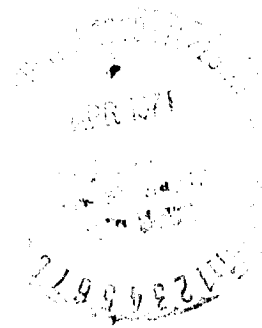
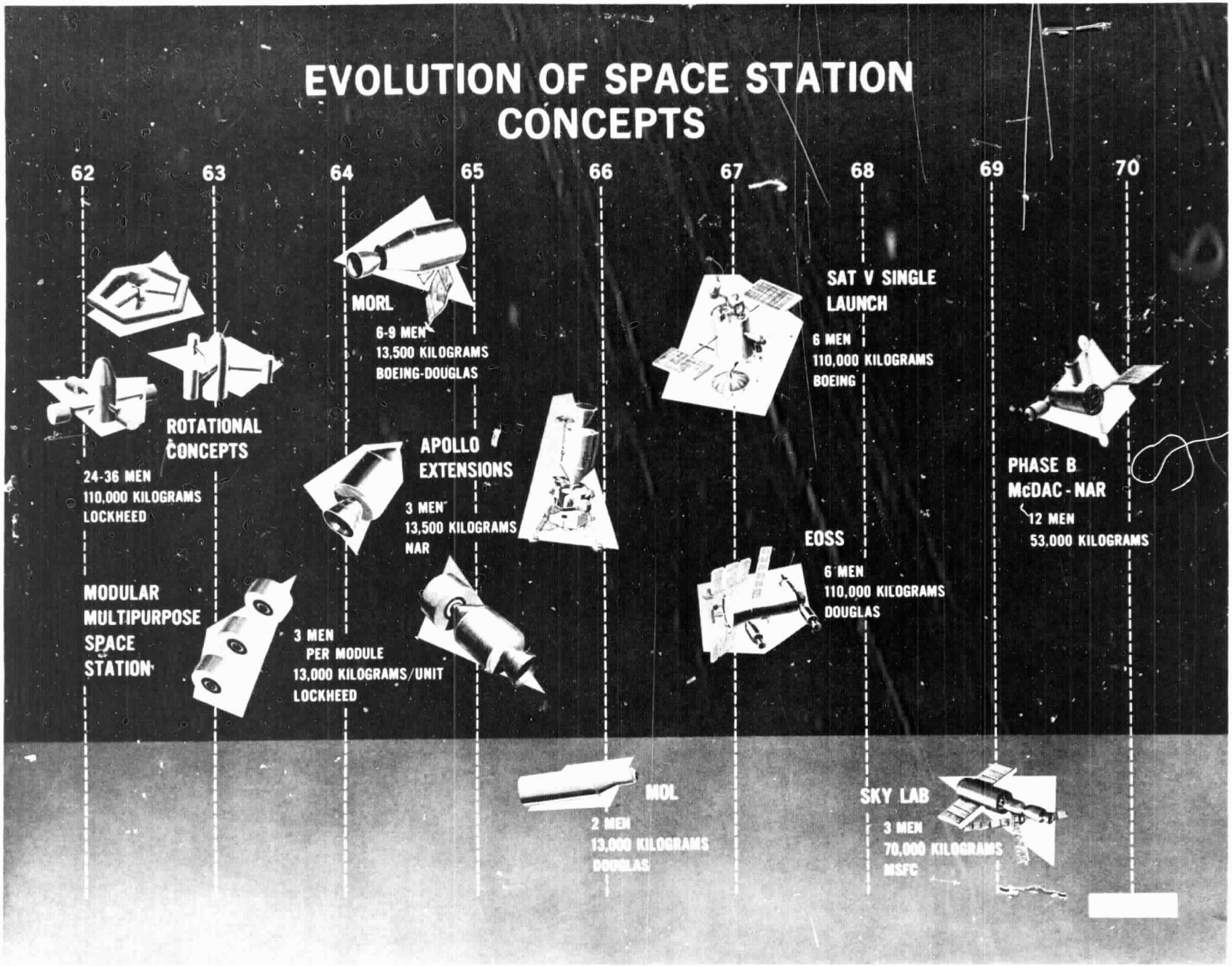
SPACE STATION PROGRAM PLANS

by Douglas R. Lord
Deputy Director, Space Station Task Force
National Aeronautics and Space Administration

Briefing to ESRO
Paris, France
June 3, 1970




EVOLUTION OF SPACE STATION CONCEPTS
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63
64
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66
67
68
69
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ROTATIONAL CONCEPTS
24-36 MEN
110,000 KILOGRAMS
LOCKHEED
MORL
6-9 MEN
13,500 KILOGRAMS
BOEING-DOUGLAS
APOLLO EXTENSIONS
3 MEN
13,500 KILOGRAMS
NAR
SAT V SINGLE LAUNCH
6 MEN
110,000 KILOGRAMS
BOEING
PHASE B
McDAC-NAR
12 MEN
53,000 KILOGRAMS
MODULAR MULTIPURPOSE SPACE STATION
3 MEN
PER MODULE
13,000 KILOGRAMS/UNIT
LOCKHEED
EOSS
6 MEN
110,000 KILOGRAMS
DOUGLAS
MOL
2 MEN
13,000 KILOGRAMS
DOUGLAS
SKY LAB
3 MEN
70,000 KILOGRAMS
MSFC

Figure 1

A decade of technical studies of space station concepts, including supporting studies relating to utilization, operations, ground support, and other aspects, has laid the foundation for the present NASA effort. This figure illustrates some of the major configurational concepts that have been examined, ranging from 2-man to 36-man systems. The Manned Orbital Laboratory was an approved development program until its cancellation last year by the U.S. Air Force. The Skylab is an approved program now underway as an outgrowth of earlier spent stage studies.

It is generally concluded from studies to date that the next step in manned space flight for exploiting the near Earth environment should be a multi-disciplinary space station providing crew accommodations for a crew on the order of 12 men. Present study effort is concentrated on defining such a program to a preliminary design level.

PRESENT SPACE STATION PROGRAM

TECHNICAL STUDIES

- UTILIZATION
- CONFIGURATIONS
- OPERATIONS
- LOGISTICS

FACILITY PLANNING

- EXPERIMENT DEFINITION
- SKYLAB EXPERIMENTS
- PROJECT TEKTITE

ADVANCED TECHNOLOGY

- SUBSYSTEMS
- HUMAN FACTORS

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Figure 2

The present program encompasses three main areas of effort: technical studies of the space station and its related uses and operations; definition and planning of experiments and integrated observatory-type space facilities; and research and development on advancements in technology which may have application in this program.

