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~~CONFIDENTIAL~~ 06264

PRELIMINARY PERFORMANCE/
DESIGN REQUIREMENTS

FOR THE

MANNED ORBITING LABORATORY SYSTEM
(MOL)

GENERAL SPECIFICATION FOR

NOVEMBER 1964

HEADQUARTERS
SPACE SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE

SPECIAL HANDLING REQUIRED
NOT RELEASABLE TO FOREIGN NATIONALS.

DOWNGRADED AT 12 YEAR INTERVALS.
NOT AUTOMATICALLY DECLASSIFIED
DOD DIR 5200.10

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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.

Military specifications, standards, exhibits, manuals, regulations, publications, bulletins, pamphlets, and other documents are herein 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.

A two letter prefix code is provided to assist in associating those documents which are applicable to a particular type of specification requirement. This prefix code is indicated in the applicable sections of this specification, such as Safety, General Design and Construction Requirements, Workmanship, etc. The key to the prefix code follows:

CV	-	Civil
DG	-	Design and Construction (Guidance only)
DR	-	Design and Construction Requirements
EE	-	Electrical
EI	-	Electromagnetic Interference
GP	-	Human Performance (Guidance)
HP	-	Human Performance (applicable)
HY	-	Hydraulic
IM	-	Identification and Marking
MP	-	Materials, Parts, and Processes
MS	-	Maintenance Support
SF	-	Safety
ST	-	Storage
WK	-	Workmanship

2.1 SPECIFICATIONS AND STANDARDS.

2.1.1 MIL Specifications.

MIL-A-8421B General Specification for Air Transportability Requirement, 5 May 1960

EE	-	MIL-C-5015	Connectors, Electric, AN Type
IM	-	MIL-C-18012	Control Configuration and Markings
IM	-	MIL-C-25050	Colors, Aero Lignts and Lighting Equipment, General Specification for
EE	-	MIL-C-26482 (Suppl 1)	Connectors, Electric, Circular, Miniature Quick Disconnect, 10 Aug 1962
MS	-	MIL-C-45662A	Calibration of System Requirements
SF	-	MIL-D-9310	Safety Hazard Analysis
		MIL-D-70327	Drawings, Engineering Assoc. Lists
HP	-	MIL-D-26239A	Data, QQPRI
EE	-	MIL-E-4158E	Electronic Equipment, Ground, General Requirement for
		MIL-E-5272C	Environmental Testing, Aeronautical and Assoc. Equipment, General Specification for
DR	-	MIL-E-5400F	Electronic Equipment, Aircraft, General Specification for
EE	-	MIL-E-6051C	Electro-Electronic System Compatibility and Interference Control Requirement
EE	-	MIL-E-19600	General Specification for Electronic Modules
EE	-	MIL-E-0025366B	Electrical and Electronic Equipment and Systems, Guided Missiles, Installation, General Specification for
		MIL-F-7179	Finishes and Coatings, General Specifications for Protection of Aerospace Weapons Systems, Structures and Parts
HY	-	MIL-H-25475A	Hydraulic Systems, Missile, Design, Installation Test and Data Requirement, General Requirement for
HP	-	MIL-H-27894A	Human Engineering Required for Aerospace Systems and Equipment

	MIL-HDBK-300	Technical Information File of AGE for Air Weapon System
WK -	MIL-I-4520B	Inspection System Requirement
EI -	MIL-I-6181B	Interference Control Requirements Aircraft Equipment
	MIL-I-8500B	Interchangeability and Replaceability of Component Parts
EI -	MIL-I-26600	Interference Control Requirement, Aeronautical Equipment
DR -	MIL-M-8090C	Mobility Requirement, Ground Support Equipment, General Specification for
DR -	MIL-M-8555	Missiles, Guided: Design and Construction, General Specification for
GP -	MIL-M-26512C	Maintainability Requirement for Aerospace System and Equipment. with Exceptions as Specified in Attachment 1 to SSD Exhibit 62 - 170
IM -	MIL-N-18307	Nomenclature and Nameplates for Aeronautical Electronic and Associated Equipment
ST -	MIL-P-116C	Preservation, Methods of
HY -	MIL-P-5518C (Suppl. 1)	Pneumatic Systems, Aircraft, Design, Installation and Data Requirement for
DR -	MIL-P-9024B	Packaging, Air Weapon Systems. Specification and General Design Requirement for
MS -	MIL-Q-9858A	Quality Control System Requirements
DR -	MIL-S-852B	Handling Ground Equipment, General Requirements for
	MIL-S-8512B	Support Equipment, Aeronautical, Special General Specification for the Design of
	MIL-S-38000	Qualified Parts Lists
SF -	MIL-S-38130	Safety Engineering of Systems, and Associated Subsystems and Equipment

IM	-	MIL-STD-130A	Identification Marking of U.S. Military Property
DG	-	MIL-STD-143A	Specifications and Standards, Order of Precedence for the Selection of
IM	-	MIL-STD-195	Marking of Connections for Electric Assemblies
		MIL-STD-210	Climatic Extremes for Military Equipment
		MIL-STD-447	Definition of Interchangeable Substitute and Replacement Items, 29 May 1962
IM	-	MIL-STD-795	Colors
GP	-	MIL-STD-803	Human Engineering Design Criteria for Aerospace Systems and Equipment
		MIL-STD-810	Environmental Test Methods for Aerospace and Ground Equipment
EI	-	MIL-STD-826	Electromagnetic Interference Test Requirement and Test Methods
IM	-	MIL-STD-1247	Identification of Pipe, Hose, and Tube Lines for Aircraft, Missiles, Space Vehicles, and Associated Support Equipment and Facilities
HP	-	MIL-T-27382	Training Equipment, Subsystem, Technical Data, Preparation of
EE	-	MIL-W-8160D (Amend. 1)	Wiring, Guided Missiles, Installation of, General Specification for
DG	-	MIL-W-9411A	System Classification of Critical Characteristics
IM	-	MS-24123A	Plate Identification
MP	-	MS-33586A	Metals, Definition of Dissimilar

Air Force BMD/BSD/SSD Exhibits.

IM	-	BMD 58-20A	Gas, Fluid Line Identification
GP	-	BMD 59-17C	Training Equipment Procurement for AFBM and Military Space Systems
IM	-	BMD 59-31	Color Requirement for Space System Ground Equipment and Facility Items

GP -	BMD 60-1	PSS Testing for Ballistic Missile and Space Systems
GP -	BSD 61-99	Human Engineering, General Specification
GP -	BSD 63-19	PSS (Personnel Subsystem)
IM -	SSD 61-70A	Identification Requirements
	SSD 61-81	Compliance Specification
WK -	SSD 62-117	Reliability and Quality Assurance Program Required
	SSD 62-128	Titan III AGE Design Req.
	SSD 62-130	Facilities Requirement, General Specification
GP -	SSD 62-131	PSS Requirement, General Specification
GP -	SSD 62-162	Basic Data for PSS Development Specification
	SSD 62-166A	Environmental Requirement Specification Rev. A, 1 July 1964
ST -	SSD 62-181	Preservation to Packaging, Packing and Container Marking of Equipment, and Spare Parts for Shipment and Storage for Space/Satellite Systems
	SSD 63-14	Spare Parts Provisioning Requirements
DR -	SSD 63-3	Engineering for Transportability

2.1.3 Federal Standards.

IM -	FED-STD-5	Standard Guides for Preparation of of Item Identifications by Government Suppliers
IM -	FED-STD-595	Colors

2.2 MANUALS, REGULATIONS, PUBLICATIONS.

2.2.1 SSD Documents.

WK -	SSD Pamphlet 375-1-1	Quality Assurance

2.2.2 Air Force Regulations (AFR).

HP -	AFR 30-8	Development of a Personnel Subsystem for Aerospace Systems
SF -	AFR 32-20	Responsibilities for Explosive Safety Program
HP -	AFR 50-19	Management of Training Equipment
IM -	AFR 71-6	Preservation, Packaging, Packing, and Marking Policy
DG -	AFR 73-1	Defense Standardization Program
IM -	AFR 74-2	Identify Calibrations Requirements of Systems, Subsystems & Equipment
HP -	AFR 84-7	Requirements for Contractor Operating Procedures and Flight Crews
SF -	AFR 160-3	Hazardous Noise Exposure

2.2.3 Air Force Manuals (AFM).

SF -	AFM 32-3	Accident Prevention Handbook
SF -	AFM 32-6	Explosives Safety Manual
SF -	AFM 71-4	Packaging and Handling of Dangerous Materials for Transportation by Military Aircraft
CV -	AFM 86-8	Airfield and Airspace Criteria
	AFM 88-2	Definitive Designs of Air Force Structures
SF -	AFM 127-201	Accident Prevention Handbook

2.2.4 Air Force Procurement Instructions (AFPI).

SF -	AFPI 7-4047	Safety and Accident Prevention
SF -	AFPI 7-4048	Safety Precautions for Dangerous Materials

2.2.5 Air Force Pamphlets (AFP).

MP -	AFP 88-002-1	Evaluation of New Materials and/or Methods of Construction for Air Force Facilities

CV - AF 88-009-1	Miscellaneous Instructions and Criteria for Design and Construction of Air Force Facilities

2.2.6 AFSC Regulations (AFSCR).

HP - AFSCR 80-16	Personnel Subsystems Program for Aerospace, Support & Command & Control Systems
MP - AFSCR 400-3	Joint Use of Contractors' In-Production Support Materials and Operational Support Spares in Selected Missile Programs

2.2.7 AFSC Manuals (AFSCM).

DR - AFSCM 80-1	Handbook of Instructions for Aircraft Designers, Vol I, II, III
DR - AFSCM 80-3	Handbook of Instructions for Aerospace Personnel Subsystem Designers (NIAPSD)
DR - AFSCM 80-5	Handbook of Instruction for Ground Equipment Designers (HIGED)
DR - AFSCM 80-6	Handbook of Instructions for AGE Designers (HIAGED)
DR - AFSCM 80-7	Handbook of Instructions for Aerospace Vehicle Equipment Design
DR - AFSCM 80-8	Handbook of Instructions for Missile Designers
DR - AFSCM 80-9	Handbook of Instructions for Aerospace Systems Design
DG - AFSCM 81-1	Specifications and Standards Manual
AFSCM 310-1 (AFLCM 310-1)	Vol I and II - Management of Contractor Data and Reports
AFSCM 375-1	Configuration Management During (All) Phase

2.2.8 Bulletins

ANA Bulletin 400T	Electronic Equipment, Aircraft & Guided Missiles, Applicable Documents, Mar 1963

USAF Bulletin No. 515		Material Review Procedures

2.3 OTHER DOCUMENTS.

IM	-	AFLCM 65-3 (Part IV)	Source and Maintenance Coding USAF Aeronautical and Supporting Equipment
MP	-	ASPR 7-105.7	Material Inspection and Receiving Report "DD Form 250"
MS	-	DCAS Checklist 61-87	Weapon System/Equipment Operations and Maintenance Records
DG	-	DOD Manual 200A	Defense Standardization Manual
SF	-	ICC Tariff No. 15	Requirements for Transport of Explosives
--		--	NASA Life Science Data Book
EE	-	NEC	National Electric Code -1959
SF	-	T.O. 00-11C-1-6	General Safety Procedures for Chemical Guided Missile Propellants
MS	-	T.O. 33-1-14	Repair, Calibration and Certification of Precision Measurement Equipment
		WADC TR 52-321	Anthropometry of Flying Personnel, 1950 dated Sept. 1954

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 Vehicle consists of a Laboratory, a modified Gemini spacecraft (Gemini B), and the transtage of Titan IIIC. This will be launched by Titan IIIC from Cape Kennedy. During the ascent to orbit the flight crew will be in the Gemini B, will 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 flight crew will be the primary source of on-orbit flight decisions.

Orbiting Vehicle operations involving orbital abort, attitude control, translational control, transtage engine maneuvers, 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 flight 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 flight crew and mission control functions will be controlled from a mission control center (MCC). A network of tracking and data acquisition stations will provide world-wide communications 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 flight 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 chase vehicle will be launched 15 to 30 days after the target vehicle. The chase vehicle 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 by manual control and visual reference. Interchange of one flight crew member between chase and target Orbiting Vehicles will be accomplished and one Gemini B will return to earth. The two Laboratory Vehicles and a Gemini B will remain on orbit an additional full mission period.

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 flight 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 flight crew to the Gemini B, 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 flight crew, Gemini B, 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 Flight Crew Launch Occupancy.

The time to launch a MOL system after flight crew insertion in the Gemini B 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 flight crew enters the Gemini B.

3.1.1.1.2.3 Flight Crew Escape.

Prior to lift-off, escape from the MOL Vehicle in the event of an emergency shall be by egress from the flight 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 Gemini B 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.M. perigee and 160 N.M. apogee, then circularized at approximately 160 N.M. Nominal orbit inclination shall be 32°.

3.1.1.1.3.4 Communication.

The system shall provide communication between the flight crew in the Gemini B and the mission control center (MCC) during all portions of powered ascent.

3.1.1.1.3.5 Flight Crew Escape.

A flight crew escape system shall be provided which will allow safe escape and recovery if 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. M. 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. M. throughout the mission.

3.1.1.1.4.4 Abort.

The system shall be capable of retrieving the MOL flight 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. Flight 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 flight 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 flight crew between the Gemini B and the Laboratory shall normally be accomplished within a pressurized tunnel which provides protection from the space environment. Capability for extravehicular 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 flight 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 of 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 flight 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 flight crew.

3.1.1.1.5.3 Retrofire Orientation.

Re-entry and de-boost data shall be provided the Gemini B flight 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 N. M., and downrange 400 N. M. 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.

3.1.1.1.6.1 Flotation.

Following water impact, the Gemini B shall float in a command-flight crew 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 flight crew, Gemini B, 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 flight 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 a chase vehicle, 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 chase 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 flight crew 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 Laboratory Vehicle contractor's facility as appropriate. Those system segments of the Orbiting Vehicle which are supplied to the Laboratory 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 Circulation 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 (SSD), AFSC.

3.1.1.1.10.2 Launch Operations.

Launch operations are the responsibility of SSD, 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 flight crew shall be the responsibility of SSD. 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 (MCC) shall be operated by SSD and supported by NRD.

