7 Gravity Countermeasures

The MOL system configuration shall have the capability, without major changes, of providing for local countermeasures to the effects of zero gravity. These provisions shall include sufficient space for possible installation of an internal centrifuge.

3.3.2.2.10.8 Experiment Provisions

Installation space shall be provided in the Laboratory Vehicle which is compatible with the Experiment equipment requirements. The space allocated shall permit installation of support brackets, signal and power conductors, and coolant lines to any set of Experiment equipments, as required.

3.3.2.2.10.9 Laboratory Peculiar AGE

The Lab Segment peculiar AGE shall consist of Operating Ground Equipment and Maintenance Ground Equipment designed to support all Lab Segment operations from after final acceptance at the contractor's facility through launch. This Laboratory peculiar equipment shall be designed for operability, maintainability and reliability per the requirements generated by this specification. Maximum utilization shall be made of existing equipment. The Laboratory Segment peculiar Operating Ground Equipment at the Launch Pad shall be designed for inclusion in one GFE railroad adapted 40' x 10' van, to be shared with the Experiment Segments Operating Ground Equipment. Payload Control Room No. 2 in the VIB shall be utilized jointly by the Laboratory Segment Operating Ground Equipment, and the Experiment Segments Operating Ground Equipment. Data transmitted between the Laboratory and its Operating Ground Equipment, shall consist of signals compatible with the Data Transmission System of the ITL System. The Laboratory AGE utilized at ETR shall be functionally identical to the AGE utilized during factory acceptance of the Laboratory.

3.3.2.2.10.9.1 Performance

The Laboratory Segment peculiar AGE shall include all the equipment necessary to transport, handle, store, verify, calibrate, checkout, monitor, record, and service the Laboratory Vehicle. This AGE shall be capable of providing a means of verifying the proper operation of the Laboratory Vehicle and identifying areas of failure or operation outside the prescribed limits. This AGE shall be capable of integration with the complete MOL system AGE at CKAFS. Fault isolation equipment at the launch site will be limited to that equipment necessary to isolate faults to the black box or replaceable component level. Detailed fault isolation and failure analysis within black boxes and/or components will be conducted at contractor/subcontractor plants and/or at AF depots.

3.3.3 Gemini B

3.3.3 Gemini B System Segment

The Gemini B is a modified NASA Gemini spacecraft consisting of a re-entry module, an adapter section, a crew escape system and the supporting ground system. The spacecraft shall be capable of performing 30 day earth orbital flights as an integral part of the orbiting vehicle and shall be capable of controlled earth orbit, re-entry and water landing as an autonomous spacecraft. The spacecraft shall be dependent on other system segments for performance of certain functions; the extent of this dependency upon other segments shall be as specified herein and in other appropriate documentation.

3.3.3.1 Allocated Performance and Design Requirements

3.3.3.1.1 Weights

Nominal design launch weight of the Gemini B, including the complete re-entry module, the adapter section, escape system, crew, and flight equipment shall be 6300 pounds. This weight is distributed as follows:

Re-entry Module	4750 pounds
Adapter Section	1550 pounds

A more detailed presentation of weight ranges associated with each phase of flight, to be used for analysis purposes, is given in the appropriate supporting documents.

3.3.3.1.2 Electrical Power

Electrical power for the Gemini B during the phases of flight of launch, on-orbit prior to crew transfer to the Laboratory Vehicle, post separation, de-orbit and re-entry shall be provided by Gemini B systems. The Laboratory Vehicle shall supply the power for the on-orbit storage phase and the power prior to launch shall be supplied by AGE.

3.3.3.1.3 Effectiveness

Data shall be furnished to support a detailed apportionment of effectiveness to the Gemini B System Segment. A plan shall be developed to show how substantial compliance of this effectiveness allocation will be demonstrated prior to acceptance and how actual compliance to this effectiveness allocation is judged during each mission.

3.3.3.1.4 Crew Stay Time

The maximum total time the crew will be required to stay in the Gemini B is 60 hours. This maximum crew stay time is allocated to the mission phases as follows:

Pre-launch	5 hours
Launch, until crew transfer	8 hours
On-orbit, pre-separation	9 hours
On-orbit, post-separation (includes loiter time)	14 hours
Re-entry	1 hour
Post-landing	36 hours

3.3.3.1.5 Leak Rate

The Gemini B re-entry module leak rate, including the crew transfer tunnel, shall not exceed 2.5 lbs/day. These leak rates are for a pressurization of 5.0 psi under orbit environmental conditions.

3.3.3.2 Peculiar Performance and Design Requirements

3.3.3.2.1 Spacecraft Requirements

3.3.3.2.1.1 General

The design of the Gemini B shall be based on a service life of one mission.

3.3.3.2.1.2 Re-entry Module

The Gemini B re-entry module shall consist of a modified Gemini A re-entry module. This module shall provide protection for the crew from the environment of launch, space, re-entry and landing. Provisions shall be included for mounting and protecting the equipment necessary for meeting the requirements of the subsequent paragraphs. Capability shall be provided for return of experimental data.

3.3.3.2.1.3 Adapter Section

The conical adapter section shall consist of the structure required to transition from the re-entry module to the 120" diameter Laboratory Vehicle. The crew transfer tunnel shall be included as part of the adapter section. The tunnel attachment to the laboratory shall be a rigid seal. The Gemini B shall have the capability of separating from the Laboratory at the Laboratory/Gemini B retrograde adapter separation plane. The Gemini B shall also have the capability of separating the re-entry module from the retrograde adapter section.

3.3.3.2.1.4 Strength and Rigidity

The structure of the Gemini B shall be capable of sustaining all loads and environments imposed during the MOL mission of ground handling and transportation, pre-launch, launch, on-orbit, retrograde, re-entry, landing and recovery.

3.3.3.2.1.5 Aerothermodynamic

The re-entry module center of gravity shall be located so that the re-entry module trims at an angle of attack capable of producing more than 40 nautical miles crossrange and 400 n. mi. along the ground track. The maximum deceleration experienced by the crew during normal guided re-entry shall not exceed 10 g.

3.3.3.2.2 Guidance and Control Requirements

3.3.3.2.2.1 General

The Gemini B shall have the capability for re-entry control recovery of ± 8 nautical miles (3 dispersions) at 70,000 feet altitude. This control shall be obtained by employing re-entry module atmospheric maneuvers.

3.3.3.2.2.2 Re-entry Guidance and Control

A guidance capability shall be included to provide spacecraft attitude reference in all attitudes about three axes, control touchdown points for normal and aborted missions, maneuver control logic required for re-entry touchdown control, and control function outputs to applicable systems. An attitude control capability consistent with the guidance accuracy requirement shall be provided. This capability shall provide automatic attitude and attitude rate control signals, automatic response to manually initiated inputs for attitude and the means for manual control of spacecraft attitude propulsion systems. Provisions shall be made for visual horizon reference during retrofire for all de-boost design altitudes by at least one crew member.

3.3.3.2.2.3 On-orbit Post Separation Control

The capability shall be provided for both manual and automatic control of spacecraft attitude during on-orbit periods following separation from the Laboratory Vehicle.

3.3.3.2.3 Instrumentation Requirements

The Gemini B shall have the capability to sense, condition and provide data appropriate to the particular flight phase. The instrumentation of the Gemini B shall provide capability to monitor critical spacecraft and launch vehicle events, critical launch vehicle parameters, spacecraft system status and certain critical laboratory status items during all mission phases.

3.3.3.2.4 Environmental Control Requirements

3.3.3.2.4.1 General

The Gemini B shall provide the environmental control and life support for the crew members until crew transfer. The Gemini B shall again provide environmental control and life support for the crew members after the Gemini B is re-activated for mission termination.

3.3.3.2.4.2 Cabin Environmental Control

The capability shall be provided for complete environmental life support while the spacecraft is manned. The crew pressure suits shall be considered as an emergency backup capability for this phase. A potable water supply and a method for handling urine shall be provided. The cabin temperature shall be maintained within a range of 60°F. to 95°F. while occupied on-orbit; during re-entry, the temperature shall not exceed 200°F.

3.3.3.2.4.3 Suit Environmental Control

Metabolic oxygen, pressurization and ventilation shall be provided for the pressure suits. Individual oxygen supplies shall be provided for each crew member for emergency use during high altitude seat ejection. The capability shall be provided to allow the crew to perform the necessary operational functions in a closed loop suit with the cabin either pressurized or depressurized.

3.3.3.2.4.4 Equipment Environmental Control

Provisions shall be included for maintaining the Gemini B equipment within the required temperature range for both operating conditions and on-orbit dormant storage conditions.

3.3.3.2.4.5 Crew Transfer Environmental Control

The Gemini B ECS will supply ventilation, breathing oxygen, and emergency pressurization (if required) during transfer to the Laboratory. This same function shall be performed by the Laboratory ECS during transfer to the Gemini B.

3.3.3.2.5 Propulsion Requirements

3.3.3.2.5.1 General

Sufficient propulsive capability shall be provided to permit attitude control of the Gemini B, separation of the Gemini B from the Laboratory Vehicle and application of de-orbit velocity increment.

3.3.3.2.5.2 Re-entry Control

The re-entry control system shall provide control required to achieve the required touch down accuracy, structural/temperature constraints and crew load factor constraints.

3.3.3.2.5.3 On-Orbit Post Separation Control

Propulsive capability shall be provided for control of the attitude and attitude rates of the Gemini B for on-orbit loiter up to 14 hours after separation from the Laboratory Vehicle prior to de-orbit.

3.3.3.2.5.4 Launch Abort Separation

Abort modes using the Gemini re-entry module shall use the retrograde propulsion to produce separation. In other modes the ejection seats shall be used. Provision for a shut-down signal to the Titan III from Gemini B shall be provided.

3.3.3.2.5.5 On-Orbit Separation

A propulsive capability shall be provided to separate the Gemini B from the Laboratory Vehicle on-orbit. The separation propulsion shall not impose detrimental effects on the Laboratory Vehicle. Sufficient separation distance shall be developed to preclude imposing detrimental effects on the Laboratory Vehicle by the operation of the retrograde motors. The Gemini B shall be capable of discarding the transtage when desired.

3.3.3.2.5.6 Retrograde

The capability shall be provided of imparting the necessary retrograde impulse to the re-entry module for re-entry from 16- n. mi. design orbit altitudes. The retrograde impulse timing, orientation and magnitude shall provide re-entry conditions which, considering all dispersions and re-entry bank angle command schedules, will not produce structural temperatures greater than the design values at any time during re-entry or at water impact.

3.3.3.2.6 Electrical Power Requirements

3.3.3.2.6.1 General

The capability for supplying Gemini B electrical power for the pre-launch, launch, pre-laboratory activation on-orbit, post-separation, de-orbit, re-entry and post landing phases shall be provided. Provisions shall be made for utilization of ground power prior to pre-launch and for all ground checkout. Provisions shall be made for the Laboratory Vehicle to supply power on orbit during Gemini B dormancy.

3.3.3.2.6.2 Electrical Power Supply

Electrical power supply shall consist of a D. C. power source. A. C. power, as required by specific systems, shall be supplied by inverters and regulators considered a part of the utilizing system. There shall be redundancy in all power sources. Re-entry power sources must be active during the launch phase for abort purposes. Independent and redundant power sources shall be provided for pyrotechnic circuits.

3.3.3.2.6.3 Electrical Power Distribution

A capability for distributing the electrical power from the power supply to the using system shall be provided. The spacecraft structure shall not be used as an electrical current path. The system negative shall be grounded at one point only in the spacecraft. A compatible grounding network between Gemini B, Laboratory, and Titan IIIC shall be designed to maintain this concept.

3.3.3.2.6.4 EMI

Electromagnetic Interference (EMI) of the Gemini B shall be minimized consistent with weight and performance constraints. The subsystems shall neither generate excessive interference, nor shall they be excessively susceptible to radiated and conducted noise.

3.3.3.2.7 Time Reference Requirements

3.3.3.2.7.1 Basic Time Reference

An electronic capability shall be provided to furnish accurate accounting of elapsed time or time-to-go for the following types of events: during ascent; time-to-go retrofire; time-to-go to start of re-entry; etc. A reset capability shall be included.

3.3.3.2.7.2 Event Timer

A capability for providing short-term timing of functions shall be provided.

3.3.3.2.8 Pyrotechnic Requirements

3.3.3.2.8.1 General

The Gemini B shall have the capability for actuating, severing, separating, deploying, etc., by utilizing pyrotechnic devices.

3.3.3.2.8.2 Safety

Actuation of pyrotechnic devices shall not endanger the crew or damage adjacent systems. Installation of pyrotechnic devices shall be so designed that the hazard to launch crews is minimized during assembly and checkout of the Gemini B.

3.3.3.2.8.3 Reliability

All functions requiring the use of pyrotechnic devices shall utilize either redundant devices or have an alternate mode of operation.

3.3.3.2.9 Landing Requirements

3.3.3.2.9.1 General

The Gemini B re-entry module shall have the capability of return to earth's surface by deployment of recovery System after satisfactory retrograde and re-entry. Initiation of the landing system shall be manual with automatic backup. The capability shall be provided for seat ejection to permit emergency landing.

3.3.3.2.9.2 Descent and Impact

The rate of descent of the re-entry module shall be 30 ± 2 fps at sea level for a weight of 4400 pounds.

The water and sea state impact loads on the re-entry module shall not exceed the deceleration levels in the following directions:

Forward	30 g
Aft	30 g
Up	11 g
Down	15 g
Left	11 g
Right	11 g

3.3.3.2.10 Post Landing and Survival Requirements

3.3.3.2.10.1 Location

The means for location of the re-entry module and the crew members after landing shall be provided. This location and capability shall include visual devices for both day and night operation as well as HF and UHF capability. Location aids in the re-entry module shall be operable for a post landing period of 36 hours.

3.3.3.2.10.2 Crew Safety

Sufficient food and potable water shall be provided for a post landing period of 48 hours. Equipment to permit crew survival outside the re-entry module either on water or land shall be provided.

3.3.3.2.11 Back-up Crew Transfer Requirements

Back-up transfer shall be extravehicular via the regular Gemini B hatches. These hatches shall remain closed after transfer of the last crewman. Provisions shall be made for opening and closing the hatches from inside and outside Gemini B while in a pressurized suit.

3.3.3.2.12 Crew Equipment and Display Requirements

3.3.3.2.12.1 General

The design and arrangement of the crew station shall be based on seating two crew members of the 15th through the 75th percentile man size as defined in WADC TR 52-321 "Anthropometry of Flying Personnel, 1950", dated September 1954, in a side by side arrangement. The crew members shall be clothed in pressure suits.

3.3.3.2.12.2 Displays and Controls

Provisions shall be included to allow the crew members to monitor and manually control desired functions; these provisions shall permit the crew members to be in either a pressurized or unpressurized suit.

3.3.3.2.12.3 Crew Seating

Provisions shall be included for seating of the two crew members in the proper position and with adequate restraint to minimize the effect of launch and re-entry acceleration forces. These seat provisions shall include the capability of ejecting the crew members from the re-entry module for certain modes of launch phase abort and for emergency landing.

3.3.3.2.13 Communications and Command Requirements

3.3.3.2.13.1 General

A capability for communication and command compatible with the Test Operations Support System Segment shall be provided. This shall include the capability for providing two way voice communications, providing spacecraft to ground telemetry, aiding tracking and recovery, accepting digital commands from the ground and providing intercommunication between the crew at all times. These functions shall be supplied only when the Gemini B is active.

3.3.3.2.13.2 Voice Communications

Both UHF and HF voice communication shall be provided. A capability for post landing operation as a primary voice communication mode and as a backup recovery aid shall be provided.

3.3.3.2.13.3 A capability for spacecraft to ground real time telemetry shall be provided. This telemetry capability shall be continuously available during launch and re-entry phases. Provisions for accepting PCM-FM signals from spacecraft and other instrumentation shall be included.

3.3.3.2.13.4 Tracking and Recovery Location

Aids for flight phase radar tracking and post landing recovery location shall be provided. Radar tracking aids shall be capable of continuous operation during launch and re-entry phases and shall be compatible with C-Band ground tracking stations. Post landing recovery location aids capable of operating on the international distress frequency of 243 megacycles shall be provided.

3.3.3.2.13.5 Command

The Gemini B, when activated, shall be provided with the capability of receiving digital command intelligence from any properly equipped ground station.

3.3.3.2.13.6 Intercommunication

The capability for intercommunication between the crew shall be provided during all mission phases. These phases shall include those times when both crew members are in the Gemini B, when one crew member is in the Gemini B and the other crew member is in the crew transfer mode, and when one crew member is in the Gemini B and the other crew member is in the Laboratory Vehicle. The system required for intercommunication shall be compatible with the systems required for spacecraft to ground voice communications.

3.3.3.2.14 Gemini B Peculiar Ground Systems

3.3.3.2.14.1 Gemini B Peculiar AGE

3.3.3.2.14.1.1 General

The Gemini B Segment peculiar AGE shall be designed in accordance with the AGE System Criteria Section.

3.3.3.2.14.1.2 Design

The Gemini B Segment peculiar AGE shall consist of OGE and MGE designed to support all Gemini B Segment operations from after final acceptance at the contractor's facility through launch. This Gemini B peculiar AGE shall be designed per the requirements established by this specification. Wherever possible, maximum utilization shall be made of existing or modified Gemini A design. The Gemini B AGE utilized at ETR shall be functionally identical to the AGE utilized at the Contractor's facility and the AGE utilized during factory acceptance.

