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PRELIMINARY
TECHNICAL DEVELOPMENT PLAN
FOR THE
MANNED ORBITING LABORATORY

[redacted]

MICROFILMED BY TIM

APRIL 1964

Status
as of

30 JUNE 1964

REVIEW ON 31 Dec 1994

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This edition has been prepared to correct and to update the April 1964 MOL Program PTDP to reflect program activities and planning as of 30 June 1964.

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FOREWORD

This Preliminary Technical Development Plan (PTDP) is addressed primarily to the in-house and contractual activity planned for the Pre-Phase I time period. The Pre-Phase I period will be devoted to two areas of activity.

First, the experiments to be conducted during the initial MOL flight program will be defined with sufficient precision and detail to reveal how a technically successful MOL Program will determine the usefulness of man as an element of possible future military space systems. This definition will precede selection of a Laboratory Vehicle contractor and initiation of Phase I.

Second, vehicle systems, subsystems, and interface alternatives will be studied to reduce to a practical minimum the technical questions remaining to be resolved during the Phase I period when the Laboratory Vehicle contractor and all other associate contractors will be engaged in detailed definition of the MOL Phase II program.

A revised version of the MOL PTDP will be submitted at the conclusion of the Pre-Phase I effort. This revised PTDP will describe the Phase I program in a more explicit and detailed fashion and will include a plan for the Project Definition Phase (PDP). The Phase I Project Definition Phase is presumed to begin after approval to proceed with Phase I is received, and proposals are requested from industry for definition and development of the Laboratory Vehicle, the only new vehicular element of the Manned Orbiting Laboratory System.

William D Brady
WILLIAM D. BRADY
Colonel, USAF
System Program Director, MOL

Joseph S. Bleymaier
JOSEPH S. BLEYMAIER
Brig Gen, USAF
Deputy Commander for
Manned Systems

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*** Indicates the sections included within this PTDP. The other sections are merely added in tabular form for continuity to conform to the PSPP outline which will be formulated during Phase I.**

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SECTION 1

PROGRAM SUMMARY

SECTION 1

PROGRAM SUMMARY

1.0 INTRODUCTION.

The Director of Defense Research and Engineering Memorandum to the Assistant Secretary of the Air Force (R&D), subject "Manned Orbital Program," dated 11 Dec 1963 announced that a Military Manned Orbital Program had been approved by the Secretary of Defense and that the program has been assigned to the Air Force. During 3-7 January 1964 the Space Systems Division of AFSC presented to Hq USAF, the Assistant Secretary of the Air Force, and the Deputy Director of Defense Research and Engineering/ Space a preliminary Air Force approach for implementing the MOL program. This presentation outlined in general terms the objectives of the program, an approach toward selecting equipments and defining the configurations of the Orbital vehicle, and a concept for the management of the MOL program.

This Preliminary Technical Development Plan (PTDP) responds to instructions from Hq AFSC contained in Secret Msg, MSF 9-3-13. It has been prepared to present a specific plan for initiating the Manned Orbiting Laboratory program. It consists of detailed information on the Pre-Project Definition Phase (Pre-Phase I), planning information for a Project Definition Phase (Phase I), and a System Acquisition Phase (Phase II). Primarily, this plan has been prepared to indicate the management and contractor structure for the program, the roles and responsibilities of the participating organizations, and the schedule and decision networks and funding required for the early phases of the program. Particular emphasis has been placed on the process of completing the selection of experiments to meet the primary objective of the MOL program. Detailed schedules and costing for the total program will be generated during the Phase I. In preparing this PTDP an earnest effort has been made to conform to the provisions of AFSCM 375-4.

1.1 PROGRAM OBJECTIVES.

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.

Accomplishment of this objective necessitates defining basic military tasks and design experiments that will determine and evaluate man's value in the accomplishment of these tasks. The selected experiments will be performed in an orbiting laboratory designed to be launched by the Titan IIIC Standard Launch Vehicle using a Gemini B Spacecraft for personnel transport. The objective of the MOL program is not to develop an operational manned military system, but to determine if there is sufficient justification to develop manned military space systems in the future, and, in the process, determine what the role of man should be and how his unique capabilities should be integrated into space systems to increase their military effectiveness.

The second objective is to accomplish the primary objective at minimum cost in dollars and time and with a maximum of safety. To achieve maximum economy, a "bare bones" approach will characterize program definition and conduct. Minimum changes to developed and proven vehicle and ground hardware, procedures, and facilities will be the rule in order to take full advantage of the accomplishments of prior DOD and NASA programs in the interest of safety and reliability as well as minimizing cost and time for development and test.

1.2 BRIEF SYSTEM DESCRIPTION.

The MOL Vehicle System consists of three principle elements: a Titan IIIC launch vehicle, a Laboratory Vehicle, and a Gemini B spacecraft. The system concept centers around an Orbiting Vehicle which consists of a Laboratory Vehicle, and a Gemini B spacecraft. The Titan III transtage may or may not be retained as an element of the Orbiting Vehicle. The Orbiting Vehicle is designed to provide a space base for military manned orbiting laboratory operation. The Orbiting Vehicle is to be integrally launched by the Titan IIIC. Although resupply and crew rotation by means of in-space rendezvous and docking do not figure in the initial flight program, the system is to be designed for later incorporation of these capabilities. The Laboratory Vehicle will be designed to provide life support for a crew of two without resupply for thirty days in order to perform military space experiments. Once the mission is complete, or in case of an emergency, the crew will return to earth via the Gemini B spacecraft. The Laboratory Vehicle may be left in orbit for future use, or it may be destroyed by command re-entry if the performance penalties prove tolerable. The general characteristics of the MOL System are listed in the following paragraphs.

a. System Characteristics:

(1) 30 day orbit duration
(2) 2 man crew
(3) Integral launch
(4) Shirt sleeve environment
(5) Large test and experimental capacity
(6) Rendezvous, docking, and transfer provisions

b. Operating Characteristics:

(1) Atlantic Missile Range Launch
(2) Low earth orbit 125-250° NM
(3) Inclination less than 36°

1.3 EXPERIMENTS.

Since the major purpose for developing the MOL is to provide a laboratory for evaluating man's potential as an element of a military space system through experiments in the true space environment, the accent will be on man's performance rather than equipment performance. Therefore, maximum ingenuity is being applied to conceive experiments which use existing, light, and inexpensive equipment as far as possible to obtain a valid measure of what man will do in an operational system. An evaluation of aircraft and ground tests will be made for the insight it provides into non-space system elements.

Experiments have been divided into two catagories; primary experiments, which provide measurement of man's utility; and, secondary experiments, which are of technical and scientific importance.

Efforts are now underway to evaluate the impact of man's performance on the design of experimental equipments for use in the MOL. The present in-house military studies and the industry Orbital Space Station Study (OSSS) results, together with certain supplemental contract studies, will be used to identify and define the experiment data to be included in the RFP for the Project Definition - Phase I Laboratory Vehicle program.

The foregoing discussion applies equally to the U.S. Navy Package, which is summarized in Section 18* and presented in detail in reference (14.1). Owing to the demanding schedule, raw experiment proposals by the Navy for MOL were submitted directly to the Air Force Space Systems Division as they were generated by the various Navy laboratories. However, the Navy, in addition, formed a MOL Technical Panel to review the laboratories' output, to develop a specific program responsive to Navy requirements related to ocean surveillance, and to identify particular experiment proposals which were of key interest to the Navy in areas other than that of ocean surveillance (e.g. general science). It will be necessary in forthcoming Pre-Phase I studies to establish common hardware performance requirements, to refine experiment concepts and missions proposed by the Navy, and to correlate current cost estimates and eliminate overlaps. The Navy is arranging to participate actively in these studies.

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*The references cited in Section 18 correspond to the list of references appearing in reference (14.1)

1.4 PROGRAM DEVELOPMENT SUMMARY.

1.4.1 General.

Although many space station configurations have been studied and preliminarily designed by industry with government and/or industry funding, insufficient information exists today to state specific costs, schedules, and specifications for the development of the MOL system. Once the specific MOL experiments have been selected, additional analysis and evaluation will be required to determine their influence on the MOL system design. Therefore, it becomes necessary to conduct a series of Pre-Phase I studies in addition to a Phase I and a Phase II program.

1.4.2 Pre-Phase I.

During the Pre-Phase I period the OSSS and selected additional experiment study contracts will complement in-house efforts in identifying MOL experiments and providing sufficient basic technical information on experiment packages for the Laboratory Vehicle Phase I Request for Proposal (RFP). Constructive use will be made of this Pre-Phase I interval to conduct several other studies which will further solidify MOL planning by narrowing the field of vehicle interface questions, permitting more solid guidance to be given the Laboratory Vehicle contractor aspirants in the Phase I RFP. These include studies to determine the degree to which the Apollo, with minimum changes to the NASA configuration, and the one-man Gemini on the Titan II Gemini Launch Vehicle can satisfy MOL objectives; studies by McDonnell on the Gemini B and by the Martin Company on the Titan IIIC configuration for MOL; and finally, selected contract studies of major subsystems of the Laboratory Vehicle to supplement an Aerospace in-house concentration on the total systems aspect of the Laboratory Vehicle.

1.4.3 Phase I.

This phase of the program will be subdivided into three parts. Phase IA begins with approval to release RFPs for the industry Phase IB

Project Definition efforts. Proposal evaluation, contractor selection, and award of Phase IB contracts will be completed by the end of Phase IA.

The Systems Program Office (SPO) organization will be brought up to full strength for Phase I. Phase IB will be accomplished by industry contractors using an associate contractor structure and firm fixed-price contracts. During Phase IB the contractor under SSD/Aerospace guidance will provide completely defined proposals and performance specifications with detailed schedule estimates of sufficient quality to support maximum use of incentive contracts during the Phase II System Acquisition program. Phase IB will be a period of concurrent definition of the system, of the program for acquiring the system, and preparation of incentive contract formulas. Phase IB will not be limited to preliminary design and other "paper" effort. Sufficient structures, wind tunnel space environmental, and other specialized testing will be accomplished to provide adequate confidence in the reliability of the Phase IB product as a foundation for Phase II.

During Phase IC, the final part of Phase I, Phase II cost proposals will be obtained and evaluated based on the program defined in Phase IB. Negotiation of incentive fee contracts for Phase II will be continued and the Phase II Program Plan submitted for approval. Meanwhile, contractors for Phase II will be permitted to continue work at a level of effort which will assure a running start on Phase II.

1.4.4 Phase II.

During Phase II the contractors will provide all engineering, fabrication, testing, and services required to accomplish the MOL program. Associate contractor procedures will be used with the Aerospace Corporation performing General Systems Engineering/Technical Direction (GSE/TD) for the SPO at the Space Systems Division. Testing during the program phase includes all development ground and flight testing, as well as MOL Flight Operations for the conduct of the experiments to meet MOL program objectives. The detailed management procedures for this phase, developed during the Phase I program, will employ PERT/Cost and PERT/Time procedures to ensure effective control of the total contractor and government efforts on the program.

1.4.5 Graphic Presentation of Action Schedules and Networks.

The time-phasing of the events described in the program summary is graphically displayed in the Master Program Summary Schedule, The Action Schedule, and the individual phase summary charts in Section 2. An action network is found in Section 17.

1.4.6 Preliminary Cost Estimates.

Preliminary cost estimates are outlined in Section 11.

1.5 MAJOR MILESTONE SUMMARY.

A summary of the major milestones in Pre-Phase I, Phase I, and Phase II is made in the Action Schedule (Section 2) and the Action Network (Section 17).

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SECTION 2

SCHEDULES

SECTION 2

SCHEDULES

2.0 INTRODUCTION.

This section contains the scheduled milestones, actions, and efforts for the Pre-Phase I and the Phase I periods.

2.1 PRE-PHASE I.

Figure 2-1 presents the schedule of activities for the Pre-Project Definition Phase. It reflects the tasks required to develop the foundation for follow-on contractor efforts to define the experiments and vehicle program during Phase I.

2.2 PHASE I.

Figure 2-2 is self-explanatory.

2.3 MASTER PROGRAM SUMMARY SCHEDULE.

Figure 2-3 presents the present schedule for the complete MOL program.

2.4 RELATED FLIGHT TEST SCHEDULE.

Figure 2-4 depicts the major related NASA and DOD flight programs.

2.5 ACTION SCHEDULE.

Figure 2-5 shows the time-phased actions which the various headquarters organizations must take to achieve the schedule displayed on earlier schedule charts in this section.

2.6 SUPPORT AGENCIES.

Figure 2-6 indicates the laboratory technical and test support which will be provided to the MOL program by various agencies. In addition, some of these agencies will serve as sponsors of MOL experiments.

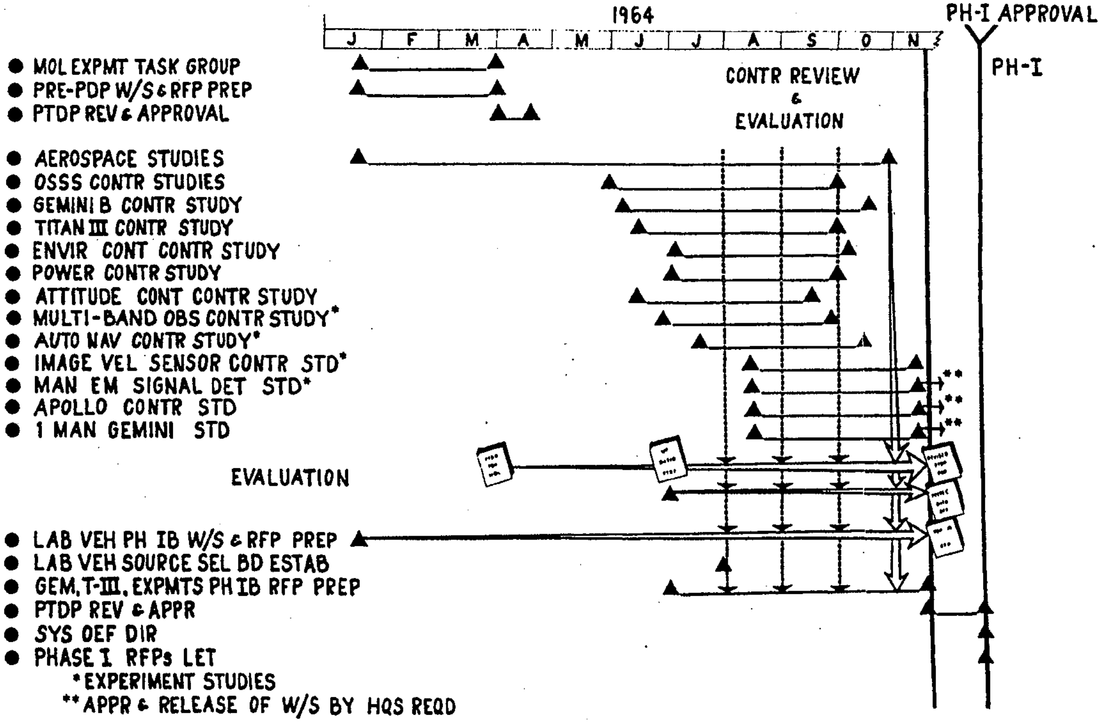


Figure 2-1. Pre-Project Definition Phase

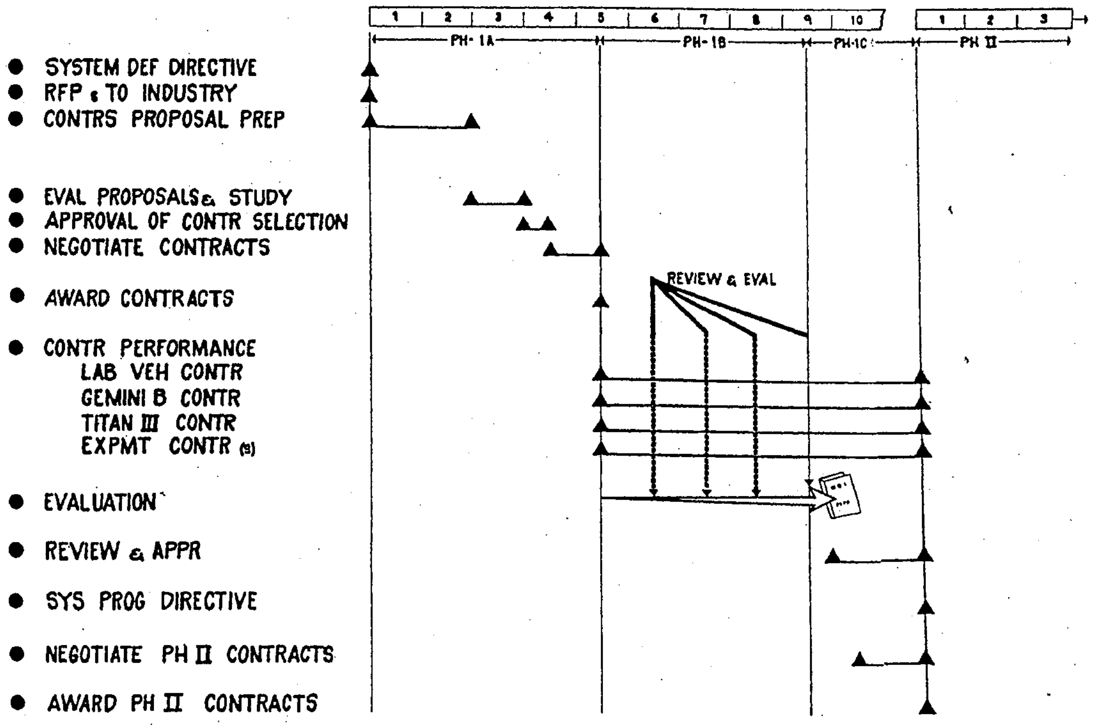


Figure 2-2. Project Definition Phase

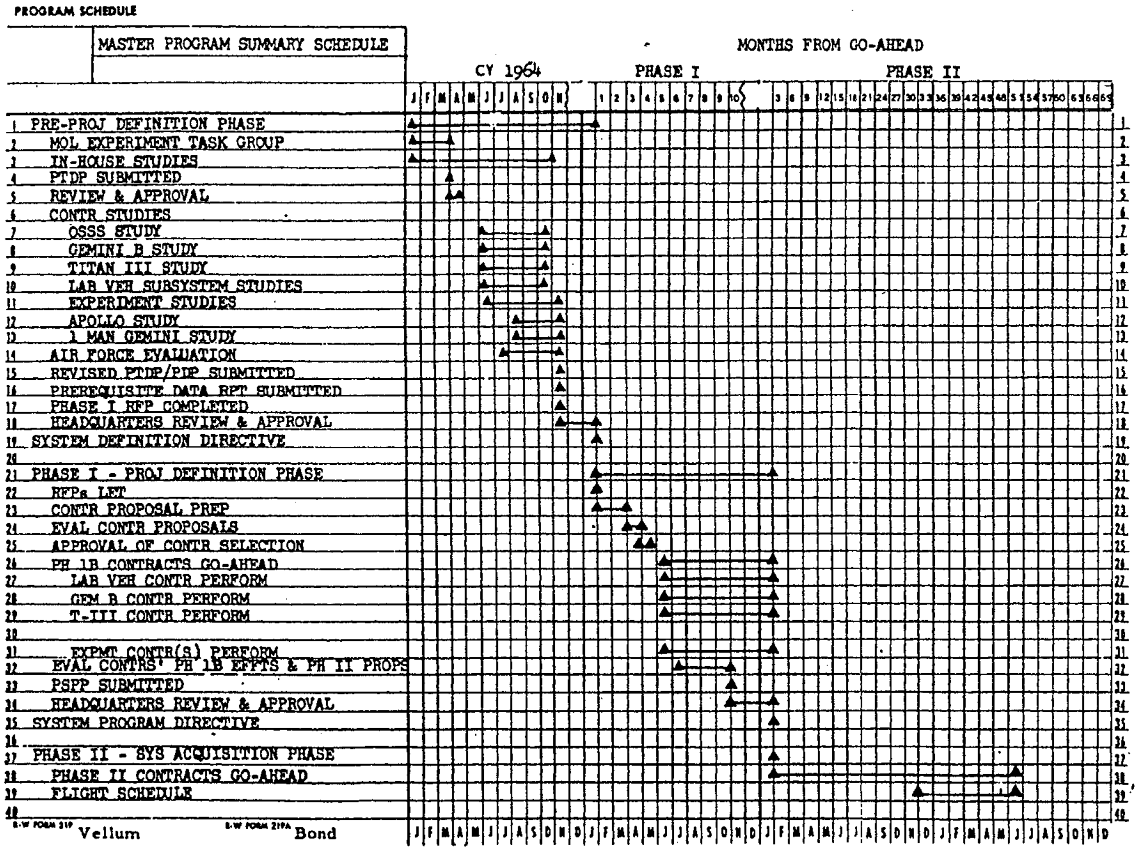


Figure 2-3. Master Program Summary Schedule

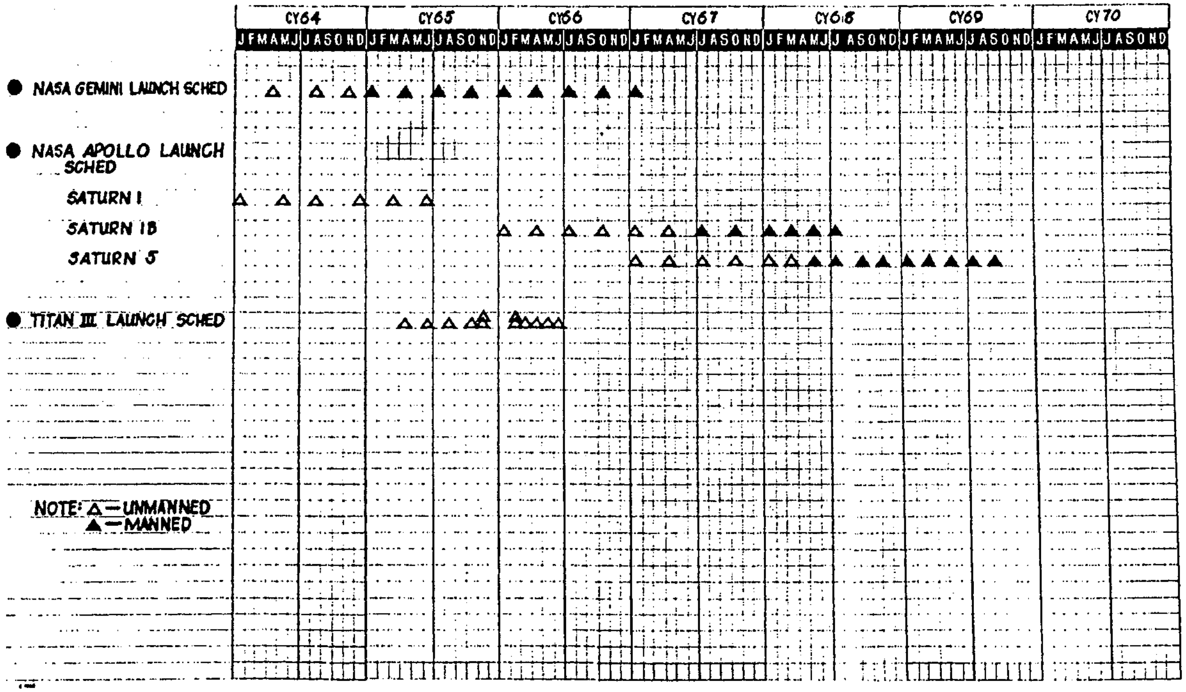


Figure 2-4. Related Flight Test Schedule

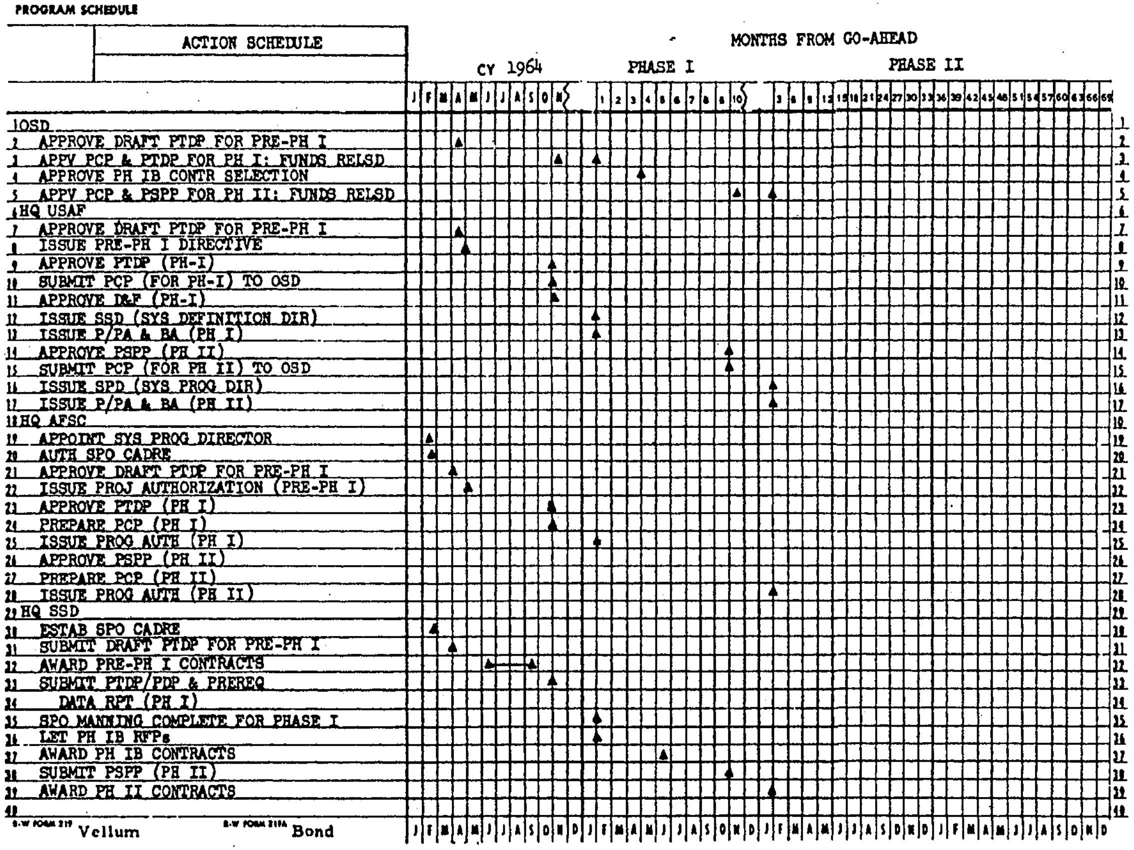
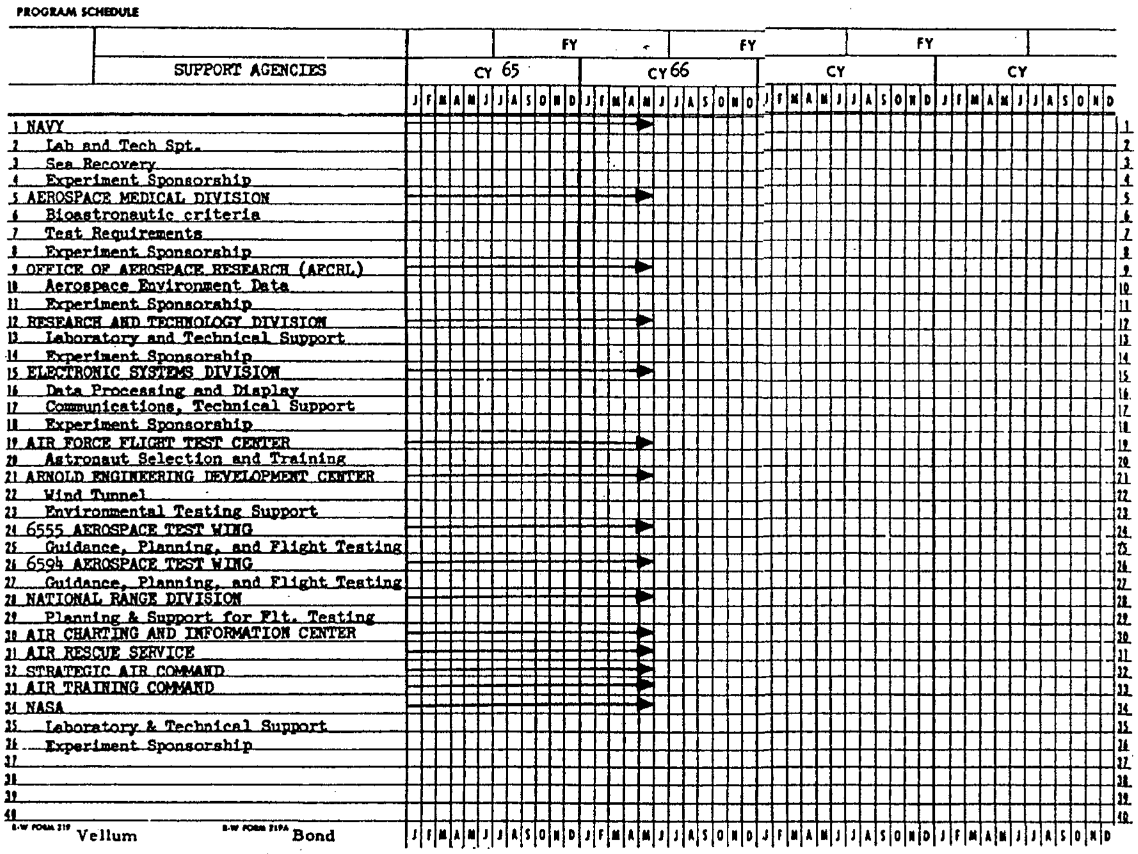


Figure 2-5. Action Schedule



1 NAVY
2 Lab and Tech Spt.
3 Sea Recovery
4 Experiment Sponsorship
5 AEROSPACE MEDICAL DIVISION
6 Bioastronautic criteria
7 Test Requirements
8 Experiment Sponsorship
9 OFFICE OF AEROSPACE RESEARCH (AFCRL)
10 Aerospace Environment Data
11 Experiment Sponsorship
12 RESEARCH AND TECHNOLOGY DIVISION
13 Laboratory and Technical Support
14 Experiment Sponsorship
15 ELECTRONIC SYSTEMS DIVISION
16 Data Processing and Display
17 Communications, Technical Support
18 Experiment Sponsorship
19 AIR FORCE FLIGHT TEST CENTER
20 Astronaut Selection and Training
21 ARNOLD ENGINEERING DEVELOPMENT CENTER
22 Wind Tunnel
23 Environmental Testing Support
24 6555 AEROSPACE TEST WING
25 Guidance, Planning, and Flight Testing
26 6594 AEROSPACE TEST WING
27 Guidance, Planning, and Flight Testing
28 NATIONAL RANGE DIVISION
29 Planning & Support for Flt. Testing
30 AIR CHARTING AND INFORMATION CENTER
31 AIR RESCUE SERVICE
32 STRATEGIC AIR COMMAND
33 AIR TRAINING COMMAND
34 NASA
35 Laboratory & Technical Support
36 Experiment Sponsorship
37
38
39
40

Figure 2-6. Support Agencies

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SECTION 3

PROGRAM MANAGEMENT

FIGURES

SECTION 3

PROGRAM MANAGEMENT

3.0 INTRODUCTION.

The MOL has been defined in a gross but important sense by the decision already made regarding vehicle elements to be used, the employment of state-of-the-art design, and the integral launch mode for initial operations. The major problems that lie ahead in the definition and execution of the MOL program are in the area of management to achieve present MOL objectives and to provide the potential for continued utility of the MOL at minimum cost.

This section describes the management techniques, the procedures, and the planned management structure for accomplishing the MOL program; in addition program responsibilities and specific tasks to be performed by various industrial and government organizations are presented. The time-phasing, inter-relationships, and the major decision points concerning these responsibilities and tasks are presented in the schedule networks in Section 17 - Preliminary Definition Plan, and summarized in Section 2 (Figure 2-5).

3.1 MANAGEMENT PHILOSOPHY.

DOD has assigned the responsibility for conducting the MOL program to the Air Force, and the responsibility for developing the operating system has been delegated to the Space Systems Division, where it will be directed by a Deputy Commander for Manned Systems (SSH). SSD will utilize the GSE/TD capabilities of the Aerospace Corporation and will work directly with the appropriate AFSC agencies that will be responsible for direct technical and support inputs. In addition, SSD will work closely with other agencies within DOD, and with NASA and industry to ensure that technical and management data essential to the MOL program is obtained and disseminated.

The major management problem facing the program is integration. A Laboratory Vehicle contractor will be responsible for the design, construction and integration of the Laboratory Vehicle, its sub-systems, the mission equipment payloads, and its interfaces with the Gemini B and the Titan IIIC launch system. An Orbiting Vehicle contractor (presently planned to be the same contractor as the Laboratory Vehicle contractor) will be responsible for the integration, assembly, and checkout of the Orbiting Vehicle (the composite of the Laboratory Vehicle, the Gemini B, and the Titan III transtage of it is retained in orbit) prior to launch, and for monitoring and back-up support during orbital operations. A launch service contractor will have primary responsibility for all common support (common to both the launch system and the Orbiting Vehicle system), launch integration, countdown, and launch of the integrated system; further, he will be responsible for telemetry to the point of injection into orbit.

The Air Force procurement philosophy of breaking out for direct Air Force prime procurement those identifiable components/sub-assemblies which are now being subcontracted is the main method of introducing substantial price competition into SSD/R&D type procurement. This philosophy will be applied to the extent practicable. The MOL System will be procured under the "Associate Contractor" concept using associate contractors for the major elements of the system. These participating AF prime contractors will represent the SPO's effort to adhere to the policy set forth in AFR 70-9, "System Procurement". Backing up these AF prime contractors will be an array of major component subcontractors and major elements of the AF Systems Command. This structure will be responsive to a single management voice, the System Program Director.

The decision to purchase subsystems or components through subcontract versus direct procurement by the Air Force will represent deliberate consideration of trade-offs between time, quality, economy and the SPO's own internal capability to manage the program. Reviews and decisions will be made on an item-by-item basis. Timeliness, quality, and economy can be attained by breaking out certain of these items for direct purchase whenever possible.

The industry contracts during the Pre-Phase I program will be sole source only where required, with the major portion being awarded as a result of wide technical competition. Source selection procedures will be used. During Phase I, the industry contracts will be awarded on a fixed-price basis. For Phase II, the method of contracting selected must satisfy the basic requirements for program integrity and unity. Careful consideration is being given to performance as an incentive factor. The objective of both the government and contractor should be to give the best possible product. In this vital man-rated program, this objective is paramount, but will not be sought at the expense of paying a cost beyond that considered appropriate. In general, the use of incentives effectively exerts pressure on the contractor to control cost, adhere to schedules, insure quality design and quality control, and generally establish a tightly disciplined operation. Therefore, to the maximum extent practical, Phase II will be negotiated on a cost plus incentive fee contract (CPIF-P) basis. Procurement planning does not envision the use of letter contracts to initiate work for any portion of the program.

Sponsor organizations will be established for each experiment. The MOL program office will maintain overall management responsibility for all experiment packages.

Other agencies of the DOD will contribute to the MOL program in a number of important respects, although the responsibilities of all of these supporting agencies have yet to be completely defined. In addition to SSD, other AFSC divisions and the Navy will sponsor DOD experiments. Sponsorship includes initiating a requirement, participation in experiment definition, and being awarded and accepting responsibility for development and acquisition of the experiment hardware according to a defined plan. The Phase II experiment program is to be centrally funded as a part of the MOL program. DOD sponsors will not be responsible for experiment funding for Primary Experiments; secondary experiments will be funded by sponsoring agencies and MOL/SPO will act as the integrating agency for them. NASA experiments will be funded as well as sponsored by NASA.

In addition to sponsoring experiments, other agencies of DOD will contribute ground test, training facilities, and technical consultation. The Navy will be asked to contribute sea recovery services during the flight program. NASA will be asked to contribute the use of NASA Gemini, operations resources, technical consultation, and documentation on the Gemini spacecraft.

