MAY 1971

MDC G2134

NUCLEAR SHUTTLE

SYSTEM DEFINITION STUDY, PHASE III

FINAL REPORT

PREPARED FOR NASA-MSFC
UNDER CONTRACT NAS8-24714
DRL NO. MSFC-DRL-196,
LINE ITEM 3

VOLUME VII
RNS Project Requirements

COPY NO. 43

MCDONNELL DOUGLAS ASTRONAUTICS COMPANY

MCDONNELL DOUGLAS CORPORATION

MCDONNELL DOUGLAS

NUCLEAR SHUTTLE SYSTEM DEFINITION STUDY
PHASE III FINAL REPORT

VOLUME VII
RNS Project Requirements

MAY 1971

MDC G2134

PREPARED FOR NASA-MSFC
UNDER CONTRACT NAS8-14714
DRL NO. MSFC-DRL-196
LINE ITEM 3

MCDONNELL DOUGLAS ASTRONAUTICS COMPANY
5301 Bolsa Avenue, Huntington Beach, CA 92647

FOREWORD

This document contains the results of the RNS project requirements definition effort performed during the Phase III Nuclear Shuttle System Definition Study. Requirements for both RNS concepts are treated here. This work was accomplished for the National Aeronautics and Space Administration, George C. Marshall Space Flight Center, Huntsville, Alabama, under Contract NAS8-24714. The final report was generated to fulfill the requirements of DRL No. MSFC-DRL-196, Line Item 3, and it covers the period from 1 May 1970 to 1 May 1971.

The study effort described in this volume was performed under the direction of S. Gronich and R. G. Riedesel, with G. Markus having the primary responsibility for the functional analysis effort. Additional support was provided by the various members of the study team in the areas of system operations and system design.

PREFACE

The material contained in this document represnets a portion of the final report documentation for the Phase III Nuclear Shuttle System Definition Study. The study effort was performed as a 12-month extension to the existing Nuclear Flight System Definition Study Contract (NAS8-24714), with the objective of establishing Phase A conceptual definition for two classes of reusable nuclear shuttle concepts. The first concept class is characterized as a 33-ft-diameter configuration that is launched integrally to orbit by a Saturn V INT-21 vehicle. The second concept class is characterized as a modular configuration which is assembled in earth orbit from modules carried to orbit in a space shuttle.

The final report documentation has been organized to provide separable information for the two concepts, where appropriate, and to combine report material common to both concepts in singular documents. The total documentation for the study is listed below, with this document identified in the left margin.

O	Volume I:	Executive Summary
	Volume II:	Concept and Feasibility Analysis
		Part A—Class 1 Hybrid RNS
O		Book 1—System Analysis and Operations
O		Book 2—System Definition
		Part B—Class 3 RNS
O		Book 1—System Analysis and Operations
O		Book 2—System Definition
	Volume III:	Program Support Requirements
O		Part A—Class 1 Hybrid RNS
O		Part B—Class 3 RNS
O		Part C—Test Program Analyses and SRT Requirements
O	Volume IV:	Cost Data
O		Part A—Class 1 Hybrid RNS
O		Part B—Class 3 RNS
O	Volume V:	Schedules, Milestones, and Networks
O	Volume VI:	Reliability and Safety Analysis
●	Volume VII:	RNS Project Requirements

CONTENTS

FIGURES

TABLES

Section 1
RNS PROJECT

The RNS Project Requirements Document contains all working data from functional analysis and operations analysis activities conducted during the RNS Phase III study. In addition, the document is envisioned as containing all other programmatic information affecting the nuclear shuttle. Much of the material presently contained in the guidelines and constraints document furnished by NASA (MSFC Document No. PD-SA-P-70-63, Revision 3, dated February 1, 1971) has also been included here as a basis, with the intent of updating material as warranted during future RNS study activities.

Pertinent data from this document could be used at a later date to formulate an RNS system specification, as well as to provide interface requirements information for use by other elements of the integrated space program.

1.1 GENERAL

A Reusable Nuclear Shuttle (RNS) will be used to transport a payload (cargo and/or personnel) as part of a low-cost space transportation system.

It will be capable of performing the following classes of missions:

A. Lunar/geosynchronous orbit shuttle missions (Class I)
B. Unmanned planetary missions (Class II)
C. Manned planetary missions (Class III)

The specific objectives of the program are to support the exploration of space:

A. By providing an economically attractive and safe source of transportation.
B. By demonstrating the practicality of establishing, operating, and maintaining long-lived transportation elements.
C. By developing new operational techniques and equipment which can substantially reduce the operating costs associated with space transportation.

1.2 MISSIONS

1.2.1 Design and Performance Reference

The RNS will be used to transport manned and unmanned payloads between low earth orbit and lunar orbit. The reference lunar mission for performance reporting purposes and worst condition design analysis will be characterized by the following:

Earth departure/arrival orbit altitude	260 nmi
Earth departure/arrival orbit inclination	31.5 degrees
Lunar arrival/departure orbit altitude	60 nmi
Lunar arrival/departure orbit inclination	90 degrees
Earth-to-moon coast time	108 hours
Moon-to-earth coast time	72 hours
Lunar arrival plane change	30 degrees
Lunar departure plane change	30 degrees
Midcourse ΔV	50 fps per mission leg
Flight performance reserve	0.75 percent ΔV

Multiple impulse maneuvers may be used for accomplishing plane change maneuvers.

Table 1-1 presents the reference mission timeline.

1.2.2 Economics and Operations Reference

The RNS will be used to transport manned and unmanned payloads between low earth orbit and lunar orbit. For economics and operations analyses, the mission profile to be considered will consist of the minimum-energy transfer, having the following characteristics:

Earth departure/arrival orbit altitude	260 nmi
Earth departure/arrival orbit inclination	31.5 degrees
Lunar arrival/departure orbit altitude	60 nmi
Lunar arrival/departure orbit inclination	90 degrees
Earth-to-moon coast time	108 hours
Moon-to-earth coast time	72 hours
Midcourse ΔV	50 fps/mission leg
Flight performance reserve	0.75 percent ΔV

Table 1-1

LUNAR SHUTTLE MISSION TIMELINE–DESIGN PROFILE

Event	Time Hours	* TBi + Δt	Comment
Translunar injection (TLI)			108-hr transfer
Start chill	0	+0	
Full thrust achieved	0	+1 Min.	
Commence throttle	0.5	+30 Min.	
Start pulse cooldown	0.75	+45 Min.	Close PSoV's, Wp = 165, 730 lb
Terminate cooldown	120.75	+120.75 hr	5kw, Wp_{cd} = 7, 300 lb
Midcourse correction(s)	10→70(typ)	---	Total Accum. ΔV = 50 fps Wp = 1, 030 lb ($\dot{W}$ = 2 lb/sec)
Lunar orbit injection (LOI)-I			24-hr period
Start chill	108.5	+0	
Full thrust achieved	108.5	+1 Min.	
Commence throttle	108.5	+2.2 Min.	
Start pulse cooldown	108.6	+5.4 Min.	Wp = 10, 740 lb
Terminate cooldown	121.1	+12.6 hr +12.3	Wp_{cd} = 770 lb
Apolune plane change			30 degrees
Start chill	120.5	+0	
Full thrust achieved	120.5	+1 Min.	Throttle mode (45, 000-lb thrust)
Commence throttle	120.5	+1.4 Min.	
Start pulse cooldown	120.6	+4.2 Min.	Wp ~ 4, 800 lb
Terminate cooldown	125.5	+5 hr	Wp_{cd} ~ 360 lb
Lunar orbit injection (LOI)-II			60-nmi circular
Start chill	132.4	+0	
Full thrust achieved	132.4	+1 Min.	
Commence throttle	132.5	+3.7 Min.	
Start pulse cooldown	132.6	+7.8 Min.	Wp = 19, 330 lb
Terminate cooldown	151.5	+19.1 hr	Wp_{cd} = 1, 350 lb
Lunar orbit operations			

*TB_i ≡ Time Base

Table 1-1 (Continued)

LUNAR SHUTTLE MISSION TIMELINE–DESIGN PROFILE

Event	Time Hours	* TBi + Δt	Comment
Transearth injection (TEI)-I			24-hr Period
Start chill	518.8	+0	
Full thrust achieved	518.8	+1 Min.	
Commence throttle	518.8	+2.4 Min.	
Start pulse cooldown	518.9	+5.8 Min.	Wp = 11,860 lb
Terminate cooldown	533.0	+14.1 hr	Wp_{cd} = 850 lb
Apolune plane change			30 degrees
Start chill	530.9	+0	
Full thrust achieved	530.9	+1 Min.	Throttle mode (45,000-lb thrust)
Commence throttle	530.9	+1 Min.	
Start pulse cooldown	530.9	+3.5 Min.	Wp ~ 2,700 lb
Terminate cooldown	536	+3 hr	Wp_{cd} ~200 lb
Transearth injection (TEI)-II			72-hr transfer
Start chill	542.9	+0	
Full thrust achieved	542.9	+1 Min.	
Commence throttle	542.9	+1.7 Min.	
Start pulse cooldown	543.0	+4.8 Min.	Wp = 8,200 lb
Terminate cooldown	553.1	+10.1 hr	Wp_{cd} = 600 lb
Midcourse correction(s)	558→603	---	Total accum. ΔV = 50 fps Wp = 500 lb ($\dot{w}$ = 2 lb/sec)
Earth orbit injection (EOI)			
Start chill	614.8	+0	
Full thrust achieved	614.8	+1 Min.	
Commence throttle	614.9	+8.8 Min.	
Start pulse cooldown	615.1	+15.2 Min.	Wp = 47,530 lb
Terminate cooldown	660.1	+45 hr	Wp_{cd} = 2,800 lb
Earth orbit operations			

*TB_i ≡ Time Base

Table 1-2 presents the corresponding mission timeline.

1.2.3 Additional Missions

Although the RNS will be designed for the lunar shuttle mission, it will have the capability to perform the following:

A. The RNS will be used to transport manned and unmanned payloads between low earth orbit and geosynchronous orbit. The reference geosynchronous mission for performance reporting purposes will be characterized by the following:

Earth departure/arrival orbit altitude	260 nmi
Earth departure/arrival orbit inclination	31.5 degrees
Geosynchronous arrival/departure/orbit Inclination	0 degrees
Midcourse ΔV	50 fps per mission leg

B. An evolutionary version of the RNS will be used to provide propulsion for manned Mars missions. For the purpose of this study, a 1986 outbound Venus swingby Mars mission and a 1990 conjunction class Mars mission will be evaluated. The stopover time for the Venus swingby mission will be 60 days. The reference mission guidelines are as follows:

Earth assembly/departure orbit inclination	31.5 degrees
Earth assembly/departure orbit altitude	260 nmi
Earth assembly/departure orbit eccentricity	0
Mars parking/orbit—periapsis altitude	270 nmi
elliptic orbit period	12 hours
Earth arrival orbit—periapsis altitude	270 nmi
elliptic orbit period	24 hours
Midcourse correction ΔV allowance/ mission leg	500 fps
Mars orbit trim ΔV	150 fps

An alternate earth assembly/departure orbit eccentricity may be used, but mission weight requirements will include orbit-to-orbit RNS propellant from the 260-nmi circular orbit.

Table 1-2

LUNAR SHUTTLE MISSION TIMELINE

FOUR-BURN OPERATIONAL PROFILE

Event	Initiation Time (Days)	Duration	RNS Propellant Used (lb)
Ground launch of shuttle to 260-nmi operational orbit	0	-	-
Orbit assembly and checkout operations	0	9 days	-
Translunar injection (108-hr transfer)	9	47 min	174,820
Cooldown	9	125 hr	7,600
Midcourse correction(s) (idle mode)	10	9 min	1,080
Insertion into 60-nmi lunar orbit	13.5	11 min	31,520
Cooldown	13.5	33 hr	2,000
Lunar orbit operations	13.5	18.1 days	-
Transearth injection (72-hr transfer)	31.6	7.8 min	19,400
Cooldown	31.6	23 hr	1,400
Midcourse correction(s) (idle mode)	32.6	4.2 min	500
Earth orbit insertion	34.6	15.2 min	47,530
Cooldown	34.6	45 hr	2,800

1.3 OPERATIONS

A first flight test of the RNS will be in mid-calendar year 1979.

Initial operating capability (IOC) for the RNS will be in calendar year 1981.

The RNS may have an operational interface with the following system elements currently included in NASA planning:

A. Earth orbital space station/base
B. Space shuttle
C. Propellant depot
D. Space tug
E. Lunar orbit space station and surface base

F. Manned and unmanned payloads

G. Manned planetary mission spacecraft

The program model will consist of lunar shuttle missions only.

The range of lunar mission flights will consider 2, 4, 6, and 8 RNS flights per year.

Earth return payload for each flight will be assumed to be 20, 000 lb.

Two space shuttle payload capabilities will be considered for determining the number of space shuttle flights required to support the RNS:

A. 25, 000-lb capability to 55-degree inclination and 270 nmi yielding 33, 000-lb to 260 nmi x 31. 5-degree orbit

B. 40, 000-lb capability to 55-degree inclination and 270 nmi yielding 50, 000-lb to 260 nmi x 31. 5-degree orbit.

The operational program will be 10 years.

In-orbit maintenance and propellant refueling of the RNS will be accomplished only at the RNS operations orbit defined in Section 1. 2.

The RNS will have automated rendezvous and docking capability.

The RNS astrionics system will be independent of payload.

For manned operations, crew will have override capability for RNS control.

The RNS will be checked out in the RNS operations orbit prior to each mission.

Payloads, LH_2 propellants, and maintenance supplies for the RNS will be delivered by the logistics vehicle and assembled in the RNS operations orbit.

The space tug may be used to maneuver the payload to the RNS for assembly.

The RNS will maintain attitude control while the payload is maneuvered and docked to the RNS.

Final automated checkout of the vehicle occurs after payload docking.

Aftercooling pulses on the RNS during a mission will be used to the maximum practical extent for final velocity attainment, midcourse corrections, and/or gross rendezvous maneuvers.

Payload transfer between RNS and the lunar space station or geosynchronous space station may be accomplished by the space tug.

During lunar or geosynchronous orbit operations, the RNS will remain at a safe distance from and in the same orbit as the lunar or geosynchronous space station. The distance is to be determined by radiation dose criteria defined in Section 1.4.

1.4 SAFETY

The RNS will be man-rated.

All credible single failure modes or credible combinations of failures and errors which result in loss of crew and passengers or unacceptable risk to general population groups will be eliminated by design change and/or mission modification.

No single failure or credible combination of failures and errors will prevent or preclude operation of the NERVA engine in the emergency mode.

Total radiation dose from the NERVA engine and related sources during reactor power operation will be limited to 10 REM per passenger per round trip shuttle mission. Payload and spacecraft attenuation, unless specifically estimated, will be assumed to be negligible. If a need is identified for a

crew member to make more than one trip per year, additional protection must be provided so that the dose per trip to that crew member is reduced proportionately. Limits for passenger or crew radiation doses from post-shutdown NERVA sources, other nuclear systems, and natural space radiation are not specified. However, no assumption or requirement of any nuclear stage operations or configuration should cause the additional dose received from these sources to exceed 10 REM per round trip.

RNS maintenance personnel will not receive more than 25 REM per year from the RNS.

Total integrated radiation dose from the RNS to any manned space station or manned orbital system will not exceed 0.1 REM during any single NERVA engine burn.

Additional safety guidelines are defined in a paper by F. Gavigan, "Operational Safety of Nuclear Rockets."

1.5 RELIABILITY

The RNS will be designed to achieve a reliability of 0.975 for the intransit phase of each flight. The RNS subsystems will be designed to achieve the reliability allocations in Tables 1-3 and 1-4.

1.6 MAINTAINABILITY

System maintenance will be considered to affect economic operation of the RNS which requires multiple use. Provisions for maintenance shall be an integral part of the system design. The following maintainability criteria will be implemented:

A. The level of in situ maintenance will be by module replacement.
B. Man's role for in situ maintenance will be minimized.
C. Location of terrestrial maintenance and level of refurbishment TBD.

Table 1-3

RELIABILITY ALLOCATION—CLASS 1 HYBRID RNS

	System	System Totals		CCM		Propellant Module		Propulsion Module	
2.0	Structure	0.9987		0.9998		0.9992		0.9997	
3.0	Meteoroid	0.9975		0.9999		0.9978		0.9998	
5.0	Main Propulsion	0.9893		---		0.9970		0.9923	
	5.01 NERVA		0.9950		---		---		0.9950
	5.05 Propellant Feed		0.9981		---		0.9988		0.9993
	5.06 Pressurization		0.9979		---		0.9988		0.9991
	5.09 Fill		0.9991		---		0.9999		0.9992
	5.10 Gound Vent		0.9998		---		0.9998		---
	5.11 Flight Vent		0.9994		---		0.9997		0.9997
6.0	Auxiliary Propulsion	0.9970		0.9971		---	---	0.9999	
7.0	Astrionics	0.9927		0.9934		0.9997		0.9996	
	7.01 Guid, Nav, and Control		0.9990		0.9992		0.9999		0.9999
	7.04 Electrical Power		0.9967		0.9967		---		---
	7.05 Electrical Networks		0.9985		0.9990		0.9998		0.9997
	7.09 Data Mgmt		0.9985		0.9985		---		---
8.0	Safety	0.9998		0.9999		0.99995		0.99995	
	Totals	0.9750		0.9901		0.99365		0.99125	

Table 1-4

RELIABILITY ALLOCATION–CLASS 3 RNS

		System Totals	CCM	Propellant Module	Propulsion Module
		(1-8-1)			
2.0	Structure	0.9987	0.99996	0.99986	0.99986
3.0	Meteoroid	0.9975	0.9999	0.999725	0.9998
5.0	Main Propulsion	0.9848	--- ---	0.99891	0.99352
	5.01 NERVA	0.9950	---	---	0.9950
	5.05 Propellant Feed	0.99598	---	0.99956	0.9995
	5.06 Pressurization	0.9955	---	0.9995	0.9995
	5.09 Fill	0.9993	---	0.99996	0.99962
	5.10 Ground Vent	0.99992	---	0.99999	---
	5.11 Flight Vent	0.9991	---	0.9999	0.9999
6.0	Auxiliary Propulsion	0.9982	0.9983	---	0.9999
7.0	Astrionics	0.9960	0.9967	0.99993	0.99986
	7.01 Guid, Nav & Control	0.9992	0.9994	0.99998	0.99996
	7.04 Electrical Power	0.9985	0.9985	---	---
	7.05 Electrical Networks	0.9993	0.9998	0.99995	0.9999
	7.09 Data Mgmt	0.9990	0.9990	---	---
8.0	Safety	0.9998	0.9999	0.99999	0.99998
	Totals 1-1-1	---	0.99476	0.998415	0.99292
	1-8-1	0.9750	0.99476	0.98732	0.99292

Section 2

PROJECT INTEGRATION DATA

2.1 RNS SYSTEM DEFINITION

The RNS design concepts will provide low-cost transportation for support of the projected lunar exploration program. Two classes of RNS concepts to be considered are:

A. A three-module system using a 33-ft-diameter single propellant tank configuration, propulsion module, and command and control module, that are launched to orbit by the Saturn INT-21 vehicle and the space shuttle.

B. A multiple-tank configuration which is assembled in earth orbit from modules carried to orbit in a space shuttle.

Figures 2-1 and 2-2 present typical conceptual drawings of the two configurations.

- Initial RNS design concepts will reflect a 1974 state-of-the-art; consideration will be given to later incorporation of more advanced technology.
- All versions of the RNS will be man-rated, i.e., they will meet all structural, material, and quality standards required for manned application.
- Government facilities and associated utilities and special test equipment will be used to the maximum extent possible. This is particularly so in relation to the ground and flight demonstration programs and the supporting technology programs.
- The design lifetime for the RNS will be up to 3 years in space with the capability for maintenance in earth orbit.
- The RNS will be capable of withstanding the applicable natural environment, during all phases of the mission, as specified by NASA TM X-53865 and NASA TM X-53872.

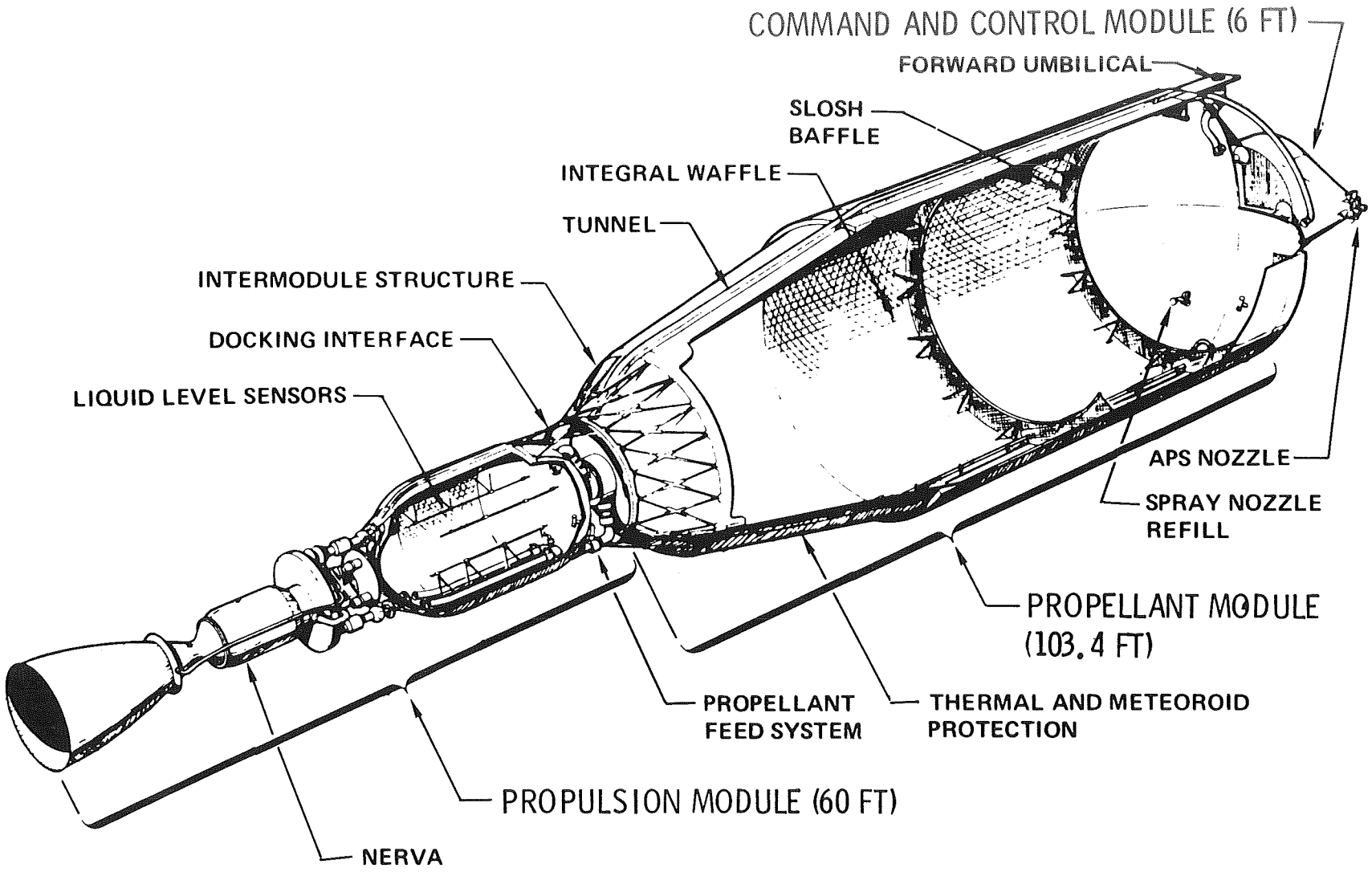


Figure 2-1 CLASS 1 HYBRID RNS

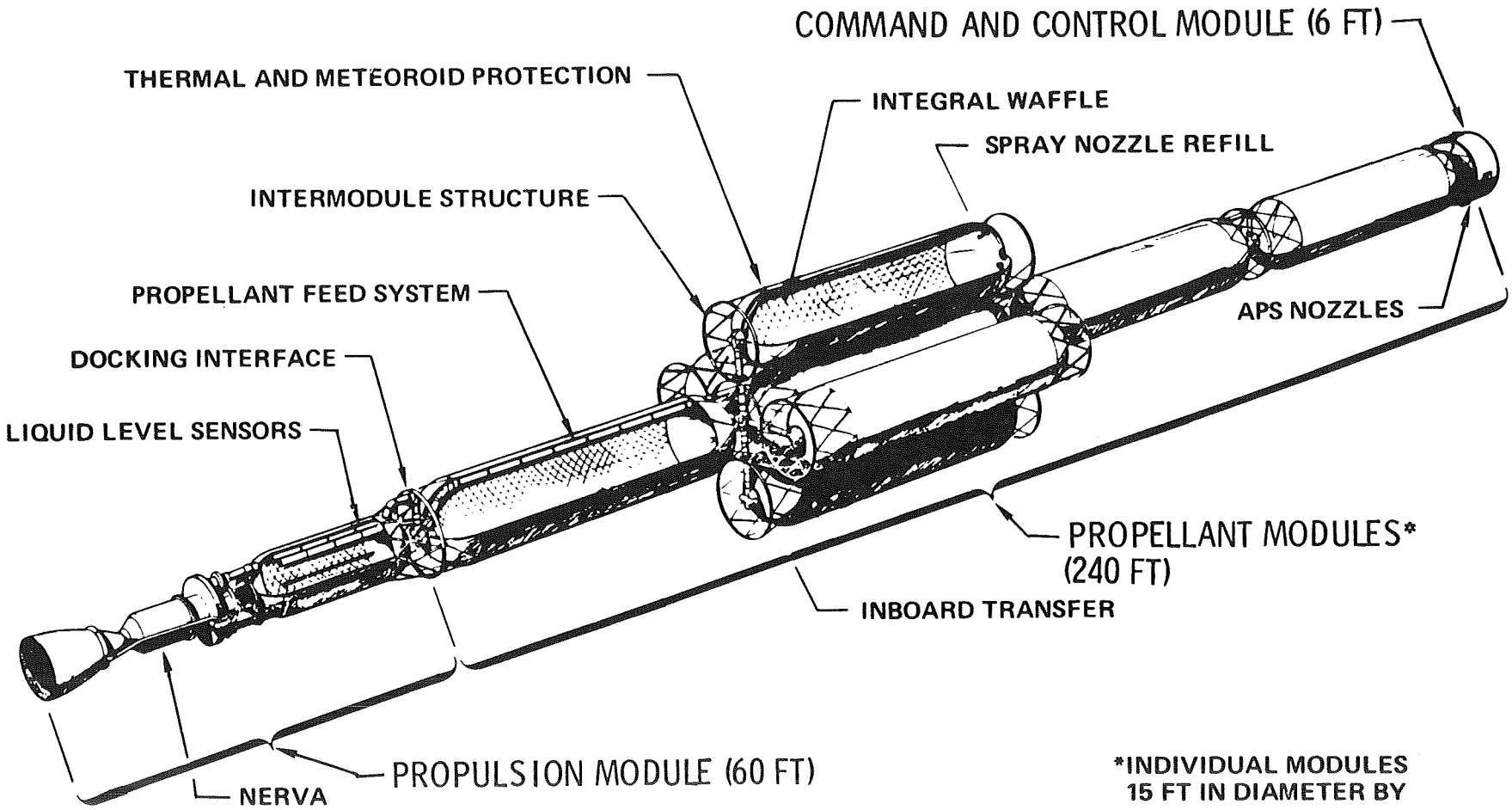


Figure 2-2

CLASS 3 RNS

- The meteoroid shielding for the RNS propellant tank(s) will be designed for a no tank penetration criteria. The RNS will be assumed to have random orientation, i.e., no advantage will be taken of the apparent directionality of stream meteoroids. The meteoroid shielding will be designed for at least a 0.995 probability of no tank penetration in one lunar mission (maximum 45 days) using the meteoroid flux criteria of NASA TM X-53865.

2.1.1 Class 1 Hybrid RNS

The Class 1 Hybrid RNS (RNS-1H) is a hybrid configuration composed of a 33-ft-diameter propellant module and space shuttle compatible propulsion and command and control modules. The propellant module is launched to orbit with the INT-21 launch vehicle. The propulsion module and command and control module are launched within the space shuttle and mated with the propellant module in the operational earth orbit. The RNS-1H system is composed of these modules plus the GSE, facilities, test hardware and operations, and systems management required to develop, support, test, operate and maintain the system.

2.1.1.1 Propellant Module (Figure 2-3)

The propellant module provides for storage of propellants. It is sized to contain 289,150 lb of LH_2 with a 5 percent ullage volume. It is passive and responsive to external control. Thermal/meteoroid protection is provided through an integral system composed of HPI blankets surrounded by foam and fiber glass.

2.1.1.2 Propulsion Module (Figure 2-4)

The propulsion module provides propellant supply to the NERVA through a run tank sized for 10,850 lb of LH_2. Additionally it provides the prepressurization function for engine starts. It has a minimum stabilization and control capability for support of maintenance and assembly operations as well as end-of-life disposal. The propulsion module is designed to be launched within the space shuttle.

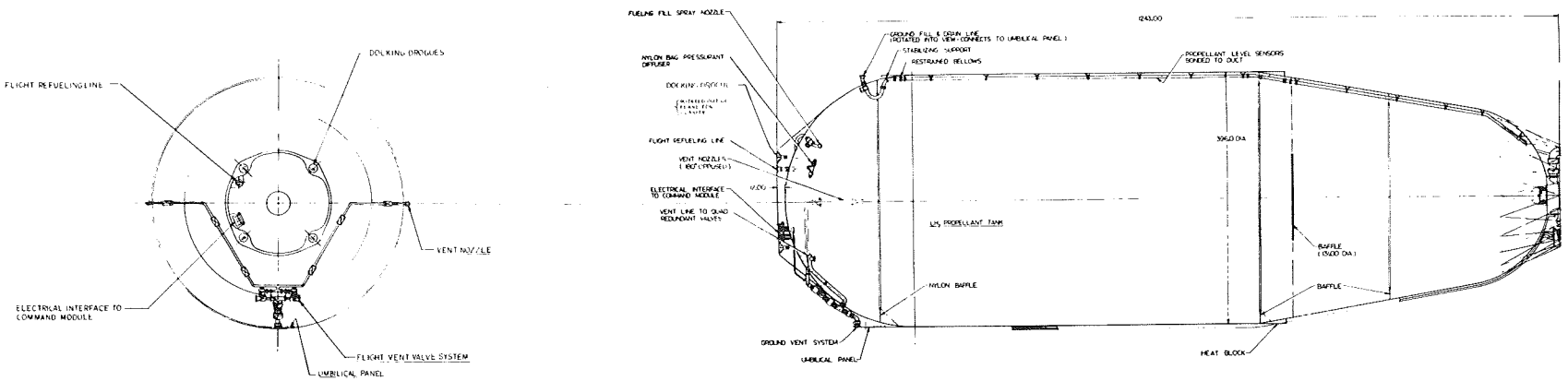


Figure 2-3. Class I Hybrid RNS Propellant Module

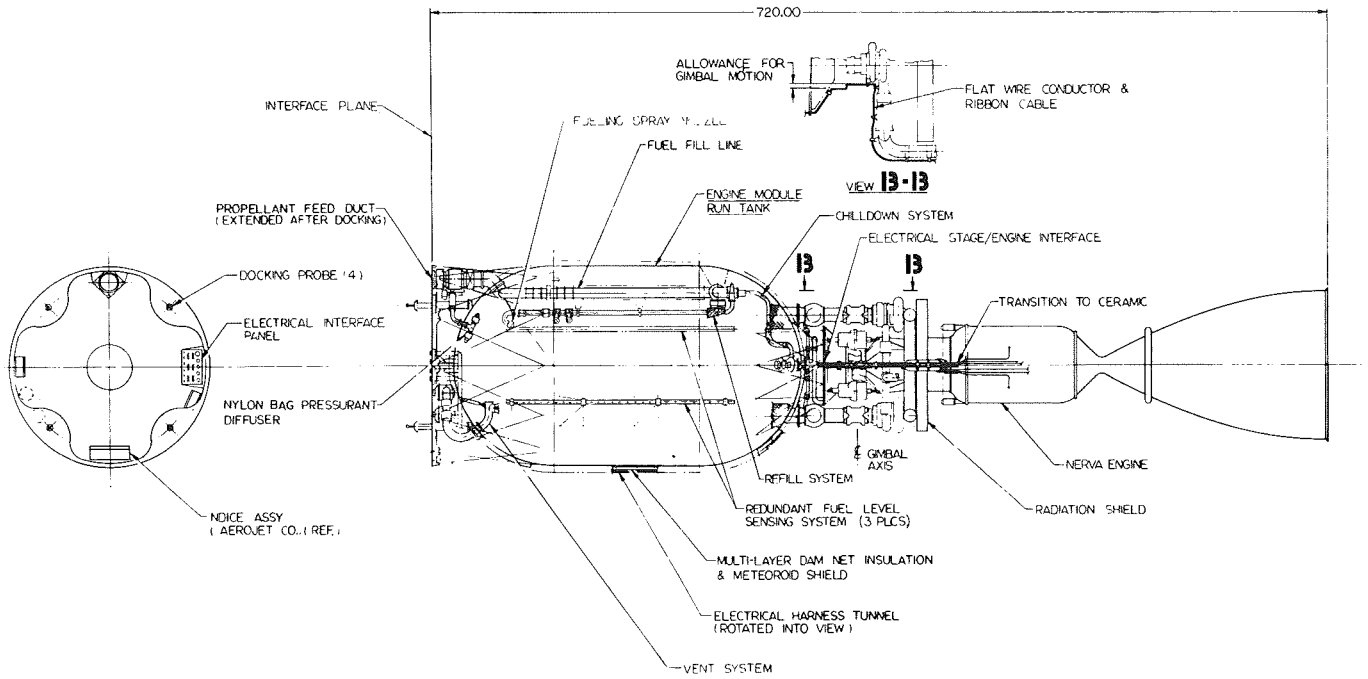


Figure 2-4. RNS Propulsion Module

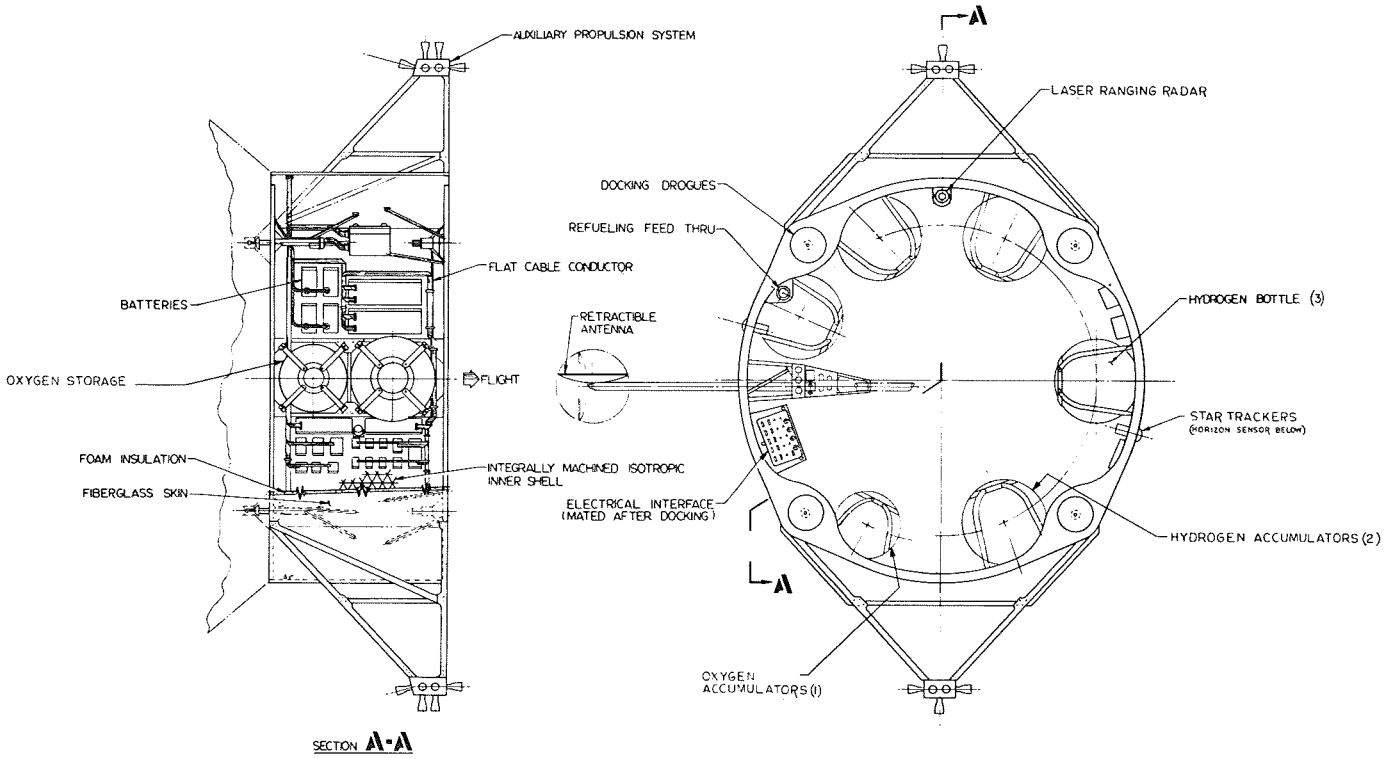


Figure 2-5. Class I Hybrid RNS Command and Control Module

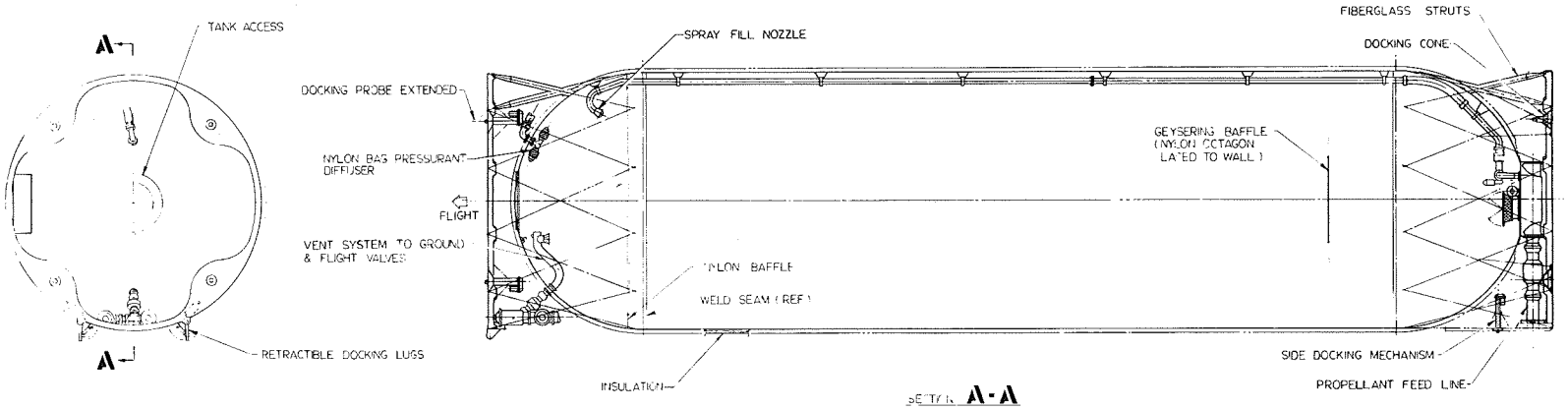


Figure 2-6. Class 3 RNS Propellant Module

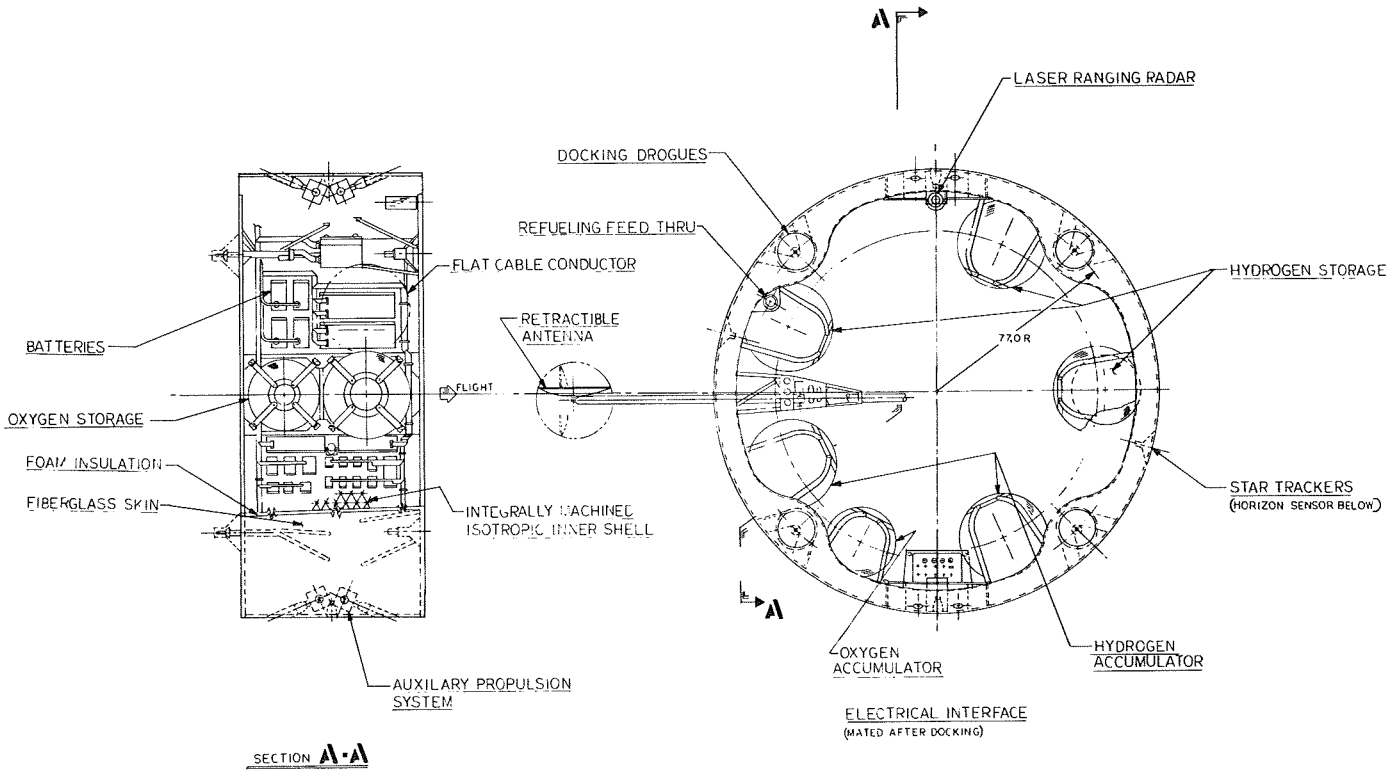


Figure 2-7. Class 3 RNS Command and Control Module

2.1.1.3 Command and Control Module (Figure 2-5)

The CCM provides all the astrionics functions (navigation guidance and control, electrical power, and data management) as well as auxiliary propulsion. Propellant resupply of the RNS is accomplished through the CCM.

2.1.2 Class 3 RNS

The Class 3 RNS (RNS-3) is a multiple tank configuration composed of eight propellant modules, one propulsion module and one command and control module. The elements are launched individually within a space shuttle assembled into an RNS in earth orbit. The RNS-3 system is composed of these modules plus the GSE, facilities, test hardware and operations and systems management required to develop, support, test, operate and maintain the RNS-3.

2.1.2.1 Propellant Modules (Figure 2-6)

The provision for propellant storage is divided among eight individual propellant modules clustered together and having interconnecting plumbing. The overall size of each module is governed by the payload bay of the space shuttle orbiter, i.e., 15-ft diameter by 60 ft long. The resulting propellant capacity for each module is 36,500 lbs with a 5 percent ullage volume. Thermal/meteoroid protection is provided through an integral system composed of HPI blankets and surrounded by foam and fiber glass. Docking and clustering mechanisms are incorporated to allow on-orbit assembly and disassembly.

2.1.2.2 Propulsion Module (Figure 2-4)

The propulsion module for the Class 3 RNS is identical to the RNS-1H propulsion module.

2.1.2.3 Command and Control Module (Figure 2-7)

The CCM for Class 3 is similar to that for RNS-1H, with the exception of dimensional characteristics.

2.2 PROJECT SYSTEM MANAGEMENT

The data contained in the following paragraphs are intended to provide top level programmatic information regarding the Reusable Nuclear Shuttle

Project. The data will be updated and expanded as appropriated during subsequent RNS study phases.

2.2.1 Work Breakdown Structure

A program WBS to the system level, i.e., level 4, and a project WBS for the RNS to the subsystem level, i.e., level 5, are included in Figure 2-8. The figure is taken directly from the Guidelines and Constraints document furnished by MSFC, and serves as the basis for formulation of the specification tree, as well as the definition of primary and secondary functional areas in Section 4 of this document.

2.2.2 Specification Tree

The specification tree for the RNS project is shown in Figure 2-9. It will be modified as appropriate during subsequent phases of study.

2.2.3 Functional Flow Diagram

The top level functional flow diagram for the RNS is shown in Figure 2-10. It is applicable to either version of the RNS, and to any mission, with the first level breakdown of the blocks indicating differences between RNS configurations and missions. These functional flow diagrams are contained in Section 4.

