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MODULAR **space station** PHASE B EXTENSION

PROGRAM OPERATIONS PLAN



PREPARED BY PROGRAM ENGINEERING
30 NOVEMBER 1971



Space Division
North American Rockwell

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Approved by

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Space Division
North American Rockwell

FOREWORD

This document is one of a series of documents required by Contract NAS9-9953, Exhibit C, Statement of Work for Phase B Extension-Modular Space Station Program Definition. It has been prepared by the Space Division, North American Rockwell Corporation, and is submitted to the National Aeronautics and Space Administration's Manned Spacecraft Center, Houston, Texas, in accordance with the requirements of Data Requirements List (DRL) MSC-T-575, Line Item 74.

Total documentation products of the extension period are listed in the following chart in categories that indicate their purpose and relationship to the program.

ADMINISTRATIVE REPORTS	TECHNICAL REPORTS		STUDY PROGRAMMATIC REPORTS	DOCUMENTATION FOR PHASES C AND D	
				SPECIFICATIONS	PLANNING DATA
EXTENSION PERIOD STUDY PLAN DRL-62 DRD MA-207T SD 71-201	MSS PRELIMINARY SYSTEM DESIGN DRL-68 DRD SE-371T SD 71-217	MSS DRAWINGS DRL-67 DRD SE-370T SD 71-216	EXTENSION PERIOD EXECUTIVE SUMMARY DRL-65 DRD MA-012 SD 71-214	MSS PRELIMINARY PERFORMANCE SPECIFICATIONS DRL-66 DRD SE-369T SD 71-215	MSS PROGRAM MASTER PLAN DRL-76 DRD MA-209T SD 71-225
QUARTERLY PROGRESS REPORTS DRL-64 DRD MA-208T SD 71-213, -235, -576	MSS MASS PROPERTIES DRL-69 DRD SE-372T SD 71-218, -219	MSS MOCKUP REVIEW AND EVALUATION DRL-70 DRD SE-373T SD 71-220			MSS PROGRAM COST AND SCHEDULE ESTIMATES DRL-77 DRD MA-013(REV. A) SD 71-226
FINANCIAL MANAGEMENT REPORTS DRL-63 DRD MF-004	MSS INTEGRATED GROUND OPERATIONS DRL-73 DRD SE-376T SD 71-222	MSS KSC LAUNCH SITE SUPPORT DEFINITION DRL-61 DRD AL-005T SD 71-211			MSS PROGRAM OPERATIONS PLAN DRL-74 DRD SE-377T SD 71-223
	MSS SHUTTLE INTERFACE REQUIREMENTS DRL-71 DRD SE-374T SD 71-221	INFORMATION MANAGEMENT ADVANCED DEVELOPMENT DRL-72 DRD SE-375T SD 72-11			
	MSS SAFETY ANALYSIS DRL-75 DRD SA-032T SD 71-224				

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ABSTRACT
THIS DOCUMENT IS A PLAN WHICH DEFINES AN ORGANIZED APPROACH FOR ESTABLISHING THE MOST SIGNIFICANT REQUIREMENTS PERTAINING TO MISSION OPERATIONS, INFORMATION MANAGEMENT, AND COMPUTER PROGRAM DESIGN AND DEVELOPMENT FOR THE MODULAR SPACE STATION PROGRAM. THESE REQUIREMENTS SHALL BE DERIVED FROM PHASE B STUDY RESULTS AND FURTHER STUDIES REQUIRED IN PHASE C. THIS DOCUMENT IS INTENDED TO REFLECT PROGRAM PLANNING FOR NASA.

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1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this document is to define an organized approach for establishing the most significant requirements for the modular space station (MSS) program operations plan. The MSS program operations plan shall define and describe mission operations, information management, and computer program development (software management) activities for the Phase C design.

1.2 SCOPE

The MSS program operations plan shall pertain to the space station and experiment module program elements and to the ground elements required for mission management and mission support operations. The plan shall include sections on mission operations, information management, and computer design and development.