3.1.1.1.10.4 Experiment Operations.

Experiment equipment, developmental simulators, procedures, and data analysis, shall be supplied by SSD, and the U. S. Navy. The

Aerospace Corporation is responsible for providing general systems engineering and technical direction for SSD Contractors, as well as for the coordination and integration task.

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.

3.1.1.2.1 Supply Support.

3.1.1.2.1.1 Spare parts support for the Laboratory Vehicle, Gemini B, Experiments, Flight Crew Equipment, T-IIIC and attendant AGE shall be provided in accordance with SSD 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 flight crew capability for 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 paragraph 2.0 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. 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: Flight Crew and Ground Crew. These are treated separately in this specification and throughout the program.

The Flight Crew, their flight equipment, and training requirements are described in Section 3.3.5. Ground Crew 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)

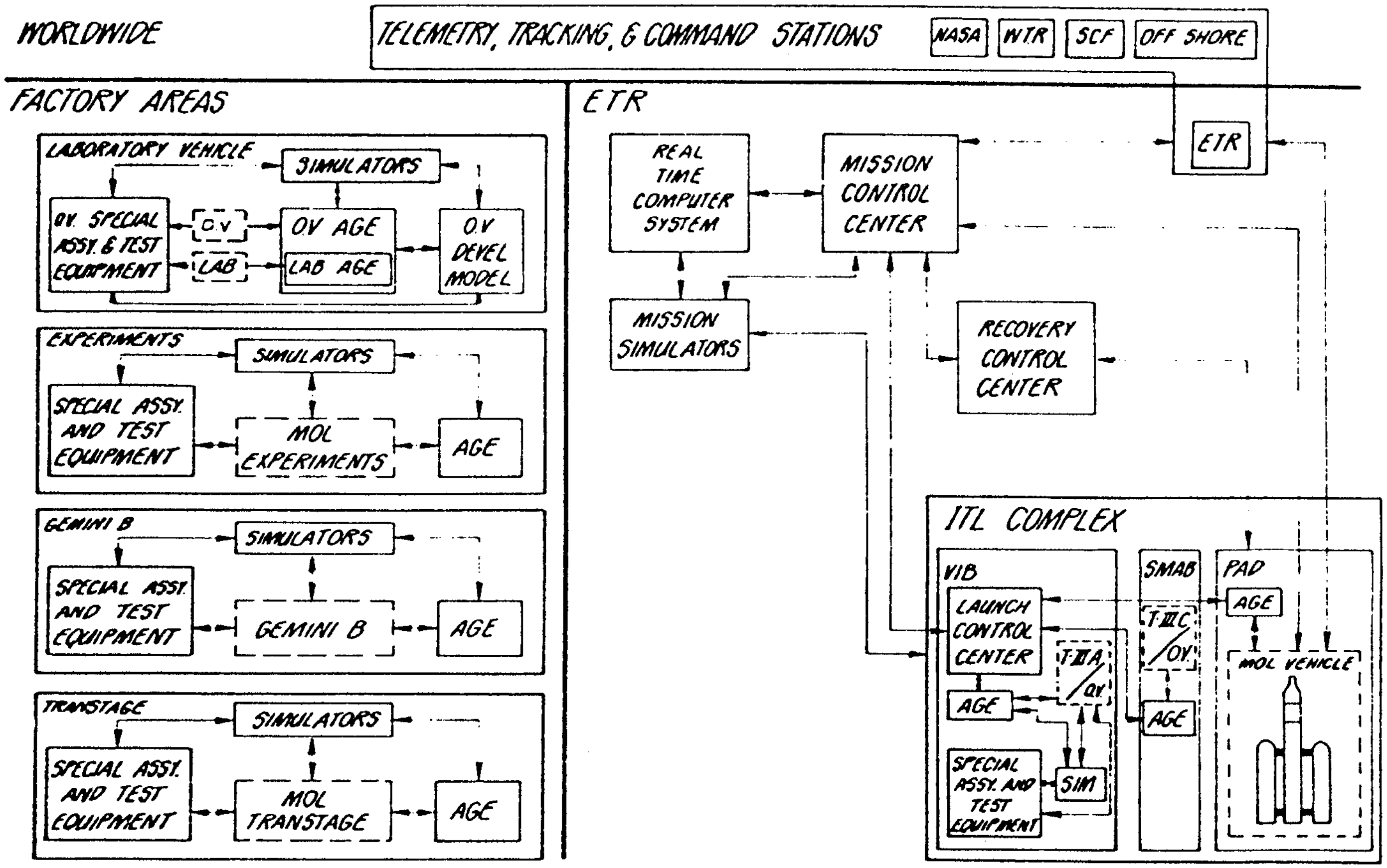
b. "Perform MOL Rendezvous Mission and Recovery Operations" (Figure 3.1.2.1.2.3.b)

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

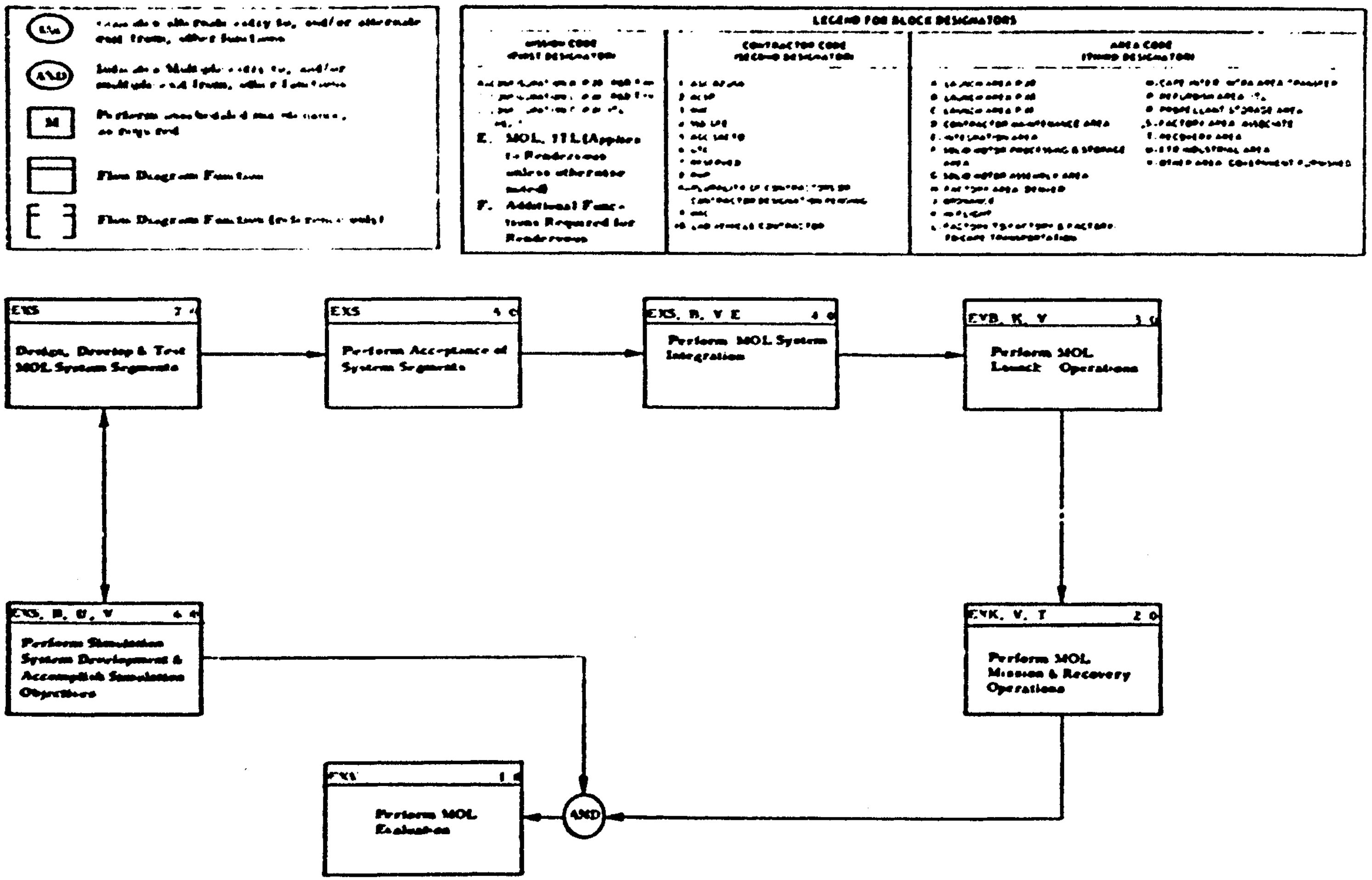
3.1.2.1.2.5 MOL System First Level Function Flow Diagram "Perform System Integration and Pre-Launch Operations" (Figure 3.1.2.1.2.5).

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).