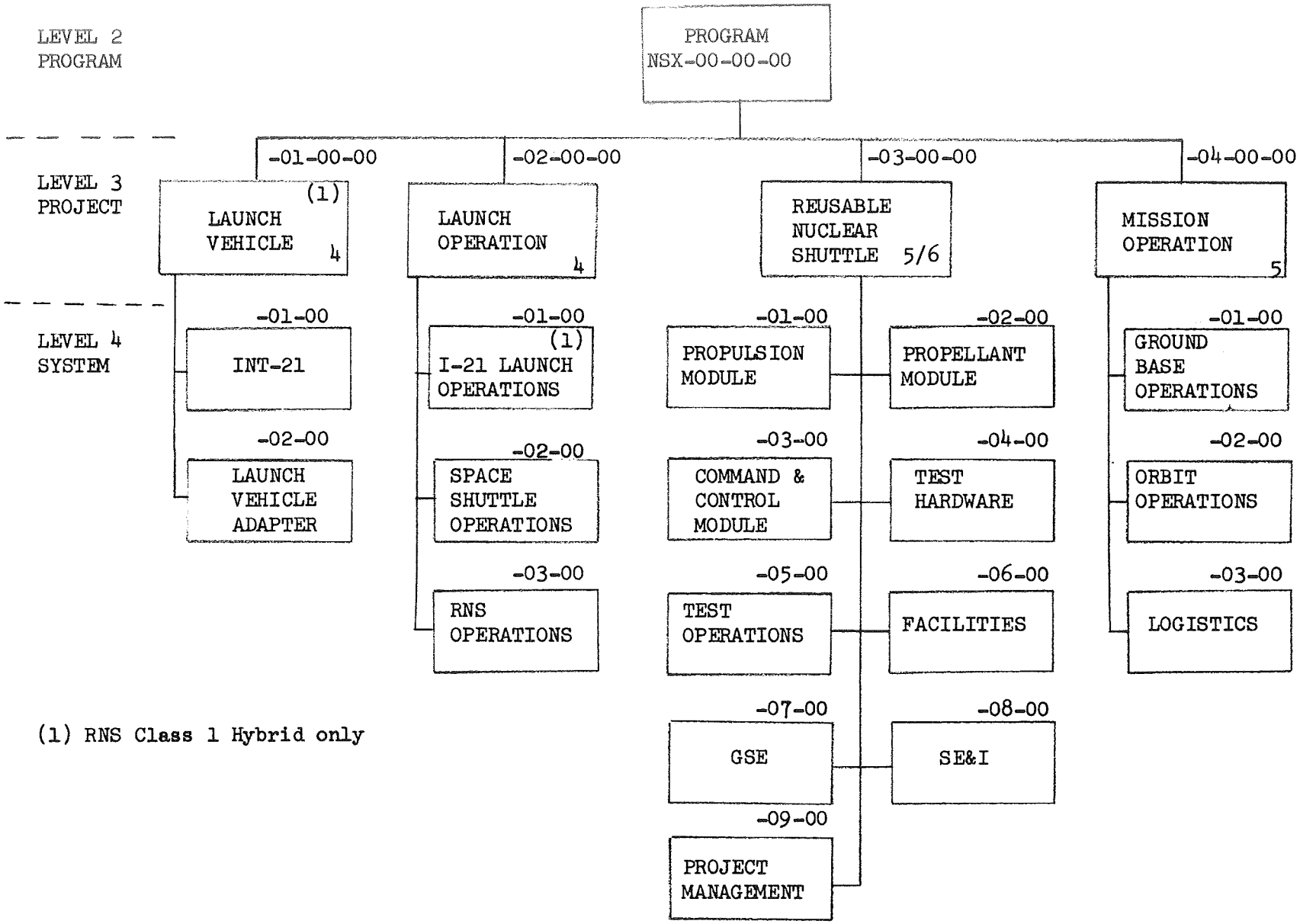
2.2.4 Project Level Schematic

Preliminary top level pictorials of hardware and facilities and their interrelationships are shown in Figures 2-11 and 2-12 with emphasis on the interactions between facilities and hardware as follows:

Facilities	Hardware
Manufacturing	RNS elements
Testing	RNS launch vehicle(s)
Launch	RNS logistic vehicle
Mission control	

2.2.5 Project Schedule

The project schedule generated during the study is shown in Figure 2-13 for the RNS program.



(1) RNS Class 1 Hybrid only

Figure 2-8 RNS WORK BREAKDOWN STRUCTURE Sheet 1 of 3

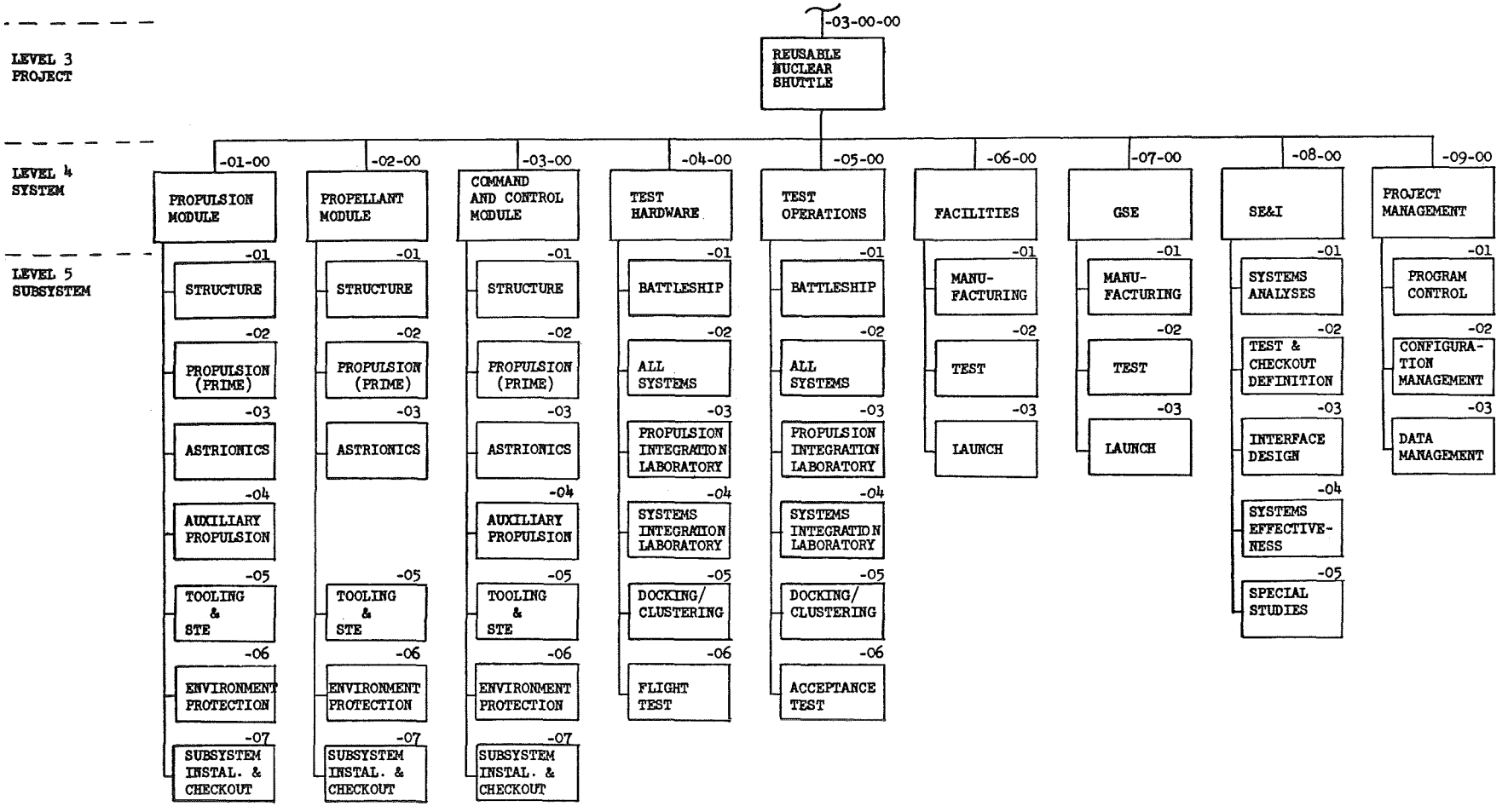


Figure 2-8 RNS WORK BREAKDOWN STRUCTURE (Sheet 2 of 3)

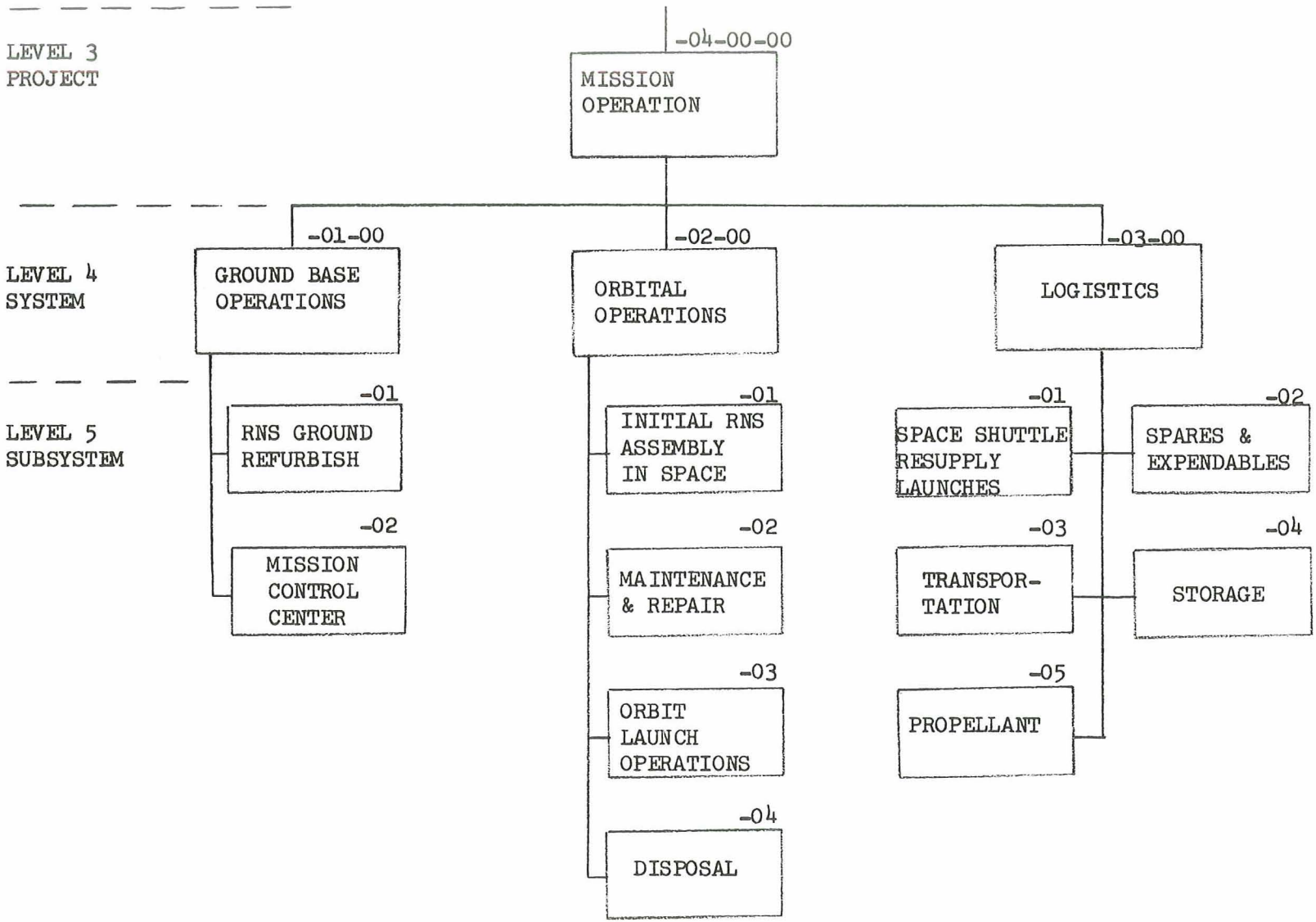


Figure 2-8 RNS WORK BREAKDOWN STRUCTURE Sheet 3 of 3

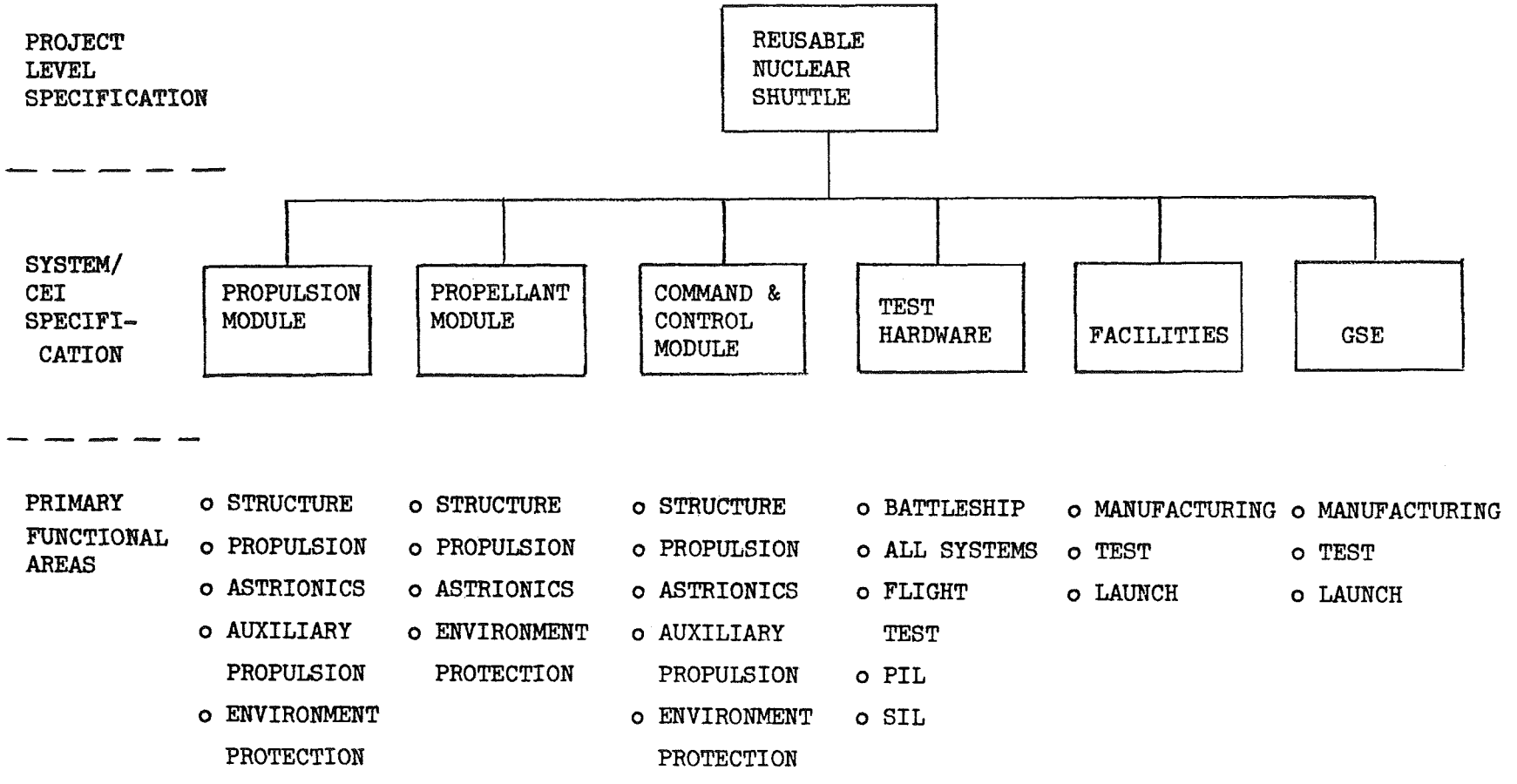
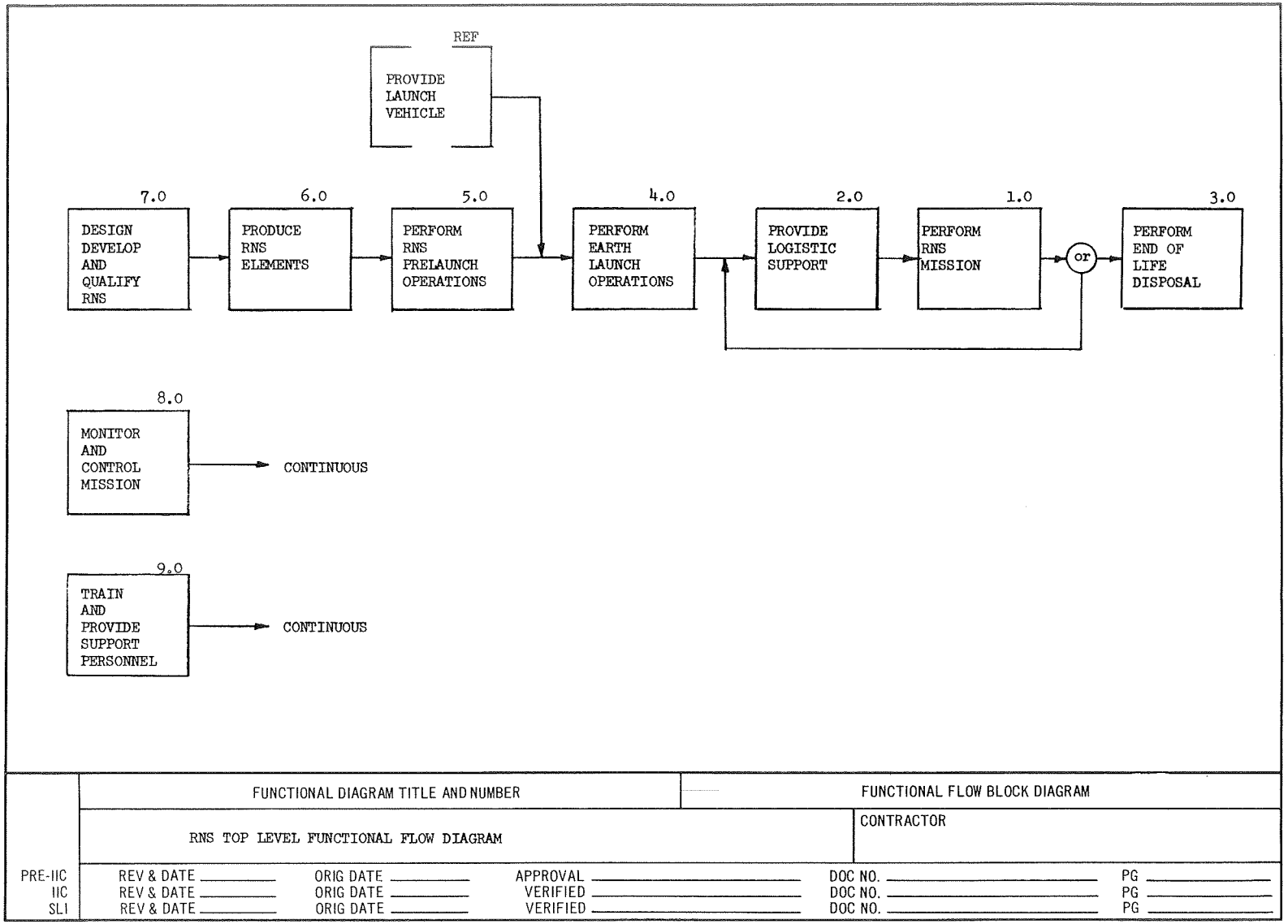


Figure 2-9 RNS PROJECT SPECIFICATION TREE



	FUNCTIONAL DIAGRAM TITLE AND NUMBER			FUNCTIONAL FLOW BLOCK DIAGRAM	
	RNS TOP LEVEL FUNCTIONAL FLOW DIAGRAM			CONTRACTOR	
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG

FIGURE 2-10 RNS TOP LEVEL FUNCTIONAL FLOW

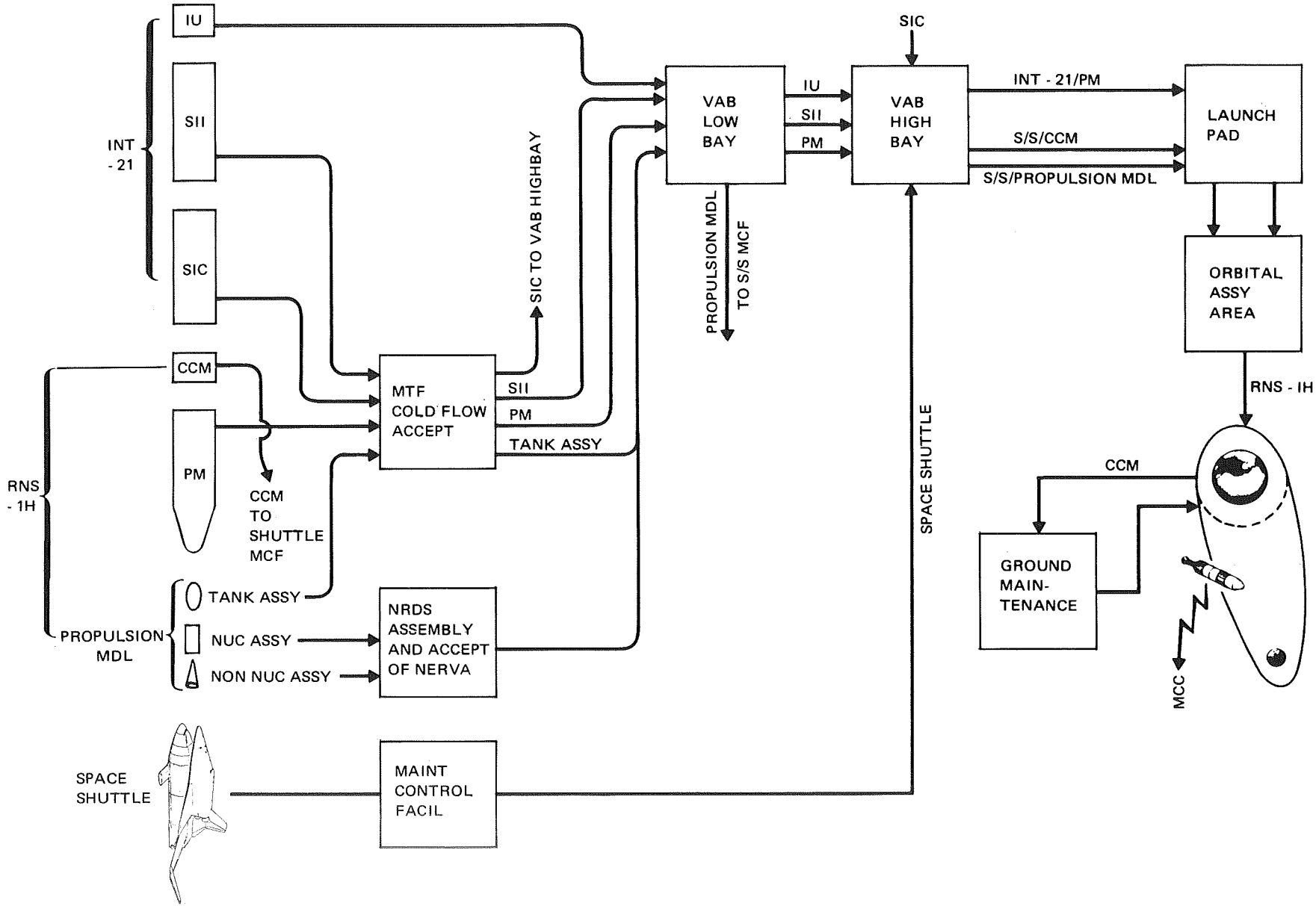


Figure 2-11. RNS-1H Program Schematic—Top Level

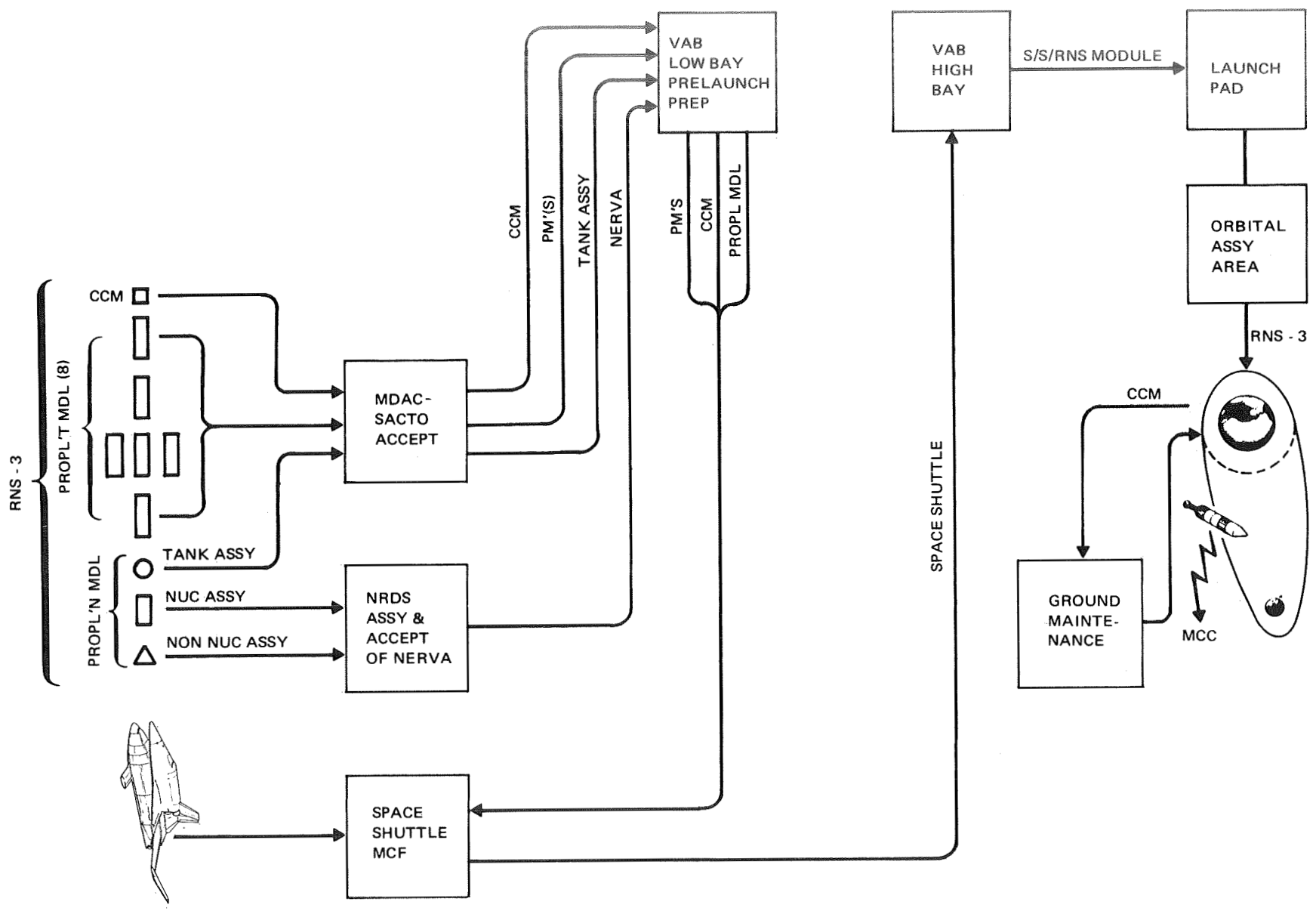


Figure 2-12. RNS-3 Program Schematic—Top Level

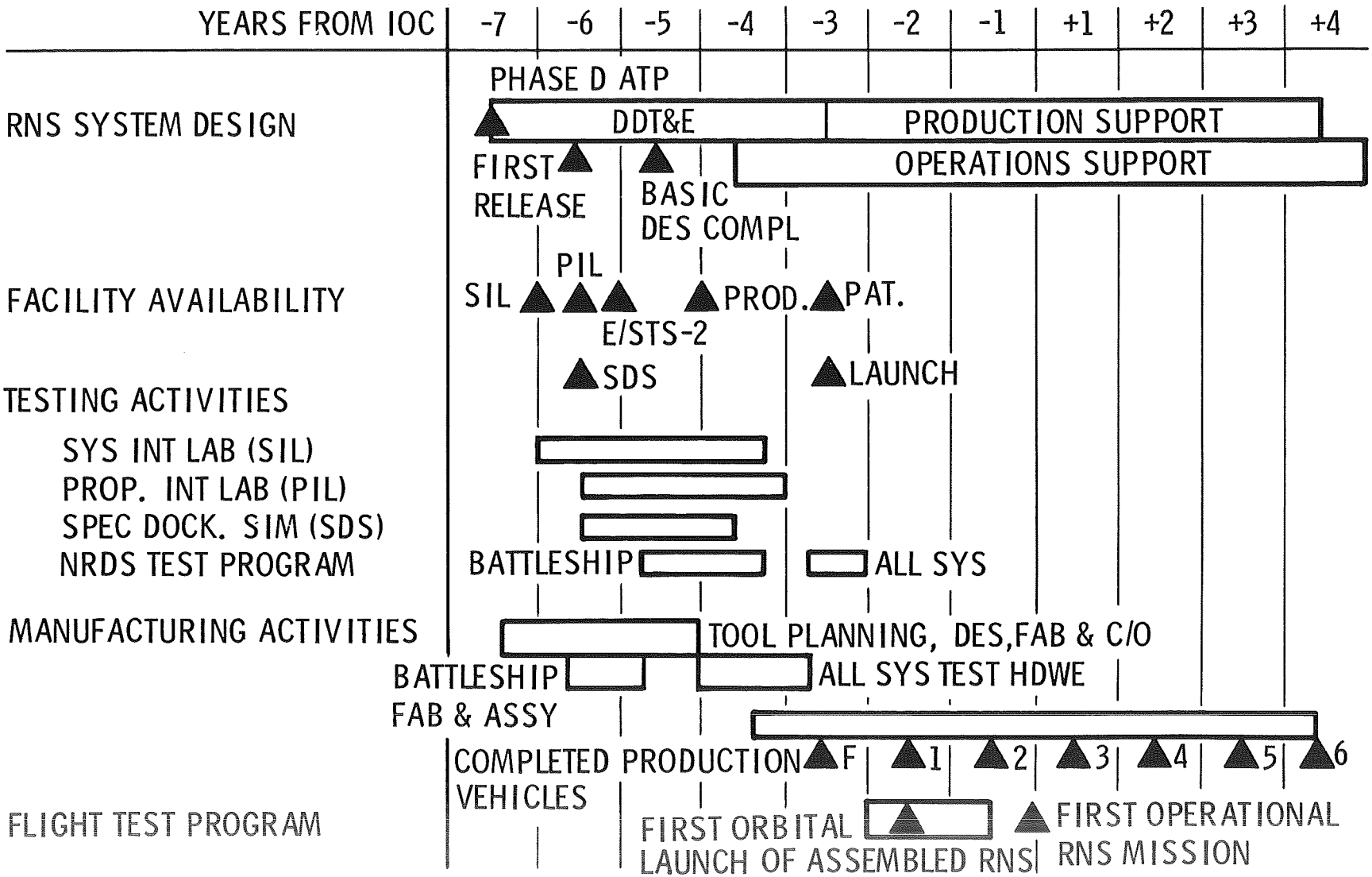


Figure 2-13 RNS PROJECT SCHEDULE

Section 3

PROJECT SUPPORT AND INTERFACE REQUIREMENTS

3.1 RNS LAUNCH VEHICLE

3.1.1 General

The launch vehicle for the Class 1 Hybrid RNS configuration defined in Section 2.1 is the Saturn INT-21 vehicle using standard J-2 engines for the propellant module and the space shuttle for propulsion and command and control modules.

The launch vehicle for the multiple module configuration RNS defined in Section 2.1 is the space shuttle for all modules.

3.1.2 Operations

The Saturn INT-21 vehicle is to be launched from Kennedy Space Center.

The space shuttle is to be launched from Kennedy Space Center.

Earth launch vehicles will be available as required to support the RNS test program and subsequent missions.

3.1.3 Configurations

The Saturn INT-21 vehicle is defined in Boeing Documents D5-15583, "Intermediate-21 Launch Vehicle Preliminary Description for a Phase B Space Station Design," August 22, 1969 and Boeing 5-1085-INT-21-07, "Report, Preliminary Analysis of INT-21 Launch Vehicle/McDonnell Douglas (MDAC) Space Station Payload—Mission No. 1," February 23, 1970.

The space shuttle is defined in Section 3.2.

3.2 RNS LOGISTICS SYSTEM

3.2.1 General

The logistics vehicle which supports the RNS will be used to transport LH_2 propellant, maintenance parts and supplies, and payloads from earth to earth orbit.

The logistics vehicle will be the space shuttle.

The space shuttle payload capability to the RNS operations orbit is defined in Figure 3-1.

3.2.2 Configurations

The cargo bay of the space shuttle will be sized to have a clear volume of 15-ft diameter by 60-ft length. This will be interpreted as meaning the external dimensions of the payload may be up to 15-ft in diameter by 60-ft long.

The space shuttle will have provisions for deployment and boarding of a cylindrical payload of 15-ft diameter by 60-ft length.

The impact of alternate cargo bay sizes and increased payload capability over the baseline space shuttle defined here will be considered and assessed in trade studies.

3.2.3 Operations

The space shuttle which supports the RNS will be launched from Kennedy Space Center.

Space shuttles will be available as required to support the RNS.

Baseline operations guidelines for the space shuttle are defined as follows:

A. The orbiter stage of the space shuttle will be capable of landing with a full payload.

B. The space shuttle will have an all azimuth launch capability.

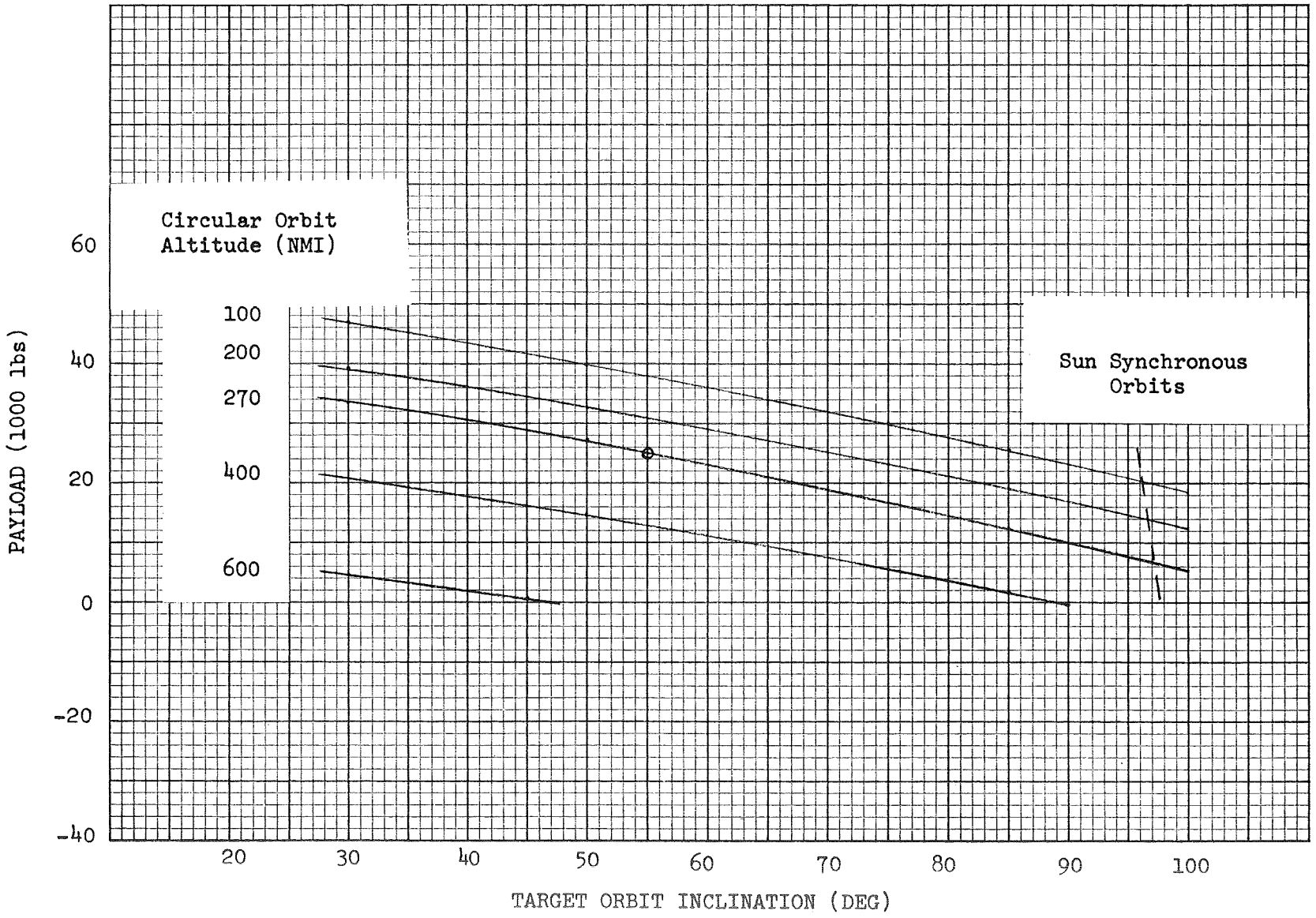


Figure 3-1 25 K SPACE SHUTTLE PAYLOAD CAPABILITY

C. Space shuttle trajectory design load factors are 3g.

D. The space shuttle will be capable of up to 7 days of self-sustaining lifetime. For missions in excess of 7 days, the weight of the expendables will be charged against the payload.

E. Cargo elements containing hazardous material will have self-contained protective devices or provisions against all hazards.

F. The IOC date for the space shuttle is the second half of 1977.

G. An operational cost of $5 million per launch of the space shuttle will be assumed for the nuclear shuttle system definition studies.

H. Additional support functions and interface requirements are TBD.

3.3 RNS OPERATIONS SUPPORT

3.3.1 Space Tug

Unique requirements imposed on the space tug by the RNS operations are TBD. Guidelines for the space tug are defined below.

The space tug may be used with the RNS for support operations in low earth orbit, geosynchronous orbit, and lunar orbit.

The space tug is a vehicle system that will vary in geometric arrangement of its components to adapt to the specific mission that it is called upon to perform. To accomplish this variability, the space tug has four basic modules and appropriate mission-oriented kits. These are:

Basic Modules

- Crew Module (CM)
- Propulsion module (PM/PPE)
- Cargo Module (CaM)
- Intelligence Module (IM)

Typical Kits

- Landing Legs (LL)
- Environmental Control and Life Support System (EC/LS)
- Manipulator Arms (MA)
- Propulsion Module—Secondary (PM/SPE)
- Extendable Support Arms (ESA)

The CM, as an RNS payload, will house men during transfer between low earth orbit and the geosynchronous orbit space station or the lunar orbit space station. The CM in conjunction with the PM/PPE and associated kits can service and support the RNS as required. Basic characteristics and requirements of the CM are as follows:

A. Support up to three men for 28 days plus 14 days contingency in earth orbit for service and support of the RNS.
B. Support up to six men for 14 days plus 14 days contingency as a crew transporter from low earth orbit to geosynchronous or lunar orbit and return.
C. CM gross weight is 15, 000 lb.

In addition to service and support of the RNS, the PM/PPE will be used to transfer payloads from the lunar orbit space station to the lunar surface and return. Characteristics and requirements of the PM/PPE are as follows:

A. Land and return payloads of up to 20, 000 lb on lunar surface from lunar orbit.
B. Dry weight of PM/PPE is 10, 000 lb.
C. Maximum propellant capacity of PM/PPE is 60, 000 lb of LO_2/LH_2.

The CaM will be used to carry discretionary payload in inter/intra orbit cargo transfer and from lunar orbit to lunar surface. The CaM weight is 4, 000 lb, empty.

The weights of typical kits are as follows:

LL	5, 000 lb
EC/LS	5, 000 lb
IM	2, 000 lb
MA	500 lb

3.3.2 Lunar Orbital Space Station and Lunar Surface Base

A lunar orbital space station will be in a 60-nmi circular orbit inclined at 90 degress to the equator. Additional guidelines for the lunar orbital space station and lunar surface base are defined below.

The lunar orbit space station will begin operations in TBD.

The lunar orbit space station is initially delivered from earth orbit to polar lunar orbit by the RNS.

The lunar orbit space station configuration is an assembly of four decks, each of 22 or 33 ft in diameter by 9-ft-high dimensions. The gross weight of the initial system delivered to lunar orbit is 65,000 lb.

The lunar orbit space station initially has a normal crew complement of six men.

The lunar orbit space station will be capable of operations over a ten year period with resupply.

Crew rotation will occur at six-month intervals.

The lunar surface base (LSB) will support extensive exploration activities, including providing a base for long-range mobility units and will begin operations in TBD.

The LSB configuration is an assembly of two to three decks. Each is 22 or 33 ft in diameter and 9-ft-high. The gross weight of the initial LSB delivered to lunar surface is 65, 000 lb.

The LSB will support six to nine personnel in its initial operation, but will have the capability of being expanded to a larger 24 to 48 personnel operation, probably through the landing of additional modules in close proximity to the initial base.

The LSB will operate for extended durations (up to five years) with replenishment of consumables.

Crew rotation will occur at six-month intervals.

3.4 RNS PAYLOAD

3.4.1 Unmanned Payloads

Guidelines for unmanned payloads are TBD.

3.4.2 Manned Payloads

Guidelines for the manned planetary mission spacecraft for the opposition class with a venus swingby and the conjunction class Mars missions are summarized below:

	Opposition Class(4)	Conjunction Class(5)
Planetary Mission Module(1)	145,000 lb	170,000 lb
Manned Mars Excursion Module(2)	100,000	200,000(6)
Probes At: Mars(2)	30,000	30,000
Venus	6,000	---
MEM and Probe Compartment(2)	5,500	11,500
Overboard Expendable Rate(3)	13 lb/day	13 lb/day

NOTES: (1) PMM is retained throughout the mission

(2) Jettisoned at Mars

(3) Includes attitude control, atmospheric leaks, etc.

(4) 560-day mission

(5) 1,040-day mission

(6) Two MEM's are included for conjunction class missions

The general weight variation for the PMM is determined by:

$$PMM = 117,292 + 50.73\ T$$

Where T is total mission duration.

Lunar mission payload guidelines are TBD.

Geosynchronous mission payload guidelines are TBD.

Section 4

SYSTEM ENGINEERING DOCUMENTATION

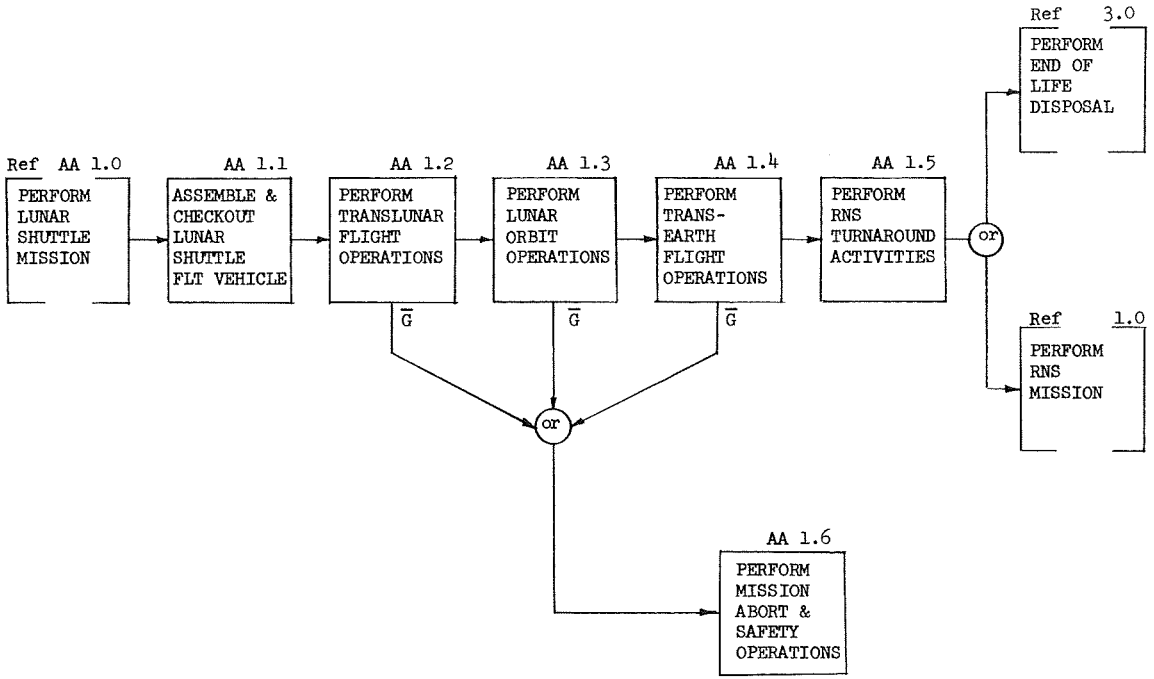
This section contains the following information, as generated during the Phase III study:

- Functional Flow Block Diagrams
- Requirement Allocation Sheets
- Timeline Sheets

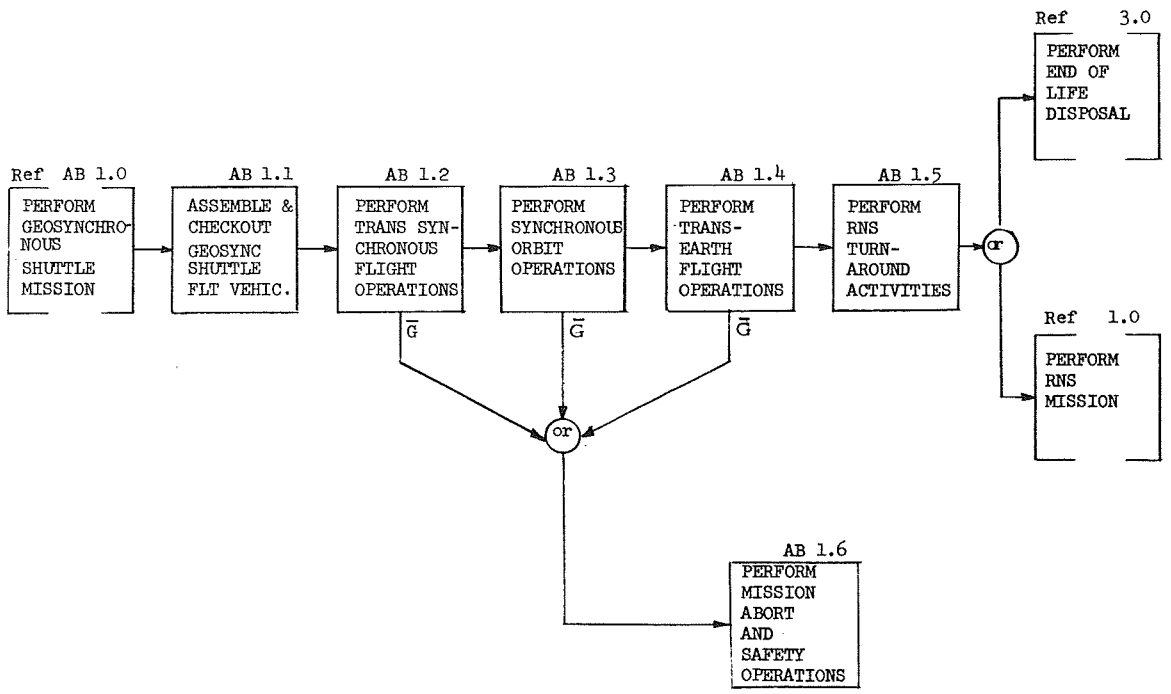
At the present, emphasis is upon the Class I lunar shuttle mission. Other missions are treated only at the first level. Additional missions will be included as appropriate subsections as they are analyzed in future studies.

