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MOL Flight Test and Operations Plan

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FOREWORD

Although this initial issue of the Flight Test and Operations Plan may contain inaccuracies and deficiencies, it is being issued without further delay to provide top-level operational guidance to all contractors and government agencies who will be involved in the flight tests. Comments on this document are solicited from all recipients for use in improving planned future issues.

Subsequent updated information will be furnished as it becomes available or as operational concepts are evolved through the proceedings of the Flight Operations Planning Group. The Charter in Appendix C establishes this Group and defines its organization, functions, and responsibilities.

Col

J. S. Bleymaier, Major General USAF
for ~~Deputy~~ Deputy Director, MOL

CONTENTS

CONTENTS (Continued)

CONTENTS (Continued)

CONTENTS (Continued)

CONTENTS (Continued)

CONTENTS (Continued)

TABLES

TABLES (Continued)

FIGURES

FIGURES (Continued)

FIGURES (Continued)

FIGURES (Continued)

1.0 INTRODUCTION

1.1 PURPOSE

The Flight Test and Opertions Plan (FTOP) represents the current concept for the conduct of MOL flight tests and, as such, provides top-level operational direction to all contractors and government agencies developing plans for their participation in the MOL flight test operations. In this respect, the FTOP represents the MOL baseline for flight tests and is the basis for developing the details of subordinate operations documentation.

The FTOP also provides program management with an overview of the operational concepts and philosophies to be employed in the operation associated with the flight tests. Much of the detailed information contained in this FTOP is not yet available in lower-level documents and, hence, is included here for completeness.

1.2 SCOPE

The FTOP covers the flight operations from liftoff of the flight vehicle at the launch base through publication of final test reports. It also includes those activities required to prepare the flight operation support systems (simulations, rehearsals, system test, software validation, personnel training, etc.) prior to launch activity.

Although the FTOP is generally applicable to the total flight test program of seven flights, a typical manned/automatic flight is described in detail. Because it is most typical of these flights, Flight 4 has been chosen as baseline for this document. The most notable exception to this policy is in the area of System Test Objectives. Here, objectives of each flight category are listed to point out the differences between the flights and to illustrate how different objectives may modify the baseline operations concept. Details of operations peculiar to the unmanned flights will be added, as appropriate, after the definition phase of those flights.

1.3 DOCUMENT ORGANIZATION

Section 1.0 presents basic concepts and fundamental MOL flight configurations. Section 2.0 provides MOL program and first level flight-specific objectives. Section 3.0 provides gross overview of the roles and responsibilities of the operations organizations. Additional details and time-ordered functions for the operational periods are described in Section 4.0, Flight Plan. Sections 5.0 through 9.0 contain the details of the Launch Operations Interface, Flight Operations, Recovery Operations, Crew Operations, and Flight Test Data Evaluation, respectively. Sections 5.0 through 12.0 contain discussions of specialized topics.

Appendices provide further definition or rationale for critical operations concepts.

Major operational organizations are named for the functions they perform (i.e., Launch Operations, Powered Flight Operations, etc.). Similarly, the phases of the Flight Test are named for the major function occurring during that time period (i.e., Launch, Ascent, etc.). The reader must recognize that a distinction exists between organizations and Flight Test phases and that, in general, most of the organizations operate to some degree in all operational time phases. The approach in Sections 5.0 through 12.0 is to define the organization responsibilities across the entire Flight Test time framework.

1.4 DOCUMENT COMPLETION

It is currently planned that a revised and completed FTOP will be published approximately six months after the date of this publication and only if required thereafter. Detailed and current information will be contained in the Orbital Requirements Document (ORD), Program Requirements Document (PRD), Systems Test Objectives (STO), Manned Recovery Requirements Document (MRRD), etc. The Flight Operations Planning Group (FOPG) will be the group responsible for the FTOP.

1.5 SECURITY

All material is marked SSH and determination of what material can be used at the Secret SAR level has not been made. Until such time as an FTOP at the Secret SAR level is published, other program documentation must serve as a guide, where adequate. The reader is cautioned that much of the material in this document is restricted to covert channels, and contracts for major items such as the TRW MPE software do not even exist outside of covert channels.

1.6 BASIC CONCEPTS

1.6.1 General

The Systems Test Operations Plan (STOP) (Ref. 1) is the top-level program document which describes the basic program operational philosophy and objectives. From the STOP flow two basic test operations planning documents, the General Ground Test Plan (GGTP) and the Flight Test Operations Plan (FTOP).

Those concepts generally applicable to ground, acceptance, and prelaunch testing will be contained in the GGTP (Ref. 2). Those concepts will not be repeated here except where they impact upon flight operations. This Section contains any interpretations or expansions required to particularly make those concepts applicable to activities within the scope of the FTOP.

The approach to flight operations documentation is necessarily different from that to ground test documentation, primarily because the majority of the resources of the flight system are provided and operated by other agencies for use by all satellite programs.

The Air Force (SPO and AFSCF) also provide the operators for such MOL-peculiar functions as orbit analysis, mission planning, and command generation. The contractor role is primarily that of supporting the overall operation as well as certain specific contributions of hardware, software, procedures, reference materials and the like, as appropriate to its segment.

Concepts contained in the FTOP should be reflected in the ORD, PRD, STO, Flight Director's Handbook, and MRRD. The FTOP should serve as both the technical and administrative basis for these documents.

Basic to understanding the MOL operating philosophies is understanding the requirement for concurrent research and development (R&D) flight testing and operational utilization of the MOL system. Assuming understanding on the part of the reader with respect to R&D testing, it is necessary to explain the role of The User community and its interface with test operations.

The organizations desiring to obtain photography for operational use are designated "The User" within this document. The User has certain requirements of the system, which have been reflected in the MOL design (i.e., photographic resolution, photographic film load, software, and mission length). The User's operational requirements are recognized in the design of MOL operations.

The extent to which The User requirements are factored into the operation design, the operation, and the relationship of User and R&D objectives is best shown by an explanation of Figure 1-1 which is a simplification of the functional interactions involved.

a. This Figure assumes: that an initial orbit has been selected which has considered all factors described in paragraph 4.2 and which meets both User and R&D requirements; that a flight

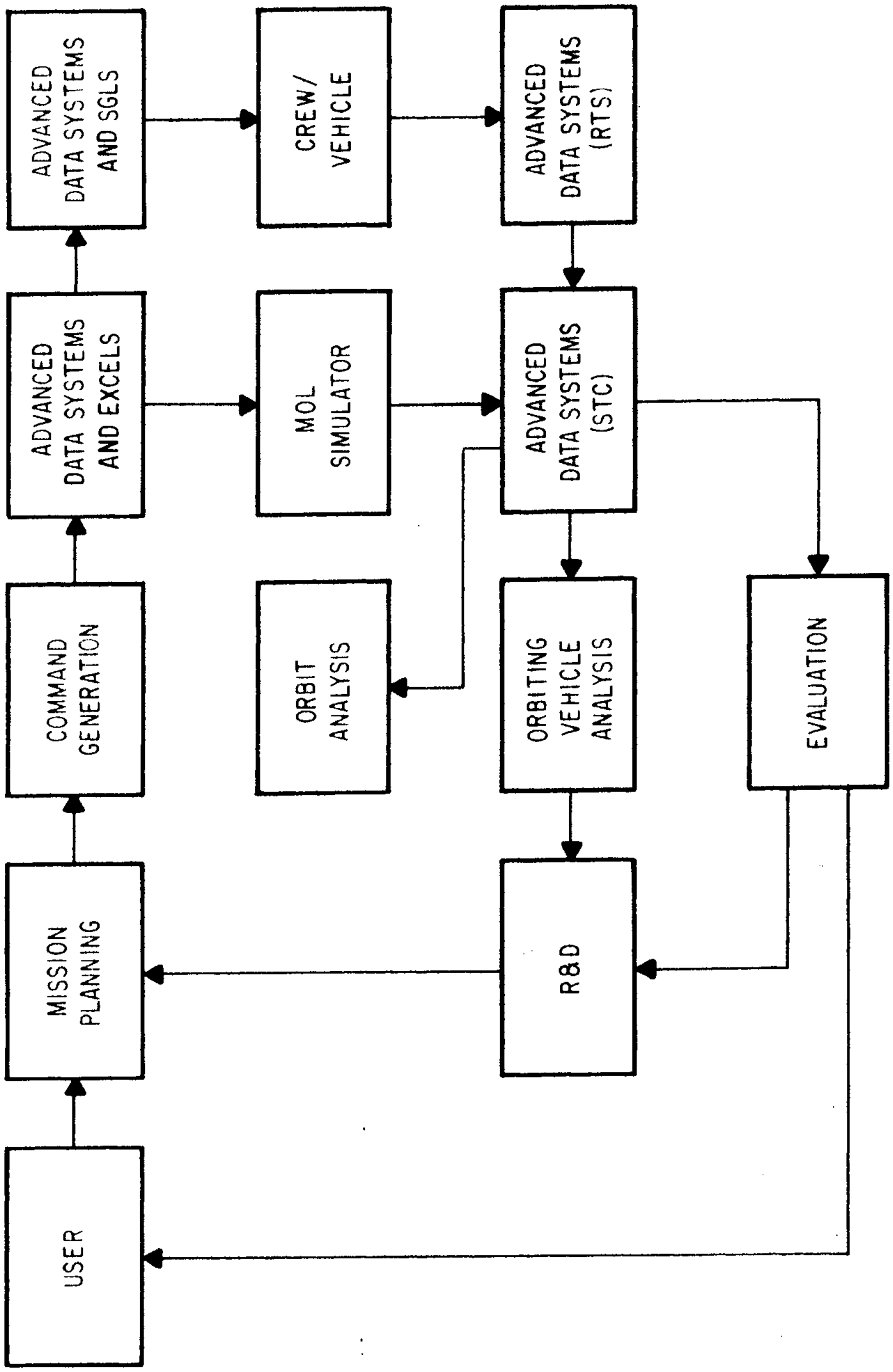

Figure 1-1 MOL System Functional Relationships

plan has been generated by the software; that a nominal launch has occurred and all subsystems are operational; and that payload operations are to begin the next few orbits.

b. The mission planning software considers The User and R&D requirements on the payload, and defines the photographic activity to occur on specified orbits.

c. The command generation software translates these requirements plus any other requirements into MOL command messages.

d. The advanced data system of the AFSCF [at both the Satellite Test Center (STC) and Remote Tracking Station (RTS)] through the expanded communications electronic system (EXCELS) and the space-ground link subsystem (SGLS) acts as a link to transmit these requirements to the MOL.

e. The crew and the MOL equipment respond to the commands and instructions and perform photographic and R&D operations. This activity produces on-board data consisting of telemetry voice commentary and film records. The film record is stored in the Gemini B for reentry with the flight crew. Evidence of what photographs have been taken is a part of the vehicle telemetry data.

f. The advanced data system (ADS), EXCELS, and SGLS again act as a transmission link between the MOL and the ground, providing telemetry, tracking, and voice data for analysis.

g. The telemetry and voice data are evaluated to determine: which targets have been photographed and how well; what resulted from R&D experiments or investigations; and the health status of MOL. Tracking data is analyzed to fulfill the MOL navigational requirements.

h. The evaluation of the photographic operations is reported to The User so he may realign target priorities and make new operational requirements on the system.

i. Completion of certain R&D objectives modifies the R&D requirements for subsequent orbital operations.

j. The cycle has been completed and is ready to start again.

In the development and testing of the operational system, the MOL Mission Simulator simulates the RTS and the orbiting vehicle (OV). It will be used to develop procedures and plans, check-out software, and rehearse personnel.

The above brief discussion is the concept upon which MOL Flight Operations are based. The purpose of the FTOP is to explain in greater detail the various operations functions, how these functions are allocated to organizations, and how the functions and organizations are interfaced.

1.6.2 Operations Planning Ground Rules

The seven-flight program will be considered primarily as an R&D program, although the third and subsequent flights are intended to produce valuable target intelligence. During flight, conflicts between the requirement to take photographs of actual targets and R&D efforts which cannot be otherwise accommodated (e.g., troubleshooting) to perfect manned or automatic mission equipment will be resolved by the Mission Director.

It is highly desirable to preserve the option to fly the last two flights manned. Operations planning shall accommodate this option.

1.6.2.1 Development Flights

Prior to the first manned flight:

a. The capability of the T-IIIM to safely place the fully functional manned MOL system into a nominal MOL orbit will be demonstrated by two unmanned flights.

b. One launch, reentry, and recovery of a full-mission-configured Gemini B will be successfully demonstrated.

c. One successful flight demonstration of the structural integrity of the laboratory vehicle will be accomplished.

A summary of flight No. 3 prerequisites is shown below:

a. Demonstrate T-IIIM Capability - Two T-IIIM flights to adequately demonstrate T-IIIM ability to place a manned/automatic MOL into orbit.

b. Demonstrate Laboratory Vehicle Structural Integrity - One successful flight of a laboratory vehicle structure to demonstrate structural integrity.

c. Demonstrate Gemini B Capability - One successful flight to demonstrate Gemini B ability to protect the crew during ascent, reentry, and retrieval.

1.6.2.2 Safety

Safety of personnel is paramount. Therefore, establishment of the spaceworthiness of the MOL system from a human safety viewpoint will take precedence over conduct of mission tasks, in the following order of priority:

a. The capability of MOL systems, subsystem, and components critical to the ability of the crew to successfully achieve orbit and to return safely shall be demonstrated prior to conduct of manned flight.

b. The capability of the OV to safely maintain the crew in the launch pad and ascent configuration and on-orbit, and to permit their safe return to earth in the Gemini B shall be assured prior to and during crew engagement in mission activity.

c. On-orbit failures of systems, subsystems, and equipments to the point where failure of an additional subsystem would preclude safe return of the crew will be cause for mission abort. (Failure of the transfer tunnel will necessitate EVA transfer from the Gemini B to the laboratory vehicle and return, but will not be cause for mission abort.)

1.6.2.3 Flight Planning

Flight test objectives are identified in Section 2.0. In preparing the MOL flight plan, the following ground rules apply to scheduling flight test objectives:

a. All primary objectives are to be accomplished at the earliest possible opportunity, consistent with their priority.

b. Objectives with lesser precedence may be scheduled ahead of higher ones if they better fit the flight plan at that point. Lower priority objectives, however, will not be attempted if they tend to compromise higher priority objectives.

The flight plan for each manned flight will include contingency provisions which will ensure maximum beneficial utilization of crew duty time in furtherance of program objectives, by priority, in the event that in-flight failure precludes adherence to the nominal flight plan.

1.6.2.4 Abort

Failure of man-related components during orbital test or inability of the crew to perform assigned tasks (where such failures do not involve crew safety) will not be cause for abort, as long as useful intelligence is being produced by the photographic reconnaissance payload or other primary objectives may be accomplished.

1.6.3 Laboratory Vehicle Disposal

After completion of the primary and extended mission in the manned or automatic mode, the laboratory vehicle for the manned/automatic mode (OV for automatic mode) will be deorbited into an open ocean area by applying retro thrust to the laboratory vehicle (or OV) at a predetermined point. It is possible that some time constraints may be associated with disposal, but they are not yet identified.

The most important reason for a controlled deorbit into an open ocean area is to prevent the camera cues and other payload equipment from being compromised. Equipment surviving a reentry would be burned but might be recognized as a camera optical system. If a natural decaying laboratory vehicle (or OV) were tracked to impact on or near any land area, a determined effort would be made by others to find the remains for political and security reasons. In the event of an abort during ascent, forces will be deployed to ensure retrieval or destruction of the mission payload.

1.7 MOL SYSTEM CONFIGURATION

1.7.1 General

A description of the flight 3 configuration and the significant differences between flight 3 and the other flights are presented in Table 1-1. The flight vehicle configuration is shown in Figure 1-2.

The development flights consist of two flights to prove the capability of the T-IIIM to orbit a MOL, to prove the laboratory vehicle structural integrity, to prove the capability of the Gemini B to protect the crew during ascent, reentry, and retrieval, and to provide MOL operational experience to ground support organizations.

The first flight will be launched into orbit by a T-IIIM with T-III standard payload fairings ballasted to simulate the weight of an operational MOL.

The second flight will employ a T-IIIM, a laboratory vehicle structure simulating the weight, CG, and dynamics of a flight-article laboratory vehicle, and an unmanned Gemini B. This flight will be suborbital and will provide ascent environmental data for the Gemini B and laboratory vehicle, and reentry environmental data for the Gemini B. The Gemini B will be retrieved, affording a demonstration of the Recovery Force operation.

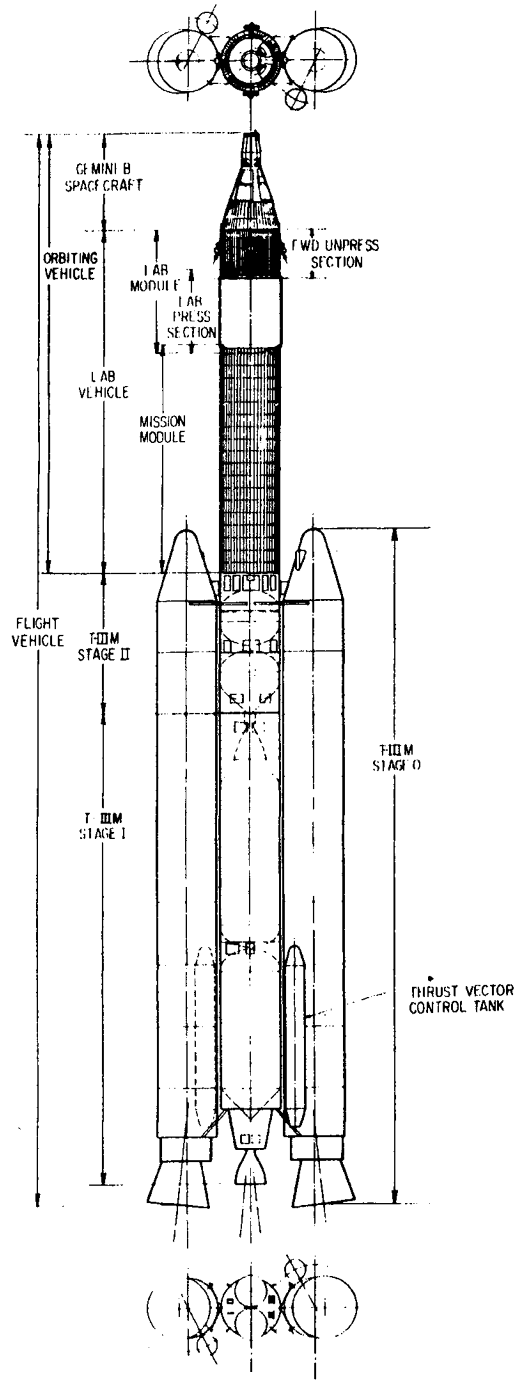

Figure 1-2 MOL Flight Vehicle

The Operational/Development flights consist of five flights. Flights 3 through 5 will be manned/automatic, while flights 6 and 7 will be fully automatic. The purpose of these flights is to gather photographic reconnaissance data and to develop the system to full operational capacity.

Table 1-1. Summary of MOL Configuration Requirements

	Dev Flt 1	Dev Flt 2	Flts 3-5	Flts 6-7
Launch Vehicle - T-IIIM				
R&D Instrumentation (to obtain aero-mechanical and thermal environment data)	X	X	X	X
Standard T-III Payload fairings	X	-	-	-
Ballast Simulating FV Weight	X	-	-	-
Gemini B				
Operational (manned)	-	-	X	-
Unmanned	-	X	-	-
Two Crewmen	-	-	X	-
Delete Crew Seats	-	X	-	-
R&D Instrumentation (to obtain aero-mechanical and thermal environment) (add weights to simulate manned weight CG and dynamics)	-	X	-	-
Laboratory Vehicle				
Manned/Automatic Configuration	-	-	X	-
Automatic Configuration	-	-	-	X
R&D Instrumentation (to obtain aero-mechanical and thermal environment data)	-	-	X	X
Substitute Laboratory Vehicle Structure simulating flight article weight, CG, and dynamics	-	X	-	-

Table 1-1. Summary of MOL Configuration Requirements (Continued)

	Dev Flt 1	Dev Flt 2	Flts 3-5	Flts 6-7
Mission Payload				
Manned/Automatic Operational Configuration (includes secondary camera and film)	-	-	X	-
Automatic Configuration (Support Module)	-	-	-	X
Boilerplate (no operational equipment but ascent environmental data mass simulated in mission module)	-	X	-	-
Support				
AFSCF Orbital Support	-	-	X	X
RCG Support for DRV	-	-	-	X
DDMS				
Manned MOL Recovery Configuration	-	-	X	-
Ascent Abort Configuration only	-	X	-	-

2.0 FLIGHT TEST OBJECTIVES

2.1 INTRODUCTION

Detailed objectives and test philosophy presented in this Section are derived from MOL Program objectives and constraints described in paragraph 2.2. They will be used as the basis for the development of more specific flight test objectives to be presented in STO documents. Guidance for the development of these documents is also furnished.

The baseline used in establishing the objectives presented assumes a fully successful seven-flight program and is constrained by the ground rules shown in paragraph 1.6.2. In addition, the objectives of each flight series have been established so the total program will be conducted in a logical sequence to insure that:

a. By the end of the flight program, all flight objectives (including tertiary objectives) will be successfully achieved, to the extent possible.

b. The individual tasks assigned for accomplishment within each flight, and from flight to flight, are conducted in a progressive sequence of tasks and flights, first in establishing space worthiness qualification of the basic MOL system, and thence through progressive accomplishment of program objectives in accordance with their respective priorities.

c. Loss of a flight or flights (e.g., through gross failure) will have minimum adverse impact on accomplishment of the primary General Test Objectives.

In consonance with the above philosophy, the general objectives, configuration, and flight profile for the individual flights are summarized in Table 2-1.

Table 2-1. General Objectives, Configuration, and Flight Profile for Individual Flights

Flight Series	General Objective	Configuration	Profile
Development Flight No. 1	Demonstrate T-IIIM.	T-IIIM and fairing. Simulated OV (ballast).	Orbital.
Development Flight No. 2	Demonstrate T-IIIM. Demonstrate laboratory vehicle structure. Qualify Gemini B.	T-IIIM. Laboratory vehicle structure. Unmanned Gemini B.	Suborbital; Gemini B retrieval.
Manned/Automatic Flight No. 3 Flight No. 4 Flight No. 5	High-resolution photography. Assess man's contribution. Demonstrate 30-day capability.	T-IIIM. Manned laboratory vehicle. Manned Gemini B.	Orbital; 30-day mission; Gemini B retrieval & laboratory vehicle disposal.
Automatic- Flight No. 6 Flight No. 7	High-resolution photography. Demonstrate maximum duration mission capability (up to 60 days).	T-IIIM. Automatic laboratory vehicle. Support module with 6 DRVs.	Orbital; 30-60 days; DRV recoveries & OV disposal.

2.2 GENERAL FLIGHT TEST OBJECTIVES

The following MOL program objectives and constraints, extracted from the SP/DR (Ref. 20), were used as a guide for preparation of this FTOP and are presented below for information.

2.2.1 System Objectives

a. The MOL program shall provide a capability for stereo photographic reconnaissance, to include both manned/automatic and automatic operations, with a probability of 30-day mission effectiveness of 0.85 for the manned/automatic system and 0.63 for the automatic system.

b. The MOL program shall provide a system capability [redacted] resolution photography with 2:1 contrast under conditions of light providing 890 ft lamberts at the aperture for targets at nadir from an 80 n mi orbit. Satisfaction of this requirement presupposes the availability of 3404 type film with an exposure index of 6.

c. The manned/automatic system shall have the capability for a mission duration of 30 days on the baseline orbit with a two-man flight crew.

d. The laboratory vehicle for the manned/automatic system shall provide a capability for a shirtsleeve environment for the 30 days.

e. The automatic system shall have the capability for a mission duration as long as possible within the capabilities of the manned/automatic system hardware with available or augmented expendables and consistent with launch vehicle capabilities. The automatic system shall be qualified for 30 days.

f. An orbital inclination capability of 80 to 100 deg shall be provided. The nominal orbit shall be at 90 deg inclination and 80 n mi perigee altitude.

g. The system shall provide the capability for access to arbitrarily located targets anywhere on the sunlit surface of the earth between 80 deg S and 80 deg N latitude at least three times during a 30-day mission.

h. The manned/automatic system shall provide the capability to expose 15,000 frames during the 30-day mission and to maximize cloud-free photography (in accordance with User requirements).

i. The automatic system shall provide the capability to expose 500 frames per day and to maximize cloud-free photography (in accordance with User requirements).

j. To the extent possible, the manned/automatic system shall provide the capability for early development of the automatic mission capability and the enhancement of the quality and quantity of intelligence data in the manned/automatic system.

k. System capability shall provide for one launch every four months.

l. The MOL system shall be capable of responding to a redirection of the planned operational orbit, within the design constraints on inclination and altitude, as late as seven days prior to a scheduled launch.

m. Information derived from the manned/automatic operations shall be used to assess the usefulness of man in the development and operation of reconnaissance space systems.

2.2.2 Safety Objectives

a. The design philosophy in terms of redundant systems and backup modes shall be such that, where practicable, no single failure will cause mission abort or crew fatality.

b. Crew safety, where measurable, shall be equivalent to that predicted for the NASA Gemini program. An abort capability shall be provided for all phases of flight, where practicable.

c. Biomedical monitoring shall be provided for assurance of crew safety and an indication of crew capability limits.

2.2.3 System Constraints

a. Maximum use shall be made of existing man-rated subsystems, components, and facilities.

b. The automatic system shall have maximum commonality with the manned/automatic system.

c. The basic launch vehicle to be utilized for the MOL shall be the Titan IIIM which is a Titan IIIC with minimum necessary changes and uprating to meet the MOL requirements for orbit, payload, and safety.

d. The Gemini B shall be utilized for crew transport during ascent and for return of the crew at mission termination. The Gemini B shall be derived from the NASA Gemini spacecraft through minimum modifications.

e. Mission Control shall utilize the Air Force Satellite Control Facility (AFSCF).

f. The recovery force shall be comprised of sea, land, and air units and specialist teams in such quantities and at such locations in the recovery area or appropriate bases as necessary to effect retrieval of the spacecraft and crew or the data recovery vehicles (DRVs). Such sources shall be provided from existing government sources, wherever possible and practicable.

g. Upon mission completion or ascent abort, the laboratory vehicle shall be disposed of in the ocean to avoid compromise of intelligence information.

h. All MOL launches shall be from Vandenberg Air Force Base (VAFB) using a single launch pad.

i. The initial MOL system capability shall be based on integral launches of the crew and laboratory.

j. Prior to the first manned flight, two launch vehicle flights including one Gemini B flight shall be made to contribute to a man-rated system.

k. Security shall be maintained to prevent compromise of classified information.

l. For the manned/automatic system, capability shall be provided to return intelligence data in the Gemini B reentry module (REM).

m. For the automatic system, capability for intelligence data recovery shall be provided by using a support module, in place of the Gemini B, with sufficient DRVs to allow for return no less often than one every 10 days.

n. The manned/automatic system shall provide the capability to accept a wideband readout system and one Mk V DRV for follow-on vehicles.

o. The simulation program shall be adequate to support development and to provide training for the crew and support personnel to insure crew safety and mission success but shall minimize the required amount of new and specialized simulation equipment.

p. Postflight evaluation will be carried out with data provided for real-time systems management; no special AVE shall be provided for this purpose alone.

q. The ground maintenance concept shall be one of replacement of components and small assemblies for repair at factory without major vehicle disassembly. On-orbit crew maintenance shall be utilized to enhance system reliability and mission effectiveness.

2.3 DETAILED FLIGHT TEST OBJECTIVES

The detailed flight test objectives presented in Tables 2-2 through 2-13 are organized by flight series and represent a first order of detail beyond that contained in paragraph 2.2. More specific objectives, on a flight-by-flight basis, will be developed and presented in a series of STO documents.

Tables 2-2 through 2-13 identify each objective as primary, secondary, or tertiary. These categories, when related to detailed objectives, are defined as follows:

a. Primary Test Objectives - Accomplishment of these objectives is considered mandatory.

Primary test objectives are those for which a flight test is conducted and must not be compromised by any discernible inadequacy of airborne or ground equipment. Any malfunction of test vehicle or system equipment which would jeopardize the attainment or means of evaluating a primary objective will demand holding, recycling, or terminating the launch countdown. In addition, any tendency toward malfunction of equipment, worsening of weather conditions, or change of Range status that could in any manner jeopardize the accomplishment of a primary objective will demand delaying the flight.

b. Secondary Flight Test Objectives - Accomplishment of these objectives will provide substantive information to validate decisions affecting the future of the military space program (e.g., the nature of a follow-on MOL program, manned/automatic considerations, new missions, etc.). These objectives are secondary only because their accomplishment may not interfere with accomplishment of the primary objectives.

Secondary flight test objectives are of vital concern to research and development of the system or to malfunction analysis, but not of vital concern to the attainment of a primary objective. If a secondary objective or its means of evaluation appear to be in jeopardy at any time prior to a specific point in the countdown, the countdown will be held, recycled, or terminated to resolve the difficulty. Once past the specified point, the countdown will be continued and a final determination of whether to hold or recycle will be made during the final countdown evaluation.

c. Tertiary Flight Test Objectives - These objectives will provide valuable information pertaining to general military and scientific space technology and are to be accomplished only on the basis of non-interference with primary and secondary test objectives.

Tertiary flight test objectives contribute to design research, environmental research, associated projects, or a supporting engineering effort. There will be no count-down delay, hold, or recycle to assure the accomplishment of a tertiary objective.

Table 2-2. Detailed Flight Test Objectives, Launch Vehicle

No.	Objective	For Flight Series			
		Development			
		1	2	3,4,&5	6&7
1.1	Demonstrate the capability of the T-IIIM to provide the necessary functions required to safely inject the MOL vehicle into the planned orbit.	P	P	P	P
1.2	Evaluate the capability of the redundant flight control system to perform within design requirements.	P	P		
1.3	Demonstrate the capability of the booster inertial guidance system (BIGS) to perform within design requirements.	P	P		
1.4	Evaluate the capability of Stage 0/I/II systems to perform within design requirements.	P	P		
1.5	Evaluate the malfunction detection system (MDS) capability to perform within design requirements.	P	P		
1.6	Demonstrate 0/I, I/II staging and separation.	P	P		
1.7	Verify that the environmental conditions experienced during launch and ascent are within design limits.	S	S	S	S
1.8	Evaluate the proper operation of the launch vehicle instrumentation and telemetry systems.	S	S		

Legend: P = Primary S = Secondary T = Tertiary

Table 2-2. Detailed Flight Test Objectives, Launch Vehicle (Continued)

		For Flight Series			
		Development			
No.	Objective	1	2	3,4,&5	6&7
1.9	Evaluate the proper performance of the flight safety system.	S	S		
1.10	Demonstrate laboratory vehicle and T-IIIM separation	P			

Legend: P = Primary S = Secondary T = Tertiary

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Table 2-3. Detailed Flight Test Objectives, Gemini B

No.	Objective	For Flight Series			
		Development			
		1	2	3,4,&5	6&7
2.1	Demonstrate the capability of the Gemini B to withstand the typical MOL flight environment (including launch, ascent, reentry, and retrieval).		P		
2.2	Evaluate the capability of the Gemini B subsystems to perform within design requirements.		P		
2.3	Evaluate the compatability of the interfaces between the Gemini B and the T-IIIM, the laboratory vehicle structure, the AGE, and supporting ground systems.		P		
2.4	Demonstrate the capability of the Gemini B to properly protect the crew throughout all phases of the flight and to safely return the crew and payload data in accordance with design requirements.			P	
2.5	Demonstrate the compatibility of the interfaces between the Gemini B and the manned configuration of the laboratory vehicle.			P	
2.6	Verify the capability of the Gemini B to repressurize while on orbit and to survive in a quiescent mode for mission duration.			P	
2.7	Determine the effect of dispersions on the location of impact point.		S		

Legend: P = Primary S = Secondary T = Tertiary

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Table 2-3. Detailed Flight Test Objectives, Gemini B (Continued)

No.	Objective	For Flight Series: Development 1	Development 2	3,4,&5	6&7
2.8	Validate crew transfer procedures.			S	

Legend: P = Primary S = Secondary T = Tertiary

Table 2-4. Detailed Flight Test Objectives, Support Module

No.	Objective	For Flight Series: Development 1	Development 2	3,4,&5	6&7
3.1	Demonstrate the ability of the DRV and support module to load, record, cut and seal the film, and perform bucket transfer in serial fashion for the full complement of DRVs.				P
3.2	Demonstrate capability of the DRV and support module to maintain film chute and tunnel pressure for the full mission, and to seal the film transport tunnel without catastrophic pressure loss as the DRVs are filled and ejected.				P
3.3	Demonstrate the system capability to eject and successfully deorbit the DRVs from the support module.				P
3.4	Demonstrate the system capability to program the sequencing of the DRVs in the event of early calldown or malfunction of the DRVs or of the navigation and control subsystems.				S
3.5	Demonstrate capability to provide mechanical and thermal environment for DRVs throughout mission.				P

Legend: P = Primary S = Secondary T = Tertiary

Table 2-5. Detailed Flight Test Objectives, Laboratory Vehicle

		For Flight Series			
		Development			
No.	Objective	1	2	3,4,&5	6&7
4.1	Demonstrate the laboratory vehicle structural integrity in a typical flight environment.		P		
4.2	Demonstrate adequate crew accommodations and protection for a 30-day mission.			P	
4.3	Verify the performance of subsystems to meet overall system requirements.			P	P
4.4	Demonstrate adequate provisions for loading and transfer of DRCs to Gemini B to permit return of data packages to earth.			P	
4.5	Demonstrate the capability of complete automatic operation.			P	P
4.6	Demonstrate the system capability to perform the required maneuvers associated with deorbit of the DRVs from the support module.				P
4.7	Demonstrate the controlled disposal of the laboratory vehicle.			P	P

Legend: P = Primary S = Secondary T = Tertiary

Table 2-5. Detailed Flight Test Objectives, Laboratory Vehicle (Continued)

No.	Objective	For Flight Series			
		Development			
		1	2	3,4,&5	6&7
4.8	Determine maintainability of subsystems by demonstrating:				
	Malfunction indication, detection, and isolation.				
	Adequacy of redundant systems and switchover mechanism.				
	Adequacy of spares.				
	Capability to adjust, replace, and/or repair.			S	S
4.9	Demonstrate the capability of the mission termination subsystem to program and provide for the successful deorbiting of loaded and partially loaded DRVs in the event of system failure of attitude control and/or command, control, and telemetry subsystem.				S

Legend: P = Primary S = Secondary T = Tertiary

Table 2-6. Detailed Flight Test Objectives, Mission Payload

No.	Objective	For Flight Series			
		Development			
		1	2	3,4,&5	6&7
5.1	Demonstrate the capability to obtain photography of preselected targets [redacted] resolution operating in either the manned/automatic or the automatic mode.			P P	P
5.2	Demonstrate the structural integrity and proper operation of the mission payload throughout the: (1) 30 day flight (2) 30-60 day flight.			P	P
5.3	Demonstrate the capability of the secondary camera and on-board processing systems to meet system requirements.			P	
5.4	Demonstrate the operation of the facilities provided for film handling, storage, and loading.			P	
5.5	Demonstrate the capability of the on-board computer software to accurately point the primary optics and ATSs as commanded by the ground software.			P	P
5.6	Evaluate the IVS as a means of inhibiting photography of weathered targets.			P	P
5.7	Perform an R&D investigation of the tracking mirror roll gimbal bearing stiction problem.			S	S
5.8	Evaluate man's ability to speed system development.			P	

Legend: P = Primary S = Secondary T = Tertiary

Table 2-7. Detailed Flight Test Objectives, Flight Crew

No.	Objective	For Flight Series: Development 1	Development 2	3,4,&5	6&7
6.1	Quantitatively evaluate the nature and value of man's ability to increase the intelligence quality and quantity of the collection system by:			P	
	Operating the secondary camera using various types of film.				
	Performing adjustments to insure peak performance of MOL system equipments.				
	Demonstrating the ability to load DRCs, transfer them to the Gemini B, and return them from orbit.				
	Demonstrating the ability to reprogram the mission based on mission progress and updated data and commands furnished from the ground.				
	Demonstrating the ability to divert the optics from the pre-planned target to a pre-selected alternate target because of weather coverage of the primary, or significant activity at an alternate.				
	Demonstrating the ability to update ADC data to compensate for errors in ephemerides and target geographical position.				

Legend: P = Primary S = Secondary T = Tertiary

Table 2-7. Detailed Flight Test Objectives, Flight Crew (Continued)

No.	Objective	For Flight Series: Development 1	Development 2	3,4,&5	6&7
	Taking corrective action to compensate for malfunctions of laboratory vehicle or mission module equipment.				
	Making voice recording of significant intelligence information obtained through visual observation during target passes.				
6.2	Demonstrate man's ability to transfer from the Gemini B to the laboratory vehicle, work in shirt-sleeve environment for a 30-day mission, retransfer to Gemini B, and effect safe reentry and retrieval of crew and mission data.			P	
6.3	Verify the adequacy of man's interface with the MOL system during conduct of the reconnaissance mission in both manual and automatic modes.			P	
6.4	Verify the adequacy of target cueing material and method of display for target acquisition and pointing, considering the study time constraints.			P	
6.5	Assess the effectiveness of man to increase the quantity and quality of information by conserving film through judicious target selection.			P	
6.6	Measure man's well being, effectiveness, and operational techniques involving the man-machine interface.			S	

Legend: P = Primary S = Secondary T = Tertiary

Table 2-7. Detailed Flight Test Objectives, Flight Crew (Continued)

No.	Objective	For Flight Series: Development 1	Development 2	3,4,&5	6&7
6.7	Verify the ability to perform extravehicular activity (EVA) as required by actual contingency situations.			T	

Legend: P = Primary S = Secondary T = Tertiary

Table 2-6. Detailed Flight Test Objectives, Pressure Suit Assembly

No.	Objective	For Flight Series: Development 1	Development 2	3,4,&5	6&7
7.1	Verify the adequacy of the pressure suit (pressurized and unpressurized) for routine intra-vehicular operation in the following areas:			P	
	Thermal, pressure, partial gaseous flow, communications, telemetry data.				
	Don-doff and checkout for emergency operation.				
	Maintainability for 30 days operation.				
	Mobility for routine use.				
7.2	Verify the adequacy of the pressure suit with respect to:			S	
	Mobility for emergency use.				
	Storage accessibility.				
	Suit/laboratory module interfaces.				
	Suit tethers and attachments interfaces.				
7.3	Verify the adequacy of the pressure suit for EVA should an actual contingency present the requirement.			T	

Legend: P = Primary S = Secondary T = Tertiary

Table 2-9. Detailed Flight Test Objectives, Flight Operations

No.	Objective	For Flight Series: Development 1	Development 2	3,4,&5	6&7
8.1	Demonstrate the capability of the MCC personnel, procedures, and equipment to perform the required control functions during ascent and powered flight.	P	P	P	
8.2	Verify the MCC/STC interfaces.	P	P	P	P
8.3	Evaluate the ability of the MCC to perform real time, slow malfunction detection until loss of radar and telemetry data.	S	P	P	
8.4	Demonstrate the capability of the AFSCF to properly support MOL powered flight operations.	P	P	P	P
8.5	Demonstrate ability of the AFWTR to provide continuous telemetry data and GERTS tracking data (from Stage I ignition until LOS) to the STC.				S
8.6	Demonstrate the capability of the AFWTR, the PRM, and the MIS to receive, process, and transmit to the AFSCF those data required for ascent monitoring.	P	P	S	S

Legend: P = Primary S = Secondary T = Tertiary

Table 2-9. Detailed Flight Test Objectives, Flight Operations (Continued)

No.	Objective	For Flight Series: Development 1	Development 2	3,4,&5	6&7
8.7	Demonstrate the capability of the MCC/STC personnel, procedures, and equipment to perform the necessary orbital control functions for (1) a 30 day flight; and (2) a 30 to 60 day flight.			P	P
8.8	Verify the proper operation of the MCC/STC interfaces.			P	P
8.9	Demonstrate the capability to interface with the SOC to receive target requests, and keep The User informed of progress in meeting these requests.			P	P
8.10	Demonstrate the MCC capability to support the secondary photographic objectives.			S	S

Legend: P = Primary S = Secondary T = Tertiary

Table 2-10. Detailed Flight Test Objectives, Recovery Operations

No.	Objective	For Flight Series			
		Development			
		1	2	3,4,&5	6&7
9.1	Demonstrate the recovery of the Gemini B REM or multiple DRVs within specified times and without damage to the recovered object or its contents.		P	P	P
9.2	Demonstrate the capability of the MCC personnel, procedures, and facilities to properly control recovery functions.		P	P	P
9.3	Verify the MCC/Recovery force interfaces required for contingency recovery operations during ascent and for normal recovery operations.		P	P	P
9.4	Verify adequacy of medical facilities and procedures for end-of-mission assessment of flight crews.			P	P
9.5	Validate procedures for handling DORIAN mission data recovered.			P	P
9.6	Retrieve the R&R section.		S		
9.7	Retrieve the Gemini B main parachute.		S		

Legend: P = Primary S = Secondary T = Tertiary

D ~~SECRET~~ SPECIAL HANDLING

2.4 SYSTEM TEST OBJECTIVES DOCUMENTS

An STO document will be published for each flight test. The basic purpose of the STO will be to:

a. Inform the participating test agencies of the specific objectives of the flight test.

b. Provide the Flight Director with a planning basis for making real-time decisions on program priorities and tradeoffs.

c. Provide a basis for evaluating the results of the flight test.

The following paragraphs provide guidance as to development and minimum content of the individual flight STOs.

2.4.1 Document Content

a. Vehicle Configuration - Each STO will include a description of the flight vehicle (FV) configuration that is complete enough to identify the system to be flown. This will include vehicle and subsystem description to the level of significant block diagrams or drawings, where warranted.

b. Test Objectives - This section of the STO will develop the test objectives presented in the FTOP to a greater level of detail. The objectives will be classified as primary, secondary, and tertiary, using the definitions of paragraph 2.3. The criteria for satisfactorily meeting each objective will be stated. Each test objective will be correlated to those parametric data points necessary to determine flight vehicle performance and to assess the degree to which the performance meets the acceptance criteria.

Data points will be categorized as primary or secondary. Primary points are those points which most readily show the level of performance (usually those data points that are needed to verify the test objective). Secondary points are those data points which may be used in lieu of the primary points, if necessary, to determine performance. The use of secondary points is usually not as desirable due to more involved analyses or possible loss in accuracy. Redundancy of data points will be shown for both primary and secondary points, as applicable. Redundancy exists only where there is no difference in the manner of analysis, degree of accuracy, or preference between two points. If tertiary points exist, this fact should be shown, but no special effort to develop tertiary points will be made. Data points will be identified by number and title.

The range over which the data points may vary and the engineering units will be specified.

The phase of the operation during which the objective must be evaluated will be stated as well as the interval of time, distance, or the event over which the measurement must be observed.

c. Flight Plan - The STO will contain a description of the flight plan to include the specific constraints for the flight by phase (i.e., launch, ascent, orbit, reentry, retrieval).

d. Flight Data - The STO will provide details on data handling, format, and distribution (further information on this requirement is included in Section 9.0). Test-peculiar telemetry and instrumentation schedules cross-referenced to identify specific test objectives with each point will also be shown. This section should also contain a list of the launch and AFSCF facilities required to be operational for launch.

e. Appendices - As appended data, the STO will include a glossary of definitions and abbreviations and a list of referenced documents.

3.0 OPERATIONS ORGANIZATION AND RESPONSIBILITIES

3.1 GENERAL

This Section presents the overall MOL operations organization and the functions to be performed by the organizational elements. It depicts the Mission Director's (MD) role and his interface with his subordinate directors and provides a description of the functions performed under each director. The functions are organized to indicate the sub-organizational responsibilities as a function of operational phases.

Flight Operations interface operating procedures among the MOL SPO, AFSCF, and associates will be established and controlled by the Director of MOL Test Operations through the Flight Operations Planning Group.

3.2 MISSION DIRECTION

Mission direction is the real-time operational direction provided by the MOL Program Deputy Director in the conduct of an operational test of the MOL system. In this capacity, the MOL Program Deputy Director (or his designated representative) acts as the MD. The operational interface of the MD are shown in Figures 3-1 to 3-3.

3.2.1 Responsibilities

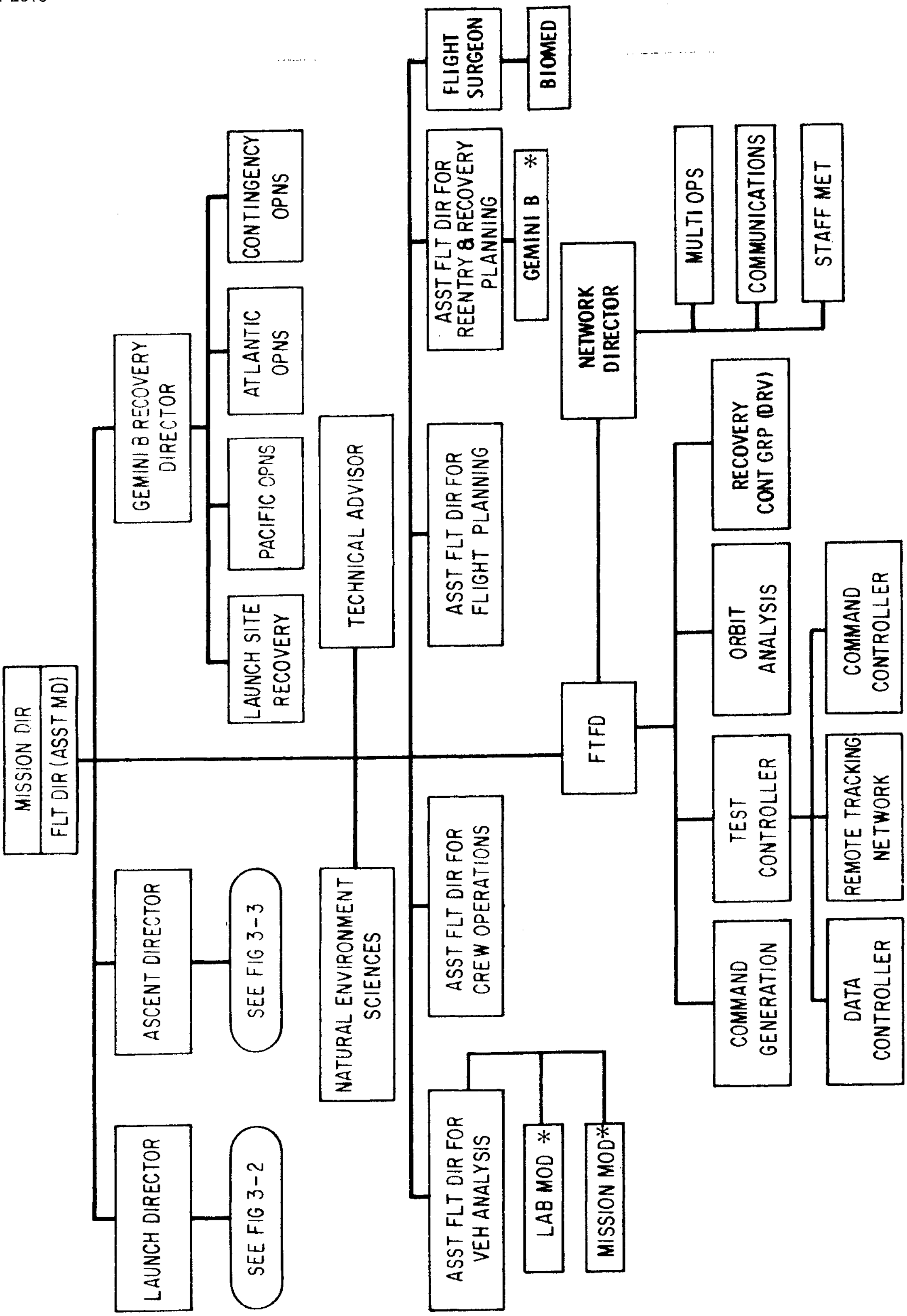
3.2.1.1 Real-Time Control

The limits of authority within which the Launch and Flight Directors (LD and FD) may operate will be defined by MOL Program Directives and policy decisions prior to an operational test. These limitations are delineated in the appropriate Director's Handbooks. The MD has the overall responsibility for the operational test of the MOL system.

The MD must assure that he has proper visibility of the operation to recognize that the Launch, Ascent, Gemini B Recovery, and FD are operating within the bounds of their authority. Also, he must be sufficiently informed on all aspects of the operation to make judgments and render real-time decisions on matters outside the purview of the directors.

3.2.1.2 Flight Readiness Determination

Prior to each flight, MOL system readiness must be established by the MOL System Readiness Review Board (Ref. 1). The MOL Flight Vehicle Technical Readiness Program (Ref. 21) will encompass factory and VAFB activity from assembly through factory testing, acceptance, VAFB launch operations, and launch of the MOL flight vehicle. The Flight Readiness Program will encompass all AFSCF and OTEF flight test and operations activities including ground hardware, software, and operations personnel, as well as the flight crew.



* INCLUDES ASSOCIATE CONTRACTOR SUPPORT PERSONNEL

Figure 3-1 Operations Organization

D-~~SECRET~~ SPECIAL HANDLING

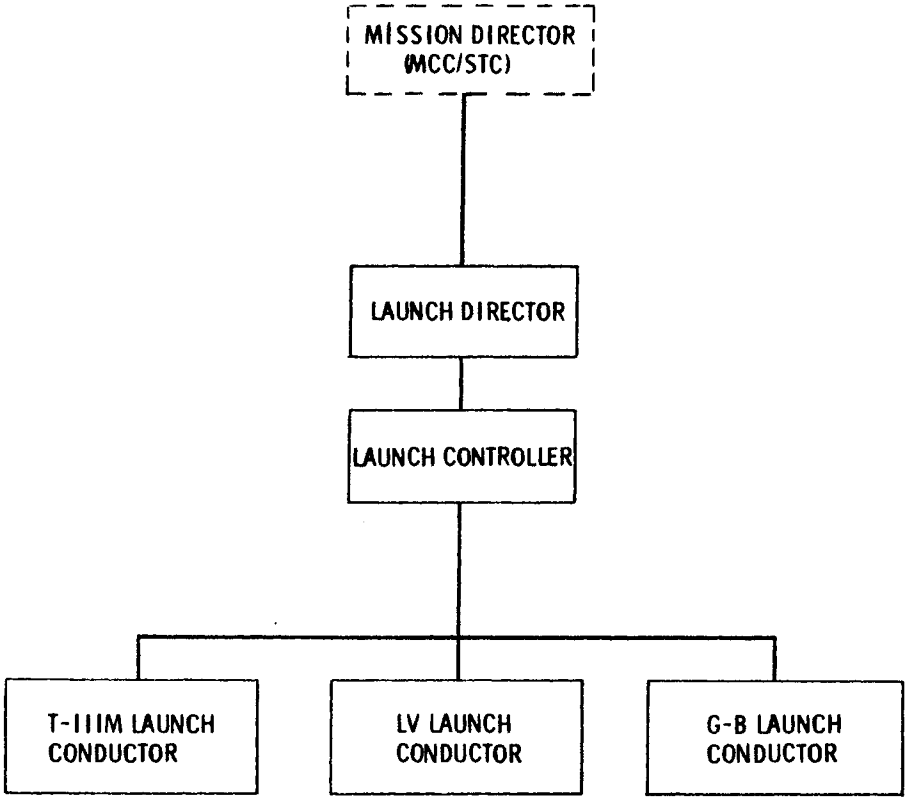


Figure 3-2 Launch Director Organization

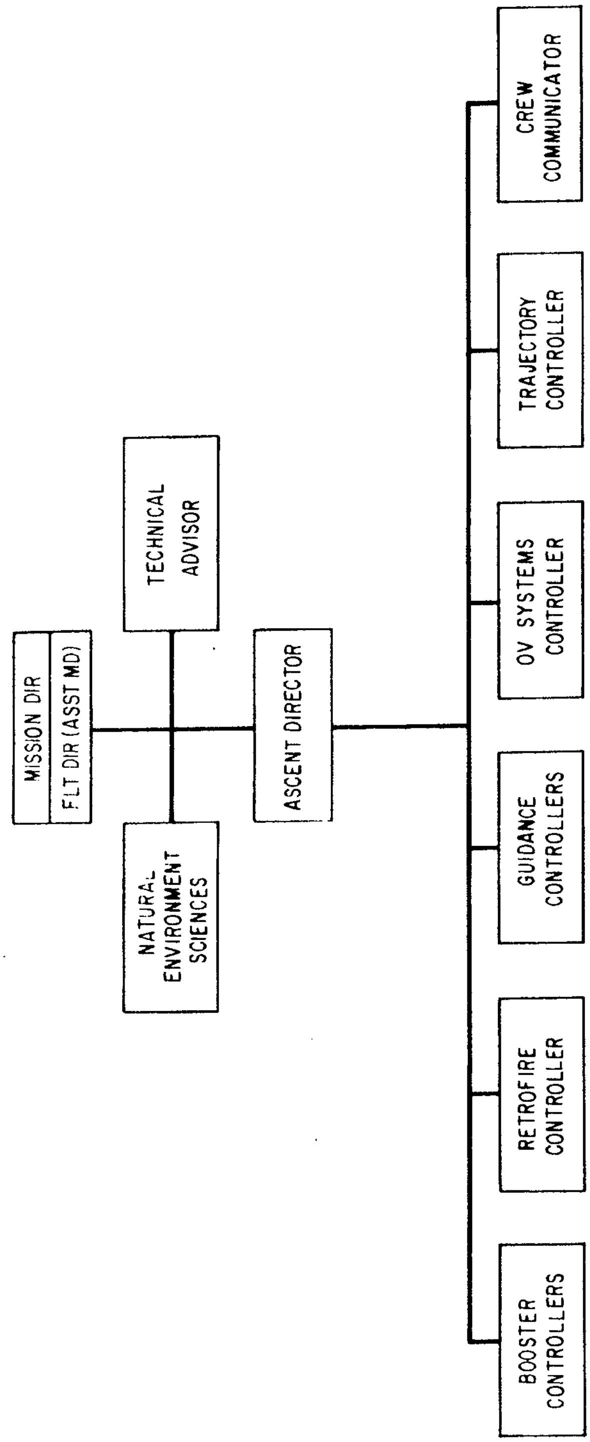


Figure 3-3 Ascent Director Organization

Flight readiness culminates in the Flight Readiness Review conducted by the MOL Flight Readiness Review Board. On approximately Launch Day minus one (L -1), each responsible operations organization or agency is represented and presents its readiness report:

a. The Ascent Director (AD) reports on the state of readiness of the MCC hardware, software, and personnel to support powered flight.

b. Assistant Flight Directors (AFDs) for Vehicle Analysis, Crew Operations, Flight Planning, Reentry and Recovery Planning report the state of readiness for their respective areas of responsibility.

c. FTFD reports the status of the AFSCF capabilities and reports the state of AFSCF readiness to support the flight.

d. The Gemini B Recovery Director (DDMS) reports the status and level of readiness of the recovery forces to support abort, normal, and contingency recovery.

e. The command pilot reports on flight crew readiness and crew assessment of the other reports given.

f. The chief flight surgeon reports on the physical and psychological readiness of the flight crew.

g. The AFSCF Staff Meteorologist (SMOTW) provides briefings of expected environmental conditions, makes recommendations relative to conducting the test on the planned timetable, and reports the state of readiness to support the flight.

h. AFWTR reports the state of readiness of its facilities to support the ascent phase.

The senior member of the Flight Readiness Review Board delivers the readiness reports to the MOL System Readiness Review Board, gives an assessment of all reports affecting Flight Operations, briefs the planned operation, and makes recommendations regarding overall readiness.

The MOL System Readiness Review Board, after hearing all readiness reports, briefings, and recommendations, makes the final decision on launch. Should a planned launch be delayed for any reason after the Readiness Review, another Readiness Review (either complete or partial, as appropriate) may be initiated to satisfy the readiness criteria.

3.3 LAUNCH OPERATIONS

See VAFB Launch Operations Requirements (Ref. 22).

3.4 FLIGHT OPERATIONS

3.4.1 General

The Flight Operations organization as shown in Figures 3-1 through 3-3 will conduct the flight test during ascent, early orbit, orbit, late orbit and the reentry phases of the operation. The responsibilities of the Flight Operations groups vary as a function of the operations phases, as explained in the following paragraphs.

3.4.2 Flight Phase

During launch and ascent, the organization is structured to perform the required functions in an optimum manner. In this period, the FD is concerned primarily with those aspects of the operation required to prepare for orbital operations, delegating the real time functions to the AD. The AD controls the functions of all MCR consoles. The rationale for this organizational framework is found in the fact that decisions during ascent must be made with minimum time lag to avoid abort situations and, once an abort situation is diagnosed, the abort recommendation requires decisions and action in minimum time. Not only does the organizational structure reflect these requirements, the physical layout of the MCR consoles is dictated by this philosophy. During the 500 sec time period from liftoff through OV injection, the organization is dictated by the requirements of the Powered Flight Operations.

For the remainder of flight operations, the FD delegates specific areas of responsibility to key personnel, as shown in Figure 3-1.

The consoles are manned by personnel trained and certified by the SPO Test Operations Division and by the MOL FTFD.

3.5 MOL FUNCTIONAL RESPONSIBILITIES

3.5.1 Flight Director

The FD is a senior USAF officer from the MOL SPO who is responsible to the MD for the conduct of the Flight Operations within the guidelines established by the Flight Director's Handbook. The FD makes all decisions affecting the manner in which the operation is conducted. He must refer to the MD all decisions which are not covered in the Handbook and which affect either crew safety or mission success. He is responsible for the personnel interface between the MOL Test Operations and The User to ensure that User requests are honored and that The User is informed of mission progress. The FD is responsible for ensuring that all support agencies meet their commitments to the MOL program. Should additional requirements be generated, he negotiates these requirements with the agencies involved. If resolution of these requirements cannot be achieved, he will refer them to the MD for action.

The FD is responsible to assure that all subordinate organizations (see Figures 3-1 and 3-3) are properly trained, to certify their readiness for orbital and powered flight support, to direct their operational activities along the lines of authority shown, and to maintain operational discipline throughout the flight phase of the Test Operations.

3.5.1.1 Prelaunch Phase

During the prelaunch phase, the FD:

a. Is responsible for scheduling MOL SPO, Aerospace, and associate contractor support personnel for software and personnel validation and training exercises involving the AFSCF. He coordinates all such activities with the MOL FTFD and is responsible for coordinating all integrated training or tests with MOL Launch Operations, the flight crew, and the OTEF.

b. Is responsible for the development of the Flight Director's Handbook.

c. Acts with the MOL FTFD in appointing members to the "Rehearsal Committee" and critiques all training exercises.

d. Certifies to the MD that all MOL personnel, procedures, and software are ready for flight.

3.5.1.2 Launch Phase

During the launch phase, the FD, in conjunction with the AD, keeps the MD apprised of the AFSCF and MOL operations personnel readiness to support the ascent and orbit phases of flight. Should the need arise, he makes recommendations to the MD as to whether to hold or scrub the countdown.

3.5.1.3 Flight Phase

During ascent, the FD monitors the activities of the AD and makes recommendations to the MD, as required.

For the remainder of flight, the FD is responsible for the following decisions and actions:

a. Approval of all flight plan changes that affect the accomplishment of a test objective.

b. Recommendations to the MD on the priority and the timing of accomplishing secondary test objectives.

c. Recommendations to the MD on continuing or terminating the flight test.

d. Approval of change in priority of MOL data system utilization.

3.5.1.4 Postflight Phase

During postflight operations, the FD is responsible for ensuring that the Post Operations Assessment Directive (POAD) is complete, accurate, and released on schedule.

3.5.2 Ascent Director

The AD is a senior USAF officer from the MOL SPO who is responsible for the conduct of powered flight operations.

3.5.2.1 Prelaunch Phase

During the prelaunch phase, the AD will coordinate all activities in support of the preparation for the real time control of the powered flight portion of flight test.

3.5.2.2 Launch Phase

During the launch phase, the AD in conjunction with the FD, keeps the MD apprised of the AFSCF and MOL operations personnel readiness to support the ascent and orbit phases of flight. Should the need arise, he makes recommendations to the MD as to whether to hold or scrub the countdown.

3.5.2.3 Powered Flight Phase

During powered flight, the AD is responsible for decisions and actions covering:

a. Abort recommendations to the flight crew during ascent.

b. Guidance switchover recommendations during ascent.

c. Supplying touchdown data to the recovery forces.

d. Application of flight test rules caused by anomalous flight vehicle behavior.

The AD exercises control, through the FTFD/Test Controller, for the AFSCF and supporting Range and other data acquisition facilities during all periods of powered flight. The AD also exercises control of the MCR and of the Flight Controllers. He is responsible for adherence to the Flight Plan, the Flight Test Rules, and Flight Crew Safety requirements. Subsequent to this phase, the AD has no responsibilities and the function ceases to exist except for his inputs to post flight analysis.

3.5.3 Technical Advisor and Staff

The senior Aerospace Corporation representative is the Technical Advisor (TA) to the FD. He is supported by a staff of Aerospace and associate contractor personnel.

3.5.3.1 Prelaunch Phase

During the prelaunch phase, the TA assists the FD in his prelaunch activities in preparation of documentation, validation of software and procedures, personnel training, and certification. The TA and his staff participate in training exercises and, serve on the "Rehearsal Committee". In addition, the TA assists the FD in the preflight planning of the flight and the mission.

3.5.3.2 Launch Phase

During the Launch phase, the TA is responsible to keep the FD apprised of OV status and of TA support capability for orbital operations.

3.5.3.3 Flight Phase

During ascent the TA monitors the general health of the OV to predict OV status for RTS acquisition.

For the remainder of the flight, the TA is responsible for closely following the operation and providing TA staff operational recommendations to the FD.

The TA and staff are responsible for coordinating the operations in the laboratory module, mission module, and Gemini B contractor analysis areas. They are also responsible for coordinating offline analyses and investigations using the AFSCF, MOL Contractor Support Facility, or contractor home plant facilities, as required. They are required to keep the FD apprised of all such investigations and the results thereof. They also provide technical assistance to the FD in the flight planning area.

The TA and staff are responsible for the analysis leading to and the drafting of the quick-look reports.

3.5.3.4 Postflight Phase

The TA is responsible for drafting the POAD and providing inputs to other reports.

3.5.4 Assistant Flight Director for Flight Planning (AFD/FP)

The AFD/FP provides the flight and mission planning staff function to the FD. This AFD heads a group of personnel. The composition and responsibilities of this group vary as a function of the flight phases, as shown below.

3.5.4.1 Prelaunch Phase

During the prelaunch phase, this group is responsible to provide to the FD a flight plan for the entire flight. During this time period, the group is comprised of MOL SPO, Aerospace, and AFSCF Command Generation personnel.

3.5.4.2 Launch Phase

No particular responsibility is identified for this time period, assuming that no last-minute targeting changes have been made. However, should such changes occur, this group will assess their impact and modify the flight plan accordingly. Group composition during this time span will be principally MOL SPO personnel with Aerospace assistance.

3.5.4.3 Flight Phase

The FP group is responsible for assessing the impact of targeting requirements and long-term changes in OV capability on the full-flight flight plan. The group is responsible to provide a one-to-two-day flight plan to Command Generation for guidance in command message generation and review all mission payload system segment (MPSS) event generator computer runs. This group is responsible for the evaluation of MPSS performance as evaluated from the mission correlation data (MCD) and ensures that crew voice comments become a part of the MCD. During this period, the group is comprised of MOL SPO, Aerospace, and associate contractor representatives, as required.

The group provides inputs to the quick-look reports.

3.5.4.4 Postflight Phase

The group is responsible to assist the TA in writing the POAD.

3.5.5 Assistant Flight Director for Crew Operations (AFD/CO)

The AFD/CO, a flight crew member from the MOL flight crew division, is responsible to the FD for all activities affecting crew operations and serves as the principal assistant to the FD. He acts as the crew communicator.

3.5.5.1 Prelaunch Phase

The AFD/CO is responsible for development, documentation, and validation of crew/STC procedures. He participates in training and rehearsal activities at the MCC.

3.5.5.2 Launch Phase

The AFD/CO monitors countdown activities, crew activity, and reports as required to the FD on crew status.

3.5.5.3 Flight Phase

The AFD/CO relays all voice instructions from the AD to the flight crew and keeps the AD advised of flight crew status during ascent.

During the remainder of the flight phase, the AFD/CO monitors flight crew operations and aids the flight crew in following the flight plan, advises the flight crew of consumable quantities, and relays recommendations from other flight controllers. He provides flight crew status to the FD, and provides inputs to the quick look reports on matters affecting the flight crew and the communication link.

3.5.5.4 Postflight Phase

The AFD/CO assists in flight crew debriefing and provides inputs to the FD for inclusion in the POAD.

3.5.6 Assistant Flight Director for Vehicle Analysis (AFD/VA)

The AFD/VA directs a group of contractor systems analysts who monitor those OV systems in which malfunctions could lead to abort recommendations or require other real time action on the part of the ground or flight crews.

3.5.6.1 Prelaunch Phase

This group is responsible for developing, publishing, and validating procedures that integrate the real-time OV status reporting function with the operation of the "back rooms" and the MCR. They will participate in personnel training and rehearsals.

3.5.6.2 Launch Phase

The AFD/VA will monitor OV data displays and the conduct of the countdown to assure that the OV displays are valid, and will report any observed or reported anomalies to the FD.

3.5.6.3 Flight Phase

During the ascent phase the AFD/VA will monitor orbiting vehicle systems in preparation for conduct of orbital phase.

For the remainder of the operation, the AFD/VA will report to the FD those items of OV status of significance and for which real time action may be required. He will provide inputs to the quick look reports.

3.5.6.4 Postflight Phase

The OV systems controller will be responsible to provide coordinated inputs to the postflight reports concerning those OV anomalies observed during launch and ascent.

3.5.7 Assistant Flight Director for Reentry and Recovery Planning (AFD/RRP)

The AFD/RRP provides a function only after ascent, and is the AFD for coordinating, for the FD, all aspects associated with Gemini B, DRV, and laboratory vehicle reentry for all remaining phases of the flight.

3.5.8 Flight Surgeon

The flight surgeon (FS) is responsible to the FD for all aspects of crew health. With the assistance of biomedical personnel and facilities of the staff support room he will monitor the physical status of the crew, Gemini B and laboratory module internal environment, environmental control and life support (EC/LS) function, and radiation levels. When necessary he will make recommendations to the FD in matters related to crew health and safety. He will routinely coordinate with the AFD/CO on crew activities and keep him informed of crew health status. He will also coordinate with AFD/VA to assess the impact of malfunctions or degraded modes on crew performance. The FS is also responsible for providing inputs to quick look and postflight reports.

3.5.8.1 Prelaunch Phase

The FS is responsible for development, documentation, and validation of biomedical procedures at STC and the simulators. He will participate in training and rehearsal activities at MCC.

3.5.8.2 Launch Phase

The FS monitors countdown activities and reports as required to the FD on crew health status.

3.5.8.3 Flight Phase

The FS will provide for analysis of data received by voice and TM related to crew health. He will coordinate with AFD/CO, AFD/VA, and others to provide reports and recommendations to FD as required.

3.5.8.4 Postflight Phase

The FS provides inputs to the FD for inclusion in the postflight reports.

3.5.9 Technical Advisor on Natural Aerospace Environment (MOL STAFFMET)

See paragraphs 12.3 and 12.6.

3.6 AFSCF FUNCTIONAL RESPONSIBILITIES

3.6.1 MOL Field Test Force Director (FTFD)

The FTFD is the AFSCF representative from the STC who is responsible for interfacing and implementing the MOL AFSCF operational requirements within the AFSCF. During the development and planning phase, he is the point of contact between the STC and the MOL SPO. He is responsible for MOL personnel training in the AFSCF and will conduct system simulations. During the operational phases he will man a console and share the AFSCF operations support function with the Test Controllers in the following manner. The FTFD will delegate authority to the Test Controllers for all "RTS Pass" control of the AFSCF allocated to the MOL project. He will retain authority over all other AFSCF aspects of his office. In this sense, "RTS Pass" means the rev-to-rev operation normally performed by the test controller (see paragraph 3.6.2).

3.6.1.1 Prelaunch Phase

During the prelaunch phase, the FTFD:

a. Reviews AFSCF operational requirements levied by the MOL SPO and assists in their implementation at the STC and RTSs.

b. Obtains AFSCF support for MOL operations planning.

c. Works closely with the FD in planning, scheduling, and conducting personnel, software, and procedures validation, training and certification exercises. He will be responsible for scheduling all AFSCF and AFWTR support for such exercises.

d. Develops, publishes and validates any MOL/AFSCF interface procedures required.

e. Reviews and comments on all MOL SPO-developed procedures prior to their trial and final implementation at the MCC.

f. Prepares the MOL Test Operations Order (TOO).

g. Ensures that all required AFSCF support facilities are scheduled for the operation.

h. Certifies to the FD, the readiness of AFSCF personnel, equipment and software in support of the MOL flights.

3.6.1.2 Launch Phase

During launch, the FTFD assures that all nominally requested support facilities are available, and secures such other facilities that may be required due to contingency situations.

3.6.1.3 Flight Phase

During the ascent phase, the FTFD will have no specific responsibilities above his general role.

During the orbital phase, the FTFD will:

a. Interface the requirements of the FD with AFSCF.

b. Ensure that the Test Controller accomplishes all RTS Pass requirements of the FD.

c. Personally direct all other activities concerning FD requirements which must be met.

d. Present MOL requirements to the AFSCF Network Director (ND) and attempt first-level resolution of any conflicts.

e. Bring to the FD for approval those circumstances affecting the accomplishment of test objectives.

3.6.1.4 Postflight Phase

During the postflight phase, the FTFD provides required personnel and facility support to the FD and TA staff to produce the POAD and provides AFSCF inputs to the POAD.

3.6.2 Test Controller

The Test Controller (TC) is responsible to the FTFD for portions of the FTFD area of responsibility (see paragraph 3.6.1). His primary responsibilities are in the area of RTS pass activities, but, as an arm of the FTFD, the TC is responsive to FTFD requests.

3.6.2.1 Prelaunch Phase

During the prelaunch phase, the TC is responsible for preparation, publication, and validation of Test Control procedures, and for integration of the subordinate operations organizations' procedures with the MOL MCC operation. The TC assists the FTFD in his duties related to procedures, software, and personnel validation/certification, particularly with respect to scheduling and conducting autonomous AFSCF training exercises. The TC participates both as TC and as a member of the Rehearsal Committee for MOL Operations Rehearsals, assisting the FTFD in preparation of the rehearsal critiques.

3.6.2.2 Launch Phase

During the launch phase, the TC assures proper data/communications systems coordination with AFWTR. He receives status reports from AFSCF support facilities and keeps the FTFD informed of AFSCF status. He monitors operations control traffic to assure correct formatting, addressing, and transmission procedures, and ensures that proper AFSCF net discipline is maintained.

3.6.2.3 Flight Phase

During the flight phase, the TC and his assistant perform the functions described in paragraph 3.6.2.1, except that there is no AFWTR interface.

The TC ensures that network personnel follow established flight control procedures.

The TC conducts a prepass briefing for STC personnel and the RTSs involved. He is responsible for the real time control of the RTSs and the subordinate AFSCF network shown in Figure 3-1 during the RTS Pass period. The TC provides inputs to the quick-look reports, as applicable.

3.6.2.4 Postflight Activity

The TC provides to the FTFD a critique of the test control function for the flight for inclusion in the postflight reports.

3.6.3 Remote Tracking Network

The RTSs are assigned to the MOL program in accordance with the Orbital Support Plan (OSP), the approved flight plan, and scheduling requirements of the AFSCF. When assigned to MOL for a given time period, the RTSs are responsible to provide telemetry, tracking, and voice data from the OV, and to transmit commands and voice to the OV.

3.6.3.1 Prelaunch Phase

During this phase, the remote tracking network develops procedures, checks out software, and participates in personnel training exercises and submits required status reports. The RTS at VAFB (VTS) participates in prelaunch testing.

3.6.3.2 Launch Phase

During the launch phase, the RTS performs final readiness checks and submits required status reports. VTS supports the launch pad activity during selected portions of the countdown.

3.6.3.3 Flight Phase

Only VTS is involved during ascent. VTS is responsible for acquiring the FV and returning OV telemetry data to the STC during its view period of the ascent.

During the orbital phase, each RTS is responsible to meet its scheduled MOL operations times as determined by the Network Director. Each will provide tracking, telemetry, command, and voice (TTCV) services, as scheduled. Each RTS will process, transmit, and record the data as provided for in the OSP and the Pass Plan.

3.6.3.4 Postflight Phase

The RTSs will provide significant inputs to AFSCF operational reports.

3.6.4 Command Controller

The Command Controller, an AFSCF officer, supports the FTFD during command generation and the Test Controller during command loading. He keeps the TC advised of laboratory vehicle command system capability and status, and contents of the Current Vehicle Command Table (CVCT), and the status and content of the command message for loading. He is the interface between the TC and the Command Generation Group during command loading. During the RTS pass, and upon the approval of the TC, the Command Controller is responsible for transmitting the commands.

The other functions of the Command Controller parallel those of the command generators for the various operations phases; therefore, they will not be repeated.

3.6.5 Data Controller

The Data Controller (DACON) is an AFSCF officer responsible for the coordinated use of the AFSCF data system. The data system includes all of the computer hardware and AFSCF and MOL ground software and is comprised of the ADS, the Advanced Orbit Ephemeris System (AOES), and System II (CDC-3800s and SYMON). The DACON reports directly to the TC during the RTS pass period; at other times, he is responsive to the direction of the FTFD.

3.6.5.1 Prelaunch Phase

During the prelaunch phase, the DACON:

a. Prepares, validates, and publishes data control procedures which integrate the data system and its use into the MOL MCC operation.

b. Participates in the validation of all MOL/AFSCF software.

c. Supports all training exercises and participates in the development of the flight plan.

d. Formulates the Data System Management Plan (DSMP), a subset of the Flight Plan, which specifies what programs or functions are scheduled to run at any given time on the off-line computers (CDC-3800s).

3.6.5.2 Launch Phase

During the launch phase, the DACON assures the operational integrity of the data system by running any required diagnostic programs. He is responsible to see that the schedule of the DSMP is maintained and to update it, if required.

3.6.5.3 Flight Phase

During this phase, the DACON must ensure proper real-time operation of the CDC-3800 computers in support of powered flight. He is responsible to report for correction any indicated anomalous data system operation and to assure display switchover to the backup CDC-3800 for continuity of real-time data. He is also responsible for ensuring proper data input and reentry software operation during normal and contingency reentry activities.

During this phase, the DACON is responsible for updating the DSMP with each update of the flight plan. He will receive for consideration and approval, within the constraints of a pre-established priority structure, all requests for data system utilization not in accordance with the DSMP. He is responsible to report to the FTFD any occurrence or prediction that would preclude successful accomplishment of the DSMP. During those time periods which the DSMP gives priority to the real-time operation (i.e., during an RTS pass), the DACON reports directly to the TC.

3.6.5.4 Postflight Phase

During the postflight phase, the DACON is required to submit any significant data system events to the FTFD for inclusion in AFSCF postflight reports.

3.6.6 Command Generation Group

This is an AFSCF-manned group responsible for transforming the flight plan requirements into commands, airborne digital computer (ADC) data, and prose-message instructions to the flight crew. The group is responsible to the FTFD to assure conflict-free command loads. The group must maintain cognizance of the orbiting vehicle and AFSCF command systems capabilities and ensure command messages compatible with those capabilities. They must keep the FTFD and TC appraised of command generation status through the Command Controller.

3.6.6.1 Prelaunch Phase

During this phase the Command Generation Group is responsible to develop, validate, and publish their operational procedures. They participate in the validation of the Command and Control (C&C) software and operations exercises

for personnel training and certification. They assist the Flight Planning Group in establishing the full flight flight planning software.
The group will generate the pad load command message and any other command messages required at the launch site for pad checkout of the OV and command tapes for open loop simulations.

3.6.6.2 Launch Phase

During this phase, the Command Generation Group perform diagnostic checks to ascertain the status of their software and reports the status to the FTFD.

3.6.6.3 Flight Phase

During this phase, the Command Generation Group is responsible to prepare command messages in accordance with the flight plan and to update the 1-2 day flight plan to reflect the short range OV and AFSCF capabilities. They make recommendations to the Flight Planning Group with respect to the development of the 1-2 day flight plan.

3.6.6.4 Postflight Phase

The Command Generation Group reports all operational events of significance to the FTFD for incorporation into the AFSCF postflight reports.

3.6.7 Orbit Analysis Group

This is an AFSCF-manned group responsible for orbit planning, tracking-data evaluation and processing, orbit determination, ephemeris generation, and for computations required for orbit adjust, Gemini B and DRV reentry, and laboratory vehicle (or automatic-mode OV) disposal. This group is responsive to the direction of the FTFD.

3.6.7.1 Prelaunch Phase

During the prelaunch phase, this group:

a. Prepares, validates, and publishes their operational procedures.

b. Assists the Flight Planning Group in Preparation of the Flight Plan by providing orbit mechanics technology and making runs of the flight plan generator.

c. Participates in software, procedures, and personnel validation and certification exercises.

d. Provides assistance as required to the FD/TA in event of last minute orbit parameter changes.

3.6.7.2 Launch Phase

During the launch phase, the Orbit Analysis Group ensures proper operation of their software and reports status to the FTFD.

3.6.7.3 Flight Phase

During this phase, the Orbit Analysis Group is responsible for orbit determination runs, preparation of ephemerides, computation of orbit adjusts, development of the reentry parameters for Gemini B, the laboratory vehicle (or automatic-mode OV), and DRVs and the prediction of their impact points. In addition, the group is responsible for making runs of the flight plan generator for updating the Flight Plan and for securing the required flight plan coordination.

3.6.7.4 Postflight Phase

During the postflight phase, this group provides inputs of significant operations events to the FTFD for incorporation into the AFSCF postflight reports.

3.6.8 Recovery Control Group

The Recovery Control Group (RCG), located at Hickam AFB, Hawaii, is responsible to provide personnel, aircraft, secure surface ship, and ARRS support for recovery of the DRV. It is also responsible to direct DRV recovery training exercises, certify DRV recovery readiness, and conduct DRV recovery in support of the MOL program.

RCG support is required for flights 6 and 7 only. Prior to these flights, the RCG will develop, validate, and publish MOL support plans and procedures. The group will also provide postflight reports covering significant operations events.

3.6.9 Network Director

The AFSCF ND, the senior AFSCF operational representative on duty, is a senior USAF officer, responsible for assuring that the AFSCF commitments made to the various program offices are met in a multi-operations environment. He controls all of the AFSCF resources and allocates them to best meet the needs of the USAF. When conflicts in the use of the AFSCF arise, he is responsible for suggesting alternative means of meeting the AFSCF commitment without significant degradation of program objectives. Where this cannot be done, he implements the priority structure established by the program offices with the AFSCF. His allocations are subject to review by the directors of programs supported by the AFSCF when necessary they may make additional or different tradeoffs within the capabilities of the AFSCF.

The guidelines used by the ND in AFSCF allocations are documented in the various program ORDs, OSPs, and, for MOL, in the Flight Plan.

The functions of the ND are not varied as to the operational phases of MOL (although the priority of MOL requirements may be); therefore, no breakout of these functions is made on an operational phase basis.

The functions of the staff meteorologist (STAFFMET), multi-operations, and recovery control are described in the following paragraphs.

3.6.9.1 Multi-Operations

Multi-operations, a staff function of the ND is responsible for the overall AFSCF scheduling and for scheduling all AFSCF facilities and personnel for such activities as equipment installation, modification and checkout, rehearsals, and actual operations. Multi-operations is also responsible to the ND to detect conflicts in requirements placed on the AFSCF and to suggest means of eliminating or minimizing the effects of conflicts.

Multi-operations is responsible to provide MOL support at any time MOL is utilizing the AFSCF from prelaunch through postlfight.

3.6.9.2 Communications System

The Communications Group is responsible for all AFSCF communications, communications with outside agencies and organizations supporting the flight test, and the closed circuit television (CCTV) within the STC. This specifically includes communications RTS-to-STC, intra-STC, and STC-to-Other-agencies, whether by data line, teletype, voice, facsimile, data phone, land line, microwave, radio, etc. Communications facilities are provided in accordance with the OSP, Flight Plan, and schedules promulgated by the ND.

3.6.9.2.1 Prelaunch Phase

During this phase, communications personnel are responsible to prepare, validate, and publish any special communications procedures required for MOL operations. They are required to support all scheduled software and personnel validation and training exercises.

3.6.9.2.2 Launch Phase

During launch phase, the communications group:

a. Calls up all required circuits and verifies circuit quality.

b. Monitors all circuits and takes any necessary corrective action required to assure continuous communication.

c. Accepts operations control messages from the TC for transmission, and routes all incoming operational traffic to designated addressees.

d. Keeps the TC advised of communications system status.

3.6.9.2.3 Flight Phase

Ascent and orbital communications responsibilities are the same as for the launch phase.

3.6.9.2.4 Postflight Phase

Postflight responsibilities of the communications group is limited to inputs of significant events to AFSCF reports.

3.6.9.3 AFSCF Staff Meteorologist

The AFSCF STAFFMET (AWS) and his staff are responsible to support the MOL program with meterological data. STAFFMET support is to be provided during all operational phases including rehearsals. A detailed description of natural aerospace environment (ENV) activities is provided in Section 12.0.

3.7 GEMINI B RECOVERY FUNCTIONAL RESPONSIBILITIES

The Recovery Operations organization (see Figure 3-1) is under the jurisdiction of the DOD Manager for Manned Spaceflight Support Operations (DDMS) and is responsible for the recovery of the Gemini B, the flight crew, and the DRCs. The organization of the Recovery Operations Group is described below.

3.7.1 Recovery Director

The Gemini B Recovery Director, a representative of DDMS, will be located in the Recovery Control Room (RCR) at the STC and will assume command and control of the recovery forces at R -1 day. He is responsible for planning and control of Gemini B recovery and retrieval operations for abort, contingency, and normal operating modes, support plans preparation, training and rehearsal validation, operational readiness determination, and post-operations evaluation. He is also responsible for placing requirements on the recovery support agencies (i.e., ARRS, USN, etc.) to meet the recovery requirements as specified in the GBRRD and the MRRD.

3.7.1.1 Launch Site Recovery Operations

Launch Site Recovery Operations is located at VAFB and is controlled by a DDMS representative. The recovery force is a composite of AFWTR and ARRS forces. Launch Site Recovery Operations is responsible for pad and early ascent abort recovery of the Gemini B and flight crew.

3.7.1.2 Pacific Recovery Operations

Pacific Recovery Operations is located in Hawaii and is controlled by Commander Hawaiian Sea Frontier, who is Commander Task Force, Pacific (CTF 130).

CTF 130 is responsible to the Recovery Director for providing the support personnel and equipment necessary to accomplish recovery operations for MOL in any area under his jurisdiction.

3.7.1.3 Atlantic Recovery Operations

Atlantic Operations, located at Norfolk, Virginia, is controlled by Commander Task Force, Atlantic (CTF 140). CTF 140 is responsible to the Recovery Director for providing the support personnel and equipment necessary to accomplish recovery operations for MOL in any area under his jurisdiction.

3.7.1.4 Contingency Recovery Operations

Contingency Recovery Operations are under the control of the local area commander where the contingency landing occurs. Each Commander is responsible for the planning and organization of forces and the conduct of search and recovery operations within his area for any contingency recovery not within the geographical limits of a planned recovery area or in territory held by nations unfriendly to the USA.

3.8 ASSOCIATE CONTRACTORS' SUPPORT ROLE

This Section describes briefly the operational role of the associate contractors in support of the MOL operation in the Sunnyvale area. In this preliminary FTOP, it represents the guidance required in this area to place the rest of the FTOP in the proper context for the development of the associate's requirements for flight test support. Subsequent issues of the FTOP will reflect the roles as modified by the associate contractors' support plans.

The Sunnyvale operation will be principally supported by DAC, MAC, GE, and EK. Other contractors, such as TRW, may perform a software maintenance role, but it is the intent of this Section to only detail the prinicpal support roles.

3.8.1 Prelaunch Phase

During this phase, and particularly for the first manned flight, preparation is made for the flight. The MOL SPO and Aerospace Corporation will have a field operations office in Sunnyvale to work with the associate contractors and the AFSCF in planning for and in the conduct of operational tests, training and rehearsals. The associates will each establish local offices (possibly in the MCSF) to provide operational support to the Sunnyvale effort. The level of manning of those offices will be commensurate with the level of effort expected during any given time period in this phase.

a. The associates will be responsible for planning and conducting formal and informal training sessions for MOL SPO, Aerospace, AFSCF, and any other contractor's operations personnel requiring technical instruction on the associate's segment (hardware and software).

b. The associates operational personnel will attend formal and informal training sessions conducted by the AFSCF on AFSCF operations, capabilities, concepts, and procedures.

c. The associates' operational personnel will attend formal and informal training sessions conducted by the MOL SPO on MOL MCC operating concepts and procedures.

d. The associates will work with the MOL SPO field office in developing operations handbooks and procedures.

e. The associates will support software verification exercises as requested by the FD.

f. The associates will support AFSCF training exercises and rehearsals with those personnel committed to AFSCF operations support. From this group the associates will support the AFSCF Rehearsal Committee (see Section 11.0) as requested by the FD. During selected training exercises, the associates will be required to provide support at the MCSF and their in-plant facilities to validate concepts and procedures for the coordination of operations analyses requirements and data handling.

g. The associates will assist, as required, in the development of the operational data base, operational TLM data modes and displays.

h. The associates will provide support as required, including studies for the development and formulation of the Flight Plan.

i. The associates will be certified, based on an approved certification plan, as to their readiness to support Flight Operations. The associates' senior representative will report on their preparedness to the FD. Critical to this certification will be the level of technical compentence of the associate personnel provided, their evidence of knowledge of MOL and AFSCF operations, concepts and procedures, and their participation in training exercises and rehearsals. The Associates' personnel will be organized for operation in accordance with Figure 3-1 and the details presented in the paragraphs below.

3.8.2 Launch Phase

At the appropriate time during this phase, the associates' operational positions are manned. During the operation, the associates will staff their MCC support areas, the MCSF, and their in-plant facilities in accordance with the plans developed during the prelaunch phase. Staffing levels will vary dependent upon the expected level of activity. The MCC will be manned continuously. Staffing at the MCSF will be as required and/or on an on-call basis; staffing for support at the associates' in-plant facilities will be on an on-call basis until needed and then as required. From this point until the termination of the flight, the associate personnel will be responsive to the operations organization. The TA will be authorized to act for the FD in coordinating the activities of the associates. The senior representative (at any given time) for each associate will act as staff to the TA in addition to directing his support personnel.

Upon manning the support rooms, the associates will check out equipment and report readiness to the FD. As FV data is made available to the STC from the pad, the associates will monitor their respective segments and report any discrepancies. During this time period, all support room effort is directed to the post-injection period, unless specifically directed otherwise by the FD.

3.8.3 Flight Phase

During ascent, all available data will be monitored and analyzed to predict OV status for the first RTS pass. No special data requirements for this purpose will be requested for real time ascent monitoring. After injection, stored data will be retransmitted from VAFB to supplement this effort and special data modes may be requested at this time.

During the remainder of the flight phase, the associates will monitor their segment's performance in the MCC reporting all anomalies or suspected problems and recommended solutions. They will request that applicable software runs be made for predicting TLM or the consumption of expendables, for determining trend analyses or for developing recommended vehicle command sequences. They will respond to requests of the FD for first-level evaluations and analyses. They will flag for more detailed analyses problem areas needing resolution, but which are beyond the scope of the MCC support.

The senior associate contractor representative will respond to requests from proper authority for analyses beyond those performed at the MCC. He will direct the efforts of his MCSF personnel and will request and coordinate such assistance as required from his in-plant facilities. Upon completion of these analyses, he will make appropriate recommendations to the TA and FD for action. He will prepare the segment inputs to the quick-look reports and make recommendations in the preparation of the initial POAD. Once the initial POAD is published, he will direct and coordinate any associate MCSF effort required in the support of the segment reports.

3.8.4 Postflight Phase

During this phase the senior associate representative will consult with the MOL SPO/Aerospace field office and make recommendations with respect to the final POAD. Once the POAD is released, he will coordinate the requirements for his segment in obtaining from the MCSF the necessary data for analyses required in response to the POAD. He will support these analyses to the extent that this support does not interfere with the requirements to prepare for the next flight.

4.0 FLIGHT PLAN

4.1 GENERAL

This Section provides an overview of the flight test operations: a brief resume of the flight test profile is described in paragraph 4.2; paragraph 4.3 contains a discussion of significant milestones of the launch and orbital phases of a nominal operations test.

Typical launch, orbital, and recovery parameters for a manned/automatic flight are shown in Table 4-1. Specific values for these parameters will be contained in the Systems Test Objectives document for that flight. A summary of trajectory parameters is presented in Table 4-2.

4.2 OPERATIONS TEST PROFILE RESUME

4.2.1 Prelaunch

For the Flight Operations personnel, the prelaunch phase is arbitrarily chosen as starting with the release of the final STO for the flight* (L-4 months) and concludes at start of countdown. It may begin somewhat earlier for the flight crew, the exact time depending upon reconfiguration of the MOL mission simulator (MS) from the previous flight. During this period, the Flight Operations crews at the MCC will "shakedown" the ground support hardware and software, conduct training exercises, make final plans for the flight, and rehearse the flight operations aspects with the launch and flight crews. The prelaunch phase ends with a Flight Readiness Review at which each identifiable portion of the MOL system is determined to be ready and the Program Director approves the initiation of the launch phase.

*For the first manned flight, the prelaunch phase begins 12 months prior to launch. During this period, the mission simulator will support the MCC.

Table 4-1. Typical Launch and Orbit Parameters

Launch		
	Site	SLC-6, Vandenberg AFB
	Azimuth	180 deg
	Date	4 April 1971
	Window	2100-2200 GMT
	Nominal Time	2100 GMT
Orbit (baseline)		
	Inclination	90 deg
	Perigee Altitude	80 n mi
	Perigee Location	55 deg N lat (descending)
	Apogee Altitude	186 n mi
	Orbit Cycles/ Siderial Day (q)	16-2/15*
	Orbit Adjust Cycle	Every 3 days
Flight Duration		30 days

*Value for q is a function of the orbit adjust cycle. The above value is average over the 3-day interval.

Table 4-2. Typical Summary of Trajectory Parameters

Trajectory Parameter	Event							
	Maximum Dynamic Pressure	Stage I Ignition	SRM Jettison	Stage I Jettison	Stage II Shutdown	Orbit Inject	First Apogee	First Perigee
Time of Flight, sec	58	122.3	128.6	290.6	494.4	504.4	2700.8	5321.4
Inertial Velocity, fps	2,021	5,892	6,056	16,311	25,757	25,792	25,080	25,846
Radius, ft	20,939,439	21,053,441	21,066,731	21,301,696	21,426,367	21,428,628	22,019,568	21,364,869
Altitude, n mi	5.9	24.6	26.8	64.6	83.4	83.7	187.0	80.0
Inertial Flight Pat Angle, deg	38.588	21.351	19.838	5.125	0.498	0.507	-0-	-0-
Dynamic Pressure, psf	930	60	38	0.03	—	—	—	—
Angle of Attack, deg	-0.14	3.54	4.09	—	—	—	—	—
Aeroheating Indicator, ft-lb/ft^2	25.7×10^6	100.6×10^6	102.4×10^6	106.6×10^6	106.8×10^6	106.8×10^6	—	—
Mach Number	1.67	5.42	5.53	—	—	—	—	—
Axial Acceleration, g's	2.06	2.10	1.26	4.20	2.50	—	—	—
Veh Wt Prior to Jettison, lb	1,166,437	612,051	596,416	124,878	40,729	40,530	30,952	30,952
Veh Wt Following Jettison, lb	—	—	407,731	106,826	—	30,956	—	—
Geodetic Latitude, deg N	34.54	34.01	33.92	29.60	18.54	17.85	-51.25	55.00
Longitude, deg E	239.37	239.34	239.34	239.06	238.35	238.31	49.18	218.23
Downrange Distance, n mi	2.8	34.4	40.1	299.1	961.6	1,003.1	—	—
Azimuth of Inertial Velocity Vector, deg	136.3	169.6	170.1	178.4	180.0	180.0	359.9	180.1
Azimuth of Vehicle Centerline, deg	182.5	182.6	182.6	182.8	182.4	182.4	359.9	180.1

D ~~SECRET~~ SPECIAL HANDLING

4.2.2 Launch

The launch phase begins with the start of countdown (approximately 590 min prior to liftoff) and concludes at FV liftoff. During this period, the launch crew makes final preparation for launch, and the flight crew enters the Gemini B. The flight operations crew at the MCC monitors the countdown and the AFSCF status, and determines readiness for flight initiation.

4.2.3 Ascent

The ascent phase begins with FV liftoff from the launch pad and concludes with initiation of T-IIIM/OV severance ordnance (approximately L +500 sec). The altitude and event profile is shown in Figure 4-1; T-IIIM downrange staging is presented in Figure 4-2. The sequence of events is shown in Table 4-3. As indicated in Section 3.0, control during this phase of the flight resides with the MD at the MCC in Sunnyvale. However, the FD and the controllers perform the monitoring and ensure adherence to preselected operating procedures. The controllers monitor those FV and tracking parameters required to support the flight crew in a backup mode and those required for slow malfunction* detection. These are monitored for any anomalous behavior which might lead to an abort or guidance switchover recommendation. The MCC maintains voice contact with the crew throughout this period, primarily to provide information relating to either of these recommendations. In addition to the voice link, the requirement exists to transmit two commands which will light indicators in the Gemini B and will inform the flight crew of the MCRs recommendations for "Guidance Switchover" or "Abort". This link is only serviceable during the VTS contact period ($\approx$ T+15 sec to T+70 and T+130 to T+370 sec); however, this is considered adequate (see Figure 4-1).

Throughout most of the ascent phase (liftoff to T+ ~ 400), the TLM and tracking data is supplied by VTS, AFWTR, or PMR, and the operation will be as described in Section 6.0; however, during the latter part of the ascent phase (T+ ~ 400

*Those malfunctions permitting a reaction time of 6 sec or longer.