During the program, proven management techniques such as: Configuration Management, Program Evaluation Review Techniques (PERT), and Schedule Interface Logs will be used.

a. Configuration management assures early configuration identification and control of changes to the configuration. As the acquisition phase of the system progresses toward prototype hardware, configuration management will provide the means for positive control of the system detailed design. The overall configuration management effort will be carried out in accordance with AFSCM 375-1 "Configuration Management".

b. PERT Time/Cost applications will be prescribed as a management control system for all participating organizations. The PERT/Time/Cost system has proven an effective management tool and will be used by the SPO and all associate contractors.

c. The Schedule Interface Log is an official reference planning document for all participating organizations. By use of electronic data processing equipment, it provides systematic and expeditious means for the accountability and information exchange of the thousands of items which make up the schedule interface requirements for the total program. The log maintains and provides descriptive information of specific PERT activities. This tool is a primary control and will be applied to all participants.

3.2 ROLES AND RESPONSIBILITIES.

3.2.1 Manned Systems Organization.

The Air Force Systems Command, through its Space Systems Division, has complete responsibility for management of the MOL program.

The SSD organization set up for MOL facilitates central management at the field level.

a. A Deputy Commander for Manned Systems, SSH, has been appointed. (Authorized grade: Brigadier General.) This Deputy Commander is delegated full authority for field implementation of the MOL program and is authorized direct access to streamlined channels established for expedited action on Designated Systems Programs and the MOL Program.

b. The Deputy Commander for Manned Systems will have complete control of allotted finanical resources, and will follow established procedures to assure support of all elements of the program.

c. Field detachments at test sites and factory representatives at selected contractors' plants will be established as required, and will report directly to the Deputy Commander for Manned Systems.

d. Military and civilian personnel will be assigned as required to implement the approved program. The personnel requirements will be delineated in the PSPP.

e. Procedures are being developed which stipulate the manner in which the MOL Program and its primary elements are to be handled by field activities, Headquarters AFSC, and higher authority. Pending approval of the special management procedures, the Deputy Commander for Manned Systems, is authorized direct access to the Commander, SSD, and Commander, AFSC. The Deputy Commander Manned Systems span of command will encompass the Manned Orbiting Laboratory and Titan III System Program Offices.

3.2.1.1 MOL SPO Cadre.

Hq AFSC directed SSD to establish a MOL SPO Cadre on 2 March 1964. This Cadre has been formed to initiate the Pre-Phase I effort and will be the nucleus around which the MOL SPO will grow as management requirements dictate.

3.2.1.1.1 Pre-Phase I Responsibilities - The basic responsibilities of the SPO Cadre during the Pre-Phase I are:

a. To prepare a SPO activation plan in accordance with AFSCR 375-7.

b. To prepare preliminary integration and implementation plans to guide the Pre-Phase I effort.

c. To manage the Pre-Phase I effort.

d. To generate those documents that are necessary to acquire Phase I approval and to initiate Phase I.

3.2.1.1.2 SPO Cadre Tasks - The tasks that the SPO Cadre will perform during the Pre-PDP are:

a. Update the Draft PTDP. (The draft PTDP is structured to the PSPP, one of the end items of Phase I. All sections are added in tabular form for continuity to conform to the PSPP outline. This will provide for the continuing orderly updating of the entire package as the Pre-Phase I and the Phase I progresses).

b. Initiate Pre-Phase I study contracts, manage the contractors' efforts, and evaluate the study results.

c. Specify System Performance Requirements and System Design Constraints.

d. Definition of the experiments package. Experiments sponsors and supporting agencies will contribute to this task.

e. Prepare initial System Performance/Design Requirements Specification.

f. Prepare initial breakdown of Contractor End-Item Specifications through 1st Level.

g. Prepare Phase I Plans and Schedules.

h. Prepare Preliminary Program Breakdown Structure.

i. Initiate formation of a Source Selection Board for the Laboratory Vehicle Contractor.

j. Prepare Preliminary Program Management Network.

k. Prepare Test Planning Requirements.

l. Prepare Phase IB Work Statements.

m. Prepare Phase II Specimen Work Statements.

n. Prepare Procurement Plan.

o. Prepare Request for Proposals.

p. Determine Eligible Contractors.

Upon approval of the program and receipt of the System Definition Directive with funds, the RFPs will be released to industry, thus initiating the Phase I.

3.2.1.2 Formal MOL SPO.

With the issuance of the System Definition Directive (SDD), the SPO Cadre build-up will be completed. The structure of this organization is outlined on Figure 3-1.

3.2.1.2.1 Roles and Responsibilities - Phase I.

The System Program Director of the MOL SPO will be responsible to the DCMS for all aspects of the research, development, test and acquisition of the Manned Orbital Laboratory System. Specifically, this includes the development, fabrication, system integration, launching, injection into orbit, and functional testing of spacecraft vehicles and payload equipment including scheduling, integrating, and conducting orbital experiments. The functions of the various elements of the MOL SPO are shown on Figure 3-2.

3.2.1.2.2 Formal MOL SPO Tasks.

The initial major task to be performed by the SPO in Phase I is to complete final contract negotiations and to award Phase IB contracts. The subsequent major tasks to be performed are delineated in the AFSCM 375-4 and they will have been precisely defined during Pre-Phase I.

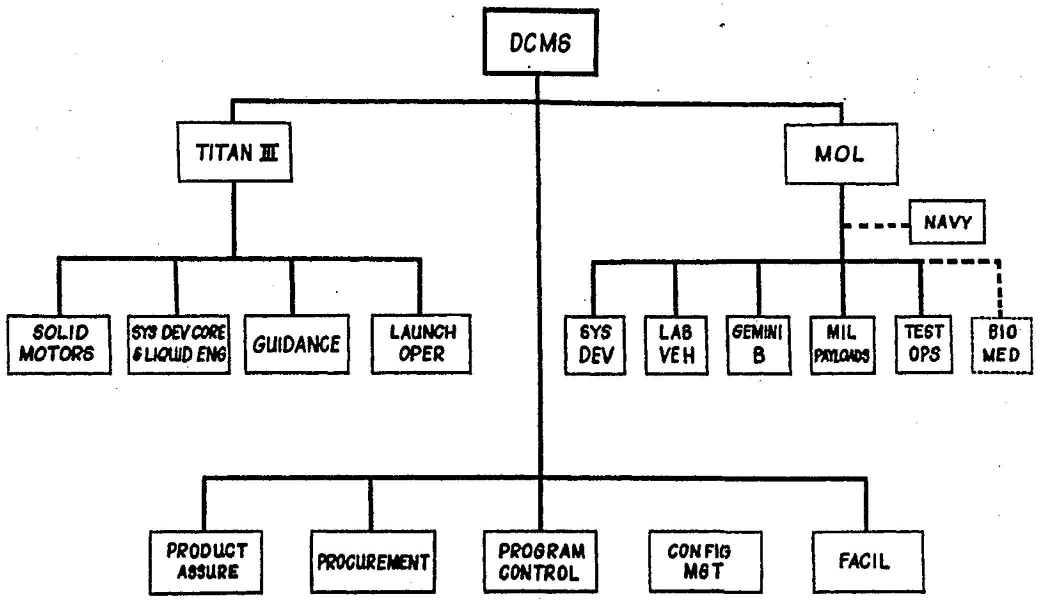

Figure 3-1. Deputy Commander For Manned Systems

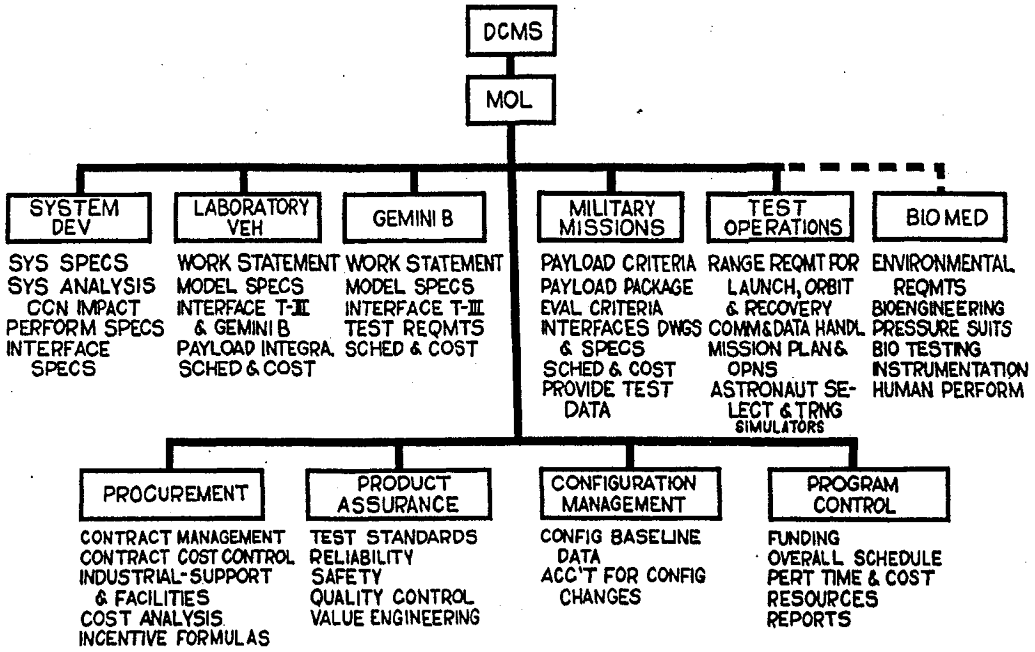

Figure 3-2. MOL Systems Program Office

3.2.2 Support Agencies.

Because of the complexity and scope of the MOL program it is anticipated that support will be required from the following organizations:

3.2.2.1 Aerospace Medical Division (AFSC) - Will provide bioastronautic and human factor design criteria and test requirements and possible experiment sponsorship.

3.2.2.2 Office of Aerospace Research (AFCRL) - Will provide Aerospace environment data and possible experiment sponsorship.

3.2.2.3 Research & Technology Division (AFSC) - Will provide laboratory and technical support and experiment sponsorship.

3.2.2.4 Electronic Systems Division (AFSC) - Will provide technical support on data processing, display and communications, and possible experiment sponsorship.

3.2.2.5 Air Force Flight Test Center (AFSC) - Will provide support in the selection and training of astronauts.

3.2.2.6 Arnold Engineering Development Center (AFSC) - Will provide wind tunnel and environmental testing support.

3.2.2.7 6555th Aerospace Test Wing (AFSC) - Will provide guidance and planning for and participation in flight testing.

3.2.2.8 6594th Aerospace Test Wing (AFSC) - Will provide guidance and planning for secure data retrieval and processing.

3.2.2.9 National Range Division - Will supply planning and support for flight testing.

3.2.2.10 Navy - Will provide laboratory and technical support, experiment sponsorship, and sea recovery.

3.2.2.11 In addition to the above, specific support is being provided by the Air Charting and Information Center and the Air Rescue Service directly to the MOL SPO. Further, the Strategic Air Command and the Air Training Command have representatives working directly with the SPO.

3.2.2.12 NASA - Will provide laboratory and technical support and experiment sponsorship.

3.2.3 Aerospace Corporation.

The Aerospace Corporation is a not-for-profit contractor to SSD performing general systems engineering as an in-house function and providing technical direction for the industrial contractor effort (GSE/TD) for MOL. The basic roles and responsibilities of the Aerospace Corporation during the conduct of the MOL program will be to provide the services of a technical group responsible for GSE/TD for the MOL program: GSE- Overall integration of the MOL system, design compromises among subsystems, definition of interfaces, analysis of subsystems and supervision of system testing; and, TD - The process of reviewing associate contractor efforts, exchanging technical information, preparing work statements for contract actions, and, where it will better achieve Air Force objectives, the contractor's technical effort is modified, realigned or redirected.

3.2.4 Participating Contractors.

3.2.4.1 Orbiting Vehicle (Laboratory Vehicle) Contractor.

The Orbiting Vehicle Contractor, will be selected by source selection procedures in accordance with AFR 70-10. The selected contractor will perform Phase IB, IC (sustaining), and Phase II. A program office, including a specially constituted group to perform mission equipment integration, will be established within the selected contractor's organization. The basic roles and responsibilities of the selected Orbiting Vehicle (Laboratory Vehicle) contractor during the conduct of the program are:

a. Design and develop the Laboratory Vehicle.
b. Manufacture and test the Laboratory Vehicle.
c. Integrate Laboratory Vehicle Subsystems.
d. Design, develop, and manufacture the Laboratory Vehicle Associated Ground Equipment (AGE) and insure integration with the Orbiting Vehicle Ground Environment.
e. Integrate and install the mission equipment.
f. Integrate experiment procedures.
g. Integrate the complete Orbiting Vehicle.
h. Assure compatibility of the Orbiting Vehicle with the booster system.
i. Assure compatibility of the Orbiting Vehicle AGE.
j. Assure compatibility of the Orbiting Vehicle and the Tracking, Communications, and Control system.
k. Provide for the checkout of the Orbiting Vehicle prior to astronaut entry.
l. Provide the composite Vehicle simulator(s).
m. Devise on-orbit procedures.
n. Provide for on-orbit abort procedures.
o. Checkout Orbiting Vehicle before mating to the launch vehicle.
p. Provide on-orbit technical support for the Orbiting Vehicle.
q. Provide on-orbit Orbiting Vehicle data management capability.
r. Collect, distribute and analyze Orbiting Vehicle sustention data. (Exclusive of on-orbit experiment data.)

(See Section 6.3 and 6.4 for detailed definition of Laboratory and Orbiting Vehicles.)

3.2.4.2 Gemini B Contractor.

A sole source contract for Gemini B is justified since it is a follow-on to the present NASA Gemini program. The basic roles and responsibilities of the Gemini B contractor during the conduct of this program will include:

a. Design and develop a modified Gemini B capsule.
b. Manufacture and test the Gemini B capsule.
c. Design, develop, and/or modify Gemini B AGE.
d. Provide for Gemini B monitoring and checkout on-orbit.
e. Devise crew transfer procedures.
f. Assure safe Gemini B separation.
g. Devise crew procedures during re-entry and recovery.
h. Provide vehicle-borne communications during launch, re-entry, and recovery.
i. Pre-launch checkout of Gemini.
j. Analyze Gemini B telemetry.
k. Provide Gemini B recovery procedures.
l. Provide safe abort during launch.

3.2.4.3 Titan III Contractor.

A sole source contract for Titan III is justified since it is a follow-on to the present Titan III program. The basic roles and responsibilities of the Titan III contractor during the conduct of this program will be as follows:

a. Design launch system modification.
b. Manufacture and test the launch vehicle.
c. Integrate MOL Vehicle elements for launch phase.
d. Assemble the Orbiting Vehicle on the launch vehicle.
e. Operate the launch facility.
f. Conduct checkout and launch operations.
g. Determine launch trajectories.
h. Analyze flight dynamics.

i. Determine launch vehicle adequacy.
j. Define launch environment.
k. Define launch abort environment.
l. Analyze launch vehicle telemetry.

3.2.4.4 Experiment Equipment Contractor(s).

Whenever practical, these contractors will be selected competitively using source selection procedures in accordance with AFR 70-10. Some of the experiment contractors may qualify as sole sources because of unique capabilities and/or continuation of present efforts. The basic roles and responsibilities of the experiment contractors during the conduct of the MOL Program are outlined below:

a. Design and develop the experiment mission equipment.
b. Manufacture and test the experiment equipment.
c. Design, develop, and manufacture the associated AGE.
d. Check-out and deliver the equipment to the Laboratory Vehicle Contractor.
e. Assure compatibility with the Laboratory Vehicle.
f. Establish experiment test procedures.
g. Checkout the experimental equipment.
h. Analyze the experimental data.

3.3 PRE-PHASE I, PHASE I & PHASE II.

3.3.1 Pre-Phase I.

Approval to proceed with Phase I will be contingent upon the evolution of a group of experiments which, in the judgment of the approving authority, meets the criteria set for the MOL program and justifies the cost of proceeding. A Pre-Phase I effort consisting of Air Force, Navy, and Aerospace in-house plus industrial contractor studies is required to produce this experiment package. This effort constitutes the "critical path" in the overall program definition effort. This experiment study activity is also beneficial in that it will enable the technical and operational characteristics of the experiments to be specified in the Laboratory Vehicle RFP much more accurately. While not a mandatory requirement for contractor selection, this inclusion insures that the selected contractor will not have to be substantially redirected upon Phase IB go-ahead, thus saving time and avoiding wasted effort. Furthermore, the three months of contractor performance required for generation of experiment information affords time for launch vehicle and Gemini B studies to provide interface and design constraints information which will enable laboratory proposers to configure more intelligently the laboratory and its interfaces with adjacent vehicle elements. Studies by subsystems contractors will contribute specific trade-off information on Laboratory Vehicle subsystems. These contractor efforts will further the decrease number and complexity of inter-vehicle iterations required during Phase IB and reduce the time required in Phase IB to select Laboratory Vehicle subsystems designs. More precise RFP inputs will also reduce waste motion by Laboratory Vehicle aspirants during the proposal period (Phase IA). The timing of these Pre-Phase I studies allows the contractual relationship with McDonnell and Martin to be interrupted during the Laboratory Vehicle proposal and source selection period - a cleaner arrangement if these contractors complete for the laboratory contract.

The industrial contract studies to be conducted are described below.

3.3.1.1 Orbital Space Station Studies.

Three contractors have been selected and are performing this study for the primary purpose of deriving MOL experiments. This study, as presently planned, does not involve the selection of space station configurations or the design of space stations. The resulting experiments will be mission-derived, but oriented toward assessing man's ability to perform military missions in space. The tasks to be performed during each of these studies are:

Task 1 - Technical Requirements Planning
Task 2 - Test Operations Planning
Task 3 - Parametric System Definition

3.3.1.2 Experiment Studies.

Detailed technical, cost, and schedule information will be required for each experiment to provide the Laboratory Vehicle contractor sufficient data to carry out Phase IB. Detailed definition of experiments will be accomplished to the maximum extent possible by in-house study using the full capabilities of AFSC. However, supplemental contract studies will be necessary to define the equipment and techniques for experiments where the technical approach is uncertain. These studies will provide trade-off comparisons and data sufficient to determine feasibility, validity, and preferred approach. Contract studies identified to date include:

3.3.1.2.1 Image Velocity Sensor Subsystem Study.

A study will be performed to analyze and define the experimental equipment required for three experiments identified as: P-1 - Acquisition and Tracking of Ground Targets; P-2 - [redacted] [redacted] and P-3 - Direct Viewing for Ground and Sea Targets. Request for proposal No. 04-695-64-24-247 - Image Velocity Sensor Subsystem Study was issued 20 June 1964 and responses are expected 21 July 1964. One contractor will be selected to perform the following tasks:

Task 1 - Elemental Simulations
Task 2 - Parametric and Tradeoff Analysis
Task 3 - Functions of Man
Task 4 - Vehicle Interface
Task 5 - Image Quality Analysis
Task 6 - Experimental Testing and Mockup
Task 7 - Preliminary Design Recommendations and Configuration
Task 8 - Experiment Procedure Planning
Task 9 - Experiment Simulation
Task 10 - Program Planning

3.3.1.2.2 Multiband Spectral Observation Study.

Proposals in response to RFP No. 04-695-64-250 were received 4 June 1964 and have been evaluated. A contract is being negotiated on a price competition basis to accomplish the following tasks:

Task 1 - Preliminary Study
Task 2 - Preliminary Experiment Description
Task 3 - Parametric Analysis and Tradeoff Studies
Task 4 - Preliminary Design Recommendations and Configuration
Task 5 - Simulation Definition
Task 6 - Program Planning

3.3.1.2.3 Autonomous Navigation Definition Study.

Proposals for this study were received 23 June 1964. A contract will be awarded to one contractor to accomplish the following tasks:

Task 1 - Experiment Procedures
Task 2 - Equipment Requirements
Task 3 - Mapping and Geodetic Survey of Selected Terrestrial Sights
Task 4 - Vehicle Interface
Task 5 - Parametric Analysis and Trade-off Study
Task 6 - Simulation Program Definition
Task 7 - Astronaut Functions
Task 8 - Preliminary Design Recommendations and Configuration
Task 9 - Program Planning

3.3.1.2.4 Manned Electromagnetic Signal Detection Studies.

One contractor is required to perform the following tasks: Approval and release of this work statement is required from higher headquarters.

Task 1 - Equipment Definition and Techniques Studies
Task 2 - Astronaut Functions

Task 3 - Preliminary Design Recommendations and Configuration

Task 4 - Program Planning

3.3.1.3 Gemini B Pre-Phase I Study.

A contract has been negotiated with the McDonnell Aircraft Corporation to conduct a study under a fixed price contract for the purpose of: (a) defining the configuration of Gemini B as an element of the MOL system to the extent practical prior to Laboratory Vehicle definition, (b) providing early identification and recognition of interface problems and recommended solutions, and (c) identifying tasks and costs required to complete Gemini B definition. Resolution of certain questions regarding MOL vehicle systems and subsystems can best be obtained with the assistance of the McDonnell Aircraft Corporation and Martin-Marietta Corporation performing specific studies in coordination. For those tasks which require effort by both contractors, one contractor will be designated lead and the other will be the supporting contractor. The technique being employed is as follows:

a. Briefly review and summarize previous studies which have enabled selection of promising alternatives.
b. Perform preliminary design for selected alternatives.
c. Evaluate each alternative against criteria chosen to reveal reliability, safety performance, time and cost impacts.
d. Prepare conclusions and recommendations on each task.

The specific tasks the McDonnell Aircraft Corporation are performing are as follows:

Task 1 - Gemini B System Functional Analyses

The Contractor will conduct a functional analysis of operation and in-space monitoring, checkout and maintenance of the Gemini B spacecraft. Both routine and emergency situations will be covered. The results of this task will be used in concert with analyses of other MOL system elements for the identification of initial system requirements.

Task 2 - Crew Transfer Techniques.

Alternative techniques for crew transfer between Gemini B and the Laboratory Vehicle will be defined and evaluated. The constraints placed on the Laboratory Vehicle will be set forth for each method.

Task 3 - Crew Escape Methods.

Alternative methods of crew escape on the pad and during boost will be studied. This task will be based on an abort environment model provided by the Martin Co.

Task 4 - Retrograde and Retrograde and Re-entry System.

The modifications required to enable Gemini B to de-orbit and re-enter from the MOL flight altitude (higher than that of the NASA Gemini) will be identified and the system operational constraints will be defined.

Task 5 - Subsystem Studies.

Studies of the Gemini Subsystems will be conducted to determine modification and test required to insure reliable performance after 30 days on orbit, to provide designs for on-orbit monitoring and checkout and to determine how subsystems not required for the period of Laboratory operation can best be secured.

Task 6 - Gemini B/Laboratory Vehicle Interface.

The objective of this task is to define the interface problems between the Gemini B and the Laboratory Vehicle. Problem areas include the requirements of the Gemini B for on-orbit power and environmental control, the choice of design atmosphere for the Gemini B, and checkout and monitoring of the Gemini B from the Laboratory Vehicle.

Task 7 - ITL/MOL Compatibility Study.

The purpose of this task is to evaluate the use of the AMR ITL facility compared to on-pad assembly of the orbital vehicle. New facility and OGE requirements will be identified. Design changes which will have a major effect on the ground system requirements will be defined.

Task 8 - Rescue Mission Analysis

This study task will identify the rescue system requirements and characteristics and Gemini equipment modifications required to provide a capability for rescuing a MOL crew.

Task 9 - Piggyback/Simulation Flight Tests

This study will define a flight test program, consisting of a minimum number of piggyback flights on Titan IIIC R&D launches, adequate to proof test the Gemini B and thereby reduce the number of unmanned MOL flights.

Task 10 - Program Planning.

The Contractor will formulate a program plan for Phase I and a preliminary plan for Phase II. These plans will identify, define, and relate the tasks to be performed in development of Gemini B and provide cost and schedule estimates, contractor, and government resources required consistent with the Master Program Schedule.

Task 11 - Final Technical Documentary Report.

The final report will contain all the significant technical data resulting from the work performed and will include the Contractor's conclusions and recommendations. It will be used as an input to the Laboratory Vehicle RFP.

3.3.1.4 Titan III Pre-Phase I Study.

A contract has been negotiated with the Martin-Marietta Corporation to conduct a study under a fixed price contract for the purpose of: (a) defining the configuration of Titan III as an element of the MOL system to the extent practical prior to Laboratory Vehicle definition, (b) to provide early identification and recognition of interface problems and recommended solutions, and (c) to identify tasks and costs required to complete the definition of the Titan III configuration for MOL. The techniques to be employed in conducting this study will be as described in Paragraph 3.3.1.3 above. The specific tasks are as follows:

Task 1 - Titan III System Functional Analyses.

The Contractor will review the functional analysis which was performed during the Titan III Program Definition Phase and determine the impact of MOL. New or modified functions will be analyzed to determine additional system requirements and constraints on the laboratory vehicle.

Task 2 - Launch Vehicle Constraints on Payload.

A study will be conducted to define the launch vehicle constraints on the Laboratory Vehicle design.

Task 3 - Guidance Study.

The Gemini inertial guidance system (IGS) will be evaluated for application as a primary guidance system and as a backup for the MOL launch phase.

Task 4 - ITL/MOL Compatibility.

The purpose of this task is to evaluate the use of the AMR ITL facility compared to on-pad assembly of the Orbiting Vehicle. New facility and AGE requirements will be identified. Design changes which will have a major effect on the ground system requirements will be defined.

Task 5 - Transtage Study.

Use of the transtage to perform on-orbit stabilization and propulsion will be investigated and required modifications will be identified.

Task 6 - Payload Performance.

An analysis will be performed on the Titan III payload capability for MOL application. The calculations will be conducted for both minimum and nominal limit launch vehicle characteristics.

Task 7 - Crew Safety.

The abort hazard environment will be determined in terms of fireball position and overpressure as a function of position in the launch trajectory.

Task 8 - Rescue.

Launch vehicle and launch complex requirements will be determined for providing the capability to launch an unmanned Gemini with Titan III or the Titan II Gemini Launch Vehicle for rescuing the crew of a MOL spacecraft.

Task 9 - Program Planning.

The Contractor will formulate a program plan for Phase I and a preliminary plan for Phase II. These plans will define, note inputs required from and outputs to other associate contractors, schedule the tasks to be performed and provide cost estimates, contractor, and government resources required consistent with the Master Program Schedule.

Task 10 - Final Technical Documentary Report.

The final report will contain all the significant technical data resulting from the work performed and will include the Contractor's conclusions and recommendations for inclusion in the Laboratory Vehicle RFP.

3.3.1.5 Apollo Pre-Phase I Study.

It has been recommended that North American Aviation, Inc. perform a funded systems study to provide information needed to determine the potential of the Apollo system to perform the MOL mission. The study will be based on the MOL system characteristics and requirements as they are currently defined. The study will take advantage of the Extended Apollo Study performed under NASA contract and will follow the concept of minimum changes to the present NASA Apollo configuration. Both the Saturn IB and Titan IIIC launch vehicles will be considered. On the basis of this study the capability of the Apollo to perform the MOL mission will be determined. Approval and release of the Apollo Study Tasks to be performed under this study are as follows:

Task 1 - Mission Analysis

The contractor will perform mission and functional analysis to determine requirements imposed on the Apollo system by the MOL program objective.

Task 2 - System Analysis and Design.

This task requires the selection of the most desirable Apollo configuration for accomplishing the MOL mission. Trade-off analysis of configuration considered is required.

Task 3 - Program Planning.

The contractor will define an optimum program plan which shall include, but not be limited to, the following subtasks: development, ground test, aircraft test, space flight test program, program schedule, and time-phases costs for recommended flight programs.

3.3.1.6 <u>One Man Gemini Study</u>.

It has been recommended that the McDonnell Aircraft Corporation conduct a funded study to investigate the degree to which a GLV-launched Gemini spacecraft modified for operation by one astronaut can satisfy MOL objectives. The contractor will determine the modifications necessary to carry and operate experiment equipment within the performance and volumetric capacity of the system, and to remain in orbit as long as is practical with this system up to thirty days. He will determine a preferred operational procedure, derive the time available for conduct of experiments, identify and describe the experiments to be conducted and develop a program schedule and cost. Specific tasks are:

Task 1 - Functional Analyses
Task 2 - Experiment Integrations
Task 3 - Program Planning
Task 4 - Final Technical Documentary Report

3.3.1.7 Laboratory Vehicle Subsystem Studies.

Pre-Phase I studies will provide MOL-specific trade-off information on alternative designs and components in each subsystem modular area. Each study will cover the evaluation spectrum, furnishing technical, reliability, safety, schedule, and cost information. As a part of the Laboratory Vehicle RFP data, information generated by these studies will start proposing contractors' efforts closer to the final answer in each of these areas. Each of these studies will stress design to make the most of the presence of the crew to increase simplicity and reliability. It will be the goal of each to identify a single preferred approach. In any case, the trade-off analyses will reduce the area of uncertainty and will identify further study and tests to be conducted in Phase IB to produce final decisions and subsystem specifications.

3.3.1.7.1 Environmental Control Subsystems Study.

This study is in the process of contract negotiations with the Hamilton Standard and Garrett Corporations. These contractors will conduct an evaluation of a single versus a two-gas subsystem for the Laboratory Vehicle. Since this system will probably supply the environmental control needs of the Gemini B during its 30-day period of storage on orbit, this study will consider the needs of the entire Orbiting Vehicle. It will be closely coupled to the Gemini B study in progress during the Pre-Phase I period.

3.3.1.7.2 Electrical Power Subsystem Study.

This study is in the process of contract negotiations. The electrical power supply for the Orbiting Vehicle, located in the Laboratory Vehicle, will consist either of a solar cell-rechargeable battery system, or of fuel cells, or a combination of the two approaches. These approaches exhibit different advantages and disadvantages and the contractor studies will be conducted to determine the optimum system. The selection of the electrical power system profoundly affects the Laboratory Vehicle design and constrains the ability of the MOL to perform its initial and possible electrical power system profoundly affects the Laboratory Vehicle design and constrains the ability of the MOL to perform its initial and possible future missions.

3.3.1.7.3 Attitude Control Subsystem (ACS) Study.

A contract has been negotiated with the Minneapolis-Honeywell Corporation. This study will provide design criteria for the MOL ACS system through a range of requirements which may be imposed by experiments and other subsystems, such as solar panel orientation and crew motion. A crossfeed will be maintained between this study and other subsystems studies so that impulse requirements can be determined and a preferred ACS system can be specified.

3.3.1.7.4 Guidance Subsystem Study.

Martin is required to analyze T-III guidance for use through injection plus pilot in loop at launch. McDonnell is analyzing uses of Gemini Inertial system for de-orbit and re-entry in view of this and anticipated data from Standard Space Guidance Study plus the fact that it now appears that no one industry source would provide a complete and objective analysis of the overall problem, no additional funded industry support is planned at this time. MOL guidance system will be collected and compared. This study will be closely coupled with guidance requirements studies for Titan III launch and Gemini B re-entry guidance during the Pre-Phase I period.

3.3.1.7.5 Communications and Control Subsystem.

It was originally intended that this effort would consist of a funded study with industry and encompass five task areas:

a. On-board data management and transmission.
b. Ground support.
c. Inter-site communications.
d. Display, control, analysis, and simulation.

e. Rendezvous requirements on the ground system. Further review of these tasks reveal that they could more effectively be accomplished by utilization of DOD resources. Specifically, arrangements have been made wherein NRD supported by SCF will accomplish tasks B and C. Tasks A and D are to be accomplished in-house by Aerospace with possible support from ESD. Task E has been deleted in view of similar analysis in the 706 Phase 0 studies. It is possible that some future contractor effort of a small nature will be utilized in support of the NRD efforts.

3.3.1.7.6 Vehicle Design Requirements of a Side-Looking Radar.

Design requirements of a side-looking radar: In view of the capability existing in SSD/Aerospace and ASD initial phases of this task are being accomplished in-house. It may be desirable to have funded industry effort in this area in the future.

3.3.1.8 Aerospace Corporation Pre-Phase I Effort.

Task 1 - System Functional Analyses to derive:

a. Preliminary performance requirements
b. Preliminary design criteria
c. Functional interfaces
d. End item identification

Task 2 - Experiments Program to derive:

a. Experiments definition
b. Integrated Experiment Payload Package
c. Vehicle Interface Requirements
d. Payload Specifications
e. Necessary documentation for Ph I (work statements, RFP data, etc.)

Task 3 - Identify Major Technical Problems and alternative solutions.

Task 4 - Necessary technical support data, work statements, and RFP data for Phase I to include laboratory vehicle, vehicle subsystems, Gemini B, T-III, flight test plans and documentation, prerequisite data as reflected in DOD Directive 3200.9, and other required support documentation.

Task 5 - In-house studies and analyses leading to a sound approach for the MOL vehicle.

Task 6 - Preparation of Pre-Phase I Contractor Task Descriptions.

Task 7 - Evaluation of Pre-Phase I Study Results.

Task 8 - Preparation of Phase I Contractors Task Description.

Task 9 - Pre-Phase I Studies.

a. Stablization
b. Monitoring and checkout on orbit
c. Electrical power subsystem
d. Environmental control system
e. On-board data handling
f. Electromagnetic interference (EMI) Compatibility
g. Communications
h. Flight test plan
i. Program integrated ground test plan
j. Telemetry, tracking and communications
k. Analysis of existing and programmed TT&C capability
l. MOL information processing
m. MOL support planning
n. Communications and control interface definition
o. Communications and Control Subsystem on-board data management and transmission
p. Communications and Control Subsystem display, control, analysis, and simulation
q. Configuration analysis
r. Compartimentization
s. Docking methods
t. MOL diameter/length trade-off
u. Orbital life trade-off
v. Astronaut rescue

w. Vehicle design
x. Subsystem integration
y. Configuration development/control
z. Environmental criteria
aa. Crew utilization/human factors
bb. Redundance/maintainability
cc. Astronaut safety criteria
dd. Design requirements of side-locking radar

Task 10 - Final Detailed Technical Report (one for each Pre-Phase I Study).

Task 11 - MOL Experiments Studies.

Task 12 - Prepare MOL System Performance/Design Requirements Specification.

Task 13 - Prepare Data Package (for Phase I RFPs).

The Aerospace studies, coupled and augmented by the industry studies, will significantly improve the quality of the RFPs so that the Phase IB efforts can be accomplished with reduced number of iterations and in the time allotted.

Task 14 - Preparation of Technical Development Plan

3.3.2 Project Definition Phase I.

Phase I will be the formal step in the MOL development process preceding full-scale development (Phase II), during which preliminary engineering and contract and management planning will be accomplished. The primary objectives of Phase I are:

a. To establish firm performance specifications down to the vehicle element, interface and experiments level.
b. To define contractor roles and missions.
c. To identify high risk areas.
d. To select technical approaches.
e. To define work statements and establish firm and realistic schedules.
f. To evolve and negotiate incentive contract formulas for Phase II.

g. To cost realistically the defined Phase II program.

h. To prepare the documentation and technical data necessary to request Phase II program approval.

This phase, consisting of three subphases (IA, IB and IC), will begin with approval to proceed and release of funds by the Office of the Secretary of Defense (OSD). It will end with OSD approval to initiate Phase II.

3.3.2.1 Aerospace Corporation.

During Project Definition Phase, the Aerospace Corporation will perform the following tasks:

Task 1 - General Systems Engineering

- a. Establish performance requirements
- b. Define design criteria
- c. Identify and define interfaces
- d. Evaluate alternative approaches to technical problems
- e. Identify technical solutions to systems problems

Task 2 - Provision of technical support to source selection

Task 3 - Evaluation of Phase I contractor's efforts

Task 4 - Maintenance of Data Book

Task 5 - Review and evaluation of contractors' Phase II proposals

Task 6 - Provide technical advice to Air Force in contract negotiations

3.3.2.2 Phase IA - Preparation for Contractor Definition.

Upon approval to proceed with Phase I, the Laboratory Vehicle RFP will be released to industry. This RFP will solicit proposals for the Contractor Definition Phase IB and planning proposals for the Phase II development of the Laboratory Vehicle.