All nomenclature on the functional flow block diagrams in this section is consistent with the top level diagram contained in Section 2.2.3. The system engineering documentation is organized by major top level function, and begins for each of these functions on the following pages of this section:

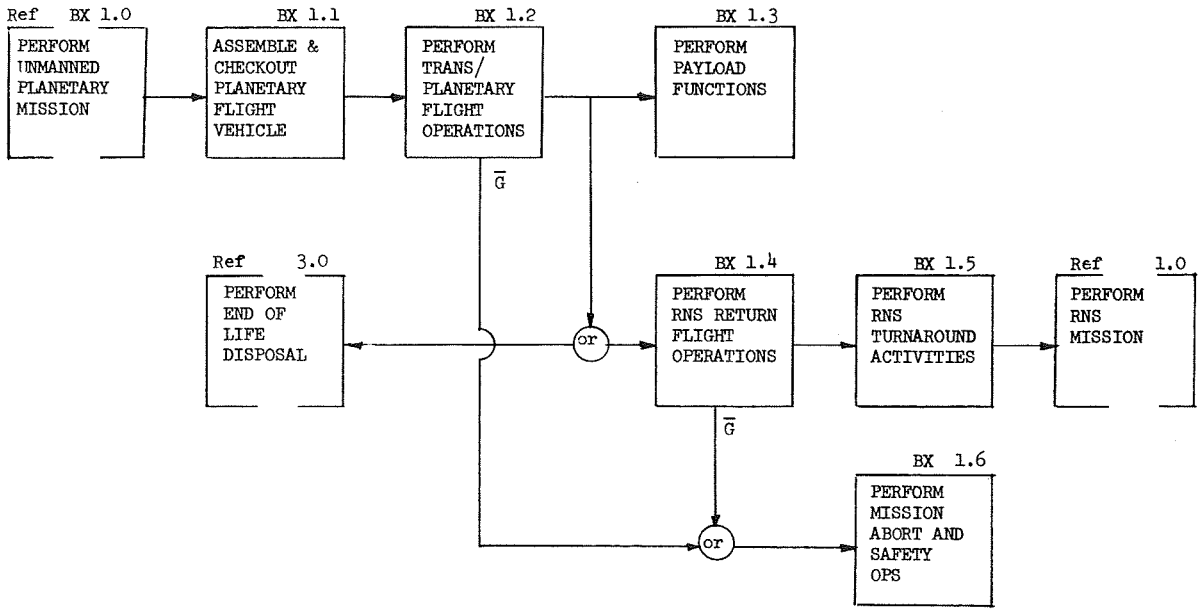
The depth of analysis varies from function to function, and includes first, second, and third level functional flow block diagrams, first, second, and third level requirement allocation sheets, and first and second level timeline sheets. Major emphasis was placed upon functions 1.0 and 4.0. The documentation is applicable to either RNS concept, with unique areas treated separately and noted as M or H to identify the Class 3 or Class 1 Hybrid RNS.



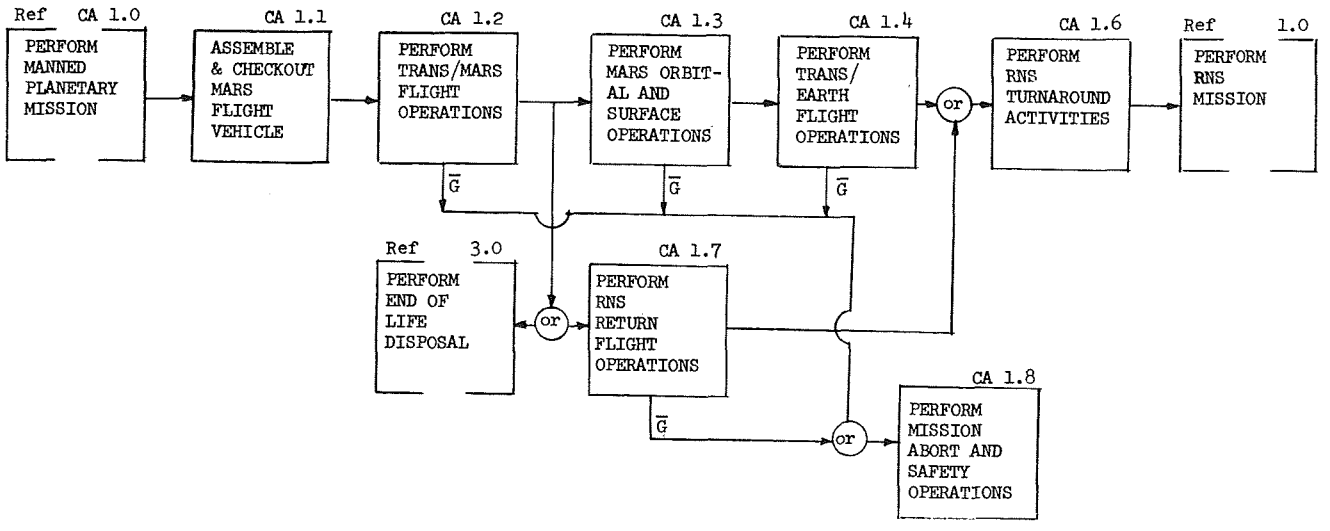
	FUNCTIONAL DIAGRAM TITLE AND NUMBER			FUNCTIONAL FLOW BLOCK DIAGRAM	
	PERFORM LUNAR SHUTTLE MISSION AA 1.0			CONTRACTOR	
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG



	FUNCTIONAL DIAGRAM TITLE AND NUMBER			FUNCTIONAL FLOW BLOCK DIAGRAM	
	PERFORM GEOSYNCHRONOUS SHUTTLE MISSION AB 1.0			CONTRACTOR	
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG



	FUNCTIONAL DIAGRAM TITLE AND NUMBER			FUNCTIONAL FLOW BLOCK DIAGRAM	
	PERFORM UNMANNED PLANETARY MISSION BX 1.0			CONTRACTOR	
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG



	FUNCTIONAL DIAGRAM TITLE AND NUMBER			FUNCTIONAL FLOW BLOCK DIAGRAM	
	PERFORM MANNED PLANETARY MISSION CA 1.0			CONTRACTOR	
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM RNS MISSION 1.0	A. Functional Description A Reusable Nuclear Shuttle (RNS) will be utilized to transport a payload (cargo and/or personnel) as part of a low cost transportation system proposed in a NASA integrated space program plan. It shall be capable of performing the following classes of missions: A. Class I - Lunar/Geosynchronous orbit shuttle missions B. Class II - Unmanned planetary missions C. Class III - Manned planetary missions B. Design Characteristics/Constraints 1. Initial operational capability of the RNS will be CY 1981. 2. The baseline RNS operations orbit for lunar shuttle flight vehicle assembly, initiation of translunar injection, and earth orbit turnaround operations will be a 260 Nmi. circular orbit at an inclination of 31.5 degrees. 3. The following reference mission characteristics shall be used for performance reporting purposes and worst condition design analyses: A. Class I - Lunar Mission Earth departure/arrival orbit altitude 260 Nmi. Earth departure/arrival orbit inclination 31.5 Deg. Lunar arrival/departure orbit altitude 60 Nmi. Lunar arrival/departure orbit inclination 90 Deg. Earth to moon coast time 108 Hr.	NASA Guidelines and constraints document No. PD-SA-P-70-63 Revision No.2 Oct. 1, 1970			Evaluate alternate earth orbit altitudes and inclinations (B.2) Evaluate lunar phase and ground rendezvous compatibility (B.2)

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM RNS MISSION - 1.0	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 7
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM RNS MISSION 1.0 (CONT'D)	Moon to earth coast time 72 Hr. Lunar arrival plane change 30 Deg. Lunar departure plane change 30 Deg. Midcourse ΔV 50 Ft/sec per mission leg Flight performance reserve 0.75 percent ΔV				Evaluate necessity and method for lunar plane change requirements (B.3)
	4. The following reference mission characteristics shall be used for economics and operations analyses:	MDAC Phase III Study Baseline			Evaluate necessity for 50 Ft/sec mid-course correction (B.3)
	A. Class I - Lunar mission Earth departure/arrival orbit altitude 260 Nmi. Earth departure/arrival orbit inclination 31.5 Deg. Lunar arrival/departure orbit altitude 60 Nmi. Lunar arrival/departure orbit inclination 90 Deg. Earth to moon coast time 108 Hr. Moon to earth coast time 72 Hr. Midcourse ΔV 50 Ft/sec per mission leg Flight performance reserve 0.75 Percent ΔV				Evaluate alternate lunar shuttle profiles (B.3)
	5. Although the RNS shall be designed for the lunar shuttle mission, it shall have the additional capability of performing the following missions: Class I - Geosynchronous Mission Earth departure/arrival orbit altitude 260 Nmi. Earth departure/arrival orbit inclination 31.5 Deg.	NASA Guidelines and Constraints Document No. PD-SA-P-70-63			Evaluate alternate geosynchronous shuttle mission profiles (B.5)

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM RNS MISSION - 1.0	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 7
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM RNS MISSION 1.0 (CONT'D)	Geosynchronous arrival/departure orbit inclination 0 Deg. Midcourse ΔV 50 Ft/sec per mission leg Class III - Manned Mars Mission An evolutionary version of the RNS will be used to provide propulsion for manned Mars missions. For the purpose of this study a 1986 Outbound Venus Swingby Mars mission and a 1990 Conjunction Class Mars mission will be evaluated. The stopover time for the Venus Swingby mission will be 60 days. The reference mission characteristics are as follows: Earth assembly/departure orbit altitude 260 Nmi. Earth assembly/departure orbit inclination 31.5 Deg. Earth assembly/departure orbit eccentricity 0 Mars parking orbit - periapsis altitude 270 Nmi. elliptic orbit period 12 Hrs. Earth arrival orbit- periapsis altitude 270 Nmi. elliptic orbit period 24 Hrs. Midcourse correction ΔV 500 Ft/sec per mission leg Mars orbit trim ΔV 150 Ft/sec 6. Initial RNS design concepts will reflect a 1974 state of the art. 7. Government facilities and associated utilities and special test equipment will be used to the maximum extent possible.	Revision No. 2, Oct. 1, 1970			Determine optimum split of plane change ΔV between low earth orbit and geosynchronous orbit (B.5) Evaluate alternate manned Mars mission profiles (B.5) Evaluate alternate earth orbit eccentricities for assembly (B.5) Evaluate module peculiar lifetime allocation (B.8)

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM RNS MISSION - 1.0	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 3 of 7 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM RNS MISSION 1.0 (CONT'D)	8. The design lifetime for the RNS will be up to 3 years in space with the capability for maintenance in earth orbit. 9. In-orbit maintenance and propellant refueling of the RNS will be accomplished only at the RNS operations orbit. 10. The RNS will be functionally independent of the payload. 11. For manned operations, the crew will have override capability for RNS control. 12. The RNS will be checked out in the RNS operations orbit prior to each mission. 13. The RNS will have automated rendezvous and docking capability. 14. Payloads, LH_2, and maintenance supplies for the RNS will be delivered by the logistics vehicle and assembled in the RNS operations orbit. The logistics vehicle will be the space shuttle. 15. The space tug may be used to maneuver the payload to the RNS for assembly. It may also be used to support geosynchronous and lunar orbit operations. 16. The RNS will be manrated. 17. The RNS will maintain attitude control while the payload is maneuvered and docked to the RNS. 18. Payload transfer between the RNS and the lunar or geosynchronous space station may be accomplished by the space tug. 19. Propellant capacity will be about 300,000 lbs. LH_2. D. Effectiveness Requirements 1. Reliability	NASA Guidelines and Constraints Document No. PD-SA-P-70-63 Revision No. 2, Oct. 1, 1970			Establish an in-orbit maintenance policy (B.9) Evaluate safety for additional sites (B.9) Establish checkout policy (B.12) Evaluate use of space shuttle only for orbital operations (B.15) Evaluate use of RNS C&C module only for orbital operations (B.15) Evaluate impact of lowering the reliability requirement (D.1)

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM RNS MISSION - 1.0	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 4 of 7
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM RNS MISSION 1.0 (CONT'D)	The RNS shall have a total mission success probability of 0.975 at the initiation of each cycle of operations (exclusive of payload induced mission failures). 2. Safety A. All credible single failure modes or credible combinations of failures and errors which result in a loss of crew and passengers or unacceptable risk to the general public will be eliminated by design change and/or mission modification. B. No single failure or credible combinations of failures and errors will prevent or preclude operation of the NERVA engine in the emergency mode. C. Total radiation dose from the NERVA engine and plume sources will be limited to 10 REM per passenger and 3 REM per crew member per round trip shuttle mission. Payload attenuation factor will be assumed to be 3. D. RNS maintenance personnel (if any) will not receive more than 25 REM per year from the RNS. E. Total integrated radiation dose from the RNS to any manned space station or manned orbital system will not exceed 0.1 REM during any single NERVA engine burn. F. The RNS will meet all structural, materials, and quality control standards required for manned application. G. During lunar or geosynchronous orbit operations the RNS will remain at a	MDAC-allocation NASA Guidelines and Constraints Document No. PD-SA-P-70-63 Revision No. 2, Oct. 1, 1970			Evaluate onboard VS External abort capability (D.2.A) Perform fault tree analyses (D.2.B) Evaluate utility of NERVA emergency operating mode capability (D.2.B) Perform failure mode and effects analyses (D.2.B) Determine allowable maintenance time for various classes of maintenance (D.3)

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM RNS MISSION - 1.0	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 5 of 7 REV & DATE _____ VERIFIED _____	

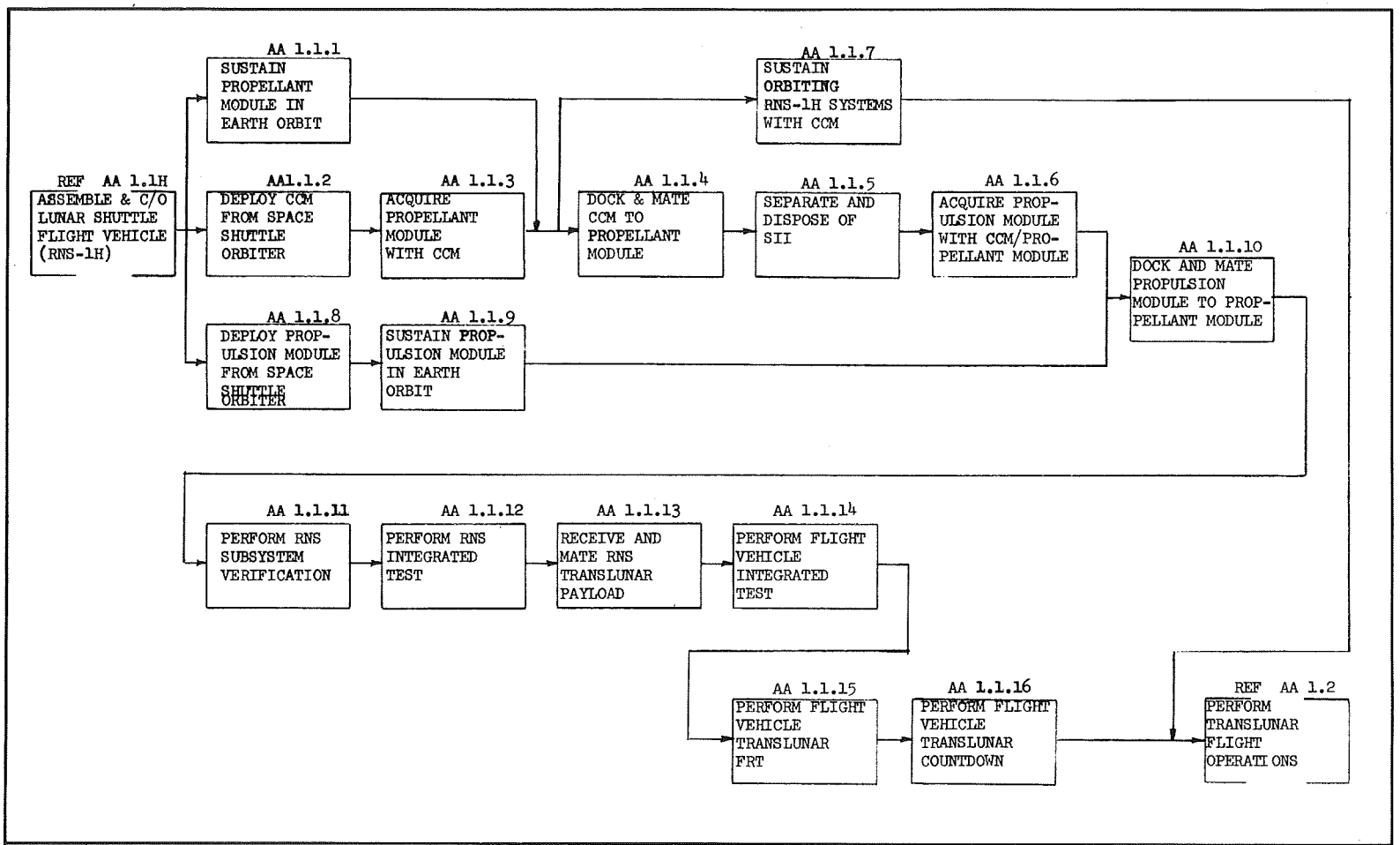
FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM RNS MISSION 1.0 (CONT'D)	safe distance from and in the same orbit as the lunar or geosynchronous space station. 3. Maintainability A. The RNS design will reflect the capability to perform maintenance in the operations orbit and on the ground. B. The level of on-orbit maintenance shall be restricted to the module level, i.e., propulsion module, command and control module, propellant module. C. While inflight, maintenance shall be restricted to switchable redundancies. E. Interface Requirements 1. During RNS mission operation the nuclear shuttle may have an operational support interface with the following system elements: A. Earth orbital space station/base operating in a 262 nmi, 55 Deg. inclination circular orbit. B. Geosynchronous orbit space station at 0 Deg. inclination. C. Lunar orbital space station operating in a 60 nmi, 90 Deg inclination circular orbit. D. Propellant depot (if required) deployed in the RNS operations orbit. E. Space tug deployed in earth operations and lunar operations orbits. F. Space shuttle logistics vehicle having a clear volume of 15 foot diameter and 60 foot length, and a self sustaining lifetime of up to 7 days.	NASA Guidelines and Constraints Document MDAC-Phase II Study (MDC Report No. G0585,Vol II, Part 3, May 1970) MDAC Ground rule study NASA Guidelines and Constraints Document			Determine impact on orbital operations resulting from this constraint (D.2.E) Determine minimum allowable separation distance (D.2.G) Evaluate alternate modes of target orbit arrival & departure (D.2.G) Mix of terrestrial and on orbit maintenance (D.3.A) Evaluate selective lower levels of on-orbit maintenance (D.3.B)

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM RNS MISSION - 1.0	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 6 of 7
REV & DATE _____ VERIFIED _____

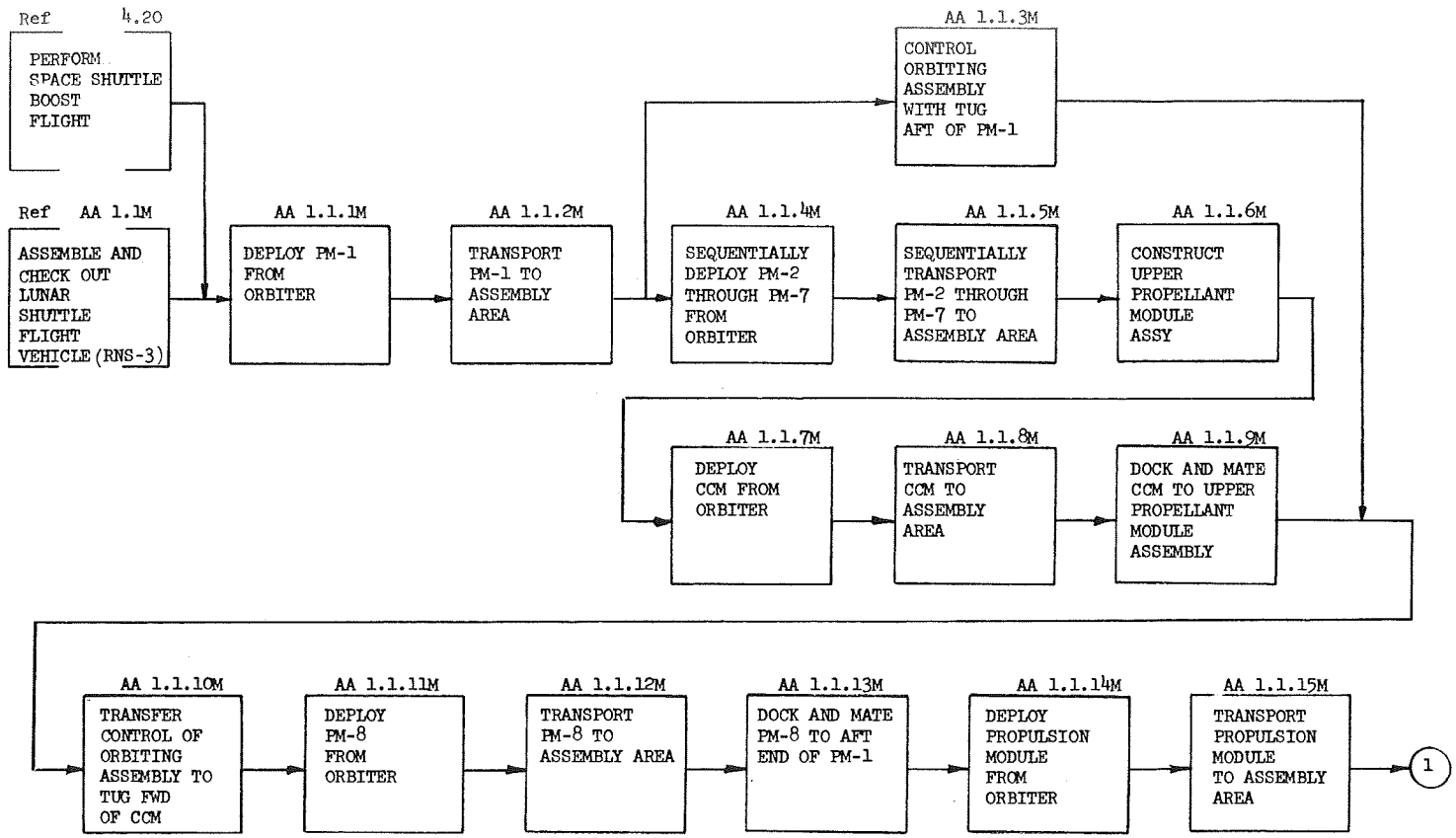
FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM RNS MISSION 1.0 (CONT'D)	2. As part of the performance of the RNS mission the nuclear shuttle will have limited interfaces with proposed payloads for data exchange and structural support.	MDAC ground rule			Evaluate requirements for propellant depot (E.1.D) Evaluate safety benefits from having LH_2 resupply capability in lunar orbit (E.1.D) Perform parametric evaluation of the size (E.1.F)

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM RNS MISSION - 1.0	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 7 of 7 REV & DATE _____ VERIFIED _____	

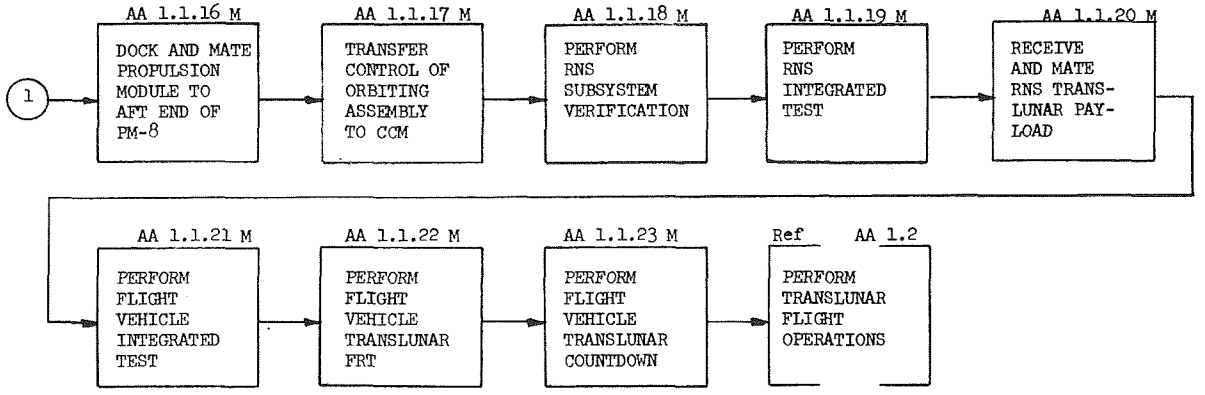


	FUNCTIONAL DIAGRAM TITLE AND NUMBER	FUNCTIONAL FLOW BLOCK DIAGRAM
	ASSEMBLE AND CHECKOUT LUNAR SHUTTLE FLIGHT VEHICLE (RNS-1H) AA 1.1H	CONTRACTOR

PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG 1 OF 1
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG



	FUNCTIONAL DIAGRAM TITLE AND NUMBER			FUNCTIONAL FLOW BLOCK DIAGRAM	
	ASSEMBLE AND CHECK OUT LUNAR SHUTTLE FLIGHT VEHICLE - (RNS-3) AA 1.1M			CONTRACTOR	
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG 1 of 2
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG



	FUNCTIONAL DIAGRAM TITLE AND NUMBER			FUNCTIONAL FLOW BLOCK DIAGRAM	
	ASSEMBLE AND CHECK OUT LUNAR SHUTTLE FLIGHT VEHICLE - (RNS-3) AA 1.1M (Cont'd)			CONTRACTOR	
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG 2 of 2
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
ASSEMBLE AND CHECKOUT LUNAR SHUTTLE FLIGHT VEHICLE AA 1.1M	A. Functional Description The RNS-3 is composed of 8 propellant modules (PM's), one propulsion module and one command and control module (CCM). Each is placed into orbit individually via space shuttle. It is the objective of this function to combine these elements to form an integrated stage which when supplied with payload forms the lunar shuttle flight vehicle. This function is initiated with the placement of the first PM in orbit and is terminated with successful flight vehicle countdown. B. Design Characteristics/Constraints A. Functional requirements 1. Provide the capability of deploying RNS-3 modules out of the space shuttle in a uniform manner. 2. Provide the capability of transporting modules from deployment to assembly areas. 3. Provide the capability of on-orbit removal of NERVA poison wire assembly. 4. Provide for sequential checkout of each installed module. 5. Provide for propellant topping. 6. Provide for control of evolving RNS-3 orbiting assembly including attitude control and stabilization, electrical power, data management, etc. 7. Provide end to end docking and side to side clustering mechanisms as required by the flight vehicle configuration.	Baseline Baseline Baseline Baseline Payload limitation			Evaluate effect on propulsion module deployment (A.1) Evaluate use of tug vs space shuttle (A.2) Evaluate removal on launch pad or in VAB (A.3) Evaluate alternate control agents e.g. space tug, CCM, space shuttle (A.6)

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	ASSEMBLE AND CHECKOUT LUNAR SHUTTLE FLIGHT VEHICLE - AA 1.1M	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 4 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
ASSEMBLE AND CHECKOUT LUNAR SHUTTLE FLIGHT VEHICLE AA 1.1M	8. Provide for the integration of a manned/unmanned payload. 9. Verify flight readiness of the flight vehicle prior to the initiation of each lunar shuttle mission. 10. Verify successful integration of all modules into an RNS-3 prior to mating it to its lunar payload. 11. Provide functional subsystems on the RNS modules to facilitate automated rendezvous, docking, mating and checkout. 12. Provide for external monitoring and control of RNS-3 modules' rendezvous, docking and mating. 13. Provide for automated flight vehicle countdown with terrestrial based control. For manned payloads provide the backup capability for crew override. B. Subsystem Requirements 1. Structures ° Provide attach points for orbiter deployment mechanism. ° Provide sufficient structural integrity to accomodate deployment and assembly loads. ° Provide a docking and clustering mechanism which aligns the modules, locks them rigidly together, transmits all subsequent loads, and allows verification of its integrity. 2. Propulsion Subsystem	NASA G&C Document Revision No. 2 Oct. 1, 1970 Baseline			Analyze dynamics of transfer of the control function (A.6) Evaluate impact of manned/unmanned payloads on configuration Determine method of module cluster (i.e. actuation) (A.7) Evaluate automated rendezvous and docking concepts (A.11) Determine structural latching, fluid line deployment, and electrical connecting mechanisms (A.11) Evaluate space base vs terrestrial control (A.13)

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	ASSEMBLE AND CHECKOUT LUNAR SHUTTLE FLIGHT VEHICLE - AA 1.1M	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 4
REV & DATE _____ VERIFIED _____

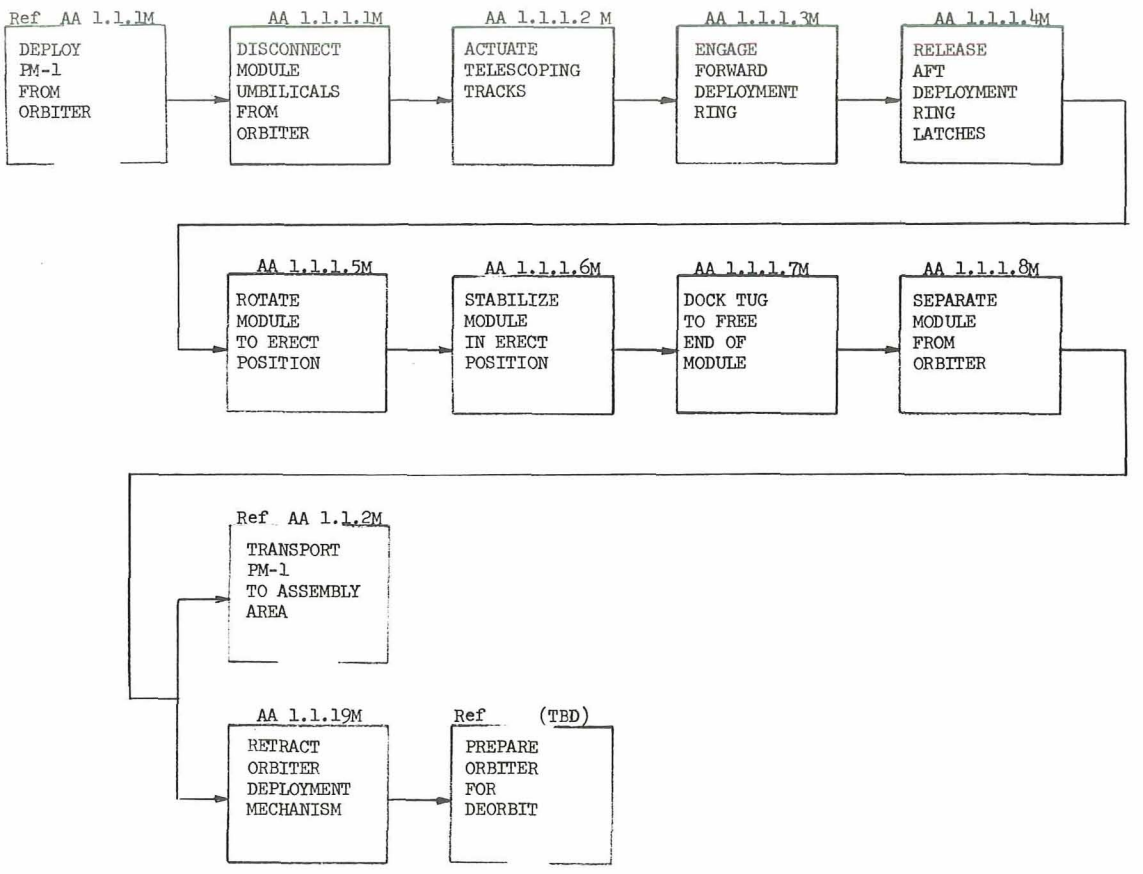
FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
ASSEMBLE AND CHECKOUT LUNAR SHUTTLE FLIGHT VEHICLE AA 1.1M	° Provide for on orbit topping of propellant. ° Provide for automated functional and leak checks of each module as it is integrated into the total system. ° All discrete LH_2 tanks shall be designed to permit isolation. ° Fluid line coupling and decoupling shall be performed under automatic and remote control. Docking forces shall not be used for coupling. ° A pressure sensor controlled vent system shall be utilized to assure on orbit safety. Venting shall not be propulsive. 3. Astrionics Subsystem ° During assembly operations the astrionics functions of power, data management, stability and control shall be provided by sources external to the RNS. ° Navigational aids will be provided on the RNS modules to aid in rendezvous and docking. ° Instrumentation will be provided on each module to allow its individual checkout. The data shall be compatible with the capabilities of supporting segments (e.g. space tug). ° Subsequent to completion of assembly the astrionics function shall be provided by the CCM. D. Effectiveness Requirements 1. Reliability				Evaluate use of space base as well as complete autonomy (A.13)

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	ASSEMBLE AND CHECKOUT LUNAR SHUTTLE FLIGHT VEHICLE - AA 1.1M	CONTRACTOR

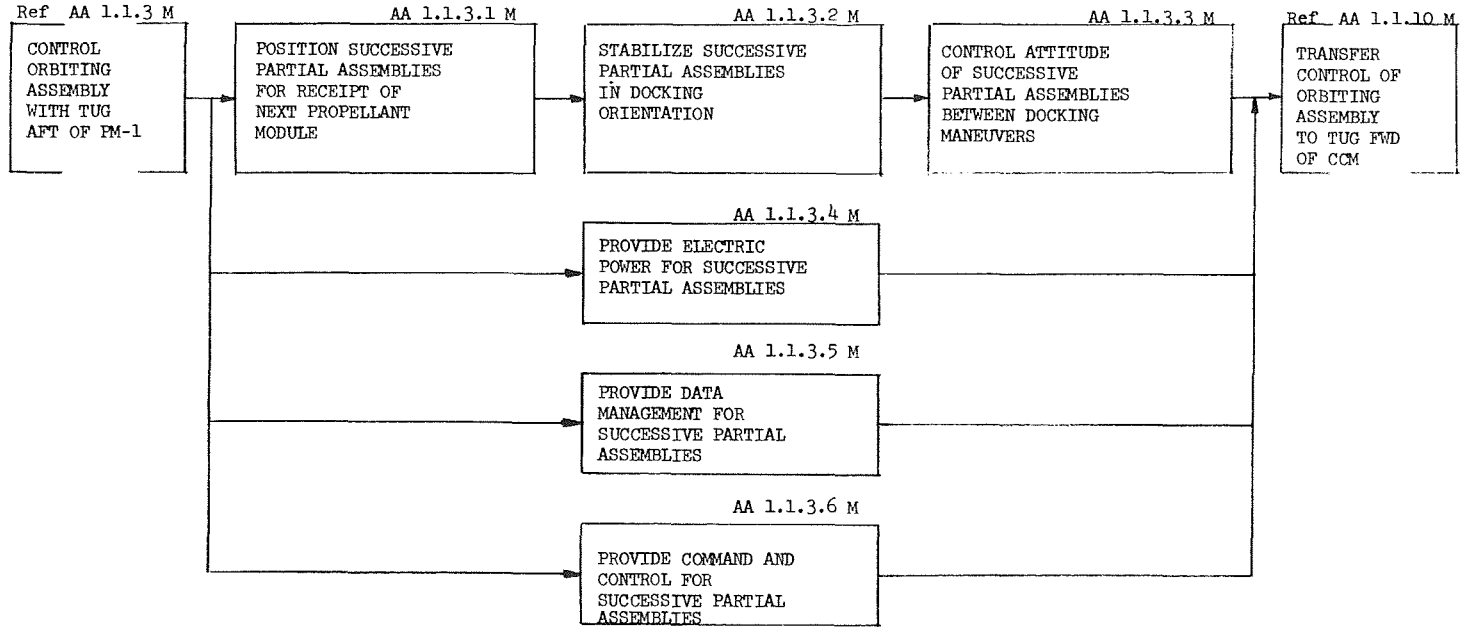
REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 3 of 4
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
ASSEMBLE AND CHECKOUT LUNAR SHUTTLE FLIGHT VEHICLE AA 1.1M	a. The assembly of the RNS shall have a success probability of 0.99 b. Checkout of the flight vehicle shall assure that a safe vehicle is launched with a probability of not less than 0.99 for manned payloads and 0.99 for unmanned payloads 2. Safety TBD 3. Maintainability a. Maintenance and repair of the RNS in orbit shall be restricted to removal and replacement of affected module. E. Interface Requirements 1. The docking interfaces between the RNS modules, space tug, payloads, and space shuttle shall be common. 2. The RNS modules shall be compatible with space shuttle provisions for deployment. 3. The evolving orbiting assembly shall provide monitoring data to the supporting segments (e.g. space tug, space shuttle) for formatting and transmission. 4. The evolving orbiting assembly shall draw sustaining power from its supporting orbiting segments during the assembly operations.				

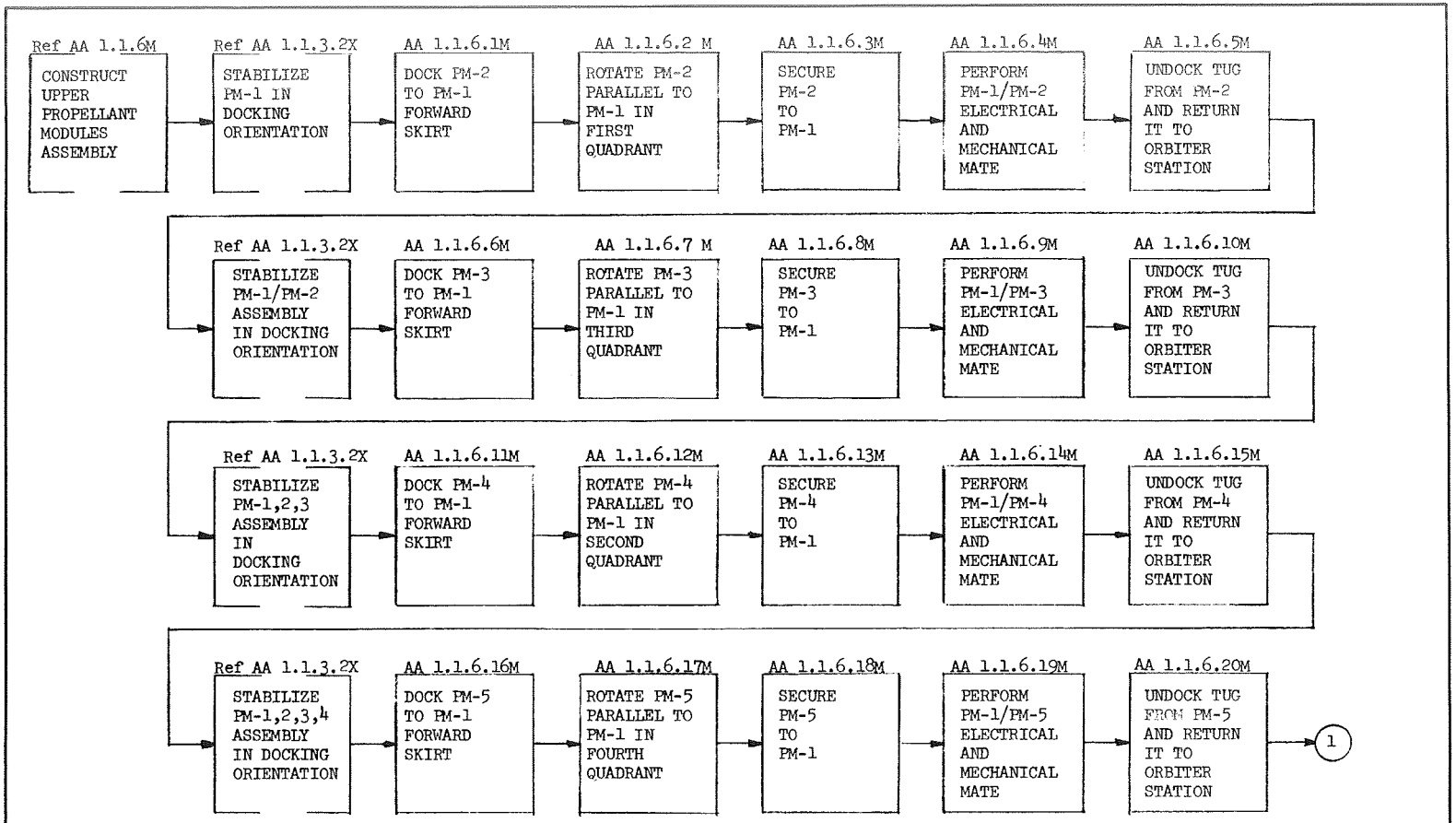
RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	ASSEMBLE AND CHECKOUT LUNAR SHUTTLE FLIGHT VEHICLE - AA 1.1M	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 4 of 4 REV & DATE _____ VERIFIED _____	



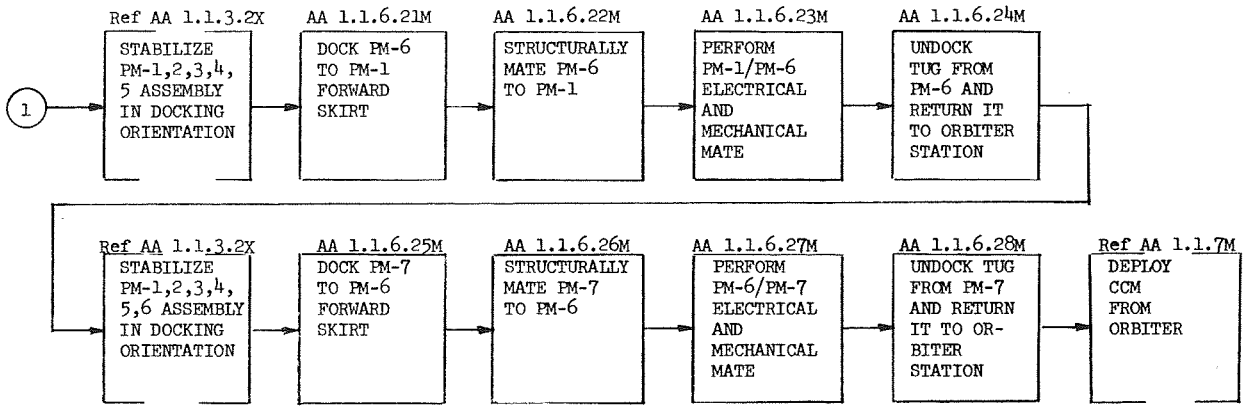
	FUNCTIONAL DIAGRAM TITLE AND NUMBER			FUNCTIONAL FLOW BLOCK DIAGRAM	
	DEPLOY PM-1 FROM ORBITER - AA 1.1.1.M			CONTRACTOR	
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG



	FUNCTIONAL DIAGRAM TITLE AND NUMBER			FUNCTIONAL FLOW BLOCK DIAGRAM	
	CONTROL ORBITING ASSEMBLY WITH TUG AFT ON PM-1 - AA 1.1.3 M			CONTRACTOR	
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG

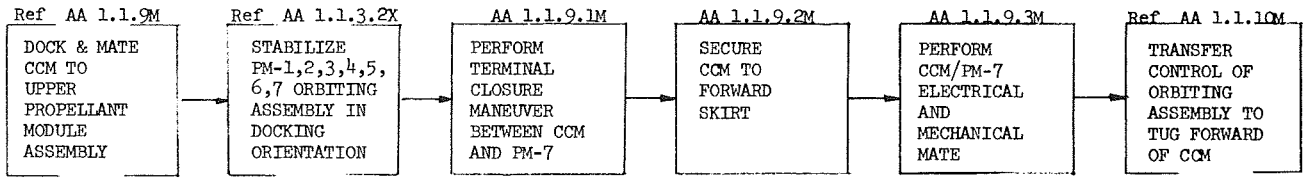


	FUNCTIONAL DIAGRAM TITLE AND NUMBER			FUNCTIONAL FLOW BLOCK DIAGRAM	
	CONSTRUCT UPPER PROPELLANT MODULES ASSEMBLY - AA 1.1.6M			CONTRACTOR	
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG 1 of 2
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG

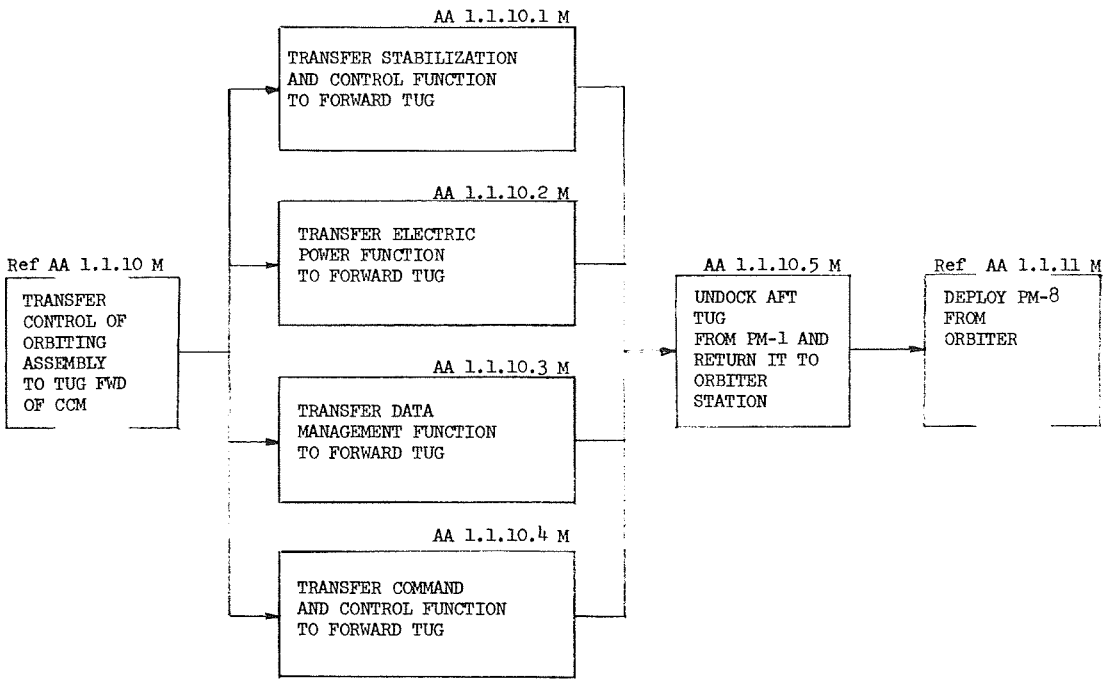


	FUNCTIONAL DIAGRAM TITLE AND NUMBER	FUNCTIONAL FLOW BLOCK DIAGRAM
	CONSTRUCT UPPER PROPELLANT MODULE ASSEMBLY - AA 1.1.6 M (Cont'd)	CONTRACTOR