The mission operations section (2.0) shall provide the approach to: identification of activities from space station pad operations to crew ascent; initial space station buildup, checkout and activation, and other manned assembly operations; rendezvous and docking; logistics operations; design reference missions; space station and orbiter in-orbit operations and disposal; and recovery or retrieval of experiment modules.

Section 3.0, Information Management, shall establish the approach to identifying activities of the communications and tracking network, data relay satellites, and operation of experiments, including the interfaces with the experiment community.

The approach necessary to design, develop, control, verify, and maintain all flight and ground computer programs to support the MSS program shall be identified in Section 4.0, Computer Program Development.

2.0 MISSION OPERATIONS

2.1 MISSION SUMMARY

The mission summary shall be based on the design reference mission and mission sequence plan that identifies the phases of buildup to the initial space station, buildup to the growth space station, logistics operations, and the experiment phasing program. The philosophy and guidelines used to establish (1) sequences of module buildup, (2) on-orbit assembly, checkout and subsystem activation, (3) experiment phasing, (4) logistics resupply scheduling, and (5) operational orbit and flight mode selection shall be defined.

Design Reference Mission

A design reference mission shall be defined which imposes the conditions and constraints which establish subsystem design requirements. The design reference mission shall be made up of a number of flight phases that do not necessarily connect but represent those extremes that exist within established flight and/or mission boundaries. The design reference mission shall identify the design-to orbit (altitude and inclination), which establishes: orbit makeup requirements, light-dark cycles, control moment gyro (cmg) requirements, worst-case rendezvous phasing requirements, and maximum logistics resupply requirements. Ascent and recovery loads (accelerations) shall be defined for modules delivered to the space station and returned to the ground.

Experiment Discipline Activity Levels and Support Requirements

During MSS operation, the level of manned activity within the established experiment disciplines will vary, depending upon the experiment demands and interdiscipline priorities. Rather than attempt to establish fixed activity levels or priorities, the MSS operational capabilities shall be developed to permit various levels of activity within a given experiment discipline.

Crew, electrical power, data, logistics support, and accommodation requirements to support established activity levels in the various experiment disciplines shall be defined.

Operational and Program Scheduling Constraints

Scheduling constraints shall be derived from programmatic, operational, and design constraints. These shall include crew size, experiment duration, experiment sequencing, interexperiment and intraexperiment time completion-initiation constraints, experiment equipment availability (development constraint), and concurrent experiment operation requirements.

Mission Sequence Plan

The mission sequence plan shall represent an overall programmatic description of the MSS mission and shall indicate the general order and timing of significant mission operations. The plan shall be based on the experiment and modular station operations (both initial and growth) needed to support the NASA Experiment Program. It shall be derived by time-phasing various

experiment operating modes to obtain maximum benefits at minimum cost. The significant mission operations shall be defined in terms of initial station buildup operations, logistics operations, crew rotation requirements, growth station buildup operations, overall experiment operations, and station disposition.

A representative mission sequence plan is provided in the MSS Preliminary System Design document, SD 71-217, Volume II, as developed during the Phase B definition study.

2.2 OPERATIONS AND REQUIREMENTS

This section shall present the sequence of operations and requirements of the MSS program elements throughout all phases of the modular station mission. The major operational phases for the MSS program include: (1) prelaunch operations, (2) ascent-to-orbit operations, (3) on-orbit assembly operations, (4) routine operations, and (5) periodic operations. For each of the major mission phases, the major operation-related functions which either affect subsystem design requirements or which shall be derived from subsystem design and operational requirements, and the minimum and maximum time duration of each of the phases or significant operations shall be defined. The major operation-related functions shall also include the identification of required safety precautions and warnings for each operational phase.

Prelaunch Operations

Prelaunch operations include those sequences of events that occur from module delivery through launch preparations, launch readiness verification, consumables and cargo loading (when applicable), module loading in orbiter, and launch countdown as related to the payload modules. Specific operations and sequences affecting information management and software requirements (such as the common data base computer program) shall be defined.