3.3.3.2.14.1.3 Performance

The Gemini B Segment peculiar AGE shall include all the equipment necessary to transport, handle, store, verify, calibrate, checkout, monitor, record, service and control the Gemini B Segment. This AGE shall be capable of providing a means of (1) verifying the proper operation of the Gemini B Segment to assure successful operation of all systems during all Segment test and factory acceptance, (2) determining whether the Gemini B Segment is operable within prescribed limits, (3) identifying to the black box and/or replaceable component areas of failure or operation outside of prescribed limits. This AGE shall support the GSS AGE end-to-end systems test of the Gemini B Segment when integrated with the Laboratory Segment, Experiments and/or Titan III Segment (Transtage). Fault isolation equipment at the launch site will be limited to that equipment necessary to isolate faults to the black box or replaceable component level. Detailed fault isolation and failure analysis within black boxes and/or components will be conducted at contractor/subcontractor plants and/or at AF depots.

3.3.3.2.15 <u>Crew Safety Requirements</u>

The crew safety requirements for the Gemini B shall include the inherent safety of the Gemini B and the safety provided the crew by the crew escape system in the case of aborts.

3.3.3.2.16 Rendezvous

After orbital catchup, the rendezvous of a chase and target Orbiting Vehicle shall be controlled from the Gemini B of the chase OV. Such capability shall include sensors, computation capability, displays, and necessary control signals to the Transtage and OV attitude control systems.

The Gemini B shall be capable of storage on-orbit for 60 days and then reactivation for crew return.

3.3.4 Experiments

3.3.4 Experiment System Segment

The experiment system segment consists of primary experiments to evaluate the effectiveness of man in space doing military tasks, secondary experiments to develop technology and acquire scientific knowledge, and an experiment information system to facilitate expeditious experiment accomplishment.

3.3.4.1 Allocated Performance and Design Requirements

Experiments shall be allocated to flights in such a manner to maximize the return of data within the cumulative payload capability of the program. The specific characteristics and requirements of the experiments are to be defined as part of the program.

3.3.4.1.1 Effectiveness Allocation

Data shall be furnished to support a detailed apportionment of effectiveness to each of the experiments and to the experiments as a group aboard each Orbiting Vehicle. A plan shall be developed to show how substantial compliance of this effectiveness allocation will be demonstrated prior to acceptance and how actual compliance to this effectiveness allocation is judged during each mission.

3.3.4.2 Peculiar Performance and Design Requirements

3.3.4.2.1 General

3.3.4.2.1.1 Repair Requirement

All experiment equipments except P-11 and P-12 shall have provisions for malfunction detection and on-orbit repair.

3.3.4.2.2 Experiment Information System Data

A general purpose, stored program computer shall be provided for experimental equipment operation and experimental data processing. The computer shall have provisions for malfunction detection and on-orbit repair. The computer shall be capable of continuous operation during the entire 30-day on-orbit period.

3.3.4.2.2.1 Computer Control

A combination of automatic and manual control functions shall be provided. The control functions shall allow the crew to initiate computation routines, and control display and transmission of selected portions of the computer output data.

3.3.4.2.2.2 Data Handling Provisions

The experiment information system shall be capable of accepting input data from the various experiment sensors, converting to computer language, and performing computations and data reduction as required by the experiment.

3.3.4.2.2.3 Read-Out Capability

The experiment information system output format and data rate shall be compatible with the laboratory vehicle to ground link. The capability for crew control for frequency of read-out shall be provided.

3.3.4.2.2.4 Data Storage Capability

Adequate data storage shall be provided to prevent loss of data due to transmission failure and to provide permanent records for future analysis.

3.3.4.2.2.5 Data Transfer for Return

The capability for data transmission continuously during a pass over the readout station shall be provided. This capability shall be under manual control of the crew.

3.3.4.2.3 P-1 Acquiring and Tracking Preassigned Earth Targets;
P-2 [redacted]
P-3 Detecting and Tracking Ground Targets of Opportunity.

3.3.4.2.3.1 Objectives

P-1 (a) To evaluate man's capability to acquire preassigned land targets and track them with an accuracy compatible with precise IMC determination under various conditions of lighting and target type.

(b) To assess the effects of reference material quality on the astronaut's acquisition performance.

P-2 [redacted]

P-3 (a) To evaluate the astronaut's proficiency in detecting ground targets of opportunity under various conditions of lighting, target type, and background.

(b) To define scanning techniques to optimize percentage of land area covered per pass.

3.3.4.2.3.2 Equipment Requirements

[redacted]

3.3.4.2.3.3 Experiment Procedure

In the P-1 experiment the astronaut will scan the general target area using the PTS. Reference material will be displayed to assist in acquisition. Upon acquisition, the field-of-view will be decreased and the magnification increased. The astronaut will center the crosshairs on target and proceed with the tracking run aided by the tracking servo. During the tracking run the coupled camera will record the image, including the crosshair reference at periodic intervals.

[redacted]

In the P-3 experiment the astronaut will scan with the PTS in both manual and automatic modes to evaluate his ability to assess targets of opportunity.

3.3.4.2.3.4 Orbital Vehicle Design Requirements

a. Provision shall be made for disabling the vehicle attitude control system during tracking runs.

b. Provision shall be made to protect external portions of the PTS during vehicle ascent. A method for removing this protection after attaining orbit shall be provided.

c. An unobstructed view of a major portion of the space below the vehicle shall be required.

d. A viewport is required in the bottom of the vehicle adjacent to the PTS control console.

e. Vehicle rigidity shall be compatible with precise optical alignments.

f. Storage space shall be provided for film magnetic tapes, punched card digital information and spares.

g. Exposed film and data shall be transferable to the Gemini vehicle for re-entry.

h. Thermal control of the MOL environment shall be consistent with maintaining precise optical alignments and accurate operation of servos and computers.

i. Outgassing during tracking runs shall not cause attitude errors or rates in excess of those specified.

j. Ejected control gas shall not enter the field-of-view of the PTS.

3.3.4.2.3.5 Evaluation Requirement

[redacted]

In Experiment P-3, sufficient data shall be recorded and recovered to allow quantitative evaluation of the experiment.

3.3.4.2.3.6 Simulation Requirements

The development simulators shall be capable of providing visual and operating duplication of space operations in order to determine and evaluate equipment design parameters, detailed experiment and evaluation procedures, variance between subjects, and provide pre-and post-flight reference data on the astronauts.

3.3.4.2.3.7 Experiment Interactions Requirements

The PTS shall be capable of operation with the star acquisition and ranging equipment of Experiment P-8, providing angle data for P-7, the pointing and tracking of the P-10 collector optics and pointing of selected antennas of P-4.

3.3.4.2.3.8 Setup and Calibration Requirements

Provisions shall be made to perform on-orbit setup and calibration, consistent with the evaluation requirements.

3.3.4.2.4 P-4 Electromagnetic Signal Detection

3.3.4.2.4.1 Objectives

The objective is to evaluate the effectiveness of the crew in performing tasks associated with detection, processing, display, measurement, and recording of electromagnetic signals.

3.3.4.2.4.2 Equipment Requirements

Equipments to be supplied for the P-4 experiment are to include the antennas, receivers, processing gear, display consoles, and recorders to permit evaluation of the astronaut's ability to process signal radiation from coordinated emitters in two or three separate frequency bands. This equipment shall be designed to provide a real-time analysis and display capability for sophisticated signals and modulation techniques.

3.3.4.2.4.3 Experiment Procedures

As the orbital vehicle passes over preselected target areas alerting shall be accomplished by operator scanning, or through automatic preset alarm criteria. The operator will make the proper adjustment of controls to isolate the desired signals and display these in an optimal fashion for identification of signal characteristics. Tests will be performed to evaluate performance of the equipment and the operator in low versus dense signal environments, simple versus complex signal parameters, and maximum versus minimum preinstruction.

3.3.4.2.4.4 Orbital Vehicle Design Requirements

a. Vehicle stability during the equipment operation shall be to allow tracking of ground-based electromagnetic sources.

b. Storage space shall be provided for film, magnetic tapes, and spares. Exposed film and tapes shall be transferable to the Gemini vehicle for re-entry.

c. A tracking antenna shall be provided for weak signals as well as signal locating and shall be extendable from the unpressurized portion of the MOL.

d. Precaution shall be taken from EMI standpoint to avoid deleterious interference with vehicle subsystem functioning, medical monitoring gear, telemetry and communication gear.

e. Antenna arrays external to the vehicle shall be suitably protected during ascent to preclude damage from the environment. Covers shall be ejected after commencing orbit operations.

3.3.4.2.4.5 Evaluation Requirements

Data shall be recorded and recovered to determine quantitatively the ability of the astronaut to detect, analyze and identify sophisticated signals, the time required to optimally display the signals, and the distribution of functions accomplished by the operator.

3.3.4.2.4.6 Simulation Requirement

The developmental simulations shall provide a means for synthesizing typical RF signal environments to allow for evaluation of the spaceborne processing and display equipment, developing and testing operating and evaluation techniques, establishing variance between operators, and providing pre- and post-flight baseline reference data.

3.3.4.2.4.7 Experiment Interactions

P-4 equipment shall be compatible with operation of the P-13 surveillance radar and display equipment.

3.3.4.2.4.8 Setup and Calibration

Provisions shall be made to perform on-orbit setup and calibration, consistent with the evaluation requirements.

3.3.4.2.5 P-5 In-Space Maintenance

3.3.4.2.5.1 Objectives

To provide quantitative and qualitative measures of man's ability to perform maintenance, calibration and adjustment on complex orbital equipment on-orbit within the spacecraft on a preventative and emergency basis.

3.3.4.2.5.2 Equipment Requirements

Equipments to be supplied for P-5 shall include fault detection gear, standardized tools, attachments for various work stations, and suitable audio and visual recording devices for evaluation. In addition, maintenance models are required for functions not to be covered by normal maintenance operations.

3.3.4.2.5.3 Experiment Procedures

Data concerned with maintenance activities connected with both vehicle and experiment subsystems shall be collected. Particular attention shall be given to acquire data which can be utilized to evaluate tools, work positions, level of repair, time requirements, and types of tasks. In addition, maintenance models shall be used to gain data on malfunction, repair, calibration tasks not included in the basic maintenance requirements. Also to be considered and evaluated are advanced techniques and technologies which would have application to future maintenance requirements.

3.3.4.2.5.4 Orbital Vehicle Design Requirements

Suitable attachment points within the vehicle shall be provided for each maintenance position.

Storage provisions for tools, repair kits, malfunction detection equipment, and maintenance models shall be provided.

3.3.4.2.5.5 Evaluation Requirements

Evaluation data shall be acquired to determine the effectiveness of various tools and attachments on different levels and types of maintenance. Of particular interest is the time required in space-relative to the same task on the ground.

3.3.4.2.5.6 Simulation Requirements

Suitable development simulations will be devised to establish tool, malfunction detection, and attachment design characteristics, evaluate operating and evaluating procedures and provide pre- and post-flight reference data.

3.3.4.2.5.7 Experiment Interactions

Vehicle subsystem and all experimental equipments shall be designed for in-space maintenance of critical elements.

3.3.4.2.6 P-6 Extravehicular Activities

3.3.4.2.6.1 Objectives

To provide a qualitative assessment of man's extravehicular capability, using a maneuvering unit, for operations on the external surface of the vehicle and at a distance from the vehicle.

3.3.4.2.6.2 Equipment Requirements

Equipment to be supplied shall include a task panel, suitable attaching and ambulating devices for surface operations, and an maneuvering unit that can be attached to the crew member to provide attitude stabilization and maneuvering capability. The maneuvering unit shall have an integral life support capability including suit-cooling to sustain operation for periods of at least one hour.

3.3.4.2.6.3 Experiment Procedure

The crew member will don the pressure suit and check it out in the air lock compartment and perform selected tasks. He will then depressurize the lock and egress out to the surface of the vehicle and propel himself along with a variety of ambulation techniques and devices. He shall perform a number of tasks such as erecting vehicle appendages, applying patches to the skin of the vehicle, and replacing typical components using standard space maintenance tools.

For extended operations he shall don the maneuvering unit in the pressure lock, depressurize, and test its operation. He will then egress from the vehicle, first performing simple maneuvers to evaluate the equipment and techniques while in retrievable distance with the tether line. After satisfactory completion of this phase he shall maneuver out to a proportioned target and proceed to return it to the vehicle.

3.3.4.2.6.4 Design Requirements

a. The air lock compartment shall be of sufficient dimension to permit donning the suit and astronaut maneuvering unit. The hatch external to the vehicle shall be of sufficient size to permit easy egress to or egress from the vehicle.

b. Provisions for attachments to the laboratory vehicle shall be provided for surface operations.

c. An umbilical shall be provided for life support and communication for surface operations.

d. The maneuvering unit shall be designed to be refurbishable in order to allow at least three complete cycles of operation of the unit. Provision shall be provided in the laboratory vehicle for communication to the maneuvering unit.

e. Storage of AMU expendables shall be provided for in the air lock compartment of the vehicle.

f. A vehicle viewing port shall be positioned so that the astronaut can be immediately viewed after egressing from the air lock.

g. External illumination shall be provided.

3.3.4.2.6.5 Evaluation Requirements

Evaluation shall be accomplished primarily through audio and video recordings made during operations and by debriefing. The astronaut shall describe his progress and time tones shall be superimposed on the record for time line analysis purposes. Extended operations shall be recorded by other astronaut, using a hand held camera at a viewing port or other suitable camera or television device.

3.3.4.2.6.6 Simulation Requirements

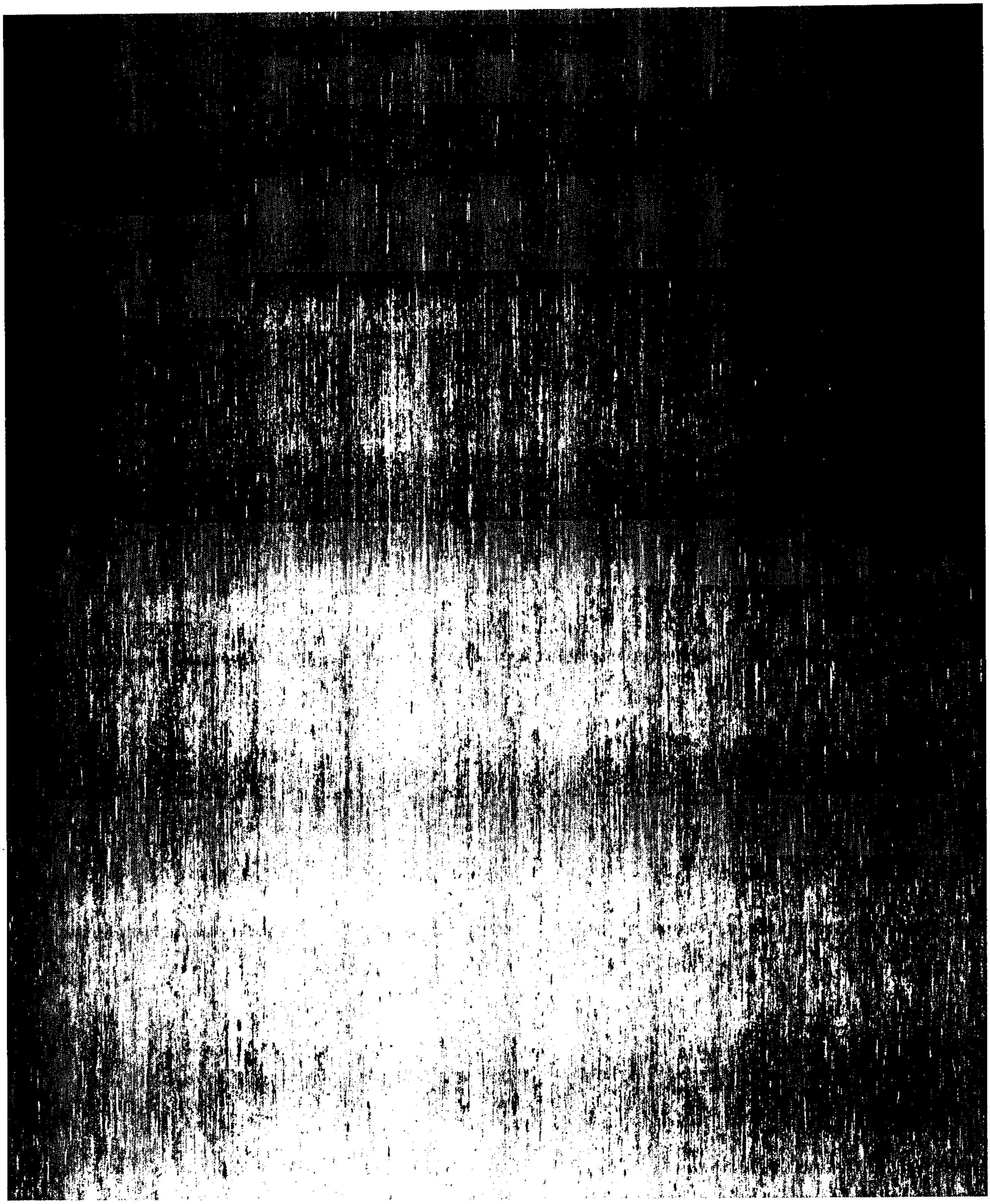
Developmental simulation shall be carried out to evaluate the design of the astronaut maneuvering unit and to develope techniques of maneuvering. The surface ambulation and attachment techniques shall be evaluated to determine their effectiveness, perfect techniques, and determine training requirements.