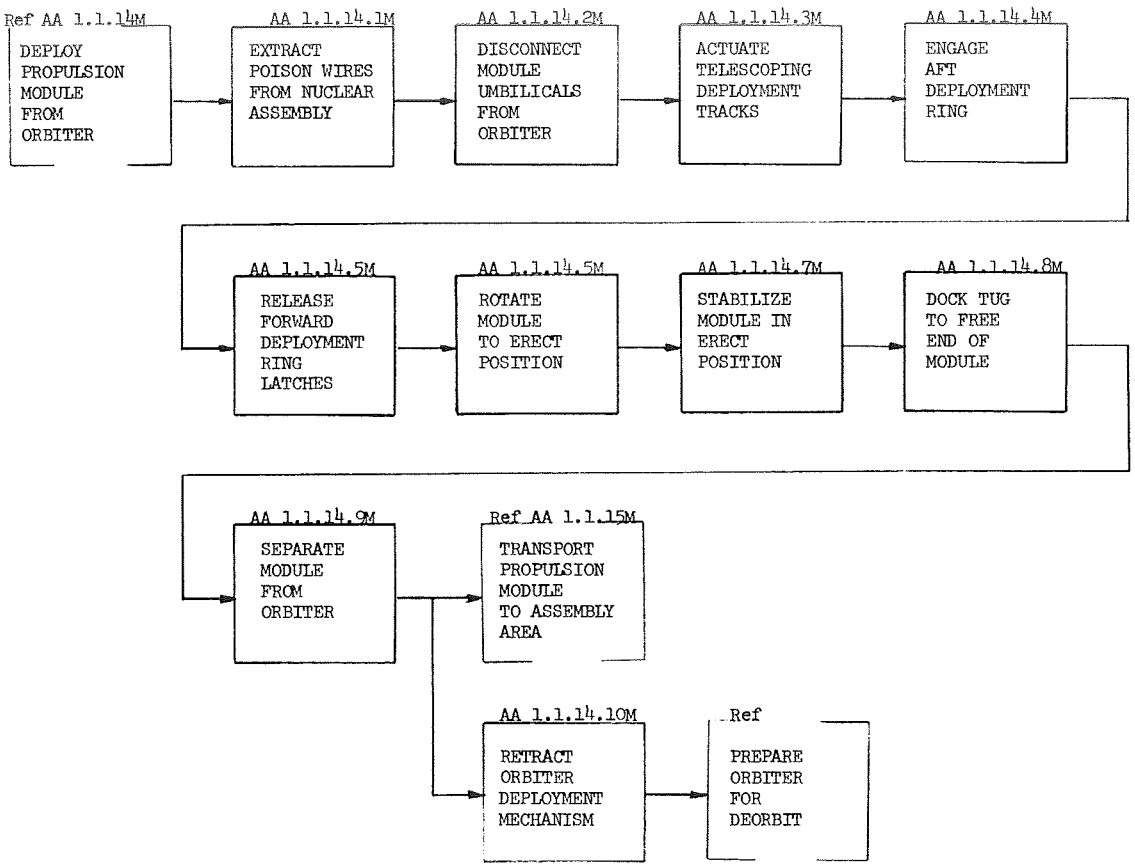
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG 2 of 2
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG



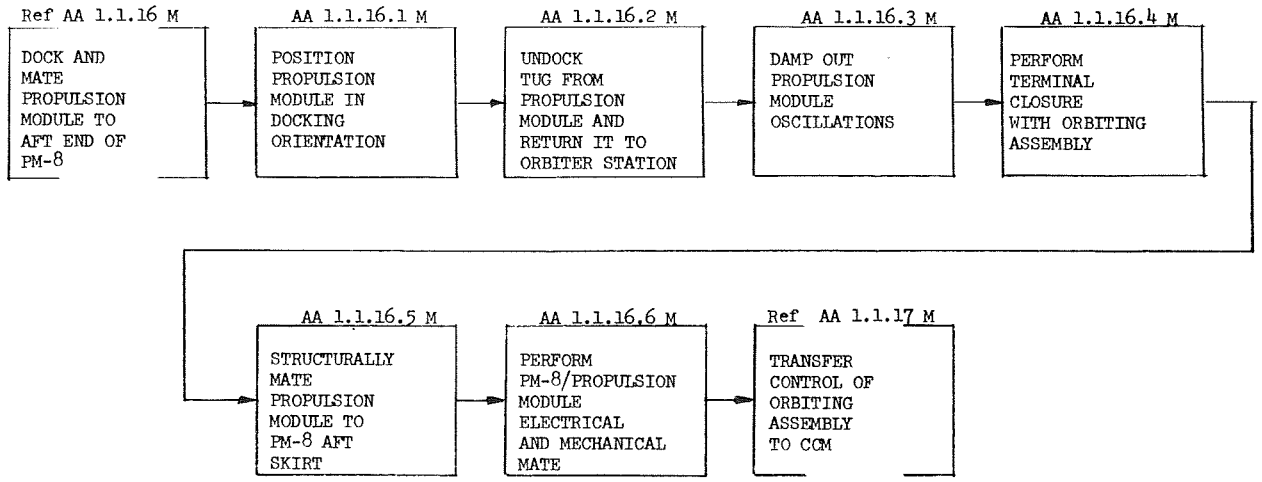
	FUNCTIONAL DIAGRAM TITLE AND NUMBER			FUNCTIONAL FLOW BLOCK DIAGRAM	
	DOCK AND MATE CCM TO UPPER PROPELLANT MODULE ASSEMBLY - AA1.1.9 M			CONTRACTOR	
PRE-IIC	REV & DATE _____	ORIG DATE _____	APPROVAL _____	DOC NO. _____	PG _____
IIC	REV & DATE _____	ORIG DATE _____	VERIFIED _____	DOC NO. _____	PG _____
SLI	REV & DATE _____	ORIG DATE _____	VERIFIED _____	DOC NO. _____	PG _____



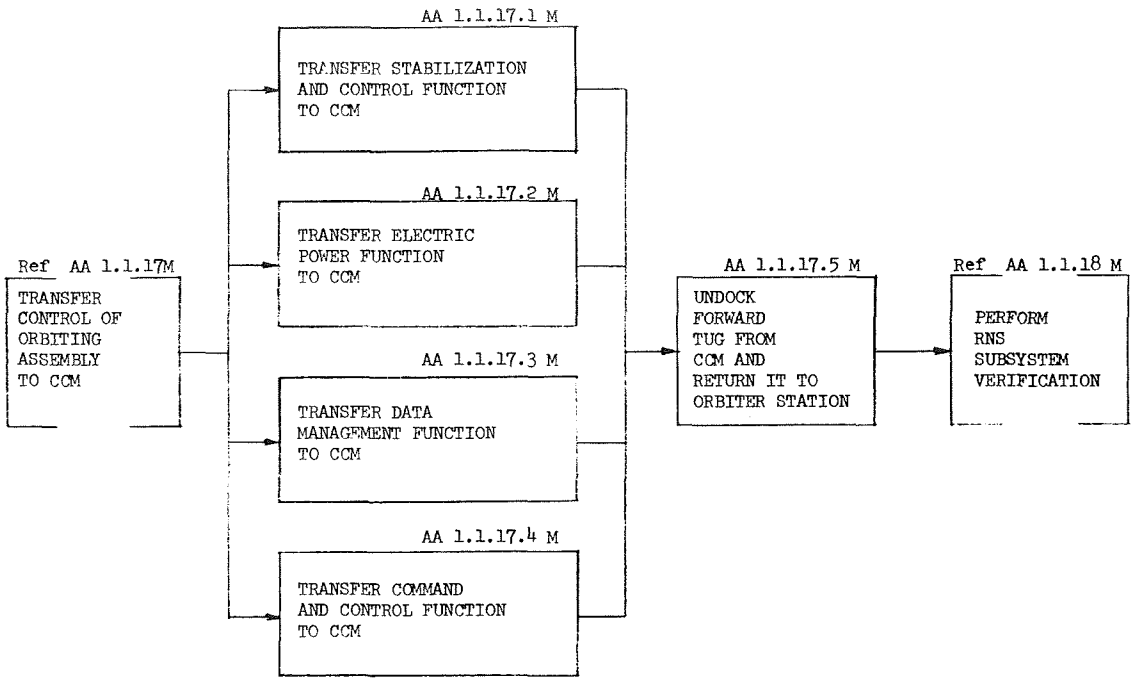
	FUNCTIONAL DIAGRAM TITLE AND NUMBER			FUNCTIONAL FLOW BLOCK DIAGRAM	
	TRANSFER CONTROL OF ORBITING ASSEMBLY TO TUG FORWARD OF CCM - AA 1.1.10 M			CONTRACTOR	
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG



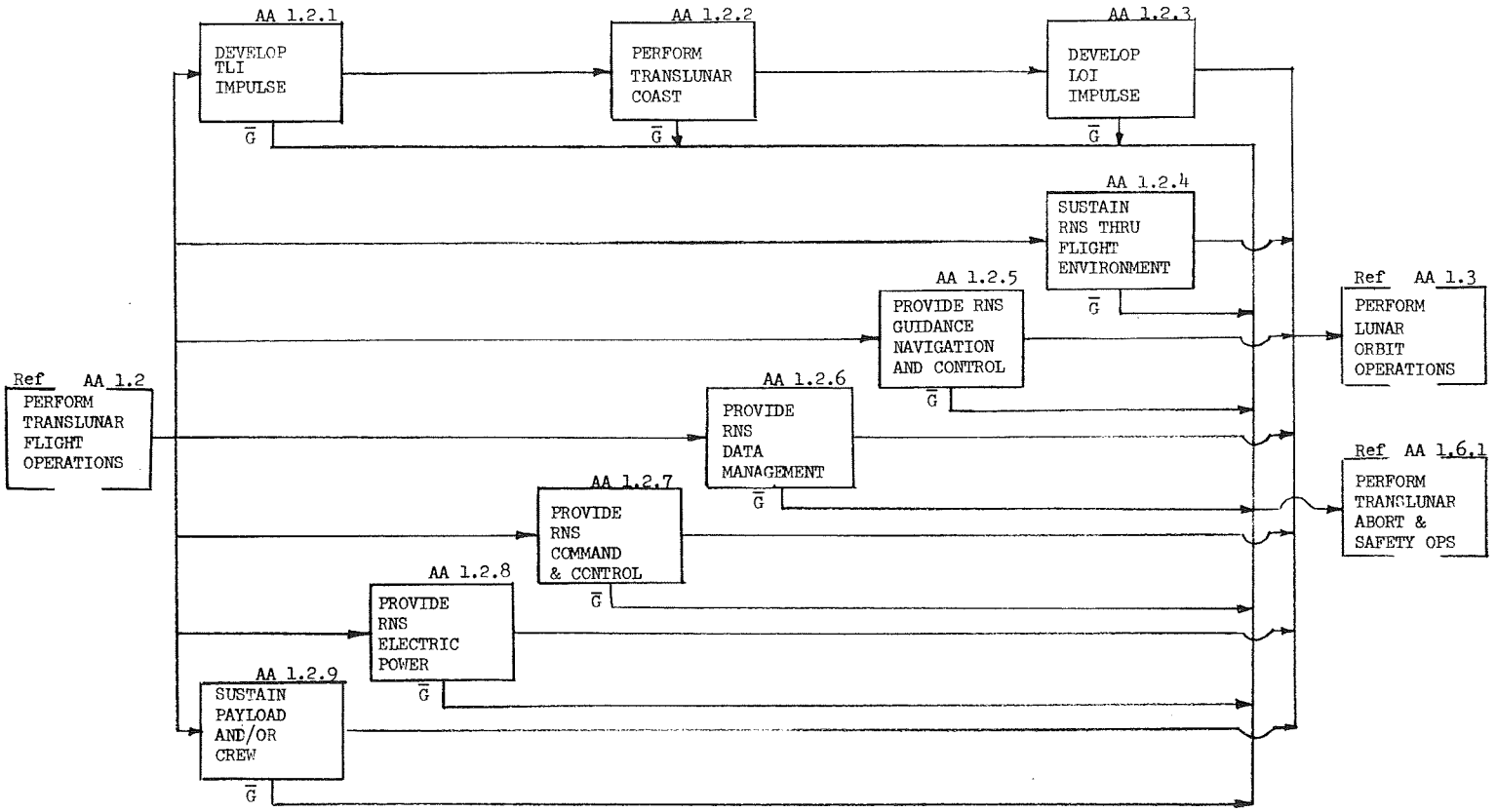
	FUNCTIONAL DIAGRAM TITLE AND NUMBER			FUNCTIONAL FLOW BLOCK DIAGRAM	
	DEPLOY PROPULSION MODULE FROM ORBITER - AA 1.1.14 M			CONTRACTOR	
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG



	FUNCTIONAL DIAGRAM TITLE AND NUMBER			FUNCTIONAL FLOW BLOCK DIAGRAM	
	DOCK AND MATE PROPULSION MODULE TO AFT END OF PM-8 - AA 1.1.16 M			CONTRACTOR	
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG



	FUNCTIONAL DIAGRAM TITLE AND NUMBER			FUNCTIONAL FLOW BLOCK DIAGRAM	
	TRANSFER CONTROL OF ORBITING ASSEMBLY TO CCM - AA 1.1.17 M			CONTRACTOR	
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG



	FUNCTIONAL DIAGRAM TITLE AND NUMBER			FUNCTIONAL FLOW BLOCK DIAGRAM	
	PERFORM TRANSLUNAR FLIGHT OPERATIONS - AA 1.2			CONTRACTOR	
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM TRANSLUNAR FLIGHT OPERATIONS AA 1.2	A. Functional Description The objective of this function is to perform the flight operations required to transfer a useful payload from the earth operations orbit to the prescribed lunar operations orbit. This function is initiated at the successful completion of the translunar countdown and is terminated with successful injection into the prescribed lunar target orbit. B. Design Characteristics/Constraints a. Functional requirements 1. Provide translunar and lunar orbit injection impulses commensurate with the following: Earth departure orbit-260 NM, 31.5 Deg. Lunar arrival orbit - 60 NM, 90 Deg. Earth-Moon coast time - 108 Hr. 2. Provide for midcourse correction to achieve prescribed target orbit parameters reflecting a translunar injection error in delivered impulse of ± 20 K lb sec; time ± 15 sec 3. Provide electrical power, instrumentation and guidance and control to support the translunar flight operation independent of the payload. 4. Provide the means to sustain the flight vehicle through the flight environment (induced and natural) encountered in the translunar flight.	NASA G&C NPRD NASA G&C Baseline			

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM TRANSLUNAR FLIGHT OPERATIONS - AA 1.2	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 5 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM TRANSLUNAR FLIGHT OPERATIONS AA 1.2 (Cont'd)	b. Subsystem Requirements 1. Structure subsystem o Provide sufficient strength, rigidity and other characteristics required to contain 300,000 lbs of LH_2. Factors of safety as defined by "Guidelines for Structural Design Criteria" PD-SA-P-70-193, MSFC memorandum dated Aug. 7, 1970. o Provide sufficient meteoroid protection to survive the translunar environment as defined in NASA TMX-53798 (and augmented by NASA TMX 53957) with a probability of 0.99875. o Provide sufficient thermal protection to control propellant loss and tank pressure buildup resulting from natural and induced flight environment. The RNS assembly shall be designed for the orbital and mission thermal environment defined in "Space Environment Criteria Guidelines for use in Space Vehicle Development" (1969 Revision), NASA TM-X-53957, Oct. 1969. o Accommodate the environment resulting from the operation of the NERVA engine. 2. Propulsion Subsystem o Provide a propellant management capable of providing the NERVA prerequisites as defined in NERVA Program Requirements Document, SNPO-NPRD-1, Jan. 19, 1970; NERVA Reference Data	NASA G&C			

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM TRANSLUNAR FLIGHT OPERATIONS - AA 1.2	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 5
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM TRANSLUNAR FLIGHT OPERATIONS AA 1.2 (Cont'd)	(full flow engine), AGC Rep 4 S-130-CP-090290-FL-Prel. Apr. 1970 and NERVA Status Presentation, AGC, 9/3/70. o Pressure level during coast shall be at saturation. o Actuation control for liquid and gas flow shall be provided. o Expulsion pressurization gas shall be provided by the engine. o Controlled venting as well as safety relief shall be provided during flight as required. The operating band shall be minimized. o Provide APS for thrust vector control during idle mode for mid-course correction, flight vehicle stabilization and orientation control, propellant settling, rendezvous and docking and separation maneuvers. 3. Astrionics Subsystem o Provide an astrionics system independent of the RNS payload o Provide both primary and secondary power sources and attendant distribution and regulation network for engine and stage. o Provide the capability to gather, format and transmit diagnostic information to predict failures, to evaluate performance, and to aid in mission control. Selected data shall be made available for display in a manned payload. Transmission of data to ground shall be compatible with existing processing and receiving capability.	NASA G&C MDAC G&C ϕ III Study			Perform maintenance trade study to identify required diagnostics

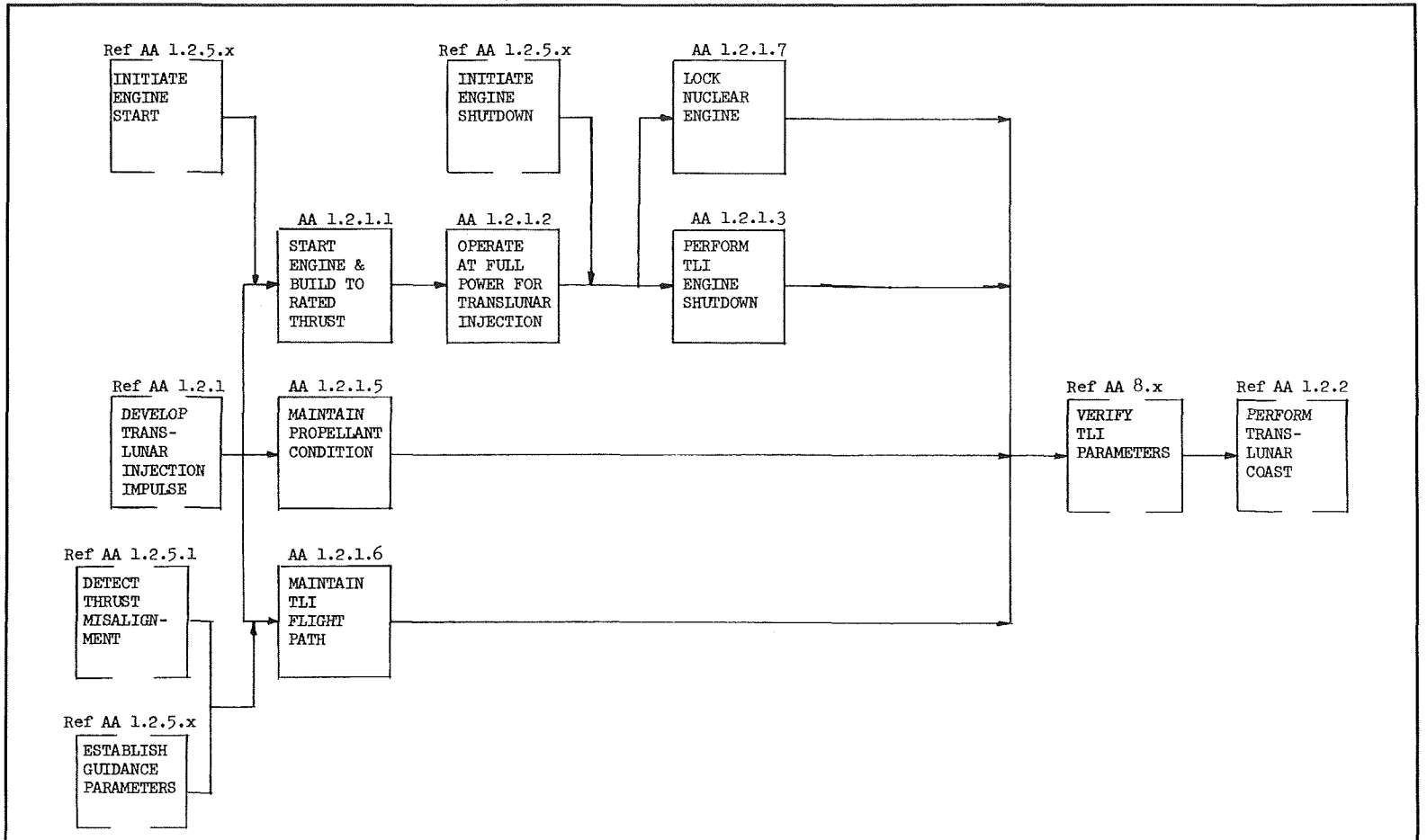
RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM TRANSLUNAR FLIGHT OPERATIONS - AA 1.2	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 3 of 5 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM TRANSLUNAR FLIGHT OPERATIONS AA 1.2 (Cont'd)	o Provide autonomous navigation guidance and control capability for translunar flight operations. Included are determination of position and velocity, ephemeris, engine command generation, as well as attitude and roll control command generation. The GN&C requirements shall incorporate the utilization of aftercooling thrust. o Provide thermal protection to operating equipment commensurate with the design specifications. D. Effectiveness Requirements 1. Reliability a. The RNS shall have a 0.9859 probability of successful completion of the translunar flight operations. 2. Safety a. The RNS design shall accommodate an emergency mode of operation reflecting NERVA engine operation at minimums of 30,000 Lbf, 500 sec Isp and 10^8 lb-sec impulse. b. Provisions shall be included to limit the exposure due to RNS malfunction to any member of the general public to no more than 2.5 Rem, c. Provisions shall be included to detect incipient catastrophic failures allowing sufficient time for remedial actions.	∅ III Study Result NASA G&C			Evaluate alternate 'Navigation, 'Guidance and Control techniques

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM TRANSLUNAR FLIGHT OPERATIONS - AA 1.2	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 4 of 5 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM TRANSLUNAR FLIGHT OPERATIONS AA 1.2 (Cont'd)	3. Maintainability There shall be no inflight maintenance. E. Interface Requirements 1. System Level Support Systems The RNS shall interface with ground stations for the purpose of mission control and identification of abort options in case of failures. Ground communications shall be compatible with capabilities of DSIF. NERVA Engine The definition of the NERVA engine and its requirements are contained principally in: NERVA Program Requirements, Document, SNPO NPRD-1, Jan. 19, 1970, and NERVA Reference Data (Full Flow Engine), AGC Report S-130-CP-090290-F1-Prel, Apr. 1970. The stage shall provide primary power for NERVA operations. Payload A maximum mission payload 15 ft in dia x 140 ft long of uniform density, weighing 118,000 pounds, with a stiffness equal to the propellant + tanks shall be considered. The RNS shall be designed to neither require nor provide electrical services to the payload. A discrete display and control capability for crew override will be provided.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM TRANSLUNAR FLIGHT OPERATIONS - AA 1.2	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 5 of 5 REV & DATE _____ VERIFIED _____	



	FUNCTIONAL DIAGRAM TITLE AND NUMBER			FUNCTIONAL FLOW BLOCK DIAGRAM	
	DEVELOP TRANSLUNAR INJECTION IMPULSE AA 1.2.1			CONTRACTOR	
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
DEVELOP TRANSLUNAR INJECTION IMPULSE AA 1.2.1	A. Functional Description The objective of this function is to provide the energy and vehicle control required to place the flight vehicle into a translunar orbit. This function is initiated with receipt of engine start command and is terminated via guidance command and verification of injection into the preestablished translunar orbit. B. Design Characteristics/Constraints a. Functional Requirements 1. Provide for a ΔV of 10,372 fps Translunar Injection Conditions at termination of full thrust (75,000 Lb) $C_3 = -4.518\ Km^2/sec^2$ e = 0.9157 (eccentricity) R = 5122.8 nmi 2. Provide thrust vector control for the purpose of maintaining a pre-programmed flight path utilizing commands generated by the onboard guidance subsystem. 3. Provide liquid hydrogen at tank outlet commensurate with engine requirements for start, steady state, shutdown and aftercool as defined in the NPRD:	MDAC Ø III results			

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	DEVELOP TRANSLUNAR INJECTION IMPULSE - AA 1.2.1	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 5
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
DEVELOP TRANSLUNAR INJECTION IMPULSE AA 1.2.1 (Cont'd)					

	Flow Rate lb/sec	Total Pressure PSIA (Min)	Temperature °R	Quality % Vapor by Volume
Startup	0 to 91.9	24 to 30	Saturated	0
Steady State	91.0	30	"	0 - 15
Shutdown	91.9 to 4.0	30	"	0 - 15
Aftercooling	4.0	30	"	0

4. Provide control discretes for engine operation and thrust vector control.
5. Provide for terminating nuclear engine thrust in predictable and controlled manner allowing 100 percent utilization of aftercool impulse.
6. During pulsed aftercooling the engine will be centered with ± 0.1 deg of its neutral position. Attitude control shall be provided by an auxiliary propulsion system.

b. Subsystem Requirements

1. Structure subsystem

None

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	DEVELOP TRANSLUNAR INJECTION IMPULSE - AA 1.2.1	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 5 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
DEVELOP TRANSLUNAR INJECTION IMPULSE AA 1.2.1 (Cont'd)	2. Propulsion Subsystem o The roll control system will provide for: Roll attitude control during steady state powered flight and coast within ±5 degrees. Adequate torque to overcome all steady state disturbances during powered flight and coast. Adequate torque to reestablish attitude control within TBD degrees within TBD seconds after NERVA start. Adequate torque to establish a roll rate of 0.1/deg/sec within TBD seconds for orbital maneuvers. o The APS shall provide initial orientation and attitude control during startup **and shutdown.** o The engine shall be preconditioned for satisfactory bootstrap. o The propulsion subsystem shall provide the following diagnostic information for the purpose of performance evaluation, control and safety: TBD. 3. Astrionics Subsystem o The N&G system shall maintain knowledge of radial position to ± 1.8 nmi at injection and a velocity to 2 fps. o Update guidance parameters shall be provided by onboard equipment at initiation of this function	∅ III Study Result NPRD			NG&C Trade Study

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	DEVELOP TRANSLUNAR INJECTION IMPULSE - AA 1.2.1	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 3 of 5
REV & DATE _____ VERIFIED _____

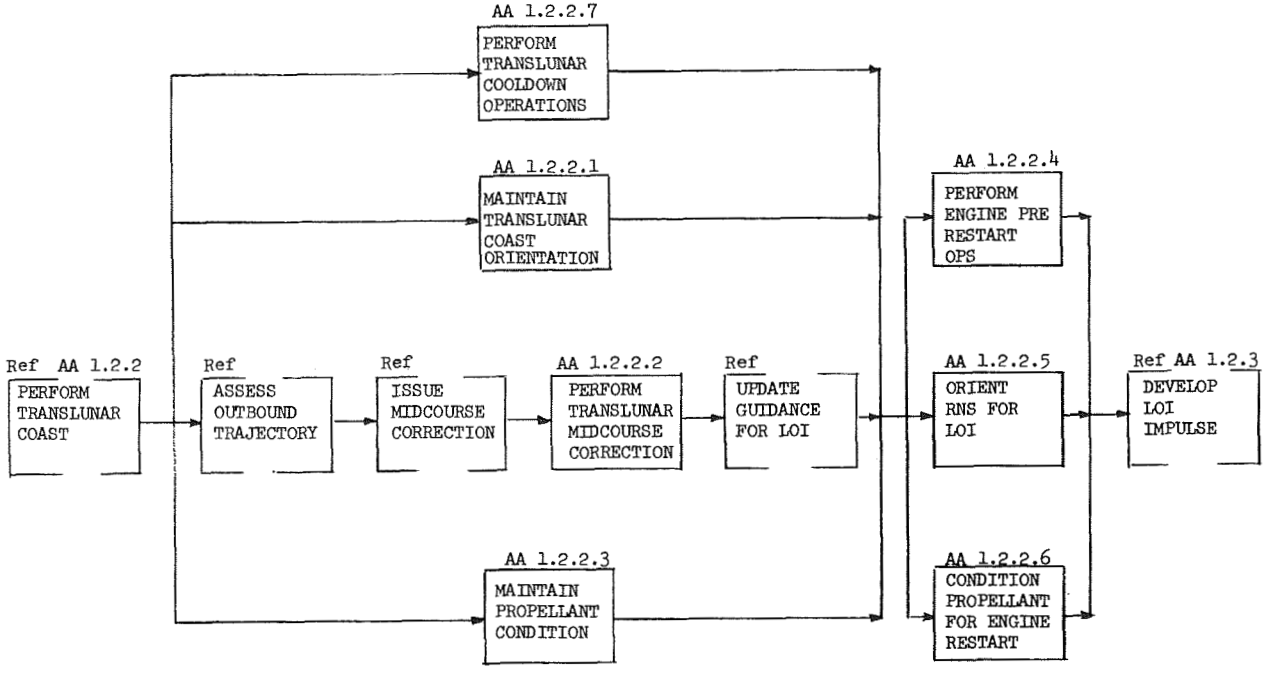
FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
DEVELOP TRANSLUNAR INJECTION IMPULSE AA 1.2.1 (Cont'd)	o The Guidance Navigation and Control subsystem shall command thrust vector control to achieve the required impulse within 20,000 lb-sec and ± 15 sec in time. o During cooldown the desired orientation of the flight vehicle shall be held to within ±5 deg in all axes. o Flight vehicle characteristics associated with the performance of this function shall be formatted and transmitted to mission control and the manned payload. D. Effectiveness Requirements 1. Reliability a. The RNS shall be capable of performing all required functions for translunar injection with a probability of not less than .9959. 2. Safety a. For a manned payload module the accumulated dose (for a complete cycle) experienced shall not exceed 3.3 Rem. Correspondingly the dose experienced by the crew during this function shall not exceed 1 Rem as a result of engine operation. b. In case of mission abort during the performance of this function provision shall be incorporated within the payload module for safe return of its passengers and crew.	Ø III Study Results			

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	DEVELOP TRANSLUNAR INJECTION IMPULSE - AA 1.2.1	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 4 of 5
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
DEVELOP TRANSLUNAR INJECTION IMPULSE AA 1.2.1 (Cont'd)	3. Maintainability a. No inflight maintenance is required. E. Interface Requirements 1. Engine/Guidance & Control for sequence initiation signals and TVC Commands. 2. Engine/Airframe for transmission of loads, environment, and propellant. 3. Engine/Airframe for equipment mounting. 4. Engine/RNS subsystems for power, telemetry, etc.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	DEVELOP TRANSLUNAR INJECTION IMPULSE - AA 1.2.1	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 5 of 5 REV & DATE _____ VERIFIED _____	



	FUNCTIONAL DIAGRAM TITLE AND NUMBER				FUNCTIONAL FLOW BLOCK DIAGRAM	
	PERFORM TRANSLUNAR COAST AA 1.2.2				CONTRACTOR	
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL		DOC NO.	PG
IIC	REV & DATE	ORIG DATE	VERIFIED		DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED		DOC NO.	PG

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM TRANSLUNAR COAST AA 1.2.2	A. Functional Description Subsequent to the termination of thrust applied for translunar injection (TLI) the flight vehicle shall coast on a predetermined flight path to the vicinity of the moon. This function is initiated at PSOV's closure and is terminated in the vicinity of the moon with preparation of the RNS for the Lunar Orbit Injection. B. Design Characteristics/Constraints a. Functional Requirements 1. Provide for NERVA cooldown after TLI burn. 2. Provide the capability for correcting translunar injection errors. 3. Provide the capability to stabilize and control vehicle attitude and orientation. 4. Provide the capability for monitoring flight vehicle status, and functions. 5. Provide the capability for maintaining propellant condition at desired condition. 6. Provide for engine prestart activities. b. Subsystem Requirements 1. Structure o Provide thermal protection of propellant throughout the translunar coast ($\approx$ 108 hrs).				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM TRANSLUNAR COAST - AA 1.2.2	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 3
REV & DATE _____ VERIFIED _____

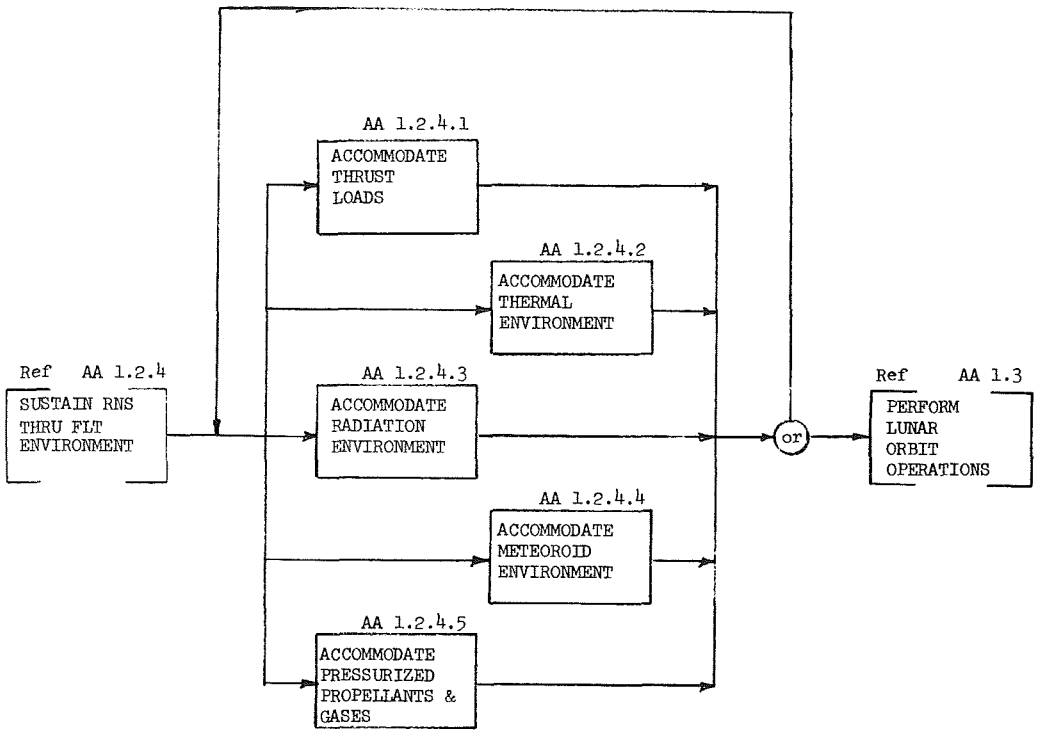
FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM TRANSLUNAR COAST AA 1.2.2 (Cont'd)	o Provide meteoroid protection consistent with 0.99875 probability of no penetrations during translunar coast. 2. Propulsion o The RNS shall provide orientation and attitude control during cooldown, coast and idle mode operations. o The APS shall provide the capability of orienting the flight vehicle at a retro attitude for lunar orbit injection. o Provide the capability to condition the engine and propellant during cooldown, idle mode and to enable a restart for translunar orbit injection. (start conditions defined in RAS AA 1.2). o Provide the capability to monitor the status and functions of the propulsion system for the purpose of performance evaluation, control, and safety. 3. Astrionics o The N&G subsystem shall maintain knowledge of position to ± 15 nmi, velocity to 2 fps and attitude to ± .05 with respect to inertial space. o Provide the autonomous capability to establish midcourse correction requirements. o Provide the capability to issue discretes for affecting midcourse maneuvers, flight vehicle stabilization, and orientation control.	∅ III Study Results			

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM TRANSLUNAR COAST - AA 1.2.2	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 3 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM TRANSLUNAR COAST AA 1.2.2 (Cont'd)	o Ground tracking data available as backup for the navigation function. D. Effectiveness Requirements 1. Reliability The RNS shall perform all functions during coast and have a probability of being ready to develop the Lunar Orbit Injection impulse of not less than .9940 2. Safety See RAS AA 1.2.1 3. Maintainability No inflight requirement E. Interface Requirement 1. Project/System Level a. RNS/MCC for monitoring and backup control. b. RNS/Payload Module (Manned) for status display and control. 2. Subsystem Level a. Propulsion/Guidance Navigation and Control, for issuance of discretes and control of maneuvers. b. Power/using subsystems, for regulated supply of electric power. c. Data Management/all others, for determination of system performance.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM TRANSLUNAR COAST - AA 1.2.2	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 3 of 3
REV & DATE _____ VERIFIED _____



	FUNCTIONAL DIAGRAM TITLE AND NUMBER			FUNCTIONAL FLOW BLOCK DIAGRAM	
	SUSTAIN RNS THROUGH FLIGHT ENVIRONMENT AA 1.2.4			CONTRACTOR	
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
SUSTAIN RNS THROUGH FLIGHT ENVIRONMENT AA 1.2.4	A. Function Description The RSN shall possess sufficient strength, rigidity, and other necessary characteristics required to survive the loading conditions that exist during translunar RNS flight operation. In addition it shall possess the capability of protecting its propellant and equipment from the environment either natural or induced to which it is exposed during a cycle of operation. The functions to be performed by the RNS include: a. Accommodate thrust loads b. Accommodate thermal environment c. Accommodate radiation environment d. Accommodate meteoroid environment e. Hold pressurized propellants and gases B. Design Characteristics/Constraints 1. All pressure vessels shall be designed such that pressure stabilization is not required. 2. The design limit values for regulated pressures shall be based on the upper limit of the relief valve setting (30 psia for RNS-3, 29 psia for RNS-1H) when pressure is detrimental to structural load-carrying capability. 3. When pressure increases structural load carrying capability, the lower limit of the operating pressure schedule (26 psia) shall be the design limit value.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	SUSTAIN RNS THROUGH FLIGHT ENVIRONMENT - AA 1.2.4	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 7 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
SUSTAIN RNS THROUGH FLIGHT ENVIRONMENT AA 1.2.4 (Cont'd)	4. Propellant tanks shall accept the design pressure for mission operations at the temperature of the expulsion pressurant ($250^{\circ}R$) 5. All pressure vessels shall be capable of withstanding a minimum of 100 cycles of pressurization. 6. Sufficient meteoroid protection shall be provided for propellant tank(s) to ensure zero pitting. 7. Primary load carrying structures shall not be employed as meteoroid protection for RNS subsystems 8. The design of the RNS shall account for dynamic loads, including thrust vector interaction, thrust transients, pogo, slosh, staging, docking, aeroelastics, and acoustic conditions. 9. The RNS design shall reflect the loads resulting from the following misalignments: a. Payload misalignment b. Guidance System misalignment c. Thrust mount interface misalignment d. Thrust mount misalignment e. Flight control system misalignment f. Nozzle misalignment g. Thrust vector control misalignment h. Module assembly misalignment				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	SUSTAIN RNS THROUGH FLIGHT ENVIRONMENT - AA 1.2.4	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 7
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
SUSTAIN RNS THROUGH FLIGHT ENVIRONMENT AA 1.2.4 (Cont'd)	11. Structures shall be designed for normal operational loads, and loads arising from abort conditions shall be limited to those of normal operations. 12. The induced loads resulting from docking, mating and demating operations shall be less than 60 lbs. 13. The RNS structure shall withstand engine induced loads (transients, acceleration, and gimbal hard over) and environments (mechanical, thermal, vibration, and radiation) reflecting the following NERVA parameters: Thrust — 75,000 lbs ± 2,000 Mass (without external shield) — 27,800 lbs Overall length — 408 in. Gimbal point — 23 in (from interface) Center of gravity — 140 in. (from interface) Thrust vector control Displacement — 3 deg Velocity — 0.75 deg/sec Acceleration — 0.5 deg/sec^2 14(a) RNS-3 materials used shall be compatible with the following radiation dose profile:				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	SUSTAIN RNS THROUGH FLIGHT ENVIRONMENT - AA 1.2.4	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 3 of 7 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
SUSTAIN RNS THROUGH FLIGHT ENVIRONMENT AA 1.2.4 (Cont'd)	Region — Dose (Rads) Propulsion Module - Aft — 2.4×10^8 hydrogenous; 1.4×10^8 non hydrogenous Propulsion Module - Forward — 5×10^6 Inboard Propellant Module - Aft — 5×10^6 Outboard Propellant Module - Aft — 5×10^6 Outboard Propellant Module - Forward — 1×10^5 Inboard Propellant Module - Forward — 5×10^3 Inboard Propellant Module - Forward — 5×10^3 CCM — 5×10^3; 10^9 n/cm^2 (neutrons) 14(b) RNS-1H materials used shall be compatible with the following radiation dose profile: Region — Dose (Rads) Propulsion Module - Aft — 2.4×10^8 hydrogenous; 1.4×10^8 non hydrogenous Propulsion Module - Forward — 5×10^6 Propellant Module - Aft — 5×10^6 Propellant Module - Forward — 5×10^3 CCM — 5×10^3; 10^9 n/cm^2 (neutrons)				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	SUSTAIN RNS THROUGH FLIGHT ENVIRONMENT - AA 1.2.4	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 4 of 7 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
SUSTAIN RNS THROUGH FLIGHT ENVIRONMENT AA 1.2.4 (Cont'd)	16. In defining the meteoroid protection for translunar flight the reference flux is $\log N = -14.46 - 1.213 \log m.$ The effective exposure time is 0.888 times the actual transfer time, i.e, 0.888 x 132 = 177 hrs. 17. The damage criterion for tankage shall provide for no penetration of the tank wall. 18. No vehicle orientation requirements shall be imposed on the RNS during any mission or coast phase for meteoroid protection purposes. 19. The RNS surface coatings shall take into account the performance degradation of absorptivity and emissivity after extended exposure in space. 20. The RNS HPI design shall account for the effects of blanked design and installation (including perforations, joints, studs, and tank attachment) and effects of environments (including compression, decompression, evacuation, and degradation from meteoroid damage). 21. The thermal protection system shall impose no requirements for vehicle orientation during any operation or mission phases. It shall reflect any thermal loads induced by operational requirements for specific orientations.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	SUSTAIN RNS THROUGH FLIGHT ENVIRONMENT - AA 1.2.4	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 5 of 7

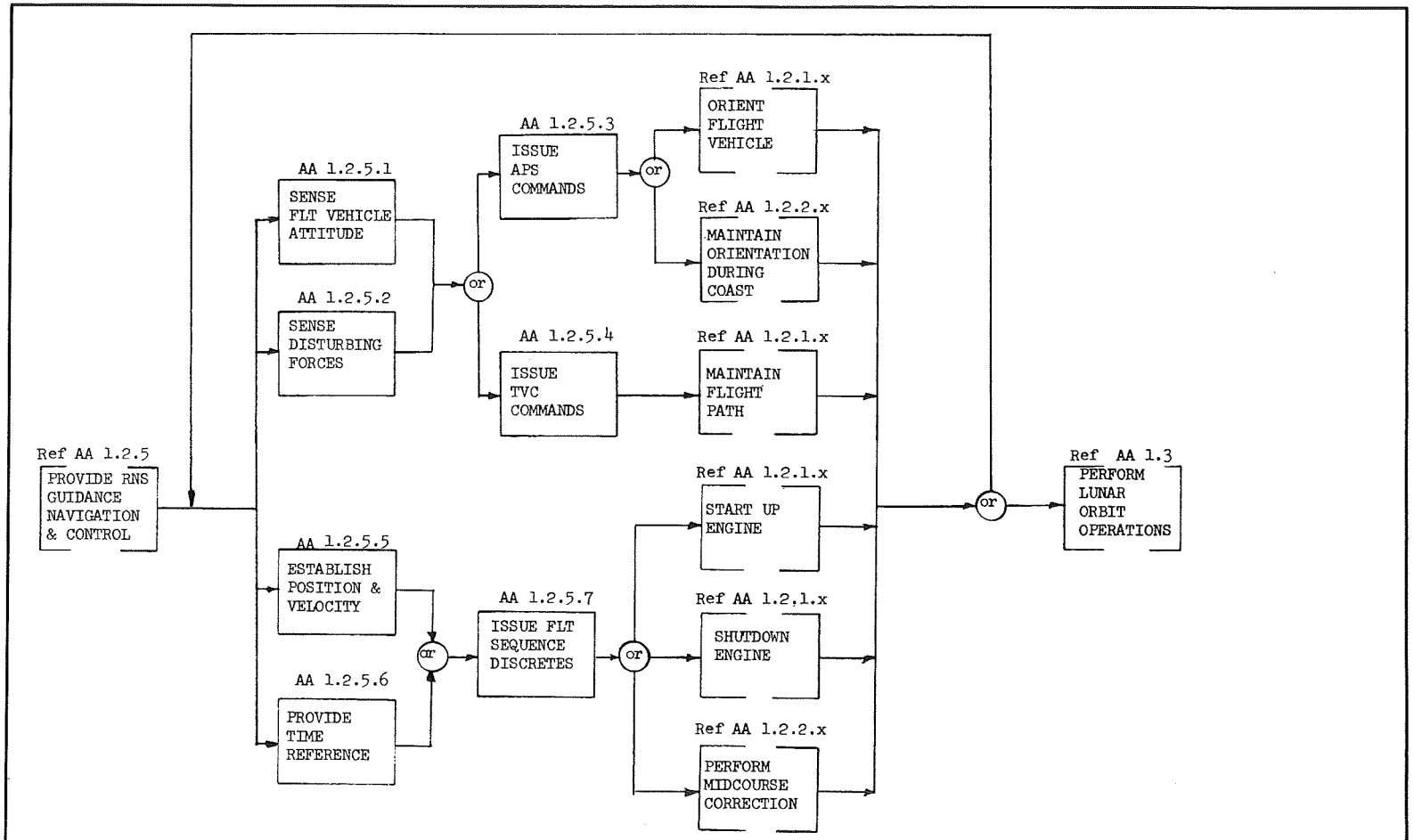
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
SUSTAIN RNS THROUGH FLIGHT ENVIRONMENT AA 1.2.4 (Cont'd)	22. A reference surface temperature of -90°F or 370°R is adopted for thermal protection system design. 23. The total energy deposition rate at full power is 13 KW (4 KW from gammas and 9 KW from neutrons) D. Effectiveness Requirements 1. Reliability a. The RNS shall be capable of surviving the loads and flight environment with a probability of not less than .9859. b. The meteoroid protection subsystem shall provide a survival probability of 0.9975 during transit. 2. Safety The RNS design shall employ manned vehicle factors of safety for all modules a. General Safety Factors: Yield factor of safety = 1.1 Ultimate factor of safety = 1.4 b. Propellant Tanks Proof Pressure = 1.05 x limit pressure Yield Pressure = 1.10 x limit pressure Ultimate Pressure = 1.40 x limit pressure				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	SUSTAIN RNS THROUGH FLIGHT ENVIRONMENT - AA 1.2.4	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 6 of 7 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
SUSTAIN RNS THROUGH FLIGHT ENVIRONMENT AA 1.2.4 (Cont'd)	3. Maintainability There shall be no inflight maintenance. E. Interface Requirements 1. The RNS shall interface mechanically with the payload module for the purpose of transmitting loads and impulse. 2. The loading characteristics at the RNS payload interface shall be defined in Exhibit ____.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	SUSTAIN RNS THROUGH FLIGHT ENVIRONMENT - AA 1.2.4	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 7 of 7 REV & DATE _____ VERIFIED _____	



	FUNCTIONAL DIAGRAM TITLE AND NUMBER			FUNCTIONAL FLOW BLOCK DIAGRAM	
	PROVIDE RNS GUIDANCE NAVIGATION AND CONTROL AA 1.2.5			CONTRACTOR	
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PROVIDE RNS GUIDANCE AND CONTROL AA 1.2.5	A. Functional Description The RNS shall provide autonomous navigation, guidance and control during its translunar flight operations, in order to maintain the required trajectory, prevent uncontrolled vehicle motion or oscillation, and allow maximum utilization of thrust for the attainment of mission objectives. Included in this function are: providing navigation, guidance and control for translunar injection, translunar coast, and lunar orbit injection. B. Design Characteristics/Constraints 1. Provide attitude and disturbance sensing and vehicle control commands. During translunar coast the flight vehicle shall be controlled to within ± 5 degrees. Vehicle maneuver rates shall be below .1°/sec. 2. Provide thrust vector control commands during injection maneuvers, with the following range of mass inertias and moment arms:	∅ III Study Results "			

		Class 1	Class 3
Start Mission	cg (in)	1197	1946
	Mass (LB-sec^2/in)	1206	1253
	Inertia (LB-sec^2/in)	7.55 x 10^8	2.02 x 10^9
End Mission	cg (in)	665	1385
	Mass (LB-Sec^2/in)	243	274
	Inertia (LB-Sec^2/in)	1.33 x 10^8	4.27 x 10^8

Integrated pitch, yaw and roll angle accuracy tolerances shall be TBD of selected angle.