Ascent-to-Orbit Operations

Ascent-to-orbit operations shall include data on the initial and subsequent launches (which include station modules, cargo modules, and RAM's). Operational data will cover on-orbit delta-V requirements, final on-orbit altitude and payload allowance (shuttle capability), shuttle delivery mission duration, ascent profiles, and phasing data.

On-Orbit Assembly Operations

On-orbit assembly operations shall include requirements information on module berthing, module direct docking, and buildup sequences for initial and growth stations. The buildup sequence for the initial station shall include details on intermittent manned operations (shuttle present) and quiescent operations (unmanned, between shuttle flights during buildup).

Berthing operations shall include basic manipulator operations, timelines, visibility displays, and lighting requirements. Shuttle attitude control propellant requirements while berthed to the modular station also will be defined.

Direct docking shall include shuttle delta-V requirements, timelines, visibility displays, and lighting requirements.

Buildup sequences shall include data on gross launch schedules, logistic resupply requirements, early manning capabilities, and the advantages (pro or con) for maximum feasible launch rates. Intermittent manned operations shall define crew requirements, tasks, skills, assembly operations and timelines, and the degree of checkout and subsystem activation. Quiescent operations shall include station-to-shuttle and station-to-ground telemetry requirements and the level of subsystems activation. Orbit makeup, station maneuver, and attitude flight modes shall be defined for intermittent manned and quiescent operations.

Routine Operations

Routine operations constitute the major time duration of the modular space station program. During this phase, the NASA-specified Candidate Experiment Program is performed. The following principal activities and resulting requirements shall be defined:

1. Experiment operations. These operations include the routine day-to-day scientific and engineering operations needed to perform the established experiment program. This shall include the operation and control of laboratory equipment and attached and detached research and applications modules (RAM's).
2. Experiment support operations. These shall include the crew and primary subsystem operations directly supporting the experiment program. This shall include subsystem operations involved with providing experiment electrical power, stability and control, environmental control, and data handling.
3. Station operations. These operations shall involve flight, administration and management, maintenance, and housekeeping operations that indirectly support the experiment crew members and program.

Periodic Operations

Periodic operations occur concurrently with routine operations but are uniquely different in that they are generally infrequent, intermittent, or cyclical, and are of short duration (compared to total program length) in occurrence. The following principal activities and resulting requirements associated with periodic operations shall be defined:



Logistics resupply. Resupply shall include crew replacement requirements definition and quantities of consumables, spares, replacements, waste, experiment data (up and down), logistic flight frequencies, and cargo module hookups and operations associated with delivery and return of the cargo module.

Orbit maintenance. Orbit makeup maneuvers to provide altitude control for earth-viewing, astronomy, biology, and physics experiments shall be determined.

Orientation maneuvers. Maneuvers to various flight modes for experiment viewing, capture by shuttle manipulator or direct shuttle docking, and small translation maneuvers shall be determined.

Experiment module delivery. Delivery operations and requirements associated with attached and detached modules shall be defined and shall include command and control, berthing and docking control, and attitude and stability requirements.

Detached experiment module management. Retrieval, servicing, maintenance, refurbishment, and deployment operations shall be identified. Also, the relative operating ranges, predicted relative positions, and retrieval frequencies shall be defined.

Solar array replacement. Flight, docking, power switching, system activation, and command operations involved with the removal and replacement of the solar arrays shall be determined.

3.0 INFORMATION MANAGEMENT

3.1 INFORMATION MANAGEMENT CONCEPT

Information management is defined as those activities (in space and on the ground) that are required for the acquisition, flow, storage, processing, analysis, control, and display of all intelligence required to accomplish the MSS program objectives.

Modular Space Station

The information management concept for the modular station shall be defined for each mission phase, and the relationship of this subsystem with other program flight elements and ground data and information complexes shall be determined. The mission phases shall include:

- Prelaunch operations
- Ascent-to-orbit operations
- On-orbit assembly operations
- Routine operations
- Periodic operations

For the detailed operations of each of these phases, concepts for tracking and acquisition, communications, data processing, command and control, principal investigator interface, and other program element interfaces (if applicable) shall be defined.