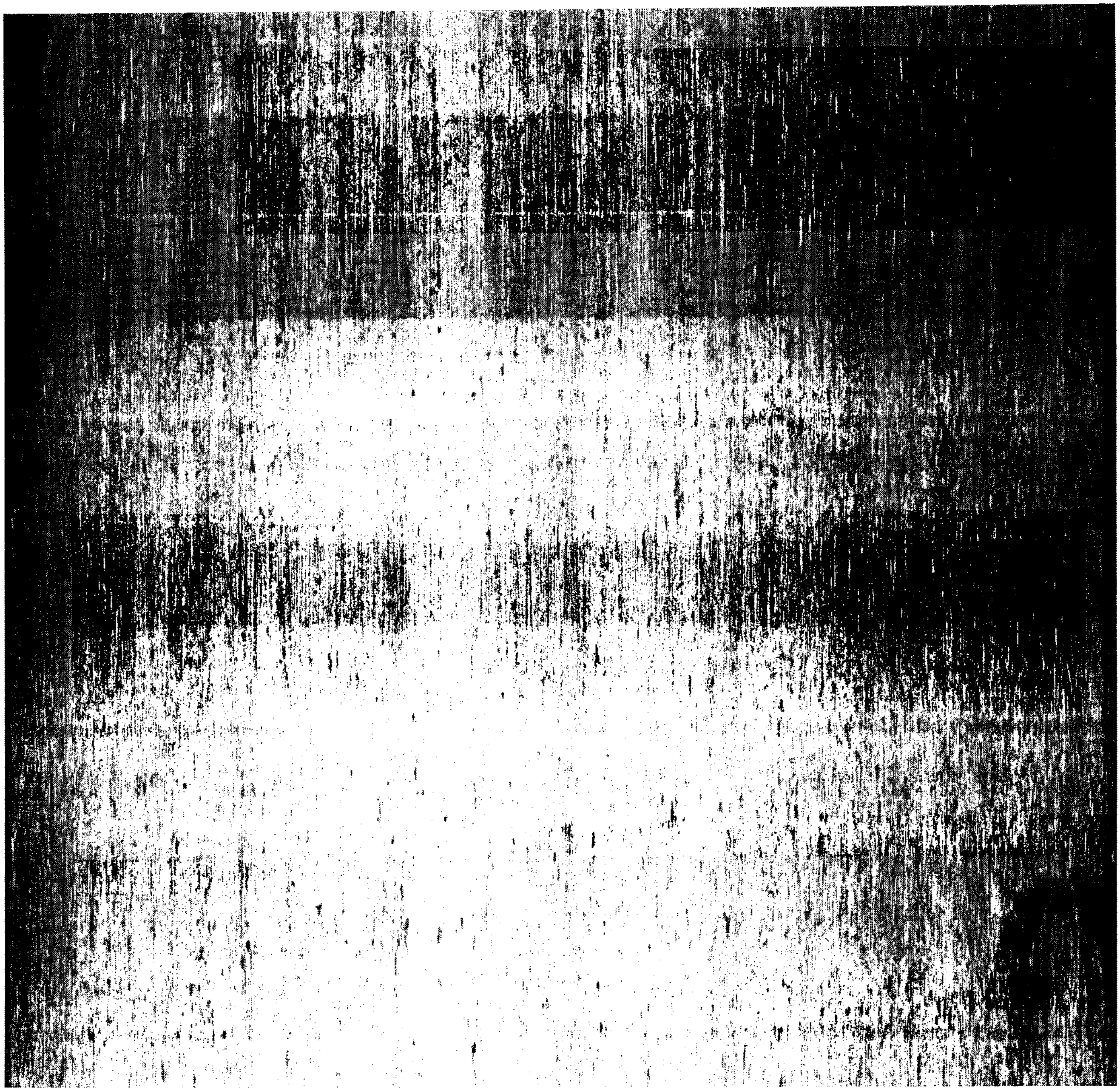
3.3.4.2.6.7 Experiment Interactions

No other experiment shall be performed during extravehicular operations.

3.3.4.2.6.8 Setup and Calibration

There shall be no calibration necessary for the equipment of this experiment.





3.3.4.2.8 P-8 Autonomous Navigation and Geodesy

3.3.4.2.8.1 Objective

The objective of Experiment P-8 is to evaluate the ability of man to act as spacecraft navigator and to determine man's ability to perform geodetic survey of uncooperative targets through the acquisition of data for use in subsequent post-flight analysis.

3.3.4.2.8.2 Equipment Requirements

Equipments to be supplied for the P-8 experiment are an inertial measuring unit, two automatic star trackers, a horizon scanner, a precision time reference system, a photo-optical system, a ranging device, displays and various prepared navigational data. The pointing and tracking scope for use in this experiment shall be the PTS described in Experiments P-1, 2, 3. The digital computer used in this experiment shall be the experiment information system central computer.

3.3.4.2.8.3 Experiment Procedures

It is required that measurements be made of inertial and terrestrial references as functions of time. The spacecraft's inertial orientation shall be provided by the inertial measuring unit which is periodically up-dated by celestial sightings; an alternate operating mode shall be provided utilizing celestial sightings, with star trackers, to obtain the inertial reference without recourse to an inertial measuring unit. Terrestrial references shall be obtained through measurements of the earth's horizon or the sighting of known landmarks. Data filtering and smoothing techniques shall be applied to the above measurements.

The geodesy portion of the experiment shall employ the pointing and tracking scope to acquire the terrestrial feature to be surveyed. A ranging device such as a laser shall be slaved to the pointing and tracking scope. Time shall be obtained from the spacecraft time reference system. Spacecraft attitude shall be determined by the star tracker-inertial measuring unit combination together with a photo-optical system.

3.3.4.2.8.4 Orbital Vehicle Design Requirements

a. The star trackers shall be positioned to provide adequate tracking of stars during terrestrial pointing of the pointing and tracking scope.

b. A theodolite slaved to the star-trackers shall be positioned such that the operating FOV is the same as that for the star trackers.

c. A sufficiently unimpeded visual path shall exist between the navigation IMU and the star-trackers to accomplish optical alignment if necessary.

d. The horizon scanner and ranging device shall be located on the earth-facing side of the vehicle.

e. Storage space shall be provided for film and prints as well as other data. Exposed film and data shall be transferable to the Gemini vehicle for recovery.

f. Thermal control of the MOL environment shall be consistent with maintaining precise optical alignments and accurate operation of inertial components, servos and computers.

g. Outgasing during data acquisition runs shall not cause attitude errors or rates in excess of those specified.

h. Ejected control gas shall not enter the fields-of-view of the star-trackers, horizon sensor or the theodolite.

3.3.4.2.8.5 Evaluation Requirements

Sufficient data shall be recorded and recovered to allow quantitative evaluation of accuracy and efficiency of on-board orbit determination ephemeris prediction and navigation problem solution and to allow quantitative evaluation of the astronaut's ability to obtain high precision geodetic information.

3.3.4.2.8.6 Simulation Requirements

The development simulators shall be capable of providing visual and operating duplication of space operations in order to determine and evaluate equipment design parameters, detailed experiment and evaluation procedures, variance between subjects, and provide pre- and post-flight reference data on the astronauts.

3.3.4.2.8.7 Experiment Interaction Requirements

Compatible operation with the PTS and the experiments information system shall be provided.

3.3.4.2.8.8 Setup and Calibration

Provisions shall be made to perform on-orbit setup and calibration, consistent with the evaluation requirements.

3.3.4.2.9 P-10 Multiband Spectral Observations

3.3.4.2.9.1 Objectives

The primary objective of the multiband spectral experiment is to evaluate man's ability to operate specialized radiometric and related equipment as aids in the following military mission and related scientific activities:

a. Collection of a wide range of background measurements and sky background data which will be used to design advanced sensing systems.
b. Acquisition and tracking of orbiting objects and/or ballistic missiles during boost, midcourse and re-entry phases.
c. Determination of temperature distribution of ground and sea, and of orbiting targets.
d. Detection and identification of camouflage in both day and night observations.
e. Collection of data essential to the design of improved horizon sensors from which advanced attitude control subsystems may be derived.
f. Detection of high-flying aircraft in clear weather or against cloud background.

3.3.4.2.9.2 Equipment Requirements

Equipments to be supplied for Experiment P-10 shall include an IR/UV multiband scanning radiometer capable of measuring radiation from cooperatively launched missiles, orbiting objects, high flying aircraft and from adverse earth background. The pointing and tracking scope (PTS) shall be used as an optical director.

3.3.4.2.9.3 Experiment Procedure

The astronaut's activities shall include pointing of optics in the direction of phenomena or targets using the PTS or other controls, selection of area for measurement, selection of detectors, selection of scanning mechanisms and associated equipment, selection of filters, adjustments and calibrations, preliminary evaluation, recording of data, verbal descriptions, and coordination with the ground.

3.3.4.2.9.4 Orbital Vehicle Design Requirements

a. The optical system shall be mounted on the earth-facing side of the laboratory so that any portion of the earth observable from the satellite may be brought into the field-of-view.

b. The laboratory vehicle shall provide adequate protection to maintain the mechanical and electrical integrity of P-10 equipment.

c. The laboratory shall provide the necessary means of housing the P-10 equipment either in the air lock compartment with a special mounting hatch or a radiometer bay located in the unpressurized compartment and contiguous with a portion of the pressure module. Provisions for an environmental door allowing pressurization of the bay shall be included.

d. Access with a pressurized environment shall be provided to the P-10 equipment when retracted in order to effect changes of filters and sensors, and to permit maintenance.

e. P-10 equipment shall be effectively protected from any source of heat.

f. Ejected control gas shall not enter the field-of-view of the optics.

3.3.4.2.9.5 Evaluation Requirements

In Experiment P-10 sufficient data shall be recorded and recovered to allow quantitative evaluation of the astronaut's performance in detecting, acquiring, tracking and interpreting multiband spectral signals.

3.3.4.2.9.6 Simulation Requirements

The development simulators shall be capable of providing operating duplication of space operations in order to determine and evaluate man-machine design parameters, detailed experiment and evaluation procedures, variance between subjects and provide pre- and post-flight reference data on the astronauts.

3.3.4.2.9.7 Experiment Interactions

The P-10 equipment shall be compatible and slaved to the Pointing and Tracking Scope.

3.3.4.2.9.8 Setup and Calibration

Provisions shall be made to perform on-orbit setup and calibration, consistent with the evaluation requirements.

3.3.4.2.10 P-11 General Human Performance

3.3.4.2.10.1 Objective

The objective of this experiment is to measure space crew performance on a standardized basis in order to detect changes in performance as a function of the environment or the conditions under which the performance occurs.

3.3.4.2.10.2 Equipment Requirements

The equipment to be utilized in this experiment consists of a control-display panel which presents tasks to the crew member as tests of various aspects of his performance capability. The panel displays shall be controlled by the experiment information system programmed to present the task stimulii.

3.3.4.2.10.3 Experiment Procedures

a. Each space crew member shall perform the test sequence twice during every other day.

b. The test sequence consists of the crew member's starting the test, observing the display panel and responding by utilizing the panel controls in a previously learned manner.

c. The experiments information system, central computer shall, in addition to controlling the panel displays, accept the responses made on the panel controls, and process this information for recording and transmission.

3.3.4.2.10.4 Design Requirements

The display control panel shall be mounted so that a restrained crew member can view the panel and operate the controls.

3.3.4.2.10.5 Evaluation Requirements

The results of this experiment shall be compared with extensive ground-gathered, baseline data, and correlated with biomedical data to provide an evaluation of the effects of the MOL environment and conditions on man's general performance capability.

3.3.4.2.10.6 Simulation Requirements

A program of research utilizing simulations of the human performance tests to be used on P-11 shall be conducted in order to specify the detailed performance and statistical characteristics of the P-11 test battery and to minimize on-orbit testing time requirements.

A program of testing on the total potential space crew population shall be conducted utilizing an exact copy of the P-11 test battery and, where possible, a simulation of test conditions in order to train the space crew sufficiently to remove learning effects during testing, and to establish baseline data against which orbital data will be compared.

3.3.4.2.10.7 Setup and Calibration

There shall be, as a portion of the P-11 control program utilized by the MOL experiments information system computer, a brief checkout and calibration program which shall be initiated and used immediately prior to each P-11 test session.

3.3.4.2.11 P-12 Biomedical and Physiological Evaluation

3.3.4.2.11.1 Objectives

The primary objectives are the quantitative measurement and evaluation of the following physiological aspects of the weightlessness environment:

a. Effects on gravity-dependent functions as modified by countermeasures.

b. Providing sufficient data to make plausible extrapolations for longer duration flights.

c. Compare the physiological results with related aspects of human performance.

Environmental parameters of the mission other than weightlessness shall also be evaluated; these include the effects of launch, re-entry, and recovery, as well as the total environment on orbit.

3.3.4.2.11.2 Equipment Requirements

The test equipment shall be designed to:

a. Make a series of physiological measurements while operating in the weightlessness environment.

b. Provide, either continuous or on-demand measurements of certain vital functions, e.g. cardiac and respiratory, for medical monitoring purposes.

c. Allow non-medical crew members to perform the tests with acceptable precision after an appropriate interval of training.

d. Provide chemical analysis, e.g. mass spectrometer, shall have the capability for manual analysis of the atmospheric constituents, i.e. H_e, N_2, O_2, CO_2, H_2O and at least gross estimate of contaminates.

3.3.4.2.11.3 Experiment Procedures

The measures to be used are classified into five categories as follows:

a. Those requiring the space crew member to don one of the special garments containing sensors and to establish appropriate links with automatic processing or recording equipment.

b. Those requiring the space crew member to perform a task for a period of time on one of the pieces of equipment designed to measure specialized aspects of his output and to provide or establish the resultant data input into processing or recording equipment.

c. Those requiring one space crew member to perform a measurement procedure on the other, recording the results appropriately.

d. Those requiring one or both of the space crewmen to perform detailed analyses procedures utilizing specialized analytical equipment and to record the results for processing or recording.

e. Those requiring the space crewmen to measure, identify and record their own metabolic intakes and to collect, process and identify samples of their own metabolic products.

The space crew shall collect, transfer and return samples to the earth for processing after recovery.

3.3.4.2.11.4 Evaluation Requirements

Evaluation shall be against the following requirements:

a. Certain data shall be examined on a real-time or near real-time basis so that medical decisions may be made for mission safely.

b. Certain of the data shall be analyzed in an ongoing or sequential manner in order to detect trends requiring changes in the experimental data requirements or mission operations.

c. The remaining data shall be evaluated in comparison with ground-based data and correlated with other orbital data in order to satisfy the objectives of the experiment.

3.3.4.2.11.5 Simulation Requirements

Simulation of equipment items shall be conducted throughout the program with increasing sophistication, beginning with simple mock-ups of sensors, test panels and procedures and culminating in actual hardware utilization in appropriate space environment simulators.

3.3.4.2.11.6 Setup and Calibration Requirements

Setup and calibration shall be designed into the test equipment and procedures. For clinical analyses the standard gas and liquid samples shall be packaged to allow direct insertion into the analytical equipment.

3.3.4.2.12 P-13 Integrated Navy Experiments

3.3.4.2.12.1 Objective

The objective is to evaluate the capability of the astronaut to control, coordinate, and utilize a number of sensors to detect, track, classify, and catalog sea targets.

3.3.4.2.12.2 Equipment Requirements

The equipment requirements of this experiment shall be the same as the equipment requirements for P-1, P-4 and P-10. In addition to these equipments, an ocean surveillance radar (OSR), display equipment for correlation of data, and low-light level television (LLTV) to be used in conjunction with P-10 shall be provided. The digital computer used in this experiment shall be the experiment information system, central computer.

3.3.4.2.12.3 Experiment Procedure

Under normal operation the first detection of a sea surface target shall be made by the electromagnetic signal detector sensor (P-4). Upon alarm and identification of the target radiated signal, the characteristics shall be measured and recorded. The OSR shall scan for additional targets not identified by the electromagnetic signal detection sensor. During daylight operation, the astronaut shall track selected targets through the PTS to determine the proper image motion compensation and obtain photographs for classification. During night operation the low-light level TV sensor shall be used and the display recorded.

3.3.4.2.12.4 Orbital Vehicle Design Requirements

The LLTV and OSR shall be oriented to look in the forward down direction.

Provision shall be made to provide an ascent protective cover for the ocean surveillance radar antenna and a mechanism for ejecting this cover.

3.3.4.2.12.5 Evaluation Requirements

Sufficient data shall be recorded and recovered to allow quantitative evaluation of the astronaut's performance in detecting, acquiring, classifying, and determining concentrations of sea targets.

3.3.4.2.12.6 Simulation Requirements

The development simulators shall be capable of providing visual and operating duplication of space operations in order to determine and evaluate equipment design parameters, detailed experiment and evaluation procedures, variance between subjects and provide pre- and post-flight reference data on the astronauts.

3.3.4.2.12.7 Experiment Interaction Requirements

The experiment interaction requirements shall include those of experiments P-1, P-4, and P-10.

3.3.4.2.12.8 Setup and Calibration Requirements

Provisions shall be made to perform on-orbit setup and calibration consistent with the evaluation requirements.

3.3.4.3 Experiments Peculiar Ground System

3.3.4.3.1 Experiments Peculiar AGE

3.3.4.3.1.1 Design

The AGE peculiar to the various experiments shall consist of both the OGE and the MGE designed to support all Experiment operations following final acceptance at the contractor's facility through launch. This Experiments peculiar equipment shall be designed for operability, maintainability, reliability, etc., per the requirements generated by this specification and the Experiment contract end item specifications. Where compatible, common usage shall be made of the AGE to support the requirements of several Experiments. The Experiments OGE required at the launch pad shall be designed for inclusion in one GFE railroad adapted 40' x 10' van to be shared with the Laboratory OGE. Payload Control Room No. 2 in the VIB shall be utilized jointly by the Experiments fixed OGE and the Laboratory fixed OGE. Data transmitted between Experiment peculiar OGE and the VIB shall consist of signals compatible with the Data Transmission System of the ITL System. As far as possible, the Experiment AGE utilized at ETR shall be functionally identical to the AGE utilized at the Laboratory Vehicle contractor's facility.