Technical studies include analyses of science and applications uses of the station, engineering configurational designs, analysis of launch and flight operations, and the evaluation of logistics resupply. Facility planning includes the definition of specific flight experiments by potential principal investigators, the development of precursor experiments to be flown in the Skylab Program, and the NASA participation in Project Tektite, where rotating crews are performing a scientific mission in a hostile environment beneath the ocean surface. Advanced technology activities include both efforts on mechanical subsystem elements and also on men and their relationships in space station environments.

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SCHEDULE OF CONTRACTED STUDIES

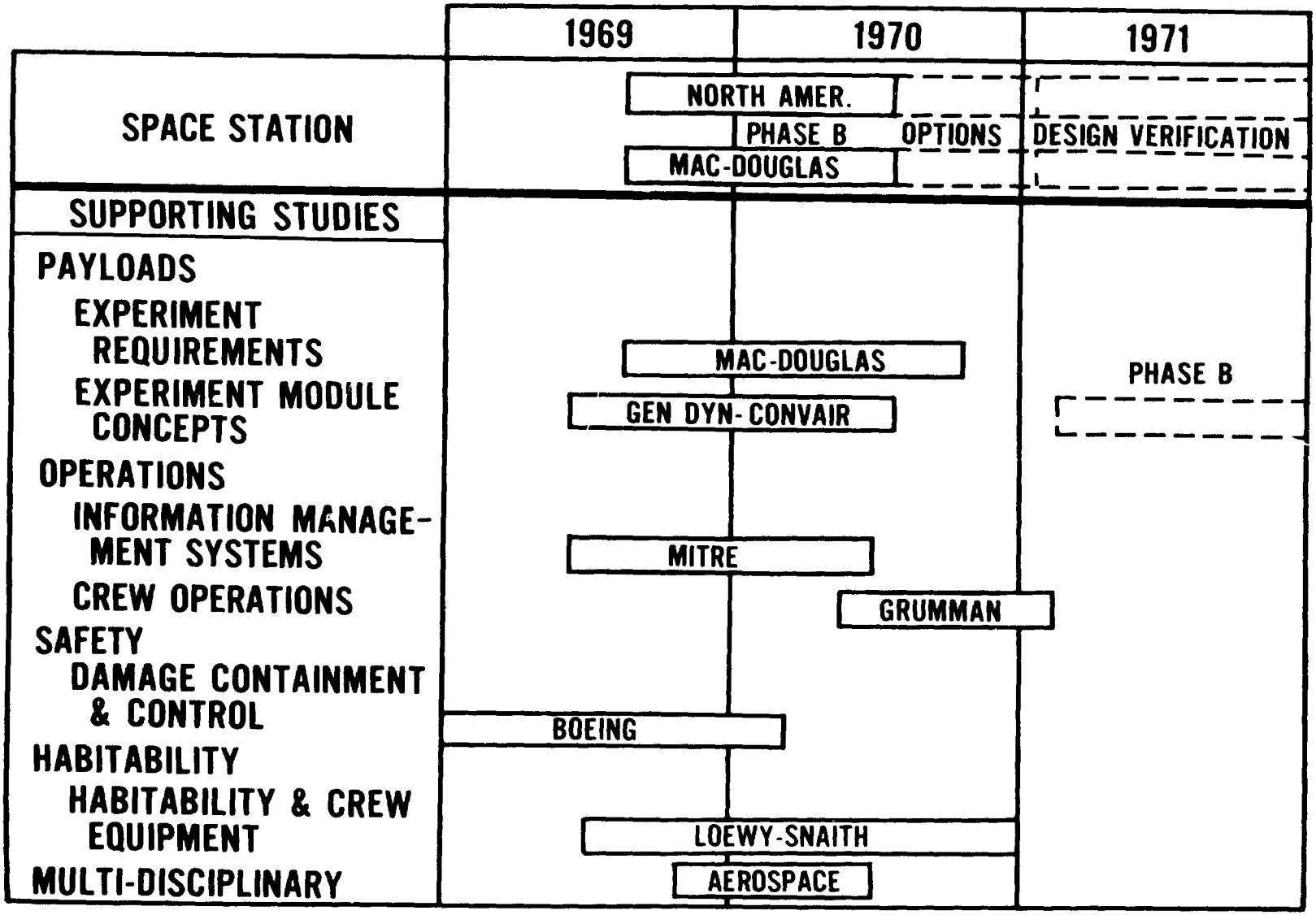

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Figure 3

The present study effort is focused about a number of contracts with industrial firms, with emphasis being placed on the Phase B (Program Definition) Studies by the North American Rockwell and McDonnell Douglas teams. These two primary studies will be discussed in some detail in the next two briefings.

In order to place the total study program in proper context, it should be remembered that the other studies in this chart are intended primarily to provide additional inputs to the Phase B Studies and the planned follow-on efforts. In the area of Payloads, two studies are underway, one by McDonnell Douglas looking in further depth at experiments which should be considered for the space station, and another by Convair on modular concepts for accommodating these experiments. In Operations, two studies are addressing information management and crew operations by Mitre and Grumman, respectively. A Safety study was recently completed by Boeing and a continuing Habitability analysis has been underway by an industrial design concern, Loewy-Snaith. The final effort is the Aerospace contract which is multi-disciplinary in nature, covering such related concerns as mission operations, space tug, and nuclear shuttles. Each of these studies will be described in more detail on subsequent charts.

EARTH ORBITAL EXPERIMENT REQUIREMENTS STUDY

OBJECTIVES

- MANNED EXPERIMENT IDENTIFICATION
- TECHNOLOGY DEVELOPMENT REQUIREMENTS
- DATA MANAGEMENT REQUIREMENTS
- COSTS AND SCHEDULES

USE OF RESULTS

- SPACE STATION PAYLOAD PLANNING
- STATION SUPPORT/ACCOMODATION REQUIREMENTS

STUDY TEAM

- LANGLEY RESEARCH CENTER
- Mc DONNELL-DOUGLAS

LEVEL OF EFFORT

- APPROXIMATELY 30 MAN-YEARS

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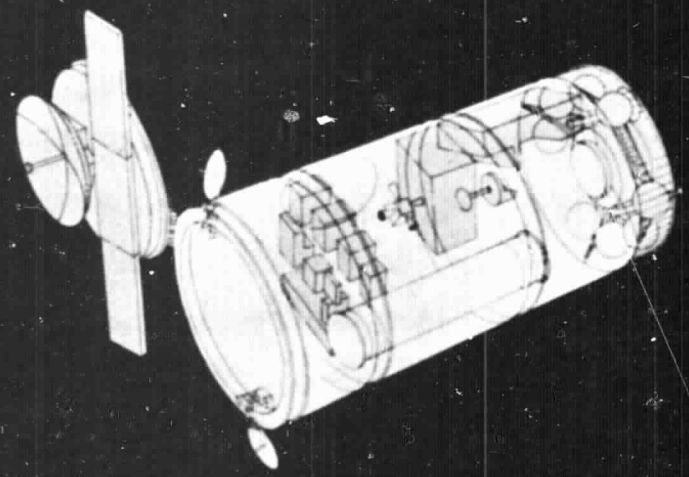
Figure 4