Mission Operations Support System

The mission operations support system (MOSS) encompasses the sites, facilities, equipment, and services for the executive direction, management, planning and operational support for the MSS and the experiment program. The MOSS concepts shall be defined for the mission management site and mission support sites. These concepts shall be integrated into a ground information subsystem.

3.2 INFORMATION MANAGEMENT FUNCTIONAL REQUIREMENTS

The information management system functional requirements shall be derived by considering the on-board and ground functions shown in Figure 1. These functions (not considered as all-inclusive) shall be used to determine specific baseline requirements for the modular space station information subsystem and ground facilities. A matrix of functional interfaces between program elements and flight phases shall be developed for the principal functions of tracking and acquisition, communications, and data processing. Functional requirements also shall be defined for a data relay satellite system (DRSS), mission support sites, and for the scientific community interface.

Tracking and Acquisition

The number of mission support sites required to provide the mission

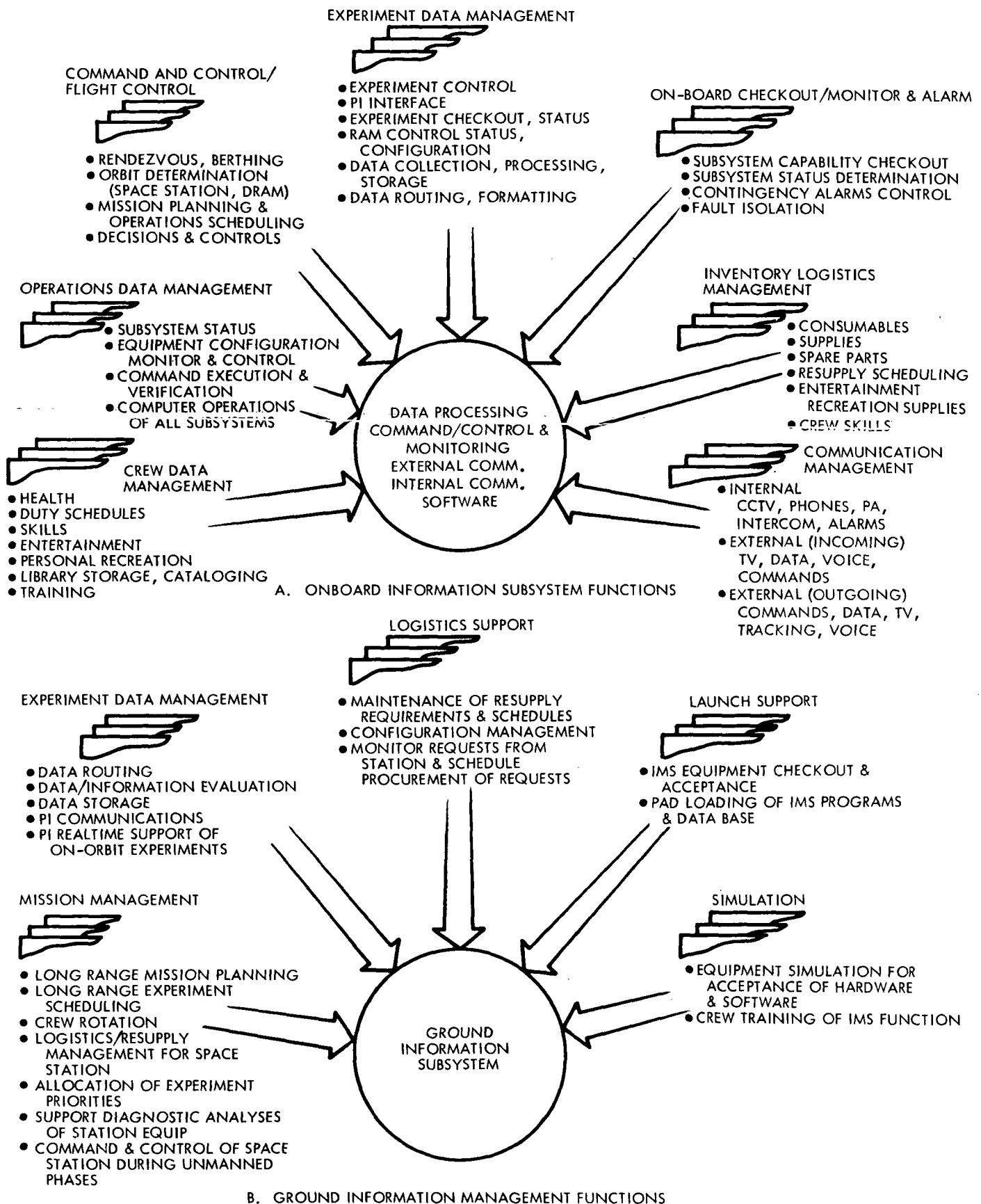


Figure 1. Information Management System Functions

management site current tracking data on the modular station and detached research and applications modules (DRAM's) shall be defined. The requirement for a DRSS to assist in tracking orbiting vehicles also shall be determined.

The use of semidirectional and parabolic antennas on the MSS to provide tracking of DRAM's and the shuttle shall be defined.

Communications

The functional communications requirements of all MSS program elements shall be defined. Simultaneous communication requirements, number of RF links, and channel baseband sizes shall be identified. Various data modes, such as voice, telemetry, TV, etc., also shall be defined.

Data Processing

The type functions and anticipated quantities of data processing shall be determined for all mission flight phases. Types of data processing shall include (1) the input and retrieval of information from the common data base, (2) ground and on-board checkout, (3) logistics inventory (ground and flight), (4) operations data management, (5) flight operations, and (6) experiment data management.

Scientific Community Interface

Functional requirements for the collection, collation, processing, evaluation, storage, and distribution of MSS experiment data shall be determined. In addition, the need for real-time or minimum delayed response in communications between the space station and ground truth sites shall be identified for candidate experiment operations.

3.3 INFORMATION MANAGEMENT BASELINE