Following proposal evaluation via source selection procedures, a contractor will be selected to conduct Phase IB. Concurrently, McDonnell and Martin and supporting contractors in vehicle subsystems areas will be requested to submit proposals for providing Phase IB support to the definition of the complete MOL system and completing the definition of the Gemini B and Titan IIIC configurations. In addition, sole source and/or competitive selection procedures will be used to award contracts for selected MOL experimental packages. During Phase IA the SPO, together with Aerospace, will evolve a detailed plan for coordinating the iterative preliminary design process that is the heart of the IB effort. Other associate contractors may also enter the program in Phase I. Phase IA terminates with the initiation of the Phase IB Definition contracts.

3.3.2.3 Phase IB - Contractor Definition.

During this period the contractors will accomplish the preliminary engineering that is required to define the MOL system along with developing the contract and management for Phase II. The SPO, with Aerospace technical support, will closely direct contractor effort according to the plan developed during IA and provide additional guidance as needed to assure that the resulting system definition is optimized. During definition of the technical, schedule, and management aspects of the development program, the contractors will continuously update specifications and proposals, including work statements, for the Phase II development. Also, Phase IB will see continuous negotiation of incentive contract formulas for Phase II.

The tasks to be performed by the contractors during Phase IB are summarized below, but will be expressed in detail in the Phase IB work statements. The work statements (IB) will be prepared during the Pre-Phase I period and updated upon receipt and evaluation of the contractors' proposals. They will form the basis for Phase IB contract negotiation.

The Phase IB work statement tasks are summarized for the Laboratory contractor in the next paragraph. Since the work statement structure and the essential elements of the tasks are substantially the same for all Phase IB contractors, no additional summaries are shown for other Phase IB associates.

3.3.2.3.1 Laboratory Vehicle Contractor Phase IB Tasks.

Task 1 - System Engineering

The contractor will conduct studies and perform preliminary design in accordance with the system engineering definition provided in AFSCM 375-1 and AFSCM 375-4. The following technical studies will be accomplished in addition to the speciality area studies required to prepare the necessary functional management plans:

a. Mission Profile Analysis

The pre-launch, launch and injection, and orbital operation periods will be analyzed to determine design requirements for the laboratory vehicle.

b. System Analysis

System analyses of single or dual compartment trade-offs, rendezvous and docking, extended mission duration, growth provisions, crew transfer, abort operations, and interface investigations will be conducted and design approaches defined.

c. Subsystem Analysis

Subsystem analyses including crew performance, integration of experiments, propulsion systems, environmental control, stabilization and control, data recovery, and communications will be accomplished and technical design requirements determined as necessary to prepare the appropriate end-item specifications.

d. Special Studies

The contractor will accomplish selected special studies as required to define the laboratory vehicle and prepare the required system specifications. Typical studies are: disposal of the laboratory vehicle, test program philosophy, recovery requirements, and identification of high risk areas. Additional special studies may be generated by SSD/Aerospace or the contractor as required to insure the optimized system definition.

Task 2 - Phase II Proposal

The contractor will prepare a firm proposal for the acquisition of the Laboratory Vehicle system. This Phase II - System Acquisition proposal will form the basis for negotiation between the AF and the contractor and will include all work packages for the program. The contractor will accomplish the following sub-tasks in order to prepare the laboratory vehicle proposal:

a. System and End-Item Design/Performance Requirement Specifications

All specifications required from the system to the end-items will be prepared by the contractor.

b. Functional Management Plans

The contractor will prepare all the functional management plans that are necessary to acquire the Laboratory Vehicle system. Specifically, a Program Plan, Program Test Plan, System Effectiveness Plan, Material Support Plan, Documentation and Data Requirements Plan, Configuration Management Plan, Financial Plan, and an Interface Control Plan will be prepared. The System Effectiveness Plan is further subdivided into the Reliability, Quality Assurance, Maintainability, Personnel Subsystem, Safety, and Transportability Programs. The Material Support Plan includes the Maintenance, Supply, and Transportation Program, and the Financial Plan includes Cost Estimates, Incentive-Fee Plan, Make-Buy Plan, Value Engineering Plan, and the Contractors Financial Data.

c. PERT/Time/Cost System

A plan for implementing a PERT/ Time and Cost System for the complete Phase II program will be prepared.

d. Phase II Work Statement

The contractor will prepare a detailed Work Statement for the Phase II program, and this work statement will be patterned after the Specimen Phase II Work Statement provided with the Phase I Laboratory Vehicle RFP.

Task 3 - Contractor Phase IB Summary Report

3.3.2.4 Phase IC - Review & Decision.

This period will start with the receipt of the contractors' Phase IB reports and Phase II program proposals, all significant features of which were negotiated in Phase IB, and Phase II cost proposals. These reports and proposals will be evaluated, necessary changes made in the work statements, and firm program costs be determined. Definitive contracts will be negotiated during this phase. Phase IC will end with OSD approval to initiate the Phase II. During the Phase IC evaluation and approval process, the contractors will be funded at a level adequate to insure program continuity and to permit preparation for prompt procurement of long-lead items.

3.3.3. System Acquisition Phase II.

Phase II is the full scale development period (including development and testing) which follows Phase I. It will begin with OSD approval to initiate Phase II and end when development activity is no longer significant. It should be emphasized that the Phase II data reflected within this plan is not firm data, and is only provided for preliminary planning purposes. The Phase I effort will generate the detailed information required to develop the system during a Phase II program. The actual tests and experiments to be conducted by MOL to assess man's utility in performing military missions are all considered part of this Phase II effort. In the development of a normal operational military system, a Phase III Operations period follows System Acquisition. However, MOL as presently conceived will remain in Phase II throughout its flight history. Should the MOL ever be used as an operational system, it would require a follow-on Phase III program. The tasks to be performed by the Associate Contractor during Phase II will be formulated during Pre-Phase I and presented via the Phase II Specimen Work Statement. These work statements, for the Laboratory Vehicle, Gemini B, Titan III, and Experiment Contractor will become a part of the Phase IB RFPs.

3.4 DOD-NASA RELATIONSHIP.

The 21 January 1963 agreement between the NASA and the DOD concerning the Gemini Program has established the basis as well as the

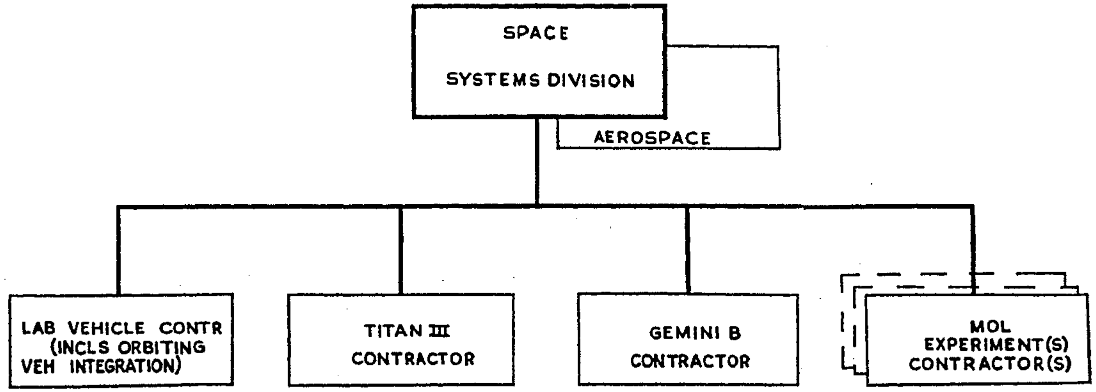

Figure 3-3. Associate Contractor Structure For Phases I & II

precedent for development of working relations between the two agencies for the MOL program. The three major NASA-DOD interfaces envisioned are:

a. Contracting for Gemini B
b. Common use of existing facilities
c. Inclusion of NASA experiments

In regard to contracting for the Gemini B, the Air Force desires a direct contractual relationship with McDonnell in order to employ the management principles and procedures of the DOD. NASA is concerned that such an arrangement might result in competition for McDonnell resources to the detriment of the NASA Gemini program. An additional agreement between the Associate Administration of NASA and the Director of Defense Research and Engineering on 23 January 1964 included interface problems growing out of the Gemini and Gemini B/MOL, in the charter of the Gemini Program Planning Board (GPPB). This agreement also recognized the intention of the Air Force to contract directly with McDonnell for the preliminary design of the Gemini B. The work statement for the Gemini B Pre-Phase I contract includes a task to develop the time-phased McDonnell resource requirement to conduct the Gemini B definition and development effort. The resource requirement for Phase II will be updated during Phase IB. It will be meshed with NASA requirements for the same resources so that a plan with adequate controls can be evolved to preclude interference between the two programs. Effective working relations have been established between the SSD and the Manned Spacecraft Center (MSC). An MSC liaison engineer has been named and has been working with SSD since mid-February 1964. Experience to date indicates that problems of NASA Gemini - Gemini B interface will not be difficult to resolve.

The interface problems in the area of ground facilities for training and flight operations must be resolved during the Pre-Phase I and Phase I periods. Such facilities will include the Mercury Control Center, tracking station, communications facilities, and the joint use of DOD recovery forces. Explicit DOD/NASA agreements must be arrived at for the use of these resources.

The concept for MOL includes the acceptance of NASA experiments on a basis analogous to that governing placement of DOD experiments aboard the NASA Gemini flights. A NASA representative at SSD represents NASA in the day-to-day work of integrating NASA-sponsored experiments in the MOL.

SECTION 4
INTELLIGENCE ESTIMATE

NOT APPLICABLE AT THIS TIME

DATA PERTINENT TO THIS SECTION
MAY BE GENERATED DURING PHASE IB

SECTION 5

OPERATIONS

NOT APPLICABLE AT THIS TIME

THIS SECTION IS ADDRESSED TO PHASE III OPERATIONS WHICH IS NOT A CONSIDERATION IN THE MOL PROGRAM AT THIS TIME

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SECTION 6

ACQUISITION

6.0 SYSTEM SUMMARY.

The MOL System consists of major elements presently in various stages of development. The NASA Gemini vehicle is scheduled to be flown with a man aboard in the latter part of 1964, and the Titan IIIC is scheduled to be man-rated in 1966. The Laboratory Vehicle still remains to be defined and engineered. Therefore, a prime Laboratory Vehicle objective is to make maximum use of available hardware and the efforts of other programs, but, at the same time, design and develop a system that meets the established MOL program objectives to assess man's utility and ability to perform military space missions.

The overall MOL System will consist of an Orbiting Vehicle, a Titan III Standard Launch System, a Ground Environment System and flight and ground personnel. The Orbiting Vehicle is composed of the Laboratory Vehicle with experiments installed and the Gemini B re-entry capsule. An overall profile of the MOL flight vehicle at time of launch is presented in Figure 6-1.

6.1 MOL EXPERIMENTS.

The selection of specific experiments is a critical item in achieving the MOL program objectives. The definition of the experiments in terms of equipments, test procedures, and evaluation procedures is an important input to the overall laboratory design and will be needed before this effort can be accomplished to any large degree.

A preliminary experiments package is defined in the following paragraphs. Selection of this package is the result of across-the-board DOD participation. Requirements submitted by the Army, Navy, and Air Force in support of their respective missions have been analyzed by a

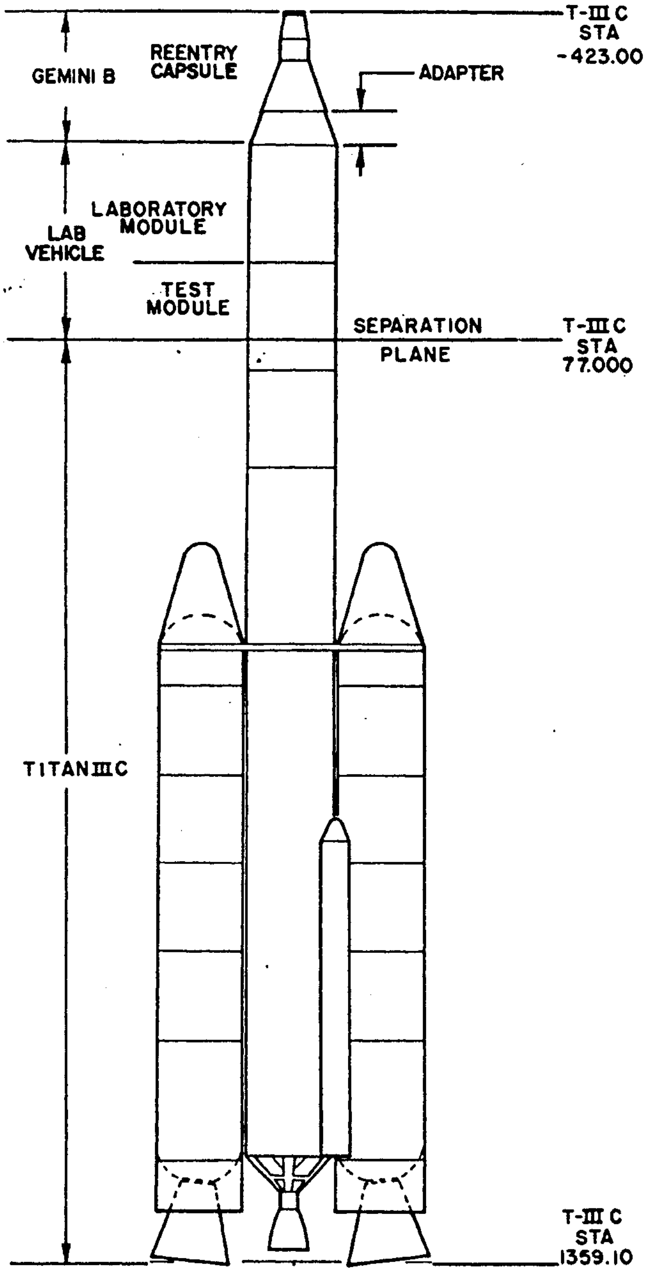

Figure 6-1. MOL Flight Vehicle

composite experiments working group. This package requires additional definition which is to be achieved in the Pre-Phase I and Phase I program activities. Particularly this PTDP emphasizes the Pre-Phase I activities as they represent the next step in the program. As the program develops, it is expected that there will be additions and deletions to the experiments package as a result of further definitions.

6.1.1 Objective of the Experiments Program.

The objective of the MOL experiments program is to establish a qualitative and quantitative measure of man's usefulness in space for performing military tasks.

6.1.2 Criteria for Selection of Experiments.

The experiments presented in the subsequent paragraphs have been selected on the basis of guidance and direction received from Higher Headquarters (Ref. Section 14) and the statement of the program objectives. The criteria established are:

a. The MOL is a space laboratory, not an operational vehicle.
b. The experiments should be focused upon the role of man rather than specific equipment.
c. The proposed experiments should consider the entire spectrum of possible military applications.
d. Photography of reconnaissance quality will not be used to record or verify experiments.
e. Maximum use should be made of ground simulations, aircraft tests, and existing space programs for testing.
f. Experiments selected for MOL should be those that cannot be achieved in any other way, or which constitute a proof test of experiments primarily conducted in ground simulations or aircraft tests.
g. The cost of the experimental program should be minimum, making use of existing equipment, and provide a comprehensive and meaningful test effort.
h. Where new or modified test equipments are required the equipments must be technically feasible of attainment with minimum technical risk and readily available within the MOL program schedule.

i. Experiments which contribute to the development of military technologies which are scientific experiments of national importance may be considered as secondary experiments, particularly if they provide an assessment of man's utility.

6.1.3 Manned System Basic Considerations.

6.1.3.1 Man's Utility.

Man's utility for performing military space tasks results from five basic abilities; the ability to: see, hear, reason, manipulate, and talk. These abilities combine to form a unique functional capability that has not as yet and probably will not, in the foreseeable future, be duplicated by any unmanned means. These unique functions are pattern recognition, systems management, and providing a versatile servomechanism capability.

Pattern recognition is a function that is important in many present day military applications such as flying aircraft, assessing a situation, acquiring targets, identifying targets, identifying targets and check points, and making damage assessments. The systems management function includes such tasks as selection of sensors or weapons, overriding or switching to alternate equipments, adaptive programming of propellant, selection of alternate targets, and deployment of defense measures. The servomechanism function is evident in all operations where the man performs direct manipulations such as vehicle control, sensor pointing and adjustments, and calibrations of equipment. The same functions of man are expected to be the basis for utilization of man in military space missions. The subsequent mission analysis discussion (paragraph 6.1.4) is predicated on the continued supremacy of man in these three unique functional areas.

6.1.3.2 Man's Limitations.

While man will add new dimensions to future military space systems, his operations will be limited by natural radiation and may also be limited by artificial radiation. The geomagnetic field about the earth traps cosmic electrons and protons forming a radiation belt which, for 30-day missions and allowable biological doses on the order of 25 to 50 rads, limits manned operations to 300 nautical mile orbits and below, or to orbits of 20,000 nautical miles or more.

6.1.4 Mission Analysis.

In order to define a meaningful set of experiments which will provide an assessment of man's ability in military space tasks, it is necessary to analyze each military space mission and determine how man could be used to enhance the mission capability. While man can provide trivial functions such as throwing switches, if his inclusion is going to be justified it must provide significant improvement in mission capability. In Table 6-1 the critical mission functions which employ man's utility, discussed in paragraph 6. 1. 3. 1, are listed across the top of the page. On the left are listed the complete spectrum of potential military space missions. For each mission area the analysis has been carried out to determine the critical manned functions and these are marked in the appropriate columns.

In performing this analysis no consideration was given initially to mission overall feasibility or the detrimental aspects of incorporating the man. This was done because in the case of manned satellites several missions might be accomplished with one satellite, making it feasible to have the man there; whereas if each mission were performed individually the additional cost of the man would not be justifiable. As an example, manned meteorological satellites appear economically prohibitive, whereas if this mission is combined with land and ocean observation it appears as an attractive possibility for manned satellite system. Nuclear detection on the other hand appears to be a poor candidate for a manned system because of the limited contribution the man can make and the unique orbital altitude requirements.

While most of the entries in Table 6-1 are self-explanatory, the items of maintenance, satellite defense, and logistics need explanation. Maintenance may be the most significant single contribution man can provide, particularly where the mission requires keeping the system on orbit for long periods of time. Manned maintenance becomes increasingly

MAN'S CRITICAL APPLIED FUNCTIONS / POTENTIAL MILITARY SPACE MISSIONS	TARGET ACQUISITION PATTERN RECOGNITION	TARGET ACQUISITION BACKGROUND DISCRIMINATION	TARGET TRACKING	SENSOR SELECTION	SENSOR POINTING	SENSOR ADJUSTMENT	SENSOR OPERATION	VEHICLE CONTROL	DATA PROCESSING INTERPRETATION	COMMUNICATION	ORBIT ADJUSTMENT	MAINTENANCE		ARMING		MANUAL OPERATION					SATELLITE DEFENSE	LOGISTICS (RESUPPLY FOR LONG-TERM MISSIONS)
OBSERVATION:																						
Land Observations	X		X	X	X	X	X	X	X	X	X	X				X					X	X
Electromagnetic Observations						X	X		X	X		X				X					X	X
Ocean Observations		X		X	X		X		X	X	X	X				X					X	X
DEFENSE:																						
[redacted]																						
Space Based AICBM	X		X	X	X				X	X		X		X							X	X
Nuclear Detection												X										
Missile Launch Detection	X		X	X	X				X	X		X									X	X
OFFENSE:																						
Weapons Delivery	X		X							X		X		X							X	X
COMMAND AND CONTROL:																						
Orbital Command Post									X	X		X									X	X
SUPPORT:									X	X		X										
Communication												X										
Meteorology	X			X			X		X	X		X										X
Navigation										X		X										
Rescue		X	X					X		X	X					X						
Geodesy	X	X	X		X				X													
SATELLITE DEFENSE		X	X	X	X				X													
Logistics																						
Resupply for Long-Term Missions		X	X					X								X						

Table 6-1. Manned Military Mission Assessment

attractive as the weight of the man and his support equipment are a smaller fraction of the mission payload. In some mission areas, such as possible future orbital bombardment stations, manned maintenance may be the key factor in ultimately achieving an economically feasible approach. In other areas such as nuclear detection, about the only significant manned contributions that can be cited is maintenance, but the payload weight and reliability are such that inclusion of a man is impractical from an economic standpoint.

Satellite defense becomes important for those systems that must endure long periods of time or exist during general hot war conditions. It too, is like maintenance in that the bigger or more critical the system is, the more justifiable is the inclusion of man for operation of defense capabilities.

Logistic support will be required on all long duration manned missions. If the missions were to be accomplished unmanned, undoubtedly the satellite would have to be replaced. Whereas in the manned case, the presence of the man makes it feasible to consider rendezvous, docking, and resupplying of the basic spacecraft.

6.1.5 Experiments Definition.

The experiments program is divided into primary and secondary experiments. The primary experiments are those which form an integral part of the MOL Program and are defined as:

a. Experiments to directly assess quantitatively and qualitatively the role of man in military space tasks.

b. Experiments required as a result of the presence of the man in spacecraft, such as biomedical monitoring.

The secondary experiments are defined as experiments where the objective is the advancement of technology which will be applicable to future military space missions or acquisition of scientific data of national importance.

6.1.6 Primary Experiments - Assessment of Man's Utility.

P-1	Acquisition and Tracking of Ground Targets
P-2	[redacted]
P-3	Direct Viewing for Ground and Sea Targets
P-4	Electromagnetic Signal Detection
P-5	In-Space Maintenance
P-6	Extravehicular Activity
P-7	[redacted]
P-8	Autonomous Navigation
P-9	Deleted by Direction
P-10	Multi-band Spectral Observations
P-11	General Performance in Military Space
P-12	Biomedical and Physiological Evaluation

6.1.6.1 Acquisition and Tracking of Ground Targets - Experiment P-1.

6.1.6.1.1 Objective.

The objectives of this experiment are to evaluate man's performance in acquiring preassigned targets and tracking them to an accuracy compatible with the requirements for precise IMC determination.

6.1.6.1.2 Experiment Description.

The equipment required for this experiment includes a direct-viewing, pointing and tracking scope; a general purpose computer; and a coupled camera.

The pointing and tracking scope will be an optical device similar to a bombsight in design in that it will have a gimballed optical element for viewing in elevation and a rotatable barrel for azimuthal viewing. These adjustable elements will be driven by suitable servo motors based on computer input which will nominally hold the scene fixed in the field of view. The movement of the scene will be taken out by the astronaut tracking the target with a set of manually controlled cross hairs. Error signals proportional to the cross hair displacements will be fed into the computer and the nominal rates of the servo drive adjusted to center the target in the field of view, trim the rates, and eliminate the drift. Additionally, since wider fields of view at less magnification are desirable during the acquisition phase, and narrower fields of view at higher magnification during the tracking phase, the optical configuration will be capable of being zoomed over a range from 6 to possibly 100 power, the exact powers to be determined as part of the Pre-Phase I Study and Simulation effort.

The computer will be a general purpose stored program type to allow it to be adaptable to other experiments. It will compute the tracking rates using geometrical considerations and smooth tracking data, and will compute the correct image motion compensation rates for taking high resolution pictures. Inputs to the computer will include both pointing and tracking scope data and inertial platform angular reference data.

The pointing and tracking scope will have a coupled camera which allows pictures to be taken through the same basic optics used by the astronaut for viewing. The purpose of this camera is to verify that the astronaut has acquired the proper target and to permit evaluation of the man's performance in accomplishing the tracking function. During the tracking run, periodic photos will be taken, with the manually controlled cross hairs superimposed on the image, to determine the operator's proficiency in keeping the cross hairs on the target.

The test procedure is to fly over preselected targets in the ZI which may include military airfields, operational missile sites, AMR, naval bases, and specifically prepared target sites. The typical scenario is as follows:

1. The astronaut aligns the vehicle in yaw by pointing the PTS at the ground underneath him with a grid in the field of view and with a zero azimuth angle. The grid lines will be parallel to the vehicle longitudinal axis and yaw alignment errors will be indicated by target points drifting across the grid lines instead of parallel to them.

2. At the appropriate time, based on knowledge of orbit ephemeris, the astronaut scans the land area where he expects to find the target using his direct-viewing, pointing and tracking scope at low magnification.
3. The astronaut attempts to identify some segment of that land area with the reference photo of the target area which will be supplied before lift-off.
4. Upon matching the target area, the astronaut centers the particular target in the field of view of the telescope and initiates the tracking mode.
5. During the tracking run, the astronaut attempts to keep the cross hairs of the pointing and tracking telescope positioned on the target, and the computer will smooth the tracking data.

To evaluate the man's proficiency in target acquisition, the reference photos of the various targets will be intentionally varied in quality. Repeated acquisition and tracking tests will be made to evaluate the astronaut's proficiency under varying conditions of lighting, and the target areas so selected as to provide various background and color conditions.

The evaluation procedure is to take photographs with the coupled camera during the acquisition and tracking operation showing the position of the cross hairs relative to the target, as well as the time. Analysis of these photos will enable determination of the accuracy to which the required IMC would have been determined. On-board film processing equipment would permit analysis of the test results and thereby limit communication/data retrieval requirements and provide additional measures of man's utility.

6.1.6.1.3 Importance of Test.

Future land observation missions may require the capability to obtain very high resolution photographs, for example, for technical intelligence purposes. Very high resolution photographs can, in theory, be obtained if a sufficiently large optical system is provided, and if precise image motion compensation can be accomplished.

6.1.6.1.4 Vehicle Requirements.

The weight of the PTS with the coupled camera is estimated as 400 lbs, the computer 50 lbs, and the film processing gear as 75 lbs, for a total of 525 lbs. The actual equipment volume includes 3. 5 cu ft for the PTS, 1. 5 cu ft for the computer, and 1. 0 cu ft for the film processor. The power levels are expected to be low on the order of 200 watts. The stabilization requirements for the PTS are not critical; however if the IMC data were to be useful, then the target must pass through the field of view of future high resolution sensors. This would result in a requirement for vehicle pointing accuracies of approximately 0. 1° and rate accuracies of 0. 001°/ sec.

6.1.6.2 [redacted] - Experiment P-2.

6.1.6.2.1 Objective.

[redacted]

6.1.6.2.2 Experiment Description.

[redacted]

[redacted]

[redacted]

6.1.6.2.3 Importance of Test.

[redacted]

6.1.6.2.4 Vehicle Requirements.

[redacted]

6.1.6.3 Direct Viewing for Ground and Sea Targets - Experiment P-3.

6.1.6.3.1 Objective.

The objective of this experiment is to evaluate man's ability to scan and acquire land targets of opportunity, to scan and detect ships and surfaces submarines, and to examine ships and surfaced submarines for classification purposes.

6.1.6.3.2 Experiment Description

The pointing and tracking scope and general purpose computer provided for in Experiment P-1 will be used for this experiment. The procedure to be employed for land targets is to have the astronaut on selected orbital passes operate the direct viewing system in an automatic or manual scanning mode at the lowest magnification and attempt to detect certain types of targets of opportunity. Repeated tests with the direct viewing system should be made at various magnifications and scanning rates to determine the percentage of targets detected and correlate results with ground and aircraft simulations.

Upon detection of a target of interest the astronaut engages the tracking drive and zooms the viewer. He notes his observations with a direct voice recorder. In some cases it may be desirable to obtain verification pictures with the directly coupled camera.

The ship and submarine detection experiment will be carried out using the same equipment (i. e., the PTS), but equipped with filters both chromatic and polarizing in order to minimize contrast attenuation.

The test procedure will involve placing target vessels in otherwise deserted ocean areas which lie near or under the MOL orbital path during local daylight hours. The astronaut will be given pointing instructions (or approximate target geo-coordinates depending on computer-servo implementation) and be required to perform a visual search of the prescribed area of the ocean surface during the overflight. Parameters to be measured include detection capability as a function of target ship size, contrast (color), speed (wake), line-of-sight angle, sea state, atmospheric condition (contrast transmittance), magnification, filtering, etc. Additional tests will include search for targets of opportunity in densely populated shipping areas, observation of Kepplerian wakes from cooperative submerged submarines, and recording of results with the coupled camera and/or such other means as are appropriate to both the operational and scientific aspects of the detection tests.

The ship identification experiments will also use the PTS. The targets should include as many classes of ships as possible, both naval and merchant vessels. The ships should be deployed in selected ocean areas having low probability of cloud cover. A relatively small number of vessels are required in the controlled tests, augmented by tests on normal ocean traffic using low flying aircraft (or other means) to provide identification simultaneously with spacecraft overflight.

The typical scenario is envisioned as follows:

1. Following the detection experiment, the astronaut selects a target, slews the scope to put the target into the field-of-view at low magnification.
2. The scope is zoomed as rapidly as possible (without losing the target) to a specified magnification and the tracking drive engaged.
3. The astronaut spends a specified time examining the target and records his impression of ship class, heading, and any uniquely identifying features he can discern.

6.1.6.3.3 Importance of Test.

Detection and acquisition of data on land targets of opportunity could be of significant value to future reconnaissance and surveillance operations. It is a unique function that man can do because of the real time requirement. Detection of ships at sea and the ability to classify ships is of great importance to the ocean surveillance mission. These functions could be valuable for a Cuban-type crisis requiring a naval blockade. Optical detection may be a problem because of the low contrast transmissibility on clear days over the sea. However, the experiment will allow correlation with the considerable simulation data developed by the Navy, and with restricted scanning and higher magnification greater detection probabilities may be achieved than in the simulations.

6.1.6.3.4 Vehicle Requirements.

No additional vehicle capabilities are required over and above those of P-1.

6.1.6.4 Electromagnetic Signal Detection - Experiment P-4.

6.1.6.4.1 Objective.

The objective of this experiment is to evaluate man's capability for making semi-analytical decisions and control adjustments to optimize the orbital collection of intercept data from advanced electro-magnetic emitters.

6.1.6.4.2 Experiment Description.

The equipment involved in this experiment includes antennas, receivers, displays, control console, and recorders. [redacted]

Additional supporting equipments needed in the performance of the experiment are ground and sea-based emitters as sources of specific known signals. Since emphasis of this effort is on sophisticated emitters, such targets will include frequency agility, long pulse internal coding, and other intentioned parameter modulations or complex scan modes. Use of vessel-based emitters under U.S. Navy or U.S. Air Force control (i.e., missile launch cruisers and tracking vessels such as ARIS) could provide fairly sophisticated targets in light density environments.

The extension of simulation program results to orbital test will require some calibration of the initial performance capability of the operator as a frame of reference to subsequent performance. It is therefore necessary to utilize targets representative of those employed in aircraft simulation tests, thus providing continuity in evaluation.

For MOL testing purposes, on-orbit inclination will be chosen to give some continuous overflight of ZI territory, or other areas well controlled, accessible, and in good communication to the MOL Flight Control.

The basic matrix of tests includes:

1. Light vs dense signal environments.
2. Simple versus highly complex signal parameters.
3. Self versus machine-aided alerting.
4. Maximum vs minimum precognition or instruction.

On each available orbit including day and night crossings of the test points, the console operator performs successively more difficult problems in terms of the above-mentioned matrix of choices.

Specific control actions required by the console operator include:

1. Main frequency tuning adjustment to center signal in pass-band.
2. Choose optimum bandwidth for S/N improvement.
3. Set gain controls for dynamic range control in recording most important sections of strong signals or extracting weak ones.
4. Adjust synchronizing controls of displays to maximize or minimize effects of interleaved clutter signals.
5. Employ time gating or frequency exclusion gating for removing clutter.
6. Select appropriate detector outputs for display, particularly with reference to clarifying signal coding.

7. Select appropriate recording medium and length of recording.
8. After a pass, play back recordings, as desired, for evaluation of next pass procedure, or improvement of approach.
9. Monitor and report "events" in "activity level", unusual noise level, etc.
10. Alert other sensors.

The evaluation of test results will, in part, be a function of the data reporting system available. A combination of "hot-flash" verbal reporting, video signal readout, tape and/or photo recovery, while in flight, will exercise and grade the operator on his accuracy, quality of intercept, and ability to compress data. Specific scoring elements should include:

1. Recognition and recording of significant signal parameter modulations.
2. Recognition and recording of emitter radiation patterns.
3. Recognition of aperiodic, "noninstructed" activity level events.
4. Speed of acquisition and processing time per test intercept.
5. Response to "system degradation" or "failure" modes of operation.

6.1.6.4.3 Importance of Test.

Automatic systems have certain inherent limitations, including: quantizing of intercept parameters, limited logic and possible loss of intelligence, conserving data storage in long missions; need for frequent readout or recovery for wide-band analog data; sensitivity loss to reduce false alarms; and tendencies to "lock up" program logic on strong or saturating signal conditions.

Semi-automatic manned systems, although inherently limited by man's slow time constants and requiring visual/aural displays, have certain potential advantages: optimum adjustment of collection system controls; lower false alarm threshold; recognition of anomolous signal characteristics; conservation of wide-band recording media; real-time adaptive redirection of mission objectives, and override of logic routines.

6.1.6.4.4 Vehicle Requirements.

Major Equipment	Weight (lb)	Volume (ft³)	Power (w)
Antennas	75	1.5	50
Receivers	100	1.5	200
Display console	200	3.0	300
Recorders	125	2.0	200
	500	8.0	750

Vehicle stabilization of ± 0.25° is required. Apertures may be required for control cables and possible mechanisms for erection and/or extension of antenna arrays.

6.1.6.5 In-Space Maintenance - Experiment P-5.

6.1.6.5.1 Objective.

The objective of this test is to evaluate man's capability to perform malfunction detection, repair, and maintenance of complex military peculiar equipments.

6.1.6.5.2 Experiment Description.

This experiment will be carried out in conjunction with Experiment P-4 equipments. The additional equipments include a malfunction detection panel for fault isolation, spares, appropriate tools and a portable checkout unit.

The experimental procedure is to evaluate malfunctions of two types. One involves flight degradations which must be detected by the operator by noting erratic or substandard equipment performance. The other type involves complete failures of sequential elements causing major degradations in equipment operation. The operator on noting failure will detect the errant chassis with the malfunction detection panel and will then work down to the replacable modular elements with the portable checkout equipment.

Evaluation will be achieved by the astronauts maintaining maintenance records to be compared with mission success.

The equipment is to be located so that a camera will take a series of pictures of the operation with time recording on each picture to allow for later analysis and comparison with ground and aircraft simulation data.

In addition to this specific maintenance experiment, it is expected that other maintenance and assembly will be performed by the astronauts on basic spacecraft components and subsystems as a result of random failures. By incorporating the proper recording procedures considerable additional data relative to man's in-space proficiency for maintenance could be obtained.

6.1.6.5.3 Importance of Test.

In future military space missions one of the key factors in achieving economic feasibility and cost-effective operations is attaining high reliability of the necessarily complex military peculiar electronics equipment. If man can provide effective malfunction detection and effect repairs of these equipments with relatively few standardized replacement modules, then the inherent equipment reliability limitations will be overcome with the corresponding reduced operating costs.

6.1.6.5.4 Vehicle Requirements.

	Weight	Volume	Power
Malfunction Detection Panel	30	5.0	100
Portable Checkout Unit	7	0.2	Self-contained
Tool Kit	5	-	-
Camera and Lights	20	1.0	750
	62	6.2	850

6.1.6.6 Extravehicular Activity - Experiment P-6.

6.1.6.6.1 Objective.

The objective of this test is to evaluate man's ability in the performance of extravehicular operations peculiar to future military operations, including external spacecraft maintenance.

6.1.6.6.2 Experiment Description.

The basic equipment required for extravehicular operations includes: tetherlines, strap-on maneuver and control unit, and environment control system. In addition, task peculiar equipment, other than basic hand tools, will include those necessary to carry out the following tasks:

1. Replacement Task (e. g., solar cell).
2. Connecting Task (e. g., 2 fuel lines).
3. Patching Task (e. g., external pressure patch).
4. Retrieval Task (e. g., recovery of ejected target).