3.3.4.3.1.2 Performance

The Experiments peculiar AGE shall include all the equipment necessary to transport, handle, store, verify, calibrate, checkout, monitor, record, and service the various Experiments. The AGE shall be capable of providing a means of (1) verifying the proper operation of each Experiment to assure successful operation within prescribed limits of all systems, and (2) identifying to the black-box and/or replaceable component levels of failure operation outside of prescribed limits. Detailed fault isolation and failure analysis within black boxes and/or components will be conducted at contractor's/subcontractor's plants and/or at Air Force depots.

3.3.4.3.2 In-flight Maintenance

In-flight maintenance shall be performed on all experimental equipment where such maintenance, either preventative or repairative, may improve the possibility of mission success and completion. The maintenance guidlines as outlined in this specification shall be followed in establishing such Experiment equipment maintenance.

3.3.5 Flight Crew

3.3.5 Flight Crew and Crew Equipment System Segment

This system segment defines the Flight Crew and crew equipment requirements for performance of the MOL mission.

3.3.5.1 Allocated Performance and Design Requirements

3.3.5.1.1 Effectiveness Allocation

The human performance requirements shall be generated and specified according to each explicit task element for MOL mission operations. These human performance requirements will form the basis for the training criteria and mission evaluation. The following criteria applies to the laboratory segment.

3.3.5.1.2 Weight

Crew members shall weigh 138-192 lbs. Individual space suits and portable environmental control sybsystem will weigh approximately 85 lbs. per man. This total weight of crew and flight crew equipment is contained in the Gemini weight. Back-up suit units, portable oxygen units, "shirt-sleeve" clothing, medical (first-aid) kit and personal items, weight - approximately 300 lbs. total - shall be included in the Lab. Weights for remaining crew accommodations items are included in the Gemini B and Laboratory System Segments.

3.3.5.1.3 Volume

Baseline functional volumes for laboratory vehicle design for the human operator will be base upon anthropomorphic data using 10-90 percentile men by weight and 10-90 percentile by height. Both shirt sleeve and suited mode, pressurized and unpressurized, will be considered. Storage volume for back-up suits, clothing, medical treatment and personal items shall be provided. The baseline design of the laboratory vehicle shall provide a minimum of 200 cu. ft. per man of free volume. The total free volume in the final design will be based upon the optimal design for man system effectiveness in the laboratory vehicle.

3.3.5.2. Peculiar Performance and Design Requirements

3.3.5.2.1 Flight Crew Complement and Performance Allocation

3.3.5.2.1.1 Orbital Vehicle Crew Performance

Functional areas of the Orbital Vehicle System Segment to which the flight crew shall contribute are:

a. Laboratory activation and checkout
b. Transfer locomotion and control
c. Gemini B reactivation and checkout
d. Gemini B - Laboratory separation
e. Extravehicular activity

3.3.5.2.1.2 Gemini B Crew Performance

Functional areas of the Gemini B system segment performance to which the flight crew shall contribute are:

a. Launch monitoring and backup control of sub-systems.
b. Launch abort monitoring and control
c. On-orbit shutdown of Gemini B
d. On-orbit checkout of Gemini B and preparation for re-entry.
e. Re-entry Control

3.3.5.2.1.3 Laboratory Crew Performance

Functional areas of laboratory system performance to which man as a flight crew member shall contribute are:

a. Monitoring and primary or backup control of subsystems
b. Personal maintenance including monitoring and maintenance of crew health
c. Maintenance of essential systems
d. Laboratory vehicle data management
e. Communication
f. Mission control decisions

3.3.5.2.1.4 Experiments Crew Performance

The flight crew shall perform the following functions in the accomplishment of the experiments mission of the MOL:

a. Operation and maintenance of experimental equipment
b. Experiments data management
c. Communication concerned with experiments
d. Control and performance of the experimental observations
e. Experimental subject.

3.3.5.2.1.5 Crew Performance Data

The exact human performance (tasks) to be utilized in the various system segments will be defined as a result of engineering studies to optimize the man-machine relationships and to develop the procedures to be used in the operation and maintenance of the system segments. These human performance requirements shall be documented in task and time line analyses.

3.3.5.2.2 Flight Crew Selection

The Air Force will have primary responsibility and control of flight crew selection from qualified military personnel, according to specific mission, medical, and psychological criteria.

3.3.5.2.3 Flight Crew Training

The Air Force shall have primary responsibility for flight crew training. This training shall be controlled and coordinated by the Training Director in the MOL SSD system program office.

3.3.5.2.3.1 Training Stages

After flight crew candidates are selected, training shall take place in three major stages. After each stage general evaluation of the training program and students shall take place in order to adjust the program or to provide additional training in any areas which are considered necessary.

3.3.5.2.3.1.1 Stage 1 - Preliminary General Training

This stage of training shall consist of six months of postgraduate training at the Aerospace Research Pilot School, Edwards Air Force Base, California. This course shall be specifically designed for the MOL program and shall include advanced academic training, simulation (including environmental familiarization), bioastronautics training, site and contractor field trips, flight training and a physical fitness program.

3.3.5.2.3.1.2 Stage 2 - Engineering Development and Crew Training

During this stage flight crew candidates shall be attached to the MOL program office and participate in certain aspects of the development program including serving as subjects in developmental simulation, participating in design reviews, mockup inspections, and design inspections. In addition, they shall receive more intensive training and familiarization on MOL systems undergoing development and continue their physical fitness and flight training programs. During this stage the more intensive and specialized experiments training which will be required for specific flights will be initiated. In addition, contingency training shall be initiated during this stage.

3.3.5.2.3.1.3 Stage 3 - Preflight Training

The preflight training phase shall begin approximately six months prior to a scheduled launch. By this date the primary and secondary crew members will have been designated as well as the specific spacecraft with specific mission objectives for this launch date. These crew members shall then begin a detailed training program designed especially for their particular spacecraft, equipment, mission objectives, and mission profile. Spacecraft checkout and acceptance testing of the particular spacecraft will involve the assigned crew members. The training shall include part-task simulation of boost and ascent, attitude control, orbit modification, reentry retrofire and reentry control, and launch vehicle abort; simulation of experiments; whole mission rehearsal of the Gemini profile; and whole mission rehearsal of the MOL spacecraft mission, including ground support operations. Refresher training shall be given in the areas of environment, egress, contingency, and extravehicular activity.

Toward the latter part of pre-flight training, simulation of all aspects of each experiment will be required. Baseline data shall be gathered on the crew after proficiency is obtained in the experimental routines for the particular flight. This baseline data shall cover crew participation in the integrated system over a representative period of time.

Crew member capabilities for inflight maintenance will need to be evaluated during preflight training for comparison with inflight performance.

3.3.5.2.3.2 Training and Proficiency Data

Detailed training requirements and proficiency criteria shall be developed on the basis of the Space Crew performance required to meet the task and time line analyses.

During development simulation and all stages of training, crew proficiency data shall be gathered, analyzed and stored in a systematic manner in order to provide a training and human performance data base for the MOL and future programs.

3.3.5.2.4 Flight Crew Activity Programming

The activities of the Flight Crew required for vehicle operations, for performance of the array of experiments on a given flight and for personal maintenance - eating, sleeping, hygiene, etc. - shall be programmed for each MOL flight in order to achieve maximum mission success. Such programming shall contain alternate paths, and the capability for reprogramming crew time should contingencies arise requiring a reordering or reallocation of crew activities. The Flight Crew activity programs shall contain designated points or junctures wherein the crewmen will participate in selecting or deciding upon the alternative sequence of activities to pursue.

3.3.5.2.5 Nutritional and Metabolic Requirements

3.3.5.2.5.1 Caloric Needs

Firm energy requirements for activities in the weightless state cannot be specified until orbital data is secured. Estimates of energy allocations are as follows: 8 hours sleep, 500 ± 90 kcal; 14 hours duty, 1600 kcal; 2 hours exercise, 700 kcal.

3.3.5.2.5.2 Food Composition

The 2800 kcal diet will consist of a minimum of 70 g of protein, (carbohydrate and fat to be defined) and fortified with vitamins and minerals and having a calcium content less than 500 mg.

A major part of the diet will be administered in liquid form utilizing approximately 1500 ml water per day. Weight and volume requirements are not firm but can be based on isocaloric equivalents of freeze-dehydrated diets established for the NASA Gemini program.

3.3.5.2.5.3 Water Requirements

Total water intake is expected to be 3000 ± 300 g per man day, including the water used to reconstitute the food for the liquid diet. Potability standards and associated control measures will be established for water use during the entire mission.

3.3.5.2.6 Personal Hygiene

General skin hygiene to be preserved by simplified system of moist skin scrubbing; non-aqueous materials of questionable use. Oral hygiene by water and brush without dentifrice. Beard clipping aspirated and filtered to eliminate debris from cabin atmosphere.

3.3.5.2.7 Physiological Conditioning

Combination of dynamic muscular exercise, peripheral vascular "exercises", such as lower body negative pressure, and skeletal loading will constitute the basic regime. The free volume of the laboratory is to be used for conditioning exercises.

3.3.5.2.8 Medical Monitoring and Operational Support

The baseline scheme for monitoring during launch and re-entry will consist of the basic NASA Gemini monitoring scheme. This includes 2 leads of EKG, blood pressure, respiration profile and oral temperature.

3.3.5.2.9 Pressure Suit and Associated Equipment

The latest version of the NASA/Gemini 4-C, extravehicular space suit shall be modified as necessary to meet the requirements for the MOL space suit. In particular, the extravehicular transfer mode shall be a basic capability -- including the life support subsystem.

Additional modifications shall be made for tethering, tool storage and other mission requirements.

3.3.5.2.10 Flight Crew Training Equipment

The flight crew training requirements are set forth earlier in this section. In accordance with these requirements, five major classes of flight crew training equipment may be defined. It will be noted in the paragraphs which follow that certain of those devices shall provide static representations of MOL subsystems, operations, or equipments. Certain devices will provide dynamic simulation of the operating situation and others will provide both static and dynamic simulation for training the flight crew in MOL operations and maintenance.

3.3.5.2.10.1 Function Trainers

Training aids, as warranted, shall be developed for use in the study or demonstration of structure, function or operation of a single system or subsystem of a major segment of the MOL system, e.g., device representing the ECS of the Gemini-B.

3.3.5.2.10.2 Part Task Trainers

Training devices as warranted shall be developed for use in practice of a selected function or functions of the MOL operation, where a specific critical skill or skills is required, e.g., manned re-entry simulation.

3.3.5.2.10.3 System Trainers

Training devices shall be developed in which simulated operation, including operation under contingency conditions, of an entire segment of the MOL system can be conducted. These procedures trainers (simulators) shall include training devices for the Gemini-B, Laboratory, and Experiments system segments. These trainers shall incorporate high fidelity simulation of the physical layout.

3.3.5.2.10.4 Mission Trainer

A mission training simulator, consisting of the system trainers insofar as possible, shall be developed to provide an integrated simulation of all segments of the MOL system. This shall include interacting ground support facilities through which full mission operations can be practiced, developed, and rehearsed.

3.3.5.2.10.5 Environmental Trainers

Training equipments shall be provided for use in part task training in special environments such as acceleration (centrifuges), weightlessness (zero-g aircraft), and reduced pressures and special atmospheric compositions (space chambers).

3.3.5.2.10.6 Development Simulators

Development simulators for experiment equipments shall be used in the training program to minimize the number and types of trainers.

3.3.6 T-IIIC

3.3.6 Titan III System Segment

The Titan IIIC launch vehicle consists of Stage O (solids), Stage I, Stage II and transtage, and the flight control, electrical, pressurization, propulsion, inertial guidance, tracking and flight safety, instrumentation, and malfunction detection system. Basic requirements for performance and reliability are specified hereunder.

3.3.6.1 Allocated Performance and Design Requirements

3.3.6.1.1 Minimum Payload Performance

The minimum on-orbit payload, including all elements of the laboratory and Gemini B shall be as defined in the following for launch from ETR:

Orbital Inclination	Altitude N. Mi.	Payload lb.
28.4°	100	23,000
	160	22,400
	250	21,500
32°	100	22,800
	160	22,200
	250	21,300
36°	100	22,500
	160	21,900
	250	21,000

3.3.6.1.2 Degradation of Performance vs. Diameter

The performance degradation which results from laboratories in excess of 10 feet shall be as follows:

Payload degradation, lbs.	Payload diameter, ft.
0	10
140	12
350	13

3.3.6.1.3 Propellant Capacity

The payloads given previously are for no remaining useful propellant on-orbit. The specific impulse for calculation of available velocity which can be gained by adding propellant shall be 305 seconds. The useful propellant which can be added in the tanks to provide orbital maneuver propulsion at the expense of payload is defined in the following table:

Launch Inclination	Altitude N. M.	Propellant Capacity, lb.
28.4°	100	4700
	160	4100
	250	3200
32°	100	4600
	160	3900
	250	2900
36°	100	4300
	160	3500
	250	2600

3.3.6.1.4 Injection Accuracy

The required injection accuracy from the nominal injection altitude circular orbit shall be as follows:

	Nominal Altitude at Circular Orbit		
	100 n. m.	160 n. m.	250 n. m.
Inclination	± 0.12°	± 0.12°	± 0.12°
Altitude, ft.	± 3,000	± 21,000	± 22,000
Eccentricity	0.4×10^{-3}	3.0×10^{-3}	3.0×10^{-3}

3.3.6.1.5 Reliability

The following are predicted values for the booster and transtage:

1.	Countdown	0.87
2.	Boost	0.908
3.	Transtage (to inject)	0.915
4.	Transtage (30 days on-orbit)	0.864

3.3.6.1.6 Constraints

3.3.6.1.6.1 Length and Diameter

The Titan IIIC is required to accept laboratory diameters between 10 and 13 feet. It shall accept laboratory lengths falling below a straight line on a plot of payload length versus diameter. The plot is defined by the following points:

Payload Length, Feet	Payload Diameter, Feet
48	10
29	13

Payload length is defined as the distance from launch vehicle station 77 to the top of the Gemini B without tower. Diameter is the outside diameter of the laboratory.

3.3.6.1.6.2 Center of Gravity Location

The launch vehicle shall be capable of accepting laboratories with C.G. location between 30 and 60 percent of the laboratory length, measured from the transtage interface, launch vehicle station 77.

3.3.6.1.6.3 Weights

The above payload length, diameter and C.G. requirements shall be met with payload weights between 15,000 pounds and 25,000 pounds.

3.3.6.2 Peculiar Performance and Design Requirements

3.3.6.2.1 Malfunction Detection System (MDS)

The MDS shall be provided to allow man-rating. The MDS shall sense potentially catastrophic malfunctions, and either provide cockpit displays (slow malfunctions) to the Gemini B, or initiate an abort sequence (fast malfunctions).

3.3.6.2.1.1 Abort Logic

The MDS shall be capable of accepting engine shut-down commands. The MDS shall include the capability of initiating thrust termination in Stage 0 flight, and initiating engine shutdown in those cases where safe abort is achievable. The MDS shall be compatible with the Flight Safety and Tracking System. The MDS system shall be active during the ascent phase.

3.3.6.2.1.2 Displays

Signals indicating potentially catastrophic booster or transtage failures shall be provided as displays in the Gemini B and/or laboratory.

3.3.6.2.1.3 Safety Criteria

The probability that the booster will function properly or that a timely abort signal will be generated shall be 0.998 minimum. The probability that the MDS will not generate a false abort shall be 0.994 minimum.

3.3.6.2.2 Transtage On-Orbit Characteristics

The transtage shall be available for 30 days on-orbit for sustenance propulsion, orbital correction, and either backup or alternate attitude control. The propellants are nitrogen tetroxide and a 50-50 blend of hydrazine and unsymmetrical dimethylhydrazine (UDHM) for both systems. Nitrogen is the pressurant for the attitude control system, helium for the main engines.

After injection and stabilization, the booster guidance and control system shall be made inoperative. The transtage engines and attitude control system (ACS) modules shall then be available for use on orbit, and shall have capabilities as defined hereunder. The main transtage engines are currently started after application of a settling impulse from the ACS modules.

The vehicle-laboratory interface is at vehicle and transtage station 77.

3.3.6.2.2.1 Main Engines

Two engines having a nominal vacuum thrust of 8,000 lb each are gimballed by mechanical feedback actuators to provide pitch, yaw, and roll control, as well as forward thrust.

3.3.6.2.2.1.1 Number of Restarts

After injection into orbit the main engines shall be capable of at least 10 restarts, depending on the duty cycle and propellant available.

3.3.6.2.2.1.2 Servo Interface

On-orbit the effective gimbal actuator electrical interface with the laboratory is at the gimbal servo valve.

3.3.6.2.2.1.3 Propellant Settling

Propellant settling impulse required for restart of the main engines on-orbit shall be provided by the ACS engines. Alternatively, a laboratory system may be used to provide the settling impulse.

3.3.6.2.2.2 Attitude Control System (ACS)

The attitude control and propellant settling system modules consist of the following:

a. Four fixed thrust chambers directed aft for pitch and yaw control at Station 133.6, 63 inches from the transtage centerline, having a nominal vacuum thrust of 45 pounds each.

b. Four fixed thrust chambers directed tangentially, providing couplers for roll control at the same station and radius, having a nominal vacuum thrust of 25 pounds each.

3.3.6.2.2.3 Retrorocket System

Transtage retrothrust shall be provided on the transtage for separation.