The Earth Orbital Experiment Requirements study seeks to identify desirable space observations and measurements which would benefit from man's participation, determine the technology to be developed for their accomplishment, analyze data management requirements, and assess the costs and schedules. These results are being used in space station payload planning and to indicate requirements which the space station must meet to support and accommodate such experiments. This effort is sponsored by all of the NASA Program Offices, but the contracted effort at McDonnell Douglas is under the specific direction of the NASA Langley Research Center. The approximately one-year effort will consume the equivalent output of 30 men, though many more than this number are involved in various phases of the study.

EXPERIMENT MODULE CONCEPTS STUDY

OBJECTIVES

- COMMONALITY ANALYSIS OF CANDIDATE EXPERIMENT PROGRAM
- ASSESS LEAST NUMBER OF COMMON MODULES
- CONCEPTUAL DESIGN OF MODULES



USE OF RESULTS

- SPACE STATION INTERFACE INFORMATION
- CONCEPTS FOR FOLLOW-ON DEFINITION
- EXPERIMENT PLANNING GUIDE LINES

STUDY TEAM

- MARSHALL SPACE FLIGHT CENTER
- GENERAL DYNAMICS-CONVAIR

LEVEL OF EFFORT

- APPROXIMATELY 20 MAN-YEARS

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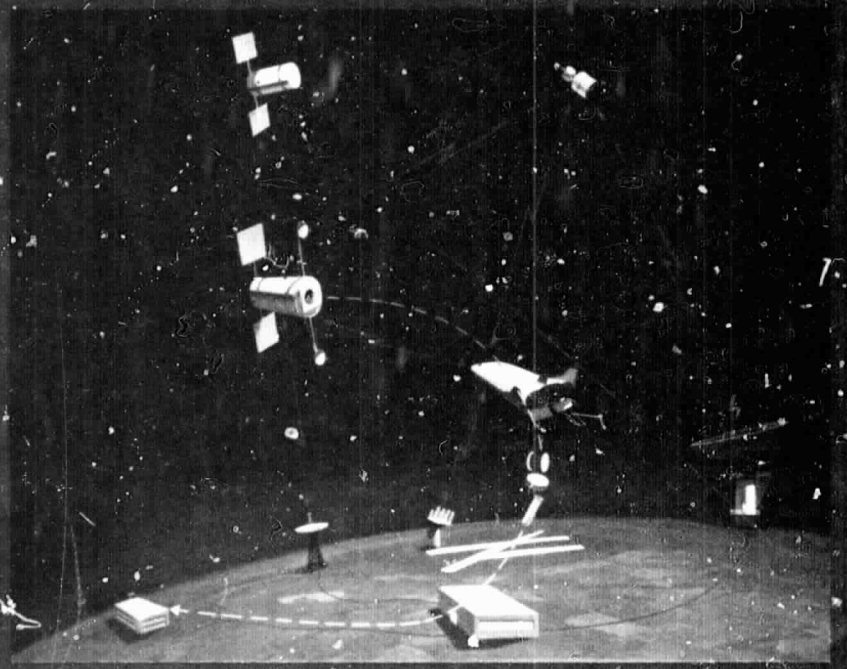
Figure 5

The Experiment Module Concepts study is a major effort directed toward attached and free-flying modules which can accommodate integrated packages of experiments to be operated in conjunction with the space station. In addition to this special emphasis study, each of the Phase B contractors will report on analyses which they have conducted of similar concepts.

The study first analyzed common elements of the experiment program which could be grouped on modules, then assessed the minimum number of modules required, and is presently developing conceptual designs for those selected.

In addition to providing valuable information to the Space Station contractor, this study is paving the way for specific Phase B level studies on the modules, and defining guidelines for further experiment planning. The NASA Marshall Space Flight Center directs this 20 man-year effort at the Convair Division of the General Dynamics Corporation.

INFORMATION MANAGEMENT STUDY



OBJECTIVES

- DEFINE INFORMATION MANAGEMENT REQUIREMENTS
- IDENTIFY SYSTEM CONCEPTS
- SELECT MOST ADVANTAGEOUS APPROACHES
- DETERMINE CRITERIA FOR SYSTEM DESIGN & DEVELOPMENT

USE OF RESULTS

- INPUTS TO THE SPACE STATION STUDY
- EVALUATION CRITERIA FOR NEXT PHASE

STUDY TEAM

- MANNED SPACECRAFT CENTER
- MITRE CORPORATION

LEVEL OF EFFORT

- APPROXIMATELY 10 MAN-YEARS

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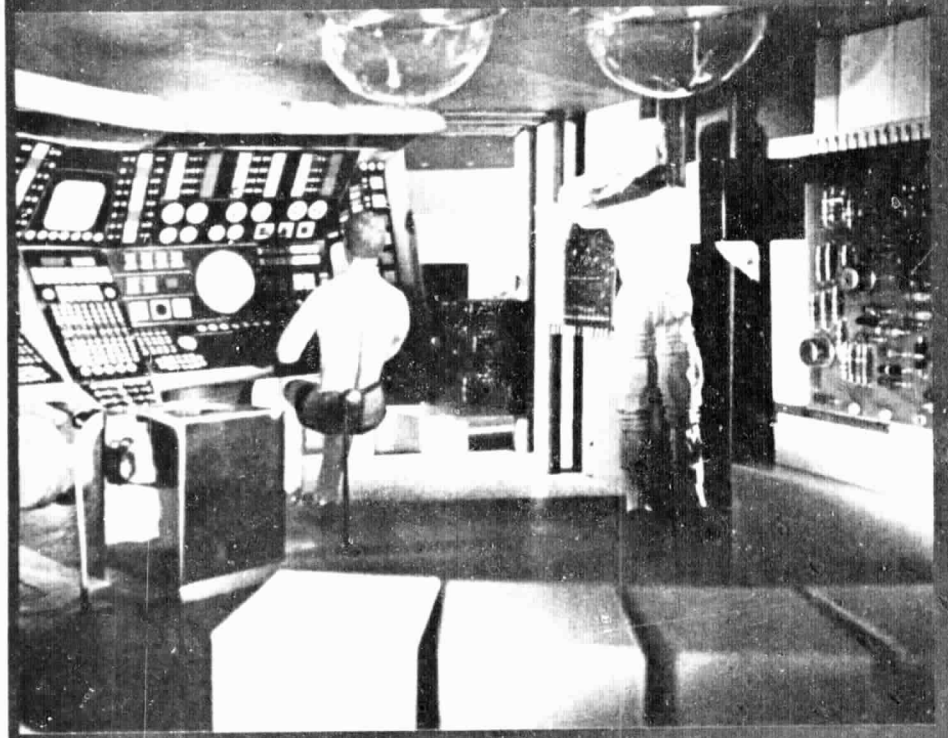
Figure 6