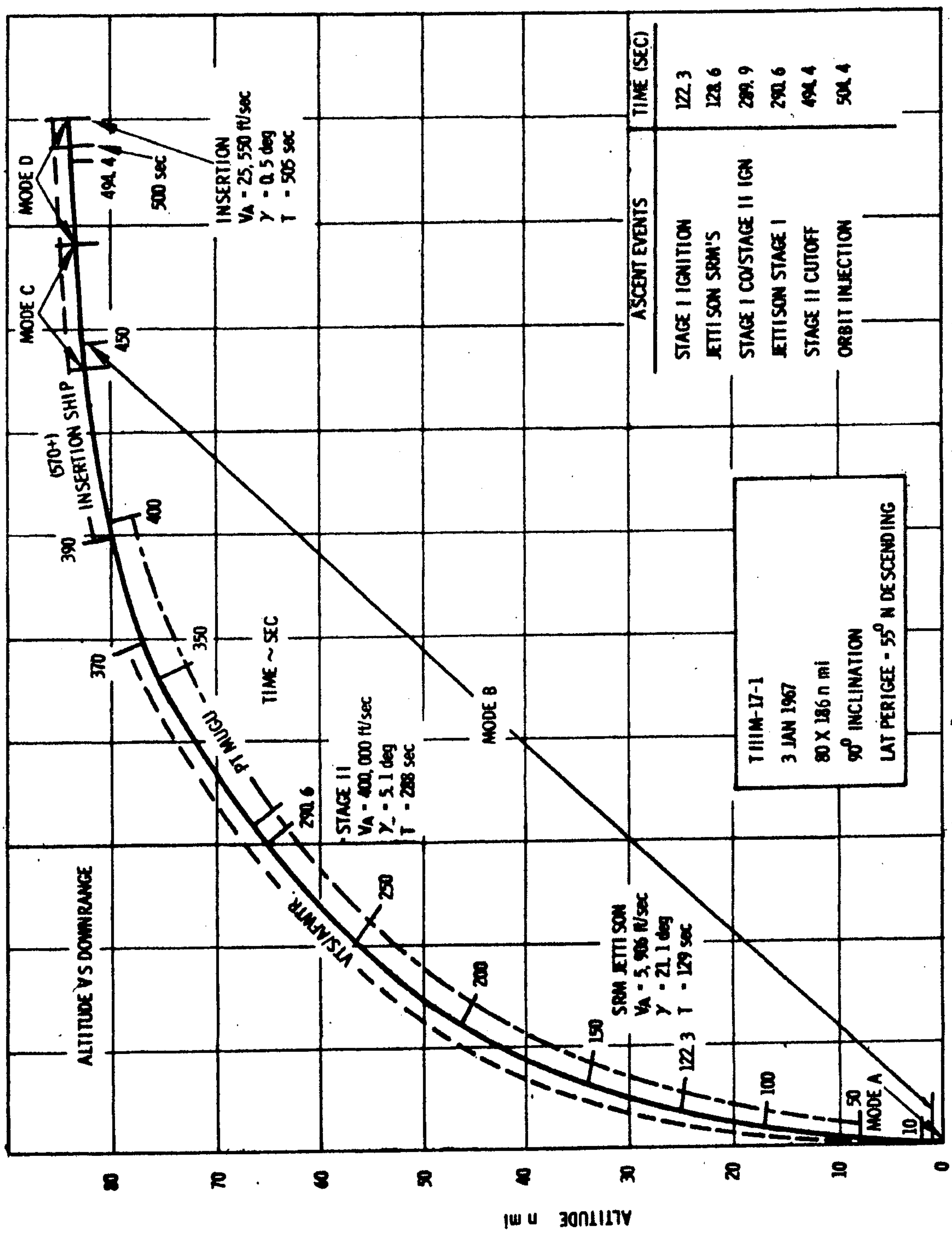


Figure 4-1 Altitude and Event Profile

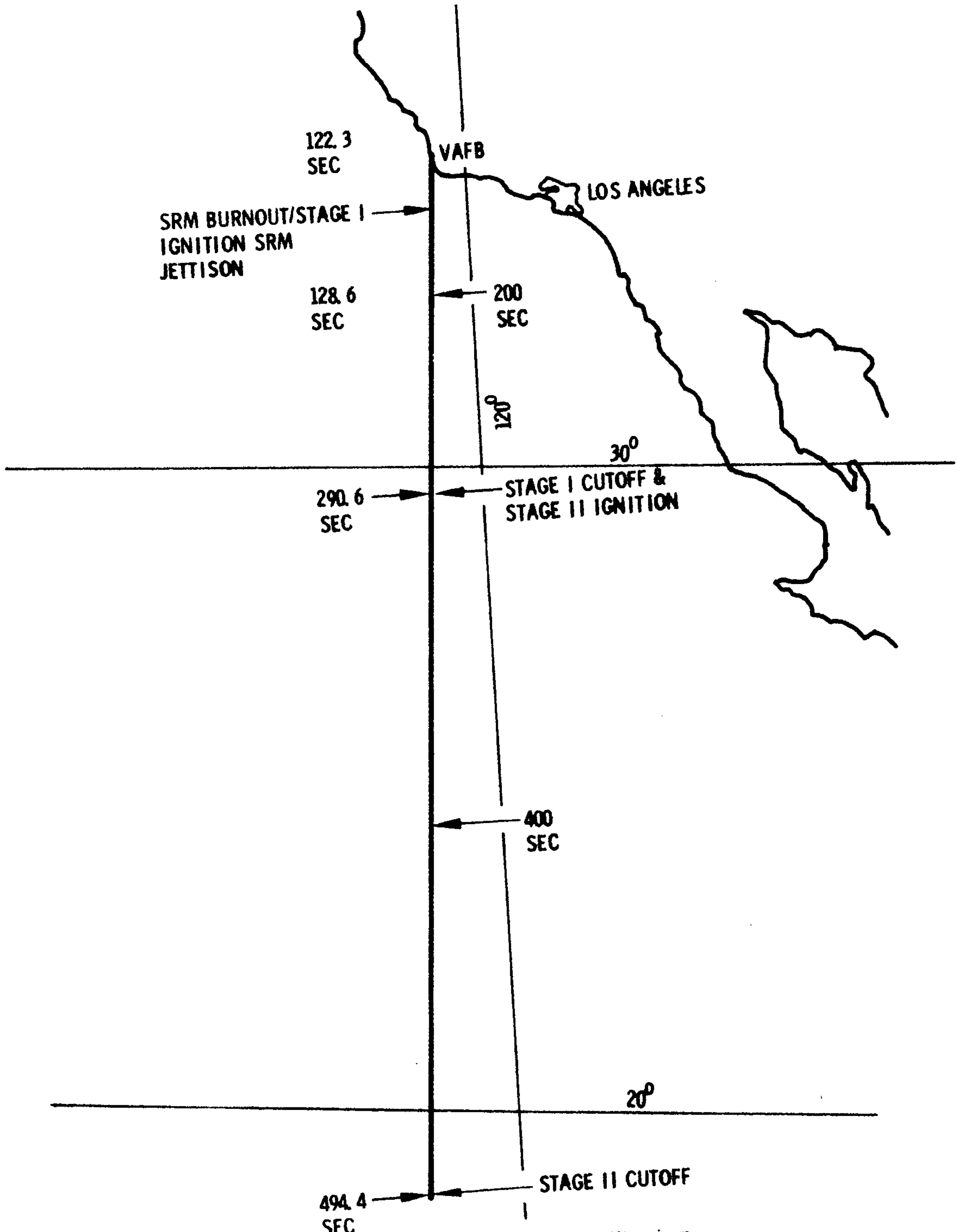


Figure 4-2 T-IIIM Staging

Table 4-3. Sequence of Events

Time From Liftoff (sec)	Event
0	Liftoff, begin vertical rise
5	Initiate Roll
10	Terminate Roll
10	Initiate 1st TARS pitch rate
20	Initiate 2nd TARS pitch rate
30	Initiate 3rd TARS pitch rate
60	Initiate 4th TARS pitch rate
90	Initiate 5th TARS pitch rate
121.3	Sense staging g level (1.49 g)
121.4	Stage I fire switch (87FS1)
122.3	Stage I ignition
128.6	Jettison SRMs, initiate 6th TARS pitch rate
132	Initiate Stage I closed loop guidance steering
289.9	Initiate Stage I-Stage II staging sequence (87FS2, 91FS1)
290.6	Jettison Stage I
494.4	Initiate Stage II shutdown (91FS2), begin staging sequence
504.4	Stage II tailoff complete, orbit Injection achieved
2700.8	First apogee
5321.4	First perigee

to end of ascent) the MOL Insertion Ship (MIS) will perform certain of these functions. The MIS will receive and record all FV data and will re-transmit selected parameters, via a communications satellite (comsat) and its associated network, to the STC.

The MIS will also have a touchdown predictor and will provide near real-time orbit verification. In addition to these responsibilities, the MIS may also perform recovery should the requirement exist and will provide weather information required to support ascent. The MIS function ceases shortly after OV insertion into orbit and loss of signal.

The ascent phase for a nominal flight is completed when orbital insertion has been confirmed. The resulting MCC Controller duties reflect this: the Booster, Guidance, and Trajectory Controllers will be replaced; however, the functions of the OV Systems Controller, Retrofire Controller, Flight Support Officer, Crew Communicator, and Flight Director will continue into the early orbit phase.

If an abort occurs during ascent, the Ascent Abort Program will be called into the STC computer, and the flight crew and recovery forces will be supported by the MCC.

The operations support provided for this condition is somewhat dependent upon the abort modes, but in general, will consist of supplying information to the crew or the recovery forces. The predicted touchdown point will be computed. The computer program required to support this effort is stored in the System II disc memory and is readily accessible during ascent.

4.2.4 Early Orbit, Orbit, and Late Orbit

These orbital phases begin with T-IIIM/OV severance and conclude with severance of the Gemini B from the laboratory vehicle. The recommendation for flight crew transfer can be made during the second rev based on the prediction of proper operation of the OV and crew for 18 revs following insertion into orbit (primary recovery area). The criteria for the recommendation of flight crew transfer include tracking data, biomedical data, and vehicle/subsystem performance data.

The data is analyzed and, if it is within specified limits, the recommendation will be made to the MD for the crew to transfer to the laboratory vehicle. Upon completion of crew transfer, normal laboratory vehicle operation begins. Payload operations commence after all mission module system segment (MMSS) and photographic system segment (PSS) subsystems are checked, aligned, and conditions are "go". This is expected to be completed in time for photography on rev 6. The MCC flight operations crew: constantly analyzes OV data to assure proper systems operation; continually updates the ephemeris; and revises the mission plan to meet the requirements of The User. Orbit adjusts will be scheduled as the orbit decays due to atmospheric drag. These MCC Flight Operations activities require the continual generation of commands, ADC data, and instructions to the flight crew which are transmitted by the AFSCF, via SGLS, to the OV. The Recovery Director will be continually apprised of the test status by Flight Operations so the forces may be properly positioned for either normal or contingency recovery operations.

4.2.5 Reentry and Retrieval

For the manned/automatic mode, the reentry phase begins with initiation of severance of the Gemini B from the laboratory vehicle and concludes with Gemini B REM splashdown. This phase includes retrofire, reentry, parachute deployment, and REM touchdown.

The retrieval phase begins with splashdown of the REM and ends when the crew, data, and REM are retrieved and delivered to predetermined locations for initiation of postflight analyses. This phase includes location of the REM, physical recovery of the REM, crew, mission data, and initial medical examination and initial debriefing of the crew.

Orbital reentry operations support will consist of supplying information required for reentry tracking and spacecraft location for normal and contingency reentry, reentry planning, updating the Gemini B prior to separation, performing confidence checks on the Gemini B on-board computations, and Gemini B updating for contingency situations.

Reentry planning will be performed on a regular schedule and the pertinent information will be supplied to the crew over the normal SGLS uplink for on-board teleprinter output.

After receiving instructions, the crew transfers to the Gemini B. They initiate reentry after Gemini B separation from the laboratory vehicle. After Gemini B separation, the laboratory vehicle is operated in the automatic mode until ready for disposal. During Gemini B reentry, the Recovery Force tracks the Gemini B VHF recovery beacon, converges on the splash point, and effects recovery of the Gemini B and flight crew. Orbital operations are concluded with the disposal of the laboratory vehicle in a planned ocean area.

The postflight data evaluation period starts upon conclusion of orbital operations. A quick-look report will be issued during the orbital operation period covering the first five days of operation. Also issued will be the first POAD. (The POAD specifies the level and direction of the postflight analysis effort.) This activity is culminated when the final Flight Test Engineering Report is issued approximately 90 days after the conclusion of the orbital phase.

4.3 TEST PROFILE

The Test Profile is a time-ordered sequence of major operational events associated with prelaunch. The Test Profile for flights is contained in the FVTL (Ref. 23). The profile (see Table 4-4) shows the major prelaunch milestones in a typical operation, the approximate relationship of activity between the various operational groups, and the total timespan involved.

Little attempt has been made in Table 4-4 to accurately show the times of the various milestones. The main purpose is to show major functions that must be performed. Further operational design and documentation will precisely pinpoint these activities.

Certain assumptions were made in developing the profile:

a. The profile is typical for a manned/automatic flight.

b. The initial AFSCF and simulator facilities have been installed and checked out, and software integration tests have been successfully accomplished.

c. Flight crew simulator training starts as soon as the simulator configuration is changed from the previous flight.

For this preliminary issue of the FTOP, only those events readily identifiable have been included to provide an example of the planned presentation of information. The final FTOP will provide more specific events for the baseline profile.

Table 4-4. Typical Flight Test Operations Prelaunch Profile

Phase	Time	Description
Prelaunch	IML - 12 mo (required to support MS, MCC training, and ADS checkout)	Rehearsal training plan Flight support software System support software OV TLM signature tape STO - initial Calibration Data Book - initial
	IML - 9 mo	MS operational Flight plan - initial
	L -120 days	STO published by SAFSL (includes launch information, vehicle constraints, recovery constraints, configuration, etc.)
	L -90 days	Flight plan prepared Training and rehearsal plan prepared Primary and alternate orbits selected (less apogee altitude of alternate orbit)
	L -77 days	Laboratory vehicle segment checkout*
	L -60 days	Technical Operations Order (TOO) published by AFSCF Flight support software to STC Data base update to STC Calibration Data Book to STC Command Definition Specification and Hardware/Software Limitation Specification updated
	L -56 days	OV verification and checkout*
	L -49 days	FV integrated systems test*
	L -28 days	Launch dress rehearsal*
	L -14 days	Flight readiness test*

*See Ref. 22 for detail.

Table 4-4. Typical Flight Test Operations Prelaunch Profile (Continued)

Phase	Time	Description
Prelaunch (continued)	L -10 days	Certify final flight support and system support software
	L -7 days	Receipt of final target deck from User Selection of primary or alternate orbit (final selection of apogee altitude) Receipt of final cues from ACIC Update Flight Plan Prepare dress rehearsal training plan
	L -6 days	Begin dress rehearsals
	L -5 days	Prepare pad load command message
	L -1 day	Flight Readiness Review Board
Launch	T -590 min	Support launch countdown

4.4 FLIGHT VEHICLE TIMELINE (FVTL)

A brief summary of the FVTL is presented to acquaint the reader with the intent, purpose, use, and scope of the timeline. At this early point in the planning, it represents Operation's best estimate of how the OV will be used, and as such, allows a point for examining design philosophy. At a later date, when vehicle design is frozen, the FVTL will be the basis for initial flight planning. At present, it provides a source for a detailed insight, beyond that presented within the FTOP, into operational thinking on how the OV will be operated at a given time during the flight. Readers are cautioned not to extrapolate its use beyond that for which it is intended without first obtaining assurance that it is valid for their application.

4.4.1 General Objectives

The FVTL provides a means for integrating the operational and the design requirements of the MOL system to permit evaluation of the operational capability of the total system.

4.4.2 Specific Uses

a. Provides an insight to assessing system validity.

b. Flags potential design and operations problems.

c. Establishes the requirements for specific problem investigations.

d. Develops FV operational sequences and associated consumable profiles, procedures, ground rules and constraints contributing to the development of the flight planning data base.

e. Provides a nominal reference and point of departure for contingency analysis.

f. Identifies a need for additional engineering and operations trade studies.

g. Provides support to system effectiveness evaluation.

h. Provides support to simulator design and operation (development and mission).

i. Provides a basis for OV ground test definition.

j. Provides support to assessing system safety.

4.4.3 FVTL Definition

The FVTL is an engineering tool which provides a thorough analysis of an operational profile based on a consistent set of design parameters within the nominal operating range defined by the SP/DR (Ref. 20). It is a detailed examination of the operational capability of the total system based on typical operational loadings of the component systems. The FVTL presents on a time and location basis: the subsystem operating status; consumable profiles; and ground support requirements associated with typical operating sequences required to accomplish MOL test objectives. The time period covered extends from crew ingress on the pad to Gemini B splashdown and laboratory vehicle disposal. It is based on a given set of assumptions, definitions, and constraints.

4.4.4 Users of the FVTL

FVTL work is applicable to the following functional disciplines within the MOL SPO and associate contractor organizations:

a. Systems engineering

b. Simulator design and operations

c. Operations planning

d. Software development

e. FV ground testing

f. System segment design

g. Crew/task analysis

h. System effectiveness

i. Safety evaluation

j. Consumables management

To assure optimum use of the FVTL, maximum consistency/compatibility must exist between the FVTL work and other functional disciplines.

4.4.5 FVTL Report

Table 4-5 contains a list of items found the FVTL. The total FVTL starts with awakening of the crew on the day of launch and ends with the Gemini B landing and disposal of the laboratory vehicle. It is plotted to a scale of one-inch equals 20 minutes. FVTLs are generated for specific orbit cases and include the best target data available for payload operations.

Currently, an FVTL exists for the 80 deg inclination orbit (Ref. 23). A FVTL for the baseline orbit (90 deg inclination) is scheduled for publication in September 1968. Timeline reissues or revisions are planned on 9-month centers.

Table 4-5. FVTL Column Headings

Crewman A Sequences
 	
Crewman B Sequences
 	
System Time
   GMT
   SEC
 	
Automatic Sequences
 	
Rev, Day-Night Cycle, Sun Angle
 	
Latitude, Longitude
 	
Ground Support
 	
Ground Stations
 	
Tape Usage
   PCM
   Voice 1
   Voice 2
 	
Subsystem Status
   Data Management
      Computation
      Command
   Mission Module
   Communication
   ACTS
   Data Acquisition
   EC/LS
   Power
	Expendables
	   MMH
	      Expended
	      Remaining
	   N_2O_4
	      Expended
	      Remaining
	   H_2
	      Expended
	      Remaining
	   O_2
	      Expended
	      Remaining
	   He
	      Expended
	      Remaining
	   Film Usage
	
	Power
	   LM
	      PK
	      AVE
	   MM
	      PK
	      AVE
	   GB
	      PK
	      AVE
	   Total
	      PK
	      AVE

5.0 LAUNCH OPERATIONS INTERFACE

5.1 GENERAL

The interfaces between the Launch Operations portion of the ground test and the Flight Test Operations are presented in this Section. The ground testing and flight operations testing reciprocal requirements are described. A brief description of the Launch Operations portion of the ground test is presented for information only. In the event of any differences between this description and that contained in the General Ground Test Plan (Ref. 2), the latter will take precedence.

5.2 LAUNCH OPERATIONS

The 6595th ATW is responsible to the MOL SPO for the overall conduct of Launch Operations.

The various associate contractors will be responsible for their particular flight hardware, prelaunch, and launch operations are under the management of the 6595th ATW. The MOL program integrating contractors will also be responsible for specific integration tasks, under the direction of the ATW, such as the planning of test flow, integration of checkout and countdown requirements, etc. Figure 5-1 illustrates the MOL VAFB Space Launch Complex No. 6 (SLC-6) as secured during countdown. Specific functions and responsibilities in the conduct of Launch Operations are designated and defined in the SAFSL Exhibit 20023 (Ref. 22).

5.2.1 Launch Operations Profile

Launch Operations requirements are broadly defined in this Section to permit latitude in the development of lower-level documents and procedures (see Ref. 2 for details). Test requirements will vary where configuration differences indicate a nonapplicable operation or test. However, upon receipt of a vehicle segment AVE at VAFB, launch test planning will assume: (1) a minimum

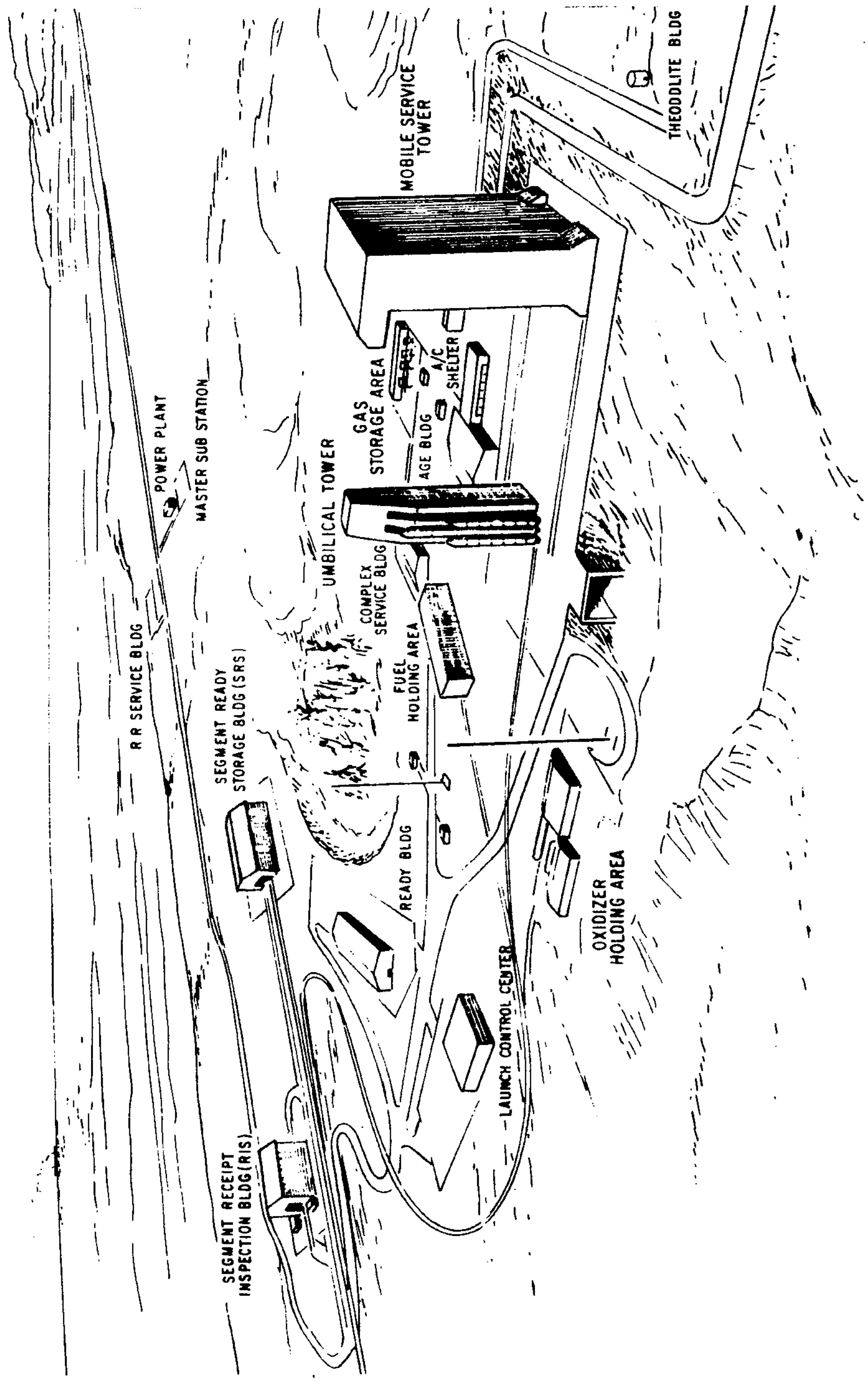


Figure 5-1 MOL VAFB Launch Complex

of factory open tasks and engineering modifications for VAFB accomplishment; and (2) highest possible confidence in structural and functional integrity as received from the various segment factory sites. In-plant tests and acceptance test requirements will be documented in the General Ground Test Plan.

In the appropriate sequence, all interfaces with the AFWTR, VTS, MCC, and crew, will be exercised for verification. The flight crew will participate as necessary to verify their compatibility with the FV. A launch dress rehearsal will be performed to demonstrate the ability to conduct and control time-critical and sequential functions during the launch countdown. Integrated prelaunch phase testing will normally be concluded on completion of a Flight Readiness Test (FRT). This FRT is a final all-agency, all systems-up test conducted immediately prior to initiation of Launch Readiness Operations. The results of the FRT and preceding tests will provide the necessary baseline for final commitment to the launch preparation and the launch phase of operations.

5.2.1.1 Launch Readiness Operations

Launch Readiness Operations, the final step before entry into the countdown, consists of such tasks as ordnance installation, propellant, cryogenic and pressurant loading, vehicle alignment checks, flight battery installation, subsystems final verifications, and AGE demate. The sequencing and content of these functions will be determined by safety and validity considerations. Control, as with all launch operations, will be the responsibility of the 6595th ATW.

5.2.1.2 Countdown

The countdown will be a clock-controlled sequence checkoff of final systems tasks and verifications with all agencies "on-line" and maintaining full and responsive status in their areas of responsibility. Milestones in the countdown sequence are: tracking, data, and command networks-ready; final ordnance installation and hook-up; propellant tanks to flight pressures;

airborne systems final validation; primary flight crew insertion; mobile service tower (MST) roll-back; entry into automatic sequence; liftoff.

Final liftoff commitment for launch operations will be the decision of the LCC launch director under cognizance of MCC. Countdown sequential operations procedures will be contained in the Countdown Manual for each specific flight. A preliminary countdown procedures document will also be published for planning purposes.

5.2.1.3 Post-Launch Operations

The post-launch operations phase will commence upon FV liftoff and will consist of those operations necessary to restore SLC-6 to the configuration required to accept the next vehicle segments and to report on the evaluation of the launch operations. These operations will include facility and AGE standard and non-standard refurbishment both by repair and/or replacement and facility and/or AGE modifications necessary to support the next FV and all possible revalidation of the facility and AGE.

During this phase, all locally available data and films from the launch and flight will be reviewed for possible anomalies and/or significant trends.

Test and operating procedures for the next vehicle will be reviewed and revised as necessary to support the next vehicle.

6.0 FLIGHT OPERATIONS

6.1 GENERAL

The plan for MOL Flight Operations is described in this Section. While the flight phase only includes liftoff through disposal of the laboratory vehicle, Flight Operations includes all the preparation (development, integration/system test, and rehearsal) for that phase as well as the postflight reporting. This Section describes the facilities and resources, including the AFSCF, used by Flight Operations. The data handling system and the software system are treated as separate, integral systems to provide a more comprehensive and understandable description. The MOL Operations concepts are explained by descriptions of the command and data handling philosophies and the preflight planning concept of orbit planning and selections.

6.2 FACILITIES AND RESOURCES

The facilities and resources which MOL Operations expects to utilize are the AFSCF; the AFSCF and AFWTR data handling facilities required for ascent and on orbit control; the integrated MOL/AFSCF software system; and the MCSF.

6.2.1 Air Force Satellite Control Facility (AFSCF)

6.2.1.1 General

The AFSCF is a ground-based, worldwide network of ground stations designed to monitor, control, and recover earth-orbiting space vehicles. Overall system management and direction is provided by Headquarters, SAMSO, LAAFS.

6.2.1.2 Satellite Test Center (STC)

The STC, located in Sunnyvale, California, is the central system-control point for directing test operations, and is capable of directing the support of many satellites in orbit simultaneously.

A network of seven RTSs under the operational control of the STC performs tracking, commanding, and data-retrieval processing and relay functions from selected points around the world. Three of the RTSs have sufficient equipment to provide a dual test-support capability.

Associated with the operation of the AFSCF is an aerial and surface recovery force stationed in Hawaii which recovers preselected space vehicles that have terminated their flight phase. Additional support aircraft are located at Edwards AFB, California, to provide downrange surface-to-air pickup and delivery of launch-and-ascent data tapes.

The facilities and capabilities at the STC and the RTSs will be expanded to enable the AFSCF to support the increased number, complexity, and capability of satellites of existing and future programs. Among these will be the MOL vehicles. The expansion of facilities includes the construction of an additional four story operations building, the Advanced STC (ASTC), adjacent to the present STC (see Figure 6-1). The expansion of the AFSCF capability includes updating the existing data handling and processing facility with additional and more advanced computers to form an ADS and the automated checkout and reconfiguration of the communications system by installing advanced switching capability to form the EXCELS.

The configuration and capability of the STC's Mission Control Complex (MCC) areas will be increased to allow faster, more complete access to data, and to allow for program control of the access to its data.

6.2.1.2.1 Advanced Satellite Test Center

The mission of the ASTC is to provide centralized management, direction, and control of the readiness, execution, and evaluation activities of Test Force Elements in support of program test operations. These responsibilities include: (1) development and publication of network operating policies and procedures; (2) test-operation planning; (3) system readiness for test operations; (4) real time, on-orbit satellite command and control (plus recovery, if required); (5) orbit determination and analysis; (6) data retrieval, processing, and distribution; (7) system resource management; (8) management of a communications network linking the STC with all satellite test-force elements; and (9) ENV services. The facilities described below are required to perform these functions.

The AFSCF Director for Test Operations (SMOT), responsible for the direction of space-vehicle program testing at the STC, appoints an officer as FTFD for each specific space program to be supported (see paragraph 3.6.1).

6.2.1.2.2 Operations Building

The operations building at the ASTC will be a four-story structure containing approximately 120,000 sq ft of floor area (see Figure 6-1).

a. First Floor - The first floor of this building will include a 24,400 sq ft communications area which will house the communications and security equipments for the AFSCF network.

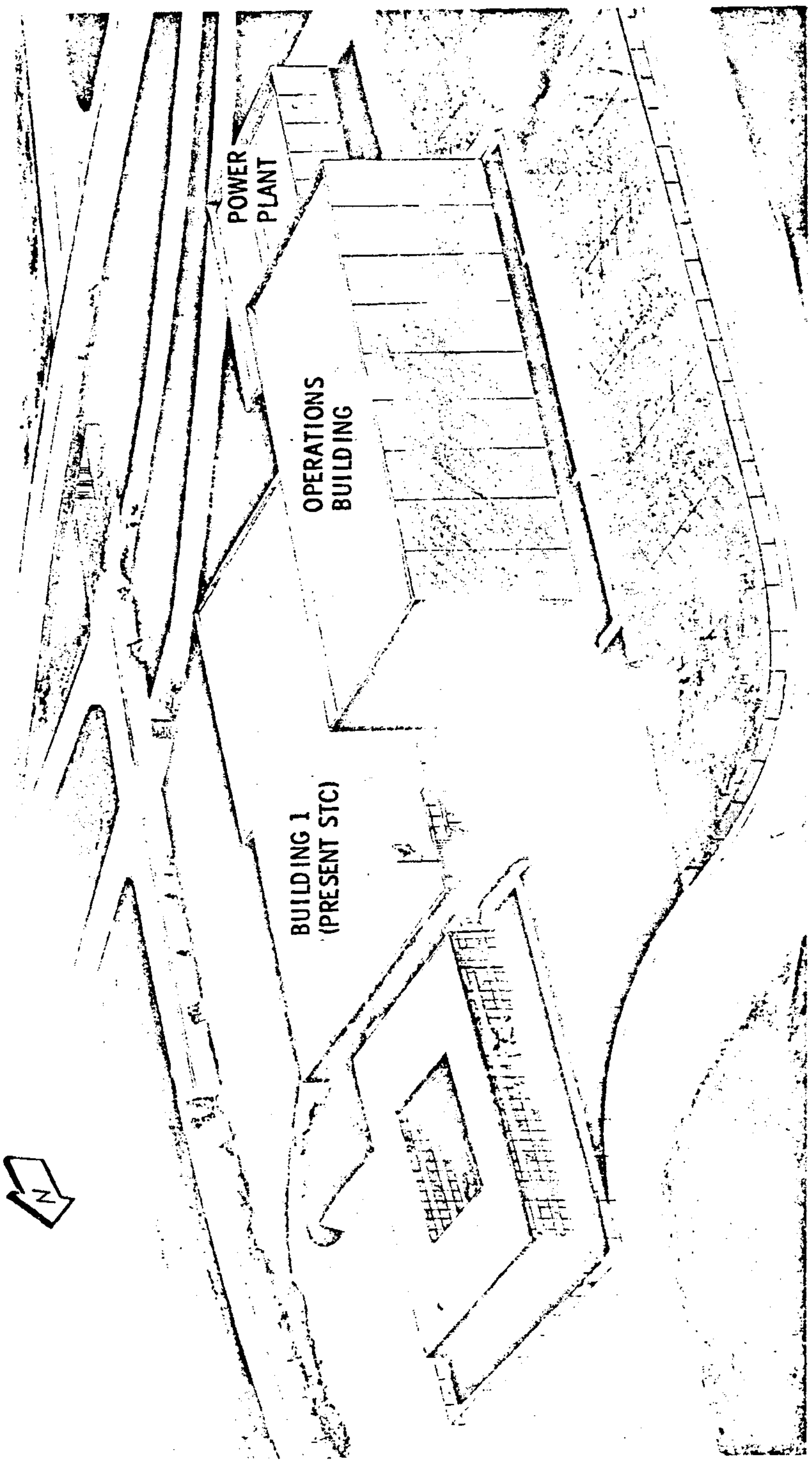


Figure 6-1 Artist's Concept of the STC at VAFB Sunnyvale

In addition to the normal communications terminal equipment, a communications control computer complex will be installed in the first-floor communications area.

b. Second Floor - The second floor of the structure, designated the Data Systems Area, will consist of approximately 27,000 sq ft of technical floor space. The bulk of the data handling and processing for the AFSCF will be accomplished here. Included in the data area are five secured computer rooms that contain CDC 3800 computers.

c. Third and Fourth Floors - The third and fourth floors are designated the operational floors. A modular-type floor-plan has been developed to meet the requirements for satellite mission control. A typical mission control module consists of three operating rooms and three technical support rooms arranged in a square (60 x 60 ft) configuration. A Mission Control Complex, defined as a contiguous group of rooms assigned to support one particular program, is then configured by assigning the necessary rooms from one or more mission control modules to the particular satellite program.

d. Area L - Communications with The User will be routed through Area L on the fourth floor above the MOL MCC. Direct communications with The User will be tied in with the MOL MCC by use of private keys and cabling of lines between consoles in the MCC and Area L. This area will provide centralized control of the black ADS in support of the MOL and other MCCs. The AFSCF ND will control the white ADS in the same manner. The MOL MCC will have access to the required information under distribution and priority control by Area L.

6.2.1.2.3 MOL Mission Control Complex

The MOL MCC, one of five MCCs to be located on the third floor of the new ASTC, will be composed of three standard 60 x 60 ft mission control modules arranged in an L shape (see Figure 6-2).

The MCC provides a centralized control point for the management, direction, control, and scheduling of all aspects of the MOL program. All decisions affecting present and future actions will be made by the FD in the mission control room (MCR).

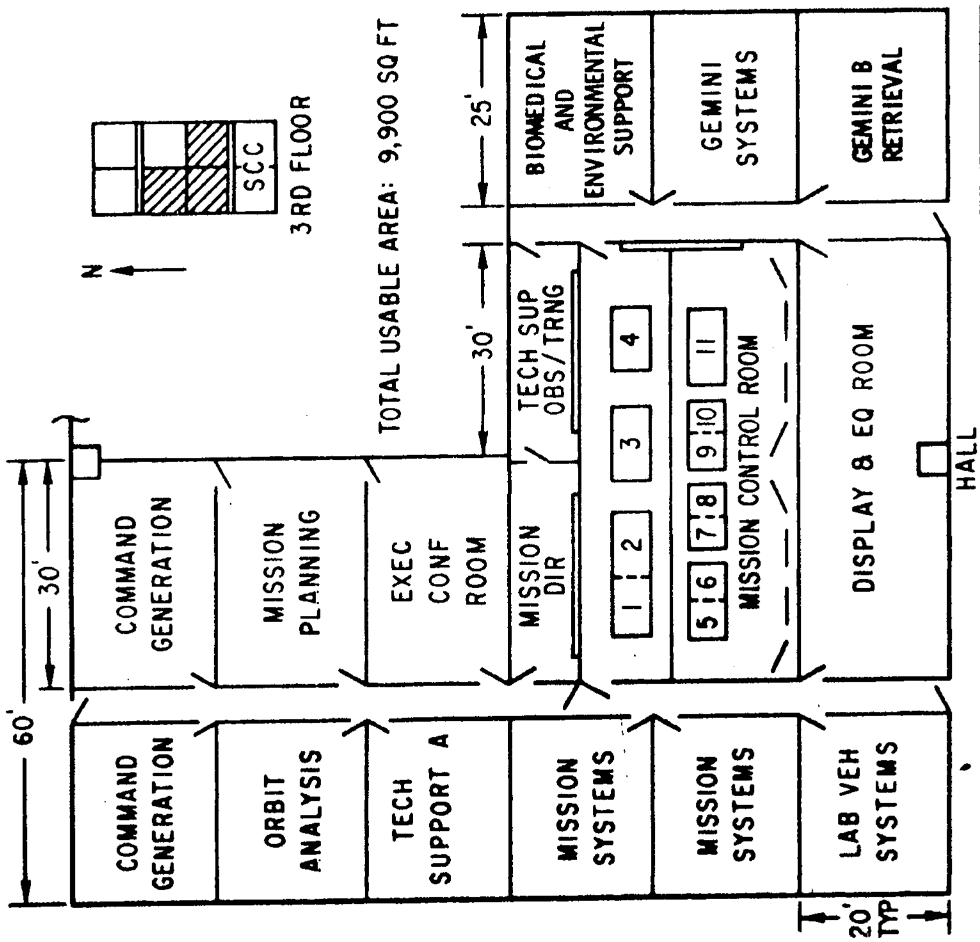


Figure 6-2 Mission Cor pl Center Configuration

The 30 x 60 ft MCR will contain the consoles required for real time control (see Figure 6-3). The three 20 x 25 ft technical support rooms shown in Figure 6-2 are planned to be used as follows: one for use of contractor personnel; one for use as the RCR (see Figure 6-5); and the third for bio-medical monitoring. The 20 x 30 ft support rooms (see Figure 6-4) will be used for mission planning, orbit analysis, vehicle analysis, etc.

The design of the MCC will assure complete security within the MCC from other programs. Only those personnel associated with the MOL program will be allowed into the complex. Access to MOL data is restricted to personnel within the complex.

MOL program access to the AFSCF facilities necessary for MOL support rests with the FTFD within the MOL control room. The FTFD will respond to requirements levied upon him by the FD. All significant deviations from planned operating procedures and mission requirements must be approved by the FD prior to implementation. All identifiable contingencies must be resolved prior to flight; guidelines for corrective action will be included in the Flight Test Rules document.

The FTFD will coordinate all AFSCF resources, including AFSCF personnel in the MOL control room and in the support rooms, to satisfy MOL requirements. The FTFD will act as liaison between the MOL SPO and the AFSCF. All changes to operating procedures, schedules, or MOL requirements will, after FD approval, be passed through the FTFD for integration into the AFSCF operation. The FTFD will actively coordinate all AFSCF resources during flight in accordance with published procedures, directives, and schedules to meet mission requirements. He will follow the flight test rules in resolving anomalies and contingencies.

Since the MOL program will be operating within a multi-satellite-program environment, all changes or contemplated changes to schedules, plans, or requirements must be coordinated through Network Control by the FTFD.

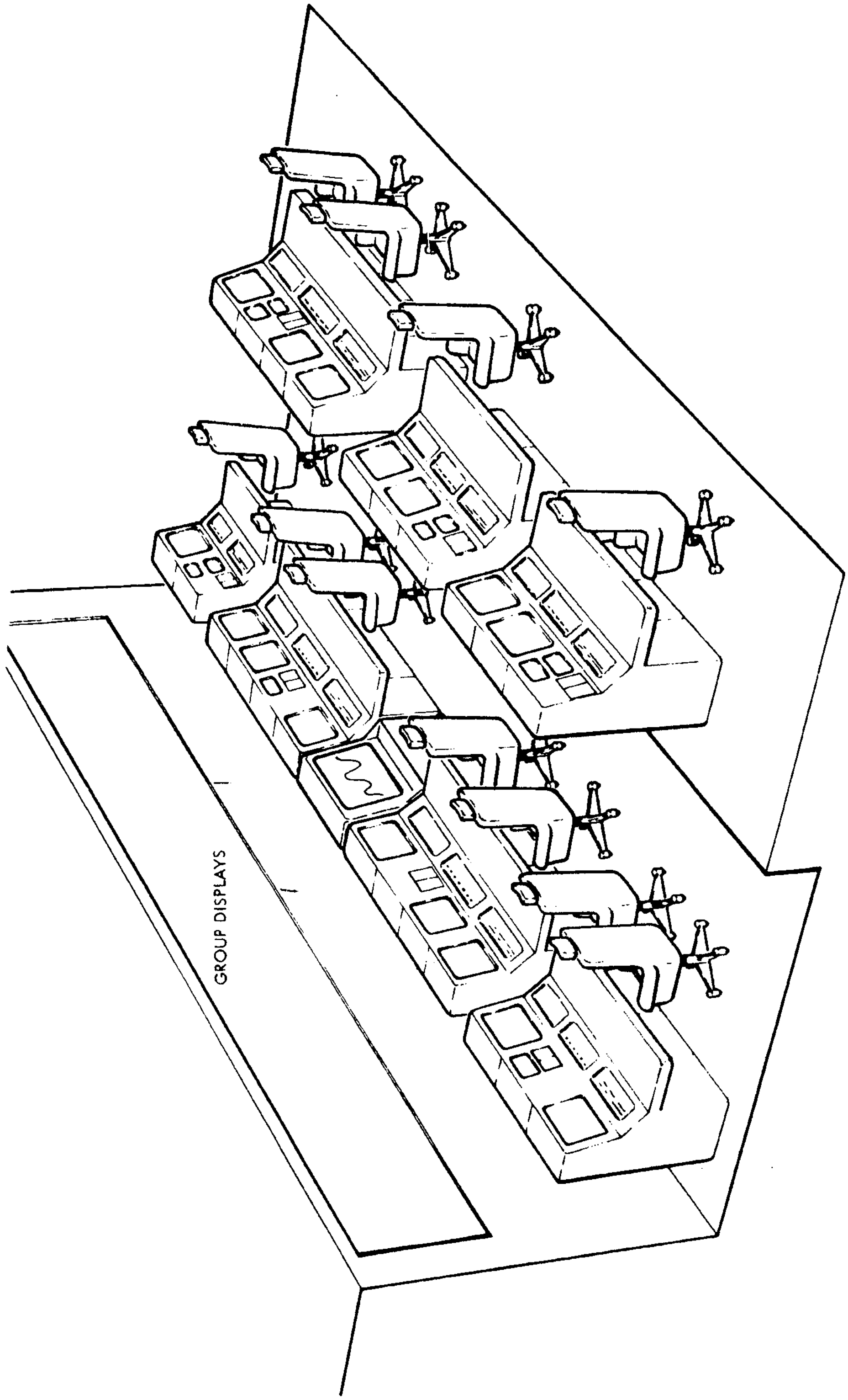


Figure 6-3 Typical Console Arrangement for Program 632A Mission Control Room

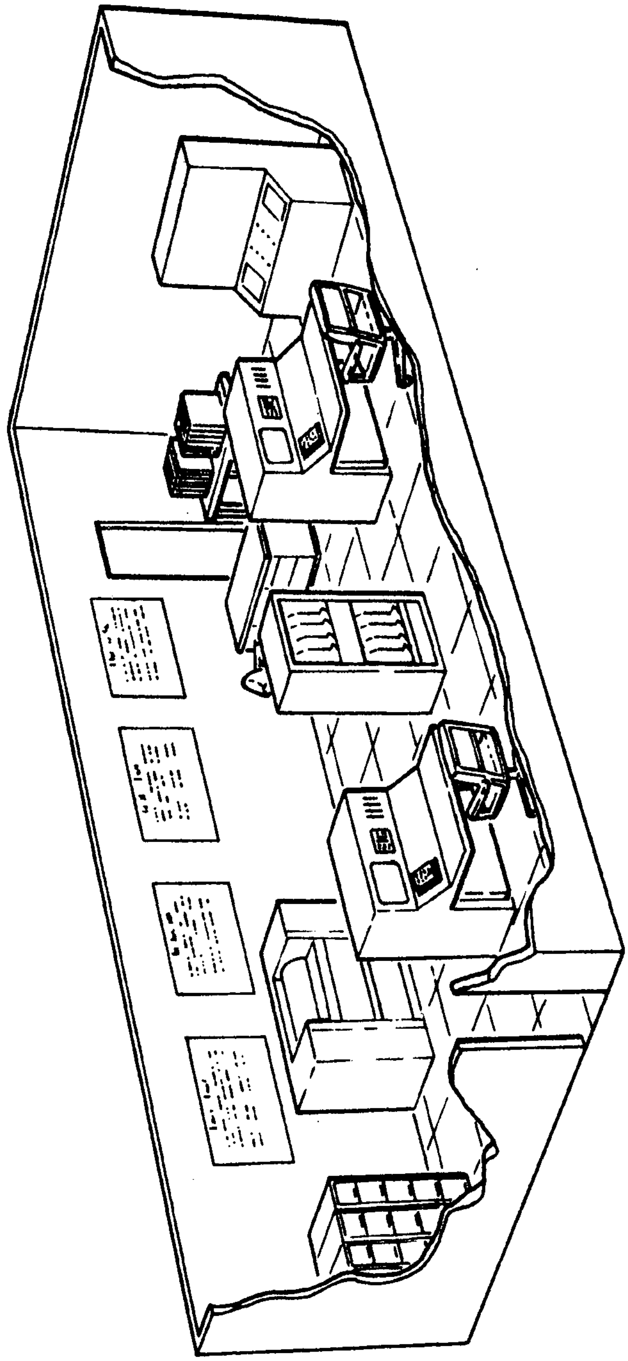


Figure 6-4 Artist's Concept of a Technical Support Room

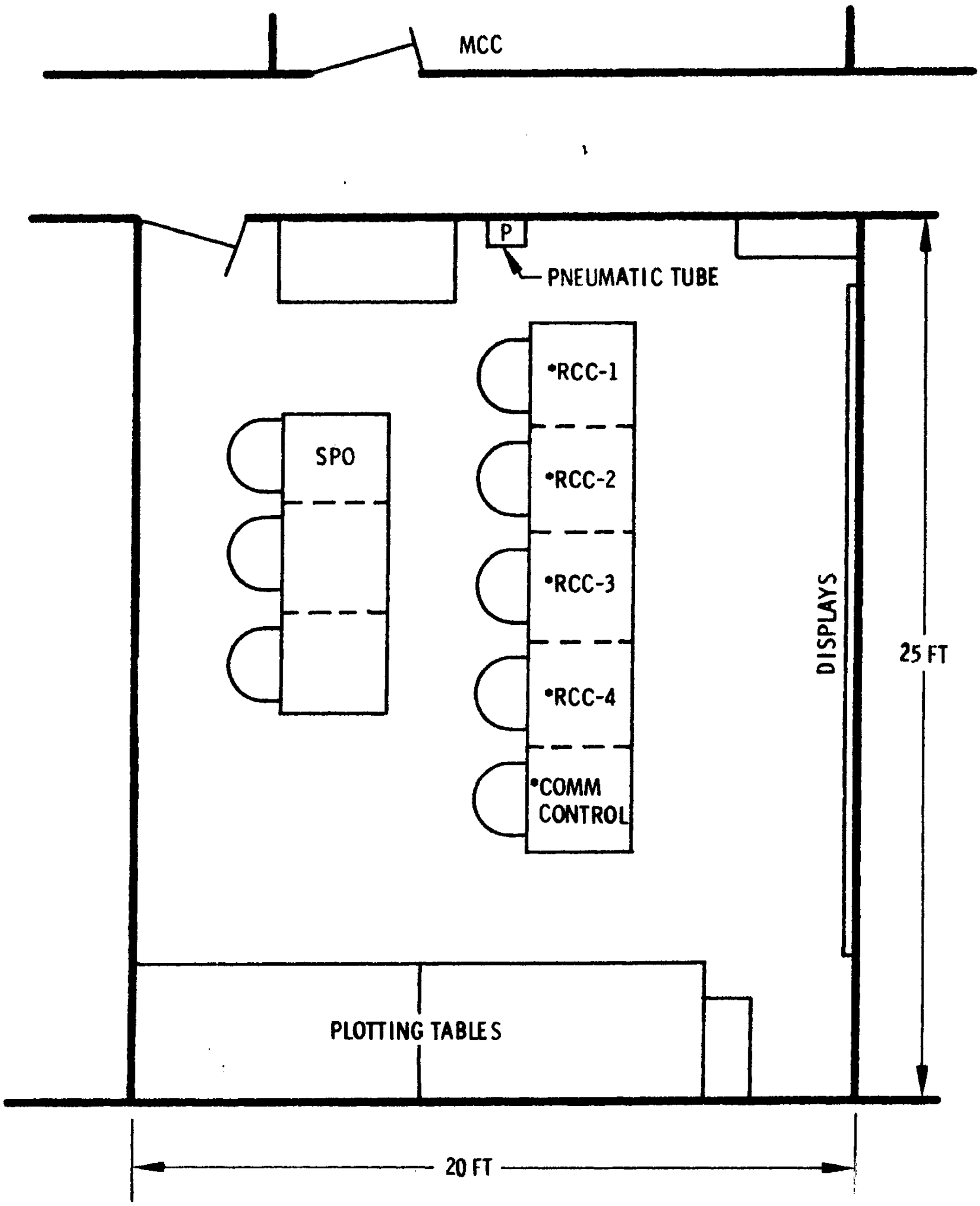


Figure 6-5 Proposed Recovery Control Room

Procedures for controlling inputs to the AFSCF data base are developed and coordinated by the FD and the FTFD. Any changes in these procedures must be coordinated through the FTFD. Any changes to the planned contractor or MOL SPO personnel access to STC computers and to the MOL-peculiar data base will be coordinated and scheduled through the FTFD.

Functions of key elements within the MCC are described in Section 3.0. The Command Generation and Orbit Analysis functions (see Figure 6-2) are performed from support rooms, not the control room.

6.2.1.3 Network Control Complex

The ASTC Network Control Complex (NCC) provides a centralized control point for the management, direction, and scheduling of all activities using AFSCF resources to accomplish satellite test objectives.

The ADS, with its large data storage capacity, sophisticated programming, and advanced display subsystems, will provide the ability to automate: (1) scheduling with emphasis on conflict avoidance; (2) RTS configuration; and (3) system checkout and fault isolation. An intervention capability is provided for manual override of the system. The NCC provides facilities for three major functions: network control, network scheduling, and inter-range liaison.

6.2.1.3.1 Network Control

The Network Control Room is the focal point of the support allocation and configuration control activity and provides facilities for the Network Controller and his immediate supporting staff (the Configuration Controller, Data Systems Operations Controller, Communications Controller, and the Data System Security Controller).

a. Network Controller - Prime function is resource allocation. Provides overall network management and staff direction within the NCC. Directs conflict resolution by negotiation, priority application, or emergency resolution authority. Monitors MCC status and directs solution of real-time problems.

1. Configuration Controller - Implements the schedule by verifying correct ASTC/RTS configuration. Maintains cognizance of network status; evaluates the impact of outages, and coordinates with Scheduling for alternative courses of action.

2. Data System Operations Controller - Exercises operational control of the ASTC/RTS ADS, computer loading, and ADS diagnostic and recovery efforts.

3. Communications Controller - Monitors EXCELS operation for automatic switching and manually switches when directed by the Network Controller. Expedites circuit restoration and interfaces with communication elements external to the ASTC.

4. Data System Security Controller - Controls and maintains coded keys for classified data access and monitors the security subsystem for any improper attempt to access this data base.

6.2.1.3.2 System Scheduling

The second major functional area in the NCC is Network Scheduling which is manned by six schedulers on a 24-hr basis. All AFSCF activities, including flight support, qualification activities, maintenance, equipment installation, and software development are scheduled by manipulation of the scheduling data base. Long range planning is provided to allow for major modification and installation of AFSCF equipments as projected through a 12-month period. Operational scheduling is conducted over a two-week period to provide maximum support of all program and maintenance requirements through conflict avoidance. The real-time schedule covers the immediate 24 hr period when all remaining conflicts are identified with alternative resolutions presented for the Network Controllers' decision.

The dynamic satellite support requirements require constant manipulation and update of the data base.

6.2.1.3.3 Inter-Range Liaison

The last major function performed within the NCC is the inter-range liaison and recovery operation. This staff function provides the ASTC interface with outside agencies for operational range support including cognizance of Range capabilities. Additionally, the scheduling of AFSCF recovery forces and the resolution of recovery force conflicts will be a major responsibility.

6.2.1.4 Remote Tracking Stations

The AFSCF RTSs are under the operational control of the STC during support operations. They contain the transmitting, receiving, and tracking equipment necessary to determine the position of, and command and receive data from, a satellite as it passes within range. Each RTS will have the ground-based part of the new SGLS and will have its own complement of the ADS and EXCELS subsystems linked with the STC central data-processing facility.

Automatic control of the tracking, telemetry, command, and communication functions is performed from an MCC in the STC via direct computer-to-computer transfer of instructions and data. Two computers at each RTS are programmed to allow processing of important data to continue uninterrupted if one computer complex fails. In the event of other equipment malfunction, such as the loss of the interstation data link, control may be exercised from the RTS control and display subsystems. Although the RTS ADS control and display subsystem is similar to that for the STC ADS, only AFSCF functions can be displayed at the RTS. The three prime station functions for present programs are:

a. Telemetry - The tracking station performs limited processing, handling and relay functions by receiving and transmitting telemetry data from orbital vehicles to the STC. The RTS receives the records telemetry data from orbiting vehicles and provides selected computer processed data items to the STC as required for real time control.

b. Tracking - Data consisting of range, range rate, and angle information are derived and transferred to STC to derive the orbital parameters and ephemerides of the satellite.

c. Command - The RTS, in response to computer-issued instructions from the STC, sends a variety of commands to the vehicle by automatic relay, or manually during emergency conditions.

For MOL Operations, a fourth function, voice, will be implemented. The voice system will utilize the analog link of the SGLS for clear voice or the digital link for secure voice. The RTS acts only as a relay for voice communications between the MCC and the MOL.

The seven AFSCF RTSs are each connected to the STC via the EXCELS:

Station	Capability*
**New Hampshire Tracking Station (NTS)	AFSCF
Vandenburg Tracking Station (VTS)*	AFSCF
**Hawaii Tracking Station (HB)	AFSCF
Indian Ocean Tracking Station (IOS)***	AFSCF
Kodiak Tracking Station (KB)***	AFSCF
Operating Location 5 (OL-5)*** (Thule, Greenland)	AFSCF
Operating Location 10 (Guam) (GTS)	AFSCF

6.2.1.5 AFSCF Communications System

The communications system within the AFSCF consists of intra-STC communications and inter-AFSCF communications. In addition, the system may be patched to other non-AFSCF systems for utilization during contingency situations. A detailed description of the system's capabilities, including plans for MOL, is presented in the following paragraphs.

*AFSCF capability means full SGLS TTCV.

**Sufficient equipment to support two satellites simultaneously, thus increasing the actional capability of the tracking network to a total of 10 stations.

***Full SGLS plus VHF voice.

6.2.1.5.1 Intra-STC Communications

a. Pneumatic Tube System - A pneumatic tube system will be installed which will provide full duplex service among the following areas:

1. MCC control rooms.

2. Communication center.

3. Communication control room.

4. Network control complex.

5. Data recording center.

Delivery time from a terminal to any other terminal in the loop will be less than one minute.

b. Black Telephone System (Unclassified Voice Communications) - Each MCC will be provided one or more 304 voice drops. In the event of failure of automated communications, this system will be used for voice contact with tracking stations. All administrative communications from the ASTC will be minimized and will be routed through the system 304 switching system to the STC administrative switchboard.

c. Green Telephone System [Secret Special Access Required (SAR) Voice Communications] - This system will comprise the main ASTC intra-communications. Each TC console will be equipped with a direct access panel capable of calling up as many as 12 stations in conference. The system will be cleared for classified information up to and including secret. A limited number of green telephones will be extended to the "old building".

d. Red Telephone System [Secret Special Handling (SSH) Voice Communication] - A discrete secure voice communication system will be installed in each MCC, primarily for program-secure conferences. All switching equipment and circuits will be wholly contained within the MCC with the exception of one voice link to Area L. At the TC position, a privacy feature will be installed that will enable him to call up any combination of telephones and lock-out the remaining telephones. The equipment will be designed to permit three independent secure voice conferences.

e. Printed Traffic Communications - Each MCC will have a printed traffic terminal consisting of a cathode ray tube (CRT), keyboard, and electrostatic printer. Transmission rates will be as high as 3000 wpm (compared to the existing 100 wpm machines). Messages addressed to an MCC will be automatically routed to the message terminal in the MCC where the TC will have the option of selecting CRT and/or electrostatic page copy. The TC, by interrogating the 8500 computer, will be able to recall any messages addressed to his program. A memory-protect device programmed into 8500 computer instructions will prevent any unauthorized message terminal from accessing program material. Additionally, a series of fixed format messages which a Controller can call up on the CRT will be stored in the 8500 computer. With the aid of the cursor and the keyboard, he will be able to fill in the blanks and transmit the messages automatically throughout the network.

6.2.1.5.2 Inter-AFSCF Communications

a. Data Circuits - The primary AFSCF communications system will consist of multiple secure 2400 bps digital circuits to all tracking stations, the OTEF, the RCG, and a MOL-peculiar dedicated voice circuit. Communications modes of voice, printed traffic, and digital traffic to the ADS will be contained in this automatic communications system, EXCELS. Similar digital communications with the Launch Operations Control Center, AFWTR, AFETR, SPADATS, and the AF Global Weather Central (AFGWC) is envisioned for the 1969-1971 time period.

b. Automated Digital Communications - The 2400 bps circuits will be controlled by two Collins 8500 series computers at the STC. Two additional computers will be initialized in a standby mode to be automatically switched on-line in the event of primary computer failure. Under computer control, the digital circuits will be automatically switched to the control of the MCC that is scheduled for a pass with an RTS. A periodic schedule will be transmitted from the ADS computer to the EXCELS computer on a core-to-core interface. The TC in the MCC can switch any circuit to any service desired (i.e., spare line to voice, printed traffic to data, etc.). In addition, the 8500 computers will automatically substitute a spare circuit whenever the data quality for ADS falls below a designated threshold. Real time changes, reassignments, pre-emptions, etc., will be made from a communications console in the NCC on the third floor of the ASTC.

A duplicate console will be located in the Communications area on the first floor to be used as a maintenance point and backup console for Network Control.

c. Secure Voice - When assigned a tracking station, the TC in each MCC can dial up any of the standard AFSCF secure telephones at that tracking station. Additionally, if he is assigned more than one tracking station, the TC can connect these stations together for simultaneous transmissions to the RTSs. At the STC, the TC will have a speaker net system connected to each secure voice terminal so that the individual rooms within the MCC can monitor the commentary. The TC also will have switches by which he can eliminate any one or all of the speakers from the commentary. Slave telephones (extensions) from the TCs master phone will be located at other consoles within the MCC. Tracking stations will be available for dial-up by any MCC if the circuits have not been scheduled by the Master Systems Schedule. (This system should not be confused with the MOL private secure voice line.)

d. Fault Isolation - An extensive malfunction detection and display subsystem is programmed into the EXCELS system to allow for fault isolation and rapid correction. One of the features of this system is link exercising whereby all spare circuits will be continually monitored with a test pattern. When error thresholds are exceeded, alarms will display the failing link for immediate restoration action. EXCELS is required to maintain an undetected bit error rate of less than 1×10^{-8}; however, no error correction system is included. Data errors exceeding the preset threshold will be flagged by EXCELS for the ADS.

6.2.1.5.3 MOL Communications

MOL will be provided with the capabilities described above. The MCC will use four 2400 bps EXCELS data circuits in the following manner for the support of MOL:

a. Secure voice for RTS control.

b. High speed telemetry, tracking, and command data line.

c. High speed teleprinter line for control messages.

d. Spare line to substitute for any of the above.

In addition to the four lines indicated, a fifth 2400 bps line will be a MOL-dedicated secure-voice line outside the EXCELS for MCC-to-OV communications. This line may be used for any of the services listed in paragraph 6.2.1.5.2, at the discretion of the FD, by a manual patch capability.

6.2.2 Data Handling System

Typical MOL data handling of the AFSCF and AFWTR system during MOL operations is described below. This data handling system is the basis for numerous operations concepts; conversely, its capabilities reflect operational concepts devised to take maximum advantage of the MOL capabilities. The basic data handling philosophy is described in paragraph 6.3.3.

Control and monitoring of the MOL vehicle is achieved principally through the OV uplink and downlink channels, and the data handling, display, and processing capability of the AFSCF and the MCSF. Maximum efficiency, thoroughness, and speed of monitoring and controlling the MOL flight is achieved by proper utilization of all MOL associated data sources, communications links (both between the OV and ground, and within the AFSCF), data handling sources, and data processing capability. The following paragraphs describe in detail the method of utilizing the MOL data sources and briefly mention the handling capability established to meet the MOL flight objectives.

6.2.2.1 Real Time Ascent Data Handling

AFWTR facilities required for Flight Operations are restricted to the communication and data handling required to support the ascent phase.

Data that is processed for MCC display originates either as TLM data from the launch vehicle and the OV, or as radar tracking data. The launch vehicle data is carried on an S-band link, and the OV data is transmitted via the SGLS. The voice, TLM and/or radar sites are located at VTS, AFWTR, PMR, and the MIS. Figure 6-6 shows the ascent TLM and radar facilities at the different sites, the time periods following liftoff during which the ground sites should deliver acceptable data, and the communication links, processing areas, and

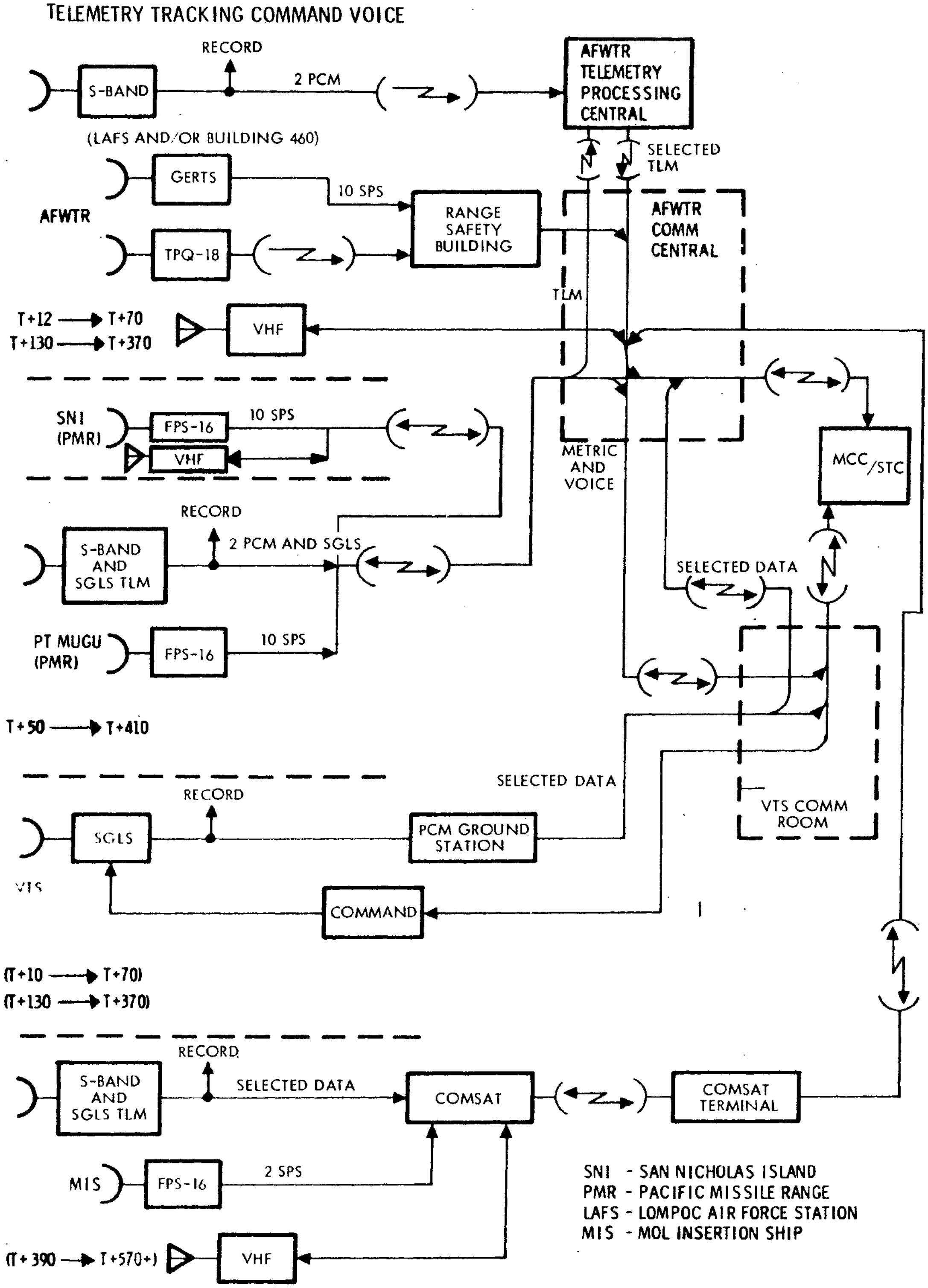


Figure 6-6 Real-Time Data Flow - Ascent

communication centers which handle the data. The data are preprocessed and formatted before transmittal to the STC. The data will be transmitted from the AFWTR communication central (Bldg. 475) over redundant wide band microwave links (475/VTS/STC - Western Union System; and 475/STC - Pacific Telephone System). The MIS data are transmitted via the communications satellite system to AFWTR for re-transmission tc the STC. The detailed processing, formatting, and routing are discussed in Refs. 15 and 16.

Upon arrival at the STC, the data is accepted by the ADS for formatting, and routing, and is then sent to the CDC-3800 for processing. The CDC-3800 performs the computations necessary to transform the data into the proper parameters for display, formats the data, and returns it to the ADS. (Two of the System II computers are on line during the ascent phase, with one acting as a "hot" backup to the other.) The ADS then reformats the data for processing by the format and display definition buffer, and sends it through the display controller for subsequent display. A schematic representation of the relationship between the software application programs and the 632A MCC displays is depicted in Figure 6-7. The number of computations required for a particular CRT or status light panel display have been grouped by functions and defined as tasks in Ref. 4.

6.2.2.2 Orbital Operations Data Handling

6.2.2.2.1 Uplink

The uplink capability includes development of the uplink messages initiated within the STC upon directions from the MCC and transferred to the OV via the RTS. The uplink data is comprised of command messages (all, or any, of the following: real time and stored program commands; prose messages; target and ephemeris data) and secure voice digital data.

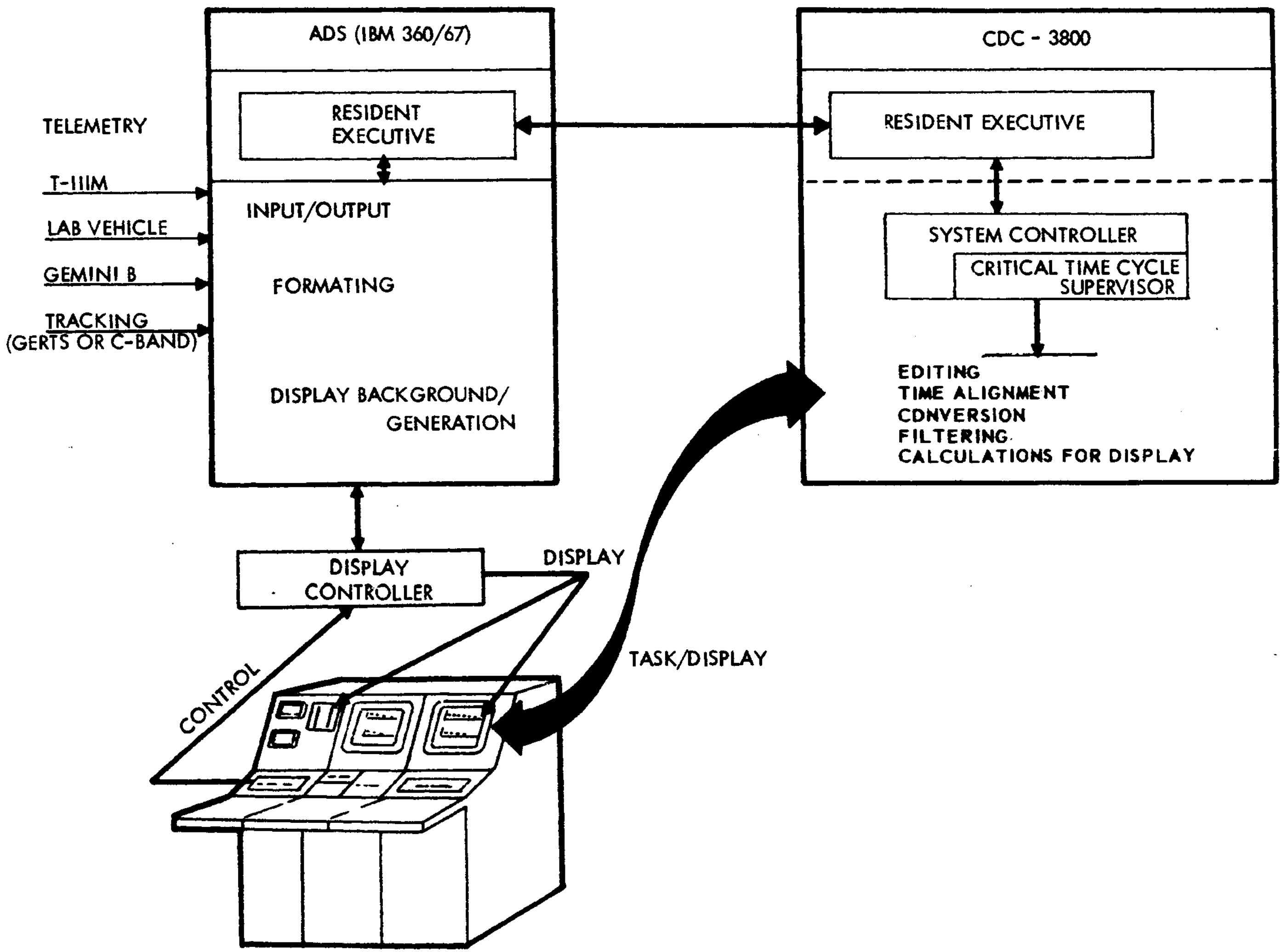


Figure 6-7 Applications Program/Display Relationship

6.2.2.2.1.1 Command Messages - STC Handling

Based on the required MOL flight plan and analysis of the current condition of the OV, the MCC, by means of the CDC-3800 computer within the STC, formats the OV command messages and makes block assignments and stores the message in the STC IBM 360/67 buffer computer. During the prepass period, the message is transmitted to the RTS via secure EXCELS link (KG-13).

6.2.2.2.1.2 Command Message - RTS Handling

The RTS decrypts (KG-13) and temporarily stores the command messages for transmittal to the OV when required. No command message processing is performed at the RTS. When the initial message is received, it is returned to the STC for a bit-by-bit comparison with the original message. Then the message is stored in the RTS 1230 MTC computer. At this point, the message is in clear format.

When the OV is in contact with the RTS, the MCC initiates command message transmission. At that time, the command message stored in the RTS computer is sent to the RTS's SGLS transmitter via a KGT-29 for encryption.

6.2.2.2.1.3 Command Message - OV Handling

The command message is received in the OV by the SGLS-compatible communications system (see Figure 6-8). After being decrypted, the SPCs are sent to the computer via the command logic unit (CLU) and laboratory data adapter unit (LDAU) for storage. Laboratory module real time commands are sent directly to the laboratory decoders via the CLU. Mission module real time commands are sent to the mission module decoders via CLU, LDAU, computer, and mission data adapter unit (MDAU). Using the LDAU, the computer sends data to the printer and/or alphanumeric displays. Under anomalous conditions, prose data can be sent directly to the printer using "S" pulses for fill.

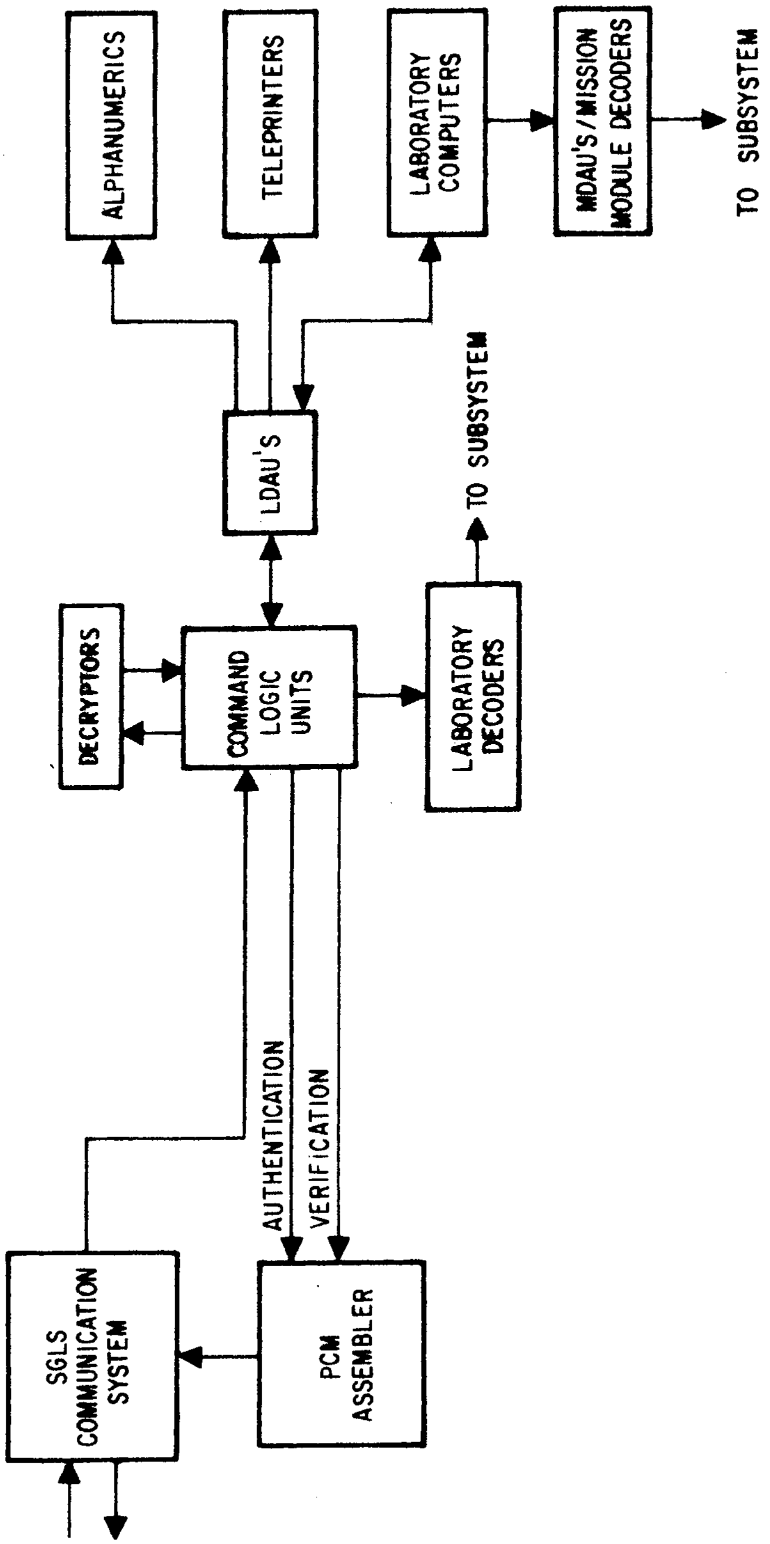


Figure 6-8 Orbiting Vehicle Command Message Processing and Handling Functional Diagram

6.2.2.2.1.4 Voice Messages - STC Handling

Uplink voice communications are transmitted in real time. The content of these messages will be dependent on the need at the time of RTS contact. The voice communications will normally be restricted to conversations between the MOL MCR and the crew. It is anticipated, however, that the need for voice communications will last throughout the RTS contact with the OV. For transmission between the STC and RTSs, analog voice is digitized by a synthesizing process (vocoder) performed by the audio frequency coder. Digitizing in this manner allows the transmission of digitized voice over the narrow bandwidth of the 2400 bps communication lines of the AFSCF. The digitized voice is then encrypted and sent to the RTS. A simplified diagram of the STC voice converter/handling system is shown in Figure 6-9. The clear voice comes from the MCR and is sent to the RTS over the 2400 bps line (in analog form) with no further processing or handling by the STC.

6.2.2.2.1.5 Voice Messages - RTS Handling

The real time voice from the STC is received at the RTS in an encrypted, synthesized digital form. Therefore, the received real time voice is first decrypted and then converted back to analog by the vocoder system. The analog voice is then digitized by a variable slope delta (VSD) modulator.

The VSD is used for digital coding voice that is transmitted over the 42.6 kbps uplink encoder and sent to the SGLS system. A simplified configuration of voice encoding/decoding at a typical RTS is shown in Figure 6-10. The clear voice is sent directly from the 2400 bps lines to either the SGLS system or the VHF transceiver. No processing is performed on it within the RTS.

6.2.2.2.1.6 Voice Messages - OV Handling

The uplink digital voice is decrypted and transferred to the VSD decoder. The VSD decoder sends it to the laboratory module intracommunications system which then sends the voice to each crewman. No on-board recording capability

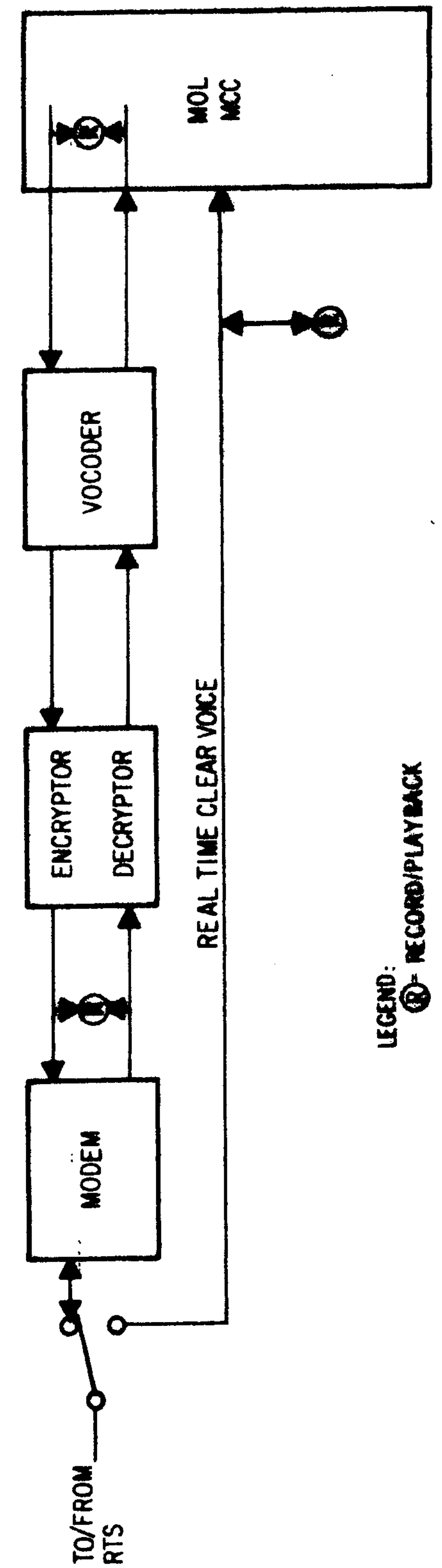


Figure 6- 9 STC Voice Converter/Handling System

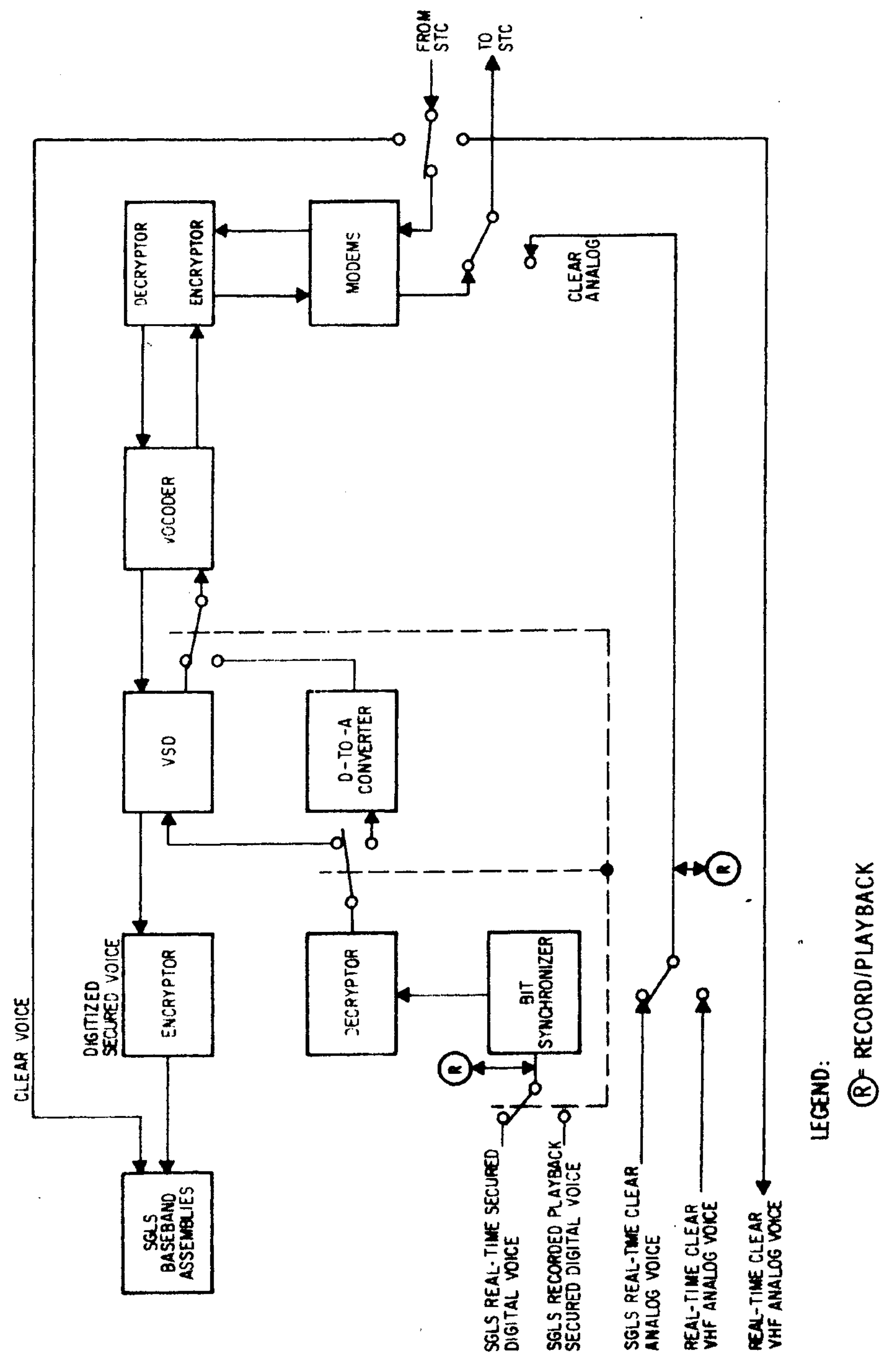


Figure 6-10 Simplified RTS Voice Converter Handling Systems

exists for uplink voice. Figure 6-11 shows the on-board SGLS-compatible subsystem for handling the uplink command/data and voice. The communications system separates the uplink information into ranging, voice, and command/data information which is then sent to the proper locations in the OV. Backup for voice can be provided by manually changing to half-duplex. Backup for uplink voice is also provided by the teleprinter.

6.2.2.2.2 <u>On-Board Data Handling</u>

6.2.2.2.2.1 <u>Command Message Handling</u>

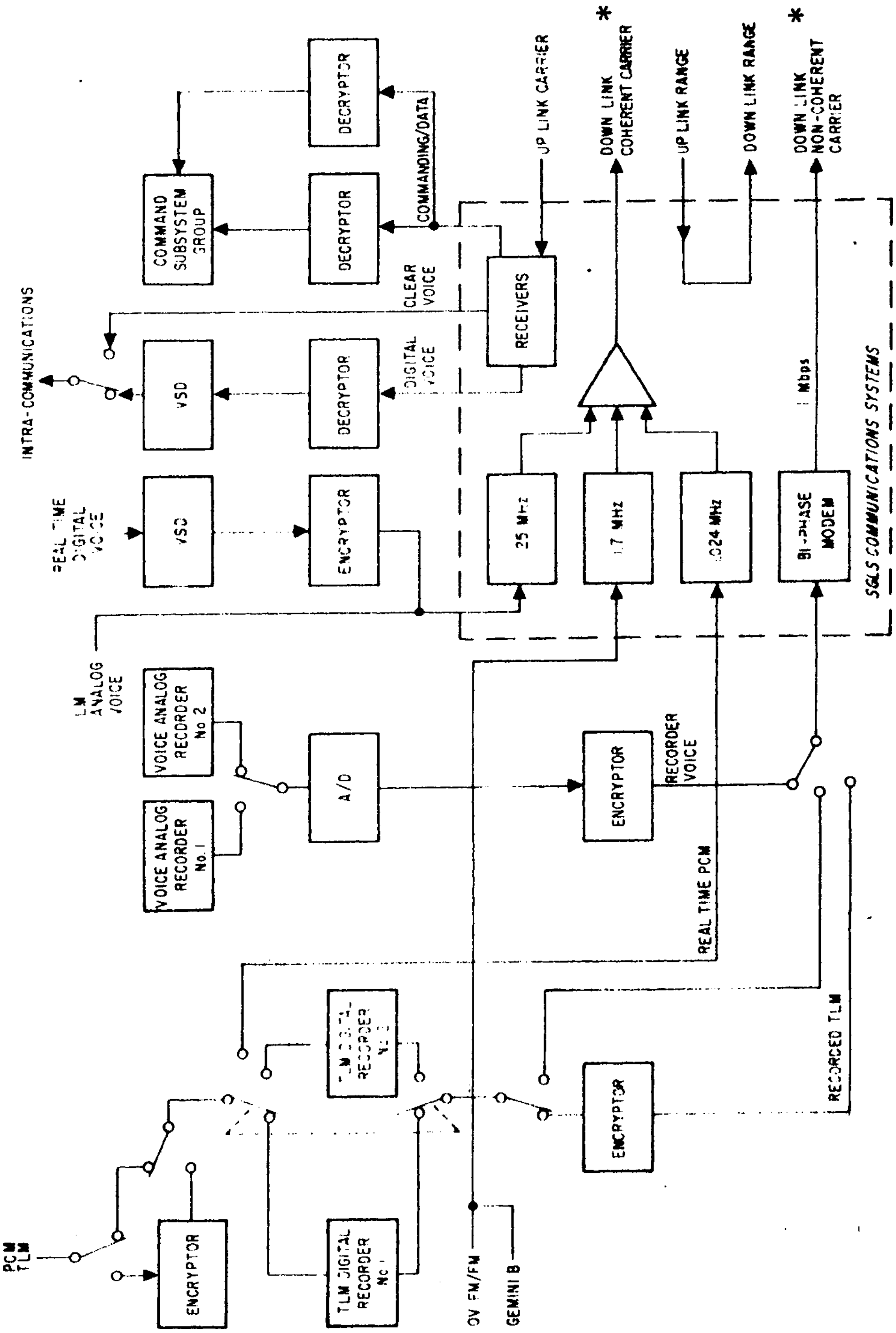
The various components of the command message are handled as described below.

a. <u>Prose Messages</u> - Prose messages are normally sent to the ADC in blocks for storage in a buffer and clocked out at a rate compatible with the teleprinter. [Use of the computer may be eliminated, if desired, by proper ground formatting which inserts the correct number of "S" (timing) pulses into the bit stream which makes the uplink data rate compatible with the teleprinter and using the proper word format. Although this eliminates the need for the computer, it requires additional ground formatting and is not an efficient use of the uplink.]

b. <u>Stored Program Command (SPC) Blocks</u> - SPC blocks are sent to the computer where they are merged into a chronological command list and stored. The time label for the command(s) with the next execution time is placed in the stored command execution timer (SCET) located in the MDAU. If the computer is shut down when the time for execution occurs on the vehicle clock, the SCET turns the computer on and the computer issues the command to the proper system decoder for execution.

c. <u>Ephemeris Data</u> - Ephemeris data is sent to the computer for storage and is used for subsequent operation during the operational periods.

d. <u>Target Data</u> - Target data is sent to the computer for storage and subsequent use during the payload operational periods. At that time this data, auxiliary memory unit (AMU) data, ephemeris data, and star tracker data are combined with crew input data and used to perform photographic operations.



* IN THE EVENT ONE CARRIER IS INOPERATIVE, THIS DATA MAY BE TRANSMITTED ON THE OTHER CARRIER BY TIME-SHARING

Figure 6-11 Orbiting Vehicle SGLS Communications Group

6.2.2.2.2.2 On-Board Generation of Recorded Data

a. TLM Data - During a payload operation various parameters required to determine payload operation, which targets were photographed, etc., are monitored and recorded by the TLM subsystem. A subset of these parameters is entered into computer storage (computer summary data). During periods where the payload is not operating, the TLM subsystem is turned on for 16 sec every 10 minutes and the TLM data recorded. At any time the monitor and alarm system (MAS) detects an out-of-limit condition on any parameter monitored, the TLM system is activated and the out-of-limits subsystem is switched to a redundant system or turned off.

Two PCM TLM recorders are on board. Their recording capacity is 160 megabits each (providing approximately 40 minutes of time per recorder at a 65 kbps PCM data rate).

Three different on-board TLM formats are available for acquiring the most desirable data. The content of each TLM format is different and is designated to meet a variety of requirements. The first format contains general OV TLM information and ADC core dump. The ADC core dump can be accomplished in real time or recorded for later playback. This format (64 main frames/sec) is designated for real time or recorded TLM. When a contingency exists and continuous (instead of periodic) TLM operation is desirable, the second format at a slower main frame rate (4 main frames/sec) will reduce the possibility that more data will be accumulated than can be recorded. The third format is for demand medical data (EKG) and is designed for recorded TLM only. It can be selected either manually by the crew or by commands from the ground.

b. Voice Data - At any time desired by the flight crew, and particularly during payload activity, the crew voice can be recorded by a recorder system which may be voice actuated. Each crewman has a separate recorder which has a recording capacity of one hour.

c. Biomedical Data - Heart beat interval for each crewman is continuously stored in a special core memory for transfer to the PCM tape recorder when it is turned on periodically.

EKG data is selectable by a crew or ground command and is contained in the fourth TLM format. EKG exists only in the PCM data and is recorded on the TLM recorder.

6.2.2.2.2.3 Crew Interface with the OV Data System

A brief description of additional interfaces between the crew and the OV is presented below to add continuity to this section. These interfaces are described in detail and from the viewpoint of the crew in Section 8.0.

a. Alphanumeric/Keyboard/Teleprinters - Through this keyboard, the crew has access to the TLM subsystem, the command subsystem, and the ADC for operation use. Any TLM point can be displayed on the alphanumeric display and/or teleprinter by crew call-up from the keyboard. Commands (either RTCs or SPCs), can be generated from the keyboard. The ADC core can be called up for display on the teleprinter and new data inserted into core. ADC programs such as DCSG self-test can be run by the crew.

b. OV Monitoring - Selected OV status parameters are displayed for the crew on the different subsystem panels.

c. Navigation - When the geoposition display program is loaded into the ADC from the AMU, the crew may use the ATS to track a point and obtain a display of information which defines the location of the point. The information on the location of the point can also be recorded by the ADC and subsequently by TLM.

6.2.2.2.2.4 On-Board Equipment Configuration

OV TLM data includes FM/FM analog, Gemini B, PCM, and voice. The method of encryption and the communication system used for transferring the data to the RTS is shown in Figure 6-11. The relationship of the dual recorders for TLM and voice are also shown in Figure 6-11.

6.2.2.2.3 Downlink

The downlink capabilities include the on-board sources of either real time or recorded information and the means for transferring the information from the OV to the RTS to the STC. The nominal downlink information includes real time and recorded laboratory vehicle PCM data, real time and recorded voice, real time FM/FM and Gemini B PCM data, and real time and stored (core/tape) medical data.

The on-board TLM system provides the means for continuously accumulating data from the OV and crew. TLM also contains command authentication and verification indications. During an RTS pass, real time TLM data and voice are sent directly to the ground. Information is recorded between RTS passes and played back during the RTS passes.

6.2.2.2.3.1 Encryption of Downlink Data

All data transferred between the ground and OV are encrypted for nominal operations (except for analog voice, VHF voice, and range data). Location of the crypto system in the command and control system is shown in Figure 6-11. As indicated, PCM can be recorded, encrypted, or decrypted. The second PCM encryptor on the output of the PCM recorder can be used as backup by reconfiguration.

Backup for the downlink digital voice is clear analog voice, VHF voice, or recorded voice. To preclude curtailment of uplink (or downlink) communications because of a double crypto equipment failure, the OV TLM system baseline requires that the voice and PCM crypto units be capable of being manually interchanged by the crew.

The OV has three separate crypto keys. The telemetry links, both real time and recorded, use a common crypto key. The real time and recorded voice use a common crypto key. The command system uses a unique crypto key.

6.2.2.2.3.2 SGLS Compatible Downlink System

The downlink provides the means for transmitting recorded and real time TLM data, recorded and real time digitized voice, FM/FM, analog voice, medical data, and range data. The downlink carriers lie in one of the 20 available SGLS channels. This channel provides a coherent carrier and a non-coherent carrier. The coherent carrier transmits 200 Hz to 4 kHz analog clear voice, 42.6 kbps digital voice, 65.8 kbps PCM, 1.5 MHz ranging; Gemini B, OV FM/FM and medical data are on the third subcarrier. The Gemini B and FM/FM use the same subcarrier. The non-coherent carrier transmits 1024 kbps recorded digital voice or PCM.

Real time PCM data is transmitted to the RTS during a station contact on the coherent carrier. During a contact where it is desired to obtain the computer summary data stored in ADC core from a payload activity, the computer must be on. When the computer is on, those data slots in the PCM stream allocated to computer summary data are filled from the ADC.

Recorded PCM data requires that either SPCs, RTCs or manual commands be used to initiate the PCM TLM tape recorder readout. The PCM recorder data is transmitted on the 1 Mbit non-coherent carrier link.

6.2.2.2.3.3 <u>TLM Data Handling</u>

The laboratory vehicle PCM data consists of mission payload laboratory vehicle status, computer, command, heartbeat interval, and spectrometer data. (There are approximately 2200 data points.) This data is normally PCM on the 1.024 MHz subcarrier which is phase-modulated on the coherent carrier. The PCM recorded data can be replaced with this data on the noncoherent carrier, if necessary.

6.2.2.2.3.4 <u>TLM Data RTS Handling</u>

As indicated in Figure 6-12, selected parameters of the real time PCM data pass through the ground stations and then on to the ADS for selective editing, processing, and compression; selective data samples are then forwarded to the STC via EXCELS.

a. <u>PCM Data</u> - Real time PCM data (including Gemini B) is processed by the RTS using the data compression algorithms and sent to the STC.

   Recorded PCM data received at the RTS is recorded for post-pass processing, editing, and transmission of selected portions to the STC.

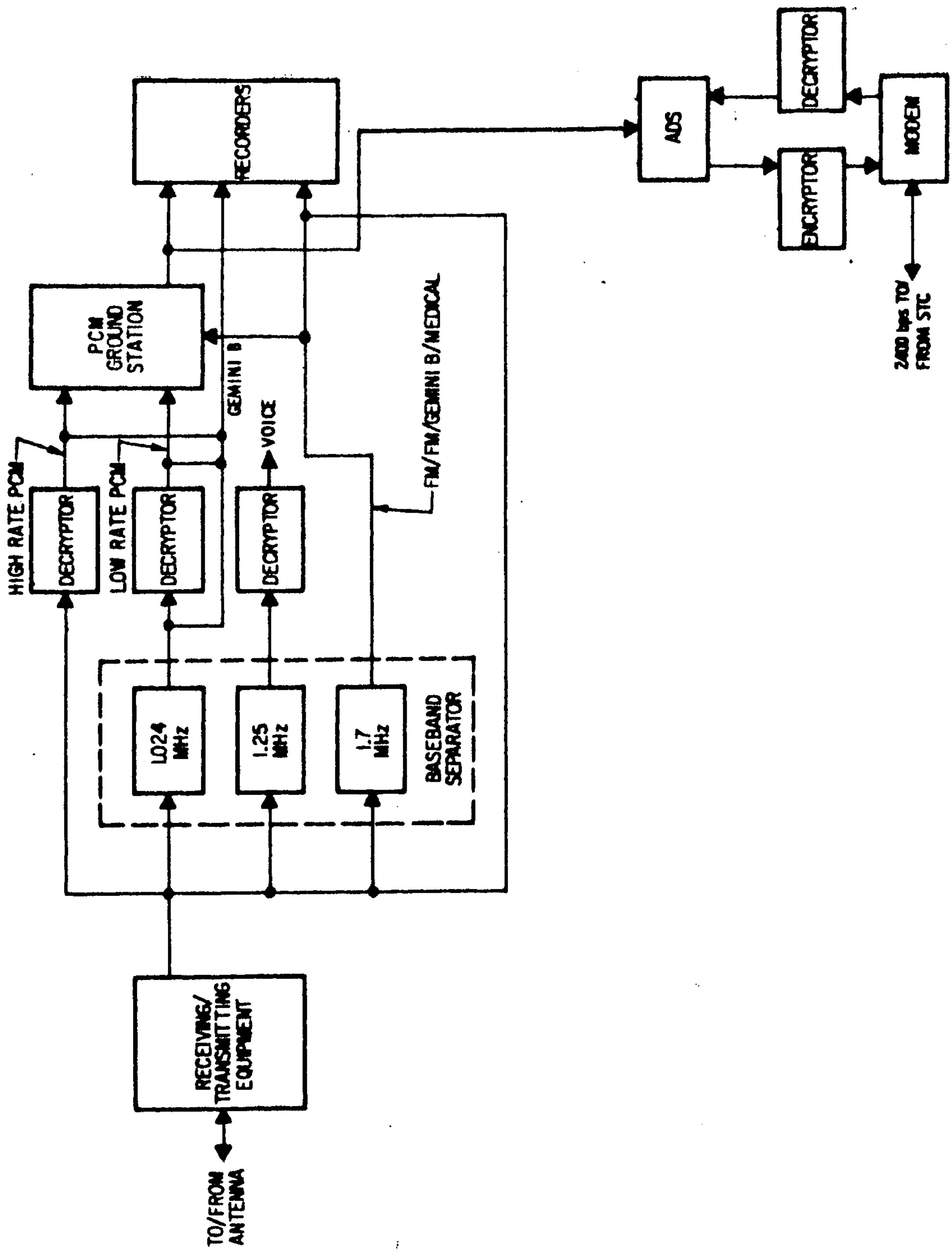


Figure 6-12 Simplified RTS TLM Data Handling System

b. FM/FM Data - Real time FM/FM analog TLM is only recorded at the RTS and not transmitted to the STC. It is packaged for postpass shipment to the STC.

c. All data is recorded at several points during its transfer through the RTS (see Figure 6-12). These recorded tapes will be MOL-peculiar and station time annotated for limited, quick postpass retrieval. These tapes will be shipped back to the STC where they will be processed and/or stored.

d. Data Transmission - RTS to STC - The nominal means of transmitting information from the RTSs to the STC is by 2400 bps digital data lines.

Nominally, because of overhead such as header and identification bits, the useful data transferred over the lines is reduced to 1800 to 2000 bps. The microwave link between VTS and STC can transmit at a nominal rate of (TBD).

Most of the RTS data will be retained on tape (real time and OV recorded) in the raw form. Periodically, this data will be physically shipped to the STC and stored. This data will be processed, as required, for additional and more detailed analysis.

The crypto security associated with the RTS is shown in Figure 6-12. All data passing to and from the OV is secured, and all data to and from the STC is crypto-secured.

6.2.2.2.3.5 TLM Data STC Handling

All processed RTS data passes through and is directed to its destination within the STC by a buffer computer. Most real time data samples will be selectively displayed in the MCC on CRT, printers, and/or plotters. Other data will be sent to the CDC-3800 computers for further processing and then, as required, displayed in the MCC. Most of the data received by the STC will be stored in data bases until finally recorded for storage.

6.2.2.2.3.6 Voice Data Handling

During an RTS pass, voice is sent back to the ground in real time over the 42.6 kbps carrier. A VSD system is used to digitize the analog voice signal. The two crew voice recorders must be commanded "on" by the RTC or SPC for playback over the RTS. The digitized recorded voice is transmitted to the RTS alternately with the recorded PCM over the 1 Mb link.

a. Voice Data - RTS Handling - At the RTS, real time voice is decrypted, sent to the VSD, the vocoder, and then to the STC via the communications system. Recorded voice is stored at the RTS in raw form for postpass playback to the STC. Because of the higher transmission rate used between the OV and RTS, the VSD equipment at the RTS cannot be used. A digital/analog encoder is used in the OV and therefore a similar decoder must be used at the RTS. The real time and recorded voice data processing at the RTS is limited to recording, decoding, encoding, decryption, and encryption. No editing takes place.

   Downlink clear analog voice goes directly from the baseband separator to the RTS communications system and then to the STC. This voice is also recorded and, as needed, played back on a postpass basis.

b. Voice Data - STC Handling - Other than decrypting and vocoder synthesizing, the real time voice information requires no processing by the STC. Within the MCC voice is also recorded for storage and further analysis. OV playback voice must be manually edited and time-identified.