3.3.6.2.2.4 Telemetry

Excess channels are available from the transtage for use in the boost and orbital phase. Due consideration shall be made to the use of this capability. Primary use of this system shall be for instrumentation of the Titan III vehicle during boost and orbital phases. The PCM transmitter operates in the 225 and 260 MC band, with an output power of 50 watts.

3.3.6.2.3 ITL AGE

AGE provided for the Gemini B and laboratory shall be compatible with the Integrate-Transfer-Launch AGE at the Eastern Test Range, and shall be integrated with existing Titan III equipment. Titan III AGE is designed in accordance with SSD Exhibit 62-128. The ITL concept provides for build-up of the launch vehicle in buildings away from the launch areas and transport of the assembled vehicle to the launch pad in a ready condition requiring only a combined system test and a discrete vehicle checkout. Before mating of the orbiting vehicle to Titan III all subsystems must have been accepted and checked. An end-to-end check must be performed after transport to the Eastern Test Range.

3.3.7 TOSS

3.3.7 Test Operations System Segment (TOSS)

The Test Operations System Segment (TOSS) shall consist of the launch environment, remote station network, control centers, recovery forces, equipment, communications, computer programs, personnel, techniques, Range support, and procedures necessary for test operation and mission control of the MOL system from the initiation of the launch countdown through MOL crew recovery and data retrieval. The segment also shall include provisions for integration, simulation, training, and system exercising.

The TOSS shall function as a total operational system segment with functional performance during each operational phase as appropriate for test operations and mission control. The TOSS shall be designed, implemented, tested, and operated as a system and shall have integral system validation capability.

The TOSS is composed of three sub-segments; Mission Control, Test Support, and Recovery. The Mission Control sub-segment shall include the Launch and Mission Control Centers and their interfaces with the Test Support and Recovery sub-segments, the mission-peculiar computer programs, the ground system simulation equipment and computer programs, and the mission operations personnel techniques and procedures. The Test Support sub-segment includes a worldwide network of telemetry, tracking and command (TT&C) stations, an interstation communications network, extensive worldwide meteorological support, instrumentation, post-flight data handling and computation, optical and photographic support, and all Range support services necessary to support MOL launch and flight coverage. The Recovery sub-segment includes land, sea, and air units deployed to support planned, contingency and emergency recovery modes as well as pad and ascent aborts.

The Test Operations function shall be under the direct control of the MOL System Program Office (SPO), SSD. The nominal point of control shall be located at CKAFS.

3.3.7.1 Performance Allocations

3.3.7.1.1 Effectiveness

The effectiveness of the Test Operations System Segment shall be developed to the highest level consistent with maximum MOL Program cost effectiveness (Reference 3.1.3.1). That effectiveness shall be not less than 98 percent unless the models and procedures developed per paragraph 3.1.3.1 indicate that a lesser level will benefit program cost effectiveness. Should such a situation arise, a request for adoption of a lesser level together with the supporting analysis shall be submitted to SSD/Aerospace for review and SSD approval. Overall segment mission availability shall be not less than .999.

3.3.7.2 Functional Requirements Allocations

3.3.7.2.1 Launch Phase

This phase shall extend from the initiation of terminal countdown to the point of lift-off.

3.3.7.2.1.1 Initial Conditions

At the initiation of the terminal countdown the integration, assembly, and checkout of the complete MOL vehicle has been completed. Within the preceeding 24 hours, the instrumentation network, recovery force system, mission control center, and its supporting centers will have been checked out individually and, when inter-connected, will have been checked out on an end-to-end system basis. Other supporting services, such as weather forecasting and launch range materials handling services will have been active during previous operations and are on-line as required. MOL vehicle/AGE/instrumentation/MCC interfaces have been validated.

3.3.7.2.1.2 Mission Control

Throughout all phases the mission control function shall have available the MOL Mission Control Center and the worldwide facilities for range support and recovery support which have been assigned to the program. The overall function shall be considered as a number of sub-functions plus a number of closely interfaced supporting functions described as follows:

3.3.7.2.1.2.1 Launch Control

Prior to lift-off, all launch control capability will be contained within the ITL/T-III (LCC) complex at Cape Kennedy. Decisions as to readiness of the test vehicles from an equipment standpoint shall be made there with readiness decisions being monitored by the MCC. From the countdown until the instrumentation systems normally used during ascent become primary, the LCC shall function as an arm of mission control. During the countdown all LCC interfaces with the MCC are revalidated and the required display/control functions activated.

3.3.7.2.1.2.2 Vehicle/Crew Control

This function shall be physically located in the MCC and, for all intents and purposes, is the prime function for mission control from lift-off until re-entry, crew recovery, and data retrieval. This Vehicle-Flight Crew Control Center shall be located at Cape Kennedy. Since the responsibilities of this control are exercised for the duration of the complete mission, means must be available for insuring readiness of the worldwide TT&C network, the flight vehicle, the MCC and the crews that man these resources. During the countdown all displays and control capabilities are brought on line and checked out with the data handling and instrumentation elements.

3.3.7.2.1.2.3 Network Control

Launch area and worldwide instrumentation data handling and communications support shall be controlled during all phases by a network or range control function which shall be represented in the MCC by a summary status and control element. During the countdown all network control functions are validated and brought on-line.

3.3.7.2.1.2.4 Range Safety

Range Safety control is exercised at the ETR Range Safety Control Center.

3.3.7.2.1.2.5 Recovery Control

This function shall be physically centralized in the MCC and shall include the capability for deployment and control of forces for planned, contingency and emergency recovery support. The time constraints associated with this function are extreme for aborts on-pad and during early powered flight. Pad recovery forces are expected to be under the direct control of an appropriately located field commander. During the countdown, Recovery forces are brought to the appropriate state of readiness.

3.3.7.2.1.3 Instrumentation and Communications Network

During the countdown the ETR instrumentation systems are exercised and brought on-line by a combination of closed-loop and RF radiation techniques. Actual vehicle frequency and other signal checks are made and last minute corrections transmitted to the world-wide network. All stations are brought on line and exercised using tapes and simulation equipment on a complete system basis, in which the MCC data processing and display functions participate.

3.3.7.2.2 Ascent Phase

The ascent phase extends from lift-off until injection into final orbit.

3.3.7.2.2.1 Mission Control

During early powered flight, mission control displays augment the crew displays and are concerned with trajectory and impact location in the event of abort. During coast a detailed assessment is performed of the vehicle and crew's performance during powered flight and a baseline established for decision purposes. Necessary modifications to the planned final injection (circularization) maneuver are determined. During this maneuver, which occurs in range of a remote-site tracking station in Australia, mission control is essentially on line.

3.3.7.2.2.2 Tracking

The tracking systems shall derive position information adequate for the control functions, including range and crew safety, during ascent. Data derived from combinations of range, range rate, and interferometry systems at uprange ETR shall be used fro alignment and calibration of vehicle systems as required. During the later phases of burn, the ground-derived tracking data shall be used to verify achievement of orbital insertion and orbit life and to make alternate control decisions. Tracking data shall be obtained in real time after transtage shutdown for sufficient time to provide for smoothing data and verifying first insertion into orbit.

For the coast phase the tracking systems at selected remote sites shall derive position information which is adequate to assist in determining malfunction of the vehicle guidance and control system and upon which to base corrective action for the injection burn. Tracking requirements during the injection burn shall be those necessary to determine a catastrophic malfunction. Tracking immediately after burn shall be adequate to derive an initial ephemeris for control purposes.

3.3.7.2.2.3 Telemetry Acquisition

Continuous telemetry data shall be obtained at downrange ETR sites from launch vehicle, OV and crew from before lift-off to the verification of successful first insertion into orbit. Telemetry data shall be obtained during coast on a selected basis. Extensive telemetry service shall be used during circularization. All data shall be recorded on site and selected data shall be transmitted to the MCC in real time and near-real time. Data shall be selected locally as required.

3.3.7.2.2.4 Commanding

Commands to the Gemini B shall up-date displays, guidance systems, and other vehicle systems as required. The commanding system also shall provide the necessary range safety destruct commands for the launch vehicle.

3.3.7.2.2.5 Communications

Reliable communications shall be provided from the MCC to all remote sites for tracking, telemetry, and command data. Voice communications with the flight crew and with flight control personnel at the remote sites shall be provided. Administrative and range control communications shall be provided separately in cases where interference with mission requirements would result.

3.3.7.2.2.6 Data Flow, Computation and Display

Tracking data and selected booster guidance telemetry data shall be furnished to the ETR Real Time Computer Center in real time and used directly for trajectory, IIP, crew safety, and related calculations. The outputs of these processes shall be displayed at the MCC and, in certain cases, at the Range Safety Control Center. Certain outputs may be used directly in the commanding process. Selected OV and crew telemetry data shall be converted to engineering units and displayed in real time at the MCC. Selected launch vehicle telemetry data shall be displayed in real time at the MCC and Range Safety Control Center. A large amount of telemetry data shall be collected, processed, and stored or displayed at the MCC in near-real time in order to establish a performance baseline for later decisions and to aid in verification of the eventual OV status. Commands shall be initiated directly by the Range Safety Officer, by the Computer Center, as programmed, and from MCC.

3.3.7.2.2.7 Coverage

Coverage of the ascent phase shall be continuous, using selected downrange sites and ships as required, with adequate overlap and acquisition aids to assure against loss of data or track.

As a minimum one full station pass exceeding 5 minutes in duration shall be obtained during the coast phase.

3.3.7.2.3 On-Orbit Phase

This phase shall be considered in two sub-phases; early orbit and orbit. The early orbit sub-phase shall extend from final injection through lab activation, crew transfer, and verification of a satisfactory orbit operational configuration. The orbit sub-phase extends throughout the 30-day mission and ends at Gemini B separation from the Laboratory. The requirement to support on-orbit emergencies shall be considered.

3.3.7.2.3.1 Mission Control

During the critical early orbit sub-phase, the mission control function enters directly into a large number of decisions. The function includes a detailed analysis of the OV and crew telemetry data to establish the validity of the orbit configuration and provide malfunction detection and remedial action. Updating or modification to the system operations plans based on the actual orbit and vehicle/crew condition shall be performed.

During the orbit sub-phase mission control primarily performs detailed analysis, failure prediction, fault location and remedial planning as well as systems operational planning. The flight crew is expected to achieve a high degree of self-sufficiency for routine operations. Close crew/mission control interaction shall be required during emergencies and during performance of certain types of experiments. The mission control function is expected to achieve a high degree of centralization, particularly during later flights.

3.3.7.2.3.1.1 Experiment Control

This function shall be exercised at the MCC. The possibility of subsidiary control points for specific experiments exists. Little or no experiment control is expected during the early orbit sub-phase. During the orbit sub-phase experiment analysis and control will cover a broad technical and operational spectrum and includes deployment of surface resources in the atmosphere and in space. The time constraints associated with the experiment control function are only critical with regard to scheduling; other functions normally operate in a control cycle on the order of a day.

3.3.7.2.3.2 Tracking

At least three valid tracking passes are required to establish the orbit for control purposes. Thereafter, the nominal ephemeris accuracy requirements are expected to be achievable with 2-4 tracking passes per day. Special experiment tracking requirements may necessitate extensive tracking (up to one pass per revolution) and optical tracking. Call-up tracking to support emergencies is a consideration. In the case where velocity changes are applied to the OV for orbit phase changes or maneuvers, three valid tracking passes shall be required to re-establish the ephemeris.

3.3.7.2.3.3 Telemetry Acquisition

During early orbits telemetry data shall be obtained from transtage, laboratory, and Gemini B at all sites and recorded on site. At all primary stations throughout the mission, it shall be possible to select a set of data from any link and display in real time. It shall be possible to select a different set or the same set of data, edit or summarize and transmit to the MCC in real time. During the early orbit phase it shall be possible to perform this process on both the Gemini B and Laboratory real time links simultaneously. During routine on-orbit operations, time sharing of status and experiment data dumps and selection in real time of a limited amount of received data for transmission to the MCC shall be normal modes of operation. Additional requirements derived from the experiments in the combinations of extra links or special formats on the vehicle status links shall be processed, both in real time and near-real time modes. The requirement to support special wide band experiment links at selected remote sites is expected.

3.3.7.2.3.4 Commanding

Commanding of the Laboratory shall update displays, the guidance system, and other vehicle systems as required. The commanding system shall be capable of providing ephemeris information, pointing instructions, and other information to the Experiments Subsystems. The vehicle data system shall routinely be controlled from the ground. All primary sites shall have the capability to command the Gemini B systems required for reentry.

3.3.7.2.3.5 Communications

Communications requirements are generally the same as those for ascent. In view of the practical limitations of achieving reliable wide band data over the early orbit sub-phase, it is expected that the discrimination, interpretation, and compression ability of mission trained personnel will be used at certain remote sites. During routine on-orbit operations, temporary restrictions in the rate capability of communications to the control center may be tolerated, provided that transmission of critical data is not interrupted.

3.3.7.2.3.6 Data Flow, Computation and Display

During the early orbit sub-phase, tracking data shall be processed in real time at the central computer complex until the final ephemeris is established and verified. A large amount of telemetry data will be processed in real time and displayed to the mission control elements. Telemetry data also shall be collected and filed for use in later trend analysis. Transmission of complex digital command loads from remote sites is expected to be limited to quasi-real time, in which data is transferred to the remote site at a reduced rate and stored for re-transmission to the vehicle.

During on-orbit operations, the average data handling load is expected to decrease significantly from that of the early orbit phase. However, the peak load may increase due to certain experiments which may require high rates and special data processing. The requirements to process different formats, information rates, and quantities of multiplexed vehicle and experiments data, together with the requirement to store data for trend analysis purposes shall require flexibility in the remote site and MCC data handling and display systems. In addition, the continuous capability shall exist to compute the impact point based upon a tracking pass after retrofire or after receipt of the information of the time of retrofire. Command data flow shall be a real time function for passes over the MCC, Antigua and possibly the West Coast site.

3.3.7.2.3.7 Coverage

Extensive coverage, comprising two to four passes per orbit and relatively continous coverage over the continental United States shall be available during the critical early orbits.

On-orbit coverage for telemetry and command shall be nominally a minimum of once per orbital revolution. Extensive coverage shall be provided for orbits covering the continental U.S. Gaps in telemetry, and command coverage occurring shall be backed up by voice. During later MOL flights the coverage requirement for telemetry and command during normal modes of operation shall be decreased to a minimum network configuration involving coverage as little as once per three or four orbits except for those orbits in which contact is made with the MCC directly. Tracking coverage after deboost is required in case of planned recovery, and is desired in case of contingency recovery.

3.3.7.2.4 Loiter & Re-entry Phase

The Loiter & Re-entry Phase extends from separation of Gemini B and Laboratory to water impact

3.3.7.2.4.1 Mission Control

The mission control function during this phase is concerned primarily with providing maximum support to crew and vehicle. Close crew/mission control interaction also shall be required for the initiation of the re-entry sequence. This may require use of local flight control personnel on site for the planned de-orbit sequence. As a result of the limited loiter time capability and back-up capability of the Gemini B, the recovery system assumes a critical operational mode during this phase.

3.3.7.2.4.2 Tracking

Tracking requirements shall be of sufficient coverage to establish the new ephemeris for the Gemini B after separation from the Lab. More extensive support for the Gemini B may be required of the worldwide tracking system to handle emergency as well as planned de-orbit during this phase.

For the primary recovery area in the West Atlantic, radar tracking shall be provided almost continuously from shortly after deboost until water landing. In case of other types of recovery, radar tracking will be utilized where available. The primary tracking system after emergency from the ionization blackout shall be UHF direction finding equipment on aircraft and ships.

3.3.7.2.4.3 Telemetry Acquisition

Telemetry acquisition requirements shall support the Gemini B only. Support should be the maximum achievable with the primary network. Call-up of additional stations is a possibility. The primary method of retrieval of data during deboost and re-entry will be by recording type from the capsule.

Commanding of the Gemini B shall update displays, the guidance system, and other vehicle systems as required. Ground command control shall provide retrofire times and segments for both planned recovery and emergency contingency areas during this phase.

3.3.7.2.4.5 Communications

Communication requirements shall support the Gemini B only. More extensive support will be required of the worldwide communication system to handle emergency as well as planned de-orbit during this phase. Relatively continuous voice coverage will be provided. Recovery communications shall generally be a separate net from the normal TT&C network, however, the hard wire capability of the latter shall supplement recovery communications as applicable.

3.3.7.2.4.6 Data Handling, Computation, and Display

Gemini B telemetry and tracking data shall be processed in real time and near-real time and displayed at the MCC. Data displays may be utilized at remote sites which are required for backup support and are not part of primary MOL ground network support. Commanding from the remote sites shall be limited to quasi-real time.

3.3.7.2.4.7 Coverage

Extensive instrumentation and voice coverage shall be planned to support the Gemini B during loiter time for both emergency and planned de-orbit.

Emergency recovery coverage shall be available for all areas covered by the MOL orbit. Contingency coverage shall be a limited number of areas based upon trade-off studies of abort modes, area size, force deployment, access time requirements, daylight and weather constraints, and techniques. The planned landing area is in the West Atlantic.

3.3.7.2.5 Recovery Phase

The recovery phase extends from water impact to retrieval of crew, spacecraft,and data.

3.3.7.2.5.1 Track/Search

The track/search operations will make use of aircraft and ship DF equipment compatible with the Gemini B UHF and HF recovery aids. A flashing light and sea marker will be used as optical search aids. It is expected that electronic buoys will be dropped to augment the capsule aids after it is first located.

3.3.7.2.5.2 Access and Retrieval

Access time is defined from impact to that time when either flotation gear is rigged in a safe sea state (4 or less), or the spacecraft and crew are received on deck or the crew and data have been retrieved from the spacecraft. Access time varies during mission phases as a result of crew safety criteria.