The baseline information management system shall be described for both the modular space station and the mission operations support systems and shall have the capability of performing the functional requirements previously identified in Section 3.2.

Modular Space Station Information Subsystem

The MSS information subsystem shall perform the functions of command and control, communications and tracking, and data processing utilizing station computer programs that are operated, maintained, and improved by crew participation. Baseline capabilities shall be defined for the following functions.

Command and control. Capabilities shall include flight management, station operations management, planning and schedule management, and experiment operations and management.

Communications and tracking. This function shall include external communications, internal communications such as audio entertainment and paging, audio/video, digital data distribution, and tracking.

Data processing. Acquisition, processing, distribution, and storage shall be included.

Ground Information Subsystem

The ground information subsystem is an inherent part of the mission operations support system and is defined to be part of the ground complex. The ground information subsystem baseline shall be described in terms of the ground complex facilities, which perform the functions of mission management and mission support.

Mission Management

The mission management site shall provide the overall management and planning for the MSS program. These functions shall include mission planning, flight operations management, logistics inventory management, experiment operations planning, and experiment operations management. Further definition of these functions follow:

Mission planning. Mission planning shall provide the executive function of the mission operations support system by integrating and controlling plans and schedules for launch, resupply, crew rotation, and conducting training experiments. Priorities and ground facility and resource planning and scheduling also shall be included.

Flight operations management. Flight operations management shall maintain executive control of the mission and shall integrate analyses of the MSS status and experiment objectives accomplishment. It also shall provide the centralized control of communication with the MSS mission elements.

Logistics inventory management. Based on the plans and schedules developed and integrated by mission planning, the logistics inventory management function shall provide for equipment, consumables, spares, and experiments. It also shall provide a similar function for the ground sites required to support the MSS.

Experiment operations planning. The experiment operations planning function shall provide the procedures timeline requirements and scheduling requirements to the mission planning function for integration into the overall mission management.