6.2.3 Computer Software System

6.2.3.1 General

For the purposes of this document, five basic software system components will be used by MOL Operations: (1) system support; (2) uplink processing; (3) AVE software; (4) downlink processing; and (5) ascent and reentry. The last four can be considered together as the MOL software. The first four components used in orbital operations are depicted in Figure 6-13 and show the close interface between these components as well as their physical location.

6.2.3.1.1 Data Flow

The data flow is divided into the orbit keeping, commanding, on-board, and telemetry functions. The commanding function is the generation and sending of instructions to the vehicle; the on-board function is the control of

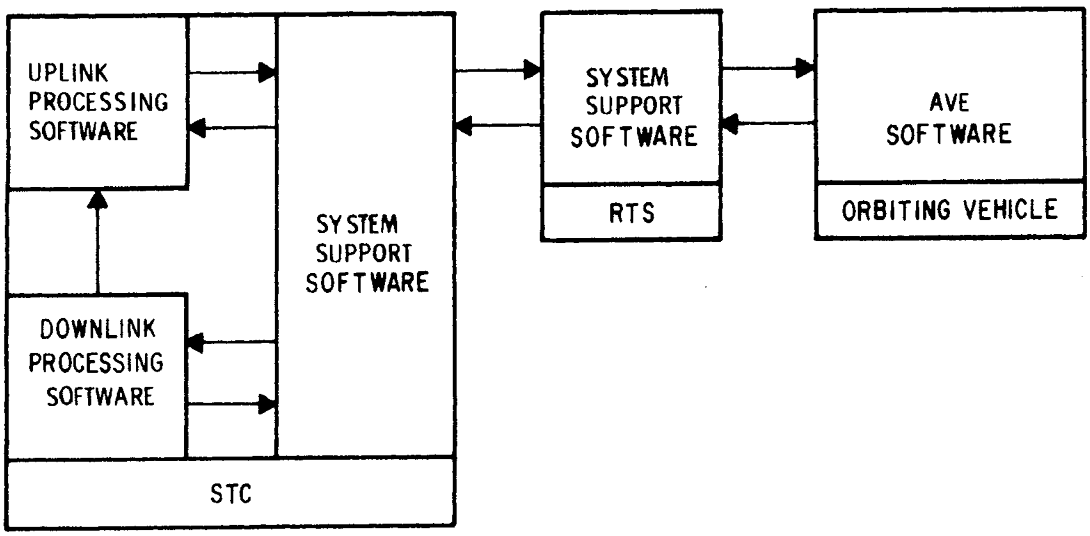


Figure 6-13 Orbital Operations Computer Software System

necessary servo and camera operations, uplink data handling, command and execution, downlink data generation, crew support functions and diagnostics; the TLM function is the monitoring and analyses of the vehicle telemetry to determine if the instructions were accomplished, to determine the health of the vehicle, and to determine the status of the mission and the vehicle. All other functions of the software system (orbit prediction; generating station acquisition predictions; antenna look angles; vehicle tracking; updating predictions based on actual tracking data; orbit adjusting; formatting and transmitting of tracking, commanding, and telemetry messages to and from the STC to RTSs; generating telemetry modes; and the interfaces of the AFSCF with other tracking networks) can be grouped under the general heading of "orbit keeping".

The following flow is the sequence of events of those program functions that must be determined for the flight of MOL.

a. Prelaunch and Launch - Before liftoff, the following tasks must be performed for flight support:

The nominal pointing data is prepared in the CDC-3800 computer by the AOES, transmitted to the buffer computer in formal messages, and sent from the buffer computer to the RTS as tracking prepass messages.

The TLM modes are also prepared on the CDC-3800 program, and are transmitted through the buffer computer to the RTSs in the same manner. TLM mode generation starts well before the launch of the vehicle. A library of modes is built and maintained on the buffer computer and the RTS prepass tapes. Procedures in the software can change the modes or switch from one mode to another during the vehicle pass.

Scheduling inputs are prepared through the computer program for the multi-operations scheduling of those AFSCF equipments required for flight.

The nominal ephemeris data is prepared in the CDC-3800 by the AOES.

Commanding data is prepared in the uplink segment, formatted for transmission by a CDC-3800 program, and transmitted to the launch site pad for loading of the OV. All this data is transmitted through the EXCELS to the RTSs on the 2400 bps lines. When each task is completed, the system is ready to support on-orbit operation.

b. Ascent - The ascent programs require a new and unique configuration in the AFSCF. The display generation programs in the CDC-3800 require data from the launch vehicle, Gemini B, and laboratory vehicle during the launch phase. The data is collected at AFWTR, sent to the STC, and sorted in the ADS buffer computer. From the data in the CDC-3800, displays are generated to allow ascent phase monitoring from the MCC. After insertion, a vector is input to the CDC-3800 AOES system and used as a nominal vector for the orbit operation.

c. On-Orbit - During station pass tracking, commanding, and telemetry, data are received and processed at the remote stations and selected data is sent to the STC ADS computer. The computer processes and stores the telemetry data and displays selected data to the MCC for CRT display and printout. Selected displays of the tracking and command verification are also processed and displayed at the MCC. Orbits and the central data base are updated periodically by the AOES system.

d. Reentry - The reentry program in the CDC-3800 computes retrofire times for the Gemini B or DRVs, as applicable, and the impact points for the recovery area selected. The reentry trajectory is predicted to the designated recovery point.

6.2.3.2 System Support Software

The AFSCF system support software consists of those programs operated at the STC and the RTSs and those programs which provide interface operation between the RTSs and the STC. The system support software falls into two basic categories: (1) general-purpose software, including AOES, System II, the ADS real time computer program subsystem serving the STC and the RTS; and (2) MOL-peculiar software.

In addition to dividing the AFSCF system support software into the two categories (general-purpose and MOL-peculiar), this discussion will further classify the software into those areas of more common usage within the AFSCF. Under each of the two major divisions, the programs will be classified as either STC or RTS, and will contain a functional breakdown as to orbit keeping, commanding, or TLM. In addition, the functions will be characterized as either off-line or on-line. The composition of the AFSCF system support software is shown in Table 6-1.

The AFSCF computer system includes the complex computer installation at the STC, and the smaller computer systems located at each of the seven RTSs. Each RTS will track the OV during the time the vehicle can be contacted by that station. During contact, the RTS can command the OV and monitor its status from telemetry data. The RTS is connected to the STC during the OV pass by voice lines and by high-speed data lines terminated in the STC computer system. During the pass, the software is characterized as being in real-time; all other software functions are designated non-real-time.

In the AFSCF, those functions performed before an RTS can acquire, track, command, and monitor the telemetry of an OV during a pass are called prepass functions; all the functions performed during a contact are called pass or real-time functions; all functions performed after a pass are called postpass functions.

6.2.3.2.1 AFSCF General-Purpose Programs

The AFSCF general-purpose programs are CDC-3800 and ADS computer programs designed to perform functions common to groups of flight projects (e.g., station contact, orbit determination and prediction from tracking data, reentry programs, etc.). The main interfaces between the system support programs and the MOL software will be through the use of the data bases, necessitating construction and updating of data base tables used by various software elements.

The CDC 3800 System IIC Operating System provides a versatile executive system which will control those programs which satisfy the large scale computational requirements of the AFSCF. Those programs comprise the operational subsystem which processes data collected from User satellites, present

Table 6-1. AFSCF System Support Software

General-Purpose AFSCF Software	MOL-Peculiar AFSCF Software
STC Software	STC Software
System II Software Mode Generation Programs CDC-3800 Executive and Utility System JOVIAL Compiler AOES System	System II Command Formatting
ADS Software Buffer Executive 360/67 Powered Flight Controller (if different from Executive) Background Display Generator Buffer Prepass Generator Programs	
RTS Software (Part Of ADS)	RTS Software
Prepass Receipt and Generation Program	Site Commanding Program
SGLS Telemetry Processing Programs	MOL TLM Processing Program
AFSCF Tracking Programs	

The User with computational results to make operational decisions, prepare control information for transmission to the satellites, and evaluate the satellites' performance. The programs of the System II operating system are involved in supporting the operational programs (e.g., those used in producing and maintaining data bases, masters, and COMPOOLS; scheduling tasks; etc.).

6.2.3.2.1.1 <u>System IIC Objectives</u>

The basic objectives of System IIC are:

a. To function by remote control in both real-time and non-real time as envisioned for the ADS time period.

b. To interface with the ADS System which will replace the Bird Buffer 160A/RTS 160A System currently in use. ADS will provide a central system data base storage facility to drive the control and display equipment which allows The User in the MCC to communicate with the total system from his own work area.

To meet the basic objectives of real-time support on a remotely controlled CDC-3800, System IIC must provide these basic characteristics:

a. Routing real-time data received from an external source to the appropriate recipient.

b. Scheduling tasks based upon events controlled by interrupts and I/O processing.

c. Processing multiple interrupts.

d. Rapid response to real-time inquiries or tasks.

e. Transmitting diagnostic machine performance (state-of-health) information periodically to the control computer.

f. Asynchronous processing of I/O utilizing a queueing technique.

g. Providing man/machine interface with the control computer.

h. Controlling time initiated tasks.

i. Rapid loading of specified elements into core during execution of another element.

j. Storing information by name on the disc for either sequential (serial) or random retrieval.

k. Providing a centralized data base on the disc.

l. Implementing pseudo re-entrant routines for multi-tasking operations.

m. Transmitting error messages to the control computer with continuation control centralized there.

n. Providing a data protection feature, upon completion of a job, to clear memory and set secured areas of other devices to random numbers.

o. Initializing and updating of the data base at the beginning and ending of a job.

p. Retaining printer information on the CDC-3800 and transmitting it to ADS at the end of the job.

q. Allowing $50{,}000_{10}$ cells of memory for The User.

r. Utilizing magnetic tapes and disc packs as scratch mediums.

s. Retaining elements transmitted from ADS on the local CDC-3800 until the end of the job.

t. Providing error recovery.

u. Eliminating automatic aborts.

v. Allowing a time estimate to be specified by ADS in the batch mode for an entire job.

6.2.3.2.1.2 System IIC Capabilities

In addition to the real-time and remote control requirements, the following capabilities will be provided:

a. A "stand-alone" mode of operation, (i.e., a capability to operate independently of external computers).

b. The mechanism for communicating from program-to-program and between a program and its environment.

c. The system will be COMPOOL-sensitive.

d. The User's data base, a depository for COMPOOL-defined data, will be maintained on disc packs.

e. A macro request capability will be provided to invoke the operation of a predefined sequence of programs.

f. A call-by-name technique will be provided for manipulating data on the disc.

g. A description of all the symbols used by a routine will be retained on disc to facilitate symbolic correctors and symbolic input to parameter test.

h. A data-base generation, update, and list capability will be provided.

i. The concept of auxiliary masters, COMPOOLS, and data bases will be ratained to supplement the system information.

j. Diagnostic aids will be provided by the executive as well as by the parameter test subsystem.

k. An on-line corrector capability will be provided.

l. A User-invoked data base retrieval feature will be provided.

m. A feature to dynamically invoke the loading of additional elements into memory during program execution will be provided.

n. Routines will be maintained in a relocatable format.

o. Core storage will be dynamically allocated at load time.

p. The feature of equipment specification will be retained.

q. The JOVIAL compiler will provide the system with a procedure-oriented general-purpose programming language and give it a large degree of machine independence.

r. A complete formatting capability will be provided to facilitate data I/O.

s. Masters will be provided primarily for permanent storage of routines; however, data blocks, macro request definitions, and COMPOOLS may be included.

t. Up to 173 program parameters may be input on an operation request. This information may then be accessed by the requested program.

u. Control parameters may be input on the operation requests to control the services provided by the monitor.

v. The computer interrupt system will be used to provide the executive and system programs with several capabilities. The use of illegal instructions and jumping out of bounds by User programs will be prohibited. The interrupt system is also used to control I/O, to process manual interrupts, to provide timing and tracing features, to switch AM images, etc.

w. Centralized I/O routines will be provided.

x. The magnetic tapes will have generalized labels.

y. A system blocking/deblocking feature will be provided.

z. The operation requests will be grouped logically into a job.

aa. The system will utilize two banks of core via the paging hardware.

6.2.3.2.1.3 <u>Advanced Orbit Ephemeris System</u>

MOL ephemerides will be generated by the AOES. AOES is a major subsystem of the AFSCF and, as such, will operate in conjunction with System II and ADS.

AOES is a system of general-purpose routines or modules used to determine a satellite's orbit from tracking data. Also, AOES will predict the future position and velocity of a satellite for use by: (1) orbit selection; (2) test control; (3) command generation; (4) payload analysis; (5) TAs and other interested agencies and organizations.

The following accuracy and timing requirements are AOES design goals:

a. <u>Postflight Orbit Determination Accuracies</u> - During postflight orbit determination of a near-earth satellite with a period of 90 min, the following accuracies will be attainable on any rev:

1. 200 ft in-track

2. 50 ft crosstrack

3. 100 ft radial distance

b. Prediction Accuracies - After an orbit update for a satellite with a period of 90 min and with an orbit determined from seven tracking station passes of data, the following prediction accuracies (eight revs of predictions) will be attainable:

1. 1500 ft in-track

2. 600 ft crosstrack

3. 1000 ft radial distance

c. Computer Run-Time - The elapsed time will not exceed 12 min from the time that raw tracking data are available in the computer to the time that the best estimate of the orbit is obtained for the following conditions:

1. 90-min period

2. 8-rev span prediction

3. 10 tracking station passes of data

4. 4-sec data rate

The GCHAP computer program currently in use in the AFSCF should be adequate for the orbit adjust techniques described in Appendix B.4.

The AOES must accept telemetry data from an on-board low-g accelerometer and analyze this data using techniques which will be finalized in the near future. Further, the AOES must also provide predicted accelerometer data for use by the on-board computer.

The capability must exist to provide a real time in-track update from any tracking station (LRL).

Additional AOES descriptive detail is provided in Ref. 19.

6.2.3.2.2 AFSCF MOL-Peculiar Programs

The AFSCF MOL-peculiar programs are those programs supplied by the AFSCF which are applicable only to the MOL Operations (e.g., command authentication and verification at the RTSs, MOL-peculiar orbit adjust capability, specialized TLM processing, display generation, etc.). Other components of the MOL software interface with the MOL-peculiar AFSCF software either through data base definition or by generating specific performance requirements to be met by the AFSCF programs.

6.2.3.3 MOL Software

6.2.3.3.1 Uplink Processing Elements

Four basic software elements comprise the uplink processing software: (1) the flight planning element; (2) the event generation element; (3) the command generation element; and (4) the message generation element. These four elements are depicted in Figure 6-14; the relationship between these software elements and the SYMON system executive on all operational phases except ascent is shown.

6.2.3.3.1.1 Flight Planning Software (FPS) Element

The FPS can facilitate construction and modification of the computer-based flight plan. This plan contains data relating to the flight crew, AFSCF, Gemini B, laboratory, and mission payload activity schedules. Using the flight plan as input, the FPS determines the available data parameters required by the SYMON executive to drive the computer programs required for operations support and planning of the MOL Operations test.

The FPS performs appropriate tasks for advanced planning purposes and operational support during the course of a flight test. The operational support function includes both the capability of controlling the appropriate software

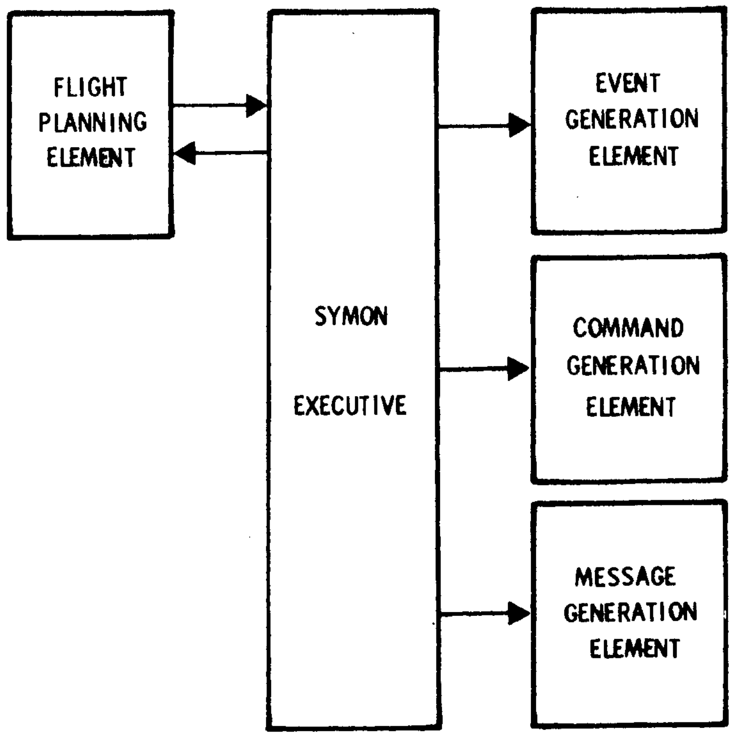


Figure 6-14 Uplink Processing Element Interface with SYMON

programs to generate the uplink messages as well as making short-term planning tradeoffs and evaluations.

6.2.3.3.1.2 Event Generation Software Element

The event generation software element consists of the event generators required to develop an uplink message. The output of each event generator either assures that the events produced are conflict-free or flags conflicts at a related inter-event level.

The basic event generators which comprise the event generation element are described below on a functional basis. (It should be noted that portions of the functions described are part of the AFSCF system support software; these are indicated by an asterisk to preserve clarity in understanding the operations of these programs; no distinction is made in the text.)

a. Mission Planning Event Generator (TRW) - This event generator, commonly referred to as the mission planning software, represents the largest and most complex piece of software of any of the event generators. This event generator performs four basic functions: (1) target file preparation function; (2) target acquisition function; (3) targeting strategy function; and (4) event generation function.

   1. Target File Preparation Function - This function receives targeting requirements from The User and target countdown data from the downlink processing software. Using these inputs, the target preparation portion of the software processes the information and produces a current updated target list which is used by the target acquisition function of the mission planning event generation software.

   2. Target Acquisition Function - This function utilizes data input to it from the target file prepared by the target file preparation programs, vehicle capability data input to it from the vehicle capability file, and the mission ephemeris input to it from the current ephemeris file. By processing these data, the target acquisition portion produces the target acquisition file which contains those candidate targets for the revolution span of interest.

3. Target Strategy Function - This function receives inputs from the target acquisition file, mission ephemeris file, vehicle capability file, and the weather file. This function processes these input data and through targeting strategy algorithms selects the targets for the primary optics path and the alternate targets to be viewed by the crew members. In addition to producing the targets, this function also computes all necessary control parameters and data required by the AVE software.

4. Event Generator Function - The event generator function of the mission planning event generator software processes the target selection file produced by the targeting strategy function and produces the actual mission planning events. In addition to this nominal mode of operation, the event generator also processes special secondary flight objective requirements and produces the required events.

b. Star Selection Event Generator (GE) - The star selection event generator shall produce a star event file which specifies the stars to be tracked during payload operation. The star selection event generator considers the target selection file, mission ephemeris file, vehicle capability file, and the star file in determining which stars are to be selected.

c. Station Contact Event Generator* (GE/AFSCF) - The station contact event generator produces the necessary events to assure contact between the MOL and preselected RTSs which have been previously planned.

d. Vehicle Ephemeris Event Generator* (GE/AFSCF) - The vehicle ephemeris event generator is used to generate the ephemeris, accelerometer, and other data which will be transmitted to the MOL as part of the current command message. This event generator allows positive control over the allocation of ephemeris data over different message generation cycles.

e. Reentry Event Generator (GE) - The DRV and laboratory reentry event generators generate the events required to perform reentry of the DRVs and laboratory. This generator also computes the reentry trajectories.

*Part of the AFSCF System Support Software

f. Gemini B Reentry Event Generator (TRW) - The Gemini B reentry event generator computes and provides the reentry events, data, and trajectories for the Gemini B. This program is nominally run several times a day as the mission ephemeris is updated. It is also run after all orbit adjust computations to update the reentry messages and verify the acceptability of the orbit adjust.

g. Orbit Adjust Event Generator* (GE/AFSCF) - The orbit adjust event generator computes the events necessary to perform an orbit adjust and updates the orbit file corresponding to the planned orbit adjust.

h. LMSS Event Generator (DAC) - The LMSS event generator processes laboratory requirements input to it in the form of laboratory objectives, diagnostic commands, corrective action, etc., and produces the events required to execute these requirements.

i. Special Flight Requirements (SFR) Event Generator (GE) - This generator shall provide the means of generating events for special activities which cannot be readily accomplished by the LMSS event generator functions (e.g., ADC partial core dumps).

6.2.3.3.1.3 Command Generation Element (GE)

The command generation software element consists of the functions required to develop the conflict-free commands to be sent to the MOL. Three basic functions comprise the command generation element: (1) event conflict identification and resolution; (2) function input and ordering; and (3) the function conflict identification and resolution.

a. Event Conflict Identification and Resolution - This function receives data from the event files produced by the event generators and identifies conflicts which exist among these events as a result of current constraints. Where possible conflicts will be automatically resolved; otherwise, the conflicts will require manual resolution.

*Part of the AFSCF System Support Software

b. Function Input and Ordering - This function translates events from the chronological events file and places the resulting functions in chronological order. In addition, manual function and command requests shall be incorporated into the ordered data.

c. Command/Prose Translation - This function shall convert input commands or prose into their constituent functions, or, conversely, shall convert input functions into sets of available command types or prose words.

d. Function Conflict Identification and Resolution - This function investigates for conflicting function/states, performs allowable conflict resolution, and flags unresolved conflicts. It outputs to the conflicted chronological function file. Recorder management optimization shall also be accomplished as part of this function.

6.2.3.3.1.4 Message Generation Element (GE)

The message generation element consists of two basic functions: command assembly, and block assignment/message formatting.

a. Command Assembly - The command assembly function receives inputs from the conflicted chronological function file and the command and prose translation routine to assemble the required SPC, AVE computer data, and prose messages. These (SPCs, data, and prose) are then output to the assembled command, data, and prose file.

b. Block Assignment/Message Formatting - The block assignment/message formatting function accepts the assembled command, data, and prose file as an input and rearranges this list into blocks of data meeting the uplink command philosophy constraints.

At this point, the command message is in proper format for AFSCF handling for encryption, checking, and transmission to the RTS.

6.2.3.3.2 AVE Software Functions

The AVE software system is comprised basically of the following software functions: (1) executive; (2) station contact uplink; (3) station contact downlink; (4) command execution; (5) flight crew support; (6) pre-payload; (7) payload; and (8) diagnostic.

a. Executive (DAC) - The executive function provides program control by calling up the appropriate programs at the required time.

   This function performs storage management by providing core area for non-resident programs when they are requested from the AMU and for resident programs that require temporary data storage areas.

   The executive function supervises interrupts received from various sources requesting computation service, and processes the I/O requests from the various application computer programs by performing channel scheduling and I/O initiation for the designated devices.

   This function also performs system services consisting of system initialization, system error handling, timing services, corrector data handling, core dumps, provides a universal common data base area, and provides for recovery from a power interrupt.

b. Station Contact Uplink (GE) - The station contact uplink function accepts, verifies, and processes the uplink data (command, computer, and teleprinter data). It transfers data from the on-line (active) computer to the off-line (backup) computer so the latter will be ready to instantly come on-line and assume all the on-line computer functions in the event of on-line computer failure. This function executes those real time commands addressed to the MPSS. It also accepts prose data at the uplink rate and buffers it for output to the teleprinter at the teleprinter rate.

c. Station Contact Downlink - This function provides for core dumps on command by either dumping core in real time over an RTS or putting it on the on-board TLM recorder for later RTS readout. In addition, it combines low-g accelerometer (LGA) data and a summary of data associated with payload operations with the real time TLM for transmission over the RTS.

d. Command Execution (GE) - The command execution functions include the execution of ground-generated SPCs and those on-board commands generated from the uplink computer data. It provides a command profile on the flight recorder which indicates the executed commands.

e. Flight Crew Support - This function provides services to the flight crew which will allow them to operate the keyboard and receive data on the A/N display and teleprinter for TLM access, enter data into the core, display core contents, insert commands, perform focus exercises, advance the visual display and delete SPCs.

f. Pre-Payload (GE) - The pre-payload functions include obtaining selected target coordinates from the AMU, and displaying the cues associated with each target to the flight crew. These functions also provide a control to the star trackers in searching, acquiring, and locking on to the assigned stars.

g. Payload (GE) - The payload function uses seventh degree polynominal coefficients provided by the ground to compute vehicle position and velocity with applicable drag corrections. Corrections are computed based on either small accelerations sensed by a closed loop, on-board LGA or last radar look (LRL). In the latter case, ground-based radar provides a means of detecting small errors in the ephemeris. These errors are sent on the uplink as in-trade corrections for the ADC to apply to the ephemeris. Other computations are vehicle attitude from the star trackers for payload operation or from the ACTS attitude base in the event star trackers are not operable. The ADC programs the path of the primary optics and the two acquisition and tracking scopes (ATS) to the targets specified in the ground-generated photographic plan sent by the uplink. At the proper time, it slews the primary optics and ATSs to the targets and tracks them.

This function inhibits and enables the ACTS in a manner permitting ACTS inhibit during photography, yet maintaining attitude control. It presents displays to assist the crew during payload operation. These displays include real time cueing and lights for countdown to decision time. It accepts crew inputs on each target viewed and, according to the precedence established on the ground, votes at the decision time to determine which of several targets will be photographed. For each target selected, it computes and generates commands for the primary and secondary cameras. These include such parameters as slant range compensation, platen jog angle and velocity, and slit orientation. It updates the optics pointing information from the crew stick (i.e., "benchmark" data, update position, and real time tracking inputs) or from the image velocity sensor (IVS).

This function generates, for film edge exposure and the flight recorder, computer summary data consisting of attitude and pointing data, camera parameters, and exposure times. Upon crew request, it will compute and display the latitude and longitude of any point in the center of either ATS.

h. Diagnostic - The diagnostic function will provide self-health tests on the DCSG. It will also perform diagnoses on the MPSS by providing servo health checks, alignment bias determination, and servo bias determination.

6.2.3.3.3 Downlink Processing Software

Three basic software elements comprise the downlink processing software: (1) the MCD software element; (2) the TLM analysis software element; and (3) the telemetry/trend prediction software element. These three elements are shown in Figure 6-15, along with the relationship between these software elements and other elements and components of the MOL software system.

6.2.3.3.3.1 Mission Correlation Data Software Element (TRW)

A basic function of the MCD software element is to process mission TLM data and produce the data necessary to enable The User to perform sufficient photographic interpretation of the photography obtained from the DORIAN mission. In addition to producing MCD reports, this element also provides data to the mission planning software for future targets to be photographed.

The AVE computer stores, in core, data including targets which were sufficiently photographed, alternates which interdicted the primary path, and crew evaluation of targets. This stored data is transmitted via the real time telemetry link and is available on a postpass basis at the STC. These data are used to prepare postpass target selection reports for The User and to facilitate on-orbit advanced planning functions at the STC. The edge data printed on the film is processed by the AVE computer and stored on the TLM tape for transmittal on the non-coherent link. These data are processed daily by the MCD programs and are transmitted to The User to allow him to perform

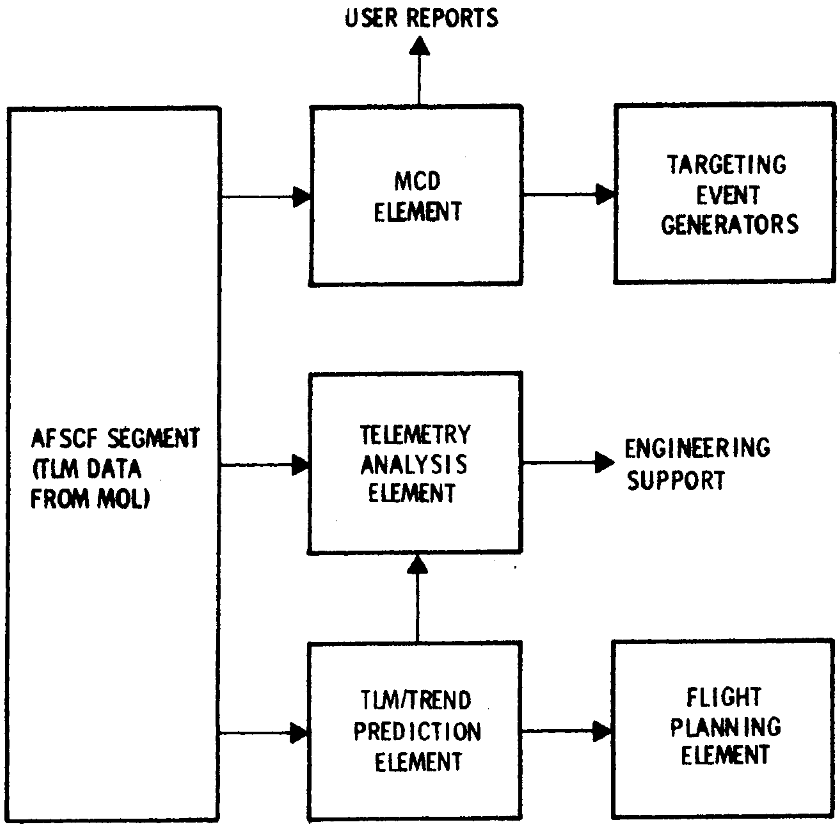


Figure 6-15 Downlink Processing Software Interface with Other MOL System Software

planning functions for photographic interpretation as well as to provide edge data and supplemental vehicle data for photographic intrepretation.

6.2.3.3.3.2 TLM Analysis Software Element (GE/DAC)

The TLM analysis software element has the basic responsibility to monitor the health of the MOL as ascertained from the downlink telemetry data. If anomalies occur with the MOL, this software alerts the MCC and indicates the probable causes of the malfunctions.

There is a close interface between the AFSCF system support software and this processing element, since much preprocessing is accomplished by ADS. It should be noted, however, that the processing performed by the system support software on MOL telemetry is controlled by the downlink processing software.

6.2.3.3.3.3 TLM/Trend Prediction Software Element (GE/DAC)

The TLM/trend prediction software element processes real time TLM data and predicts the future status of the MOL. The output of the trend analysis software element is used both for the TLM analysis processing and as inputs to the flight planning element to validate and predict flight test profiles. The TLM prediction software predicts future TLM parameter values based on the commands to be executed in the OV. The predicted values are sent to the appropriate RTS in the prepass message for use with the limit checking telemetry modes.

6.2.3.3.4 Ascent and Reentry Software

6.2.3.3.4.1 Ascent Software Element

To enhance crew safety and the probability of mission success, the 632A MCC, located at the AFSCF, must be able to recommend an abort or a switchover to secondary guidance. This requires monitoring the progress of the powered ascent trajectory and the associated status of vehicle (launch vehicle spacecraft) systems from liftoff to orbit insertion or abort. The ascent software element contains the MOL-specific computations to be performed on the tracking data and vehicle TLM data required for display in the MCC. By providing display information and response to MCC console requests, the ascent software is specifically designed to support the following Flight Controller personnel: Trajectory, Guidance, Booster, and Orbiting Vehicle Systems. (The other Flight Controllers in the MOL MCC, FD, Crew Communicator, and FTFD presently can call up any of the displays available to the above controllers.)

To support the above MOL Flight Controllers, the ascent software element will be used to transform the raw TLM and tracking data into a form suitable for monitoring purposes. This requires computational routines to process data originating in the FV and radar tracking system. Input data from these various sources must first be accepted, converted to proper units, limit checked, and time-alinged. These preprocessing operations are generally performed prior to further computations needed to prepare the data for display.

Those inputs originating within the MCC that regulate the ascent software performance consist of monitor-initiated commands such as prelaunch initialization, abort, and discrete overrides. Typical of these overrides are liftoff, staging, guidance mode change, etc. In addition, the ascent software element must respond to instructions originating in the CDC-3800 resident executive and/or the ADS computer. These are concerned with computer operation-oriented activities such as timing, housekeeping, I/O control, etc.

Telemetry information from the T-IIIM, Gemini B, and laboratory vehicle systems is processed into parameters for monitoring purposes by the series of tasks in the ascent software in the CDC-3800. Before the ground-based radar data can be used in detecting a malfunctioning or failed ascent guidance system, the data received by the CDC-3800 through the ADS must first be processed and smoothed by means of a filter routine in the ascent software.

In the event that a Mode B or C abort is actually called, the System Controller of the ascent software will call into core the ascent abort touchdown prediction task (ASABOR) loaded on the CDC-3800 disc before launch from the ascent flight support tape. ASABOR provides reentry support to the MCC by more accurate computation of the post-abort trajectory parameters and the predicted touchdown point. This information will also be available for use by the recovery forces. ASABOR can accept data obtained from voice information and from any vector updates provided by tracking to improve the accuracy of its reentry trajectory and touchdown prediction. It uses many of the mathematical functions defined in the reentry software element.

6.2.3.3.4.2 Reentry Software Element

In support of the above objectives, the reentry software element will perform any of the following reentry tasks upon request by MCC personnel (during real or simulated flight or test operations). The associated inputs for each task are obtained from the MCC via the ADS computer from the AOES program (which resides on the orbital flight support tape). The tasks are described below:

a. Normal Reentry - This task calculates the time-to-retrofire and Gemini B predeparture update parameters needed for on-board computations.

b. Contingency - This task computes the time-to-retrofire in the event that the crew is unable to perform the calculation on-board. It also provides the required Gemini B contingency update parameters for reentry guidance initiation.

c. Reentry Planning - The time-to-retrofire and Gemini B pre-departure update parameters are determined for each of the selected touchdown points.

d. Touchdown Prediction - This task assumes that the time-to-retrofire and reentry steering mode are known and predicts the touchdown point.

The first two tasks also compute additional parameters consisting of retrofire attitude, number of engines to be fired, and time-to-retrofire for zero lift. The Reentry Planning Task additionally computes retrofire attitude and number of engines to be fired.

The Reentry Support Program will reside on the orbital flight support tape. As seen from the task descriptions, the program provides MCC support for reentry from orbit only. The task for supporting abort reentry from ascent is provided by a separate program (ascent abort program) that will reside on the ascent flight support tape. The Ascent Abort Program is similar in design and utilizes many of the same functions as the Reentry Support Program.

The heart of the Reentry Support Program is the trajectory propagator. The design basis of the trajectory propagator is the on-board computer program, which has been modified and expanded to provide additional ground support for the MOL reentry phase. The trajectory propagator models the events affecting the trajectory (such as separation of the Gemini B from the laboratory, retrofire, and parachute deployment).

6.2.4 MOL Contractor Support Facility (MCSF)*

An MCSF near the STC is planned to provide required contractor office space and analysis capability (in excess of that available from the AFSCF) for both operations and postflight phases. The facility will be contractor-operated under MOL SPO direction.

During operations, the MCSF provides vital support to the decision-making process in the MCC. It provides responsive, flexible capability to process TLM tapes (from the RTS or the STC) and microwave data to aid in diagnosis of contingencies. It provides for correlation and analysis of current data with that obtained during ground tests on previous flights and earlier in the current flight. Included are displays and working areas for contractor specialist teams to solve problems and synthesize "best-fit" solutions. Necessary access to command histories and current command loads will be provided (a vital part of the analysis problem). The MCSF will be able to provide (when required) edited, digital computer tapes to contractor plants for more detailed analysis using design analysis techniques. These requirements exceed the scope of support available from the STC.

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*MCSF is an interim term and subject to change.

The second requirement is to support the "postflight" type of analysis process (which actually will commence shortly after insertion) by providing a central facility for processing data into a form most easily used by the contractors (i.e., digital data tapes in compatible computer format). This will eliminate need for individual contractor SGLS equipment and PCM ground stations, provide the appropriate data to each contractor in the form required, and allow necessary control of the security levels of the data on each tape.

The MCSF will contain office space for contractor personnel and a technical area with adequate space for a PCM recorder and SGLS input processor, a CDC-3800 computer, and hard-copy output devices.

The MCSF will also be used before flight in the development and checkout of MOL CDC-3800 computer programs. The total expected load in such activities has been estimated as 10,000 hr, exceeding the anticipated time available in the AFSCF/CPDC. This capability, which is responsive to the needs of MOL program debugging, will also greatly reduce delays occasioned by unavailability of the AFSCF computers.

The MCSF will be connected to the STC and to the prime MOL contractors' home plant processing centers by duplex data-phone type communication links. This will allow, as required, data to be sent directly from the STC computer and/or MCC to the off-site processing complexes. As an example, command data is essential to the analysis process and will be transferred. In turn, as data is processed and the need arises, data may be sent from the processing center to the MCC for display or to update a data file. Data transmittal to and from the MOL contractors' plants will also be possible. This information will be used to supplement that received directly from the AFSCF either via the STC or in raw form on tapes from the RTSs. When necessary, the processed data will also be physically carried from the off-site complex to the STC. Dubbed and/or edited tapes for contractors' use must be physically delivered to contractors' plants for further processing and analysis.

6.3 MOL OPERATIONS CONCEPTS

6.3.1 General

MOL operations within the AFSCF environment are described below. The command and control (C&C) philosophy, data handling philosophy, and the details of flight planning (e.g., orbit selection) are explained.

6.3.2 Command Philosophy

6.3.2.1 General

The baseline operations concepts applicable to the command function are described below. Details beyond those presented here may be found in the documents discussed in the following paragraphs.

6.3.2.2 Command Documentation

a. Command Definition Specification - This document contains the OV command repertoire (identification of commands available for uplink transmission, manual control commands, automatic subsystem generated commands, computer-generated commands, monitor and alarm subsystem-generated commands, and the backup commands available for utilization on AVE 6 and AVE 7). The ground-to-air software-to-hardware and software-to-software interfaces are also discussed in detail.

   In addition, this document contains the Command Function List (function-to-command correlation information), an encyclopedia of possible function/states for OV subsystems. Further, this document describes the physical phenomena which occur in the OV when a given function/state is occupied. Additionally, this document contains the time-ordered function/state relationships associated with each defined event, the events associated with each sequence, and the sequences associated with each flight test operation.

b. Hardware/Software Limitation Specification - This document contains the OV functional limitations expressed as constraints on function/state occupation. This document also contains explanations of the problems avoided by proper function/state occupation as well as the corresponding effects of improper occupation. The data contained in this document serves as a data base for uplink message conflict identification and resolution performed in uplink message preparation.

c. CPCEI Specifications - These documents consist of the GE AVE-MPSS, the DAC executive, the DAC ground-LMCP, the TRW MP&E, and the GE C&C. These documents form a part of the basis of knowledge necessary to understand the computer programs being used, and to isolate and correct software problems occurring during on-orbit operations.

6.3.2.3 Prelaunch Phase

During the period beginning some months before a flight test and continuing into the flight test time period, the Flight Planning staff will produce the flight plans. This task can be separated into two subtasks which are performed serially. The first involves generation of the flight plan to be followed if no substantial anomalies are encountered during the flight test. The second involves continuous identification and assessment of the anomalies which significantly impact the existing flight plan, and the generation of new flight plans which allow maximization of flight test effectiveness within the constraints imposed by the anomalies.

Integral to the development and assessment of flight plans is the CDC-3800 flight planning software described in paragraph 6.2.3.3.1.1. It serves as a computer-assist to the flight planning personnel and facilitates rapid development and assessment of flight plans. This software is used for flight planning both prior to and during the flight test.

Other aids to flight planning are the FVTLs (one is addressed to the manned/automatic flights, and a second to the automatic flights). These documents are developed prior to actual flight planning for a specific flight and depict a set of scheduled sequences for nominal system test operations. The FVTLs represent a starting point in planning the operations for a particular flight.

The concurrent development of the FVTLs and the Sequence Definition and Task/Event Files leads to a major part of the data base information necessary for flight planning.

The flight plan comprised of a scheduled set of sequences for the flight crew and MCC and RTS operations, will be available to authorized personnel in both hard copy and computer display. Its use transcends the command generation area and could have possible impact in all areas of flight test operations.

Command generation will be required to produce command tapes for use in the simulator for prelaunch training exercises.

6.3.2.4 Launch Phase

The prelaunch activity culminates in formulation of a command message which is loaded into the laboratory vehicle while on the launch pad during the launch phase. This "pad load" contains those commands required to establish the initial RTS contact on rev 1 plus successive contacts well beyond the anticipated RTS contact planned for a new command message loading. Due to the anticipated long setup time required for the payload and ephemeris uncertainty, the pad load will contain no payload operations data.

6.3.2.5 Ascent Phase

During this phase no commands, per se, are to be sent. The requirement exists, however, to transmit two instructional commands to light indicators in the Gemini B to inform the flight crew of ground recommendations for guidance switchover (BIGS to GIGS) or abort.

Both of these commands are to be backed up by voice recommendations. A voice recommendation may also be used to inform the crew to inhibit switchover to GIGS. Final authority, however, rests with the flight crew. The exact method of implementation of these commands remains to be determined.

6.3.2.6 Early Orbit Phase

Little commanding is anticipated during this phase. Vehicle status and tracking data will be gathered during this time for input to the first command load generation. Vehicle status data will be analyzed to determine the vehicle capabilities. All RTSs capable of VHF voice contact will be scheduled for

VHF voice as well as SGLS data acquisition.

A command system analysis will be made by observing reaction to special test messages sent on the uplink, execution of SPCs from the pad load, and test RTCs sent by the MCC. Tracking data will provide an ephemeris for subsequent command loads. It is anticipated that at least three RTS passes of tracking data will be required to generate meaningful payload events from the mission planning software and that five RTS passes of data will be required to provide the accuracies necessary for actual payload operation. After receiving three passes of tracking data the Mission Planning event generator will be run and a command message composed for loading on, or prior to, rev 6.

6.3.2.7 Orbit Phase

During the uplink message generation process performed at the MCC with the command generation software, the following will be prepared for transmission to the OV during a station pass: (1) ephemeris data; (2) star data; (3) target data; (4) other computer data; (5) teleprinter data; (6) SPCs; and (7) RTCs.

Items a. through f. will be prepared in blocks of approximately 20 to 30 computer words each. Any given block will contain only one type of computer data or only teleprinter data or only SPCs. RTCs will not be prepared in blocks.

After four revs of tracking data have been received, an LRL correction message will be generated and transmitted to the OV on rev 5, permitting payload operation to begin on rev 6.

On a nominal basis, an uplink message will be transmitted to the OV on alternate revs with enough data for the succeeding three revs of operations. Characteristics of a nominal message are:

a. 16 teleprinter data blocks.

b. 30 target data blocks.

c. 12 ephemeris data blocks.

d. 1 star data block.

e. 7 command (SPCs) blocks.

f. (TBD) RTCs.

g. One minute maximum transmission time at the nominal uplink transmission rate.

h. Equipment "off" and "on" commands will be in the same block.

i. Commands associated with a given event will not be in more than one block.

j. Where a function/state is changed by a "delete and add" message, the "delete" and "add" shall be in the same block.

The composition of the uplink message can be varied, however, to any extent that fits within the ADC core allocation constraints. Further, where the desired composition does not fit within those constraints, the constraints can be modified by sending reallocation instructions to the computer as the initial part of the uplink message. For example, reallocation may be required for automatic subsystem operation: (1) Many subsystems, although nominally scheduled for automatic operation (i.e., purge the fuel cells), can be operated by ground commands. (2) Although the current nominal computer core allocation for SPCs may be inadequate where SPC operation of a subsystem is required, the SPC storage area in the ADC can be substantially enlarged (with an attendant reduction in storage area for other data) in the event of such occurrences.

Command message generation is accomplished by the uplink portion of command and control (C&C) software. This software, designed for semiautomatic operation, allows for manual intervention at restricted points for message change or correction.

The philosophy for message change or correction is based upon an optimization of manual intervention. This optimization involves identification of those areas where such intervention is necessary and those areas where manual intervention would cause deleterious effects.

Man is of primary aid where rapid decisions involving many alternates are required. Thus, for those areas of message generation such as conflict resolution and message changes quite late in the process, all but the simplest, most well-defined solutions will be provided manually. Conversely, while man is a rapid-decision maker in very complex situations, there is a substantial probability that he has neglected to adequately evaluate the impact of his decision in some of the more obscure areas. For this reason, there can be no manual intervention into message generation without a subsequent automatic check on that decision. Usually, this checking will be based upon the Hardware/Software Limitations Specification (Ref. 24) information.

There is the capability to effectively override a defined hardware/software limitation. This override, however, may be effected only by manually changing the limitation through data base input at the Flight Planning level and by obtaining proper authorization prior to accessing that data base.

Late manual intervention is discouraged by limiting manual inputs to the beginning of message generation at the Flight Planning level and approximately three-fourths of the way through the process at the function/state assembly level. Except for manually generated teleprinter data, there is no capability to directly change any command or datum contained in the uplink message.

Certain real time capabilities must be available to the ground (notwithstanding the manual intervention provisions described above) for use during emergency situations where the health of the flight crew is endangered and they are unable to respond to voice instructions. These capabilities will exist during the flight test.

In the same way, but to a lesser extent, a similar type of capability must be available for automatic flights where only immediate action can preclude total failure of the remaining portion of the system test.

6.3.2.8 Flight Crew Inhibits

In the event of certain on-orbit contingencies or hardware-software malfunctions, the flight crew may exercise substantial control over the effects of the uplink message. By throwing switches, the flight crew can inhibit the responses of certain subsystems to uplink commands. The flight crew inhibit capability will be provided in the Hardware/Software Limitations Specification (Ref. 24).

6.3.3 Data Handling Philosophy

6.3.3.1 General

Baseline operations concepts applicable to data handling are presented below. Both nominal and contingency situations are considered, and such subjects as the concept of command data encryption are covered.

6.3.3.2 Real-Time Data Handling

It has been estimated that, because of the ADS hardware and software configuration, data transfer between the PCM ground station and computer will be limited to a 50,000 bps rate. This restriction is based on the handling of 500 parameters or less, set by the computer's memory size, the type of computer processing algorithm used, and the time required by the computer to perform the algorithm. In addition, TLM data output from the RTS to the STC is limited to 1800 to 2000 bps, requiring extensive data compression.

Presently, approximately 2200 OV parameters must be handled by the ADS. To meet the nominal requirement of processing each parameter at least once during an RTS pass, the PCM ground station will be programmed to selectively scan the OV TLM points in groups of about 500 parameters for a preselected time period (presently anticipated to require 90 sec of the station contact time for the entire 2200 OV parameters). After sweeping through all the points once (in groups of 500), the scan will be repeated unless changed.

The computer will send one value of all OV parameters to the STC. However, values of operationally dynamic parameters will be continuously evaluated and the results sent back to the STC. The computer will also perform limit checks, status checks, comparison, etc., on a limited number of parameters. As directed, the computer will report out-of-tolerance parameters and transmit the values to the STC. In certain limited cases, it will be required that values of critical TLM parameters be sent to the STC more often than once per RTS pass. In addition, priorities will be established requiring that selected (e.g., monitor and alarm indicators) TLM parameters be monitored first. Also, certain parameters (e.g., vehicle time and command telemetry) must be monitored continuously (be made part of every block scanned).

Limit checking will be accomplished by first determining the expected nominal TLM reading considering current OV TLM and the commands to be executed prior to the next RTS pass. This prediction will be performed at the STC by the MOL CDC 3800 C&C software. Once a nominal value is determined, proper limits will be selected and sent to the RTS in the prepass message. During the pass, any OV TLM point exceeding the limit specified will be flagged and transmitted to the MCC. TLM points remaining within limits will not be transmitted except as specified in the TLM mode being processed. The current initial concept for the formation of data modes for the return of downlink data from the RTSs to the STC is provided in appendix D.

Except for D-to-A converting and vocoding, real time voice is not modified by the RTS. The RTS acts only as a switching unit and transfers the real time voice to the STC.

6.3.3.3 Postpass Playback

Immediate postpass processing of data stored at the RTS is required to assess the state of commandable elements, health check of payload, MCD (deferred postpass), command verification (functional). If there are anomalies, considerably more data will be required.

a. If the RTS pass is short, the RTS will be required to process a limited, selected amount of recorded real time data and/or OV recorded data for use in trend analysis. (It is difficult to acquire sufficient data for this purpose during a two-minute real-time RTS pass.)

b. More in-depth/detailed data will be required when an anomalous condition is revealed during the monitoring of real time data. By processing the RTS recorded real time and/or OV recorder data, it is possible to determine when particular data becomes anomalous. This aids in determining the specific data necessary for investigation of the cause and cure of the problem.

c. Normally support of the on-orbit operation will principally use OV PCM and voice data. However, at times, review of other types of information will be required. Because of the amount of PCM data requiring real time processing, only limited Gemini B PCM data will be handled during real time. Therefore, to secure additional information, Gemini B will be processed postpass. Also in this category is the OV-recorded PCM data which is required postpass to further evaluate the payload activities (MCD).

d. The requirement exists to scan the OV-recorded PCM data to check its quality. Operationally, it is proposed that OV recorder No. 1 be used from one RTS to the next. The information on that recorder will then be played back at the first opportunity. Recorder No. 2 will be used during the next rev. In the meantime, the playback of recorder No. 1 data will be checked for quality. If the quality is unsatisfactory due to transmission difficulties, data from both OV tape recorders will be played back over the next station (as the time of the next RTS pass allows, giving priority to the current data).

It is proposed that, as soon as physically possible (within hours of the OV pass over the RTS), the raw tapes containing the PCM, voice, FM/FM, and Gemini B data be returned physically to the STC. Therefore, the RTS must retain dubbed tapes temporarily while the original tapes are in transit to the STC.

6.3.3.4 STC Processing

The STC receives OV data via: (1) the 2400 bps communication lines from the RTS; (2) the microwave link from VTS; (3) hard copy or magnetic storage physically transported from RTS, MCSF or contractor in-house complexes; and (4) data phones from the MCSF. The method of handling and processing MOL data received by the STC depends on the form of the data.

a. 2400 bps Data - Most of the data coming from the RTS via the 2400 bps lines is in a form that can be immediately displayed or transferred to the data bases. Therefore, the STC computers, after identifying the data, will direct the data to the proper display within the MCC. As required, that same data will also be put in the MOL data base. Data will be selected by the CDC-3800 computers for further processing, display, and/or storage and then retrieved for immediate display, for delayed display, or for call-up. Data such as command verification and tracking data will be used to update information being formulated for future RTS passes.

   The MCC has manual control over MOL data processing at the RTSs and the STC. Should an analysis indicate the need for a different mode of processing, the desired mode can be called up by utilizing the appropriate keyboard within the MCC. Ten to 20 different TLM processing modes will be available; these modes vary from general handling and processing of all TLM parameters to monitoring points associated only with a particular subsystem.

b. VTS Microwave Link - Selected data will be transmitted from VTS over the microwave link to the STC.

c. Hard Copy and Magnetic Storage - MCSF and the contractors' in-house complexes will have the capability to produce either hard copies of data or digital tapes. The hard copy data will be delivered to the MCC and used for supplementary analysis. The digital tapes will be processed by the STCs ADS system to update the data bases, for additional MCC information, and/or for backup data for in-depth analyses. Digital discpacks can also be received from the RTS. These would contain processed data from the RTS computers and would be installed in the CDC-3800 STC computer complexes for additional processing and/or display in the MCC.

d. Data Phone - The MCSF will be connected to the STC by data phones. As data is processed and is needed, it can be sent over the data phone to the ADS within the STC for entry into the data base and/or displayed. Since the MOL contractor will be connected to the MCSF by data phone, their processed data could also be sent via the MCSF to the STC.

6.3.3.5 Contractors' In-House Complexes

Each contractor will have an in-house capability for handling and processing AFSCF MOL-provided data to isolate the cause of anomalous operations and for evaluating the operation of their OV equipments. This capability will be integrated with that necessary for qualification test and acceptance test data processing. The in-house complex will be able to produce hard copy of the processed data and/or tapes. The complexes shall also be able to transmit selected data samples via data phones to the MCSF in Sunnyvale. All data used by these contractor complexes will be provided by the MCSF in the form of digital computer tapes. No raw RTS tapes will be transmitted to any contractor in-house facility.

6.3.3.6 Uplink Data Handling Philosophy

All uplink data (see Figure 6-16) will be generated at the STC and sent prepass to the RTS over the encrypted EXCELS lines. It will be stored in the RTS computer in decrypted from. For this reason, teleprinter message content must be limited to formats that will not compromise the covert nature of the mission and/or adequate safeguards must be instituted (e.g., using either cleared personnel or secure procedures).

During RF contact between the RTS and the OV, the uplink message is encrypted and transmitted at a one K bit rate over the command link. Each uplink message is made up of variable numbers of blocks. Upon verification of receipt of the data or command by the OV command subsystem, transmission of the next command message and/or block will be initiated. All uplink data is decrypted in the laboratory vehicle by a KGR-29.

An authenticated header precedes the SPC blocks, computer data, and teleprinter to assure the OV that the succeeding blocks are from an authorized source. In effect, the header allows the data which follows to be identified and distributed by the OV. Although a separate header is not sent and authenticated by the OV for each block of data, each block contains the unique parity check word for that load. Should an interruption occur in the uplink message, the OV command subsystem will reject any further commands until directed to accept commands by an authenticated word. SPCs will be used to initiate and configure the OV for the RTS pass and uplink transmission. RTCs will be transmitted in the authenticate mode only. All uplink message transmission from the RTS to the OV will be controlled nominally from the MCC, but the ability to control message transmission from an RTS will be available.

Because the blocks are parity checked in the ADC on a block-by-block basis, any single block error will cause rejection of the entire current message.

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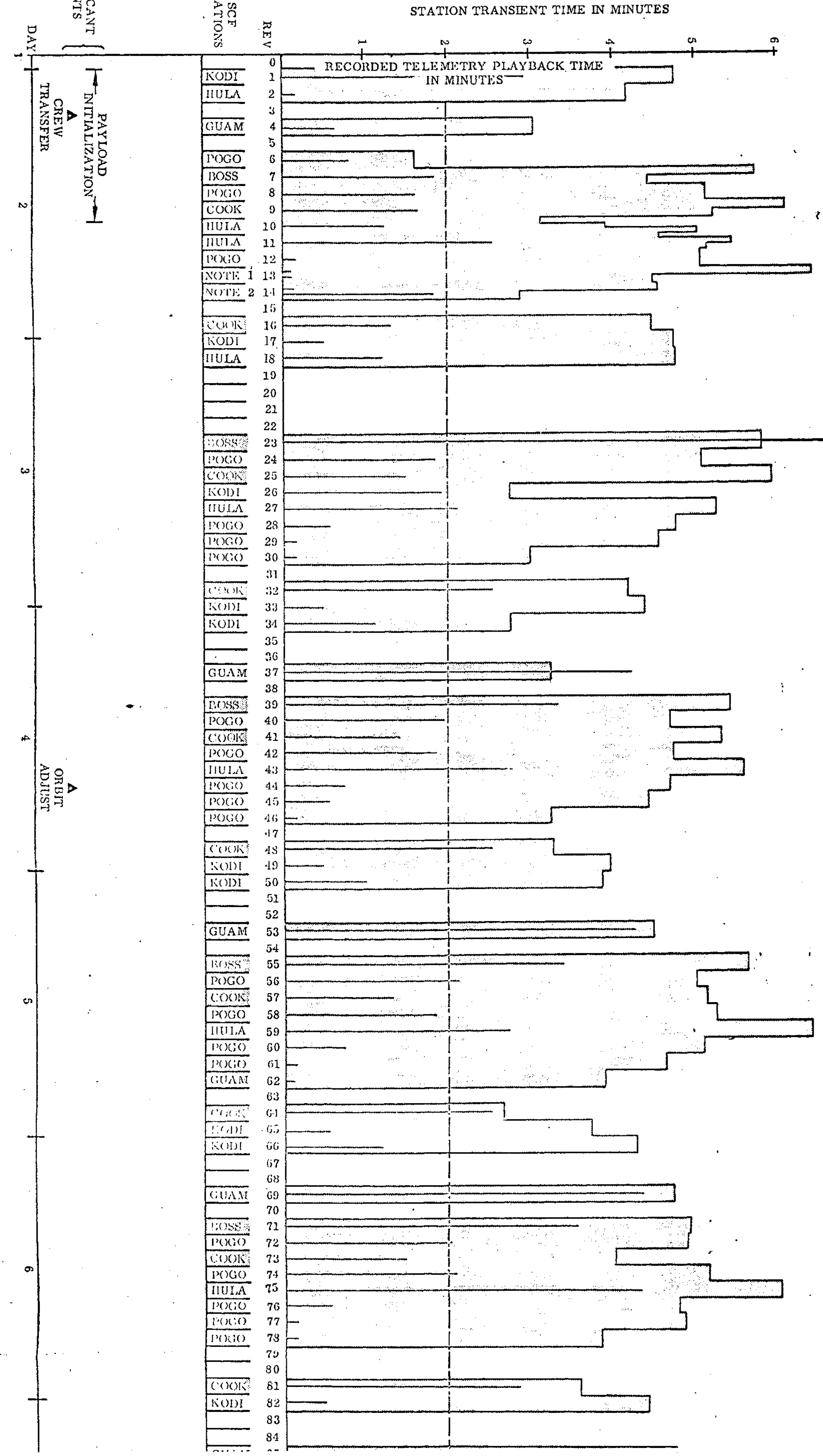

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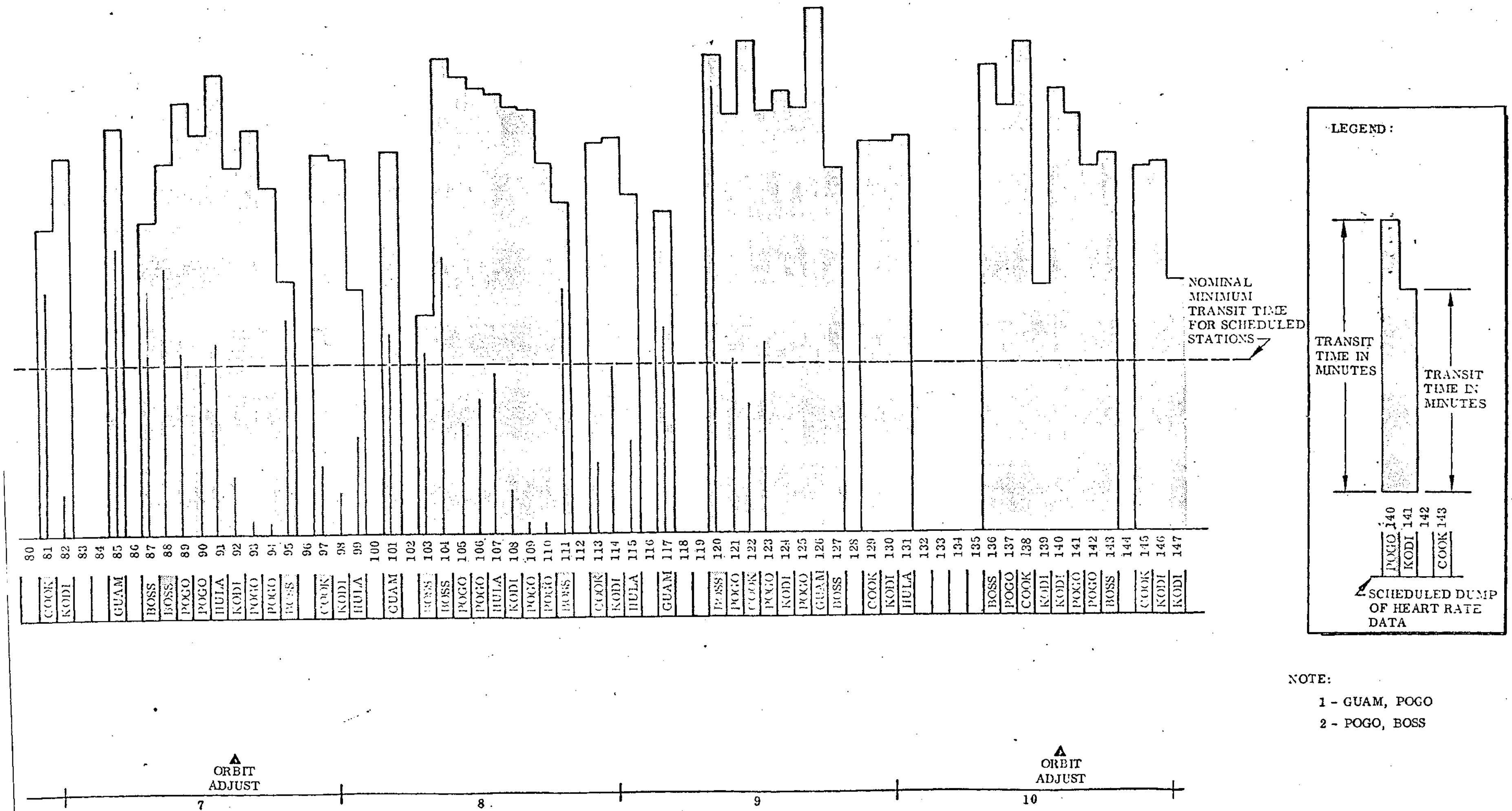

NOTE:

1 - GUAM, POGO
2 - POGO, BOSS

Figure 6-16 Uplink Data Loading
6-73/-74

D ~~SECRET~~ SPECIAL HANDLING

6.3.3.7 Downlink Data Handling Philosophy

Problems exist due to the quantity of data in the OV and the length of certain RTS passes. When a large amount of playback data is accumulated because of a typical busy operating schedule for the payload, as long as 90 sec could be required to play back the recorded PCM plus 110 sec to play back the recorded voice, or a total of approximately 200 sec to dump both (they share the same downlink). This would require in excess of 200 sec above 2.5 deg elevation. However, plots of typical record and playback times for the MOL operations indicate that there is sufficient time to playback the OV recorded PCM and voice data. A typical plot of the anticipated amount of PCM and voice data that will be recorded and the time necessary to play it back vs the pass time over the RTSs is shown in Figure 6-17.

Finally, as previously mentioned, there is also a desire to confirm the quality of the playback of recorded PCM data before the vehicle record is erased. If this is not possible during an RTS pass, the alternate PCM recorder shall be used until receipt of good TLM from the last RTS pass is confirmed. (Theoretically, the recording capacity of one tape can be exceeded between successive RTS TLM passes, making use of the alternate recorder necessary and limiting the above procedure.)

It can be concluded from the above comments that the TLM playback time over an RTS must be efficiently used. In addition, contingency conditions could drastically affect the amounts of real time data received at the RTS. Therefore, alternate operation procedures must be made for use during contingencies to allow for alternate times for the playback of OV recorded data.

6.3.3.8 Contingency

The nominal method of transferring data is described in preceding paragraphs. Should anomalous flight operations occur, additional capabilities will probably have to be implemented to handle greater quantities of MOL data more rapidly. The VTS-to-STC microwave link will be required to transmit large blocks of selected data to the STC. Extensive amounts of recorded data may be required on a near real time basis. It may be feasible to utilize the RTS-to-STC backup 2400 bps line (at dual RTS stations) to double the amount of data being transmitted back to the STC. Supplementary physical means may be required for more rapid data transfer from the RTSs to the STC and from the STC to other associated MOL processing complexes.

a. <u>Data Mode Selection</u> - The first course of action during contingency situations aboard the OV is to select special RTS TLM modes to restrict processing to individual or selected groups of parameters, selected parameters restricted to systems, selected parameters restricted to the monitoring of the performance of certain functions, and/or selected parameters restricted to the monitoring of individual subsystems. Ten to 20 different RTS TLM processing modes will be available to the MCC. By using these modes, the MCC will be able, in real time (depending on the length of the RTS pass), to manually isolate and make recommendations for correcting an anomalous operation.

b. <u>Security</u> - As previously mentioned (see paragraph 6.2.3), all uplink information under nominal conditions is encrypted before it is sent to the OV. The uplink information is decrypted before it is sent to the CLU. If required, commands may be sent up decrypted, bypassing the decryptors in the OV. LM analog voice, VHF voice, and range data are not encrypted.

Backup for the uplink voice is clear analog voice, VHF voice, or teleprinter message transmission.

c. <u>Core Dump</u> - Contingency situations may require use of the ADC selectable core dump capability. The ADC selectable core dump data is handled and processed by the ADS as nominal PCM data. It is included in PCM format 1 and will appear as recorded PCM data in the specification data slots of the nominal TLM format. Retrieving this data at an RTS will not require any special processing except for selecting that RTS processing mode which retrieves and transmits the ADC core data back to the STC. The extent of the core dump (whole or partial) will be determined by the ADC software which has been given start and stop core dump addresses. This data can be retrieved and handled either as anomalons real time or on a postpass basis.

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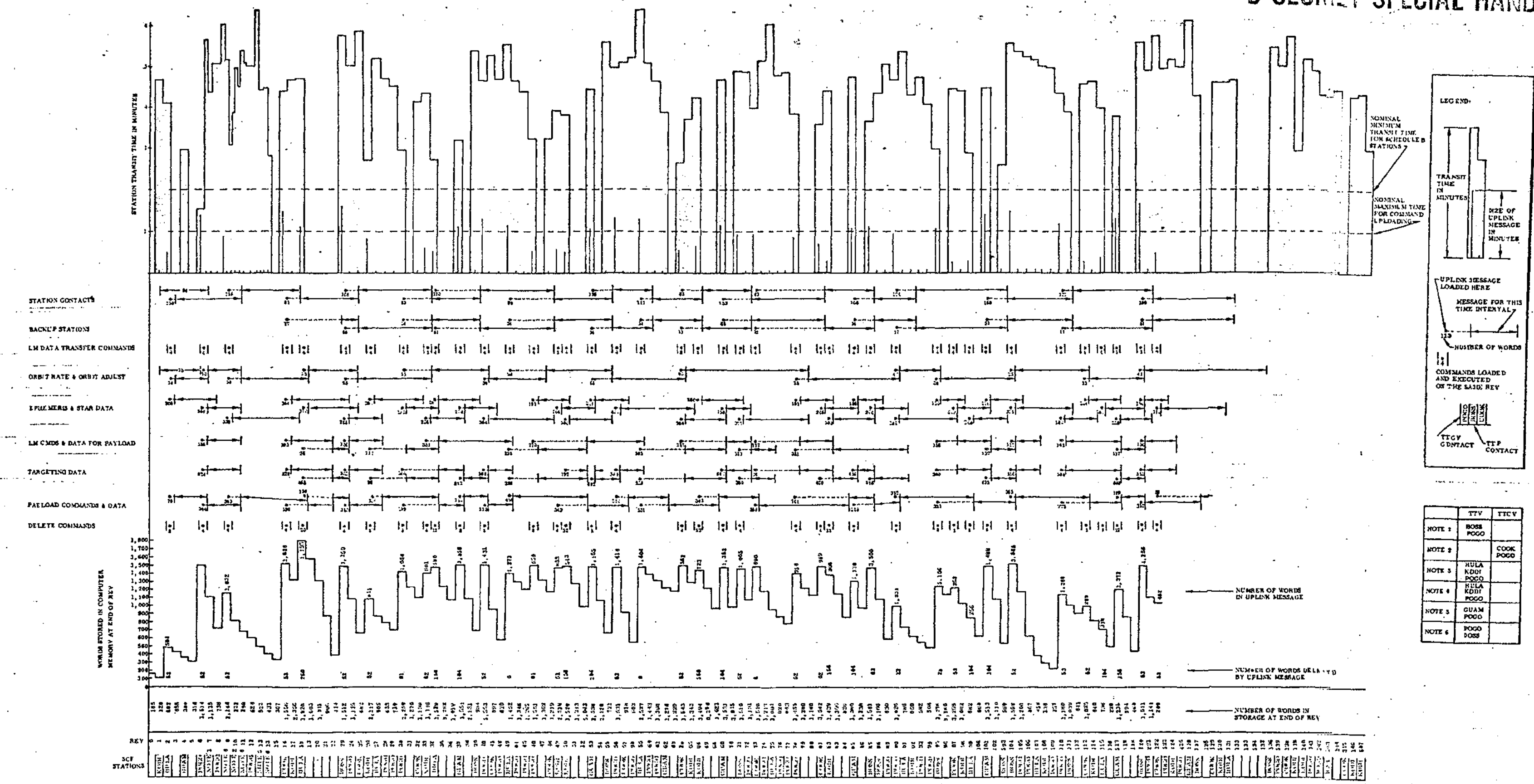


	TTV	TTCV
NOTE 1	BOSS POGO	
NOTE 2		COOK POGO
NOTE 3	HULA KODI POGO	
NOTE 4	HULA KODI POGO	
NOTE 5	GUAM POGO	
NOTE 6	POGO BOSS	

Figure 6-17. Downlink Data Loading
6-77/-78

D-~~SECRET~~ SPECIAL HANDLING

6.3.4 Voice Communications Philosophy

Voice communications with the flight crew will be restricted to relaying essential data. When the crew is in the laboratory vehicle, all communications concerning payload operation, targeting requirements, crew health, and status of the OV will normally be conducted on secure voice. While the crew is in the Gemini B, the clear VHF link must be used. At other times, only the flight crew or the FD will have the authority to relax the security requirement to fit the needs of the situation.

SGLS voice contacts will normally be scheduled for all station contacts where tracking, telemetry, and command are scheduled. During early and late orbit and loiter, all RTSs (and other required stations) having a VHF capability will be scheduled for VHF voice contacts. During normal orbital operations, all stations not scheduled for tracking, telemetry, and command, but having pass durations exceeding one minute, will be scheduled to guard a voice channel during the period of the pass. Channel guarding will consist of providing a listening watch on the designated frequency and pointing the appropriate antenna in accordance with the prepass message. The VHF will be guarded at IOS, KTS, and OL-5,; for other stations, the SGLS will be used unless they have a VHF capability. This will permit the flight crew to alert the ground of unexpected problems in advance of the next scheduled TTCV contact.

6.3.5 Flight Planning

6.3.5.1 General

The Flight Planning function is described below in greater detail than in previous paragraphs. Those factors which must be considered when initially selecting an orbit, the problems attendant to orbit sustenance, the orbit analysis function during the operation, and the process of flight plan generation are discussed.

6.3.5.2 Definition of Terms

The uncommon or MOL-unique terms and symbols used in the following paragraphs are grouped below to provide a consolidated listing. Terms having standard definitions are not shown here.

Inclination angle:	i (deg)
Perigee location (initial):	δ_p (deg of lat)
Perigee altitude (initial):	h_p (n mi)
Apogee altitude (initial):	h_a (n mi)
Satellite repetition parameter:	q (rev/sidereal day)
Nodal period:	T_n (min.)
Vehicle drag factor:	W/C_DA (lb/sq ft)
Ground illumination sun angle:	η (deg)
Orbital solar incidence angle:	β (deg)

6.3.5.3 Initial Orbital Selection

Orbit selection will be performed by the Flight Planning organization assisted by Orbit Analysis and Command Generation. Initial orbit selection will provide the required information for trajectory determination to Launch Operations.

The primary and alternate orbits selected will be sent to the using agency in Washington prior to L -90 days for approval. Typically, the actual launch vehicle segment weights will be available at L -120, payload weight estimated at L -110, and T-IIIM performance capability (using tag values) at L -95. Consequently, the Flight Planning group will have at least five days for selection of the primary and alternate orbit. The turnaround sequence associated with an alternate orbit must be initiated by L -7 days. To allow adequate flexibility, it has been proposed that a late change could be made to the apogee altitude for the alternate mission (together with a slight perigee latitude change), but that the perigee altitude inclination, and the pitch program associated with the alternate mission ascent profile remain fixed. This would result in a revised alternate mission which would best satisfy any particular change to mission requirements as late as seven days prior to launch. Since the pitch program for the alternate orbit will be less severe than that of the primary orbit, a loads analysis and validation need not be run for the alternate orbit. Orbit selection is further described in Appendix B-2.

6.3.5.3.1 Orbit Selection Criteria

The MOL program flight planning philosophy will provide the greatest probability of mission success based upon User requirements and consistent with MOL system constraints (and capabilities). Essentially, orbit selection is based upon consideration of:

a. User requirements.

b. Launch constraints.

c. Launch vehicle constraints.

d. Orbiting vehicle constraints.

e. Tracking station constraints.

f. Recovery constraints.

A flow chart showing this concept of orbit selection based on consideration of the above items is shown in Figure 6-18. The double arrows indicate that the elements are not independent, but, generally, are mutually interdependent. A matrix résumé of the following paragraphs is shown in Table 6-2.

The following paragraphs give the major, but not necessarily all, considerations for the requirements and constraints listed above. As will be seen,

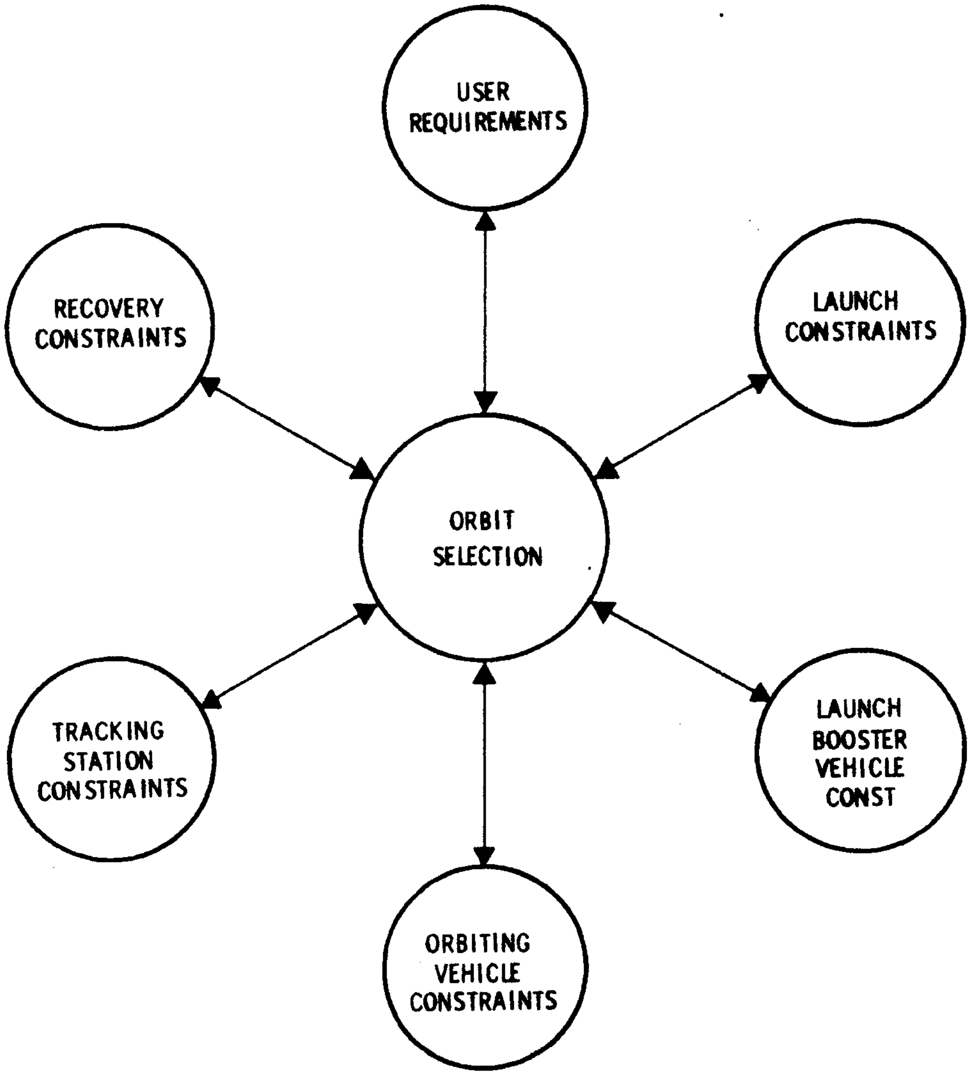


Figure 6-18 Orbit Selection Criteria

Table 6-2. Résumé of Constraints vs Orbit Parameters Affected

Requirement/ Constraint	Orbital/Launch Parameters							
	i	h_a	h_p	δ_p	q	T_N	Launch Date	Launch Time
User Requirements								
Primary area coverage	x				x			
Resolution								
range			x	x				
illumination (η)	x						x	x
Launch Vehicle Constraints								
Payload Weight to Orbit	x	x	x		x	x		
OV Constraints								
Gemini B	x	x	x		x	x		
Laboratory Vehicle (β)	x							x
Sustenance	x	x	x	x	x	x	x	
Tracking Station Constraints								
No. of contacts	x				x			
Duration		x	x	x				
Recovery								
Ship deployment	x	x	x		x	x		
Crew retrieval							x	x

it is not always possible to clearly assign constraints exclusively to any one of the categories listed.

a. User Requirements - Photography of the maximum number of targets with a potential for high intelligence value. This requirement places emphasis on continuous coverage over the area of primary interest with conditions allowing best photographic resolution.

1. Continuous Coverage (no gaps in longitude) - Establishes the q parameter which is generally chosen to provide at least 3 looks at the area between 80 deg N and 80°s lat for a 30-day flight. (See Appendix B.3 for further details on target coverage frequency.)

2. Best Photographic Resolution - Requires minimum altitude over the area of interest with good target illumination. Altitude over the target establishes the range of h_p and δ_p (h_p and q establish h_a and T_n). Perigee altitude cannot be determined to optimize only the photographic requirements as will be shown later. Perigee latitude δ_p can be fixed as nominally over the area of primary interest, in this case approximately 55 deg N.

   The ground illumination sun angle (η) is defined as the angle between the local horizontal of the target point and the sun ray vector. The ground illumination sun angle at a particular latitude is principally a function of: launch date, launch time, inclination angle, and time from launch. The last two factors are explained here, the first two in b., below.

   Inclination angle and time from launch determine the history of illumination over the area of interest. An $i = 96.4$ deg gives a sun synchronous orbit; therefore, with $i = 96.4$ and a launch at noon (PST), the launch latitude will have noon illumination for every daytime pass. With $i \neq 96.4$ deg, the precession of the line of nodes causes a change in the local time at which the OV passes over the launch latitude. The rate of change is a function of i, and the total change a function of time from launch and the rate of change. Appendix B.1 provides histograms of the sun angle (η) for various length flights for several values of i.

b. Launch Constraints - The launch constraints pertinent to MOL flight objectives are:

1. Desired ground illumination sun angle (η).

2. Orbital solar incidence angle (β) constraint of ± 60 deg.

3. Launch abort recovery constraints.

   (a) Sunrise at AFWTR < T = 0 < sunset at AFWTR.

   (b) T = 0 < sunset -2.45 hr at 40 deg S (Mode C abort recovery region).

Launch date effects can be illustrated simply by the fact that launch in mid-winter will find high latitude targets dark or poorly lighted much of the time.

Launch time effects can be shown by the fact that noon launches will provide good illumination over the area of interest (for at least the first few days of the flight); evening or morning launches will provide poor illumination.

Launch time also determines whether photographs are taken on the ascending or descending portion of the orbit. As a general rule, night launches (not planned for early manned flights) would require ascending photography while daytime launches dictate descending photography.

Appendix B.1 shows the effects launch date and illumination angle (η), as a function of latitude and inclination angle.

The launch time, launch date, and inclination angle also affect the orbital solar incidence angle (β). The β angle is dictated by vehicle environmental thermal and power constraints. Currently the vehicle is designed to operate within a β envelope of ± 60 deg. However, operational requirements can be met within a β variation of ± 45 deg.

Launch abort recovery constraints are associated with daylight considerations at the launch pad and in the 40 deg lat Mode C abort region. These further affect launch time for any given launch date.

Constraint charts which include the above considerations are discussed in Appendix B.1. These constraint charts provide a basis for thorough investigation of the tradeoffs and for determination of launch window as a function of launch date.

c. Launch Vehicle Constraints - The primary constraint on the launch vehicle is the payload it is capable of lifting into a given orbit. If the weight of the OV is considered fixed, the launch vehicle capability may be considered a function of i, h_p, and h_a. At present, for desirable values of h_p, h_a, OV weight and stated launch vehicle capability, i is limited to approximately 90 deg and 96.4 deg as maximum values for manned and automatic flight, respectively. A more complete explanation of the launch vehicle constraints is provided in Appendix B.1.

d. Orbiting Vehicle Constraints - OV constraints consist of Gemini B constraints and laboratory vehicle constraints.

The Gemini B is constrained to an approximate upper altitude limit on h_a of 215 n mi at i = 80 deg decreasing to 205 n mi or i = 91.5 deg in a linear manner. This constraint is imposed by its capability to safely reenter from any point on the orbit.

Studies are in process to determine allowable increases in h_a vs restrictions in the deboost point.

Laboratory vehicle constraints include the β constraint of $/\beta/ \leq 60$ deg, an allocation of propellants for O/A equivalent to approximately 415 fps ΔV and a low limit of h_a of 120 n mi based on safe orbit and ΔV for O/A. The OV constraints are discussed in Appendix B.2.

e. Tracking Station Constraints - With a network of seven geographically fixed RTSs, changes in i, h_a, h_p, and δ_p affect the number, sequence, and duration of RTS contacts. Requirements for some minimum time period above a given minimum elevation angle (2 min above 2.5 deg) for TLM, commanding and secure voice--as well as a station's physical obscura--reduce the total RTS contacts to some lesser number of usable contacts.

Targeting requirements which necessitate changes in the orbital inclination angle between 80 and 100 deg can change the RTS contact pattern drastically. The duration of the pass and rev numbers for contact from a particular station will change as the inclination angle is varied. For inclinations of 80, 85, 90, and 96.4 deg, those revs over a five day period for which no station contacts are available are shown in Table 6-3. The first set of data includes Pogo, Kodi, Hula, Boss, and Cook and the second set of data includes Wake and Guam in addition to those in the first set of data. Even though the data presented has sampled only five days of an orbit, with a 15 day repeat cycle it is believed that the trend shown is valid. This trend shows the number of revs where no RTS contacts are available to be generally decreasing as the inclination angle is increased between 80 and 96.4 deg. A particular rev where contacts are needed may necessitate a requirement or constraint on the range of acceptable orbital inclination angles (e.g., if a contact on rev 5 is required, the 80 and 85 deg orbits would be unacceptable).

The enhancement gained from the addition of Guam and Wake as RTSs is clearly shown in Table 6-3. This enhancement is maximized at inclination angles of 90 and 96.4 deg.

The effect of varying the q parameter while holding the inclination angle constant is considered to have a negligible effect upon the station contact problem.

f. Recovery Constraints

1. Recovery Force Redeployment at 40 deg Latitude - Coverage of the 40 deg S latitude region to satisfy the Mode C launch abort requirements does not appear to be a constraining factor for orbits with inclinations between 80 and 100 deg.

2. Mode C and Mode D Abort Logic - Changing the inclination while maintaining perigee altitude, perigee latitude, and satellite repetition parameter will mean that injection will occur at a higher altitude and a larger inertial flight path angle. This could affect the Mode C-Mode D abort logic in the event of a malfunction by shortening the time interval during which abort could occur by either the Mode C or Mode D abort concept. It is not anticipated that this would create a "dead man's zone" based upon the presently established 40 deg S impact limit.

Table 6-3. Station Contact Summary

Data Set	Day	Revs Having No Station Contacts*			
		= 80°	=85°	= 90°	= 96.4°
I: Pogo, Kodi, Hula, Boss, Cook, Indy	1	3,4,5,6,15	3,4,5,15	3,4,11,12	7,11,12,13
	2	19,20,21,22,31	19,20,21,31	19,20,27,28	23,27,28,29
	3	35,36,37,38,47	35,36,37	35,36,43,44	39,43,44,45
	4	51,52,53,54,63,64	51,52,53,63,64	51,52,59,60	55,59,60,61
	5	67,68,69,70,79,80	65,67,68,69,80	67,68,75,76,80	71,75,76,77,78
II: Pogo, Kodi, Hula, Boss, Cook, Guam, Wake, Indy	1	4,5,6,15	5,15	4,11	7,13
	2	19,20,21,22,31	19,20,21,31	20,27	23
	3	35,37,47	35,36,37	43	39,43
	4	51,54,63,64	51,63,64	51,52,59	55,59
	5	67,69,79,80	65,67,80	67,68,75,80	71,75,78

*Assumes at least 5 deg elevation angle for one minute

Perigee initially at 80 n mi and 55 deg N (descending)

3. Recovery Ship Deployment and Lateral Speed Required Within Recovery Fences - Orbit parameter changes which change the satellite repetition parameter will affect the lateral speed of the recovery ships within the recovery fence. Assuming the use of two ships each with an average speed of 15 knots, each ship can cover 360 n mi in one 24-hr period. At the equator (approximate latitude of eastern fence), a ship can cover 6 deg of longitude, while at 20 deg N latitude (approximate latitude of the Wake fence) the ship can cover 6.4 deg of longitude. The most stringent requirement for the ship will be that of covering a given longitudinal area near the equator. Consequently, the satellite repetition parameter (q) cannot exceed some q_{max} which is determined as follows:

$$q_{max} \leq \frac{16}{1 - \frac{\Delta L_{EQ}}{360}} \qquad (1)$$

where ΔL_{EQ} = longitudinal coverage at equator in degrees

Since the ship has the capability of $\Delta L_{EQ} = 6°$, q_{max} from equation (1) cannot exceed 16.27. If the assumption is made that the initial perigee altitude is 80 n mi and initial perigee latitude is 55 deg N, it can be shown, for orbits of different inclination, that the apogee altitude must be greater than, or equal to, those values tabulated below for the use of only two recovery ships; otherwise, the recovery ships cannot keep up with the eastward movement of the ground traces.

Inclination (deg)	Minimum Acceptable Apogee Altitude (n mi)
80	116
85	126
90	136
95	147
100	158

Based upon the above discussion, it is not anticipated that special targeting requirements necessitating orbital parameter changes will cause the present recovery fences to be changed.

This constraint is presented here to flag a possible problem in the event orbit requirements are changed with insufficient time to effect a change in the recovery support. The addition of a third ship, ships with increased speed, and/or the use of helicopters would relax this constraint considerably.

6.3.5.4 Orbit Sustenance

The nature of the DORIAN mission has necessitated a requirement to maintain the perigee location between certain latitudes and maintain certain ground trace coverage patterns.

Atmospheric drag and the effects of the nonspherical gravitational potential are the primary factors which result in orbital decay and apsidal rotation. Orbital decay reduces h_p, h_a with an attendant increase in q, changing the ground trace coverage pattern. Apsidal rotation results in a change to δ_p, thereby changing the altitude over the target area with an accompanying change in photographic resolution. The orbital sustenance technique proposed for MOL will correct h_p, h_a, and δ_p.

A ΔV of 415 fps is allocated for orbit sustenance from a total ACTS/Prop capability of 460 fps ΔV. A two-burn O/A will be accomplished approximately every 48th rev to correct the orbital parameters. In the case of the lower inclination orbits (i.e., $i < 85$ deg), apsidal rotation correction is "free". For orbits where $i \leq 85$ deg, apsidal rotation requires the second burn to be in a reverse direction and costs additional ΔV. A more detailed explanation of the sustenance technique is presented in Appendix B.4.

6.3.5.5 Oribt Analysis

In general, an orbit update will be required to meet the SP/DR prediction accuracy requirements every 2-4 revs plus an LRL, depending upon the atmospheric conditions. For polar orbits, the ephemeris prediction accuracy requirement (based on five tracking station passes) probably can be met the first day after rev 4. In general, a fit can be made from only one tracking station pass if the pass is of at least 1 min duration; the accuracy associated with this type of fit, however, is typically no better than an indication of being orbital. After approximately 8-10 station passes, additional tracking station passes will not enhance the prediction accuracies.

After an orbit adjust, if tracking data only is used, 3 tracking station passes will be required to reestablish the desired ephemeris prediction accuracies. If an orbit adjust is performed on subcycle 12, adequate tracking data will have been generated by subcycle 1 to meet the required ephemeris prediction accuracies (see Table 6-4). This is important for payload targeting. Table 6-4 is based upon a 5 deg minimum elevation angle station capability for a duration of 2 min and, as such, is quite conservative since the baseline operation will consider SGLS operable as low as 2.5 deg.

6.3.5.6 Flight Plan Generation

The flight planning software described in 6.2.3.3.1.1 provides an automatic capability to assist in developing a flight plan. Flight planning considers: orbit selection, station selection/scheduling, TLM mode selection/scheduling, special flight requirements scheduling, command loading station selection, flight crew activities, payload activities, orbit adjust scheduling, STC computer load scheduling, tape recorder readout scheduling, expendables management, Gemini B reentry and laboratory vehicle disposal.

The FVTL will serve as a basis for initial flight plan development.

Table 6-4. Station Contacts (5 deg Minimum Elevation) of at Least Two Minutes Duration
(i = 90°)

Day	No. of Station Contacts Subcycle						
	12	13	14	15	16	1	Total
1	0	2	2	1	1	0	6
2	0	2	2	1	1	0	6
3	0	2	1	1	1	0	5
4	0	2	2	1	1	0	6
5	0	2	2	1	0	0	5
6	0	1	2	1	0	1	5
7	0	1	2	1	0	1	5
8	0	1	2	1	0	1	5
9	0	1	1	2	1	1	6
10	0	0	1	2	1	1	5
11	0	0	1	2	1	1	5
12	0	0	2	2	1	1	6
13	0	0	2	2	1	1	6
14	0	0	2	2	1	1	6
15	0	0	2	2	1	1	6

6.4 POWERED FLIGHT OPERATIONS

6.4.1 General

Powered Flight Operations includes those activities performed in support of powered flight ascent and the retro sequence and reentry operation. These activities also include preflight checkout activities, and writing the POADs and the final test reports. These operational phases include those periods from liftoff to orbital insertion and from preparation for retrorocket firing to splashdown. This latter time period covers both the reentry following ascent abort and reentry from orbit.

6.4.2 Background

The MCR displays and computer programs used during powered flight were designed using the following constraints:

a. Only those parameters that provide direct detection of slow malfunctions leading to an abort or guidance switchover decision, or that are displayed to the flight crew, will be monitored on the ground.

b. Two indications (cues) of any malfunction will be available to the ground monitor to minimize the possibility of erroneous abort or guidance switchover recommendations.

c. The ground monitoring system is not required to detect two serial malfunctions.

d. If possible, all parameters will be capable of being displayed on hardware specified in the ADS design specifications.

e. Selected spacecraft-displayed parameters will also be displayed in the MCC.

f. All information required for real-time display monitoring will be available in the main room of the MCC.

6.4.3 MCR Console Operator Functions

During launch and ascent, MCR console configuration will be as shown in Figure 6-19, and the parameters required for the abort/switchover decision

1. TEST CONTROLLER
2. FTFD
3. ASCENT DIRECTOR (FLIGHT DIRECTOR)
4. CREW COMMUNICATOR
5.* BOOSTER CONTROLLER
6. BOOSTER CONTROLLER
7. RETROFIRE OFFICER
8. TRAJECTORY OFFICER
9. GUIDANCE OFFICER
10. GUIDANCE OFFICER
11. OV SYSTEMS CONTROLLER

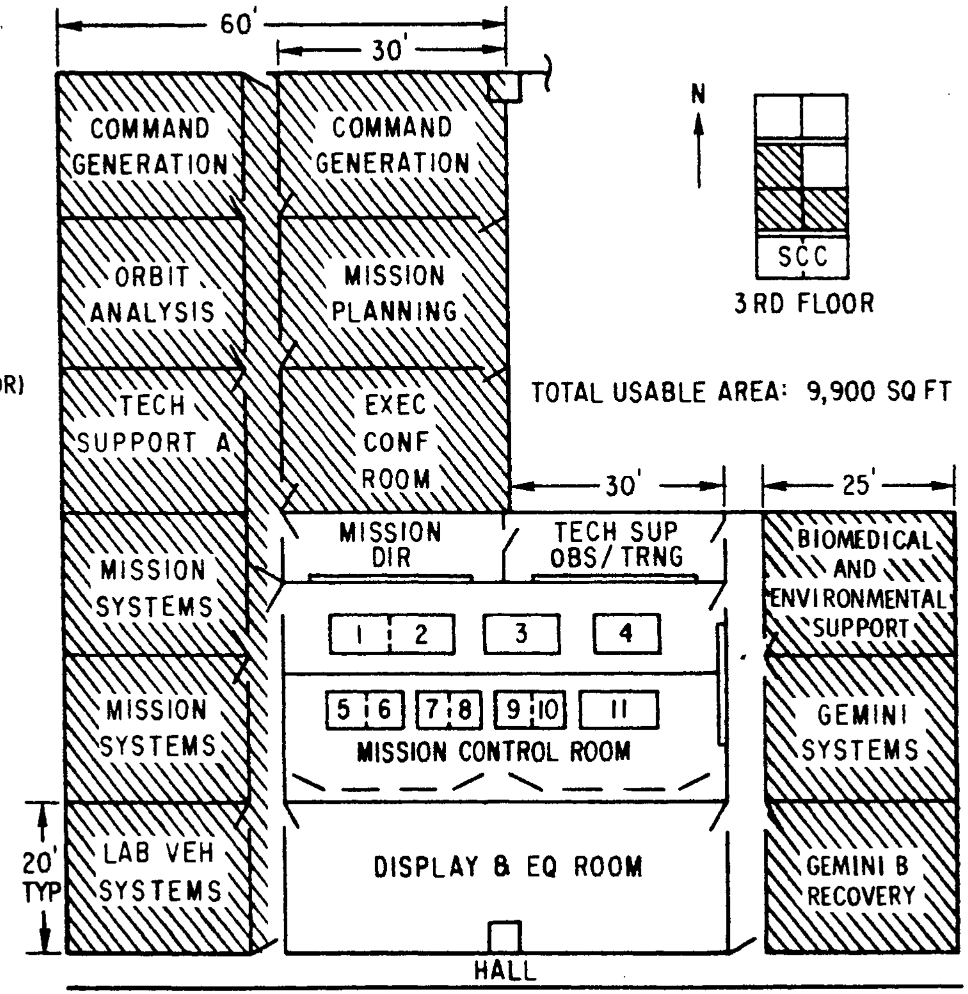


Figure 6-19 MCR Config tion for Launch and Ascent

shall be displayed in real time. During this time, seven consoles, consisting of 23 bays and one X-Y plotboard, are required for presentation of the display parameters to the 11 ground monitors (controllers) in the MCR. Three consoles require one monitor each, and four (guidance, booster, trajectory/retrofire, and flight support) require two monitors each.

These displays are based on monitoring powered flight ascent from liftoff to orbit injection and include no special prelaunch phase monitoring displays. In the event of an ascent abort, the Ascent Abort Touchdown Prediction Program (Ref. 4) is called into the CDC-3800 core, and the appropriate reentry parameters are computed and displayed, in lieu of the ascent monitoring parameters. Subsequent to orbital injection, the Reentry Support Program (Ref. 5), which is loaded into the CDC-3800 by the orbital flight support tape, will use the console for the display of parameters appropriate to each of its task modes of operation.

The MCR, as the focal point for detailed mission control, will be manned by MOL SPO and AFSCF personnel. These personnel may be functionally subdivided into the three following groups:

a. Powered Flight Command and Control Group.

b. Powered Flight Systems Operations Group.

c. Powered Flight Dynamics Group.

These groups will provide direct support to the FD, AD, and RD.

6.4.3.1 Powered Flight Command and Control Group

This group exercises real-time control during powered flight from operating positions located in the main control room of the MCC. The group will: (1) analyze prelaunch operations to ensure that mission control criteria have been met; (2) direct the Powered Flight Operations; (3) monitor and analyze powered flight progress continuously; (4) alter the MCC powered flight profile where necessary to remain consistent with Flight Plans and Flight Test Rules; (5) coordinate all flight control activities within the MCC and the AFSCF network; and (6) monitor the network tracking, data acquisition, and communication operations.

This group includes MD, FD, RD, AD, FTFD, AFD/CO, and the TC.

6.4.3.2 Powered Flight Systems Operations Group

This group, in the MCR, is composed of three flight controllers and is responsible to the AD for monitoring, evaluating, and analyzing the performance of all electrical, mechanical, and life support systems aboard the FV. In addition, this group is responsible for determining preventive, alternate, or remedial actions if contingencies and malfunctions occur. This group will: (1) Analyze and continuously evaluate all pertinent FV systems performance during powered flight, utilizing FV telemetry, tracking, and flight crew reports. (2) Detect slow malfunctions or impending slow malfunctions in FV systems during powered flight. (3) Diagnose malfunctions to determine effects and probable cause. (4) Recommend actions (including abort recommendations, if the situation dictates) to the AD and to the flight crew to correct or circumvent malfunctions or impending malfunctions. (5) Maintain trends of Gemini B consumable quantities and recommend appropriate actions based on these analyses. (6) Correlate data to accomplish the above tasks.

This group includes the two Booster Controllers and the AFD/VA.

6.4.3.3 Powered Flight Dynamics Group

This group, comprised of the Trajectory Controller, Retrofire Officer, and two Guidance Controllers, is concerned primarily with FV trajectories. It monitors and evaluates aspects of powered flight concerning crew safety and orbital insertion and continuously updates retrofire information for both planned and contingency reentry.

6.4.3.4 Ascent Director

The AD (see paragraph 3.5.1.3) will be responsible to the MD for the direction of ground monitoring personnel within the MCC. The AD is responsible for actions and decisions concerning:

a. Abort recommendations to the flight crew during ascent.

b. Guidance switchover recommendations during ascent.

c. Touchdown data transmission to the RCR.

d. Application of mission rules caused by anomalous FV behavior.

During powered flight, the AD will interface with the AFSCF and other supporting agencies through the FTFD and will exercise direct control over the other 10 ground monitoring personnel (controllers) in the MCR during powered flight.

The capability of contacting any of the trajectory/retrofire, guidance, launch vehicle and OV systems consoles displays will be provided to the AD during the powered flight ascent phase.

6.4.3.5 Trajectory/Retrofire Controllers

During powered flight ascent, the trajectory/retrofire console will be manned by the Trajectory and Retrofire Controllers. Their primary functions are:

a. To monitor the ascent trajectory to determine whether trajectory deviations due to vehicle malfunctions are such that an abort recommendation to the AD (if time permits) and/or flight crew is necessary.

b. To provide predicted touchdown data and delayed abort information to the AD and other 632A MCC ground monitors as required.

During reentry from orbit, the primary functions of the Trajectory/Retrofire Controllers are:

a. To ensure that a safe deboost and reentry will occur for nominal or off-nominal orbital conditions.

b. To provide reentry and recovery data for transmission to the flight crew prior to deorbit.

c. To ensure proper MCC/recovery force coordination.