The Information Management Study is addressing the question of how to handle the multitude of kinds of data that will be required in the conduct of a space station program, both for its operation and its utilization. Its objectives are first, to define the data requirements, then to identify system concepts for handling this data, to select the best approaches and then determine criteria for system design and development. This effort supplements similar analyses by the Phase B contractors and will provide valuable criteria for the evaluation of the proposed concepts and selection of approaches to the final design and operation. The study is being directed by the NASA Manned Spacecraft Center and requires 10 man-years of effort by the Mitre Corporation.

CREW OPERATIONS STUDY

OBJECTIVES

- DEFINE CREW COMMAND STRUCTURE
- INVESTIGATE SELECTION, TRAINING, & DUTY CYCLES



USE OF RESULTS

- STATION DESIGN OF CREW EQUIPMENT & ACCOMODATIONS
- PLANS FOR CREW SELECTION & TRAINING
- SIMULATOR REQUIREMENTS
- FLIGHT OPERATING PLANS

STUDY TEAM

- MANNED SPACECRAFT CENTER
- GRUMMAN

LEVEL OF EFFORT

- APPROXIMATELY 3 MAN-YEARS

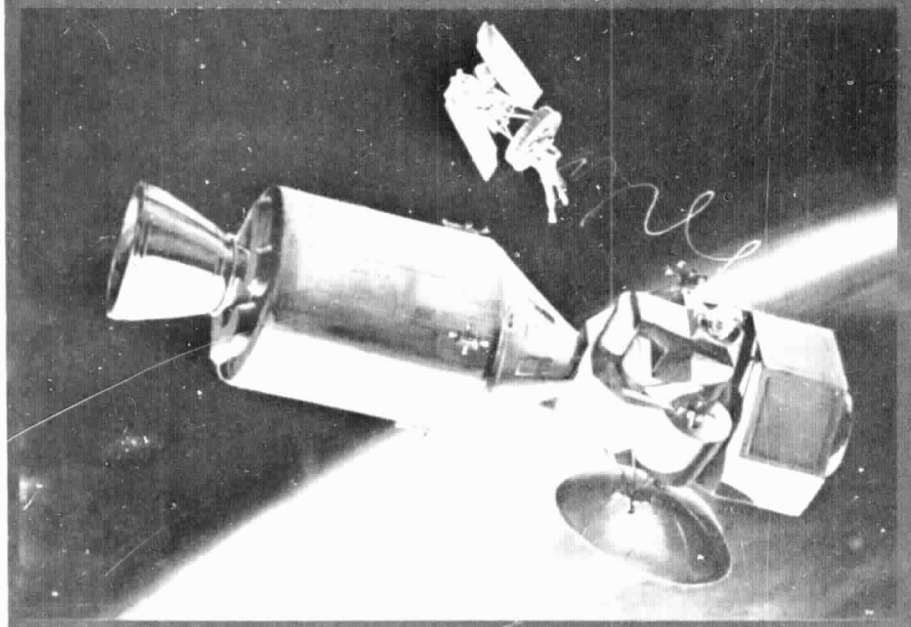
Figure 7

Since the maximum crew size that we have used to date in space is 3, the Crew Operations Study is intended to define the command structure that should be considered for larger crews such as a space station would have, and to investigate selection, training and duty cycles for such crews. This study will impact the more detailed design of the station, the astronaut selection and training plans, the requirements for ground and flight simulations, and the mission operating plans. It is presently in the final stages of contract negotiation and will be under the direction of the NASA Manned Spacecraft Center. The Grumman Aerospace Corporation is the contractor for this 3 man-year effort.

DAMAGE CONTAINMENT AND CONTROL STUDY

OBJECTIVES

- ESTABLISH EARLY SAFETY GUIDE LINES
- PROVIDE A TOOL FOR DESIGN SAFETY EVALVATION



USE OF RESULTS

- 282 GUIDELINES FOR CREW SAFETY APPLIED TO SPACE STATION DESIGN
- SPACE STATION DESIGN BEING ASSESSED IN TERMS OF SOLUTIONS TO 12 AREAS OF HAZARD (FOR EXAMPLE-IMPACT, ILLNESS, EXPLOSION, RADIATION, & OTHERS)

STUDY TEAM

- MANNED SPACECRAFT CENTER
- BOEING

LEVEL OF EFFORT

- APPROXIMATELY 8 MAN-YEARS

Figure 8

The Damage Containment and Control Study was a recently completed 8 man-year effort by the Boeing Corporation, conducted under the supervision of the NASA Manned Spacecraft Center. Its objectives were to establish early safety guidelines for the space station and to provide a tool for evaluation of the space station design from the safety standpoint. 282 guidelines were derived which have now been provided to the space station Phase B contractors for possible application. The conceptual designs developed to date are now being assessed in terms of their adequacy in handling hazards in the 12 different safety areas which were identified.

HABITABILITY AND CREW EQUIPMENT STUDY

OBJECTIVES

- INTERIOR DESIGNS FOR LONG-TERM HABITATION
- INNOVATIVE CONCEPTS FOR MATERIAL HANDLING
- SOFT MOCKUPS & MODELS OF LIVING & WORK AREAS

USE OF RESULTS

- INPUTS TO SPACE STATION DESIGN
- HABITABILITY INVESTIGATIONS FOR SKYLAB

STUDY TEAM

- HEADQUARTERS
- LOEWY-SNAITH

LEVEL OF EFFORT

- APPOXIMATELY 8 MAN-YEARS

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Figure 9

The Habitability and Crew Equipment Study is considering interior designs for the space station with special emphasis on long-term manned habitation problems, exploring innovative concepts for handling materials, and preparing soft mockups and models of the crew living and working areas. These results are being used by the space station design teams and in some cases are being selected for preliminary evaluation in the Skylab missions. This contract with Loewy-Snaith requires about 8 man-years effort and is under NASA Headquarters direction.