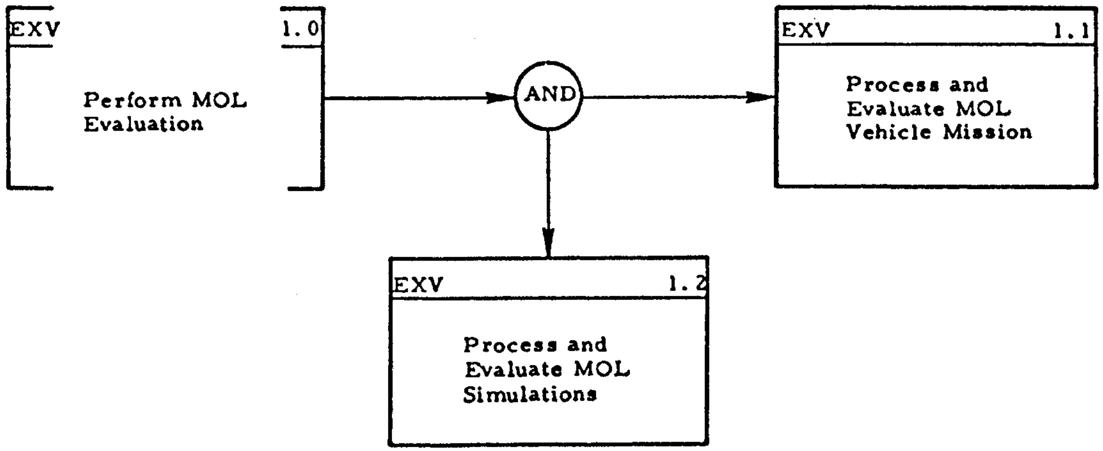


3.1.2.1.1 MOL SYSTEM SCHEMATIC DIAGRAM

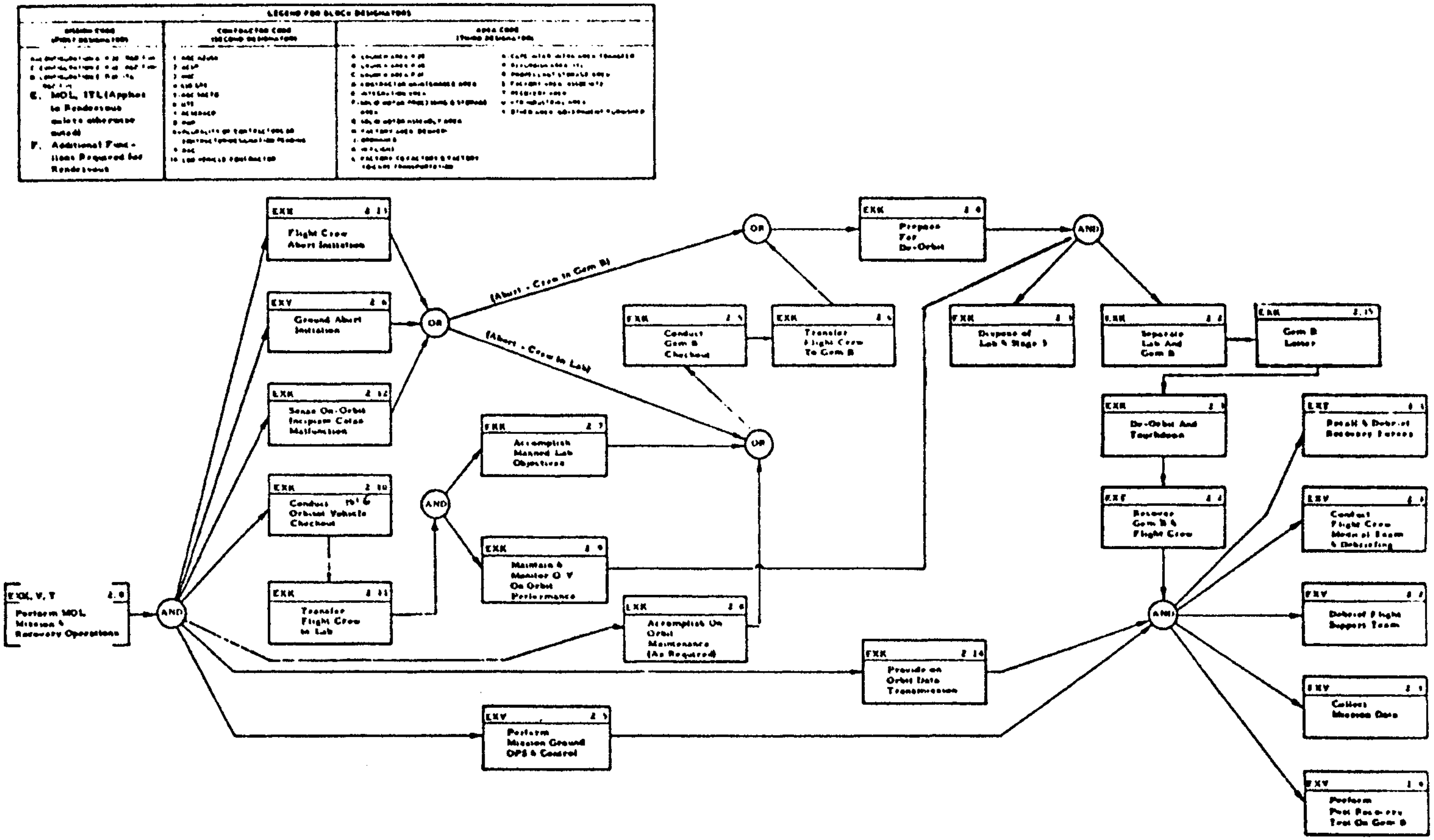


3.1.2.1.2.1 MOL SYSTEM TOP LEVEL FUNCTIONAL FLOW DIAGRAM

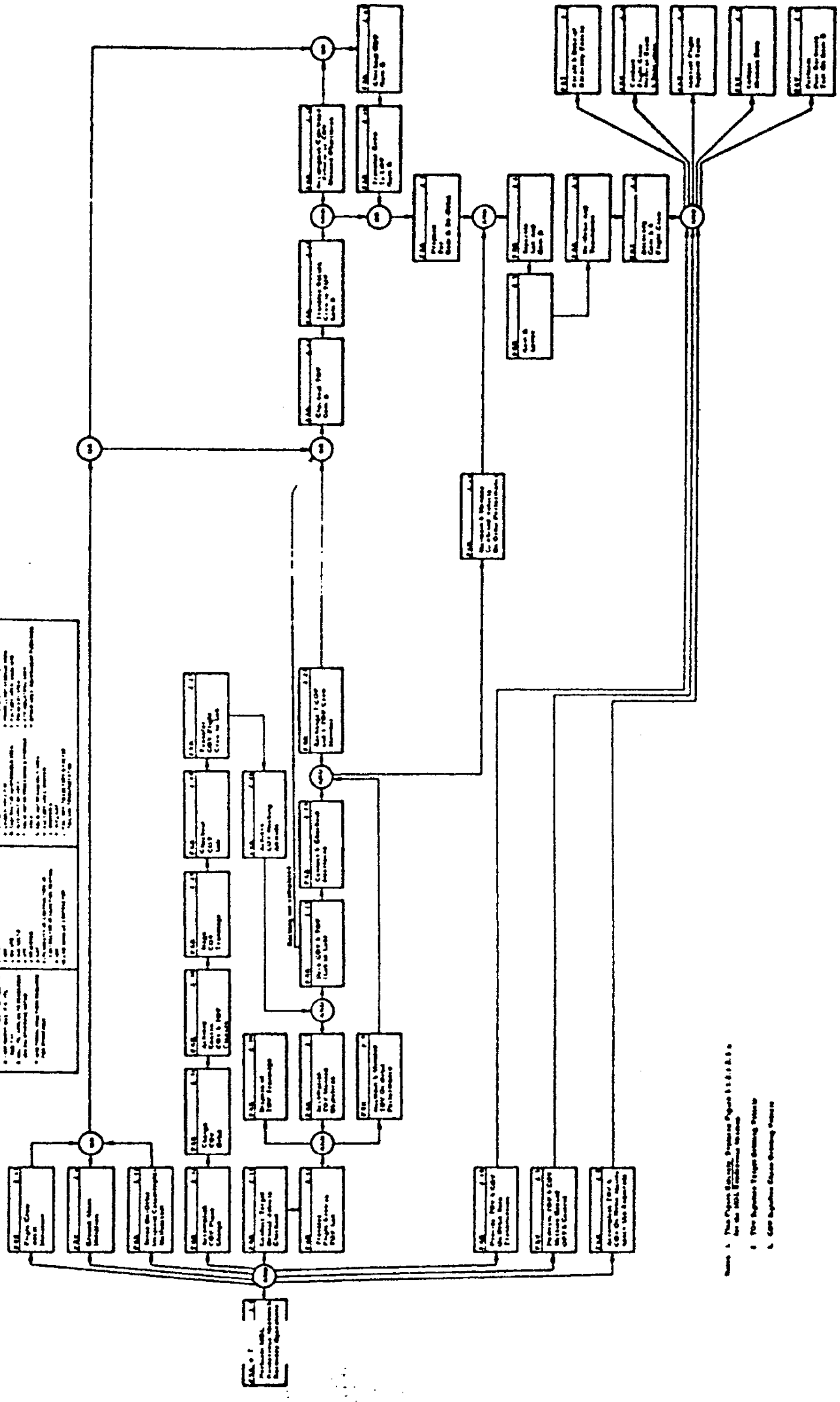
LEGEND FOR BLOCK DESIGNATORS		
MISSION CODE (FIRST DESIGNATOR)	CONTRACTOR CODE (SECOND DESIGNATOR)	AREA CODE (THIRD DESIGNATOR)
A–CONFIGURATION A, P-20, (R&D T-III) C–CONFIGURATION C, P-40, (R&D T-III) O–CONFIGURATION C, P-41, ITL, (R&D T-III) E. MOL, ITL (Applies to Rendezvous unless otherwise noted) F. Additional Functions Required for Rendezvous	1–AGC AZUSA 2–ACSP 3–MMC 4–SSO 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)



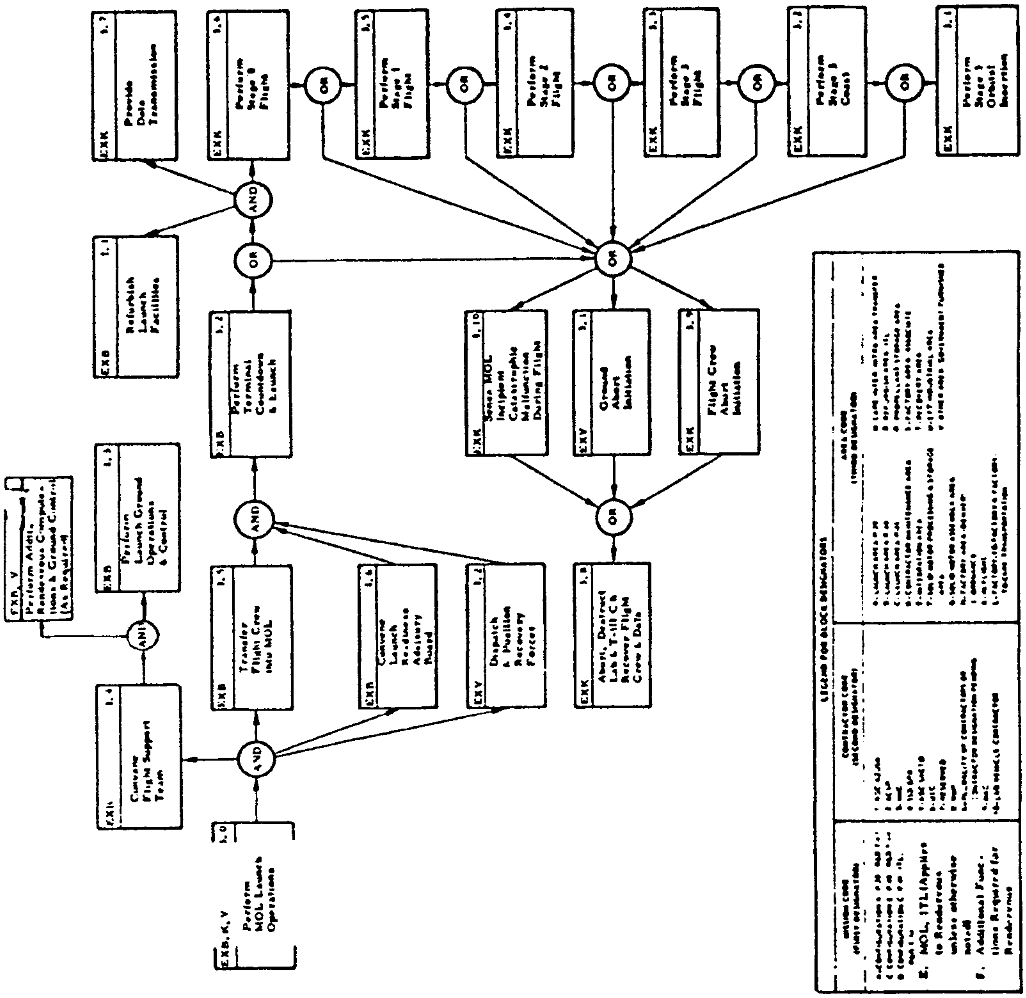
3.1.2.1.2.2 MOL SYSTEM FIRST LEVEL FUNCTIONAL FLOW DIAGRAM
"Perform MOL Evaluation"



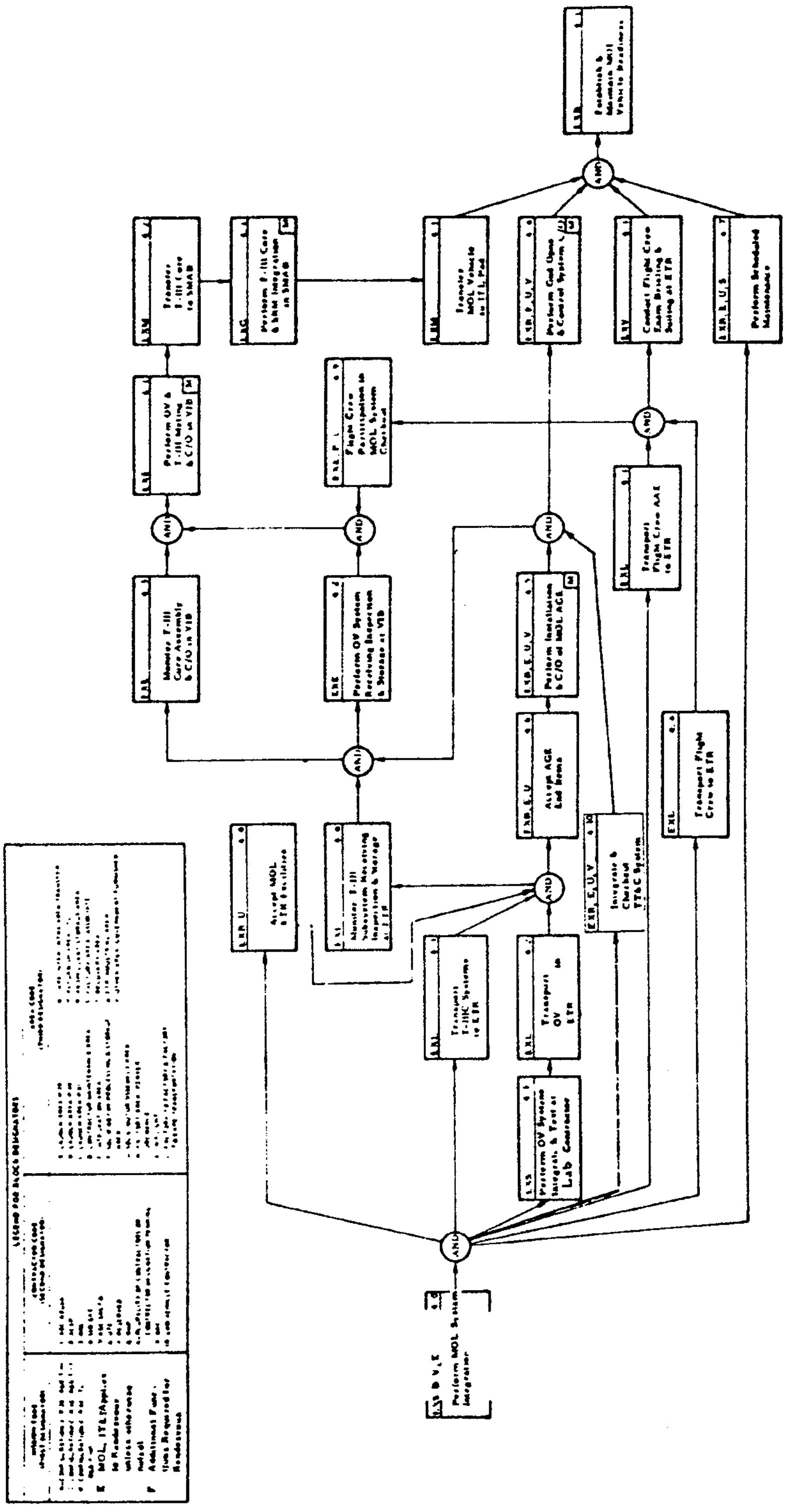
3.1.2.1.2.3.a MOL SYSTEM FIRST LEVEL FUNCTIONAL FLOW DIAGRAM
"Perform MOL Mission & Recovery Operations"
(Not Applicable to Rendezvous Mission - See 3.1.2.1.2.3.b)



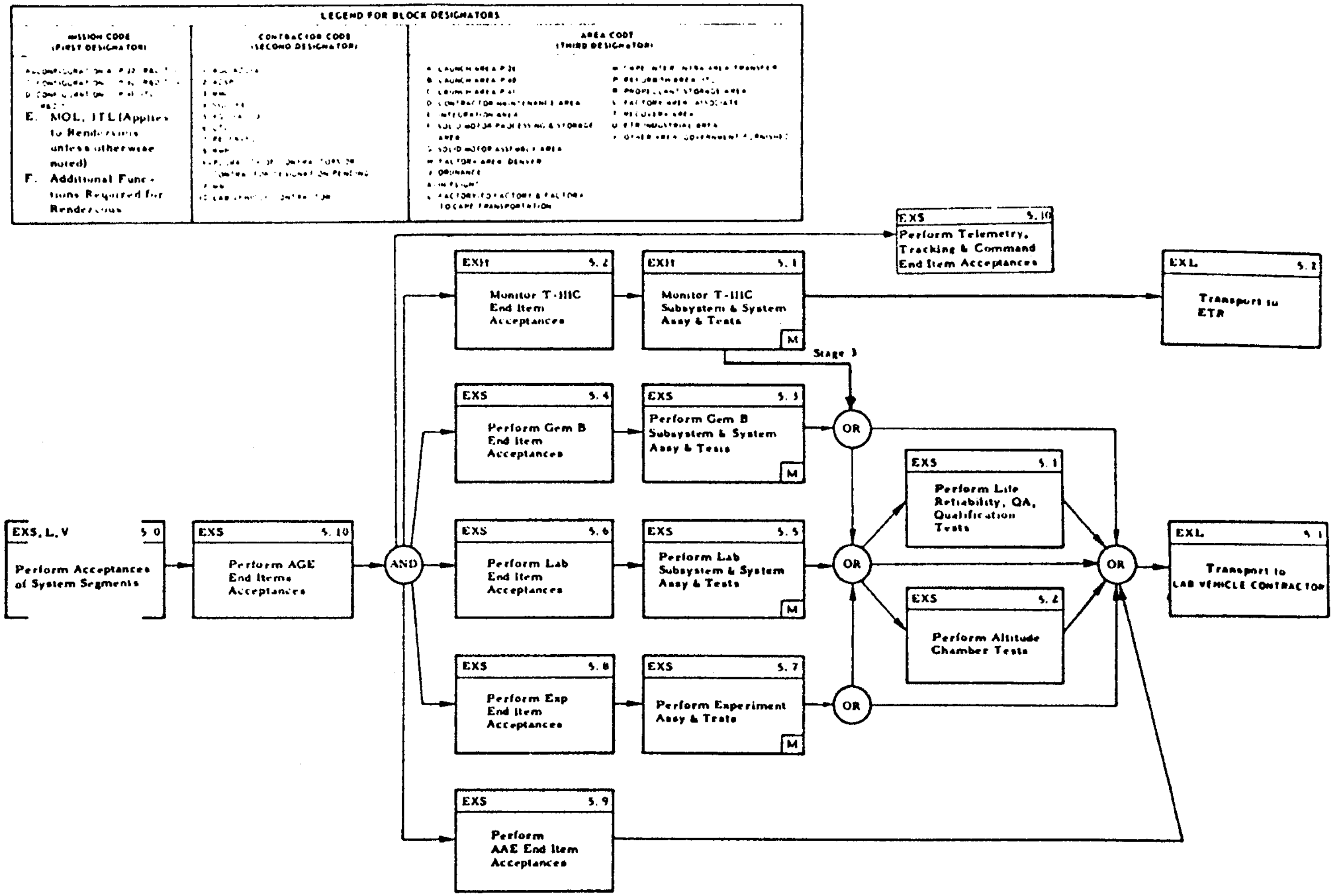
3.1.2.1.2.3.b MOL SYSTEM FIRST LEVEL FUNCTIONAL FLOW DIAGRAM
"Perform MOL Rendezvous Mission & Recovery Operations"