The test should be designed in such a manner as to minimize the astronaut hazards and to provide an evaluation of how effectively both tethered and untethered extravehicular activities can be carried out. In order to perform the extravehicular capability the astronaut must have his own environmental control system and a suitably designed spacesuit. It is essential that a measure of the difficulty of the task (i. e., man's BTU output) be made so that environmental control capabilities and capacities can be established. The purpose of this experiment is to investigate locomotion, powered and unpowered.

First the tasks will be performed inside the laboratory to determine life support and performance information. The conditions to be considered include: operation with and without the suit; various suit pressures; different environmental system flow rates; tests with both astronauts, with and without the extravehicular ECS and maneuvering units(s); and various alternate procedures.

After satisfactory completion of the above tests, the testing in space will proceed. The same information will be recorded as was in the in-capsule tests and photographs will be taken with a TV monitor as the astronaut proceeds through the air lock, moves over the exterior surface, operates while tethered, and performs with the maneuvering unit both tethered and untethered. The actual procedures used will depend upon the results obtained in ground and aircraft simulations as well as the experiments performed inside the spacecraft. The capacities of the extravehicular environmental control system and maneuvering unit will be set based on ground simulation and checked in the spacecraft before attempting space operations.

6.1.6.6.3 Importance of Test.

Extravehicular operations are important to future military space missions for providing external maintenance of spacecraft which are resupplied and stay on orbit for long periods of time. In addition, military peculiar equipments such as large radar antennae may require erection, alignment, and adjustment in space. In case of failures that preclude direct access through internal tunnels to the recovery vehicle, extravehicular capability may be needed for the safety of the astronauts. Also extravehicular activity may prove valuable for logistic reasons to allow the transfer of equipments, [redacted] and rescue operations.

6.1.6.6.4 Vehicle Requirements.

The extravehicular equipment is estimated to weigh approximately 400 pounds, will require approximately 14 cubic feet of internal space and, while not directly requiring power, the lighting for the TV cameras, the operation of the TV cameras, and the recording will require about 1 kw of power. Vehicle stabilization is not critical, but should be on the order of 1 degree, and 0.01 degree/second to make egress and ingress simple and to ease the difficulty of performing the experiment tasks. The additional equipment will include a tetherline reel and exterior hand and footholds, and boom mounted TV capable of retraction into the vehicle.

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6.1.6.7 [redacted] - Experiment P-7.

[redacted]

[redacted]

6.1.6.7.3 Importance of Test.

[redacted]

6.1.6.7.4 Vehicle Requirements.

[redacted]

6.1.6.8 Autonomous Navigation - Experiment P-8.

6.1.6.8.1 Objective.

The objective of this group of experiments is to evaluate the capability of a man using various combinations of equipment to act as a spacecraft navigator and provide autonomous navigation. Results of this experiment will also comtribute directly to a more precise knowledge of the location of positions on the earth's surface.

6.1.6.8.2 Experiment Description.

These experiments are to be performed with a basic equipment group consisting of a pointing and tracking scope (see Experiment P-1), a set of horizon scanners, a precision time reference system, two automatic star trackers, a general purpose, reprogrammable digital computer (see Experiment P-1) and various prepared navigational data. Of this equipment, only the star trackers are not available from the equipment used in other experiments. Additional provision for display, control, and computer access is only a minor additional equipment requirement which may place demands on the arrangement of various instruments for convenient observation.

The test procedure is extremely flexible. Many different experiments can be performed without any hardware change, however, two typical experiments can be described: In the first type, the classical orbit determination problem is duplicated in space. A specific and well known location on the surface of the earth is chosen and located with the pointing and tracking scope. The astronaut trains the scope on this point on the ground as long as it remains visible. Two navigation stars, chosen by the astronaut to suit the geometry of the problem, are located and the star trackers locked on to them. While the earth site is being tracked, a time history of the angular relationship between these stars and the site is recorded by the computer and these data are smoothed. An approximate orbit can be generated on the basis of these observations and a priori information relative to the general parameters of the MOL orbit. This function is performed again with another ground location and the data refined by well known methods of orbit determination. Once the orbit parameters have been estimated, the future position can be predicted and checked against observations. Unknown positions on the earth's surface can also be located precisely by reversing the tracking sequence, i. e., from a known orbit position to a surface point position.

The last possibility gives rise to a second type of experiment, essentially a refinement of the orbit whose parameters are known fairly well in advance but are gradually changing due to air drag or other poorly predictable phenomena. A specific point is selected as a desired "over-fly" site. The orbital trace over the earth is estimated from on-board data and the time angular relationship of the local vertical and several check points are computed and predicted. As each check point is reached, the tracking and spotting scope is trained on it by the operator and angular data taken from the scope and the horizon scanners are fed into the computer. The small variations in the computed position from the predicted position are then used to generate new orbit trace predictions. If the future predicted position is to be unsatisfactory, then the proper maneuver is computed, performed, and the process of iterated course checking is continued.

The evaluation of the experiments will be made on several bases. The astronaut's tracking capability, ability to locate and lock on stars, and other mechanical functions will be evaluated. The ability of the astronaut to use his judgment for the navigation method required to suit his problem, to use the computer and its input/output displays, perform graphical checks on the digital computations can also be assessed as well as his total capacity to act as a spacecraft navigator, i. e., determining future position, designing maneuvers to produce the desired trajectory, and to operate the spacecraft without ground support.

6.1.6.8.3 Importance of the Test.

The navigation and position fixing experiments are an important part of the general objective of achieving the full potential of autonomy of operation inherent in a manned spacecraft. The complex array of measurements and data reduction routines which are available can be mated to the situation at hand. The difficult problem of terrain feature recognition and tracking is not required to be automated, therefore the whole navigation problem can be solved with manned systems.

This capability, if developed, will liberate future space military systems from the extremely costly and complex ground systems otherwise required. This freedom will permit the simultaneous operation of many spacecraft and rapid response to new situations without mission control facility improvement. Present estimates of the uncertainty of positional errors of certain areas of the earth's surface are as large as 2000 to 5000 feet. In many cases the positional location inaccuracy of potential military targets is greater than acceptable for the effective employment of the in-being missile force. As missile accuracies are improved and employment against hardened point targets increase, it is essential that a capability be obtained to reduce geodetic inaccuracies to the minimum.

6.1.6.8.4 Vehicle Requirements.

As previously stated, the basic new equipment requirement is for the addition of two automatic star trackers, and for display and control of the computer. The vehicle requirements are:

	Weight (lb)	Volume (ft^3)	Power (w)
Star tracker	15	3	100
Console	50	4	100
	65	7	200

6.1.6.9 Negation and Damage Assessment - Experiment P-9.

Deleted by direction.

6.1.6.10 Multiband Spectral Observations - Experiment P-10.

6.1.6.10.1 Objective.

The objective of this test is to evaluate man's ability to detect high radiance gradient background events and missile signatures using multiband spectral sensors and to provide additional measurements data on backgrounds and missile signatures.

6.1.6.10.2 Experiment Description.

The basic test apparatus required is an optical system together with several plug-in detector assemblies to be used singly for measurements in the infrared or the ultraviolet. The four basic items are:

1. [redacted]
2.
3.
4.

There are five parts to the test procedure for this experiment:

1. Infrared Background Measurements.

   Regions of strong background returns are sought visually and observed using the spatial scanning array in appropriate wavelengths selected by the astronaut based on monitoring intercepted signal strength.

2. Infrared and Ultraviolet Ballistic Targets.

   Using the appropriate detector and filter combinations, the astronaut tracks cooperative ballistic targets from boost to re-entry, if possible.

3. Infrared Ground Mapping.

   Using the proper filter-detector-radiometer combination, the astronaut points the radiometer to the region of the earth to be mapped. The astronaut attempts to detect thermal structures produced by ocean currents and sea states, harbor activities, shipping and wakes, air field activities, meteorological formations, geological formations, underground nuclear tests, and man-made structures such as missile sites and underground factories.

4. Horizon Sensor.

   Again selecting the proper equipment combination, the astronaut scans the horizon spatially and spectrally to determine its sharpness for the best spectral response of the radiometer. Horizon position is determined for various azimuth angles, latitudes, sun positions, and weather conditions.

5. Detection and Tracking of High Flying Aircraft.

   The astronaut attempts to detect and track high flying aircraft against the sunlit earth background. The astronaut's functions in these tests are to: make measurements in regions of interest only, track targets, point scan across regions of interest, assemble and adjust the many possible equipment combinations, and calibrate and maintain the equipment.

   The targets will consist of missiles cooperatively launched from aircraft, ships, and submarines deployed in predetermined target patterns.

6.1.6.10.3 Importance of Test.

The MOL provides a unique opportunity to measure the radiation from missiles under the most adverse earth background conditions without burdening the system with nonessential data. The manned function will be performed under conditions similar to those that would be encountered in future manned satellite launch detection and space based AICBM systems. The earth background and ballistic target measurements are of crucial importance also in sensor development for future launch detection and space based AICBM systems. The horizon radiance data could allow development of more accurate horizon sensors.

6.1.6.10.4 Vehicle Requirements.

The spectral measurements equipment are estimated to weigh 350 pounds, require 12 ft^3, and use up to 300 watts of power. Stabilization required is 0. 5 and 0. 01 deg/sec.

6.1.6.11 General Performance in Military Space Operations - Experiment P-11.

6.1.6.11.1 Objective.

The objective of this test is to obtain reliable and valid measures of man's basic performance as it relates to applied mission functions and physiological changes occurring during the stresses of the MOL flights.

6.1.6.11.2 Description of Experiment.

The equipment required is a standard test battery constructed either as a separate package or as part of specific subsystems. The use of standard tests will allow comparison of the in-space performance against statistically significant ground performance data.

The test procedure is to have the crew perform the procedures designed to measure such basic psychological functions as visual acuity, auditory acuity, monitoring and processing information from dynamic processes, mental computation, perceptual discrimination, decision making, and three-dimensional tracking. It is desirable for these tasks to be measured at various times of the day and with respect to changes in workrest cycles.

The evaluation will make use of extensive ground simulation and analysis to provide reliable measures of behavior against which to compare in-flight results.

6.1.6.11.3 Importance of Test.

Whereas measures of applied military functions performed in the other primary experiments permit a gross evaluation of man's basic performance capabilities, the proposed test battery should provide:

1. Indications of possible performance degradation in more extended flights not evident from physiological changes (performance and physiological measures usually do not show high correlations).
2. Comparison against possible degradations in the applied mission functions which do not clearly indicate the possible causes for such degradation. Variables such as overloading, the intangible effects of prolonged weightlessness and confinement, and changes in performance associated with diurnal variation may be analyzed with respect to degradation of specific aspects of man's abilities and the subsystem loop of which man is an element.

6.1.6.11.4 Vehicle Requirements.

The test and recording equipments are estimated to weigh 15 pounds, require 1/4 ft^3 volume, and 20 watts power.

6.1.6.12 Biomedical and Physiological Evaluation - Experiment P-12.

6.1.6.12.1 Objective.

The objective of this test is to evaluate those effects of weightlessness which can potentially compromise mission success. Sufficient data are required to validate supportive measures employed, devise improved methods, if necessary, and afford plausible estimates of biomedical status for missions longer than 30 days.

6.1.6.12.2 Description of Experiment.

By taking full advantage of pre-flight and post-flight studies, as well as all previous manned orbital flight experience, the only tests to be conducted during flight are those which fulfill the necessary and sufficiency statements given in the Test Objectives. Measurements will be made of the following functions considering the effects of weightlessness, environmental loads, and body demands: (1) blood volume, pressure and flow; (2) the electromechanical behavior of the heart; (3) fluid and electrolyte levels and balance; (4) gastro-intestinal function and nutritional status; (5) metabolism of selected body materials, e.g., calcium and protein; (6) respiratory mechanics and rate of energy metabolism; (7) nervous system functions, e.g., muscle strength and coordination, general mental status. Important associated environmental parameters will be measured, including physical and tissue equivalent radiation measurements. The experimental equipments will consist of the following:

1. Sensors for electrical, mechanical, and chemical measurements, signal analyzers and converters, data recording and storage systems.
2. Equipment for selective data transmission.
3. Voice communication equipment.
4. Real time TV or motion picture recording if feasible.

Typical procedures include donning a vest with sensors and leads, switching on recording systems, and monitoring results to assure adequate recording; recording fluid and food intake; measuring and recording urine output and preserving samples for subsequent analysis; performing simple chemical (spectrophotometric and electrode chemistry) determinations on urine and occasionally on blood. Specific sequence of procedure will be determined by ground-based studies and simulation in Pre-phase I and Phase I. These procedures will be carried out by giving one member of the crew the requisite training to conduct all the tests in a reliable manner.

Evaluation will be accomplished by partially interpreting results in real time both during flight and through transmission of selected data to ground. Quantitative data obtained are directly and unequivocally translated into meaningful evaluation of normality or deterioration in physiologic status of the astronauts. Other data along with pre- and post-flight data will be used to evaluate overall results, devise subsequent test plans, and guide future flight procedures.

6.1.6.12.3 Importance of Test.

The physiological effects of long term weightlessness can be predicted to some extent qualitatively, but cannot be determined quantitatively with an adequate level of confidence through ground-based studies. The MOL 30-day flights presume prior 14-day weightless NASA flights; while these add some applicable data and an additional level of confidence, they do not eliminate the requirements for tests during the 30-day MOL missions. The measures proposed reflect a reasonable concern for both the astronaut's health and the need for his support to ensure mission success.

The mission profiles and manned operational modes envisioned for useful military applications (e. g., in enhancing reconnaissance capabilities) require that the crew be maintained in good physiological status. Tests are essential to establish that such status, in fact, exists. The severe configuration and operational constraints of providing an artificial gravity implies that it is mandatory to secure the type of test data indicated. Such data will serve to devise improved preventative measures - short of artificial gravity - or for a major decision to employ some gravity mode.

6.1.6.12.4 Vehicle Requirements.

The biomedical test equipment is estimated to weigh 260 lbs, require 12 cu ft ov volume, and take an average 30 watts of power with peak load of 300.

The omnidirectional proton, electron, and alpha spectrometer should be mounted externally or extended from the unpressurized compartment during operation. In the cosmic ray emulsion experiment, an aperture must be available through which emulsions can be extended and exposed for predetermined periods of time.

6.1.7 Experiments versus Missions & Applied Functions.

In order to provide a graphical assessment of how well the primary MOL experiments will provide a measure of man's utility in critical applied military mission functions, Table 6-2 has been prepared. All functions will be explored by at least one experiment, and in many cases several experiments will be performed including the same function, thus allowing evaluation under a variety of conditions.

Table 6-3 indicates those experiments that support mission requirements.

6.1.8 Secondary Experiments.

The following secondary experiments are not meant to be all-inclusive, but are considered representative. Unlike the primary experiments, the secondary experiments are not considered essential to accomplish the basic objectives of MOL. As they do have potential military mission value or are of scientific importance, they warrant consideration for potential testing in MOL. Hence they should be continually assessed for mission value, status of development and definition and vehicular interface effect.

S-1 VLF Communication-Propagation Experiment
S-2 Secure Communcations Using Narrow Beams
S-3 Laser Propagation Experiment
S-4 High Frequency Ionospheric Ducting Communication
S-5 [redacted]
S-6 Expandable Structures Techniques
S-7 Antenna Deployment, Alignment and Pointing
S-8 Space Rendezvous Radar
S-9 [redacted]
S-10 Mapping and Geodetic Survey for Identified Points
S-11 Determination of Mass
S-12 Hydrogen Reduction Atmospheric Regeneration System
S-13 Vapor Compression Distillation Water Purification System

MAN'S CRITICAL APPLIED FUNCTIONS PRIMARY EXPERIMENT FOR ASSESSMENT OF MAN'S UTILITY	TARGET ACQUISITION PATTERN RECOGNITION	TARGET ACQUISITION BACKGROUND DISCRIMINATION	TARGET TRACKING	SENSOR SELECTION	SENSOR POINTING	SENSOR ADJUSTMENT	SENSOR OPERATION	VEHICLE CONTROL	DATA PROCESSING INTERPRETATION	COMMUNICATION	ORBIT ADJUSTMENT	MAINTENANCE				MANUAL OPERATION
1. Acquisition & Tracking of Ground Targets	x		x		x		x		x	x						
2. [redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
3. Direct Viewing for Ground and Sea Targets	x	x			x		x		x	x						
4. Electromagnetic Signal Detection	x					x	x		x	x						
5. In-Space Maintenance									x	x		x				x
6. Extravehicular Activity									x	x		x				x
7. [redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
8. Autonomous Navigation	x		x		x			x	x	x	x					
10. Multi-band Spectral Observations				x	x	x	x		x	x						
11. General Performance in Military Space									x	x						
12. Biomedical and Physiological Evaluation																

Table 6-2. Manned Military Mission Assessment Mission-Peculiar Experiment Relation Summary

PRIMARY EXPERIMENT FOR ASSESSMENT OF MAN'S UTILITY POTENTIAL MILITARY SPACE MISSIONS	1. ACQUISITION & TRACKING OF GROUND TARGETS	[redacted]	3. DIRECT VIEWING FOR GROUND & SEA TARGETS	4. ELECTROMAGNETIC SIGNAL DETECTION	5. IN-SPACE MAINTENANCE	6. EXTRAVEHICULAR ACTIVITY	[redacted]	8. AUTONOMOUS NAVIGATION		10. MULTI-BAND SPECTRAL OBSERVATIONS	11. GENERAL PERFORMANCE IN MILITARY SPACE	12. BIOMEDICAL AND PHYSIOLOGICAL EVALUATION
OBSERVATION:												
Land Observations	X		X		X							
Electromagnetic Observations				X	X							
Ocean Observations			X		X							
DEFENSE:												
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Nuclear Detection												
Missile Launch Detection										X		
OFFENSE:												
Weapons Delivery					X							
COMMAND & CONTROL:												
Orbital Command Post												
SUPPORT:												
Communication												
Meteorology												
Navigation												
Rescue		X				X		X				
Geodesy												

Table 6-3. Manned Military Mission Assessment Mission-Peculiar Experiment Relation Summary

S-14 Passive Propellant Settling Systems
S-15 Coherent E-M Propagation and Antenna Loading
S-16 Solar X-Ray Warning System
S-17 Materials Degradation and Malfunction Analysis
S-18 Astronomical Photography

A summary description of the secondary experiments is included in Section 20.

6.1.9 Summary of Vehicle Requirements.

The following is a summary of vehicle requirements which is a composite of the individual experiments. The weights include all equipments; the volume is only the estimated equipment volume inside the MOL environmental module; the power is the maximum single power requirement assuming none of the experiments will run simultaneously. The stabilization was divided between fine and coarse because the experiments basically fell into two categories. Maneuvering propulsion is a gross estimate set by Experiment P-2. On flights on which this experiment is not to be performed a 200-foot/sec ΔV will be adequate.

6.1.9.1 Summary of Primary Experiment Vehicle Requirements.

Weight (lb)	Volume (ft^3)	Power (w)	Stabilization (deg) (deg/sec)	Maneuvering (ft/sec)
2712	78	1000	0.1, 0.001 Fine 0.5, 0.01 Coarse	2000

6.1.9.2 Summary of Secondary Experiment Vehicle Requirements.

Weight (lb)	Volume (ft^3)	Power (w)	Stabilization (deg) (deg/sec)	Maneuvering (ft/sec)
3000	104	1.8	0.5, 0.01	200

6.1.10 Summary of Simulation Requirements.

The basic philosophy to be employed in the MOL Experiments Program is to make maximum use of ground and aircraft simulations and use MOL space testing as a selective verification and proof testing. The simulation program will include elemental human performance laboratory simulations, combined man and equipment laboratory and aircraft simulations, complete flight test simulations in ground environmental chambers, and possibly an aircraft simulation for zero "g" with a complete station mock-up. The immediate problem is the necessary Pre-Phase I elemental simulations to determine feasibility and provide basic design data for the experimental equipments. These simulations include both proposed funded contractor efforts as well as in-house programs. The contractor efforts are:

Simulation	Experiment Number	Estimated Costs
Target Acquisition & Tracking	P-1	Included in Study, ref. Paragraph 3.3.1.2.1

The in-house simulation effort will include:

Simulation	Experiment Number	Organization
General Performance Test Battery	P-11	AMD
Biomedical Test Sequence	P-12	AMD

6.1.10.1 Target Acquisition and Tracking Simulation.

The basic data derived from this ground simulation will be used in the design study of the pointing and tracking scope and possibly could be performed by the same contractor. The tasks and the basic data to be determined are:

1. The proper magnification, fields of view, and scan rates for target detection/acquisition.

2. The preferred manual techniques for target reacquisition after discontinuation of automatic scan mode.
3. The preferred magnifications for precise tracking.
4. The desirable design approaches and techniques for precise tracking.

6.1.10.2 Electromagnetic Intercept Feasibility Simulation.

This simulation consists of using existing aircraft and flying over a specifically prepared target pattern at V/H values that would approximate space operations. The critical aspect of space electromagnetic intercept is the short time the operator has for his real time analysis, tuning of sensors, and recording. The aircraft, pilots, and equipment operators would be presently trained Air Force personnel, and the study effort would consist of the following:

1. Assessment of control and display functions analogous to a potential MOL console.
2. Determination of suitable flight test areas providing proper emitter targets.
3. Layout of a test matrix embodying the proper parameter variations.
4. Decision on type of operator selected for testing.
5. Test plan for flights and ground coordination.
6. Evaluation procedures capable of being extended to future simulations in other modes.

6.1.10.3 General Performance Test Battery Simulation.

This simulation will be accomplished by the Aero-Medical Division and will primarily involve simulating conditions in MOL and determining a test battery procedure which can provide adequate results but not require large amounts of time.

6.1.10.4 Biomedical Test Sequence Simulation.

This simulation work will be accomplished in-house by the Aero-Medical Division and include simulation of all biomedical tests in realistic sequence in a MOL environmental mock-up to establish test validity, equipment modification and location, and task-time requirements. The radiation measurements will also be simulated as part of the biomedical experiment.

6.1.11 Summary of Funded Definition Studies.

All selected primary experiments must be defined during the Pre-Phase I period to an extent that will allow preparation of an experiments interface document which can be supplied to the MOL Phase I vehicle contractors, and in addition allow for preparation of Phase I equipment RFP's that can be used for the selection of sensor contractors. These proposed funded contractor studies consist of the following:

Study	Experiment Number	Estimated Cost
Image Velocity Sensor Subsystem	P-1, P-2, P-3	$360,000
Manned Electromagnetic Signal Detector Experiment	P-4, P-5	$180,000
Autonomous Navigation	P-8	$100,000
Multiband Spectral Observation	P-10	$125,000

All of these studies would be carried out under SSD management. The responsibility for the in-house studies to define the remaining experimental areas in support of SSD, the lead division in the MOL program, are:

	Experiment	Responsibility
P-6	Extravehicular Activity	RTD
P-7	[redacted]	RTD
P-11	General Performance in Military	AMD
P-12	Biomedical and Physiological Evaluation	AMD

6.1.11.1 Pointing and Tracking Scope Study.

While the concept of manned tracking for precise IMC determination has been explored in sufficient depth to establish general validity, it is particularly important to conduct a study to provide more definition for the experimental IMC subsystem. Included in this subsystem study are the direct viewing, pointing and tracking telescope, the tracking servo, the coupled camera, and the general purpose computer requirements. The importance of this subsystem is evident in that it is the primary instrument in four of the primary experiments and directly used in three others. The proposed contractor study will include consideration of the following:

1. Pointing and tracking scope optical configuration.
2. Coupled camera and film processing equipment design.
3. Tracking servo system analyses and design.
4. IMC computational requirements and associated computer specifications.
5. Vehicle interfaces.
6. Functions of man with respect to set-up, operation, and maintenance of the IMC subsystem.

6.1.11.2 Electronic Intercept and In-Space Maintenance.

A study of the electronic intercept equipment is necessary as this equipment will place a significant interface requirement on the vehicle. The study will include the following tasks:

1. Optimum Orbit and Antenna Patterns.

   This task will explore the orbital inclination, altitude, and repetition pattern most suitable for conducting this experiment. Ground range availability, including sea-borne targets, and emitter choices consistent with simulation testing are to be studied. Antenna patterns will be explored for highest acquisition probability, spatial clutter filtering, location fixing, and gain.

2. Study of Spaceborne Display Systems for Rapid Recognition of Signal Modulation Variations.

The console for the MOL operator will be limited in size and weight. It is of great importance to be able to present displays emphasizing departures from simple non-varying signal modulations. Consolidation of display and/or correlative displays should be studied for possible improved presentation systems.

3. Study of Recording, Storage, Readout, and Recovery of Selected Intercept Data in MOL experiments.

This task is directed to analysis of the quantity of data to be taken and its digestion and manipulation in the testing of the operator's activities. Attention is directed to recording and storage time necessary, bandwidths, status, and monitoring recording. This study is interrelated with the general problem of on-orbit test reporting and would provide inputs to that effort.

4. Maintenance Analysis of Military Electronic Equipments

This task is directed at determining the most probable types of malfunction and will form basic input to Task (5).

5. Conceptual Design of the Malfunction Programmer, Malfunction Detection Panel, and Checkout Unit.

6. Establishment of Vehicle Requirements.

6.1.11.3 Autonomous Navigation Study.

Many navigation and space position fixing schemes have been proposed for this experiment. A study is required which will identify the techniques which would be applicable, make a comparative analysis of the approaches identified and select the most promising ones for Phase I consideration.

For the selected navigation experiments an analysis of system requirements based on a preliminary system design will be accomplished to insure that equipment which must be shared with other experiments can be developed with an adequate appreciation of the requirements imposed by the navigation experiments.

The star trackers, a unique requirement for this experiment, will be the subject of a survey of existing equipment to identify suitable hardware for Phase I study.

A preliminary experiment operational plan will be developed in order to have the data required for experiment integration and task analysis. Similar data will be generated for ground equipment requirements.

6.1.11.4 Multiband Spectral Observations.

Much effort has been expended on spectral measurements equipment for missile and background measurements; however, the previous work was done for unmanned approaches using narrow spectral filter bands. This experiment will be the first test of wide band UV/IR detectors under complete control of a manned operator and thus the study will be oriented to evaluating the man and make maximum use of the man for the acquisition spectral signature data.

The proposed contractor's study will include the following:

1. Experiment equipment requirements definition.
2. Survey existing equipment suitable for adaptation to the MOL.
3. Selection of detectors for appropriate spectral zones.
4. Investigation of cryogenic cooling systems.
5. Filter insertion mechanisms design.
6. Definition of the optical system.
7. Data recording, handling, and reduction definition.
8. Mission Test Profile and astronaut duty cycles study.
9. MOL installation and operational interface considerations.
10. Manned functions in the test operation.
11. Control and console design requirements.
12. Target requirements definition.
13. Checkout equipment, AGE, and launch facilities definition.

6.1.12 U. S. Navy Package.

Numerous proposals for experiments by a number of Navy activities have been included, either directly or indirectly, in the MOL program plan as it appears to this point. This was possible because all proposals from Navy activities were submitted directly to USAF, Space Systems Division for consideration as MOL experiments. Simultaneously with this submission, an identical submission was made to a technical panel convened by the Bureau of Naval Weapons to examine the specific naval interests in a manned space program.

From the recommendations of this technical panel, the Bureau of Naval Weapons in turn submitted to Space Systems Division its recommendations for Navy participation in the MOL program (see Reference 14.2.4, U. S. Naval Research Laboratory Memorandum Report #1507, Manned Orbital Laboratory Technical Panel, First Preliminary Report, 17 March 1964.) The Navy concept, which is described in Section 18, provides for an integrated ocean surveillance experiment as its primary ingredient. It includes other specific experiments in communications, satellite surveillance and detection, ELINT, bioastronautics, and general science. Of these experiments, most have already been included in the list of primary and secondary experiments as a result of direct submission to SSD. However, further review is required to insure complete integration of the Navy requirements.

To provide a more detailed definition of the Navy experiment package, an early series of pre-PDP studies is planned by the Navy. For the integrated ocean surveillance experiment, for example, a study has been initiated for this purpose. In this study, the experiment will be analyzed in detail to effect proper technical consideration of all sensors, to establish the necessary and preferred relationships of sensors to each other and to ancillary equipment, to identify the technical and human interfaces, and to establish performance criteria for measurement of effectiveness. A thorough analysis including these factors and others will be attempted for all experiments in the Navy package. It is possible that new or modified proposals may result.

6.2 MISSION PROFILE.

The MOL flights will be conducted from the Titan III launch complex at Cape Kennedy. Upon achieving orbit, the astronauts who are located in the Gemini B during launch will prepare to transfer to the Laboratory Vehicle by conducting a checkout of the essential Laboratory subsystems from the Gemini and by activation of those Laboratory subsystems which must be in operation during the transfer. Several methods of astronaut transfer from the Gemini B to the Laboratory Vehicle are under investigation. Upon entering the Laboratory, the astronauts will proceed to activate the remaining Laboratory subsystems and place the Laboratory Vehicle subsystems in a fully-operating condition before removing their space suits. The flight crew will be the primary source of on-orbit decisions. Astronaut functions will include monitoring and, if necessary, controlling vehicle subsystems operations. Status of subsystems in the Gemini B essential to safe return will particularly be checked. Data from the experiments, as well as telemetry of orbiting vehicle condition and astronaut physiological functions will be transmitted from the Orbiting Vehicle to ground receiving stations. Laboratory activities will be monitored and communication with the astronauts will be conducted on the ground from the Mission Control Center.

Upon completion of the 30-day mission period, the astronauts will perform final checks of the condition of the Gemini capsule and activate those systems required for crew transfer. They will then put on their space suits, deactivate certain subsystems in the Laboratory, and transfer to the Gemini. After separation from the Laboratory Vehicle the Gemini capsule will be oriented for the retro-firing maneuver. Following re-entry into the atmosphere and deceleration of the capsule, a parachute will be deployed to lower the capsule to a water landing.

During the entire mission, emergency abort provisions must be made for crew safety in the event of a malfunction. On the launch pad and during launch, abort will be possible by means yet to be finally selected. During the on-orbit period, abort may require re-entry and landing in an emergency recovery area. An emergency recovery force (probably serving both NASA and Air Force programs) will be deployed for emergency recovery operations.

6.3 VEHICLE SYSTEM.

In order to combine enhanced reliability and safety with minimum cost and time for development and test, adaptations of the standard Titan IIIC Launch System and of the Gemini to meet MOL requirements will be held to a minimum by deliberate design. Also, Gemini subsystems which give the NASA Gemini orbital autonomy not necessarily required by the MOL application will be considered for adaptation to the MOL Orbital Vehicle to take advantage of the development and test which these components will receive under the NASA program. Examples are: the Gemini Environmental Control System; the Gemini Orbital Attitude and Maneuvering System; the Gemini Inertial Guidance System; and the Gemini Rendezvous System. Furthermore, the Titan III transtage is also being considered for adaptation to service as an orbital attitude and maneuvering system for the Orbiting Vehicle.

The subsections which follow (subsection 6.4 through 6.6) describe the major configuration alternatives still being considered for the Laboratory Vehicle, the Gemini B, and the Titan III-C. Specific in-house MOL Vehicle studies (in progress since the MOL Program was announced in December 1963) augmenting earlier, more generalized studies and studies by industry and NASA on similar vehicle concepts, have narrowed the field of configuration alternatives to the few leading candidates in each subsystem area which are discussed below. These in-house efforts will continue, materially aided by the Pre-Phase I studies by McDonnell on the Gemini B, and Martin on the Titan IIIC MOL Launch System together with selected Laboratory Vehicle subsystems studies. Final decisions on some configuration questions will be made prior to issuance of the Laboratory Vehicle RFP. Others, especially those which cannot be made independently of the Laboratory Vehicle configuration, must await the concerted definition effort of Phase IB.

6.3.1 Orbiting Vehicle (OV).

The Orbiting Vehicle will consist of Gemini B, a Laboratory Vehicle (probably consisting of a pressurized Laboratory Module for the crew and some experiments, and a Test Module for other experiment installations) and possible the transtage for on-orbit propulsion requirements.

A representative Orbiting Vehicle might have a weight distribution as follows:

ELEMENT		WEIGHT (lb)
Gemini B plus Adapter		6,000
Laboratory Vehicle (Pressurized	Laboratory Vehicle	5,910
Test Module (Unpressurized)		1,150
Experiment Payload Available		5,940
Weight Contingency		2,000
SUBTOTAL		21,000
Dry Transtage (If Retained on Orbit)		4,300
TOTAL		25,300

The Gemini B weight includes only the re-entry capsule and its adapter without an autonomous on-orbit capability. The Laboratory Vehicle includes a pressurized Laboratory Module, an unpressurized Test Module, and an experiment payload. The transtage is presumed empty of propellants. Any propellants retained for orbital maneuvers must come out of this experiment payload budget.

A 2000 lb. contingency has been provided for possible weight growth of the Orbiting Vehicle. There is another 2000 lb. contingency for any reduction of the Titan IIIC performance capability. Titan IIIC is estimated to provide a 23,000 lb payload to a 200 n. mi. orbit at inclinations of about 30 degrees. If the 5940 lb available for experiments is completely used for on-orbit maneuvering with transtage, 2500 ft/sec can be provided. A trade-off appears available for maneuvering experiment requirements vs. non-maneuvering experiment requirements.

6.4 LABORATORY VEHICLE.

6.4.1 Structural Arrangement.

A typical Laboratory Vehicle will consist of a modular structural arrangement comprised of a pressurized crew living/working area or Laboratory Module and an unpressurized equipment module or Test Module. Figures 6-2 and 6-3 illustrate Laboratory Vehicles with single and dual pressurized compartments.

Mission experiment monitor and controls equipment will be installed in the aft section to permit compatible interfacing of components with the test module. Life support and other systems will be grouped for optimum space utilization, accessibility, and functional compatibility. Exterior equipment arrangements may include solar panel assemblies, side-looking radar antenna, communications and tracking antenna, attitude control reaction nozzles, and thermal control radiators. A constraint on vehicle geometry is the requirement for adequate living/working volumes. A design goal of 200 cubic feet of free volume per astronaut has been adopted for design planning. The probability of crew survival may be increased by separation of the crew volume into two pressurized compartments. Design goals for dual compartmentation may entail significant weight penalties, and the trade between system performance and astronaut safety increment must be made within the context of overall system safety goals.

The Titan IIIC transtage diameter of 10 feet establishes a minimum desirable Laboratory diameter. Use of a larger Laboratory diameter involves increased aerodynamic buffeting loads, but provides a decreased system length which tends to minimize potential problems connected with launch vehicle strength and dynamics.

The structural configuration will probably consist of a foam-filled aluminum truss-core sandwich. This approach combines effective strength and environmental protection capabilities.

Final configuration of the Laboratory Vehicle will await the results of the Laboratory Vehicle contractor's Phase IB effort.