Experiment operations management. The control of experiment data flow and processing shall be provided by experiment operations management. It shall provide the analysis function for reassessment of experiment performance. Requirements for resources and facilities scheduling to support experiment data acquisition shall be provided to mission planning by experiment operations management.

The baseline subsystems shall be defined and shall satisfy the functional requirements previously defined for each management function.

Mission Support

The mission support baseline subsystems shall be defined and shall satisfy the functional requirements established in Section 3.2. The baseline shall be defined for the following mission phases:

- Prelaunch operations
- Ascent-to-orbit operations
- On-orbit operations
- Routine operations
- Periodic operations

This shall include baseline capabilities for acquisition and tracking, communications, data processing, and data management (dissemination and disposal).

3.4 TASK SUMMARIES

Task summaries shall be prepared that define the activities required for the development of the information management system. These task summaries shall be prepared for the following program elements.

- Modular space station
- Logistics system
- Research and application modules (RAM's)
- Mission launch site
- Mission management site
- Mission support sites

Task summaries also shall be prepared for the common data base, which shall integrate specific categories of information from all program elements for storage and retrieval throughout the MSS program.

3.5 TECHNICAL DOCUMENTATION REQUIREMENTS

The following documents shall be prepared for the development of the information management system.

- Information Management Traffic Flow Model
- Flight Operations Information Management Plan
- Mission Support Operations Information Management Plan
- Common Data Base Information Management Plan

4.0 COMPUTER PROGRAM DESIGN AND DEVELOPMENT

Because of the magnitude, complexity, and duration of the space station program, the most feasible approach to establishing an MSS computer program is through the development of modular computer programs. These computer programs should be managed and controlled at authority levels that parallel hardware management. For the successful development of all modular computer programs, a common set of rules, formats, user's languages, and production/acceptance procedures shall be established and followed to assure interchangeability and versatile utilization of the end-product computer routines.

The following paragraphs identify the requirements for a well-planned development concept, computer program system requirements, computer program development, task summaries, and technical documentation requirements.

4.1 COMPUTER PROGRAM DEVELOPMENT CONCEPT

Computer programs of a wide variety and considerably different nature shall be required for the modular space station program. These shall range from simple sorting and formatting to complex guidance and control equations or to interactive experiment planning or the performance of on-board checkout scheduling routines as well as the evolution and use of the common data base. Initially, the structure required for the design and development of all computer programs for the MSS program shall be defined. This shall be based upon Phase C/D contract requirements and more specifically on the MSS system specifications.

A computer program integration control (CPIC) organization shall be established and shall be responsible to the user agencies for the design and development of all computer programs. All hardware prime contractors and most major subcontractors shall support the computer program development functions. CPIC shall be required to ensure compatibility between computer program/computer program, computer program/hardware, and computer program/personnel. This management function shall be implemented through the use of planning documents, established computer standards and conventions, computer program specifications, design and development reviews, and timely and well-managed change control procedures.

Computer program system requirements analyses and tradeoff studies shall be performed based on contractual documents and the MSS systems specifications. These analyses shall provide the definition of the computer program structure and organization. This shall include a definition of computer programs at the program, program element, systems, subsystems, assemblies, and component levels. The design and development of these defined computer programs then shall be assigned to the appropriate contractor.

Design specifications shall be established for each computer program. These specifications shall include the system performance requirements to be met by both operational and support computer programs as well as relevant design requirements and design constraints relating to such parameters as timing, data sources and quantities, use of higher-order language, modes or

display-data presentation, and simulation. The specifications also shall define the minimum essential interfaces between other computer programs, computer equipment, communication links, and personnel. Furthermore, it shall include such requirements as types and capacities of computer and file storage, timing, types and capacities of display and input-output equipment as well as expected data link types, formats, and rates.

Computer program validation tests shall be defined and shall demonstrate that each modular computer program meets specification requirements and hardware requirements and is compatible with other interfacing computer programs. The CPIC shall develop these verification test plans. Contractors responsible for computer program development shall prepare user's manuals and computer program validation test procedures with the concurrence of the CPIC.