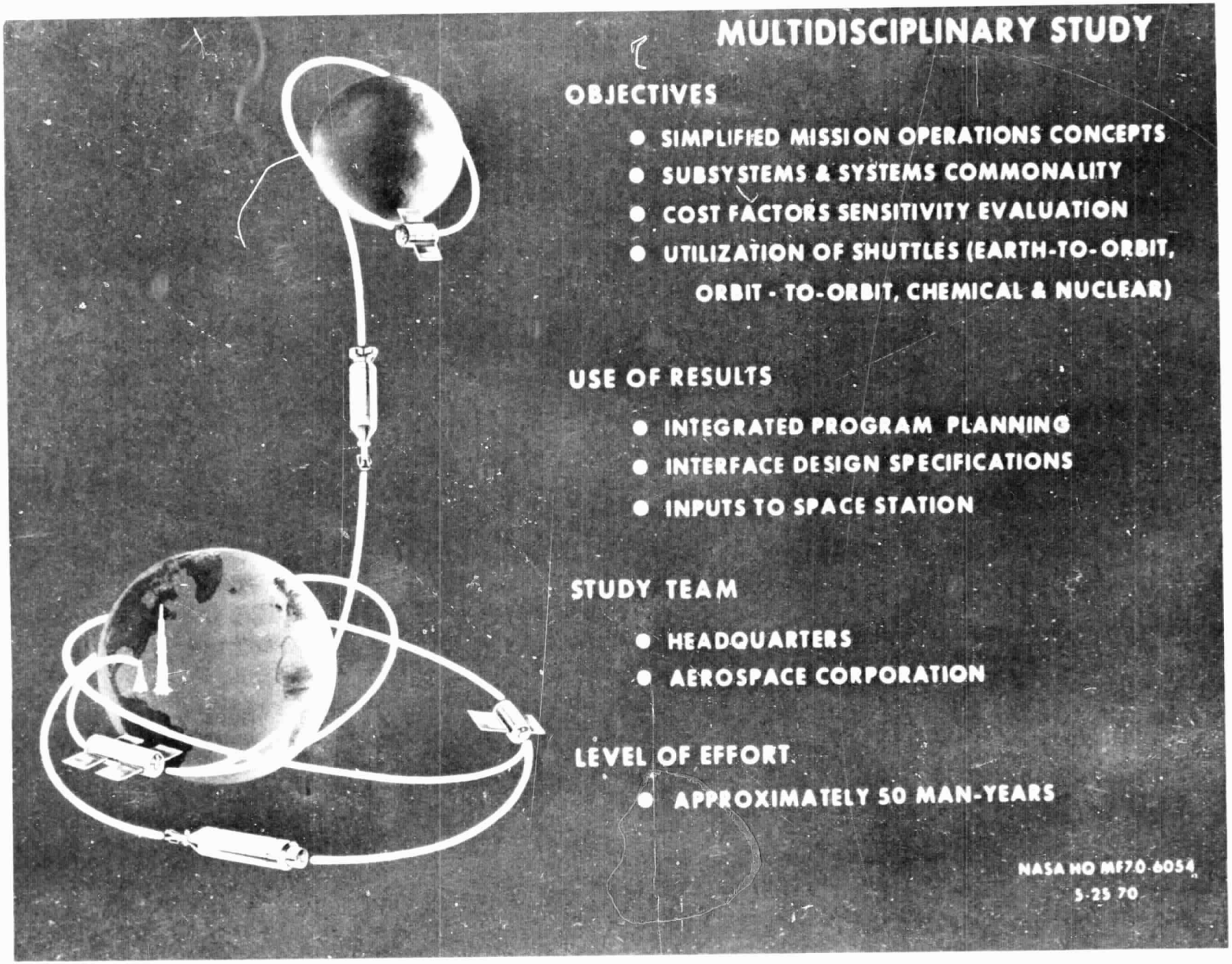
MULTIDISCIPLINARY STUDY
OBJECTIVES
• SIMPLIFIED MISSION OPERATIONS CONCEPTS
• SUBSYSTEMS & SYSTEMS COMMONALITY
• COST FACTORS SENSITIVITY EVALUATION
• UTILIZATION OF SHUTTLES (EARTH-TO-ORBIT, ORBIT - TO-ORBIT, CHEMICAL & NUCLEAR)
USE OF RESULTS
• INTEGRATED PROGRAM PLANNING
• INTERFACE DESIGN SPECIFICATIONS
• INPUTS TO SPACE STATION
STUDY TEAM
• HEADQUARTERS
• AEROSPACE CORPORATION
LEVEL OF EFFORT
• APPROXIMATELY 50 MAN-YEARS
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Figure 10

A sizeable study effort has also been underway for the last year by the Aerospace Corporation under NASA Headquarters direction. In this study analyses have been made of simplified concepts for conducting mission operations, of common applications of space station systems in shuttle and other future programs, of the sensitivity of various space station cost factors, and of the utilization of both Earth-to-orbit and orbit-to-orbit shuttles (or space tugs). The results of this study are being used for long-range integrated planning efforts, in considering interface problems between major systems and programs, and as direct inputs to the space station designs.

SPACE STATION PHASE B STUDY SUMMARY

OBJECTIVES

- SPACE STATION PROGRAM DEFINITION
- STATION USE FOR SPECIAL MISSIONS
- GROWTH TO SPACE BASE OR PLANETARY MODULE
- LOGISTICS SYSTEM INTERFACES

USE OF RESULTS

- BASIS FOR PHASE C&D DESIGN & DEVELOPMENT

STUDY TEAM

- TEAM 1 : MANNED SPACECRAFT CENTER
  NORTH AMERICAN ROCKWELL
- TEAM 2 : MARSHALL SPACE FLIGHT CENTER
  Mc DONNELL-DOUGLAS

LEVEL OF EFFORT

- APPROXIMATELY 75 MAN-YEARS EACH

Figure 11

The previous charts (4-10) described the supporting studies in the Space Station Program. This chart summarizes the Phase B (Program Definition) studies which constitute the primary effort now underway and which serve as the focus for all related technology, planning and study efforts. The remainder of this briefing will describe the philosophy underlying this activity and the summary technical basis for the studies, which will then be covered in detail in subsequent briefings.