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

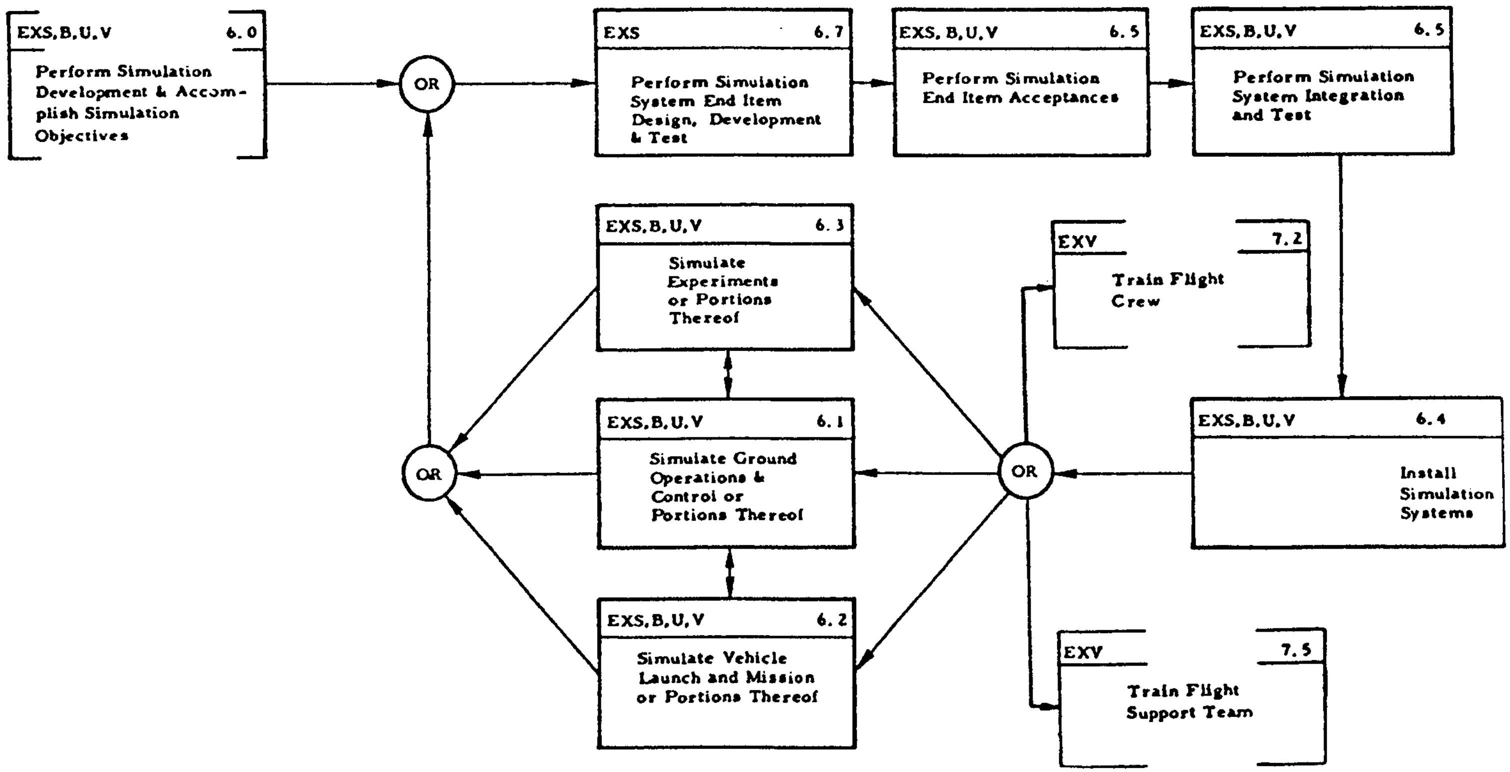


3.1.2.1.2.5 MOL SYSTEM FIRST LEVEL FUNCTIONAL FLOW DIAGRAM
"Perform MOL System Integration"



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 P20 R&D THRU C-CONFIGURATION C P40 R&D THRU D-CONFIGURATION C P41 ITL E. MOL, ITL (Applies to Rendezvous unless otherwise noted) F. Additional Functions Required for Rendezvous	1-AGC AZUSA 2-ACLP 3-MMC 4-SSD GFE 5-AGC SACTO 6-UTC 7-RESERVED 8-PMP A-PLURALITY OF CONTRACTORS OR CONTRACTOR DESIGNATION PENDING 9-MAC 10-LAB VEHICLE CONTRACTOR	A-LAUNCH AREA P20 B-LAUNCH AREA P40 C-LAUNCH AREA P41 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 and Test MOL Vehicle System Segments" (Figure 3.1.2.1.2.8).

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.

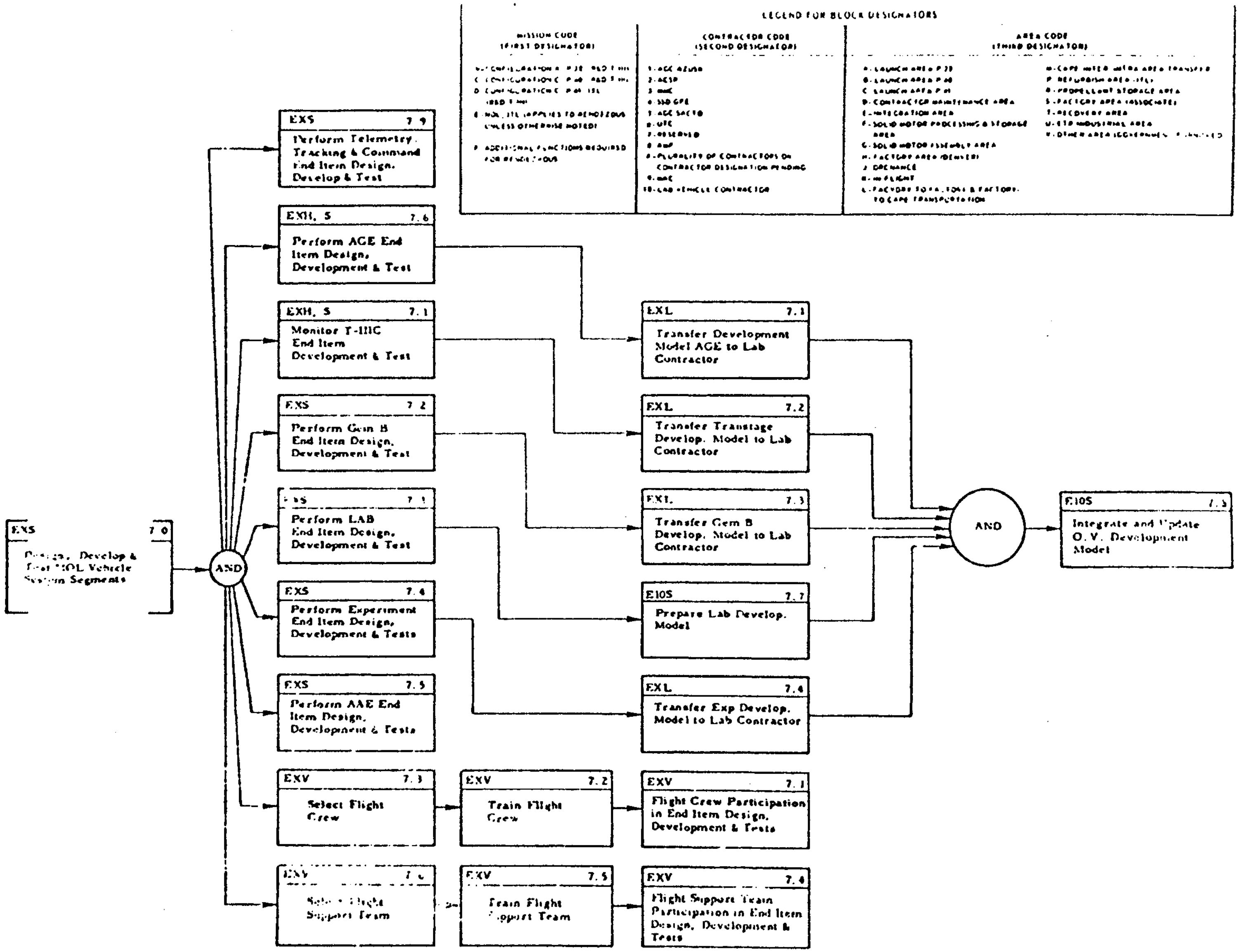
This consists of a number of independent or inter-related experimental programs, each of which may be considered a sub-segment. Developmental simulators are included under each experiment.

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.



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

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.

(See appropriate paragraph in each system segment section.)

3.1.2.3.1 Special Flight CEI's.

3.1.2.3.1.1 Modification Group List for Flight 1.

3.1.2.3.1.2 Modification Group List for Flight 2.

3.1.2.3.1.3 Modification Group List for Flight 3.

3.1.2.3.1.4 Modification Group List for Flight 4.

3.1.2.3.1.5 Modification Group List for Flight 5.

3.1.2.3.1.6 Modification Group List for Flight 6.

3.1.2.3.1.7 Modification Group List for Flight 7.

3.1.2.3.1.8 Modification Group List for Flight 8.

3.1.2.4 Interfaces.

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

3.1.3 System Effectiveness.

3.1.3.1 Effectiveness Measures.

3.1.3.1.1 General.

System effectiveness is defined as the probability that a system will accomplish a specified mission. The measure of MOL Program effectiveness shall be the extent to which the primary experiments and the required data retrieval are accomplished. Since, however, the experiments are many and varied, and since there is duplication on different flights, the "mission" is not a unique event.

Factors included in system effectiveness are reliability, maintainability, quality assurance, human engineering, and permeating all these, safety. Although a high inherent reliability level for MOL is essential, presence of the flight crew may permit maintenance on orbit if appropriate design measures are taken to allow checkout, access, and replacement. Determination of the extent to which manned maintenance can contribute to reliable space operations is a goal of the program. Contractor shall minimize the effects of single failures on mission accomplishments, for example, through the flexibility of alternate modes, even if degradation results.

3.1.3.1.2 Total Program Effectiveness.

In order to assure the highest probability of obtaining the experimental results, basic experiments shall be programmed on at least two flights, flight crew tasks on orbit shall be scheduled to maximize data output, and recording and transmission shall optimize data retrieval. Flight crew safety on individual flights shall not be compromised. The primary MOL Program objective, for purposes of this requirement, is defined as:

a. Completion of the total of the orbital man-hours activity for a single performance of all primary experiments including such checkout, alignment, calibration, repair, preparation, execution, processing, examination, communications, and similar tasks which are an integral part of, or are in direct support of, the experiments; and

b. Return to designated ground stations of the specified types, quantities, and qualities of data including that delivered by the astronauts in person; and

c. Provision of environmental conditions, life support, performance capabilities, and ground support for the duration of the missions as required to sustain the system and to perform the experiments.

3.1.3.1.3 System Capability.

System capability, in essence operational effectiveness, is composed of both engineering performance and operational availability as these combine relative to mission requirements. Engineering performance requirements have been stipulated under segment 3.3. The capability of the system to sustain this performance level for the duration of its prescribed mission shall be determined.

Performance requirements may vary for different missions or may be fixed for all missions. For any particular function, a criterion shall be established for determining whether the system is in an acceptable state. The acceptable risk of not meeting requirements on a particular mission must be determined in order to predict and verify whether the system involved meets its performance requirements. With the aid of such criterion the acceptable system states shall be determined.

3.1.3.1.4 Effectiveness Apportionment.

Effectiveness is to be apportioned by parameter among and within the system segments consistent with their mission requirements in a manner which will maximize MOL program cost effectiveness. The models and procedures for accomplishing the apportionment and for maximizing MOL program cost effectiveness will be developed by the contractors within guidelines provided by SSD/Aerospace. These models and procedures will be subject to the approval of the Air Force.