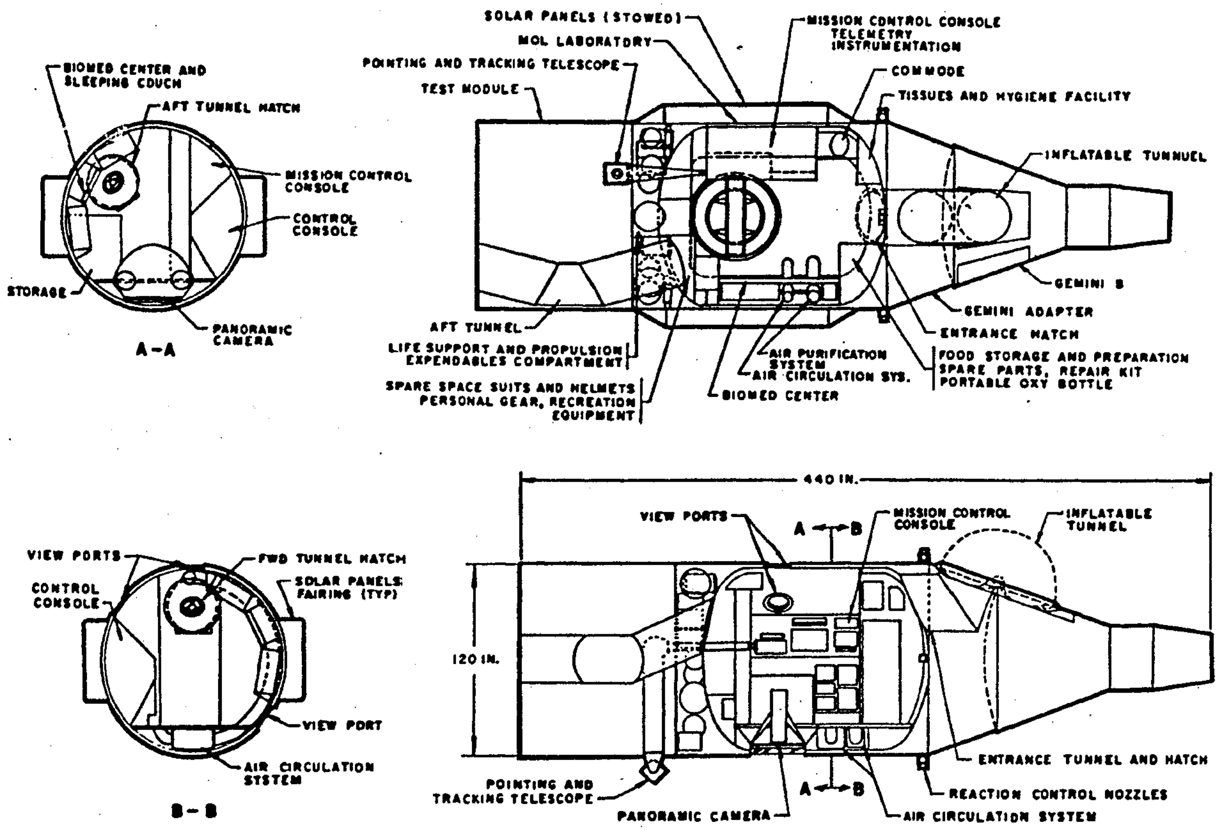

Figure 6-2. MOL Laboratory Vehicle - Single Pressure Compartment

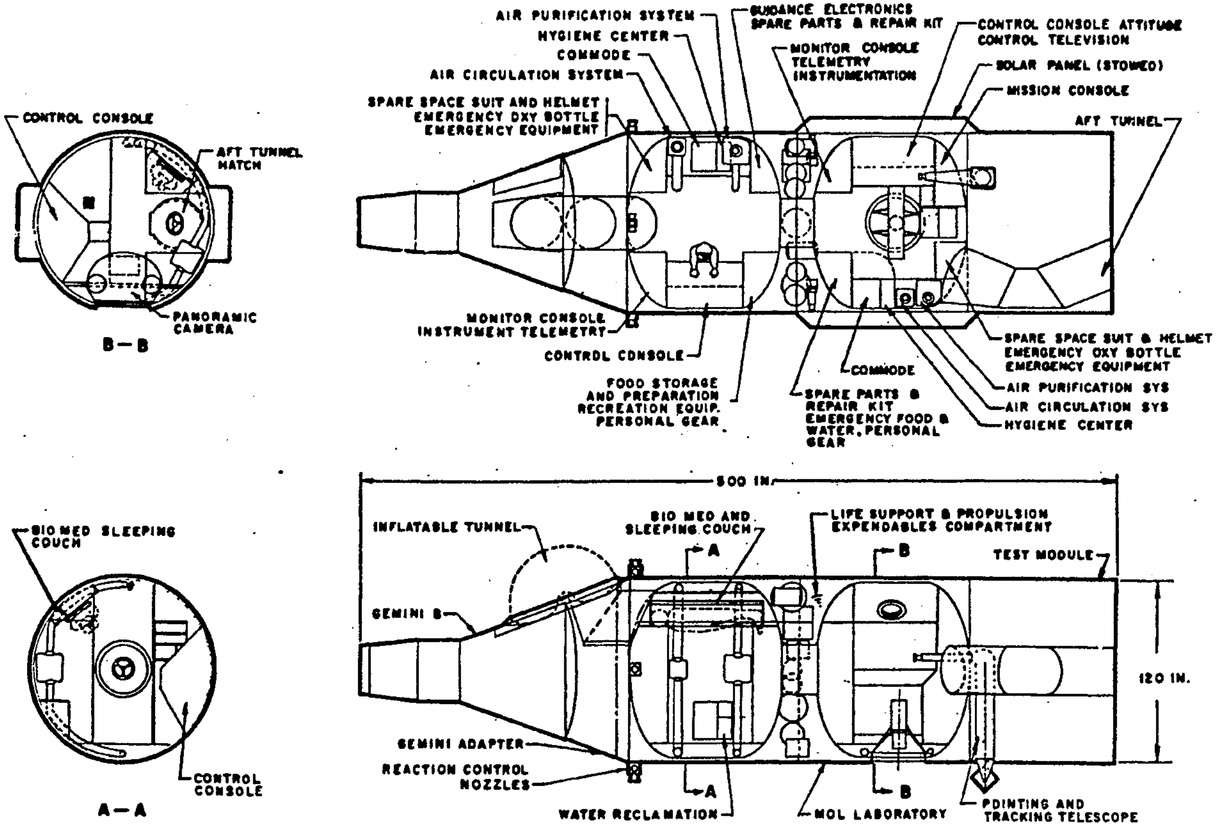

Figure 6-3. MOL Laboratory Vehicle - Dual Pressure Compartment

6.4.2 Astronaut Transfer.

Alternative astronaut transfer methods include deployable tunnel, inflatable tunnel, hatch-to-hatch (Gemini rotation), hole-through-heat shield, and extra-vehicular (see Figure 6-4). Evaluation criteria include reliability, crew safety, weight, development time and cost, impact upon Gemini B and Laboratory Vehicle, and compatibility with system growth including docking and space maneuvering.

The external inflatable tunnel is emerging as a particularly promising method for crew transfer. This tunnel would connect the Gemini B crew access hatch to the Laboratory Vehicle through a porthole in the Gemini B adapter assembly. Emergency access to the pressurized compartments may be obtained through a tunnel in the Test Module. Structural and space provisions could be made for a universal docking and mooring mechanism on the aft end of the Test Module section.

The subject of astronaut transfer will continue to be pursued in-house, particularly from the Laboratory Vehicle standpoint, and is the subject of a major task in the McDonnell Pre-Phase I contract. A decision will probably be made before the Laboratory Vehicle RFP is released to industry.

6.4.3 Environmental Control.

Trade-off studies to date favor an atmosphere control system for the Laboratory Module consisting of (1) a 7.5 psia 50% oxygen/50% nitrogen atmosphere, (2) temperature control by way of a heat exchanger, (3) carbon dioxide absorption using a silica gel-molecular sieve and (4) trace contaminant removal by absorption and catalytic burning. Subcritical cryogenic storage appears desirable. The life support system for the Laboratory Module must include (1) food provisions, (2) disposal of waste, (3) hygiene, and, probably (4) water-recovery. However, the adaptation of two Gemini life support systems is also being considered. This 5.0 psia all-oxygen system has the very real advantages of simplicity and proof through development and space use by NASA. However, it is considerably heavier and its

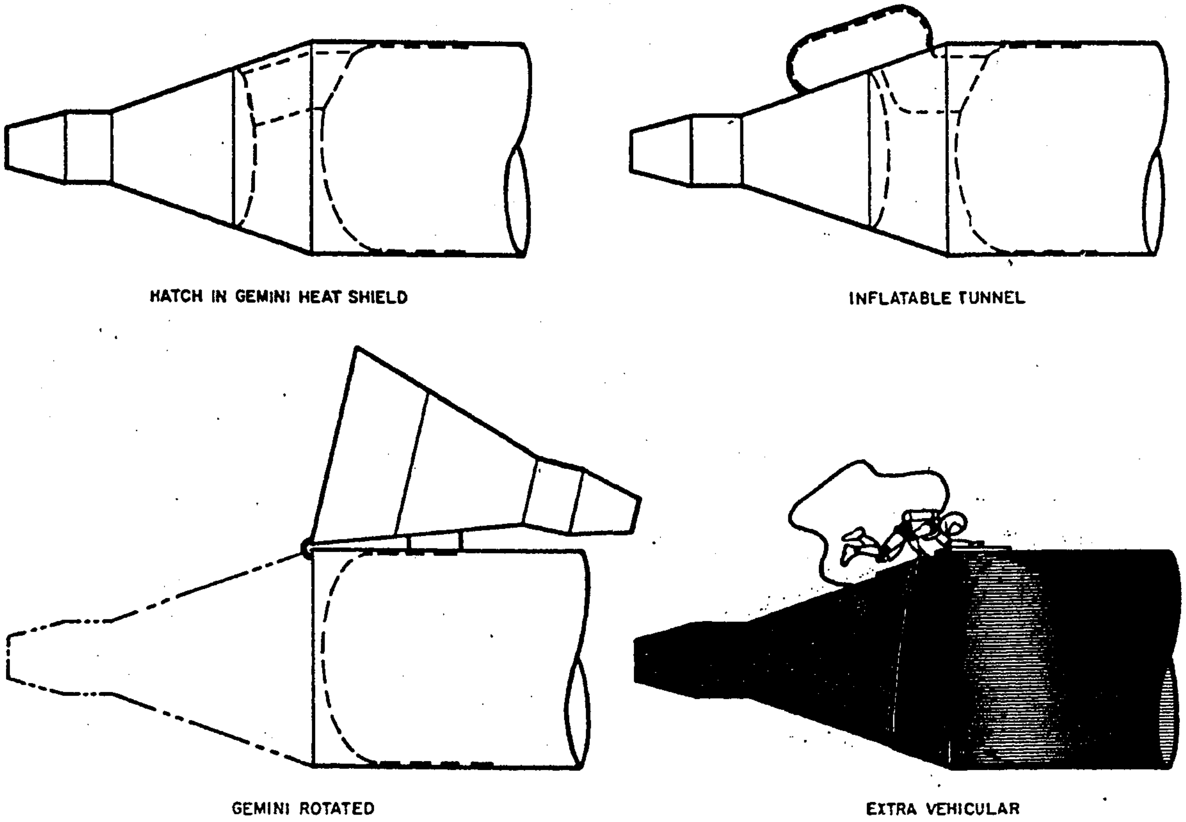

Figure 6-4. Astronaut Transfer Concepts

safety aspects for MOL use are still under investigation. A final decision will probably await participation by the Laboratory Vehicle contractor.

Artificial gravity is not planned as a feature of the MOL System. However provisions for exercise, including measures which provide self-induced accelerations are being studied for inclusion in the Laboratory Vehicle.

6.4.4 In-Space Maneuvering.

This topic applies to the entire Orbiting Vehicle. It includes maneuvers in orbit required by experiments and maneuvers to effect rendezvous and docking. For either purpose, the transtage presents a "ready-made" propulsion capability. It must be adapted to these uses by providing pilot-in-the-loop provisions involving displays in the Gemini B or Laboratory cockpit and controls leading from the Gemini to the transtage. Investigating solutions to this requirement is an item in the McDonnell Pre-Phase I study with Martin support. The transtage presently is capable of only a few restarts, and would require improvement in this respect. An alternate approach to using the transtage would be to add low level thrustors to the Laboratory and separate the transtage at orbital injection.

A requirement for docking provisions may be imposed on the Laboratory Vehicle design as a result of astronaut rescue and/or system growth considerations. Feasible docking alternatives include tail-to-tail, nose-to-nose, and side-by-side (see Figure 6-5). Evaluation criteria include ease of cargo transfer, ease of vehicle approach maneuver, drag area presented by docked configuration, and design implications on the Gemini B and Laboratory Vehicle.

The degree to which "provisions for" rendezvous and docking will be built into the initial version of the MOL Vehicle and ground systems is still in the early investigative stage.

Rescue, a topic bearing on this issue, is to be studied during Pre-Phase I contract study activity, with coordinated inputs by Martin and McDonnell. Furthermore, as an aid to deciding the degree to which

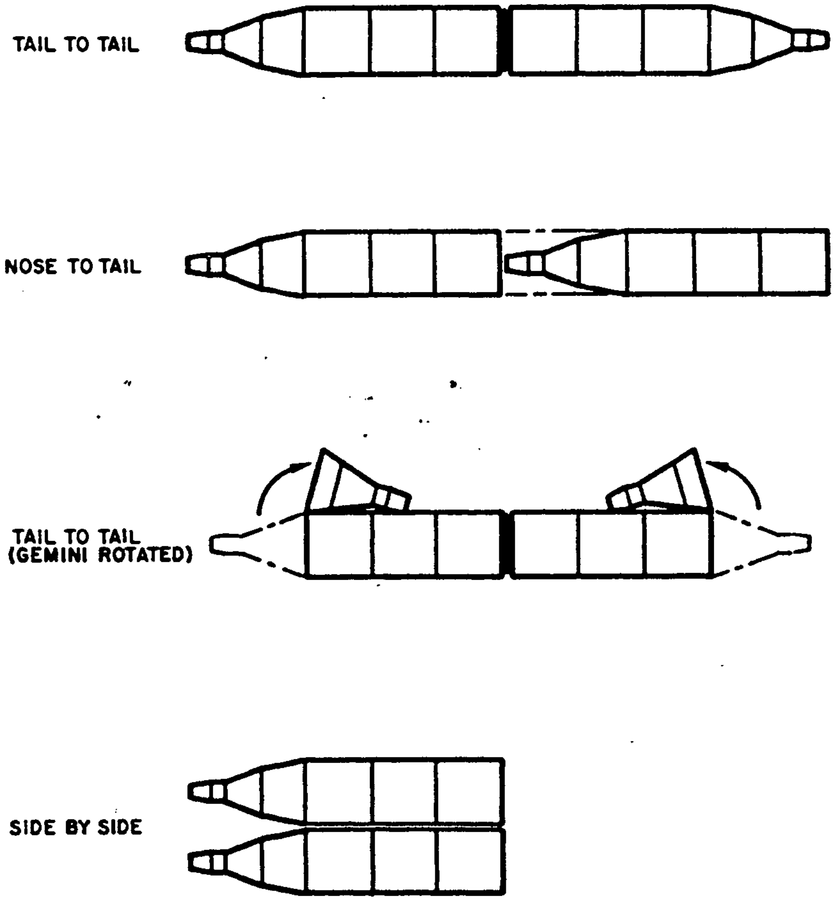

Figure 6-5. Docking and Mooring Concepts

rendezvous and docking should be incorporated initially, trade-off studies balancing the cost in dollars, weight, and complexity of incorporating elements of the rendezvous and docking system initially against the cost in dollars and time to incorporate it later will extend into Phase IB.

6.4.5 Crew Duty Cycle.

Crew duty cycle, task priorities, and physical capabilities and limitations under Orbital Laboratory conditions directly influence Laboratory design in the following primary areas: reliability, safety, availability, and the trade-off between redundancy and maintenance. These in turn influence system weight, volume, operational flexibility, and cost. Bioastronautic experiments are expected to be primarily manual. Military experiments will probably be semiautomatic, and will be designed to take advantage of astronaut capabilities for calibration, selection, monitoring, and partial control.

The following general times may be assigned to those items not related directly to the performance of the specific MOL mission. The times assigned are based upon a 30-day or longer mission.

A representative crew duty-cycle is shown in Table 6-4.

Table 6-4. Representative Crew Duty Cycle (2 Man Crew)

Task	Man hrs/day
1. Sleep	16
2. Eat	2
3. Exercise	2
4. Hygiene	2
5. Leisure	3
6. Station operation	4
7. Experiments	11
8. Maintenance	4
9. Miscellaneous	4
Total	48

6.4.6 Navigation and On-Orbit Control.

Determination of the requirement for a navigation system to be included in the Laboratory Vehicle must await definitions of the experiments program. Meanwhile alternative solutions are being investigated over a range of possible requirements. Improvements to the Gemini system are being studies in-house as a potential solution; McDonnell participation is planned for the Pre-Phase I contractual period.

The requirements being used in attitude control system investigations are as follows:

Attitude (Mode)	Control (Attitude Deg.)	Requirements (Rate, Deg/Sec)
Coarse	± 0.50	0.01
Fine	± 0.10	0.001

Preliminary studies indicate that a constant thrust two-level hypergolic bipropellant propulsion system for reaction control should be adequate.

6.4.7 Electrical Power.

Power estimates indicate an average power level for normal station operation of about 1.2 kilowatts exclusive of the experiments, the Gemini B, and the transtage. Further study is required to determine what additional power is required for experiments. The impact of short duration (approximately 10 minutes) high power level requirements such as 5 to 10 kw radar for experimental equipment must still be evaluated. The basic power could be supplied by a solar cell array with batteries and/or fuel cells incorporated to provide electrical power during the pre-launch, launch, activation, orbital nighttime passages, and peak power loads. Other methods are also being considered, including fuel cells, [redacted] APU's, and hybrid arrangements of these.

6.4.8 Data Processing and Communications.

As the experiments and vehicle studies become more firm, specific studies of data management will be made. A preliminary investigation indicates that the Gemini computer would be limited in capacity for MOL data management and its reliability may also be a problem.

Communication requirements for the Laboratory Vehicle consist of transmitters, receivers, beacons, antennas, and auxiliary equipments required to provide a capability for space-to-earth voice communications, experiment and spacecraft telemetry, video (TV), tracking, and command communications. The Gemini communications system augmented by the 10 mc capability (New Hampshire and Vandenberg) of the Air Force Satellite Control net may provide an adequate basis for the experiments as currently envisioned. Consideration is being given to FM/FM and PAM/FM/FM telemetry, and to the USAF integrated S-band system or the NASA unified system.

6.4.9 Reliability, Monitoring, and Checkout.

A reliability trade-off exists between subsystem redundancy and on-orbit manned maintenance. Decisions made in this area specifically influence all details of subsystem selection, and exert strong direction upon vehicle arrangement. It presently appears prudent to consider a design philosophy in which most manned maintenance operations are regarded as noncritical experiments rather than mission-critical functions for the early MOL Program.

Several operating and display consoles will be required for the operation monitoring and checkout functions for each of the Orbiting Vehicle subsystems. The consoles will enable the crew to monitor the status of critical components, provide automatic warning indication, provide means for isolating malfunctions, and monitor and checkout the Gemini re-entry vehicle subsystems during storage.

6.4.10 Weight Breakdown.

The MOL Vehicle preliminary weight estimates for a typical single pressurized compartment configuration are as follows:

Subsystem or Item	Weight (lb)	
Electronics	335	
Leak Detection System	50	
Electrical Distribution System	150	
Heat Rejection	292	
Air Circulation System	158	
Pressure Suits and Suit Circuits	160	
Atmosphere Resupply	989	
Water Management	172	
Waste Management (Including Disposal System)	50	
Food	216	
Cleaning Materials	24	
Disposable Clothing	24	
Reaction Control System	306	
Solar Array System	824	
Laboratory Structure	1,685	
Displays and Furnishings	345	
Spare Parts	130	
Laboratory Module Subtotal		5,910
Test Module Structure	1,150	
Experiment Payload	5,940	
Subtotal		7,090
MOL Vehicle Total		13,000

6.5 GEMINI B.

6.5.1 General.

Paragraph 3.3.1.3 lists the Gemini B design problems to be studied by McDonnell during the Pre-Phase I contract period to define the Gemini B as precisely as possible prior to release of Laboratory Vehicle RFP. The discussion which follows is based largely upon in-house efforts which have been exerted by Aerospace up to this time. Most of the configuration questions in this discussion are covered in the McDonnell study.

The Gemini B is composed of a re-entry capsule, an escape tower (if required), and an adapter. A possible Gemini B configuration is shown in Figure 6-6. The re-entry capsule is essentially the NASA Gemini re-entry capsule with modifications required as a result of the change in mission. An escape tower similar to the Mercury tower may be required for use in event of an abort on pad or during early phases of powered flight. The adapter shown in Figure 6-6 is a new component and contains the retrograde propulsion subsystem, power and environmental control subsystems for use during the launch phase, and an inflatable tunnel for crew transfer. The Gemini B will be an integral part of the Orbiting Vehicle, probably with no maneuvering capability, and self-sufficient only during the launch and re-entry phases.

6.5.2 Design and Modification Considerations.

The modifications to the NASA Gemini for the MOL application will probably consist of the deletion of subsystems not required for the MOL mission and alterations required by the Titan IIIC launch environment, the Laboratory Vehicle interface, and the 30-day storage on orbit. Subsystems added likely will include the crew escape tower or alternative, provisions for crew transfer, and provisions for on-orbit monitoring and checkout of the Gemini B from the Laboratory. Possible modifications of subsystems because of the on-orbit semi-dormant storage include replacement of cryogenic storage bottles with high-pressure bottles, and replacement of fuel cells with batteries. The present Gemini inertial guidance system may be replaced by a simplified system capable of supplying attitude reference for retrofire and re-entry. The existing Gemini IGS could be used either as the primary or backup guidance system for the launch phase.

6.5.3 Gemini Subsystems.

The structure of the Gemini must be slightly strengthened if an escape tower is used or if a transfer hatch is added within one of the large existing hatches for crew transfer. The current NASA Gemini heat shield concept will be used. A slight increase in thickness (adding about 20 pounds)

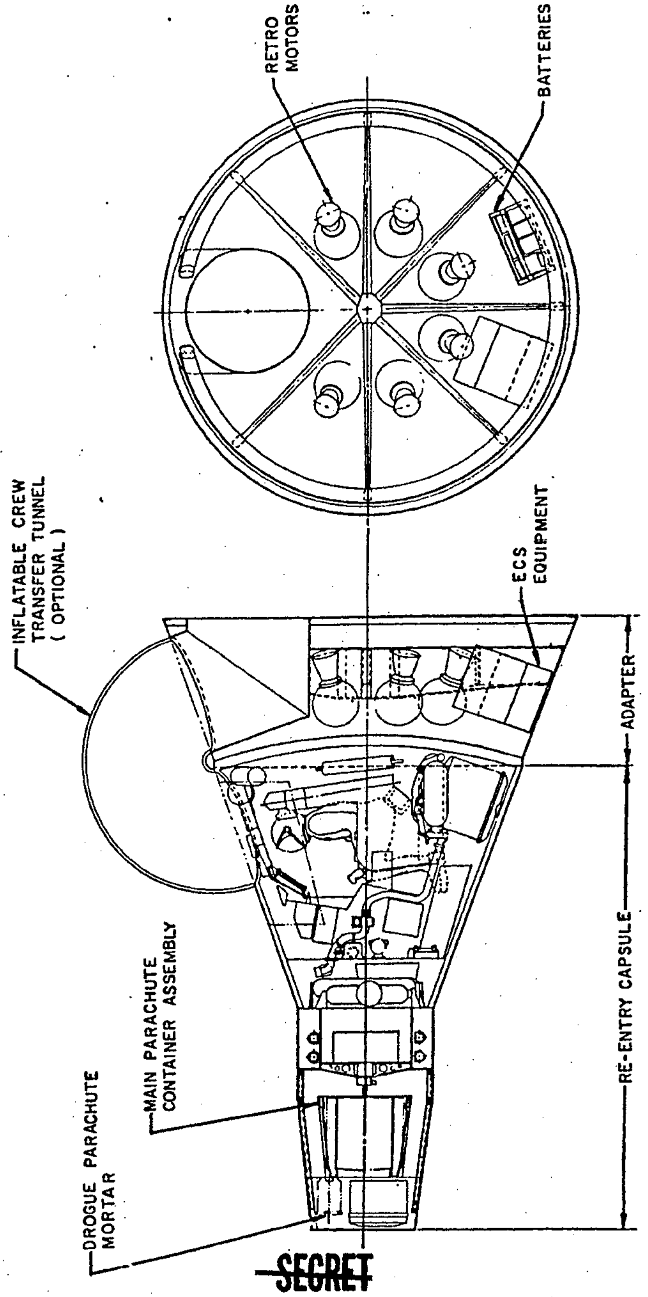

Figure 6-6. Gemini B Vehicle

may be made to accept a wider range of re-entry conditions. The NASA Gemini parachute recovery system with waterlanding will probably be used and a new adapter section will likely be required.

6.5.4 Interfaces.

Provisions will be made for monitoring and checkout of the Gemini B from the Laboratory and monitoring and activation of the Laboratory from the Gemini B. In addition, the Laboratory Vehicle will probably supply power and environmental control to the Gemini B during the on-orbit period. There appears to be no major interface between the Gemini B and the experiments except that it may be necessary to add provisions in the Gemini to return small data packages from orbit.

6.5.5 Major Problem Areas.

The launch abort problem has been aggravated by the change from the GLV to the Titan IIIC because of the greatly increased size of propellant load and because of altered flight characteristics, including accelerations and dynamic pressures. An escape tower, among other alternatives, is being assessed as an approach to improve the Gemini B escape capabilities.

Several alternative methods of crew transfer from the Gemini B to the Laboratory require investigation. Only extra-vehicular transfer has no major effect on the Gemini B design. The other alternatives require changes to the heat shield or to the access hatches, considerable relocation of equipment in the re-entry module, and additions of tunnels or mechanisms to the adapter.

After a 30-day period of semi-dormant storage in space many of the Gemini B subsystems must be reactivated. This requirement will require a review of the subsystems and may lead to the addition of redundant subsystems or replacement by simpler and more reliable subsystems.

6.5.6 Gemini B Preliminary Weight Breakdown.

Re-entry Module		4, 372
Structure	1, 407	
Heat Protection System	318	
Attitude, Stabilization and Control	359	
Retrograde, Landing and Recovery	217	
Navigation Equipment	138	
Tele-Instrumentation	113	
Electrical Power System	277	
Communications System	58	
Crew and Survival	940	
Miscellaneous and Contingency	220	
Adapter Module		1, 628
Structure	290	
Crew Transfer System	180	
Retrograde System	509	
Electrical Power System	200	
Environmental Control System	257	
Tele-Instrumentation	88	
Miscellaneous and Contingency	104	
Escape Tower (Effective On-Orbit Weight = 100 lb)		2, 500
Total Gemini B Weight at Launch		8, 500
Total Gemini B Weight On-Orbit (equivalent)		6, 100

6.6 LAUNCH VEHICLE.

6.6.1 Description.

The launch vehicle for the MOL Program is the standard Titan IIIC vehicle. The vehicle is comprised of two segmented solid propellant motors, modified Titan II liquid propellant stages, and a pressure-fed upper stage (transtage) including a control module (Figure 6-7).

6.6.2 Modification Considerations.

Modifications may possibly be made to the electrical, attitude, and guidance systems to permit their performing on-orbit functions, if desired. In addition, the inertial guidance system may be deleted. The

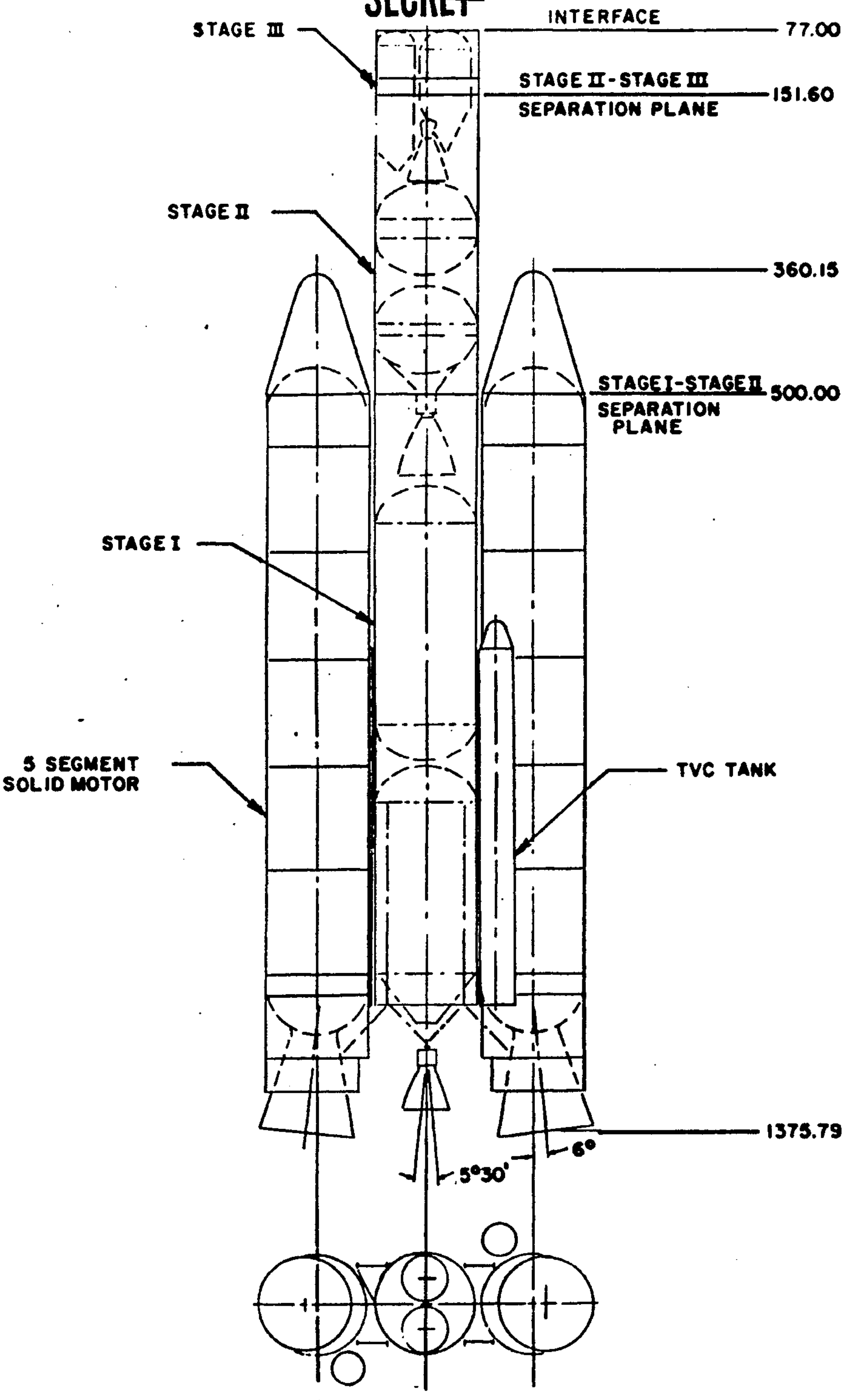

Figure 6-7. Titan IIIC Vehicle

control module may possible be used to perform certain functions for the Orbiting Vehicle; for example, the transtage could provide attitude control, at least in limit cycle modes, for the life of the Laboratory Vehicle. Additionally, the transtage suitable modified could provide on-orbit maneuvering propulsion capability. These possibilities plus a description of the abort environment faced by the Gemini and Laboratory design constraints imposed by the Titan III are to be developed by Martin under a Pre-Phase I study.

6.6.3 Interfaces.

The major interface with the Laboratory is the common mechanical joint, launch-vehicle-imposed structural and acoustical loading, and possible use of transtage subsystems on-orbit. Major interfaces with the Gemini B include structural and acoustical loading, crew safety, and possible use of the Gemini IGS as guidance for the launch phase.

6.6.4 Problem Areas.

Principal problem areas include the launch vehicle constraints on the payload with respect to diameter, length, strength, and c. g. location, and the effect of the Titan IIIC on crew safety.

6.6.5 Payload Capability.

The payload capability used in the MOL study is 21, 000 pounds for a nearly-east launch from AMR into a 200 n. mi. reference circular orbit. This includes a launch vehicle payload pad of 2000 pounds for possible performance contingencies.

6.7 GROUND SUPPORT.

6.7.1 Checkout and Launch (Launch Site).

The checkout and launch facilities at AMR will include new facilities and AGE for receipt and inspection of the Laboratory and the Gemini B. The Titan IIIC ITL facility (see Figure 6-8) will be used for

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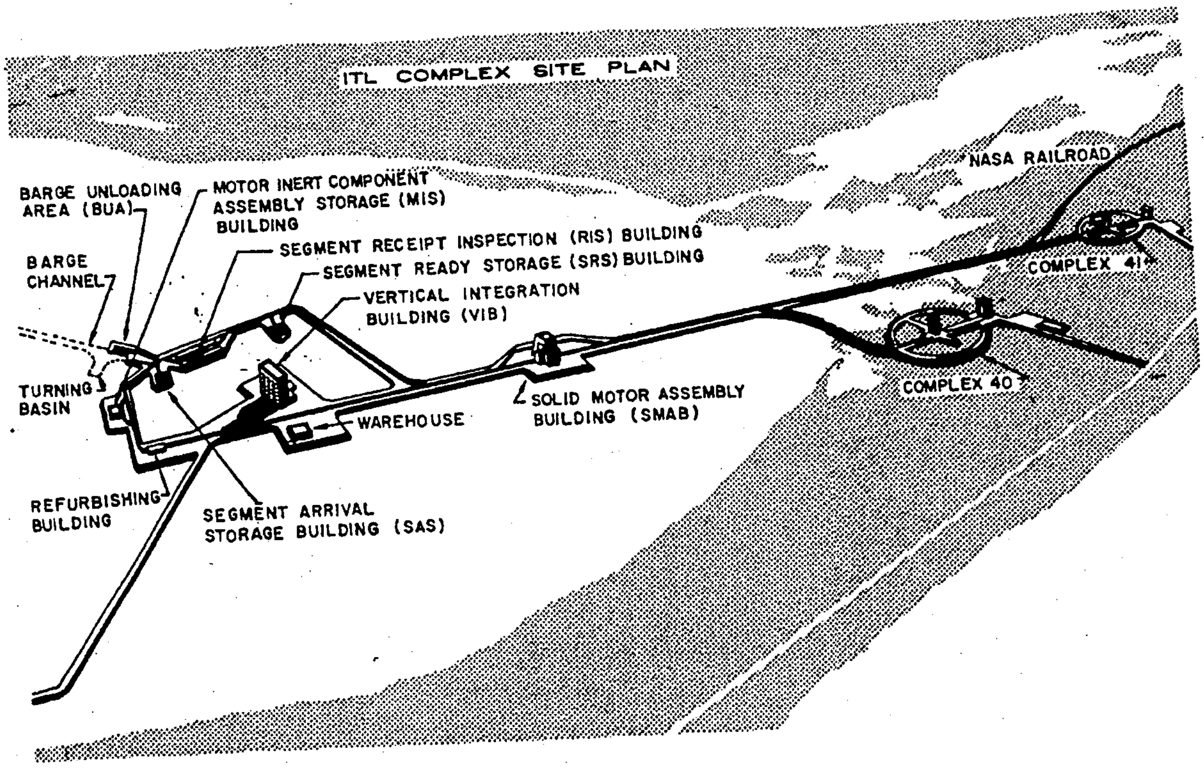

Figure 6-8. Titan IIIC ITL Facility

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assembly of the Titan IIIC booster, for integration of the Laboratory and Gemini (which may be performed in the VIB or on the pad), and for complete system checkout prior to launch.

6.7.2 Mission Control Center.

The Mission Control Center will be located at Cape Kennedy and will consist of a number of separate Centers including the Launch Control Center, the Range Control Center, the Range Safety Control Center, the Recovery Control Center (physically located in the MCC), the Vehicle-Astronaut Control Center (located in the MCC), and the Experiment Control Center. It is presently contemplated that the Gemini Mission Control Center will be utilized. Facilities and equipment for certain of the above Centers are adequate as existing or planned; these will be used to the maximum extent possible. For the other Centers, requirements for additional facilities and equipment are under study.

6.7.3 Remote Station Network.

Network support requirements include extensive coverage on ascent and until vehicle system status is established, nominal on-orbit coverage of once-per-orbit (with possible decreased frequency with successful on-orbit performance), provisions for extra coverage for special events (crew transfer and deboost), and provisions for emergency abort and recovery impact prediction. It appears that MOL requirements for remote station coverage can be met by using a combination of existing locations (assuming that joint use of certain sites with other national space programs is possible) augmented by at least one additional station. Studies of alternative network configurations are in process.