6.4.3.5.1 Ascent Monitoring

The primary function of the Trajectory Controller during powered flight ascent is to determine the severity of any launch vehicle trajectory deviations that may lead to an abort recommendation. The Trajectory Controller may also detect trajectory deviations which would indicate a guidance slow malfunction; however, the recommendation for a guidance switchover command would be given to either the AD or Guidance Controller.

The primary functions of the Retrofire Controller during ascent are to assist the Trajectory Controller in observing trajectory deviations that may lead to an abort recommendation and verify that the predicted spacecraft touchdown point is within the planned recovery areas. The Retrofire Controller may have additional duties during the ascent phase:

a. Recording liftoff time and confirming that the correct liftoff time has been entered in the ground computer.

b. Informing the AD that the vehicle clock has started and advise the Guidance Monitor if the spacecraft leads or lags the ground elapsed time.

c. Confirming flight events with the AFD for crew operation.

The Retrofire Controller must also be notified of the location of various recovery forces and current weather conditions in the abort areas through intercom with the RCR.

For ascent operations, the MOL baseline ascent abort modes and associated flight sequences have been defined as follows:

a. Mode A Abort - (on pad to approximately 30 sec in flight) - Automatic or manual thrust terminate, manual salvofire six retrorockets (posigrade) on the spacecraft for maximum altitude and then seat ejection from the spacecraft.

b. Mode B Abort - (from approximately 30 sec after liftoff to an inertial velocity of 24,000 fps) - Thrust terminate, separate from launch vehicle, salvofire six or two retrorockets posigrade) and descend to drogue chute altitude using a full lift entry attitude, deploy recovery system, and land with spacecraft.

c. Mode C Abort - (from an inertial velocity of 24,000 fps to approximately 488 sec of flight time) - Thrust terminate, separate and reorient spacecraft, time retrofire (six rockets in retrograde direction), descend to drogue chute altitude using a variable bank angle entry attitude (predetermined to achieve a desired touchdown point) and complete normal spacecraft recovery.

d. Mode D Abort - (used only the last few seconds of ascent to abort into orbit for a minimum lifetime of 14 hr with the Gemini B detached) - Separate the OV from the T-IIIM, accelerate to orbital velocity with laboratory ACTS, perform degraded mission to the extent possible.

Should an abort be recommended, the Retrofire Controller will receive additional display information relevant to the spacecraft reentry as computed by the Ascent Abort Touchdown Task Ref. 6).

6.4.3.5.2 Reentry Monitoring

The primary function of the Trajectory/Retrofire Controllers during on-orbit operations is to support nominal or abort reentry planning prior to orbital deboost and to transmit updated information to the flight crew after deboost. The various displays, available to the ground monitors, support the above functions based on four reentry program task modes (Ref. 5); the ascent abort task mode, which supports the ascent monitoring requirements, is also defined. The detailed explanation of the logic capabilities and computations involved in accomplishing the reentry tasks are discussed in Ref. 5.

6.4.3.6 Guidance Controllers

The primary function of the Guidance Controllers is to analyze the status of the BIGS, GIGS, the launch vehicle ARS, and data from the GERTS to determine which onboard guidance system should be used as the primary system for steering the vehicle. BIGS will initially assume the primary guidance system role unless and until a malfunction occurs in this system. A malfunction may cause ascent trajectory deviations from the nominal profile or a detrimental effect on the FV, the Guidance Controllers will then make the guidance switchover recommendation that would be transmitted to the AD (if time permits) and/or flight crew. Conversely, if the GIGS should fail, a switchover inhibit recommendation will be made to the AD and/or flight crew. The Guidance Controllers will also be required to provide BIGS and GIGS status information to the other ground monitors, particularly the Trajectory/Retrofire Controllers. They will transmit, to the AD or the AFD/CO, their observations for relay to the flight crew based on their monitoring of the pertinent displays.

6.4.3.7 Booster Controllers

The primary responsiblity of the Booster Controllers is to analyze the launch vehicle propulsion and control systems to aid in determining abort recommendations under the following conditions:

a. Loss or degradation of the launch vehicle control system resulting in deviations of the ascent trajectory or possible structural breakup.

b. Pressure drops in the Stage I and/or Stage II propulsion system tanks during Stage 0 leading to structural breakup.

c. Failure of one or both of the Stage I subassemblies to ignite or perform within established limits.

d. Premature shutdown of one or both Stage I subassemblies prior to SRM staging.

e. Failure of the Stage II engine to ignite or perform within established limits.

f. Any non-nominal performance not causing structural breakup but resulting in a hazard to crew safety and/or mission success.

In addition, the Booster Controllers will inform the AD and other console monitors when Stage I and/or Stage II tank pressures are non-nominal but the vehicle is not in danger of structural breakup, and when one of the core engines is operating below minimum specified limits. The low tank pressure warning will inform MCC personnel that a problem exists in the propulsion pressurization system. Low tank pressures could lead to an abort situation, or cause non-nominal engine performance resulting in deviations of the ascent trajectory.

The low engine performance warning indicates that deviations in the ascent trajectory may occur which could lead to an abort recommendation by the Trajectory Controllers. The Booster Controller will have the capability of recommending abort action to the AD (if time permits) and/or the flight crew based on the propulsion and control parameters monitored.

6.4.3.8 OV Systems Controller

The primary function of the OV Systems Controller during ascent is to analyze those systems of the Gemini B spacecraft and the laboratory vehicle in which malfunctions during powered flight ascent could lead to an abort recommendation to the AD and Trajectory/Retrofire Controllers. It should be noted, however, that he will not recommend abort action directly to the flight crew. The prime reason for this is the direct correlation required between the type of OV system malfunction and the vehicle trajectory prior to initiating an abort recommendation to the flight crew. The systems to be monitored are:

a. Gemini B

1. Reentry control system

2. Environmental control system
3. Electrical power system
4. Instrumentation system

b. Laboratory Vehicle

1. Attitude control and translation system.
2. Electrical power system.
3. Environmental control/Life Support System.

In addition, the OV System Controller will provide OV status information to the other ground monitoring consoles as required, and to the flight crew via the Crew Communicator. GIGS monitoring will be performed by the Guidance Controllers.

6.4.3.9 Assistant Flight Director for Crew Operation

The primary function of the AFD/CO during ascent is to provide ground-monitored flight information to the flight crew. In this role, the AFD/CO will be the primary source of ground communication to the flight crew, relating flight events during powered flight ascent (e.g., programmed pitch and roll maneuvers, staging, engine start, etc.).

The role of the AFD/CO will differ from that of the AD in terms of authority concerning ground monitoring recommendations to the flight crew. The AD will have the responsiblity for all decisions made concerning ground monitoring and will relay flight information to the crew and make recommendations on crew status to the AD. The display capability available to the AFD/CO will be similar to that of the AD to provide adequate flight information to the crew concerning specific events s required.

6.4.3.10 AFSCF Flight Support

The FTFD and the TC will be primarily responsible for the status of the supporting AFSCF network at all times. (Their individual roles during the launch and ascent phases are defined in Section 3.0). They will report and respond to the FD and maintain close liaison with the AFSCF System Controller to maintain the integrity of the supporting network elements. Their general functions will include:

a. Coordinating requirements and assuring quality of supporting elements of the AFSCF and AFWTR interfaces.

b. Knowledge of validity and selection of all data and communication sources.

c. Responsiblity for maintaining data quality.

d. Responsiblity for recommending switching of prime computers and non-EXCELS data transmission lines assigned to the MOL program during powered flight to backup devices in the event that processing or quality is degraded.

The above functions will be performed in close liaison with the AFSCF ND and those specialized support personnel located in remote areas.

These personnel will work closely with all MCR monitoring personnel, and, in particular, with the Trajectory/Retrofire Controllers during the powered flight ascent phase. They will not, however, be in the loop for real-time decisions (abort or guidance switchover) based on vehicle performance during powered flight.

6.4.4 Interfaces

6.4.4.1 AFSCF

The AFSCF interface is handled through the FTFD/TC and includes the AFWTR, (1 each Range to coordinate all Government agency facility interfaces).

6.4.4.2 Flight Crew

Since the flight crew, Gemini B cockpit displays, and the FV MDS are prime for the ascent phase, the real-time interface between the MCR and the flight crew will primarily be in support of the crew in the slow malfunction area (those malfunctions with 6 sec or greater lead time from first indication to catastrophic results). The MCR will also serve as a backup for the crew displays. The MCR will make recommendations regarding abort and guidance switchover. The reentry interface consists of providing parameters for reinitializing the Gemini B computer and confirmation of airborne computer outputs.

6.4.4.3 Recovery Control Room

The RCR is located in the MOL MCC and is controlled by DDMS. This agency has the responsiblity for the spacecraft recovery and crew retrieval. The MCR will supply to the RCR the best available information regarding the anticipated landing point and time and information regarding the reentry altitude, position, and time profile.

6.4.4.4 Launch Control Center

Voice only to the level necessary through the FD/LD.

6.5 ORBITAL OPERATIONS

6.5.1 General

Orbital Operations consists of those activities required to control the MOL during the orbital phase of the Operations Test to satisfy the flight objectives. These activities range from flight preparation to on-orbit control of MOL, to the writing of final test reports. The full range of these activities is described below, except for those prelaunch activities associated with training of operations crews (see Section 11.0) and the flight test data evaluation (see Section 9.0).

This discussion ties together the functions described in other parts of this document and provides details to make the profile in Section 4.0 more meaningful. Repetitive major activities or functions, as well as those that may only occur once (e.g., laboratory vehicle disposal) are described.

This material provides a typical picture of nominal operations; no attempt is made to account for the variety of activities categorized as "special case".

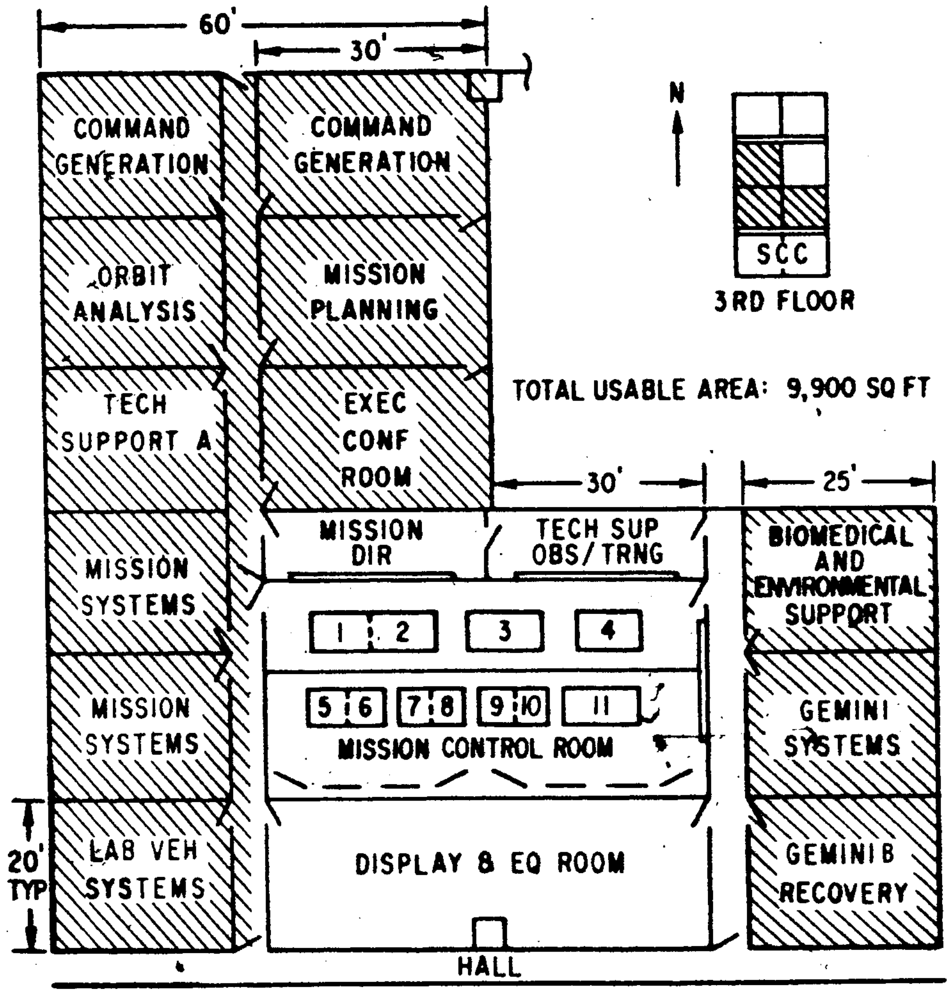
During the orbital operations phase, the MCR is configured as shown in Figure 6-20.

6.5.2 Nominal Duties of Operations Elements

The following paragraphs provide a brief overview of the duties of each of the elements shown in Figure 6-20 during the orbital phase. While this is redundant to information contained in Section 3.0, it is included here to make this discussion more independent of Section 3.0, and to refresh the reader on those aspects of the functions most important to orbital operations.

a. Flight Director

1. Responsible for overall program control, crew safety, and mission requirements.



1. TEST CONTROLLER
2. FTFD
3. FLIGHT DIRECTOR
4. AFD/CO
5. DATA CONTROLLER
6. RESERVED FOR FLIGHT SURGEON
7. ASSISTANT TEST CONTROLLER
8. COMMAND CONTROLLER
9. RESERVED FOR AFD/FP
10. RESERVED FOR AFD/RRP
11. RESERVED FOR ASSISTANT DIRECTOR FOR VEHICLE ANALYSIS

Figure 6-20 MCR Configu   on for Orbital Operations

2. Levies requirements on the AFSCF through the FTFD.

3. Reviews real time operation and approves any action that will result in a change to the pass plan prior to accomplishment of that action.

4. Responsible for overall program readiness.

b. FTFD

1. Exercises detailed control of all elements of the AFSCF, affiliated agencies supporting program, and specifically, operational elements of the MCC. He is responsible for adherence to program profiles, flight test rules, and emergency procedures.

2. Verifies readiness of global network to FD.

3. Evaluates operational capabilities of MCC systems in accordance with directives and flight test rules.

4. Conducts validations, exercises, and rehearsals as required to ensure operational capability of all AFSCF software, hardware, and personnel affiliated with the program.

c. Test Controller

1. Responsible to the FTFD for smooth integration and detailed implementation of flight planning and control procedures. Assists FTFD as necessary in all C&C functions.

2. Specifically responsible for schedules, network discipline, and adherence to procedures.

3. Maintains close liaison with subsystem technical advisors to ensure timely knowledge of subsystem status.

4. Advises FTFD of possible changes to flight planning as a result of hardware or software planning throughout global network, and STC in particular.

5. Maintains close liaison with Network Control to ensure satisfaction of program requirements.

d. AFD/CO

1. Responsible for flight crew/MCC operations and crew health.

2. Ensures effective voice communications between MCC and flight crew.

3. Assists flight crew in following flight plan.

4. Makes recommendations to the FD concerning flight crew status.

e. AFD/VA

Monitors OV systems in real time during RTS passes and informs FD of any significant status events. Works with TA staff on vehicle systems problems, follows up on special problem areas as FD representative.

f. Command Controller

1. Maintains close liaison with FTFD, SPO, TC, and Command Generation to ensure exact status knowledge of all command messages.

2. Monitors and controls all aspects of transmission of command messages to tracking stations.

3. Keeps FTFD and TC informed of status of all command messages.

g. Data Controller

1. Monitors and controls all aspects of the data system assigned to MOL. Ensures that programs are run on schedule.

2. Takes remedial action when required to ensure uninterrupted data flow.

3. Keeps FTFD and TC advised of status of data system.

The following important elements are not represented in the control room but deserve a review at this point.

h. Command Generation

1. Composes command messages, on a timely basis, to be sent to the vehicle.

2. Ensures that command messages contain all instructions required to follow the flight plan.

3. Works closely with data coordination to ensure most recent ephemeris information is utilized.

4. Works closely with orbit analysis to ensure accurate command messages for orbit adjust, deboost, and reentry.

i. Orbit Analysis

1. Maintains current orbital parameters.

2. Makes all O/A computations and advises the FTFD when such action might be required.

3. Makes rapid calculations to provide an early orbit definition to the FTFD.

4. Performs all computations and recommendations concerning reentry and deboost.

5. Works closely with data coordinator to ensure most timely information is being used in referenced computations.

6. Assists the TC maintain strict adherence to the flight plan.

7. Conducts analysis diagnostics and study runs as required by the FTFD in any aspect of orbital mechanics.

j. Natural Aerospace Environment Technical Advisor (MOL STAFFMET)

See Section 12.0.

k. TA Staff (Aerospace/Contractors)

1. Reviews status of OV systems health after each RTS pass.

2. Advises FD of any trends toward anomalous OV conditions.

3. Flags anomalous OV conditions.

4. Supports software operation with design and programming personnel.

5. Runs or directs in-depth analysis of any OV system anomalies discovered.

l. AFD/FP

1. Is the FD representative in working problems with The User, Command Generation, and Orbit Analysis.

2. Updates the flight plan over a one-to-two-day interval based on User requirements.

3. Evaluates the payload activity using the mission correlation data.

m. AFD/RRP

1. Is the FD representative to coordinate orbital operational matters with the RD.

2. Coordinates the periodic update of Gemini B reentry parameters with Orbit Analysis.

3. Coordinates DRV reentry requirements for the FD and command generation with the RCG and Orbit Analysis.

4. Coordinates the laboratory vehicle deboost sequence with Oribt Analysis, command generation, and government agencies cooperation in assuring remnants of the LV are recovered or destroyed.

6.5.3 Nominal Operations

6.5.3.1 Normal Rev-to-Rev Operations

The description of pass activity begins with the prepass briefing and makes the following assumptions:

a. No anomalies exist or will be encountered.

b. All plans for the forthcoming pass have been made.

c. All prerequisite activity (e.g., command generation, orbit planning, etc.) required for the pass and the briefing are in progress or complete.

d. The pass is a typical orbital operation (i.e., no special case such as reentry or laboratory vehicle disposal).

6.5.3.2 Prepass Briefing

The prepass briefing is conducted by the TC and is attended by an authorized representative of the MD*; FD; FTFD; TAs; AFD/CO; AFD/VA; AFD/FP; AFD/RRP; Orbit Analysis; Data Controller; Command Controller; Command Generator.

The briefing is held at approximately RTS acquisition -45 min to discuss the proposed real-time operations plan for the pass to provide general understanding, to allow for minor but essential changes in the plan, and to obtain FD/FTFD concurrence.

A typical agenda for the prepass briefing may be as follows:

a. Orbit Analysis will brief on the geometrical aspects of the station contact such as: (for each station involved if there are more than one) rise time, set time, total contact time, maximum pass elevation, time available to meet TLM readout and commanding constraints.

b. Command Generator will brief on the command aspects of the pass such as: critical OV SPCs that will be executed in conjunction with the pass; RTCs that will be sent and those that will conflict with OV activity if sent; significant contents of the command message to be loaded including payload activity, rev span for the message, Gemini B reentry information, etc.; optimum message transmission times; possible contingency actions; etc.

c. AFD/VA systems briefing will consist of a report on the status of OV and any problems noted or anticipated. It will also include the TLM modes required for the next pass, questions requiring answers from the flight crew and any rationale necessary.

d. AFD/CO briefing will include a briefing on flight crew health and list of voice information to be passed to the crew. This will consist of instructions and questions requiring crew action and answers.

e. The TC will poll the representatives not presenting briefings to see if they have questions and comments, make his own comments, ask for concurrence with the plan from the FTFD and FD, and adjourn the prepass briefing.

6.5.3.3 MCC Prepass Preparation

Following the prepass briefing, the following actions are taken by the organization indicated to assure that the MCC and the AFSCF are prepared for the pass:

a. The TC briefs the RTS personnel on all pass activity that affects their station operation. He ensures that all necessary AFSCF resources required to support the pass have been scheduled and are available.

b. The Data Controller assures that the RTS is furnished with all data required for station configuration and antenna pointing, that AFSCF communications are aware of the communication requirements.

c. The Command Controller assures that a valid command message has been transmitted to the RTS and its retransmission to the STC has been checked for accuracy.

d. The AFD/VA assures that OV displays are properly called up and configured and that all required telemetry has been programmed for the pass.

6.5.3.4 Real-Time Activities

The real-time pass starts at approximately ETA -1 minute with the RTS antennas positioned and the receivers in frequency search. The significant action taken by each organization is delineated below:

a. The RTS reports its status; searches for the OV transmitter about the predicted frequency; acquires the signal and locks on, in frequency, angles, and range and begins tracking. Tracking data is transmitted to the STC. Once the TLM discriminators and decommutators are in lock, the requested TLM mode data is transmitted to the STC. Secure voice transmission between the OV and the MCR is relayed to both points from the RTS, but boice is not generally available at the RTS in decrypted form. All data received by the RTS, both by RF from the OV and hardwire from the MCC, is magnetically recorded with system time for record. After the OV fades the RTS reports fade, secures its antennas, receivers, and transmitters, and prepares for postpass playback.

b. The TC directs activity in accordance with the pass plan. He keeps the RTS apprised of MCC operations affecting their activity (e.g., RTCs that turn data links on/off, data system instructions that change TLM modes or transmit command messages from the RTS computer memory). The TC instructs the command controller to transmit RTCs and command loads to the OV. He monitors commanding operations to assure that proper verification is received for commands and command messages. He instructs the Data Controller to change RTS TLM modes. He controls all MOL dedicated AFSCF resources during the real-time pass.

c. The AFD/CO establishes voice contact with the flight crew, obtains a general verbal status of their operation since the last RTS contact, relays the questions from his pass plan, receives answers from the flight crew, receives questions from the flight crew and answers in real-time those questions possible, deferring to the next pass those not readily answered. He gives verbal information on the command load and any changes in the operations schedule.

d. OV Systems monitors TLM displays and calls up display formats that provide details of the applicable subsystems. OV Systems also looks for subsystem anomalous operation in real-time to alert AFD/VA and to establish any changes to the postpass TLM mode requirements with minimum delay.

e. The TAs monitor the pass by listening to conversations between crew/MCR, TC/RTS, TC/Data Coordinator, and TC/Command Controller. They monitor certain portions of the OV subsystem displays, and assess the operation, from a system point of view, to advise the FD.

6.5.3.5 Postpass Activities

After the OV has passed beyond the horizon at the RTS, the postpass activities begin:

a. The RTS prepares magnetically recorded data (the recorded real time data link and the recorded AVE playback data link) for playback through the RTS portion of the ADS. The MCC specifies the TLM modes to be used for playback of the real-time link. Data is extracted from the AVE TLM recorder data based on source (i.e., biomedical, OV TLM, or crew voice) and those portions transmitted to the MCC as requested. Playback will be specified by source, time, and TLM mode (in the case of OV TLM data). After postpass playback, the RTS will dub magnetic recordings for their temporary storage library, and prepare the originals for air shipment to the STC.

b. The TC coordinates the OV Systems requirements for RTS data playback through the Data Controller.

c. The TAs report to the FD after they have had time to make a systems analysis. They recommend any changes they believe necessary in the flight plan.

d. The Flight Planning Group, using payload data received from previous passes, runs the MCD programs to perform the evaluation function. They run the mission planning programs to define the payload activity for some future period (e.g., the next day). They check this activity for meeting mission constraints and submit it to the FD as a recommended plan of action.

e. OV Systems runs initial short-term trend analysis programs to update the TLM trends using the data points from the previous pass to predict TLM for the next pass. They have the previous pass TLM data inserted into the data base pass. They perform data analysis to detect any anomalies or incipient failures and prepare the OV systems briefing for the next pass.

f. Orbit Analysis runs orbit and ephemeris programs to update the ephemeris with tracking data from the previous pass. They analyze the data to determine the drag factor and to verify that the orbit adjust (O/A) is currently scheduled at the right time for orbit maintenance. Should an O/A be required for the next command load rev span, the O/A programs are run to provide the O/A parameters; these parameters are verified and inserted into the data base. Orbit analysis conducts all study runs concerning reentry information, impact prediction, and deboost, and all computer runs to determine station look angles, pass duration, etc. They prepare the briefing for the next pass.

g. Command Generation runs the command and control program picking up from the data base all new data inserted since the last rev. They produce a command load for the next loading pass to cover the load rev span as specified in the flight plan. They keep the Command Controller apprised of their activity by reporting significant status milestones.

h. The Data Controller controls the running of all the programs on the offline computers in accordance with the DSMP. The DSMP is a profile of offline computer system utilization and is a subset of the flight plan. The Data Controller uses tracking data from the previous pass to update the ephemeris.

i. The FTFD is apprised by the FD of any new requirements on the AFSCF generated as a result of postpass activity. He requests additional AFSCF resources through Network Control. He resolves conflicts with other requesting satellite programs to satisfy MOL program requirements. He maintains close liaison with the FD to identify possible requirements on the AFSCF as soon as possible. He is responsible for the AFSCF personnel within the MCC.

j. The FD reviews the pass with his technical staff, determines any changes required in the plans, and levies requirements on operations organizations to implement these changes.

6.5.3.6 Planning Conferences

Planning conferences will be held to inform the Mission, Flight, and Recovery Directors of operational status. The times for these conferences will be selected considering such factors as payload activity and time required to analyze quick look results, possible recovery passes, and the time to reposition forces, etc. At this time, the following conferences have been identified as being required:

a. Daily Planning Conference to keep the MD apprised of general operation status. This conference will be held each morning after the previous evening's payload activity had been initially assessed. It will be conducted by the FD with representatives from all major operational areas in attendance.

b. R&D Planning Conference to plan the next day's R&D activity (primarily, but not limited to payload). This conference will be held each day as required, near the end of the normal working day, to provide the required lead time to set up any required ZI targets, do the required planning, and generate the command loads for the activity to occur the following day over the ZI. The conference will be conducted by the FD and will be attended by representatives of all major operational areas.

c. Recovery Planning Conference to plan the next day's nominal and contingency recovery passes, assess the weather situation, and assess the probability of recovery based on OV health status and mission accomplishment. This daily conference will be held mid-day to provide sufficient lead time to the recovery forces and not interfere with the possible R&D conference. This conference will be conducted by the RD and will be attended by representatives of all the operational areas.

6.5.4 Software System Operations

6.5.4.1 General Operation Description

There are two basic operational modes which will be used for a 30-day MOL flight profile. These two modes are identified as the preflight planning mode and the orbital phase operational mode. The orbital phase operational mode utilizes the software segments described in paragraph 6.2.3 (except ascent/reentry) and the planning mode utilizes only the uplink processing segment.

6.5.4.2 Preflight Planning Mode

The basic function of the preflight planning mode is to produce the flight plan for the 30-day flight. The initial operation required to produce the flight plan is to select the orbital parameters of the flight. These parameters will normally be selected based upon system and mission constraints and will have been verified and approved by The User (see paragraph 6.3.4). Once the orbit has been selected, profiles of station contacts, payload activity, O/A, etc., can be generated by the flight plan software element calling through SYMON macros appropriate portions of the AFSCF/system support software, event generation elements, command generation elements, and message generation elements. As the planning process proceeds, selection of secondary flight objectives (e.g., R&D experiments, ZI photography, etc.) can be included in the flight plan.

During the generation of the flight plan, the flight plan element will perform conflict identification and resource analysis. After conflicts have been identified and resolved, the process will continue in an iterative fashion until a conflict-free 30-day flight plan has been produced.

The flight plan element, in addition to producing the flight plan, will simultaneously generate and store all data required to perform planning tradeoffs and analysis during the flight.

6.5.4.3 Orbital Phase Operational Mode

The orbital phase operational mode is concerned with two distinct processes. The first process is the preparation and transmission of uplink command messages to the OV. The second process is concerned with processing downlink TLM and tracking data. Tracking data is processed by using the AFSCF System Support software and is described in paragraph 6.2.3.2. MOL TLM is processed by both the AFSCF and MOL downlink software segments to determine vehicle health, diagnose anomalies, and produce mission correlation data. During the flight, the profile may be updated by selectively generating portions of the flight plan which require alteration. These segments can be generated in an iterative manner to assess the impact of changes for the duration of the flight.

6.5.4.3.1 Uplink Message Generation

The basic operational requirement for ground software uplink message generation during the orbital phase is to maintain sufficient data in the AVE computer to allow performance of mission activities for several revs. The uplink message generation process must continually produce messages which update the AVE computer data several revs ahead of the current time.

The data being generated and sent to the AVE computer will include the identification of the targets to be photographed and viewed, stars to be selected, ephemeris data and correction parameters, real-time commands, SPCs, and teleprinter data. The real-time and SPCs will be those commands generated because of orbital requirements arising from orbit adjust, reentry, special flight requirements (SFR), station contacts, etc.

The uplink message generation process is initiated and controlled by the flight plan. For purposes of explanation, it is assumed that the flight plan has been generated and that the rev span over which the current command load is being generated involved payload activity, special flight requirements, station contacts, orbit adjust, and reentry events.

The generation and development of the uplink message can best be explained by reference to Figure 6-21 and paragraph 6.2.3.3.1. The flight plan calls the appropriate event generators through SYMON macros over the rev span of interest as well as supplying the necessary input data, allowing the event generators to operate without further manual inputs (e.g., function cards, data cards, etc.). It should be noted, however, that manual operation of the event generator is permitted but is not the intended mode of operation. In this example, each event generator is called for and operated over the rev span of interest.

As shown in Figure 6-21, the output of the event generators proceeds along different paths. The first major function performed after the events have been generated is inter-event conflicting. The basic event data from all generators is conflicted and potential conflicts are then flagged and resolved. The conflict identification requires not only the output from the event generators but also the current constraints which exist within the MOL system. Each event is then translated into its constituent functions for conflicting at this detailed level.

Pure data (e.g., ephemeris) to be sent to the AVE computer is identified and dummy functions are produced for conflicting. After the command assembler has produced a conflict-free chronological functional list, the actual commands which will be transmitted to the MOL (assemblied command list) are synthesized and optimized. The command compatibility module examines them to assure compatibility with the current list of commands in the MOL computer which will remain after this message is loaded into the OV.

After the conflicts have been resolved by command compatibility checks, the composite message assembler processes and merges the assembled command list, targeting data and control parameters, ephemeris data, and prose. The merged message is then formatted and prepared for transmission through ADS to the RTS.

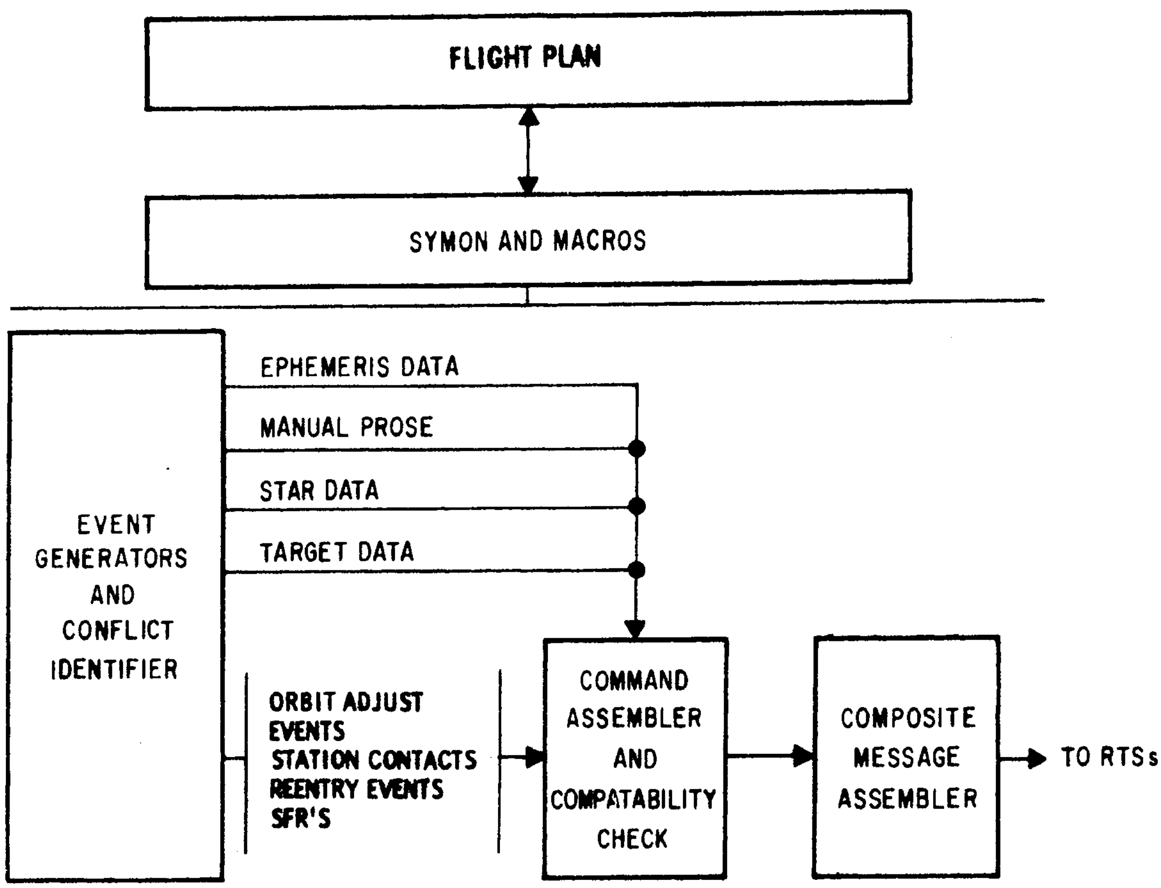


Figure 6-21 Uplink Message Generation

6.5.4.3.2 Downlink Processing Mode

The two basic operational requirements for ground software downlink processing during the orbital phase are to verify and analyze the status of the OV and to process and generate the MCD. Because MCD is generated on a daily gasis, on-line real time operation is not required. TLM data processing to verify the OV status, however, is both an on-line real time process within the ADS and a postpass off-line process within the ADS and 3800 computer.

6.5.4.3.2.1 MOL Vehicle Status Determination

Each time station contact is made with the OV, the real time TLM link is processed at the RTS and data returned to the STC over the 2400 bps line. This data is then processed with STC MOL-peculiar programs to display critical vehicle parameters, to supply data necessary for trend prediction programs, and to be operated upon to produce verification of vehicle performance and health. Data is also contained in the real time TLM which will be used later by the MCD program to perform countdown of target lists.

It is the basic operational philosophy to allow the real time TLM link to verify the OV health. This is done by having several different modes of data processing at the RTSs which can be scheduled by the downlink processing software element. Hence, by processing data at the RTS and changing modes, the time of a station pass (nominally 2 to 4 min) will allow adequate examination of the TLM parameters to indicate OV health.

An important real time-operation for the automatic mode is required for complete assurance of OV health utilizing data contained on the real time TLM link. The primary optics must be operated periodically during a station contact to determine that the primary optics are pointing and tracking correctly. It should be noted, however, that as a matter of practicality, the AVE recorded TLM tapes will be processed and the pointing angles and camera operations verified for each target photographed using this data.

In addition to using the real-time TLM link to indicate the OV health, the real-time TLM and non executed command data is processed to predict values of TLM points during future station contacts. Because these values are not required in real time during the current station contact, these programs will not be run on-line with the real time TLM and health verification programs.

The data contained on the AVE recorded TLM link consists primarily of historical data sampled and recorded periodically during flight and continuously during payload activity. In case of anomalous behavior, AVE recorded TLM data will be processed and analyzed to diagnose the anomalous behavior. Postflight analysis of this data will also provide for system and mission evaluation. Further details of downlink processing are provided in paragraph 6.3.4.4.

6.5.4.3.2.2 Mission Correlation Data Generation

The MCD program is run using data provided by the AVE recorded telemetry. Normally, the MCD is run once a day and data supplied to The User to assist in planning and performing photographic interpretation, and to provide the detailed data required to perform mensuration. The specific data supplied for the MCD includes which targets are captured on each frame, the relative geometry of the viewer with respect to the targets, IMC smear associated with the various areas in the frame, sun angle, etc. It is necessary to rely on the AVE recorded TLM to provide this data to determine any random errors in the photographic payload system at the time of actual payload activity.

6.5.5 Contingency Operations

6.5.5.1 General

The responses to possible contingency situations are discussed below. The handbooks available to the FD and the flight crew members will detail the procedures to be followed in all defined situations. Those contingencies which occur and have not been defined will be treated on a real time basis, applying the general concepts applicable to flight crew safety, priority of the photographic mission, other flight objectives, the probability of continuing the flight for 30 days, etc. The following paragraphs provide information concerning planning in this area. All on-orbit maintenance, whether preventive or corrective, is considered a part of the contingency situation although, in the strict sense, scheduled preventive maintenance is not a contingency condition.

6.5.5.2 On-Orbit Maintenance

The laboratory vehicle design has incorporated maintainability for those components or system elements where tradeoff studies show that flight crew safety, mission completion, or design adequacy will be improved by providing a maintenance capability. Although maintenance will normally be limited to the interior of the laboratory, external maintenance is not precluded.

On-orbit maintenance is classified as preventive and corrective. Elements of both classes of maintenance have been defined by identifying maintainable systems and components. The Flight and Ground Crew Handbooks will contain step-by-step procedures for all defined maintenance. Each procedure will have an associated timeline showing procedural milestones and the time to complete. All preventive maintenance will be scheduled into the overall Flight Plan at the frequency cycle determined from the maintenance requirements. Corrective maintenance will be scheduled as required. Auch factors as crew safety, mission requirements, station contacts, ground operations interfaces, and interference with other planned activities will influence corrective maintenance scheduling.

The System Test Rules will contain a specific section devoted to the operational ground rules for on-orbit maintenance.

6.5.5.3 Contingency Analysis

Contingency analysis will be performed by the flight crew and the ground operations crews. Contingency flow diagrams, available to ground operations personnel, include all identifiable failure modes, given an initial set of laboratory conditions in the form of subsystem performance, subsystem panel indicators, MAS indicators, and other crew input cues.

a. The contingency flow diagram, an instrument to assist the systems analyst in OV subsystem fault isolation:

   1. Provides subsystem design information.

   2. Is a single-thread analytic process to ensure crew safety and is designed to reflect the flight crew/OV systems interfaces at levels adequate for this purpose.

b. All contingency flow diagrams are plotted by the following ground rules:

   1. The case underlying the contingency analyzed is within the subsystem and all subsystems except for the contingency subsystem are operating within tolerance (i.e., single failures only).

   2. All laboratory subsystem switches are in their prescribed positions.

   3. All spare and redundant resources provided in the laboratory are available for corrective action.

c. The essential information contained in the typical contingency flow diagram is as follows:

   1. Contingency mode statement of the indicated malfunction or situation to be analyzed.

   2. Crew input signals and cues comprising such items as MAS lights, warning annunciators, etc.

   3. Crew action most logical as a result of situation or previous actions.

4. Crew decision aids which provide supporting information.

5. Task statements to indicate the required tasks to be performed in support of the crew action indicated.

6. Crew decision statements indicating the most logical question the crew would have as a result of a previous instruction.

7. Resultant-degraded mode lists all tasks required of the crew to operate in this mode.

8. Resultant-normal mode indicates that the action has returned the subsystem to normal operation.

9. On-board maintenance action statement indicates required on-board maintenance (if any).

10. Dual failure statement indicates that more than one failure exists and that the flow diagram cannot be used further.

d. Where the contingency poses no threat to the crew, contingency procedures are provided to cover the two priority cases (see "contingency" definition, Appedinx F.1) and are sub-classified as follows:

1. <u>Priority I</u>

(a) Remedial, with the potential of again reaching full capability.

(b) Remedial, with potential of attaining partial capability. This may or may not result in early flight termination.

(c) No remedial action. This will entail early flight termination.

2. <u>Priority II</u>

(a) Remedial, with potential to again reach full capability.

(b) Remedial, with partial capability resumption.

(c) No remedial action. This will result in degraded system effectiveness because of the reduced amount or kind of on-orbit data return.

Contingency evaluation is approached from the first and most obvious indicator and proceeds with the appropriate sequence of crew instructions and questions to produce the most feasible corrective actions (the first corrective action is verification of the subsystem out-of-tolerance condition).

7.0 RECOVERY OPERATIONS

7.1 GENERAL

The mission of the Recovery Organization described in paragraph 3.4 is to locate and retrieve the photographic data and the crew and spacecraft (or DRVs in the automatic mode) and transport them to their designated locations. Recovery will be required as the result of the normal end of mission, planned abort modes, or contingency landing situations.

The Recovery Director is the DOD Manager for Manned Space Flight Support Operations (DDMS) or his representative. He assumes command and control of the recovery forces at T-24 hours. The DDMS Recovery Force Director will be located in the Recovery Control Room, Mission Control Center, Sunnyvale, California. The agencies that will provide recovery support during the 30-day mission include the Aerospace Rescue and Recovery Service (ARRS); Commander, Task Force, Pacific (CTF 130); Commander, Task Force, Atlantic (CTF 140); Military Airlift Command; Air Weather Service; AFWTR; and other governmental agencies.

Gemini B recovery support will require fixed-wing aircraft, surface vessels, and helicopters.

7.2 PREFLIGHT PLANNING

The Preliminary Manned Recovery Requirements Document (Ref. 10) contains the general requirements for MOL recovery operational support and provides the DDMS information and requirements for long-range planning. A final Manned Recovery Requirements Document is scheduled to be available approximately 12 months prior to scheduled launch. Recovery operations and procedures are planned for all conceivable landing situations. Safe return and recovery of the flight crew and the photographic data is a prime concern. Spacecraft retrieval is a secondary consideration but will be accomplished whenever possible.

Spacecraft landing probabilities in the planned landing areas are considered to be sufficiently high to justify predeployment of forces for location, on-scene assistance, and retrieval. Probability of the spacecraft landing in the contingency landing areas is considered low, and will be supported by normal search and rescue forces located at various areas throughout the world. Prior to each MOL flight, DDMS designates the operational control staff to assist in recovery phases of the mission. The DDMS establishes the interfaces required to obtain worldwide communication coverage between the RCR in the MCC and all recovery units, recovery forces, the DOD, the Department of State, Hq ARRS, and other agencies. These interfaces are identified in the Program Requirements Document, the Preliminary Manned Recovery Requirements Document, and the Orbital Requirements Document (Refs. 7, 10, and 6, respectively).

7.3 RECOVERY AREAS

Recovery areas for the MOL mission have been divided into two major categories: the planned landing areas (forces prepositioned); and the contingency landing areas (see Figure 7-1).

7.3.1 Planned Landing Areas

7.3.1.1 Launch Site Abort Recovery Area

The launch site abort recovery area surrounds the launch pad and ground track to a distance not yet precisely defined, but not expected to be more than 5 n mi beyond the coastline. Recovery of the flight crew and spacecraft will be accomplished by helicopters, surface vessels, or land vehicles. From the launch pad to a radius of 2000 ft, the access time is 5 min and flight crew retrieval as soon as possible. From the shoreline to approximately 1 n mi offshore (surf area), access time is 2 min and flight crew retrieval as soon as possible. No time limits will be specified for spacecraft retrieval in the launch site area.

7.3.1.2 Powered Flight Abort Recovery Area

In the event of abort during the powered flight, recovery of the flight crew, cues, and spacecraft must be effected throughout a ground track area which is 30 n mi wide and extends to 40 deg S latitude. High abort probabilities occur during launch vehicle staging. Therefore, the first 1000 n mi of the ground track and an elliptical area 30 X 200 n mi near 40 deg S latitude are designated as high probability abort areas. The remainder of the ground track is considered to be a low probability abort area. Surface vessels, fixed wing aircraft, and helicopters will execute the recovery functions. The first half of the entire ground track will be supported by aircraft staged from San Diego. A staging area at Easter Island will be utilized for aircraft support in the southern half of the ground track. Access time is 2 hr and retrieval time is 4 hr in the high probability areas. Access time is 4 hr and retrieval time 18 hr in the low probability area. Spacecraft retrieval in both areas is 72 hr maximum.

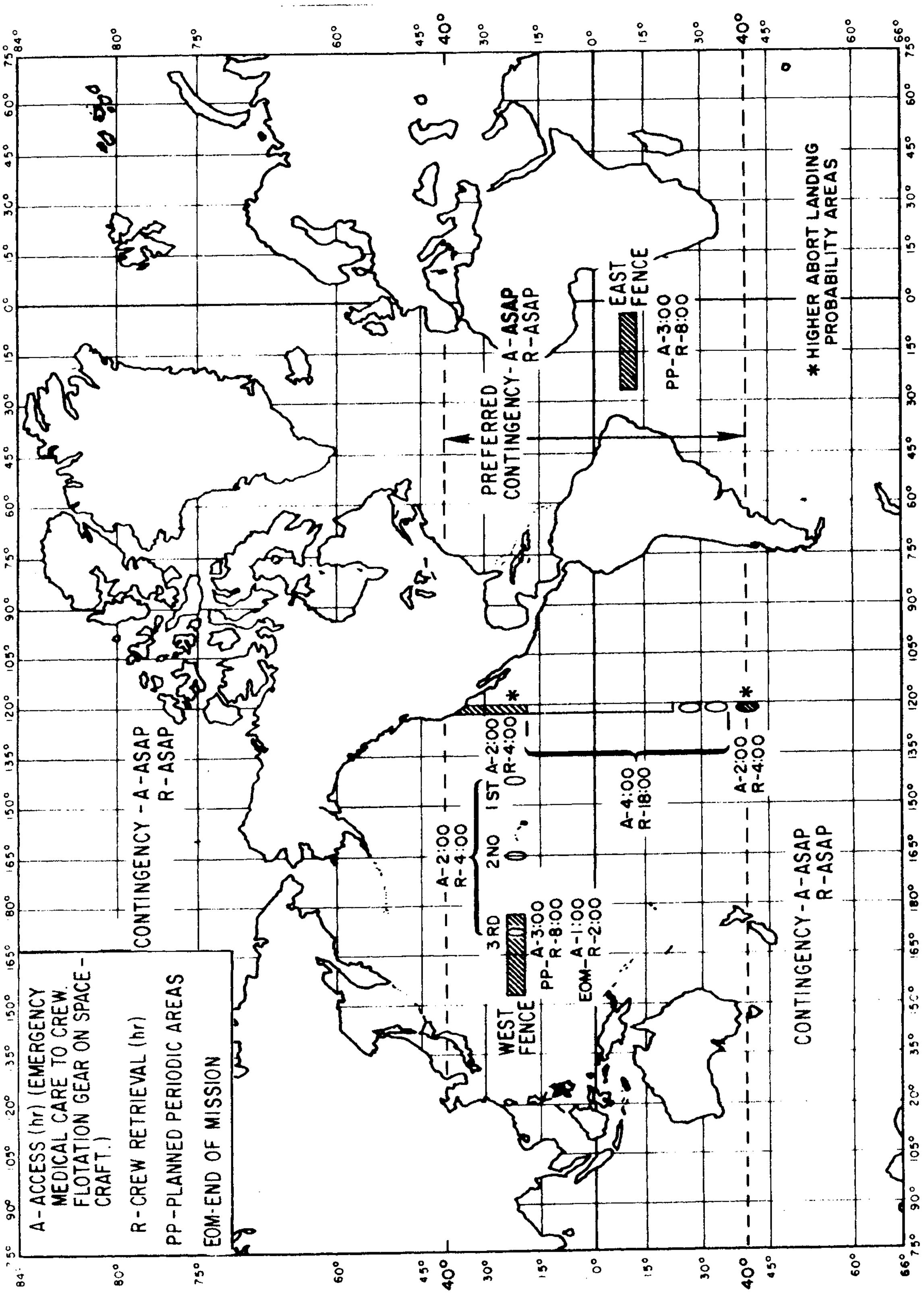


Figure 7-1 Synopsis of MOL Recovery Requirements

7.3.1.3 Early Orbit Abort Recovery Area

Planned Gemini B landing areas have been established for each of the first three revs. These are identified as Early Orbit Abort Recovery Areas. Recovery support for these areas, required only for launch day, involves fixed wing aircraft and secondary recovery ships. Access and retrieval times are similar to those stated for the powered flight high probability areas. Spacecraft retrieval will be accomplished within 12 hr.

7.3.1.4 Abort from Orbit Recovery Areas

The Gemini B will have a 14 hr loiter capability after separation from the laboratory vehicle. This loiter capability provides one daylight landing and recovery opportunity every 12 hr in one of two planned periodic recovery areas.

These areas, also referred to as "recovery fences", are located in the Atlantic and the Pacific Oceans. They span 22.5 deg longitude, the approximate distance between the ground tracks of two successive polar orbits. Recovery forces (secondary recovery ships and aircraft) will be in these "fences" throughout the mission. Access time is 3 hr, retrieval time is 8 hr, and the spacecraft will be recovered within 12 hr.

7.3.1.5 End-of-Mission Recovery

The Gemini B will be programmed for an end-of-mission landing in the Pacific Ocean recovery fence. Aircraft and a surface vessel with helicopter capability will be on station to execute recovery functions. Access time is 1 hr, crew and data retrieval time is 2 hr, and the spacecraft will be retrieved within 6 hr.

7.3.2 Contingency Landing Areas

7.3.2.1 Preferred Contingency Landing Area

The area between 40 deg N and 40 deg S latitudes (excluding planned landing and unfriendly areas) is considered Preferred Contingency Landing Area.

Recovery will be effected through the use of Search and Rescue (SAR) forces established at many locations within these latitudes. The spacecraft will be retrieved whenever practical.

7.3.2.2 General Contingency Landing Area

Gemini B landing in an area outside 40 deg N and 40 deg S latitudes is considered general contingency. All available data (including latest information concerning Gemini B landing coordinates) will be passed to the SAR force located near the predicted landing area to facilitate rapid crew and data retrieval.

7.4 TYPICAL RECOVERY OPERATION

The following is a description of a typical recovery operation for a Gemini B return-from-orbit situation. The operation will be somewhat similar whether it is the planned end-of-mission or an emergency situation, if the landing occurs within one of the fences and there is sufficient advance notice of the intention to terminate the mission.

The MD will inform the RCR of the intention to deorbit the Gemini B. The RCR will have all pertinent information regarding the recovery force status and weather conditions in the recovery areas displayed and, based on this information, will recommend to the MD the landing area and reentry rev number to be used. If the recommended area and rev number are acceptable, this information, along with the latitude of the desired aim point, will be transmitted to the FTFD to be used in the calculation of retrofire parameters.

The RCR will then advise the recovery forces in the selected area of the approximate time and position of the landing. The recovery ship will steam toward this point.

The Retrofire Officer will transmit RCR retrofire parameters calculated by the AFSCF to the RCR. These will include time and position of retrofire, time of entry into blackout, time of exit from blackout, time of drogue chute deployment, and time and position of spacecraft landing.

This information will be transmitted to the recovery forces. A continuous flow of information will come to the RCR from the recovery forces, including estimated time of arrival (ETA) of ship on station, aircraft takeoff times, ETA of aircraft on station, weather in the area, etc. This information will be displayed in the RCR.

The flight crew will initiate retrofire procedures based on the information calculated on board the spacecraft and/or ground computations. After retrofire, the flight crew will transmit, assuming a ground station is available, via VHF voice, such actual retrofire parameters as time of retrofire and ΔV. This information will be used by the MCC to verify or update the predicted landing point. This information will be given to the RCR for subsequent transmittal to the recovery forces.

At some time during retrofire procedures, a VHF beacon (243.0 Mc) on board the spacecraft will be activated. This beacon will be tracked, except during blackout, by recovery force HC-130H aircraft in the landing area. Time of entry into blackout and exit from blackout will be noted and will give some verification, if nominal, of the predicted landing point. Once the spacecraft has landed, this beacon will provide an RF homing source for the recovery aircraft. The approximate location will be immediately fixed by triangulation from these aircraft, and the recovery ship will proceed toward that point. The spacecraft will undoubtedly be first reached by one of the recovery aircraft or helicopters. The flotation collar will be affixed by swimmers from whichever unit arrives first. This aircraft will then vector the ship to the spacecraft location.

The flight crew may, at their option, be retrieved by helicopter or wait until arrival of the ship. If the wait for the ship is long, the flight crew, the DRCs with floatation devices attached and other sensitive data will be taken by helicopter to the ship.

The ship will proceed to the spacecraft location and bring it aboard. The ship will then steam to a point near enough the land base that the flight crew and data can be transferred via helicopter or COD flight to that base for transportation back to the Z1.

The ship will then proceed to a predetermined port where the spacecraft will be off-loaded. The spacecraft will be met at this port by an aircraft with the RCS decontamination equipment. The spacecraft RCS will be deserviced at this port. The spacecraft will then be loaded aboard the aircraft for transportation to the predetermined point of delivery.

During the entire recovery operation, the RCR will be constantly informed of status and progress by reports from the recovery forces.

7.5 DRV RECOVERY OPERATIONS

7.5.1 General

DRV recovery is only applicable to the automatic flights. A total of six DRVs are contained in the support module. As these DRVs are filled with exposed film from the photographic payload, they are prepared for ejection and deorbiting. Preparation includes cutting the film, sealing the container, energizing the DRV systems, and orienting the OV to the proper attitude. These actions are accomplished automatically by the command load previously sent to the OV. Ejection and deorbiting burning are monitored by an RTS and the DRV is tracked to its reentry trajectory.

The DRV is slowed by atmospheric drag and final descent is by parachute. The parachute-suspended DRV is acquired by the recovery force and tracked by means of a radio beacon. Once visual contact is established, an aerial retrieval is accomplished and the DRV returned to a designated point. The details of this operation are described below.

7.5.2 Mission Control Center DRV Recovery Operations

The MCC operations start when the FD determines that DRV recovery is required. This information is passed to the RCC and the MCC support areas to prepare for DRV reentry and recovery. The desired recovery rev is established based on surface ship position, weather, RTS coverage, command loading pass, etc. Once established, the required command load is generated and transmitted to the OV. The RCC is advised of the final predicted impact point and time based on the commands in the OV.

The RTS tracks the OV on the recovery rev as for a normal pass, except that, at separation of the DRV and OV, tracking and TLM data are acquired from the DRV as well as the OV. Predicts are run at the STC using DRV tracking data to provide the recovery force with a "splash" point, if required.

The MCC keeps the RCC fully informed of the critical events as they occur.

7.5.3 DRV

When enough film has been exposed to fill the DRV, or data from an important target is desired, the DRV will be prepared for ejection. A recovery sequence reset command is sent to the automatic support subsystem. The exposed film, plus a few layers of unexposed film, is run out of the camera into the cassette. The film is then cut and the chute is sealed.

After the OV has been properly oriented, the DRV is separated at a predetermined time. The DRV is spun up and the retrorocket fired. When the retrorocket has burned out, the DRV is despun and the thrust cone containing the expended rocket is separated. The reentry events are telemetered to the ground on two radio beacon carriers. A communication blackout occurs when the DRV first enters the atmosphere.

After the DRV emerges from the communications blackout area, it continues to slow down due to atmospheric drag. At a specified "g" point, the parachute system deploys, further slowing the DRV as it descends to the level for aerial retrieval. When the deceleration rate decreases to a predetermined level, a recovery timer is started, sequencing the thermal cover and forebody off, drogue chute out, flashing light on, main chute out reefed, and main chute dereefed.

7.5.4 Recovery Force Operations

The DRV recovery forces are organized under the RCC at Hickam AFB, Hawaii (see paragraph 3.6.9.3). These forces are comprised of C-130 aircraft, surface ships, and helicopters. The responsibility of these forces is to acquire the parachute-borne DRV, retrieve it mid-air (primary) or from the surface of the water (secondary), and transport it to a designated point.

The recovery forces will be deployed to provide the greatest opportunity for detecting and acquiring the DRV. The small, or primary, recovery area covers the nominal dispersions which will occur if all vehicle subsystems operate within their specified tolerances. The larger, or secondary, area covers the dispersions which can occur if the deboost subsystem and/or the orbital correction subsystem do not perform nominally. The recovery forces and their deployment are configured to assure a high probability of detecting and acquiring the capsule with the smallest possible expenditure of personnel, equipment, and time.

Deployment of these forces is ordered when it is determined that DRV recovery is required. Nominally, recovery will be designated in the Flight Plan to occur on specified revs; however, the airborne recovery forces are maintained in a state of readiness throughout the flight phase of an automatic flight for quick reaction to a sudden recovery requirement.

The surface ships are deployed prior to liftoff and take up stations which move to cover the movement of the possible recovery passes within the recovery area.

7.5.5 DRV Security

Provisions are made for the security of the DRV capsule after recovery.

After air or water recovery, the capsule will be reeled on board the aircraft. The parachute will be detached from the capsule; the capsule and the parachute will then be placed inside a container provided for this purpose. A similar container is carried aboard the recovery ships.

If the antennas on the capsule interfere with the closing of the container, the antennas may be bent or broken, as necessary. The container will then be locked with a combination lock. The lock will not be opened until the container arrives at its destination.

If the capsule cannot be found or cannot be recovered, provision is made to preclude recovery by others at a later time. The capsule is designed to sink within 50 to 90 hr after splashdown.

If, at the moment of separation from the OV, the orientation of the DRV is incorrect or the retrorocket malfunctions, the capsule may not descend within the area where it can be recovered by the recovery forces. To protect against recovery of the capsule by unfriendly forces, an inhibit function is included. The recovery timer sequences the thermal cover off, heat shield off, and the main parachute out. These are activated by a backup timer after the normal reentry time has elapsed: When the capsule reenters the atmosphere, it will have no heat protection, the chute will be destroyed, and DORIAN information will be burned. If any portion of the capsule survives the reentry, it will be burned beyond recognition and will sink on impact.

8.0 CREW OPERATIONS

8.1 GENERAL

Much of the detail for this Section has yet to be developed. Currently, studies are in progress to more clearly define the details of crew operations and the evaluation of man's contribution.

Appendix A contains the concept for operating the DORIAN system, including the crew and ground operations interface with the AVE.

Crew training activities are described in Section 11.0.

8.2 OPERATIONAL PHILOSOPHY ON THE USES OF THE CREW

Basically the crew is on board to enhance the operation of the photographic payload, to gather and relay intelligence data to the ground, to aid in the early development of the automatic system, and to perform as a backup in case of certain critical subsystem failures. The AVE subsystems and ground capability is being developed in concurrence with this philosophy. By relieving the crew of unnecessary functions, more useful orbital flight is achieved and more intelligence information and data on system operating characteristics can be obtained. The system permits crew monitoring of the Mission Module (MM), Laboratory Module (LM), and applicable Gemini B systems. The crew may be able to determine the cause of subsystem failures and the necessary corrective actions. Crew actions will include selecting proper equipment operational modes, switching in redundant units, replacing or repairing failed components, and performing equipment functions until other corrective actions can be determined and taken.

For critical items, crew backup is provided through manual target acquisition, centering, and tracking. Crew backup also provides for alignment of main optics elements, vehicle attitude control and orbit control and propellant usage scheduling in the event of improper ACTS operation, cabin atmosphere and temperature control, and reporting of systems status via the voice link in the event of TLM downlink failure.

For development purposes, the system permits crew diagnosis and evaluation, through a controlled series of tests, of main optics pointing and tracking errors, and of camera imagery. Since crew evaluation of the camera imagery is required, the system provides for on-board processing and examination of portions of the photographic record.

The system takes full advantage of the crew's ability to enhance the quality of the intelligence data gathered. The system has the capability to permit the crew to rapidly evaluate preprogrammed potential photographic targets for weather and for the presence of activity indicators, and permits crew inputs to photographic target selection. Provisions are made for coordinated two-man operation when both crewmen are performing the target inspection functions or when one crewman is required to perform main optics or attitude control backup tasks. The capability is provided for crew visual reconnanissance and comment upon target state, using either the ATS, visual optics, or a processed photograph to aid in mission planning and target programming decisions.

The capability is provided to boresight the visual optics and the acquistion telescopes and to slave the main optics tracking mirror to acquisition telescope pointing and tracking commands.

Control of the commandable and automatic support systems is provided to the crew as a backup to preclude abort in the event of a subsystem failure. In any system where crew safety is concerned, the crew can lock-out the ground commands. In all cases, the crew has the capability to negate or modify ground-generated commands. This can be done by either a command panel switch or by keyboard entry to the ADC.

8.3 CREW INTERFACES

This paragraph will ultimately contain descriptions of crew interfaces with the hardware and software on board the MOL and with the ground operations. The following is a partial list of information to be covered:

a. Crew activities including launch, crew transfer, payload setup, pre-payload operation pass, payload operation pass, RTS pass, orbit adjust, DRC, film processor, nominal housekeeping, reentry, and recovery.

b. AVE usage including MAS, ADC, and teleprinter.

c. Interface with ground including voice reports, manual command execution, fault isolation, and maintenance.

d. Evaluation of man's contribution and identification of those functions where man's contribution is most meaningful.

9.0 FLIGHT TEST DATA EVALUATION

9.1 GENERAL

This Section contains information management, distribution, evaluation, and reporting of the data produced during the Flight Test Operation.

9.2 DATA MANAGEMENT AND DISTRIBUTION

9.2.1 General

The problems associated with data acquired or generated in real time or non-real time which be collected for non-real time evaluation are discussed below.

"Data" is defined in this Section as that collection of raw information derived from the MOL operation and the various processed forms in which it may exist. Specifically, data includes MOL photography, telemetry, tracking, commands, and voice transmissions, and the variety of computer inputs and outputs, manual plots, tables, charts, etc. "TLM" includes all the downlink data except voice. "Commands" includes all the uplink data. "Voice" includes both uplink and downlink voice as well as that between the MCC and RTSs.

Data recording is generally desirable at each major point of reception, transmission, processing, or display. These recordings may exist in a variety of forms (e.g., magnetic tape, photographic film, paper printouts, oscillographic traces, manual plots, etc.). Whatever their form, they become a part of the MOL Flight Test Data and are subject to the management and distribution specified herein.

The concepts developed in this paragraph that generate requirements on other operation agencies will be levied in the appropriate requirements documents (e.g., the PRD, ORD, MRRD, etc.).

9.2.2 Security

Considerable expense, in both money and time, has been given to safeguard MOL data from those with no need-to-know and others who would use it to the detriment of the United States. Therefore, security measures must be applied to the data in its various forms according to the content of the data or its potential use with other data. This subsection addresses the problem of what general classes and forms of data are protected by the various security classifications.

9.2.2.1 Security Classifications

The classifications which apply to MOL data are generally categorized as "black" and "white".

a. The black category includes all data that could reveal the covert mission of MOL.

b. The white category includes all other MOL data.

Within these two general categories, the normal security classifications will be applied. Black data will have one of three classifications: "Secret Special Handling", "Top Secret Special Handling", and "Black Limited Access". White data will have conventional DOD security classifications of "Unclassified", "Confidential", "Secret", "Secret - Special Access Required", "Top Secret", and "Top Secret - Special Access Required".

9.2.2.2 Security Guide

A generally applicable guide for applying a security classification to MOL Flight Test Operations data is provided in Table 9-1. With the capability to edit data, a general rule for a broad class of data cannot be fully developed. If offending data is deleted from a given data set, it may be downgraded in some manner. This requires knowledge and judgement. Some general rules can be made to apply:

a. Encrypted data is unclassified.

Table 9-1. MOL Flight Test Operations Data Security Classification Guide*

Data	Highest Possible Classification						
	Black			White			
	Limited Access	Top Secret SH	Secret SH	Top Secret (SAR)	Secret (SAR)	Confiden-tial	Unclassi-fied
Photographic							
Film (exposed)	X						
Processed Film/Prints	X						
Film Unexposed			X				
Cue Material							
Film, Text, Recording	X						
Target	X						
Telemetry							
Encrypted Mag. Recording							X
Decrypted Mag. Recording	X						
Payload Activity vs Time	X						
Tabular By Chan No					X		
Tabular By Chan Name			X				
Ascent Data Recording							X
Digital Tapes					X		

*This table is incomplete

Table 9-1. MOL Flight Test Operations Data Security Classification Guide* (Continued)

Data	Highest Possible Classification						
	Black			White			
	Limited Access	Top Secret SH	Secret SH	Top Secret (SAR)	Secret (SAR)	Confiden-tial	Unclassi-fied
Tracking							
Encrypted Mag. Recording							X
Decrypted Mag. Recording						X	
Ascent Data Recording							X
Ephemerides					X		
Voice							
Encrypted Mag. Recording							X
Decrypted Mag. Recording	X						
VHF Transmission Recording							X
Command							
Encrypted Mag. Recording							X
Decrypted Mag. Recording		X					

*This table is incomplete

b. Data disclosing the covert MOL mission is SSH, at a minimum.

c. Exposed film, processed film, and prints have Limited Access even in DORIAN areas.

d. Target location information is Limited Access; therefore, so is payload activity versus time (except for ZI activity).

9.2.2.3 Procedures and Facilities

At each operating location, adequate procedures and facilities for classifying, transmitting, storing, and safeguarding MOL data will be established. Adequate consideration must be given to the needs of security while simultaneously recognizing the requirement to work with the data unimpeded by involved accounting and handling procedures.

9.2.3 AFSCF Data

All significant data acquired by the AFSCF will be collected, recorded, routed, stored, and made available as required to the MOL program. These general requirements are described below.

9.2.3.1 RTS Data

Data magnetically recorded at the RTSs will be duplicated by on-station tape-dubbing. Within each 24-hr period the original data will be packaged and shipped to the STC by the most expeditious means. The dubbed tapes will be stored in an appropriate area for the flight duration plus 10 days, or as specified by the MOL SPO. Dubbed tapes of encrypted data may be degaussed at the end of this period and reused for subsequent dubbing. All data stored at or shipped from the RTS will be labeled to fully identify the contents by program, FV number, RTS, rev number, track assignments, recording speeds, etc.

9.2.3.2 STC Data

The STC will maintain a data library service which will expeditiously collect data sent from external sources, such as the RTSs, AFWTR, etc. These data will be available for checkout by authorized organizations, as required. In addition, the STC will acquire data from the operations areas and ensure rapid delivery between areas and to the data library. These data consist of magnetically recorded data base overflow (estimated once each 24-hr period), computer printouts, microfilm from displays, etc.

9.2.4 AFWTR Data

In addition to the data required by launch operations, flight operations requires that a dubbed magnetic recording of all metric and TLM data acquired by the AFWTR be packaged and shipped by expeditious means to the STC data library. These data will be labeled to properly identify the contents by program, FV number, launch data, track assignments, recording speeds, source, etc.

This data includes any from AFWTR downrange ships. Data acquired by land-based stations will not be delayed to include ship data, but additional packages will be sent to the STC as data is returned to AFWTR. Launch and ascent data will be distributed to contractors through normal Range channels as documented in the PRD (Ref. 7).

9.2.5 MOL Contractor Support Facility (MCSF)

The MCSF will act as a distribution center to provide data to contractors (in-plant) and to contractor personnel at the MCSF to support the near real time analysis performed at that facility. This does not include ascent data.

The MCSF will provide courier service to pick up and return data from the STC data library. When it is determined that specific RTS/STC or AFWTR data tapes are required for near-real time or postflight evaluation, the MCSF will check out this data from the STC data library.

The MCSF will process the RTS tapes contained in the STC library to edit and format them as required by security and the requirements of the associate contractors. New tapes will be made in the edited digital format for shipment to contractors' facilities for postflight analysis.

Data to be analyzed at the MCSF will be input to the MOL data base for processing and analysis. If near-real time analysis is required at a contractor's facility, the appropriate data will be sent by electrical interface between the MCSF and the contractor's facility.

When the need for the STC library data no longer exists, the data will be returned to the STC.

To preclude reprocessing STC data tapes, the MCSF will maintain a temporary library of any edited formats shipped to the contractor until the contractor acknowledges receipt of the shipment. The temporary tape may then be degaussed for reuse.

9.3 DATA EVALUATION AND REPORTING

9.3.1 General

Data evaluation may basically be classed into near-real time and post operations evaluations. Near-real time evaluations occur before the end of the operation and are directed toward analysis of operational problems for which an on-orbit correction might exist, or which require additional knowledge to optimize or save the present flight. Post operations evaluations are conducted with a view to solving postflight problems to preclude recurrence in future operations. Therefore, it is not when the evaluation is performed, but for what purpose that places the evaluation in a given classification. Also, evaluations started as near-real time may evolve into post-operations when the character of their purpose changes.

9.3.2 Data Evaluation

9.3.2.1 Near-Real Time Evaluation

The AFD/VA and the TA are responsible to assure that analyses and evaluations are conducted in support of the flight operations. In this task, they are assisted by associate contractor personnel. In addition to the direct support afforded by the associate contractor personnel at the MCSF and the STC, certain specialists are available at contractors' home plant facilities to support near-real time analysis and evaluation as required and as data can be made available through data tapes or electrically transmitted data.

Near-real time evaluation is of two types: (1) mission evaluation, which uses the MCD and evaluates how well The User's requirements are being met in photographing given targets; (2) general OV evaluation to determine the OV operational status.

It is the near-real time evaluation that flags problems in such a manner that they can be classified as near-real time or post-operations.

9.3.2.1.1 Mission Correlation

Mission correlation is conducted by the MP&E organization and supported by the TA Staff by means of special computer programs (MCD of the MP&E software) using the data available from the real-time TLM and the AVE-recorded TLM. The reports issued by this group are used in two ways: (1) to modify The User requirements for subsequent photography of targets already taken; and (2) to provide mensuration data to the photo-interpreters (PI) for their post-operation evaluation of the photographs.

9.3.2.1.2 Orbiting Vehicle Evaluation

The near-real time evaluation of the OV is conducted to ensure a continuing knowledge of the OV subsystems operation, detection of anomalous operation, predict consumption of expendables, and quick reaction to contingencies. This evaluation is characterized by two principal activities, the rev-to-rev evaluation and the long-term analyses.

Rev-to-rev evaluation is of a quick-check nature and: (1) uses the real-time displays to detect and flag areas for more detailed study; (2) determines the depth of study required in specific areas; (3) determines whether the OV status is good for a short rev span of activity or that conservative measures should be taken until a more detailed analysis can be made.

The long-term analyses and evaluations may require the complete RTS data tapes and take several days to determine the full effects of any anomaly flagged by the rev-to-rev activity. From this will come recommendations for full contingency operations, predictions of lifetime, etc. For serious anomalies, special requirements may be levied to play back full data from a previous RTS pass to permit an early, detailed analysis.

9.3.2.2 Post Operations Evaluation

Post operations evaluation is not a responsibility of the operations organization (see Figure 3-1) per se (although some of the operations staff may have responsibilities in this area because of the dual nature of their work assignments). The near-real time analysis identifies problem areas and classifies the manner of their treatment (i.e., near-real time or post operations).

Evaluation and exploitation of the mission photographic product and associated mission data and debriefing information (which fall within the production, dissemination, and use phases of the intelligence cycle) are primarily the functional responsibilities of the intelligence community. The MOL program elements (including contractor support) will normally participate in such activities only to the extent necessary to provide support to the agencies within the community or to verify the degree of success achieved in the collection operations.

The POAD establishes the areas and priorities for the post operations contractors' evaluation effort. Contractor effort is conducted primarily at the contractors' home plant facilities.

Post operations evaluations for the MOL program shall be conducted by the MOL SPO or by appropriate contractors to accomplish the following:

a. To analyze and resolve to corrective levels MOL system preflight and flight anomalies in response to MOL SPO direction.

b. To verify specific MOL flight test objectives not directly determined as a result of accomplishment of system test and operations and wherein the analyses required do not duplicate analyses conducted during ground or flight tests.

Contractors shall maintain appropriate test results, data bases, and subsystem design, analysis, and effective models required to accomplish "a." and "b.", above, in conjunction with flight test data that will be provided by the MOL SPO (see paragraph 9.2.5). This flight test data will be formatted to establish contractor digital computer requirements.

Data for post-operations evaluation shall be appropriately selected by the MOL SPO and contractors from the large volume of data available from ground and flight tests. By this means of selectivity as well as through evaluations already completed during the flight tests, it is expected that a small percentage of the test data not processed during flight will require post operations reduction to permit accomplishment of all post-operations analyses.

The results of post-operations evaluations shall be documented with appropriate recommendations. Following approval of recommendations, appropriate corrective actions shall be initiated.

9.3.2.3 Flight Test Objectives Evaluation

Specific flight test objectives to be evaluated include the following:

a. Evaluate stero photographic reconnaissance, including manned and automatic operations, with a probability of 30-day mission effectiveness of 0.85 for the manned system and 0.63 for the automatic system. Evaluation of the effectiveness of each MOL system segment for each flight phase shall include appropriate comparisons of measured subsystem performance with allocated effectiveness values.

b. Evaluate the MOL system capability of [redacted] resolution photography with 2:1 contrast under conditions of light providing 890 ft lamberts at the aperture for targets at nadir from 80 n mi orbit presupposing the availability of 3404 type film with an exposure index of 6. The evaluation shall permit analytical extrapolation within requisite OV functions or target photographic conditions not attained during controlled (test) photography environments.

1. Evaluate OV performance during test and anomalous photography. The evolution shall include the comparison of actual AVE flight performance data* with required

* Actual AVE flight performance data shall be provided by the MOL SPO to appropriate MOL contractors in digital computer input form within the parameters selection and format requirements requested by the contractors.

performance data to determine actual OV location, equipment performance, and crew actions associated with controlled test or anomalous photography.

2. Evaluate controlled test or anomalous photography. The evaluation shall include:

   (a) Determination of photographed target resolution considering known target weather, lighting, contrast, and location.

   (b) Determination of automatic photography equipment operation, including image stabilization, target centering, focus, and exposure.

   (c) Assessment of the crew contribution to the photography accomplished.

c. Evaluate the manned system capability for a mission duration of 30 days on the baseline orbit with a two-man flight crew.

The evaluations shall be in response to MOL SPO direction, shall not duplicate analyses or evaluations accomplished during the conduct of the orbital flight, and shall include:

1. Analysis of those AVE preflight and flight anomalies which shall lead to timely equipment, software, facility, personnel, or procedural corrective actions.

2. Analysis of system performance which leads directly to determination of specific MOL program objective accomplishment.

Contractors shall maintain appropriate preflight test data and shall provide the subsystem design and analysis models required to accomplish "1." and "2." above, consistent with utilizing actual AVE flight performance data, provided by the MOL SPO, in digital computer input form as requested by the contractors. Contractor data requests shall specify the performance parameters required, the system time intervals of interest, and the data format.

d. Evaluate specific flight objective accomplishments, including:

1. Adequacy of Mission Control personnel and facilities to support a 30-day manned mission.

2. Automatic operation of AVE subsystems, including those subsystems incorporating redundant or backup elements.

3. Flight crew operability and monitoring of appropriate laboratory vehicle subsystems.

4. Flight crew film handling in the LM.

5. OV capability to accomplish required O/A and attitude control.

6. OV capability to sustain the orbital environment, including meteoroid protection, radiation shielding, and environmental control.

7. OV provision for and utilization of expendables.

e. Evaluate the manned system laboratory vehicle 30-day shirtsleeve environment. The evaluations shall include:

1. Flight crew accommodations in the LM, including temperature and humidity control, radiation protection and shielding, life support, suiting and unsuiting, and waste removal;

2. Flight crew safety monitoring and alarm, including detection and alarm of unsafe OV performance, detection of excessive crew radiation dosage and detection of crew illness (heart rate);

3. Shirtsleeve environment effects on laboratory vehicle equipments.

f. Evaluate the automatic system capabilities for a mission duration as long as possible within the capabilities of the manned/automatic system hardware with available or augmented expendables and consistent with launch vehicle capabilities. Qualification of the automatic system shall be for 30 days.

Applicable manned/automatic system evaluation shall be performed in accordance with the requirements of paragraph "c.". Specific additional evaluation shall include:

1. Support module capability to sustain long duration in orbit.

2. Support module capability to accomplish film transport and stowage.

3. LM capability to perform attitude control for DRV ejection.

4. Proper selection and ejection of DRVs.

5. Adequacy of Mission Control capability to plan support module and LM events and expendables usage.

6. Capability of laboratory vehicle to sustain long duration orbital mission.

7. Laboratory vehicle expendables usage.

g. Evaluate the orbital inclination capability of 80 to 100 deg with the nominal orbit at 90 deg inclination and 80 n mi perigee altitude. The evaluation shall include:

1. LM O/A and maintenance capability.

2. Ground drag predictions with LGA measurements.

3. Ephemeris data, LGA, LRL, and benchmark data utilization in orbit maintenance.

4. OV data management over the inclination range.

h. Evaluate complete target access at latitudes greater than 30 deg N four times during the 30-day mission. The evaluation shall include:

1. Mission Control capability to select OV attitude.

2. ATS and tracking mirror capabilities to subtend look angles of required target coverage.

i. Evaluate the manned/automatic system capability to expose 15,000 frames during the 30-day mission and maximize cloud-free photography. The evaluation shall include Mission Control maximization of target photography.

j. Evaluate the automatic system capability to expose 500 frames per day and maximize cloud-free photography. The evaluation shall include:

   1. Mission Control maximization of target photography.

   2. Validity and accuracy of ground provided weather predictions with that of IVS measurements and actual cloud cover data as shown in the target photography.

k. Evaluate the system capability for one launch every four months. The evaluation shall consider:

   1. Pad damage extent assessment.

   2. FV pad integration and checkout.

   3. Launch Control support.

   4. Mission Control support.

   5. Recovery Force deployment.

   6. Flight crew readiness compatibility.

l. Evaluate the system capability of responding to a redirection of the planned operational orbit, within the design constraints on inclination and altitude, as late as seven days prior to a scheduled launch. The evaluation shall utilize development test and analysis data in lieu of actual data wherein redirection does not occur and shall consider:

   1. AFSCF flight replanning;

   2. Recovery Force redeployment;

   3. AFWTR support redeployment;

   4. FV guidance reprogramming and test.

m. Evaluate the usefulness of man in the development and operation of reconnaissance space systems including:

1. Evaluation of man's contribution to early development of the automatic mission:

(a) Man's contribution to flight duration extension including monitoring and switching of AVE and modes; AVE replacement or repair; contribution to MCC diagnosis of AVE malfunctions; and AVE backup.

(b) Man's contribution to AVE performance and malfunction diagnosis including diagnosis of pointing error causes; diagnosis of target tracking error causes; diagnosis of camera performance; and sensing of environment and subsystem operating characteristics.

2. Evaluation of man's contribution to intelligence data enhancement as follows:

(a) Contribution to photography, including exposure and other camera corrections; image rate corrections; target centering corrections; cue contribution to target observation; and crew observation of target activity on target selection and color film photography on target intelligence.

(b) Contribution of secondary camera photography.

(c) Updating of target locations and cues.

(d) Verification of ground weather predictions.

(e) Contribution of visual intelligence due to ATS viewing of selected targets and on-board photography processing.

3. Evaluation of man's potential contribution to automatic mission photography accomplishment and AVE malfunction correction.

n. Evaluate the use of redundant systems and back-up modes to assure that no single failure caused mission abort or crew fatality during abort. The evaluation shall include:

1. Determination of proper operation of redundant or back-up equipment in cases of single failures.

2. Determination of failures in redundant or back-up equipment when utilized.

o. Evaluate MOL System crew safety, including:

1. Effectiveness or readiness of abort operations.

2. Flight crew contribution to abort operations.

3. Mission Control capabilities during abort operations.

4. Effect of non-continuous OV-MCC contact.

p. Evaluate the biomedical monitoring of the flight crew, including:

1. Monitoring of crew in Gemini B.

2. Monitoring of crew in suits in the LM.

3. Monitoring of crew in LM shirtsleeve environment.

4. Effect of non-continuous monitoring of crew by MCC on crew health and safety.

5. Effect of countdown, ascent, orbit, and retrieval on the crew.

6. Crew activity, events, and radiation dosage on crew health and safety and mission accomplishment.

7. Crew capability management.

8. Effect of eating, sleeping, exercise, and radiation on the crew.

q. Evaluate differences in operations and performance of the manned equipment in the automatic mission.

r. Evaluate the T-IIIM launch vehicle, including:

1. Flight anomalies.

2. Orbital insertion of the OV, including the launch time effect, subsystem performance and the integrity of the T-IIIM/Gemini B interface.

Flight crew safety monitoring and alarm.

s. Evaluate the Gemini B, including:

1. Flight anomalies as directed by the MOL SPO.

2. Reentry performance and heating.

3. Crew transfer between the Gemini B and the laboratory vehicle.

4. 30-day orbital storage.

5. Crew safety monitoring and alarm.

6. Loiter accomplishment.

7. Expendables usage.

8. GIGS performance during ascent.

9. Gemini B/laboratory vehicle separation and Gemini B deorbit.

t. Evaluate Mission Control utilizing the AFSCF. The evaluation shall include:

1. Non-continuous crew monitoring effects on crew safety.

2. Non-continuous OV monitoring effects on mission performance.

3. Effects of AFSCF multi-user environment scheduling on mission accomplishment.

u. Evaluate the use of existing recovery forces to effect retrieval of the Gemini B and crew, or the DRVs. The evaluation shall include:

1. Effect of Recovery Force deployment and scheduling on launch time.

2. Retrieval of the Gemini B, crew, and film.

3. Effects of Recovery Force multi-user environment on Gemini B retrieval.

4. Retrieval of DRVs and film canisters.

5. Effects of AFSCF DRV Recovery Force multi-user environment on DRV retrieval.

v. Evaluate laboratory vehicle disposal, including:

1. Laboratory vehicle deorbit.

2. Laboratory vehicle reentry.

3. Laboratory vehicle probable impact point prediction.

w. Evaluate MOL launch from VAFB using a single launch pad. The evaluation shall include:

1. Pad and early ascent abort effects.

2. Effect of ground environment on launch.

3. Effect of the radio frequency transmission system on launch.

x. Evaluate two launch vehicle flights, including one flight with the Gemini B. Development flights 1 and 2 shall be evaluated as well as determination of the accomplishment of the flight 3 system prerequisite objectives as follows:

1. <u>Flight 1</u>

(a) Demonstrate T-IIIM capability to provide the functions required to inject the manned/automatic MOL into the planned orbit.

(b) Evaluate T-IIIM subsystem performance.

(c) Demonstrate the capability of the launch personnel and the launch vehicle AGE to perform their functions in an operational environment during prelaunch, launch, and powered flight.

(d) Demonstrate, to the extent possible, the capability of the MCC facilities and personnel to perform the required launch and ascent functions.

2. Flight 2

(a) Demonstrate T-IIIM capability to provide the functions required to inject the manned/automatic MOL into the planned orbit.

(b) Evaluate T-IIIM subsystem performance.

(c) Demonstrate flight vehicle structural integrity in a typical manned/automatic powered flight environment.

(d) Demonstrate Gemini B capability to withstand a selected flight environment for ascent, reentry, and retrieval.

(e) Obtain data on selected flight environment parameters.

(f) Evaluate Gemini B subsystem performance during the critical flight periods of ascent and reentry.

(g) Demonstrate the retrieval of the Gemini B REM.

(h) Demonstrate the compatibility of the interface between the Gemini B and the T-IIIM.

(i) Demonstrate laboratory vehicle/T-IIIM separation.

(j) Demonstrate the capability of the launch personnel and the FV AGE to perform the prelaunch and launch functions in the operational environment.

(k) Demonstrate the capability of the MCC facilities and personnel to perform the required launch, ascent, and retrieval functions.

y. Evaluate the return of intelligence data in the Gemini B REM for the manned system. The evaluation shall include:

1. DRC transfer from the LM to the Gemini B.

2. DRC stowage effects on crew comfort and safety.

3. Effect of DRC transfer, stowage, and heating on product integrity.

4. Effect of DRC contingency procedures.

z. Evaluate the automatic mode DRV return on product integrity.

aa. Evaluate the simulation program adequacy of providing training of the crew and support personnel. The evaluation shall include:

1. Adequacy of crew training.

2. Adequacy of support personnel training.

3. Adequacy of simulation fidelity.

4. Effect of simulation and training on crew mission accomplishment.

bb. Evaluate maintenance including:

1. The AGE support of launch on time.

2. AGE isolation of AVE malfunctions to replaceable elements.

3. AVE isolation of malfunctions to corrective levels.

4. Correction of AVE malfunctions in orbit.

9.3.3 Reporting

9.3.3.1 General

A summary of the following reports is provided in Table 9-2.

9.3.3.2 Mission Evaluation Reports

The mission evaluation reports are the responsibility of the MP&E organization. The mission correlation data will be used on a daily basis or transmitted as a computer report to The User.

A target select report will be made after each RTS pass and will provide computer summary data showing payload activity. It will evaluate the photographic activity to at least show which targets were taken and in what modes, which targets were obsecured by weather, and whether "activity" existed.

Table 9-2. System Test Data Evaluation Documents

Evaluation Documents	MAC	DAC	MMC	AGC	UTC	ACED	GE	Whirl.	HS	EK	Integ/ Publ	Release Date	Description
Quick-Look Ascent & Orbit Report	X	X					X		X	X	MOL SPO	L +7 days	Preliminary report covering performance of individual segments & problem areas during ascent & early orbit.
Flight Termination Report											MOL SPO	FT	Establishes due date for associate's inputs to Quick-Look Post-Operations Report.
Quick-Look Post-Operations Report	X	X					X		X	X	MOL SPO	FT +5 days	Preliminary report covering performance of individual segments & problem areas during total flight.
Post-Operations Assessment Directive (POAD)											MOL SPO		Defines major problems of concern & assigns work priority to problems. Utilizes the Quick-Look Reports.
Initial												L +10 days	Covers first 5 days of operation.
Final												FT +10 days	Covers operation through laboratory vehicle disposal.
Final Launch Evaluation Report											MOL SPO	L +20 days	Final report on launch operations performance analysis.
Powered Flight, Orbit, & Recovery Evaluation Report											AFSCF	FT +30 days	AFSCF ground network operations report to the MOL SPO.
Flight Crew Debriefing Report											MOL SPO	As Dir	On-orbit timeline performance report; biomedical report; performance, procedures, & equipment report; & mission summary.

X = Individual inputs.

Table 9-2. System Test Data Evaluation Documents (Continued)

Evaluation Documents	MAC	DAC	MMC	AGC	UTC	ACED	GE	Whirl.	HS	EK	Integ/ Publ	Release Date	Description
Manned Recovery Report											DDMS	FT +30 days	An operations report; will contain an evaluation, conclusions, & recommendations.
Gemini B Qualification Recovery Report											DDMS	FT +30 days	An operations report; will contain an evaluation, conclusions, & recommendations.
Contractor Postflight Segment											Each Contr		Evaluation of subsystem/segment/system non-nominal performance vs test objectives. Detailed engineering analysis of failure or deficiencies in performance. Summary of problems encountered & their solutions.
Interim	X	(X)	X				X		X	X		POAD +20 days	
Final	X	(X)	X				X		X	X		POAD +50 days	
*Final Flight Test Engineering Report											MOL SPO	POAD +80 days	A systems-level report. Evaluation of system test objectives vs performance results attained. Detailed engineering analysis of systems performance.

* = Inputs are all evaluation documents.
X = Individual inputs.
(X) = T-III integrated inputs.

The Daily Countdown Report will be made each 24-hr and will use OV-recorded data. This recorded data will be recovered from the RTS either from a postpass playback or shipment of data tapes. This report provides more information on all targets photographed, primarily to assist the PIs during post operations evaluation. Because it also influences the selection of targets on subsequent passes over the same geographical area, the Daily Countdown Report has some near-real time aspects.

9.3.3.3 Quick-Look Ascent and Orbit Report

This report is a responsibility of the TA. Inputs to the report are reports from the Launch Operations Director and each of the associate contractors. It is a preliminary report covering the performance of the individual segments and problem areas encountered during ascent and the first five days of orbit. All inputs are required by L +7 days. The report issued by the FD will consist of a compilation of contractor inputs and will be released within 24 hr of the receipt of all inputs.

9.3.3.4 Flight Termination Report

This is a TWX report sent by the FD to notify all concerned that all official MOL operations have been concluded on a particular flight. This notification establishes the due date for associate contractor inputs to the quick-look post-operations report.

9.3.3.5 Quick-Look Post-Operations Report

This report is a responsibility of the TA. Inputs to the report are submitted by each associate contractor as semi-formal or TWX reports and may include daily log sheets. Each input covers the period of L +5 days through flight termination (FT). Information contained in the quick look and ascent report is not repeated, except to amplify or clarify information previously submitted. Inputs are due at FT +5 days. The integrated report issued by the

FD within 24 hr of receipt of all inputs is a preliminary report covering L +5 days through FT. Flight crew and recovery activities are not reported as direct inputs in this report.

9.3.3.6 Post Operations Assessment Directive (POAD)

The POAD is prepared by the TA for the MD and is released twice for each flight: L +10 days, and FT +10 days. The initial directive will cover the first five days of the operation and the final directive will cover the operation through laboratory vehicle disposal. These two directives will define the major problems of concern and will assign work priority for postflight analyses to these problems. Inputs to these directives will be derived from the quick-look reports.

9.3.3.7 Final Launch Evaluation Report

This report, the responsibility of the 6595th ATW, describes the general performance of the test support system segment and evaluates ascent in terms of FV performance. This report is due L +20 days.

9.3.3.8 Powered Flight, Orbit, and DRV Recovery Evaluation Report

This report, the responsibility of the AFSCF, describes the operational activities of the AFSCF and the AFWTR in support of the flight. The published report is due FT +30 days.

9.3.3.9 Flight Crew Debriefing Report

This report, a responsibility of the MOL SPO, Flight Crew Division, (SAFSL-7C), is: an on-orbit timeline performance report; biomedical report; performance, procedures, and equipment report; and flight summary. This report will be published on an "as directed" basis.

9.3.3.10 Manned Recovery Report

This report is the responsibility of DDMS. The manned recovery operation is evaluated, with appropriate conclusions and recommendations. The published report is due FT +30 days.

9.3.3.11 Gemini B Qualification Recovery Report

This report by DDMS on the GBQ recovery is similar to the manned recovery report.

9.3.3.12 Contractor Postflight Segment Report

These reports are due twice for each flight from each associate contractor: initial POAD +20 days, and final POAD +50 days. These reports: (1) evaluate subsystem/segment/system non-nominal performance vs test objectives; (2) contain detailed engineering analysis of performance failures or deficiencies; and (3) summarize problems encountered and their solutions. The postflight segment reports are responsive to the POAD.

9.3.3.13 Final Flight Test Engineering Report

This report is the responsibility of the MOL SPO. It is due at POAD +80 days and uses the postflight reports of the contractors and government agencies as inputs. It is a system-level report and contains an evaluation of system test objectives vs performance results obtained.

10.0 FLIGHT TEST CONSTRAINTS

10.1 GENERAL

This Section provides a consistent set of constraints (see Tables 10-1 through 10-6) for use in subordinate documents. These constraints are typical of those identified at the time of this writing. In many cases, values are unavailable. When values are given, the constraints are in use as hardware, software, and operations design baseline criteria. Many of these constraints will be superseded, modified, or supplemented and missing values provided with time as well as additional constraints being defined. An attempt will be made to keep this Section current through the period of development of the Hardware/Software Limitations Specification (Ref. 24). This Section will be superseded by the constraints defined by that document when it is released.

Table 10-1. Launch Constraints

Item	Constraints	Remarks
Time	1. Abort Recovery a. Daylight @ VAFB for Mode A & B b. 2 hr 45 min daylight @ 40 deg S lat for Mode C 2. Vehicle - Provide -60 deg $\leq \beta \leq$ 60 deg during total period of flight. 3. Payload - Provide max η for greatest number of targets in the primary area of interest for total period of flight.	1. Baseline (April launch) Manned/Automatic 1300-1500 PST (does not meet l.b. after 1400 PST) Automatic 1300-1230 PST 2. Constraint 3 is also a function of inclination angle (i).
Date	1. Payload - Launch date must be selected to provide suitable η history for full length of flight for inclination angle chosen. 2. Orbiting Vehicle - Launch date and initial β angle must be selected to provide a β history over full flight length of -60 deg < β < +60 deg.	

Table 10-1. Launch Constraints (Continued)

Item	Constraints	Remarks
Trajectory/ Insertion	1. Flight Path Angle (T) - Provide optimized (initial) δ_p	1. Constraint 1 - δ_p depends on O/A technique selected for orbit sustenance.
	2. Velocity - Provide for Mode C abort.	
	3. Altitude - Observe Gemini B abort floor.	
Weather	1. Launch Area - Ceiling, visibility, precipitation, winds (surface-aloft-shear) within limits.	1. Constraint 1 limits set by structures, control, and pad abort requirements.
	2. Abort Recovery Areas - Ceiling, visibility, precipitation, winds, sea state.	2. Constraint 2 not required for Flights 1, 6, and 7.
	3. Nominal/Contingency Areas - Long range forecast within limits specified in STO for Flight 6 includes DRV recovery on Flights 6 and 7.	3. Constraint 3 not required for Flights 1 and 2.
Equipment	1. Flight Vehicle - Telemetry operational and within limits specified by STO for flight.	
	2. AFWTR - MIS, Range Safety, computers, communication links, tracking and TLM operational as specified in PRD for flight.	

Table 10-1. Launch Constraints (Continued)

Item	Constraints	Remarks
Equipment (Continued)	3. AFSCF - STC, MCC, RTS, computers, communications operational as specified in STO for flight.	
Recovery Forces	1. Abort - Forces deployed and operational as specified in MRRD.	1. Constraint 1 for Flights 2, 3, 4, and 5 only.
	2. Nominal/Emergency Recovery - Forces deployed (or in standby) and operational as specified in MRRD.	2. Constraint 2 for Flights 3, 4, and 5 only.
	3. DRV Recovery - Forces deployed or at staging areas and in operational status as specified in STO.	3. Constraint 3 for Flights 6 and 7 only.
Orbital Parameters	1. Inclination Angle (i) a. Max i constrained by OV weight and T-IIIM capability: Manned/automatic 90 deg max, Lat_p = 45 deg N, for 30,850 lb OV Automatic ___ max b. Desired i - 96.4 deg from payload considerations to provide a sun-synchronous orbit.	1. Constraint 1.b., maximizes η (see launch time). 2. Constraint 1.b., c., not necessarily compatible. 3. SP/DR envelope for: Manned/automatic flights Automatic Flights 4. Orbit sustenance O/A technique selected depends on i and ΔV allocation for sustenance.

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Table 10-1. Launch Constraints (Continued)

Item	Constraints	Remarks
Orbital Parameters (Continued)	c. Selected to provide early access to high value targets or greatest number of high value targets.	5. Baseline: Manned/automatic i = 90 deg Automatic i = 96.4 deg
	d. Where i≠ 96.4 deg - chosen to provide best time history of η for flight duration.	
	e. Access to an RTS on each pass for early orbits for health checks and transfer and on later orbits on sufficient passes for payload command loading.	
	2. Perigee Altitude/Location	6. Baseline (manned/automatic): h_p = 80 n mi δ_p = 55 deg N (descending)
	a. Minimize for maximum photographic payload resolution.	
	b. Above established tumbling lifetime limits.	
	c. δ_p for optimum photography over area of primary interest.	
	d. δ_p initial location and range depending on O/A sustenance technique.	

Table 10-1. Launch Constraints (Continued)

Item	Constraints	Remarks
Orbital Parameters (Continued)	3. q a. Selected to provide three accesses to all targets between 80 deg N and 80 deg S for a 30-day flight. b. With given h_p, q establishes T_N and h_a. c. q = 16.27 is max for current baseline Recovery ship deployment. 4. h_a a. Determined by h_p and q. b. Cannot exceed h_a max = f (i) due to Gemini B capability to retrofire from orbit.	7. Baseline: q - 16-2/15 8. Baseline: h_a 187 n mi
Change of Launch Trajectory/Orbit	1. Launch Operations a. Requires 90 days to prepare and Checkout trajectory guidance for complete set of trajectory parameters.	

Table 10-1. Launch Constraints (Continued)

Item	Constraints	Remarks
Change of Launch Trajectory/Orbit (Continued)	b. Requires 7 days to prepare and checkout trajectory guidance for change to h_a and δ_p - all other parameters remaining constant. 2. AFWTR a. Requires ____ hr notice of launch date change for rescheduling purposes. b. Requires ____ hr notice for launch trajectory change for Range Safety. 3. AFSCF Requires ____ hr notice of launch date change for rescheduling purposes. 4. DDMS a. Requires ____ hr notice of launch date change to reschedule. b. Requires 72 hr maximum notice of launch trajectory change to reposition abort recovery forces.	

Table 10-1. Launch Constraints (Continued)

Item	Constraints	Remarks
Launch Recycling (Following a scrubbed countdown)	1. Launch Operations Requires ____ hr minimum* countdown to be recycled to T-____ min, minimum.	1. Rescheduling times for major support agencies shown in "Change of Launch Trajectory/Orbit".
	2. Flight Operations (STC) Requires ____ hr minimum* for recycling.	2. Includes time necessary to re-initialize ground hardware/software at STC.
	3. Flight Crew a. Cannot recycle for 24 hr*.	3. If crew has entered Gemini B, more than two consecutive sleep periods would be interrupted.
	b. Can recycle for launch next day*.	4. If crew has not been inserted.

*Exclusive of time to fix problem.

Table 10-2. Data Computational Subsystem Group Constraints

Item	Constraints	Remarks
Auxiliary Memory Unit	1. Number Available: 2	
	2. Readout Cycles: _______ max	
	3. Storage Allocation	
	a. Total Capacity: 200,000 words	
	b. Programs: _______ words	
	c. Target Data: _______ words	
Airborne Digital Computer	1. Number Available: 2	
	2. Power Usage: _______ watts when "on"	
	3. Earliest Time Usable: L+_______ sec	
	4. Core Allocation	
	a. Total Capacity: 16,384 words	
	b. Resident Executives: 4,000 words	

Table 10-2. Data Computational Subsystem Group Constraints

Item	Constraints	Remarks
Airborne Digital Computer (Continued)	c. Resident Programs: 12,384 words d. SPCs: ______ words e. Ephemeris Data: ______ words f. Star Data: ______ words g. Low G Accelerometer: ______ words h. Teleprinter: ______ words	

Table 10-3. Data Recorders Constraints

Item	Constraints	Remarks
Recorder PCM Telemetry	1. Number: 2 2. Capacity: Modes 1 and 2 65.536 kbps, 64 frames/sec, 128 words/frame. Modes 3 and 4 4.096 kbps, 4 frames/sec, 128 words/frame. 3. Readout a. Speed: ____ kbps, ____ sec max b. Direction: Forward or reverse 4. Record a. Rate: ____ pbs b. Direction: Forward 5. Rewind: Playback, reverse ____ sec max	

Table 10-3. Data Recorders Constraints (Continued)

Item	Constraints	Remarks
Recorder Voice	1. Number: 2 2. Capacity: ____ min 3. Readout a. Speed: ____ sec max b. Direction: Forward 4. Rewind	1. One per crewman. 2. Continuous recording. 3. Readout forward only due to vocoder restrictions. (Constraint under investigation.)