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PROVIDE RNS GUIDANCE AND CONTROL - AA 1.2.5	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 4
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PROVIDE RNS GUIDANCE AND CONTROL AA 1.2.5 (Cont'd)	3. Provide digital flight control system to provide system sequencers, gain and filter changes, and torquing the gyros.	Ø III Study Results			
	4. The engine gimbal deflection in both pitch and yaw shall be ± 3.0 degrees.	NPRD			
	5. The steering command shall reflect an engine capable of being gimballed at a velocity not to exceed 0. 5 deg/sec. The nominal acceleration of the gimbaled mass shall be a maximum of 0.5 deg/sec^2.	NPRD			
	6. The electrical equipment of the guidance and control function will operate on 28 VDC primary power source.	Baseline G & C			
	7. The system will not malfunction or exhibit out of tolerance conditions as a result of external or internal EMI.	"			
	8. Whenever possible mounting points shall be selected to minimize assymetric forces acting on equipment.	"			
	9. Ground tracking data is assumed available and utilized by the RNS as backup.	"			
	10. An attitude reference base, to which all guidance, navigation and control sensors are to be aligned shall be star trackers.	Ø III Study Results			
	11. The GNC subsystem shall provide the capability of determining RNS position and velocity automatically and independent of ground support. These are: TLI ± 1.8 nmi and 2 fps (radial) Coast ± 15 nmi and 2 fps (radial) EOI ± 10 nmi and 2 fps (radial)	"			

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PROVIDE RNS GUIDANCE AND CONTROL - AA 1.2.5	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 4 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PROVIDE RNS GUIDANCE AND CONTROL AA 1.2.5 (Cont'd)	12. The GNC shall have the capability of being active or passive in terminal rendezvous and docking maneuvers. 13. The GNC subsystem shall time share a centralized digital computer to perform the required computations. 14. The integrated radiation dose experienced by the GNC equipment shall be limited to 10^9 n/cm^2. D. Effectiveness Requirements 1. Reliability The probability of performing all required guidance navigation and control functions for the translunar flight operations shall be no less than .9995. 2. Safety The system shall be designed such that no single failure shall cause destruction of the stage, injury to the crew, or hazard to the general public.	Ø III Study Results " " NASA G & C			

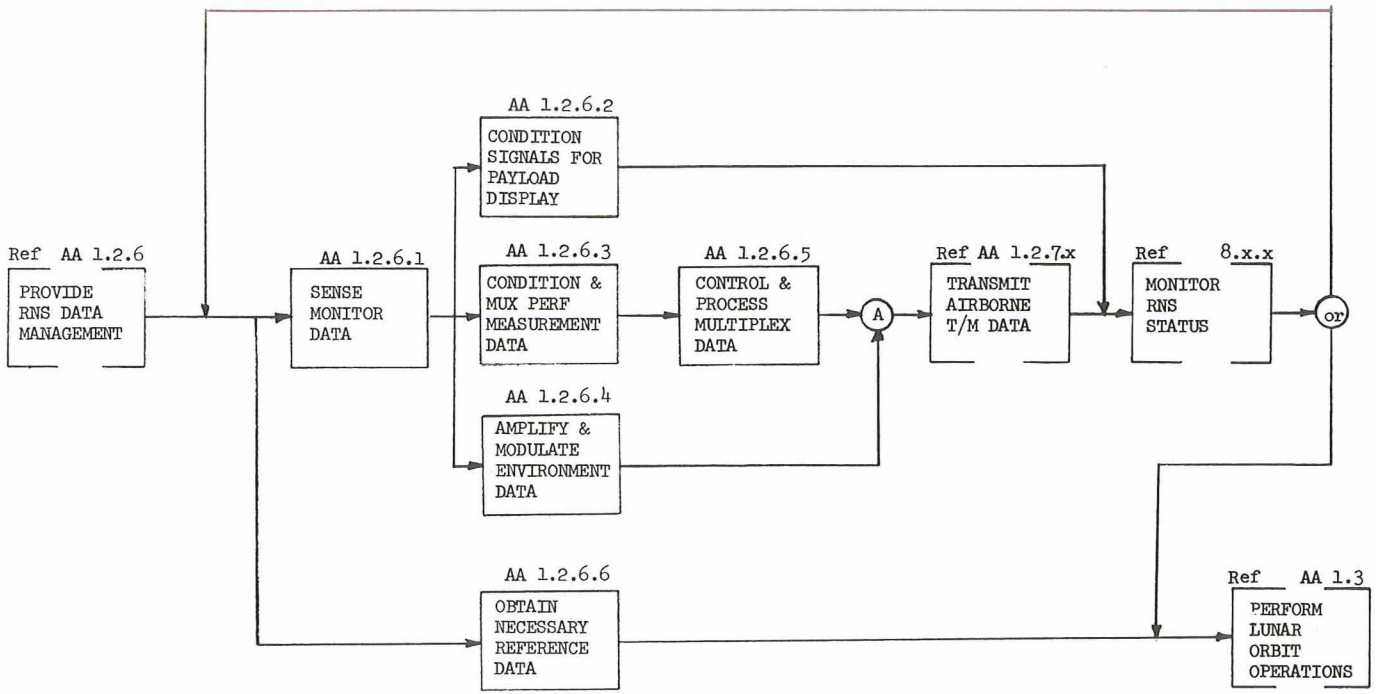
RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PROVIDE RNS GUIDANCE AND CONTROL - AA 1.2.5	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 3 of 4
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PROVIDE RNS GUIDANCE AND CONTROL AA 1.2.5 (Cont'd)	3. Maintainability There shall be no inflight maintenance E. Interface Requirements 1. Interface requirements between GNC subsystem and other projects. a. Provide for cooperative ranging with other systems, e.g., Earth Space Base, Lunar Space Station. b. Provide for receipt of ground tracking data for RNS navigation. c. Provide for control and display from and to a manned payload. 2. Interface requirements between GNC subsystems and other RNS subsystems. a. Electrical power from electrical power subsystem power requirement: Engine operation: Normal (Watts) 500; Peak (Watts) 2,000 Aftercooling: Normal (Watts) 400; Peak (Watts) 400 Coast: Normal (Watts) 50; Peak (Watts) 50 b. Environmental protection from environment control subsystem. Thermal output of GNC subsystem TBD. c. Provide commands to auxiliary propulsion to activate appropriate thrusters for attitude control. d. Provide commands to communication system for initial pointing requirements. e. Provide commands to engine system for thrust vector control and issuance of discretes, e.g., engine start. f. Provide characteristics to data acquisition subsystems for diagnostics and control of the GNC subsystem. g. Provide for 79,200 OPS/sec processing requirements and 16,000 words storage.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PROVIDE RNS GUIDANCE AND CONTROL - AA 1.2.5	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 4 of 4
REV & DATE _____ VERIFIED _____



	FUNCTIONAL DIAGRAM TITLE AND NUMBER			FUNCTIONAL FLOW BLOCK DIAGRAM	
	PROVIDE RNS DATA MANAGEMENT AA 1.2.6			CONTRACTOR	
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PROVIDE RNS DATA MANAGEMENT AA 1.2.6	A. Functional Description A data management subsystem shall be provided to gather, process, store, and distribute internal performance and environmental data required to determine and evaluate subsystem performance, isolate malfunctions and exercise mission control. This function is composed of a. Computation b. Data Acquisition c. Data Distribution d. Data Storage e. Display B. Design Characteristics/Constraints 1. General (a) The Data Management Subsystem (DMS) shall be designed for the operational requirements with kit modifications to be used on development flights. (b) The airborne system shall be designed to operate on 28 VDC power. (c) Instrumentation components developed and/or qualified on preceding programs shall be utilized to maximum extent practicable. (d) The airborne system shall be designed to operate in the thermal, acceleration, temperature, radiation, acoustic, etc., environment established by stage and defined in RNS design criteria.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PROVIDE RNS DATA MANAGEMENT - AA 1.2.6	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 5
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PROVIDE RNS DATA MANAGEMENT AA 1.2.6 (Cont'd)	(e) Internal data distribution, data formatting, timing, maintenance information and display generation shall be under software control. (f) The DMS shall be fully automated with manual override capability. (g) The DMS shall provide the primary data for check out of other sub-systems as well as itself to the replaceable element level. (h) The DMS shall be capable of accepting uplink data. (i) Provision shall be included for data compression. 2. Specific (a) Computation o The computation function performing automated RNS control shall be continuously available and capable of 250,000 equivalent adds/second. o Provisions for replacement or revision of programs shall be included on the ground and via uplink. o Fast and slow access storage shall be available; 38,000 words of 32 bit high speed storage and 100,000 words of bulk storage is required. (b) Data Acquisition o The data acquisition functional element shall provide the signal conditioning, conversion, and message formatting. o The data acquisition functional element shall include the capability for time division multiplexing and digitizing at each data acquisition terminal.	MDAC Data Mgmt Trade Study			

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PROVIDE RNS DATA MANAGEMENT - AA 1.2.6	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 5 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PROVIDE RNS DATA MANAGEMENT AA 1.2.6 (Cont'd)	o Data acquisition terminals shall be modular, include address decoding, priority queueing and special instruction capability to facilitate the order of message acquisition. o Provisions will be made for 591 analog and 141 discrete measurements on the operational vehicle. o Sampling rates of encoded digital and analog data will be at the rate of 8800 samples per second or 88,000 bits/sec. (c) Data Distribution o Provision will be made to route command and control data to each module. o Module interface shall be via a data bus capable of a data rate of 0.5 x 0^6 Bits/sec (d) Data Storage o Provide for storage and retrieval of data for onboard processing, transmission to earth at a rate of 8.5 x 10^3 bits/sec from earth orbit and 10^3 bits/sec at lunar distances. o Store data for 1 complete earth orbit or 5 x 10^6 bits of data. (e) Display o Allow for selected display of mission critical parameters in a manned RNS payload.	MDAC Design Criteria MDAC Data Mgmt Trade Study MDAC Data Mgmt Trade Study MDAC Data Mgmt Trade Study			

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PROVIDE RNS DATA MANAGEMENT - AA 1.2.6	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 3 of 5
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PROVIDE RNS DATA MANAGEMENT AA 1.2.6 (Cont'd)	D. Effectiveness Requirements 1. Reliability a. The attainment of internal performance data shall not be considered a flight critical function. b. The probability of not achieving mission objectives due to improper performance of this function shall be less than 0.0024 based on a 45 day mission. 2. Safety N/A 3. Maintainability No inflight maintenance is required. E. Interface Requirements The Data Management Subsystem shall interface with the following: 1. Project/system Level a. The DMS shall provide for display of RNS characteristics in a manned payload module. b. The DMS shall provide for access from ground stations, orbital stations and/or manned payloads. 2. Subsystem Level a. Communication - transmission of data, source of T/M data b. Structural - structural support and mounting, source of T/M data				

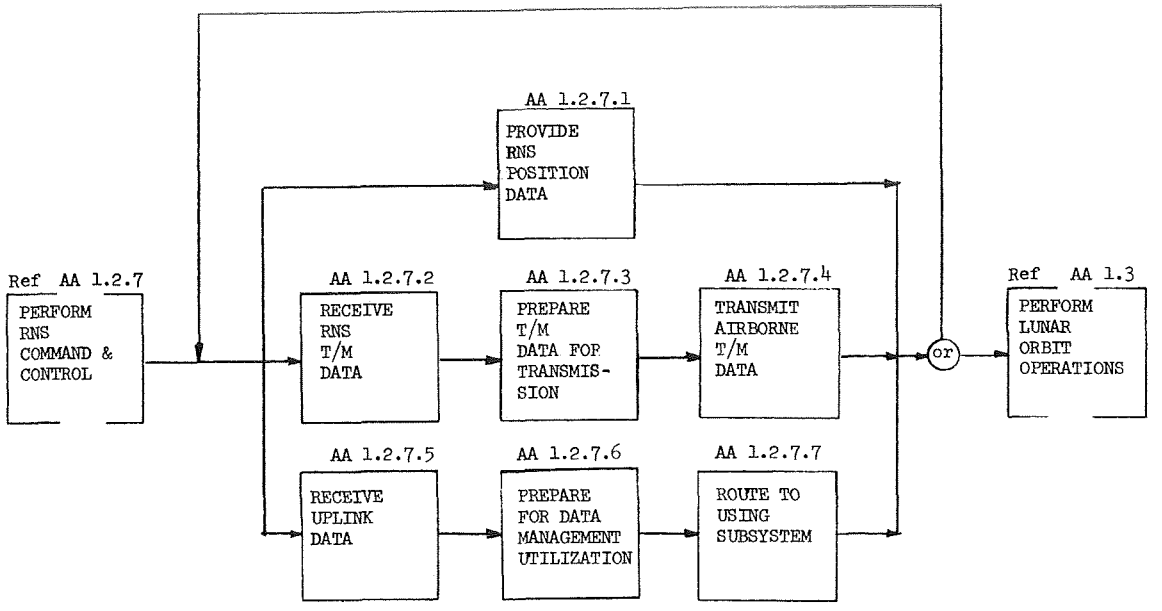
RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PROVIDE RNS DATA MANAGEMENT - AA 1.2.6	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 4 of 5
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PROVIDE RNS DATA MANAGEMENT AA 1.2.6 (Cont'd)	c. Guidance Navigation and Control - source of T/M data d. Electrical Power - supply of power, source of T/M data e. Propulsion - source of T/M data 3. The DMS data bus shall provide for control signals and supply data to the data bus of the space shuttle or space tug during periods of band connection.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PROVIDE RNS DATA MANAGEMENT - AA 1.2.6	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 5 of 5
REV & DATE _____ VERIFIED _____



	FUNCTIONAL DIAGRAM TITLE AND NUMBER			FUNCTIONAL FLOW BLOCK DIAGRAM	
	PERFORM RNS COMMAND & CONTROL AA 1.2.7			CONTRACTOR	
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PROVIDE RNS COMMAND AND CONTROL AA 1.2.7	A. Functional Description A command and control function is required to enable the transmission of data between the RNS and supporting or dependent external elements. These data to be utilized for performance evaluation, mission control, and safety operations. B. Design Characteristics/Constraints 1. Provide for direct transmission with ground stations and/or transmission paths through data relay satellites to ground. 2. Provide for emergency transmission to accommodate safety or abort actions. 3. Provide for receipt of narrowband signals, demodulating up to TBD Kbps of PSK digital data. 4. Provide ranging signals upon request to augment ground tracking. 5. Provide for high and low gain antenna system having TBD characteristics. 6. Transmission distances shall vary from earth operations orbit (262 nmi) to lunar distances (220,000 nmi). 7. Provide for real time communication. D. Effectiveness Requirements 1. Reliability The probability of successful performance of this function shall not be less than .9995.				

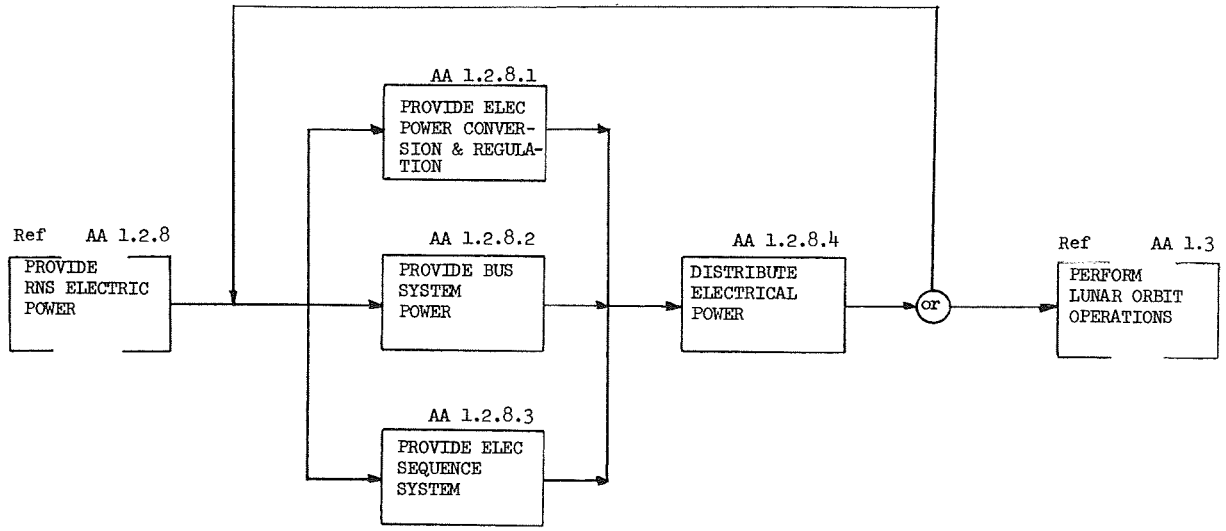
RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PROVIDE RNS COMMAND AND CONTROL - AA 1.2.7	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 2
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PROVIDE RNS COMMAND AND CONTROL AA 1.2.7 (Cont'd)	2. Safety The performance of this function shall not be considered flight critical. 3. Maintainability No inflight maintenance. E. Interface Requirements 1. The command and control subsystem shall be compatible with ground processing and receiving capability. 2. The command and control subsystem shall interface with the data management subsystem for the transmission to the ground of diagnostic data. 3. Allow for control and data transfer with the space shuttle and space tug during periods of physical mating.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PROVIDE RNS COMMAND AND CONTROL - AA 1.2.7	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 2
REV & DATE _____ VERIFIED _____



	FUNCTIONAL DIAGRAM TITLE AND NUMBER				FUNCTIONAL FLOW BLOCK DIAGRAM	
	PROVIDE RNS ELECTRIC POWER AA 1.2.8				CONTRACTOR	
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL		DOC NO.	PG
IIC	REV & DATE	ORIG DATE	VERIFIED		DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED		DOC NO.	PG

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PROVIDE ELECTRICAL POWER AA 1.2.8	A. Functional Description Provisions will be made to generate, transmit, control, and distribute electrical power to the RNS's power consuming subsystems during the trans-lunar flight operations. B. Design Characteristics/Constraints 1. During engine operation the electrical power system (EPS) shall provide 3.50 KWe nominal and 6.70 KWe peak for short periods. 2. During the aftercooling phase the EPS shall provide 1.20 KWe nominal and 2.50 KWe peak for short periods. 3. During the coast period the EPS shall provide 0.33 KWe nominal and 0.81 KWe peak for short periods. 4. The EPS shall consist of not less than two independent sources, each of which shall be capable of supplying emergency power for an extended period assuming no second failure mode. 5. The RNS's EPS shall be autonomous. However it shall have the capability of providing or receiving electrical power to or from the payload module as a backup for emergency conditions. 6. Circuit protection devices shall be provided as necessary. 7. The EPS shall provide for remote monitoring capability when the RNS is used in conjunction with a manned payload.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PROVIDE ELECTRICAL POWER - AA 1.2.8	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 3
REV & DATE _____ VERIFIED _____

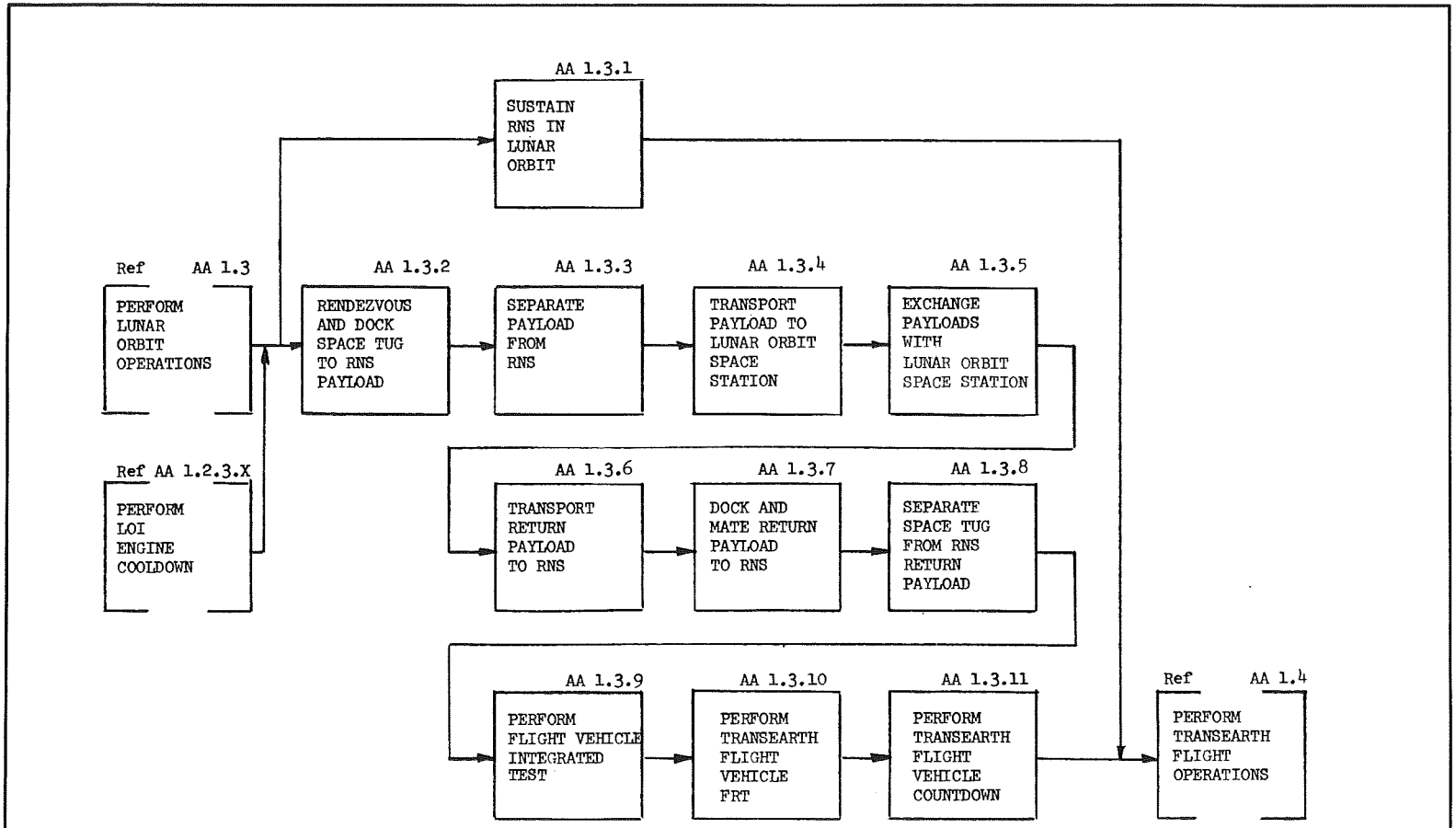
FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PROVIDE ELECTRICAL POWER AA 1.2.8 (Cont'd)	8. All components of the electrical system must withstand the environment of the applicable compartment as defined in_____. 9. All inductive loads will be supressed. 10. The electrical equipment must operate without adverse electro-interference effects on surrounding equipment and without being affected by external electro-interference. 11. Electrical circuits shall be designed to prevent excessive transients from appearing on power buses. 12. The RNS electrical system shall meet the requirement of NASA spec _____. D. Effectiveness Requirements 1. Reliability a. Critical circuitry and components shall be designed to comply with the basic criteria that the probability of mission success shall not be less than .9976. 2. Safety See RAS AA 1.2.5 3. Maintainability No inflight maintenance required.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PROVIDE ELECTRICAL POWER - AA 1.2.8	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 3 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PROVIDE ELECTRICAL POWER AA 1.2.8 (Cont'd)	E. Interface Requirements 1. Functional interfaces between power system and the subsystems it supports. 2. Functional interfaces with payload module for emergency backup and remote display. 3. Structural-interfaces for equipment support. 4. Data Management - instrumentation for performance analysis.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PROVIDE ELECTRICAL POWER - AA 1.2.8	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 3 of 3
REV & DATE _____ VERIFIED _____



	FUNCTIONAL DIAGRAM TITLE AND NUMBER			FUNCTIONAL FLOW BLOCK DIAGRAM	
	PERFORM LUNAR ORBIT OPERATIONS - AA 1.3			CONTRACTOR	
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM LUNAR ORBIT OPERATIONS AA 1.3	A. Functional Description Subsequent to the Lunar Orbit Injection and the associated cooldown maneuver lunar orbit operations will be required to enable the exchange of payloads between the RNS and the receiving agency (e.g. lunar space station). B. Design Characteristics/Constraints a. Functional Requirements 1. The RNS shall act as a passive but cooperative target during rendezvous with a lunar orbit space tug.	Baseline			Evaluate alternate RNS role
	2. The RNS payload shall provide for docking and mating to the space tug.	Baseline			
	3. The RNS payload shall be transported to the LOSS via space tug.	Baseline			Evaluate RNS hard dock to LOSS
	4. The RNS shall be capable of sustaining itself while in the lunar operations orbit.	Baseline			
	5. The RNS shall verify flight worthiness prior to injecting into the transearth flight.	Safety			Evaluate using space tug
	6. Provide the capability of separating and reacquiring payload while in the lunar operations orbit.	Baseline			
	7. Provide the capability for performing an automatic but remotely controlled flight vehicle countdown.	Baseline			Evaluate possible autonomy
	b. Subsystem Requirements 1. Structure Subsysten o Provide a docking mechanism which aligns the payload,locks it rigidly				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM LUNAR ORBIT OPERATIONS AA 1.3	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 3
REV & DATE _____ VERIFIED _____

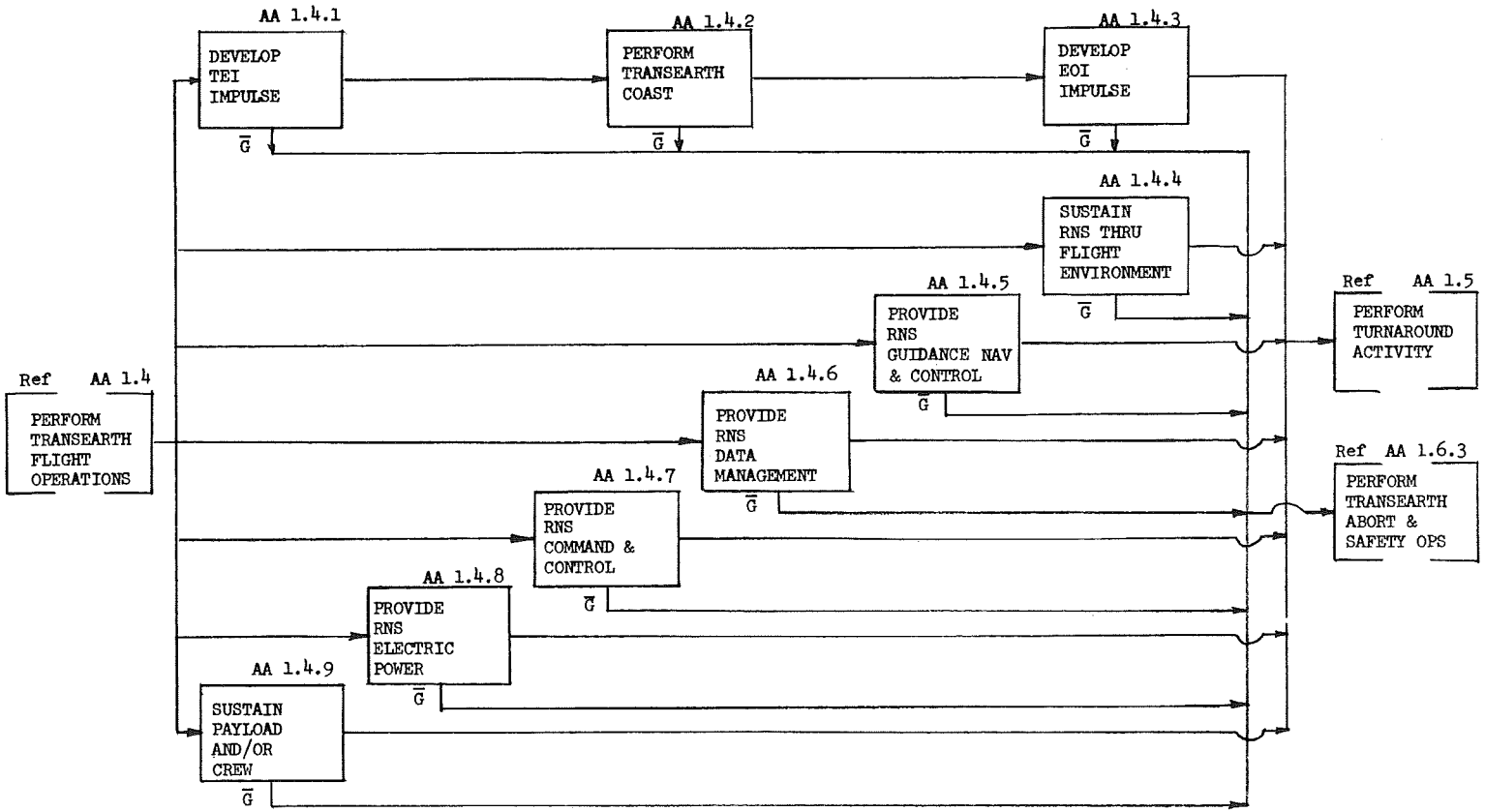
FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM LUNAR ORBIT OPERATIONS AA 1.3	to the CCM, transmits all subsequent loads and allows verification of its integrity after acquiring the return payload. ° Provide sufficient meteoroid and thermal protection to survive a lunar orbit stay of up to 19 days, and ensuring zero pitting. ° Provide sufficient structural inegrity to withstand the loads resulting from payload undocking and docking. 2. Propulsion Subsystem ° Provide an APS for attitude stabilization and control for lunar orbit configurations with and without payload. ° Provide a propellant management capability to maintain pressurization within the structural capability of propellant tanks. ° Provide for an automated C/O prior to commital to return flight. 3. Astrionics Subsystem ° Provide the functional subsystems to support power requirements, attitude control and stabilization, telemetry, communication, and flight vehicle checkout while in lunar orbit. ° Provide for a low power mode of operation while in a standby mode in lunar orbit. ° Provide navigation aids for rendezvous and docking to space tug for payload exchange maneuvers.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM LUNAR ORBIT OPERATIONS AA 1.3	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 3
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM LUNAR ORBIT OPERATIONS AA 1.3	D. Effectiveness Requirements 1. Reliability a. The probability that the functional subsystems shall degrade in capability so as to endanger the return leg shall not exceed .98. b. Checkout of the flight vehicle shall assure that no faulty vehicle is launched on the return leg, with a probability of .99 for manned payloads and .99 for unmanned payloads. 2. Safety a. The RNS shall not expose any lunar orbit system element to a radiation dose greater than 0.1 Rem per single NERVA engine burn. 3. Maintainability a. There shall be no requirement for lunar orbit maintenance. E. Interface Requirements 1. The docking interface between CCM and payload returned to earth shall be common to that used for payload delivered to the moon. 2. The RNS shall receive updated navigation data from MCC, as a backup.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM LUNAR ORBIT OPERATIONS AA 1.3	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 3 of 3 REV & DATE _____ VERIFIED _____	



	FUNCTIONAL DIAGRAM TITLE AND NUMBER			FUNCTIONAL FLOW BLOCK DIAGRAM	
	PERFORM TRANSEARTH FLIGHT OPERATIONS - AA 1.4			CONTRACTOR	
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG

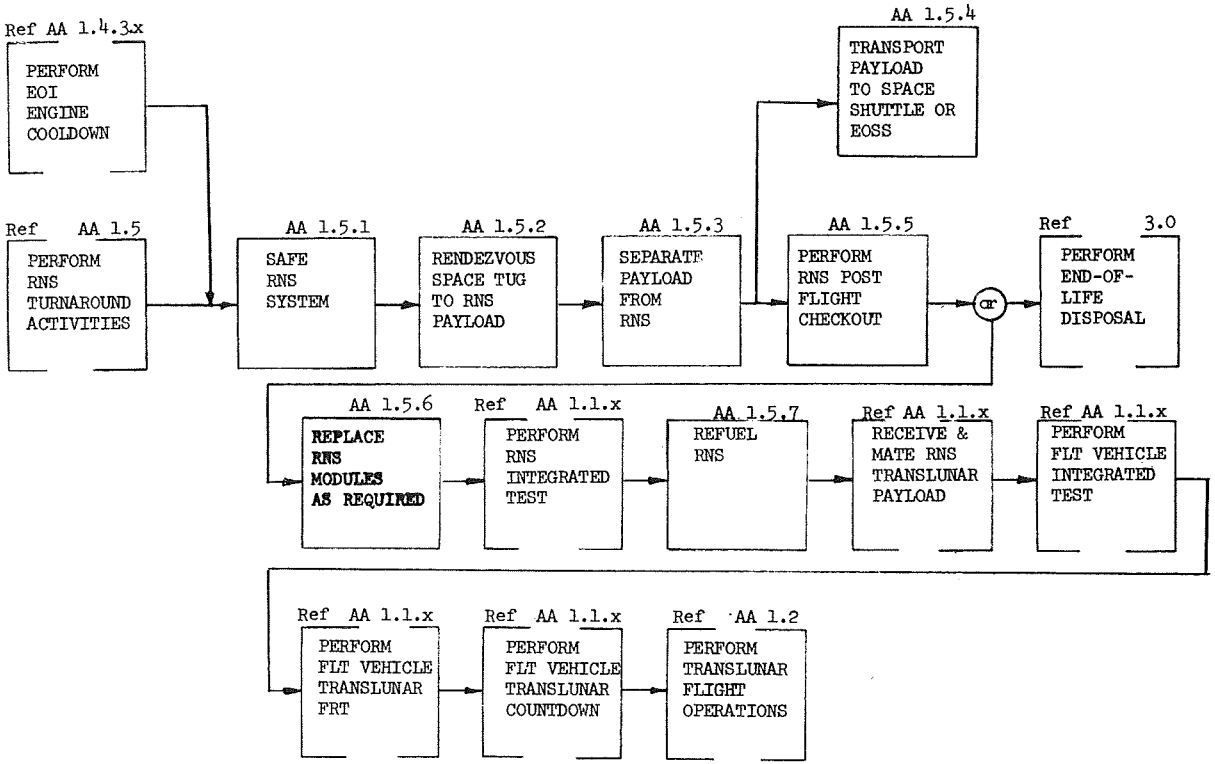
FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM TRANSEARTH FLIGHT OPERATIONS AA 1.4	A. Functional Description The objective of this function is to perform the flight operations required to return the RNS and its payload to the earth operations orbit from the lunar operations orbit. This function is initiated at the successful completion of the transearth countdown and is terminated with successful injection into the prescribed earth operations orbit. B. Design Characteristics/Constraints General: The design characteristics/constraints identified for function AA 1.2 (Perform translunar flight operations) generally apply to this function as well (replacing transearth for translunar). The following are characteristics and constraints peculiar to the transearth portion of the mission. 1. Function Requirements a. Provide transearth and earth orbit injection impulses commensurate with the following: Lunar departure orbit - 60 NM, 90 Deg. Earth Arrival orbit -260 NM, 31.5 Deg. Moon-Earth flight time - 72 Hrs. 2. Subsystem Requirements a. Structure Subsystem o Propellant loading varies from 71,000 lbs at initiation to				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM TRANSEARTH FLIGHT OPERATIONS AA 1.4	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 2
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM TRANSEARTH FLIGHT OPERATIONS AA 1.4	2,310 lbs (residual) at completion of this function. D. Effectiveness Requirements These are identical to Function 1.2 transposing transearth for translunar, except that the reliability goal is .9800. E. Interface Requirements Same comment as the "D".				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM TRANSEARTH FLIGHT OPERATIONS AA 1.4	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 2 REV & DATE _____ VERIFIED _____	



	FUNCTIONAL DIAGRAM TITLE AND NUMBER			FUNCTIONAL FLOW BLOCK DIAGRAM	
	PERFORM RNS TURNAROUND ACTIVITIES AA 1.5			CONTRACTOR	
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM RNS TURNAROUND ACTIVITIES AA 1.5	A. Functional Descriptions The objective of this function is to perform those operations required to recycle the RNS on to its next mission. This function is initiated at the completion of cooldown required after earth orbit injection and is terminated with successful countdown for translunar injection. B. Design Characteristics/Constraints The following are requirements in addition to those identified in Function AA 1.2 (Assemble and checkout lunar shuttle flight vehicle). 1. Functional Requirements a. Provide for positive safing of the RNS system subsequent to powered flight. b. Provide the capability of separating and transporting the return payload to its designated site. c. Provide the capability to perform a post flight checkout for the purpose of identifying corrective maintenance. d. Provide the capability to perform in situ maintenance to the module level (i.e., CCM, propellant module, propulsion module) e. Provide the capability to refuel the RNS with up to 300,000 lbs of LH_2.	Mission success Requirement Maintenance level trade study Baseline			Autonomous vs ground control or space base control Evaluate alternate propellant resupply concepts

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM RNS TURNAROUND ACTIVITIES AA 1.5	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 3
REV & DATE _____ VERIFIED _____

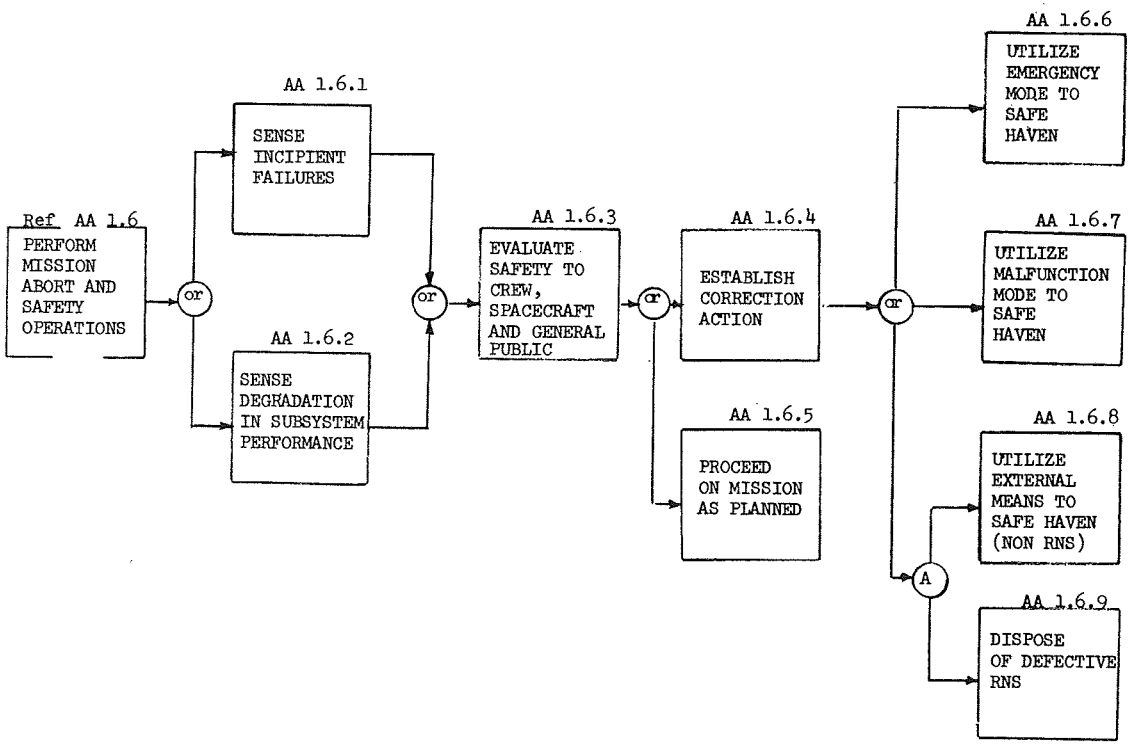
FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM RNS TURNAROUND ACTIVITIES AA 1.5	2. Subsystem Requirements a. Structure subsystem same as for Function AA 1.1M. b. Propulsion subsystem ° Provide the functional subsystems to support on orbit refueling. Included are the provisions for positive acceleration flow level control, etc. c. Astrionics Subsystem ° Provide the data management capability to support post flight checkout and propellant refueling operations. ° Provide attitude stabilization and control for the RNS having a varying weight history reflecting a zero and full propellant load. D. Effectiveness Requirements 1. Reliability a. Post flight checkout shall assure identification of a faulty module with a success probability of not less than .99. b. At the completion of the turnaround activities the RNS shall have a mission success probability of not less than .9750 for the ensuing mission. 2. Safety a. Total radiation dose for RNS maintenance personnel will not exceed 25 Rem per year.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM RNS TURNAROUND ACTIVITIES AA 1.5	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 3
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM RNS TURNAROUND ACTIVITIES AA 1.5	b. Total integrated radiation dose from the RNS to any manned orbital support system will not exceed 25 Rem per year.	NASA G&C			
	3. Maintainability				
	a. In orbit maintenance shall be restricted to module replacement level.				Evaluate Alternate maintenance levels
	b. Only the CCM shall require routine maintenance, maintenance on other modules shall be on a need basis.				Evaluate logistics for return of propellant modules to earth
	E. Interface Requirements				
	1. System Level				
	a. Propellant resupply for the RNS shall be by way of integral source shuttle tanker, as a result functional subsystems shall be required to manage the propellant transfer and control the orbiting configuration.	First period trade study			

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM RNS TURNAROUND ACTIVITIES AA 1.5	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 3 of 3 REV & DATE _____ VERIFIED _____	



	FUNCTIONAL DIAGRAM TITLE AND NUMBER			FUNCTIONAL FLOW BLOCK DIAGRAM	
	PERFORM MISSION ABORT AND SAFETY OPERATIONS AA 1.6			CONTRACTOR	
PRE-IIC	REV & DATE _____	ORIG DATE _____	APPROVAL _____	DOC NO. _____	PG _____
IIC	REV & DATE _____	ORIG DATE _____	VERIFIED _____	DOC NO. _____	PG _____
SLI	REV & DATE _____	ORIG DATE _____	VERIFIED _____	DOC NO. _____	PG _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM MISSION ABORT AND SAFETY OPERATIONS AA 1.6	A. Functional Description The objective of this function is to provide the means to protect the spacecraft, personnel and general public in the advent of an RNS failure, at any time throughout the mission profile. B. Design Characteristics/Constraints 1. No single failure or credible multiple failures in the RNS shall cause either the direct death of the crew or general public, nor the inability of the crew to reach a safe haven with internal or reasonable external means. 2. Provision shall be made to accommodate the following classes of failure: a. Failures which do not require an abort or significant alteration of the normal mission plan and do not result in the addition of single failure points to the system. b. Failures which allow the stage to continue at normal rated conditions; do not require an immediate abort but do introduce additional single future points to the system. 1. Failures that do not require any action to continue and complete the mission. 2. Failures that require some action to allow continued normal operation but completion of the mission is allowed. 3. Failures that allow normal operation but at a penalty to consumables thereby creating a situation where mission completion	NASA Guidelines and Constraints Document			

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM MISSION ABORT AND SAFETY OPERATIONS AA 1.6	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 3
REV & DATE _____ VERIFIED _____

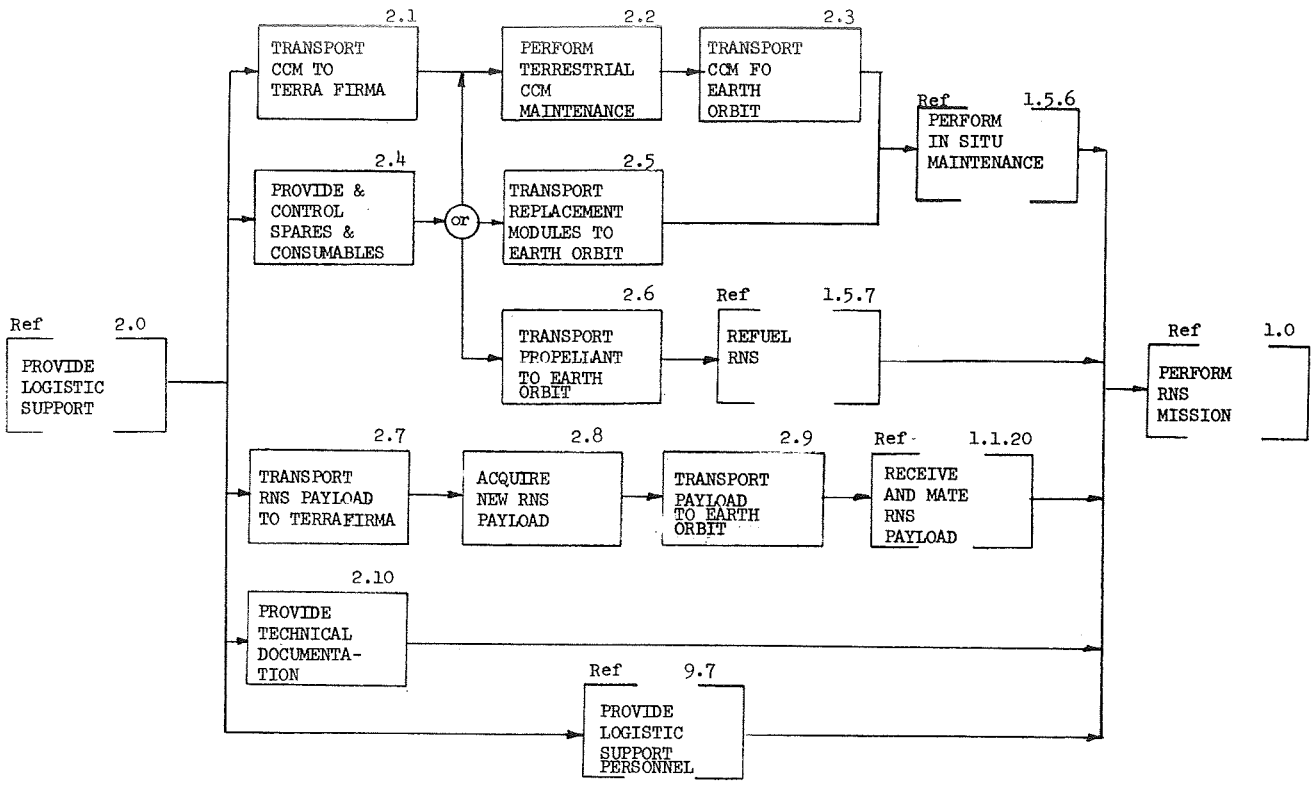
FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM MISSION ABORT AND SAFETY OPERATIONS AA 1.6	may not be possible. c. Failures that result in the loss of ability to achieve or maintain normal conditions but will allow operation at a reduced level. d. Failures that result in a prompt loss of RNS control or thrust capability, or prompt destruction of the RNS. 1. Failures which result in loss of control of the flight path. 2. Failures that result in complete loss of engine operation except cooldown. 3. Failures that result in complete loss of engine operation including cooldown. 4. Failures that result in prompt destruction of the RNS. e. Failures that result in inability to perform earth orbit or lunar orbit operations. 3. To the degree possible functional subsystems shall be designed to fail safe. 4. Provisions will be made for engine operation in an emergency mode for a single cycle yielding the following: Sustained thrust - 30,000 lbs Specific Impulse - 500 sec Total Impulse - 10^8 lb-sec 5. Provisions will be made for engine operation in a malfunction mode resulting from failure in one of the legs in the engine's propellant feed system.	Baseline NERVA Reference Data Sept 1970 NERVA Reference Data Sept 1970			