The CPIC shall prepare verification test reports on all modular and integrated computer program tests. From these test reports, the CPIC shall update computer program listings, the common data base package and user's manuals to complete the software total computer program configuration baseline. This computer software baseline shall then be used for operational readiness testing prior to the launch of the first module of the Modular Space Station.

4.2 COMPUTER PROGRAM SYSTEM REQUIREMENTS

Computer program system requirements are the results of analyses that are performed at program, project system, and subsystem levels and which define the basic requirements, standards and conventions, and constraints needed for developing various modular computer programs. The following paragraphs identify some of the basic requirements (but are not all-inclusive) that shall be identified for all modular computer programs.

A detailed analysis of computer program requirements for all program elements (modular station, ground, DRAM's, and shuttle) and all mission phases (ground checkout, refurbishment, prelaunch, on-orbit operations, and recovery) shall be performed based on NASA program requirements and the MSS project and system specifications. These analyses shall define all computational requirements for the control of systems, subsystems, and experiments either in flight or on the ground. This shall include control of flight operations, communications, performance of testing and checkout, assessing sensed data, processing scientific data, maintaining records, and performing all other types of computations.

Analyses shall be performed to determine data flow requirements at random peak intervals and at periodic intervals as well as for steady-state operations for all equipments, sensors, or subsystems to establish the data traffic flow model. The use of executive programs shall be evaluated for both flight and ground computer programs to increase program efficiency. In addition, the use of dedicated memory and processing units for certain applications shall be analyzed for effectively reducing data bus traffic.

The stage of development of programming languages and compiler or metacompiler requirements for translating the programs to MSS machine language shall be determined. The impact of developing separate languages

(for example: GN&C space-flight oriented language for vector/matrix expressions, data management oriented language, a test language, or a man-machine type language) or a single language shall be evaluated to indicate which program development approach should proceed.

In addition to computer software language, software requirements for all man-machine interfaces shall be defined. The definition shall include the types of displays, keyboards, switches, and controls that are most efficient for use from both the man and software interface considerations. Simulation and training programs shall be established to demonstrate, evaluate, and verify the selection of these software requirements.

A computer program development plan and a computer program system design specification shall be developed and shall illustrate how all system requirements are integrated into an operational computer program system design. This plan and specification shall apply to both ground and flight computer programs. A computer program system interface specification shall be developed to ensure compatibility between interfacing computer programs. Interfaces between computer programs shall be defined, and modifications to computer programs to resolve incompatibilities shall be accomplished or directed by the CPIC.

4.3 COMPUTER PROGRAM DEVELOPMENT

Following a logic design review to assure that the planned computer program will satisfy specification requirements, computer program coding shall be accomplished in the language specified. A coding review also shall be conducted to assure strict adherence to flow charts, maximize the use of comment statements to identify segments of calculations, and to minimize data transferral between subroutines or other computer programs.

Reviews of the software development by system engineers, scientific experimenters, hardware implementation engineers, and users shall be held regularly in the development of the preliminary software package configuration and flow chart design. Documentation shall specify exact configuration information, including flow charts, timing and sequencing, storage allocation, common data base characteristics (including organization, lists of files and tables, and table descriptions), computer program component characteristics, interfaces, and limitations.

Validation tests shall be accomplished through the use of checkout problems identified in the test plan developed during system design. Individual computer programs shall be accepted initially on the basis of the results of these checkout problems. Final acceptance will be accomplished during the verification phase. A test report shall accompany each program at the time of initial acceptance and shall identify the computer program and test, describe the functions tested, identify procedures used, and give results and recommendations.

A validation of the integrated computer program system for each program element (MSS, mission control center (MCC), or DRAM) shall be performed after all programs are individually validated and accepted. Validation of the



integrated computer programs shall consist of testing the programs in the operational environment in all expected modes possible, and, where not possible, simulations may be used. Validation will be accomplished with the operational computers interfacing with operational equipment wherever the operational equipment is available. Simulation computers may be used to generate responses where nonoperational equipment is most practical or feasible.