The parameters to be considered in effectiveness shall include the following:

a. Crew Safety - The probability that no crew casualties will be experienced in either normal or emergency operations during the period in which the crew constitutes a segment of the MOL System. That period extends from the time during the Pre-launch Phase at which the crew enters the Gemini B, through the completion of the Recovery Phase. A casualty, for purposes of the MOL mission, is defined as a fatality or an injury which renders the flight crew incapable of further services in the mission. Any lesser injury shall be considered to constitute a performance degradation.

b. Mission Completion - The probability that no failures occur during the mission which result in major damage/destruction or which require abandonment of the launch vehicle, laboratory, and/or re-entry vehicle.

c. Design Adequacy - The probability that no failures occur during the mission which result in a reduction of performance capabilities such that mission objectives are compromised.

d. Availability - The probability that a specified element will be capable of performing a specified function at a given point in time.

3.1.3.1.4.1 Orbiting Vehicle System Segment.

The allocation of effectiveness assigned to the Orbiting Vehicle segment will involve the time period from injection into orbit to separation of the Gemini B, and return of the flight crew from orbit. This, therefore, involves the success of Gemini B in maintaining its required operating characteristics during the entire orbital mission, the satisfactory performance of the Laboratory during the on-orbit portion, operation of the Transtage as required, satisfactory accomplishment of experiments (including data retrieval), satisfactory crew performance, and appropriate operation of the crew equipment. Since the Orbiting Vehicle system combines portions of a number of other segments, values will be assigned under the other segments.

3.1.3.1.4.2 Laboratory System Segment.

The Laboratory Vehicle Systems, after having been placed into orbit, shall be capable of satisfactorily operating and sustaining the crew for 30 days with a probability of at least 0.96, including on-orbit maintenance.

3.1.3.1.4.3 Gemini B System Segment.

The MOL Gemini B problems of launch and re-entry are similar to those of the NASA Gemini Program. However, the boosters are different, the requirement for loiter of 14 hours on-orbit, and a higher altitude for Gemini B are additional impositions. For launch and re-entry, it is required that Gemini B have at least as high a probability of accomplishment as does the NASA Gemini. For on-orbit operations, Gemini B must be capable of enduring the space environment for at least 30 days (60 days for rendezvous mission), and of complete reactivation for the re-entry phase with a probability of at least 0.97. The probability that successful re-entry (after separation from the Laboratory) is attained shall be at least 0.998.

3.1.3.1.4.4 Experiment System Segment.

Conduct of each experiment shall not affect the survivability of the Orbital Vehicle. Allocations for each experiment are dependent on such factors as priorities for results, detailed equipment characteristics, and capability for maintenance. Allocations shall be made when more details have been developed for these factors.

3.1.3.1.4.5 Flight Crew and Crew Equipment System Segment.

Since a major aspect of MOL is the evaluation of flight crew capabilities, this will develop as crew is selected, simulations carried out, and tests conducted. However, it is essential that crew equipment operate satisfactorily. The probability of crew equipment to support the mission shall be at least 0.98 without emergency back-up and 0.998 including available emergency modes.

3.1.3.1.4.6 Titan III System Segment.

Predicted reliability of Titan IIIC to injection is 0.869 and for 30 day orbital operation of the Transtage is 0.864. These shall be considered as minima and any modifications shall not decrease these estimates.

3.1.3.1.4.7 Test Operations System Segment.

Adequate maintenance and/or redundancy are assumed to exist in control, communications and recovery so that no significant deterioration of system effectiveness will be experienced here. The probability that TOSS operates satisfactorily shall be at least 0.999.

3.1.3.1.4.8 Facilities Segment.

Effectiveness allocations are not made directly for the Facilities Segment.

3.1.3.1.5 Reliability Apportionment.

Quantitative reliability requirements to support the overall system effectiveness shall be established in accordance with the requirement of MIL-R-27542A and MIL-STD-721 dated 15 October 61. Reliability values for the entire system shall be apportioned from the system to system elements as a basis for design methods, parts application and testing. Apportioned objectives shall be used in design, test planning, evaluation, trade-off studies and identifying problem or risk areas in consideration of complexity, effects of failure and degree of importance to their mission. The selection of parts shall be in conformance with the requirements of MIL-R-38100A.

3.1.3.1.6 Determination of Compliance.

Compliance with the allocated values for mission success is difficult to measure in a program in which the number of flights is so limited. Compliance will therefore be evaluated in terms of the following:

a. Analysis.

Utilizing the best possible methods of reliability analysis and introducing basic experimental evidence as appropriate, the value of the probability for mission success for the particular segment involved shall be greater than the number specified. Methods of analysis shall be approved by SSD/Aerospace in order to assure consistency, acceptability of data, appropriate inclusion of all significant factors, and utilization of the best available techniques.

b. Tests.

Appropriate qualification, acceptance, and reliability tests of both subsystems and system segments shall be identified for purposes of mission success evaluation. Results of test evaluations shall indicate effectiveness values not less than those specified in the preceding sections. Appropriate measures in design, quality control, fabrication, or procedures shall be taken, and tests repeated until satisfactory results are obtained. The criteria, environment, number and nature of tests shall be presented to SSD for approval and tests shall be conducted in accordance with such agreements. Specific review of all failures occuring during such tests shall be conducted to determine corrective actions. Based directly on observed results, models shall be developed for the measurement of MOL system effectiveness during flight tests. Results incorporated in the models shall emphasize percentages of experiments completed and percentage of required data retrieved, with necessary weightings.

3.1.3.2 Maintainability.

To assure that maintainability objectives are achieved, a maintainability program must be implemented to run concurrent with equipment design, development, production and system operation. Such a program is established to meet the requirements of military specifications calling for maximum equipment availability and reduced maintenance costs.

3.1.3.2.1 Maintenance Requirements.

3.1.3.2.1.1 Gound 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. Adaquate 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 Airborne Vehicle and pad)

d. Descent and Recovery - (applicable to Gemini B)

3.1.3.4.1 Appendix B, "Environmental Criteria Specification for the MOL System", contains all of the details on the applicable environments for the Prelaunch and On-orbit general classifications.

3.1.3.4.2 SSD Exhibit 62-166A, "Environmental Requirements Specification, Program 624A", Revision A, 1 July 1964, covers the Launch and Early Ascent phases. The Laboratory Vehicle and Gemini B shall meet the applicable requirements of this Exhibit as modified to incorporate the changes in the environment at various station levels.

3.1.3.4.3 The Gemini B shall meet, as a minimum, the descent and recovery environments imposed on the NASA Gemini.

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 Para. 2.0 with these prefixes:

Applicable or partially applicable	Prefix HP
Guidance	Prefix GP

3.1.3.7 Safety.

3.1.3.7.1 Applicable Documents for Safety are listed in Paragraph 2 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 general safety engineering requirements specified under this paragraph shall include design efforts to preclude the inadvertent destruction of the system or injury to the crew and operating personnel. The requirement includes all possible hazardous interactions of facilities, equipment, procedures and personnel, either singularly or in combination. The possible sources of system destruction or degradation which shall be covered by the requirement shall include but not be limited to:

(1) High pressure
(2) Explosive
(3) Combustive
(4) Accelerative
(5) Corrosive
(6) Electrical
(7) Radiative
(8) Vibrative

(9) Stress

(10) Fatigue

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 Orbiting Vehicle 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 exposures.

d. Dangerous materials and components will be prepared for delivery in accordance with Section 5 hereof, with special reference to paragraph 3f of SSD Exhibit 62-181.

3.1.3.9 Noise and Vibration.

(See Appendix B for Environmental Criteria)

3.1.3.10 Life Support.

(See Appendix B for Environmental Criteria)

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 end item specifications. The documents listed in paragraph 2.0 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 paragraph 2.0 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. (SSD 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 paragraph 2.0 with the prefix letters MP apply to the Materials, Parts, and Processes requirements.

3.2.1.3 Standard 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 Moisture and Fungus Resistance.

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 Corrosion of Metal Parts.

3.2.1.5.1 Electrolytic Corrosion of Metal Parts.

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 paragraph 2.0 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 paragraph 2.0 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 64-4 titled, Electromagnetic Interference Control Specification for Manned Orbiting Laboratory. Applicable Military Specifications are listed in Paragraph 2.0 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 related to Specification and Marking are listed in Paragraph 2.0 with the prefix letters IM.

3.2.1.10 <u>Storage.</u>

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 Paragraph 2.0 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 64-5, titled, General Specification, Wiring Harness. The applicable documents for this subject are listed in Paragraph 2.0 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 Paragraph 2.0 with the prefix letters HV.

3.2.2.4 Civil.

Applicable civil reference documents are listed in Paragraph 2.0 with the prefix letters CV.

3.3 PERFORMANCE ALLOCATIONS.

3.3.1 Orbiting Vehicle System Segment.

The Orbiting Vehicle shall be composed of the following system segments: the Gemini B; the Laboratory; the Experiments; and the Titan III Transtage and Flight Crew and Crew equipment. The rendezvous and docking aspect of the segment is treated in Paragraph 3.3.1.2.10.

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 flight 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 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.

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.

As discussed in Section 3.1.3.1.3.1 the apportionment of effectiveness for the Orbiting Vehicle involves a number of factors. Since the Orbiting Vehicle will contain different payloads and tasks for various flights, separate analyses shall be made for each flight. Effectiveness considerations shall be included in determining experiments to be carried on each flight.

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 Orbiting Vehicle 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. Capability to control the transtage ACS from the Lab shall be provided. The interface between the transtage propulsion systems 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 Laboratory Vehicle shall be compatible in terms of load transmission capability and mating at the interface 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 Flight Crew Transfer.

3.3.1.2.4.1 Normal Mode.

An internal pressurized tunnel through the heat shield shall be provided to transfer the flight 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 flight 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 and/or to an information recovery capsule for return and recovery.

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.

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 flight crewman commences transfer to the Laboratory while the Orbiting Vehicle is within range of communication stations. Upon completion of Laboratory activation, the second crewman 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 shirtsleeve 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, deployment of targets and remotely controlled units, 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 flight 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.

3.3.1.2.6.3 Data Recovery Capsule.

Provisions shall be made for the incorporation of the necessary equipment for a recoverable data capsule aboard any desired flight. Such provisions shall include: access for placing data into the capsule in an environmentally controlled atmosphere; means of adjusting and measuring any required ballast; means of deploying the capsule without adverse effects on the Orbiting Vehicle; and means of controlling the attitude and time of release, and adjusting the retrograde impulse.

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 system 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 or 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 flight 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.

3.3.1.2.10.2.2.3 The OAMS of either the chase 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.

3.3.1.2.10.3 Laboratory Requirements.

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

3.3.1.2.10.3.2 The target vehicle shall contain: a flight 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 flight 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.

3.3.1.2.10.3.3 The chase vehicle structure shall contain: a flight crew transfer tunnel assembly which connects the vehicle pressurized compartment to the mating face of the target vehicle at the docking plane, a flight 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.

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

3.3.1.2.10.3.5 The chase vehicle (including subsystems) and the chase experimental payload shall be qualified for a minimum of 45 days.

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

3.3.1.2.10.3.7 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.

3.3.1.2.10.4 Gemini B Requirements.

3.3.1.2.10.4.1 The Gemini B shall be capable of storage on-orbit for 60 days.

3.3.1.2.10.5 Transtage Requirements.

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

3.3.1.3 Functional Interfaces.

(The contractor shall identify the functional interfaces between his system segments and other MOL system segments.)

3.3.1.4 Contract End Items.

(The contractor shall provide for incorporation in this paragraph a list by contract end item number, nomenclature and the CEI to which it installs, all contract end items included in his system segment.)

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 flight 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 flight crew interference and injury. The over-all internal arrangement shall provide for convenient and simple management of the vehicle by the flight crew.

3.3.2.1.3 Flight Crew Stay Time.

The Laboratory Vehicle shall provide for a nominal on-orbit stay time for a two-man flight 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 Data Recovery Capsule.

The laboratory shall be designed to incorporate provisions for recovery of experimental data via a capsule delivery system.

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 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:

a. Accept electrical signals from the flight crew and Experiments Information System.
b. Provide equipment for signal conditioning, coding and multiplexing the instrumentation signals for telemetry and recording.
c. Provides tape recorders/reproducing equipment.
d. 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/F, 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 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 type 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 voic.: communications subsystem must provide two-way communications between ground and crew and intercommunication between the flight crew during laboratory and transfer operations and extravehicular excursions.

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 flight 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 Orbiting Vehicle 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 wideband 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. Flight Crew Hygiene

The specific requirements for each of the above sub-systems 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, and temperature 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 unit 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 diluent gas supply and control from the dual gas provisions. An independent oxygen partial pressure indicator shall be provided. The partial pressures of the various atmospheric components shall be controlled to assure alveolar oxygen pressure between 60 and 175 mm Hg under all conditions. The normal operating level for alveolar oxygen pressure shall not be less than 100 mm Hg.

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 pressure for pressure suit operation.

3.3.2.2.6.2.3.2 Dual Gas Pressure Control.

An oxygen partial pressure sensor shall be used to maintain the composition for the dual gas mode. Redundant partial pressure oxygen sensors shall be provided. A pressure regulation system shall control the total pressure for the dual gas mode and shall be designed to preclude flooding the pressure compartments with the diluent gas.

3.3.2.2.6.2.3.3 Metabolic Gas Flux.

A nominal oxygen consumption of 2.00 lbs/man/day and CO_2 production of 2.32 lbs/man/day shall be utilized for system designs.

3.3.2.2.6.2.4 Environmental Temperature and Humidity.

The average temperature of the atmosphere shall be capable of control to ± 3.0°F of set point temperature over the range of 60°F to 90°F. The average atmosphere water vapor partial pressure shall be capable of control to ± 3.0 mm Hg of set point over the range of 5.0 mm Hg to 15 mm Hg. The actual design temperatures and water vapor partial pressures are to be selected within these ranges to assure optimum crew comfort under all predictable environmental conditions.

3.3.2.2.6.2.5 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, and for Gemini B reactivation.

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

c. Oxygen and diluent 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 diluent requirements, over and above those allowances made for any purge and leakage.

3.3.2.2.6.2.6 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.

3.3.2.2.6.2.7 Carbon Dioxide Control.

A non-regenerable CO_2 absorbent system will be used until a trade study shall establish whether it should be regenerable.

The environmental control system will maintain nominal CO_2 levels within 5 ± 3 mm Hg.

3.3.2.2.6.2.8 Odor and Contaminant Control.

Equipment shall be provided for the control of odor and trace gases. Atmospheric debris traps will be provided.