The objectives of this study are to define a total space station program, to assess the station use for special orbit missions, to evaluate its growth capability to a large space base or planetary mission module, and to examine the interfaces with potential logistics resupply systems. Upon the completion of Phase B definition studies, final design and development can be considered.

The efforts to date have required on the order of 75 man-years effort each and have been performed by major industrial teams under the supervision of NASA center task teams. The Manned Spacecraft Center contract is with the North American Rockwell Corporation, with the General Electric Company as a prime subcontractor. The Marshall Space Flight Center contract is with the McDonnell Douglas Astronautics Corporation, with the Martin Marietta Corporation and the International Business Machines Corporation as prime subcontractors.

PHASE B STUDY
SCOPE AND APPROACH

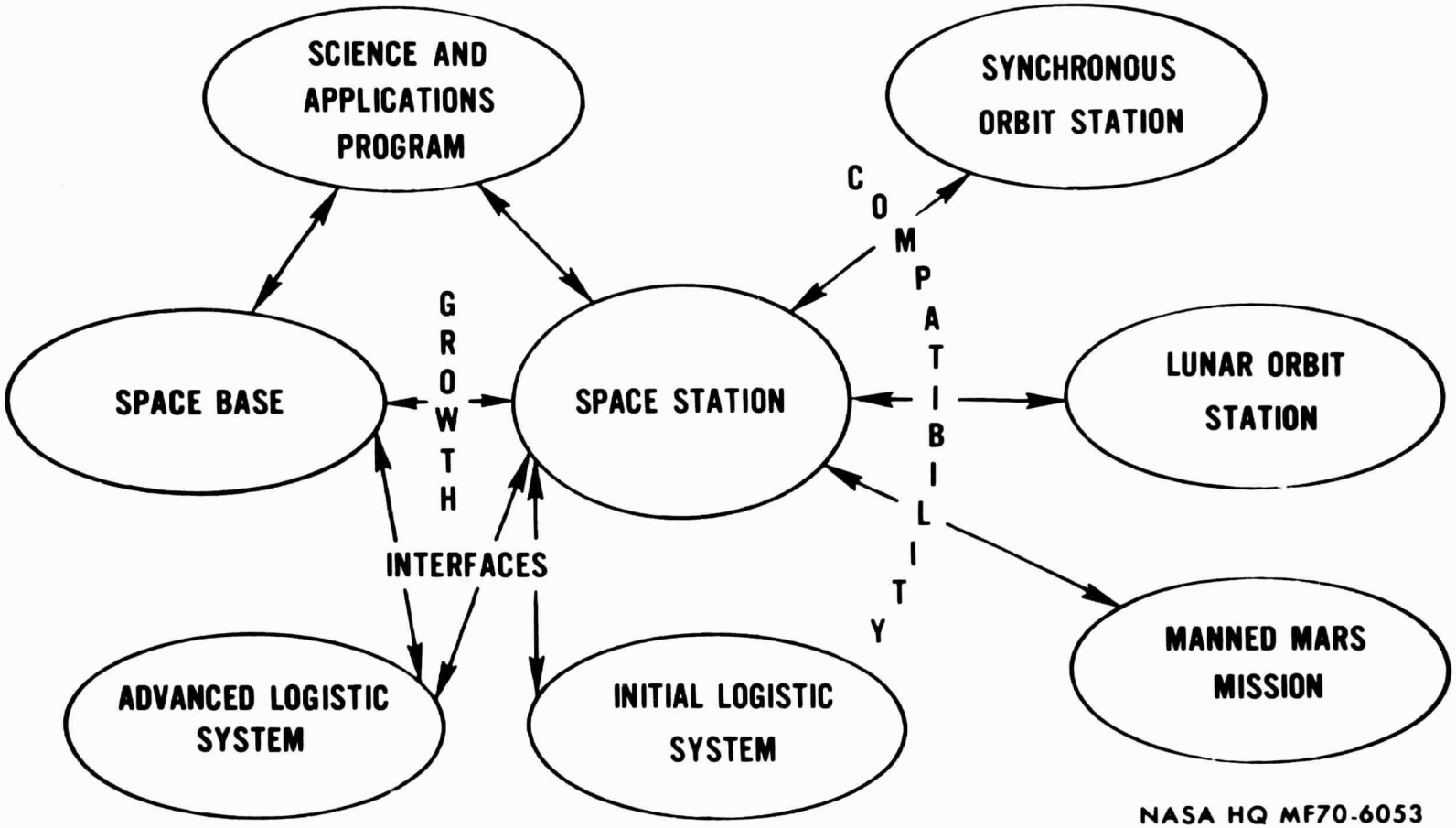

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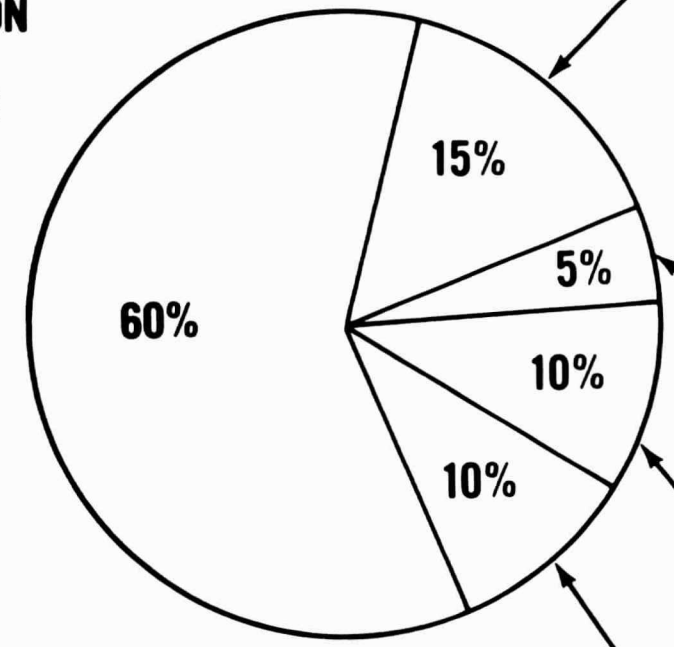
Figure 12

Although the major emphasis of the Phase B Study is a 12-man space station for low Earth orbit, the contractors were asked to first consider a 50-man space base into which the station could eventually evolve.

A candidate experiment program, which will be described in more detail in another briefing, was given to the contractors to provide a science and applications program to be accommodated. The contractors were asked to consider interfaces between the base or station and potential logistics systems: an interim or initial system based on previous studies of expandable concepts derived from the Gemini/Apollo/Saturn family; and an advanced logistics system (the Space Shuttle). The contractors were also directed to examine the applicability of the station design to geosynchronous and lunar orbit missions and as a manned planetary mission module.