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM MISSION ABORT AND SAFETY OPERATIONS AA 1.6	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 3
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM MISSION ABORT AND SAFETY OPERATIONS AA 1.6	The resultant thrust shall be at least 80% of rated value with specific impulse at rated value. Engine flight operations shall be normal. 6. Functional subsystems and software shall be provided to sense incipient failures and degradation in subsystem performance the result of which may endanger the crew, spacecraft, or general public and/or compromise mission success. D. Effectiveness Requirements 1. Reliability a. Provisions shall be made for corrective actions that will assure a crew survival probability of not less than .999 at any phase of the mission. E. Interface Requirements 1. Provisions shall be made for external control of the RNS to affect abort				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM MISSION ABORT AND SAFETY OPERATIONS AA 1.6	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 3 of 3 REV & DATE _____ VERIFIED _____	



	FUNCTIONAL DIAGRAM TITLE AND NUMBER			FUNCTIONAL FLOW BLOCK DIAGRAM	
	PROVIDE LOGISTIC SUPPORT 2.0			CONTRACTOR	
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PROVIDE LOGISTIC SUPPORT 2.0	A. Functional Description The objective of this function is to define the composite of elements necessary to assure the effective and economical support of the RNS system or equipment at all levels of maintenance for its programmed life cycle. B. Design Characteristics/Constraints 1. In situ maintenance of the RNS shall be restricted to replacement of complete modules; e.g., propellant module, command and control module, propulsion module. 2. Terrestrial logistics of RNS modules shall reflect 100 percent replacement maintenance capability. 3. Replenishment of LH_2 propelllant shall be via direct transfer from space shuttle. 4. No EVA shall be required to support in situ maintenance. Disassembly and replacement of modules shall be automated. 5. Control and management of logistic support operations will be organizationally and geographically centralized for RNS support during pre-launch, mission and post flight operations. 6. Provide operating and maintenance instructions/procedures for both in situ and terrestrial environments. These documentations will be in handbook format so as to facilitate their updating. 7. Initial spares and supplies for the RNS shall be based on logistics analyses. Provisions will be maie to draw on them in response to maintenance demands.	Phase III Study result " " " " " "			

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PROVIDE LOGISTIC SUPPORT 2.0	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 3 REV & DATE _____ VERIFIED _____	

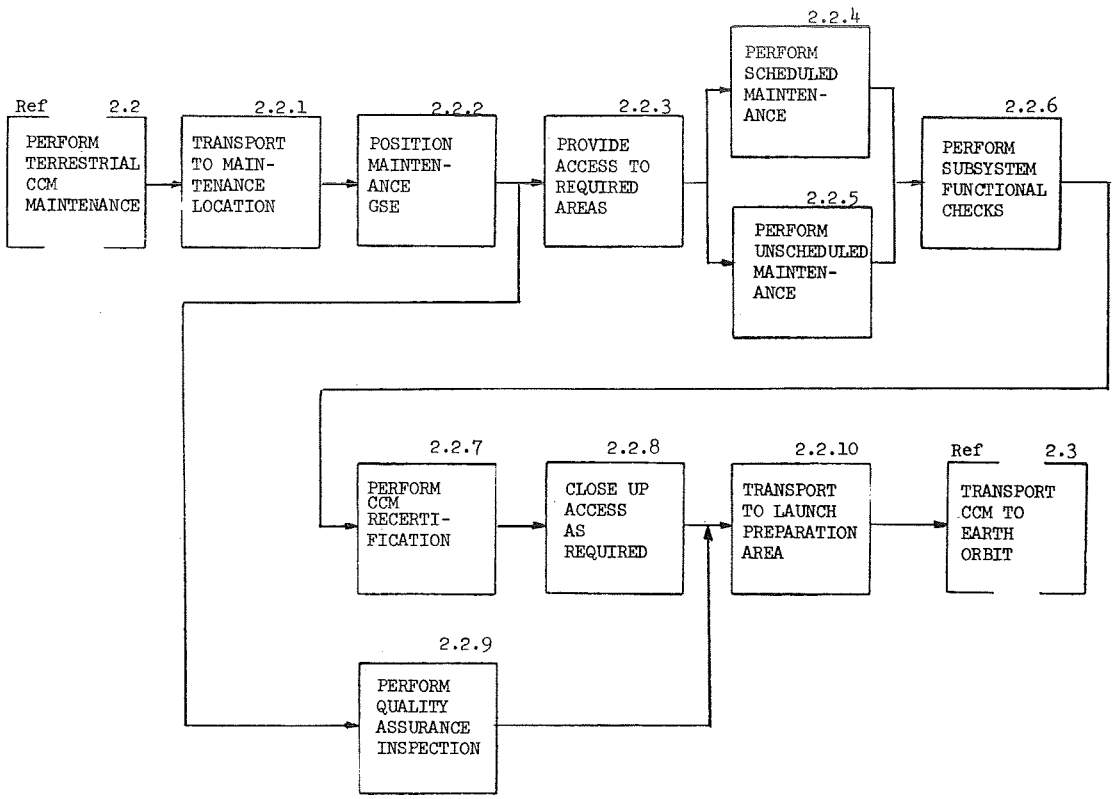
FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PROVIDE LOGISTIC SUPPORT 2.0	Replenishment of stock will be based on inventory control levels. 8. Provide for the management of spares and supply levels reflecting maintenance activities and pipeline constraints. Included are surveillance accountability and "on line" reporting of all assets, resupply planning to identify long term requirements for each resupply mission, and staging of resupply material. 9. Provide for packaging and transportation of spares and supply. Requirements for terrestrial shipments and storage shall be in accordance with TBD. Requirements for shipments to earth orbit shall assure survival during launch; and shall facilitate deployment in a weightless environment and in an automatic mode. 10. Provide configuration management support through identification of inventories and implementation of equipment changes during terrestrial maintenance. 11. Maintain a staff of qualified personnel at required locations to assure the availability of required skills to support the logistics operations. 12. Provide the capability to perform terrestrial maintenance on the CCM. Included are the functions of preventive maintenance, corrective maintenance, refurbishment and bench repair. D. Effectiveness The probability that the CCM downtime as a result of a subsystem or equipment				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PROVIDE LOGISTIC SUPPORT 2.0	CONTRACTOR

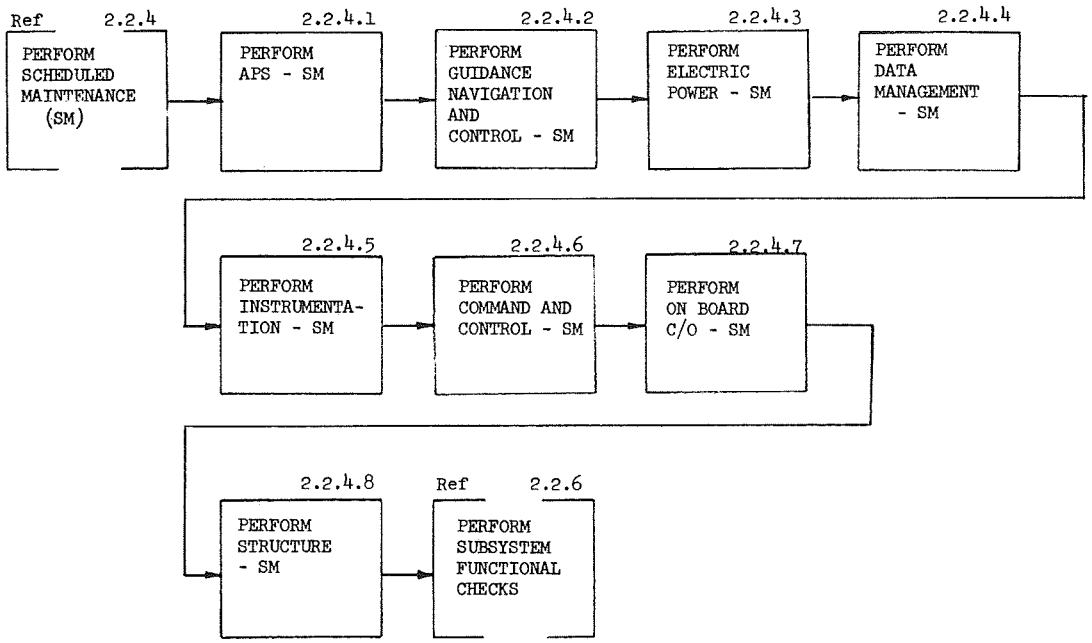
REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 3
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM LOGISTIC SUPPORT 2.0	failure will not exceed .05 percent of the allowable downtime for terrestrial maintenance. Sufficient CCM's shall be in the pipeline such that if one regularly scheduled resupply mission is missed, it will not jeopardize the scheduled operation of the RNS. E. Interfaces The logistics support function shall interface with the following: a. Manufacturing - production of spares and supply. b. Configuration Mgmt - identification of incorporated mod kits. c. Space shuttle - scheduling and packaging of spares and supply. d. RNS Operations - scheduling and packaging of spares and supply. Definition of allowable pipelines.				

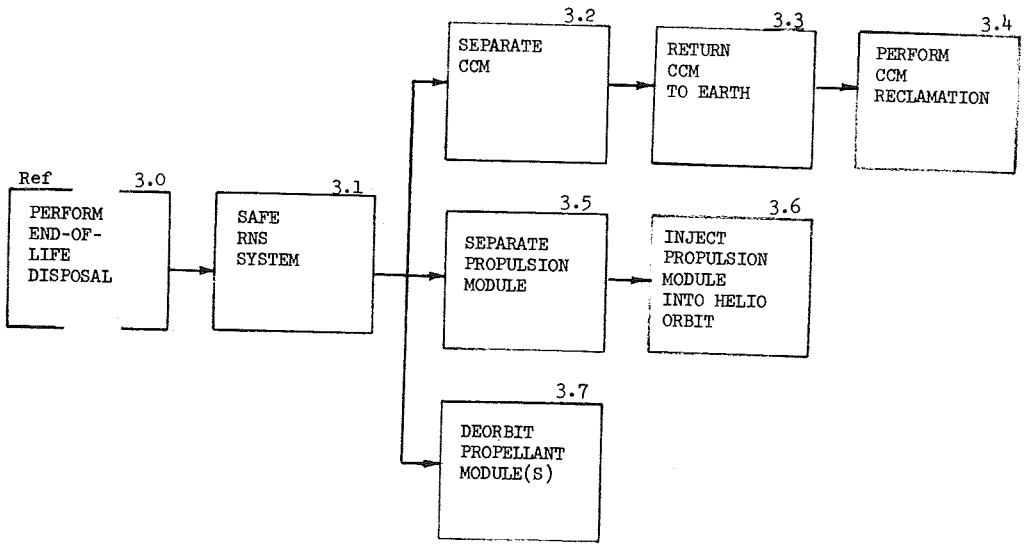
RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM LOGISTIC SUPPORT 2.0	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 3 of 3 REV & DATE _____ VERIFIED _____	



	FUNCTIONAL DIAGRAM TITLE AND NUMBER			FUNCTIONAL FLOW BLOCK DIAGRAM	
	PERFORM TERRESTRIAL CCM MAINTENANCE 2.2			CONTRACTOR	
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG



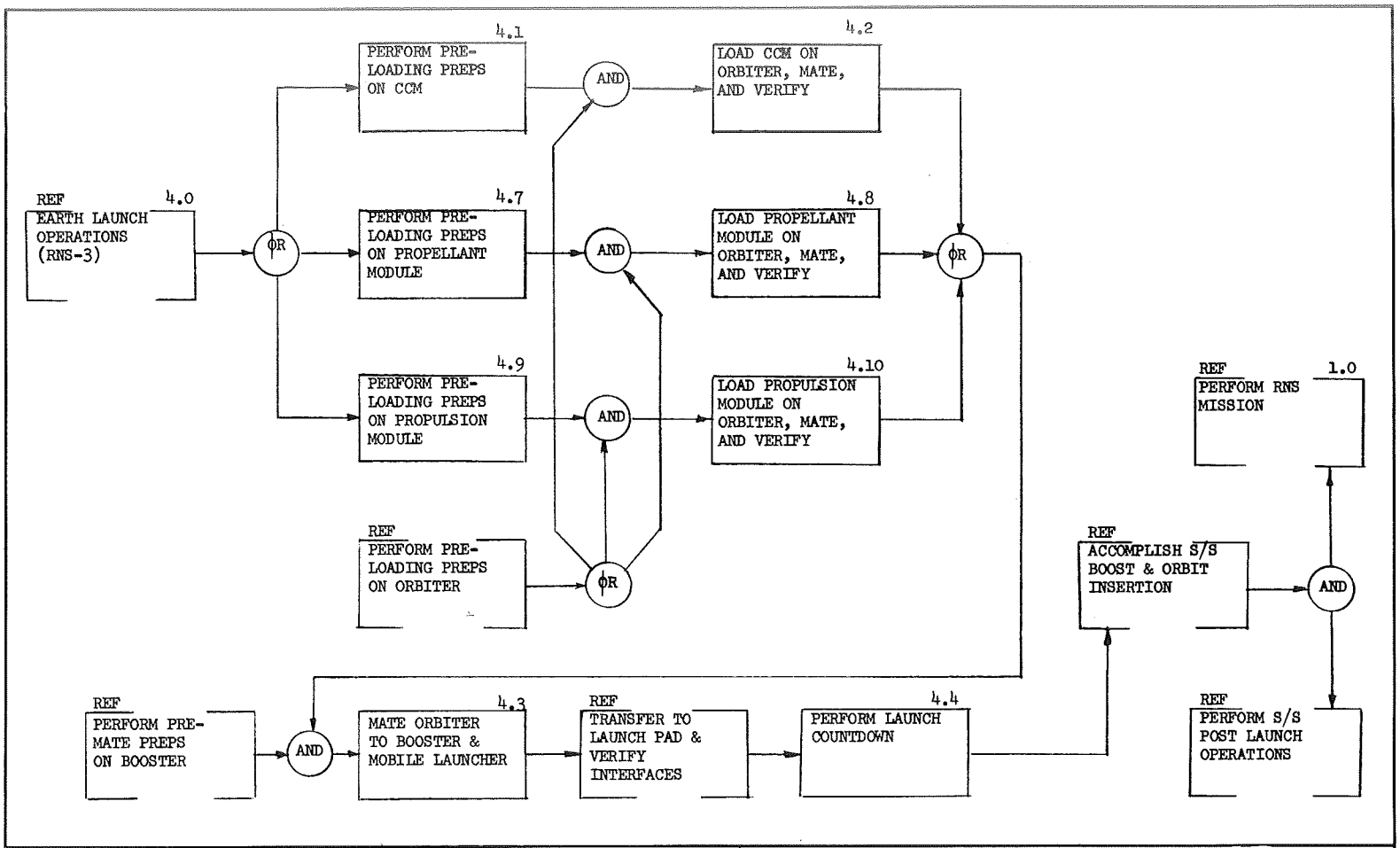
	FUNCTIONAL DIAGRAM TITLE AND NUMBER				FUNCTIONAL FLOW BLOCK DIAGRAM	
	PERFORM SCHEDULED MAINTENANCE 2.2.4				CONTRACTOR	
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL		DOC NO.	PG
IIC	REV & DATE	ORIG DATE	VERIFIED		DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED		DOC NO.	PG



	FUNCTIONAL DIAGRAM TITLE AND NUMBER			FUNCTIONAL FLOW BLOCK DIAGRAM	
	PERFORM END-OF-LIFE DISPOSAL 3.0			CONTRACTOR	
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM END-OF-LIFE DISPOSAL 3.0	A. Functional Description Provide the means for fractional and integral disposal of the RNS system subsequent to its completion of the 10^{th} cycle of operations. (Disposal requirements resulting from abort are discussed separately in Reference 1.6). B. Design Characteristics/Constraints 1. Provide the means to inject the propulsion module into a heliocentric orbit. 2. Provide the means for a one way unmanned payload trip to a heliocentric orbit. 3. Provide for return of CCM to earth for possible salvage and/or refurbishment. 4. Disposal of propellant modules(s) shall be passive (i.e. via natural orbit decay). 5. End of life disposal shall be initiated from the nominal earth operations orbit. D. Effectiveness Requirements 1. Reliability The probability of a safe disposal of the propulsion module shall be at least .995. 2. Safety a. Disposal of the propulsion module shall be performed so as to preclude exposure to the general public. b. Engine integrity during disposal shall be assured.	MDAC Phase II study MDAC Ground-rule MDAC Ground-rule MDAC Ground-rule			Evaluate integral disposal of RNS Evaluate use of disposal for operational mission Evaluate self disposal vs use of external source Evaluate rqmts for positive de-orbit into controlled area. For RNS-3 include return via space shuttle Evaluate alternate disposal locations

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM END-OF-LIFE DISPOSAL 3.0	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 1 REV & DATE _____ _____ VERIFIED _____	



	FUNCTIONAL DIAGRAM TITLE AND NUMBER			FUNCTIONAL FLOW BLOCK DIAGRAM	
	4.0 EARTH LAUNCH OPERATIONS, RNS-3, FIRST LEVEL			CONTRACTOR	
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM RNS-3 EARTH LAUNCH OPERATIONS 4.0	A. Functional Description The Class 3 RNS will be received at Launch Complex 39 of KSC in modular form. Each module will be inspected, checked out, prepared for its intended function as appropriate, mated to its launch vehicle, and boosted to a 260 nmi 31.5° inclination circular orbit. B. Design Characteristics/Constraints 1. The Class 3 RNS is composed of: a. Eight propellant modules. Each module is 60 ft long by 15 ft in diameter and has a propellant capacity of 36,500 lb of LH_2. b. One propulsion module - This module is 59 ft long and 13.3 ft in diameter. It includes a 10,850 lb LH_2 run tank, the NERVA nuclear engine, an APS, and the associated electrical control equipment. c. One command & control module - It is 6 ft long and approximately 15 ft in diameter and contains all the astrionics functions, the auxiliary propulsion system, and the electric power system. 2. The Class 3 RNS modules will be launched to orbit by the space shuttle. 3. The space shuttle consists of the "orbiter" and the "booster" and will be as defined by the shuttle studies.	MDAC PHASE III STUDY NASA G&C NASA G&C			Component L.O., Shielding Operations Maintenance, Equipment Requirements

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM RNS-3 EARTH LAUNCH OPERATIONS 4.0	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 4
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM RNS-3 EARTH LAUNCH OPERATIONS 4.0	4. When launched to orbit, the RNS Class 3 propellant modules will contain approximately 27,000 lbm of LH_2.	Wt. Limitation			
	5. The propulsion module will contain no propellant when launched to orbit and it will be fully poisoned with poison wires.	Wt. Limitation MDAC G&C			
	6. The command & control module will be launched to orbit fully charged with APS propellant and electric power system reactant. Power will be brought "up" in orbit.				
	7. The individual modules of the Class 3 RNS will be received fully checked out. Their functional interfaces with the orbiter and their contiguous modules in orbit will be verified as correct at the manufacturers through master fixtures.	MDAC G&C			
	8. Checkout of the Class 3 RNS propulsion module at KSC will be limited to receiving inspection, and verification of their interfaces' proper installation into the space shuttle orbiter.				
	9. Modules of the Class 3 RNS will be monitored by the shuttle orbiter after installation of the module into the orbiter with relay capability to mission control.				
	10. The modules will be passive during boost to orbit except for monitoring required by safety, venting, and pressurization.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM RNS-3 EARTH LAUNCH OPERATIONS 4.0	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 4

REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM RNS-3 EARTH LAUNCH OPERATIONS 4.0 (Cont'd)	11. Subsystem checkout of the space shuttle orbiter will be completed prior to loading of r odule into the orbiter. 12. Environmental protection of the modules will be provided and maintained. External sources will be used. (Includes HPI purge). C. Effectiveness 1. Reliability (same as RNS 1H RAS) 2. Safety (same as RNS 1H RAS) D. Interfaces 1. RNS/Launch Vehicle a. The interfaces between the RNS Class III modules and the space shuttle launch vehicle will satisfy the following requirements: o Provide structural support and stability during launch. o Accommodate dimensional changes due to thermal expansion and contraction. o Provide propellant and reactants load capability to modules from ground umbilicals.	MDAC G&C			

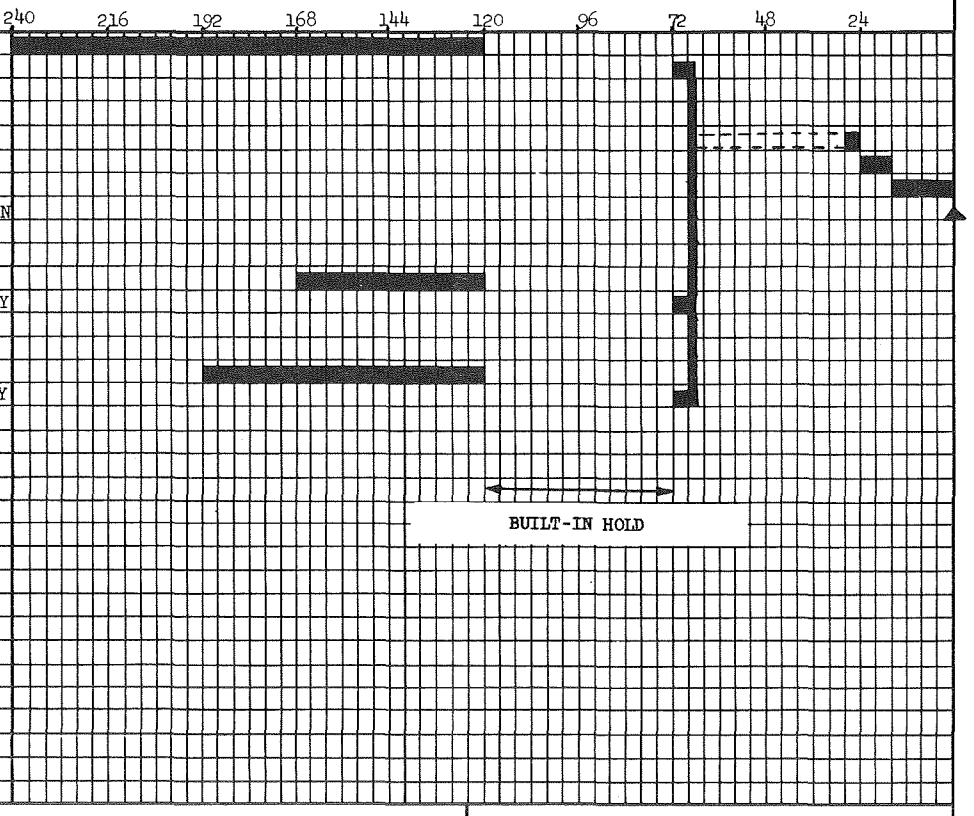
RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM RNS-3 EARTH LAUNCH OPERATIONS 4.0	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 3 of 4 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM RNS-3 EARTH LAUNCH OPERATIONS 4.0 (Cont'd)	o Provide payload status monitoring capability to shuttle crew and to mission control, and provide for receipt and relay of ground signals to the payload. o Provide the necessary environmental control for the module in the cargo bay.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM RNS-3 EARTH LAUNCH OPERATIONS 4.0	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 4 of 4 REV & DATE _____ VERIFIED _____	

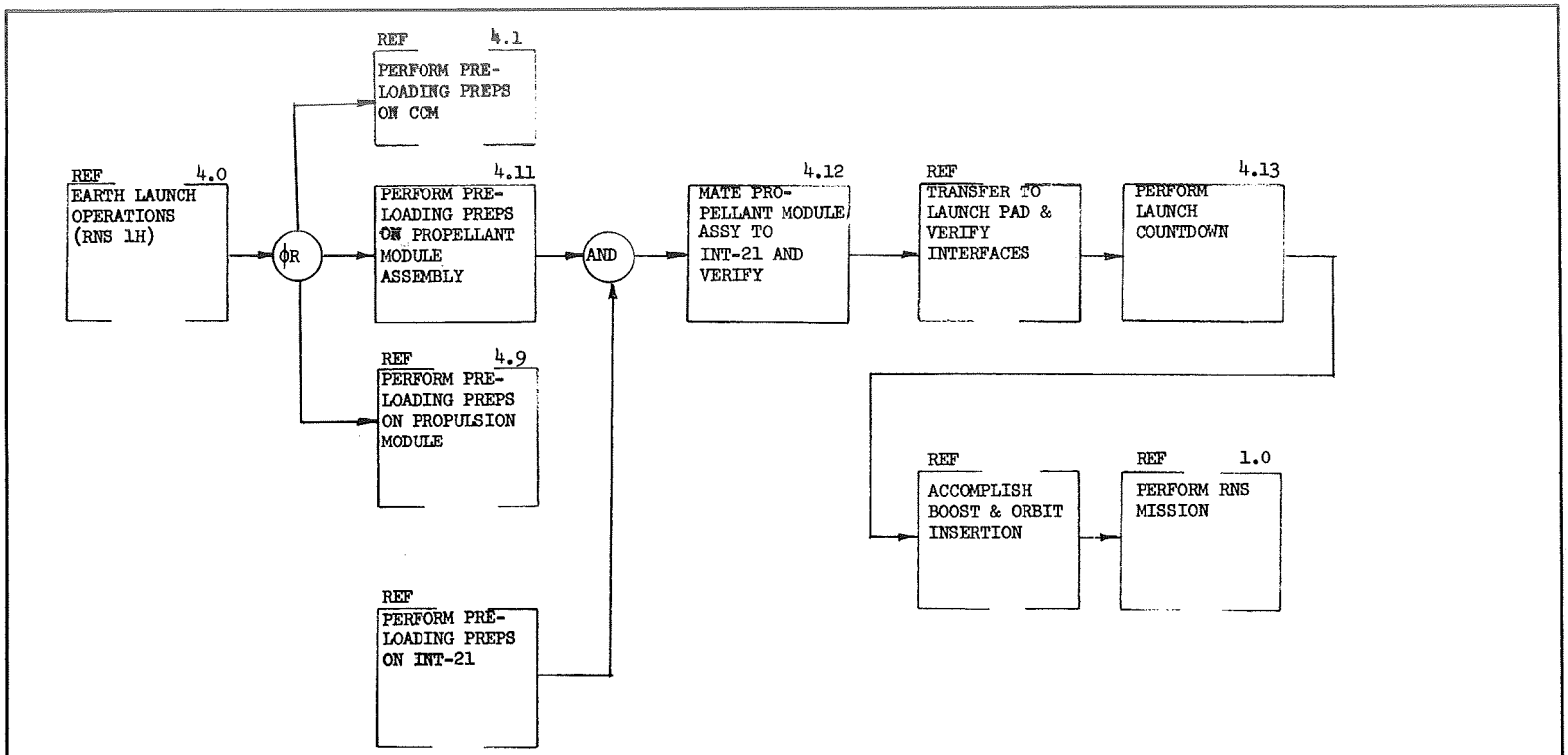
FUNCTION	LOCATION	TYPE OF MAINTENANCE (IF APPLICABLE)
PERFORM EARTH LAUNCH OPERATIONS - 1st LEVEL CLASS 3 RNS	KENNEDY SPACE CENTER	

SOURCE OF FUNCTION	FUNCTION & CORRESPONDING TASKS (IF APPLICABLE)
4.1	PERFORM PRELOADING PREPARATIONS ON CCM
4.2	LOAD CCM ON ORBITER, MATE, & VERIFY
4.3	MATE ORBITER TO BOOSTER & PERFORM SYSTEM TESTS
(REF)	TRANSFER TO PAD & VERIFY INTERFACES
4.4	PERFORM LAUNCH COUNTDOWN
(REF)	ACCOMPLISH SPACE SHUTTLE BOOST & ORBIT INSERTION
4.7	PERFORM PRELOADING PREPARATIONS ON PROPEL. MOD.
4.8	LOAD PROPELLANT MODULE ON ORBITER, MATE & VERIFY
4.9	PERFORM PRELOADING PREPARATIONS ON PROPUL. MOD.
4.10	LOAD PROPULSION MODULE ON ORBITER, MATE, & VERIFY



TIME LINE SHEET

PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG



	FUNCTIONAL DIAGRAM TITLE AND NUMBER	FUNCTIONAL FLOW BLOCK DIAGRAM
	4.0 EARTH LAUNCH OPERATIONS, RNS-1H, FIRST LEVEL	CONTRACTOR

PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.		PG
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.		PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.		PG

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM EARTH LAUNCH OPERATIONS (RNS-1H) 4.0	A. Functional Description The RNS-1H will be received at KSC, complex 39, in modular form, inspected, checked out, mated to its launch vehicles, and boosted into its earth operations orbit B. Design Characteristics/Constraints 1. The Class 1 hybrid reusable nuclear stage (RNS-1H) is composed of three modules: a. Propellant Module (PM) - 33 ft diameter, 100 ft long having a propellant capacity of 289,150 Klbs. b. Engine Module (EM) - 13.3 ft diameter, 59 ft long. It is composed of the NERVA nuclear engine and a run tank with associated supporting electrical equipment. c. Command and Control Module - 6 ft high, max. diameter of approx 22 ft. It houses the astrionics functions. 2. The RNS-1H will be launched in a fractional mode utilizing the INT-21 for the propellant module, and EOS for the engine module and Command and Control module. 3. The INT-21 Launch Vehicle (LV) shall consist of the SIC first stage, SII second stage, and a reconfigured 33 ft diameter IU stage. All stages are functionally similar to existing systems, and are defined in the Boeing Co. documents D5-15583 and 5-1085-INT-21-07 4. For initial deployment the propellant module will be filled with 92,000 lbs of LH_2	MDAC PHASE III STUDY NASA G&C MDAC PHASE III STUDY MDAC Ground Rule NASA, G&C Document PD-SA-P-70-63 5/28/60 INT-21 Pld Capability into earth operations orbit			Maintenance Shielding, Aft/dome Shielding, Operations, Component L.O. Evaluate Integral Launch

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM EARTH LAUNCH OPERATIONS (RNS-1H) - 4.0	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 4
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM EARTH LAUNCH OPERATIONS (RNS-1H) 4.0 (Cont'd)	5. The engine module will be devoid of propellants for launch within the EOS.	Wt. Limitation			
	6. Launch will be from KSC complex 39, either pad A or B.	NASA G&C			
	7. The physical and functional interfaces between the RNS-1H modules and their respective launch vehicles are as described in Section D.	"			
	8. The engine module launch shall be within one day after the insertion of the propellant module into orbit.	MDAC G&C			
	9. The individual RNS-1H modules shall be received at KSC fully checked out. Interfaces between RNS-1H elements will be functionally verified at the factory using master interface substitutes.	"			
	10. The onboard checkout system within the command module will be used as the basic test instrument for launch operations on the propellant module. Additional GSE will be furnished as required, e.g., power, special stimuli, etc.	"			
	11. Checkout of the RNS-1H engine modules at KSC will be restricted to receiving inspection and verification of proper installation into the EOS orbiter.	"			
	12. The individual RNS-1H modules will be passive during the boost function with the exception of a monitoring and control capability for RNS-1H system safety, e.g., venting and pressurization.	"			
	13. All INT-21 launch vehicle assembly and checkout operations will be performed with existing equipment and procedures. However, some modifications will be required to accommodate a new IU configuration.	NASA G&C			
	14. EOS launch vehicle assembly and checkout TBD.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM EARTH LAUNCH OPERATIONS (RNS-1H) - 4.0	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 4 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM EARTH LAUNCH OPERATIONS (RNS-1H) 4.0 (Cont'd)	15. The INT-21 Launch Vehicle will have successfully passed the integrated launch vehicle test prior to the mating of the RNS-1H propellant module.	MDAC G&C			
	16. The EOS orbiter will have accomplished subsystem checkout prior to loading of the RNH-1H engine module and command and control module.	"			
	17. Existing Complex 39 facilities shall be used to the maximum degree feasible. Included are the Mobile Launcher, VAB, Launch Pad, and Launch Control Center; the Mobile Service Structure will be excluded.	"			
	18. During launch checkout operations environmental control will be provided by external sources.	"			
	D. Effectiveness 1. Reliability a. Assembly, C/O, and launch of the RNS-1H propellant module via INT-21 shall be performed within TBD days with a probability of .90. b. Assembly, C/O, and launch of the RNS-1H engine module and command and control module via EOS shall be performed within TBD days with a probability of .90. c. The reliability goal of successful injection of the modules into a 260 nmi, 31.5 deg orbit shall be 0.895 for the propellant module and TBD for the engine module.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM EARTH LAUNCH OPERATIONS (RNS-1H) - 4.0	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 3 of 4 REV & DATE _____ VERIFIED _____	

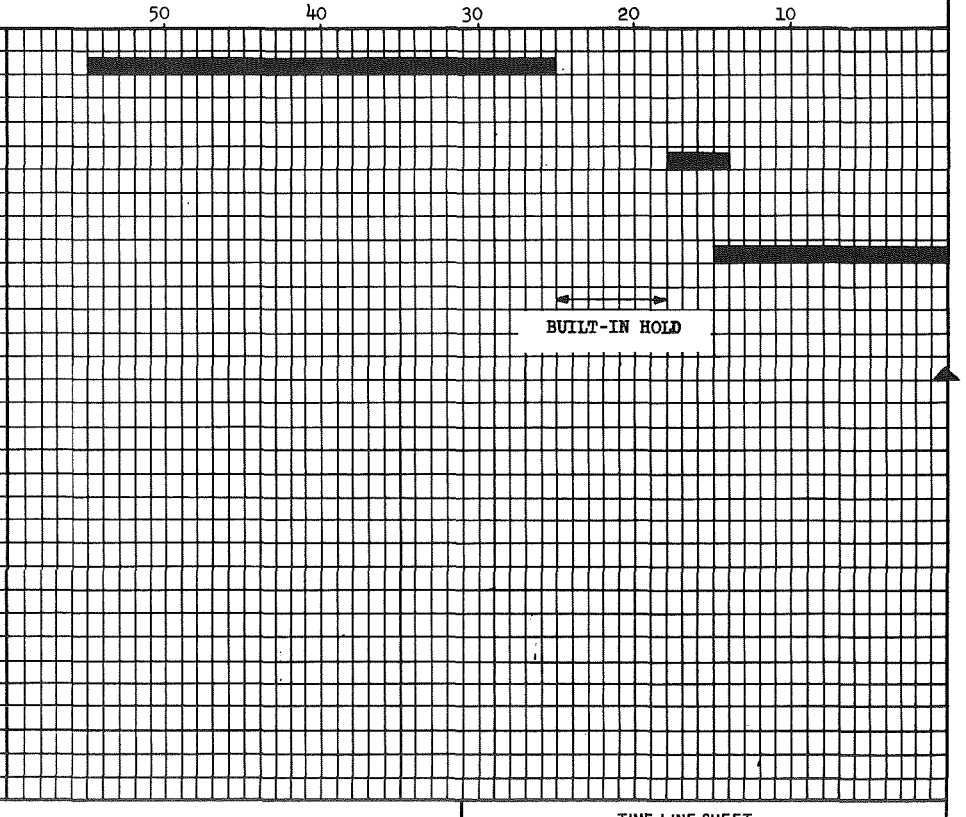
FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM EARTH LAUNCH OPERATIONS (RNS-1H) 4.0 (Cont'd)	2. Safety a. In the event of a nearby explosion of a facility or launch vehicle the flight vehicle shall withstand a peak overpressure of 0.4 psi. b. The engine module shall be so configured as not to compromise the safety of the EOS. c. A capability for performing a criticality monitoring function on the NERVA during the launch operations shall be provided. D. Interfaces 1. The interfaces between the RNS-1H modules and their respective launch vehicles will include the following requirements: o Provide structural support of the modules during launch - INT-21 for Propellant Module Space Shuttle for Engine Module. o Provide access capability to the Engine Module while installed in the cargo bay of the Space Shuttle orbiter. o Provide capability for transmission of payload status information to mission control and for receipt and relay of ground signals to the payload - INT - 21 for Propellant Module, Space Shuttle for Engine Module.	MDAC G&C " "			

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM EARTH LAUNCH OPERATIONS (RNS-1H) - 4.0	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 4 of 4
REV & DATE _____ VERIFIED _____

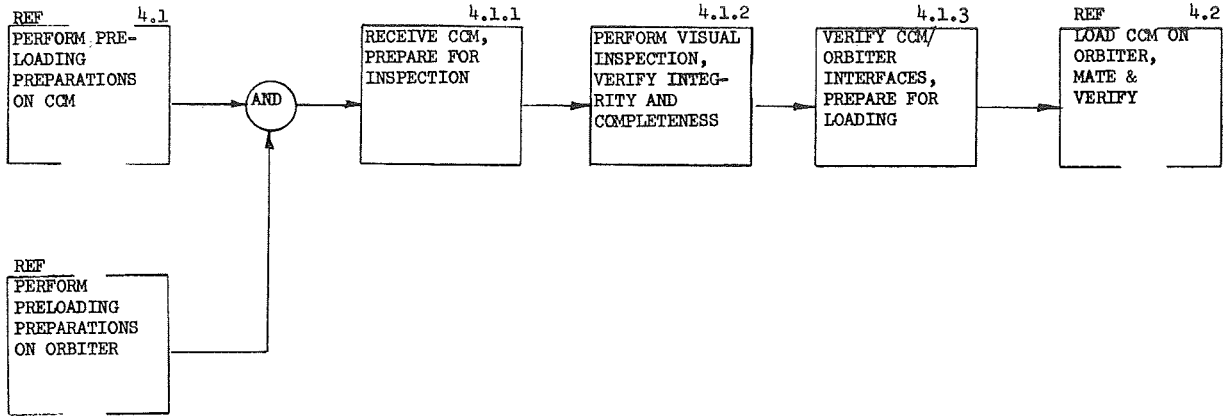
FUNCTION	LOCATION	TYPE OF MAINTENANCE (IF APPLICABLE)
PERFORM EARTH LAUNCH OPERATIONS - FIRST LEVEL, RNS-1H	KENNEDY SPACE CENTER	

SOURCE OF FUNCTION	FUNCTION & CORRESPONDING TASKS (IF APPLICABLE)	TIME - WORKING DAYS BEFORE LAUNCH
4.11	PERFORM PRELOADING PREPS ON PROPELLANT MODULE ASSEMBLY	
4.12	MATE PROPELLANT MODULE ASSEMBLY TO INT-21 LAUNCH VEHICLE & VERIFY	
4.13	PERFORM LAUNCH COUNTDOWN	
(REF)	ACCOMPLISH BOOST & ORBITAL INSERTION	



TIME LINE SHEET

PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG



	FUNCTIONAL DIAGRAM TITLE AND NUMBER			FUNCTIONAL FLOW BLOCK DIAGRAM	
	PERFORM PRELOADING PREPARATIONS ON CCM - 4.1			CONTRACTOR	
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM PRELOADING PREPARATIONS ON COMMAND AND CONTROL MODULE 4.1	A. Functional Description The command and control module will be received. It will be inspected, tested, checked out, and prepared for its mate to the Space Shuttle Orbiter. B. Design Characteristics/Constraints 1. The command and control module consists of the electric power system, auxiliary propulsion system, and astrionics system for the RNS. 2. The CCM will interface with the orbiter so that it accommodates the launch loads imparted to it and provides status information to the orbiter during countdown, boost, and orbital deployment. 3. The CCM will be received at the KSC in a fully checkout condition from the manufacturer. It will be received in a hermetic container that is coupled to monitoring instrumentation which maintains a record of the environmental stresses to which the CCM is subject prior to arrival at KSC. 4. The CCM will accommodate the orbiter/mobile launcher umbilical interfaces for loading of APS propellant and charging of the EPS reactants on the launch pad during countdown. C. Effectiveness 1. Reliability - The probability of a successful inspection, test and checkout shall be greater than 0.99 2. Safety N/A			o CCM instrumentation kit, Environmental. o CCM instrumentation trailer, Environmental. o Umbilical kit	

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM PRELOADING PREPARATIONS ON COMMAND AND CONTROL MODULE 4.1	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 2 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM PRELOADING PREPARATIONS ON COMMAND AND CONTROL MODULE 4.1 (cont'd)	D. Interfaces 1. CCM/Receiving - Facility a. The CCM and the launch facility will satisfy the following requirements: o Provide an environmentally controlled area that will accommodate the receiving and unloading of the CCM. o Provide the capabilities necessary to accomplish the visual inspection of the CCM, its verification as to integrity, and the completeness of the received shipment with respect to the requirements of the launch. o Provide capability to verify the conformity of the interface structure of the CCM with the interface structure of the orbiter			o Access kit o Orbiter subsitute (50% of DSV-48-267) o CCM Instrumentation checkout unit (100% of 279) o Interface test fixtures CCM/orbiter CCM/ML	

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM PRELOADING PREPARATIONS ON COMMAND AND CONTROL MODULE 4.1	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 2 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
RECEIVE CCM PREPARE FOR INSPECTION 4.1.1	A. Functional Description The command and control module be received and its protective covers removed. It will be installed on an inspection fixture, access kits and test sets installed. B. Design Characteristics/Constraints 1. The CCM will be received at the Low Bay of the VAB, unloaded from its transporter, and installed in a Low Bay Cell for receiving inspection. 2. The handling equipment and inspection fixtures will accommodate the CCM together with the necessary protective devices, and not subject it to undue loads or environmental stress. C. Effectiveness 1. Reliability N/A 2. Safety N/A D. Interfaces 1. The CCM will interface with the receiving inspection handling equipment and inspection fixture. These equipment and fixtures will satisfy the following requirements:	PHASE III BASELINE		o Environmental Protection cover kit (25% of 304) o Handling kit, CCM (25% of 302) o Cradles kit, CCM (25% of 301) o Hoist kit, CCM (35% of 303) o Special tool kit, CCM (50% of 305) o Pneumatic Console (100% of 436)	

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	RECEIVE CCM, PREPARE FOR INSPECTION 4.1.1	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 2 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
RECEIVE CCM PREPARE FOR INSPECTION 4.1.1 (cont'd)	a. Attach to and remove the CCM from its transporter so that the CCM is protected from any degradation of its launch ready condition. b. The environmental protection covers used during shipment will be removed safely. c. The CCM will be installed in its receiving inspection fixture so it can be inspected visually, and its integrity and completeness verified.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	RECEIVE CCM, PREPARE FOR INSPECTION 4.1.1	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 2 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM VISUAL INSPECTION, VERIFY INTEGRITY & COMPLETENESS 4.1.2	A. Functional Description The CCM will receive a walk around inspection and be checked for completeness. Its monitoring systems used during shipment and their records will be removed and checked. B. Design Characteristics and Constraints 1. The inspection fixture will support the CCM safely and without damage. It will support the CCM in a position that provides maximum convenience in facilitating inspection. And it will provide access as necessary to personnel and checkout equipment in order that all inspection functions may be completed. 2. The monitoring equipment, its sensors and recorders will have convenient check points to facilitate verification that it is functioning properly and has properly recorded the status of the CCM during shipment. 3. The sensing devices attached to the CCM will be removable without imposing any compromise on the functional integrity of the CCM. C. Effectiveness 1. Reliability The probability of a successful inspection shall be 0.999. 2. Safety N/A	PHASE III BASELINE			

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM VISUAL INSPECTION, VERIFY INTEGRITY & COMPLETENESS 4.1.2	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 2 REV & DATE _____ VERIFIED _____	

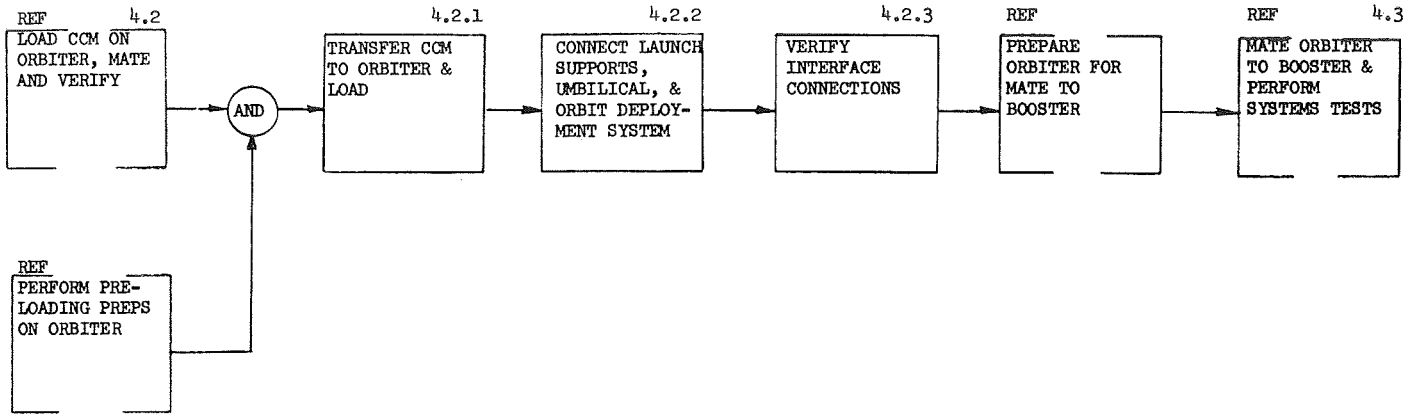
FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM VISUAL INSPECTION, VERIFY INTEGRITY & COMPLETENESS 4.1.2 (Cont'd)	D. Interfaces 1. The CCM monitoring equipment will interface with the crew and the CCM. a. It will be removable while the CCM is installed in the inspection fixture. b. The parameters measured and their records will be accessible to the crew. c. The sensors used by the monitoring equipment will be removable if appropriate. Otherwise, they will be designed to remain in place without compromising the integrity of the CCM.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM VISUAL INSPECTION, VERIFY INTEGRITY & COMPLETENESS 4.1.2	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 2
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
VERIFY CCM/ ORBITER INTERFACE, PREPARE FOR LOADING 4.1.3	A. Functional Description The interfaces of the CCM/orbiter will be verified to be ready for loading. B. Design Characteristics/Constraints 1. The CCM will mate to the Orbiter/CCM verification fixture. Their mechanical and electrical interface will be verified. 2. The CCM will mate to the orbital dock & mate verification fixture. Configuration control will be maintained to guarantee that the dock & mate characteristics of the CCM conform to its orbital assembly requirements. 3. The CCM and its interfaces with the transfer dolly and handling kits will be verified as necessary to assure safe transfer to the loading area. C. Effectiveness 1. Reliability The probability of a successful mating shall be greater than 0.999. 2. Safety N/A D. Interfaces 1. The interface of the CCM with its orbiter/CCM interface verification fixture will not degrade the flight readiness of the CCM. 2. The interface of the CCM with its dock & mate verification fixture will satisfy its functions in a manner that will not degrade the flight readiness of the CCM.			o CCM/orbiter interface verification fixture (new) o Orbiter/CCM interface verification fixture (new) o CCM/orbiter umbilical kit (50% of 314) o CCM substitute, orbiter (100% of 268) o Orbiter substitute CCM (100% of 268)	