6.7.4 Tracking, Communications, and Control (TC and C).

As part of the MOL System design, detailed study is being performed of requirements of each subsystem and experiment for TC and C data types, quantities, accuracies, frequency response, sampling for control vs analysis, etc. Guidelines will be established for information flow and processing on-board the vehicle, at the tracking station, and at the Control Center.

Based on data obtained to date, the objective that no development of TC and C ground equipment shall be necessary appears to pose little constraint to the MOL System, with the possible exception of wide-band data links for special experiments. However, a 10 Mc link capability already exists at two SCF stations which may suffice, with little modifications, for experiments usage.

The application of integrated systems such as the NASA Unified S-Band System and the Air Force Space-Ground-Link Subsystem to the MOL is being studied. Although such systems will offer significant advantages when operational, the fluidity of present implementation plans do not indicate the advisability of a commitment of the MOL Program to them at this time.

6.7.5 Satellite Recovery Complex.

The recovery operation will require a Recovery Control Center (paragraph 6. 7. 2), a communication network connecting the Control Center and the recovery forces, a weather data collection point in the Control Center, the recovery forces, and logistic support bases for the recovery forces. Water recovery sites will be selected to provide a near once-per-orbit recovery capability. Recovery over land will occur only in emergencies.

6.7.6 Data Processing.

Real-time selection and processing of telemetry data and processing of command data in large blocks of digital words is a present feature of the SCF and the Gemini network and is expected to be required for the MOL. Digital processing of tracking data is a normal process within the planned capabilities. Data reduction in less than real time will be handled by normal NRD procedures. Use of NRD facilities is planned.

6.8 MANUFACTURING AND GROUND TEST FACILITIES.

The manufacturing and ground test facilities for the MOL Program are those applicable to the Titan III Program (Ref SSP for T-III, 31 January 1964), those applicable to the Gemini B contractor (MAC), and those applicable to the Laboratory contractor (to be determined). Certain existing buildings at Cape Kennedy Air Force Station (CKAFS) have been tentatively identified as desirable for ground test for the program, but will require some modification to meet test requirements. These facilities are Hangars AF, S, and L. Additional test facility requirements have not been determined at this time, but the NASA Merritt Island facilities, the AEDC facilities, and the AFFTC facilities are being examined.

6.9 COMPONENT AND SUBSYSTEM DEVELOPMENT TESTING.

It is the objective of the MOL Ground Test Program to perform, to the maximum extent possible, complete subsystems and systems integrated testing to verify, with the highest degree of confidence, the flight-worthiness of the program equipments.

To accomplish this objective, a philosophy of ground testing has been established which will require the spacecraft, Laboratory, experiments and launching system to have completed extensive simulated launch, injection, on-orbit, de-orbit, and profile integrated testing at the manufacturers' facilities prior to shipment to CKAFS.

It is anticipated that prior to Government acceptance at the manufacturers' facilities, the manufacturers will have demonstrated the flight-worthiness of the flight articles by successfully conducting an all-systems test. Upon satisfactory completion of the all-systems testing of the Gemini B and Laboratory at the manufacturers' facilities, it is likely, although not certain, that the Gemini B will be shipped to the Laboratory contractor's facility as Government Furnished Equipment (GFG). The associate contractors (Gemini B, Laboratory, experiments) and astronauts would then perform integrated MOL tests to demonstrate MOL subsystems compatibility.

Two methods of operation at CKAFS appear possible at this time. These are (1) installation and checkout of the Gemini B and Laboratory with the Titan IIIC in the VIB, or (2) installation and checkout of the Gemini B and Laboratory with the Titan IIIC at the launch complex.

In the event of a major malfunction or modification, it is anticipated that the complete article (Gemini B or Laboratory) would be returned to the manufacturer's facilities for repair, replacement, or rework, as required, and that the systems would be revalidated prior to return to CKAFS.

6.10 SYSTEM FLIGHT TEST AND OBJECTIVES.

6.10.1 Test Operations Concept.

The following test operations concepts will be observed in the conduct of the MOL Program.

a. "Buy-in" as cheaply as possible by making effective use of available DOD/NASA resources.
b. Maximum use will be made of NASA Gemini planning hardware test results and opportunities for training.
c. Test Force Direction and primary mission control will be performed by the USAF.
d. Flight crews will be selected and trained by the USAF.
e. Primary flight control will rest with MOL crew.
f. A governing factor in mission success is crew safety.
g. Crew and mission simulation (with appropriate network exercising) is a significant part of the System Test Program.
h. Delivery of launch-ready flight hardware to launch site.
i. Minimum launch site checkout.
j. Earliest manned flight possible.
k. Water recovery.
l. Primary recovery is the Atlantic (Puerto Rico).
m. Secondary recovery area is the Pacific (Midway).
n. Secure de-orbit (or alternative secure disposition) of Laboratory Module is necessary.

6.10.2 Flight Test Planning.

For initial planning purposes, the MOL flight program will consist of six flights. This number is not considered inalterable should studies during Pre-Phase I or Phase I show sufficient reason for a different number.

An objective of program definition studies will be to obtain the maximum return in terms of MOL test objectives accomplished as early as possible and for the least dollar investment. In terms of flight program planning, this objective indicates that as many as possible of the MOL flights should be manned flights of the complete MOL system including experiments.

In addition to making maximum use of systems and subsystems which will have been space flight tested in other programs, and employing ground testing, simulation and aircraft testing to the maximum practical extent, full scale "piggyback" testing will be investigated to reduce to a minimum the number of MOL flights programmed for unmanned systems verification. One approach to be explored will be to test the Gemini B on Titan IIIC test flights, including investigating the practicability of using recovered NASA Gemini capsules refurbished and modified to the minimum extent necessary to yield valid test results. A structure would be used to join the Gemini to the Titan III which is dynamically similar to the Laboratory Vehicle.

6.11 ACQUISITION SUPPORT.

The requirements for the acquisition support items listed below will be determined during Pre-Phase I.

a. Reliability
b. Quality Assurance
c. Configuration Management
d. Maintenance/Operations
e. Spare Parts/Support Support
f. Propellant Support

g. Transportability
h. Transportation
i. Packaging & Preservation
j. Human Engineering
k. Safety Engineering
l. Photographic Programs

6.12 PERSONNEL TRAINING.

Flight crew members will be selected from the pool of graduates of the Aerospace Research Pilot School. Complete evaluation will ensure that the selected MOL astronauts are in excellent physical and mental health, and are physiologically normal in all respects. Criteria for medical evaluation will be those established by the USAF School of Aerospace Medicine for the evaluation of space pilots and those additional criteria deemed necessary to eliminate abnormalities which would predispose to medical problems upon exposure to the combined stresses of the space environment.

Each selected MOL astronaut will have had a basic scientific or engineering education as well as a sound indoctrination in the principles of space flight. Additional training prior to flight will be in the following categories.

a. (no change)
b. (no change)
c. (no change)
d. (no change)
e. Simulations: Individual operational and experimental tasks and full mission simulation will be used both for training purposes and to validate proposed procedures and plans.
f. (no change)
g. (no change)
h. (no change)
i. Medical Support: Medical evaluation and monitoring teams and recovery and rescue teams will be trained and integrated into the overall operational support program.

6.13 MOL SPECIFICATIONS.

The MOL system specification will include the performance and design requirements for each segment of the MOL system. The preliminary system specification breakdown is presented in Figure 6-9. Supporting the system specification will be the Contractor End-Item (CEI) specifications for each item to be procured for the program. These CEI's will be identified (through the top levels) prior to release of the Phase I RFPs, and will be provided to the contractors for further expansion during the proposal period and the Phase I effort.

6.14 RELATED STUDIES.

List of NASA MOL Studies

Study Title	Contract Number	Responsible Office or Center
a. Mission Definition Studies		
Biomedical Requirements	NASw-776 NASw-775	OMSF
Advanced Orbital Launch Operations	NAS8-5344	MSFC
b. Logistics Systems and Operations Studies		
Modified Gemini Ferry	NAS1-3121	LRC
Modified Apollo Ferry	NAS9-1506	MSC
Operations and Logistics	NAS9-1422	MSC
12-Man Ballistic Concepts	NAS9-1666	MSC
12-Man Lifting Body Concept	NAS9-1689	MSC
100 Ton Reusable Launch Vehicle	NAS8-5036	MSFC
10-Passenger Reusable Ferry Vehicle	NAS8-5037 NAS8-2687	MSFC
c. Small MOL Studies		
MORL Concepts -- Phase I	NAS1-2975 NAS1-2974	LRC LRC
Extended Apollo Concepts -- Phase I	NAS9-1963	MSC

List of NASA MOL Studies (Cont)

Study Title	Contract Number	Responsible Office or Center
d. Large MOL Studies		
Zero G Station Concepts	NAS9-1688	MSC
Rotating Station Concepts	NAS9-1665	MSC
Electric Power Systems	NAS9-1307	MSC
Large Life Support	NAS9-1498	MSC
e. Supporting Studies		
Small Life Support System	NAS1-2934	LRC
Nuclear Reactor Power	NAS3-1460	LeRC
Nuclear Isotope Power	NAS3-1461	LeRC
Artificial G Cable Concept	NAS1-2946	LRC
Sealing Study	NAS9-1563	MSC
Titan III Launch Vehicle Study	NAS1-3308	LRC

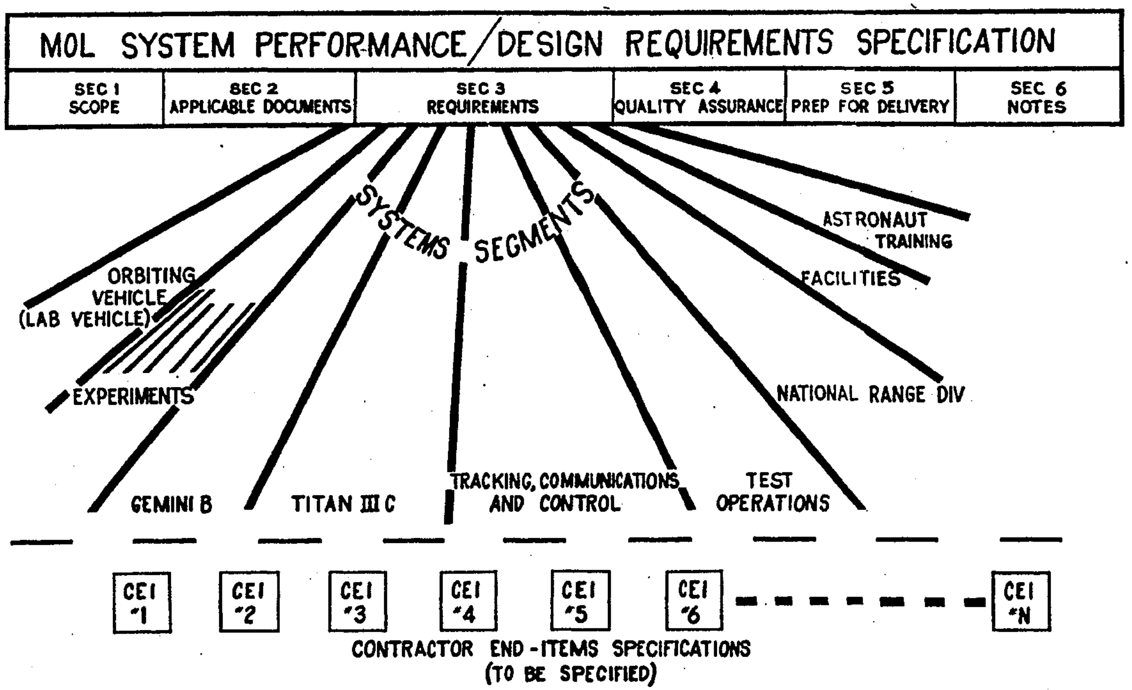

Figure 6-9. MOL System Specifications

SECTION 7
CIVIL ENGINEERING

NOT APPLICABLE AT THIS TIME

THIS SECTION IS BASICALLY ADDRESSED TO THAT CIVIL ENGINEERING PECULIAR TO PHASE III OPERATIONS. CIVIL ENGINEERING PECULIAR TO PHASE II SYSTEM ACQUISITION IS DISCUSSED IN SECTION 6 (ACQUISITION)

SECTION 8

LOGISTICS

NOT APPLICABLE AT THIS TIME

THIS SECTION IS BASICALLY ADDRESSED TO THE LOGISTICS REQUIREMENT OF PHASE III OPERATION.
LOGISTICS UNIQUE PHASE II SYSTEM ACQUISITION WILL BE OUTLINED IN SECTION 6 AS ACQUIRED DURING PHASE IB

SECTION 9

MANPOWER AND ORGANIZATION

NOT APPLICABLE AT THIS TIME

THIS SECTION IS BASICALLY ADDRESSED TO PHASE III OPERATIONS. MANPOWER REQUIREMENTS FOR STAFFING THE SPO IS OUTLINED IN SECTION 3 - PROGRAM MANAGEMENT

SECTION 10

PERSONNEL TRAINING

NOT APPLICABLE AT THIS TIME

CREW TRAINING AS IT PERTAINS TO ASTRONAUT REQUIREMENT FOR FLIGHT TEST DURING PHASE II - SYSTEM ACQUISITION IS DISCUSSED IN SECTION 6 (ACQUISITION)

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11.0 INTRODUCTION.

When submitted to AFSC Hq at the end of Pre-Phase I, the revised Preliminary Technical Development Plan for the MOL will contain estimated funding requirements for the complete program. These estimates will be reviewed and finalized during Phase I so that firm contractor proposals will be available for negotiation on Phase II. However, in this PTDP only costs pertaining to the Pre-Phase I and Phase I are included. Because of the cursory nature of this document and the constant changes which occur during Pre-Phase I planning and programming, no detailed cost analysis has been presented. As the Phase I requirements come more sharply into focus and with the issue of the revised PTDP, the detailed cost breakdowns will be presented.

Figure 11-1 presents the estimated total funding requirements for the MOL program as presently foreseen. Figure 11-2 presents a more detailed breakdown of how the Pre-Phase I funds will be used to conduct selected essential studies leading to Phase I. Figure 11-3 presents estimates of the funding for the Phase I effort and the areas where the funds will be applied.

FY YR	1964	1965	1966	1967	1968	1969	1970	TOTAL
o PRE-PHASE I 57x3600 - RDT&E AF Appropriation	$5.5	$ 1.0*						$ 6.5
o PHASE I 57x3600 - RDT&E		30.0						30.0
TOTAL	5.5	31.0						36.5
o PHASE II 57x3600 - RDT&E 57x3306 - MCP	(TO BE DETERMINED DURING PHASE I)							

*Required to fund present pre-phase I effort thru 1st Qtr FY 65

Figure 11-1. Total MOL Program Funding Appropriation (In Millions)

OSS Study Contractors ($1.0 previously approved - not MOL Funds)		
Douglas, Martin, General Electric		
Experiment Study Contracts:		1.150
Image Velocity Sensor Subsystem Study	350	
Manned Electromagnetic Signal Detection Study	225	
Autonomous Navigation Equipment Study	100	
Multi-band Spectral Observation Study	125	
RTD Study in support of P-6, P-7	200	
AMD Study in support of P-11, P-12	150	
Gemini "B" Study Contractor		1.20
Titan III Study Contractor		1.00
Lab Vehicle Subsystem Support Studies		.40
Environmental Control Subsystem	100	
Electrical Subsystems	200	
Attitude Control Subsystem	100	
Apollo Study		.20
One Man Gemini Study		.10
Contingency - $1.0		1.450
		4.50
Aerospace		1.00
Navy		.50
	Total	6.00

Figure 11-2. FY-1964 Pre-Phase I Funding

o ORBITING VEHICLE CONTRACTOR	$ 8.0
o GEMINI "B" CONTRACTOR	5.0
o TITAN III (SLV-5C) CONTRACTOR	3.0
o EXPERIMENT CONTRACTORS	4.0
o SUPPORTING STUDIES & TESTS	3.5
o AEROSPACE CORPORATION	6.5
TOTAL	$30.0

Figure 11-3. MOL Phase I Funding Estimate (In Millions)

SECTION 12

REQUIREMENTS

NOT APPLICABLE AT THIS TIME

DATA PERTINENT TO THIS SECTION WILL BE GENERATED DURING PHASE I

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SECTION 13

AUTHORIZATION

~~SECRET~~

~~FOR OFFICIAL USE ONLY~~

HEADQUARTERS
AIR FORCE SYSTEMS COMMAND
United States Air Force
Andrews Air Force Base
Washington 25, D.C.

COPY

REPLY TO
ATTN OF: SCG

SUBJECT: Field Level Management of the MOLS Program

10 Mar 1964

TO: SSD (Major General Ben I. Funk)
Air Force Unit Post Office
Los Angeles 45, California

1. Forwarded for your information and compliance.

2. Procedures are being developed stipulating the manner in which the MOL Program and its primary elements are to be handled by field activities, Headquarters AFSC, and higher authority. Pending approval of the special management procedures, the Deputy Commander, SSD, for Manned Systems, is authorized direct access to the Commander, SSD, and Commander, AFSC.

1 Atch
Charter for the Deputy Cmdr
SSD, for Manned Systems

Signed
B.A. SCHRIEVER
General, USAF
Commander

1st Ind (SSG)

Hq SSD, AF Unit PO, Los Angeles, Calif. 90045

TO: DISTRIBUTION: A-1, 5

General Schriever's letter is forwarded for your information and necessary action. Specific procedures will be furnished when developed.

Signed
BEN I. FUNK
Major General, USAF
Commander

1 Atch - n/c

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~~SECRET~~

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CHARTER FOR THE DEPUTY COMMANDER, SPACE SYSTEMS DIVISION FOR MANNED SYSTEMS

The Secretary of Defense has directed that the Air Force initiate the development of a Manned Orbiting Laboratory (MOL). Specific guidance from OSD and OSAF has emphasized the need for deviation from standard management structure and procedure because of the complex nature of the program, the cooperative effort with the NASA that will be involved, and the requirement for participation by the Secretary of Defense, the Secretary of the Air Force, and their staffs. The Air Force Systems Command, through its Space Systems Division, has complete responsibility for management of the MOL program, including its essential elements within the framework of approved program plans.

To accord the MOL program the requisite integrated field level management, a Deputy Commander, SSD, for Manned Systems, will be appointed; to facilitate the early attainment of the program objectives, he will have unusual and extraordinary autonomy and authority. The following principles will be employed:

1. The Deputy Commander, SSD, for Manned Systems will be appointed in the authorized grade of Brigadier General.

2. The Deputy Commander, SSD, for Manned Systems, is delegated full authority for field implementation of the approved MOL program.

3. The Deputy Commander, SSD, for Manned Systems, is authorized direct access to streamlined channels which have been established for expedited action on Designated Systems Programs and the MOL Program.

4. As the overall field level program director for all aspects of the MOL program, the Deputy Commander, SSD, for Manned Systems, will have complete control of allotted financial resources and will follow established procedures to assure support of all elements of the program.

5. Field detachments at test sites and factory representatives at selected contractors' plants will be established as required, and will report directly to the Deputy Commander, SSD, for Manned Systems.

6. Military and civilian personnel will be assigned as required to implement the approved program.

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HEADQUARTERS
AIR FORCE SYSTEMS COMMAND
United States Air Force
Andrews Air Force Base
Washington 25, D.C.

REPLY TO
ATTN OF: SCG

SUBJECT: Manned Space Program

16 Dec 1963

TO: SSD (SSG, General Funk)
AF Unit Post Office
Los Angeles, Calif 90045

1. The Department of Defense has directed the following actions:

a. Termination of the X-20 Program.

b. Initiation of a Manned Orbiting Laboratory (MOL) Program.

c. Expansion of the ASSET Program to provide basic technology for future space vehicles.

2. It is incumbent upon AFSC to manage the allocated resources in order to provide the best possible program. The ground rules for action follow:

a. The lead division for management of this entire manned space effort, including ASSET, is SSD. The full support of the other divisions and centers is essential.

b. Manpower spaces made available by the termination of the X-20 Program will be converted to presently validated space requirements of the division or center involved. No manpower spaces will be transferred at this time from one division or center to another as a result of the decisions enumerated in paragraph 1.

c. Upon termination of the X-20 Program, all possible funds will be recovered consistent with the additional instructions which follow.

3. The X-20 Program must be closed out in a manner which provides maximum benefit to the Government. It is therefore necessary to take action to terminate all activities in support of the X-20 as rapidly as it can prudently be accomplished. Much of the materials, components, subsystems, studies, techniques, etc., from the X-20 Program will be useful in other efforts. As a part

of the X-20 termination, these items will be made available to fulfill the requirements of other agencies. Military construction currently under contract which will be useful for other programs may be completed. No new contracts will be let. A briefing and report of the plan and status of X-20 termination will be provided to this Headquarters and to Hq USAF as soon as possible. The X-20 contractor efforts should be terminated in a manner similar to the actions taken in the GAM-87 Program. It is specifically desired that the program termination remain under the direction of the X-20 SPO until after decisions are made as to what effort should be continued, transferred, etc. Normal termination procedures will be applied as early as possible following the preliminary report to USAF on 16 December 1963.

4. With the termination of the X-20 Program, it is necessary to consider expansion of an ASSET type program to obtain hypersonic flight data during lifting re-entry. SSD is assigned management responsibility for this expanded ASSET type project within the total MOL Program. A plan should be immediately prepared covering the proposal for modifying or augmenting the existing ASSET Program. The specific objective of the program should be immediately prepared covering the proposal for modifying or augmenting the existing ASSET Program. The specific objective of the program should be to settle basic design questions using unmanned scale models that will be required preliminary to a decision to initiate an advanced manned ferry vehicle. In the review of the X-20 Program, specific attention should be given to the possible use in the ASSET Program of the materials, components, and subsystems which are surplus as a result of the X-20 termination. RTD and ASD will provide their recommendation to SSD for use in preparing reoriented ASSET program plan. The plan should include a discussion of the possible cooling techniques for advanced re-entry vehicles in matrix format against critical parameters, which will be required to support your recommendation. Consideration should be given to the promising approaches which merit development of the technology and flight testing to demonstrate capability of the techniques.

5. The plan should be available for review by this Headquarters on 27 December 1963 prior to its presentation to OSD by 31 December 1963.

Signed
B.A. SCHRIEVER
General, USAF
Commander

Similar letters sent to ASD,
ESD, and RTD

COPY

ACTION: SSB

1964 Mar 10 AM 6:32

SSGE, SST, SSM

DE RUEAGL 157 09/2232Z
R 092218Z
FM AFSC
TO SSD LOS ANGELES CALIF
BT
~~SECRET~~ MSF-9-3-13 SECTION 1 OF 2.

FOR SSG SUBJ: PRELIMINARY TECHNICAL DEVELOPMENT PLAN (PTDP) FOR THE MOL PROGRAM. 1. IT IS APPARENT THAT APPROVAL OF A PLAN FOR DEVELOPMENT OF THE MOL PROGRAM WILL NOT BE FORTHCOMING FROM DOD UNTIL WE PRESENT TO THE SEC OF DEFENSE A CONVINCING ACCOUNT OF MOL PROGRAM EXPERIMENTS WHICH WILL SATISFY THE OBJECTIVE OF DEMONSTRATING QUALITATIVELY AND QUANTITATIVELY THE MILITARY USEFULNESS OF MAN IN SPACE. THE PRELIMINARY DEVELOPMENT PLAN OUTLINE SUBMITTED TO DOD ON 7 JAN 64 DID NOT FULLY MEET THIS REQUIREMENT THEREFORE, THERE IS A NEED TO SUBMIT A PTPD WHICH EMPHASIZES THE APPROACH TO BE TAKEN TO MEET THE PROGRAM OBJECTIVES. 2. ACCORDINGLY, SSD IS REQUESTED TO PREPARE A PTDP WHICH WILL SERVE THE FOLLOWING PURPOSES: (A) IT WILL SERVE AS THE SINGLE AUTHORITATIVE REFERENCE DOCUMENT ON THE MOL PROGRAM AND, AS SUCH, PROVIDE THE FRAMEWORK WITHIN WHICH ALL SUBSEQUENT PROGRAM ELEMENTS AND ACTIONS CAN BE INTEGRATED BY SUBSEQUENT PERIODICAL UPDATING. THUS IT WILL PERMIT FOCUS WITHIN A SINGLE DOCUMENT UPON ALL ACTIVITIES INITIATED IN SUPPORT OF THE MOL PROGRAM. (B) IN ITS INITIAL VERSION, IT WILL DESCRIBE IN DETAIL THE PRE-PHASE I STUDIES AND EFFORTS TO BE UNDERTAKEN IN DEFINING EXPERIMENTS REQUIRED TO SUPPORT THE CONTINUING EFFORT IN THE MOL PROGRAM. IT WILL THUS SERVE TO INSURE THAT THESE EFFORTS WILL BE CORDINATED AND, IN AGGREGATE, CONSTITUTE A COMPLETE AND VIABLE PRE-PHASE I EFFORT UPON WHICH THE PREPARATION OF THE MOL PHASE I RFPS CAN BE BASED. IT WILL SERVE AS THE DOCUMENT TO OBTAIN DOD APPROVAL FOR STUDIES IN THE PRE-PHASE I PERIOD WITHOUT COMMITTING DOD TO THE APPROVAL OF THE ENTIRE MOL PROGRAM. (C) IN ADDITION, IT WILL CONSTISTUTE AN OUTLINE AND FORMAT OF A COMPLETE TDP FOR THE CONDUCT OF THE MOL PROGRAM. HOWEVER, THE INITIAL DOCUMENT NEED NOT GO INTO DEPTH IN THE PROGRAM ACTIVITIES REQUIRED AFTER THE INITIATION OF PHASE I. THESE SHOULD BE COVERED IN GENERAL TERMS AND WHERE INFORMATION IS NOT AVAILABLE, SIMPLY INDICATE THAT SECTIONS ARE OMITTED AND WILL BE INCLUDED WHEN THE INFORMATION IS AVAILABLE. THIS WILL PROVIDE FOR THE ORDERLY UPDATING OF THE ENTIRE PACKAGE. 3. PROPOSED STUDIES AND OVER-ALL APPROACH IN PRE-PHASE I SHOULD BE DIRECTED TOWARD

COPY

THE DEFINITION AND SYNTHESIS OF EXPERIMENTS WHICH MEET THE APPROVED CRITERIA. IE: THEY WILL ESTABLISH QUALITIVE AND QUANTITATIVE MEASUREMENTS OF MAN'S USEFULNESS IN SPACE IN PERFORMING MILITARY TASKS. THE PROPOSED EXPERIMENTS SHOULD HAVE CONSIDERED THE ENTIRE SPECTRUM OF POSSIBLE MILITARY APPLICATIONS. IN THIS REGARD, THEY SHOULD BE FOCUSED UPON THE ROLE OF MAN RATHER THAN UPON THE ROLE OF SPECIFIC EQUIPMENT. 4. WHILE EXPERIMENTS WHICH WOULD ASSESS MAN'S ROLE IN RECONNAISSANCE MAY BE CONSIDERED, IT IS EMPHASIZED THAT THE DEVELOPMENT OF A MANNED RECONNAISSANCE SYSTEM IS NOT AN APPROVED OBJECTIVE FOR THE MOL PROGRAM. EXPERIMENTS RELATED TO RECONNAISSANCE WILL ATTEMPT TO DETERMINE MAN'S CAPABILITIES, WITH APPROPRIATE AIDS TO POINT AN INSTRUMENT WITH ACCURACY BETTER THAN ONE HALF MILE, TO ADJUST FOR IMAGE MOTION TO BETTER THAN 0.2 PERCENT, AND TO FOCUS PRECISELY (IF THIS IS NECESSARY). A. ALL MOL DEVELOPMENT PLANS AND BRIEFINGS IN RELATION TO RECONNAISSANCE OBJECTIVES WILL BE CONFINED TO THESE PARTICULAR OBJECTIVES AND EVERY STEP WILL BE TAKEN TO AVOID SPONSORING OR ENCOURAGING ANY EFFORTS TO PROPOSE ACTUAL RECONNAISSANCE CAPABILITY OR TO DESCRIBE THE ESTIMATED STATE OF THE ART IN SATELLITE RECONNAISSANCE. ALL AFSC IN-HOUSE AND CONTRACTOR WORK, INCLUDING DISCUSSIONS WITH CONTRACTORS, WILL BE CONFINED TO THESE OBJECTIVES. B. PHOTOGRAPHY OF RECONNAISSANCE QUALITY WILL NOT BE USED TO RECORD OR VERIFY PERFORMANCE. IMC AND FOCUS EXPERIMENTS WILL BE PERFORMED USING A TELESCOPIC SYSTEM. POINTING ACCURACY CAN BE RECORDED WITH A SIMPLE COLLIMATED CAMERA OF RESOLUTION EASILY AVAILABLE FROM UNCLASSIFIED EQUIPMENT. IMC PERFORMANCE CAN BE RECORDED BY PHOTOGRAPHING STARS OR BY USE OF LONG EXPOSURES OR IN OTHER REASONABLY UNSOPHISTICATED WAYS. FOCUS EXPERIMENTS, IF NECESSARY, CAN BE CONDUCTED AT SUCH MAGNIFICATION THAT RECONNAISSANCE CONDITIONS ARE SIMULATED WITHOUT BEING DUPLICATED. 5. IT MAY BE ASSUMED THAT ADDITIONAL EXPERIMENTS WILL BE UNDERTAKEN LATE IN THE PROGRAM. DETAILS OF THESE PROPOSED EXPERIMENTS WILL BE PROVIDED AT A LATER DATE BY SEPARATE CORRESPONDENCE. NO CONSIDERATION NEED BE GIVEN TO THESE ADDITIONAL EXPERIMENTS IN THE 1 APRIL SUBMISSION OF YOUR PTDP. 6. THE FOLLOWING ADDITIONAL GROUND RULES APPLY: A. THE PTDP SHOULD BE FORWARDED TO THIS HQ (ATTN: MSF-1) AS SOON AS POSSIBLE BUT NO LATER THAN 1 APRIL 1964 AND ACCOMPANIED BY AN APPROPRIATE BRIEFING. B. ALL RFPS AND WORK STATEMENTS OF ALL CONTRACTS RELATED TO MOL EXPERIMENTS WILL BE SUBMITTED TO THIS HQ PRIOR TO DISCUSSION WITH CONTRACTORS. C. MAXIMUM UTILIZATION WILL BE MADE OF EXISTING STUDIES CONDUCTED BOTH WITHIN THE AIR FORCE AND BY OTHER AGENCIES IN ORDER TO MINIMIZE THE TIME REQUIRED FOR PROGRAM APPROVAL. D. MAXIMUM USE WILL BE PROPOSED OF GROUND TESTS, SIMULATION, AIRCRAFT TESTS, AND USE OF EXISTING SPACE PROGRAMS FOR TESTING. EXPERIMENTS

COPY

PROGRAMMED FOR THE MOL SHOULD BE THOSE WHICH CANNOT BE ACHIEVED IN ANY OTHER WAY OR IN WHICH THE ACTUAL EXPERIMENT IN MOL CONSTITUTES PROOF TEST OF EXPERIMENTS PRIMARILY CONDUCTED IN OTHER AREAS. 7. THIS MESSAGE IS CLASSIFIED SECRET BECAUSE IT CONTAINS SPACE PLANNING INFORMATION VITAL TO NATIONAL DEFENSE. GP-3 BT. FINAL SECTION OF 2.

~~SECRET~~

~~(CONFIDENTIAL)~~

HEADQUARTERS
AIR FORCE SYSTEMS COMMAND
United States Air Force
Andrews Air Force Base
Washington 25, D. C.

COPY

8 May 1964

REPLY TO
ATTN OF: MSF-1

SUBJECT: Approval of USAF FY-1964 RDT&E Manned Orbiting Laboratory (MOL)

TO: SSD (DCMS)
Air Force Unit Post Office
Los Angeles, California

1. References:

a. MOL Preliminary Technical Development Plan (PTDP), dated April 1964.

b. D&F 64-11c-84 dated 13 April 1964, with attached Form 111.

c. Memorandum, DDR&E (Dr. Brown) to SecAF, same subject, dated 29 April 1964, copy attached. (Attachment #1)

d. Memorandum SAFRD (Dr. Flax) to Vice Chief of Staff, USAF, same subject, dated 4 May 1964, copy attached. (Attachment #2)

e. Letter AFRDC to AFSC, same subject, dated 6 May 1964, copy attached. (Attachment #3)

2. You are hereby directed to proceed with the pre-Phase I study program as outlined in the April 1964 PTDP, subject to the conditions listed below. PA and BA authorization is being forwarded under separate cover.

a. Contract negotiation for the following studies will be deferred pending specific authorization by this headquarters to proceed:

(1) APOLLO

(2) GEMINI (One-Man)

(3) Pointing and tracking scope definition

~~(CONFIDENTIAL)~~

~~SECRET~~

(4) Autonomous Navigation

(5) Electromagnetic Intercept

b. Prior to initiating any study effort for which sole source procurement action is contemplated, other than those already identified in paragraph 13(g) of Form 111, reference 1.b., as being sole source efforts, you will submit to this headquarters the proposed work statements and an appropriate statement identifying the proposed sole source contractor and the justification underlying your recommendation for sole source procurement.

c. Request that you review the work statements for the Pointing and Tracking Scope Definition (3.3.1.2.1) and Autonomous Navigation (3.3.1.2.6) studies as to the feasibility and desirability of extending the experiment efforts to include experiment tasks in geodesy and gravimetry which may be generally useful and provide complementary inputs to the two experiments concerned. Your recommendations, including revised work statements or a statement of justification for non-inclusion, should be forwarded to us as soon as practicable.

d. Request that you review the proposed experiment P-9 (Negation and Damage Assessment) in the light of the results of Program 706 studies. Your recommendation for its deletion or justification for retention should be submitted to this headquarters as soon as practicable. If retention is recommended, your submission should be supported by a statement of the need and importance and should include the extent of proposed in-house as well as the requirement if any, for contractor support.

e. Particular emphasis should be given in all experiments studies to the inclusion, wherever possible, of provisions for ground simulation.

FOR THE COMMANDER

Signed
RICHARD K. JACOBSON
Colonel, USAF
Asst Dep Comdr for Space for MOL

3 Atch
1. Memo, DDR&E to SecAF, 29 Apr 64, same subject.
2. Memo SAFRD to AFCVC, 4 May 64, same subject.
3. Ltr AFRDC to AFSC, 6 May 64, same subject.

SECTION 14

GENERAL INFORMATION

14.0 REFERENCED REPORTS.

14.1 US Naval Research Laboratory Memorandum Report 1507, Manned Orbital Laboratory Technical Panel. First Preliminary Report dated 17 March 1964.

14.2 Experiments for MOL, Mission Analysis Panel, SSTA-1M-3, 11 March 1964.

14.3 A Preliminary Description of Experiments for Manned Military Orbital Systems, Aerospace Corporation, TOR-269(4531-41)-1, R. Glasser, 20 Jan 64.

14.4 Proposed MOL Experiments RTD.

14.5 Bioastronautics Panel Report, 11 Mar 64.

14.6 General and Scientific Panel Report, 11 Mar 64.

14.7 Reconnaisance and Surveillance Panel Report, 11 Mar 64.

14.8 MOL Experiments Working Group Augmented Data, 23 Mar 64.

14.9 Candidate Experiments for Manned Orbiting Laboratory, Volume I, 1 April 1964, SSTA-1-9.

14.10 Candidate Experiments for Manned Orbiting Laboratory, Volume II, Parts 1 and 2, 1 April 1964, SSTA-1-10.

SECTION 15
SECURITY

NOT APPLICABLE AT THIS TIME

DATA PERTINENT TO THIS SECTION WILL BE GENERATED DURING PHASE I

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SECTION 17

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SECTION 17

PRELIMINARY DEFINITION PLAN

17.0 INTRODUCTION.

The purpose of the Preliminary Definition Plan (PDP) is to establish a framework for the eventual development of a specific plan for the accomplishment of the MOL Project Definition Phase (PDP). The final PDP plan will include all the activities to be accomplished by the SPO/ Aerospace/Contractors during Phase IA, IB and IC, and will indicate how these activities will be effectively integrated. Since many of the activities to be accomplished by the contractors during Phase IB will not be known until Phase IA is underway, the complete Definition Plan will not be available until the results of Phase IA are available.