Concentration limits for a preliminary set of possible contaminants shall be as specified in U.S. Navy Submarine Atmosphere Habitability Data Book, No. 250-649-1, Revision 1, Navy Bureau of Ships, corrected to the design atmosphere.

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

3.3.2.2.6.2.9 Pressure Maintenance.

One compartment of the pressurized volume shall be capable of maintaining normal pressure in the event of a cabin puncture in the other.

3.3.2.2.6.2.10 Repressurization.

Repressurization time for the complete pressurized volume shall 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 Laboratory Vehicle shall provide for heat transport between the vehicle interior and the vehicle heat sinks. No critical equipment shall depend on the conditioned atmosphere for cooling.

The thermal control system shall be capable of removing the heat generated under the most unfavorable combination of flight crew operational mode and atmospheric operational mode. 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 simplicity, 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. Flight 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 nominal temperatures of 155°F and 55°F. Potability assurance 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 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 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 ± 700 ml per man. This volume (less a 50 ml aliquot for physiological tests) is to be delivered to and managed by the urine disposal system. The collection and handling system shall provide for determination of urinary output volume.

The daily fecal volumes of approximately 100 ± 100 ml shall be collected in a special bag for subsequent lyophilization and storage for subsequent return to earth for analysis.

3.3.2.2.6.7 Overall System Requirements.

3.3.2.2.6.7.1 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 an excess of sea-level pressure. Ground cooling of the Laboratory shall be provided.

3.3.2.2.6.7.2 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 compatible with the specified orbital requirement. Cooling of the Laboratory Vehicle during ascent shall be provided by a water evaporator.

3.3.2.2.6.7.3 On-Orbit Operation.

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

3.3.2.2.6.7.4 Safety Features.

All valves that connect the interior of the pressurized section to the space environment shall have manual closures and/or overrides. Filters shall be provided to protect critical components such as pumps and compressors. Relief shall be provided over-pressurization. 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 ± 0.2 degree and a coarse dead-band of ± 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 flight crew.

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 flight crew 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 flight crew 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 flight crew 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 flight crew.

3.3.2.2.7.2.7 Transtage Ullage.

The mode provides the propellant settling for the main engine in the transtage. The flight crew 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 flight crew to insert the three Euler angles and the maneuver rate, as well as displaying the currently set valves.

Fine 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 flight crew.

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 commands 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 temperature 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 ± 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 flight crew 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 be 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, Laboratory 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 Laboratory CPS shall be accomplished with H_2-O_2 fuel cell modules arranged in parallel, with automatic and manually actuated interconnections.

3.3.2.2.8.1.2 Nominal Power.

The Laboratory 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 Laboratory 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 Laboratory 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 Laboratory 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 designed so 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 Laboratory, 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 pressurization 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 exercised, 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 ± 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 Laboratory 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 Appendix B.

3.3.2.2.9.2 Structural Design Criteria.

The structural design criteria applicable to the Laboratory Vehicle are specified in attachment 1, Annex A, Phase I Work Statement.

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
Hydraulic Vessels (Including Accumulators 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 performance 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 Flight 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 flight 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 flight crew activity.

3.3.2.2.10.4 Flight 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 flight 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 flight 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.

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 Laboratory 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/sub-contractor plants and/or at AF depots.

3.3.2.3 Functional Interfaces.

(The contractor shall identify the functional interfaces between his system segments and other MOL system segments.)

3.3.2.4 Contract End Items.

(The contractor shall provide for incorporation in this paragraph a list by contract and item number, nomenclature and the CEI to which it installs, all contract and items included in his system segment.)

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 flight crew escape system and the supporting ground system. The Gemini B 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 Gemini B 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, flight 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 flight 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 Flight Crew Stay Time.

The maximum total time the flight crew will be required to stay in the Gemini B is 64 hours. This maximum crew stay time is allocated to the mission phases as follows:

Pre-launch	5 hours	
Launch, until crew transfer	8 hours	Total time in these categories will not exceed 14 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 Gemini B 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 flight 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 a 56" long structure required to transition from the re-entry module to the 120" diameter Laboratory Vehicle. The flight 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 N.M. crossrange and 400 N.M. along the ground track. The maximum deceleration experienced by the crew during normal guided re-entry shall not exceed 10g.

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 N.M. (3 sigma 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 retro-fire for all de-boost design altitudes by at least one flight 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 Gemini B and launch vehicle events, critical launch vehicle parameters, Gemini B 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 flight crew members until crew transfer. The Gemini B shall again provide environmental control and life support for the flight 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 Gemini B is manned. The flight 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 flight 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 Proplulsion 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 160 NM 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 Titian 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 ground 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 $\pm$ 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 Flight Crew Safety.

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

3.3.3.2.11 Back-up Flight 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 Flight Crew Equipment and Display Requirements.

3.3.3.2.12.1 General.

The design and arrangement of the flight 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 flight crew to monitor and manually control desired functions; these provisions shall permit them to be in either a pressurized or unpressurized suit.

3.3.3.2.12.3 Flight Crew Seating.

Provisions shall be included for seating of the two man flight crew 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 vehicle 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. Whenever 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 Flight Crew Safety Requirements.

The flight crew safety requirements for the Gemini B shall include the inherent safety of the Gemini B and the safety provided by the flight 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 Orbiting Vehicle. Such capability shall include sensors, computation capability, displays, and necessary control signals to the Transtage and Orbiting Vehicle attitude control systems.

3.3.3.3 Functional Interfaces.

(The contractor shall identify the functional interfaces between his system segments and other MOL system segments.)

3.3.3.4 Contract End Items.

(The contractor shall provide for incorporation in this paragraph a list by contract and item number, nomenclature and the CEI to which it installs, all contract and items included in his system segment.)

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 effectivenss 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.

3.3.4.2.2.1 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.

3.3.4.2.2.2 An Information Recovery Capsule shall be provided for the recovery of experimental data. The capsule shall contain a payload compartment, a retrograde and parachute recovery system, and flotation and communication gear which will permit recovery by sea and air units.

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 flight 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 flight 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.

Equipments required for P-1, P-2, and P-3 experiments are a Pointing and Tracking Scope with variable magnification, manually adjustable crosshairs, a tracking servo, a coupled camera, a film processor, and film viewing and analysis equipment. The acquisition and tracking data shall be provided by the experiment information system. [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 flight crew 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 flight crew 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.

In Experiments P-1 and P-2, sufficient data shall be recorded and recovered to allow quantitative evaluation of the times of acquisition, tracking errors versus time in the image plane and the over-all smoothed tracking rate data for various target types, visual conditions and initial errors.

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 Objective.

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

3.3.4.2.4.2 Equipment Requirements.

Equipment 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 flight crew 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 Laboratory 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 Activity.

3.3.4.2.6.1 Objective.

To determine man's extravehicular capability and the equipment necessary to perform effective 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 pressure suit, an astronaut maneuvering unit (AMU), a separate portable ECS, standard type tools, zero reaction tools (ZERTS), cameras, task panel, various devices for extravehicular traversing along the MOL surface, such as handholds, foothold, etc., plus a tether line. The AMU will provide the crew member attitude stabilization and maneuvering capability and shall have an integral life support capability including suit-cooling.

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 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 traverse away from the vehicle and perform selected tasks and maneuvers.

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 from or ingress to 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. AMU refurbishment expendable storage shall be provided for and shall be accessible from 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 flight crewman shall describe his progress and time tones shall be superimposed on the record for time line analysis purposes. Extended operations shall be recorded by the other crewman, 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 flight crew maneuvering unit and to develop 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.

3.3.4.2.7 P-7 [redacted]

[redacted]

[redacted]

3.3.4.2.7.5 Evaluation Requirements.

Records of display data and flight crew control shall be recorded and recovered. Measures shall be developed for rating flight crew proficiency in performing predefined maneuvering tasks.

3.3.4.2.7.6 Simulation Requirements.

Development simulation shall be carried out to provide verification and evaluation of the [redacted] Developmental simulators shall be provided to determine the optimum control procedure and display equipment and modes, to measure flight crew variance, to determine training requirements, and develop pre- and post-flight reference data.

3.3.4.2.7.7 Experiment Interactions.

[redacted] experiment shall be designed to be visible to the PTS.

3.3.4.2.7.8 Setup and Calibration.

[redacted] shall be designed for ground alignment and calibration and shall require no on-orbit calibration.

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 B for recovery.

f. Thermal control of the Orbital Vehicle 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, ephermeris prediction and navigation problem solution and to allow quantitative evaluation of the 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 flight crew.

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 [redacted] ballistic missiles during boost, midcourse, and re-entry phases.

c. Determination of temperature distribution of ground and sea, [redacted]

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, [redacted] 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 flight crew 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 Orbiting Vehicle 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 flight crew 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 flight crew.

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 flight 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 flight 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 flight 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 flight crew member can view the panel and operate the controls.

3.3.4.2.10.5 Repair Requirements.

The equipment provided for this experiment shall be designed for minimum on-orbit maintenance, e.g., light bulb replacement.

3.3.4.2.10.6 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.

3.3.4.2.10.7 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 flight 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 flight crew sufficiently to remove learning effects during testing, and to establish baseline data against which orbital data will be compared.

3.3.4.2.10.8 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 flight 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., He, N_2, O_2, CO_2, H_2O and at least gross estimate of contaminates.

e. Provide radiation measurements to ascertain crew member status and safety and to provide information for extrapolation to future manned missions.

3.3.4.2.11.3 Experiment Procedures.

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

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

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

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

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

3.3.4.2.11.4 Repair Requirements.

The equipment for P-12 shall be designed for minimum on-orbit maintenance and shall contain sufficient spares of non-reusable items.

3.3.4.2.11.5 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 safety.

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.

3.3.4.2.11.6 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.

3.3.4.2.11.7 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 Ocean Surveillance.

3.3.4.2.12.1 Objective.

The objective is to evaluate the capability of the flight crew to control, coordinate, and utilize a number of sensors and associated displays etc., to detect, locate, track, classify, and catalog sea targets.

3.3.4.2.12.2 Equipment Requirements.

The equipment requirements on three of the sensors for this experiment shall be met by the equipment requirements for P-1, P-4, and P-10. In addition to these equipments, an ocean surveillance radar, display equipment for correlation of data, and low-light level television (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 radar shall scan for these radiating targets as well as additional targets not identified by the electromagnetic signal detection sensor. During daylight operation, the flight crew shall track selected targets through the optical sensor of P-1, P-2, and P-3 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. The optics and LLLTV shall be assisted in acquiring the target by radar localization through the experiment information system.

3.3.4.2.12.4 Orbital Vehicle Design Requirements.

The television and radar sensors shall be designed so as to operate with the Orbiting Vehicle's longitudinal axis tangent to its orbital path.

The television sensor shall have approximately the same area coverage as the P-1 optical system.

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

The radar antenna location must be such that electromagnetic interference from and with other equipments is not deleterious.

Storage space for film and prints shall be provided. Film and data should be recoverable.

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, locating, tracking, classifying, and cataloging 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 Functional Interfaces.

(The contractor shall identify the functional interfaces between his system segments and other MOL system segments.)

3.3.4.4 Contract End Items.

(The contractor shall provide for incorporation in this paragraph a list by contract and item number, nomenclature and the CEI to which it installs, all contract and items included in his system segment.)

3.3.4.5 Experiments Peculiar Ground System.

3.3.4.5.1 Experiments Peculiar AGE.

3.3.4.5.1.1 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 inclusions 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 the ETR shall be functionally identical to the AGE utilized at the Laboratory Vehicle contractor's facility.

3.3.4.5.1.2 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.

3.3.4.5.2 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 guidelines as outlined in this specification shall be followed in establishing such Experiment equipment maintenance.

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 elements 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 Vehicle segment.

3.3.5.1.2 Weight.

Flight crewman shall weigh 138-192 lbs. Individual space suits and portable environmental control subsystem will weigh approximately 85 lbs. per man. This total weight of flight crew and flight crew equipment is contained in the Gemini B 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 Laboratory. Weights for remaining flight crew accommodations items are included in the Gemini B and Laboratory Vehicle System Segments.

3.3.5.1.3 Volume.

Baseline functional volumes for Laboratory Vehicle design for the human operator will be based 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 Flight 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 Flight 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 Vehicle Flight Crew Performance.

Functional areas of Laboratory Vehicle 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 Flight 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 Flight 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 post-graduate 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 flight crew members will have been designated as well as the specific spacecraft with specific mission objectives for this launch date. These flight 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 flight 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 B 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 flight 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.

Flight 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 flight crew performance required to meet the task and time line analyses.

During development simulation and all stages of training, flight 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 Laboratory 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 administed 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.

3.3.5.3 Functional Interfaces.

(The contractor shall identify the functional interfaces between his system segments and other MOL system segments.)

3.3.5.4 Contract End Items.

(The contractor shall provide for incorporation in this paragraph a list by contract and item number, nomenclature and the CEI to which it installs, all contract and items included in his system segment.)

3.3.6 Titan III System Segment.

The Titan IIIC launch vehicle consists of Stage 0 (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. M.	Payload lb.
28.4°	100	23,000
	160	22,400
32°	100	22,800
	160	22,200

3.3.6.1.2 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
32°	100	4600
	160	3900

3.3.6.1.3 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.
Inclination	$\pm 0.12^{o}$	$\pm 0.12^{o}$
Altitude, ft.	± 3,000	±21,000
Eccentricity	0.4×10^{-3}	3.0×10^{-3}

3.3.6.1.4 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

3.3.6.1.5 Constraints.

3.3.6.1.5.1 Length and Diameter.

Payload Length, Feet	Payload Diameter, Feet
48	10

Payload length is defined as the distance from launch vehicle station 77 to the top of the Gemini B Re-entry Module. The above payload length constraint of 48' is based on a Gemini B configuration with an escape tower. Diameter is the outside diameter of the laboratory.

3.3.6.1.5.2 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.

3.3.6.1.5.3 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 33 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.

3.3.6.3 Functional Interfaces.

(The contractor shall identify the functional interfaces between his system segments and other MOL system segments.)