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	VERIFY CCM/ORBITER INTERFACE, PREPARE FOR LOADING 4.1.3	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 1 REV & DATE _____ VERIFIED _____	



	FUNCTIONAL DIAGRAM TITLE AND NUMBER			FUNCTIONAL FLOW BLOCK DIAGRAM	
	LOAD CCM ON ORBITER MATE AND VERIFY - 4.2			CONTRACTOR	
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
LOAD CCM ON ORBITER, MATE, AND VERIFY 4.2	A. Functional Description The CCM will be transported to the space shuttle maintenance area. It will be loaded into the orbiter, mated, and interface connections verified. B. Design Characteristics/Constraints 1. The transportation dolly will be designed to remove the CCM to the shuttle maintenance area such that it does not comp romise the launch readiness of the CCM. 2. The CCM/orbiter interface will accommodate the umbilical connections required and the loads imparted during boost to orbit. 3. Data from the CCM will be provided to the orbiter on its status. C. Effectiveness 1. Reliability The probability that the loading operation is successful shall be greater than 0.99. 2. Safety N/A D. Interfaces The CCM VAB transportation dolly will maintain environmental control as necessary to assure CCM arrival at the orbiter in a mate-ready condition. The CCM/orbiter interfaces will provide structural support and stability during prelaunch and launch operations that safely accommodate the loads imposed. It will			o CCM/VAB Transportation dolly o CCM/orbiter alignment kit (200% of 339) o CCM/orbiter installation sling	

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	LOAD CCM ON ORBITER, MATE, AND VERIFY 4.2	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 2 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
LOAD CCM ON ORBITER, MATE, AND VERIFY 4.2 (cont'd)	provide access for mobile launcher umbilicals and the CCM to provide for: o Load of APS propellant o Load of EPS reactants o Verification of launch-ready condition during countdown. The interface will also provide deployment and recovery capability for the CCM in orbit.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	LOAD CCM ON ORBITER, MATE, AND VERIFY 4.2	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 2

REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
TRANSFER CCM TO ORBITER 4.2.1	A. Functional Description The CCM will be transported to the space shuttle maintenance area by a transport dolly. An installation sling will be attached which will facilitate orbiter loading. The CCM will be lowered into the orbiter cargo compartment. B. Design Characteristics/Constraints 1. The handling and installation sling used will provide support and protection to the CCM during movement to and loading into the orbiter. C. Effectiveness 1. Reliability N/A 2. Safety N/A D. Interfaces The CCM will interface with the transport dolly and installation sling. They will accommodate attachment to the CCM. The CCM will have hard points appropriately located to accommodate them. Protective devices, as necessary, will be used to preclude damage to the CCM during the loading sequence.			o CCM/orbiter installation protection kit	

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	TRANSFER CCM TO ORBITER 4.2.1	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 1 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
CONNECT UMBILICALS, LAUNCH SUPPORTS, & ORBIT DEPLOYMENT SYSTEM 4.2.2	A. Functional Description The orbiter/CCM interconnect umbilicals will be attached and verified, the structural supports for launch loads and stability will be attached, and the deployment system to be used in orbit will be attached and verified. B. Design Characteristics/Constraints 1. The orbiter/CCM interconnect umbilicals will be attached to the CCM after it has been loaded into the orbiter. They will supply the following functions between the module and the orbiter and/or mission control: a. Status data on the CCM b. Command signals from the orbiter and/or mission control. c. Vent and relief as required during countdown, ascent, and orbit. 2. The orbital deployment system will be attached and verified. It will be designed to supply the following functions: a. Absorb loads from CCM movement after orbit is reached and the launch structural attach points have been released. b. Move the CCM out of the cargo compartment into the deployed position.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	CONNECT UMBILICALS, LAUNCH SUPPORTS & ORBIT DEPLOYMENT SYSTEM 4.2.2	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 2 REV & DATE _____ VERIFIED _____	

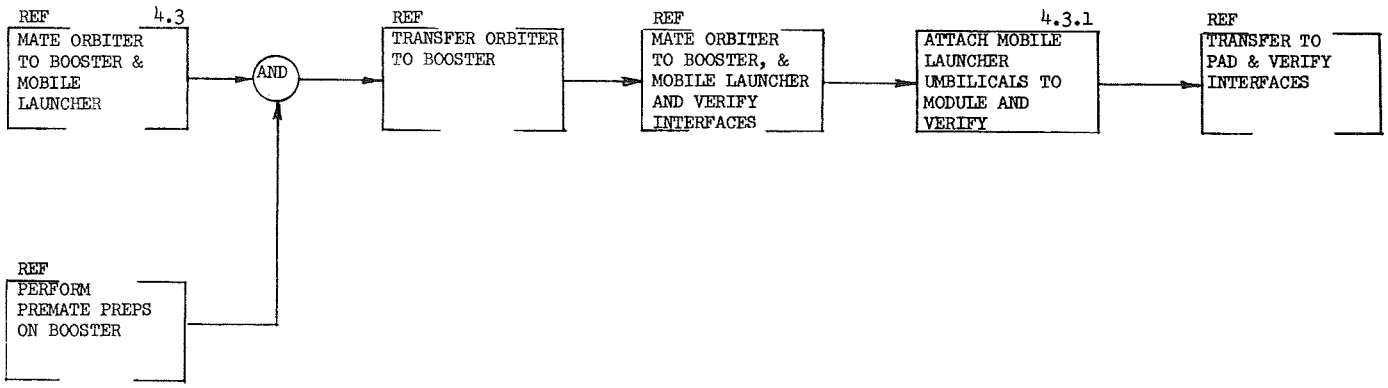
FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
CONNECT UMBILICALS, LAUNCH SUPPORTS, & ORBIT DEPLOYMENT SYSTEM 4.2.2 (Cont'd)	3. The structural supports for the CCM will be attached and verified. They will supply the following functions: a. Absorb the launch loads and stability requirements. b. Automatically release for orbital deployment. c. Have manual back-up release capability. C. Effectiveness 1. Reliability N/A 2. Safety N/A D. Interfaces The CCM/orbiter will interface at the structural attach points and umbilical interconnect. The orbiter must supply a hatch that will provide access to the CCM by the ground umbilicals of the mobile launcher.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	CONNECT UMBILICALS, LAUNCH SUPPORTS & ORBIT DEPLOYMENT SYSTEM 4.2.2	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 2 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
VERIFY INTERFACE CONNECTIONS 4.2.3	A. Functional Description The interfaces established between the orbiter and the CCM will be verified. B. Design Characteristics/Constraints 1. The CCM/orbiter interfaces will be designed for automatic checkout. 2. The automatic checkout functions will supply data necessary to verify the mate status of the CCM/orbiter assembly. C. Effectiveness 1. Reliability - The probability that the checkout operation is successful shall be greater than 0.99. 2. Safety TBD D. Interfaces The data system used to verify the CCM/orbiter structural and electrical connection will interface with the automatic check-out system for the orbiter and its payload.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	VERIFY INTERFACE CONNECTIONS 4.2.3	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 1
REV & DATE _____ VERIFIED _____



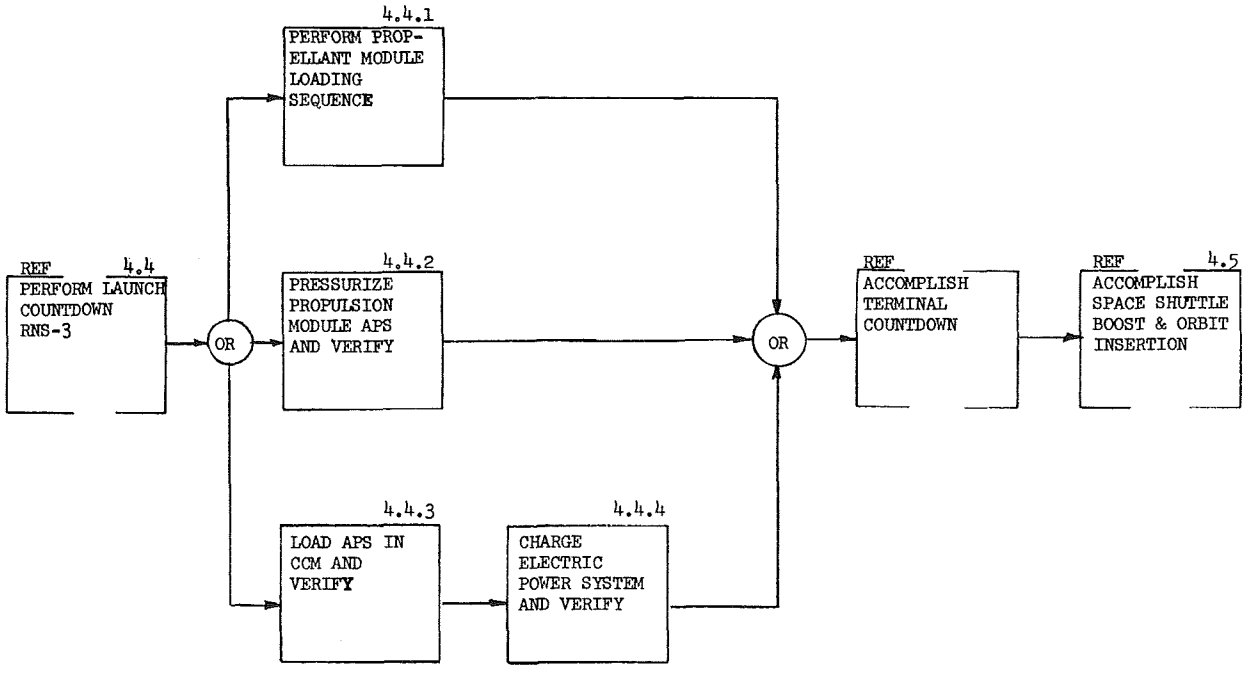
	FUNCTIONAL DIAGRAM TITLE AND NUMBER	FUNCTIONAL FLOW BLOCK DIAGRAM
	MATE ORBITER TO BOOSTER AND MOBILE LAUNCHER - 4.3	CONTRACTOR

PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG	
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG	
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
ATTACH MOBILE LAUNCHER UMBILICALS TO MODULE AND VERIFY 4.3.1	A. Functional Description The mobile launcher umbilicals required by the payload modules will be attached and their connections verified. B. Design Characteristics/Constraints The umbilical attachments will be made through the skin of the orbiter by way of an access hatch. At the time of umbilical attachment the capability of the mobile launcher umbilical to be remotely attached will be verified. Leak and electrical continuity checks will be made. C. Effectiveness 1. Reliability - The reattach capability of the mobile launcher will have a TBD probability of success in a given cycle. 2. Safety TBD D. Interfaces The RNS module will interface with the module umbilical kit and the mobile launcher.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	ATTACH MOBILE LAUNCHER UMBILICALS TO MODULE AND VERIFY 4.3.1	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 1
REV & DATE _____ VERIFIED _____



	FUNCTIONAL DIAGRAM TITLE AND NUMBER			FUNCTIONAL FLOW BLOCK DIAGRAM	
	PERFORM LAUNCH COUNTDOWN RNS-3 4.4			CONTRACTOR	
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM LAUNCH COUNTDOWN 4.4	A. Functional Description The launch countdown will be performed which includes the functions appropriate to the payload being carried by the Space Shuttle orbiter. B. Design Characteristics/Constraints The functions to be performed on the payload of the orbiter include load of cryogenics, reactants, high pressure gas, and verification of propulsion module safety systems. The umbilical connection to payload from mobile launcher must be capable of being disconnected from the payload and clear the orbiter at lift-off. In the event a scrub occurs after the ejection of the mobile launcher umbilical, the umbilical must have reconnect capability within TBD seconds. The hatch through which the umbilical access is made will be capable of reopening to permit the re-connect of the Mobile Launcher umbilical. If the launch lift-off is successful, the orbiter access hatch will close and latch after ejection of the mobile launcher umbilical. C. Effectiveness 1. Reliability The probability of success of the launch countdown shall be greater than 0.95.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM LAUNCH COUNTDOWN 4.4	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 2
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM LAUNCH COUNTDOWN 4.4	2. Safety TBD D. Interfaces The data system used to verify the CCM/orbiter structural and electrical connection will interface with the automatic checkout system for the orbiter and its payload.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM LAUNCH COUNTDOWN 4.4	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 2 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM PROPELLANT MODULE LOADING SEQUENCE 4.4.1	A. Functional Description The propellant module will be loaded with liquid hydrogen. B. Design Characteristics/Constraints A dry helium purge will be maintained on the insulation system of the propelland module at all times. The cargo compartment will have a dry gas purge to prevent condensation in the compartment. Seals will be provided as necessary on the cargo compartment to minimize the loss of purge gas. Vent and relief will be provided through a propellant module/orbiter interconnect umbilical thence to an orbiter/mobile-launcher umbilical. C. Effectiveness 1. Reliability N/A 2. Safety Applicable safety requirement for the handling of liquid hydrogen. D. Interfaces The propellant module interfaces with the mobile launcher umbilical and the orbiter/propellant module interconnect umbilical. The interface will satisfy the following requirements: 1. Cargo compartment will be purged to remove the moisture as required to prevent excessive condensation on the propellant module during and after fill with LH_2			o Pneumatic console, propellant module - (100% of 432) o Umbilical kit, PM/ML (100% of 315,316) o Umbilibal kit, PM/orbiter (new)	

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM PROPELLANT MODULE LOADING SEQUENCE 4.4.1	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 2
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM PROPELLANT MODULE LOADING SEQUENCE 4.4.1 (Cont'd)	2. The propellant tank will be purged and prepared for chilldown. 3. The propellant tank will be chilled and filled with liquid hydrogen. Topping will be maintained until lift-off is initiated.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM PROPELLANT MODULE LOADING SEQUENCE 4.4.1	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 2 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PRESSURIZE PROPULSION MODULE APS AND VERIFY 4.4.2	A. Functional Description The APS on the propulsion module will be pressurized to full capacity and verified. B. Design Characteristics/Constraints The high pressure gas bottles of the propulsion module will be pressurized with gaseous hydrogen to TBD psi. The system will have the necessary sensors to provide verification of proper loading. C. Effectiveness 1. Reliability - The probability of a successful checkout shall be greater than 0.999. 2. Safety - Applicable safety requirements for high pressure gaseous hydrogen shall apply. D. Interfaces The propulsion module APS will interface with the ground fill umbilical and satisfy the following requirements: 1. The umbilical will be capable of re-attachment in the event it is jettisoned before a launch scrub. 2. Leakage from the APS/umbilical interface will be limited to a TBD rate with an attach/detach loss of TBD quantity per cycle.			o Pneumatic Console APS, Propellant Module, (100% of 1874 & 319)	

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PRESSURIZE PROPULSION MODULE APS AND VERIFY 4.4.2	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 1
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
LOAD APS IN CCM AND VERIFY 4.4.3	A. Functional Description The APS on the command and control module will be loaded with LOX/LH_2. B. Design Characteristics/Constraints The APS of the command and control module will be loaded with LOX and LH_2 through the mobile launcher umbilical. The system will verify its status after it is loaded. C. Effectiveness 1. Reliability N/A 2. Safety Applicable safety requirement for liquid hydrogen and liquid oxygen shall apply. D. Interfaces The command and control module APS will interface with the mobile launcher umbilical and satisfy the following requirements: 1. The ML umbilical and the CCM will be capable of reattachment after jettison in TBD seconds. 2. Leakage from the APS/umbilical interface will be less than TBD rate during attach time, with an attach/detach loss of TBD per cycle.			o APS Instrumentation kit - fuel (100% of 319 & 1874) o APS Instrumentation kit - oxidizer. (100% of 319 & 1875)	

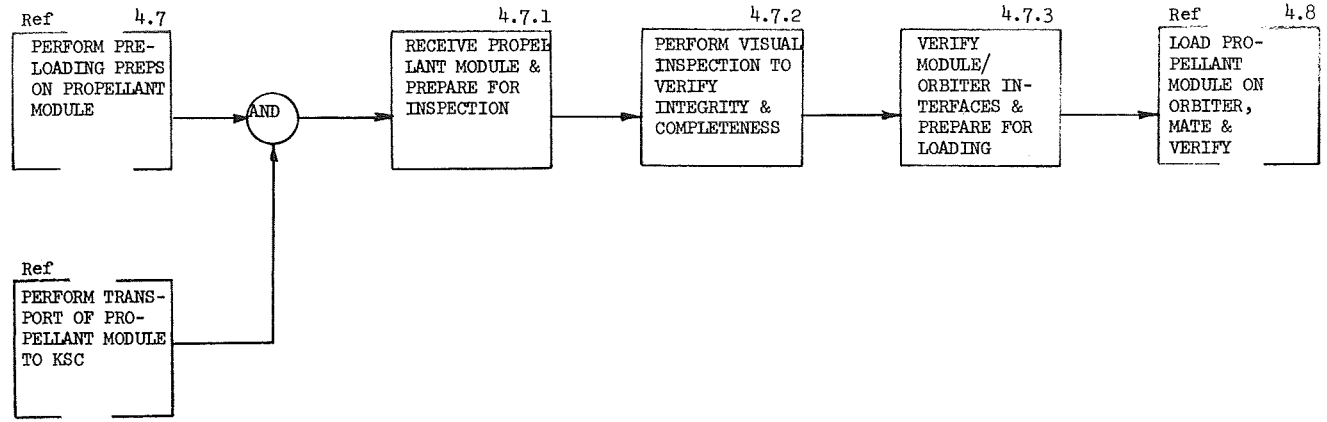
RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	LOAD APS IN CCM AND VERIFY 4.4.3	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 1 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
CHARGE ELECTRIC POWER SYSTEM AND VERIFY 4.4.4	A. Functional Description The electric power system of the command and control module will be charged with reactants (for the primary fuel cells) and the secondary battery system will be checked as to readiness for activation. (It is assumed that the secondary battery system will not be activated until the target orbit is reached). B. Design Characteristics/Constraints The EPS of the command and control module will satisfy the following requirements: 1. The fuel cells will be chargeable with reactants by the ground umbilical connections. 2. The activation of the CCM power system will take place in orbit in the case of launch in the space shuttle. (It will be activated on the ground in the case of its launch on the INT-21). In either event, the EPS will be capable of being activated upon command from the mission control center. C. Effectiveness 1. Reliability N/A 2. Safety Applicable safety requirement for the handling of liquid hydrogen and liquid oxygen shall apply.			o EPS fill console	

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	CHARGE ELECTRIC POWER SYSTEM AND VERIFY 4.4.4	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 2 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
CHARGE ELECTRIC POWER SYSTEM AND VERIFY 4.4.4 (Cont'd)	D. Interfaces The command and control module EPS will interface with the ground umbilical. It will be capable of reattachment of the umbilical in the event it is jettisoned and then needs to be reattached.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	CHARGE ELECTRIC POWER SYSTEM AND VERIFY 4.4.4	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 2 REV & DATE _____ VERIFIED _____	



	FUNCTIONAL DIAGRAM TITLE AND NUMBER			FUNCTIONAL FLOW BLOCK DIAGRAM	
	PERFORM PRELOADING PREPARATIONS ON PROPELLANT MODULE - 4.7			CONTRACTOR	
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM PRELOADING PREPS ON PROPELLANT MODULE 4.7	A. Functional Description The propellant module will be received and inspected. The interface with the space shuttle orbiter will be verified and the module prepared for loading. B. Design Characteristics/Constraints 1. The propellant module will interface with the transporter that will take it to the VAB. It will interface with the inspection and handling equipment, and the interface verification equipment. 2. The propellant module will interface with purge equipment as necessary to maintain the HPI protective purge requirements. C. Effectiveness 1. Reliability - The probability that the inspection is successful shall be greater than 0.99. 2. Safety N/A D. Interfaces 1. Propellant module/transporter The propellant module and its transporter will provide the environmental control necessary to assure the propellant module arrives in a mate-ready condition.			o Environmental protection cover (70% of 304) o Handling kit, propellant module (70% of 302) o Cradles kit, propellant module (70% of 301) o Hoist kit, fwd & aft propellant module (70% of 303) o Tool kit, special, propellant module (100% of 305) o Pneumatic console, propellant module (100% of 319) o Horizontal access kit, fwd. (70% of 484)	

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM PRELOADING PREPS ON PROPELLANT MODULE 4.7	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 2
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM PRELOADING PREPS ON PROPELLANT MODULE 4.7 (Cont'd)	2. Propellant Module/Facilities - Equipment The propellant module will provide the connections necessary to interface with launch facilities and equipment during receiving inspection and verification. It will provide umbilical interconnections for load of propellant, vent, ground power/checkout. 3. Propellant-Module/Orbiter The propellant-module/orbiter interface will: a. Provide structural support and stability required during pre-launch, and boost functions. b. Provide umbilical connection to accommodate propellant module vent during load, countdown, boost, and orbit operations. c. Provide verification of deployment system. d. Provide signal relay capability to and from the space shuttle crew and mission control. e. Provide deployment capability for the CCM in orbit and provide recovery capability.			o Horizontal access kit, aft (70% of 485)	

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM PRELOADING PREPS ON PROPELLANT MODULE 4.7	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 2 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
RECEIVE PROPELLANT MODULE & PREPARE FOR INSPECTION 4.7.1	A. Functional Description The propellant module will be received in the VAB Low Bay aisle, protective covering removed, placed on transfer dolly, and access platforms installed. B. Design Characteristics/Constraints The following functional requirements will be satisfied: 1. The protective shipment cover will be designed and constructed to permit its washdown upon receipt. 2. Handling equipment will be provided to remove the protective covering. 3. The integrity of the insulation purge system will be maintained during preparations for inspection. 4. The propellant module will be designed for support by a transfer dolly. (Note: It might advantageously interface with the orbital docking structure. If so, perhaps the verification of the module docking structure can be thus provided. C. Effectiveness 1. Reliability N/A 2. Safety N/A				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	RECEIVE PROPELLANT MODULE & PREPARE FOR INSPECTION 4.7.1	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 2 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
RECEIVE PROPELLANT MODULE & PREPARE FOR INSPECTION 4.7.1 (Cont'd)	D. Interfaces The propellant module will interface with: 1. The protective covering removal equipment. 2. The module handling fixtures used to remove it from the transporter, erect it, and emplace it on the transfer dolly. 3. The inspection fixtures that provide access to the module for inspection.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	RECEIVE PROPELLANT MODULE & PREPARE FOR INSPECTION 4.7.1	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 2 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM VISUAL INSPECTION TO VERIFY INTEGRITY AND COMPLETENESS 4.7.2	A. Functional Description The propellant module will be inspected in a VAB Low Bay cell. All portions of the module will be verified for completeness and integrity by visual inspection. The environmental record accumulated during transportation will be reviewed and used as a guide to the inspection procedure. B. Design Characteristics/Constraints The following functional requirements will be satisfied: 1. The platforms and fixtures will facilitate access to the appropriate areas of the propellant module. 2. The environmental record accumulated will be sufficiently complete and accurate to enable the verification that the launch-ready status of the module has not degraded during transportation. C. Effectiveness 1. Reliability - The probability that the visual inspection is successful shall be greater than 0.999 2. Safety N/A D. Interfaces The propellant module will interface with: 1. The horizontal access kits. - These kits must be capable of being installed and removed in a manner that does not jeopardize the propellant module. They must safely provide the crew access to the module.				

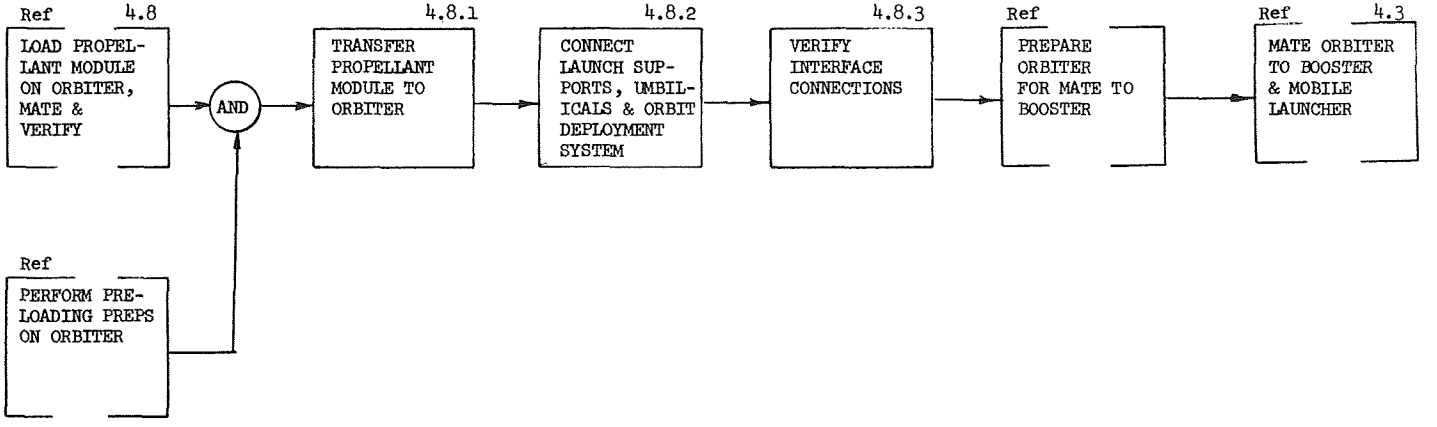
RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM VISUAL INSPECTION TO VERIFY INTEGRITY AND COMPLETENESS 4.7.2	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 1
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
VERIFY MODULE/ ORBITER INTERFACES & PREPARE FOR LOADING 4.7.3	A. Functional Description The mating interfaces between the module and the orbiter will be verified. B. Design Characteristics/Constraints The interfaces of the module will be verified by master fixtures to guarantee they are of the proper configuration for mate to the orbiter. The interfaces will have the following properties: 1. They will be accessible to the check fixtures such that the module likelihood of damage is minimized. 2. The attach points with the orbiter will be verified, as well as the mobile launcher umbilical attach points. C. Effectiveness 1. Reliability - The probability that the verification is successful shall be greater than 0.99. 2. Safety N/A D. Interfaces The module will interface with the verification fixtures and checkout equipment. These equipments will satisfy the following functional requirements: 1. The checkout function will be capable of being performed while the module is supported in its inspection fixtures. The same fixtures, or their certified replications, will be used for all modules of like kind.			o Interface Verification Fixture, Propellant module/ orbiter	

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	VERIFY MODULE/ORBITER INTERFACES & PREPARE FOR LOADING 4.7.3	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 1
REV & DATE _____ VERIFIED _____



	FUNCTIONAL DIAGRAM TITLE AND NUMBER			FUNCTIONAL FLOW BLOCK DIAGRAM	
	LOAD PROPELLANT MODULE ON ORBITER, MATE AND VERIFY - 4.8			CONTRACTOR	
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
LOAD PROPELLANT MODULE ON ORBITER, MATE & VERIFY 4.8	A. Functional Description The propellant module will be transferred to the space shuttle orbiter and loaded into the cargo compartment. B. Design Characteristics/Constraints 1. The propellant module will be loaded onto the orbiter in the horizontal position in the space shuttle maintenance area. 2. The propellant module will have all of the interfaces with the space shuttle orbiter and the mobile launcher verified prior to being removed to the mate area. 3. The propellant module preparation will be completed in a manner that assures it will meet the orbiter payload mate schedule. C. Effectiveness 1. Reliability - The probability that the loading and verification will be successful shall be greater than 0.99. 2. Safety N/A			o Installation sling, propellant module,orbiter	

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	LOAD PROPELLANT MODULE ON ORBITER, MATE & VERIFY 4.8	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 2 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
LOAD PROPELLANT MODULE ON ORBITER, MATE & VERIFY 4.8 (Cont'd)	D. Interfaces 1. The propellant module will interface with the handling equipment that transports it to the space shuttle maintenance area. 2. The propellant module will interface with the orbiter so that it accommodates the attach structure and the loads imparted to it during launch preparation, boost to orbit, and orbit operations. 3. The propellant module will interface with orbiter umbilicals to provide propellant vent capability during ground, boost, and orbit operations. Also, it will provide status monitoring and checkout capability to the crews of the orbiter and mission control. 4. The orbiter/propellant-module interface will include deployment capability to extend the propellant module out of the cargo compartment while in orbit. 5. The propellant module will interface with the umbilical connections of the mobile launcher and satisfy the requirements of countdown operations and boost.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	LOAD PROPELLANT MODULE ON ORBITER, MATE & VERIFY 4.8	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 2
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
TRANSFER PROPELLANT MODULE TO ORBITER 4.8.1	A. Functional Description The propellant module will be transferred from the receiving inspection cell in the Low Bay to the orbiter mating position in the space shuttle maintenance area. B. Design Characteristics/Constraints Transfer to the space shuttle maintenance area will be by a transport fixture and dolly. Handling fixtures will be attached which facilitate the emplacement of the payload on the orbiter. The fixtures will provide support and protection for the propellant module during movement to and loading into the orbiter. C. Effectiveness 1. Reliability N/A 2. Safety N/A D. Interfaces The propellant module will interface with the transportation dolly and handling kit. Adequate attach points and safety features will be employed. An insulation purge system will be maintained as necessary during the transfer function to insure the continued protection of the insulation.			o Propellant module VAB transportation dolly (30% of 300) o Pneumatic console, purge control (30% of 319)	

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	TRANSFER PROPELLANT MODULE TO ORBITER 4.8.1	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 1
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
CONNECT LAUNCH SUPPORTS, UMBILICAL, AND ORBIT DEPLOYMENT SYSTEM 4.8.2	A. Functional Description The propellant-module/orbiter interconnect umbilicals will be attached and verified, the structural supports for launch loads and stability will be attached, and the deployment system to be used in orbit will be attached and verified. B. Design Characteristics/Constraints 1. The interconnect umbilicals will provide the following functions to the orbiter and/or mission control: a. Propellant module status data. b. Orbiter and/or mission control command signals. c. Vent and relief of propellant to space as required during ascent and in orbit. 2. The structural launch supports will be remotely detachable and will carry the loads imposed during ascent and orbital operations. They will have manually activated backup releases and accommodate differential movement caused by thermal effects. 3. The orbital deployment system will be attached and verified. It will be designed to satisfy the following functional requirements: a. Absorb loads imposed by propellant module movement after the structural launch supports have been released in orbit. b. Move the propellant module out of the cargo compartment into the deployed position and upon command, release the module.			o Orbiter substitute, propellant module (50% of 268) o Propellant Module substitute orbiter (50% of 268)	

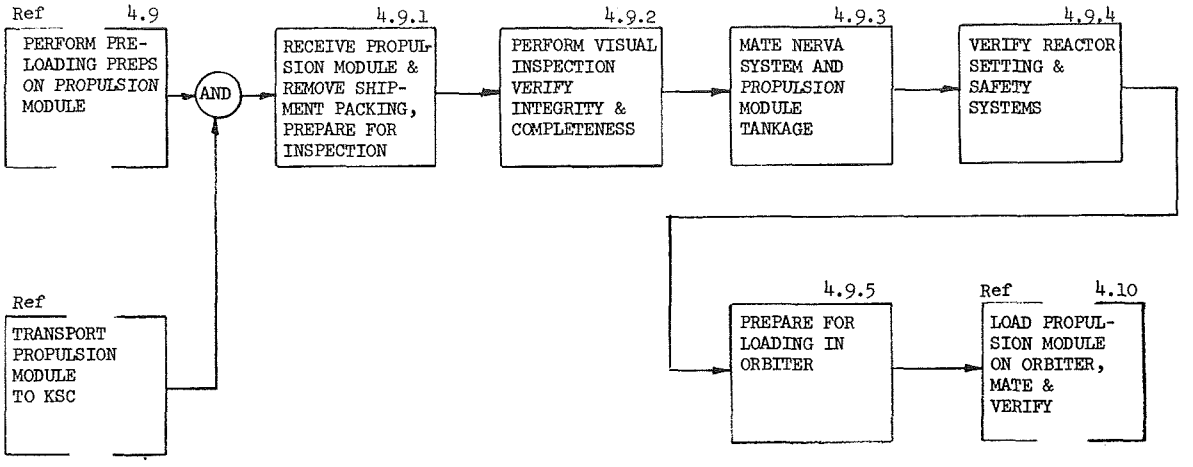
RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	CONNECT LAUNCH SUPPORTS, UMBILICAL, AND ORBIT DEPLOYMENT SYSTEM 4.8.2	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 2 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
CONNECT LAUNCH SUPPORTS, UMBILICAL, AND ORBIT DEPLOYMENT SYSTEM 4.8.2 (Cont'd)	C. Effectiveness 1. Reliability N/A 2. Safety N/A D. Interfaces The propellant-module/orbiter will interface at the structural launch supports and the umbilical interconnect. The orbiter must supply a door that will provide access to the module by the ground umbilicals of the mobile launcher. The propellant module will interface with the orbiter interconnect umbilical. During countdown the vent and relief function will be provided by the orbiter interconnect umbilical to a vent and relief umbilical of the mobile launcher.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	CONNECT LAUNCH SUPPORTS, UMBILICAL, AND ORBIT DEPLOYMENT SYSTEM 4.8.2	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 2 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
VERIFY INTERFACE CONNECTIONS 4.8.3	A. Functional Description The interfaces established between the propellant module and the orbiter will be verified. B. Design Characteristics/Constraints 1. The propellant-module/orbiter interfaces will be designed for automatic checkout. 2. The automatic checkout functions will supply the data necessary to verify the mate status of the propellant-module/orbiter assembly. C. Effectiveness 1. Reliability - The probability of a successful verification shall be greater than 0.99. 2. Safety N/A D. Interfaces The data systems of the propellant module, and the orbiter, that are used to verify the structural and electrical connections will interface with the automatic checkout system.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	VERIFY INTERFACE CONNECTIONS 4.8.3	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 1 REV & DATE _____ VERIFIED _____	



	FUNCTIONAL DIAGRAM TITLE AND NUMBER			FUNCTIONAL FLOW BLOCK DIAGRAM	
	PERFORM PRELOADING PREPARATIONS ON PROPULSION MODULE - 4.9			CONTRACTOR	
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM PRELOADING PREPARATIONS ON THE PROPULSION MODULE 4.9	A. Functional Description The NERVA system and the run tank assembly (RTA) will be received at the VAB Low Bay, mated, and prepared for load onto the orbiter, launch, and orbital deployment and assembly. B. Design Characteristics/Constraints 1. The run tank assembly and the NERVA system will be assembled into the propulsion module in the Low Bay of the VAB. 2. The NERVA system will be received without its neutron source in place. 3. The propulsion module will have its interfaces with the orbiter and mobile launcher verified prior to mate with the orbiter. 4. The propulsion module helium purge will be verified for leak tightness and the poison wire removal system of the NERVA, and the neutron source readiness will be verified. C. Effectiveness 1. Reliability N/A 2. Safety N/A				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM PRELOADING PREPARATIONS ON THE ENGINE MODULE 4.9	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 2 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM PRELOADING PREPARATIONS ON THE PROPULSION MODULE 4.9 (Cont'd)	D. Interfaces 1. The NERVA system, non-nuclear components, and the run tank assembly will interface with the transportation, handling, and access equipment that are used in VAB Low Bay operations. 2. The propulsion module will interface with checkout and inspection equipment so that its engine settings (reactor) and safety systems may be verified. 3. The propulsion module will interface with check fixtures to verify its readiness for mate with the orbiter.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM PRELOADING PREPARATIONS ON THE ENGINE MODULE 4.9	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 2 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
RECEIVE PROPULSION MODULE, REMOVE SHIPMENT PACKING, & PREPARE FOR INSPECTION 4.9.1	A. Functional Description The propulsion module will be received, its protective covers removed, installed in an inspection fixture, and access kits and test sets installed. B. Design Characteristics/Constraints 1. The propulsion module will be received at the VAB Low Bay in two units: a. The NERVA Systems. b. The Propulsion Module Tankage They will be transported to KSC by air and moved from the landing site to the VAB Low Bay by ground transporter. The shuttle landing site is assumed to be the place of delivery for the propulsion module. 2. Ground transporters will move the NERVA system and the propulsion module tankage support fixtures used during flight to the VAB area. 3. The handling and inspection fixtures in the VAB Low Bay will accommodate the mate of the NERVA system and the propellant module tankage. They will support each in a manner that facilitates inspection functions, and not subject the subassemblies to undue loads or environmental stress. C. Effectiveness 1. Reliability N/A 2. Safety N/A			o Protective cover kit, environmental propulsion module tank (25% of 304) o Protective cover kit, environmental propulsion module engine (25% of 309) o Handling kit, tankage (50% of 302) o Handling kit engine (70% of 302) o Special tool kit, tankage (70% of 305) o Special tool kit, engine (70% of 305)	

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	RECEIVE PROPULSION MODULE, REMOVE SHIPMENT PACKING, & PREPARE FOR INSPECTION 4.9.1	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 2
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
RECEIVE PROPULSION MODULE, REMOVE SHIPMENT PACKING, & PREPARE FOR INSPECTION 4.9.1 (Cont'd)	D. Interfaces This function interfaces with the transportation of the propulsion module to KSC and the performance of visual inspection and verification of the integrity and completeness of the propulsion module. The interface operations involve the following requirements: 1. Handling equipment will be available at the landing site used for delivery of the NERVA system and the propellant module tankage. It will be capable of unloading them without the likelihood of damage from the aircraft (Super Guppy) and loading them onto the ground transporter. 2. Protective systems that have been used during transportation to the landing site will have their functions continued uninterrupted. 3. The transporter used to move the NERVA system and the propellant module tankage to the inspection and mate fixtures will interface with those fixtures in a manner that assures the protection of its cargo. It will also facilitate the transfer of the cargo to the receiving inspection and mate fixtures. 4. The fixtures will interface with the receiving inspection functions and equipment. This interface will facilitate crew access to the modules as well as the emplacement and removal of any inspection equipment required.			o Cradles kit tankage (50% of 301) o Cradles kit engine (100% of 301) o Hoist kit, tankage (50% of 303) o Hoist kit, engine (100% of 203) o Access kit, fwd, tankage (50% of 484) o Access kit, aft, tankage (50% of 485)	

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	RECEIVE PROPULSION MODULE, REMOVE SHIPMENT PACKING, & PREPARE FOR INSPECTION 4.9.1	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 2 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM VISUAL INSPECTION & VERIFY INTEGRITY AND COMPLETENESS 4.9.2	A. Functional Description The propulsion module tankage and the NERVA system will be inspected. The environmental records made during transport to KSC will be reviewed to verify the module's launch ready condition. B. Design Characteristics/Constraints 1. The inspection fixtures will support the propulsion module tankage and the NERVA system safely without damage. They will be supported in a manner that provides maximum convenience and facility for the inspection activity. Access for personnel will be provided as required. Checkout equipment will be accommodated as necessary to complete the inspection. 2. The monitoring equipment used, its sensors, and recorders will have convenient check points to facilitate verification that it is functioning properly and has recorded properly the status of the modules during transportation to KSC. 3. The sensing devices attached to the NERVA system or the propulsion module tankage will be removable without compromise of its functional integrity. C. Effectiveness 1. Reliability - The probability that the inspection operation will be successful shall be greater than 0.999.			o Access kit, engine (50% of 485) o Tankage, Instrumentation kit, environmental. (100% of 175) o Engine, Instrumentation kit, environmental. (100% of 175) o Instrumentation trailer, tankage (GFE?) o Instrumentation trailer, engine (GFE?)	

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM VISUAL INSPECTION & VERIFY INTEGRITY AND COMPLETENESS 4.9.2	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 2
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM VISUAL INSPECTION & VERIFY INTEGRITY AND COMPLETENESS 4.9.2 (Cont'd)	2. Safety The NERVA system will have poison wires in place and the control drums will be locked. Access to the vicinity of the engine will be controlled, and provisions will be made for monitoring procedures that will detect the presence of any significant amount of contamination. The safety provisions will be verified as to their reliability and readiness for removal in orbit. D. Interfaces The inspection and monitoring equipment will interface with the crew and the two modules; both before and after their assembly. It will be removable while the modules are installed in their inspection fixtures. This function will interface with the propulsion module mate activity. 1. The checkout equipment will be designed to provide its functions both before and after mate operations. 2. Protective systems will remain in the performance of their functions during and after the mate process.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM VISUAL INSPECTION & VERIFY INTEGRITY AND COMPLETENESS 4.9.2	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 2
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
MATE NERVA SYSTEM & PROPULSION MODULE TANKAGE 4.9.3	A. Functional Description The propulsion module tankage and the NERVA system will be mated. B. Design Characteristics/Constraints The interface between the propulsion module tankage and the NERVA system will be designed to be mated in the vertical position in a cell of the VAB Low Bay. The inspection fixtures will accommodate the mate activities and provide access to the attach points. C. Effectiveness 1. Reliability N/A 2. Safety N/A D. Interfaces The propulsion-module-tankage and the NERVA system interface with each other and with: 1. The checkout system. 2. The support, handling and access fixtures. 3. The crew. The checkout system will be designed to verify not only the integrity of the NERVA-system/propulsion-module-tankage interface, but also the reactor settings and safety systems.			o Alignment kit, propulsion module (100% of 240)	

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	MATE NERVA SYSTEM & PROPULSION MODULE TANKAGE 4.9.3	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 2
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
MATE NERVA SYSTEM & PROPULSION MODULE TANKAGE 4.9.3 (Cont'd)	The support, handling, and access fixtures will be designed to accommodate the propulsion module both before and after mate. The crew will be provided access as necessary for it to accomplish this functional requirement.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	MATE NERVA SYSTEM & PROPULSION MODULE TANKAGE 4.9.3	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 2

REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
VERIFY REACTOR SETTINGS & SAFETY SYSTEMS 4.9.4	A. Functional Description The settings of the reactor, per manufacturer's specifications, will be verified. Each safety device incorporated in the safety system will be verified. B. Design Characteristics/Constraints The safety system of the propulsion module will be designed to enable the crew to verify its safe status. (A safeguards check list will be used as a guide.) The following checks will be made: 1. Control drum vernier settings. 2. Poison wire removal system. 3. Engine propellant valves. The control drum vernier settings are the zero settings of the control system for the engine as established by the manufacturer at the zero-power acceptance test. These settings will be verified at the launch preparations site prior to load of the propulsion module on the space shuttle. The poison wires and their removal system are installed at the acceptance test site after the zero-power test. This removal system is designed for manual operation in orbit by a member of the orbiter crew. Its readiness for orbital removal and the procedure guide will be verified.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	VERIFY REACTOR SETTINGS & SAFETY SYSTEMS 4.9.4	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 3
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
VERIFY REACTOR SETTINGS & SAFETY SYSTEMS 4.9.4 (Cont'd)	The engine propellant shut-off valves, their control and monitoring system, will be verified. C. Effectiveness 1. Reliability The safety systems and their verification procedures will be sufficiently effective to provide a reliability of .9998 in the propulsion module safety systems. 2. Safety The procedural and configurational controls over propulsion module operation will be such as to preclude the exposure of project personnel or general population to hazards, in excess of limits established by the AEC. D. Interfaces The interfaces of this function include: 1. Crew/safety systems The safety systems will be designed to facilitate its inspection & verification by the crew. Easy access and operational characteristics will be incorporated into the system configuration. 2. Crew/Reactor Settings The requirement for this function has not been fully established. The decision will depend largely on the degree to which the				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	VERIFY REACTOR SETTINGS & SAFETY SYSTEMS 4.9.4	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 3
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
VERIFY REACTOR SETTINGS & SAFETY SYSTEMS 4.9.4 (Cont'd)	propulsion module systems can be in a launch ready state when delivered to KSC. Until further requirements are established it is assumed that the control drum zero settings will be established at the acceptance test site and logged. Then these same settings will be verified at the launch site prior to load of the propulsion module onto the space shuttle orbiter. 3. Access-Stands/Propulsion-Module The ground crew must have access to the inspection points necessary, and these points must be designed so that they are easily accessible.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	VERIFY REACTOR SETTINGS & SAFETY SYSTEMS 4.9.4	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 3 of 3 REV & DATE _____ VERIFIED _____	

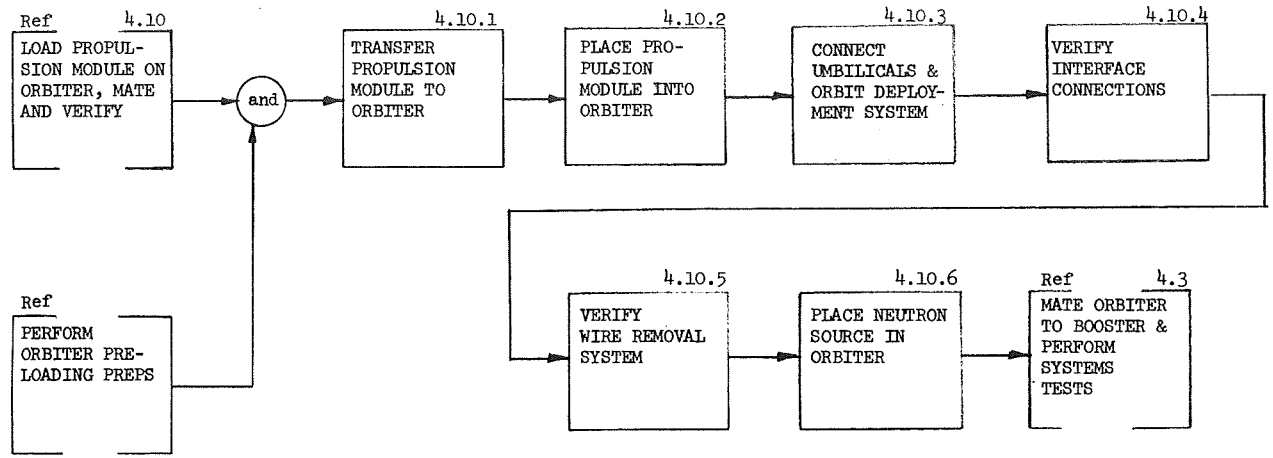
FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PREPARE FOR LOADING INTO THE ORBITER 4.9.5	A. Functional Description The propulsion module will be prepared for transfer to the space shuttle orbiter and placement on board. B. Design Characteristics/Constraints The propulsion module and its handling/access fixtures will be designed to facilitate the removal of the module to the orbiter. Access fixtures will be designed so they may be removed from the module without hazard to it. The module will be designed to accommodate the handling fixtures used to transfer it to the orbiter. The handling fixtures will be designed to provide the necessary clearance and access for installation of the module in the orbiter cargo compartment. The umbilical interfaces and the docking interface for the propulsion module will be verified for configuration accuracy. C. Effectiveness 1. Reliability N/A 2. Safety N/A D. Interfaces The propellant module will interface with:				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PREPARE FOR LOADING INTO THE ORBITER 4.9.5	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 2
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PREPARE FOR LOADING INTO THE ORBITER 4.9.5 (Cont'd)	1. The space shuttle maintenance area and the cargo handling equipment provided. This interface will require the installation of area access controls over personnel. Only specially cleared people will be given access to the propulsion module during operations involving it. 2. The access, handling, and transfer fixtures and equipment. These equipments will be removable in a manner which affords protection to the propulsion module.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PREPARE FOR LOADING INTO THE ORBITER 4.9.5	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 2 REV & DATE _____ VERIFIED _____	