In this Preliminary Technical Development Plan (PTDP) the basic framework for the Definition Plan is presented. The framework consists of schedules of Phase I activities with their interrelationships and the products of these activities.

17.1 ACTIVITY SCHEDULES AND NETWORKS.

During Phase I the DOD, USAF Headquarters, AFSC Headquarters, Space System Division, Aerospace Corporation, and selected contractor organizations will be involved. The successful completion of Phase I will require specific activities to be accomplished by each of these organizations; activity schedules in this section identify these major activities and indicate their relationship and interdependency.

This plan is based upon what are judged to be minimum realistic times for all echelons to accomplish required activities. No administrative delays are presumed and, if any occur, the schedule will slip.

17.1.1 Action Network.

The Action Network presents the flow of the mainstream activities required by the OSD, Hq USAF, AFSC, SSD/Aerospace, and the contractors to accomplish Pre-Phase I and Phase I. The network indicates when contractor in-house study efforts are to be initiated, completed, evaluated, and reported; how the various activities are dependent on each other and when program outputs are scheduled for submission to Washington for review and approval to proceed with the next step. Since this network is intended to present only mainstream activity, detailed presentations of the activities within organizational entities require reference to other sub-networks.

17.1.2 Pre-Project Definition Phase Planning Network.

The many in-house and contractor efforts required during this initial phase are presented in the Pre-Project Definition Phase Planning Network. Many activities have been underway during the past months, and these have been included to show how the various technical, management, and procurement tasks that are required to prepare for the initiation of Phase I efforts are interrelated. These activities include such tasks as: program planning; establishment of a SPO Cadre; preparation of Requests for Proposals, procurement guides, and technical work statements; accomplishment of preliminary trade-off studies; development of management control procedures; preparation of preliminary system specifications; and the preparation and updating of program documentation, such as this PTDP.

The importance of this type of planning network lies in its use to determine which program elements are pacing or critical to the attainment of the overall program objectives. A typical example is the requirement to define adequately the experiments to be conducted in the MOL prior to the release of RFP's for the Laboratory Vehicle to industry. Both in-house and contractor efforts (OSSS) are involved in this definition, and until they are accomplished the follow-on activities are constrained. Numerous other interdependencies become obvious by means of this type of network planning and the impact of specific discussions on the total program can be readily evaluated.

17.1.3 Phase I Planning Network.

A detailed Phase I Planning Network is a required element of the plan for the PDP. However, it is dependent upon the results of the Pre-Phase I studies and has not been included in this PTDP. As the various tasks in Pre-Phase I are completed, the total planning network will be developed and included as part of the revised PTDP.

17.2 MANPOWER AND FUNDING.

The proposed manpower and funding requirements for the MOL Phase I program are presented in Section 3 Program Management and Section 11 Financial respectively. This information is not repeated in this section of the PTDP, but they will be further defined during Phase I.

17.3 REQUIRED PHASE IB PRODUCTS.

The SPO is required to prepare a Proposed System Package Plan (PSPP). The PTDP forms the basis for preparing this PSPP, but the results of the SSD/Aerospace/Contractors Phase IB efforts will be required to complete the document. Therefore, specific items will be required as products of the Phase IB study efforts, but these are not all identifiable at the present time. A major purpose of Pre-Phase I is to identify these items. However, the following paragraphs indicate the typical products to be expected from the Phase IB effort.

17.3.1 Associate Contractors Final Report.

The contractor final reports will include a summary, technical data resulting from trade-off studies, a base-line system/subsystem description, performance/design requirements specifications, program schedules, and the management plans required to conduct the program.

17.3.2 Phase II Proposal.

The contractors will prepare a detailed proposal for the Phase II program. It will include all functional plans, work statements, system specifications, a PERT/Time & Cost system, incentive features, and any other item necessary to the successful accomplishment of the program objectives.

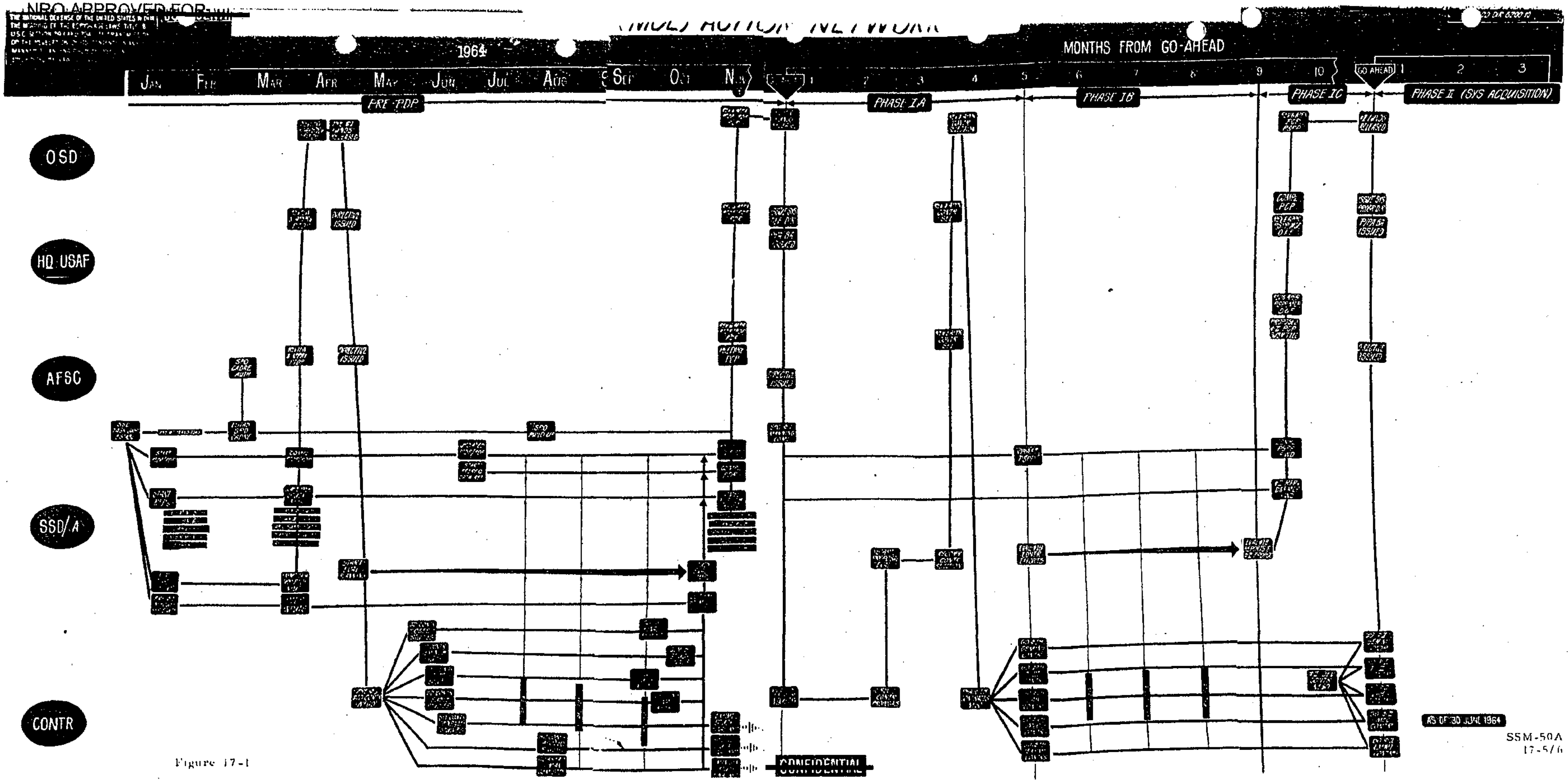
17.3.3 Aerospace Corporation Products.

The Aerospace Corporation will perform General Systems Engineering and Technical Direction (GSE/TD) during the Phase IB period. These major products will be reflected in the products provided by the contractors under their technical direction and technical documents prepared for the Air Force and for distribution to the program contractors. Under the General System Engineering function they will be responsible for the overall integration and engineering for the complete MOL system. In addition to the GSE/TD role, the Aerospace Corporation will technically support the SPO and perform selected technical trade-off studies.

17.3.4 System Program Office.

The SPO will manage the Aerospace and industry contractors efforts, prepare program documentation and briefings, perform procurement functions as required, prepare the PSPP, and accomplish all tasks required to prepare for the anticipated Phase II program.

NRO APPROVED FOR



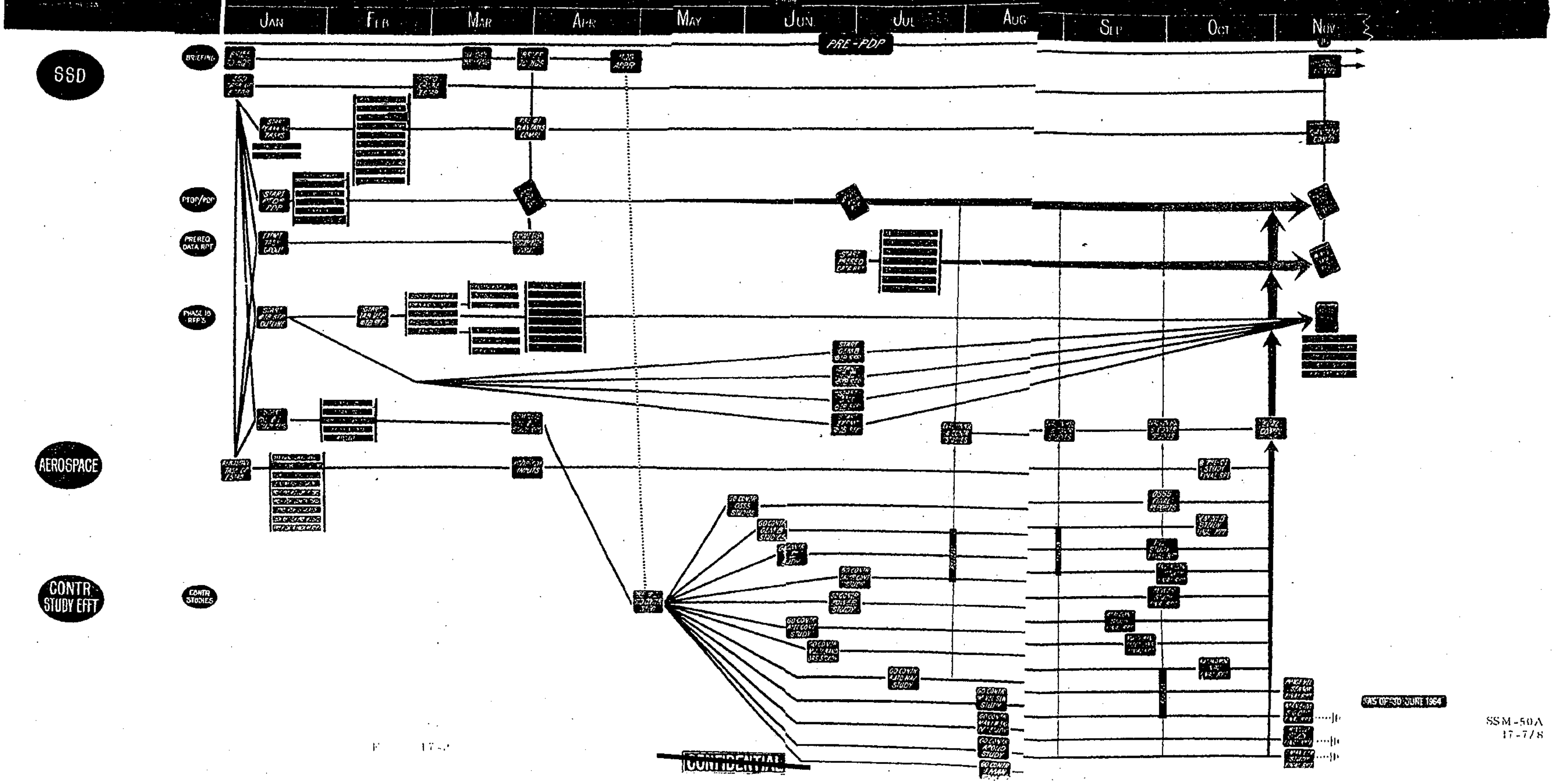
CONFIDENTIAL

Figure 17-1

CONFIDENTIAL

(MOL) PRE-PROJECT DEFINITION PHASE PLANNING NETWORK

(LEVEL 1 - PRINCIPAL ACTIVITIES)



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SECTION 18

CONCEPT FOR US NAVY EXPERIMENTS IN THE MOL PROGRAM

FIGURES

SECTION 18

CONCEPT FOR US NAVY EXPERIMENTS IN THE MOL PROGRAM

18.0 INTRODUCTION.

A preliminary report of the Navy MOL Technical Panel has been prepared for submission to the Bureau of Naval Weapons. In all, the Panel received eighty-nine proposals or ideas for experiments. From these were selected those experiments to be proposed for the MOL program. The number of experiments submitted in each area, the number recommended for support by the Navy, and the preliminary estimates of costs for these experiments are given in Figure 18-1.

Major interfaces between these experiments exist on data management, structural arrangements, vehicle stabilization and control, position determination, communications, etc. These require further study.

The experiments proposed are within the state of the art and can be orbited in the 1968-1970 time period. They are also well within the payload capability of the MOL vehicle.

The experiments described here are intended to study means for improving the performance of naval missions. Their inclusion in the MOL program is highly recommended.

18.1 OCEAN SURVEILLANCE.

In view of the obvious importance of ocean surveillance to Navy missions, a separate study group consisting of Panel representatives from the Institute of Naval Studies, the Applied Physics Laboratory, the Naval Air Development Center, the Naval Research Laboratory, the Naval Photographic Interpretation Center, and the Bureau of Naval Weapons met at the NRL to develop further this topic. The problem in ocean surveillance is to survey ships, harbors, and ocean lanes. It is necessary to detect and classify all

Over-all Summary of Experiments Recommended for MOL

	Experiments		Costs (Millions)	
Mission Area	Reviewed	Recommended	FY '65	Total
Ocean Surveillance	26	1 (8 parts)	$2.75	$39.25
Command and Control	2		?	?
Communications	3	1	0.60	2.0
[redacted]	[redacted]	[redacted]	1.50	7.0
ELINT	4	1	Included (?)	Included (?)
Bio-astronautics	14	3	0.30	3.25
General Science	35	10	0.70	6.85
	89		$6.00M*	$59.00M*

*Preliminary estimates only. Not for budget purposes.

Figure 18-1. Over-all Summary of Experiments Recommended for MOL

vessels found in either harbors or ocean lanes. The problem is complicated by the fact that the oceans are vast, that the targets are continually on the move, and that good data must be obtained to be useful. Tardy, incomplete, and inaccurate data is of little value. It is obvious that an astronautic system cannot supply the total requirement, but only supplement other means of maintaining ocean surveillance. It is probably true that the Navy's problem is not the same as that of the AF or the Army. Thus, the Navy's problem revolves around keeping track of ships on a global basis. The targets are relatively large but continually on the move. Hence, the naval requirement seems to be for a system of nominal resolution and very wide coverage.

Any consideration of the problem of ocean surveillance must begin with an understanding of the state of the art for the available sensors. Figure 18-2 gives (in summary form) the most essential information with respect to each possible sensor. Some changes may be required in the final selections. It may be necessary, for example, that an optical system be

RADAR	[redacted]
OPTICAL	CA–101, 12'RES., PROCESSOR, 100 1/MM 12"APERTURE, 48"FL
TV	100'RES 24"F.L. F2 F4 LIGHTED SHIPS AT NIGHT, STARLIGHT
I R	[redacted]
I FF	L BAND – 1 DW PEAK – 10W AVER. MILITARY SHIPS – INTERROGATION – CODING 10' DISH OR – 5' DISH, DIRECTIONAL
ELINT	HF THRU VHF, LARGELY AVAILABLE
BEACON	UHF, PULSED, NON–MILITARY FRIENDLY VESSELS

Figure 18-2. Ocean Surveillance State Of The Art, Sensors

procured having a 96"-focal-length lens, rather than the 48"-focal-length lens given in the table, to secure the desired resolution of 12' and permit at the same time some degradation of performance of the camera while in the spacecraft. The best choice for radar is similarly unsettled at the present time. Two possible choices are given: one with a rotating antenna system and one without. Note that the radar system with the non-rotating antenna leaves large gaps in the coverage of the earth below the spacecraft See Figure 18-3 for coverage obtained with the simple non-rotating antenna proposed.

The concept for ocean surveillance developed by the sub-panel is as follows: there must be advanced detection of all shipping targets followed classification by the astronaut, appropriate data processing, and read-out by ground stations.

To perform the function of detection in advance of the satellite the most promising sensors seemed to be radar, television, and infrared - in that order. It is desired that this advance detection take place as long as one minute in advance of the time when the spacecraft is over the target on the earth. At the orbital rate of travel of the spacecraft this correspon to 250 miles; thus the detection range for the broadly scanning sensor systems should be approximately 250 miles in advance of the spacecraft. All-weather radar systems having this capability can be devised. Television a infrared systems can provide initial detection under favorable conditions where the weather is clear or clouds are only thin or broken. Optical systems can also perform this function when the weather is clear or when clouds are thin and broken; but optical systems of high-resolution, particularly, are not as well adapted for automatic searching of large areas as is radar.

After the target has been detected, the next step involves classificatio Here, provided the weather is clear, a set of binoculars having variable magnification and directed by the astronaut to the coordinates indicated by the advance detection means would be used to find the target. If desired, then, through servo controls, the high-resolution camera can be caused to

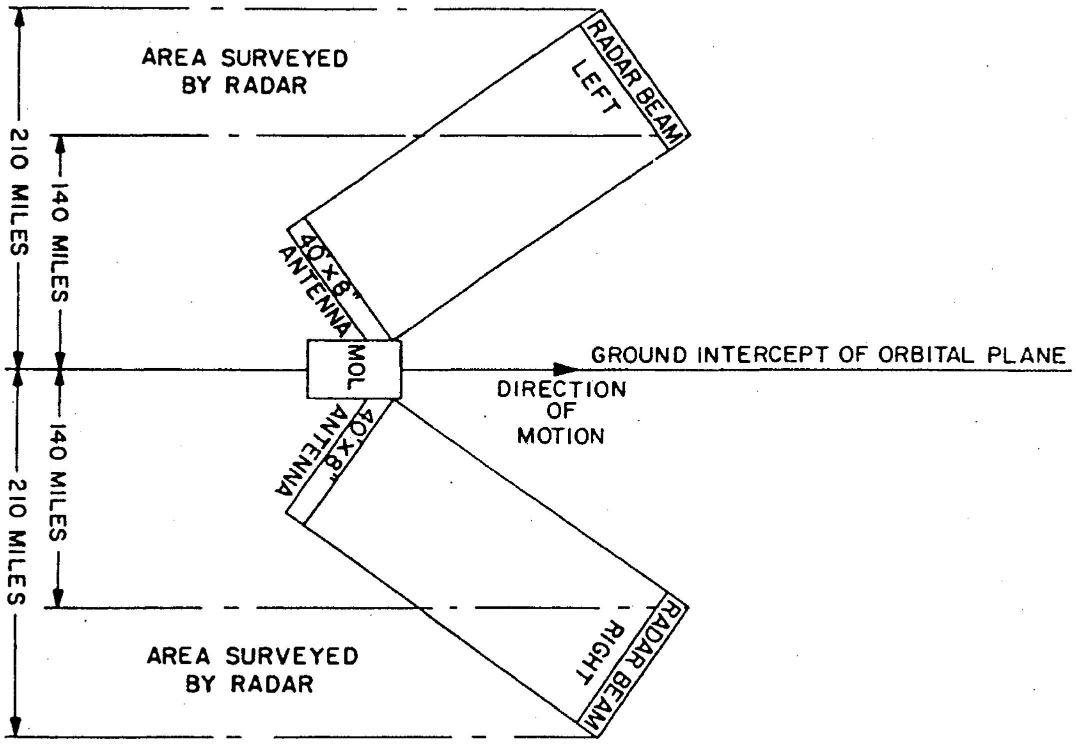


Figure 18-3. Coverage Obtained with Simple Non-Rotating Radar Antenna as Shown in Figure 18-2

photograph automatically the target under examination. The pictures would be used for detailed study on a deferred basis. If the weather is not favorable, then the astronaut must depend upon other systems to determine friend from stranger. The directivity of an IFF-type interrogating device operating from the radar antenna or a separate 5-foot dish mounted on MOL is good enough to separate ship from ship under most conditions. The ELINT also can provide from coarse to good resolution and separate "friend" from "stranger." The same is true with respect to ultra-high-frequency beacons carried by friendly merchant shipping or aircraft.

The third part of the ocean surveillance concept is that automatic position determination must be provided to the astronaut. This should record automatically the coordinates of any target selected by the astronaut. Such a system can be devised depending upon ephemeris data carried within the orbiting capsule, a gyro-stabilized platform, and means for relating the position of the classification device or camera with respect to the MOL vehicle attitude. There must be storage of all classification information provided by the astronaut. It may involve no more than operation of push buttons. There must be capability for command read-out of all data stored at such times as when the MOL capsule is over a friendly ground station desiring such information. Finally, there must be means within the data processing for instructed search to be initiated by ground command and acted upon by the astronaut. The command for instructed search given by the ground stations may be stored automatically for delivery to the astronaut at the proper time in orbit.

The astronaut may, at times, be saturated by targets; therefore, data processing techniques must be employed to reduce this problem. Automation must be provided wherever possible. High-resolution film must be used to record the nature and position of selected visible shipping and harbors and their contents for later study and classification by the astronaut. Provisions for directed search and classification aids are needed to limit demands made upon the astronaut. The several factors involved in the concept of the integration of the hardware for this experiment are shown in Figure 18-4.

ADVANCE DETECTION – 1 MIN., 250 MI.

- RADAR – ALL WEATHER
- TV – DAY OR NIGHT – CLEAR OR THIN BROKEN CLOUDS
- I R – DAY OR NIGHT – CLEAR OR THIN BROKEN CLOUDS
- OPTICAL – DAY

CLASSIFICATION –

- OPTICAL – ZOOM BINOCULARS – SLAVED CAMERA FILMS FOR DEFERRED OR DETAILED STUDY
- I FF – FRIEND OR STRANGER – DIRECTIVITY GOOD
- ELINT – COARSE TO GOOD RESOLUTION, FRIEND OR STRANGER
- BEACON – FRIEND OR STRANGER

DATA PROCESSING –

- AUTOMATIC POSITION DETERMINATION
- CLASSIFICATION STORAGE – MANNED INPUT
- COMMAND READ-OUT
- INSTRUCTED SEARCH STORAGE

TARGETS, SATURATION BY –

- AUTOMATION – DATA STORAGE
- DIRECTED SEARCH
- PROCESSED FILMS
- CLASSIFICATION AIDS

Figure 18-4. Ocean Surveillance-Concept

Figure 18-5 provides a view of the MOL astronaut engaged in ocean surveillance using his search or detection equipment to illuminate areas some 250 miles in advance for detection purposes and using his optical and other systems for inspection of targets detected.

Three situations have been devised to illustrate the usefulness of ocean surveillance capabilities which can be provided the Navy by a manned astronautic system. Figure 18-6 is the layout for the first situation which illustrate the problem of ocean surveillance with respect to Cuba. There it is required that an unfriendly country be kept under surveillance to determine its shipping both in ocean lanes and in harbors, and the departure ports as well as the terminal ports. In the performance of this mission the astronaut provides the following contributions: (1) he can be selective and look only for certain kinds of shipping; (2) he can concentrate on certain areas and spend the whole of the time he is in the area of a fixed target (e.g., Havana - approximately two minutes) in surveillance of that target alone; (3) he can filter out a target from a low contrast or noisy background; (4) he can give rapid response to a command for search, the time required, if his orbit is over the target, being less than the orbital period; (5) he can make optimum choice of the sensors to be used; (6) he can optimize performance of the system by providing necessary adjustments; (7) he can improve reliability; (8) he can enhance accuracy. One further point in favor of man is that our capacity as a nation to orbit increasing payload, thus enabling man and his necessary environment to be included, seems likely to improve at a faster rate in the next ten years than is our capacity to orbit reliable, sophisticated systems able to replace man.

Situation 2 shown in Figure 18-7 depicts a condition existing when directed search is to be instituted by ground command. In this case an area of the Sulu Sea is known to contain four ships in the locations marked with crosses in the diagram. It is also thought to contain two ships in the general location shown by stars on the diagram. The problem is to identify these unknown targets and provide their location. The instructions to the astronaut can be stored in the data processing equipment of the vehicle from any ground station over which the astronaut passes. At the appropriate time the astronaut

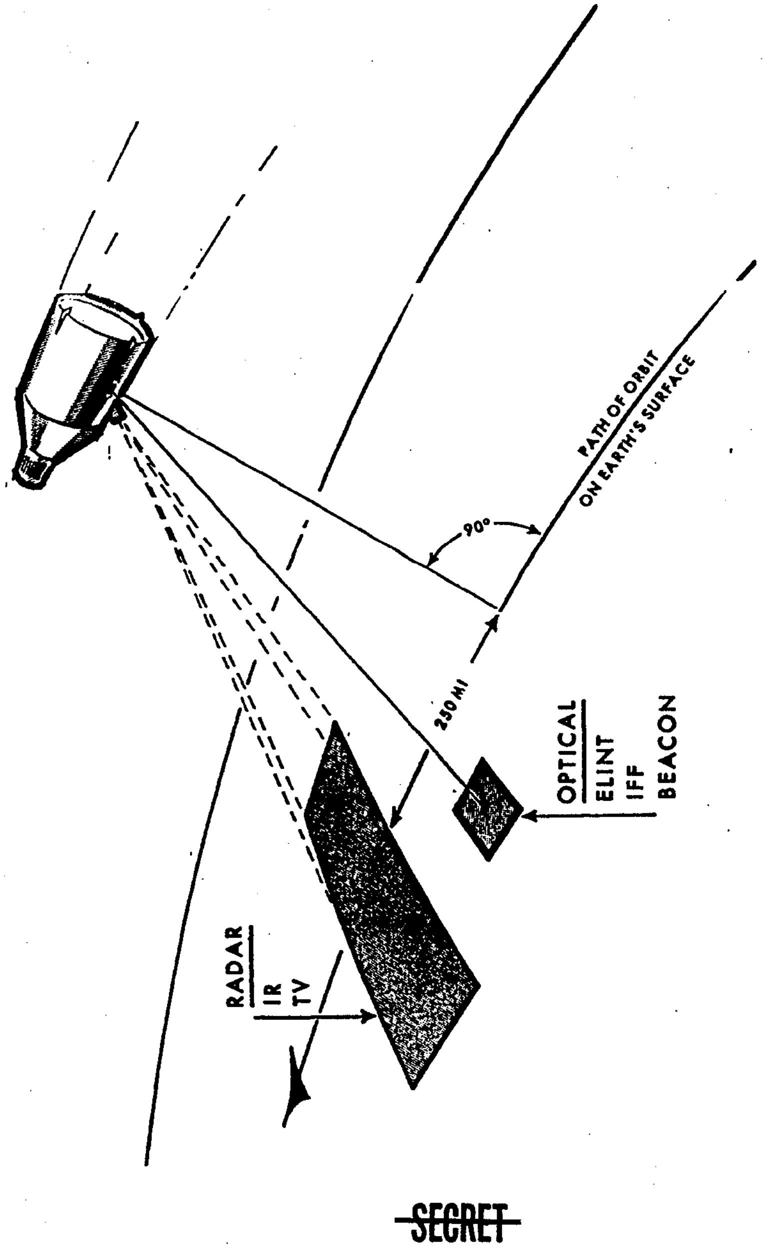


Figure 18-5. Ocean Surveillance

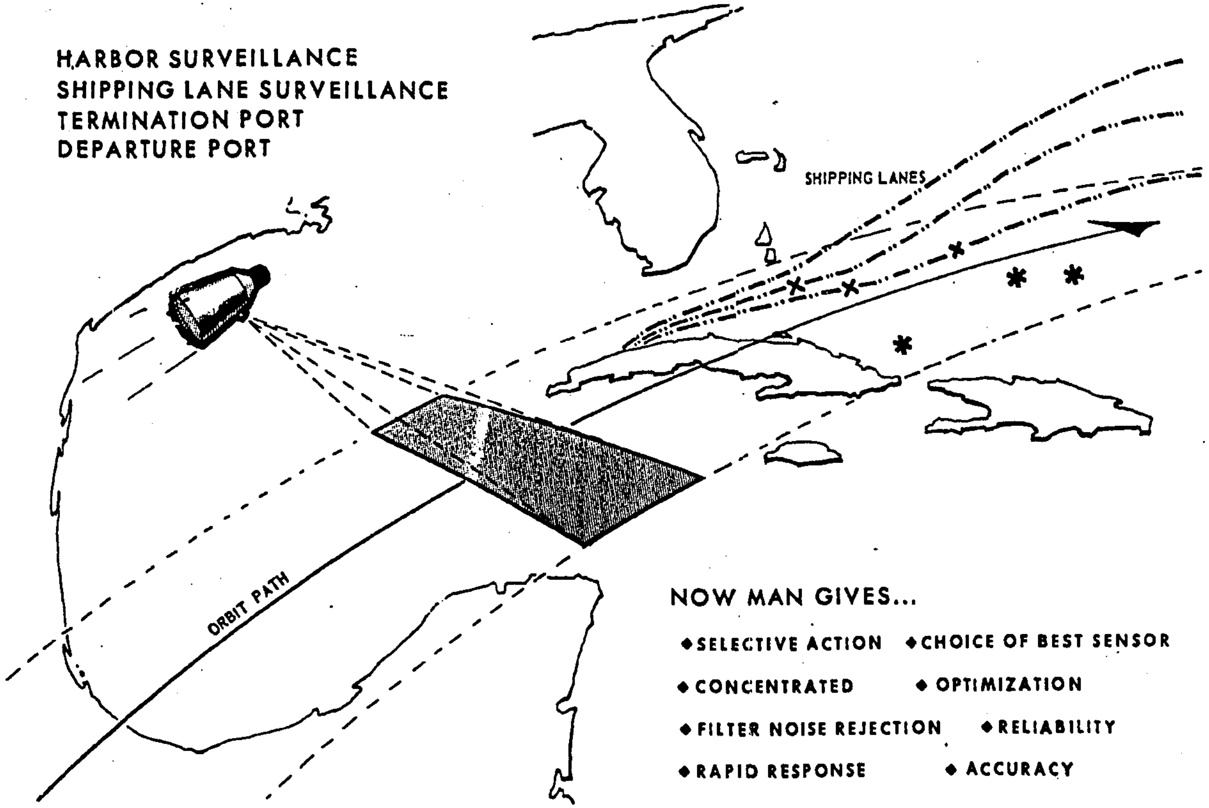


Figure 18-6. Situation 1

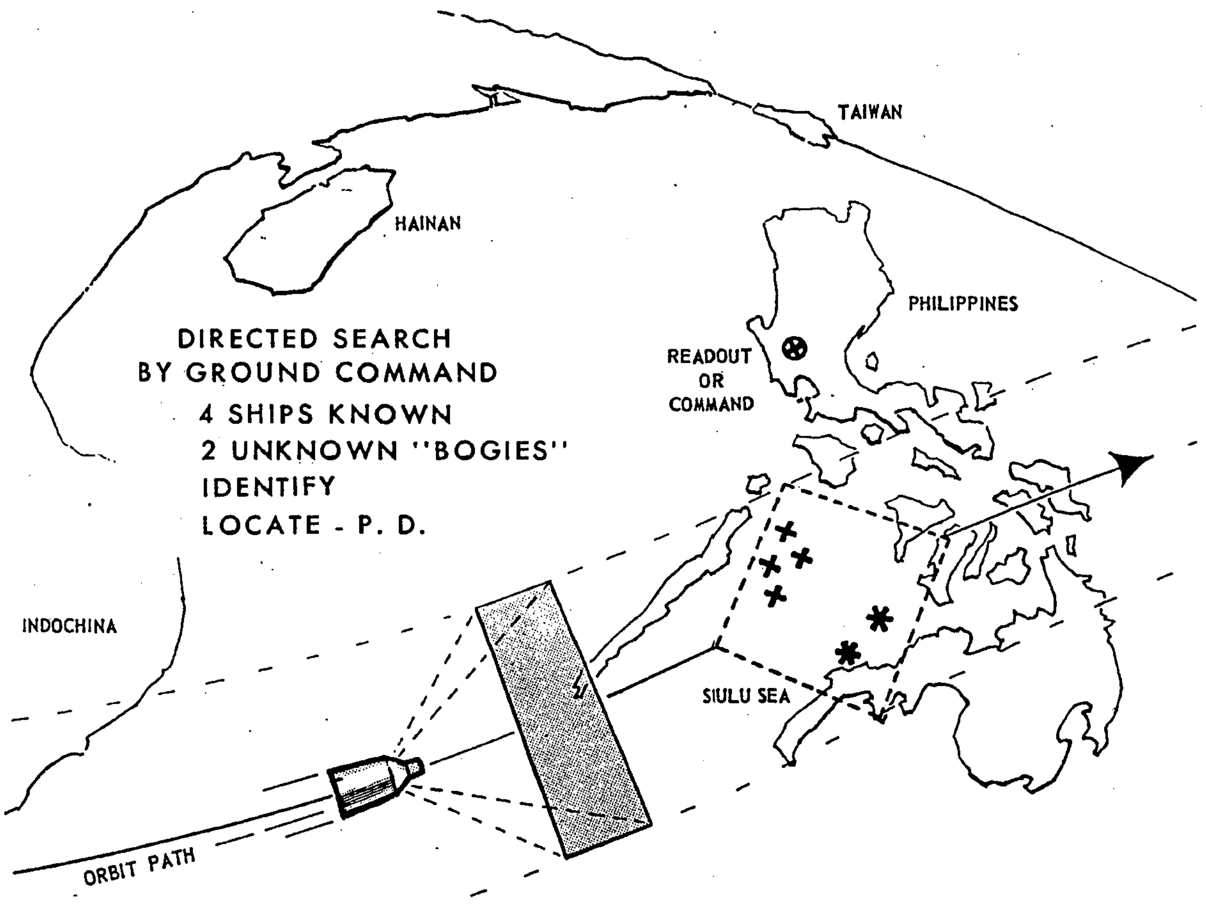


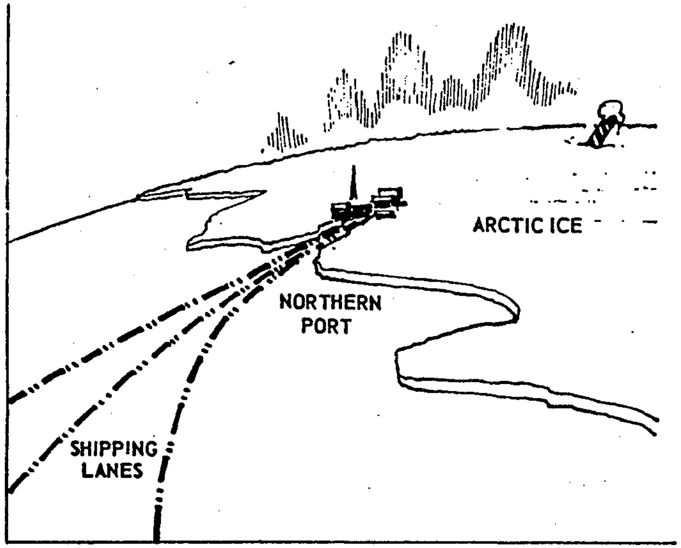
Figure 18-7. Situation 2

will be given signals from his data storage to inspect the area outlined by the dotted lines. If he is able to use the optical systems he is likely to obtain ready classification of the targets. If he is forced to use all-weather sensors then he can determine whether the unknown targets are captured by his sensors, whether they are friends or strangers, and their positions. If he is able to detect no target, but can see the surface areas whose coordinates are given, he has provided information which may help to determine whether or not the unknown targets are submarines.