3.3.7.2.5.3 Recovery Demands

The Recovery Forces shall effect safe retrieval of the crew, spacecraft, and experiment data in accordance with the following schedule:

	Crew	Recover Experiment Data	Reentry Module
1. Pad Abort	Yes	No	No
2. Ascent Abort	Yes	No	Desired
3. Mission Termination Return	Yes	Yes	Yes
4. Contingency Return (with delay)	Yes	Yes	Yes
5. Emergency Return (immediate)	Yes	Yes	Desired

3.3.7.2.5.4 Post Recovery

Post recovery operations include crew medical care and debriefing, and safe packaging of experiment data. Data and crew shall be returned to locations to be specified.

3.3.7.2.6 Rendezvous

The support and control of rendezvous flights places an additional requirement upon all aspects of TOSS during all mission phases.

3.3.7.2.6.1 Mission Control

The mission control function includes an analysis of the target vehicle and crew telemetry data to establish the validity of the on-orbit configuration for rendezvous plus the generation of mission data necessary to solve the intercept-rendezvous problem. Up-dating of this mission data is required for all mission phases of the chaser vehicle prior to the successful intercept and rendezvous with the on-orbit target vehicle. For rendezvous mission control is responsible for two vehicles and crews through the start of terminal count on the chase vehicle until recovery of one Gemini B.

3.3.7.2.6.2 Tracking

The tracking requirements shall be that of sufficient coverage to establish the position and ephemeris for mission control of both the on-orbit target vehicle and the chaser vehicle, which may be in any mission phase prior to successful intercept and rendezvous with the target vehicle. Extensive tracking support for the chaser vehicle shall be required after on-orbit phase and altitude changes. The possibility of maneuvers by both O.V.'s complicates the tracking procedures. The worldwide tracking system also shall meet a requirement to support emergency abort of the chaser vehicle and emergency de-orbits of both the chaser vehicle and target vehicle during the period before rendezvous and after separation of the space vehicles for a crew return.

3.3.7.2.6.3 Telemetry Acquisition

The world wide network shall provide simultaneous telemetry support for both the target vehicle and the chaser vehicle. Telemetry acquisition requirements for the target vehicle shall be as described for the on-orbit phase; requirements for the chaser vehicle shall be as described according to the mission phase in progress.

3.3.7.2.6.4 Commanding

The world wide network shall provide simultaneous command support for both the target vehicle and the chase vehicle. Command requirements for the target vehicle shall be as described for the on-orbit phase; requirements for the chaser vehicle shall be as described according to the mission phase in progress plus those commands necessary to solve the intercept-rendezvous problem.

3.3.7.2.6.5 Communications

Communication requirements for both vehicles shall be in accordance with the mission phases in progress.

3.3.7.2.6.6 Data Handling, Computation, and Display

Data handling, Computation, and Display shall provide simultaneous support for both vehicles in accordance with the mission phases in progress. This function also shall generate the mission data necessary to solve the intercept-rendezvous problem and provide control of the chaser vehicle and the target vehicle prior to rendezvous.

3.3.7.2.6.6 Coverage

Coverage requirements for both vehicles shall be in accordance with the mission phases in progress. More extensive coverage for the chaser vehicle shall be required for intercept-rendezvous control.

3.3.7.3 TOSS Design Requirements

3.3.7.3.1 Mission Control Sub-Segment

The Mission Control Sub-Segment shall be provided by SSD and shall be under the direct control of the MOL System Program Office, SSD, operating through appropriate agencies. The nominal point of control shall be located at Cape Kennedy (CKAFS).

3.3.7.3.1.1 Mission Control Center.

The Mission Control Center shall provide the following capabilities:

a. Display and control consoles for launch, powered flight, life support, biomedical monitoring, OV subsystems, experiments control.

b. Display and control capability for recovery and range control.

c. Working areas for analysis, control, orbit planning and biomedical staffs.

d. Experiments analysis and control staff working areas.

e. Display subsystem providing a limited number of large screen display for special events, displays for control consoles and supporting staffs.

f. Data buffering storage and retrieval subsystem for formatting, buffering, filing, retrieval and outputting telemetry data.

g. Interfaces with the launch and checkout complexes.

h. Command storage and processing subsystem.

The following supporting elements shall be required, suitably interfaced with or incorporated in the MCC:

a. Real time computer complex.

b. Communications switching terminal.

Major computational and data handling functions shall be performed by a large computer center operated as part of or in direct support of MOL Mission Control operations. This computer center may be provided as part of test support or may consist of mission-dedicated equipment with test support equipment as a backup. On-line telemetry processing, buffering, filing and display driving shall be allocated to the computer center or to small buffer computers located within the MCC. Remote site data processing functions shall be allocated to available remote site computers.

3.3.7.3.1.2 Operational Computer Program System Element

The Operational Computer Program System Element shall consist of all mission-peculiar computer programs required for the entire MOL mission integrated into a compatible system. Computer program functions include:

Input tracking sensor data
Edit & condition tracking data
Trajectory computation
Orbit computation (life, ephemeris)
Impact prediction
Ascent abort timing
Recovery instructions (per area)
Acquisition
Ship position
Drive tracking, trajectory, and orbit displays
Telemetry strip out
Telemetry convert and format
Drive telemetry displays
Telemetry alarms and checks
Data correlation
Data file for retrieval
Data trend analysis
Compute and format updated IGU
Compute and format stored program functions
Compute and format orbit changes

Crew operations scheduling
Vehicle operations scheduling
Ground support scheduling
Experiment guidance computations
Experiment acquisition - Earth related (stationary and moving)
Space related
Experiment force deployment
Experiment scheduling
Experiment data analysis
Experiment space simulation
Rendezvous-intercept instructions

3.3.7.3.1.3 Ground System Simulation Element

The Ground System Simulation Element shall provide the capability to simulate all mission phases and operations, including rendezvous-intercept, to the degree that the real time data system, including operational computer programs, and the flight control crews are exercised in a valid manner. This element shall make use of the Gemini/MOL Orbiting Vehicle Simulator. Simulation modes shall include both open loop and closed loop with various configurations of the total segment. This element shall be used to develop and test operational procedures, as well as for training and exercising.

The various modes can be described as follows (in all cases the operational MCC computer is driven as if the data were received from the the remote sites):

a. MCC open loop - the simulation computer (with its data tapes) simulates the OV and remote sites, generating all required tracking and telemetry data.

b. MCC closed loop - the MOL Orbiting Vehicle Simulator provides all necessary OV data (primarily telemetry data) to drive the simulation computer and MCC operational computer; the simulation computer generates all tracking and other data required to exercise the MCC facility.

c. Station open loop - this mode provides limited simulation of remote sites. In this mode, the simulation computer (and its tapes) simulates the OV, driving (limited) simulated station display. In some instances, tapes generated using this technique or the OV simulator will be used at the actual remote sites for training. Fly-by aircraft may be used.

d. Station/ship closed loop - this mode is similar to the open loop mode, except that the MOL Orbiting Vehicle Simulator will be used to provide OV data. In addition, actual remote sites may be integrated into the simulation, using fly-by aircraft equipped with a partial OV simulator, including a simulated flight crew.

e. System exercise - this mode provides exercise of the complete TOSS as an integrated system. The MOL Orbiting Vehicle Simulator provides OV data to drive the MCC telemetry interface while the remote sites use tapes and voice patch; the simulation computer integrates these elements to provide the most practicable realistic overall mission simulation.

3.3.7.3.2 Test Support Sub-Segment.

The Test Support Sub-Segment shall provide the worldwide network which supports on-board MOL vehicle TT&C systems. Other elements include ground system communications, meteorological support, and all Range support necessary to accomplish launch and flight coverages.

3.3.7.3.2.1 Network Support Element.

Network Support Element shall provide remote site tracking, telemetry, command, and voice functions which support on-board MOL Vehicle TT&C Systems. Site capabilities shall include data acquisition, data handling, display and intra-/inter-site communications. Each site shall be capable inaa specified time of verifying subsystem performance of an individual basis as well as verifying the total site configuration and ability to support the MOL mission. Validation of two-way interchange of data with the Mission Control Center shall be possible. The extent to which the site remains fixed in the MOL support configuration depends upon the time required and confidence achieved in the checkout and verification process.

3.3.7.3.2.1.1 Coverage

The ground network shall be capable of providing the required instrumentation coverage for vehicles launched in orbital planes between 28.4° and 36°. In addition the ground network shall be capable of providing telemetry, tracking, and command data from launch through final injection of the MOL orbiting vehicle at selected remote sites and shall assure validation of the orbiting vehicle operational capabilities during early orbits and crew transfer. On-orbit coverage then shall be a minimum of once per orbit. Extensive coverage shall be provided for orbits within the continental U. S. Also, the ground network shall be capable of updating the orbiting vehicle on-board systems with ephemeris and re-entry data at least four times per day.

3.3.7.3.2.1.2 Meteorological Support Element.

The Meteorological Support Element shall provide weather data obtained from various reporting and forecase sources necessary to support the MOL mission.

3.3.7.3.2.1.3 Loading

The ground network shall be required to provide support for two MOL orbiting vehicles in various flight phases conducting an on-orbit rendezvous mission. Consideration shall be given to the fact that certain remote sites may be involved in other multi-mission support operations.

3.3.7.3.2.1.3.1 Ground TT&C Capabilities

a. The acquisition of mission data and control of the MOL orbiting vehicle by the ground network shall be achieved by the use of: radar tracking systems for determining position and velocity, telemetry systems for ground monitoring of systems performance in real time and by the reception of on-board stored data, ground command systems for up-dating on-board systems, and voice communications between the vehicle flight crew and the flight control personnel through the ground network.

b. C-band radar tracking systems shall be employed by the ground network for tracking acquisition, launch trajectory, and orbit updating. Identification of orbiting vehicles shall be through the use of vehicle code addresses. Where feasible, skin tracking of the orbiting vehicle shall be employed.

c. VHF telemetry systems operating in the R-F frequency band of 225-260 Mc shall be employed by the ground network for telemetry data acquisition. PCM-FM modulation will be employed by the orbiting vehicle data transmission system. Ground telemetry and data handling systems shall be capable of simultaneously receiving and recording all real time and stored data transmitted from the orbiting vehicle. Telemetry dump schedules shall provide maximum use of the continental U. S. stations to assure minimum logistics and communications problems in handling the data. Depending upon mission phase, selected data shall be transmitted to the MCC in real time or near real time for analysis. Provisions for real time displays at selected remote sites shall be included.

d. A digital command system compatible with the orbiting vehicle shall be employed for ground-to-vehicle data transmission operating in the R-F frequency band of 406 to 450 Mc. Specific word format, the number of real time and stored program commands, plus the transmission modes required will be determined.

e. Voice transmission and reception in the R-F frequency band of 225 - 300 mc using AM modulation shall be required at specific remote sites.

f. Special telemetry links for experiment data in the 2200 - 2300 megacycle R-F band shall be supported at the west coast, CKAFS, and possibly downrange ETR up to a maximum of one megabit. A wide band data link having 5 Mc analog or 10 megabit digital data capability shall be supported at Vandenberg Tracking Station and at least the analog signal shall be supported at CKAFS. Ground display and recording equipment for such a link shall be supplied by the TOSS or Experiment Segments, as applicable.

g. In addition, the design of the Test Support Sub-segment and its technical and operational interfaces with the Mission Control Sub-segment shall consider the expected evolution to a standard instrumentation system for support of DOD space program development. This development will involve the use of a minimum number of remote stations and a standardized integrated S-band TT&C system such as the AFSSD Space-Ground Link Subsystem (SGLS).

3.3.7.3.2.1.4 Network Stations

The network stations tentatively selected on remote sites necessary for mission data acquisition and control of the MOL orbiting vehicle are listed as follows:

3.3.7.3.2.1.4.1 Cape Kennedy (CKAFS)

The employment of the resources at CKAFS shall include all the instrumentation necessary for the launch and ascent phases of of the flight. Cape Kennedy also shall be utilized as a primary on-orbit station having telemetry reception, radar tracking, command transmission, and air-to-ground voice capabilities. In addition, a secure capability shall be implemented for telemetry reception and air-to-ground voice communications when required by mission operations.

3.3.7.3.2.1.4.2 Grand Bahama Island, Grand Turk, Antigua, ETR Ship(s), Ascension, Pretoria, Bermuda, and Grand Canary Islands

These ETR and NASA downrange stations shall provide support for missions with launch azimuths passing over their locations. An ETR ship or ships shall be positioned to provide coverage for the first transtage shutdown due to the lack of land-based stations in the area. For the ascent phase of the flight, command and air-to-ground voice functions shall be routed from the MCC and Range Safety through Grand Bahama Island, Grand Turk, Antigua, the ETR ship(s), Bermuda, and Grand Canary Islands depending upon the launch azimuth. Selected telemetry functions shall be transmitted to the MCC in real time or near real time from these stations, and all stations shall provide C-band tracking data in real time to the MCC and Range Safety.

Antigua also shall be utilized as a primary on-orbit station having TT&C and air-to-ground voice coverage netted with the MOL MCC at CKAFS. A secure capability shall be implemented for telemetry reception and air-to-ground voice communications when required by mission operations.

3.3.7.3.2.1.4.3 Carnarvon, Australia

Carnarvon shall be utilized for the ascent and circularization phases of the flight. This station provides TT&C and air-to-ground voice coverage during transtage re-burn. Since this station is essential for circularization coverage, mission personnel may be deployed at this site. Further netting of this station for on-orbit support may be required depending upon mission requirements.

3.3.7.3.2.1.4.4 Okinawa Area

A new station or ship in the Okinawa area shall be implemented to provide primary on-orbit TT&C and air-to-ground voice coverage netted with the MOL MCC at CKAFS. This station also will provide coverage after the retrofire sequence prior to the communications blackout for the secondary Midway and South Pacific (Tahiti) recovery areas.

3.3.7.3.2.1.4.5 Hawaii Area

An existing station in the Hawaii area shall provide primary on-orbit TT&C and air-to-ground voice coverage. Stations under consideration are Kaena Point and Kokee Park. A secure capability shall be implemented for telemetry reception and air-to-ground voice communications when required by mission operations. The Hawaii area station also will provide coverage after retrofire sequence prior to the communications blackout for the primary West Atlantic/ETR recovery area.

3.3.7.3.2.1.4.6 West Coast Area

An existing station in the West Coast area shall provide primary on-orbit TT&C and air-to-ground voice coverage. Stations under consideration are Point Arguello and the Vandenberg Tracking Station. A secure capability shall be implemented for telemetry reception and air-to-ground voice communications when required by mission operations. The West Coast area station also will provide coverage prior to the communications blackout for the primary West Atlantic/ETR recovery area.

3.3.7.3.2.1.4.7 Wake, Suva (Voice only)

New air-to-ground voice only communication stations shall be implemented at Wake and Suva to fill gaps in primary station coverage. The NASA station in the Grand Canary Island also shall be utilized for this purpose.

3.3.7.3.2.1.4.8 White Sands, Eglin

These two stations shall be used as back-up for C-band radar tracking for early orbital ephemeris determination and for support of planned recovery.

3.3.7.3.2.1.5 Network Communications

The ground communications network for MOL mission support shall use existing and planned DOD and commercial networks. Channel capacity and reliability to support flight crew-to-MCC voice, station control voice, telemetry data transmission, command control, and tracking data transmission at all stations in the network shall be provided. Where feasibile, all primary on-orbit stations shall be netted with the MCC at CKAFS utilizing hardwire or equivalent circuits. Requirements for the communication support functions are described as follows:

3.3.7.3.2.1.5.1 Flight Crew-to-MCC Voice

Full duplex voice circuits from the remote sites to the MCC shall be employed for orbiting vehicle-to-ground voice relay. The capability for remote site keying of the ground-to-air transmitters from the MCC shall be implemented for all remote sites netted for MOL network support to allow direct communications between the MCC and the orbiting vehicle.

3.3.7.3.2.1.5.2 Station Control Voice

Full duplex voice circuits from the remote sites netted via the appropriate remote site control centers to the RCC shall be employed for remote site control and administration by the Test Support Sub-segment. Full duplex 100 wpm teletype circuits also shall be utilized.

3.3.7.3.2.1.5.3 Telemetry Data Transmission

Telemetry data for the ascent phase of the mission shall be transmitted to the MCC for real time control from the remote stations utilizing 40,800 bps and/or 2,400 bps High Speed Data (HSD) lines to the extent possible.

Both 100 wpm teletype and 600-1.200 bps HSD lines shall be employed at the Carnarvon, Australia site. All primary stations within the continental U.S., i.e., Cape Kennedy, Antigua, and the West Coast area, shall be netted with the MCC for telemetry transmission utilizing 40,800 bps HSD lines and a back-up 100 wpm teletype mode.

Other stations required for on-orbit telemetry support, i.e., Hawaii area, Okinawa area, and possibly Grand Canary Island, shall employ 100 wpm teletype with growth to 600-2,400 bps HSD lines.

3.3.7.3.2.1.5.4 Command Control

Command control during the mission flight phases shall be achieved through the use of HSD lines, 600-2,400 bps, for command transmission directly from the MCC via the remote site and through the use of pre-stored commands sent by 100 wpm teletype to the remote site to be initiated under MCC and mission personnel control.

3.3.7.3.2.1.5.5 Tracking Data Transmission

Tracking data for the ascent phase of the mission shall be transmitted to the MCC for real time control from the remote stations utilizing HSD lines to the extent possible.

Special early orbit considerations may require real time transmission of tracking data over HSD lines.