Table 10-4. Payload Constraints

Item	Constraints	Remarks
Film	1. Primary	1. Bimat film first ____ ft, no primary film on-board processing beyond this point.
	a. Frames: 15,000	
	b. Ft: ____	
	c. Bimat: ____ frames, ____ ft	
	2. Secondary	2. Black and white secondary film capable of on-board processing.
	a. Black and White: ____ ft ____ frames	
	b. Color: ____ ft ____ frames	
	c. Other: ____ ft ____ frames	
Data Return Containers	1. Number 3	1. DRCs in manned/automatic flights only.
	2. Capacity	
	a. Film: ____ ft each	
	b. Max weight per DRC: ____ lb	

Table 10-4. Payload Constraints (Continued)

Item	Constraints	Remarks
Data Recovery Vehicles	1. Number 6 (Capability)	1. DRVs for automatic flights only.
	2. Capacity	2. Baseline - 6 DRVs for Flights 6 and 7.
	a. Film: ____ ft each	
	b. Max weight: ____ lb	
Settle Times	1. Mirror	
	a. Pitch: ____ sec (max)	
	b. Roll: ____ sec (max)	
	2. Structure (following ACTS firing): ____ sec (max)	
Viewport Door	1. Door Open: ____ min/rev (max) in sunlight	1. Baseline - door will be closed whenever time between photo-target operations exceeds 45 sec.
	2. Time to Close: ____ sec	
	3. Time to Open: ____ sec	
	4. Number of Open/Close Cycles: ____ per ____	

Table 10-4. Payload Constraints (Continued)

Item	Constraints	Remarks
Star Tracker	1. Warm up Time: ____ min 2. Search/Lock-on Time a. Two tracker operation: 180 sec for less than 2 deg errors b. Single tracker operation: 60 sec for less than 0.5 deg errors 3. Closest Sighting to Celestial Bodies a. Sun: ± ____ deg b. Earth: ± ____ deg c. Moon: ± ____ deg 4. Viewing Limits: ____	1. Star tracker line of sight closer than specified in 3.a., will result in damage. Closer than 3.b., 3.c., may result in loss of lock-on star.
Environmental Control	1. Mirror Temperature: 70 ± ____F. 2. Mirror Temperature Gradient: 0.1°F linear between front and rear face in steady state with door closed. 3. Mission Module Bay Temperature: 70 ± ____F.	

Table 10-4. Payload Constraints (Continued)

Item	Constraints	Remarks
Photo Processing	1. Power Usage: ____ watts 2. Prohibited Times During a. Station Pass: ____ b. Mirror Slew/Track: ____ c. Photography: ____	1. Constraints on operation due to power consumption.
Photographic Operation	1. Camera Shutter Operation a. > ____ sec following tracking mirror roll slew (automatic centering/rate killing). b. > ____ sec following tracking mirror pitch slew (automatic centering/rate killing). c. Add 1 sec to a. and b., for manual centering/rate killing. d. > ____ sec of ACTS thruster burning.	

Table 10-4. Payload Constraints (Continued)

Item	Constraints	Remarks
Photographic Operation (Continued)	2. Primary Optics Interdiction a. Interdiction occurs only at a decision time (T_d) determined by the ground software. b. Interdiction occurs only as a result of a vote of the ADC considering crew inputs. c. Interdiction occurs only when the primary optics are on the primary path. 3. Alternate Targets a. ____ maximum alternates per target group. b. Alternate targets must be viewed for some minimum period (dwell time) with the ATS aspect angle less than 70 deg.	
Mirror Parameters	1. Roll Rate During Photographic Sequence Relative motion between the tracking mirror roll axis and the vehicle: >0	1. Prevention of bearing stiction noise which would result in loss of photographic resoltuion.

Table 10-4. Payload Constraints (Continued)

Item	Constraints	Remarks
Mirror Parameters (Continued)	2. Servo Rates a. Pitch (line of sight): 12 deg/sec b. Roll: 6 deg/sec 3. Obliquity Limits (unobstructed LOS): ±32 (manual) ±32.5 (automatic) 4. Effective Stereo Limits (unobstructed LOS) a. Forward: +13 deg (manual) +16 deg (automatic) b. Aft: -27 deg (manual) -30 deg (automatic)	2. Constraints 3 and 4 are stated with respect to orbital plane reference.
Focus Adjust	1. Ephemeris Accuracy a. h_p: ± ____ ft b. δ_p: ± ____ deg	

Table 10-4. Payload Constraints (Continued)

Item	Constraints	Remarks
Acquisition and Tracking Scopes	1. Obliquity Limits: +45 deg 2. Stereo Limits: +70 deg, -40 deg 3. Magnification/Field of View: ____ 4. Slew Rates a. Roll Slew: ____ b. Pitch Slew: ____ 5. Settle Times a. Roll: ____ sec b. Pitch: ____ sec 6. Field of View: ____	1. Constraints 1 and 2 stated with respect to vehicle axes.

Table 10-4. Payload Constraints (Continued)

Item	Constraints	Remarks
Primary Optics	1. Magnification/Field of View a. Photo-graphic: ____ b. Manual Viewing: ____ 2. Focus-Dynamic Range: ____	
Image Velocity Sensor	1. Minimum Lighting Requirements: ____ 2. Maximum Useful Altitude: ____	

Table 10-5. Orbiting Vehicle Constraints

Item	Constraints	Remarks
ACTS	1. Enable/Disable (During Payload Operation) a. ACTS must be enabled every 60 sec for at least 0.7 sec to meet the altitude reference accuracy requirements. b. ACTS enable must occur ____ sec prior to camera shutter operation to allow structural vibration damping.	
Environmental Control	1. Altitude Orientation - The environmental control subsystem can provide solar protection for the OV for a random altitude for 60 min, max. 2. Pressurization a. Nominal allocation for three entries to Gemini B after initial transfer. b. Each repressurization for EVA decreases ECLS capability equivalent to one day on orbit.	1. Ref. 2.a., - two Gemini B entries to transfer DRCs during flight. One Gemini B entry at end of flight.
Electrical Power	1. Total Energy: 1,314 k watt-hr	

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Table 10-5. Orbiting Vehicle Constraints (Continued)

Item	Constraints	Remarks
Electrical Power (Continued)	2. Usage	
	a. Average Power 1625 watts	
	b. Maximum Continuous 4500 watts	
	c. Peak Power	
	(1) Three cells operating ____	
	(2) Two cells operating ____	
	(3) Three cells operating ____	
Teleprinter	1. Speed ____ characters/ (equivalent to ____ bps)	
	2. Buffer Capacity	
	a. Characters: ____ total	
	b. Bits: ____ total	

Table 10-6. Crew Constraints

Item	Constraints	Remarks
Sleep	1. Sleep Periods a. Duration (nominal min): 6hr/ 24 hr/man b. Nominal sleep periods separated by: ____ hr. c. Concurrent sleep periods not prohibited but should be minimized.	1. Sleep periods should be uninterrupted. If this is not possible, minimum sleep periods of 2 hr are acceptable for a short time span of activity.
Personal Hygiene	1. Periods a. Three 30-min periods per 24 hr.	
Nutrition	1. Periods a. Four 60-min periods per 24 hr. b. Three periods to occur at earth normal intervals in relation to the sleep period.	1. Includes preparation, eating, and cleanup.
Exercise		
Housekeeping		

Table 10-6. Crew Constraints (Continued)

Item	Constraints	Remarks
Payload Operation	1. Cue Study a. 12 sec/cue b. Maximum of 30 min/pass c. As close as practicable to payload operation.	

Table 10-7. Flight Operations Constraints

Item	Constraints	Remarks
Orbit Adjust	1. Frequency - As required to provide parameters within limits specified in ____.	1. Baseline - every three days on sub-cycle 48.
	2. Location - Not less than ____ revs prior to a payload pass.	2. Location dependent on sufficient tracking data to determine orbit, generate command load, and load OV.
Data Acquisition and Commanding at RTS	1. Tracking a. Range, range rate, azimuth and elevation angle information available from horizon to horizon at RTS. 2. Telemetry a. PCM usable above 2.5 deg elevation. b. Analog FM/FM data usable from horizon to horizon. 3. Command a. Commanding requires PCM TLM. b. Commanding will be constrained to elevations above 2.5 deg.	

Table 10-7. Flight Operations Constraints (Continued)

Item	Constraints	Remarks
Data Acquisition and Commanding at RTS (Continued)	4. Voice a. Analog (clear) voice is usable from horizon to horizon (SGLS or VHF). b. Secure voice (digital) is usable only above 2.5 deg elevation.	

11.0 TRAINING, SIMULATION, AND OPERATIONAL READINESS

11.1 GENERAL

Flight and ground crew training, simulation activities, and operational readiness of ground support hardware and software systems and personnel are discussed in this section. The MOL Mission Simulator (MS) is described together with its three segments as well as ancillary development simulators and specific task trainers. The basic purposes are outlined and the equipment and software subsystems are defined. Interface areas are outlined among the three segments as well as with the Operational Training and Evaluation Facility (OTEF) and the AFSCF. The operational readiness concepts are reviewed and the relationship of the MS to these activities is outlined. Finally, the training of both flight crew and ground support personnel is discussed.

11.2 MOL MISSION SIMULATOR

MOL flight crew training will include experience in the simulated environment of the spacecraft. This experience will be gained, in part, from subsystem trainers, development simulators and specific task trainers. The MS will duplicate the spatial relationships and performance characteristics of the spacecraft itself. The MS will be ready for operation approximately nine months prior to the first manned launch. The MS, comprised of three basic segments [the Gemini B procedures simulator (GBPS), the laboratory module simulation equipment (LMSE), and the mission module simulation equipment (MMSE)] will be installed in the VAFB OTEF.

It is intended that the MS will be essentially indistinguishable at its operational interfaces (i.e., crew and MCC) from real flight.

The MS and its component segments have two primary purposes: (1) the rehearsal and training of flight crews, and (2) the rehearsal and training of mission control personnel. In addition to the primary objectives, it will serve to exercise the MOL-peculiar operational software as part of the verification procedure and will assist in development and validation of flight test rules, plans, and procedures.

11.2.1 Training and Rehearsal

The MOL training program will culminate in complete dress rehearsals just prior to the launch. These rehearsals will combine all phases, providing the means for flight crew and MCC personnel to sharpen the critical skills required for the actual flight. Although the MS will simulate normal flights, emphasis during rehearsals and training will be on emergency and backup operation as well as diagnostic analysis associated with simulated malfunctions. In preparation for complete rehearsals, the crew will have begun formal training several years before the launch.

Early training will occur in various specific task and development simulators. Crew training employing the MS will begin with development of crew proficiency in areas where specific critical skills are required. Thus, the various segments will be used independently and, perhaps, simultaneously to provide specific task training at the earliest possible time. As appropriate skills are acquired, training on specific flight phases will begin.

Launch and ascent phases will be simulated with the GBPS either alone or with the MCC. The capability for running consecutive simulations over periods of up to eight hours, will exist. Each simulated ascent may include a different set of malfunctions. Reentry rehearsal and training will be conducted in similar fashion using only the GBPS with the MCC. The GBPS is involved also in early orbit and terminal orbit operations. In this case, however, the GBPS must be operating cooperatively with the LMSE.

The LMSE and the MMSE, operating together as the laboratory vehicle procedures simulator (LVPS), will be used for on-orbit rehearsal and training. During this phase of simulation the LVPS as well as the LMSE and MMSE segments, may operate in open-loop mode thus not involving the STC or may operate closed-loop with the STC to support flight crew and MCC personnel training and flight test rehearsals. The LVPS will be capable of: simulating quasi-real-time; skipping ahead in time in accordance with the Instructor-Operator Station inputs; or recycling to selected check points in the simulated flight. The LMSE and the MMSE can operate as independent segments, when required.

For complete flight test rehearsals and some phases of training, all MS segments must be operating together and appropriately interfaced with each other as well as with the communications system (EXCELS) and ADS associated with the STC. Each segment of the MS makes a unique contribution to the total simulation process. Complete flight test rehearsals will require the MS to be tied into the MCC for 16 revs.

11.2.2 Gemini B Procedures Simulator

The GBPS is used in training the MOL flight crew to control and monitor vehicle operation during the launch, ascent, early orbit, late orbit (including loiter), and reentry phases. The GBPS consists of an Instructor-Operator Station and a computer complex with specialized signal conditioning and distribution (SC&D) equipment together with a mockup of the capsule and crew station. The interior, controls, and displays of the crew station are identical in appearance and operation to those in the actual Gemini B spacecraft. The pilot displays are largely controlled by the computer programs in the two DDP-124 computers in the computer complex. These programs send control information to the SC&D equipment which then operates the pilot displays. The SC&D equipment also monitors the switch, valve, and hand controller postions in the crew station and sends this information to the computer complex for any required processing.

The computer programs resident in the GBPS computer complex effectively model the Gemini B spacecraft and its inherent environment. A six-degree-of-freedom model of the T-IIIM vehicle is included for simulation of the ascent phase activities. Programs that solve the orbit generation and reentry equations are also included for simulation of the early orbit, late orbit (including loiter), and reentry phases. The vehicle math models include provisions for simulating various vehicle subsystems malfunctions to train the flight crew to detect and diagnose improper spacecraft or subsystem operation and to take the proper corrective action. These programs interface with the Instructor-Operator Station.

Instructors at the Instructor-Operator Station control and monitor the entire GBPS simulation activity. From this point, the instructors can initiate and control operation of the simulator and simulation exercise, insert or remove preprogrammed simulated malfunctions, and monitor the flight crew procedures and activities in the crew station. Intercom facilities allow the instructor-operator to communicate verbally with the other instructors, the flight crew, the STC simulation script coordinators, the operators of the other MS segments, and with the GBPS personnel stationed at the computer complex. Training emphasis will vary according to the flight phase being simulated.

During ascent phase simulations, the crew will be concerned primarily with detecting malfunctions in the BIGS or GIGS, performing the switchover function, and detecting launch vehicle or spacecraft malfunctions that lead to an abort condition. If an abort condition is indicated, the flight crew will rehearse the procedures required to effect a successful abort. Near the orbit insertion point, the crew will be concerned with achieving the proper orbit and if required, firing the laboratory vehicle engines to trim the orbit. In addition to training the flight crew and validating crew procedures, the GBPS will be used for training the flight controllers located in the STC and verify MOL-peculiar ascent and reentry programs resident in the STC computer complex. The interface between GBPS and STC that is necessary for these tasks is discussed in paragraph 11.2.4.3.

Once simulation reaches a point where contact with the Insertion Ship is lost, only voice communication between the crew in the GBPS and the flight controllers in the MCC is provided.

During early orbit phase simulations, the crew will learn to effect Mode D aborts, diagnose and control Gemini B failures, shutdown the Gemini B in preparation for transferring to the laboratory vehicle and to checkout the laboratory vehicle to the extent possible from the Gemini B. The GBPS computer complex will contain a functional model of the laboratory vehicle for training in the latter procedures in the simulator segment mode (i.e., the GBPS operating autonomously).

In the integrated mode, (i.e., when the GBPS is operating with the LMSE), the GBPS will provide the LMSE with Gemini B TLM data to permit full data communication with the STC. This function is described in paragraph 11.2.4.2.

Loiter phase simulations will emphasize powering up the Gemini B spacecraft, initializing the Gemini B guidance computer and inertial platform, separating from the laboratory vehicle, and preparing for the reentry phase. During reentry simulations, the flight crew will learn to effect a proper reentry from a variety of orbital conditions and with a variety of spacecraft malfunctions. A six-degree-of-freedom model in the GBPS software package will permit the flight crew to reenter using either the automatic computer program or the manual backup mode. During loiter and reentry phase simulations, verbal communications may again be established between the GBPS crew station and the STC flight controllers. Simulated reentry tracking data capability will be provided for a nominal reentry.

Upon completion of the landing sequence, the flight crew and the instructors can analyze performance by comparing the computed landing point with the aim point.

11.2.3 Laboratory Vehicle Procedures Simulator (LVPS)

The LVPS segment of the MS is the primary tool for rehearsal of the flight crew in operation of the MOL/DORIAN system in the early orbit and on-orbit phases. In addition, the LVPS will be used to train and rehearse the STC mission control personnel and to aid in verification of the AVE computer software and its interplay with the command generation and orbit/ephemeris programs at the STC.

From the crew training viewpoint, the heart of the LVPS is the simulated laboratory module (SLM). The interior of this structure is intended to be an exact replica of the interior of the actual MOL vehicle. All controls and displays within the SLM operate in a manner identical to the controls and displays in the AVE. This includes a high fidelity dynamic simulation of the pilot's field of view through the ATSs and primary optics displays. The upper compartment crew quarters areas however, are minimally functional mockups of the actual vehicle. Because of the one g environment, special provisions have been added to allow pilot access to the controls and devices in the upper compartment. Within the SLM, the flight crew will rehearse the proper procedures for operation and control of operating or malfunctioning spacecraft.

The LVPS will be controlled from the LVPS Instructor-Operator Station; the instructors can monitor and control the simulator subsystems, modify or change the training exercise being run, monitor the crew activity in the SLM, monitor the position of switches and controls within the SLM, and verbally communicate with the flight crew, GBPS instructor operators, computer complex operators, and the rehearsal coordinators at the STC. Finally, the instructors may freeze the simulation exercise at any point in time, recycle to a previous point in the simulation, or step ahead to a future time to allow the flight crew to bypass uneventful periods or study the end effects of a long time duration related malfunction.

During the LVPS operation, all phases of the on-orbit operation may be simulated including initial application of power to the laboratory subsystems, payload calibration and checkout, target passes, remote tracking station passes, and final configuring of the spacecraft prior to reentry of the Gemini B.

11.2.3.1 Laboratory Module Simulation Equipment

The LMSE, with its attendent hardware and software, simulate an LM and its orbital environment. The LMSE is comprised of the SLM (except panels 1, 2, and 8, which are part of MMSE), a simulated RTS, a computer complex with an IBM 360/Model 65 computer and its peripheral equipment, software models of the laboratory vehicle subsystems and the vehicle environment, special-purpose SC&D equipment, and an IOC for controlling the aforementioned hardware and software and for monitoring the activities of the flight crew in thy SLM.

The laboratory vehicle software models monitor the activities of the flight crew members via the LMSE SC&D equipment. The LMSE operation is best explained by example:

> When one of the crew members changes a switch position in the SLM, the change is detected by the SC&D equipment, and information defining the change is sent to the computer where the appropriate subsystem model is notified. The model subsequently computes the response that the pilot should see, dependent on the condition of that subsystem and related subsystems, and sends the appropriate control information to the SC&D equipment. The SC&D equipment then activates the appropriate display device in the SLM. The total time consumed by this process is such that no unrealistic delays between action and response are perceived by the flight crew.

The programs within the LMSE computer model laboratory vehicle subsystems that interface with the crew, including power, environmental control and life support, attitude control and translation, propulsion, and data acquisition. The environment-related routines include an orbit generation program, weight and balance, atmospheric drag model, and a functional model of a standard AFSCF RTS.

The RTS model allows the LMSE to communicate directly with the STC, using operational data formats and rates in the prepass or pass modes of operation (see paragraph 11.2.4.4).

The software executive system in thy LMSE computer insures that each model or routine is iterated at a sufficiently high rate to propagate the simulation exercise smoothly. The executive also controls the insertion of simulated malfunctions. Malfunction simulation may be inserted as a function of simulation time or as a function of flight crew action. The LMSE can simulate several hundred different malfunctions of the laboratory vehicle subsystems. Simulated malfunctions in one subsystem realistically propagate through other subsystem models (e.g., a degradation in the power system may affect many other vehicle subsystems).

The LMSE can operate in numerous different modes: (1) it may operate with the MMSE in the LVPS mode via the LMSE/MMSE interface; (2) it may operate autonomously in the segment mode, allowing the flight crew to practice and rehearse the monitoring and control procedures associated with particular laboratory vehicle subsystems; (3) it may also operate in conjunction with thy GBPS to simulate the early orbit mode with one crew member in each crew station, or it may obtain initialization parameters from the GBPS to ensure a smooth transition from the ascent phase of simulation to the on-orbit phase.

11.2.3.2 Mission Module Simulation Equipment (MMSE)

The MMSE simulates the DORIAN equipment and related subsystems. The MMSE is composed of the following subsystems: (1) three high precision optical trains that provide a realistic simulation of the two ATSs and the primary optics; (2) a computer complex comprised of an IBM 360/44, an IBM 4π, an SDS 930, and a Beckman 2200 computer with associated peripheral equipment; (3) panels 1, 2, and 8 of the SLM, with their associated electrical displays and optical eyepieces; (4) two cue projectors that give the flight crew the same type of cue presentation they will observe on the actual vehicle; and (5) a segment of the Instructor-Operator Station.

Through optical stimulus equipment, crew members in the SLM can view a realistic representation (9 x 9 in. slides of simulated target areas viewed through eyepieces) of what will be seen in the ATS and primary optics eyepieces of the actual vehicle. An anamorphic lens in the optical train provides the proper perspective. Prisms provide image rotation. Zoom lenses coupled through the computer to the pilot's zoom control provide high fidelity simulation of the zoom capabilities, as well as relative magnification due to pointing angle, both in the ATSs and primary optics. Target position with respect to the vehicle look angle is simulated by moving the optical entrance pupil to various positions over the 9 x 9 in. slide. The position of the slide with respect to the optics is determined by the computer complex and is a function of simulated vehicle position, simulated vehicle anomalies, vehicle attitude, and pilot's optics hand controller position, and position of the target on the slide. As the vehicle moves from target area to target area, a high-speed slide changer exchanges the slide at the entrance to the optical train. The optical subsystem of the MMSE also provides the timer wipeout lights in the pilot's eyepiece and the zoom reticle.

In addition to providing a means for flight crew rehearsal of DORIAN-related procedures, the MMSE will be used to assist in the verification of the AVE computer programs. The MMSE computer complex includes a MOL AVE computer with unmodified operational software. The MMSE IBM 360/44 computer coupled to the AVE computer through the Airborne Digital Computer Adapter Simulator (ADCAS) will provide the AVE computer with an environment that is indistinguishable from its actual vehicle environment. The operational software will be exercised for verification within the MMSE segment.

The IBM 360/44 computer and its accompanying programs simulates the mission-payload related subsystems such as the MDAU, the IVS, and portions of the MAS. The programs can also simulate subsystem malfunctions for flight crew rehearsal of contingency procedures. The IBM 360/44 monitors the crew activities, controls the three optical trains, and drives the electrical displays on panels 1, 2, and 8.

The MMSE is capable also of operating in a number of different modes. It may operate in the autonomous or segment mode for part-task training on MPSS-related procedures. It may also operate with the LMSE in the LVPS mode for rehearsal of overall on-orbit procedures. In the latter mode, the MMSE and LMSE computers exchange information critical to the propagation of the simulation over a channel-to-channel link.

11.2.4 MOL Mission Simulator Interfaces

The three segments of the MS, when interfaced with the STC and the OTEF, will be capable of high-fidelity simulation of the actions and reactions of the flight vehicle throughout its mission. Numerous internal and external interfaces are carefully controlled to assure the integrity of the MS.

11.2.4.1 LMSE/MMSE Interface

Although the LVPS comprises two separate segments, supplied by different contractors, it is designed to function as a unit. There is, for example, only one SLM and one Instructor Operator Station although both contractors contribute portions of each. Furthermore, both computers will operate as an integral system when functioning in the LVPS mode. Data and control signals must be transferred through the hardware and software interfaces without loss of meaning or continuity of information flow.

Interface specification IFS-MOL-117004 and related interface control drawings together with MS-3 documents for computer programs will define and control the LMSE/MMSE interfaces. Mechanical and structural as well as electrical and logical interfaces are defined.

11.2.4.2 LMSE/GBPS Interface

Although no mechancial or structural interfaces exist between the LMSE/GBPS, data transfer between the two segments is required for initialization as well as early orbit simulations where one crewman is in GBPS and the other in LVPS. Again, in late orbit simulations, TLM signals will be exchanged between the two segments where preparation for reentry is being rehearsed. This information flow interface is specified and controlled by IFS-MOL-117002 and its associated interface control drawings together with the computer program IFS-MOL-117010.

11.2.4.3 GBPS/STC Interface

During ascent phase simulation, data identical to that of real flight will be transmitted from the OTEF to the MCC. For example, GBPS will simulate the output of two PCM ground station computers located at AFWTR which are receiving and processing launch vehicle telemetry data. This data will be transmitted on two separate 19.2 Kbps data circuits to the STC. GBPS will also simulate the output of a PCM ground station at AFWTR which is receiving OV TLM on the SGLS link and transmitting to the STC on a 2.4 Kbps data circuit. Two additional 2.4 Kbps circuits are required for the simulated outputs of two radars with two different formats located at various sites under AFWTR control. Three of these 2.4 Kbps circuits are used at a later time for simulating data from the downrange tracking ship. Tracking data is generated during nominal reentry only. This interface is specified in IFS-MOL-217010 (Ref. 16).

11.2.4.4 LVPS/STC Interface

Closed-loop on-orbit simulation with the STC involves a complex array of hardware and software interfaces. During MOL flight, each RTS in the AFSCF network will have an array of four 2.4 Kbps circuits operating through an EXCELS which in turn interfaces with the ADS. To obviate the expense to the AFSCF for lines and terminals representing each station, the LVPS will simulate data outputs from each RTS (appropriately identified) over a single set of 2.4 Kbps circuits. All simulated tracking and telemetry data will be identical to that in real flight on the same ephemeris.

However, a unique set of problems exists in the LVPS/STC operation. The following are major examples of these problems. Because of the nature of the visual stimulus material, target passes must be on precise, predetermined ephemerides. Since crew actions and other uncertainties may perturb the orbit significantly and in a manner not precisely predictable, the ephemeris must be adjusted in such a way that the AOES computer programs and the command-generation programs operating in the 3800 computers are not confused. Such simulation-peculiar actions as freeze and recycle must be defined so that interfacing computer programs are not perturbed and no unreasonable action is required by operators.

The number of RTS real-time TLM modes is limited to 10. Although required to support MCC training, a final determination of the postpass TLM capability of the RTS simulation has not yet been made. Careful definition of electrical and logical interfaces with the EXCELS-type communication equipment is also required.

These interfaces are defined and controlled by IFS-MOL-117012 and IFS-MOL-117011 along with associated interface control drawings (ICD).

11.2.4.5 MS/OTEF Interface

Although no interface documents exist, careful control is exercised by MOL SPO/Aerospace and the associate contractors to assure that power, lighting, airconditioning (for computers and personnel), space, and layout as well as physical and radiation security requirements are defined in a manner compatible with simulator operation.

11.3 DEVELOPMENT AND PART TASK SIMULATORS

In addition to the MS, numerous part-task simulators perform functions that cannot be completely attained on the MS. These are:

a. Engineering development simulator (EDS)

b. Mission development simulator (MDS)

c. Abort simulator

d. Zero g simulation

e. In-house simulations

f. Human centrifuge

g. Gemini B egress trainer

h. Subsystem test articles and mockups

These simulators are required to (1) obtain early data for engineering and operations design, (2) produce environmental stimuli not obtainable on the MS, (3) provide operation of actual vehicle hardware in addition to computerized math-model simulation, (4) develop AVE software programs, and (5) obtain required statistical data on crew performance for mission enhancement. Certain part task simulators also serve as backup to the single MS in event of down-time due to malfunctions and modifications, and provide additional equipment to insure adequate flight crew preparation.

11.3.1 Engineering Development Simulator

The EDS is the first of three mission objective oriented simulators (EDS, MDS, MMSE). It consists of one crew station with simulated visual display, hand controllers for acquisition and tracking and for magnification, and target cue projection. Seventy mm positive transparencies of appropriate stimulus material are projected through the simulated ATS and main optical trains. The simulator is driven by a hybrid SDS 930/Beckman 2200 computer complex with associated interface equipment. Simulations of most subsystems, the ADC, and ephemeris are functional only.

The optical drive hand controller can be programmed with variable transfer functions, and pointing and tracking errors can be programmed for study of control system optimization. The computer-optics-crew station complex is controlled from an instructor operator station which includes a video relay of the stimulus material as viewed from the crew station. After obtaining early engineering data for vehicle development, the EDS will be expanded into the MDS.

11.3.2 Mission Development Simulator

The MDS, a modification of the EDS, will be updated to include the second crew station and completion of the common equipment bay between crew stations, dual ATS optical train, beam-split main optics, 9 x 9 in. stimulus material, conversion and switching equipment for each ATS and the primary optics, and an IBM 360-44 digital computer with associated peripheral and interface equipment. The MDS will progress in three phases:

a. During Phase I, the ADC software will be resident in the IBM 360-44 along with simulator drive software.

b. In Phase II, a prototype of the ADC will be added to the 360-44 and the ADC software will be moved incrementally to the prototype as each module is checked out on the 360-44.

c. In Phase III, all the ADC software is resident in the ADC and only simulator drive software and subsystem models are resident in the 360-44.

Mockups of the film handling equipment (cameras, DRCs, processor, etc.) will be provided in late Phase I or early Phase II.

The objectives of the MDS are to: (1) develop and aid in verification of the AVE software; (2) develop mission-oriented procedures; (3) serve as part-task simulator to ensure adequate crew preparation; and (4) obtain required statistical data on crew performance for mission enhancement.

11.3.3 Abort Simulator

The Gemini abort simulator is a Ling-Temco-Vought (LTV) owned facility consisting of a hybrid computer-operated moving-base simulator with five degrees of freedom. The Gemini gondola, used in conjunction with the LTV equipment, was transferred as GFE from NASA to MOL SPO and has been modified to the Gemini B display configuration.

This simulator can produce linear or angular accelerations that are then "washed-out" below the human threshold of perception, imparting a realistic kinesthetic motion cue to the crew members. Such accelerations are often one of two cues required for the crew to make an abort decision. Since the GBPS is a fixed-base simulator, this moving base capability is essential for part-task simulation.

The equipment can simulate the ascent phase from prelaunch to insertion. However, the first program consists of nominal and contingency powered flight through Stage 0 only. The objectives for the first launch abort program are to:

a. Evaluate man's capability to respond positively and accurately to initiate abort/escape action under simulated high stress conditions. The results of this effort will be fundamental in evaluating the need for automatic sequencing.

b. Evaluate the adequacy of crew displays relative to malfunction monitoring during Stage 0 operation.

c. Indoctrinate and familiarize all MOL crew members with the various failure modes and the abort environment of Stage 0 flight.

Future programs will incorporate nominal and contingency operations for all stages and will also serve as refresher training prior to each flight. In addition, since there is only one Gemini simulator for the MOL program, the LTV simulator can serve as a backup in the event of prolonged GBPS down-time.

11.3.4 Zero-g Simulation

Zero-g test aircraft and underwater neutral buoyancy techniques will be used to validate system design and flight procedures and to provide flight crew training. From August 1964 to date of publication, 12 series of tests have been performed with Wright-Patterson Air Force Base KC-135 zero-g test aircraft. In these flights, the aircraft followed a ballistic trajectory to produce effective weightlessness for a nominal period of 25 sec. The configuration of the mockups and associated crew equipment was maintained as close to flight configuration as possible to insure a realistic simulation.

Of the programs to date, one provided flight crew orientation, one evaluated pressure suit assembly (PSA) proposals, and the remaining were development tests. The development tests, with appropriate mockups and crew equipment have evaluated: crew transfer and DRC handling; crew conditioning equipment; suit donning station; waste management system; laboratory module restraints; and crew hygiene compartment. In addition to flight crew training, future programs will continue to evaluate modifications of the above items and EVA transfer.

Limited water immersion-neutral buoyancy tests have been conducted to evaluate crew restraints, reach envelopes, and crew procedures. Further tests are anticipated for crew station studies and to establish realistic timelines for periods exceeding the short aircraft ballistic profiles.

11.3.5 In-House Simulations

These facilities provide a flexible, but limited, capability for rapid evaluation of operational and hardware concepts, and provide information for proper definition of future, more extensive simulations on the EDS, MDS, and MMSE.

The simulations which have been held at LAAFS have been concerned with two areas: (1) initial validation of the concept of crew assessment of target activity; and (2) initial definition of stick transfer functions for crew tracking.

For activity mode evaluation, a film viewer capable of simulating ATS magnifications of 60 x and 120 x has been constructed. The device properly simulates the eyepiece, real field of view, and exit pupil. This device uses a film strip that when viewed, provides a static scene (i.e., no scene drifts, vibrations, ranging, etc).

Stick transfer function and crew tracking studies are performed using an oscilloscope for geometric target presentation. Various magnifications, reticle configuration types of scene dynamics, and target contrast levels can be provided.

11.3.6 Human Centrifuge

The human centrifuge at the Naval Air Development Center (NADC), Johnsville, Pennsylvania, will be used to familiarize the MOL flight crew with ascent and reentry acceleration profiles under normal and emergency conditions and allow them to evaluate controls, displays, restraints and PSA in a realistic acceleration environment. The centrifuge gondola is GFE from NASA and will be updated to reflect Gemini B controls, displays, and restraints.

11.3.7 Gemini B Egress Trainer

For egress training, a NASA Gemini egress trainer has been transferred to the MOL program as GFE. It will be modified to accurately reflect the Gemini B spacecraft interior, recovery equipment, and escape paths. The test article will be accurately scaled in CG location and total weight so the hydrodynamic behavior will match the actual spacecraft. Egress training is necessary because the extremely cramped quarters of the spacecraft make the removal of DRCs and pilot escape quite difficult.

11.3.8 Subsystem Test Articles and Mockups

Since the MS, in most cases, represents the operation and interaction of subsystems by computerized math models, crew members must perform part-task operation on actual hardware to have a more complete understanding of subsystem operations. This knowledge will be provided through subsystem lectures, participation in subsystem tests, and actual operation of subsystem test articles. To obtain more knowledge of integrated AVE subsystems, flight crew members will observe and participate in tests conducted on the EDCTU at Douglas, Huntington Beach facility.

11.4 READINESS CONCEPTS

11.4.1 General

Basic concepts employed in achieving operational readiness and the operational use of the simulator are described below. Although no schedules are provided, the basis for establishing schedules leading to operational readiness is discussed.

To assure operational readiness of the entire program, various elements such as physical facilities (buildings, hardware, etc.), software, procedures, and personnel must be acquired, developed, checked out, validated, trained and certified. Each activity is dependent, at some phase, on the timely completion of other related activities. Because of this interlocking relationship, integrated schedules for MOL operations are developed by starting with the need date (launch) and proceeding backwards. Thus, major milestones are established with compatible schedules and efficient times for completion. Sufficient flexibility is provided for changes (when necessary) in scheduled milestones, with minimum perturbation of the overall schedule. Operational readiness activities appear in the schedule for the last year or so before launch.

11.4.2 Rehearsal Committee

The rehearsal committee is the coordinator for all formal system and dress rehearsals. The FD/FTFD provides it with the time span and the basic objectives of the rehearsal. It is responsible for the detailed planning of the rehearsal, its scripting, the coordination of the rehearsal (not the scheduling) with the MS at the OTEF and any other agencies required. During the rehearsal, the committee monitors its progress and accomplishes any behind-the-scenes coordination to make the rehearsal run smoothly and in a realistic fashion. After the rehearsal, the committee critiques all operating elements by explaining all planned anomalies and the action taken by the element involved. If an incorrect action was taken, this fact is flagged and its effect on the rehearsal explained.

The rehearsal committee is cochaired by representatives of the FD and FTFD. It is comprised of members of the AFSCF training group and representatives from operating elements of the AFSCF and the MOL SPO/Aerospace and supported by consultants drawn from the technical staff of the associates' operational support teams. Normally the technical members serve on a one-time basis to afford equal participation on the committee to all personnel and so as not to deprive any operations personnel of the training and experience gained from the rehearsals.

11.4.3 Scheduling of Readiness Activities

Category II type system tests will be conducted in two phases. During the first phase (approximately IML - 15 mo to IML - 12 mo) both the MS and the AFSCF will essentially be tested independently. During the second phase (approximately IML - 12 mo to IML - 9 mo) the MS and the STC (including operational software) will be tested together. Category III type operational tests and rehearsals will be conducted after the MS "operational" date.

All facilities and personnel related to AFSCF support of the MOL program will be scheduled through the FTFD for MOL. Scheduling of OTEF facilities and personnel will be under the auspices of SAFSL-7. In those instances where the OTEF and AFSCF have coordinated training activities, the FD will ensure coordination between OTEF and the AFSCF schedules. For AFSCF training requiring AFWTR, the FTFD will arrange for coordinated scheduling of the required AFWTR facilities. For integrated launch operations/flight operations training, the Launch Operations Director will be responsible for AFWTR scheduling, and the FD will be responsible to ensure a coordinated schedule with the AFSCF through the FTFD. In most cases where interfaces are to be checked or validated, systems and personnel in more than one facility are involved. Some particularly difficult schedule coordination problems are likely to arise in software verification activities.

11.4.4 Software Verification

In a large and complex program such as MOL there is a highly sophisticated interplay among the various software subsystems involved. For example, the DCSG must accept commands and other updated parameters through the AFSCF ground tracking network. This information exchange occurs through a relatively long chain of hardware/software systems. When O/A commands are generated, for instance the command load is generated by software operating in the CDC 3800 computers at the STC. The information is passed on to the ADS IBM 360/67 computer system and is transmitted via EXCELS as a prepass message to a specific RTS. At the tracking station, the RTS-ADS system receives and stores the information, then, transmits it to the OV during the next pass. Although each system has been verified individually in Category I and II type tests, the entire ensemble of systems must also be verified. This is done in rehearsals and Category III tests for all software including AVE, AGE, MS, and MOL-peculiar STC software. These are exercised in conjunction with such other software systems at AFSCF, AFWTR, and MCSF. The MS is one of the tools used to accomplish Category III testing of the DCSG software. In addition, normal operation of the MS, the MDS, and certain AFSCF activities continually add to the assurance that the software is functioning properly.

Category I testing will be done primarily at the contractor's facilities except for the CDC-3800 software which will be done at the Computer Program Development Center. The bulk of Category II and III testing will be done with the operational hardware systems in accordance with approved test plans and is supplemented by simulation runs. Thus, when the simulation and verification sessions have been satisfactorily run, the AVE software, including subsequent modifications, will have been exercised to the extent necessary to establish complete confidence in its operational readiness. Similar action is required for procedures validation.

11.4.5 Procedures Validation

The training, simulation, and operational readiness programs provide a positive means for validating all procedures. In such a complex system, a seemingly simple procedural change may propagate through the system to produce undesirable effects. The time required to perform manually all procedure verification on actual hardware is usually prohibitive for a system of this magnitude.

The MDS and MS provide a practical means of exercising procedures for validation. Thus, it becomes extremely important that simulated subsystems be modeled with high fidelity and that malfunctions or errors propagate realistically from subsystem to subsystem. After review and signoff of the written procedure, validation is required to assure safety, effectiveness, and compatibility. Validation further assures that crew requirements do not exceed the capabilities of a trained crewman. Personnel training and rehearsal provide practice to attain required speed, precision, and proper habit sequence.

11.4.6 Flight Plan Validation

After individual procedures are validated, they are standardized and combined into the Flight Plan for each flight. Occasionally, procedures which seemed adequate when individually developed and validated are found to be impractical or incorrectly timed when rehearsed in the simulator as part of a complex flight timeline. For example, an array of properly timed and validated individual procedures, if called for during a single station pass, might completely overload the crew even through individual procedure times appeared to give adequate time for all operations. Because these combinations of tasks may call for different procedure treatment, all phases of the flight plans must be simulated, modified if necessary, and finally validated as an entity in the MS.

11.4.7 Flight Test Rules Validation

Flight Test Rules, as well as the Flight Plan, may require modification when placed in the context of a flight test rehearsal. The primary objective of the Flight Test Rules as described in the Flight Director's Handbook, is to provide mission control personnel and flight crew with guidelines to expedite the decision-making process. These guidelines are based on an expert analysis of operational equipment configurations for support of spacecraft systems operations and constraints, flight crew procedures, and test objectives. All these areas are reviewed and formulated into a series of basic ground rules to provide flight crew safety and to optimize the chances for mission success. These Flight Test Rules are then put to the final test during an extensive series of premission simulation and rehearsals prior to the flight test. Some rules may be modified as a result of experience gained from simulations. To assure a consistent interpretation and a complete understanding of the guidelines, a semiformal Flight Test Rules review is normally conducted with the primary and backup flight crews and with the mission control personnel prior to operations deployment. Flight Test Rules validation, along with other test and validations required, becomes a part of the Operations Certification Process.

11.4.8 Simulator Interface with Flight Operations

The simulator has a direct interface with flight operations in addition to the training and validation role.

During the orbital phase, the simulator will be maintained for a short period in its prelaunch configuration to provide on-orbit support in the checkout of computer problems and verification of any program correctors which may be required and to a limited extent, anomaly isolation and problem solution. After this period, when the simulator has been reconfigured for the subsequent flight, the current flight AVE programs will be kept in controlled storage at the OTEF in the event a requirement exists for the simulator to support the flight.

The flight target cues will be stored at the OTEF prior to flight and will be used during the flight crew training program to ensure crew familiarity with their contents.

11.5 TRAINING

An extensive personnel training and rehearsal program will be implemented for flight crew and flight operations personnel at all levels. Covering pre-flight, powered flight, orbital operations, and recovery, these exercises will serve to train technical advisors and other ground support personnel as well as mission control and flight crews.

11.5.1 Flight Crew Training

Training of a flight crew member is largely accomplished through his participation in the engineering, development, and testing phase of the program. Total training of a crew member from time of selection to flight is accomplished in three phases: preliminary training, general training, and specific-flight training. Concurrent with all other commitments, the pilots must maintain flight proficiency in high-performance aircraft.

11.5.1.1 Preliminary Training

Shortly after selection, the flight crewmen are assigned to the Aerospace Research Pilot School (ARPS) at Edwards Air Force Base for a six-month period of preliminary training consisting of basic academic lectures, field trips, systems briefings, simulation, and flying.

11.5.1.2 General Training

After the preliminary ARPS training, the flight crew is reassigned to the MOL SPO and given a series of DORIAN, mission-oriented briefings. Each crew member is then given an engineering or operational assignment in which he will both follow and participate in its development. The crew members can then educate each other in specific areas to maintain a current status of the total MOL system.

To prepare for hostile environments in contingency landing situations, the crew is trained at various geographically located government facilities for water, tropic, desert, mountain, and arctic survival.

A large porticn of the trainig during this period will be conducted on various simulators and part task trainers (see paragraphs 11.2 and 11.3).

Since the primary objective of the MOL mission is to obtain high resolution reconnaissance photographs, it will be necessary for the crew to be trained to recognize various categories of targets, active indicators, benchmarks, etc. This will be accomplished through specialized mission collection requirement training (MCRT) using available reconnaissance material for crew study. Much of this same material, properly formatted and indexed, will serve as stimulus material for the mission-oriented simulators.

11.5.1.3 Specific Flight Training

Approximately one year prior to manned flight, a prime, alternate, and support crew will be selected. The prime and alternate crews will then begin preparation for the specific flight to which it has been assigned. The support crew will assist in directing, coordinating, and participating in the numerous activities required for crew preparation during checkout, systems tests, intelligence assimilation, operations planning, simulations, and rehearsals.

11.5.2 Flight Operations Crew Training

Flight Operations crews are those required to support the real-time operation of a MOL system test flight phase within the ground network. This group includes AFSCF-assigned personnel as well as personnel from the MOL SPO, Aerospace Corporation, and associated MOL contractors who are in either permanent or temporary assignment at the STC to support MOL system tests. In addition to the division noted above, special training requirements exist for those personnel who specialize in the powered flight phase of the flight test. The Flight Operations Crew Training Plan will cover the training requirements of all these personnel. This plan will be divided into three parts:

a. Training for powered flight personnel (includes ascent, retrofire, and reentry).

b. Training for orbital operations personnel (AFSCF).

c. Technical adivsors training and orientation (contractor).

11.5.2.1 Powered Flight

The powered flight controllers who man the consoles will receive formal training by the Air Training Command (ATC) in the MOL Systems and related disciplines. After completing the formal ATC courses, the flight controllers will remain at the MOL SPO to assist in the design and development of the MCC displays and software, and to produce the required powered flight operations procedures and handbooks. When the MCC hardware becomes available, the controllers will transfer to the STC to begin procedures checkout and certification.

The training on the consoles will be conducted by the MOL SPO and the AFSCF. This will be in the form of closed-loop simulations using the OTEF, and open-loop simulations using FV tapes. It is planned to subject each controller to a minimum of (TBD) hours at his console prior to his acceptance and certification. Certification procedures and criteria will be implemented. The AFSCF will also provide training in STC procedures and modes of operation.

11.5.2.2 Orbital Operations

The AFSCF-assigned personnel receive training from MOL associate contractors in the technicalities of MOL systems, MOL requirements, and MOL-peculiar ground hardware and software. This training, planned and conducted by MOL associate contractors, may take place at contractor facilities, the STC, or the RTS, as appropriate. Included in this training will be familiarization with MS operations capabilities and its planned use with the AFSCF. The curriculum will include, but will not be limited to, the following important MOL program-dependent ground system items:

a. Software

b. Hardware

c. Operations handbooks

In addition, the total MOL operations organization and basic concepts peculiar to MOL will be included in the training program.

11.5.2.3 Technical Advisors

The AFSCF will train TA staff and contractor support personnel and MOL SPO Operations personnel in AFSCF hardware, software, procedures, etc., to allow their smooth functioning into the AFSCF operations. These personnel must be aware that they are supporting only one of several programs using the AFSCF and understand the possibilities of conflicts that can arise. This plan will be developed by AFSCF personnel who will later conduct the training classes at the STC. The curriculum for this portion of training will include, but will not be limited to:

a. AFSCF organization, capabilities, and general operational philosophies.

b. AFSCF data system indoctrination.

c. EXCELS indoctrination.

d. Use of MOL/ADS display systems.

e. AFSCF system support software.

f. The organization and manner in which training exercises or rehearsals will be conducted.

In addition to the above training, the AFSCF is responsible for the organization of a series of operational training and readiness exercises which will culminate in a final dress rehearsal. These exercises will involve various segments of the AFSCF and the simulation equipments at different times to assure readiness to participate in full-blown exercises. Rehearsals will employ those systems and personnel required to meet the objectives of the exercise and will be conducted in such a manner as to provide realism to the rehearsals. Training exercises will rehearse both normal and anomalous conditions of both the FV and ground system. The Launch Operations, Flight Operations, and flight crews will be involved in these exercises.

The objective of early training exercises will be to develop procedures. Later exercises will validate procedures. And still later, the exercises will be conducted to certify the readiness of all systems and personnel to support the MOL system test.

Some exercises employ equipment and personnel not under AFSCF jurisdiction. The AFSCF is responsible for coordinating their requirements through the MOL SPO.

11.5.3 Recovery Training

Recovery AGE will be available to the recovery forces no later than six months prior to the first scheduled MOL launch. (Flight 2 is unmanned, but will require recovery support along the powered flight ground track to approximately 40 deg S latitude). Recovery force personnel will conduct training as frequently as necessary to assure efficient performance and execution of recovery tasks and functions. An egress trainer will be used to develop techniques and train flight crews in spacecraft water egress procedures. In some flight crew egress trainer exercises, ARRS pararescue personnel will participate to assure development of the best recovery techniques for flight crew and data retrieval from the spacecraft. Since the Fulton surface-to-air retrieval system may be employed in the low probability zones of the powered flight and contingency landing areas, familiarity with and the use of the Fulton gear and related equipment will be an integral part of the flight crew/pararescue training program. No live personnel pickups employing the Fulton system are contemplated during the training exercises. Each training and readiness function makes its unique contribution to the total array required for mission success.

12.0 NATURAL AEROSPACE ENVIRONMENT (ENV)

The MOL SPO insures that the impact of the ENV on the system objectives is identified and analyzed. This Section will be provided for use by both the MOL SPO and the USAF Air Weather Service (AWS) as a Flight Test Operations ENV Support Plan.

This Section will be organized as follows:

12.1	Introduction
12.2	Methods of supporting test objectives
12.3	Roles and responsibilities
12.4 through 12.7	ENV support planning and support operations during actual test operations phases
12.8 through 12.11	Crew participation in ENV planning, analysis, and evaluation; ENV constraints on test operations; and ENV considerations during simulation and training operations

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APPENDIX A

AN OPERATIONS CONCEPT FOR THE MOL/DORIAN
MANNED/AUTOMATIC CONFIGURATION

A.1 INTRODUCTION

The current concept of the operating modes of the MOL/DORIAN manned/automatic configuration are presented in this Appendix. Some flight crew procedures, on-board computer logic, and ground support required to implement the flexibilities and capabilities required of the manned/automatic configuration are defined. This operations concept supports the MOL flight crew's primary tasks of:

a. Aiding in the early development of an automatic mission capability.

b. Enhancing the quantity and quality of intelligence data gathered on the manned/automatic flights.

Analytical and simulation studies continually being performed on these concepts are subject to modification and verification to ensure positive control, reliability, and the ability to satisfy User requirements.

A.2 GROUND RULES AND DEFINITIONS

The operational concepts presented in this Appendix are founded on a target selection process which employs a "voting" strategy (see paragraph A.2.8). In general, flight crew observations, or "votes", on several targets are gathered and, at preselected times, compared with ground supplied on-board target selection logic. A decision is then made by the ADC to select for photography the target which offers the greatest probability of mission enhancement.

The following ground rules and definitions are generally agreed upon and form the basis for these concepts:

A.2.1 Primary Targets

Primary targets are those targets which lie on the programmed path of the primary optics. The primary target path is generated by the ground-based mission planning software. The considerations involved in target path selection include:

a. User requirements expressed as priorities and weighting factors.

b. OV operational status and capabilities.

c. Specific intelligence requirements including desired photographic modes, use of special films, category allocations, specific stereo or obliquity requirements, and other User inputs.

d. Forecast weather in the area of interest.

Photography of the primary targets provides the optimum expected intelligence value available during the selected overflight of the area of interest.

The User has the option to direct that certain specific targets of unusually high intelligence value be selected in a specified photographic mode for the programmed path of the primary optics. These targets will be referred to as "mandatory primaries". Mandatory primaries will be selected for photography by the ADC/flight crew unless specifically rejected because of observed weather conditions.

A.2.2 Alternate Targets

Alternate targets are preselected non-primary targets which are scheduled to be observed by the flight crew through an ATS and, if selected by the target selection logic, photographed by the primary optics.

The alternate target paths are selected by the ground-based mission planning software using essentially the same selection criteria as the primary path but considering such additional factors as:

a. Geometrical relationship to the primary optics path.

b. Available viewing time and resolution requirements for flight crew inspection with an ATS.

c. Specific predefined conditions under which photography of the alternate target enhances the overall intelligence value of the mission.

Interdiction of the primary optics path in favor of an alternate target occurs only when the primary is rejected for observed cloud cover, allowing photography of a "weather alternate", or when the observed presence of activity indicators increases the probable intelligence value of the alternate "activity alternate" target over that of the primary target.

A.2.3 Activity Indicators

Activity indicators are those predefined objects or target characteristics which, by their observed presence (or absence), indicate an increased probability that the target scene contains information of high intelligence value. (These indicators are normally highly transitory in nature.)

A.2.4 Visual Intelligence Targets

Visual intelligence targets are those targets preselected for flight crew inspection and oral comments, but not for photography.

Generally, these types of targets will be selected for viewing for one of the following reasons:

a. When associated with a mandatory primary.

b. When the confirmation by visual observation of the mere presence or absence of an object, condition, or characteristic of the target area satisfies the intelligence requirement.

c. When vehicle constraints prevent actual photography of the target, or the penalty associated with photography is unacceptable.

A.2.5 Target Group

A target group is composed of a primary and its associated alternate targets.

Targets are assigned into specific groups by the ground-based mission planning software. Decisions are made by the ADC on each target group at a preplanned time ("decision time") for that group. At a given decision time, the flight crew inputs are polled and, based upon ground-calculated voting logic, the ADC determines whether interdiction of the primary optics path in favor of an alternate target is warranted.

A.2.6 Flight Crew Target Votes

The flight crew inputs to the computer on target conditions are:

a. Reject - Denotes clouds/weather or other undesirable conditions which would prohibit satisfactory photography of the observed target.

b. Inactive - Denotes that a target is visible but that no activity indicators have been observed.

c. Active - Denotes that a target is visible and that one or more predefined activity indicators have been observed.

d. Override - Denotes the presence of unusually high intelligence value in a target which should be photographed. This input will cause the computer to commit the primary optics to that target at group decision time without regard to other flight crew inputs or the target selection logic.

A.2.7 Decision Logic for Target Groups

Each primary and alternate target within the target group is assigned a preference value for both active and inactive states. These preference numbers provide a quantitative method for making real-time decisions when voting between targets in a group, but do not indicate target weights, scores, or priorities. For each group, the primary target will always have the highest inactive state preference. These preferences are established by the ground software, which takes into consideration the following:

a. Disturbance to the primary optics path if interdiction occurs.

b. User-supplied activity enhancement factors.

c. Photographic modes available at decision time.

d. User supplied basic target parameters (i.e., priority, etc.).

A logical table may be constructed which gives the decision rules for interdiction of the primary path. Table A-1 provides the decision logic and assumes that the primary target has been viewed and voted upon.

A.2.8 No-Vote Situation

If the flight crew does not observe and vote on the primary target of a group prior to group decision time, the ADC will consider the primary to be voted inactive to the target selection logic unless specifically requested otherwise by The User. Alternate targets in the group will be voted "reject" to the target selection logic if not voted on by group decision time.

Table A-1. Decision Rules for Interdiction of Primary Path

Crew Vote on Alternates	Crew Vote on Primary		
	Reject	Inactive	Active
All rejected	Take None	Take Primary	Take Primary
No active but at least one inactive (clear)	Vote Among Alternates	Take Primary Primary	Take Primary Primary
At least one active	Vote Among Alternates	Vote among alternates & Primary	Vote among alternates & Primary

NOTE:

1. When a vote is made among clear, inactive alternates and the primary has been rejected, it is possible that no clear alternate will be of sufficient value to warrant interdiction of the primary optics path.

2. When an alternate target is voted "active" by the flight crew, it will still be necessary to weight its preference against the preference of the primary target (active or inactive) to determine whether interdiction is warranted.

3. It is possible to have target groups that consist solely of alternate targets. Within these groups, interdiction of the primary optics path can occur for an active alternate. These groups are designated "special target groups".

A.2.9 ATS Paths

An ATS path is that sequence of aiming points to which the ATS is automatically pointed to allow flight crew observation.

Two ATS paths will be generated by the mission planning software: (1) ATS path 1 will contain the primary target of each group, plus selected alternates and visual intelligence targets. (2) ATS path 2 will be composed of alternate and visual intelligence targets only.

A third path, the ATS primary path (a modification of ATS path 1) provides the capability for rapid recovery during contingency operations and can be accomplished on-board at crew command. Manual selection of the ATS path to be monitored facilitates the various operational sub-modes (see paragraph A.4.1).

A.2.10 Variable ATS Dwell Times (Self-Pacing)

The ATS will slew to the next target scheduled for viewing within a target group only after a flight crew vote is input to the computer on the target being viewed. The ground software will compute and display to the flight crew recommended dwell times for each target. When group decision time is reached, the ATSs will step automatically to the first scheduled target in the succeeding group unless the flight crew intervenes. (Multiple scheduling provides the only means for returning to a target with an ATS once that target has been voted upon.) The ATS is inhibited from slewing to the next target of a group if the flight crew inputs an "Override" vote. It is assumed that, under these conditions, the flight crew will want to follow the target with an ATS right up to decision time.

A.2.11 Leapfrog Operations

An operational technique where one flight crewman acquires, selects, and centers a target in the upcoming group while the other is tracking a target in the current group. The crewmen operate on alternating groups from initial acquisition to completion of photography.

A.2.12 Specialist Operations

An operational technique utilized by the flight crew which results in one crewman operating an ATS to select targets for photography, while the other crewman devotes full time to the fine rate killing task on the selected targets during photography.

A.2.13 Validation of Vehicle Performance

Validation of vehicle performance for future automatic flights shall be accomplished on manned/automatic flights. To ensure the accomplishment of this objective, the flight crew must be provided with displays and controls to allow:

a. Fine tuning or adjustment of automatic systems.

b. Backup automatic systems.

c. Systems performance evaluation.

A.3 ORBITING VEHICLE ORBITING MODES AND FEATURES

There are two basic modes of operation for the manned/automatic vehicle configuration:

a. Mode A is the automatic mode in which the mission payload and its subsystems are operating properly and all target centering, IMC, and photography can be accomplished without flight crew assistance. The flight crew's functions in this mode range from enhancing the intelligence content of the photography through the target selection process, to completely checking out the operation of the automatic systems. The flight crew has the capability in this mode to fine tune and adjust the mission payload for improved photographic performance.

b. Mode B is the backup mode in which the flight crew is required to assist in target acquisition, centering, IMC, or other functions which the flight crew can perform, but which normally would be satisfactorily accomplished on computer command in Mode A. Mode B stresses the continued use of all available operational automatic features.

Both of these operating modes provide a wide range of flexibility so the system can be responsive to User and/or contingency requirements. This flexibility is attained without requiring changes in the ADC logic.

The ground-based mission planning software will be required to handle the various operational modes and sub-modes to obtain the optimum strategy for the ATS, primary optics, and the flight crew.

A.3.1 Mode A

Mode A consists of two basic operational sub-modes which may be employed, depending on the degree of confidence in the operation of the complete system in the manned/automatic configuration, or on the degree of diagnosis or verification desired of payload performance.

A.3.1.1 Operational Sub-Mode 1

This sub-mode assumes that all automatic functions are being performed satisfactorily. Either or both ATSs (depending on one- or two-man operation) are assigned targets for crew inspection. Flight crew inputs are gathered by the ADC which selects the target in each target group for photography. Provisions are currently available in the ADC for seven alternates per primary, making the maximum size of any target group eight targets. (This number results from tradeoffs between computer core storage available, uplink loading time requirements, flight crew capabilities, target distribution and density, and total time available for viewing any one target group.) The flight crew will view as many targets per target group as possible and indicate their observations or "votes" to the computer. Targets (including the primary) will be viewed in a ground-selected order which may be by order of preference within the group or chronologically by time of closest approach (TCA) (i.e., when the best viewing angles, etc., are available). Alternate targets not voted on by the decision time will be rejected by the computer from consideration for photography within that group. If the primary has not been viewed, due to time limitations, the primary target will normally be considered inactive (and clear) in the decision process. Provisions are made for the ground to allow the primary target to be rejected under no-vote situations by setting a flag in the uplink target data word. (This option may be employed in film-limited situations or when photography of a target is desired only after the confirmed presence of a given condition.) Targets may be checked for the presence of activity indicators or only for weather conditions depending on information given the flight crew in the ATS peripheral display. Generally, weather decisions will be accomplished more rapidly than activity decisions.

This sub-mode results in the greatest number of targets viewed, thus increasing the chance of enhancing the intelligence content of the mission results. It also provides weather verification in the target area.

A.3.1.2 Operational Sub-Mode 2

In this sub-mode, one crewman observes the selected target through the main visual optics while it is being tracked and photographed. This provides the highest degree of verification of weather and/or evaluation of mission payload performance. Fewer targets will be viewed by the flight crew prior to the decision time in this sub-mode because one crewman is devoting the majority of his time to the main visual optics rather than evaluating and making inputs on targets using his ATS.

This sub-mode may be further modified to require that one crewman continually observes through the main visual optics during slew and settle, as well as during track and photography.

No mode changes are required within the ADC to support the provisions of this sub-mode. This sub-mode will be very useful in verifying, diagnosing, and evaluating automatic systems performance.

A.3.2 Mode B (Back-Up)

This mode assumes that flight crew intervention, in some way, is needed to allow successful high-resolution photography flight crew control inputs from fine tuning type of adjustments to the assumption of full manual control (as in the case of IVS failure). There is no clear cut crossover point between Mode A and Mode B. No attempt is made here to identify every possible flight crew action or operational sub-mode that may be dictated by contingencies. Several operational sub-modes are identified which illustrate how some of the main system failures will be handled by the flight crew. Continuous study is underway to insure that the maximum capability of the mission payload is maintained as much as possible for every malfunction. Contingency analysis and crew procedures will be developed through simulation throughout program development. Displays and controls will be implemented as necessary to insure the satisfactory accomplishment of the mission objectives.

A.3.2.1 Operational Sub-Mode 1

This sub-mode is utilized whenever the IVS is not operating satisfactorily (automatic fine rate-killing not available). One crewman is required to view the targets selected for photography through the main visual optics and manually, through a controller, provide fine rate-killing inputs to the ADC for the tracking mirror. This will approximately halve the number of targets viewed prior to decision time because one crewman will now have to devote full time to the manual tracking task. This sub-mode may be operated by one or both crewmen in either a "leapfrog" or "specialist" technique. Selectivity is provided so that either of the two ATS paths may be inspected by the crewman making inputs for the target selection process. To enter this sub-mode, the signal from the IVS will be inhibited by the flight crew, and manual controller tracking information will be supplied by the flight crew in its place.

A.3.2.2 Operational Sub-Mode 2

This sub-mode is utilized whenever the automatic target centering (pointing) is degraded but the IVS is working properly. Although pointing information can be updated for targets in any of the modes or sub-modes delineated in this document, this sub-mode assumes that the pointing errors are sufficiently random and large as to require the flight crew to search, acquire, and center targets in their ATS, in addition to the normal target evaluation fine adjustment task. The crew can supply updated target pointing information to the ADC through the use of the "computer update" button, or by inputing to the computer an "active" or "override" vote. At decision time, the computer will select a target, apply any stored position update corrections and slew and settle the main optics on that target. The IVS will then provide the fine rate-killing necessary for high resolution photography. This sub-mode will reduce the number of targets viewed prior to decision time due to the increased requirements on the flight crew to search, acquire, center, and update position as well as evaluate targets.

This sub-mode requires no changes in ADC operation, just the capability for the ADC to accept and apply updated target position information. This capability is an operational requirement.

A.3.2.3 Operational Sub-Mode 3

This sub-mode assumes that target-centering and the IVS are both operating in a degraded or unsatisfactory manner. This sub-mode is similar to sub-modes 1 and 2 and combines the features and handicaps of both. In this mode, considerable time must be devoted to acquiring, centering, evaluating, and tracking a target manually. For this reason, provisions are made to permit the flight crew to select an ATS path schedule that ensures that the primary target is the first target observed in each group (see paragraph A.4.1). Thus, the flight crew can concentrate on assuring good photography of primary targets by devoting full time to the various manual tasks involved. This sub-mode may be operated with either a "leapfrog" or "specialist" technique.

A.3.2.4 Operational Sub-Mode 4

This sub-mode assumes that the pellicle in the main optics is damaged to the extent that neither the IVS or primary visual optics viewing are available for the fine rate killing task. In this mode, the tracking mirror will be slaved to an ATS after a target is selected for photography; the rate-killing task will be accomplished manually by the flight crew while viewing through an ATS. In this sub-mode, it is desirable to hold the ATS on the primary target from initial acquisition until completion of photography. This sub-mode provides moderate resolution, but can only be operated in a "leapfrog" technique and utilizes a limited number of alternate targets.

A.4 DISPLAYS AND CONTROLS

The displays and controls which are currently baselined for the mission bays (No. 2 and No. 8) of the OV are discussed in this Section. Extensive simulation and contingency analyses are being accomplished to ensure adequate flight crew mission payload control capability while maintaining overall system realiability and response to User requirements. A schematic of a typical mission console is shown in Figure A-1.

Only those displays and controls necessary to implement the major functions of the operations concept will be discussed here.

A.4.1 ATS Path Select Switch:

A three-position switch is located on each mission console which allows selection of the ATS Path (1, 2, or primary) to be followed by the ATS on that console. Path selection is completely independent on each console, allowing any combination of paths to be viewed by the two crewman. Both ATSs may follow the same path if desired. This facilitates a "leapfrog" operation in Mode B. When the ATS path select switch is placed in the primary position, the following functions are accomplished:

a. ATS Path 1 is selected for viewing (contains all primary targets, by definition).

b. All alternate targets of each group scheduled to be viewed prior to the primary are deleted.

c. Slewing of the ATS to the next target in the same group is inhibited for active, inactive, or override inputs to the computer.

Targets scheduled for viewing after the primary of each group are still available for viewing and photography if the primary is rejected.

The position of this switch also controls the information presented in the ATS eyepiece and the order of cue presentation on the visual display projector such that the cues and information presented always matches the targets of the path selected.

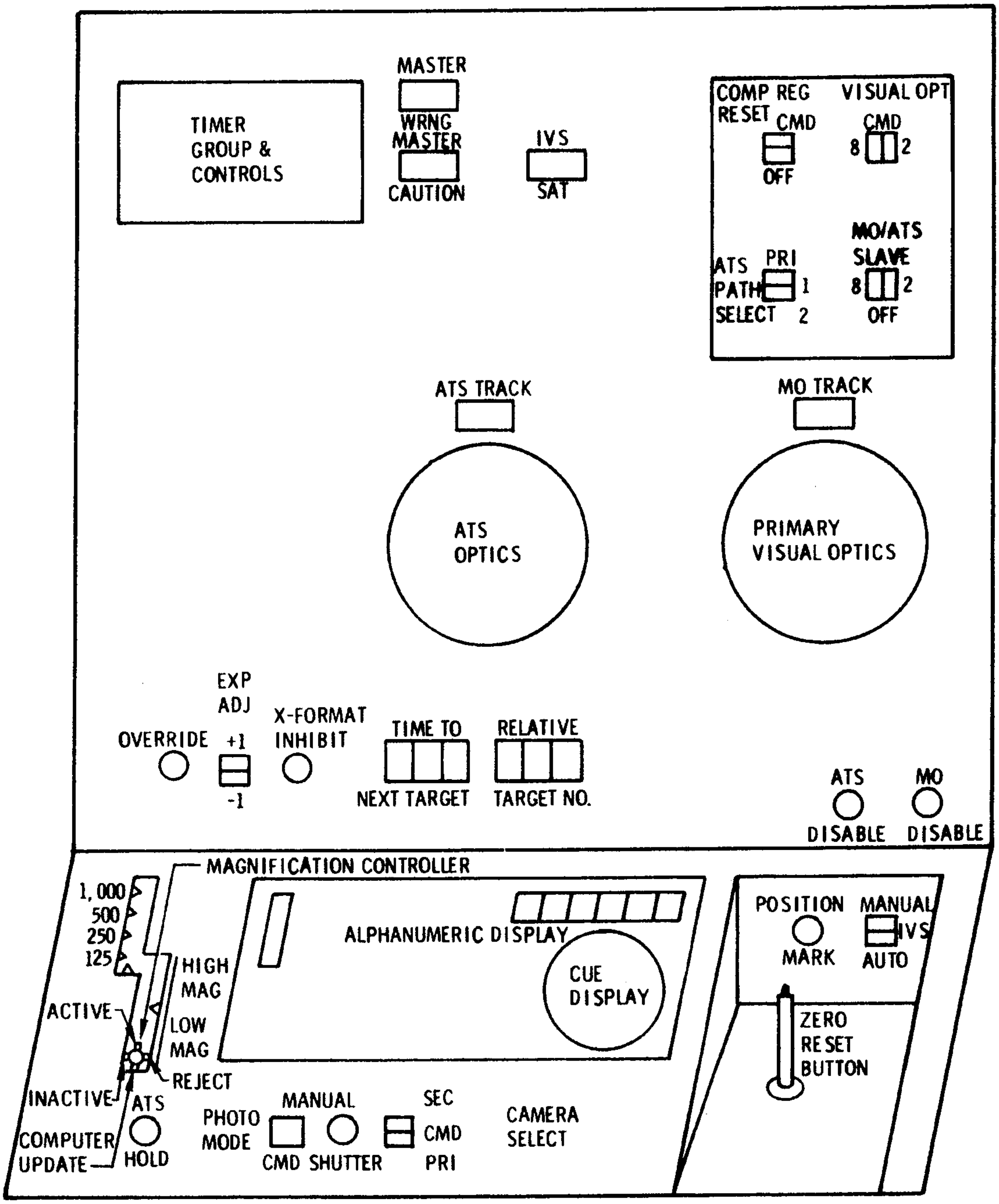

Figure A-1 Typical Mission Console

The primary position of this switch allows implementation of Mode B, operational sub-modes 3 and 4. These sub-modes will require a crew member to operate on a primary target from initial acquisition in the ATS through tracking and photography of the target.

The ATS Path 1 and 2 positions allow selectivity of the path to be viewed at each console and are useful in implementing various forms of "leapfrog", "specialist", and hybrid operations when operating in Mode B as well as flexibility of operations when one crewman is being utilized.

A.4.2 ATS Eyepiece Peripheral Display System

This display system is composed of a "bouncing ball" time display and an information display. These displays are common to both ATS eyepieces and are computer-driven to supply the flight crew with the necessary timing and target information on the ATS path selected by the ATS path select switch (see Figure A-2).

A.4.2.1 Time Display

This display consists of a ring of 25 small white lights located at the extreme of the ATS field of view (see Figure A-2). The appropriate light is illuminated at the start of viewing of each target group to indicate the total seconds remaining until group decision time. The light will "step" at 1-sec intervals toward the bottom of the display, providing a "bouncing ball" presentation of time remaining.

Individual lights will be illuminated to indicate recommended viewing times on the targets to be viewed and provide information as to the number of targets to be viewed in each group. These lights extinguish individually as the flight crewman votes on each target. The display is re-initialized at group decision time for the next target group. If group decision time is more than 25 sec away, the 25th light will be illuminated and remain on until the "Time To Next Target" display (see Figure A-1) counts down to zero and initializes the "bouncing ball" at 25 sec to group decision time.

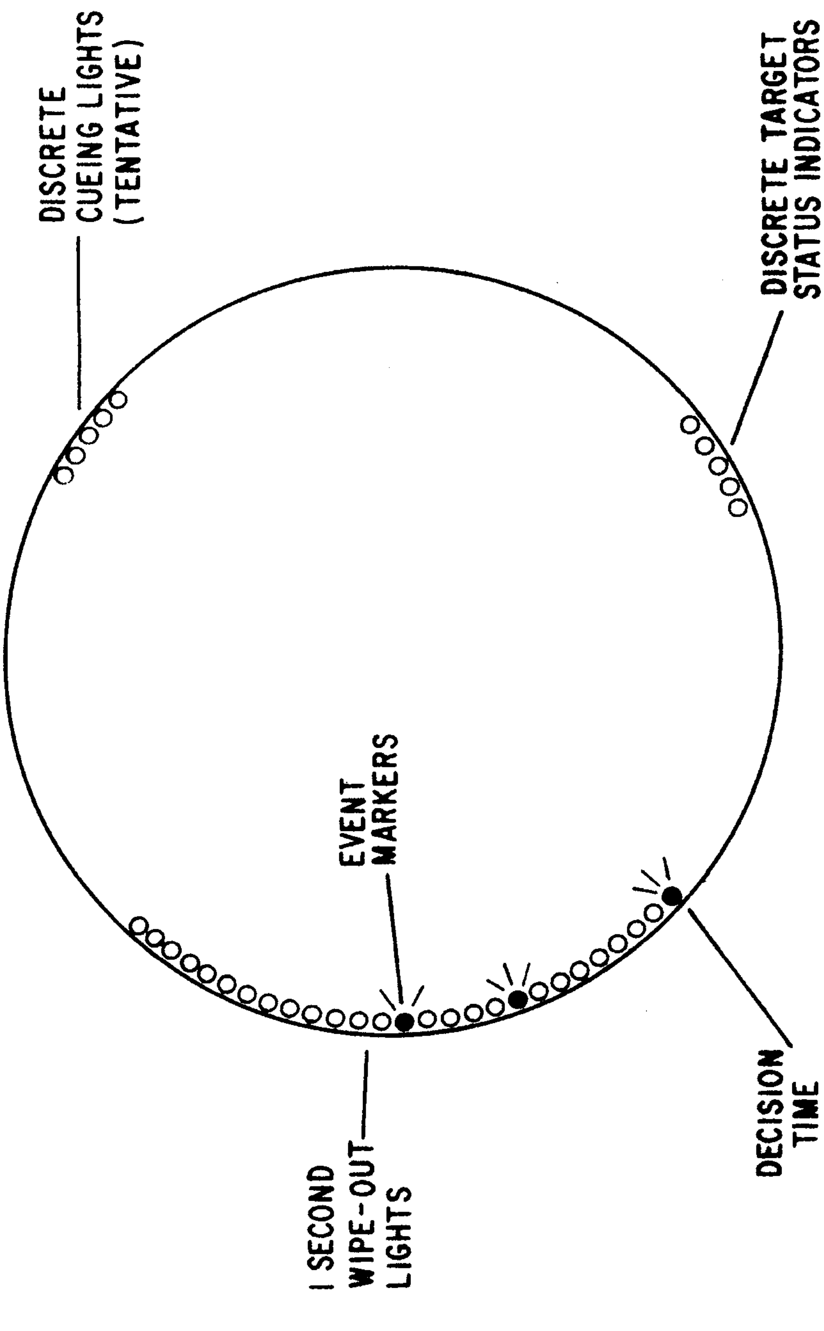

Figure A-2 ATS Eyepiece Display

A.4.2.2 Discrete Target Status Lights

Ten small white lights are provided in each ATS eyepiece to provide the flight crew with information on the target being viewed in the ATS. The lights will be illuminated in specific patterns that will indicate:

a. Primary target.

b. Benchmark target.

c. Weather alternate (assumes that activity alternate is in the normal type).

d. Visual intelligence target.

e. Target not available for photography.

f. Combinations of the above.

Simulations will be used to determine the exact patterns to be utilized and the amount of information that can be displayed to the flight crew without detracting from their primary task of target evaluation.

A.4.3 Acquisition Hold Button (ATS Hold)

When this button is depressed, the ATS will continue to track a target past group decision time and until the ATS is released by depressing the "Reject" button on the magnification controller, or the ATS runs into its aft stop. "Reject" inputs for this purpose will not be interpreted by the computer as a target vote. This button, in conjunction with the primary position of the ATS Path Select Switch, allows a primary target to be tracked from initial acquisition through the completion of the photographic sequence with an ATS, if desired.

A.4.4 Primary Visual Optics Eyepiece Display System

A display, similar to the ATS eyepiece display, is contemplated for the Primary Visual Optics eyepiece. This display will provide the viewer with the following information:

a. A timer wipeout (similar to ATS "bouncing ball") showing tracking mirror position as a function of pitch angle and/or time.

b. Event indicators to supply the scheduled number of exposures and relative exposure times of the selected target (allows improved centering between frames if sufficient time is available).

c. An indication of planned secondary camera photographs. The exact configuration of the display system will be determined on the basis of operational need, complexity, and cost.

A.4.5 Primary Optics/ATS Magnification/Zoom Controller (Magnification Controller)

This controller is a throttle-type control which controls the zoom magnification of the ATS high-power and low-power ranges when positioned in the lower slot and the primary visual optics discrete magnification selections when positioned in the upper slot. The controller configuration permits the flight crew to select a magnification to be used for primary visual optics viewing and then remove the controller to the ATS range, leaving the primary visual optics set at 125X, 250X, 500X, or 1000X. The controller must be placed in the upper slot to:

a. Change magnification selection for primary visual optics.

b. Allow manual control of the tracking mirror.

Located on the controller are three flight crew voting buttons (active, inactive, and reject). Other input buttons and controls may be mounted on the controller to facilitate ease of operation and manual control.

A.4.6 Override Button

Each mission console has an override button that is used to commit the primary optics to a particular target of a group without considering the target decision logic or other flight crew inputs. An override vote will not interrupt a photographic sequence on a previously selected target. An override vote also results in an implied ATS hold up to group decision time. It is envisioned that this button will be used only on the ra e occasion that a target is so highly "active" that it is of extremely high intelligence value.

A.4.7 Primary Visual Optics Control Switch (Visual Optics)

This switch, located on console 8, allows the primary visual optics view to be assigned from one mission console to the other, as directed by computer command, or to be manually locked to one console or the other. It will be useful in implementing one-man operations or for "specialist" operations in Mode B. In the "command" position, the computer will assign the primary visual optics view to that console from which the "winning" vote came.

A.4.8 IVS (Rate Null) Switch

An IVS (rate null) switch is located on each mission console. In the "automatic" position, the IVS signal is used by the computer to accomplish the fine rate-killing task. If the IVS is malfunctioning, as indicated by the "IVS saturate" light, or as determined by viewing through the primary visual optics, the flight crew may select the "manual" position. The computer will then reject the IVS signal and accept manual inputs from the control stick. Both crewmen may make manual control inputs to the tracking mirror (as in a "leapfrog" operation) only if each crewman has his switch in the "manual" position.

A.4.9 Manual Control Stick Assembly

A single control stick is present on each mission console to enable manual control of both the ATS and main optics. ATS control is available any time the ATS is "ON" and the magnification controller is in the ATS range. To control the main optics to accomplish manual rate killing, the primary visual optics must be assigned (either by computer command or manually) to that console, the magnification controller must be in the primary visual optics range, and the IVS switch on that console must be in "manual" (IVS signal "reject") position.

A.4.10 Computer Update Button

Each mission console contains a "computer update" button. When this button is activated, the computer updates the pointing angles of the target being viewed through the ATS. This allows centering corrections made in the ATS to be passed on to the main optics by the computer. If the target being viewed is flagged in the computer as one whose geographic position is accurately known (i.e., benchmark target), then the position update will be applied to update the ephemeris (landmark navigation). If the target being viewed is not a benchmark, the pointing correction is saved by the computer until "decision" time and applied to the main optics if the target is selected for photography.

A.5 SUMMARY

This concept stresses:

a. A simple flight crew/computer interface in the target selection process.

b. Flight crew control capability ranging from minor adjustment to complete manual control of certain mission equipment.

c. Validation capability for automatic flight.

d. Immediate reaction capability with no AVE computer logic changes to handle contingency situations.

e. The need for the mission planning software to efficiently handle various operating modes.

Operations concepts for the MOL/DORIAN system are being continuously studied and refined as the program develops. Efforts are being applied to ensure reliability, flexibility, response to User requirements, and the accomplishment of all mission objectives.

APPENDIX B
FLIGHT PLANNING

B.1 INTRODUCTION

This Appendix supplements the information contained in paragraph 6.3.4 by giving additional treatment of the technical details or by providing Figures and Tables useful to the understanding of the text material. This Appendix is further divided as follows:

B.2 Launch Constraints

B.3 Ground Trace Coverage and Station Contacts

B.4 Orbit Sustenance

B.2 LAUNCH CONSTRAINTS

B.2.1 General

In designing orbits for reconnaissance satellites which require natural light (sunlight) for target illumination, passages over a target area must occur under conditions of adequate illumination. Generally, the launch time associated with an orbit which satisfies a set of illumination criteria is restricted to certain time limits depending, for example, on the location of the launch site, target latitude, time of the year, and orbit inclination. For planning purposes, it is convenient to have, in graphical form, a set of charts which show the launch windows available at any time during the year from which orbits passing over adequately illuminated target areas can be established. Such charts also are useful in determining the launch time constraints which may be imposed on orbits of long-duration missions. Further, they provide an insight into any changes in nodal orientation which may be required to assure a long-duration mission capability if selection of a single launch time does not guarantee adequate target illumination over the entire mission.

B.2.2 Analysis

Consider the cross-section of the earth shown in Figure B-1. The plane contains the sun so that all rays reaching the surface of the earth can be indicated by parallel lines. At any given point on the surface, the local elevation angle, η, of the sun can be defined as the angle between the line of sight to the sun and the local horizontal.

The solar elevation angle, η, indicates the degree of illumination provided by the sun. For this reason, the term "illumination angle" rather than "elevation angle" is used herein. At the sub-solar point, the sun appears directly overhead (η = 90 deg). At other points on the surface of the earth, the illumination angle varies as shown in Figure B-2. For the purpose of good resolution photography, a large illumination angle is desired.

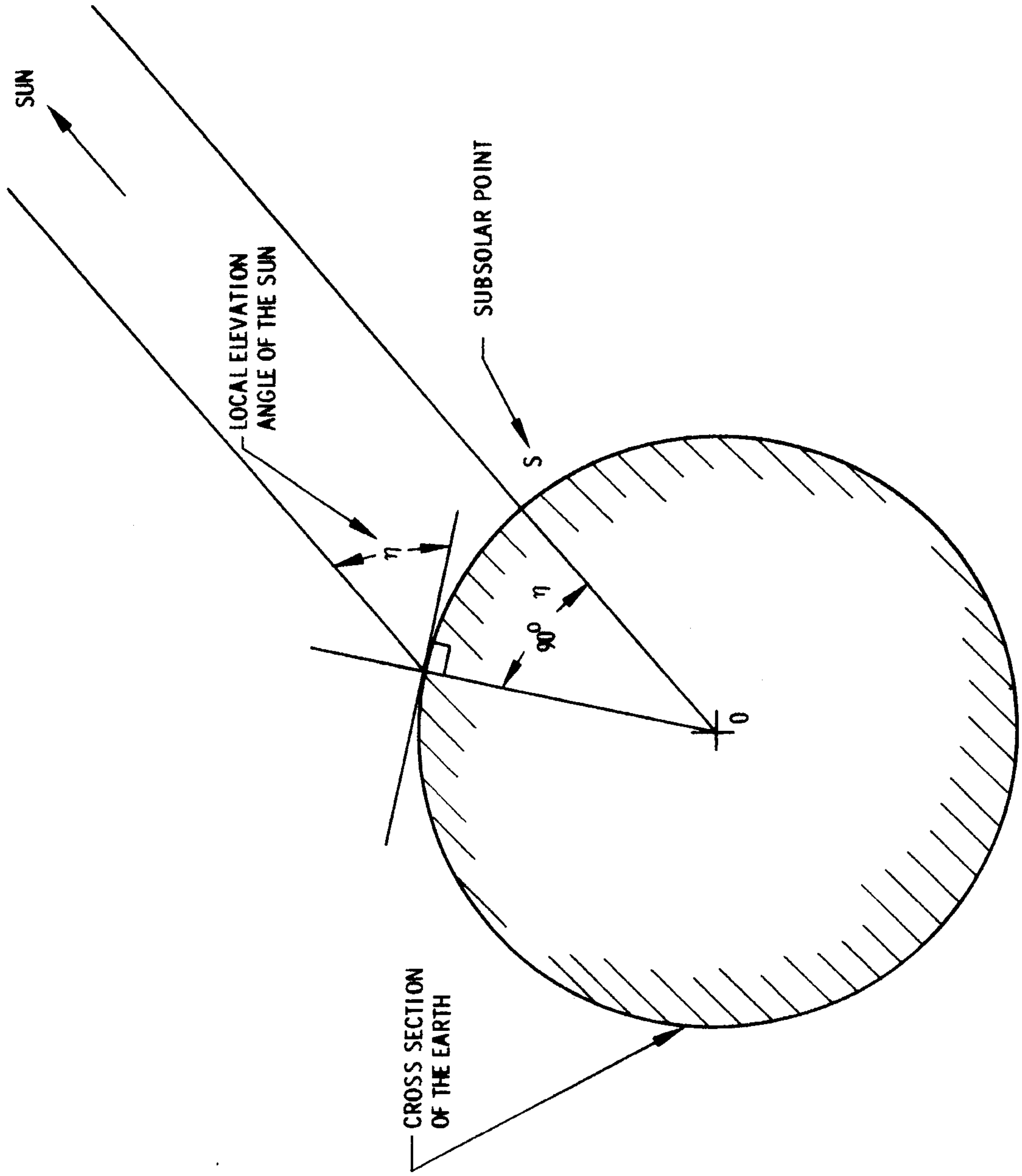

Figure B-1 Elevation Angle of the Sun

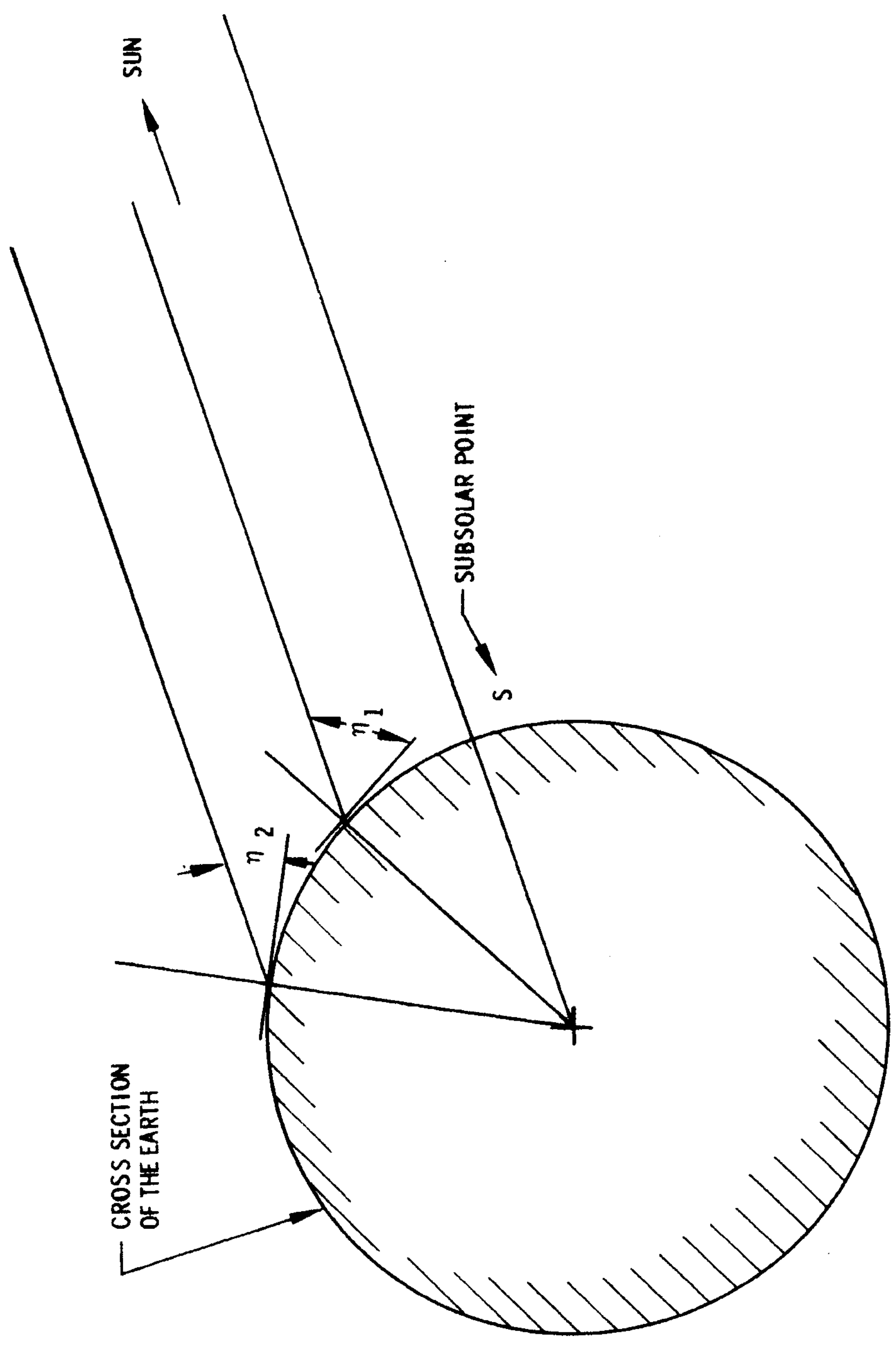

Figure B-2 Il ination Angles

Given that an observer will require some threshold of illumination for his observations, this specifies the smallest illumination angle that can be tolerated within the observed area to satisfy mission requirements. Once a minimum acceptable illumination angle is specified, a circular region (see Figure B-3) on the surface of the earth may be mapped in which the illumination angle is greater than or equal to the specified acceptable angle.

The size of the circular area is a function of the minimum acceptable illumination angle. Its orientation with respect to the earth's equator is dependent on the season of the year in that a larger portion of the area will be in the northern hemisphere during the summer months (or conversely in the southern hemisphere during the winter months) because of the obliquity of the ecliptic.

Now consider an orbit which passes over the illuminated area (see Figure B-3). For this orbit to pass over a particular target latitude while in the illuminated area, the launch time selected must assure the orbit will have a specific orientation with respect to the noon meridian. In Figure B-3, the launch time is restricted to a window which will establish an orbit passing over the target latitude in the illuminated area anywhere between the points A and B. Clearly, this launch window is dependent on the time of the year, orbit inclination, and whether the launch and target observation are to occur on the northbound or southbound sides of the orbit.

For long-duration missions, the nodal shift of the orbit must be taken into consideration. As time progresses, there is, due to the oblateness of the earth, an eastward or westward movement of the orbit's nodes depending on whether the orbital inclination is greater than or less than 90 deg. The orbit shown in Figure B-3 has an inclination of less than 90 deg. Hence, there is a westward movement of the descending node. As a result, illuminated passage over the target latitude will no longer occur after the first revolution. Conversely, if the inclination is greater than 90 deg, the nodal movement is eastward, and passage over the target latitude under illuminated conditions is assured until the orbit passes over point B.

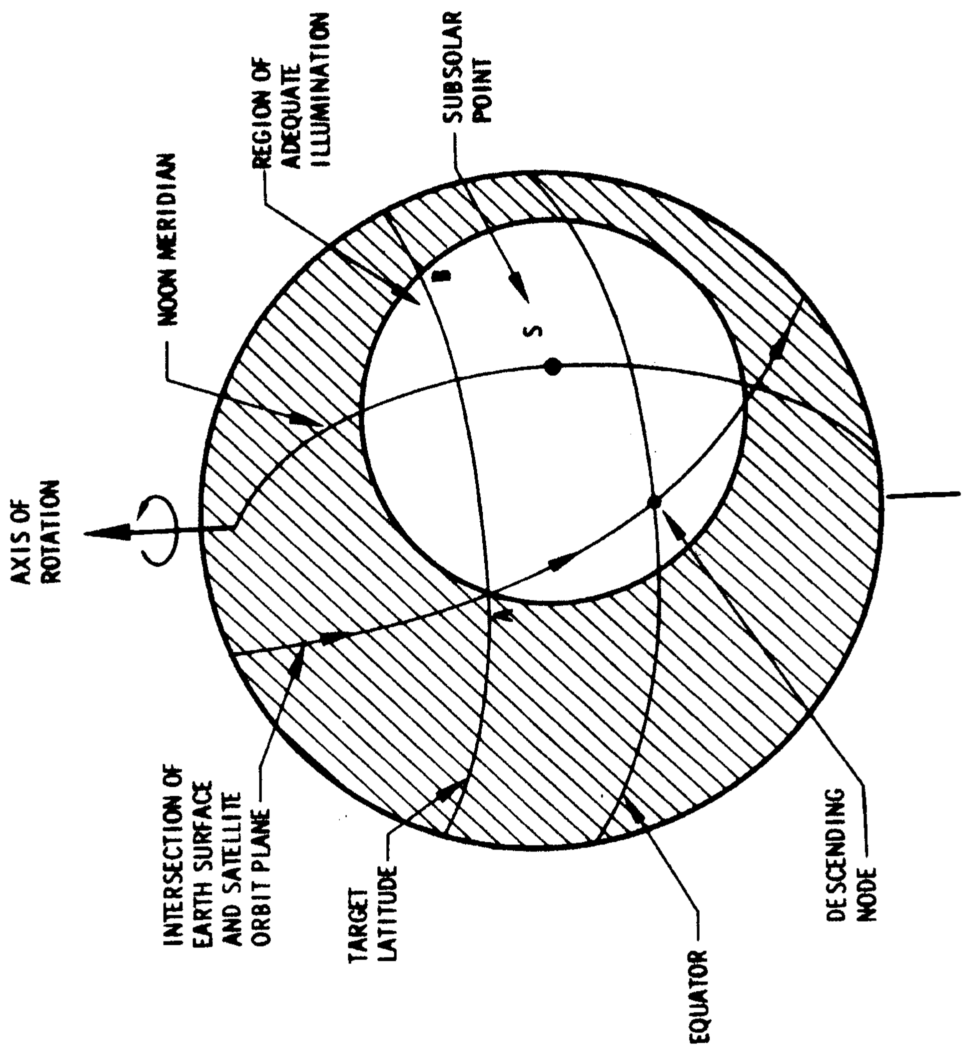

Figure B-3 Region of Acceptable Illumination

Considering that the noon meridian moves in an eastward direction at the rate of roughly one deg/day, the nodal shift with respect to the noon meridian will be of the order of 30 deg for a 30-day mission assuming that the orbit is polar ($i = 90$ deg). For orbits with inclinations of less than 90 deg, the nodal shift with respect to the noon meridian is even more pronounced. This fact implies that for long-duration missions, frequent changes of nodal positions may become necessary depending on the inclination of the selected orbit.

These considerations suggest the sun-synchronous orbit to be an effective orbit particularly from the viewpoint of target illumination and orbital correction requirements since the orientation of such an orbit with respect to the noon meridian will remain fixed throughout the mission. The only factor which influences the target illumination is the seasonal north-south movement of the illuminated area. Once a sun-synchronous orbit is established, target illumination will be adequate until the upper rim of the illuminated area moves south past the intersection of the target latitude and orbit plane.

As a means of providing a pictorial view of the seasonal effects on the launch time constraints, a set of charts has been prepared in which the time intervals available during each day of the year are shown for establishing a southbound launch from AFWTR into a low-altitude sun-synchronous orbit ($i = 96.43$ deg). Target illumination is considered to be required on the southbound side of the orbit. For a given minimum acceptable illumination angle, the available launch times are shown parametrically as a function of the target latitude to be observed and the launch date. Minimum acceptable illumination angles of $\eta = 0$, 10, 20, and 30 deg are illustrated in Figures B-7 through B-11. As an example, consider Figure B-9 which is schematically reproduced, in part, in Figure B-4.

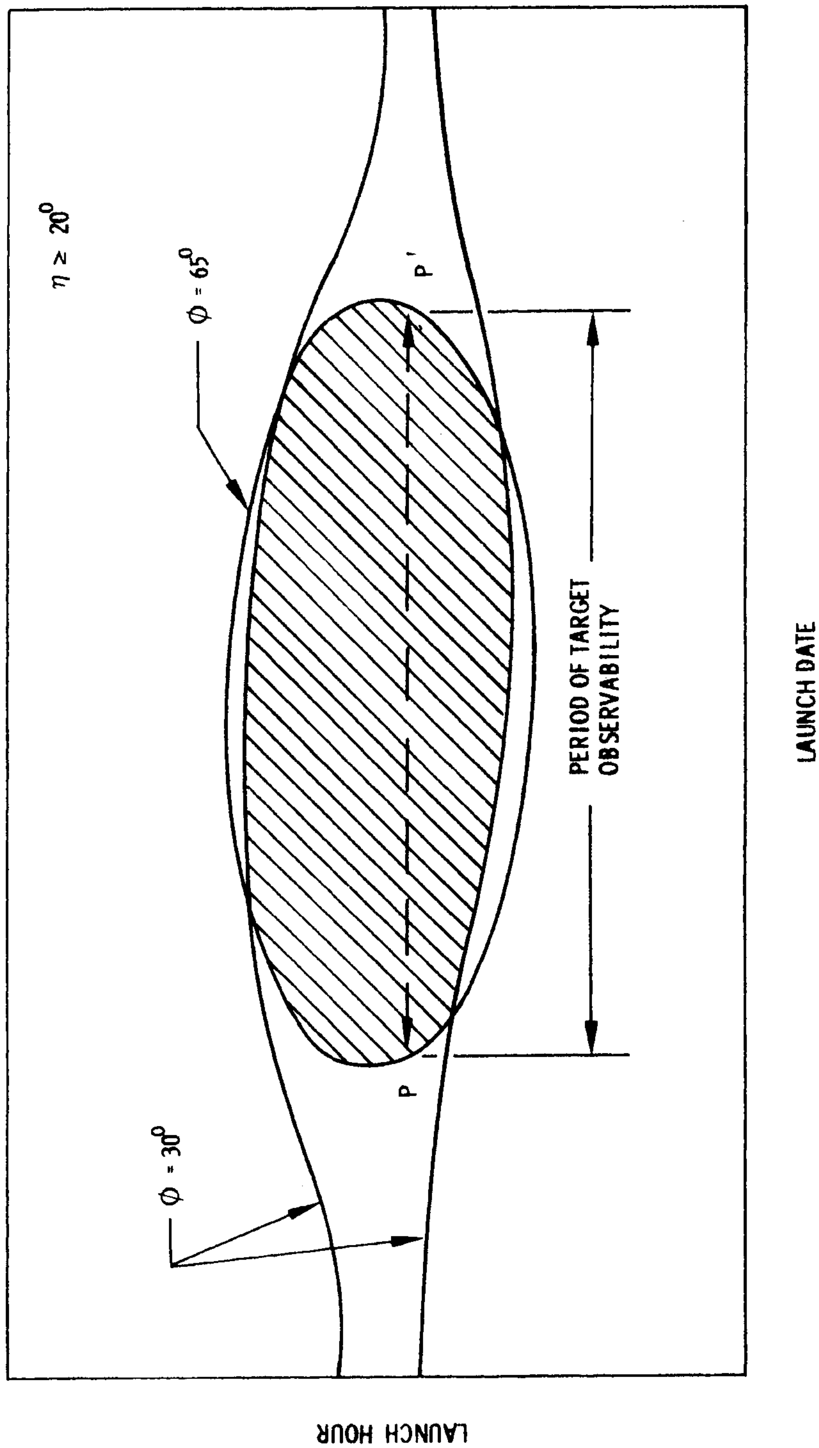

Figure B-4 Launch Windows for i = 96.43 Degrees

The constant latitude (ϕ) lines represent the upper and lower bounds of the time window within which an orbit may be established from which a satellite may observe a particular target latitude under conditions of $\eta \geq 20$ deg for at least one day. In Figure B-4, the time windows available for observing target latitudes of 30 and 65 deg N are shown as representative examples. According to the Figure, a launch window exists on every day of the year for observation of a target latitude of 30 deg N. This window is represented by the area enclosed between the two horizontal curves of ϕ = 30 deg. For a target latitude of 65 deg N, however, a launch window exists only during that part of the year indicated by the area enclosed within the oval curve of ϕ = 65 deg. The intersection of these two areas then represents the launch window for coverage of a target latitude band extending from 30 to 65 deg N lat. In Figure B-4, this intersection is indicated by the shaded area.