Situation 3 is depicted in Figure 18-8. Here the problem is to determine the trend in world shipping as a portent for some future operation of an unfriendly power. The need is to inspect something like twenty ports around the world, e.g., to catalog and count the ships in ports and in lanes to these ports. The illustration chosen is that of a northern port where certain lanes may be ice-closed. With optical equipment in suitable weather the astronaut can survey with high resolution the harbors and the approaches to the harbors and classify shipping in these areas. He can also determine which shipping lanes are open and which are closed by ice. If weather is unfavorable he can count ships which are in the lanes using equipment such as radar, IFF, ELINT, and beacons. At night, in favorable weather, he may obtain a shipping count through the television system. Here again man gives selectivity or the ability to look for only certain kinds of information; he gives the ability to concentrate on certain areas; he gives the capability for optimizing all sensors used; he gives rapid response; and he can correlate and filter data. In short, he provides more accurate, more reliable data.

Figure 18-9 is a preliminary estimate of the total cost to fund an ocean surveillance experiment on means for satisfying the naval mission requirements. In summary, it is a system utilizing radar, optical, television, infrared, ELINT, IFF, and beacon-type sensors. None of these sensors alone can do the job. All of these sensors used intelligently together can obtain great amounts of valuable information.

An estimate of the over-all weight of hardware for the ocean surveillance experiment is included in Figure 18-10.



PROBLEM...

- WORLD SHIPPING NEED TO INSPECT 20 PORTS
- CATALOGUE AND COUNT SHIPS IN PORT
- SHIPS IN LANES TO THESE PORTS

OPTICAL...

HI RES HARBORS AND APPROACHES, RADAR, TV-IR-LO RES HARBORS AND APPROACHES, OPEN LANES, ICE CLOSURES, IFF, ELINT, BEACONS, CLASSIFICATION, APPROACHES

MAN GIVES...

SELECTIVITY-CONCENTRATION, FILTERED, CORRELATED, RAPID, OPTIMIZED, RELIABILITY, ACCURATE DATA

~~SECRET~~

ITEM	SPONSOR	65 COST	TOTAL
RADAR	NRL NMC NADC	$1.5M	$10M
OPTICAL	NPIC–APEL	$0.5M	$7M
TV	NADC	$0.15	$2M
IR	NADC NOTC (C.L.)	$0.25	$2.5M
ELINT	BUWEPS NRL	$0.10	$9.25M
IFF	NRL	$0.05	$0.25M
BEACON	NADC	$0.05	$0.25M
INTEGRATION	APL INS NRL	$0.15	$8M
		$3M	$40M

Figure 18-9. Ocean Surveillance

~~SECRET~~

Weight Estimates for Ocean Surveillance Experiments

Component	Weight
Integration and Data Processing	350 lb
Radar	1,500 lb
Optical Sensors	800 lb
Television	150 lb
Infrared	150 lb
IFF	25 lb
ELINT	200 lb
Beacon	25 lb
	3,200 lb *

*This is a preliminary estimate only. Weight for primary power and gyro-stabilization is not included

Figure 18-10. Weight Estimates for Ocean Surveillance Experiments

There are a number of elements of the proposed ocean surveillance system which require further study. For example, it is necessary to determine whether the radar antenna can be a rotating one as is preferred, or whether it must be fixed to avoid disturbing the optical system. Second, it is necessary to determine whether the radar antenna can provide the multiple usage capability required by the IFF, the ELINT, the beacon, and the radar systems. It may be necessary to provide a second antenna (perhaps a 5-foot aperture dish) for use by the IFF, the ELINT, and the beacon systems to classify the targets. Third, it is necessary to determine how the optical cameras can be made adequately directive. (It is considered that an essential element of this system is that the camera should be quite flexible in its ability to be trained upon any point on the earth within 250 miles or so of the astronaut.) A fourth question has to do with the need for a camera of focal length of 98". (The 48"-focal-length camera will give the required resolution only if it is operating at its maximum effectiveness. To allow for some degradation of performance it may be necessary to use 98"-focal-length optics The camera aperture may need to be increased from 12 to 18 inches. Schedules are yet to be determined. Much more accurate cost data are required. The many interfaces between the various sensors must be thoroughly examined and properly related one to another. Also, it is necessary to determine the cost in effectiveness which will ensue to the over-all experiment if certain portions must be omitted for one reason or another.

18.2 COMMAND AND CONTROL.

In the specific area of Command and Control the Technical Panel received no experiment proposals of note. This is an unsatisfactory situation because there is a problem which exists in this area. The obvious technical requirements for command and control posts, whether in space or on shipboard, include data sensors and processors, means for communication, means for presentation of information, and means for storage and response to direction and command. The hardware already envisioned for the MOL vehicle to perform the Navy ocean surveillance mission can take care of surveillance, data processing, and communication functions envisaged for the command and control function, and therefore will support the Command and

Control mission. However, no suggestions with respect to specific experiments in command and control are provided herein. It is suggested that sponsors be sought within the Navy to develop a suitable command and control experiment.

18.3 COMMUNICATIONS.

There is much work under way on unmanned space communication experiments; however there is still a place for special experiments. The Navy has a wide interest in global communications, hence the Technical Panel accepted a communications experiment proposing further work in VLF, ELF, and HF areas. This experiment will check out the efficiency of global communication to a spacecraft on the opposite side of the earth from a ground station using VLF. It proposes to measure antenna impedances and propagation characteristics within the frequency ranges listed. Man can be very useful in tuning and adjusting the equipment to optimize the performance of the experiment and enhance its reliability and accuracy. Figure 18-11 provides a summary of the factors involved in a communication experiment. Sponsors for the proposed experiment include the NRL and NADC.

18.4 [redacted]

[redacted]

PROBLEM ——
- GLOBAL COMMUNICATIONS
- ANTENNA IMPEDANCE
- PROPAGATION CHARACTERISTICS

MAN ——
- TUNES ADJUSTS
- OPERATES
- CONTROLS ATTITUDE
- OPTIMIZES

SPONSOR —— NRL NADC

	65	TOTAL
COST	$0.6M	$2.0M

Figure 18-11. Communications VLF, ELF, HF

[redacted]

18.5 ELINT.

In the area of the ELINT mission, man can provide selectivity to examine signals which appear to be of most interest; he can filter out noise; he can provide better accuracy, and better reliability; and he can provide correlation of data input with respect to other information. Furthermore, the manned astronautic vehicle is the only manned vehicle now available for passage over foreign territory. It therefore enables the development of capability for selective, tactical, ELINT analysis which appears to be promising during the 1968-1970 period. This is particularly so in view of the fact that man's capability to launch larger payloads is presently increasing faster than is his capability to launch highly reliable, adequately sophisticated, unmanned systems to obtain some kinds of information which are desired. At least four Navy laboratories could be selected as sponsors for a selective, tactical ELINT analysis project. These include the NRL, the NADC, the NMC, and the NOL (White Oak). Costs of the hardware needed for performing the experiment are included in the estimates for the ocean surveillance system; however, some additional funding may be required to cover costs of the sponsoring activity for this particular experimental area. A summary of the factors considered in the ELINT problem is given in Figure 18-13.

PROBLEM – [redacted]

NOT UNIQUELY NAVY, MUCH AF ACTIVITY.

MAINTAIN CONTACT, DEMONSTRATE INTEREST.

EXPT.	SPONSOR	65 COST–TOTAL
[redacted]	BUWEPS	$1.0 $4M
[redacted]		
ORBITAL DEFENSE – MAN USES AND TESTS		
[redacted]	NRL	$0.5 $3M
[redacted]		
		$1.5 $7M

Figure 18-12. [redacted]

PROBLEM

SECURITY – SEPARATE APPROACHES

MAN GIVES SELECTIVITY, NOISE REJECTION,

ENHANCED ACCURACY,

RELIABILITY, CORRELATION

PASSAGE OVER FOREIGN TERRITORY

SELECTIVE, TACTICAL ELINT ANALYSIS

NADC, NMC, NRL, NOL(WO) COST INCLUDED

Figure 18-13. Elint

18.6 BIOASTRONAUTICS.

In the mission area of Bioastronautics there are several factors to be considered. In the first place, NASA has planned the launching of a series of at least six 1,000-pound bio-satellites. These are to be orbited for periods extending from three to thirty days. It is also to be remembered that the directives for the MOL program state that work in the area of bio-astronautics is not to be overdone. Hence, the Panel considered that only those experiments should be considered for naval participation in which the Navy can make some unique contribution or has some special reason for performing the experiment.

The summary included in Figure 18-14 shows that only three experiments were selected in the bio-astronautics area. The first one of these is an extension of Project ARGUS in which the Navy has been making at the Naval Medical Research Institute an extended study of the capabilities of man to exist in small parties of from 2 to 15 in number for extended periods of time in deeply submerged vehicles which are completely cut off from mankind. In such a vehicle man encounters many environmental conditions which are like those in space. Therefore, it is considered that the Navy can make a considerable contribution to the national effort by relating and extending its ARGUS studies to the MOL system. In the case of the remaining two experiments on nuclear radiation monitors proposed by the Naval Radiological Defense Laboratory, it is considered advisable that these be included in the MOL vehicle because NRDL has certain advisory responsibilities to DOD which require it to obtain first-hand information on the space environment encountered by man. Also, in the case of the heavy-particle dosimeter experiment proposed by NRDL recovery of records is necessary for further study.

PROBLEM FACTORS –

NASA BIO SATELLITES
MOL – "NOT TO BE OVERDONE"
SPECIAL EXPERIMENTS ONLY

EXPERIMENT	SPONSOR	65 COST	TOTAL
PROJ. ARGUS EXPT. IMPORTANT NAVY CONTRIBUTION	NMRI	$0.2M	$2.25M
NUCLEAR RADIATION MONITOR DOD ADVISORY RESPONSIBILITIES	NRDL	$.025M	$0.10M
HEAVY PARTICLE DOSIMETER RECOVERY NEEDED	NRDL	$0.075M	$0.90M
	TOTAL	$0.3M	$3.25M

Figure 18-14. Bioastronautics

18.7 GENERAL SCIENCE

The Navy has much capability in the area of General Science, and consequently the Panel had many experiments to review. Those ultimately selected are thought to have potential military value. Considered first were experiments that are related to the MOL vehicle and deal with space and plasma physics. For example, the proposal of the NRL to study plasma surrounding the MOL vehicle by scatter of RF energy is included. Similarly the proposal to study by the use of probe techniques the density and temperature of electrons within this plasma was included. The far-UV orthicon was included because of its military mission interest, its need for manned operation, and the inherent value of background information with respect to UV radiation in near-earth space vehicles. The airglow horizon photography was selected as being of value because the airglow is a major phenomena encountered by any optical sensor operating near the earth, and horizon sensors are of considerable interest.

Of long-range interest is the cosmic radiation coming in to earth and its direction of origin. This would be studied in one of the experiments recommended. Also, of interest is information on the white light corona about the sun and possible sky surveillance of the area near the sun. The airglow spectroscopy made possible in the MOL vehicle is also considered to be a valuable experiment. Finally, photography of the solar planets and of the geology of the earth using the camera planned for ocean surveillance from the MOL vehicle is worthwhile. (It is true, however, that the camera proposed will be only marginally effective for use in photography of the planets.)

A much more complete study of the Navy proposals in General Science has been prepared by Dr. William Faust of NRL.

The estimated cost for General Science experiments proposed by the Navy are shown in Figures 18-15 and 18-16.

~~SECRET~~

MILITARY INTEREST (CAN USE MOL VEHICLE)

I MOL ORIENTED – SPACE & PLASMA PHYSICS		65 COST–TOTAL	
SCATTER	NRL	$.95	$1.5M
ELECTRON D&T	NRL	$.20	$1.6
FAR UV ORTHICON	NRL	INCLUDED	
AIRGLOW HORIZON PHOTOGRAPHY	NRL	$.20	$1.5M
		$0.45	$4.6M

Figure 18-15. General Science

~~SECRET~~

II LONG RANGE MILITARY INTEREST			
COSMIC RADIATION	NRL	$.05	$0.75M
WHITE LIGHT CORONA AND SKY SURVEILLANCE	* NRL	$.20	$1.5M
AIRGLOW SPECTROSCOPY	NRL	INCLUDED	
III GENERAL SCIENTIFIC INTEREST			
PHOTO SOLAR PLANETS	NOTS	?	
PHOTO GEOLOGY EARTH	NOTS	?	
		$0.25	$2.25M

Figure 18-16. General Science

SECTION 19

NASA EXPERIMENTS

AS YET THEIR HAS BEEN NO DEFINITION OF NASA EXPERIMENTS. HOWEVER, IT IS EXPECTED THAT THEY WOULD FALL WITHIN THE SECONDARY GROUP OF EXPERIMENTS

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SECTION 20

SUMMARY OF SECONDARY EXPERIMENTS

INDEX (Cont'd)

SECTION 20

SUMMARY OF SECONDARY EXPERIMENTS

SECTION 20

SUMMARY OF SECONDARY EXPERIMENTS

20.1 VLF COMMUNICATION-PROPAGATION EXPERIMENT - EXPERIMENT S-1.

20.1.1 Objective.

The objective of this test is to investigate VLF propagation between globally distributed ground terminals and the orbiting MOL. It is also required to determine the effects of the diurnal variations of the ionosphere on the above propagation characteristics and deduce communication system capabilities for space-ground-space links. The astronaut will be required to monitor the VLF band for noise background and detect signals of known transmissions. He will also operate the transmitter in cooperation with ground instructions and vary the length of the VLF antenna for best coupling to the ionospheric plasma.

20.1.2 Description.

The experiment is based on having a capability in MOL to transmit and receive in the VLF range. Signals transmitted from VLF ground installation, (Jim Creek, Cutler, etc) will be monitored in MOL and signal profiles will be recorded for future analysis. Monitoring of particular transmissions will be performed initially for at least full orbit to determine if reception is continuous and global. Subsequently, monitoring will be for shorter periods based on diurnal variations of the ionosphere and position of MOL.

MOL will transmit on assigned frequencies (not during reception) and be monitored by ground receiving stations. Antenna tuning capability will be required for maximum coupling to the ionosphere. To support the test, a VLF tunable receiver, transmitter, variable length antenna, earphones, and recorder will be required. Recorded profiles will be transmitted to ground at an opportune time.

20.1.3 Importance of Test.

The current information on the propagation of VLF energy transmitted between space and the earth is inadequate to determine the full potential of this frequency range to provide global capability using a space-mission vehicle in the extension into space of the VLF network. Such a capability would improve the global coverage of the VLF net and ensure alternate routing of traffic following the degradation or destruction of ground facilities. VLF communication traffic normally transmitted from large ground antenna systems could be transmitted to a space vehicle at other frequencies and retransmitted from space at the VLF net frequency to the dependent weapon system.

20.1.4 Vehicle Requirements.

Power:	500 watts on transmission/2 watts on reception 1-3 full orbits initially thereafter 2-15 minute periods per day
Volume:	2 cu ft
Weight:	4 lb
Stabilization:	No rapid rotation during test periods
Aperture (window):	No unique requirement
Miscellaneous	

20.2 SECURE COMMUNICATIONS USING NARROW BEAMS - EXPERIMENT S-2.

20.2.1 Objective.

Tests will be performed to determine the feasibility of using a millimetric wavelength system for secure communications between MOL and aircraft and MOL and ground. Because of the narrow beamwidth ($\approx 1^{\circ}$) possible at this wavelength, the experiment will require accurate aiming by the astronaut of the antenna system. He will establish, via MOL communication support equipment, voice contact with the airborne or ground terminal and will transmit taped information on the millimetric system and record received signal profile. He will also orally monitor the received signal and evaluate its quality. The results of tests will be debriefed when opportune to do so.

20.2.2 Description.

This experiment has two major parts. The MOL-Aircraft link will use the 60-75 KMC's frequency range and the MOL-Ground link will use the 90-100 KMC's range. Both experiments need not be carried out in any one MOL, but could be alternated.

The first experiment will require an aircraft flying at an altitude of 40,000 feet or higher and along the track of MOL with test equipment similar to that in MOL. The experiment contact time will be 5 minutes average. After a link has been established, a modulation sequence can be transmitted. Both the MOL and aircraft will record received signals. The ground terminal for MOL-Ground link can be larger and a 15-foot diameter antenna is already available. The procedure for establishing the link will be the same in each case. As soon as the antennas are co-aligned and link acknowledgment is attained, automatic track will be used.

20.2.3 Importance of Test.

In order to provide a reliable and secure command capability between ground command posts, airborne command posts, and space command posts, the communication system must be resistant to jamming and interception by the enemy. Narrow beam systems respond to both these vital requirements. The test is necessary in order to respond to questions relating to the establishment of narrow-beam communication links between moving terminals. Because of the relative velocity of the terminals (i.e., space vehicle-to-space vehicle and space vehicle-to-aircraft) and, therefore, the high tracking rates involved, the initial acquisition is an important system consideration. If this experiment shows that man can contribute to initial link establishment by being able to accurately point the antenna, it would reduce the complexity (weight, power, space) which otherwise would be necessary in an automatic link establishment procedure when using narrow-beams.

20.2.4 Vehicle Requirements.

Power:	100 watts (during contact periods, not exceeding 10 minute duration)
Volume:	2.4 cu ft
Weight:	70 lbs
Stabilization:	High rotational stability of vehicle during test periods
Aperture:	Antenna system must be capable of being oriented through ± 90° to the vertical

20.3 LASER PROPAGATION EXPERIMENT - EXPERIMENT S-3.

20.3.1 Objective.

The objective of this experiment is to determine the potential of narrow beam LASER radiation for communications and reconnaissance applications. This test will examine scattering, absorption, refraction and phase scintillation caused by the atmosphere. The role of the astronaut will be to point a receiver/transmitter antenna in the direction of a ground terminal.

20.3.2 Description.

This experiment has two primary parts. The first involves a LASER receiver capability on the MOL and a LASER radar on the ground. The ground terminal will track the MOL and the signal profile of the radar pulses will be detected and recorded in MOL. Pointing of the optical receive for maximum signal will be done by the astronaut. The second part involves the use of a LASER transmitter on-board the MOL and it will be required to direct the transmitted output toward a pattern of optical receivers on the ground. A time/amplitude analysis would be done from information received in the ground complex to determine beam scattering, refraction and scintillation.

Both experiments need not be incorporated in each MOL but could be alternated. The total configuration in MOL would involve receiver, for time, angle of arrival, signal profile and a voice channel.

20.3.3 Importance of Test.

LASERS have a diverse potential for future space missions because of their extremely narrow beamwidths, which would be advantageous for secure, wideband communication links, and for reconnaissance. The results of the tests will be significant in the continuing development of LASERS for these applications. The tests are necessary to evaluate the effects of the atmosphere on LASER radiation and the test will permit the evaluation of the narrow beam acquisition problem. This experiment can only be conducted in conjunction with a space platform since there is no reasonable way to simulate the effect of the atmosphere.

20.3.4 Vehicle Requirements.

	LASER RX On-Board Only	LASER TX On-Board Only
Power:	25 watts for 5 min periods	500 watts during contact period (5 min)
Volume:	1 cu ft	1.5 cu ft
Weight:	20 lbs	50 lbs
Weight of Steerable Platform:		100 lbs
Stabilization:	High rotational stability during test	
Aperture:	Laser system must be able to see radar transmitter thru complete contact period (± 90°)	Same

20.4 HIGH FREQUENCY IONOSPHERIC DUCTING COMMUNICATION - EXPERIMENT S-4.

20.4.1 Objective.

The test is to investigate the propagation characteristics of high frequency radio waves and to determine their potential to provide beyond-line-of-sight communication links between space vehicles (at altitudes in the order of 200 N.M.) and globally distributed ground terminals and aircraft. The astronaut will be required to monitor and detect signals in the H.F. frequency band, and establish and maintain communications with ground terminals and aircraft. He will subjectively evaluate quality of the signals received and debrief results to the ground.

20.4.2 Description.

The experiment is planned in two major phases:

1. Detect and monitor the H.F. Band and note identifiable transmissions, particularly those which represent beyond-line-of-sight reception. Specific transmissions from ground terminals and aircraft, which already exist in large number, can be programmed in order to obtain duration and last-point contact with respect to the position of MOL.

2. Establish communications with ground stations and aircraft and maintain contact as long as possible to ascertain if H.F. two-way links can be global and continuous. The equipment required on board will be H.F. panoramic receiver, H.F. transmitter, graphic recorder, with time reference and a twin track voice recorder. If H.F. support communications is planned for MOL, then this equipment could form the basis of the experiment if modified as may be necessary. Quality evaluation of a voice link will be done by the astronaut and also at the other terminals (ground, aircraft).

20.4.3 Importance of Test.

From the data obtained, it will be possible to determine the number and location of ground terminals and aircraft, which are necessary to insure maintaining continuous contact with orbiting space vehicles, and to predict the frequencies and power requirements for such communications. While the communication channels are likely to be limited in bandwidth, and therefore may not serve the purpose of linking an Orbiting Command Post to the ground for high rate data transmissions, they still can form an extremely effective back-up system for the essential elements of command and control. Further, a beyond-line-of-sight communication capability between Airborne Command Posts (ABCP) and OCP is highly desirable.

20.4.4 Vehicle Requirements.

Power:	100 watts when transmitting; 10 watts receiving only
Volume:	2 cu ft
Weight:	50 lbs
Stability:	Not critical
Aperture:	Not critical (antenna extension only)

[redacted]

[redacted]

[redacted]

20.6 EXPANDABLE STRUCTURES TECHNIQUES - EXPERIMENT S-6.

20.6.1 Objective.

This experiment will provide the USAF with the capability of boosting into orbit minimum package-size structures which can be expanded into useful larger MOL's and space structures. The results of this experiment will have a direct bearing on whether or not any portion of a relatively large future space system, which of necessity must be partially formed and erected in space, can be so designed.

20.6.2 Description.

Four small expandable structure cylinders would be deployed early in the MOL mission. One cylinder will be constructed of airmat, one of expandable self-rigidizing honeycomb, one of a foamed-in-place structure, and one telescoping structure. Each cylinder will be pressurized to the cabin pressure of the MOL and will be inspected by the astronaut for structural integrity. Two small expandable solar collectors will also be expanded and rigidized to determine the ability to form useful solar energy conversion devices in space. These solar collectors will also provide sufficient test data to determine the feasibility of utilizing these types of structures for antenna systems.

20.6.3 Importance of Test.

This experiment is needed to determine which of several types of expandable structures show potential for space application. Such applications include complete space stations, space station components, solar collectors and antennas. MOL will afford the earliest possible platform from which these experiments can effectively be conducted. Man will be needed to make detailed inspection of the rigidized shapes.

20.6.4 Vehicle Requirements.

Power:	--
Volume:	5 cu ft
Weight:	100 lbs
Stabilization:	--
Aperture:	36" x 18"
Miscellaneous:	A target is required.

20.7 ANTENNA DEPLOYMENT, ALIGNMENT, AND POINTING - EXPERIMENT S-7.

20.7.1 Objective.

To deploy, align and point as necessary an antenna typical of those that may be employed in spaceborne high resolution radar equipment.

20.7.2 Description.

The astronaut will deploy (unfold or unfurl) an antenna of approximately 25 feet in length. Studies have indicated that this is a minimum length antenna for even experimental spaceborne radar equipment. After deployment, the astronaut will check the alignment of the antenna and adjust as necessary to maintain a phase relationship of 1/8 - 1/16 wavelength. If the antenna is designed for operation at X band, the alignment must be maintained to within .5.1 cm along the entire 25 foot length. The alignment must be maintained in spite of the severe temperature variations that will be encountered as the MOL moves in and out of the earth's shadow. After alignment and at an appropriate time the astronaut will position the vehicle so that the antenna will point at a calibrated ground target range. Coherent R/F energy will be transmitted and the reflected energy recorded and stored aboard the MOL vehicle. If suitable equipment exists, data processing and signal analysis may be done aboard the MOL and the astronaut may adjust equipment as necessary to optimize the performance of the system.

20.7.3 Importance of Test.

The application of high resolution radar techniques in space reconnaissance is a tremendously complicated problem in which there are many scientific and engineering unknowns. Some of the major problems of the antenna are: its construction, deployment, and alignment, the transmission of R/F energy through the microwave plumbing. It is questionable if these problem areas can be overcome in space without a man performing a vital role.

20.7.4 Vehicle Requirements.

Power:	1 kw (short periods only)
Volume:	20 cu ft in spacecraft
Weight:	1000 lbs (includes extra batteries)
Stabilization:	05 / Sec
Aperture:	Small viewing ports for astronaut to observe antenna and to assess antenna adjustments.

20.8 [redacted]

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20.10 MAPPING AND GEODETIC SURVEY FOR IDENTIFIED POINTS - EXPERIMENT S-10.

This experiment has been deleted. The primary objective of this experiment is reflected in Experiment P-8, Autonomous Navigation.

[redacted]

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20.12 HYDROGEN REDUCTION ATMOSPHERIC REGENERATION SYSTEM - EXPERIMENT S-12.

20.12.1 Objective.

Evaluate component and system performance of a chemically regenerative atmospheric control system as an integral part of a life support system.

20.12.2 Description.

The basic system consists of a reactor subsystem in which CO_2 is reduced to H_2O and an electrolysis subsystem in which the water is dissociated into hydrogen and oxygen. Water removal and CO^2 removal systems are also included to make a complete atmospheric regeneration system.

If the MOL consists of two pressurized compartments, it is proposed that the system be provided in one of the compartments for experimentation purposes. The compartment will, of course, include the basic ECS system.

Samples of the gas stream will be taken periodically and analyzed. A gas chromatograph or mass spectrometer (expected to be available as part of the MOL monitoring equipment) will monitor all trace contaminants in the cabin atmosphere.

20.12.3 Importance of Test.

As mission times and the complement of manned spacecraft increase, a point will be reached in the not-too-distant future where the penalties for the use of expendable or open cycle atmospheric control systems will be excessive. Reliable high performance atmospheric regeneration systems will have to be developed for these long duration manned space missions. The most promising systems consist of reducing CO_2 to H_2O with hydrogen and subsequent electrolysis of the water to provide breathing oxygen. It is estimated that the cross-over point between this system and an open atmospheric system is between 30 and 90 days. Two-phase operation exists in the water condenser and electrolysis cell which requires verification in a zero gravity field.

20.12.4 Vehicle Requirements:

Power:	700 watts peak 550 watts continuous
Volume:	4 ft^3
Weight:	150 lb
Stabilization:	None
Aperture (window) requirements:	None

20.13 VAPOR COMPRESSION DISTILLATION WATER PURIFICATION SYSTEM - EXPERIMENT S-13.

20.13.1 Objective.

Verify and evaluate operation of the system.

20.13.2 Description.

The basic elements of the system are an evaporator and a condenser. The water is boiled in the evaporator, the vapor is compressed and then condensed in the condenser at slightly higher pressure and temperature, which provides heat for boiling. Impurities are collected on a liner in the evaporator; as the system operates on a batch method rather than continuously, the liner can be replaced from time to time between batches. Liner replacement is required only about once in two weeks.

The system is set up and waste water supplied. The quantities of both input and output (purified) water are measured. A chemical analysis of the purified water is made at increasing intervals, as system operation is verified.

The crew will operate the system by supplying the unpurified liquid, starting the system, monitoring operation, removing the purified water, analyzing the purified water, and replacing the liner as required.

20.13.3 Importance of Test.

Waste water reclamation may be necessary for manned space vehicles having a mission greater than two weeks and which use a power supply other than a fuel cell (which produces excess water). Vapor compression distillation is attractive for military applications since it can be made compact. In one design of the system, it is made as a cylinder that rotates, theoretically making it independent of gravity. The history of life support system components and subsystems, however, shows a great reluctance to use parts that have not been tested in space. Thus space testing is necessary before the system can be considered for actual space use.

20.13.4 Vehicle Requirements.

Power:	300 watts peak 75 watts average
Volume:	3 ft^3
Weight:	45 lb
Stabilization:	None
Aperture (window) requirements:	None

20.14 PASSIVE PROPELLANT SETTLING SYSTEMS - EXPERIMENT S-14.

20.14.1 Objective.

Prove feasibility of using surface tension forces (wetted and/or non-wetted surfaces in conjunction with intermolecular fluid forces) to control location of liquids in tanks during extended periods of zero gravity. Demonstrate feasibility of expelling only liquid and/or only gas from a tank containing both, when using a fluid control device employing surface tension forces.

20.14.2 Description.

The basic test equipment is several transparent subscale tanks containing different liquids and different liquid control devices. Candidate liquids are liquid oxygen, liquid hydrogen, nitrogen tetroxide, and hydrazine. For the tests the tanks are placed where they can be observed and photographed. Still pictures are taken at regular intervals.

If weight permits, a desirable addition to the test is to provide an acceleration table so that the effects of small accelerations, such as would be imposed by propulsion system start transients, could be studied.

Having the astronaut as a test conductor will allow, in comparison with a test on an unmanned vehicle, (1) use of color film for data recording. (2) various camera angles and lighting set-ups, (3) selection of data, and (4) application of different perturbing forces.

20.14.3 Importance of Test.

Current operational techniques of fluid control at zero gravity employ "active" devices such as bladders or diaphragms that physically separate the liquid and gas in the tank. These techniques have been acceptable for many applications, but are not without limitations. The "passive" fluid control technique holds promise of being more universally applicable and may eventually result in lighter weight, more reliable, and less complex systems than possible through "active" fluid control techniques.

The "passive" fluid control technique will have applications in many areas, e.g., propellant systems, life support systems, and power systems. This experiment concentrates on applications to propellant systems, however, results will be applicable to other areas as well. "Passive" settling techniques promise to provide both positive expulsion of propellants only (no gas), and control of propellant location in the tank so that vehicle c.g. is predictable and unchanged at main engine ignition. Tests aboard the orbiting laboratory will serve to provide feasibility during extended zero gravity conditions and determine effects of disturbing forces created by reaction control system operation and propulsion system on-off thrust transients. These effects cannot be observed without orbital flight.

20.14.4 Vehicle Requirements.

Power:	150 watts peak (primarily for illumination for photography - may not be needed)
Volume:	1 - 5 ft^3*
Weight:	15 - 115 lb*
Stabilization:	None
Aperture (window) requirements:	None
Miscellaneous:	Recovery of film is required

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* Depends upon (1) number of liquids tested, (2) whether means are available to recover and use the liquids, (3) whether the acceleration table is included, and (4) whether the cameras are charged to this experiment.

20.15 COHERENT E-M PROPAGATION AND ANTENNA LOADING - EXPERIMENT S-15.

20.15.1 Objective.

To determine phase distortion and other effects due to the ionosphere on e-m emanation from satellites. A secondary objective is to investigate the problems of antenna loading and high power r-f distribution in the high vacuum and temperature extremes encountered in space.

20.15.2 Description.

The experiment will consist of a series of tests designed to measure the extent of phase distortion of the ionosphere in two way propagation of r-f energy. Calibrated ground targets will be used. Measurements will be made and recorded at both the ground targets and in the satellite. Simultaneous measurements, performed from the ground, of the existing atmospheric, tropospheric and ionospheric conditions will be made to provide correlative data.

The astronaut will adjust the various controls for optimum system performance and also vary parameters to determine loss of performance.

An antenna and T/R unit will be required in addition to such ancillary equipments as tape recorders, clocks, etc. Photographs will be taken to determine the extent of cloud layer, moisture content and to some extent other boundary conditions.

The experiment will also determine the effectiveness of various design for loading the antenna with high peak powers during the experimentation.

The astronaut will make repairs and adjustments as necessary to complete the experimentation.

20.15.3 Importance of Test.

The tests are needed to provide basic data for the design and development of a high resolution radar system.

20.15.4 Vehicle Requirements.

Power:	Never more than 1 kw for short periods
Volume:	10 ft^3
Weights:	250 lbs
Stabilization:	.05 ^{o}/Sec
Aperture:	Window for viewing antenna and antenna alignment

20.16 SOLAR X-RAY WARNING SYSTEM - EXPERIMENT S-16.

20.16.1 Objective.

To monitor incidence of soft X-rays. To correlate these occurrences, with observed solar activity to provide a means of forecasting lethal high energy proton showers.

20.16.2 Description.

Small porportional counter and associated electronics will record incident X-ray flux and spectra. This information will be recorded. If the flux exceeds a pre-set level, a warning device will be actuated, and the astronaut will take precautionary measures against the deleterious effects of possible high energy proton showers.

20.16.3 Importance of Test.

Manned orbiting missions in a polar orbit may receive lethal proton dosages. It is indicated that these showers may be preceded by sharp increases in solar X-ray emission. If this is the case, this experiment will demonstrate an excellent warning technique for astronauts.

20.16.4 Vehicle Requirements.

This equipment may be part of the space vehicle environmental monitoring equipment. If so the experiment will be dropped. It will require a telemetry channel for use only when the radiation exceeds a specified level.

Power: 100 watts

Volume: 1 ft^3

Weight: 10 lb

20.17 MATERIALS DEGRADATION AND MALFUNCTION ANALYSIS - EXPERIMENT S-17.

20.17.1 Objective.

The purpose of this experiment is to evaluate degradation and analyze any malfunction of MOL components and materials under actual space flight conditions. The spacecraft and its auxiliary equipment will be used as the object of the tests. The primary goal of this experiment is to determine the cause of failure or degradation, if it occurs. A secondary objective is to determine whether or not current strict specifications on materials and components can be relaxed without sacrifice in reliability. Maintenance and repair functions will be demonstrated by the astronaut.

20.17.2 Description.

Various subcomponents of the MOL vehicle will be tested at regular intervals for degradation and/or malfunction. These include bearings, thermal control surfaces, solar cells, lenses, windows, filters, mirrors and mating metal surfaces. Some carefully controlled sub-standard components will also be tested in order to evaluate the validity of current tight materials specifications, particularly in solar cells and thermal control equipment where the effects of sputtering, micro-meteoroid erosion and temperature effects will be observed and measured. Portions of other experiment equipment may be used. Recovered test samples will be used to correlate space and laboratory performance.

20.17.3 Importance of Test.

Degradation and minor malfunctions might occur which in themselves will not compromise the MOL mission. However, knowledge of their magnitude will permit optimization for missions of longer duration. The relaxation of current tight specifications could result in significant cost reduction for future MOL subsystems.

20.17.4 Vehicle Requirements.

Power:	100 watts
Volume:	.5 cu ft
Weight:	35 lb

20.18 MULTIBAND SPECTRAL OBSERVATIONS OF PLANETS - EXPERIMENTS S-18 (REV.)

20.18.1 Objective.

To measure portions of the IR radiation spectrum of terrestrial planets, Venus and Mars; to gain knowledge of the thermal and chemical structures of their atmospheres.

20.18.2 Description.

The equipment of P-10 is to be used to observe Venus and Mars. Scanning will be accomplished at low resolution over the entire spectrum available in the P-10 package. High resolution scans will be made in selected bands in the 3-4.5μ range (CO, N_2O, Sinton bands), and in the 7-15μ range (N_2O, CH_4, O_3, CO_2). Long integration times will be required, up to 30 minutes, requiring tracking either by the P. T. S. or possibly the star tracker.

20.18.3 Importance of Test.

The P-10 equipment provides a unique opportunity to obtain spectral measurements of Venus and Mars utilizing cooled, sensitive detectors. No such detectors have been planned for space experiments up to this time. An attempt was made on Stratoscope II to observe Mars with a helium cooled bolometer, at 80,000 ft; atmospheric absorption was found to be still great enough to be a serious problem. The test is of national significance, since plans are being laid to explore Venus and Mars by spacecraft. Atmospheric compositions are still not well known.

20.18.4 Vehicle Requirements.

No new equipment is required in addition to that for the primary experiments. The long term tracking technique requires further study.