Routine on-orbit tracking for ephemeris updating shall utilize 100 wpm teletype where HSD lines are not conveniently available.

3.3.7.3.2.1.5.6 Security

In addition, the ground communication network shall provide for secure transmission of experiment data and voice from the Okinawa area, Hawaii area, West Coast area, and Antigua.

3.3.7.3.3 Recovery Sub-segment

The recovery system shall make maximum use of those equipments, techniques, and procedures developed for Gemini/Apollo recovery support which are appropriate for MOL. Support will be obtained through the DOD Manager for Manned Space Flight Support Operations.

3.3.7.3.3.1 Recovery Force

The recovery force shall be comprised of sea, land, and air units, associated crews and specialist teams as necessary to meet the performance requirements of recovery. Such resources shall be provided from existing government sources, wherever possible and practicable.

The recovery forces shall include the HC-130 airplane equipped with HF and UHF/DF equipment and carrying a pararescue crew. Such aircraft shall be continuously deployed in the planned recovery areas during periods of planned recovery. At other times and areas, the aircraft shall be on strip alert for immediate take-off in the event landing is made in one of the contingency areas or at any other place along the ground track.

The surface recovery force shall include a Navy Destroyer modified for spacecraft pick up by the installation of special davit and winch equipment as provided under the NASA Gemini Program. Where possible, identical ships shall be used for both programs.

Aircraft and ships shall be provided in such quantities and at such locations in the recovery areas or appropriate bases as is necessary to effect retrieval of the spacecraft and crew.

Special high density recovery forces shall be provided in the immediate area of the launch pad and down-range along the ground track to a distance of 70 n.m. to insure recovery of the crew following launch phase abort. These forces shall be comprised of fixed and rotary wing aircraft, land and amphibious vehicles and high-speed sea-going vessels and shall be capable of immediate reaction in case crew abort is initiated.

3.3.8 Facilities

3.3.8 Facilities

Design and construction of new and/or modified existing facilities shall be under the direction of the Civil Engineering Office of SSD and shall satisfy the requirements of the total system as defined in this specification and in applicable Facilities Criteria Documents.

The facilities covered in this section encompass those facilities necessary to support the MOL development program and MOL operations from receipt of the segments at ETR through launch of the MOL and recovery of the Gemini B capsule. New facilities shall be provided only as required; maximum use shall be made of existing facilities modified as required.

3.3.8.1 ITL System

The MOL system will be integrated and launched from the Integrate Transfer Launch (ITL) system at the Eastern Test Range (ETR). Modification to the ITL shall only be made if essential to operation.

3.3.8.1.1 Launch Pad

Modifications to the existing Pad 40 facilities shall be accomplished to provide an environmental enclosure for the entire Orbital Vehicle (OV) while on the launch vehicle, suitable parking areas for the OV AGE rail vans and fluid servicing units, and adequate services for the support of OV launch operations. Means shall be provided to effect the safe removal of the flight crew to at least 800 feet from the spacecraft within seconds in the event a potentially dangerous condition arises between the time of flight crew insertion and lift-off. Existing facilities shall be removed or relocated as necessary to provide a clear landing area for the flight crew in case of on-pad abort.

For the rendezvous mission, it may be necessary to also modify the existing Pad 41 facilities.

3.3.8.1.2 Vertical Integration Building

Orbital vehicle integration with the TIII core shall be accomplished in the Vertical Integration Building (VIB). The VIB shall be modified to provide an environmental enclosure for the OV while on the launch vehicle, suitable parking areas for necessary OV AGE rail vans, and adequate services for the support of the TIII/OV integration and checkout.

The VIB launch control center and connecting cable ways and ducting between the AGE vans and the launch control center shall be modified as required for spacecraft AGE installations. Existing areas shall be utilized with modifications, where required. The GEEIA communication lines, which connect the launch complex and the launch control center, shall be modified to satisfy MOL system requirements.

3.3.8.2 Industrial Area

Portions of the orbiting vehicle shall be integrated in the Industrial Area at Cape Kennedy prior to entering the VIB. New facilities or modifications to existing facilities shall be provided as follows:

3.3.8.2.1 Assembly Facilities

A clean room assembly area shall be provided for the receipt and inspection of the individual segment portions of the MOL system and the integration and checkout of the MOL flight vehicle. Sufficient area shall be provided for all AGE and personnel necessary to perform systems tests required and to align, calibrate, or adjust the appropriate systems. Area shall be provided for the storage of critical spare components and elements as required.

A pyrotechnic installation facility shall be provided for the Gemini B at the location remote from the Industrial Area. The possible use of the solid motor Receiving Inspection and Storage (IRS) building in the ITL system shall be considered for this function.

3.3.8.2.2 Simulator Facilities

Facilities shall be provided as required to operate Mission Simulator in conjunction with the Mission Control Center and the world wide tracking net.

3.3.8.2.3 Engineering and Administration Facilities

An Engineering and Administration area shall be provided for the individual segment contractors, and Air Force and Aerospace personnel.

3.3.8.2.4 Mission Control Center

Facilities shall be provided for mission control and shall include provisions for housing all Mission Control Center equipment for display and control, data retrieval and storage, computation, on-orbit flight planning and changes, mission analysis, and biomedical support. Facilities necessary for the interconnection of the Mission Control Center with the ITL Launch Control Center, telemetry receiving stations, Mission Simulation Facility, Range Safety and Range Control, and range tracking station communications nets shall be installed.

3.3.8.3 Telecommunications, Tracking and Control Facilities

Additional facilities shall be provided as required to house and otherwise support the worldwide TT&C requirements specified in the TOSS Segment Section. Examples of such additional facilities are the Okinawa Station, and the voice communication stations at Wake and Suva Islands.

4.0 Verification & Test

4.0 Performance/Design Verification and Test

This section specifies the formal tests and verification methods required to demonstrate compliance of the MOL system. In addition, the test operations of the developed MOL system required to fulfill the MOL mission are specified.

The tests and verification demonstrations specified herein are those required at the overall system and major system segment levels and/or the general requirements which must be recognized in preparing Part I, section 4 of each contract end item specification.

4.1 Ground Test Requirements

4.1.1 Development Tests

4.1.1.1 General Requirements

Design development tests shall be performed to determine design feasibility, functional parameters, thermal and structural data, packaging and fabrication techniques, and environmental limitations. The majority of these tests shall be performed prior to design freeze; however, some tests are continued throughout the program.

4.1.1.2 Overall System Requirements

No "full scale" ground development tests at the overall system level are required. Subscale model wind tunnel tests of the TIIIC-Orbiting Vehicle shall be conducted to determine aerodynamic characteristics of the combined vehicle.

4.1.1.3 Orbiting Vehicle (OV) Requirements

4.1.1.3.1 Space Simulation Test

The orbiting vehicle shall be tested to a thermal and vacuum space simulation for 30 days to demonstrate the environmental and thermal control subsystems, the tunnel development, and the orbiting vehicle functional characteristics. The laboratory and Gemini B shall be used for this test. Other segments of the OV may be simulated. During this test specific performance of the normal and emergency crew transfer shall be accomplished. Contaminant measurements shall be made during this test.

4.1.1.3.2 Compatibility Test

Tests shall be conducted on the orbiting vehicle to demonstrate physical, functional and EMI compatibility.

4.1.1.3.3 Rendezvous and Docking Test

Simulations shall be performed to demonstrate the ability of the chase OV to perform the necessary rendezvous maneuvers. Docking tests shall be conducted for development and demonstration of the Rendezvous and Docking system, plumbing and electrical connections, and crew passage. Post-docking tests of all critical (e.g. ECS, power) subsystems shall be conducted.

4.1.1.3.4 Attitude Control Simulations

Appropriate air-bearing simulations to verify the control electronic and propulsion subsystem capability shall be performed for all control modes.

4.1.1.3.5 Antenna Tests

Complete antenna patterns of the laboratory and experiment segments shall be obtained with the simulated Gemini B and transtage attached.

4.1.1.4 Laboratory Vehicle Requirements

4.1.1.4.1 Structural Tests

Static tests shall be performed to limit and ultimate loads for the article design conditions to the specified structural criteria. Consideration shall be given to the thermal environment . Deformations shall not exceed the specified requirements.

Shock and vibration tests shall be performed with appropriate simulation of Gemini B, transtage and experiments.

4.1.1.4.2 Acoustic Test

The laboratory vehicle (or sections thereof) including mass simulated components shall be subjected to acoustic testing to determine the acoustic and vibration environments imposed on the lab vehicle subsystems and components. Laboratory subsystem prototypes shall be installed.

4.1.1.4.3 Subsystem Tests

Separate subsystem development tests shall be made to verify design adequacy.

4.1.1.4.4 Meteoroid and Particle Radiation Test

The ability of the lab vehicle to withstand meteroid impact and particle radiation shall be demonstrated by subjecting lab structural sections to simulated meteroid and particle radiation environment.

4.1.1.5 Gemini B Requirements

4.1.1.5.1 General

The Gemini B vehicle shall make maximum use of equipment and components developed and qualified for NASA Gemini. The requirements for Gemini B development testing shall be determined, based on an analysis of the changes to the NASA Gemini configuration and equipment necessary to meet the MOL environment and mission requirements. Two critical environments imposed on the Gemini B, not encountered by the NASA Gemini, are the TIII-C launch environment and the 30-day on-orbit standby. All components common to Gemini B and NASA Gemini shall be analyzed to determine the effects of these environments and the requirement for development and requalification testing. New and significantly modified components shall be designed to Gemini B criteria and shall undergo a complete development test program.

4.1.1.5.2 Wind Tunnel Tests

Static force, moment and pressure wind tunnel tests shall be performed on the Gemini B configurations where NASA Gemini data does not exist. These tests include those cases where the external configuration or flight parameters are significantly changed.

4.1.1.5.3 Space Environmental Tests

The effects of a prolonged period of inactivity and exposure to the space environments shall be determined by a thermal-vacuum space simulation test on the Gemini B system segment. Test of individual critical components shall be performed to assess the impact of the activation following a 30-day space standby environment. Component tests shall include environmental control, communication, electrical power, guidance and control, etc.

4.1.1.5.4 Shock and Vibration

Tests shall be performed for any shock and vibration criteria that is found to be in excess of NASA Gemini

4.1.1.5.5 Acoustic Noise

An acoustic noise test shall be performed on the Gemini B vehicle or vehicle section to determine the Gemini B vibration and acoustic criteria found to be in excess of NASA Gemini criteria.

4.1.1.5.6 Separation Tests

Staging separation tests shall be performed on the Gemini B, simulating on-orbit separation from the transtage.

4.1.1.5.7 Crew Transfer Tests

Tests shall be performed to demonstrate and verify the feasibility of the normal and emergency crew transfer between the Gemini B and the laboratory. Inflated suit and an incapacitated crewman in an emergency situation shall be simulated.

4.1.1.5.8 Abort Tests

Additional testing of the seat ejection system and the abort rockets shall be accomplished as necessary where changes are made from NASA Gemini environment and/or design to determine crew safety.

4.1.1.6 Experiments Requirements

Developmental simulations shall be required for all experiment sub-segments.

Complete development tests shall be performed for performance, temperature, shock, noise, vibration, strength, rigidity, EMI, maintainability, distortion, operability, etc.

Man-machine performance parameter shall be obtained where applicable.

4.1.1.7 Titan IIIC Requirements

Titan III-C vehicle shall be used for the MOL mission with minimum modifications as necessary to fulfill the MOL mission. Requirements for development testing shall be determined based on an analysis of Titan III changes required to meet the environments imposed by the MOL mission which exceed the present Titan III design requirements. The requirement for the transtage to perform for 30 days on-orbit, will require analysis and demonstration in a simulated thermal-vacuum environment. Additional restarts may require developmental testing.

4.1.1.8 Flight Crew and Crew Equipment Requirements

Maximum use shall be made of NASA Gemini Flight Crew equipment. Such equipment, as well as new and/or significantly modified Flight Crew equipment shall undergo complete development testing to demonstrate capability to meet MOL environmental storage, crew transfer, extravehicular, and other mission requirements.

4.1.1.9 Test Operational Support Segment (TOSS) Requirements

Development testing shall be conducted to demonstrate proper operation and compatibility of the TOSS with the Orbital Vehicle System Segment with which TOSS interfaces. Maximum use of simulation techniques such as computer mission simulation, data transfer runs, mock-flights, etc., shall be made for training and for developing early confidence in the performance of TOSS equipment and personnel for all phases of the MOL operations.

4.1.2 Qualification Tests

4.1.2.1 General Requirements

Qualification tests shall be performed to verify design adequacy and to demonstrate a minimum level of equipment performance and reliability. The test conditions shall be the design requirements and consist of time and stress level safety factors on the anticipated environments. Full qualification tests, including all applicable environments, shall be performed at the component or subsystem level. Limited qualification tests, such as thermal-vacuum and EMI, shall be performed at the system segment level. Appropriate qualification tests must be completed prior to the applicable flight.

4.1.2.2 Over-all System Requirements

Due to the size and complexity of the over-all MOL system, there are no qualification test requirements at this level of assembly. The qualification of the various system segments will constitute the qualification of the over-all system.

4.1.2.3 Orbiting Vehicle Requirements

An electro-magnetic interference qualification test shall be performed at CKAFS on the orbiting vehicle system as a complete system under conditions simulating pre-launch, launch, and on-orbit operations. Due to the size and complexity of the over-all flight vehicle there are no additional qualification test requirements at this level of assembly.

4.1.2.3.1 Mission Life Requirements

The system segments comprising the rendezvous mission orbiting vehicles and their subsystems shall be qualified for a life of sixty days on orbit. Integral launch mission orbiting vehicle segments and their subsystems shall be qualified for on-orbit life of thirty days.

4.1.2.4 Laboratory Vehicle Requirements

4.1.2.4.1 General

The laboratory vehicle system segment shall be qualified both at the system segment level and at the component/subsystem level. These requirements will be detailed in an AFSSD environmental requirements specification exhibit for the laboratory vehicle and components. These environments will be based on the environments defined in Section 3.1.3.4, Environments (Natural and Induced). In general, the components and/or subsystems will be tested to all applicable environments while the laboratory vehicle will be subjected to thermal-vacuum and EMI tests.

The crew transfer shall be qualified to the specified environmental requirements. The qualification tests of the laboratory shall be performed when possible on the laboratory, crew equipment, and experiments system which comprise the laboratory vehicle segment. The tests shall establish the capability of maintaining the required environment, electrical power, leakage rate, communication and data handling for the mission.

4.1.2.4.2 Rendezvous and Docking Equipment

The rendezvous and docking equipment, including the coupling mechanism, crew passage tunnel, electrical connections, and plumbing, shall be qualified to the specified environmental requirements including the ability to properly function for a period of sixty days on orbit.

4.1.2.5 Gemini B Requirements

The Gemini B system segment shall be qualified per the requirements of the Environmental Specification. Components and/or subsystems qualified for NASA Gemini shall not be arbitrarily requalified but shall be analyzed from previous testing and flight test history. In addition, the Gemini B System segment shall be subjected to a thermal vacuum and EMI qualification test. This test shall include, as a minimum, the sequence of operation on orbit, shut down and/or standby for an extended period of time and re-start and operation for re-entry.

4.1.2.6 Experiments Requirements

The experiments shall be qualified at the sub-segment or component level using as a basis the environmental requirements specified in SSD Exhibit 64-XX.

4.1.2.7 T-III Requirements

The T-III system segment shall be qualified per the requirements of AFSSD Exhibit 62-166A, "Environmental Requirements Specification, Program 624A", Rev. A, dated 1 July, 1964. The applicable subsystem of Titan III transtage shall be qualified for 30 days on orbit.

4.1.2.8 Space Crew and Crew Equipment Requirements

Crew equipment qualified for NASA Gemini shall not be arbitrarily requalified but shall be analyzed on a basis of environmental exposure from previous testing flight test history and contemplated usage in the MOL system environment. The crew system segment equipment shall be subjected to a qualification test including the sequence of mission operations from launch, on-orbit including extra-vehicular activities, re entry and recovery.

Training equipment and simulators shall be qualified to requirements consistent with their application and interfaces with other equipment as specified in the contract end items specifications.

4.1.2.9 Test Operational Support Segment (TOSS) Requirements

Formal qualification of the overall TOSS segment (equipment, personnel and procedures) shall be demonstrated by successful completion of the functional development testing and compatibility testing called out in Section 4.1.1.9. Qualification tests are required on new equipment and significantly modified equipment to demonstrate proper performance in the environment in which the equipment is normally required to function.

Experiment support equipment such as ground targets and special receiving facilities shall be qualified to meet the functional requirements of the experiment, the local installation environment and the operational life requirements specified in the experiment.

4.1.3 Effectiveness (Reliability) Testing

All testing performed on the MOL program is considered a part of the reliability effort. However, certain tests such as extended time tests, stress limit tests, and reliability tests are considered effectiveness tests. Extended time tests consist of cycling the component or subsystem to the critical environments such as vibration, temperature and altitude, to determine the safety margin of the equipment with respect to time. Stress limit tests consist of increasing the qualification test level until failure occurs, thereby determining the margin of safety with respect to stress level. Extended time and stress limit tests shall be phased in with the qualification test program.

4.1.4 Acceptance and Flight Readiness Tests

4.1.4.1 Acceptance Test Requirements

Acceptance tests shall be performed to improve equipment reliability by disclosing workmanship defects in time to permit corrections prior to end use of the equipment. These tests are applicable to all contract end items and deliverable equipment. The test conditions shall be comparable to end use environments and severe enough to detect and eliminate early-life failures but not so severe as to cause fatigue or wear out. A thermal-vacuum and a vibration acceptance test shall be conducted on the component or subsystem level. Other tests shall be required if the equipment is sensitive to other environments and workmanship errors are not readily detected by normal inspection methods. A thermal-vacuum acceptance test shall be performed at the system segment level where applicable. Acceptance Tests will be sufficient to assure Flight readiness test integration.