PHASE B STUDY TASK OUTPUTS



SPACE STATION

PAYLOADS
MISSION OPERATIONS
CONFIGURATIONS
SUBSYSTEMS
INTEGRATION
MODULES
CREW OPERATIONS
GROUND EQUIPMENT
SPECIAL MISSIONS
PRELIMINARY DESIGN
COST
SCHEDULES
PROGRAM PLANS

SPACE BASE

CAPABILITIES
CONFIGURATIONS
SUBSYSTEMS
BUILDUP
STATION INTERFACES
DEVELOPMENT EFFORT
TECHNOLOGY REQUIREMENTS
COST & SCHEDULES

INTERIM LOGISTICS

OPERATIONS
PAYLOADS
STATION INTERFACES

SHUTTLE LOGISTICS

OPERATIONS
BASE INTERFACES
STATION INTERFACES

PLANETARY MISSION

MISSION SYNTHESIS
MODULE DEFINITION
STATION INTERFACES
BASE INTERFACES

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Figure 13

As shown on this chart, the distribution of effort during the Phase B studies was designated and the outputs from the study in each area were also specified. These outputs will be provided to NASA in the form of documents to be delivered by September of this year. It is anticipated, however, that areas of weakness in the present studies will continue to be examined in an extension of the present contracts.

PHASE B STUDY DEPTH

PROGRAM ELEMENT	DEFINITION LEVEL	DESIGN LEVEL
SPACE STATION	PRELIMINARY DESIGN	ASSEMBLY LEVEL
SPACE BASE	CONCEPTUAL DESIGN	SUBSYSTEM LEVEL
PLANETARY MISSION MODULE	CONCEPT ANALYSIS AND REQUIREMENTS ANALYSIS	SUBSYSTEM LEVEL
SHUTTLE LOGISTIC SYSTEM	REQUIREMENTS ANALYSIS	SYSTEM LEVEL
INTERIM LOGISTICS SYSTEM	CONCEPT ANALYSIS	SYSTEM LEVEL
LUNAR ORBIT STATION AND GEOSYNCHRONOUS STATION	CONCEPT ANALYSIS AND REQUIREMENTS ANALYSIS	SYSTEM LEVEL

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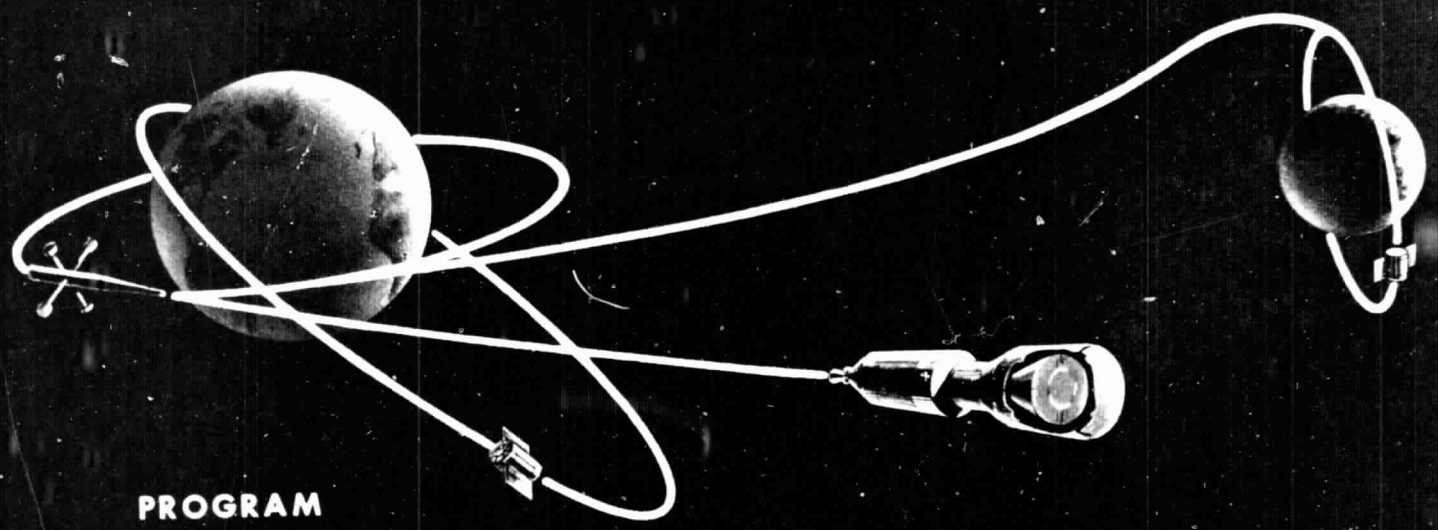
Figure 14

Although this is a total program study, all elements of the program will not be defined, nor will system elements be designed, to the same level of detail. This chart indicates the level of detail that is anticipated in each area of the contract.

GENERAL GUIDELINES
PHASE B STUDY



PROGRAM

- INITIAL SPACE STATION OPERATIONAL IN 1977
- SPACE BASE OPERATIONAL IN EARLY 1980'S
- DATA RELAY SYSTEM WILL BE AVAILABLE

MISSION

- STATION AND BASE —55° INCLINATION, 370 TO 550 km ALTITUDE
- STATION ALSO CAPABLE OF POLAR ORBIT AT 370 km ALTITUDE
- STATION AND BASE - MULTIDISCIPLINARY LABORATORIES
- STATION AND BASE - CONTROL, SERVICE, & INFORMATION MANAGEMENT CENTER FOR ATTACHED AND FREE FLYING MODULES
- BASE - SUPPORT TO GEOSYNCHRONOUS, LUNAR, & PLANETARY MISSIONS

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Figure 15

The General Guidelines which were issued for this study stated an operational readiness for the station of 1977 and several years later for the base. It was assumed that a data relay system would be available in time for initial operations with the station.

The primary mission specified for both the station and base was to provide routine operations of a multi-disciplinary laboratory in low Earth orbit at 55^{o} inclination and at altitudes between 370 and 550 kilometers. It was also emphasized that the station and base would be expected to provide centralized functions for both attached and free-flying modules. A specific guideline for the station was its capability for launch into a low Earth orbit at polar inclination. It was also assumed that the base would be capable of serving as a central support facility for advanced geosynchronous, lunar, and planetary missions.