Verification of the computer programs shall be accomplished with flight and ground crew members utilizing the systems and subsystems that make up the operational system. Ground and flight equipment shall be utilized to the maximum extent possible.

Computer programs shall be continuously maintained or updated as new requirements are established during the course of the modular space station (MSS) program. Maintenance testing programs shall be developed to the maximum extent possible utilizing automatic fault identification and recovery techniques where applicable.

Configuration and change control shall be managed throughout the design, development, and operational phases of the MSS program. Uniform procedures shall be developed and used for preparing, formatting, and processing computer program changes. The change procedure shall be utilized at all program phases after preparation of the Computer Program System Design Specification document. Changes may occur in the MSS program at any stage, but all changes shall identify the computer program impact on other stages (or documents) as they apply.

Manuals and handbooks shall be developed and provided for the integrated computer programs for each program element (MSS, MOSS, DRAM, etc.). These documents shall define instructions for utilization of the programs in an operational mode. These documents shall contain the purpose, general description of the system and functions performed, operating procedures, input and output formats, and instructions for altering programs.

A final computer program acceptance review and demonstration shall be conducted at the time of final acceptance of each program element (MSS, MOSS, DRAM, etc.) and its software development. This review shall be performed at the final installation location by the CPIC in conjunction with NASA. The complete computer program for each program element shall be delivered to NASA at this review. This package shall include the current program description, test reports, minutes of formal reviews and inspections, and the program cards and/or tapes.

Following customer acceptance of each MSS program element computer program, an integrated test and operational verification shall be performed of two or more of the computer program systems working together with the common data base. Final verification of the combined system may be accomplished by actual control of a detached RAM (while still on the ground) from the space station during a pass over the remote module.

4.4 TASK SUMMARIES

Task summaries shall be prepared that define the activities required for the development of the various computer programs. These task summaries shall be prepared for the following program elements:

- MSS
- Logistics system
- RAM's
- Mission launch site
- Mission management site
- Mission support sites

Task summaries also shall be prepared for the computer program for the common data base. This task shall integrate elements of ground and flight information for storage and retrieval throughout the MSS program.

4.5 TECHNICAL DOCUMENTATION REQUIREMENTS

The following documents shall be prepared for the development of the MSS computer programs that support the information management system:

Computer Program System Development Plan. This document shall define in detail the scheduling, monitoring, and management requirements for computer program system development. It shall define in detail the requirements for each deliverable item and major event.

Modular Space Station Program Computer Program Design Specification. This document shall define the MSS program computer program system requirements, the test requirements, and the test plan for a composite test of all the integrated computer programs. This document shall be a general specification and shall derive its requirements from the MSS mission and system requirements as established by the MSS program element specifications and other contractual documents. It also shall define the computer program system standards and conventions for each program element.

Program Element Computer Program Design Specification. This document shall define the program element computer program requirements.

Computer Program Development Specifications (Part I). These documents shall establish the design requirements baseline for each computer program contract end item.

Computer Program System Interface Specifications. These documents shall establish the computer program system interface design requirements baseline for each integrated computer program contract end item. A computer program system interface specification shall be developed for selected groups of computer program contract end items (i.e., between the MSS and DRAM computer programs, between

the MSS and logistics vehicle computer programs, and between the MSS computer programs and ground computer programs, etc.).

Computer Program Product Specifications (Part II). These documents shall provide a detailed technical description of each computer program component that is a subset of the computer program contract end item. They also shall contain the computer program verification test requirements.

Computer Program System Product Specifications (Part II). These documents shall provide a detailed technical description similar to that of item 6 but at the system level.

User Manuals and Handbooks. These documents shall define instructions for each program in an operational mode. They shall include purpose, general description, functions performed, and operating procedures in sufficient detail for nonprogrammers to understand and to be able to use the program.

Computer Program System Test Procedures. These documents shall include the procedures required for performing MSS program computer program system tests. These procedures shall be based upon the test requirements and test plan specified by the Modular Space Station Program Computer Program Design Specification.