3.3.6.4 Contract End Items.

3.3.6.4.1 A. C. Spark Plug CEI's:

	Nomenclature	Specification No.
1.	Inertial Measurement Unit MX-6478/DJQ-1	ES 8499
2.	Computer, Missile Guidance CP-781/DJQ-1	- - - -
3.	Controller, Pressure-Thermal C-6281/DJQ-1	ES 8497
4.	Signal Conditioner MX-6479/DJQ-1	ES 8484
5.	Modulator, Pulse Code MD-588/DJQ-1	ES 8498
6.	Reducer, Video Bandwidth MX-6480/DJQ-1	ES 8529
7.	Alignment-Checkout Group Missile Guidance AN/GJQ-26	ES 8403
8.	Console Guidance Monitor *	ES 8469
9.	Electrotheodolite Set, Azimuth Alignment, Lg Rng, AN/GVQ-7	ES 8509
10.	Test Set, Missile Guidance System AN/DJM- *	ES 8471
11.	Electrotheodolite Set, Azimuth Alignment, Short Range AN/	ES 8489

	Nomenclature	Specification No.
12.	Battery-Power Supply Assembly PP-4116/DJQ-1	ES 8476
13.	Shipping & Storage Container Missile Guidance Computer CY-4432/DJQ-1	ES 8511
14.	Test Set, Video Bandwidth Reducer AN/DJM-22	ES 8483
15.	Simulator, Pulse Code Modulator Input AN/ *	- - - -
16.	Test Set, Telemetry AN/ *	- - - -
17.	Monitoring Set, Telemetric Data AN/DKM-11	- - - -
18.	Filler & Bleeder, Missile Guid Coolant Sys HD-666/DJQ-1	ES 8490
19.	Coolant Fluid Tank *	ES 8550
20.	Power Elec Cable Assys *	- - - -
21.	Spec Purpose Cable Assys *	- - - -
22.	Hoses, Extension, FC-75	ES 8555
23.	Distribution Box *	- - - -
24.	Cable Assy, Power, Elec *	ES 8541
25.	Voltage Regulator *	ES 8542
26.	Carrier, Electronic Equip *	- - - -
27.	Truck, Hand, Shelf *	ES 8540
28.	Scale, Beam, Indicating *	- - - -
29.	Sump-Vacuum Pump *	- - - -
30.	Coller, Liquid Refrigerative *	- - - -
31.	Test Set, Signal Conditioner *	- - - -
32.	Telemetry Mon-Recorder Gp *	- - - -
33.	Monitor Group, Telemetric Data OA-6835/DJM-11	ES 8456
34.	Distrib-Indicator Gp, Telemetric Data OA-6836/DKM-11	ES 8457

3.3.6.4.2 Aerojet Gen. CEI's:

1.	Engine Rocket Liquid Propellant, YLR87-AJ-9	AGC40173

10.2

APPENDIX B

ENVIRONMENTAL CRITERIA SPECIFICATION

FOR THE

MOL SYSTEM PERFORMANCE/DESIGN REQUIREMENTS

GENERAL SPECIFICATION

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:	Flight Crew/TOSS
ICD Area 41:	Flight Crew/Modification Group List Per Flight 1
ICD Area 42:	Flight Crew/Modification Group List Per Flight 2
ICD Area 43:	Flight Crew/Modification Group List Per Flight 3
ICD Area 44:	Flight Crew/Modification Group List Per Flight 4
ICD Area 45:	Flight Crew/Modification Group List Per Flight 5
ICD Area 46:	Flight Crew/Modification Group List Per Flight 6
ICD Area 47:	Flight Crew/Modification Group List Per Flight 7
ICD Area 48:	Flight 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

	Nomenclature	Specification No.
53.	Tank Alcohol	AGC40169
54.	Pump, Reciprocating Power Driven	AGC40169
55.	Test Set, Rocket Engine	AGC40177
56.	Test Set Electrical Circuit	AGC40178
57.	Tool Kit, Turbopump	AGC40172
58.	Test Set, Facility Syst.	AGC40198
59.	Rocket Engine	AGC40197
60.	Nozzle Extension Kit	RED
61.	Shipping Container	AGC40199
62.	Stand, Maintenance	AGC40193
63.	Adapter, Maint. Stand	AGC40201
64.	Test Kit, Pressure	AGC40202
65.	Transport and Installation Kit, Nozzle Extension	AGC40199
66.	Test Set, Functional	AGC40194
67.	Cleaning & Purging Equip	- - - -
68.	Adapter Kit, Cleaning System	AGC40200
69.	Pump, Reciprocating	- - - -
70.	Cleaning & Purging Equip	- - - -
71.	Connecting Kit, Purge Set	AGC40200
72.	Test Set, Electrical	AGC40195
73.	Alignment Tool	AGC40196
74.	Purge Set, Portable	- - - -
75.	Connecting Kit, Purge	AGC40200
76.	Connecting Kit, Purge Set	AGC40200
77.	Link, Restrainer, Gimbal	AGC40199

C3.3.6.4.3 Martin Denver CEI's:

1.	Detail Spec for Standard Space Launch Vehicle (SSLV)	D-SLV/1A010
2.	Detail Spec for Flight Control Adapter - Programmer	D-SLV/01D110
3.	Identification Spec for Standard Space Launch Vehicle	SSS-TIII-ID-SLV

	Nomenclature	Specification No.
4.	Air Scoop and Nut Catcher	ID-SLV/01K000
5.	Attachment Kit, Rocket Motor Boosters	ID-SLV/02K000
6.	Dummy Payloads	ID-SLV/01K100
7.	Adapters, Dummy Payloads	ID-SLV/01K200
8.	Connector, Electrical-Rocket Motor Ground Power	ID-SLV/02L003
9.	Cable Assembly Set, Electrical-Rocket Motor Staging Disconnect	ID-SLV/02L002
10.	Fairing, Payload	ID-SLV/01K300
11.	Detail Spec for Hold-down Set, Explosive	D-OGE/01B581
12.	Detail Spec for Stray Voltage Detector	D-OGE/01B583
13.	Detail Spec for Propellant Loading Unit, Fuel	D-OGE/01C101
14.	Detail Spec for Propellant Loading Unit, Oxidizer	D-OGE/01C102
15.	Detail Spec for Propellant Servicing Unit	D-OGE/01C109
16.	Detail Spec for Nitrogen Pressure Controller	D-OGE/01C401
17.	Detail Spec for Pumping Unit, Hydraulic Mobile	D-OGE/01C601
18.	Detail Spec for Vehicle Air Conditioner (P-20)	D-OGE/01C703
19.	Detail Spec for Water Chiller (Guidance Package)	D-OGE/01C705
20.	Detail Spec for Air Conditioner (Vehicle)	D-OGE/01C706
21.	Detail Spec for Van Power Distribution Control	D-OGE/01EAA0
22.	Detail Spec for Control Center Power Distribution Control	D-OGE/01EAB0
23.	Detail Spec for Power Supply	D-OGE/01EAC0
24.	Detail Spec for Launch Pad Power Distribution Control	D-OGE/01EAE0

	Nomenclature	Specification No.
25.	Detail Spec for Vehicle Checkout Set	D-OGE/01FB00
26.	Detail Spec for Propellant Transfer and Pressurization Control Set	D-OGE/01FC00
27.	Detail Spec for Data Transmission Group I	D-OGE/01FDA0
28.	Detail Spec for Data Transmission Group II	D-OGE/01FDB0
29.	Detail Spec for Data Recording Set	D-OGE/01FB00
30.	Detail Spec for Combined System Test Simulator Set	D-OGE/01FF00
31.	Detail Spec for Solid Booster Simulator	D-OGE/01FG00
32.	Detail Spec for Launch Control Console	D-OGE/01FJ00
33.	Detail Spec for Control Monitor Group	D-OGE/01FL00
34.	Detail Spec for Recorder-Reproducer Set, Voice	D-OGE/01GC00
35.	Detail Spec for Flight Safety Checkout CMG	D-OGE/01JAA0
36.	Detail Spec for Pulse Tracking CMG	D-OGE/01JAB0
37.	Detail Spec for Tracking and Flight Safety Monitor Group	D-OGE/01JAC0
38.	Detail Spec for Frame, Transporter, SSLV	D-OGE/01N032
39.	Detail Spec for Launch Mount, SSLV Transporter	D-OGE/01N033
40.	Detail Spec for Umbilical Masts, SSLV	D-OGE/01N034
41.	Detail Spec for Cable Support	D-OGE/01N035
42.	Detail Spec for Frame Support, Solid Motor	D-OGE/01N036
43.	Detail Spec for Undercarriage Assembly, SSLV Transporter	D-OGE/01N043
44.	Detail Spec for Space Vehicle Checkout - Launch Control Equipment, Rail Van Mounted	D-OGE/01N571

	Nomenclature	Specification No.
45.	Detail Spec for Space Vehicle Checkout - Instrumentation Equipment, Rail Van Mounted	D-OGE/01N572
46.	Detail Spec for AGE Van	D-OGE/01N573
47.	Detail Spec for Air Conditioner AGE Van	D-OGE/01N575
48.	Detail Spec for Dehumidifier, AGE Van	D-OGE/01N576
49.	Detail Spec for Trailer, SSLV-Stage I; & Trailer, SSLV, Transtage & Interface Section or Stage II	D-OGE/01P102/4
50.	Identification Spec for Operating Ground Equipment (OGE)	SSS-TIII-ID-OGE
51.	Propellant Ready Storage Vessel,	ID-OGE/01C104
52.		
53.	Tank, Storage, Gaseous Helium	ID-OGE/01C410
54.	Ordnance Items Test Set	ID-OGE/01FN00
55.	Countdown Readout	ID-OGE/01FN00
56.	Bolt and Nut Set, Static	ID-OGE/01N523
57.	Ladders, Personnel	ID-OGE/01N524
58.	Net, Safety, Maintenance	ID-OGE/01N525
59.	Service Platform - SSLV, Internal Access	ID-OGE/01N526
60.	Crane, Floor, Portable	ID-OGE/01N527
61.	Platform Set, Service Engine Compartment, Stage II	ID-OGE/01N528
62.	Launch Mount (P-20)	ID-OGE/01N530
63.	Erector Weather Protection Curtains (P-20)	ID-OGE/01N532
64.	Service Platform Set, SSLV Transporter	ID-OGE/01N554
65.	Net Set, Safety, SSLV Transporter	ID-OGE/01N555
66.	Guard Set, Sill, Access Door	ID-OGE/01N561
67.	Servicing Platform Set - Adapter, Payload Fairing, MST	ID-OGE/01N562

	Nomenclature	Specification No.
68.	Servicing Platform Set - Adapter, Payload Fairing, UT	ID-OGE/01N563
69.	Servicing Platform Set - Adapter, Payload Fairing, VIB	ID-OGE/01N564
70.	Test Stand Service Platform Set (P-20)	ID-OGE/01N565
71.	Servicing Platform Set (P-20)	ID-OGE/01N567
72.	Crane, Floor, Portable	ID-OGE/01N569
73.	Thrust Mount Tool Kit (P-20)	ID-OGE/01P101
74.	Ring, Handling, SSLV - Forward (Stage I, Stage II and Transtage)	ID-OGE/01P110
75.	Ring, Handling SSLV - Aft, (Stage II)	ID-OGE/01P111
76.	Breather, Propellant Tank, Stage I	ID-OGE/01P112
77.	Breather Set, Propellant Tank, Stage II	ID-OGE/01P113
78.	Breather Set, Propellant Tank, Transtage	ID-OGE/01P114
79.	Cover, Protective, SSLV - Stage I	ID-OGE/01P115
80.	Cover, Protective, SSLV - Stage II	ID-OGE/01P116
81.	Cover, Protective, SSLV Propellant Tank Dome, Stage I	ID-OGE/01P119
82.	Deleted	ID-OGE/01P120
83.	Erection Fixture, SSLV - Stage I and Stage II	ID-OGE/01P122
84.	Cover, Protective, SSLV - Transtage and Interstage	ID-OGE/01P123
85.	Transport Adapter, Transtage and Interstage	ID-OGE/01P124
86.	Restraining Fixture, MST	ID-OGE/01P126
87.	SSLV Positioning Set, (P-20)	ID-OGE/01P127
88.	Positioning Set, SSLV (MST)	ID-OGE/01P133
89.	Tool Kit, Handling Equipment (MST)	ID-OGE/01P139
90.	Tool Kit, Launch Mount	ID-OGE/01P140
91.	Positioning Set, SSLV - Stage I, Stage II and Transtage, VIB	ID-OGE/01P142

	Nomenclature	Specification No.
92.	Tool Kit, Launch Nut	ID-OGE/01P148
93.	Carrying Case, Ordnance Items	ID-OGE/01P149
94.	Deleted	ID-OGE/01P150
95.	Payload Fairing Positioning Set (P-20)	ID-OGE/01P151
96.	Positioning Set, Payload Fairing (MST)	ID-OGE/01P152
97.	Positioning Set, Payload Fairing VIB	ID-OGE/01P154
98.	Platform Set, Space Vehicles	ID-OGE/01P156
99.	Alignment Kit, Solid Rocket Motors	ID-OGE/01P157
100.	Accessory Set - Dew Point Indicator	ID-OGE/01P202
101.	Adapter, Torque Wrench - Retro Motor	ID-OGE/01P208
102.	Detector, Helium Tracer Gas	ID-OGE/01S910
103.	Handling Set, Solid Rocket Motor	ID-OGE/02P155
104.	Detail Specification for Test Stand, Hydraulic System Components	D-MGE/01C602
105.	Detail Specification for Space Vehicle Hydraulic Servicing Unit (P-20)	D-MGE/01C603
106.	Detail Specification for Test Stand, Pneumatic Components	D-MGE/01N310
107.	Detail Specification for Hydraulic Control Unit	D-MGE/01NB00
108.	Identification Specification for Maintenance Ground Equipment	SSS-TIII-ID-MGE
109.	Decontamination Apparatus, Bench	ID-MGE/01N304
110.	Decontamination Apparatus, Stationary, Tank	ID-MGE/01N305
111.	Heater, Nitrogen	ID-MGE/01N311
112.	Maintenance Equipment Test Set	ID-MGE/01NF00