Now, examine the launch time constraints for long-duration missions. For the sun-synchronous orbit, the relative positions of the node and the noon meridian remain stationary at all times (see Figure B-3). This means that if a specified orbit is established by launching at a certain hour, the same orbit can be achieved on any subsequent day by launching at the same launch hour as that of the original date. It follows then that if an orbit is established, for example, by launching at point P in Figure B-4, the subsequent target illumination can be determined by extending a line horizontally and to the right of the launch point. In the particular example, observation of the 30 to 65 deg N band is possible until the time when point P is reached. Figure B-4 shows the length of target observability depends on the particular launch hour selected within the available launch window. Because of the manner in which the constant latitude (ϕ) contours are superimposed, a noon (1200 hours) or near-noon launch appears to be best suited for long-duration target observability. If the minimum acceptable illumination angle is η = 0, a noon launch will permit observation of the 30 to 65 deg N lat band throughout the year without requiring any adjustments in the nodal position of the orbit. For $\eta>0$, all regions of the target band may not be observable during the entire year. A noon launch, however, will provide for a maximum or near-maximum observable period for any target latitude within the target band. This can be illustrated by drawing a horizontal line across the charts at a launch time of 1200 hours.

If a launch window plot is prepared for non-sun-synchronous orbits, the latitude contours will, in general, appear similar to those of the sun-synchronous orbit. In contrast to the sun-synchronous orbit, however, the nodal positions of these orbits do not remain stationary with respect to the noon meridian.

As a consequence, the launch hour associated with each rev of the orbit shifts as time progresses. Hence, an inclined line, instead of a horizontal line, must be used to determine the target observability subsequent to a given launch time. For example, suppose that the launch window for observing a 30 to 65 deg N lat target band from an orbit of inclination, i = 80 deg is as shown in Figure B-5. Suppose further that a launch was made at point C of Figure B-5. Because of the non-sun-synchronous nature of the orbit, the launch hours associated with the subsequent revs are as shown by the line extending from C downward and to the right. For the case of i = 80 deg, this line is approximately 59 deg from the horizontal and a nodal correction becomes necessary at point D if observation of the target band is to continue. This nodal correction should be such that the new nodal position is associated with a launch hour which will guarantee additional coverage of the illuminated target band. A nodal correction is shown in Figure B-5 where the associated launch hour is changed from D to D'. Several nodal correction maneuvers may be necessary if the target band is to be observed during the entire period in which it is adequately illuminated.

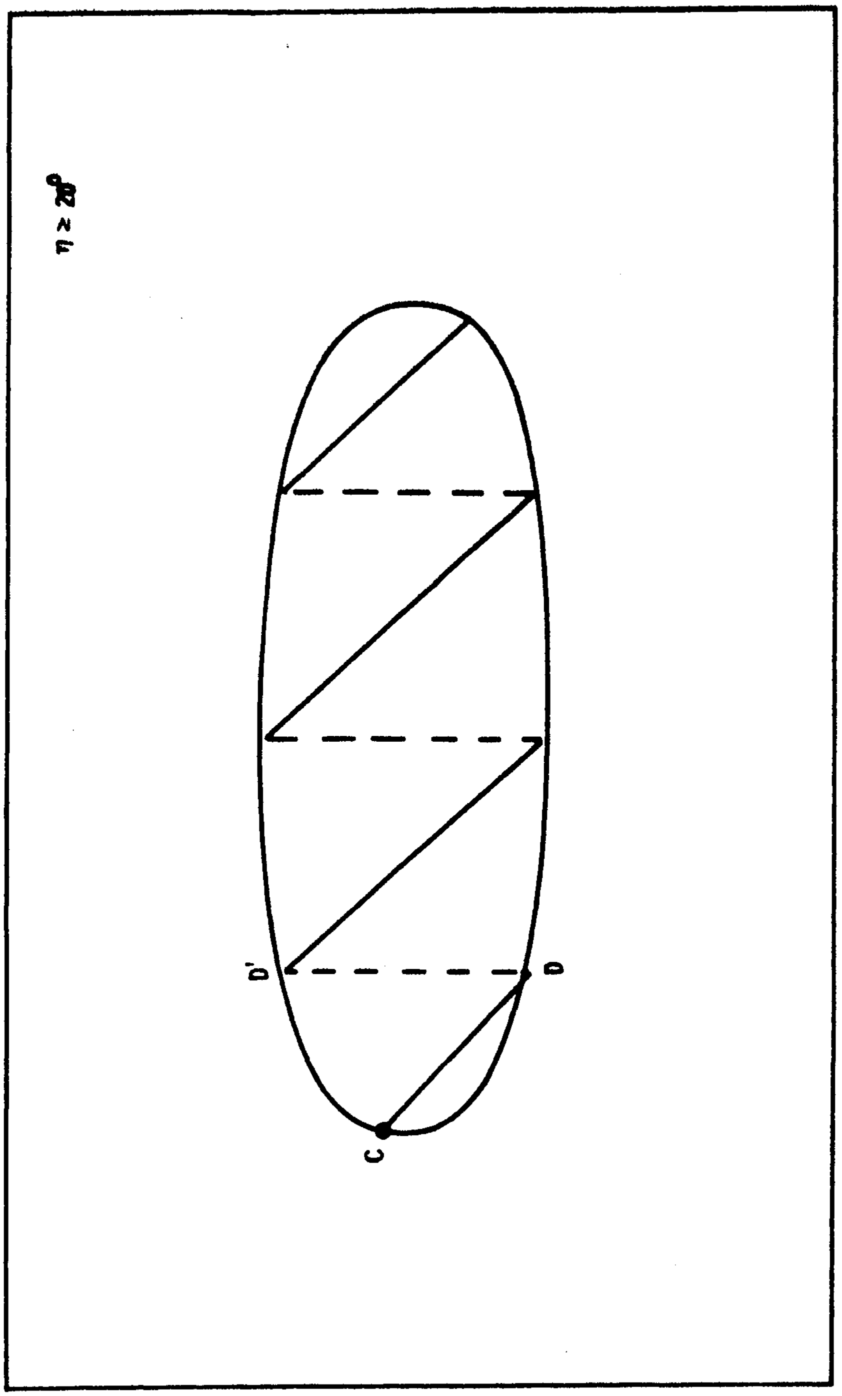

Figure B-5 Launch Window for i = 80 Degrees

D-~~SECRET~~ SPECIAL HANDLING

A nodal change can be effected at any point on the orbit by applying a velocity increment to alter the azimuth while the magnitude of the velocity vector is held fixed. The amount of velocity increment required will depend on the amount of the nodal correction to be effected and on the point at which the corrective maneuver is to occur. Generally, nodal corrections are expensive in terms of the required velocity increment. For the 80 deg inclination orbit considered previously, a velocity increment of 438 ft/sec is needed to produce a change of 1 deg in the nodal position.

Figure B-6 is a plot of ΔV required per rev to make nodal corrections.

Because of the large energy requirements, nodal corrections are not considered for MOL Operations and the time history of η for long mission becomes a constraint. Figures B-11 through B-15 are histograms of η for different values of i.

Composite launch constraint charts (Figures B-16 through B-21) present acceptable launch times as a function of the parameters listed below for orbital inclinations of 80, 90, and 96.43 deg and mission durations of 30 and 60 days. These parameters are:

a. Launch date

b. Desired ground illumination sun angle (η)

c. Orbital solar incidence angle (β) constraint of ± 60 deg.

d. Launch abort constraints

   1. Sunrise at AFWTR.

   2. Sunset at AFWTR.

   3. Sunset -2.45 hrs at 40 deg S

The available launch times for different launch dates are depicted by the crosshatched sectioning based upon those constraints listed under items c., and d. Item b., η, further restricts the launch window. If the η contours

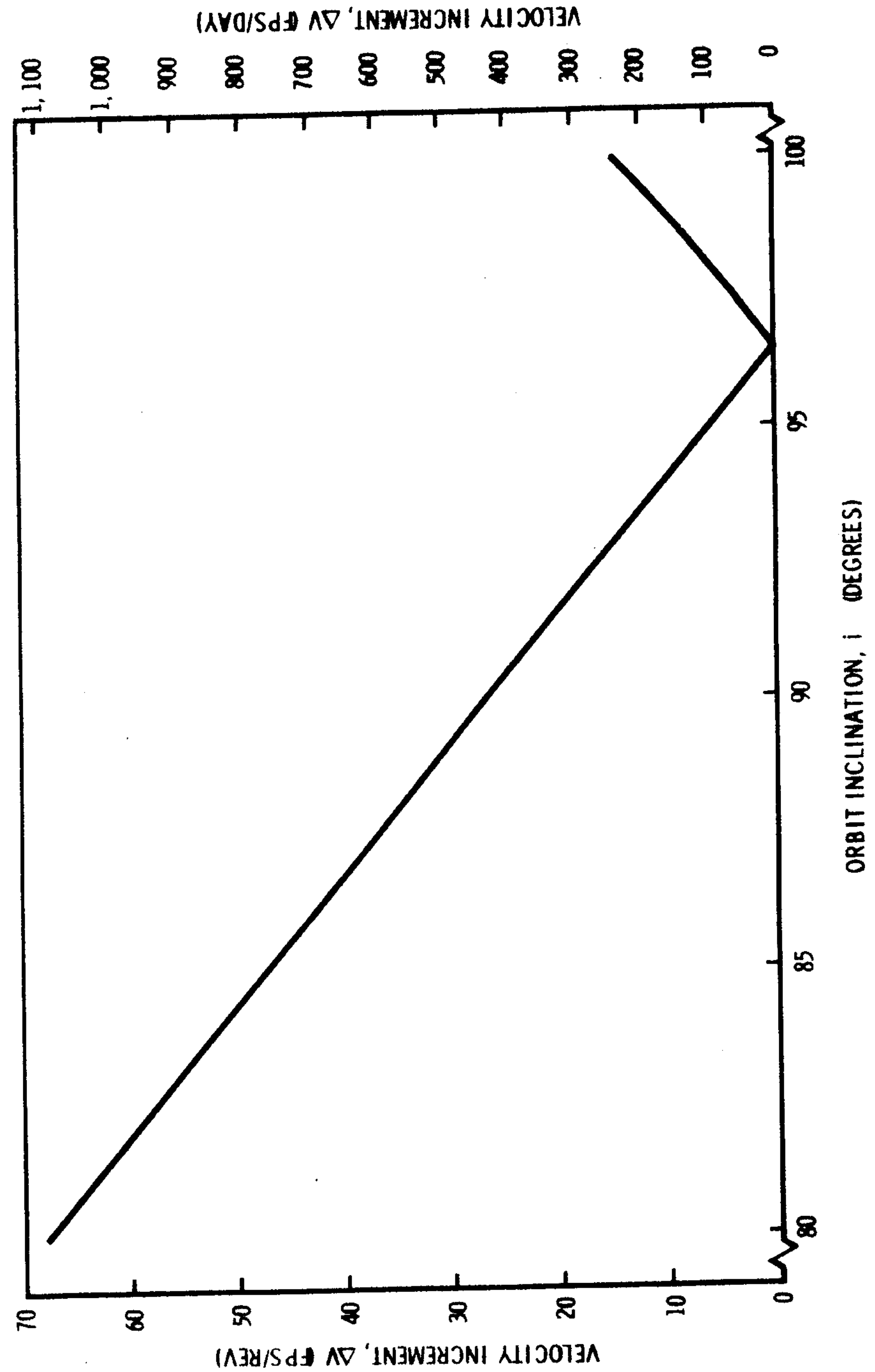

Figure B-6 Energy Requirements for Nodal Corrections are placed upon the charts, then only those areas bounded by a particular required η contour and cross-sectioned identify the true launch window as a function of the launch date. The η contour on these charts depicts the launch windows for different launch dates which will provide an η history, referenced to 55 deg N latitude, which for the duration of the mission will be greater than or equal to that η value associated with that particular η contour.

The η, β data used to produce these curves was generated by a computer program. The sunrise and sunset information was obtained from the 1967 American Ephemeris and National Almanac.

A rapid comparison of the tradeoffs between, and the influence of, the function parameters upon the launch window for any launch date can be made using Figures B-16 through B-21.

Figures B-22 through B-33 present the η history for orbital inclinations of 80, 90, and 96.4 deg as a function of days from launch for launches on the first day of every month and launch times of 1200, 1300, 1400, 1500, and 1600 PST, respectively, on these dates. Since no other launch constraints are considered in making these charts, reference must be made to Figures B-16 through B-21 to determine acceptable launch times for a particular launch date. These Figures demonstrate an η history comparison between the function parameters. No attempt has been made to relate η to photographic resolution becuase final quantitative numbers of η vs resolution are unavailable. Because the estimates have varied, the only valid relationship which can be presented at this time is η. When the η vs resolution curves become valid (or if one wishes to use present curves), these curves can be used in conjunction with Figures B-22 through B-33 to depict resolution rather than the η parameter presented.

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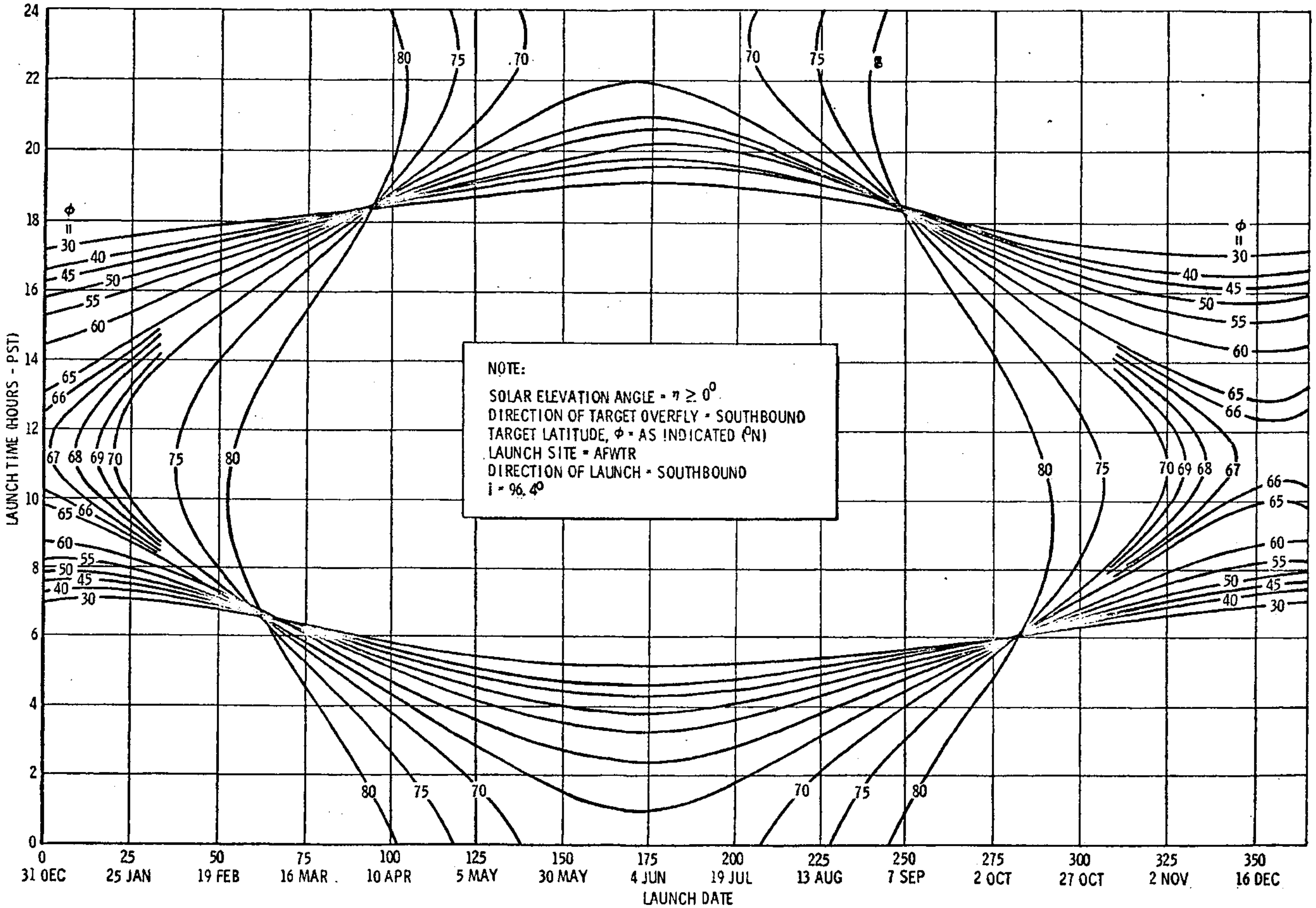

Figure B-7 Launch Times for Minimum Illumination Angle of 0 Degrees

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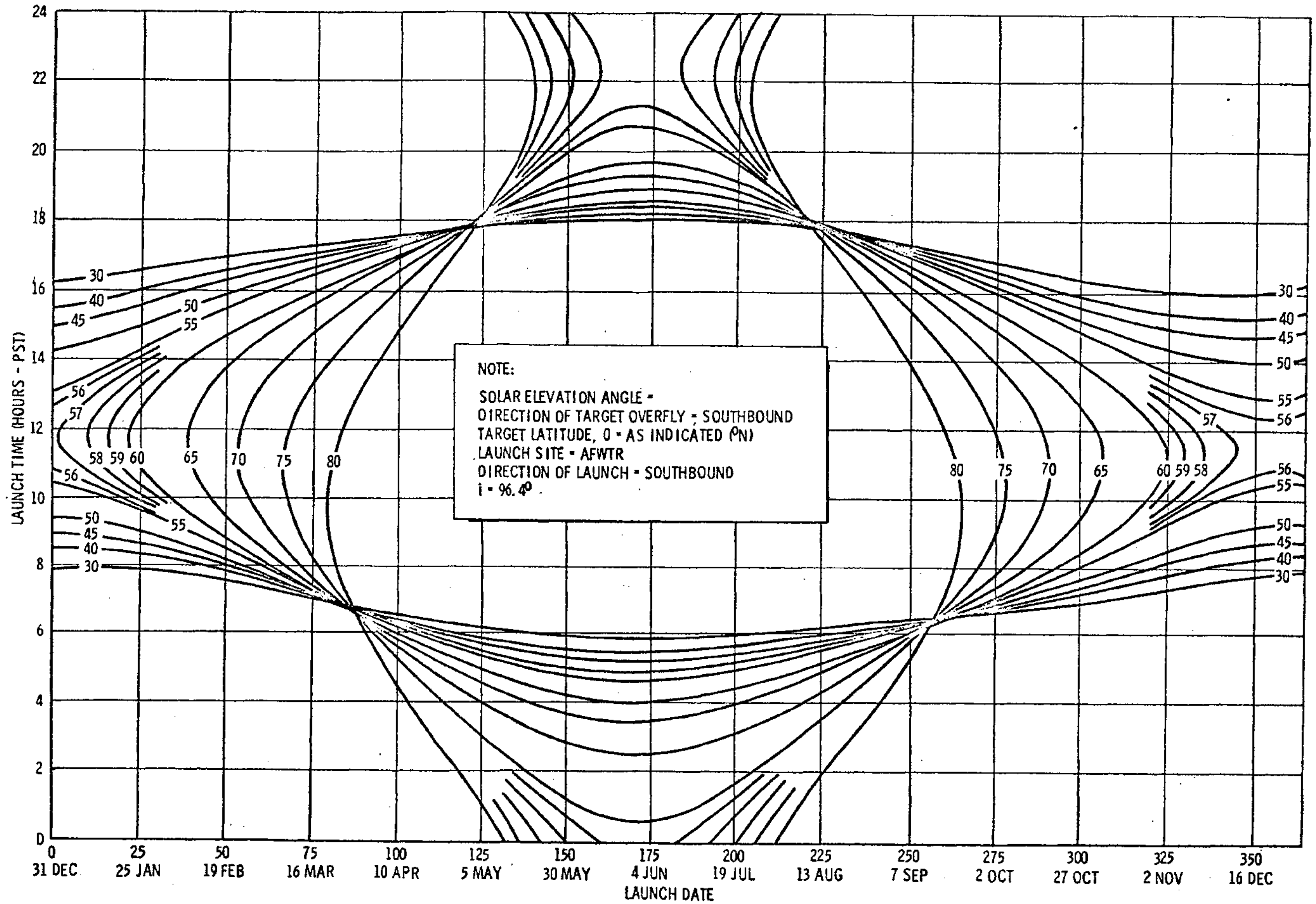

Figure B-8 Launch Times for Minimum Illumination Angle of 10 Degrees

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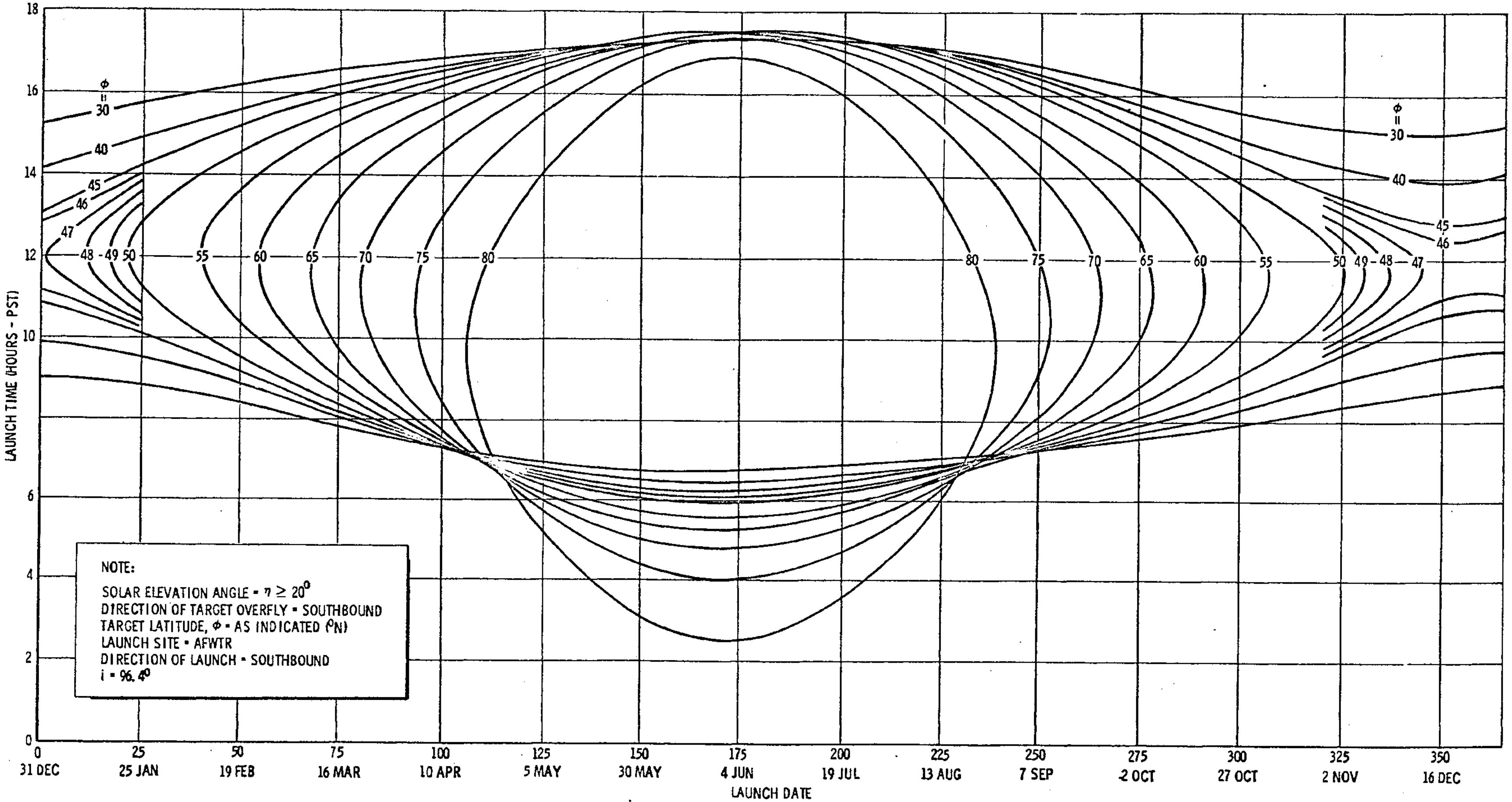

Figure B-9 Launch Times for Minimum Illumination Angle of 20 Degrees

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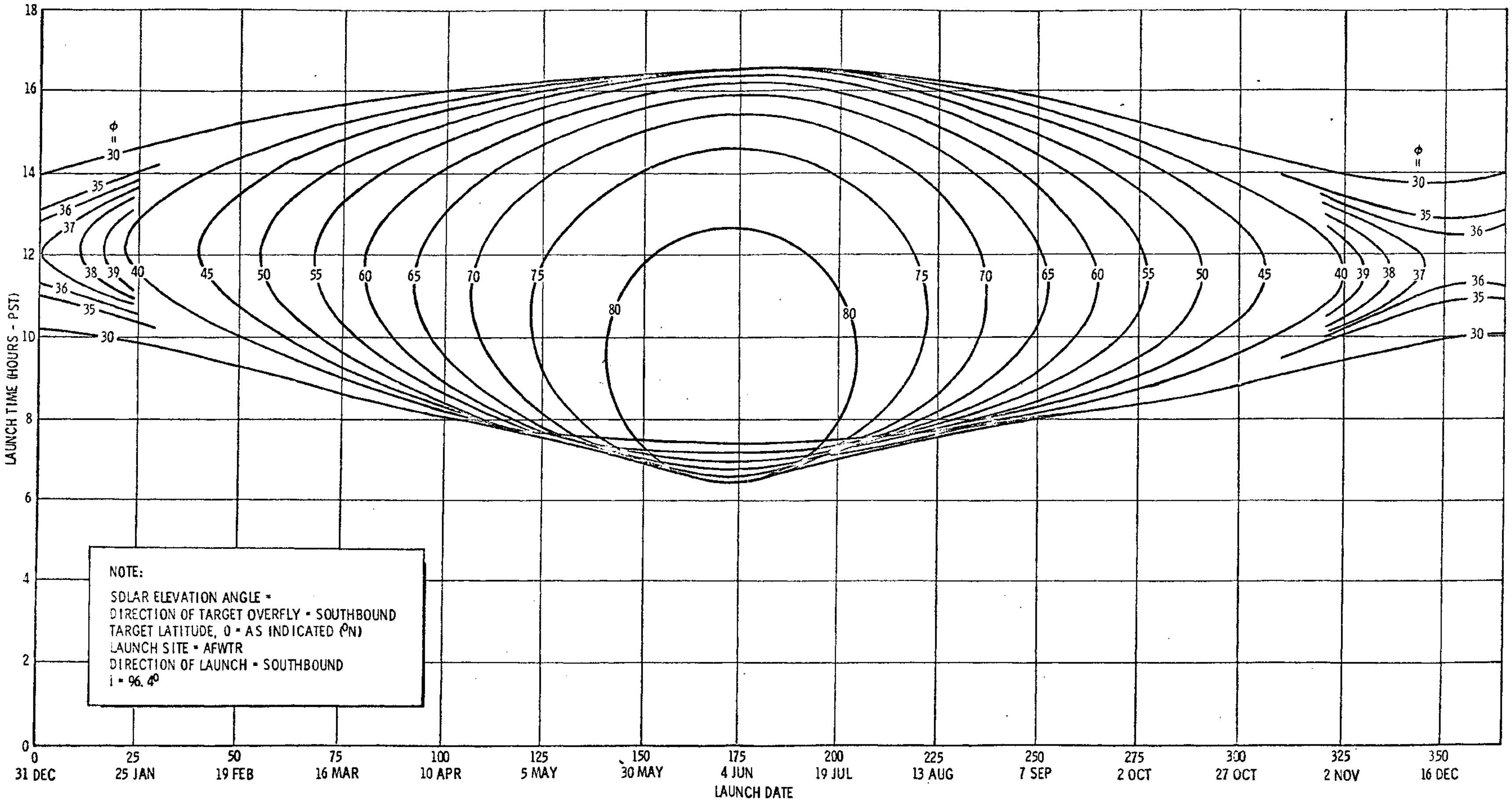

Figure B-10 Launch Times for Minimum Illumination Angle of 30 Degrees

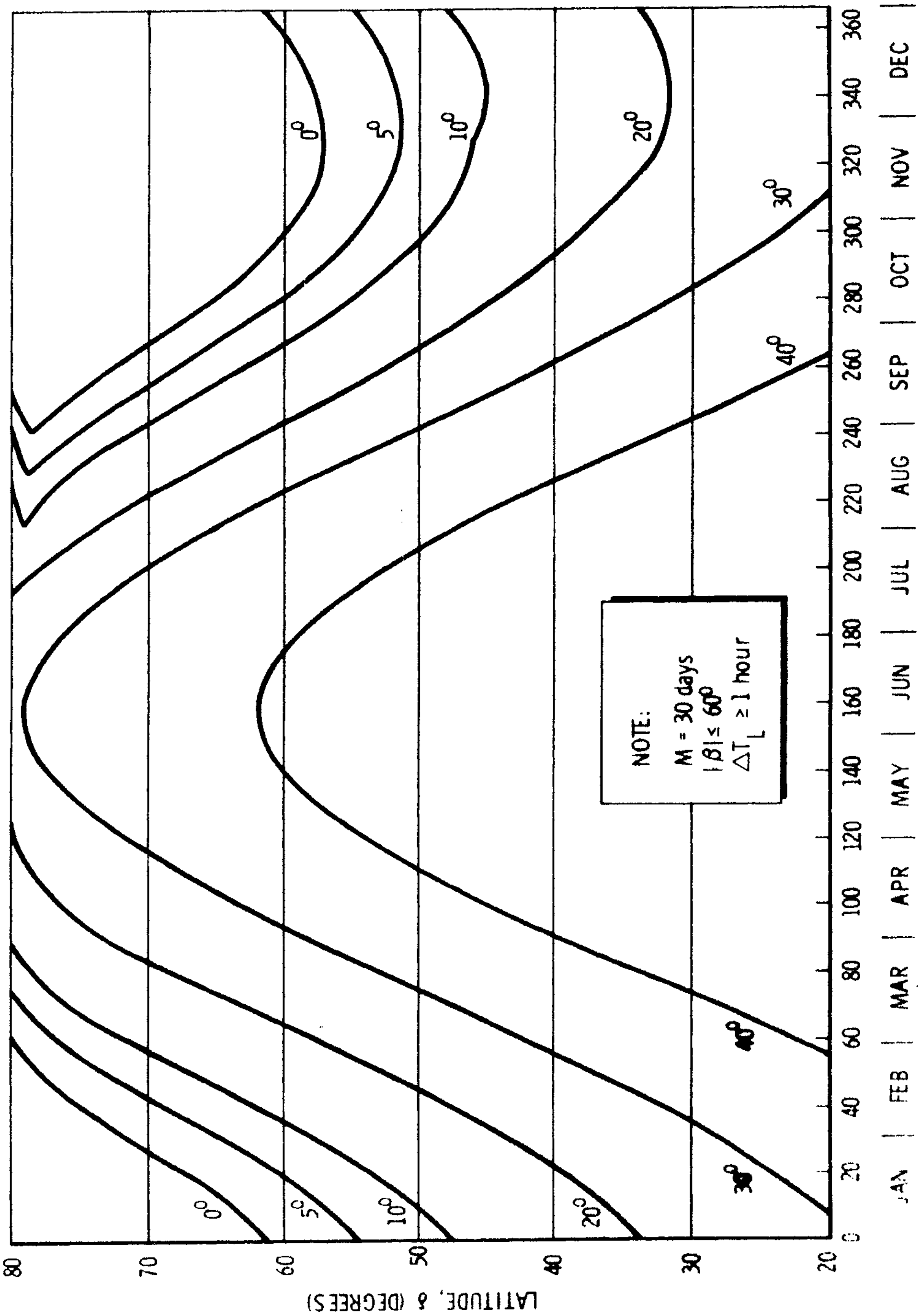

Figure B-11 Launch Season vs Latitude and Illumination Angle (η) for Orbit Inclination of 80 Degrees

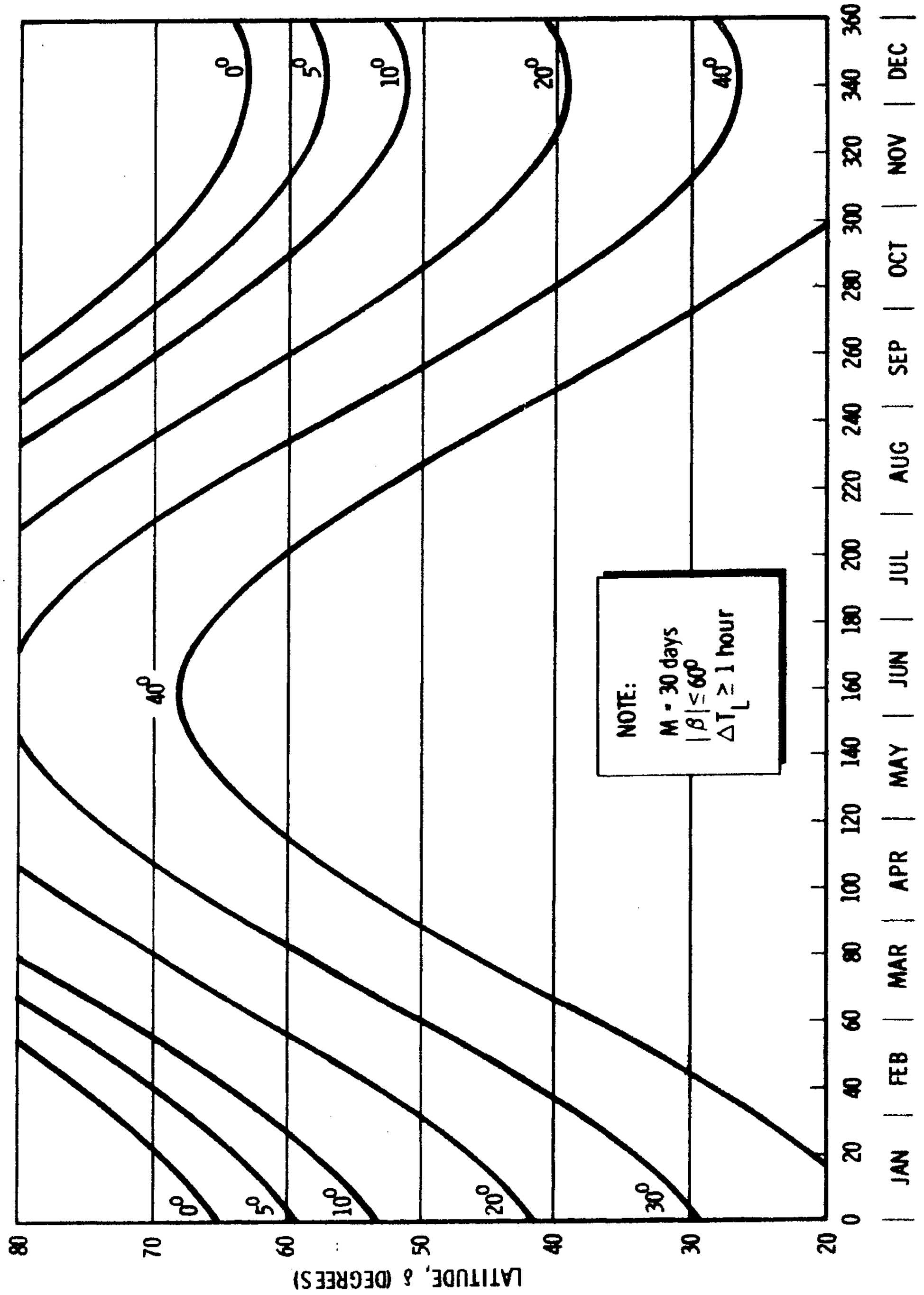

Figure B-12 Launch Season vs Latitude and Illumination Angle (η) for Orbit Inclination of 85 Degrees

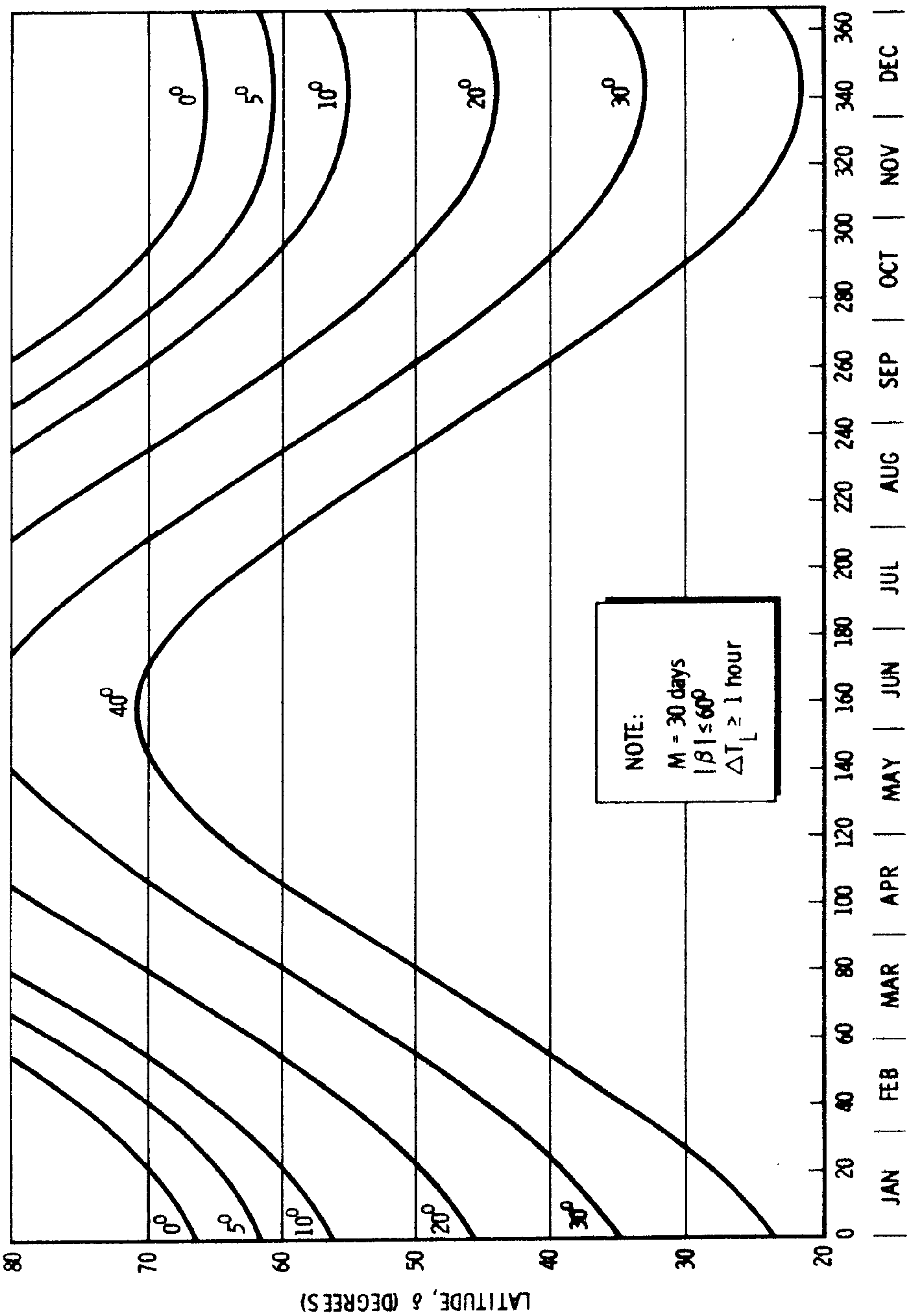

Figure B-13 Launch Season vs Latitude and Illumination Angle (η) for Orbit Inclination of 90 Degrees

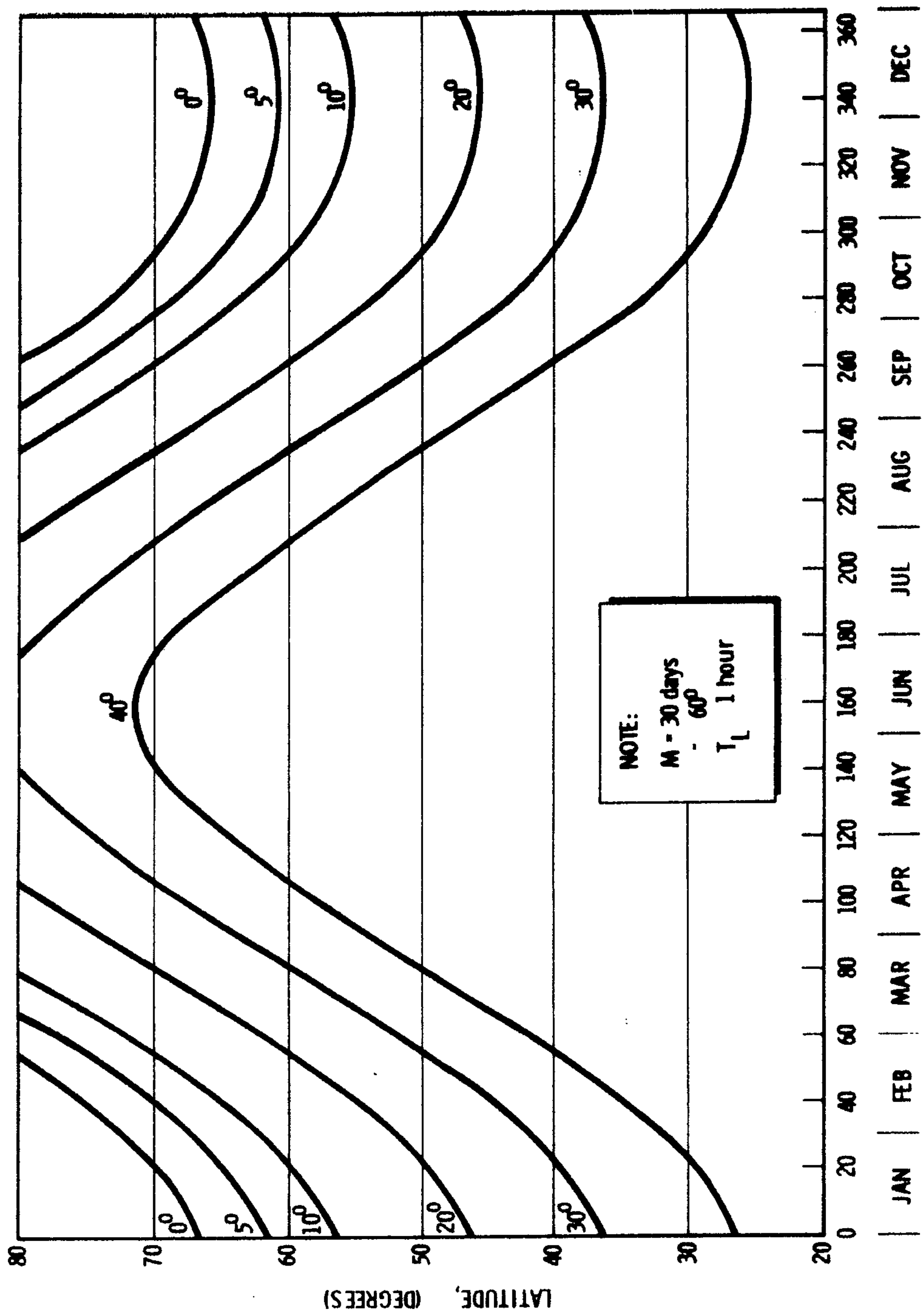

Figure B-14 Launch Season vs Latitude and Illumination Angle (η) for an Orbit Inclination of 95 Degrees

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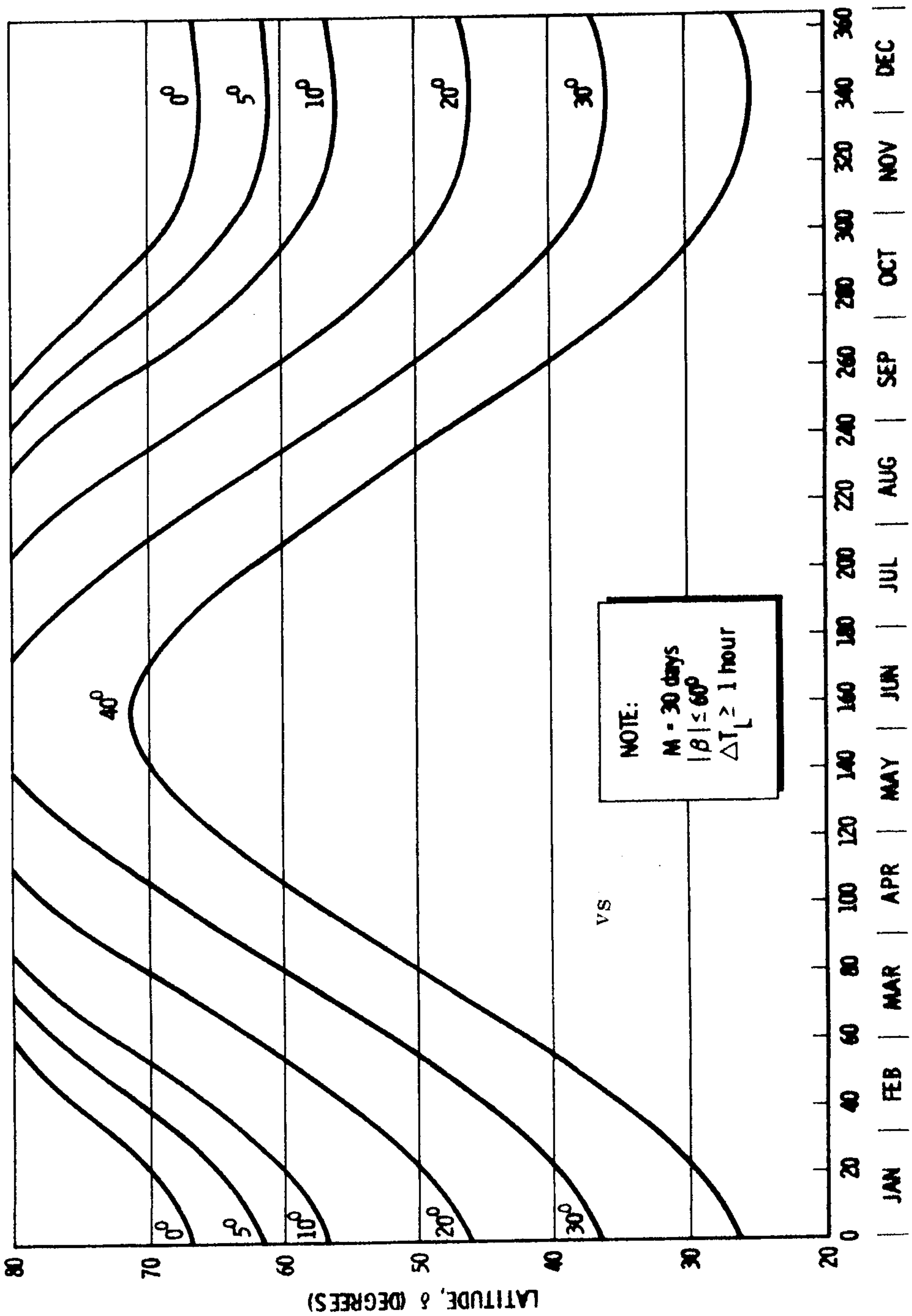


Figure B-15 Launch Season vs Latitude and Illumination Angle (η) for an Orbit Inclination of 100 Degrees

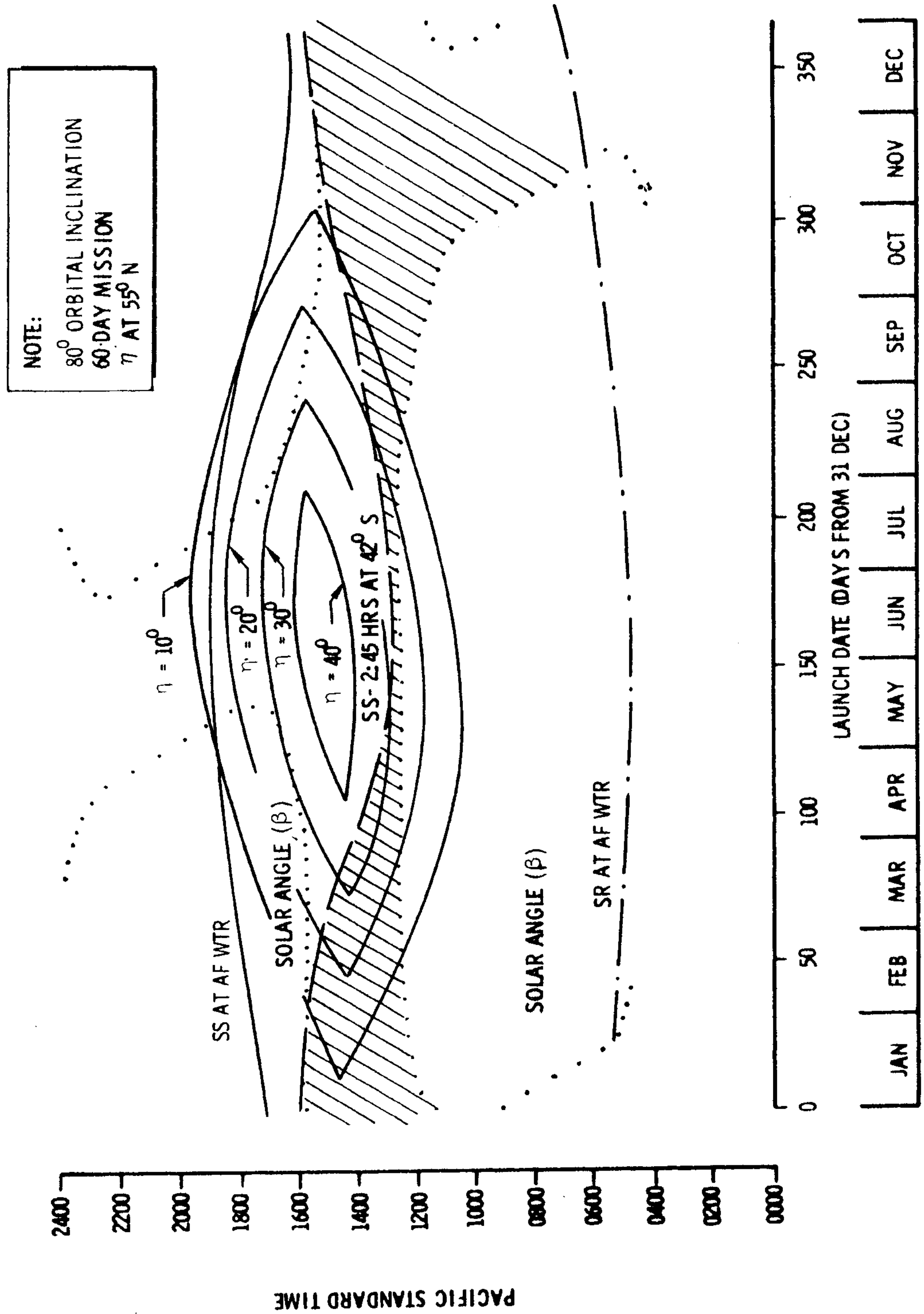


Figure B-16 MOL Launch Windows for 30-Day Mission and 80 Degree Orbit Inclination

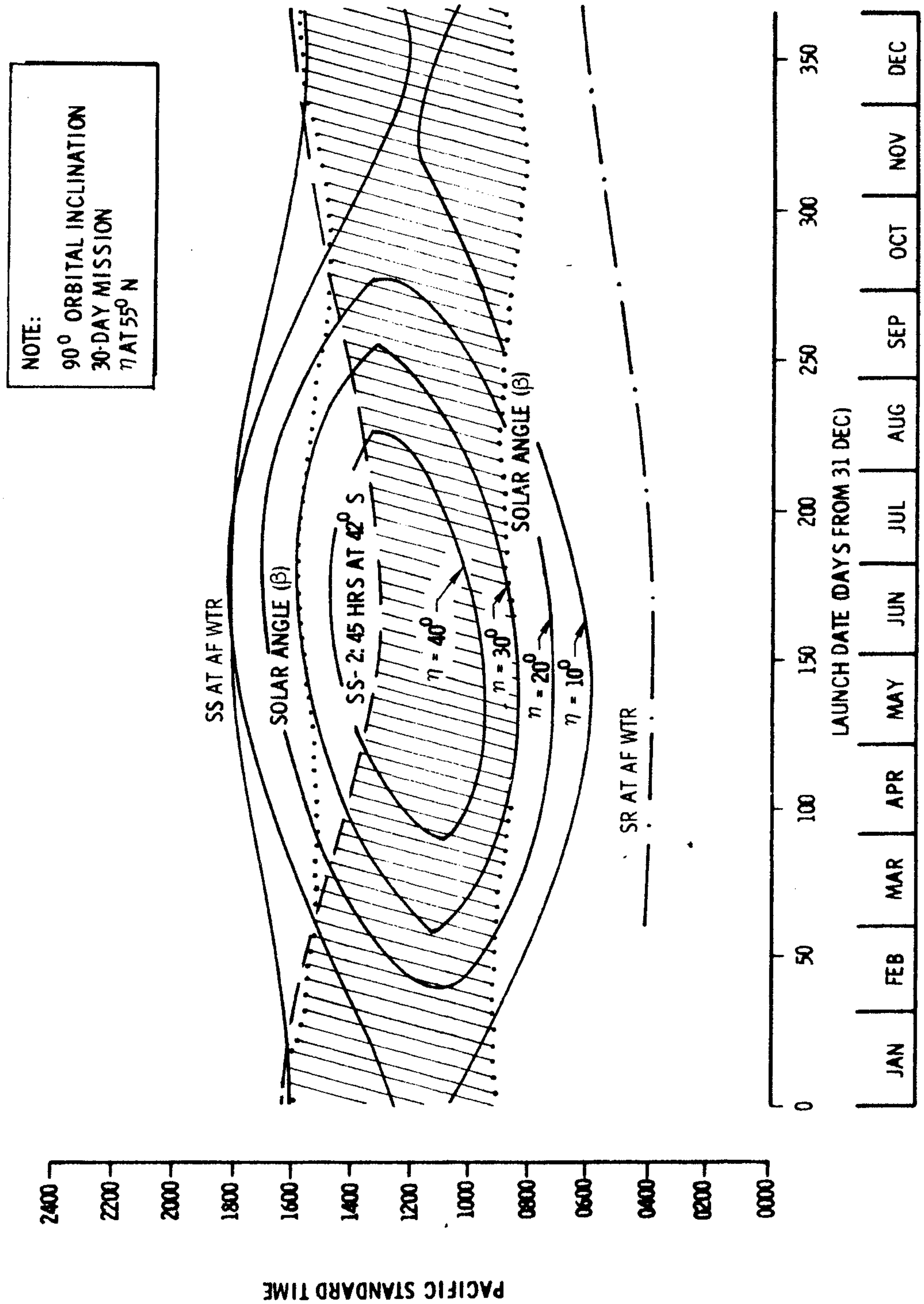


Figure B-17 MOL Launch Windows for 30-Day Mission and 90 Degree Orbit Inclination

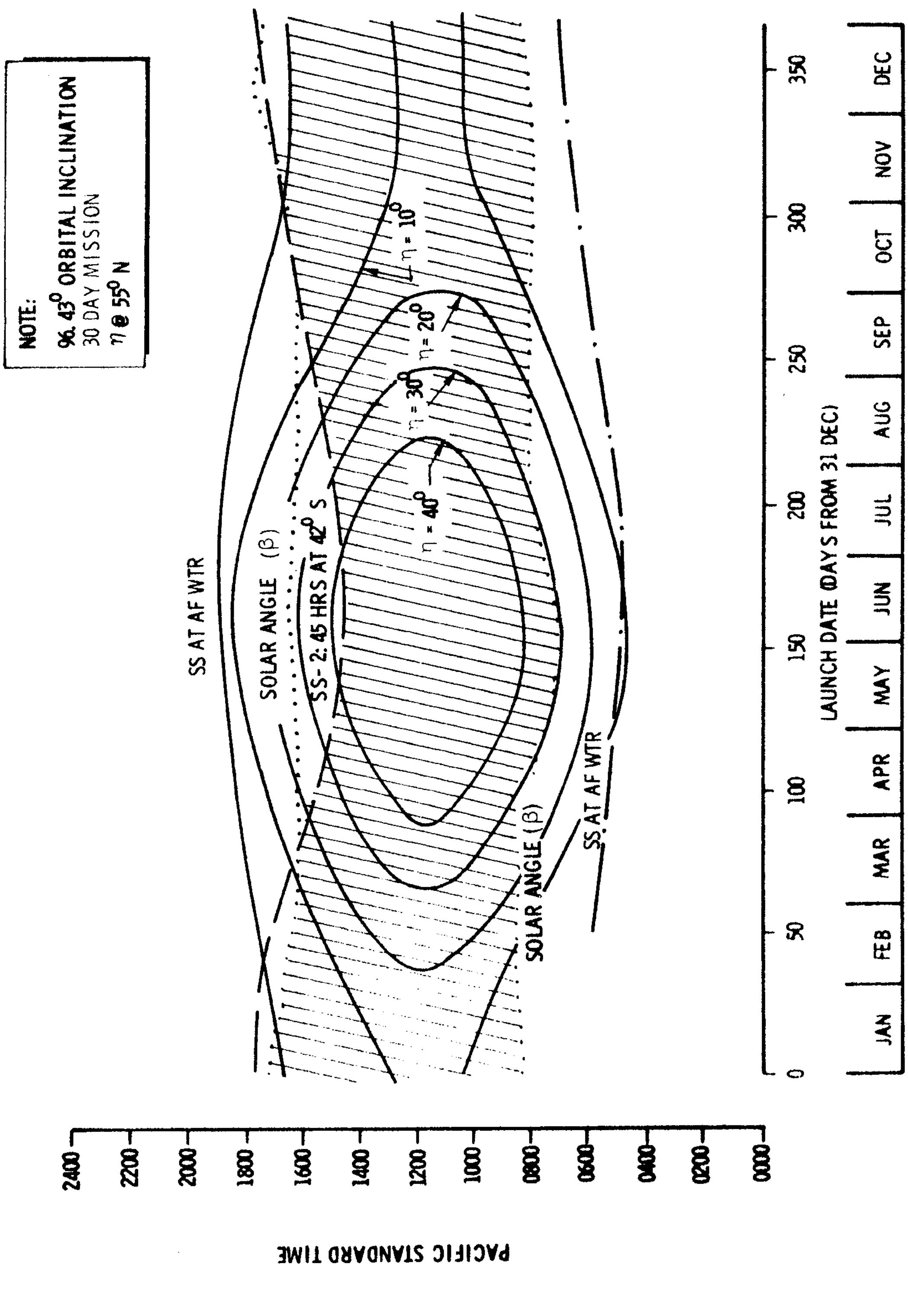


Figure B-18 MOL Launch Windows for 30-Day Mission and 96.43 Degree Orbit Inclination

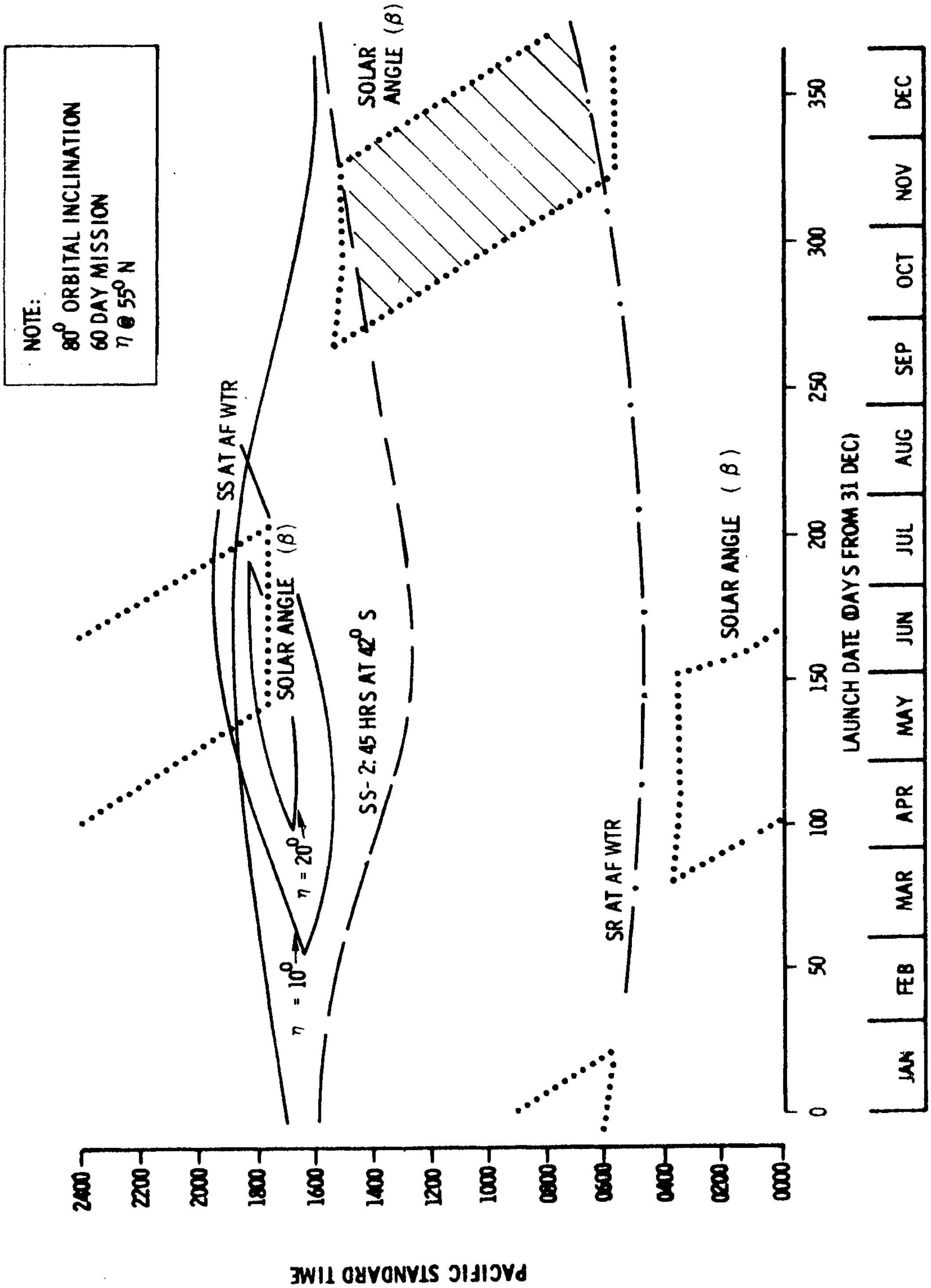


Figure B-19 MOL Launch Window for 60-Day Mission and 80 Degree Orbit Inclination

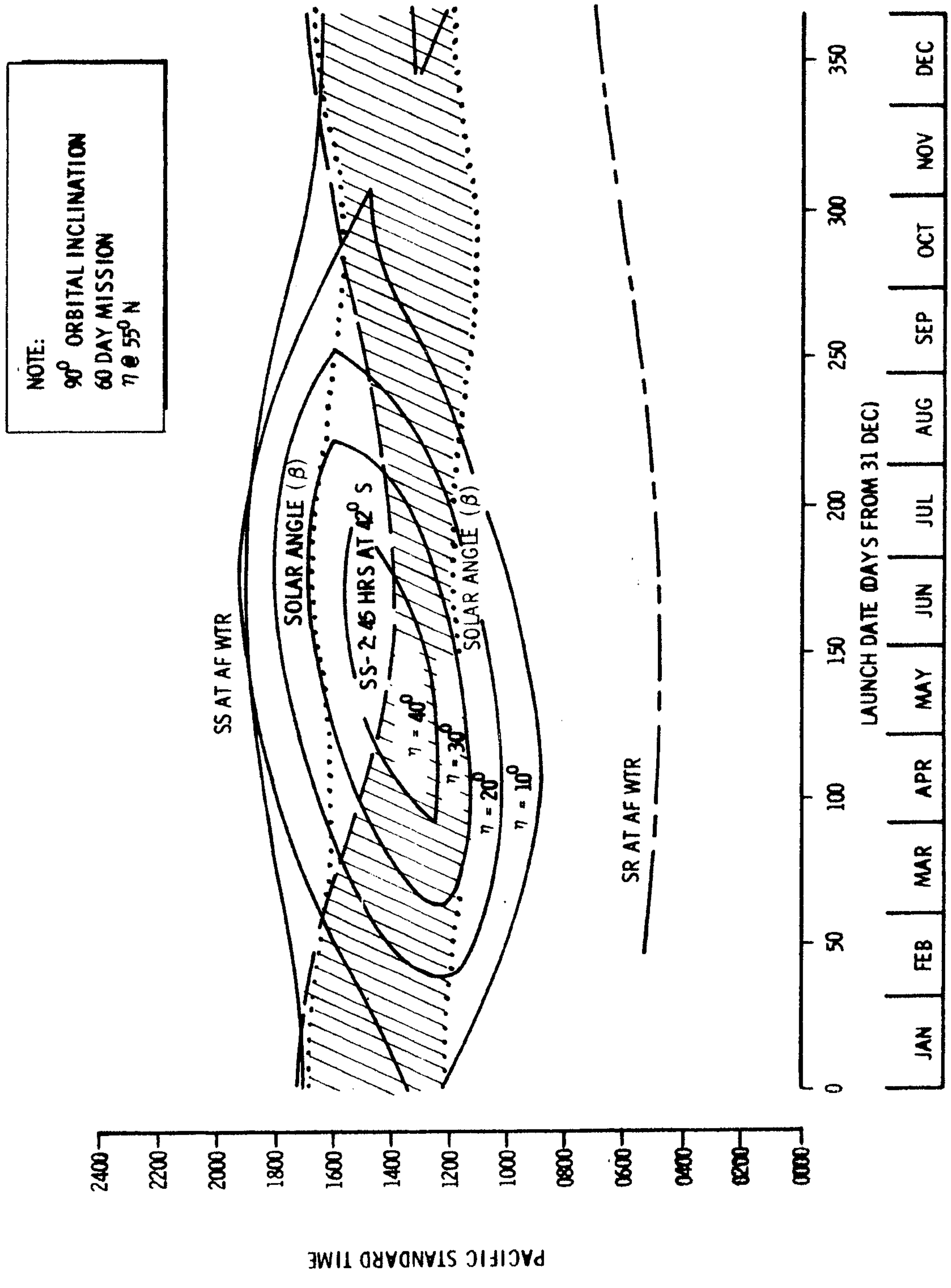


Figure B-20 MOL Launch Windows for 60-Day Mission and 90 Degree Orbit Inclination

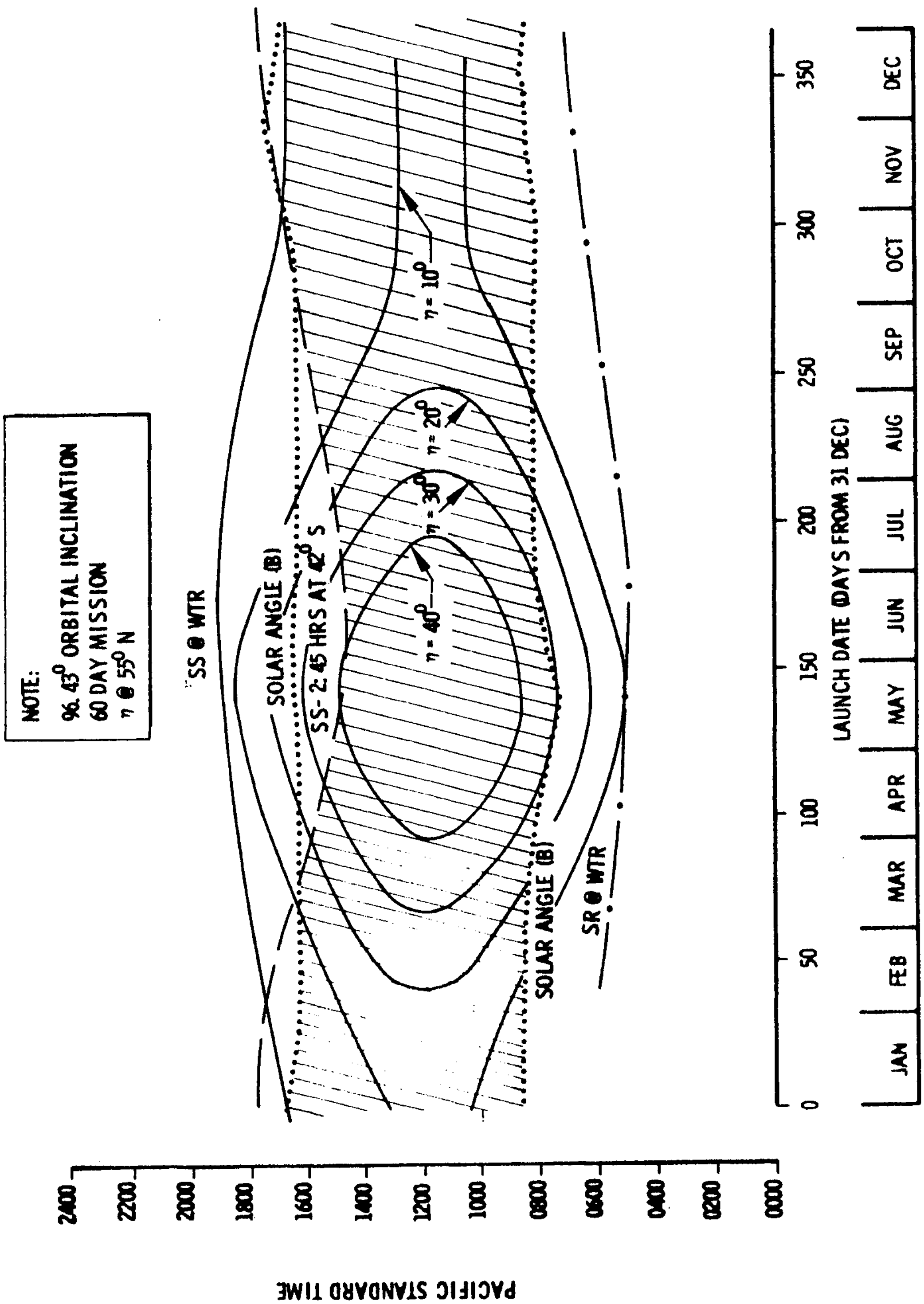


Figure B-21 MOL Launch Windows for 60-Day Mission and 96.43 Degree Orbit Inclination

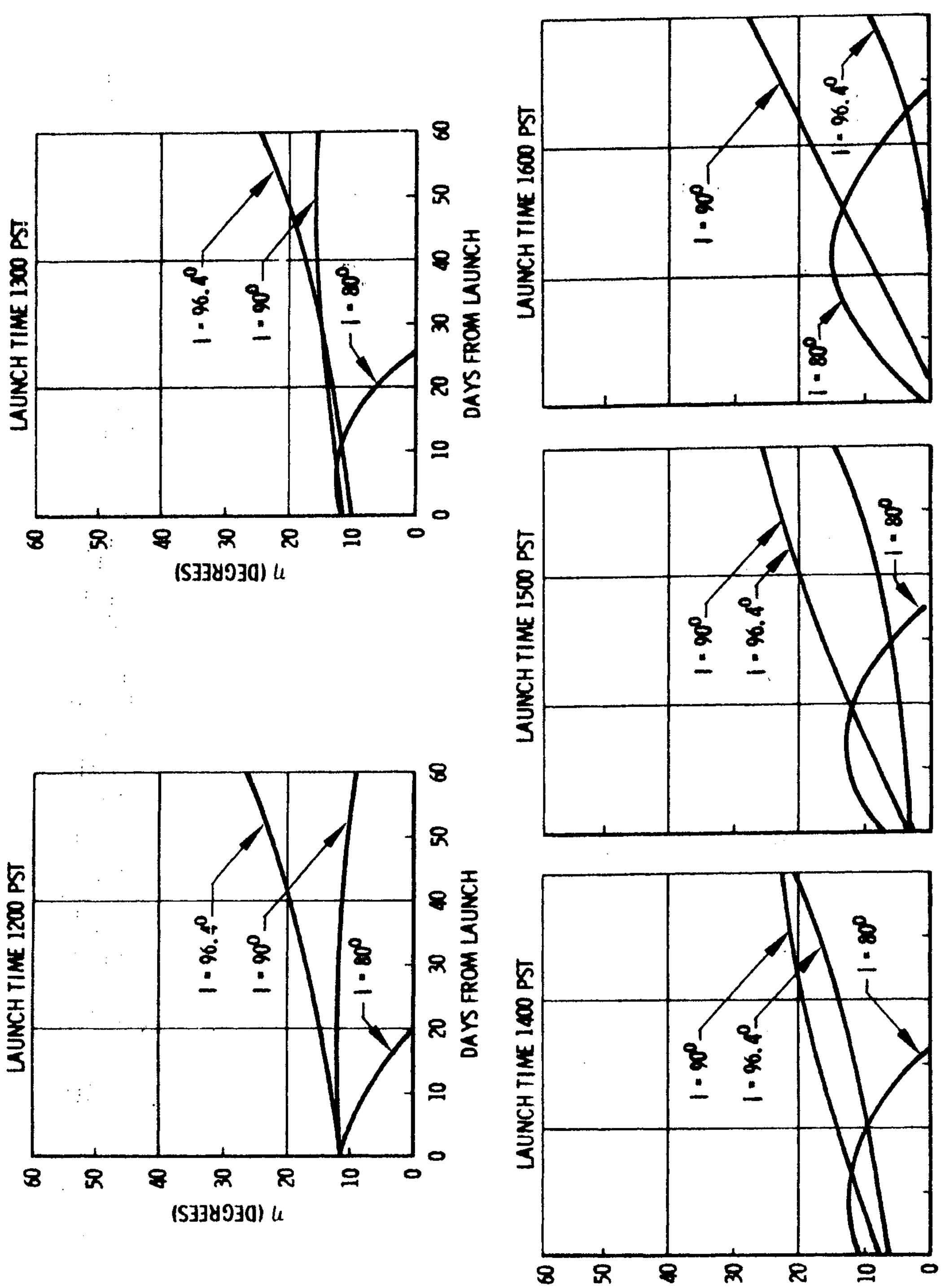


Figure B-22 History at 55 Degrees North for 1 January Launch Date As a Function of Launch Time and Orbit Inclination

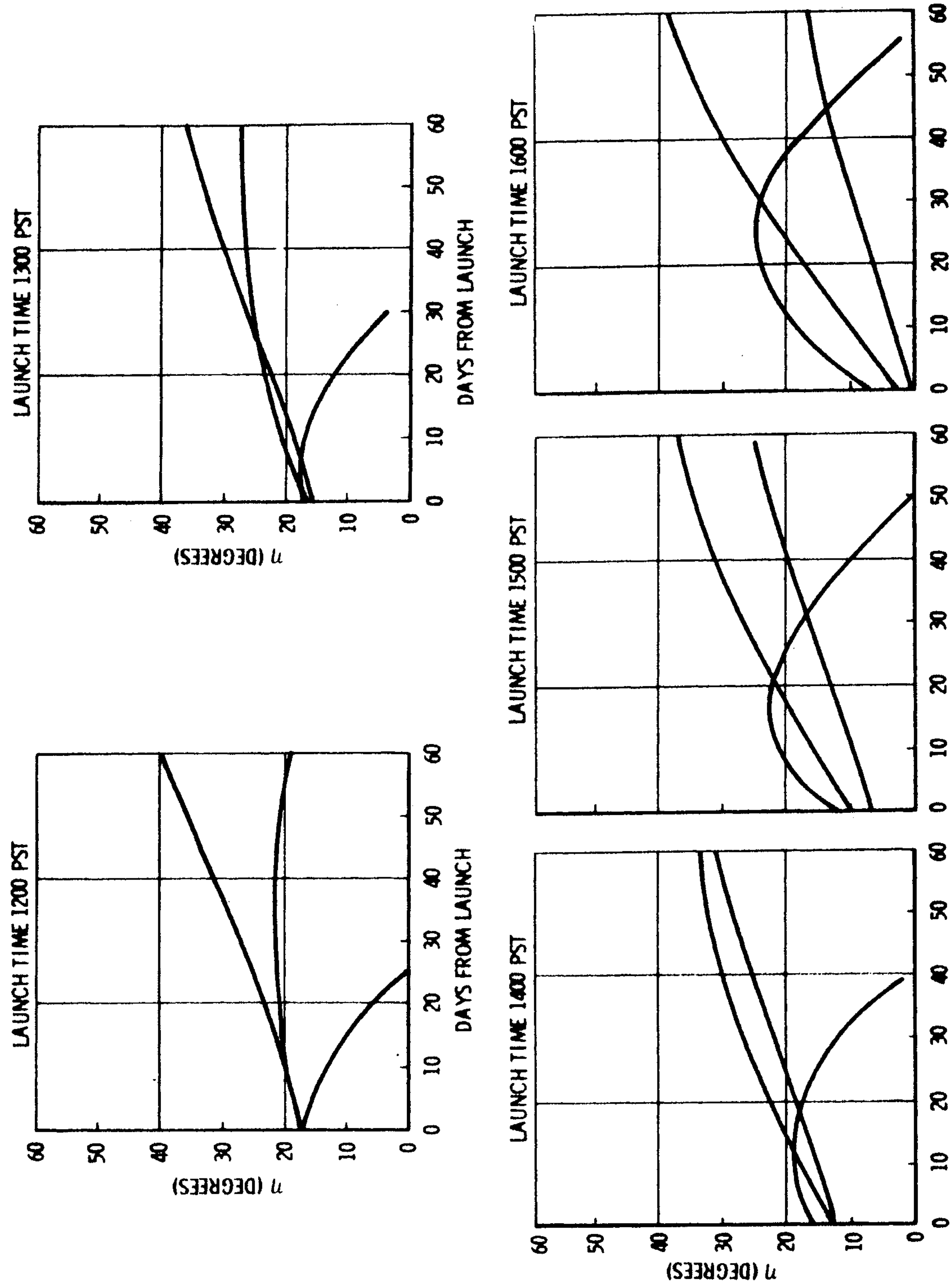


Figure B-23 History at 55 Degrees North for 1 February Launch Date As a Function of Launch Time and Orbit Inclination

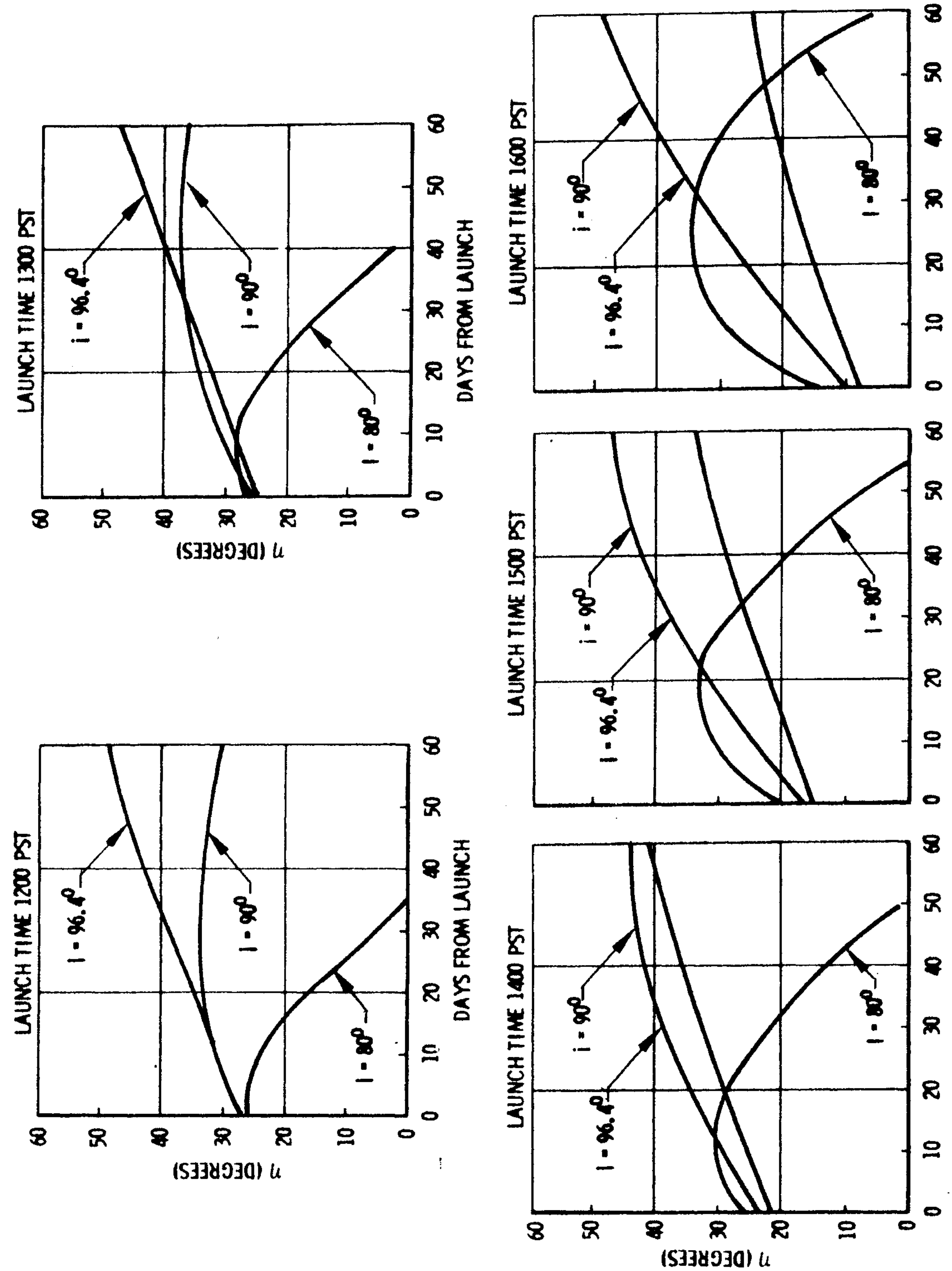


Figure B-24 History at 55 Degrees North for 1 March Launch Date As a Function of Launch Time and Orbit Inclination

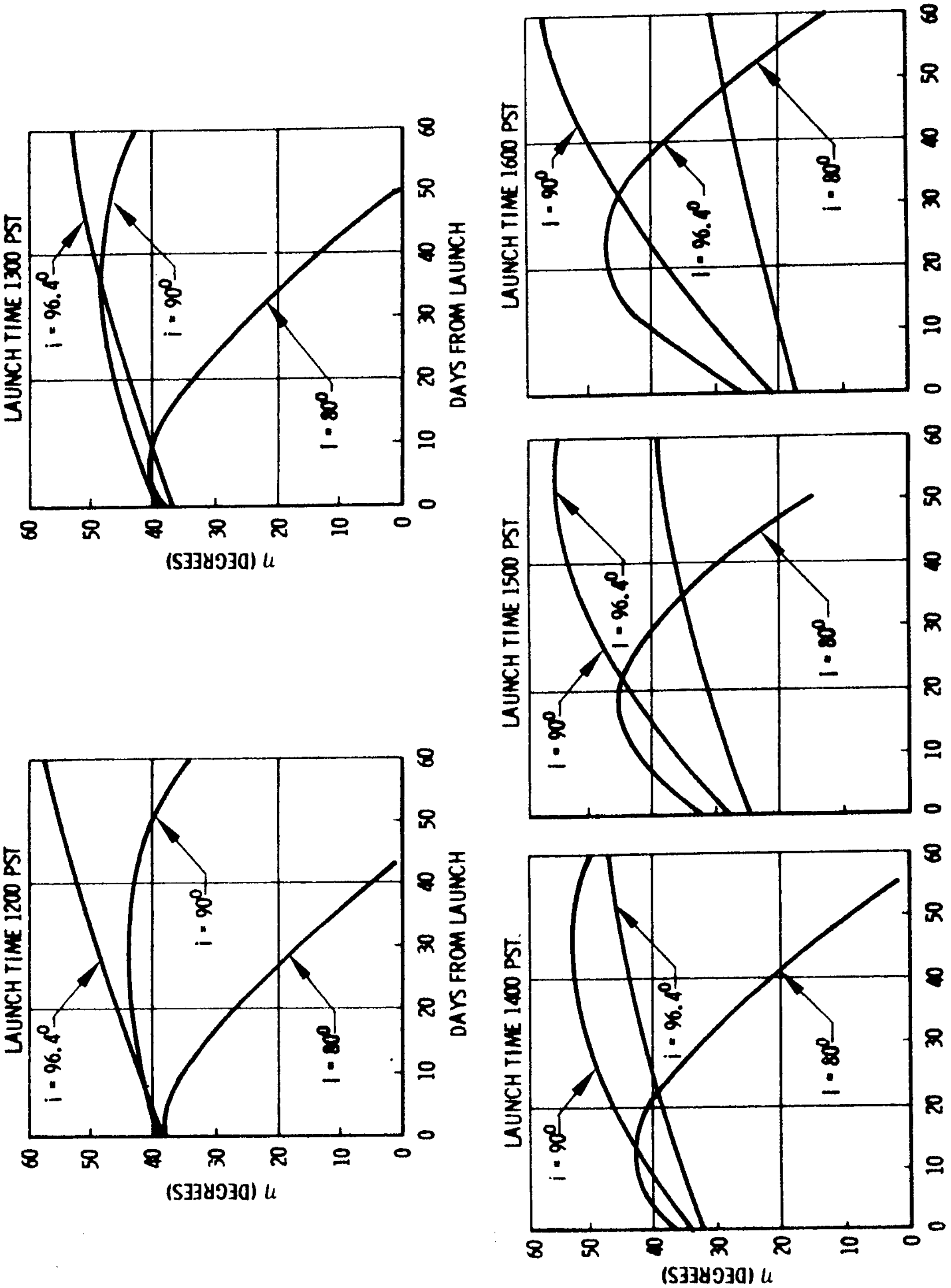


Figure B-25 History at 55 Degrees North for 1 April Launch Date As a Function of Launch Time and Orbit Inclination

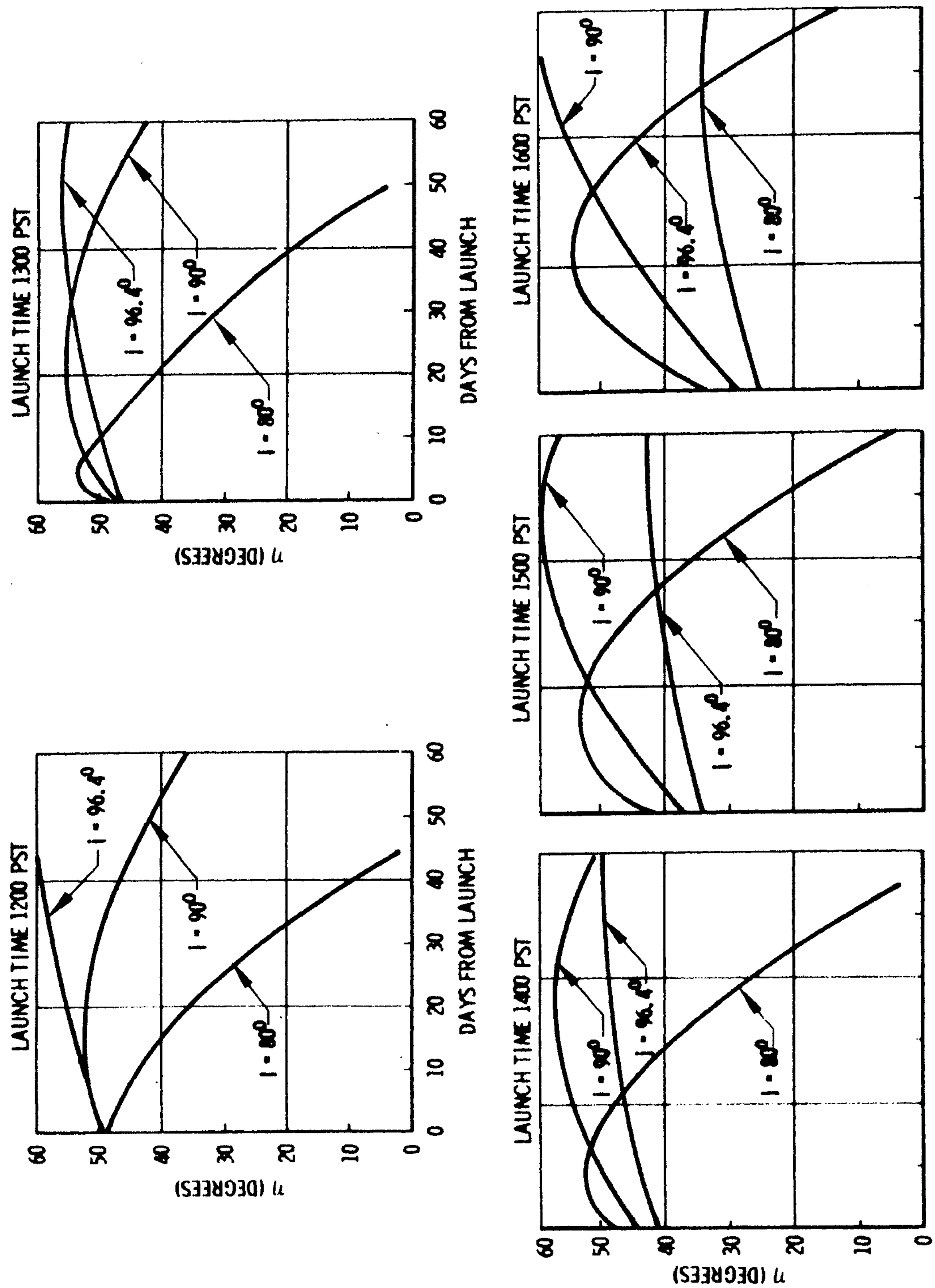


Figure B-26 History at 55 Degrees North for 1 May Launch Date As a Function of Launch Time and Orbit Inclination

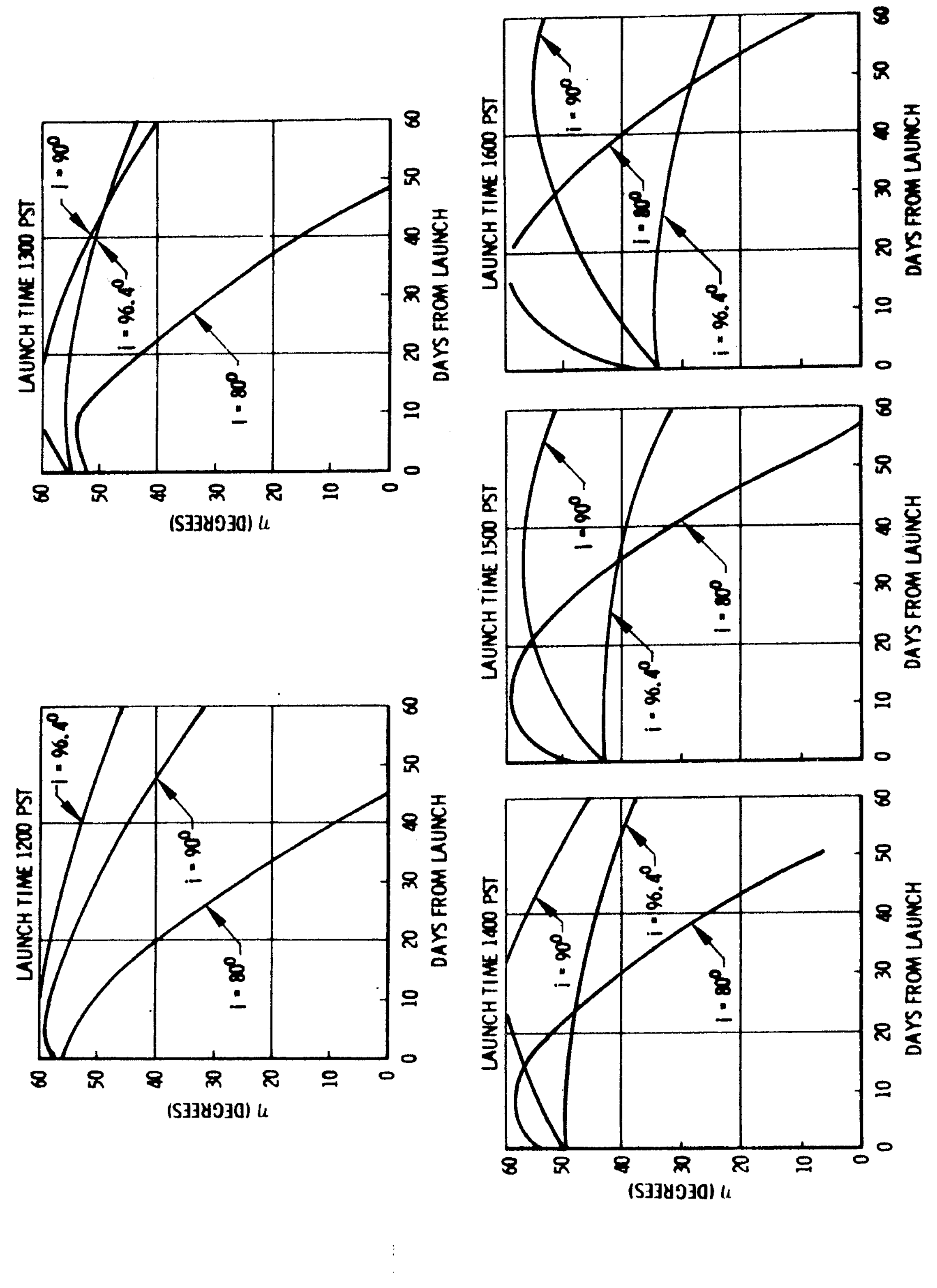


Figure B-27 History at 55 Degrees North for 1 June Launch Date As a Function of Launch Time and Orbit Inclination

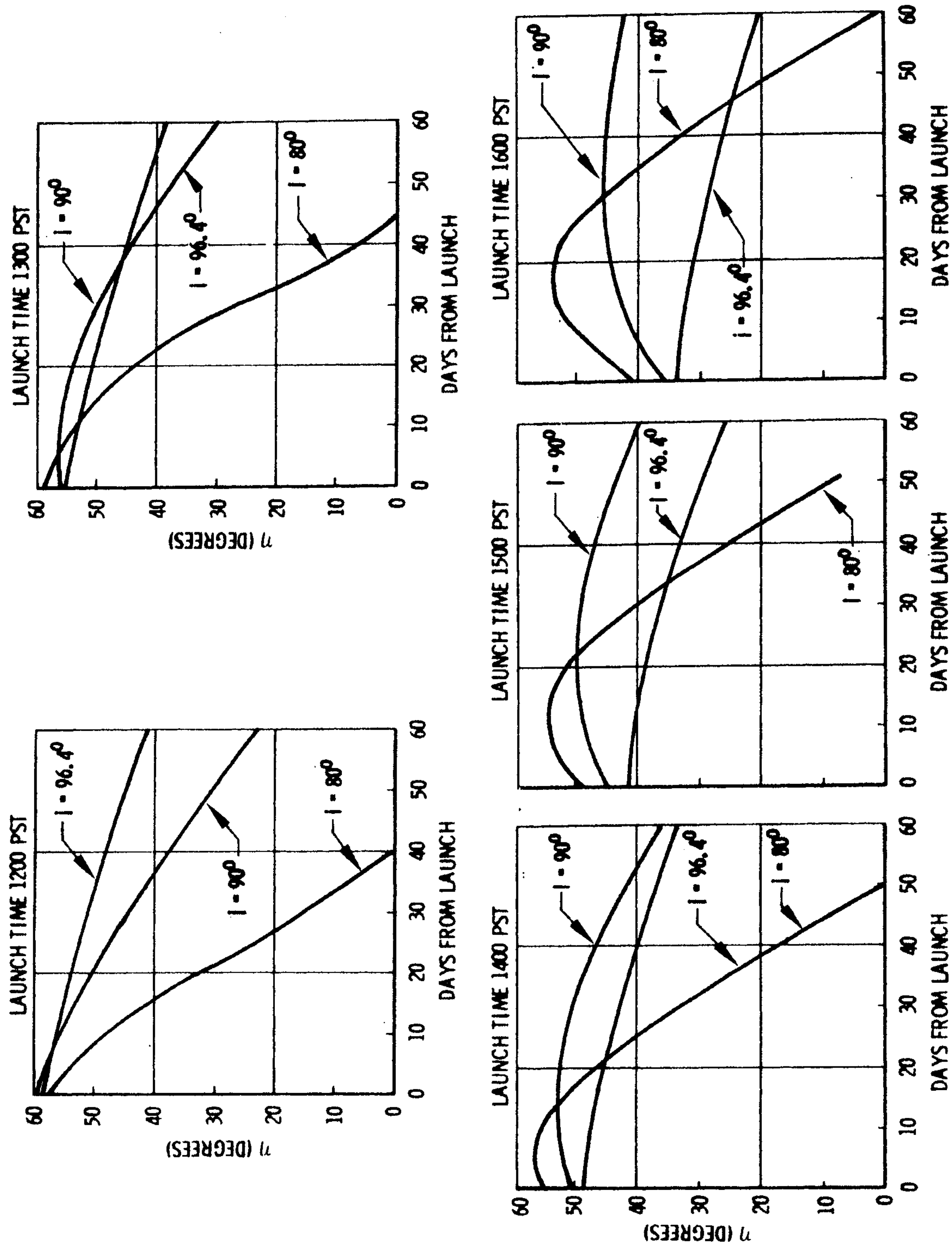


Figure B-28 History at 55 De pes North for 1 July Launch Date
As a Function of Launch Time and Orbit Inclination