4.1.4.2 MOL System Flight Readiness Test Requirements

EMI, electrical and mechanical compatibility tests, functional operations and electrical and mechanical compatibility tests, functional operations and readiness tests performed at the launch site will constitute Flight Readiness Tests. Flight Readiness will be determined by these tests, plus the acceptance of the various system segments based on their acceptance tests.

4.1.4.3 Orbiting Vehicle Requirements

The acceptance of the laboratory, crew equipment and experiment system segments for the particular flight mission objectives together with a simulated Gemini B,transtage shall be based on mechanical, electrical, thermal, electromagnetic interference, and functional operational tests performed after integration of these segments to form the complete orbiting vehicle.

4.1.4.3.1 Rendezvous Mission Vehicles

The chase and target orbiting vehicles shall be acceptance tested at the system segment level with the mission peculiar equipment accepted at the subsystem and/or component level. In addition, a physical mating and separation of the orbiting vehicles shall be accomplished to demonstrate compatibility and proper functioning of all mechanical, plumbing and electrical connections.

4.1.4.4 Laboratory Vehicle Requirements

The laboratory vehicle system segment shall be acceptance tested at the system segment level.

4.1.4.5 Gemini B Requirements

The Gemini B system segment shall be acceptance tested similar to the acceptance tests performed for NASA Gemini but modified where necessary by MOL environmental requirements. In general, all components and/or subsystems shall have a vibration and a thermal-vacuum test performed as part of the acceptance test. In addition, the Gemini B system segment shall be acceptance tested to thermal-vacuum conditions.

4.1.4.6 Experiments Requirements

The experiments shall be acceptance tested at the sub-segment level using as a basis the environmental requirements.

4.1.4.7 Titan III Requirements

The Titan III system segment shall be acceptance tested to the requirements of AFSSD Exhibit 62-166A, "Environmental Requirements Specification, Program 624A", Revision A dated 1 July 1964. The Titan III transtage acceptance tests shall be modified for the on-orbit functions and the environments.

4.1.4.8 Crew and Crew Equipment Requirements

The crew and crew equipment [illegible] shall be acceptance tested at the component and/or subsystem level. These requirements will be detailed in an AFAMD/AFEFTC environmental requirements specification exhibit for the crew and crew equipment. In general, the components and/or subsystems will be acceptance tested to vibration and thermal-vacuum conditions while the system segment will be tested to thermal-vacuum conditions only.

Training equipment and simulators shall be acceptance tested to requirements of the contract end item specification and by complete functional operation. Compatibility with other subsystem and segments shall be demonstrated in all planned sequences and modes of operations.

4.1.4.9 Test Operational Support Segment (TOSS) Requirements

Formal acceptance of the overall TOSS shall be based on the successful completion of the functional development testing and compatibility testing called out in this section. Formal acceptance of individual new equipments is required and shall normally occur following installation of the equipment in its use location and functional testing to verify specified performance has been conducted.

4.2 MOL System Flight Test Requirements

4.2.1 Test Program Description

The complete MOL System Flight Test and Evaluation consists of formal testing and evaluation spanning the integration of all system segments into a complete system in the final operational configuration and environment. All MOL System Flights shall be launched from ETR with suitable instrumentation employed to determine the system functional performance, operability, and compatibility of the system segments. During the conduct of this phase of testing, system performance shall be compared to paragraph 3.0 Requirements of Part I of CEI Specifications, where test/verifications must be accomplished during system flight testing.

4.2.2 Sub-orbital Flight

The first flight shall be unmanned and sub-orbital. The Gemini B employed shall have operable subsystems, but the Laboratory shall be only structurally complete. The Gemini B shall be separated from the laboratory for retro, reentry, and recovery downrange. The primary objective of this test is to evaluate the initial performance of the MOL system, in relation to the requirements and operability goals, under conditions and environments closely approximating those of an actual mission. In particular, the test objectives should include: verification of the aeromechanics and launch environments of the Titan-IIIC, Laboratory and Gemini B combination; as well as safety of flight; laboratory subsystems operation; and operational readiness of the ground and flight systems.

4.2.3 Orbital Flights

The second MOL flight (first orbital flight) shall be either unmanned or manned with orbital characteristics corresponding to the mission. The Laboratory shall incorporate critical subsystems for initial evaluation and a Gemini B with fully operable subsystems. The flight shall be of short orbital duration. The mission duration shall be dependent upon Laboratory Subsystem status. The

Gemini B shall be separated for retro, reentry, and recovery in a primary recovery area. This effort shall demonstrate the initial orbital capabilities of the Gemini B and Laboratory systems and initially demonstrate the Test Operational Support system. As a manned mission, the flight will also allow a preliminary check of orbital capability of the crew, crew transfer to the Laboratory, and the critical laboratory subsystems. Verification of Gemini B Subsystems will be accomplished for launch, a short duration on-orbit mission, reentry, and recovery.

The third flight shall be manned and programmed for a 30-day orbital flight for demonstration of the Orbiting Vehicle system, as well as the capability of the TOSS to support a sustained orbital operation. This flight will incorporate primarily biomedical, human performance experiments, image velocity compensation, and target observation experiments, with other experiments on non-interference and schedule permitting bases.

Subsequent manned flights shall include the complete experiment payload required for demonstration of mission objectives. Because of payload limitations, all primary experiments cannot be carried on any one flight. One of the scheduling objectives shall be to install each primary experiment aboard at least two flights.

Secondary technology experiments shall be programmed so as to utilize the available factors of weight, volume, power, schedule, and crew duty cycles, in substantial accordance with their priority assignments.

4.2.4 Rendezvous Test Missions

The rendezvous mission shall be accomplished late in the flight test program with a target orbiting vehicle and a chase orbiting vehicle. The experiment payload and equipment will be compatible with the vehicle capability and generally consist of biomedical monitoring, human performance, extravehicular activity, vehicle and experiment maintenance, electromagnetic monitoring and observation of ground targets. These experiments may satisfy the objectives of the Navy integrated ocean surveillance experiment. The objective of the mission is to remain on orbit up to sixty days after exchanging one crew member, and transferring expendables such as atmosphere gas and electric power as required, while docked with the target orbiting vehicle.

The chaser orbiting vehicle shall be launched 15 to 30 days after the target vehicle. A tail to tail docking shall be accomplished, after which one crewman from each shall exchange positions. Connections shall be made for transfer of expendables and power and monitoring and signal circuits. The chaser orbiting vehicle normally shall remain docked with the target for the remaining time on orbit. The returning crew shall return with accumulated data parcels in one of the Gemini B's, leaving both orbiting vehicles to be operated by one crew consisting of an "old" and "new" member, who will return in the remaining Gemini B.

4.3 Engineering Changes

Deficiencies encountered during the system tests shall be completely detailed and Engineering Change Proposals (ECP's) or System Change Notices (SCN's) shall be issued, approved and accomplished for appropriate corrective action.

5.0 PREPARATION FOR DELIVERY

This section covers requirements for the preparation for delivery which are peculiar to the system (other than standard practice). Specific requirements for such non-standard practices shall be contained in appropriate Contract End Item Specifications. These shall include unusual requirements for:

a. Special pressure, thermal, or other environmental control required during transportation.

b. Peculiar hoists, handling dollies, containers, and/or protective covers.

c. Safety devices for ordnance/igniters.

d. Special methods, load, shock, etc., limitation during the handling process.

5.1 Packaging for Gemini B and Laboratory

Recommendations shall be made for the preservation, packaging, packing, marking, and storage/stowage requirements for the life support items, equipment, experiments, and equipment spares for Gemini B (See 3. 3. 3), and for both the pressurized and the unpressurized sections of the Laboratory (See 3. 3. 2). The recommendations shall reflect investigation for possible use of Space Packaging studies and techniques developed in connection with other manned programs. Environmental criteria and packaging hazards peculiar to each environment shall be defined, and testing programs, as required shall be outlined to assure compatibility of the packaging materials and methods that are recommended with these environments. Consideration shall be given to compatibility of the packaging with the crew handling restraints imposed by protective clothing, etc., alternative utilization of packaging materials, disposition of packaging waste, dimensional definition of each storage space, the limitations imposed on individual package design by storage considerations such as special racks, and measures for package restraint within the storage space.

6.0 NOTES

7.0 CONTRACTOR DATA AND REPORTS

Acquisition of data and reports will be in accordance with AFSCM 310-1/AFLCM 310-1.

8.0 SPECIFICATION TREE

The MOL Specification Structure shall be depicted in the form of a Tree. The following convention shall apply for the construction of the Specification Tree.

A CEI Specification shall be shown by a solid box for each CEI Specification to be prepared. (A CEI Specification is normally prepared for each piece of hardware or equipment which is accepted by the Air Force on a Form DD-250.)

Under the AFSCM 375-1 Specification System, functional type specifications will not be prepared. The information which would have been in this type of specification will now be included in the next higher level CEI Specification or the top system specification.

An example of a functional specification as used in the past would be a specification describing all AGE. Since AGE is accepted by the Air Force piece by piece on a Form DD-250, a CEI Specification will be required for each piece of AGE accepted on a DD-250, and a functional specification is no longer required.

To assist in developing an organization and structure to the Specification Tree (since a long row of CEI specifications all on the same level is not very meaningful), a dotted box will be used where a document does not actually exist but where it is desired to establish another structured level to the Tree.

As a general rule, a dotted box should be used wherever a functional subsystem can be identified which does not require a CEI Specification (i.e., is not accepted on a Form DD-250).

10.1

APPENDIX A

APPLICABLE DOCUMENTS

FOR THE

MOL SYSTEM PERFORMANCE/DESIGN REQUIREMENTS GENERAL SPECIFICATION

PREFIX KEY FOR APPENDIX A

CV	-	Civil
DA	-	Data and Reports
DG	-	Design and Construction
DR	-	Design and Construction Requirements
EE	-	Electrical
EI	-	Electromagnetic Interference
GP	-	Human Performance (Guidance)
HP	-	Human Performance (Applicable)
HY	-	Hydraulic
IC	-	Interchangeability
IM	-	Identification and Marking
MA	-	Maintainability
MP	-	Materials, Parts and Processes
MS	-	Maintenance Support
SE	-	System Effectiveness
SF	-	Safety
SS	-	Supply Support
ST	-	Storage
TR	-	Transportability
WK	-	Workmanship

APPENDIX B

Appendix B

3.1.2.3 Contract End Item List

> Only the Principal System CEIs will be called out here and references will be made to other CEI lists covering the minor CEIs

3.1.2.3.1 Standard Flight

- 3.1.2.3.1.1 MOL Flight Vehicle CEI
- 3.1.2.3.1.2 Laboratory Vehicle CEI
- 3.1.2.3.1.3 Gemini B CEI
- 3.1.2.3.1.4 Flight Crew Equipment CEIs
- 3.1.2.3.1.5 MOL Experiment CEIs
  - 3.1.2.3.1.5.1 MOL Experiments P-1, P-2, P-3, and P-8 CEI (Typical)
  - 3.1.2.3.1.5.2 MOL Experiment P-4
- 3.1.2.3.1.6 MOL Test Operations System CEIs
- 3.1.2.3.1.7 MOL Facilities CEIs
- 3.1.2.3.1.8 Lab Vehicle AGE CEIs
- 3.1.2.3.1.9 Gemini B AGE CEIs
- 3.1.2.3.1.10 Experiments AGE CEIs
- 3.1.2.3.1.11 TOSS AGE CEIs

3.1.2.3.2 Special for Flight

- 3.1.2.3.2.1 Modification Group List for Flight 1
- 3.1.2.3.2.2 Modification Group List for Flight 2
- 3.1.2.3.2.3 Modification Group List for Flight 3
- 3.1.2.3.2.4 Modification Group List for Flight 4
- 3.1.2.3.2.5 Modification Group List for Flight 5
- 3.1.2.3.2.6 Modification Group List for Flight 6
- 3.1.2.3.2.7 Modification Group List for Flight 7
- 3.1.2.3.2.8 Modification Group List for Flight 8

10.3

Appendix C

3.3.1.3 Interface Requirements

3.3.1.3.1 Scope

Only the major inter-contractor physical, functional, and procedural interfaces will be identified and controlled within the ICD (Interface Control Document) system indicated in this section. The minor inter-contractor interfaces will be identified and controlled by a subordinate document which will be called out within each of the identified ICD Areas. An associate contractor's internal interfaces (with his own or his subcontractor's interfaces) which do not affect another associate contractor will not be covered by this ICD system. Such internal interfaces will be included in the individual associate contractor's CEI specifications and will be controlled by that contractor's internal interface control system.

3.3.1.3.2 General

Each Interface Control Document Area shown in this Appendix represents a category of interfaces within which separate Interface Control Documents will be prepared, negotiated, approved, and enforced for each interface involving more than one associate contractor.

3.3.1.3.3 Outline Requirements

The groupings in the list of ICD Areas which follow are in the general order of the principal associate contractor involved in the interface. This specification will contain only a description of the general nature of the interface and an outline of the document contents for each interface area identified. A typical example of such an outline follows:

ICD Area 1: Gemini B/Laboratory Interface
(Applicable Interface Control Documentation No. ______)

1. Scope
   1.1 General Description of Interface Area
   1.2 Intended Usage
   1.3 Contractor Responsibilities and Role
   1.4 Interface Drawings
   1.5 Changes to Specifications

2. Applicable Documents
   2.1 Subordinate ICDs

3. Interface Requirements
   3.1 General
   3.2 Mechanical Interface
   3.3 Electrical/Electronic Interface
   3.4 Environmental Control
   3.5 Crew Interactions
   3.6 Aerospace Ground Equipment Interface
   3.7 Data Transfers
   3.8 Aerodynamics
   3.9 Mass Property Data
   3.10 Effectiveness Apportionments
   3.11 Interchangeability
   3.12 Special Features
      3.12.1 Adapters

4. Test Criteria and Interface Inspection Requirements

3.3.1.3.4 ICD Area List

ICD Area 1: Gemini B/Laboratory
ICD Area 2: Gemini B/Experiments
ICD Area 3: Gemini B/Modification Group List Per Flight 1
ICD Area 4: Gemini B/Modification Group List Per Flight 2
ICD Area 5: Gemini B/Modification Group List Per Flight 3
ICD Area 6: Gemini B/Modification Group List Per Flight 4
ICD Area 7: Gemini B/Modification Group List Per Flight 5
ICD Area 8: Gemini B/Modification Group List Per Flight 6
ICD Area 9: Gemini B/Modification Group List Per Flight 7
ICD Area 10: Gemini B/Modification Group List Per Flight 8
ICD Area 11: Gemini B/Space Crew
ICD Area 12: Gemini B/TOSS
ICD Area 13: Gemini B/T-IIIC

ICD Area 14: Laboratory/Experiments
ICD Area 15: Laboratory/Space Crew
ICD Area 16: Laboratory/T-IIIC
ICD Area 17: Laboratory/Modification Group List Per Flight 1
ICD Area 18: Laboratory/Modification Group List Per Flight 2
ICD Area 19: Laboratory/Modification Group List Per Flight 3
ICD Area 20: Laboratory/Modification Group List Per Flight 4
ICD Area 21: Laboratory/Modification Group List Per Flight 5
ICD Area 22: Laboratory/Modification Group List Per Flight 6
ICD Area 23: Laboratory/Modification Group List Per Flight 7
ICD Area 24: Laboratory/Modification Group List Per Flight 8
ICD Area 25: Laboratory/TOSS

ICD Area 26: Experiments/Space Crew
ICD Area 27: Experiments/TOSS
ICD Area 28: Experiments/Data Management
ICD Area 29: Experiment/Experiments
ICD Area 30: Experiments/T-IIIC
ICD Area 31: Experiments/Modification Group List Per Flight 1
ICD Area 32: Experiments/Modification Group List Per Flight 2
ICD Area 33: Experiments/Modification Group List Per Flight 3
ICD Area 34: Experiments/Modification Group List Per Flight 4
ICD Area 35: Experiments/Modification Group List Per Flight 5
ICD Area 36: Experiments/Modification Group List Per Flight 6
ICD Area 37: Experiments/Modification Group List Per Flight 7
ICD Area 38: Experiments/Modification Group List Per Flight 8

ICD Area 39: Data Management System/Laboratory

ICD Area 40: Space Crew/TOSS
ICD Area 41: Space Crew/Modification Group List Per Flight 1
ICD Area 42: Space Crew/Modification Group List Per Flight 2
ICD Area 43: Space Crew/Modification Group List Per Flight 3
ICD Area 44: Space Crew/Modification Group List Per Flight 4
ICD Area 45: Space Crew/Modification Group List Per Flight 5
ICD Area 46: Space Crew/Modification Group List Per Flight 6
ICD Area 47: Space Crew/Modification Group List Per Flight 7
ICD Area 48: Space Crew/Modification Group List Per Flight 8

ICD Area 49: TOSS/T-IIIC
ICD Area 50: TOSS/Modification Group List Per Flight 1
ICD Area 51: TOSS/Modification Group List Per Flight 2
ICD Area 52: TOSS/Modification Group List Per Flight 3
ICD Area 53: TOSS/Modification Group List Per Flight 4
ICD Area 54: TOSS/Modification Group List Per Flight 5
ICD Area 55: TOSS/Modification Group List Per Flight 6
ICD Area 56: TOSS/Modification Group List Per Flight 7
ICD Area 57: TOSS/Modification Group List Per Flight 8
ICD Area 58: TOSS/Data Management System