3.3.6.4.4 United Technology Co. CEI's:

1.	Rocket Motor	4MDSE03101
2.	Tank Assembly, Thrust Vector Control	4TDSE51714

	Nomenclature	Specification No.
3.	Nozzle and Thrust Vector Control Assembly	4MDSE71601
4.	Electrical Cable Set, Rocket Motor	4AISE60901
5.	Battery Assembly - ISDS	4MISE53501
6.	Battery, Wet, Primary - TVC System	4MISE53501
7.	Battery, Storage - Instrumentation	4MISE53501
8.	Loaded Closure, Forward Assembly of	4MISE63201
9.	Loaded Segment	4MISE63201
10.	Loaded Aft Closure - Assembly of	4MISE63201
11.	Safety and Arming Device - TT and Destruct	4MISE63001
12.	Safety and Arming Device - Igniter	4MISE63001
13.	Igniter - Rocket Motor	4MISE63001
14.	Ordnance Set, Thrust Termination	4MISE63001
15.	Ordnance Set, Destruct System	4MISE63001
16.	Mechanical Hardware Set, Forward Closure Sub Assembly	4AISE63301
17.	Mechanical Hardware Set, Aft Closure Sub Assembly	4AISE63301
18.	Mechanical Hardware Set, Rocket Motor	4AISE63301
19.	Mechanical Hardware Set, Rocket Engine Attachment	4AISE63301
20.	Mechanical Hardware Set, TVC Tank Assembly	4AISE63301
21.	Mechanical Hardware Set, Instrumentation Raceway	4AISE63301
22.	Mechanical Hardware Set, Section	4AISE63301
23.	Mechanical Hardware Set Staging Rockets	4AISE63301
24.	Fairing, Nose Section, Rocket	4AISE63301
25.	Fairing, Cluster, Rocket Motor - Staging, Forward	4AISE63301
26.	Insulated Cover - Thrust Termination	4AISE63301

	Nomenclature	Specification No.
51.	Fixture, Handling, Nozzle-Nozzle Exit Cone Extension	4GISE81-05
52.	Beam, Hoisting, Segment-Closure	4GISE81-05
53.	Fixture, Hoisting, Segment, Aft Closure Sub-Assembly	4GISE81-05
54.	Fixture, Support, Aft Closure	4GISE81-05
55.	Fixture, Support, Segment	4GISE81-05
56.	Stand, Inspection-Subassembly, Segment-Closure	4GISE81-05
57.	Ring, External, Segment-Forward Closure	4GISE81-05
58.	Ring, External, Segment-AFT Closure	4GISE81-05
59.	Fixture, Inverting, Segment-Closure	4GISE81-05
60.	Beam, Hoisting-Segment, Closure Container	4GISE81-05
61.	Fixture, Hoisting, AFT Closure	4GISE81-05
62.	Funnel, N_2 04 Drain	4GISE81-05
63.	Beam, Hoisting-TVC Tank Assembly Trailer	4GISE81-05
64.	Fixture, Hoisting-Forward Closure	4GISE81-05
65.	Adaptor, Hoisting-Forward Closure Subassembly	4GISE81-05
66.	Beam, Hoisting, Nozzle Container	4GISE81-05
67.	Installation Kit - Nozzle	4GISE81-05
68.	Adapter, Closure	4GISE81-05
69.	Installation Kit-Nozzle Exit Cone Extension	4GISE81-05
70.	Guide-Support Skirt Installation	4GISE81-05
71.	Fixture, Hoisting, Vertical-TVC Tank Assembly	4GISE81-05
72.	Fixture, Handling-Injectant Transfer Tube	4GISE81-05
73.	Wire Rope Assembly, Single Legs	4GISE81-05

	Nomenclature	Specification No.
74.	Fixture, Handling, Igniter Cartridge - Igniter Case	4GISE81-05
75.	Fixture, Hoisting-Igniter Closure	4GISE81-05
76.	Plate, Retaining-Igniter Cartridge	4GISE81-05
77.	Installation Kit-Igniter	4GISE81-05
78.	Adaptor, Hoisting - TT Port	4GISE81-05
79.	Installation Kit - TT Port Cover	4GISE81-05
80.	Fixture, Hoisting-Nose Section Support Skirt	4GISE81-05
81.	Wrench, Safety and Arming Device Plug	4GISE81-05
82.	Cover, Protective, SRM Components	4GISE81-05
83.	Cover, Protective, SRM Components	4GISE81-05
84.	Rack, Pallet Storage	4GISE81-05
85.	Pallet, Material Handling	4GISE81-05
86.	Pin, Straight, Headless	4GISE81-05
87.	Maintenance Kit, Tank Pressurization Control System	4GISE81-06
88.	Recorder, Temperature-Humidity	4GISE81-06
89.	Recorder, Shock	4GISE81-06
90.	Recorder, Temperature	4GISE81-06
91.	Chamber, Explosion Proof	4GISE81-06
92.	Kit, Leak Detection, TVC Tank Assembly	4GISE81-06
93.	Lead, Electrical	4GISE81-07
94.	Cable Assembly, Power, Electrical	4GISE81-07
95.	Cover, Protective, Propellant, Segment-Closure	4GISE81-08
96.	Cover, Protective, Nozzle Flange	4GISE81-08
97.	Hose, Airduct, Temperature Control Unit	4GISE81-08
98.	Cover, Protective-Aft Closure Port	4GISE81-08
99.	Cover, Protective, TT Port	4GISE81-08

	Nomenclature	Specification No.
100.	Cover, Protective-Igniter Port	4GISE81-08
101.	Maintenance Platform, Portable	4GISE82-01
102.	Press, Forcing, Hydraulic	4GISE82-01
103.	Stand, Maintenance-Igniter	4GISE82-01
104.	Adapter, Installation-Removal Quick Release Pin	4GISE82-01
105.	Maintenance Kit, Environmental Control System	4GISE82-01
106.	Removal Tool, Pin, Straight, Headless	4GISE82-01

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.

Although redundancies and maintenance permit high system effectiveness of TOSS in control, communication, and recovery modes, it is also essential that all aspects of range support attain a high effectiveness. A specific value of 0.999 has been assigned. However, as a result of task identification and breakdown, it may become desirable to negotiate a lower level to 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.

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 recources. 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 vehicle and crew status, and 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 for 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 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 powered flight phases 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, including deployment of forces on the geoid, 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 several hours to several days.

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, at least 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 it in real time. It shall be possible to select a different set or the same set of data, edit or summarize it and transmit it 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 re-entry.

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 continuous 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 tape 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-oribt 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 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.

3.3.7.2.6.7 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 Functional Interfaces.

(The contractor shall identify the functional interfaces between his system segments and other MOL system segments.)

3.3.7.4 Contract End Items.

(The contractor shall provide for incorporation in this paragraph a list by contract and item number, nomenclature and the CEI to which it installs, all contract and items included in his system segment.)

3.3.7.5 TOSS Design Requirements.

3.3.7.5.1 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).

3.3.7.5.1.1 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.

3.3.7.5.1.2 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

3.3.7.5.1.3 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 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 techniques 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.

3.3.7.5.2.1.2 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.

3.3.7.5.2.1.3 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 updating on-board system, 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 also for real time displays of the selected data or different data at primary remote sites shall be included. During the early orbit phase, simultaneous selection of data from both the Gemini B and Laboratory real time links for local site display and transmission to the MCC shall be required of the primary remote sites.

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 - 400 mc using AM modulation shall be required at specific remote sites.

f. Special telemetry links for experiment data in the 2200 - 2300 megacyle 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 of a standard instrumentation system for support of DOD space program development. This development will involve the use of a minimum number of remote sites and a standardized integrated S-band TT&C system such as the AFSSD Space-Ground Link Subsystem (SGLS).

3.3.7.5.2.1.4 Network Stations.

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

3.3.7.5.2.1.4.1 Cape Kennedy (CKAFS).

The employment of the resources at CKAFS shall include all the instrumentation necessary for the launch and ascent phases of 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/ground-to-air voice communications when required by mission operations.

capability shall be implemented for telemetry and air-to-ground voice reception when required by mission operations.

3.3.7.5.2.1.4.5 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 and air-to-ground voice reception 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.

3.3.7.5.2.1.4.6 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 considieration are Point Arguello and the Vandenberg Tracking Station. A secure capability shall be implemented for telemetry and air-to-ground voice reception 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.

3.3.7.5.2.1.4.7 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.

3.3.7.5.2.1.4.8 White Sands, Eglin.

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

3.3.7.5.2.1.5 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 feasible, all primary on-orbit stations shall be netted with the MCC at CKAFS utilizating hardwire or equivalent circuits. Requirements for the communication support functions are described as follows:

3.3.7.5.2.1.5.1 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. The local site controller shall have patch-in capability.

3.3.7.5.2.1.5.2 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.

3.3.7.5.2.1.5.3 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 utilizating 40,800 bps HSD lines and a backup 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.

3.3.7.5.2.1.5.4 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.

3.3.7.5.2.1.5.5 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 ascent and early orbit considerations will require real time transmission of tracking data over HSD lines.

Routine on-orbit tracking for ephemeris up-dating shall utilize 100 wpm teletype where HSD lines are not conveniently available.

3.3.7.5.2.1.5.6 Security.

In addition, the ground communication network shall provide for secure transmission of telemetry data and voice from the Okinawa area, Hawaii area, West Coast area, and Antigua.

3.3.7.5.2.2 Meteorological Support Element.

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

3.3.7.5.3 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.

3.3.7.5.3.1 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 Systems Segment.

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. 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 Orbiting Vehicle while on the launch vehicle, suitable parking areas for the Orbiting Vehicle AGE rail vans and fluid servicing units, and adequate services for the support of Orbiting Vehicle launch operations. Means shall be provided to effect the safe removal of the flight crew to at least 800 feet from the Gemini B 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 Orbiting Vehicle while on the launch vehicle, suitable parking areas for necessary Orbiting Vehicle AGE rail vans, and adequate services for the support of the TIII/Orbiting Vehicle 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 installation. 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 (RIS) 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 an Orbiting Vehicle 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, Missile 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 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 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 Orbiting Vehicle 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 Orbiting Vehicle 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 Laboratory Vehicle to withstand meteroid impact and particle radiation shall be demonstrated by subjecting Laboratory structural sections to simulated meteoroid and particle radiation environment.

4.1.1.4.5 Atmospheric Contaminant Test.

A materials atmospheric contaminant test shall be conducted on the pressurized atmospheric environment of the Laboratory in a thermal-vacuum space simulation chamber for a time period sufficient to identify contaminants and predict 30 day contaminant concentrations. Broad spectrum measurements by infra-red gas chromatrographic and/or mass spectrophotometric techniques will be used to determine significant toxic contaminants. Such tests to be defined to Phase I and performed in Phase II.

4.1.1.5 Gemini B Requirements.

4.1.1.5.1 General.

The Gemini B 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 Flight Crew Transfer Tests.

Tests shall be performed to demonstrate and verify the feasibility of the normal and emergency flight crew transfer between the Gemini B and the Laboratory. Inflated suit and an incapacitated flight crewman in an emergency situation shall be simulated.

4.1.1.5.8 Abort Tests.

Additonal 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 flight 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, flight 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 SSD 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 flight crew transfer shall be qualified to the specified environmental requirements. The qualification tests of the Laboratory shall be performed when possible on the Laboratory, flight 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, flight 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 sub-systems 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 Appendix B.

4.1.2.7 T-III Requirements.

The T-III system segment shall be qualified per the requirements of SSD Exhibit 62-166A, "Environmental Requirements Specification, Program 624A", Rev. A, dated 1 July 1964. The applicable sub-system of Titan III transtage shall be qualified for 30 days on-orbit.

4.1.2.8 Flight Crew and Flight Crew Equipment Requirements.

Flight 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 flight 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 domonstrated 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 sub-system 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 are intended to be more severe than field conditions, but are not intended to exceed reasonable safety margins or to excite unrealistic modes of failure. 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 conducted to demonstrate that the required design, performance, and reliability levels have been achieved on 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 sub-system 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, flight 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 sub-systems 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 SSD 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 Flight Crew and Flight Crew Equipment Requirements.

The flight crew and flight crew equipment segment shall be acceptance tested at the component and/or sub-system level. These requirements will be detailed in an AFAMD/AFEFTC environmental requirements specification exhibit for the flight crew and flight crew equipment. In general, the components and/or sub-systems 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 sub-system 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 equipment 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 sub-systems, but the Laboratory shall be only structurally complete. The Gemini B shall be separated from the laboratory for retro, re-entry, 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 sub-systems 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 sub-systems for initial evaluation and a Gemini B with fully operable sub-systems. The flight shall be of short orbital duration. The mission duration shall be dependent upon Laboratory Sub-system status. The Gemini B shall be separated for retro, re-entry, 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 flight crew, crew transfer to the Laboratory, and the critical Laboratory sub-systems. Verification of Gemini B Sub-systems will be accomplished for launch, a short duration on-orbit mission, re-entry, 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 flight crew duty cycles.

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. The objective of the mission is to remain on orbit up to sixty days after exchanging one crew member, and transferring expendables such as astmosphere gas and electric power as required, while docked with the target Orbiting Vehicle.

The chase 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 chase 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 the 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

INTERFACE REQUIREMENTS

FOR THE

MOL SYSTEM PERFORMANCE/DESIGN REQUIREMENTS

GENERAL SPECIFICATION

10.1 INTERFACE REQUIREMENTS.

10.1.1 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 associated 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.

10.1.2 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.

10.1.3 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:

10.1.4 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/Flight Crew
ICD Area 12:	Gemini B/TOSS
ICD Area 13:	Gemini B/T-IIIC
ICD Area 14:	Laboratory/Experiments
ICD Area 15:	Laboratory/Flight 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/Flight 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:	Flight Crew/TOSS
ICD Area 41:	Flight Crew/Modification Group List Per Flight 1
ICD Area 42:	Flight Crew/Modification Group List Per Flight 2
ICD Area 43:	Flight Crew/Modification Group List Per Flight 3
ICD Area 44:	Flight Crew/Modification Group List Per Flight 4
ICD Area 45:	Flight Crew/Modification Group List Per Flight 5
ICD Area 46:	Flight Crew/Modification Group List Per Flight 6
ICD Area 47:	Flight Crew/Modification Group List Per Flight 7
ICD Area 48:	Flight 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