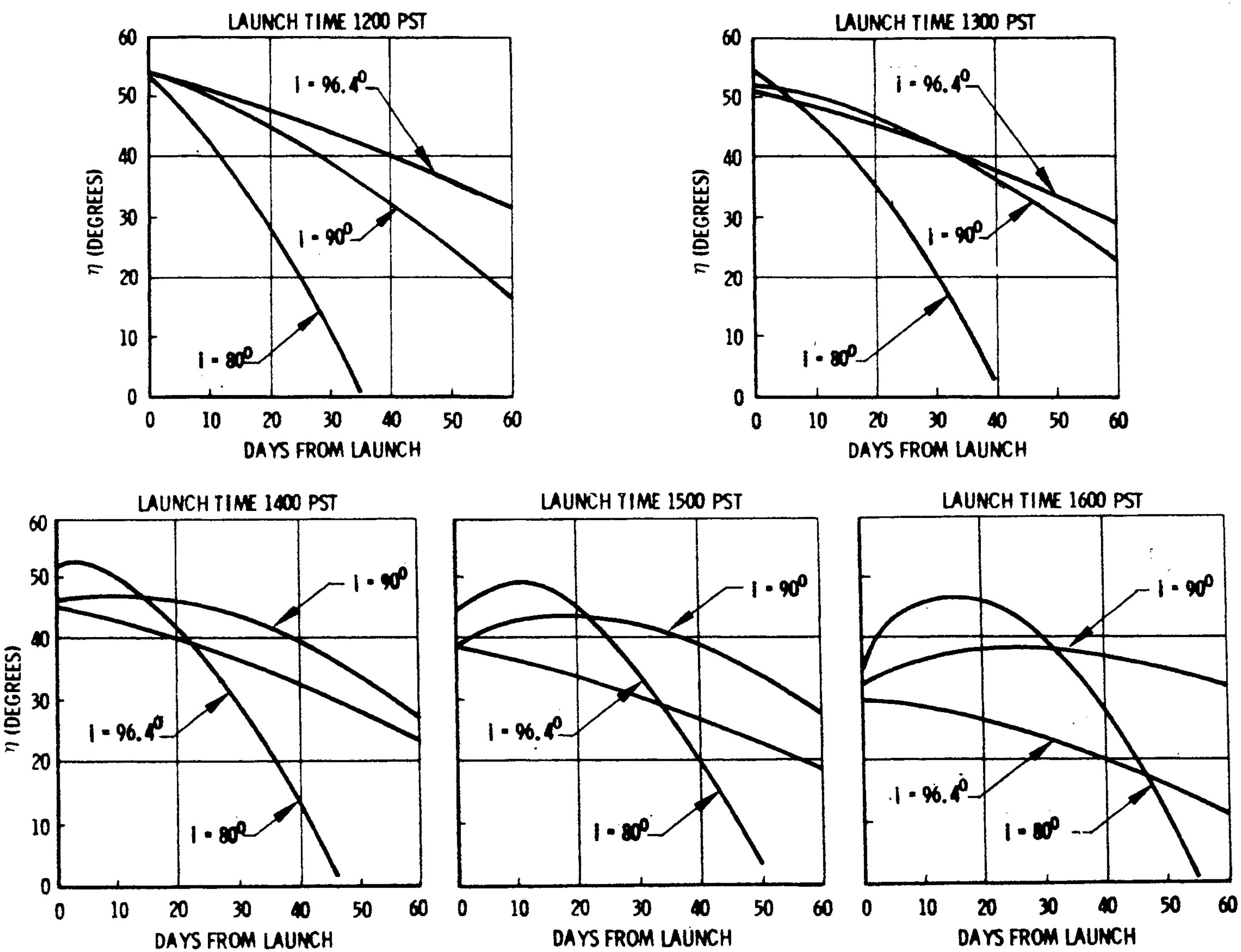


Figure B-29 History at 55 Degrees North for 1 August Launch Date As a Function of Launch Time and Orbit Inclination

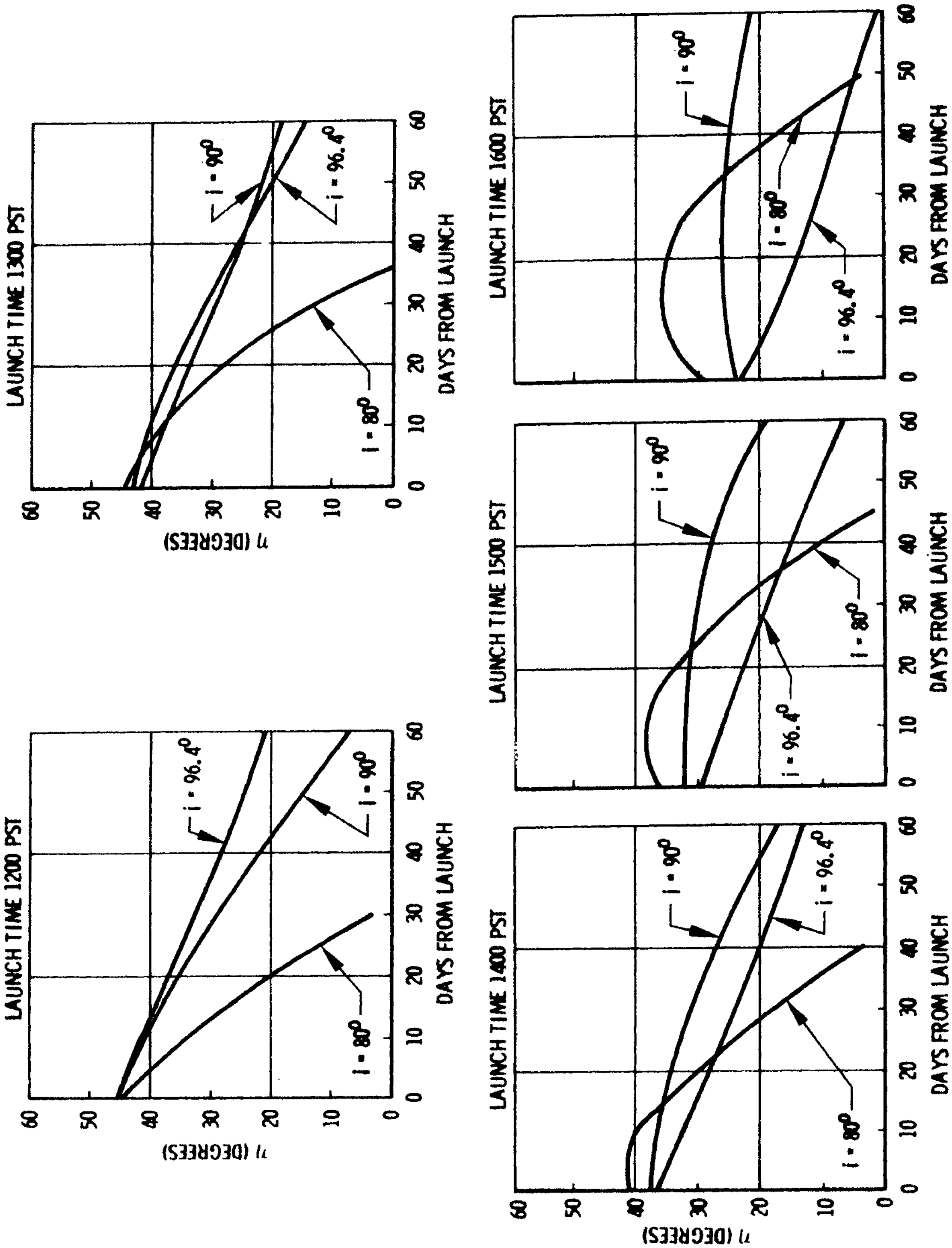


Figure B-30 History at 55 Degrees North for 1 September Launch Date As a Function of Launch Time and Orbit Inclination

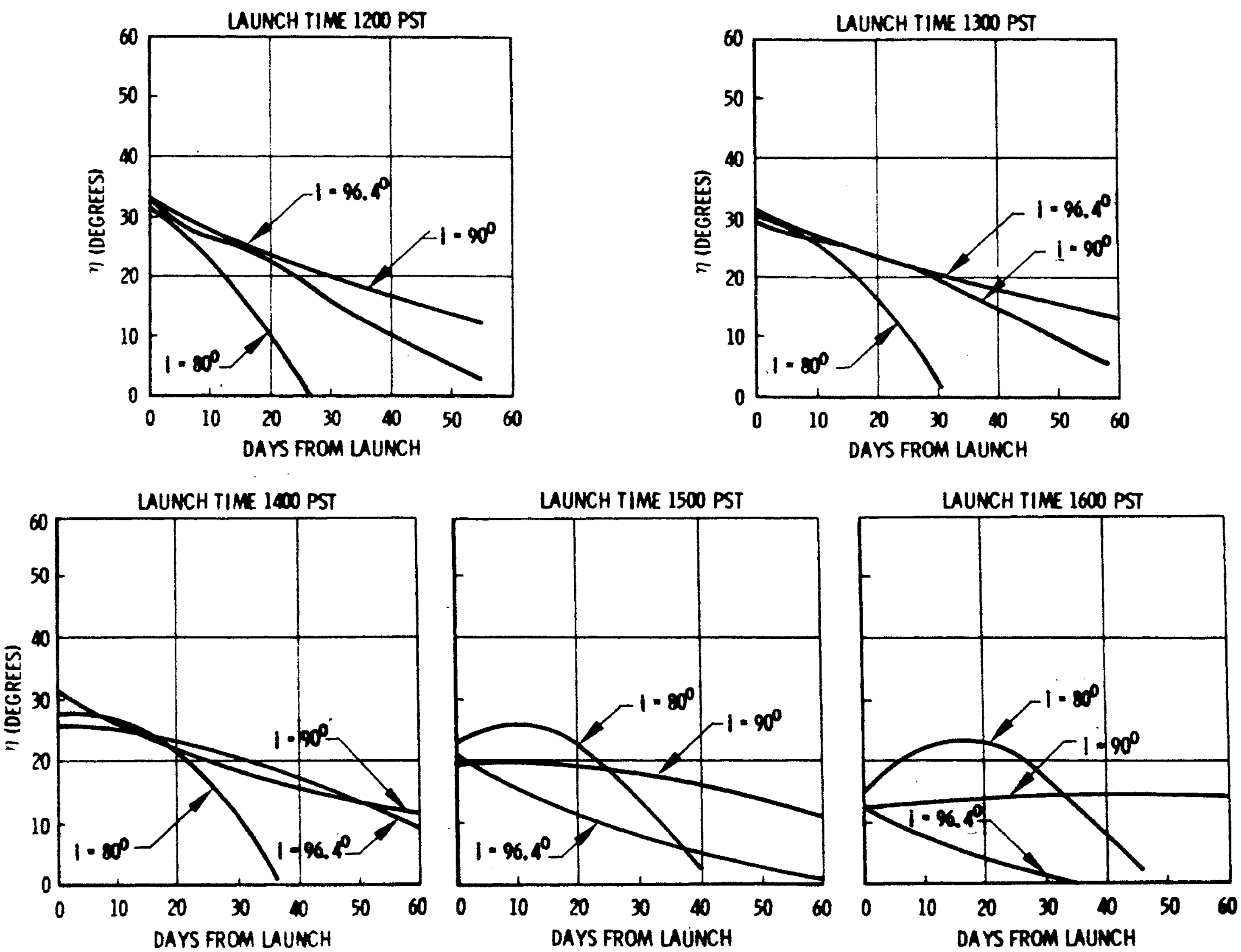


Figure B-31 History at 55 Degrees North for 1 October Launch Date As a Function of Launch Time and Orbit Inclination

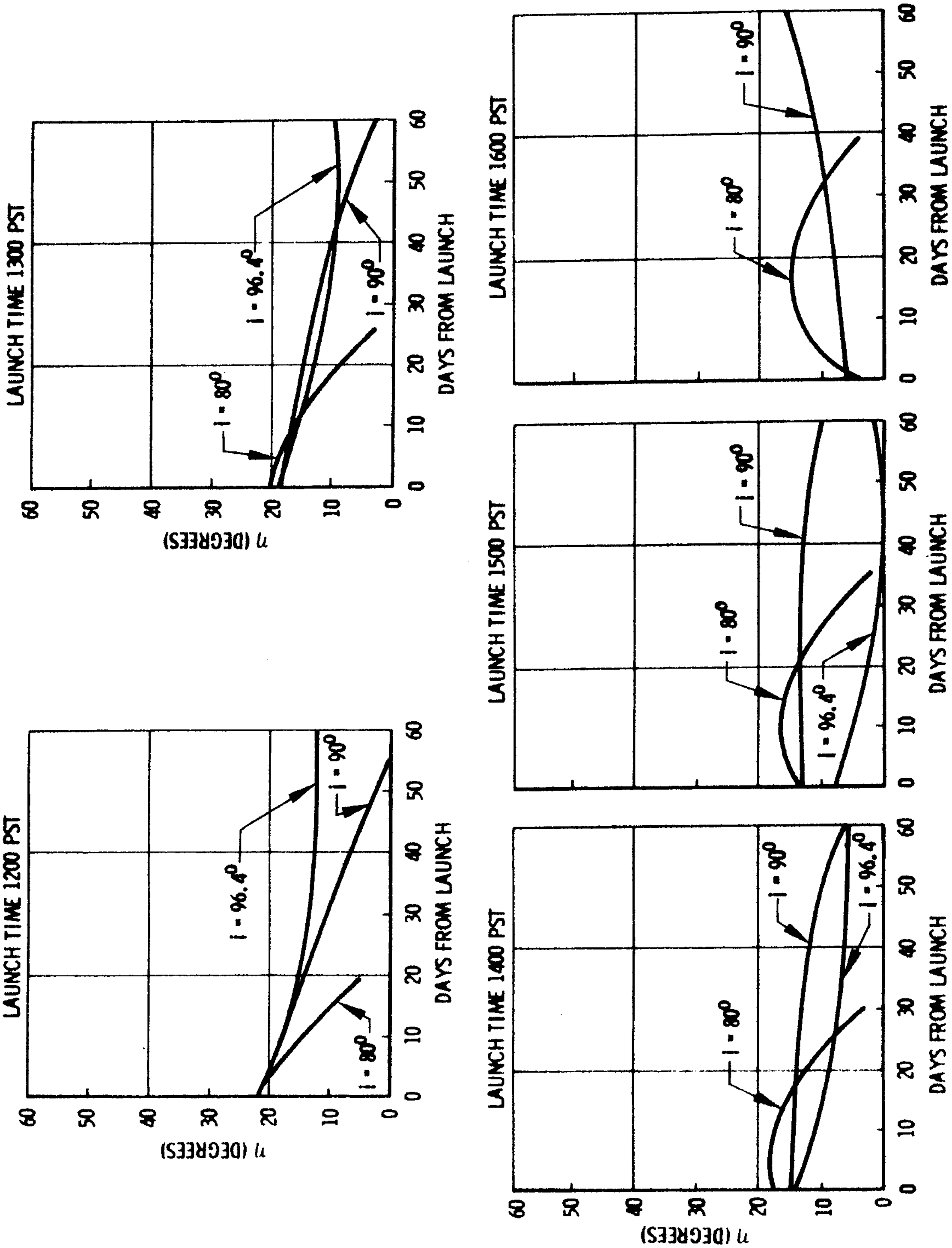


Figure B-32 History at 55 Deg es North for 1 November Launch Date As a Function of . nch Time and Orbit Inclination

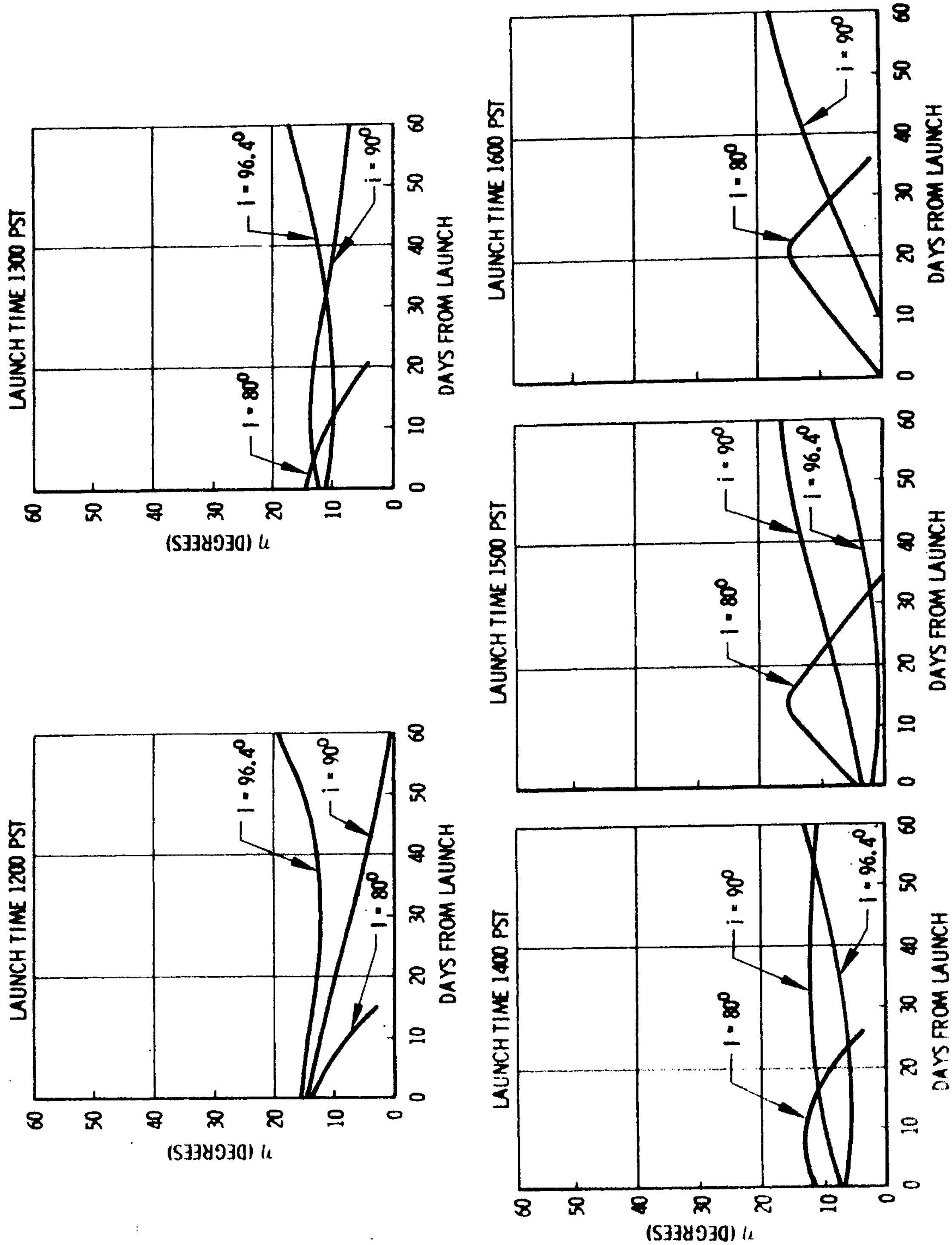


Figure B-33 History at 55 Degrees North for 1 December Launch Date As a Function of Launch Time and Orbit Inclination

The effect of orbit inclination on illumination available at a given target latitude is shown in Figures B-22 through B-26. These Figures show that the $\eta = 40$ deg contour is maximum with respect to latitude on the high (95 to 100 deg) inclination angles and that this occurs for June launch dates.

Composite launch constraint charts can be prepared to show the previously discussed constraints associated with sun angle and additional constraints such as recovery, abort, etc.

B.3 ORBIT SELECTION

Figure B-34 is used to explain the philosophy of selecting the nominal and alternate MOL orbits which will provide the greatest probability of mission success and provide a MOL turnaround capability which will satisfy certain special targeting requirements. All quantities shown in Figure B-34 are based on an orbit having an initial perigee (δ_p) located at 55 deg N (descending) at a perigee altitude (h_p) of 80 n mi. The apogee altitude shown as the ordinate of Figure B-34 represents the initial apogee altitude (h_a) of the orbit. The q parameter values shown in Figure B-34 identify lines of constant q and represent the average value of q over the orbital decay interval between orbit adjusts (O/A) for sustenance. The O/A interval applicable to this curve is three days. As such, the initial q value would be lower and the value just prior to a sustenance correction would be higher than that q value shown. The Gemini B abort ceiling (Line A-A'), the T-IIIM performance limit (line A'-C'), the recovery limit (Line C-C') for using only two recovery ships (Ref. 6.3.4.3.1f.3.), and the minimum inclination of 80 deg (Line A-C) dictated by the envelope specified in the SP/DR establish the envelope depicted by the double lines shown in Figure B-34.

Basically, any orbit within the envelope of the double lines shown in Figure B-34 may be a candidate for a MOL orbit. Because of the long mission and the wide swath coverage of the MOL vehicle, orbits providing the highest numbers of targets photographed are those which provide relatively continuous coverage of all longitudes over the mission. Repeat cycles in the order of 10 to 15 days also have the advantage that overflights over a given target are spaced such that time is provided for weather changes. A nominal MOL orbit which has been used for timeline work to date was selected on the T-IIIM performance limit, Line A'-C', at point S (a value of q = 16-2/15). The corresponding inclination is 90 deg and the initial apogee altitude is approximately 186 n mi. This particular selection of a nominal MOL orbit will satisfy all major system constraints. Further, a ± 40 deg vehicle swath width capability will provide nearly complete coverage of all targets above 40 deg N four times in a 30-day mission.

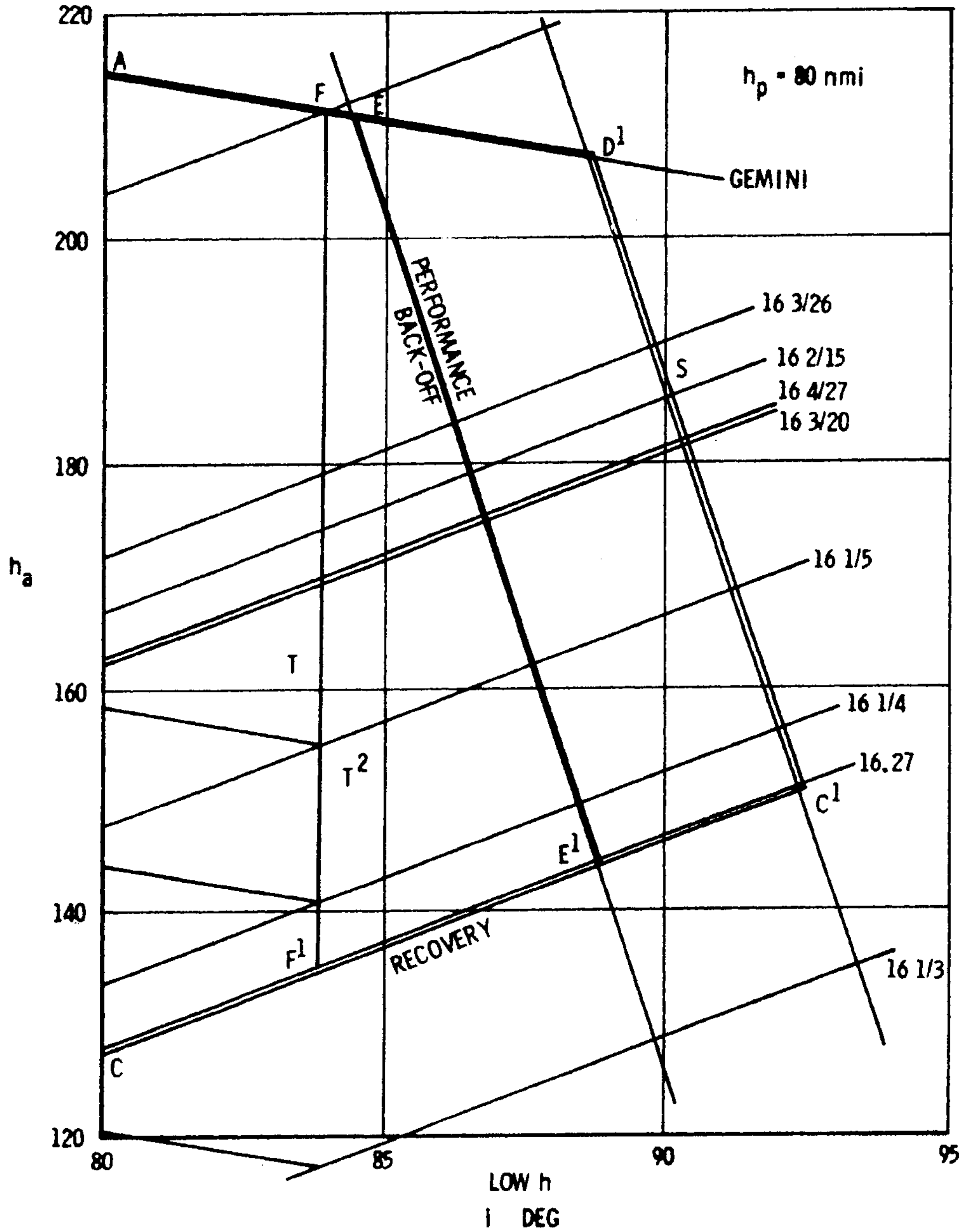


Figure B-34 Envelope of Probable Orbits

Another orbit studied has a q of 16 3/26 providing approximately three accesses to all targets between 80 deg N and 80 deg S latitude with lower obliquity angles at the higher latitudes than previously studied orbits.

An alternate orbit which may tend to optimize the capability of satisfying a special targeting requirement can also be selected using the following logic:

a. Establish a reduced T-IIIM performance limit (Line E-E') to allow for any OV weight growth or less than nominal T-IIIM performance.

b. Choose an inclination (Line F-F') within the box bounded by the Gemini B abort ceiling, the reduced T-IIIM performance limit, the recovery limit, and the minimum inclination line specified in the MOL SP/DR.

c. Choose a specific orbit, point T, which can best satisfy potential alternate mission dictated by special targeting requirements.

The backup performance limit line shown will correspond to increasing the OV by 500 lb. Studies indicate a q range of 16.0 to 16.25 will allow the MOL vehicle to directly overfly any target in the world within five days after launch. Certain specific targets may be directly overflown much sooner.

As indicated earlier, at L-7 a decision can be made to use the alternate orbit and change h_a to obtain the q (between 16.0 and 16.27) to overfly desired targets as early as possible. The limits on h_a will be from F to F' or approximately 201 to 135 n mi.

Caution must be exercised in selecting point T. Too high a q value will require more ΔV per O/A and will be very expensive in sustenance propellants. This can be compensated somewhat by only partially correcting the apsidal rotation for the remainder of the mission. (This assumes operation for the full duration is a requirement after completion of a special targeting exercise.)

Figure B-35 shows the q values required to overfly Target "A" on a given rev. With an obliquity capability of ± 40 deg a range of q ($16.112 < q < 16.21$) allows overflight on rev 24. Figures B-36 through B-39 indicate the range of q values which will allow overflight of four additional targets. These curves are based on a 90 deg inclination angle orbit. Curves similar to those presented in Figures B-35 through B-39 can be made at the alternate inclination line F-F' for each target potentially a candidate for a special targeting requirement. Overlay of a set of these curves will permit selection of a value of q (depicted by point T in Figure B-34) having the highest probability of satisfying a special targeting requirement.

The placement of line F-F' must be made considering such factors as tracking station coverage, history of sun angle in the target area of interest over the total flight, propellants required for sustenance, etc.

For any given important target, almost continuous daily surveillance can be accomplished by an O/A (after initial target acquisition) which is at or near $q = 16.0$ to provide a repetitive ground trace each day.

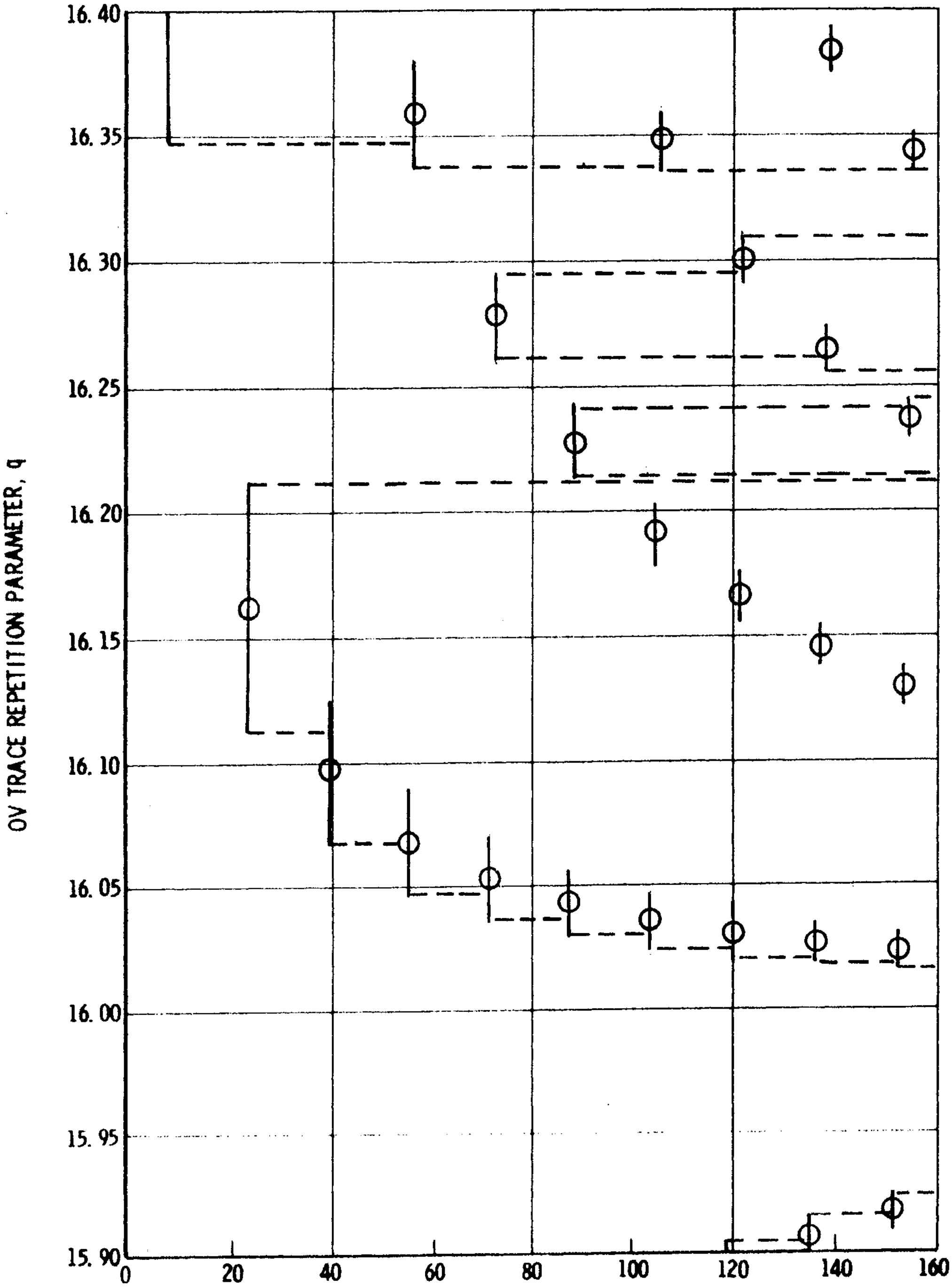


Figure B-35 q Values Required to Overfly Target A

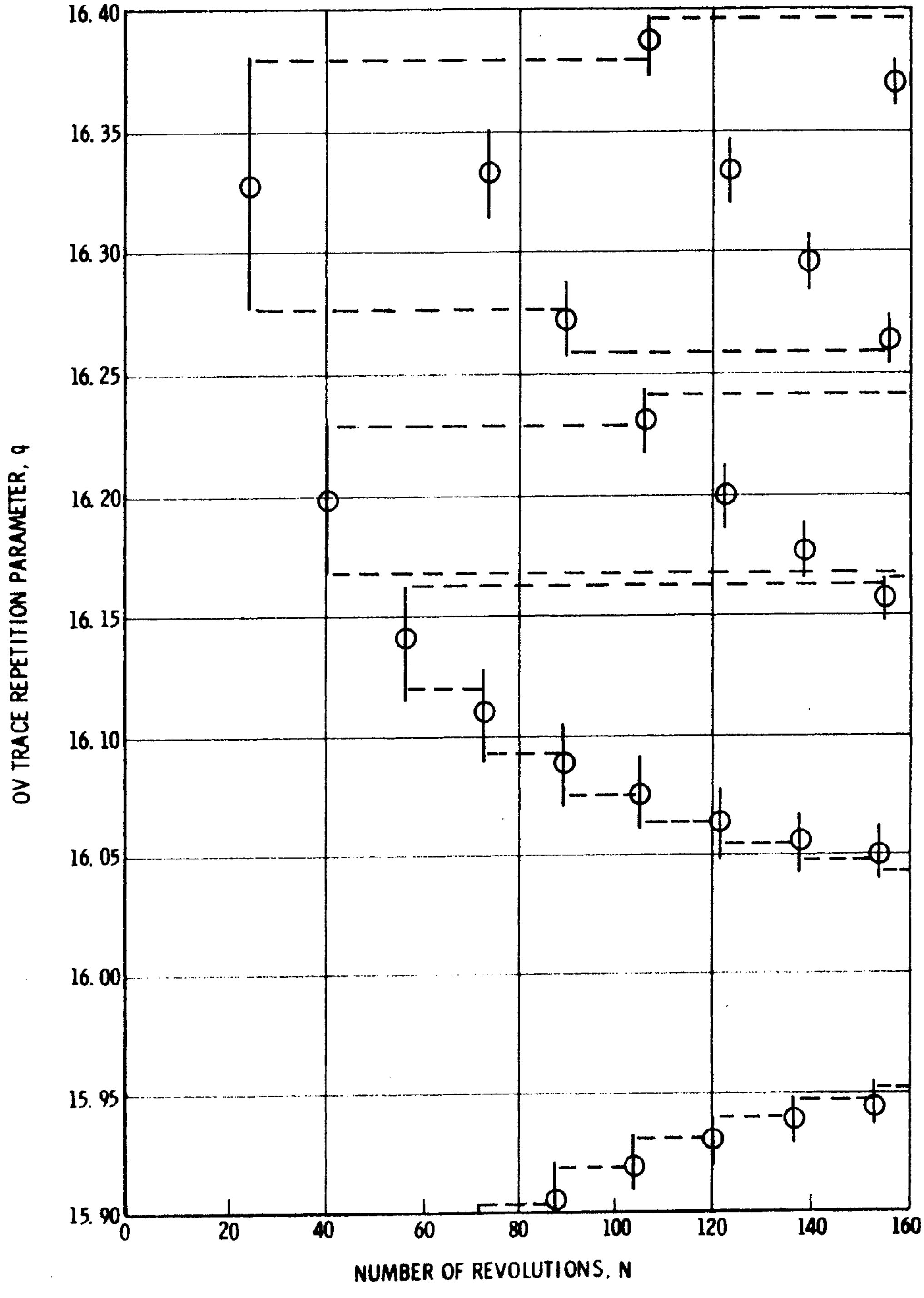


Figure B-36 q Values Required to Overfly Target B

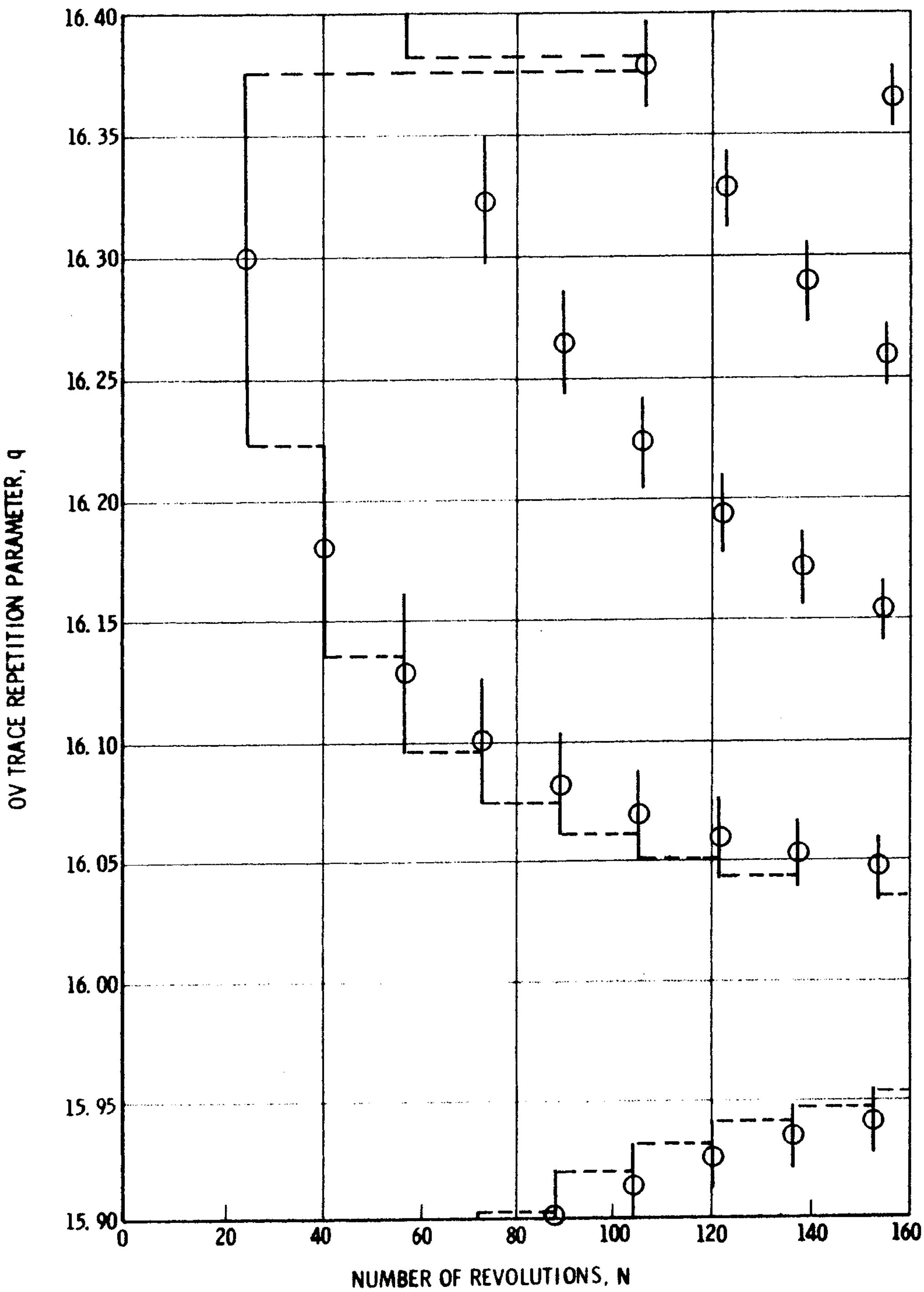


Figure B-37 q Values Required to Overfly Target C

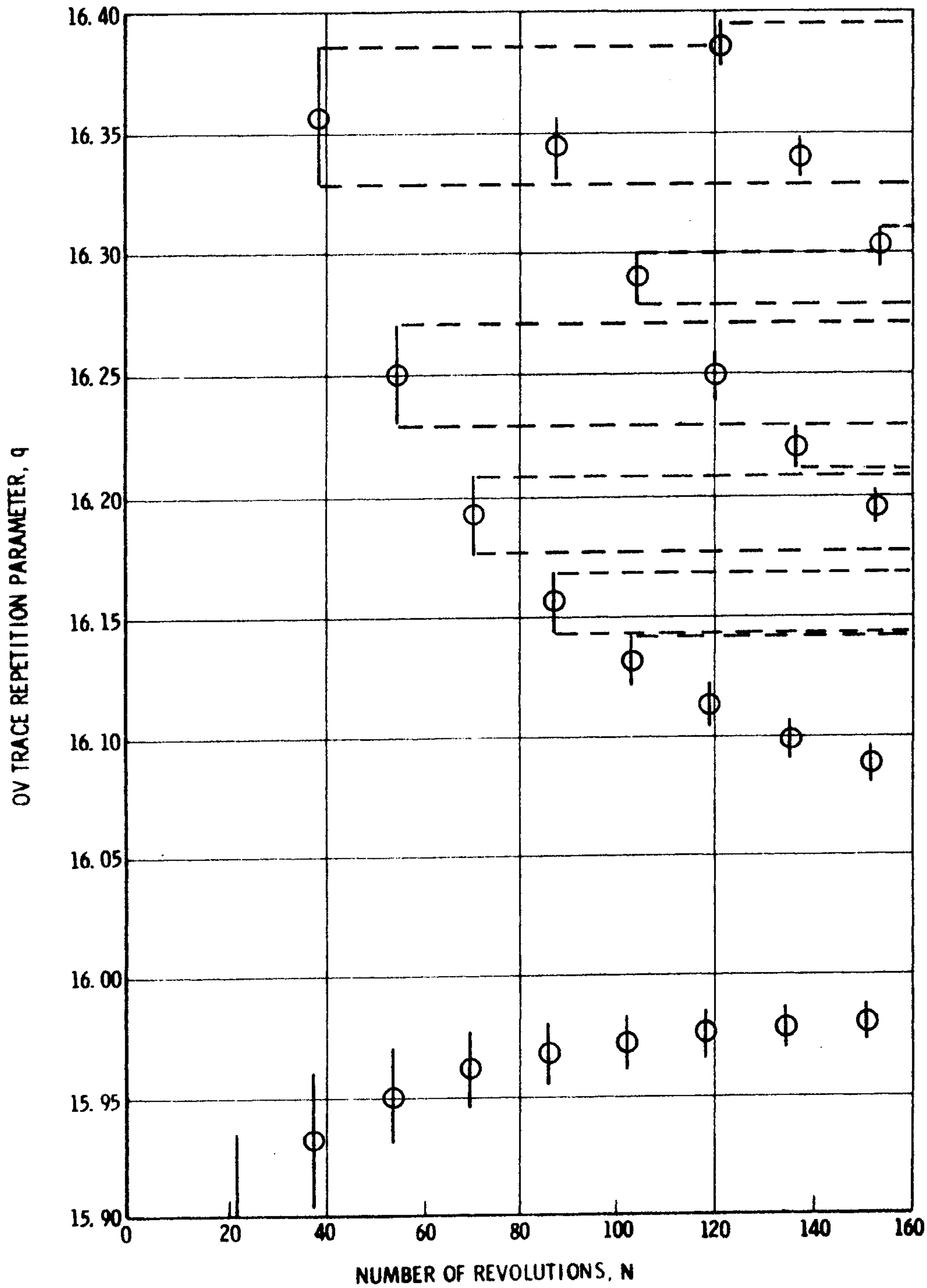


Figure B-38 q Values Required to Overfly Target D

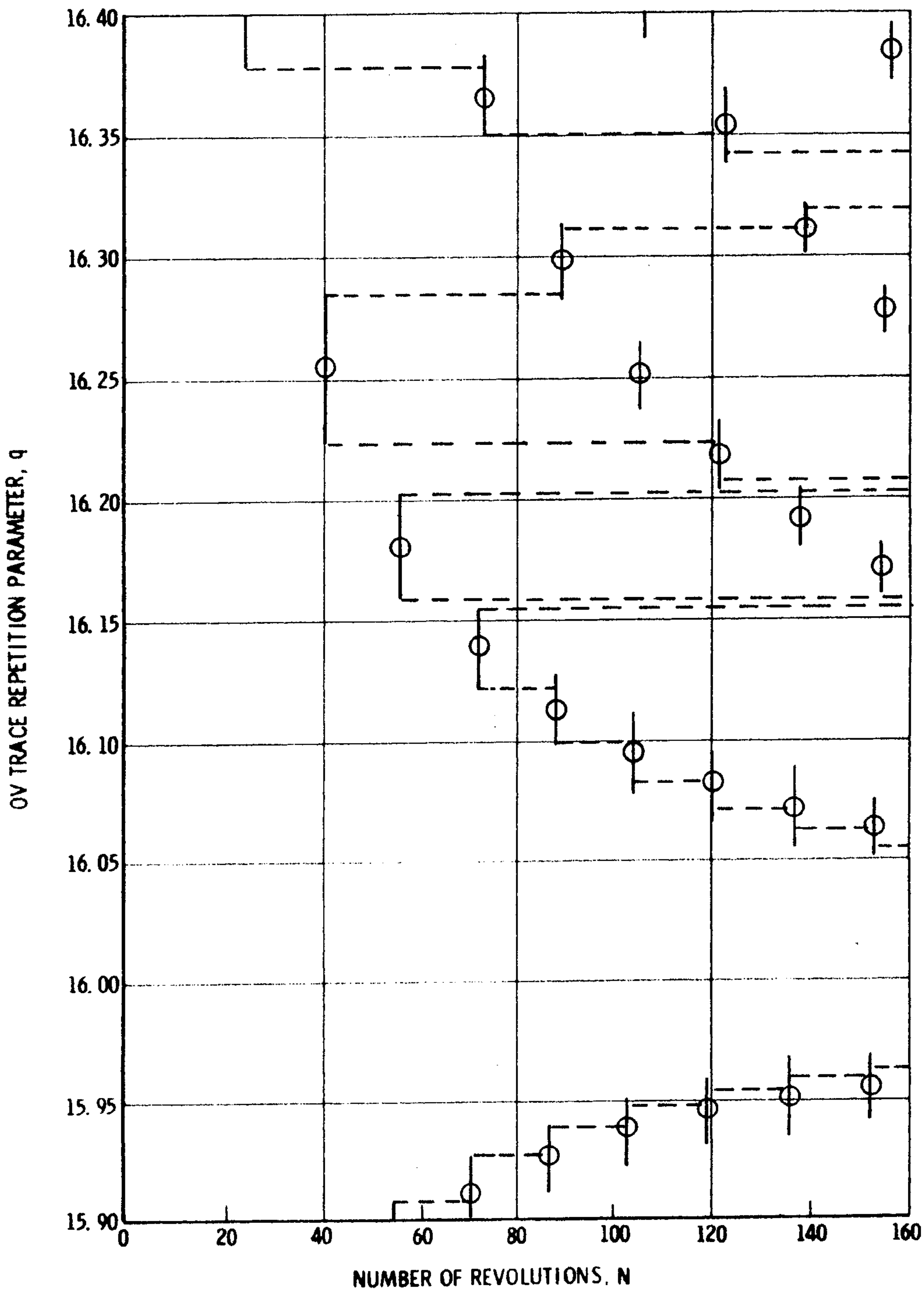


Figure B-39 q Values Required to Overfly Target E

B.4 GROUND TRACE COVERAGE PATTERN AND STATION CONTACTS

The ground trace coverage pattern and its effects on target coverage in the area of interest are developed below. Plots of typical MOL ground traces for a 90 deg inclination orbit and Tables of RTS contacts for various orbital inclination angles are provided.

The ground trace coverage pattern used in MOL sustenance studies is that pattern resulting from an orbit which repeats itself every 15 days. However, a more explicit term identified as the satellite repetition parameter, q, must be used to describe precisely the ground trace coverage pattern. The q used in the recent MOL sustenance studies is 16-2/15. The q parameter expresses the number of revs a satellite completes in a sidereal day (360 degrees of earth rotation). An expression for q is derived as follows:

a. The total number of deg the earth rotates during an orbital rev is defined by the nodal period, T_N, multiplied by the earth rotation rate, Ω_E.

b. The ascending node regresses at a rate of $\frac{d\Omega}{d_N}$.

c. The total angle of earth rotation during one rev relative to the asecnding node of the orbit, ΔS, is thus:

$$\Delta S = \frac{T_{N\Omega E}}{60} - \frac{d\ \Omega}{d_N} \qquad (1)$$

Where: T_N = nodal period in min

Ω_E = earth rotation rate in deg/hr

$\frac{d\Omega}{d_N}$ = nodal regression rate in deg/rev

d. Since ΔS is the number of deg of earth rotation per rev, then:

$$q = \frac{\text{revs}}{\text{sidereal day}} = \frac{360\ \frac{\text{deg}}{\text{sidereal day}}}{\Delta S\ \frac{\text{deg}}{\text{rev}}}$$

Therefore: $$q = \frac{360}{\frac{T_N \Omega_E}{60} - \frac{d\Omega}{d_N}} \qquad (2)$$

The nodal regression rate, $d\Omega/d_N$, for a particular orbital inclination is not affected significantly by small changes in nodal period. Consequently, an examination of the q equation indicates that as a given orbit decays thereby decreasing the nodal period, the q value actually begins to increase. The MOL sustenance studies include the effects of drag and oblate earth effects and, consequently, when a q of 16-2/15 is specified for a MOL orbit, this really means an average q value over some interval between sustenance corrections. The initial q will be lower than 16-2/15 and the q just prior to correction will be higher than 16-2/15.

For the range of orbital parameters presently feasible on MOL, the value of nodal regression rate, $d\Omega/d_N$, varies from approximately -0.10 deg/rev for an 80 deg orbital inclination to 0.0 at 90 deg orbital inclination to approximately 0.065 deg/rev at 96.43 deg orbital inclination. If the range of feasible orbital parameters based upon launch vehicle capabilities are known for each orbital inclination angle, it is easy to bound the range of q values applicable to MOL. It should be noted that the lower the nodal period the higher the value of q. For q values greater than 16, the ground track will move east every integral number of 16 revs; for q values less than 16, the ground track will move west every integral number of 16 revs. If a particular value of q is desirable for the applicable inclination range, it is possible to show, using the q equation and other fundamental orbit mechanics equations, that the apogee altitude increases approximately 20 n mi per 10 deg increase in inclination angle. This assumes an 80 n mi perigee and a q value of 16-2/15.

The movement of the ground trace for an orbit with a q parameter equal to 16-2/15 is shown in Figure B-40. This assumes no perturbations are acting upon the orbit and that the orbit is polar. Since q is 16-2/15, then:

$$\Delta S = \frac{360}{q} = 22.314 \text{ deg}$$

$$16 \times \Delta S = 357.025 \text{ deg}$$

If the first time the OV crosses the ascending node is labeled rev 1, then rev 17 (16 revs later) will be 360 deg -357.025 deg (2.975 deg) east of rev 1 and successive revs such as rev 1 and rev 2 are 22.314 deg apart. Revs 243 and 1 overlap; the ground traces repeat after 242 revs or after 15 days (note that 242/q - 15). The ground traces at the equator after 15 days are separated by 1.488 deg (see Figure B-40).

The MOL DORIAN system with its obliquity capability of 40 deg can cover a ground swath of 67.1 n mi on either side of the ground trace. Since the number of n mi in a deg of longitude varies as the latitude changes, it can be shown that the MOL DORIAN vehicle can access all longitudes above approximately 40 deg N lat after 7.5 days. Since over 90 percent of the known targets are above 40 deg N lat, an orbit with an average q value of 16-2/15 between sustenance corrections will provide for complete coverage of all longitudes four times in a 30-day mission.

The coverage pattern for a given latitude region at 40 deg N latitude is shown in Figure B-41 for the 90 deg inclination angle orbit. Drag effects are taken into consideration; the sustenance correction interval is every 48 revs (see Figure B-41). The small vertical line represents where the ground trace on a particular day intersects the longitude region specified. The horizontal lines depict swath widths commensurate with a 30 and 40 deg obliquity capability. The shorter horizontal line represents a 30 deg obliquity capability.

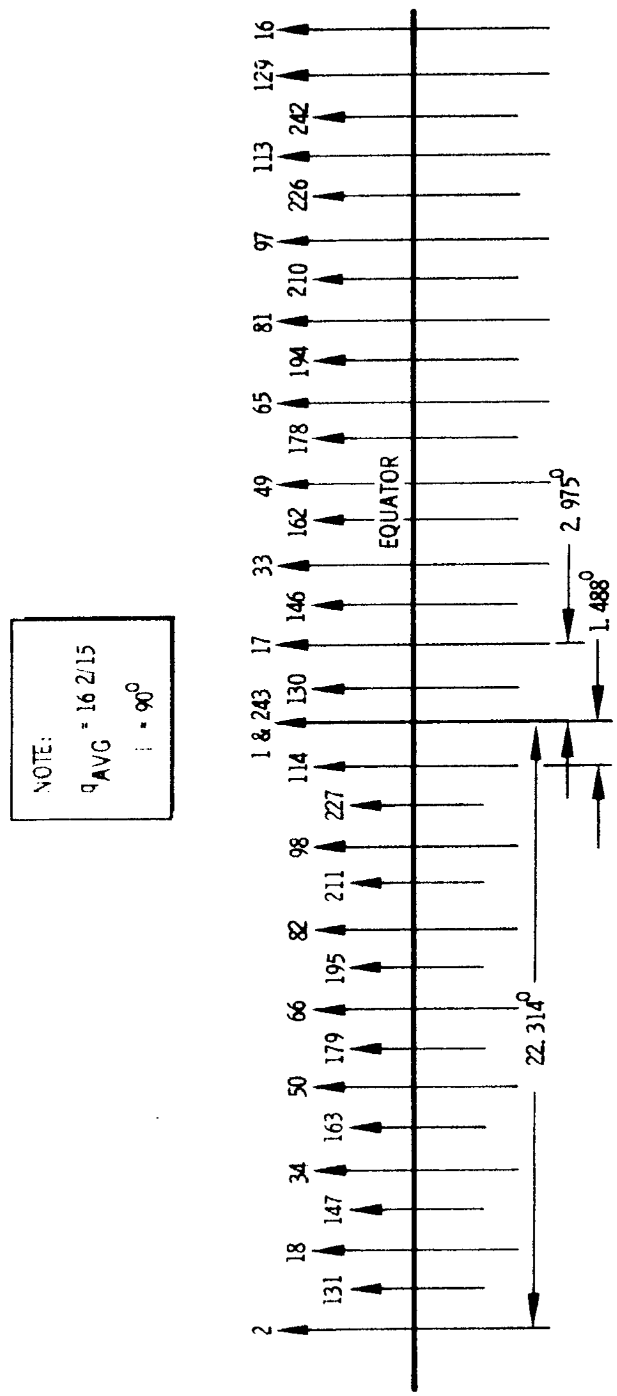
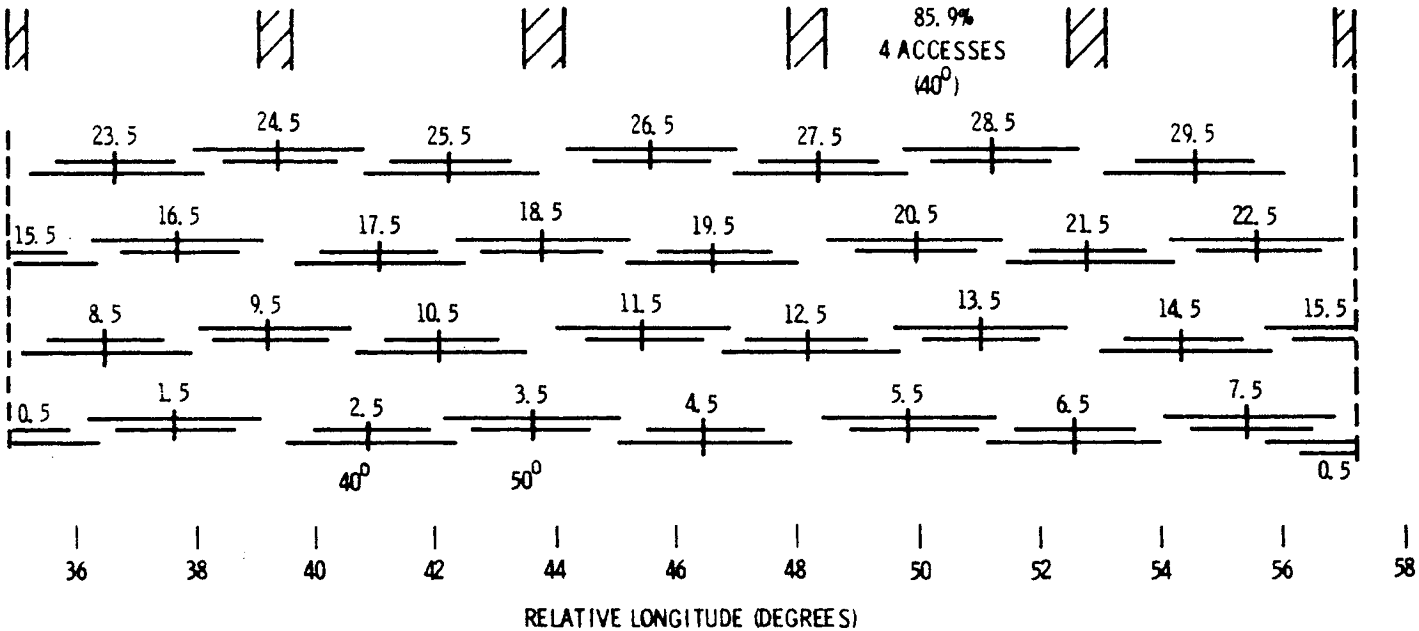


Figure B-40 Ground Traces



NOTE:

$i = 90^0$	MOD JACCHIA 1964 ATM	$\Delta V_t = 44.0 + 5(47.88) + 3(48.24)$
$h_p = 80$ n mi	$F_{10} + F_{10} = 170 \quad A_2 = 20$	$= 425.18$ FPS
$h_a = 185.81$ n mi	CORRECT APL 6.6 CONST	100% 2 ACCESSES (30°)
$\delta_a = 55^0$	W/CDA = 100 PSF	

Figure B-41 Coverage Pattern at 40 Degree North Latitude for 90 Degree Inclination Orbit

Orbit ground traces are shown in Figures B-42 through B-44 for a polar orbit for the first 3 days of a 30 day flight. This is typical of an orbit having an 80 n mi perigee and an average q value of 16-2/15 over the sustenance interval.

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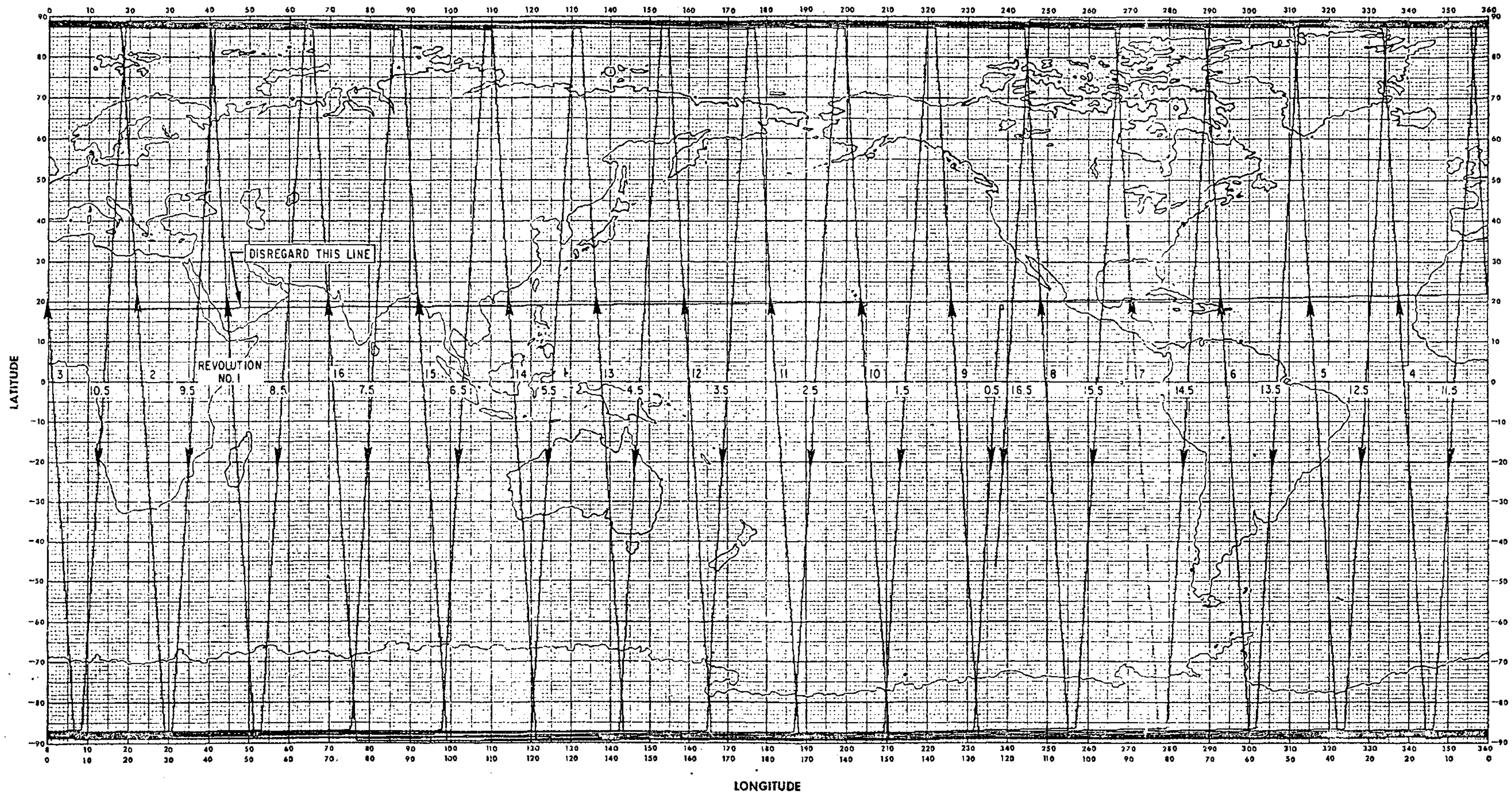

Figure B-42 Typical Ground Trace, Day 1, for Orbit of 90 Degree Inclination

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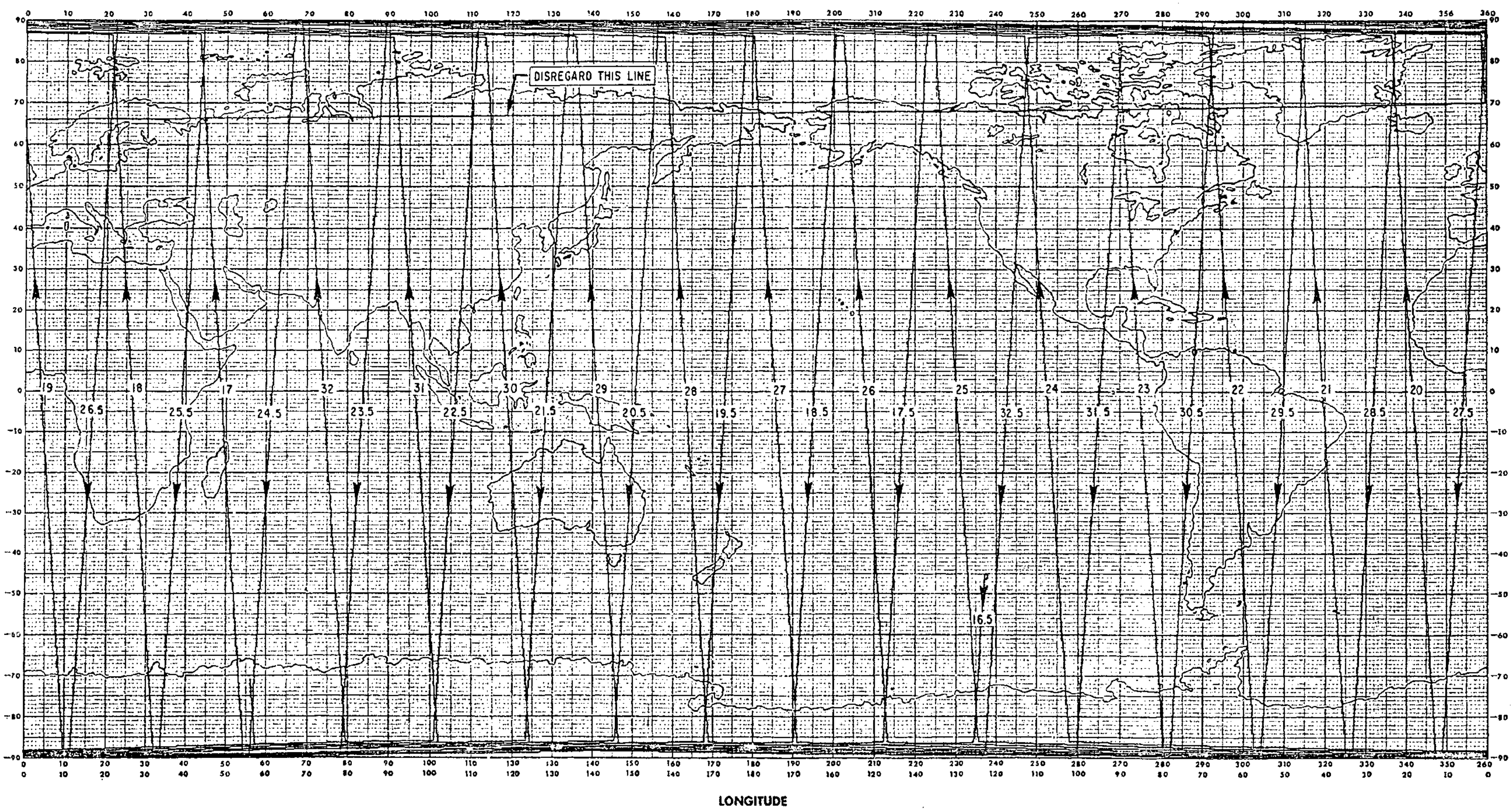

Figure B-43 Typical Ground Trace, Day 2, for Orbit of 90 Degree Inclination

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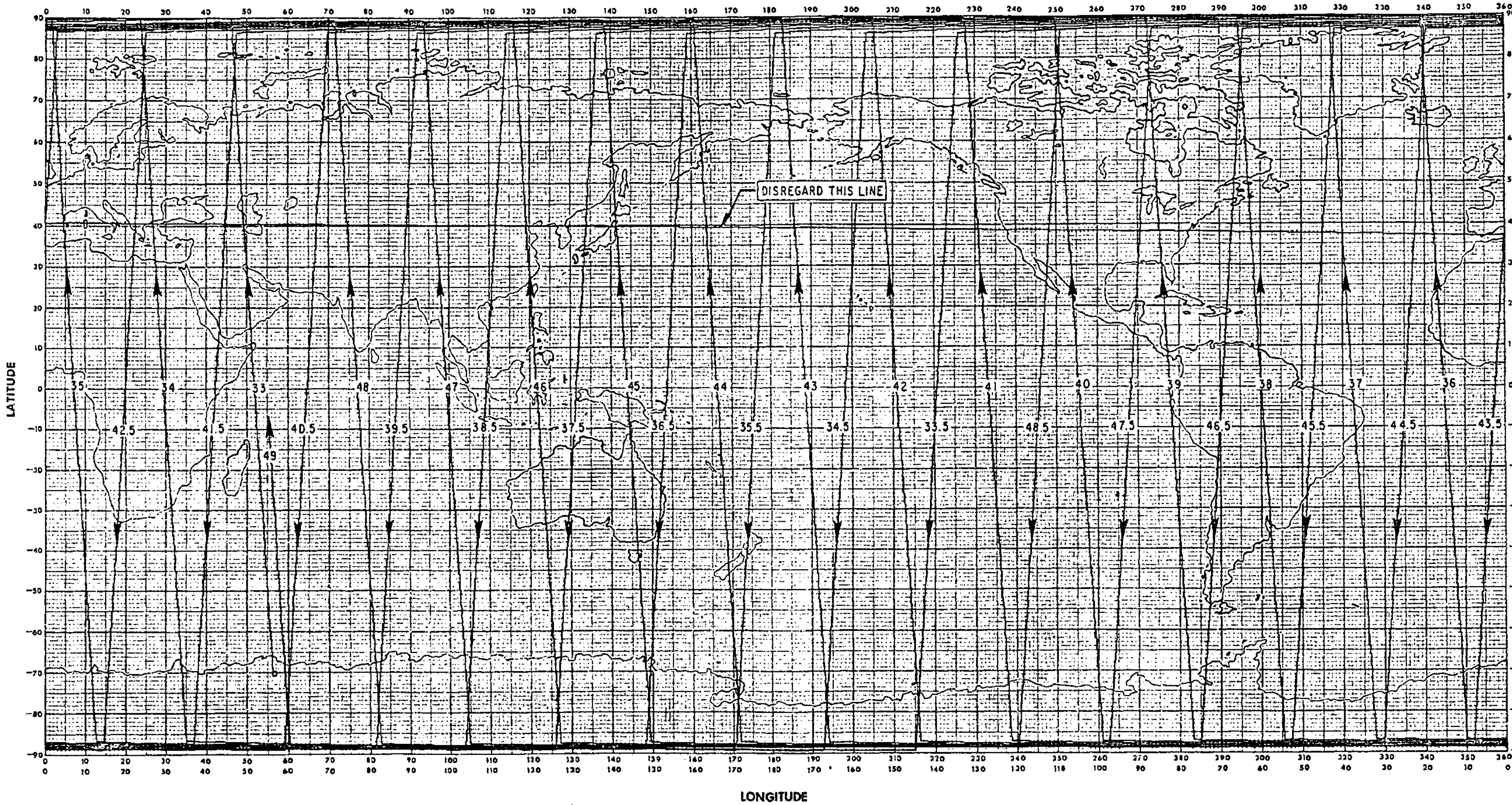

Figure B-44 Typical Ground Trace, Day 3, for Orbit of 90 Degree Inclination

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B.5 SUSTENANCE

The various methods of performing orbit adjust to sustain the orbit and the factors affecting the selections of a given method are discussed below.

The inclination angle and q parameter will also dictate the sustance technique employed in maintenance of perigee altitude, apogee altitude, and argument of perigee within fixed boundaries.

To date, MOL sustenance studies have gone through the iterations delineated in Table B-1. Essentially, these studies have considered three different inclination angle orbits and gone through three iterations on atmosphere model. Further, the statistics shown in Table B-1 are based upon a two-burn, 180 deg circumferential transfer technique. This two-burn transfer is "nearly optimum" and the impulses are added normal to the radius vector 180 deg in central angle apart. The results of this sustenance evaluation are evaluated further in Figures B-45 through B-47.

The interval between sustenance corrections which corresponds to an average q value of 16-2/15 on these curves is 48 revs (shown by the dark broken line). The orbits had an initial perigee altitude of 80 n mi at 55 deg N lat (descending). Sustenance correction intervals at other than rev 48 will provide average q values lower than 16-2/15 for revs preceding rev 48 and values higher than 16-2/15 for revs later than 48.

Figure B-45 presents ΔV/rev required vs the interval between sustenance corrections at an orbital inclination of 80 deg for the different iterations of the sustenance studies to date. The upper curve resulted from the first of the sustenance studies and was based upon the Jacchia 1964 atmosphere model which used a solar activity index, $F_{10.7}$ valve equal to 220 watts/m^2/cps. The value of 220 was selected based upon the MOL schedule as of that date and an analysis performed on $F_{10.7}$ during the active period of the solar cycle. The middle curve was generated during a second iteration on the sustenance studies and is based upon the more up-to-date atmosphere model currently being

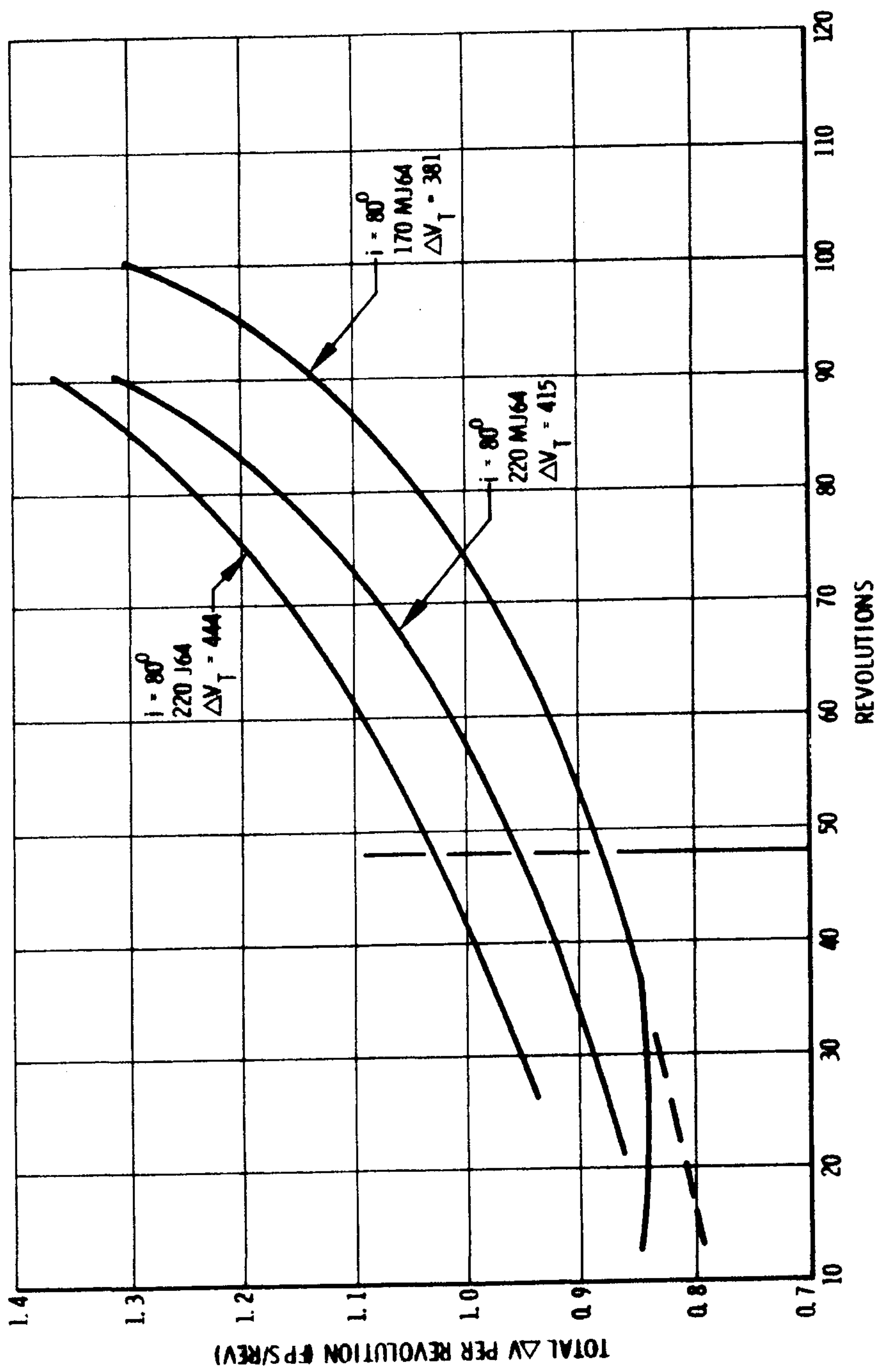


Figure B-45 Orbital Sustenance Requirements for Inclination of 80 Degrees

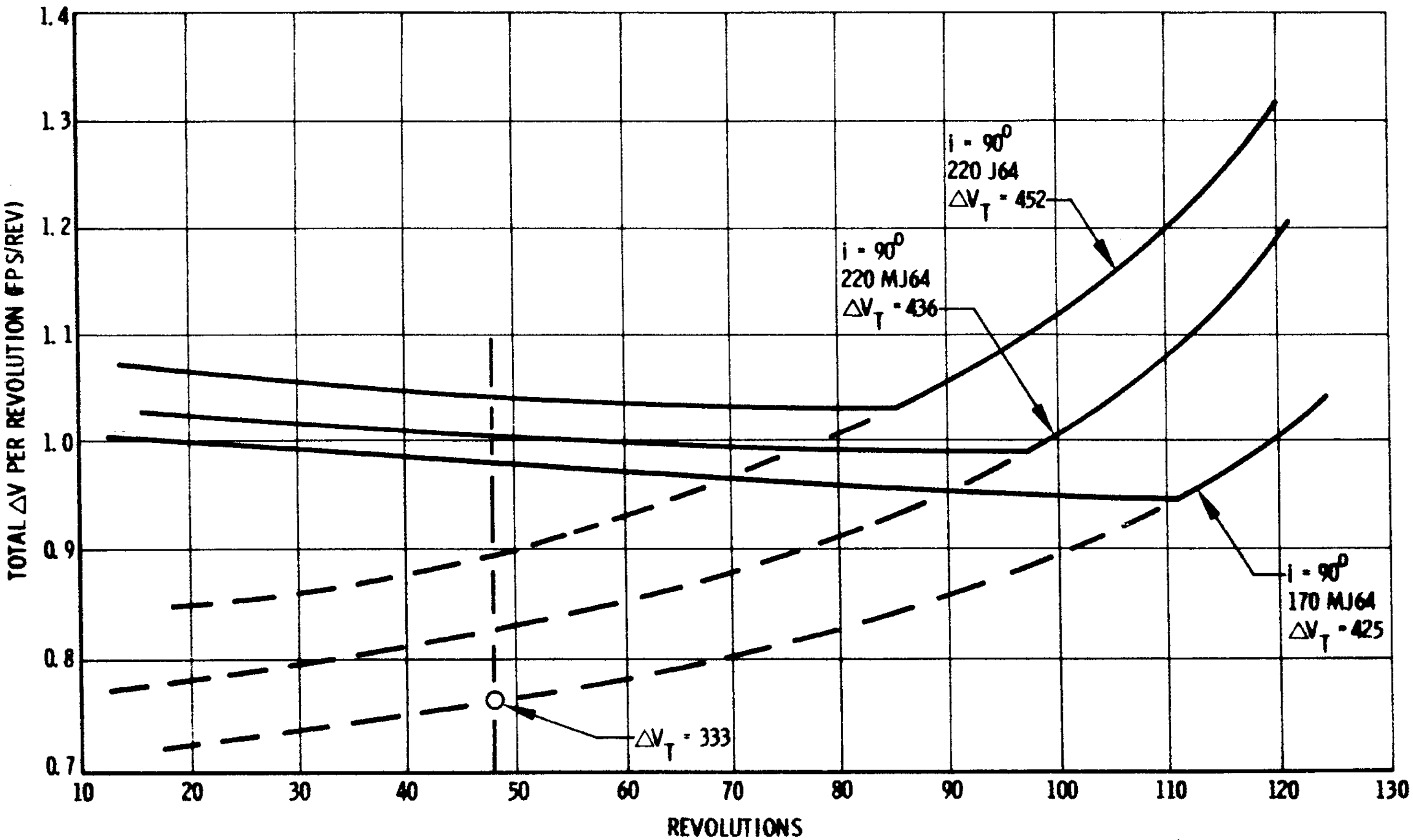


Figure B-46 Orbital Sustenance Requirements for Inclination of 90 Degrees

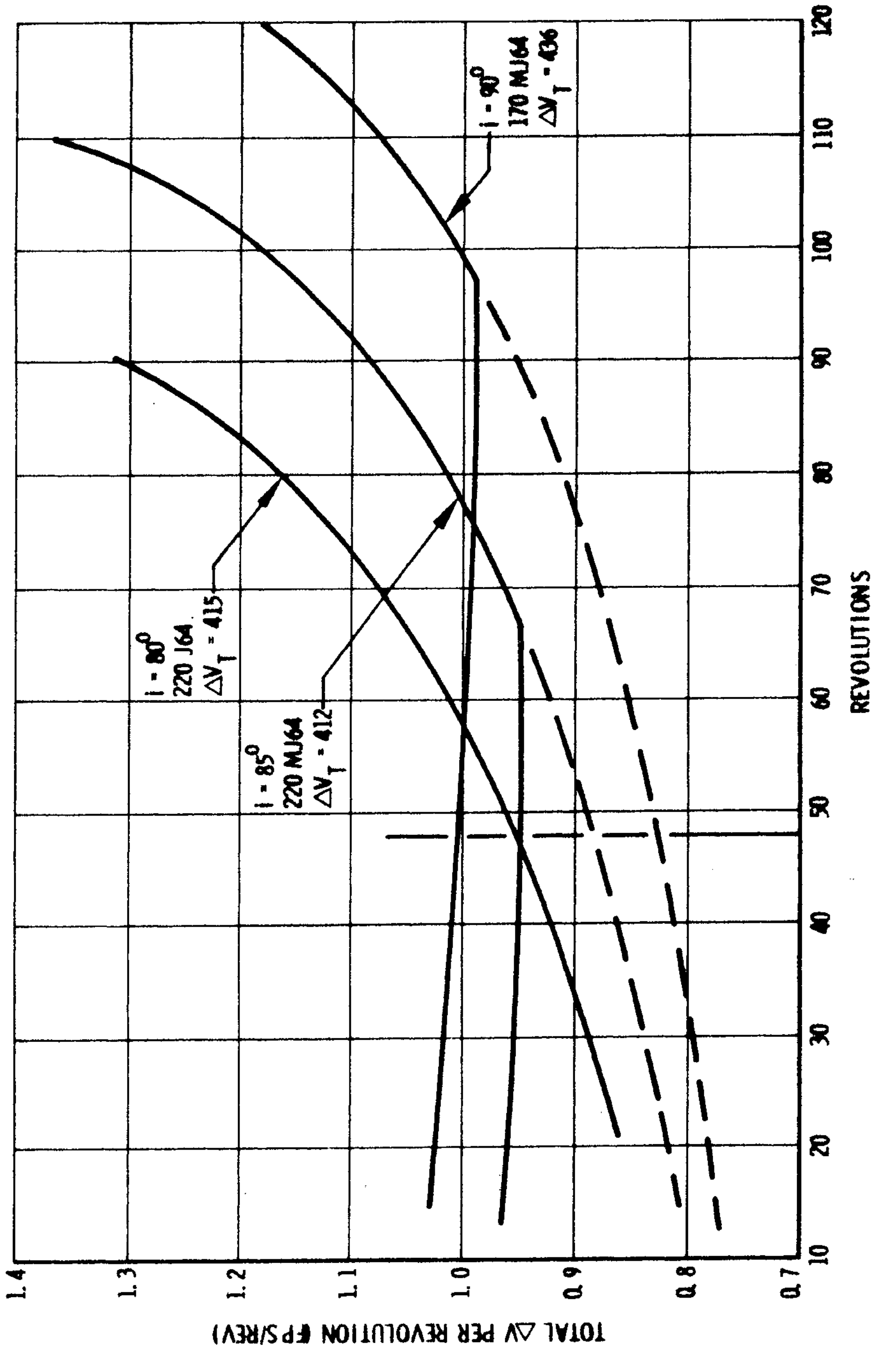


Figure B-47 Orbital Sustenance Requirements for Inclination of 80, 85, and 90 Degrees and $F_{10} = \overline{F}_{10} = 220$

used. This model is the analytical representation of the Jacchia 1964 model suggested by Walker and modified by R. W. Bruce. The value of $F_{10.7}$ used for the middle curve is also 220 watts/m^2/cps. The Bruce modified atmosphere model actually decreased the sustenance requirement over the previously used Jacchia 1964 atmosphere model as shown by Figure B-45. The lower curve of Figure B-45 is based upon the Bruce modified atmosphere model with an $F_{10.7}$ value of 170 watts/m^2/cps; this value of $F_{10.7}$ is the new mean index of solar activity based upon the new MOL schedule. The sustenance requirement is less for this curve as a result of the lower $F_{10.7}$ value (directly proportional to atmospheric mass density). The initial conditions for the three orbits exemplified by the three curves on Figure B-45 are different because of the difference in perturbations acting on the satellite as a result of the differing atmospheric environment. However, the three curves all depict orbits of the same average q value for each interval of sustenance correction. The lower curve of Figure B-45 also differs from the other two curves in that a point of discontinuity is reached at approximately a sustenance correction interval of 38 revs and the slope of the curve changes sign at approximately a sustenance correction interval of 25 revs.

Figure B-46 presents the same kind of comparison as Figure B-45 except the orbit has an inclination angle of 90 deg. The important concept shown in Figure B-46 is that the sustenance correction interval of 48 revs (only one providing an average q of 16-2/15) is further from the minimum ΔV/rev required point and that the total sustenance ΔV for the 30-day mission is higher for the 90 deg inclination angle orbit than for the 80 deg inclination angle orbit. Further, all three curves exhibit the discontinuity point previously discussed.

Figure B-47 provides a comparison of three orbits at inclinations of 80, 85, and 90 deg using an $F_{10.7}$ value of 220 watts/m^2/cps in conjunction with the Bruce modified atmosphere model. The 80 and 90 deg orbital inclination angle curves were previously shown in Figures B-45 and B-46. The 85 deg curve exhibits the discontinuity point whereas the 80 deg curve does not. The

Table B-1. Orbital Sustenance Requirements

IDEAL $q = 16\ 2/15$, $h_p = 80$ n mi $\delta_p = 55°$, $W/C_DA = 100$ psf

Atmospheric Environment		i = 80°	i = 85°	i = 90°
	$F_{10} = \bar{F}_{10} = 220$	$\Delta V_T = 444$ fps		$\Delta V_T = 452$ fps
Jacchia 1964 ATM	$A_p = 20$	$h_A = 168.9$ n mi		$h_A = 187.5$ n mi
	$F_{10} = \bar{F}_{10} = 220$	$\Delta V_T = 415$ fps	$\Delta V_T = 412$ fps	$\Delta V_T = 436$ fps
	$A_p = 20$	$h_A = 167.9$ n mi	$h_A = 176.9$ n mi	$h_A = 186.5$ n mi
Modified 1964 ATM				
	$F_{10} = \bar{F}_{10} = 170$	$\Delta V_T = 381$ fps		$\Delta V_T = 425$ fps
	$A_p = 20$	$h_A = 166.7$ n mi		$h_A = 185.8$ n mi

85 and 80 deg inclination angle curves suggest that at some inclination between these values the minimum ΔV/rev point occurs very close to the 48 rev sustenance correction interval corresponding to an average q of 16-2/15.

The curves of Figure B-47 show the total sustenance ΔV required at an 85 deg inclination angle to be slightly less than at an 80 deg inclination angle, while the 90 deg inclination angle orbit uses quite a bit more ΔV than the 80 deg inclination angle orbit. The initial and decayed orbits of the 85 and 90 deg inclination angle orbits intersect. The increased penalty of correcting the apsidal rotation of the 85 deg inclination angle orbit is nearly compensated for by the higher apogee altitude which results in a lower value of atmospheric drag on the OV. For the 90 deg inclination angle orbit, the penalty for apsidal correction is even more dominant. In general, the apsidal correction is free if the initial and decayed orbits are non-intersecting; once they intersect, a severe penalty is incurred as the orbital inclination angle is increased.

MOL sustenance studies have indicated for a q parameter of 16-2/15 that the initial and decayed orbits over the sustenance correction interval were non-intersecting when the inclination angle was $\leqq 82$ deg and intersecting for inclination angles ≤ 82 deg.

When the initial and decayed orbits are non-intersecting (see Figure B-45) both orbit correction impulses are forward along the positive velocity vector. For intersecting orbits (see Figure B-46) if two orbit corrections are employed, one impulse is forward along the velocity vector and the other is aft in the direction of the negative velocity vector. The altitude profile for a 90 deg inclination orbit over the latitude region of interest is shown in Figure B-48 for the two-orbit correction technique. The latter case necessitates turning the vehicle around. To eliminate this turnaround maneuver and also save sustenance propellant, a one-impulse technique (see Figure B-49) has been studied which essentially corrects only that amount of apsidal rotation which is obtained free in the process of correcting the

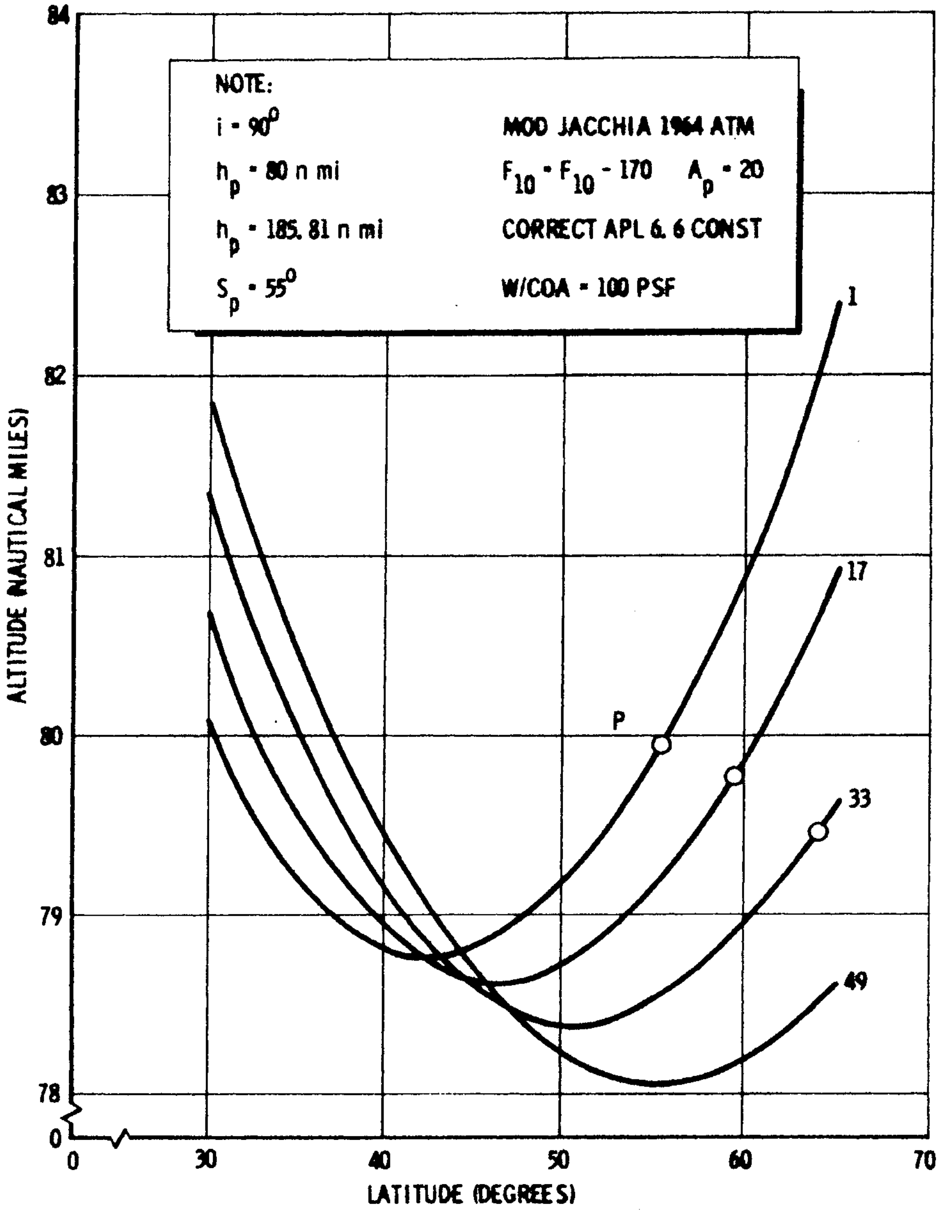
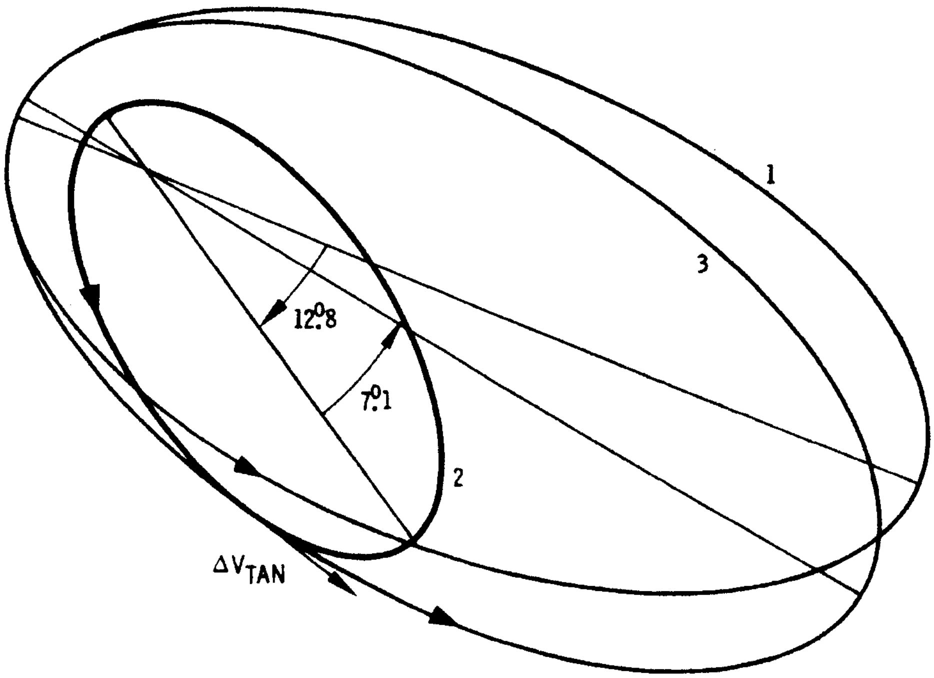


Figure B-48 Altitude Profile



PERIGEE HISTORY			
Day	δ P		ΔV, fps
0	45°N		
3	57.5	50.7	32.8
6	63.8	56.7	35.5
9	69.8	62.4	36.7
12	74.9	67.8	36.0
15	80.2	45.0	107.5
18	58.7	51.3	35.1
21	64.4	57.3	35.5
24	70.3	63.0	36.7
27	75.4	68.4	36.0
30	80.7		
TOTAL			391.8

Figure B-49 Single Impulse Sustenance Tangential Application semi-major axis every three days. By doing this, perigee is allowed to drift north a certain amount every three days, thereby necessitating initial injection conditions, which place perigee further south.

Perigee for this scheme is allowed to drift north to a maximum latitude of approximately 80 deg. This maximum perigee latitude is achieved on day 15, and at this time a two-burn orbital maneuver essentially returns perigee to the original injection condition. The semi-major axis is also corrected to the original condition during this orbit maneuver. In this way, the desired average value of q over the three-day sustenance interval can be maintained throughout the entire 30-day mission with only one two-burn maneuver. Essentially, eight one-burn maneuvers and one two-burn maneuver with only one reorientation of the vehicle are required. Figure B-50 shows the altitude profile using this concept over the area of interest for the first 15 days of a 30-day mission. The solid lines depict altitude profile just after a correction, while the dash lines depict altitude profile for the rev just prior to the correction impulse. Initially, on rev 1 perigee was located at 45 deg N (descending) at an altitude of 80 n mi. The average value of q over the sustenance interval was 16-2/15 for a polar orbit. Table B-2 shows a comparison of ΔV used between this concept and the two-impulse technique where perigee latitude is totally corrected each time back to the initial position value at 55 deg N latitude. The one-burn concept is more efficient by saving approximately 33 ft/sec, as shown in Table B-2. (The comparison is even more favorable than indicated since turnaround propellants are not included in Table B-2.) This concept is valid for only intersecting initial and decayed orbits. For non-intersecting orbits, two orbit corrections will always be required but the vehicle will never have to be turned around.

The altitude profile differences resulting from the one-impulse technique (as opposed to the two-impulse technique) for intersecting initial and decayed orbits can be readily seen by plotting Figure B-48 onto Figure B-50. These differences appear to be small.

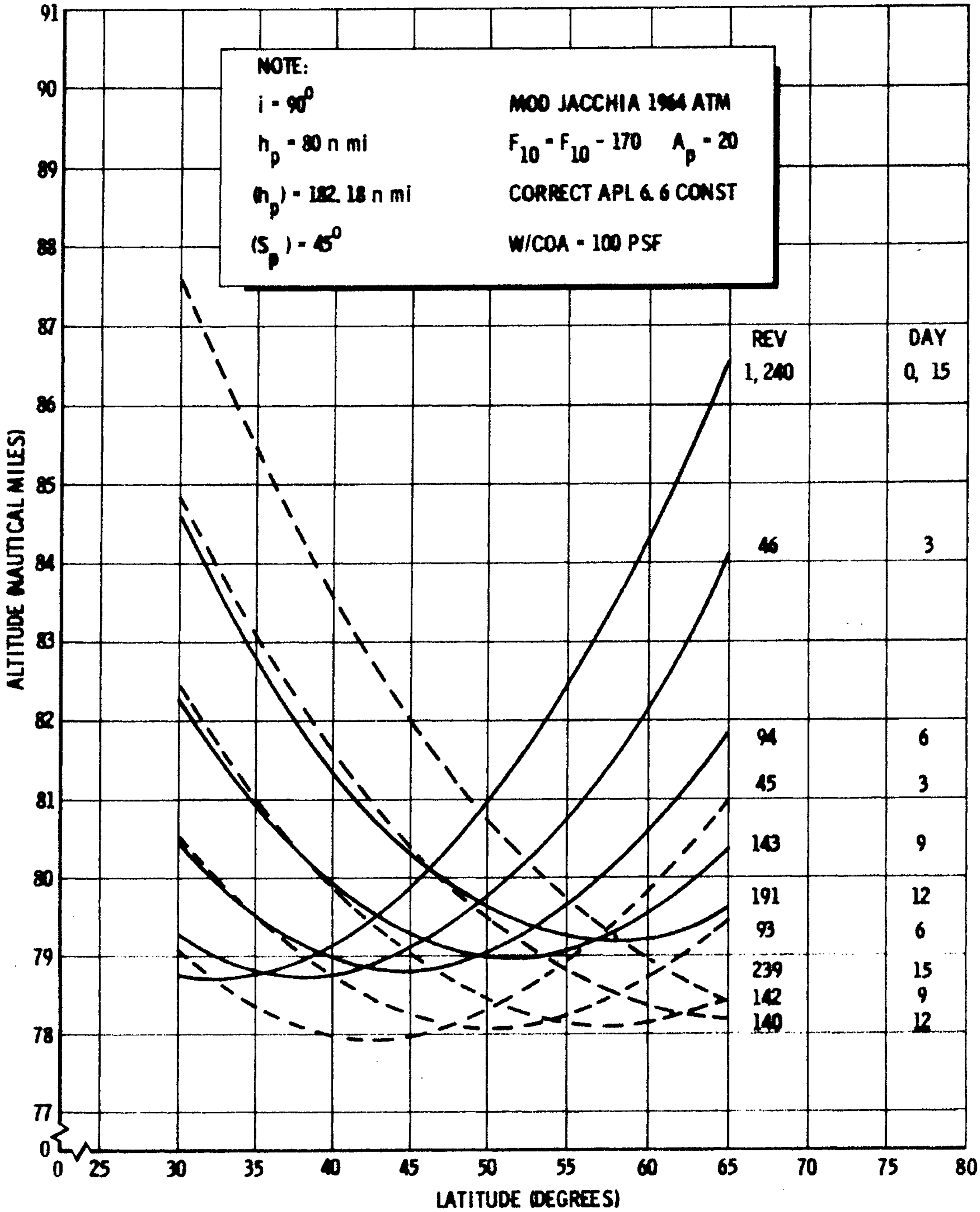


Figure B-50 Altitude Profile, Tangential Transfer Case

Table B-2. Velocity Comparison for Polar Orbit

Correction Subcycle	Total Velocity Increment (ft/sec)	
	Two-Burn* Method	One-Burn/Two-Burn** Method
1	43.9978	32.7826
2	91.2773	68.2812
3	139.5209	104.9923
4	186.8004	140.9871
5	235.0440	248.5125
6	282.3235	283.6093
7	329.6030	319.1498
8	377.8466	355.8866
9	425.0261	391.8946

* 1. Perigee returned to 55 deg N every correction subcycle

** 2. Initial perigee at 45 deg N

The total sustenance velocity can be reduced drastically by increasing the perigee altitude. Several cases investigating this tradeoff have been generated and it was found that the total velocity requirement for a 30-day mission decreased approximately 20 fps per increase of 1 n mi in perigee altitude from 80 n mi. The average q parameter over the sustenance interval of 48 revs was assumed constant at 16-2/15 for this evaluation, and a 90 deg orbit inclination angle orbit was assumed. The two-burn, 180 deg circumferential technique was employed.