	FUNCTIONAL DIAGRAM TITLE AND NUMBER			FUNCTIONAL FLOW BLOCK DIAGRAM	
	LOAD PROPULSION MODULE ON ORBITER, MATE AND VERIFY - 4.10			CONTRACTOR	
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
LOAD PROPULSION MODULE ON ORBITER, MATE, & VERIFY 4.10	A. Functional Description The propulsion module will be transferred to the space shuttle orbiter and loaded into the cargo compartment. B. Design Characteristics/Constraints 1. The propulsion module will be loaded onto the orbiter in the horizontal position in the space shuttle maintenance area. 2. The propulsion module will have all of its interfaces with the space shuttle orbiter and the mobile launcher verified before it is moved to the space shuttle maintenance area. 3. The propulsion module will have its interfaces with orbital modules verified and readied before movement to the mate area. 4. The neutron source for the nuclear engine will be mounted in the cargo compartment of the orbiter so it will be accessible and can be installed by an orbiter crew member after orbit is reached. 5. The propulsion module aft end will be accessible to an orbiter crew member while in orbit in order that he may bleed the helium from the engine, remove the nozzle seal, and remove the poison wires from the engine core. Reference note: The engine neutron source will be installed first. Then the nucleonic controls of the engine will be verified before the poison wires are removed. Additionally, the instrumentation will be carefully monitored during the removal of the poison wires.			o Umbilical kit, propulsion module/mobile launcher (50% of 315) o Propulsion module function simulator test set (100% of 268) o Orbiter function simulator test set (100% of 268)	

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	LOAD ENGINE MODULE ON ORBITER, MATE & VERIFY 4.10	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 2 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
LOAD PROPULSION MODULE ON ORBITER, MATE, & VERIFY 4.10 (Cont'd)	C. Effectiveness 1. Reliability - The probability of a successful verification shall be greater than 0.99. 2. Safety - Applicable safety requirements for movement of nuclear devices will apply. D. Interfaces 1. The propulsion module will interface with the handling equipment that transports it to the space shuttle maintenance area. 2. The propulsion module will interface with the orbiter so that it accommodates the attach structure and the loads imparted to it during launch preparations, boost to orbit, and orbit operations. 3. The propulsion module will interface with the mobile launcher and the orbiter umbilicals to satisfy countdown, boost, and orbital operations requirements. 4. The propulsion module will interface with 1) the manual installation of the neutron source, 2) verification in orbit of the nucleonics of the engine, and 3) the manual removal of the poison wires.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	LOAD ENGINE MODULE ON ORBITER, MATE & VERIFY 4.10	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 2 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
TRANSFER PROPULSION MODULE TO ORBITER 4.10.1	A. Functional Description The propulsion module will be transferred to the space shuttle maintenance area. B. Design Characteristics/Constraints 1. The propulsion module will be moved to the space shuttle maintenance area on a transfer dolly. This dolly will provide adequate protection, during transfer, to the module. 2. The module will have handling equipment attached to it and be lifted clear of the transfer dolly. 3. The module will be hoisted and moved from the transfer dolly to the space shuttle orbiter and aligned with the installation fixtures. C. Effectiveness 1. Reliability N/A 2. Safety TBD - Applicable safety requirements for movement of nuclear devices will apply. D. Interfaces The propulsion module will interface, during transfer, with: 1. The handling equipment Hoist beams and tag lines will be used to lift the module clear of its inspection fixtures and lower it onto the transfer dolly.			o Transportation dolly, VAB, propulsion module (30% of 300)	

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	TRANSFER PROPULSION MODULE TO ORBITER 4.10.1	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 2 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
TRANSFER PROPULSION MODULE TO ORBITER 4.10.1 (Cont'd)	2. The transfer dolly This dolly will be used to move the module down the aisle of the VAB to the space shuttle maintenance area. It might be appropriate to use this dolly as a support fixture in the Low Bay Cell.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	TRANSFER PROPULSION MODULE TO ORBITER 4.10.1	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 2
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PLACE PROPULSION MODULE INTO ORBITER 4.10.2	A. Functional Description The propulsion module will be lowered into the installation fixture and then lowered into the orbiter. B. Design Characteristics/Constraints The propulsion module will be guided into the orbiter and aligned with its attach points by an installation fixture. This fixture will be designed to maximize protection of the module during the installation procedure. C. Effectiveness 1. Reliability N/A 2. Safety - Applicable safety requirements for the movement of nuclear devices will apply. D. Interfaces The propulsion module will interface with installation fixture and the orbiter support structure. The installation fixture will provide guidance to the module in the last few inches of travel to facilitate alignment with the orbiter cargo compartment support structure. It will minimize the likelihood of damage or misalignment. The orbiter support structure will provide support to the module during ground handling, boost, and orbital operations.			o Alignment kit, orbiter/propulsion module (200% of 340)	

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PLACE PROPULSION MODULE INTO ORBITER 4.10.2	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 1
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
CONNECT UMBILICALS & ORBIT DEPLOYMENT SYSTEM 4.10.3	A. Functional Description The propulsion module will have the interconnect umbilicals and the orbital deployment mechanism attached to it. B. Design Characteristics/Constraints The interconnect umbilical will attach to the propulsion module and be configured, in a manner that will not interfere with the deployment of the module. It will provide the interconnect, as required, of functions between the orbiter and the module to facilitate the monitoring and command functions. The orbital deployment mechanism will be capable of moving the module out of the orbiter while in orbit. This mechanism will provide information to the orbiter crew as to its status: 1. Locked or open. 2. Angular position. 3. Cargo attached or not. C. Effectiveness 1. Reliability N/A 2. Safety N/A				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	CONNECT UMBILICALS & ORBIT DEPLOYMENT SYSTEM 4.10.3	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 2
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
CONNECT UMBILICALS & ORBIT DEPLOYMENT SYSTEM 4.10.3	D. Interfaces The module will interface with the umbilical interconnect between it and the orbiter. This interconnect will transmit to the orbiter data required to monitor the status of the propulsion module. The module will interface with the orbital deployment mechanism. This mechanism will release the module from its support structure, move it out of the orbiter, and hold the module until it has been acquired by orbital operations.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	CONNECT UMBILICALS & ORBIT DEPLOYMENT SYSTEM 4.10.3	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 2 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
VERIFY INTERFACE CONNECTIONS 4.10.4	A. Functional Description The interfaces established between the propulsion module and the orbiter will be verified. B. Design Characteristics/Constraints The interface established between the module and the deployment mechanism will supply to the checkout system the data necessary to verify that the interface is complete and that the deployment system will function properly in orbit. The interface between the module and the propulsion-module/orbiter interconnect umbilicals will be verified. These umbilicals will provide the monitor, purge, vent, and propellant fill functions as required by the propulsion module. The module will be supplied propellant after it reaches orbit. This might be done either by transfer of propellant from the orbiter, or from some orbital source such as a tanker or tank farm. C. Effectiveness 1. Reliability - The probability of a successful verification shall be greater than 0.99. 2. Safety N/A				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	VERIFY INTERFACE CONNECTIONS 4.10.4	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 2
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
VERIFY INTERFACE CONNECTIONS 4.10.4 (Cont'd)	D. Interfaces The propulsion module will interface with the orbital assembly module or tug, depending on the orbital operations profile. The orbiter will remain passive during the establishment of this interface.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	VERIFY INTERFACE CONNECTIONS 4.10.4	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 2 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
VERIFY POISON WIRE REMOVAL SYSTEM IN PROPULSION MODULE 4.10.5	A. Functional Description Access to the poison wire removal system and the tools, equipment, and procedures for their removal will be verified by a crew member. B. Design Characteristics/Constraints The functions to be performed include: 1. Entry of a crew member into the cargo compartment of the orbiter. 2. The verification by the crew member of: a. Access route. b. Completeness of tools and equipment required. c. The readiness of the poison wire removal apparatus. The system will be designed to accommodate the manual removal of the poison wires by an orbiter crew member after the target orbit has been reached. Provisions will be made to continually apprise the crew member who removes the wires of the status of the nucleonics of the engine. This requirement presumes the presence of the neutron source in the engine so that the nucleonic instrumentation is "on scale" during this operation. (These requirements are listed predicated on the assumption, as a baseline, of the need for a neutron source. This requirement has not, as yet, been established). C. Effectiveness 1. Reliability - The probability of a successful verification shall be greater than 0.99.			o Poison wire removal checkout kit (new) o Checkout space suit (can be reject)	

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	VERIFY POISON WIRE REMOVAL SYSTEM IN PROPULSION MODULE 4.10.5	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 2
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
VERIFY POISON WIRE REMOVAL SYSTEM IN PROPULSION MODULE 4.10.5 (Cont'd)	2. Safety TBD D. Interfaces The interfaces between the crew member and the propulsion module and the poison wire removal system will satisfy the following requirements: 1. There will be no protuberances or sharp edges that will offer a potential hazard to the crew member while performing these functions in space. 2. Continual contact with the nucleonic status of the engine will be available to the crew member. This capability will be verified.				

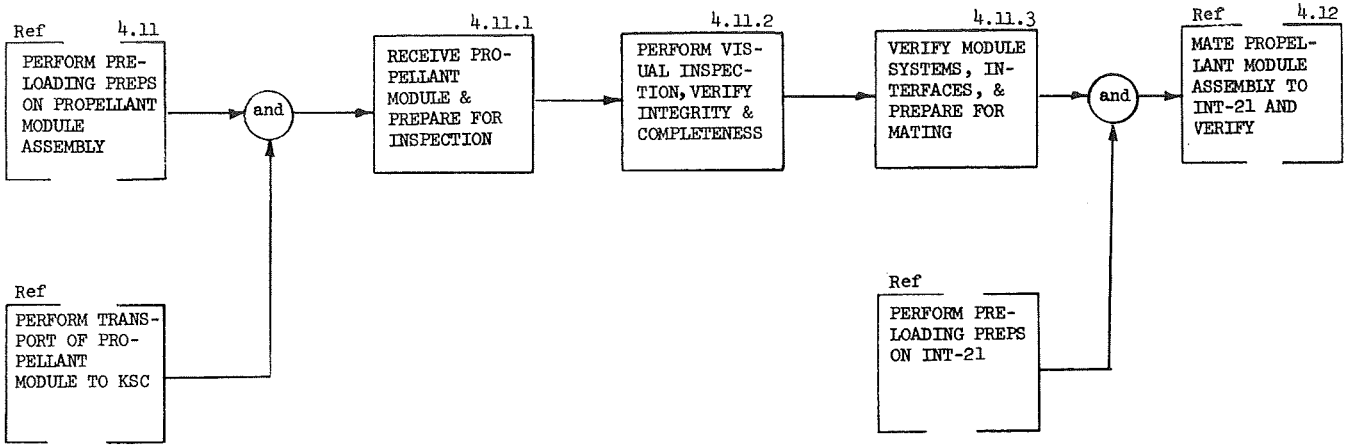
RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	VERIFY POISON WIRE REMOVAL SYSTEM IN PROPULSION MODULE 4.10.5	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 2 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PLACE NEUTRON SOURCE IN ORBITER FOR INSERTION IN MODULE IN ORBIT 4.10.6	A. Functional Description The neutron source will be placed into a receptacle in the cargo compartment. B. Design Characteristics/Constraints The following design requirements will be satisfied: 1. The neutron source will be safely held in a place that is easily accessible to a crew member in orbit. 2. It will be suitably distant or shielded, such that its affect on the engine will be negligible. 3. Handling Provisions will be made and protection provided as necessary to maintain crew man exposure to within permissible limits. C. Effectiveness 1. Reliability N/A 2. Safety - Applicable safety requirements for the movement of nuclear devices shall apply. D. Interfaces The neutron source will interface with the following: 1. A support receptacle in the space shuttle orbiter will be provided that:			o Neutron source shipping & handling cask (new) o Neutron source cask handling cart	

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PLACE NEUTRON SOURCE IN ORBITER FOR INSERTION IN MODULE ORBIT 4.10.6	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 2 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PLACE NEUTRON SOURCE IN ORBITER FOR INSERTION IN MODULE IN ORBIT 4.10.6 (Cont'd)	a. Is easily accessible to the crew man. b. Is suitable for zero-g operation. c. Safely retains the source during ascent to orbit and orbital operations. 2. The attach point on the engine will be located so it is easily accessible. 3. There will be a clear route between the neutron source support receptacle and its attach point on the engine.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PLACE NEUTRON SOURCE IN ORBITER FOR INSERTION IN MODULE ORBIT 4.10.6	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 2 REV & DATE _____ VERIFIED _____	



	FUNCTIONAL DIAGRAM TITLE AND NUMBER			FUNCTIONAL FLOW BLOCK DIAGRAM	
	PERFORM PRELOADING PREPARATIONS ON PROPELLANT MODULE ASSEMBLY - 4.11			CONTRACTOR	
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM PRELOADING PREPARATIONS ON CLASS 1H PROPELLANT MODULE 4.11	A. Functional Description The Class 1-H propellant module will be received assembled with the CCM. It will be prepared for inspection, inspected, and its interfaces with the INT-21 launch vehicle verified and prepared for mate. B. Design Characteristics/Constraints The propellant module/CCM assembly will be received in a launch ready condition as nearly as practicable. Its readiness will be verified during receiving inspection. The propulsion module interface will be verified as to its readiness for orbital assembly. Monitoring equipment will be used to record the environment and status of the assembly during transportation. This record will be used as a guide for receiving inspection. C. Effectiveness 1. Reliability N/A 2. Safety N/A D. Interfaces				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM PRELOADING PREPARATIONS ON CLASS 1-H PROPELLANT MODULE 4.11	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 2 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM PRELOADING PREPARATIONS ON CLASS 1H PROPELLANT MODULE 4.11 (Cont'd)	1. Propellant Module/Facility The propellant module/facility interface will satisfy the following requirements: o Provide an environmentally controlled area that will accommodate the receiving and unloading of the propellant module/CCM assembly. o Provide capabilities necessary to accomplish the receiving inspection, verification as to integrity, and the completeness of the received shipment with respect to launch requirements. o Provide capability to verify the conformity of the propellant module interface structure with the interface structure of the INT-21 and the propulsion module. o Provide purge capacity as necessary to supply the HPI purge. o Provide capability to verify the conformity of the CCM interface structure of the nose cone.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM PRELOADING PREPARATIONS ON CLASS 1-H PROPELLANT MODULE 4.11	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 2 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
RECEIVE PROPELLANT MODULE AND PREPARE FOR INSPECTION 4.11.1	A. Functional Description The CCM/propellant module for the Class 1-H RNS will be unloaded from the Pt. Barrow, or equivalent, at the turning basin. It will be transported to the VAB Low Bay Aisle, washed down, protective covers removed, and prepared for inspection. B. Design Characteristics/Constraints The receiving inspection facility will provide protective cover wash-down capability, handling harnesses and fixtures necessary for removal of the protective covers and the propellant module from the transporter. The module will be erected and mounted upon a handling dolly moved in the low bay aisle or in the high bay, and preparations for inspection made. C. Effectiveness 1. Reliability N/A 2. Safety N/A D. Interfaces The CCM propellant module will interface with the handling equipment and support dolly. It will interface with the access platforms and fixtures.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	RECEIVE PROPELLANT MODULE AND PREPARE FOR INSPECTION 4.11.1	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 2
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
RECEIVE PROPELLANT MODULE AND PREPARE FOR INSPECTION 4.11.1 (Cont'd)	Final decision as to the location of receiving inspection for the propellant module (Low Bay Aisle, High Bay, or new facility) will require more detailed study and definition.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	RECEIVE PROPELLANT MODULE AND PREPARE FOR INSPECTION 4.11.1	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 2 REV & DATE _____ VERIFIED _____	

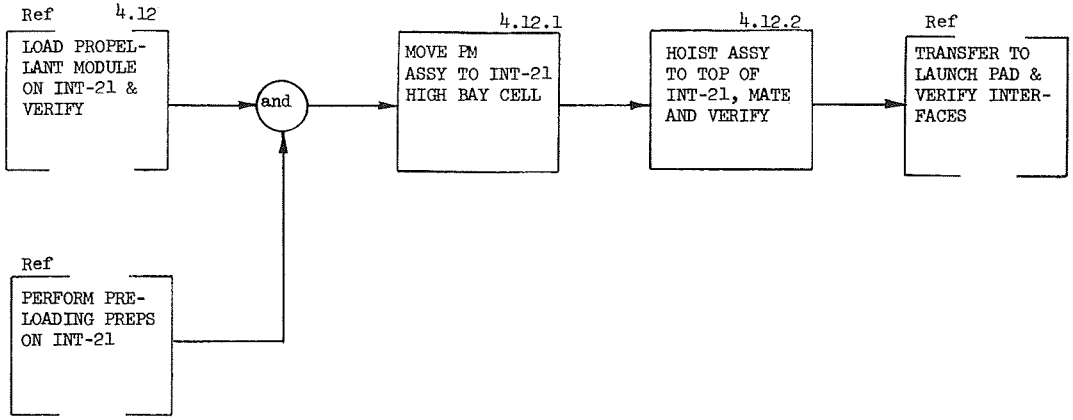
FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM VISUAL INSPECTION TO VERIFY INTEGRITY & COMPLETENESS 4.11.2	A. Functional Description The status of the CCM/propellant module will be verified against the status as defined by monitors at the acceptance test site and the record of environmental influences made during transportation. The completeness of any loose items and their readiness for installation will be verified. B. Design Characteristics/Constraints The record of environmental influences made during transportation will be available to the receiving inspection function of the propellant module. This record will be used as a guide for the receiving inspection activity. A complete check list of the loose items, if any, will be provided. C. Effectiveness 1. Reliability The probability that a successful visual inspection is accomplished shall be greater than 0.999. 2. Safety N/A D. Interfaces The CCM/propellant module will interface with the inspection crew and equipment. This interface will be designed to provide all the data necessary and facilitate the inspection process.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM VISUAL INSPECTION TO VERIFY INTEGRITY AND COMPLETENESS 4.11.2	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 1 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
VERIFY CCM-PROPELLANT-MODULE/ INT-21 INTERFACE AND PREPARE FOR MATING 4.11.3	A. Functional Description The propellant-module/INT-21 interface will be inspected and verified for mate readiness. The separation devices will be verified for readiness for installation and/or arming. (These functions will be performed at the arming tower.) B. Design Characteristics/Constraints The propellant module/INT-21 interface will be designed to facilitate the mate function. Additionally, it will include the functions required for reliable separation from the INT-21 after orbital injection. C. Effectiveness 1. Reliability - The probability that the verification is successful shall be greater than 0.99. 2. Safety N/A D. Interfaces The CCM/propellant module assembly will interface with the inspection crew and equipment. This interface will be designed to provide all the data necessary and to facilitate the inspection process.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	VERIFY PROPELLANT-MODULE/INT-21 INTERFACE AND PREPARE FOR MATING 4.11.3	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 1
REV & DATE _____ VERIFIED _____



	FUNCTIONAL DIAGRAM TITLE AND NUMBER			FUNCTIONAL FLOW BLOCK DIAGRAM	
	LOAD PROPELLANT MODULE ON INT-21 & VERIFY - 4.12			CONTRACTOR	
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
LOAD PROPELLANT MODULE ON INT-21 AND VERIFY 4.12	A. Functional Description The propellant module will be moved to the INT-21 high bay cell, hoisted to the top of the INT-21, mated, and verified. The handling ring will be removed and the top of the module prepared for mate with the nose cone. B. Design Characteristics/Constraints The handling ring, fixtures, and harnesses will support the propellant module safely and without damage. The equipment will provide maximum convenience and safety to the crew and the module. C. Effectiveness 1. Reliability - The probability that the verification is successful shall be greater than 0.99. 2. Safety N/A D. Interfaces The propellant module will interface with the hoist ring and harnesses. These equipment items will be easily attached and removed and the module will provide hard points to facilitate their attachment and removal. The module will also interface with the INT-21. This interface will satisfy design requirements that facilitate its attachment and verification.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	LOAD PROPELLANT MODULE ON INT-21 AND VERIFY 4.12	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 1
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
MOVE PROPELLANT MODULE TO INT-21 HIGH BAY CELL 4.12.1	A. Functional Description The propellant module will have handling rings and harnesses attached lifted clear of its dolly by the low bay aisle crane. It will then be moved to the high bay aisle and transferred to the high bay crane. B. Design Considerations/Constraints The transport dolly will support the module assembly while the handling ring and harnesses are being attached. The dolly will then release the assembly while it is hoisted clear by the low bay crane. Tag lines will be used as necessary. C. Effectiveness 1. Reliability N/A 2. Safety N/A D. Interfaces The module assembly will interface with the handling kits and harnesses. They will be designed to provide adequate protection, and facilitate installation and removal.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	MOVE MODULE TO INT-21 HIGH BAY CELL 4.12.1	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 2 REV & DATE _____ VERIFIED _____	

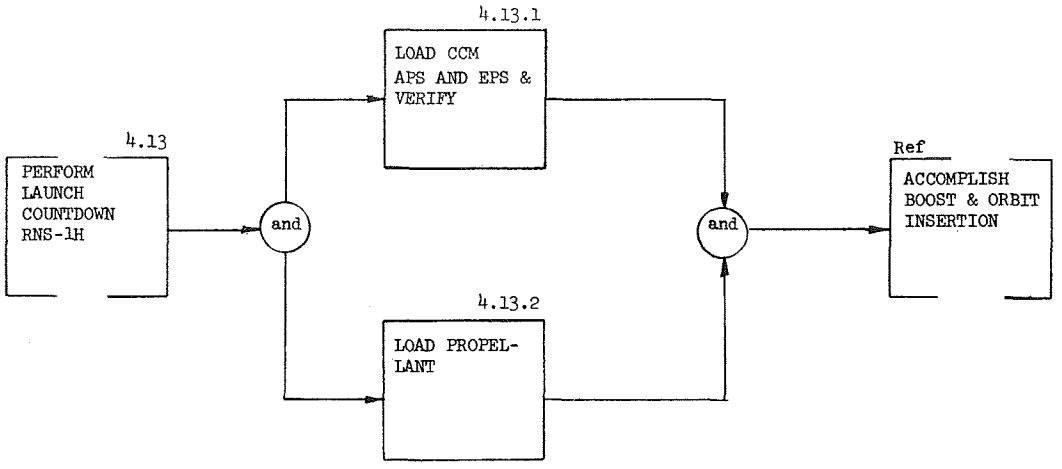
FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
MOVE PROPELLANT MODULE TO INT-21 HIGH BAY CELL 4.12.1 (Cont'd)	D. Interfaces (Cont'd) A high ranger will be used to assist in the installation of the handling ring. Protective devices will be supplied as required to prevent damage to the propellant module assembly.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	MOVE MODULE TO INT-21 HIGH BAY CELL 4.12.1	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 2 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
HOIST PROPELLANT MODULE TO TOP OF INT-21, MATE AND VERIFY 4.12.2	A. Functional Description The propellant module will be hoisted to the top of the INT-21 launch vehicle and mated. B. Design Characteristics/Constraints The hoist beam will be designed to accommodate its transfer from the Low Bay crane to the High Bay crane. The crane will support the assembly while the access platforms are emplaced. C. Effectiveness 1. Reliability N/A 2. Safety N/A D. Interfaces The propellant module will interface with the hoist ring and the handling harnesses.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	HOIST MODULE TO TOP OF INT-21, MATE AND VERIFY 4.12.2	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 1
REV & DATE _____ VERIFIED _____



	FUNCTIONAL DIAGRAM TITLE AND NUMBER			FUNCTIONAL FLOW BLOCK DIAGRAM	
	PERFORM LAUNCH COUNTDOWN RNS-1H 4.13			CONTRACTOR	
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM LAUNCH COUNTDOWN 4.13	A. Functional Description The launch countdown for the CCM/propellant module will be performed. It will include the load of the APS and electric power system of the CCM, and the load of propellant (LH_2) into the propellant module. B. Design Characteristics/Constraints Load of the CCM and load of the propellant module will be accomplished in parallel and with the countdown sequence of the space shuttle. Methods and criteria that obtain on the Saturn V will be used. C. Effectiveness 1. Reliability - The probability that the launch countdown is successful shall be greater than 0.95. 2. Safety - Applicable safety requirements for the handling of liquid hydrogen and liquid oxygen shall apply. D. Interfaces The CCM/module assembly will interface with the mobile launcher umbilicals. They will perform their functions according to Saturn V criteria.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM LAUNCH COUNTDOWN 4.13	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 1
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
LOAD CCM APS AND EPS AND VERIFY 4.13.1	A. Functional Description The APS and the EPS of the CCM will be loaded during countdown with propellant and reactant. B. Design Characteristics/Constraints LOX and LH_2 will be loaded into the CCM APS. Purge, chilldown, and fill functions will be provided to conform to Saturn V criteria. C. Effectiveness 1. Reliability N/A 2. Safety See Item 413. D. Interfaces The CCM will interface with the mobile launcher umbilical. It will perform its function according to Saturn V criteria.				

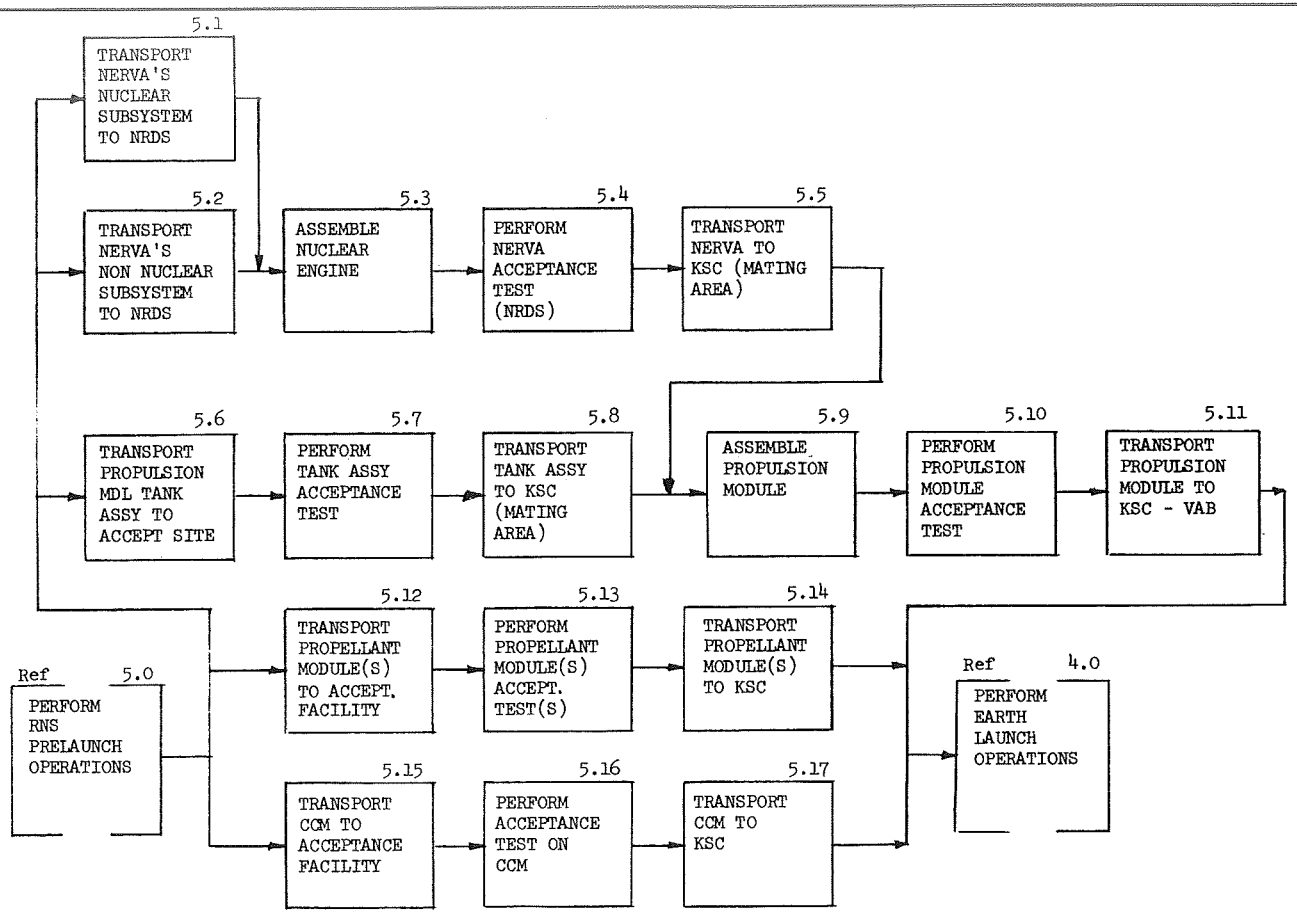
RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	LOAD CCM APS AND EPS AND VERIFY 4.13.1	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 1

REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
LOAD PROPELLANT IN PROPEL-LANT MODULE 4.13.2	A. Functional Description Liquid hydrogen will be loaded into the propellant module. B. Design Characteristics/Constraints The purge, chilldown, and fill functions for the propellant module will be performed in accordance with Saturn V criteria. C. Effectiveness 1. Reliability N/A 2. Safety See Item 413 D. Interfaces The propellant module will interface with the mobile launcher umbilicals. It will perform its function according to Saturn V Criteria.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	LOAD PROPELLANT IN PROPELLANT MODULE 4.13.2	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 1 REV & DATE _____ VERIFIED _____	



	FUNCTIONAL DIAGRAM TITLE AND NUMBER			FUNCTIONAL FLOW BLOCK DIAGRAM	
	PERFORM RNS PRELAUNCH OPERATIONS 5.0			CONTRACTOR	
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM RNS PRE-LAUNCH OPERATIONS 5.0	A. Functional Description This function covers the operations performed on the RNS from the initiation of shipment from the manufacturing site(s) to delivery at KSC. B. Design Characteristics/Constraints 1. Mating of propulsion module elements performed at KSC. 2. Provide transportation for individual RNS elements as follows: a. NERVA nuclear subsystem - Pittsburgh to NRDS. b. NERVA non nuclear subsystem - Sacramento to NRDS. c. NERVA engine system - NRDS to KSC. d. Propulsion module run tank - Huntington Beach to MTF to KSC. e. Command and control module - Huntington Beach to KSC. f_1. RNS-3 propellant modules - Huntington Beach to MTF to KSC. f_2. RNS-1H propellant module - Michoud to MTF to KSC. g. Propulsion module - mating area to VAB at KSC. 3. Acceptance testing shall be performed on all CEI's and deliverable equipment. To the extent possible, it shall be performed so as to provide a measure of overall quality, detect unsatisfactory items and be performed so that it simulates product end use and function. a. NERVA nuclear subsystem - TBD. b. NERVA non nuclear subsystem - TBD. c. NERVA engine system - TBD.	Baseline			Evaluate alternate sites Evaluate alternate modes of transportation

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM RNS PRE-LAUNCH OPERATIONS 5.0	CONTRACTOR

REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 4
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM RNS PRE-LAUNCH OPERATIONS 5.0	d. Propulsion module run tank - cryogenic proof test, electrical continuity check and interface functional checks at MTF. e. Command and control module - functional checks of subsystems including simulated APS firing at SIL in Huntington Beach. f. Propellant module(s) - cryogenic proof test, electrical continuity checks and interface functional checks at MTF. g. Propulsion module - pose mating simulated functional checks perform at KSC. D. Effectiveness Requirements 1. Reliability N/A 2. Safety a. Provisions shall be incorporated for position safing of the NERVA engine system element. b. Surface transportaion will be in accord with ICC regulation TBD when highways are used and TBD when rail or air transportation is used. c. The transportation of nuclear elements over water bodies shall be minimized to the extent possible and practical. d. All inherent hazards associated with the deisgn, e.g., high gas pressure, high voltage, radiation, etc., shall be identified.	Baseline			Establish requirements for acceptance test Evaluate alternate means of product verification

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM RNS PRE-LAUNCH OPERATIONS 5.0	CONTRACTOR

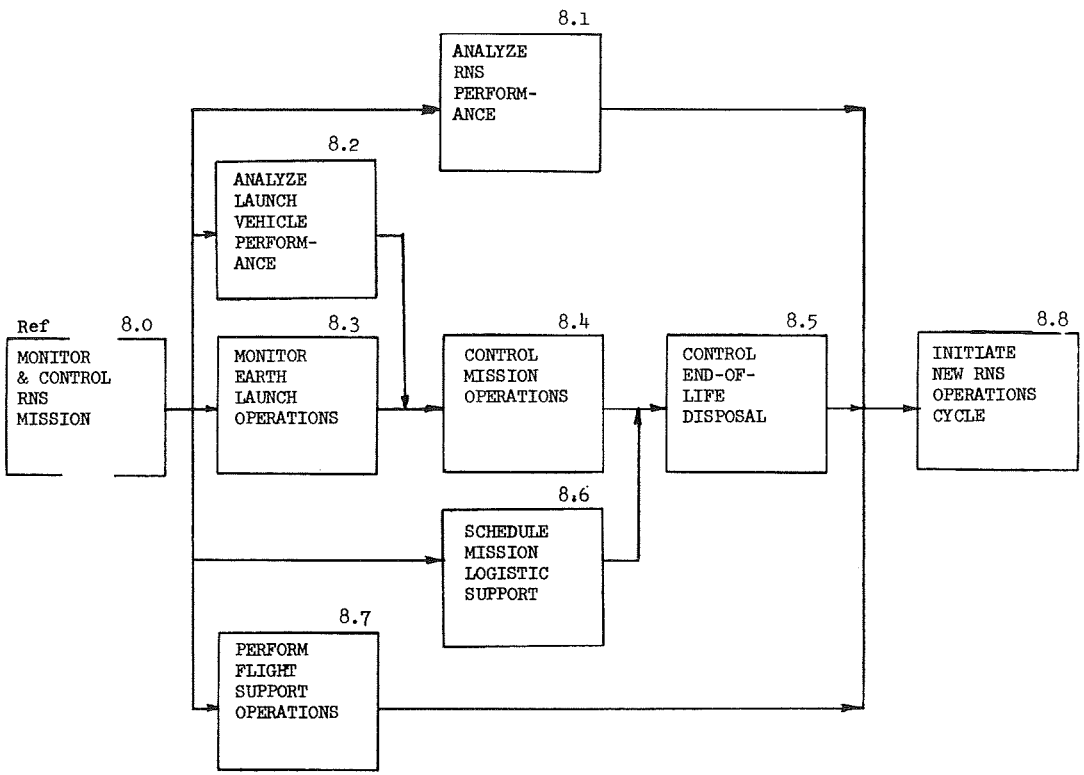
REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 4 7
REV & DATE _____ VERIFIED _____

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM RNS PRE-LAUNCH OPERATIONS 5.0	e. The use of incompatible materials, dissimilar metals, materials in the vicinity of potential spills of corrosive liquids shall not be permitted. f. Safety consideration for peronnel shall take precedence over those for equipment. g. Safety design requirements shall minimize degradation of normal operations wherever possible. h. Recommendations of contingency planning committee shall be incorporated where feasible. 3. Maintainability Equipment design shall adhere to the following accepted maintainability features. a. Minimum number and complexity of maintenance tasks. b. Rapid recognition of malfunctions. c. Rapid isolation of malfunctions. d. Optimum equipment/component accessibility. e. Minimum training requirements for maintenance personnel. f. Minimum requirements for tools and test equipment. g. Maximum safety for personnel and equipment. E. Interface Requirements				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM RNS PRE-LAUNCH OPERATIONS 5.0	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 3 of 4 / REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
PERFORM RNS PRE-LAUNCH OPERATIONS 5.0	1. The production of propulsion module run tank and engine hardware shall be in conformance with Interface Control Drawing (ICD) # TBD, to assure proper mating of same at KSC. 2. The interfaces of the elements with the supporting acceptance testing facilities shall be as defined by ICD # TBD.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	PERFORM RNS PRE-LAUNCH OPERATIONS 5.0	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 4 of 4 REV & DATE _____ VERIFIED _____	



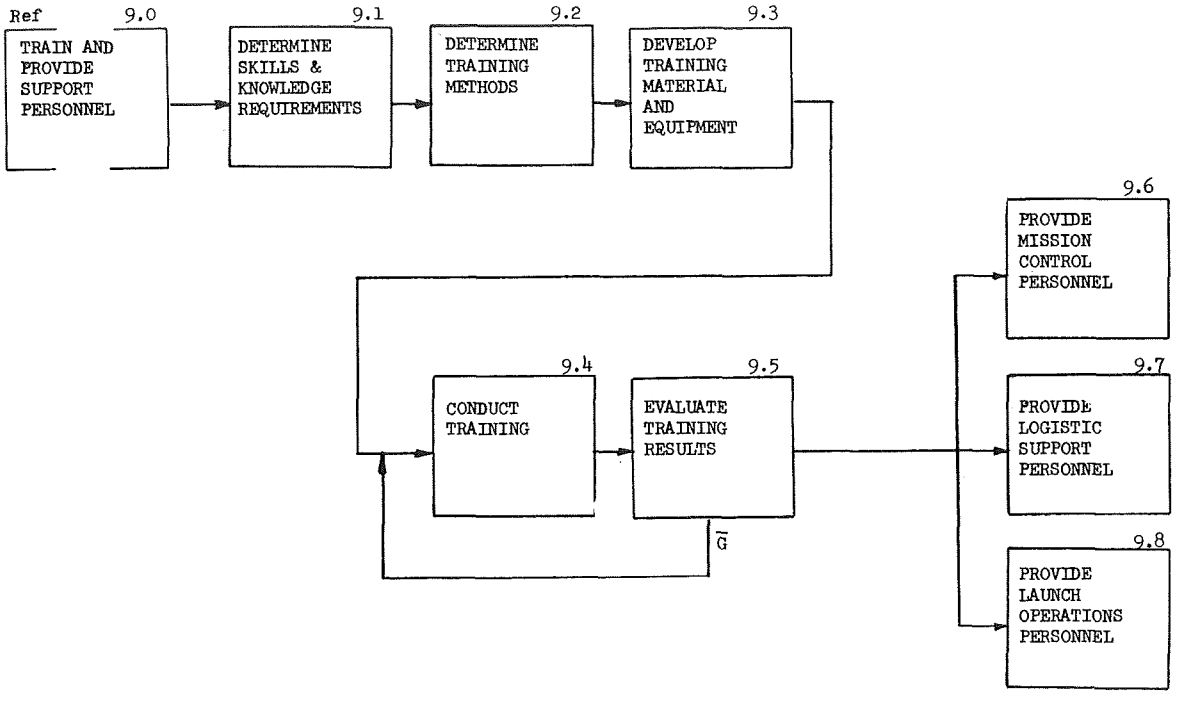
	FUNCTIONAL DIAGRAM TITLE AND NUMBER			FUNCTIONAL FLOW BLOCK DIAGRAM	
	MONITOR AND CONTROL RNS MISSION 8.0			CONTRACTOR	
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
MONITOR AND CONTROL RNS MISSION 8.0	A. Functional Description The objective of this function is to provide the means for exercising control over the performance of the missions from the initiation of liftoff at KSC ultimate end of life disposal of the RNS. B. Design Characteristics/Constraints 1. The control function is divided into three areas: earth launch operations, missions operations and end-of-life disposal operations control. 2. The control function shall be ground based. LCC shall control earth launch operations, MCC shall control mission and disposal operations. 3. Provisions will be made at these centers for detailed support in prediction analyses, fault isolation, and remedial planning. 4. Provisions shall be made for receipt of telemetry and transmission of command data between the RNS and control centers. 5. Provide for voice and video communications between control centers and manned RNS. 6. Mission Control Center (MCC) shall perform as backup to the RNS for guidance and navigation during mission operations. 7. MCC shall control the assembly operations and refuelling/resupply of the RNS while in earth orbit. 8. MCC shall have the capability of simultaneously controlling and/or monitoring several program elements (e.g. tug, shuttle, RNS, etc.).	Baseline Baseline			Evaluate alternate locations for control Evaluate mix of centralized versus remote processing of acquisition data

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	MONITOR AND CONTROL RNS MISSION 8.0	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 2 REV & DATE _____ VERIFIED _____	

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
MONITOR AND CONTROL RNS MISSION 8.0	9. MCC's control shall not be dependent on RNS configuration. 10. MCC shall accommodate real time operations. 11. The MSFN shall be employed for providing instrumentation coverage and flight support for the RNS missions in earth lunar space. D. Effectiveness Requirements Reliability The probability of successful completion of this operation shall be greater than 0.75. E. Interface Requirements The exercise of mission control shall require coordination with the logistics support function for scheduling of spares and resupply.				Evaluate usage of satellites to facilitate operations Establish whether continuous coverage is required

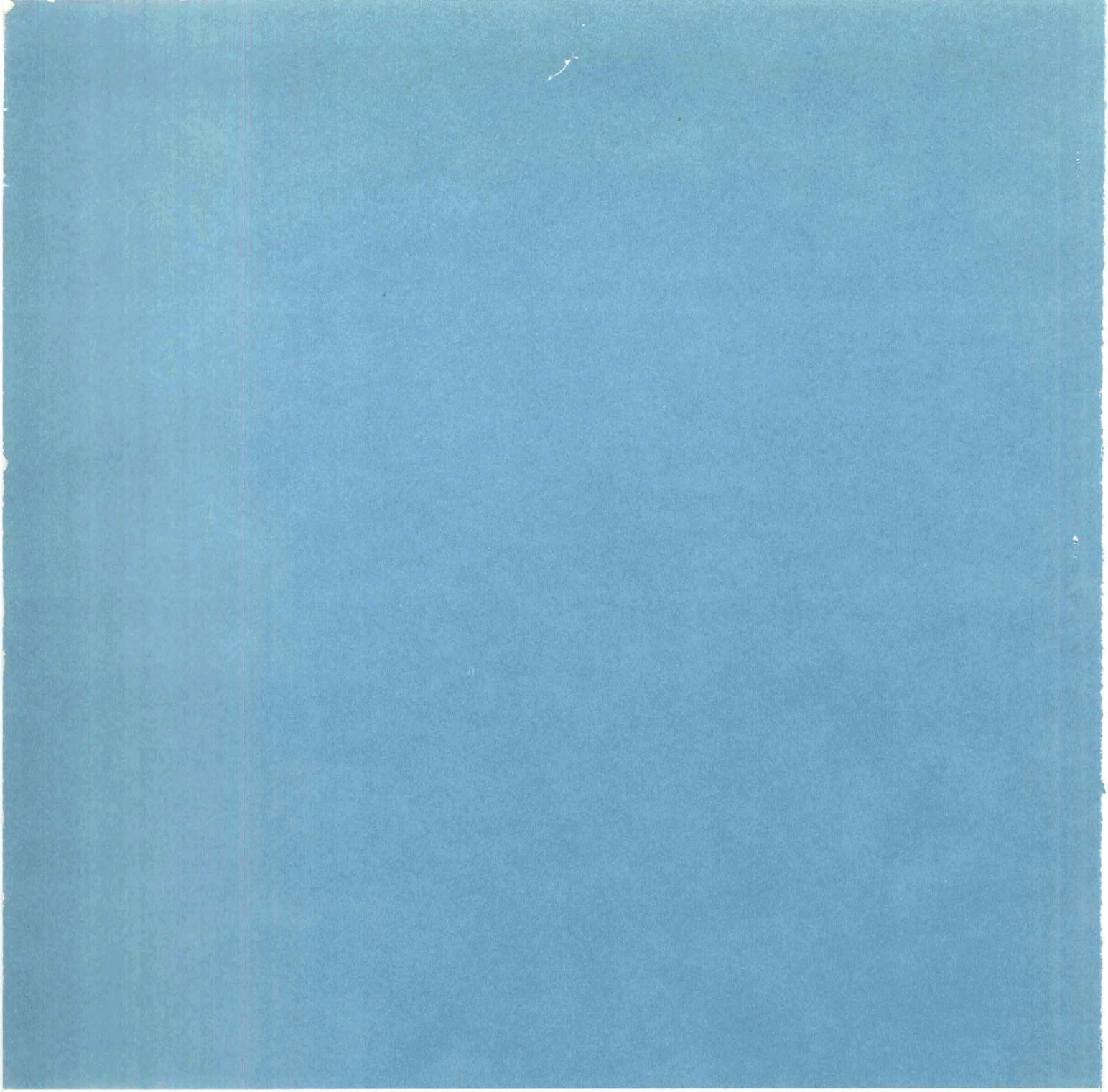
RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	MONITOR AND CONTROL RNS MISSION 8.0	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 2 of 2 REV & DATE _____ VERIFIED _____	



	FUNCTIONAL DIAGRAM TITLE AND NUMBER			FUNCTIONAL FLOW BLOCK DIAGRAM	
	TRAIN AND PROVIDE SUPPORT PERSONNEL 9. 0			CONTRACTOR	
PRE-IIC	REV & DATE	ORIG DATE	APPROVAL	DOC NO.	PG
IIC	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG
SLI	REV & DATE	ORIG DATE	VERIFIED	DOC NO.	PG

FUNCTION NAME & NUMBER	DESIGN REQUIREMENTS	REQMT SOURCE	EQUIPMENT IDENTIFICATION CEI, OR SECONDARY FUNCTIONAL AREA	FACILITY, GSE REQUIREMENTS	TRADE STUDIES, ANALYSES
TRAIN AND PROVIDE SUPPORT PERSONNEL 9.0	A. Functional Description Provisions will be made to supply qualified personnel to support launching, operating and maintaining the RNS system during its life cycle. B. Design Characteristics/Constraints 1. The RNS system personnel shall fall into the following categories: a. Launch operations - including assembly checkout, loading and launch of the RNS. b. Refurbishment and/or maintenance - on the ground and/or in earth orbit. c. Operations - flight crew performing shuttle mission within a spacecraft attached to the RNS. D. Effectiveness Requirements The RNS system and its subsystems shall require a minimum of highly skilled and specialized support personnel. E. Interface Requirements RNS support personnel shall be capable of supporting other projects, e.g., space shuttle.				

RH RAS	FUNCTIONAL DIAGRAM TITLE AND NUMBER	REQUIREMENT ALLOCATION SHEET
	TRAIN AND PROVIDE SUPPORT PERSONNEL 9.0	CONTRACTOR
	REV & DATE _____ ORIG DATE _____ APPROVAL _____ DOC NO. _____ PG. 1 of 1 REV & DATE _____ VERIFIED _____	



MCDONNELL DOUGLAS ASTRONAUTICS COMPANY

5301 Bolsa Avenue, Huntington Beach, California 92647 (714) 897-0311