The effect upon total sustenance velocity of increasing inclination from 90 to 100 deg to accommodate the SP/DR envelope decreased the total velocity required for a 30-day mission by 2 fps, and hence, is considered negligible. The sustenance technique employed was the two-burn, 180 deg circumferential with an orbit perigee of 80 n mi and the average q value of 16-2/15 over the sustenance interval of 48 revs.

Sustenance studies are continuing at Aerospace. Tools to be used in determining O/As during the flight will be developed as a result of these studies.

APPENDIX C

CHARTER: FLIGHT OPERATIONS PLANNING GROUP

C.1 PURPOSE

This document establishes the Flight Operations Planning Group (FOPG) and defines its organization, functions, and responsibilities.

The primary function of the FOPG is the integration and coordination of the orbital aspects of MOL Flight Operations concepts with AVE and AFSCF operating concepts, hardware, and software systems. Further, where a concept places a requirement upon the AVE and/or AFSCF that cannot be met by existing design plans, the FOPG will either modify the concept or present the trade-offs involved to MOL SPO management for direction as appropriate.

C.2 TERMINOLOGY

The fundamental terms with which the FOPG will be concerned are defined as follows:

a. Mission Director (MD) - MOL SPO officer responsible for the conduct of overall MOL test operations.

b. Flight Director (FD) - MOL SPO officer responsible for the conduct of MOL flight operations for the duration of the MOL. He is responsible for integrated MOL planning and training.

c. MOL Field Test Force Director (FTFD) - AFSCF officer responsible for planning and integration of MOL operational requirements on the AFSCF, for the control of AFSCF operational support to the MOL program, and for all AFSCF training necessary to accomplish same.

d. Flight Phase - The period of MOL test operations beginning at liftoff of the MOL flight vehicle and ending with laboratory vehicle disposal.

e. MOL Flight Operations - The operations (including planning and training) required to ensure successful accomplishment of those objectives of the program occurring during the flight phase of the MOL test operations. This would include the operations (including planning and training) conducted at the MCC. This includes the operations of the MD and the FD and the latter's interfaces with launch operations, flight crew operations, and the operations of any outside agency. Exclusive of planning and training, MOL flight operations for a given flight start with the beginning of the countdown during the launch phase and are concluded with the writing of the Post Operations Assessment Directive (POAD).

f. MCC Hardware - The control, display, communications and administrative supplies and equipment in the Mission Control Center (MCC) necessary to conduct Mission Control functions.

g. MCC Personnel - MOL SPO, AFSCF or contractor personnel who direct, operate, or maintain MCC hardware, software, plans, or procedures at the MCC during the conduct of MOL flight operations.

h. Flight Support - MOL SPO, AFSCF, or contractor personnel, hardware, software, or procedures which support flight operations.

i. Flight Operations Documentation - Program documentation outlined in the MOL Test and Operations Documentation Plan which pertains to flight operations.

C.3 ORGANIZATION

The membership of the FOPG will include representation from the MOL SPO, Aerospace MOL SEO, MOL associate contractors and the AFSCF. Each of these organizations will provide regular representation in all appropriate areas of interest as required and will be responsible for performing the following specific functions:

a. MOL SPO - Chair the FOPG and establish the agenda, place, and representation appropriate for each meeting.

b. AFSCF Operations - The MOL FTFD office will be represented at all FOPG meetings, and will serve as the central authority for AFSCF operational matters.

c. AFSCF Engineering - Provide engineering representation to the FOPG, to act as a consultant on AFSCF engineering capability, to provide MOL operations visibility to the AFSCF and, where practicable, support FOPG trade studies.

d. Aerospace/MOL - Serve as technical advisor to the chairman and act as Secretariat for meetings held at Air Force facilities.

e. MOL Contractors - Represent system segment responsibilities of associate contractors. Act as Secretariat for meetings held at contractor facilities.

C.4 AUTHORITY

The FOPG is authorized, through its members, to draw upon the manpower resources of the represented organizations as required to assist the Group in fulfilling its responsibilities. There is no intent that the FOPG establish any formal operational support requirements on flight support organizations, except through the accepted channels (i.e., ORD, PRD, etc.).

C.5 RESPONSIBILITIES

The FOPG is responsible for coordinating and integrating the activities associated with the development of MOL Flight Operations Planning. Specific areas of interest will include:

a. Assuring that flight operations concepts are consistent with MOL Program requirements, MOL AVE, and AFSCF capabilities.

b. Ensuring that requirements for the MCC are stated and developed in a timely manner.

c. Developing flight specific test objectives and translating them into flight plans and rules for their accomplishment.

d. Maintaining cognizance of flight operations documentation and operations procedures to determine progress toward the completion and validation of flight test objectives.

e. Resolving orbital requirements conflicts among the associate contractor/government agencies.

f. Assuring that the MCC personnel training is consistent with the operations requirements.

g. Coordination with the segment project officers on AVE requirements and constraints.

h. Coordination with other groups to properly interface their activities with Flight Operations and flag incompatibilities for resolution by the proper authority as indicated below:

1. Software Management Group - Review action of the SMG and its subgroups to ascertain the compatibility of concepts, data flow, and software compatibilities with the flight operations.

2. Flight Vehicle Timeline Working Group - Review the FVTL for consistency with flight operations concepts. FVTLWG will be incorporated as a subgroup to the FOPG at L-9 months.

3. Orbit Test Working Group - Review action of the OTWG to ensure its implementing the FOPG requirements.

4. Ascent and Reentry Working Group - Review action of the ARWG to ensure consistency with orbital operations.

5. Other Groups (formal or informal) - Review actions by other groups which develop operational concepts to ensure compatibility with flight operations.

C.6 IMPLEMENTATION

Action items will be assigned by the chairman to members of the FOPG. Any action item for a contractor that is not within the scope of his contract will be brought to the attention of the chairman for assignment through the appropriate Project Officer and Contracting Officer.

All action items will be assigned in consonance with the concept that accomplishment of MOL test objectives is a MOL SPO responsibility and that AFSCF system support to MOL and detailed operations planning is the responsibility of the AFSCF.

C.7 PROCEEDINGS

The FOPG will meet on an as-required basis on the call of the chairman. Agendas will be distributed as far in advance of meetings as possible; however, at a minimum, they will be distributed seven working days prior to the meeting.

These meetings will provide a mechanism where operational problems can be resolved and program policy direction issued. Subgroups may be formed to work specific problems. Results of subgroup deliberations will be presented to the FOPG members for approval.

The FOPG will also provide for an exchange of information between participants that will allow each contractor to coordinate his flight operations requirements before contractual submission.

APPENDIX D

RTS-STC DOWNLINK DATA RETURN MODES

PHILOSOPHY AND DESIGN CRITERIA

D.1 PURPOSE

To establish the philosophy upon which to base the formation of downlink data modes for the return of data from the tracking stations to the STC during orbital operations.

D.2 DEFINITIONS

a. Downlink Vehicle Data - All data which is transmitted from the OV to the tracking stations. This includes all telemetry, voice, and tracking data.

1. Real Time - That downlink data which is composed of information (voice and/or telemetry) which has not been prerecorded on the vehicle and which truly represents status or events which are occurring during the time of the tracking station contact. This would include current status of the ADC memory and angle tracking data.

(a) Current Real Time - That real time data which is to be processed and returned for display and/or processing at the STC as it is being recieved and stored at the tracking station.

(b) Stored Real Time - That real time data which is stored at a tracking station for subsequent processing and replay and/or shipment to the STC.

2. Recorded - That downlink data which is composed of information (voice and/or telemetry) resulting from the playback of any OV tape recorder.

(a) Current Recorded - That recorded data which is processed and returned for display and/or processing at the STC as it is being received and stored at the tracking station. At this time, no use is envisioned for this capability during MOL flight operations.

(b) Stored Recorded - That recorded data which is stored at a tracking station for subsequent processing and replay and/or shipment to the STC.

b. Downlink Information Returns - The processing and transfer of downlink data from a tracking station to the STC. These returns are further defined in order of priority as follows:

1. Immediate - The return of information resulting from the processing of data which occurs during a station contact in support of a pass plan and which is not the result of a replay of data previously stored at a tracking station. For MOL flight operations, it is expected that this return will include only information which has been processed from selected current real time downlink vehicle data.

2. Postpass - Those information returns which occur by electronic means within 15 min of station fade. Post-pass information returns will consist of processed stored real time downlink data and/or processed stored recorded downlink data.

3. Deferred - Those information returns which occur by electronic means subsequent to postpass information returns.

4. Hard Copy - The information return which involves the physical shipment of data from the tracking station to the MCSF.

c. Pass Plan - The approved plan for the conduct of the operation during the time the OV is scheduled to be in actual contact with a tracking station.

d. Data Modes - The provisioning for selection and processing of groupings of individual data points (i.e., measurands, parameters, or measurements) for achieving downlink information returns.

D.3 GROUND RULES

a. All data requirements at the STC will be satisfied by immediate, post pass, or deferred information returns and/or by reduction from previously returned hard copy.

b. Under normal circumstances, the only immediate data required at the MCC will be that necessary to accomplish the pass plan. The specific nature of the data required will depend upon the content of the pass plan.

c. The capability to command the vehicle will always be a part of any station contact for telemetry acquisition whether or not commands are included as part of the pass plan.

d. All data modes will be designed to efficiently use the capacity of the communications links between the tracking stations and the STC. When a high priority data requirement does not efficiently use the capacity of the system, it may be augmented by non-conflicting lower priority data as appropriate.

e. Modes will be formed to contain homogeneous data from the standpoint of satisfying requirements on a chronologically prioritized basis (i.e., data required during the same time period at the STC should be included in the same mode where practicable to facilitate its return at the same time).

f. The determination of the chronological priority of data will nominally be based upon the established priority of the FV instrumentation involved. It is expected that the instrumentation priorities will be established as indicated in paragraph D.6.

g. As a general rule, a data mode will be assigned the lowest downlink information return priority consistent with the time requirement for the data contained in the mode.

h. Data returns will be effected as early as possible, consistent with priority, to fully use the total capacity of the STC within the constraints of the multi-operational environment.

D.4 MODE HANDLING CAPABILITIES AND CONSTRAINTS

To be supplied.

D.5 DATA MODE DESIGN REQUIREMENTS

a. All mode designs should be based upon the time period when it is intended to be used as follows:

   1. Modes designed for immediate use must contain all required operational data (see paragraph D.6), including command verification data.

   2. Modes designed for postpass use should normally contain diagnostic data and possibly some operational data.

b. All tracking data will be included in a separate, high priority postpass data mode.

c. All modes will be designed to minimize the time required for their return to the STC over the 2400 bit lines.

d. The finite values of any measurement which is limit checked at a tracking station should be reported to the STC on a periodic basis under normal vehicle operating conditions. The frequency of reporting will depend upon the nature of the data involved.

e. Where modes report values of measurements only when out of limits (by exception), the modes should be sized to assure: (1) reasonable multiple out-of-limit conditions will not oversaturate the 2400 bps communication limitation; (2) the measurements are prioritized in a manner that will permit reporting the high priority exceptions first, but should not limit reporting of a minimal sample of all exceptions during the operation of the mode.

D.6 INSTRUMENTATION PRIORITY CRITERIA

D.6.1 Goal

To provide the criteria upon which to base the selection of FV instrumentation.

D.6.2 Ground Rules

a. To assist in the establishment of telemetry criteria, the primary purposes of the orbital flight test are hereby defined as:

1. Perform the on-board experiments.

2. Demonstrate the on-board experimental capability.

3. Assess the contribution of the flight crew to a., and b., above.

b. The primary functions of the MOL instrumentation system are to accomplish the following:

1. Provide data necessary to control the on-board experiments.

2. Provide data to demonstrate the on-board experimental capability.

3. Provide data required to assess the contribution of the flight crew.

4. Provide data critical to crew safety.

c. The inclusion of or degree of redundancy of an instrumentation point must be consistent with its priority as established herein.

D.6.3 Instrumentation Category Definitions

a. Life Critical - Instrumentation that provides data to identify a failure which could jeopardize crew safety.

b. Control Critical - Instrumentation that provides data to identify the state or status of any function or subsystem required to maintain vehicle control.

c. Experiment Critical - Instrumentation that provides data which is required to conduct the on-board experiments.

d. Experiment R&D - Instrumentation that provides data required to demonstrate the on-board experimental equipment capability.

e. Crew Contribution - Instrumentation that provides data required to assess the contribution of the flight crew toward mission success.

f. Other - Instrumentation that provides data not included in the above categories.

D.6.4 Operational

Those measurands which are used in the decision making process to determine action required by ground personnel or of the crewman.

D.6.5 Diagnostic

Those parameters which define the present real time operational configuration or status of the spacecraft, or serve to isolate malfunctions, but do not in themselves indicate that action be initiated.

D.6.6 Evaluation

Those measurands used to determine system performance and do not assist in decision making or in defining present configuration.

D.6.7 Instrumentation Priority

Based upon the above ground rules and definitions, instrumentation priorities are established as shown in Table D-1.

D.6.8 Mission-Critical Telemetry

Mission-critical telemetry is defined as that telemetry which must be sustained to allow mission payload operation to continue in the non-degraded mode, assuming that all subsystems other than telemetry are functioning in their nominal manner. Only those measurements which satisfy this definition shall be permitted in categories defined in paragraph D.6.3 a., b., and c.

It is the intent of the board that the telemetry subsystem be designed to preclude single point failure for these categories.

Table D-1. Instrumentation Priority

Instrumentation Type	Operational	Diagnostic	Evaluation
Life-Critical	1	7	13
Control-Critical	2	8	14
Experiment-Critical	3	9	15
Experiment R&D	4	10	16
Crew Contribution	5	11	17
Other	6	12	18

APPENDIX E
MOL HARDWARE DESCRIPTION

E.1 INTRODUCTION

The scope of the FTOP does not generally include hardware description. However, this Appendix includes a brief description of the DORIAN Mission Payload System Segment* since it is not documented elsewhere in readily accessible form. A hardware description of the laboratory vehicle and Gemini B is available in the MOL Data Book (Ref 23). This Appendix is further divided as follows:

E.2 Mission Payload System Segment

E.2.1 Mission Control Section (GE AVE)

E.2.2 Photographic Section (EK AVE)

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* The MPSS no longer exists, per se, but has been redesignated as two separate segments: (1) the Mission Module System Segment (MMSS), and (2) the Payload System Segment (PSS). This Appendix will be corrected to reflect this new terminology in the next issue.

E.2 MISSION PAYLOAD SYSTEM SEGMENT

The mission payload system segment (MPSS) is contained in the LM and/or MM, depending on the specific function concerned. The MPSS consists of: (1) mission control section (GE AVE); and (2) photographic section (EK AVE).

With the exception of the camera and associated film supplies and takeups, on-board film processor, ATS, visual optics, and the control consoles, the MPSS AVE is housed in the MM. The MM forward section (MMFS), ~14 ft long, contains most of the mission-related AVE provided by GE (e.g., the star trackers, gimbal, tracking mirror mount, MMFS thermal control system, and associated equipment). The tracking mirror is provided by EK. The MM aft section (MMAS), ~23 ft long, houses most of the EK optical equipment (see Figure E-1).

E.2.1 Mission Control Section (GE AVE)

Control of the MPSS dynamic elements is the responsibility of GE. The following functions will be performed: (1) establish vehicle/target location relationship; (2) establish vehicle attitude reference; (3) acquire targets; (4) provide two-degree-of-freedom motion to tracking mirror; (5) track targets with high precision; (6) provide commands to camera; (7) control tracking mirror bay thermal environment; (8) regulate and distribute electrical power to the mission payload; (9) provide mission payload command and control data handling.

The major GE AVE subsystems comprising the MPSS mission control section are described below:

a. Navigation and Control (N&C) Subsystem - The N&C subsystem generates the commands and provides the drives for pointing the primary optics tracking mirror (TM) and the ATS mirrors.

   The laboratory vehicle ACTS, supplied by DAC, maintains the vehicle within specified attitude and rate constraints. The ACTS also supplies attitude and rate reference to the computer as an aid in generating the MPSS pointing commands.

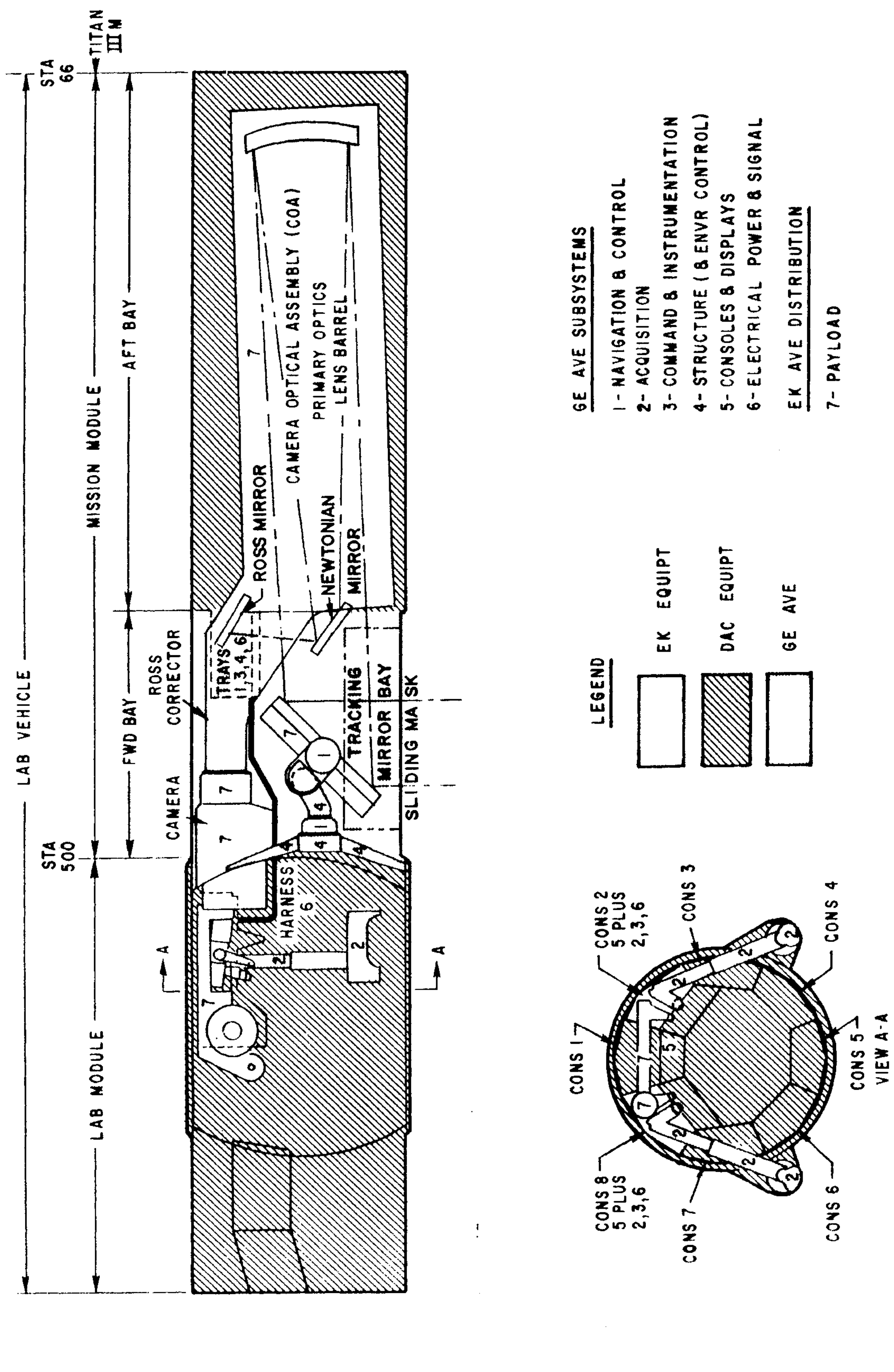

Figure E-1 Mission Payload System Segment

The N&C reference system includes two star trackers to provide precise orientation of the OV with respect to the celestial reference frame. The star-tracker information and the ACTS rate information are used in computing a fine attitude reference (FAR). An LGA measures drag effects, permitting on-board correction of the ground-predicted vehicle ephemeris.

Residual image motion due to software and hardware limitations is nulled by a two-axis IVS in the primary optics tracking mirror loops. Both the ATS and primary optics tracking mirror loops must operate smoothly and precisely over the angular and rate ranges required.

Rate and pointing corrections to the ATS and primary optics control loops may be accomplished by the flight crew. Computer learning via flight crew tracking is also provided for in the N&C subsystem.

When the OV is not over the target areas, the tracking mirror is shielded by a door for thermal protection.

Although the main optics tracking mirror drive mechanism provides line-of-sight coverage ot ± 40 deg in roll and ± 30 deg in pitch, the mechanical stops and attitude control errors limit the smooth track and photographic capability to ± 37.5 deg in roll and +17 to -24 deg in pitch.

b. Structures and Thermal Control Subsystem - This subsystem consists of mountings, bearings, and other hardware which comprise the gimbal structure to support and allow movement of the TM, and the environmental control necessary to assure proper functioning of the tracking system and to minimize TM distortion. The gimbal must provide:

1. Support for the TM and assembly during launch.

2. Housing for a control system capable of simultaneous pitch and roll motion.

3. The necessary stiffness required to maintain a sufficient margin between the natural frequency of the control system and the mounting structure.

4. The capability of operating in a 1-g field while maintaining on-orbit alignment.

c. Acquisition and Tracking Scope (ATS) - The ATS enables man to improve the quantity and quality of reconnaissance data by minimizing the degrading effects of adverse conditions. Crew members, using the ATS, can minimize the effects of target-location error, ephemeris error, etc., by appraising targets for intelligence values, rejecting pre-programmed targets obscured by weather or considered less valuable than other observed targets, and driving the TM to more valuable alternate targets. The crew members can also enhance photographic quality by refining the automatic pointing. In addition, the crew can indirectly point and minimize the motion of the main optics by operating the ATS in the "slaved" mode. This feature would be utilized, typically in a contingency mode where both the visual optics and the IVS are inoperative.

The ATS provides a maximum ground resolution of about 3.6 ft for detailed target study in a 0.5 deg field of view. The two ATSs operate independently and have a computer-driven servo system with an automatic pointing accuracy of eight arc-minutes. Two ATSs are provided to allow the crew members to inspect different areas simultaneously. The limits of the tracking angles are +70 to -30 deg in pitch and ± 45 deg in roll.

d. Consoles and Displays Subsystem - The consoles and displays associated with the mission payload (MP) (see Figure E-1) are physically located in the LM pressurized compartment. They essentially provide the visual and mechanical man-machine links to allow the crew to identify, monitor, and control out-of-tolerance conditions in the MP.

Crew stations are located in Bays 2 and 8 which contain display and operating panels for the visual optics, ATSs, cue displays, and magnification controls. Each crew station provides access to one ATS and to visual optics viewing through the primary telescope.

e. Communications, Command, and Instrumentation Subsystem - The heart of the MP communications, command, and instrumentation subsystem is the MDAU which provides the interface for command and reaction between the MP and the laboratory vehicle data management subsystem. Two redundant MDAUs are wired with the two redundant ADCs in the laboratory vehicle data management subsystem to provide high reliability.

The MM telemetry system also monitors all the MPSS systems and provides this information to the LM telemetry equipment for recording or real-time transmission to the ground.

f. Electrical Power and Signal Distribution Subsystem - This subsystem will:

1. Receive unregulated nominal 28 vdc power from the LM central power system (CPS) and distribute this power to the GE AVE equipment and to the GE AVE/EK AVE power interface.

2. Provide for current and voltage monitoring of the unregulated dc power received from the CPS across the LVSS/MPSS power interface.

3. Provide for distribution of signals among the MPSS equipments and from the MPSS to the LVSS.

E.2.2 Photographic Section

E.2.2.1 Operational Characteristics

The photographic section is comprised of optical, electrical, and structural components as required to acquire, from orbit, high-quality photographic reconnaissance pictures suitable for stereo viewing. The photographic section will provide a static lens-film resolution ≥[redacted] line-pairs/mm. This is consistent with [redacted] resolution from 80 n mi, nadir target viewing, with scene illumination at 890 ft/lamberts, 2:1 target-to-background contrast at the entrance pupil, and using film similar to type 3404 but with an exposure index of 6.0. The photographic system will be capable of both northbound and southbound orbit-passage photography from altitudes of 70 to 230 n mi. It will be operable in the manned/automatic mode or in automatic mode. The option of visual observation at high magnification through the primary optical elements shall be available for the manned/automatic mode.

The baseline MOL photographic section consists of the primary optics with necessary support structure; provision for photo recording the imagery achieved; film processing and inspection apparatus; and necessary electronic, thermal, and mechanical devices and data channels for performance management. The photographic section will be supported by appropriate ground equipment for operations and preflight or postflight activities.

E.2.2.2 Technical Description

The primary optics consist basically of a reflecting Newtonian-type telescope modified with refracting correctors to a Ross telephoto configuration.

A 70 in. diameter plano TM, servo-driven by the mission control section, determines the telescope field of view. High quality reconnaissance photographs can be achieved within the solid angle and control dynamics constraints of the mission control section equipment. Quality photographs can be obtained within the smaller solid angle within which effective tracking can be maintained.

The camera, located in the LM for crew access and control ease, is of the frame type to facilitate crew usage of the imagery and to enable incorporation of additional control of the platen for across-the-format image motion compensation. Across-the-format IMC improves off-axis resolution which is otherwise limited by prespective changes during exposure intervals. The recorded image field is circular (9.4 in. dia) with reference marks and pertinent data recorded on a frame-by-frame basis within a superscribed square area of film. Film exposure control is provided by a focal plane shutter with six alternative slit-width steps under program selection. The maximum frame rate will be one primary frame/sec.

In the manned/automatic configuration, adequate film for 15,000 frame exposures will be provided. This may consist entirely of a single primary film type or of not less than 12,000 frames of primary film and up to 3000 frames of preselected secondary film types (color, special high-speed emulsions, etc.). Secondary film, when used, can be substituted by interrupting the primary film usage, introducing briefly a second platen under additional timing constraints.

In the automatic configuration, enough primary-type film is provided for 30,000 frames; there is no secondary-type film option. This configuration automatically transports the exposed film and loads to the DRVs for remotely controlled data return from orbit.

In-flight processing equipment is provided for crew use in the manned configuration. This will permit on-board processing of limited samples of primary or appropriate secondary film footage. Viewer capabilities for inspection of processed samples are provided.

The primary optics imagery can be inspected or used by the crew in an IMC loop. This option employs supplemental lenses which can present a view at one of four magnification steps to an eyepiece at either operator station. Each eyepiece has an apparent 40 deg field of view corresponding to an external scene field angle of 0.32 deg at lowest magnification and less at higher magnification. Five percent of the primary image energy is diverted to this capability (and/or to the alternative automatic IVS).

Environmental control measures for required thermal stabiliziation of the COA during prelaunch, boost, and on-orbit phases are mandatory and provided. To supplement available passive measures, active control (zone to zone) is included, as well as operational disciplines to limit undesirable fluxes.

Special measurement and controlled adjustment provisions integral to the photographic section correct, validate, and maintain critical optical and mechanical parameters for payload internal functions, or for external navigation and control referencing purposes.

APPENDIX F

GLOSSARY OF TERMS, ABBREVIATIONS AND ACRONYMS

F.1 TERMS

Selected MOL words and terms are defined in this Appendix. Because these words and terms may have been used on other programs in different context and with different definitions, associate contractors and agencies responsible for the operational documents described in the MOL System Test and Operations Plan (Ref. 1) should use these terms as defined below.

Abort Modes

Mode A	Mode A abort is employed from the launch pad through about 30 sec of flight, or an altitude of approximately 10,000 ft. Mode A abort is implemented by terminating thrust on the launch vehicle, salvo-firing all six retro-rocket motors to separate the Gemini B from the launch vehicle, and subsequently ejecting the crew from the spacecraft on the ejection seats. The crew will then descend on their personal para-chutes to a land or surf landing.
Mode B	Mode B abort is employed from about 10,000 ft altitude to a point during the ascent where a vehicle velocity of approximately 24,000 ft/sec is attained. A Mode B abort is implemented by termi-nating thrust on the launch vehicle, rideout to diminish dynamic pressure on the spacecraft if necessary, salvo-firing six, four, or two retrorocket motors, as required, to separate the spacecraft from the launch vehicle and landing by use of the Gemini B parachute system.

Mode C	Mode C abort is employed to provide recovery from an abort at high altitude and velocity. A Mode C abort is implemented by separating the Gemini B from the laboratory vehicle by use of the separation motors, turning the spacecraft to retrofire position, timing retrofire to achieve desired landing point, retrofiring, reentry, and water landing via the spacecraft parachute system.
Mode D	Mode D abort is employed to provide for: 1. Attainment of "best possible orbit" in a late ascent phase abort case to permit partial attainment of primary mission objectives, and/or 2. Attainment of sufficient orbital lifetime to assure crew recovery at a planned recovery area. This Mode will utilize the laboratory vehicle ACTS to provide a posigrade velocity increment to permit attaining orbital velocity. The Mode D abort regime shall begin at a point in the trajectory where the available ΔV from ACTS will permit attaining at least Item 2., above. Subsequent to achieving orbital velocity, normal separation of the Gemini B from the laboratory vehicle, retrograde, reentry, and water landing shall then be accomplished at the appropriate time. Instrumentation and displays are provided to permit crew determination of required ΔV and to control the laboratory vehicle ACTS to apply the required velocity increment.
Access Time	See "Recovery Times".
Active Alternate (Target)	See "Alternate Targets".

Acquisition and Tracking Scope	Provides the crew with a visual means of target selection through a separate optical system. A target sequence will be selected for viewing through the ATS which contains two paths: (1) One path will contain all the primary targets and some selected alternate and visual intelligence targets. (2) The second path will contain only alternate and visual intelligence targets.
Activity Indicators	Certain observed target characteristics that are predefined and if found to be present through crew inspection, make that target of relatively high intelligence value.
Advanced Data Subsystem (ADS)	See "Satellite Test Center".
Aerospace Corporation	General Systems Engineering/Technical Direction Contractor. Performs GSE/TD for the MOL SPO and the T-III SPO.
Air Force Satellite Control Facility (AFSCF)	Consists of a worldwide net of seven operating locations plus the Satellite Test Center which provides telemetry, tracking, command and voice facilities for on-orbit control of satellites.
Air Force Western Test Range (AFWTR)	See "MOL Facilities at VAFB".
Alternate Target	Any preselected, non-primary target which can be observed through an ATS and photographed by the primary optics. Alternate targets are selected by the ground-based mission planning software as a function of their geometrical relation to the primary optics path, expected value of mission enhancement, and specific User requirements. Alternate targets may be selected for viewing for several reasons, including (1) observation of activity, and (2) to find a clear target if the primary is obscured.

Active Alternate	Those alternates which have predefined activity indicators.
Weather Alternate	Those targets which are observed by the flight crew and selected for photography only when weather conditions dictate a change of target to secure a visible target for photography. The primary difference in implementing active and weather alternates lies in the amount of scheduled dwell time allocated for viewing each target. In principal, alternates being viewed for weather require less recommended viewing time than alternates being viewed for activity.
Ascent Phase	See "Phase".
Automatic Mode	Payload operation is completely automatic, controlled by ground-generated commands and data. (Applicable to flights 6 and 7.)
Automatic Subsystem Generated Command	That command issued by an active control system to automatically change the function/state of a subsystem element.

Backup Command	That command sent from the ground to the vehicle, via RF link, which is routed to and recognized only by the backup decoder (BUD). Backup commands may be executed immediately (similar to RTCs or at a later time (similar to SPCs).
Basic Target Group	See "Target Groups".
Beta (β)	Orbital solar incidence angle (deg).

Candidate Targets	See "Processing Status".
Category I, II, III Tests	See "Test Programs".
Combined Systems Test	See "MOL Facilities at VAFB".
Command	Digital words which produce one or more instantaneous function/states in the vehicle.
Communication Links/Lines/Relays	See "MOL Facilities at VAFB".
Computer Data	Data sent from the ground to the vehicle via RF link, that are stored for use in the ADC.
Computer-Generated Command	Command generated in the ADC from computer data. Computer-generated commands may be executed immediately (similar to RTCs) or at a later time (similar to SPCs).
Comsat	See "MOL Facilities at VAFB".
Contingency	See "Recovery Abort Modes".
Contingency Unknown	See "Flight Abort".
Contributory Parameters	See "Mission-Critical Telemetry".
Contributory Telemetry	See "Mission-Critical Telemetry".
Countdown (Launch)	A single function to encompass all countdown activities. The terms precount, midcount, readiness count, terminal countdown, T-minus count, etc., are not appropriate terminology for describing the MOL countdown. The last 32 sec is to be called the "automatic sequence". The T-10 hold is only specified hold capability and does not divide the countdown.
Countdown (Target)	The devaluation of a target's priority to be photographed based on the fact that it has been previously photographed.
Crew Retrieval Time (Recovery)	See "Recovery Times".

Cue	Visual stimulus for crew use in recognizing specified targets.

Data Subsystem	See "Satellite Test Center".
Dedicated Facilities	Those facilities assigned to a program for exclusive use for as long as required. These facilities cannot be withdrawn from their assigned use under any circumstances without the specific permission of the using program.
Decision Times	Generated by the ground-based computer mission-planning software. At a given decision time, crew inputs are polled and, based upon on-board decision logic, a decision is made whether to interdict the primary optics path in favor of an alternate target.
Degraded Mode	See "Flight Abort".
Delta$_p$ (δ_p)	Initial perigee location (deg of lat).
Deorbit and Reentry	Begins with completion of the orbital phase and ends with Gemini B touchdown.
Dwell Time	The time allowed for viewing targets, recognition of target indicators, determination of weather conditions, or obtaining visual intelligence data.

Early Orbit	See "Phase".
Emergency	See "Flight Abort".
Ephemeris Data	Computer data associated with the predicted ephemeris to be used by the ADC.
Essential Parameters	See "Mission-Critical Telemetry".
Essential Telemetry	See "Mission-Critical Telemetry".
Eta (η)	Ground illumination sun angle (deg).
Event	A requirement for one or more necessary time-related function/states.
Expanded Communications Electronic Subsystem (EXCELS)	A communications control system which gives the test controller direct and immediate control of all communications equipment assigned to him by the system control center. Extensive safeguards are incorporated to assure protection of sensitive data.

Field Test Force Director (FTFD)	The FTFD is the program contact point at the STC in all SCF operational matters pertaining to program support. He is responsible for certifying the readiness of all elements to support the program and accomplish all program objectives.
Flight	That portion of an operations test where the flight vehicle is in a trajectory or orbital path. Flight begins with flight vehicle liftoff and concludes when all useful portions of the flight vehicle have returned to earth or are spaceborne but no longer capable of transmitting and/or being controlled.
Flight Abort (resulting from contingencies)	Indicates premature termination of the flight. The abort categories are:
Emergency	Any event resulting in a system status which presents an immediate threat to the life or the well-being of the crew, and which requires: (1) immediate repressurization of the Gemini B; and (2) shirtsleeve bailout from the laboratory vehicle to the Gemini B.
Immediate	Any event resulting in a system status which presents an immediate threat to the life or well-being of the crew and which requires: (1) immediate donning of the PSA and umbilical attachment; and (2) pressurization of the suit.
Precautionary	Any event resulting in a system status which presents a potential threat to the life or well-being of the crew and which requires immediate donning of the PSA without pressurization.
Flight Crew Computer Inputs	
Active	Denotes that the target is clear and the predefined activity indicators are present.

Inactive	Denotes that the target is visible but that no activity indicators are present.
Override	Denotes the presence of unusually high intelligence value in a target which should be photographed. This input will cause the computer to commit the primary optics to that target at the decision time without considering other crew inputs for that decision time.
Reject	Denotes clouds/weather, or other undesirable conditions which would prohibit satisfactory target photography.
Flight Director	Senior AF Operations officer from the MOL SPO. He is responsible to the Mission Director for conduct of flight operations within the limits of his established authority. He makes all decisions affecting the manner in which the operation is conducted within this authority, and refers all other decisions to the Mission Director. He is responsible for meeting User requests and informing the User of mission progress. He is also responsible to see that all supporting agencies meet their program commitments.
Flight Phase	See "Phase".
Flight Test Objectives	A defined group of one or more sequences necessary to accomplish a flight test objective. The stated program objectives for each phase of an individual flight. They are further categorized as primary, secondary, or tertiary, and form part of the basis for the Ground Rules.
Flight Test Rules	The actual rules for nominal and contingency flight situations. These rules may be divided by test phase (prelaunch, launch, orbital recovery, and postflight evaluation) and further categorized by class (Class I: crew safety and primary mission objectives; Class II: all other areas).

Flight Termination	TBS
Flight Vehicle	The flight vehicle consists of the T-IIIM launch vehicle and the orbiting vehicle.
Function/State	The smallest controllable level of a subsystem element.

Gemini B	A modified NASA Gemini with an access hatch in the heat shield for crew transfer, through a pressurized tunnel, to the laboratory vehicle. The crew will be in the Gemini B during reentry after separating from the laboratory vehicle. (See "Reentry Module".)
General Systems Engineering	That portion of systems engineering dealing with the overall integration of a system, design compromise among subsystems, definition of interfaces, analysis of subsystems, supervision of systems testing, all to the extent required to assure that system concepts and objectives are being met in an economical and timely manner.
Greenwich mean Time	See "Time"
Ground Rules	The general set of rules for overall planning of flight operations. These rules can apply to any phase of the operation and take into account all flight objectives as well as flight vehicle and ground-system constraints.

h_a	Initial apogee altitude (n mi).
h_p	Initial perigee altitude (n mi).

i	Inclination angle (deg)
Insertion Ship	See "MOL Facilities at VAFB".
Interdictable Primary Targets	See "Primary Targets".
Image Smear	To be supplied.
Immediate	See "Flight Abort".

KA	Term used in white documentation to identify Flights 3, 4, and 5.
KB	Term used in white documentation to identify Flights 6 and 7.

Laboratory Module	The pressurized compartment in which the crew will operate during the on-orbit portion of the flight.
Laboratory Vehicle	Consists of the laboratory module and the mission module.
Late Orbit Phase	See "Phase".
Launch Phase	See "Phase".
Launch Control Center (LCC)	See "MOL Facilities at VAFB".
Launch Operations	General term encompassing all activities at VAFB associated with preparation for, and launch of, the MOL flight vehicle. Launch operations include: 1. All LOFS activities. 2. Facility construction, AGE and ground system/equipment installation and checkout, activation phase activities, etc. 3. Support requirements and coordination (base, range, etc.).
Listable Targets	See "Processing Status".
Loiter Phase	See "Phase".
Lompoc Air Force Station (LAFS)	See "MOL Facilities at VAFB".

Malfunction, Slow	Permits 6 sec or greater response time.
Malfunction, Fast	Permits less than 6 sec response time.
Mandatory Primary Targets	See "Primary Targets".
Manned/Automatic Mode	Payload operation may be completely automatic, automatic with manual inputs, or completely manual. (Applicable to Flights 3, 4, and 5)
Manual Control Command	That command operation performed by the flight crew.
Mission	This term is to be used only with reference to the objectives, operations, etc., associated with the photographic payload.
Mission Phase	See "Phase".
Mission Control Complex/Center (MCC)	See "Satellite Test Center".
Mission-Critical Telemetry	That telemetry which must be sustained to allow mission payload operations to continue in the nondegraded mode, and that telemetry which is required to prevent a high risk to mission security. Mission-critical telemetry is further identified as being either essential or contributory.
Contributory Parameters (not requiring redundant paths)	Parameters required for continued accomplishment of primary test objectives if problems occur. Examples are: 1. Vehicle attitude (or subsystem status). 2. Attitude control consumable status. 3. Electrical power consumable status. 4. Electrical power subsystem status (or bus voltage).

5. Environmental control system and consumables status.

6. Status of elements which are redundant and depend upon commands for switchover.

Laboratory or mission payload events causing mission termination which would warrant immediate action to avoid risk to return of data previously acquired.

Command verification of functions (sub-set addition to command verification parameters included in essential category).

Mission payload and Gemini B telemetry data handling.

Backup command verification (or authentication).

Contributory Telemetry	Includes that data which provides major enhancement to the success of primary mission objectives.
	Mission-critical telemetry is further defined by the non-exclusive list of essential and contributory parameters.
Essential Parameters	Primary command subsystem authentication words (Comsec only).
	Verification of proper command reception (i.e., CLU and computer block validity check verifications).
	Binary vehicle time code word (BVTCW).
	Verification of command functions mandatory to subsequent transmission of essential commands.
Essential Telemetry	Assumes that all subsystems other than telemetry are functioning in their nominal manner. Failure of essential

	telemetry prevents satisfactory completion of mission objectives. Telemetry implementation of essential parameters must preclude a single-point failure in acquisition and transmission of those data points to the ground.
Mission Director	The MOL Program Deputy Director (or his representative) resident at the STC is responsible for any real time decisions necessary during the course of a flight. The Mission Director is also responsible for ultimate control of all test operations.
Mission Module	Contains the systems, support systems, and ancillary equipment required by the experiments.
Mission Payload	The MOL photographic equipment.
Mission Phase	See "Phase".
Mode A, B, C, or D Abort	See "Recovery Abort Modes".
MOL Facilities at VAFB	The following facilities are physically located at VAFB. However, during specified periods of operation, control may be vested with the MOL Mission Director:
Air Force Western Test Range (AFWTR)	This facility/agency will be used to support: ascent operations; tracking; communication links; telemetry reception; and Range safety. In performing these functions, AFWTR will utilize the Range Safety Office, the General Electric Radio Tracking System (GERTS), the TPQ-18 and FPS-16 radars, and the LAFSTM station.
Communications Links/Lines/Relays	
Comsat	The communications satellite will serve as the communication link between the insertion ship and the STC. It will carry tracking, telemetry, and voice data.

Insertion Ship	Serves as the data processing and relay link for the information from the flight vehicle and the STC. It will also serve as a backup for the MCC functions should the communication link between the ship and the STC fail. A NASA T-AGM-19 class ship will serve the first four tests.
Launch Control Center (LCC)	The LCC shall provide the focal point for conducting FV checkout and pre-launch operations for monitoring the operation of the FV segments during launch.
Lompoc Air Force Station (LAFS)	LAFS, located on a peak 4-3/4 miles ESE of Mt. Tranquillon, will serve as the telemetry receiving site for all data transmitted from the flight vehicle during the initial portion of the ascent phase.
Mobile Service Tower (MST)	The MST provides the capability to erect the FV (by means of a bridge crane near the top of the tower) and support the servicing and checkout of the FV on the launch stand.
Operations Training and Evaluation Facility (OTEF)	This facility will contain the simulation equipment for all portions of the flight vehicle and for a remote tracking station. It will be used to train the flight crew and exercise the MCC. It will have the capability to simulate countdown, launch, ascent, orbital, reentry, and recovery operations.
Range Communications Center (RCCC, or RC^3) (Bldg 475)	The RCCC is the physical interface building for all data and voice lines between AFWTR and the STC or Vandenberg Tracking Station.
SLC-6	Space Launch Comples No. 6. (Replaces the MOL Launch Complex).

Technical Management Control Center (TMCC)	All AFWTR data is processed and/or controlled through the TMCC before being routed to the RCCC. All forms of data can be selected, switched, sorted, reformatted, or reduced in the facility.
Telemetry Data Center (TDC)	
MOL Insertion Ship	See "MOL Facilities at VAFB".
MOL Program Director	The principal agent for the direction of the MOL program. He is responsible for establishment, management, and conduct of all aspects of the approved MOL program as assigned by the Secretary of the Air Force.
MOL Program Deputy Director	Responsible for MOL system procurement, design, development test and evaluation, overall systems integration and general systems engineering and technical direction (GSE/TD).
MOL SPO	The MOL System Program Office is under the direct control of the MOL Deputy Director, and is responsible for overall MOL systems test operations including crew safety. the MOL SPO will direct and control all phases of mission control from the MCC.
Monitor and Alarm Subsystem (MAS) Command	That command originating in the MAS that generates an alarm and causes changes in the function/state(s) of the affected subsystem.
MST	See "MOL Launch Facilities at VAFB".
Multi-Ops	See "Satellite Test Center".

Network Control Center	See "Satellite Test Center".
No Threat to Crew Safety	See "Flight Abort".

Obscura	The masking of a tracking station's tangential plane horizon by topography or man-made structures surrounding the station's site.
Operations Training and Evaluation Facility	See "MOL Facilities at VAFB".
Orbital Phase	See "Phase".
Orbiting Vehicle	The orbiting vehicle consists of the laboratory vehicle and the Gemini B spacecraft.

Pacific Missile Range (PMR)	The ascent operations will utilize the following U.S. Navy facilities: Point Mugu - FPS-16 San Nicolas Island - FPS-16, Telemetry Station.
Pass	That period of time during which the station is in contact with the orbiting vehicle.
Plan	A plan may be considered the summation of operations profiles and may be written for the entire operation or for some particular phase (e.g., a Flight Plan would include all sequences from liftoff through laboratory vehicle disposal, while Pass Plan would include only the activity accompanying an OV contact with an RTS.
Phase	
Prelaunch	The period from arrival of AVE at VAFB to start of countdown. This phase includes assembly of the FV at the launch pad where checkout and countdown will be conducted.
Launch	The period from start of countdown (approximately 590 min to liftoff) to FV liftoff (exclusive).
Ascent	The period from FV liftoff (inclusive) to initiation of the T-IIIM/OV severance ordnance (exclusive) (approximately L +500 sec) except as extended to include those T-IIIM functions necessary to support the staging operation.
Early Orbit	For the manned/automatic mode, the early orbit phase covers the period from initiation (inclusive) the the T-IIIM/OV severance ordnance to the closing of the laboratory vehicle tunnel hatch (inclusive) by the second crewman following transfer from the Gemini B.

This phase is not applicable to the automatic mode.

Orbit

For the manned/automatic mode, this phase begins with closure of the laboratory vehicle tunnel hatch (exclusive) by the second crewman following initial transfer from the Gemini B and concludes upon opening the laboratory vehicle tunnel hatch (exclusive) for final transfer of the first crewman to Gemini B.

For the automatic mode, this phase covers the period from initiation (inclusive) of the T-IIIM/OV severance ordnance to completion of mission operations and including DRV deorbit, reentry, and retrieval operations.

Late Orbit

For the manned/automatic mode, this phase covers the period from the opening of the laboratory vehicle tunnel hatch (inclusive) for final transfer of the first crewman to Gemini B to initiation of severance of the Gemini B from the laboratory vehicle (exclusive).

This phase does not apply to the automatic mode.

Loiter

For the manned/automatic mode, this phase covers the period from initiation of autonomous operation of the Gemini B ECS or electrical system through severance of the equipment section of the Gemini B adapter.

This phase does not apply to the automatic mode.

Reentry

For the manned/automatic mode, this phase covers the period from initiation of severance of the Gemini B from the laboratory vehicle (inclusive) to Gemini B REM splashdown (inclusive).

This phase includes retrofire, reentry, parachute deployment, REM touchdown, and the detached portions of the loiter phase.

For the automatic mode, DRV deorbit and reentry is considered part of the orbit phase.

Retrieval

For the manned/automatic mode, this phase starts with the Gemini B REM splashdown and ends when the crew, data, and REM are retrieved and delivered to predetermined locations for initiation of postflight analyses. Retrieval includes location of the REM, and physical recovery of the REM, crew, mission data, and initial medical examination and initial debriefing of the crew.

For the automatic mode, DRV retrieval is considered part of the orbit phase.

Flight

For the manned/automatic mode, the flight phase is comprised of ascent, early orbit, orbit, late orbit, Gemini B reentry, and the controlled disposal of the laboratory vehicle. Although accomplished within the time span of the flight phase, retrieval is not considered a part of the flight phase and is treated as a separate phase.

For the automatic mode, the flight phase is comprised of ascent, orbit (includes DRV deorbit, reentry, and retrieval operations), and controlled disposal of the OV.

Mission

That part of the orbit phase which concerns objectives and operations associated with the mission module experiments.

Post-Pass

The time period which begins with the normal loss of signal from the orbiting vehicle and continues until the next acquisition of the OV.

Precautionary	See "Flight Abort".
Preference (Voting Logic)	A set of 16 different software-generated numbers for each target which relate the relative value of the target as a function of crew inputs.
Prelaunch Phase	See "Phase".
Pre-Pass	That period of time before acquisition of the orbiting vehicle during which the station receives direction from the MCC as to equipment configuration, commands to be sent, telemetry modes to be used, and acquisition data for support of the orbiting vehicle pass.
Processing Status	
Listable Targets	Targets supplied by the SOC for inclusion for processing by the ground software.
Candidate Targets	When the ground software processes the listable targets, it eliminates selected targets based upon geometrical and system constraints as a function of the orbit. The remaining targets are candidate targets for a given revolution.
Programmed Targets	Targets which the ground software has selected and commanded the orbiting vehicle to photograph and/or view.
Profile	A time-ordered plan which shows sequences in the order of occurrence. Profiles are drawn for some particular phase of activity. The level of detail will usually be a function of the time span or the activity chosen (e.g., a station contact profile could be made showing only the station or OV activities during RTS contacts). Time is not accurately portrayed.
Programmed Targets	See "Processing Status".

Project Engineering Office (SSONE)	That element of the AFSCF which evaluates all program requirements levied on the network. The primary function is to formulate network support plans to meet program requirements.
Primary Targets	Those targets for which the primary optics path is programmed. There are two distinct subclasses of primary targets:
Interdictable Primary Targets	There are two distinct types of interdictable primary targets: <u>Real Interdictable Primary Targets-</u> Actual targets which lie on the primary optics path and can be interdicted by the ADC based upon flight crew inputs. <u>Pseudo-Interdictable Primary Targets-</u> Aiming points chosen by the ground software to maintain control over the primary optics path. These pseudo targets will be selected when controlling the primary optics path (without loss of primary targets) to access more desirable alternates.
Mandatory Primary Targets	Those targets of unusually high technical intelligence value which, upon User request, will be photographed under any circumstances. Photography of mandatory targets should not be interdicted by the ADC/flight crew.
Primary Target Path	Generated by ground-based mission planning software, using a strategy which considers: 1. User requirements expressed as priorities and weighting factors. 2. OV operational status and capabilities.

	3. Specific intelligence requirements, including desired or stereo mono modes, exposures, category allocations, and other User inputs.
	4. Meteorological conditions in the area of interest.
Primary Test Objectives	Accomplishment of these objectives is considered mandatory.
Pseudo-Interdictable Primary Targets	See "Primary Targets".

q	Satellite repetition parameter (revs per sidereal day).

Range Communications Control Center (RCCC)	See "MOL Facilities at VAFB".
Readiness Days (R-minus days)	Begin with receipt of AVE at SLC-6. Identified in numerically descending order, with R-0 the launch day.
Real Interdictable Primary Targets	See "Primary Targets".
Real Time Command (RTC)	That command sent from the ground to the vehicle, via RF link, that is processed immediately by an on-board decoder.
Recovery	This phase begins with touchdown, and ends when the flight crew, data, and Gemini B have been recovered and returned to the desired locations.
Recovery Director	A representative of the DOD Manager for Manned Spaceflight Support Operations (DDMS), located at the STC, who is responsible for all recovery activities.
Recovery Times	
Access Time	The maximum elapsed time (under favorable operating conditions) from establishment of the approximate spacecraft landing position until emergency medical care is available to the flight crew and the flotation collar has been attached to the spacecraft.
Crew Retrieval Time	The maximum elapsed time (under favorable operating conditions) from establishment of the approximate spacecraft landing position until retrieval (on board) of the flight crew and data.
Spacecraft Retrieval Time	The maximum elapsed time (under favorable operating conditions) from establishment of the approximate spacecraft landing position until retrieval (on board) of the spacecraft.
Reentry Module (REM)	The Gemini B minus the adapter.
Reentry Phase	See "Phase".

Rehearsal	A complete simulated operation exercise which can last from one sec to three days. All events occur according to the flight profile except that anomalies might be inserted by a rehearsal committee at the STC.
Dress Rehearsal	TBS
Rehearsal Committee	TBS
Remote Tracking Station (RTS)	See "Satellite Test Center".
Retrieval Phase	See "Phase".

Satellite Test Center (STC)	Located at Sunnyvale, California. It exercises operational control of all operating locations and other support facilities, as required by the various programs. The STC consists of the following:
Advanced Data System (ADS)	The ADS is comprised of control and display equipments in each MCC, the SCC, fail-safe data handling subsystems at each tracking station, and a central, fail-safe, data processing facility at the STC. Each of the control and display equipments is connected to the STC data processing facility which, in turn, is connected to each tracking station data handling subsystem via digital communications equipments (EXCELS). The effect is to provide a real-time digital data telemetry, tracking, command, and voice (TTCV) path between any given MCC and a vehicle via the ADS and the tracking station RF and analog equipments with which it interfaces. In addition to the MCC/vehicle data path, the ADS provides a link from each MCC and the SCC to each CDC 3800 System II computer subsystem to enable the type of computation typically performed in those computers in support of MCC/SCC operations to be controlled directly from the respective MCC/SCC.
Data Subsystem	The AFSCF digital data processing and display capability, which consists of the ADS and the System II computers.
Mission Control Complex (MCC)	The complex consists of a suite of rooms assigned to a program to provide an operational control center for the Mission Director. Facilities are provided, as required, for data display, mission analysis, and technical assistance by the various program contractors/subcontractors.

Mission Control Room (MCR)	The "front room" of the MCC from which operational control is maintained. It is manned by the Flight Director, FTFD, test controllers, etc.
Multi-Ops	An office supporting the AFSCF Network Director which flags program requirement conflicts.
Network Control Center (NCC)	This center monitors the operational readiness of all subsystems and assigns resources in consonance with the schedules established by multi-ops at the STC.
Remote Tracking Stations (RTS)	Operational sites which serve as the direct line between the STC and the orbiting vehicle for tracking, telemetry, command, and voice functions.
System 304	TBS
System II Computers	Five CDC-3800 computers with a 65k core each.
Secondary Test Objectives	Accomplishment of these objectives will provide substantive information to validate decisions affecting the future of the military space program. These objectives may not interface with accomplishment of primary objectives.
Sequence	A defined group of events.
Sequential Strategy	The sequential strategy for target selection assumes that a primary optics path has been selected in an optimum manner by the ground software. In particular the primary optics path will be selected based on an algorithm which utilizes a maximum weight concept derived through target priorities (this path will be selected as in the unmanned systems). The crew members will view alternate targets as they become available for inspection and upon identification of activity the primary optics path

	will be interdicted and the active alternate photographed.
Spacecraft Retrieval Time	See "Recovery Times".
Space-Ground Link Subsystem (SGLS)	The SGLS provides track, telemetry, voice, and command on a single antenna. The one uplink and two downlink facilities are provided for precision tracking, command, voice, FM/FM data, and both high bit rate (to 1 Mbit) and low bit rate (to 265 Kbits) PCM data.
Special Target Group	See "Target Groups".
Star Data	Computer data associated with the stars to be tracked by the on-board star trackers for altitude determination purposes.
Station Exercises	An extensive test of any given station or operating location conducted by the test controller at the STC to assure that all applicable elements from the sensor to the MCC can accomplish the required operational actions.
Stored Program Command (SPC)	That command sent from the ground to the vehicle, via RF link, that is stored in the ADC for subsequent execution.
System Time	See "Time".
System 304	See "Satellite Test Center".
System II Computers	See "Satellite Test Center".
Support	The role of assisting in some phase of the MOL Operations Test. In general, the phases supported may be classed as prelaunch, launch, ascent, flight, reentry, and recovery.

Target Classes	Independent of categorization of targets by processing, there are three distinct classes of targets: Primary Targets, Alternate Targets, and Visual Intelligence Targets.
Target Data	Computer data associated with the targets to be viewed and/or photographed during payload operations.
Target Groups	In general, targets are selected between ground software in groups for processing by the on-board crew. Each group of targets is scheduled to be viewed until a given decision time, at which point the computer selects the target to be photographed, based upon flight crew inputs. There are two types of target groups:
Basic Target Group	A group of targets which includes a primary target.
Special Target Group	A group of alternate targets between basic target groups which does not contain the primary target. Within this group, interdiction of the primary path will occur only for an active alternate.
TARS	
TARS Rate 1, 2, 3	Pitch Rates required to approximate a zero-lift condition through the high q region.
TARS Rate 4, 5	These Pitch Rates provide maximum payload capability and still satisfy the angle of attack constraint at SRM staging.
TARS Rate 6, 7	

Technical Advisor	The senior Aerospace Corporation representative who provides a staff advisory function to the Flight Director.
Technical Direction	That process by which a contractor's work is reviewed, information on problems and progress is exchanged, plans for future work are discussed, and, where it will better achieve Air Force objectives, the contractor's technical effort is modified, realigned, or redirected.
Technical Management Control Center (TMCC)	See "MOL Facilities at VAFB".
Telemetry Data Center (TDC)	See "MOL Facilities at VAFB".
Teleprinter Data	Data sent from the ground which may be relayed immediately to the flight crew on the teleprinter, or buffered in the computer for delayed teleprinter output.
Tertiary Test Objectives	These objectives will provide valuable information pertaining to general military and scientific space technology and are to be accomplished only on the basis of non-interference with primary and secondary test objectives.
Test Program	MOL computer programs (with the exception of BIGS, GIGS, and CAGE) shall be tested at the following three levels:
Category I Tests	Conducted during design and development phases to verify the performance of computer program CEIs. "Conditional acceptance" may be used at FACI to accept a CEI contingent on performance in tests which must be performed at the Category II or III level.
Category II Tests	Conducted during the system integration phase for verification of interface and subsystem performance. The tests may be conducted at contractor facilities, if feasible, or at appropriate USAF

facilities, including the actual operational system sites. The test environment, when viewed from the standpoint of the software under test, shall depict the operational environment.

Category III Tests — Total integrated system tests and rehearsals conducted prior to operational use. These exercises involve both space and ground hardware, software, and personnel. They are executed at operational sites in an environment which is essentially identical to the operational environment. These activities are conducted by or on behalf of the MOL SPO and one purpose of the exercise is evaluation and final certification of the system.

Time — Used for correlation of data and activities, and is measured by three distinct and related systems during test operations. Correlation of these three time systems is maintained on the ground by the computer system.

Greenwich Mean Time (GMT) — The mean time of the meridian of Greenwich, England used as the prime basis of standard time throughout the world. Displayed at the MCC in hrs, min and sec.

System Time — GMT converted to total sec, and varies from zero to 86,400 sec.

Vehicle Time — Determined by a clock on board the laboratory vehicle with a time resolution of 1 msec and a capacity of 49 days, 17 hr.

Timelines — Time-ordered sequences used as an engineering tool for design and development, and as an input to the Flight Plan. Timelines may be drawn for the entire test or for some particular phase. Time accuracy and resolution are necessary considerations in the development of timelines.

Titan IIIM	The Titan IIIM (T-IIIM) consists of the Stage 0 rocket motors (SRMs), the Stage I liquid propulsion system, and the Stage II liquid propulsion system.
T_n	Nodal period (minutes)

Validation Exercises	Those activities required to assure that the implementation of a modification or new design of either hardware or software has met the objectives of the applicable specifications.
Vehicle Time	See "Time".
Visual Intelligence Targets	Those targets preselected for flight crew inspection and oral comments, only, but not for photography. Generally, these types of targets will be selected for one of the following reasons: 1. When associated with a mandatory primary. 2. When the confirmation of the presence or absence of something in the target area, or a verbal description of the target area, satisfies intelligence requirements. 3. When vehicle constraints prevent actual photography of the target, or the penalty associated with photography is unacceptable.
Voting Strategy	The voting strategy utilizes the same preplanned primary optics path. However associated with each primary target, groups of alternates are identified for viewing. The crew members view these alternate targets and evaluate them for activity and at some predetermined decision time a decision is made, based upon the crew inputs, whether to interdict the primary optics path in favor of an alternate.

W/C_DA	Vehicle drag factor (lb/sq ft)
Weather Alternate	See "Alternate Targets".

F.2 ABBREVIATIONS AND ACRONYMS

The following definitions of abbreviations and acronyms are applicable to the MOL program as a whole, not just to this FTOP, and are included for informational purposes only.

A to D	analog to digital (conversion)
AAE	aerospace ancillary equipment
AAP	Apollo Applications Program (NASA)
AAS	azimuth alignment set (short or long range)
ABRES	Advanced Ballistic Re-Entry Systems (program)
AC	Aerospace Corporation
AC&SS	attitude control and stabilization system
ACE	attitude control electronics (Gemini B)
	acceptance checkout equipment
ACED	AC Electronic Division of General Motors
ACEG	attitude control electronics group (Gemini B)
ACIC	Aeronautical Chart and Information Center
ACPU	auxiliary computer power unit (Gemini B)
ACS	attitude control system (Gemini B)
ACTS	attitude control and translation system
ACTS/Prop	attitude control and translation system/propulsion (subsystem)
ACTS/SCE	attitude control and translation system/ stabilization and control electronics (subsystem)
AD	ascent director
ADA	allocation data annex
ADC	airborne digital computer
ADCAS	airborne digital computer adapter simulator
ADG	attitude display group (Gemini B)
ADS	advanced data system
AEDC	Arnold Engineering Development Center (AFSC)
AERL	Avco-Everett Research Laboratories
AES	Apollo Extension System (NASA)
AF	audio frequency
AFAL	Air Force Avionics Laboratory
AFAMD	Air Force Aeromedical Division
AFAMRL	Air Force Aeromedical Research Laboratory
AFAPL	Air Force Aero-Propulsion Laboratory
AFARL	Air Force Aerospace Research Laboratories
AFAT	Air Force acceptance team
AFC	automatic frequency control
AFCPL	Air Force Computer Program Library
AFCRL	Air Force Cambridge Research Laboratories
AFD	assistant flight director

AFD/CO . . . . assistant flight director for crew operation
AFD/FP . . . . assistant flight director for flight planning
AFD/RRP . . . . assistant flight director for reentry and recovery planning
AFD/VA . . . . assistant flight director for vehicle analysis
AFETR . . . . Air Force Eastern Test Range (NRD)
AFFDL . . . . Air Force Flight Dynamics Laboratory
AFFTC . . . . Air Force Flight Test Center (AFSC)
AFGWC . . . . Air Force Global Weather Central
AFIT . . . . Air Force Institute of Technology
AFLC . . . . Air Force Logistics Command (formerly AMC)
AFMDC . . . . Air Force Missile Development Center (AFSC) (also called WSMR)
AFML . . . . Air Force Materials Laboratory
AFO . . . . Air Force Objective
AFOTOP . . . . Air Force Objective and Technical Operating Plan
AFPR . . . . Air Force Plant Representative
AFPRO . . . . Air Force Plant Representative Office
AFRPL . . . . Air Force Rocket Propulsion Laboratory
AFRTD . . . . Air Force Research and Technology Division
AFSC . . . . Air Force Systems Command
AFSCF . . . . Air Force Satellite Control Facility (formerly SCF)
AFSCM . . . . Air Force Systems Command Manual
AFWTR . . . . Air Force Western Test Range (NRD)
AFWTW . . . . Air Force Western Test Range Staff Meteorologist Office
AGAVE . . . . automatic gimballed antenna vectoring equipment
AGC . . . . Aerojet-General Corporation
. . . . automatic gain control
AGE . . . . aerospace ground equipment
ALGOL . . . . algorithmic language
AM . . . . auxiliary memory
AMD . . . . Aerospace Medical Division (AFSC)
AML . . . . Aeromedical Laboratory (Wright-Patterson AFB)
AMRL . . . . Aerospace Medical Research Laboratory
AMU . . . . astronaut maneuvering unit
. . . . auxiliary memory unit (computer)
A/N . . . . alphanumeric
AOES . . . . advanced orbital/ephemeris subsystem
AOS . . . . acquisition of signal
APGC . . . . Air Proving Ground Center (AFSC)
APL . . . . Applied Physics Laboratory (Johns Hopkins Univ.)
APU . . . . auxiliary power unit
ARC . . . . Ames Research Center (NASA)
A/RIA . . . . Apollo/Range instrumented aircraft
ARIS . . . . Advanced Range Instrumentation Ship (also, see ORV)
ARPA . . . . Advanced Research Projects Agency (DDR&E)

ARPS . . . . Aerospace Research Pilot School
ARRS . . . . Aerospace Rescue and Recovery Service (USAF)
ARS . . . . Air Rescue Service (Military Airlift Command)
. . . . auxiliary reference system (comprised of LASS + CAD + TARS)
ARSS . . . . atmosphere and reactants supply subsystem
ARSSG . . . . atmosphere and reactants supply subsystem group
ARWG . . . . ascent/reentry working group
ASABOR . . . . ascent abort touchdown prediction task
ASCD . . . . Aerospace (Corporation) Satellite Control Directorate
ASCO . . . . Aerospace (Corporation) Satellite Control Office
ASCOP . . . . Princeton Division of Electromechanical Research
ASD . . . . Aeronautical Systems Division (AFSC) (formerly WADC/WADD)
ASTC . . . . Advanced Satellite Test Center
ASTEC . . . . advanced solar turbo-electric concept
ASTEG . . . . all-systems test equipment group
ASTM . . . . American Society for Testing and Materials
ATC . . . . Air Training Command
ATM . . . . auxiliary tape memory (Gemini B)
ATP . . . . authority to proceed
. . . . acceptance test procedures
ATS . . . . acquisition and tracking scope
ATW . . . . Aerospace Test Wing (USAF)
AVE . . . . aerospace vehicle equipment
AWG . . . . activation working group
AWN . . . . automated weather network (USAF)
AWS . . . . Air Weather Service

BECO . . . . booster engine cutoff
BEF . . . . blunt end forward
BIGS . . . . booster inertial guidance system
bit . . . . binary digit
BLC . . . . boundary layer control
BMAG . . . . body-mounted attitude gyro
BOD . . . . beneficial occupancy date
BOSU . . . . bioastronautics operational support unit
BPFR . . . . Bioastronautics Post-Flight Report
BPG . . . . basic pressure garments
bps . . . . bits per second
BSD . . . . Ballistic Systems Division (AFSC) (obs., see SAMSO)
BUD . . . . backup decoder
BVTCW . . . . binary vehicle time code word

CAB . . . . Civil Aeronautics Board
CAD . . . . controls - analog to digital

CAGE	computer AGE
CAT	constraint analysis tool
C&C	command and control
CC	crew communicator
CCB	Configuration Control Board
CCBD	Configuration Control Board Directive
CCM	counter-countermeasures
. . . .	constant current modulation
. . . .	controlled carrier modulation
CCTV	closed circuit television
CDC	Control Data Corporation
CDP	central data processor
. . . .	contract definition phase
CDR	critical design review
CDRL	Contract Data Requirement List (DD Form 1423)
CDRS	computer data reduction system
. . . .	computer data recording system (Gemini B)
CDU	command distribution unit
CDU-MO	Conductron-Missouri (Co.)
CDW	computer data words
CEI	contract end item
CFE	contractor furnished equipment
CIMC	central inventory and management control
CIMU	complete instrumentation mock-up
CIP	central information processor
CITE	computer-integrated test equipment
CKAFS	Cape Kennedy Air Force Station (Patrick AFB)
CLE	command logic equipment
CLS	command logic subsystem
CLU	command logic unit
CM	continuous monitor
CMA	contractors' maintenance area
CMC	configuration management control
CMD	Contract Management District
CMG	control moment gyro
. . . .	controls monitor group
CMP	configuration management plan
CMU	controls mock-up unit
C/O	checkout
COBOL	common business oriented languate
COD	carrier on deck
COMPOOL	communications pool
comsat	communications satellite
COMSEC	communications security
CONUS	Continental United States
CP	control point
CPAC	computer program associate contractor

CPCEI . . . . computer program contract end item
CPDC . . . . Computer Program Development Center (SDC)
CPIC . . . . computer program integration contractor
CPIF . . . . cost plus incentive fee (contract)
CPS . . . . core propulsion system
. . . . central power system
. . . . computer program system
cps . . . . cycles per second (see Hz)
CRD . . . . contractor responsibilities document
CRL(AFCRL) . . . . Air Force Cambridge Research Laboratories
CRT . . . . cathode ray tube
CSA . . . . contractor support area
CSC . . . . computer subsystem controller
CST . . . . combined systems test
CSTSS . . . . combined systems test simulator set
CTF . . . . Commander Task Force (Navy)
CTF 130 . . . . Commander Task Force, Pacific
CTF 140 . . . . Commander Task Force, Atlantic
CVCT . . . . current vehicle command table
CW . . . . clockwise

D/A . . . . digital to analog
DA&P . . . . data acquisition and processing
DAC . . . . Douglas Aircraft Company
DACON . . . . digital-to-analog converter (see D/A)
. . . . data controller
D&C . . . . display and control
D&F . . . . disposition and funding
DAG . . . . Division Advisory Group (SAMSO)
DAS . . . . data acquisition system
DASP . . . . Data Acquisition and Support Plan (see PSP)
dbm . . . . decibels relative to 1 milliwatt
DCPT . . . . dynamic crew procedures trainer
DCS . . . . digital command system
DCSG . . . . data computation subsystem group
DCU . . . . digital computer unit
DDMS . . . . DOD Manager for Manned Space Flight Support Operations
DDMS-W . . . . DDMS Assistant for Meteorology
DDPU . . . . digital data processing unit
DDR&E . . . . DOD Director of Defense Research and Engineering
DEI . . . . development engineering inspection
ΔT . . . . vehicle-ground time difference
ΔV . . . . increment of velocity
DF . . . . direction finder
. . . . development flight
DFTP . . . . development flight test plan

DKU	display-keyboard units
DOD, DoD	Department of Defense
DPL	data processing laboratory
	dual propellant loading
DQS	Douglas quality specifications
DRC	data return container
DRD	data requirements document
DRS	data recording set
DRV	data recovery vehicle
DRULS	downrange up-links
DSB	double sideband
DSMP	data system management plan
DSU	data storage unit
DTO	detailed test objectives
DTS	data transmission system
	developmental test series
DTU	digital telemetry unit
DTV	development test vehicle
DVM	digital voltmeter
E&A	engineering and analysis
EAFB	Edwards Air Force Base (AFFTC)
EAT	environmental acceptance test
ECA	electronic control assembly
ECG, EKG	electrocardiogram
EC/LS	environmental control and life support system
ECP	engineering change proposal
ECS	electrical control system
	environmental control system
ECU	environmental control unit
EDCTU	electronic development component test unit
EDP	electronic data processing
	engineering development phase
EDS	engineering development simulator
EED	electro-explosive device
EEG	electroencephalogram
EEI	electrical-electronic interference
EET	event elapsed time
EFC	equipment functional check (Gemini B)
EFT	early flight test
	environmental flight test
EFRC	Edwards Flight Research Center (NASA)
EIS	experimental information system
EK	Eastman Kodak Company
EL&S	engineering laboratories and services
EMC	electromagnetic compatibility (test)
EMI	electromagnetic interference

EMISM . . . . electromagnetic interface safety margin
EMS . . . . experiment management system
ENV . . . . natural aerospace environment
EOB . . . . engineering and operations building
EOS . . . . emergency oxygen system (Gemini B)
EPS . . . . electrical power subsystem
ERN . . . . engineering reference number
ES . . . . electron spectrometer
ESD . . . . Electronic Systems Division (AFSC)
ESDE . . . . electromagnetic signal detection equipment
ESTU . . . . electronic system test unit
ETA . . . . estimated time of acquisition
. . . . estimated time of arrival
ETAC . . . . environmental technical applications center (USAF AWS)
ETD . . . . engineering test directive
. . . . estimated time of departure
ETR . . . . Eastern Test Range (formerly AMR) (NRD)
ETT . . . . estimated time to track
EV . . . . extravehicular
EVA . . . . extravehicular activity
EVTS . . . . electrical verification test set
EVVA . . . . extravehicular visor assembly
EWR . . . . early warning radar
EXCELS . . . . expanded communications electronic system

FACE . . . . factory automatic checkout equipment
FACI . . . . first article configuration inspection
FAR . . . . fine attitude reference
FARR . . . . failure and rejection report
FAT . . . . fabrication acceptance test
FCC . . . . flight controls computer
FCEI . . . . facility contract end item
FCR . . . . facility change request
. . . . facilities capability review
FCS . . . . flight control system
FCSTS . . . . flight control system test set
FD . . . . frequency density
. . . . flight director
FDI . . . . flight director indicator
FECP . . . . facility engineering change proposal
FEI . . . . firing error indicator
FHA . . . . fuel holding area
FIC . . . . frequency interference control
FIR . . . . far infrared
FIS . . . . facility interface specification
FJ . . . . frequency jump

FLSC	flexible linear-shaped charge (Gemini B)
FM, F/M	frequency modulation
FME	failure modes and effects
FOCUS	flight operations control and utilization system
FOPG	flight operations and planning group
FOPS	flight operations planning and scheduling
FORTRAN	formula translation
FPE	flight planning and evaluation
FPL	fluctuating pressure level
FPS	flight planning software
	JANAF designation for a fixed installation, detection, and ranging radar
FR	failure rate
	frame rate
FRC	Flight Research Center (see EFRC)
FRD	flight readiness firing
FRT	flight readiness test
FS	field service
	flight surgeon
	full scale
FSE	factory support equipment
	field support equipment
FSK	frequency shift keying
FSS	flight support system
FST	flight support tape
FT	flight termination
FTC	Flight Test Center (AFSC)
FTD	feasibility test demonstration
	flight test directive
FTE	factory test equipment
FTFD	field test force director (STC)
FTOP	Flight Test and Operations Plan
FTS	flight termination system
FTV	flight test vehicle
FTWG	flight test working group
FV	flight vehicle
FVTL	flight vehicle timeline
FVTLWG	flight vehicle timeline working group
FWG	facilities working group
g	gravity
G-B	Gemini B
G/BMS	Gemini B mission simulator (MOL)
GBPS	Gemini B procedures simulator
GBPT	Gemini B procedures trainer
GBQ	Gemini B qualification
GBRRD	Gemini B Recovery Requirements Document

Gc . . . . gigacycle (10^9)
GCHAP . . . . an STC orbit adjust program
GHz . . . . gigaHertz (same as gigacycle)
G&C . . . . guidance and control (equipment or system)
GE . . . . General Electric Company
GEEIA . . . . Ground Electronics Engineering Installation Agency (AFLC)
GEMSIP . . . . Gemini stability improvement program
GE-MSVD . . . . General Electric-Missile and Space Vehicle Department
GERTS . . . . General Electric radio tracking system
GET . . . . ground elapsed time
GETS . . . . ground equipment test set
GFAE . . . . government-furnished aerospace equipment
. . . . government-furnished airborne equipment
GFE . . . . government-furnished equipment
GFP . . . . government-furnished property
GG . . . . gas generator
GCI . . . . guidance comparator indicator (Gemini B)
GGA . . . . gas generator assembly
GGTP . . . . General Ground Test Plan
$G\text{-}H_e$, $-O_2$, $-N_2$ . . . . . . gaseous helium, oxygen, nitrogen
GIA . . . . guidance interface adapter (Gemini B)
GIE . . . . government-installed equipment
. . . . ground instrumentation equipment
GIGS . . . . Gemini inertial guidance system
GMT . . . . Greenwich mean time
GSCG . . . . ground systems coordination group
GSE . . . . general systems engineering
. . . . ground support equipment (obs., see AGE)
GSE/TD . . . . general systems engineering/technical direction
GSFC . . . . Goddard Space Flight Center (NASA)
GTS . . . . Guam tracking station
GWC . . . . Global Weather Central (USAF)

HAFB . . . . Holloman Air Force Base (AFMDC)
H&T . . . . handling and transportation
H&TE . . . . handling and transportation equipment
HAT . . . . hardware acceptance team
. . . . hardware acceptance test
HCP . . . . hard-copy printers (computer)
HE . . . . human engineering
HF, hf . . . . high frequency
HFDF . . . . high-frequency direction finder
HHMU . . . . hand-held maneuvering unit
HIT . . . . (McDonnell) hypervelocity impulse tunnel
HIVOS . . . . high-vacuum orbital simulator

HSD . . . . high-speed data
HSQ . . . . heat shield qualification (test)
HST . . . . heat shield test
HTS . . . . Hawaii tracking station
Hz . . . . Hertz (same as cps)

IADPC . . . . Inter-Agency Data Processing Committee
IAP . . . . integrated activation plan
IBM . . . . International Business Machines Corporation
ICD . . . . interface control drawing (or, document)
ICM . . . . interface control meeting (SPO-controlled)
ICN . . . . interface control notice
ICNP . . . . interface change notice proposal
ICP . . . . inspection control point
ICS . . . . inspection control station
. . . . integrated command system
. . . . interface control specification
. . . . interpretive computer simulation
ICW, icw . . . . interrupted continuous wave
ICWG . . . . interface control working group
IDA . . . . Institute for Defense Analysis (DDR&E)
IDEP . . . . interservice data exchange program
IE . . . . interface event
. . . . independent experiment (contractor)
IECP . . . . interface engineering change proposal
IEEE . . . . Institute of Electrical and Electronics Engineers (formerly AIEE and IRE)
IEG . . . . independent experiment, government (agencies)
IF . . . . intermediate frequency
IFS . . . . interface specification
IG . . . . inertial guidance
IGC . . . . inertial guidance and control (equipment)
IGS . . . . inertial guidance system
IIP . . . . instantaneous impact point
IIR . . . . intermediate infrared
IL . . . . initial launch
ILC . . . . initial launch capability
IMC . . . . image motion compensation
IML . . . . initial manned launch
IMU . . . . inertial measurement unit (Gemini B)
I/O . . . . input/output
IOC . . . . instructor operator console
IOS . . . . Indian Ocean station
IR . . . . infrared
IRB . . . . Incentive Review Board
IRI . . . . Infrared Industries, Inc.
IRIG . . . . inter-range instrumentation group

ISDS . . . . inadvertent separation destruct system
IST . . . . integrated system test
ISTB . . . . Integrated System Test Board
IT . . . . integration test
ITL . . . . integrate-transfer-launch (T-III facility)
IV . . . . instrumentation van
. . . . intravehicular
IVA . . . . intravehicular activity
IVI . . . . incremental velocity indicator (Gemini B)
IVS . . . . image velocity sensor

JANAF . . . . Joint Army, Navy, Air Force
J-FACT . . . . joint facility acceptance composite test
JOA . . . . joint operating agreement
JOD . . . . joint occupancy date
JOVIAL . . . . Joule's own version of international algebraic language
JPL . . . . Jet Propulsion Laboratory (NASA)

kbits/sec . . . . kilobits per second
kc . . . . kilocycles (see kHz)
kev . . . . thousands of electron volts
kHz . . . . kiloHertz
km . . . . kilometer
KTS . . . . Kodiak tracking station
kw . . . . kilowatt(s)

L . . . . launch
LAAFS . . . . Los Angeles Air Force Station
LAFS . . . . Lompoc Air Force Station
LARC . . . . lighter amphibious resupply cargo
LASS . . . . lateral acceleration sensing system
LC . . . . launch complex
LCC . . . . launch control center
LD . . . . launch director
L/D . . . . lift-to-drag (ratio)
LDAU . . . . laboratory data adapter unit
LDO . . . . long-duration operations
LF, lf . . . . low frequency
LGA . . . . low-g accelerometer
LH_2 . . . . liquid hydrogen
L(H_e, O_2, etc.) . . . . . liquid (helium, oxygen, etc.)
LL . . . . last launch
LLTV, LLLTV . . . . low light-level television
LM . . . . laboratory module
LMCP . . . . laboratory module computer program

LMQTV . . . . laboratory module qualification test vehicle
LMSC . . . . Lockheed Missiles and Space Company
LMSE . . . . laboratory module simulation equipment
LMSS . . . . laboratory module system segment
LN_2 . . . . liquid nitrogen
LO . . . . local oscillator
LOFS . . . . launch operations flow sub-group
LOOS . . . . launch operations and orbital support
LORL . . . . large orbiting research laboratory
LOS . . . . line-of-sight
. . . . loss of signal
LOSS . . . . launch operations system segment
LOWG . . . . launch operations working group
LOX, lox, LO_2 . . . . . . liquid oxygen
LRL . . . . last radar look
LRU . . . . line-replaceable unit
LSB . . . . least-significant bit
LTD . . . . launch test directive
LTV . . . . Ling-Temco-Vought, Inc.
LTWG . . . . launch test working group (obs., see LOWG)
LV, L/V . . . . laboratory vehicle } should be avoided because
. . . . launch vehicle } of potential confusion
LVD . . . . launch vehicle development
LVDB . . . . launch vehicle data book
LVIC . . . . launch vehicle integration contractor
LV/OP . . . . local vertical and orbit plane
LVPS . . . . laboratory vehicle procedures simulator
LV/RVV . . . . local vertical/relative velocity vector
LVSS . . . . laboratory vehicle system segment

MAB . . . . missile assembly building
MAC . . . . McDonnell Astronautics Company (Division of McDonnell-Douglas Corporation)
MAC HIT . . . . McDonnell hypervelocity impulse tunnel
MADBS . . . . MOL automatic data base systems
MAMU . . . . modular astronaut maneuvering unit
MAS . . . . monitor and alarm system
max Q . . . . maximum dynamic pressure
MC . . . . Martin Company
. . . . mission control
MCC . . . . mission control center
. . . . mission control complex
MCD . . . . mission correlation data
MCL . . . . master change logs
MCM . . . . mission control module
MCP . . . . military construction program
MCR . . . . mission control room

MCRT . . . . mission collection requirements training
MCSF . . . . MOL contractor support facility
MD . . . . mission director
MDAU . . . . mission data adapter unit
MDC . . . . McDonnell-Douglas Corporation
MDF . . . . mild detonating fuze (Gemini B)
MDIU . . . . manual data insertion unit
MDKU . . . . manual data keyboard unit
MDRU . . . . manual data readout unit
MDS . . . . malfunction detection system
. . . . mission development simulator
MES . . . . mobile environmental shelter
Mev . . . . million electron volts
MF . . . . medium frequency
MFTP . . . . manned flight test plan
MGACG . . . . missile guidance alignment checkout group
MGE . . . . maintenance ground equipment
MH . . . . Minneapolis-Honeywell
MHD . . . . magnetohydrodynamics
MHz . . . . megaHertz
MINS . . . . miniature inertial navigational system
MIS . . . . mission information system
. . . . motor inert component assembly storage building (T-III)
. . . . MOL insertion ship
MLC . . . . MOL launch complex
MLS . . . . MOL launch site
MM . . . . mission module
MMAS . . . . mission module aft section
MMC . . . . Martin-Marietta Corporation
MMDAU . . . . mission module data adapter unit
MMFS . . . . mission module forward section
MMH . . . . monomethylhydrazine
MMSE . . . . mission module simulation equipment
MMSS . . . . mission module system segment
MMU . . . . modular maneuvering unit
MOCR . . . . mission operations control room
MOL . . . . Manned Orbiting Laboratory (program)
MOLCITE . . . . MOL computer-integrated test equipment
MOL SPO . . . . MOL System Program Office
MOLTOL . . . . MOL test oriented language
MOSS . . . . mission operations special support
MP . . . . mission payload
. . . . multiple payload
. . . . multiple pulse (emitter)
MP&E . . . . mission planning and evaluation

MPEO	mission planning and evaluation organization
MPS	mission payload segment
MR&PM	materials research and production method
MRRD	Manned Recovery Requirements Document
MRSP	Manned Recovery Support Plan
MS	milestone (e.g., MS-3)
. . . .	mission simulator
MSB	most-significant bit
MSCC	Manned Spacecraft Control Center (Houston, Texas) (NASA)
MSE	mission simulation equipment
MSFC	Marshall Space Flight Center (Huntsville, Alabama) (NASA)
MSI	MOL system integration
MSFN	manned space flight network
MSSD	Missile & Space Systems Division (Douglas Aircraft Company)
MST	mobile service tower
MSTS	Military Sea Transport Service (USN)
MTBF	mean time between failures
MTR, MTTR	mean time to repair
MTTF	mean time to failure
MTTFF	mean time to first failure
MUX	multiplexing equipment
N&C	navigation and control
NAA	North American Aviation, Inc.
NAD&C	Naval Air Development Center
NAS	National Academy of Sciences
NASA	National Aeronautics and Space Administration
NASB	National Academy of Sciences Board
NASP	National Academy of Sciences Panel
NAVMOL	U.S. Navy Office for MOL
NCC	network control complex
ND	network director
NEFD	Noise equivalent flux density
NHS	New Hampshire (tracking) station
NMFPA	Naval Missile Facility, Point Arguello (see SVAFB)
n mi	nautical mile
N_2O_4	nitrogen tetroxide (propellant)
NPSH	net positive suction head
NRD	National Range Division (AFSC)
NRL	Naval Research Laboratory (ONR)
NRZ	non-return to zero
NRZL	non-return to-zero level
NSA	National Security Agency

O/A . . . . orbit adjust
OAMS . . . . orbital attitude and maneuvering system (NASA Gemini)
OAMU . . . . orbital attitude and maneuvering unit
OD . . . . Operations Directive
OER . . . . orbital equipment rack
OES . . . . orbital equipment section
O/F, o/f . . . . oxidizer-to-fuel (ratio)
OGE . . . . operational (operating) ground equipment
OGS . . . . operational ground support
ONR . . . . Office of Naval Research
OOS . . . . orbital operations segment
OPCONTR . . . . operational control center
OR . . . . Operations Requirements (document)
ORD . . . . Orbital Requirements Document
ORU . . . . operational readiness unit
ORV . . . . ocean range vessel
OSAF . . . . Office of the Secretary of the Air Force
OSD . . . . Office of the Secretary of Defense
OSE . . . . ocean surveillance equipment
OSG . . . . orbital sub-working group
OSP . . . . Orbital Support Plan
OSR . . . . ocean surveillance radar
. . . . Office of Scientific Research (AFSC)
. . . . Office of Security Review (DOD)
OTEF . . . . operational training and evaluation facility
OTWG . . . . orbit test working group
OV . . . . orbiting vehicle
OVAB . . . . orbiting vehicle assembly building
OVC . . . . orbiting vehicle computers
OVSB . . . . orbiting vehicle support building

PACE . . . . pad abort control electronics
PACS . . . . pad abort control system (Gemini B)
PAFB . . . . Patrick Air Force Base
PALC . . . . Point Arguello launch complex (obs., see SLC)
PAM . . . . pulse-amplitude modulation
PATE . . . . pad-about thrust electronics (Gemini B)
PBS . . . . program breakdown structure
PCCB . . . . power coordination control board
PCM . . . . pulse-code modulation
PCO . . . . procuring contracting officer
PCP . . . . program change proposals
PDP . . . . program definition phase
. . . . program development phase
PDR . . . . prerequisite data report
. . . . preliminary design review
PE . . . . planning estimate

PERT . . . . program evaluation and review technique
PFCC . . . . powered flight control center
PI . . . . photo interpreters
. . . . program integration
PIA . . . . pre-installation acceptance
PLOT . . . . probability of launch on time
PM . . . . phase modulation
. . . . pulse modulation
PMR . . . . Pacific Missile Range (USN)
POAD . . . . Post Operations Assessment Directive
P/O . . . . print out
PPE . . . . preliminary planning estimate
PPS . . . . pulses per second
PRC . . . . Program Review Council
PRD . . . . Program Requirements Document
PRE . . . . Program Requirements Estimate
PRELORT . . . . precision long range tracking
PRF . . . . pulse repetition frequency
PRI . . . . pulse repetition interval
PRN . . . . pseudo-random noise
PRR . . . . pulse repetition rate
PRS . . . . primary recovery ship
PS . . . . program segment
PSA . . . . pressure suit assembly
P/S/A . . . . planning, scheudling, resource allocation
PSAC . . . . President's Science Advisory Committee
PSD . . . . power spectral density
PSIA . . . . production systems integration area
PSP . . . . Program Support Plan
PSPP . . . . Proposed (or Preliminary) System Package Plan
PSS . . . . photographic system segment
PTDP . . . . Preliminary Technical Development Plan
PTS . . . . pointing and tracking system
. . . . pneumatic tube system
PTT . . . . push-to-talk
PW . . . . pulse width
P&W . . . . Pratt & Whitney Aircraft (div. of United Aircraft Corp.)
PWM . . . . pulse-width modulation

QC . . . . quality control
QT . . . . qualification test
QTV . . . . qualification test vehicle
QLAP . . . . quick-look analysis program

°R . . . . degrees Rankine (temperature scale)
R . . . . reentry, or recovery

R&I . . . . receiving and inspection
RAS . . . . requirements allocation sheets
. . . . resource allocation sheets
RCC . . . . range control center
. . . . recovery control center
RCCC . . . . Range Central Communications Control (Bld'g. 475)
RCG . . . . recovery control group
RCR . . . . recovery control room
RCS . . . . reaction control system
. . . . reentry control system (Gemini B)
RD . . . . recovery director
R&D . . . . research and development
R&E . . . . research and engineering
RDT&E . . . . research, development, test, and evaluation
REM . . . . reentry module
REV . . . . reentry vehicle
RF . . . . radio frequency
RFA . . . . radio frequency allocation (request for)
RFI . . . . radio frequency interference
. . . . request for information
RFO . . . . retrofire officer
RFP . . . . request for proposal
RFTS . . . . radio frequency transmission system
RGS . . . . roll gyro sensor
RIA . . . . range instrumentation aircraft
RICS . . . . range instrumentation control system
RIP, RIPI . . . . receiving inspection and pyrotechnic installation
RIS . . . . range instrumentation ship
. . . . receipt inspection
RIV . . . . rendezvous, initial vehicle
RMIS . . . . remote multiplexing instrumentation system (T-IIIM TLM system)
RMP-B . . . . reentry measurement program B
rms . . . . root-mean-square
RMU . . . . remote maneuvering unit
RO-CAT . . . . rocket catapult
ROCC . . . . Recovery Operations Control Center (NASA)
. . . . Range Operations Control Center (Bldg. 300, VAFB)
ROS . . . . ready-only store
RPS . . . . retrograde propulsion system (Gemini B)
R&R . . . . rendezvous and recovery
R/R . . . . repair/replacement
RRD . . . . recovery requirements document
RRV . . . . rendezvous, resupply vehicle
RS . . . . range safety
RSC . . . . range safety command
RSCC . . . . range safety control center
RSO . . . . range safety officer

RSP . . . . recovery support plan
RSS . . . . range safety system
rss . . . . root-sum-square
RSV . . . . ready storage vessel
. . . . reentry stabilization velocity
RTC . . . . real-time command
RTCC . . . . real-time computer complex
RTS . . . . remote tracking station
. . . . range tracking ship
RV, R/V . . . . reentry vehicle
R/VFR . . . . reliability vehicle flight readiness
RVV . . . . relative velocity vector
RWG . . . . recovery working group
RZ . . . . return to zero

SAA . . . . Saturn-Apollo applications (program)
SAF . . . . Secretary of the Air Force
SAFSL . . . . DOD-designated symbol for the Manned Orbiting Laboratory Program
SAM . . . . School of Aerospace Medicine (USAF)
SAMSO . . . . Space and Missile Systems Organization (formerly SSD and BSD)
SAR . . . . search and rescue
. . . . special access required (security notation)
S/C . . . . spacecraft
SC&D . . . . signal conditioning and distribution
SCD . . . . specification control drawings
SCE . . . . stabilization and control electronics
SCET . . . . stored command execution timer
SCF . . . . Satellite Control Facility (obs., see AFSCF)
SCN . . . . specification change notice
SCO . . . . satellite control office
SCSU . . . . stimulus conversion and switching unit
SCU . . . . signal conditioning unit
SDC . . . . System Development Corporation
SEF . . . . small and forward
SEIP . . . . system engineering implementation plan
SEIR . . . . system engineering implementation review
SERO . . . . systems engineering release order
SE/TD . . . . systems engineering/technical direction
SF . . . . support facility
SFC . . . . solar forecast center
SFR . . . . special flight requirements
SFS . . . . space flight system
SGLS . . . . space-ground link subysstem
SGS . . . . space guidance system
SIL . . . . schedule interface log

SIMEX . . . . simulation exercises
SLC . . . . space launch complex
SLC 6 . . . . Space Launch Complex No. 6, VAFB
SLM . . . . simulated laboratory module
SMAB . . . . solid motor assembly building
SMG . . . . software management group
SMOT . . . . AFSCF Director for Test Operations
SMPSA . . . . solid motor processing and storage area
SMVT . . . . Titan III SPO symbol (formerly SSB)
S/N . . . . signal-to-noise (ratio)
SNI . . . . San Nicolas Island
SOC . . . . statement of capability
. . . . station operators console
SOFNET . . . . solar observing and forecasting network
SOR . . . . specific operational requirement
SOW . . . . statement of work
SPACETRACK . . . . tracking capability in support of NORAD
SPADATS . . . . space detection and tracking system
SPAN . . . . solar particle alert network
SPC . . . . stored program command
SP/DR . . . . common designation for SS-MOL-1, "MOL System Performance/Design Requirements General Specification"
SPERT . . . . schedule PERT
SPO . . . . system program office
SPP . . . . system package plan
SPS . . . . separation propulsion system (Gemini B)
SRM . . . . solid rocket motor
SRR . . . . system requirement reviews
SRS . . . . secondary recovery ship
. . . . segment ready-storage
SRSB . . . . segment ready-storage building
SRTC . . . . stored real-time command
SSB . . . . Titan III SPO symbol (obs., see SMVT)
. . . . single sideband
. . . . source selection board
SSC(D) . . . . Space Systems Center (Douglas)
SSD . . . . Space Systems Division (AFSC) (obs., see SAMSO)
SSECO . . . . second stage engine cutoff
SSESM . . . . spent-stage experiment Saturn module
SSOTW . . . . AFSCF staff meteorologist (organizational symbol)
SSR . . . . staff support room
SST . . . . spacecraft system (acceptance) test (Gemini B)
. . . . subsystem testing
STAFFMET . . . . staff meteorologist
STDR . . . . space technical data report (test procedures)
STC . . . . Satellite Test Center
. . . . sensitivity-time control

STE . . . . special test equipment
STIC . . . . space technical information control
STINFO . . . . Scientific and Technical Information Program (DOD)
STO . . . . Systems Test Objectives
STOP . . . . Systems Test and Operations Plan
STP . . . . Systems Test Plan
STRP . . . . System Test Requirements Profile
SUS ENGR . . . . sustaining engineer
SYMON . . . . system monitor (System II executive program)
SVAFB . . . . South Vandenberg Air Force Base

T-III . . . . Titan III
T-IIIM . . . . Titan IIIM (MOL launch vehicle)
TA . . . . technical advisor
T-AGM . . . . designation for a military sea transport service
. . . . auxiliary general missile range ship
TARS . . . . three-axis reference system
TBD . . . . to be determined
TC . . . . test controller
TCA . . . . thrust chamber assembly
TCCS . . . . test computer console system
T-Count . . . . terminal count
TCPS . . . . thrust chamber pressure sensor
TDMS . . . . telemetry data monitor set
TDP . . . . technical development plan
TE . . . . elapsed time
TEIC . . . . tissue equivalent ion chamber
TEOL . . . . test engineer oriented language (computer)
TGA . . . . thermal gravimetric analysis
TI . . . . technical interchange (meeting)
TLM . . . . telemetry
TLV . . . . threshold limit values
TM . . . . tracking mirror
TMCC . . . . technical management control center
TMG . . . . thermal meteoroid garment
TOO . . . . test operations order
TOP . . . . technical operating plan
TOPS . . . . the operational PERT system
TOR . . . . Technical Operating Report
TOSS . . . . test operations system segment
TP&E . . . . test planning and evaluation
TPA . . . . turbopump assembly
TPQ . . . . JANAF designation for a ground transportable, special-purpose radar
TPU . . . . teleprinter unit
TR . . . . time to retrofire (also, see TTRF)
T/R . . . . transmit/receive

TRS . . . . time reference system
. . . . Technical Requirements Specification
TRW . . . . TRW Systems Group, TRW Inc.
TS . . . . technical surveillance
. . . . test stand
TTC . . . . tracking, telemetry, and command
TTCV . . . . tracking, telemetry, command, and voice
TTRF . . . . time to retrofire (also, see TR)
TTY . . . . teletype
TVC . . . . thrust vector control
TW . . . . time words
TWT . . . . traveling wave tube
TWX . . . . teletypewriter exchange

UDS . . . . Unified Documentation System (NASA/DOD)
UDT . . . . underwater demolition team (USN)
UK . . . . United Kingdom
USBS . . . . unified S-band system
USN . . . . United States Navy
UTC . . . . United Technology Center, Division of United Aircraft Corporation

VAFB . . . . Vandenberg Air Force Base
VCC . . . . voice control center
VCS . . . . voice converter subsystem
VDC . . . . voice digital computer
VERLORT . . . . very long range tracking
VET . . . . vehicle elapsed time
VGP . . . . vehicle ground point
V/H . . . . velocity-to-altitude (ratio)
VIB . . . . vertical integration building (T-III)
VIP . . . . value in performance
VSD . . . . variable slope delta
VSWR . . . . voltage standing-wave ratio
VTS . . . . Vandenberg tracking station
VV . . . . vehicle verification
VVSA . . . . velocity vector sensing assembly

WADC . . . . Wright Air Development Center (obs., see ASD)
WADD . . . . Wright Air Development Division (obs., see ASD)
WBS . . . . work breakdown structure
WECO/BTL . . . . Western Electric Company/Bell Telephone Laboratories
WMS . . . . waste management system
wpm . . . . words per minute
WRO . . . . work release order

WSMR . . . . White Sands Missile Range (unofficial name; see AFMDC)

WTR . . . . Western Test Range (NRD) (obs., see AFWTR)

ZERT . . . . zero reaction tool

ZI . . . . zone of the interior

ZULU . . . . time zone including Greenwich Meridian (same as GMT)