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DESIRED SYSTEM CHARACTERISTICS

- **ROUTINE PRODUCTIVE OPERATIONS**
  - SUFFICIENTLY LARGE CREW FOR MULTIPLE RESEARCH AND APPLICATION TASKS
  - "GENERAL PURPOSE" LABORATORY.
  - FREQUENT AND CONVENIENT RESUPPLY.
  - ABILITY TO MODIFY AND REPAIR EQUIPMENT ONBOARD
- **LOW OPERATING COSTS**
  - VERY LONG USEFUL LIFE WITH MAINTENANCE AND RESUPPLY
  - LESS DEPENDENCE ON GROUND OPERATIONAL SUPPORT.
  - REUSABLE SPACE TRANSPORTATION SYSTEM (SHUTTLE).
- **PROGRAM FLEXIBILITY**
  - MODULAR REPLACEMENT AND GROWTH.
  - COMPATIBILITY WITH HIGH ENERGY MISSIONS.
  - DECOUPLING OF EXPERIMENT/PAYLOADS PROGRAM.
  - USE OF BOTH DOCKED AND FREE-FLYING EXPERIMENT MODULES.
- **CREW EFFICIENCY AND SAFETY**
  - GOOD ARCHITECTURE, FOOD, HYGIENE FACILITIES, ATMOSPHERE.
  - PROGRESS TOWARD ARTIFICIAL GRAVITY.
  - HIGHLY AUTOMATED HOUSEKEEPING.
  - ONBOARD FAULT ISOLATION, DAMAGE CONTROL, REFUGE AND MEDICAL HELP.

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Figure 16

This chart emphasizes the new philosophy of both concept and operations which is to be embodied in the space station program. Although every item on this chart does not require the same degree of sophistication or breakthrough in technology, taken in total it represents a major change in the manner of conducting manned space operations.

SPECIFIC GUIDELINES FOR SPACE STATION

PHASE B STUDY

- SELF-CONTAINED SYSTEM
- NORMAL CREW OF 12
- MINIMUM OPERATIONAL LIFE - 10 YEARS (WITH RESUPPLY)
- LAUNCHED FROM KSC ON TWO STAGE SATURN V (SIC+SII)
- CAPABLE OF OPERATING IN AND PROVIDING ARTIFICIAL 'g' AND ZERO 'g'
- MAXIMUM STATION DIAMETER OF 10 METERS
- SIX-MONTH INDEPENDENT OPERATION WITHOUT RESUPPLY
- SEPARATE PRESSURE COMPARTMENTS - OPERATE WITH ANY ONE COMPARTMENT OUT OF COMMISSION
- CLOSED LOOP WATER SYSTEM CO_2 REMOVAL AND O_2 RECOVERY AND REUSE
- COMPATIBLE WITH INITIAL AND ADVANCED LOGISTIC SYSTEMS

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Figure 17

The Specific Guidelines for the Space Station which were given to the Phase B contractors are summarized on this chart. The requirement for artificial gravity is to accomplish an assessment of such operations for a short period of time; however, the primary operational mode of the station over its extended life would be at zero gravity. The upper limit on diameter was based on the size of the Saturn V launch vehicle. Other guidelines are self-explanatory.

SPECIFIC GUIDELINES FOR SPACE BASE

PHASE B SPACE STATION

- SELF-CONTAINED SYSTEM
- NOMINAL CREW SIZE OF 50
- 10 YEAR OPERATIONAL LIFE (WITH RESUPPLY)
- PROVIDE ARTIFICIAL 'g' AND ZERO 'g' SIMULTANEOUSLY
- UTILIZE SPACE STATION MODULE AS PART (OR PROTOTYPE) OF BASE
- ACCOMMODATE HIGHLY SPECIALIZED CREW WITH MINIMUM OF ASTRONAUT-TYPE TRAINING AND CONDITIONING
- DESIGNED FOR DAMAGE CONTAINMENT, CONTROL, AND REPAIR
- COMPATIBLE WITH ADVANCED LOGISTIC SYSTEM

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Figure 18

The major difference in guidelines for the base is in the requirement for simultaneous provision of artificial gravity and zero gravity. This requirement comes from a subjective evaluation concluding that whereas some gravity level may not be required from a physiological standpoint, it may be desirable for convenience sake in long term operations, whereas the major laboratories and observatories onboard will probably desire zero gravity. Other modifications in guidelines represent a further maturation of space operations and increase in the size of the crew.

SPECIFIC GUIDELINES FOR SPACE SHUTTLE
PHASE B SPACE STATION STUDY

- EMERGENCY RETURNS FROM SS PROVIDED FROM EARTH ON CALL
- SS PROVIDES GUIDANCE, NAVIGATION, AND TRACKING DATA FOR RENDEZVOUS, DOCKING, AND DEPARTURE
- CAPABLE OF TRANSPORTING A PAYLOAD OF 13,500 kg $\pm$ 4,500 kg UP AND DOWN
- PAYLOAD COMPARTMENT SIZE - 4.5 m DIA. BY 18 m LONG
- CARGO VOLUME PRESSURIZED AND PERMITTING SHIRTSLEVE TRANSFER OPERATIONS
- PEAK ACCELERATIONS AND DECELERATIONS DURING BOOST, REENTRY, AND RECOVERY $\leq$ 4G
- CONTROLLED LAND LANDING
- FLIGHT OPERATIONS INDEPENDENT OF SS COMMUNICATIONS
- ONBOARD CHECKOUT CAPABILITY
- WITH CREW ONBOARD: AUTONOMOUS GUIDANCE AND NAVIGATION CAPABILITY

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Figure 19

These guidelines were those given to the Space Station Phase B contractors for the assumed Space Shuttle to be considered. They are essentially in consonance with the guidelines being utilized in the Space Shuttle Phase B Study presently being initiated.

SPECIAL EMPHASIS TASKS
PHASE B STUDY

1. EXPERIMENT SUPPORT REQUIREMENTS ANALYSIS
2. PRELIMINARY DEFINITION OF EXPERIMENT MODULES
3. CAPABILITIES FOR SPECIAL MISSIONS
4. ELECTRICAL POWER SUBSYSTEM TRADE OFF
5. LONG-LIFE SUBSYSTEM ASSURANCE
6. EVALUATION OF COST REDUCTION TECHNIQUES
7. INFORMATION MANAGEMENT
8. ON-BOARD CHECKOUT AND FAULT ISOLATION
9. TEST PHILOSOPHIES
10. SYSTEM SAFETY ANALYSIS
11. ARTIFICIAL GRAVITY (NORTH AMERICAN ONLY)
12. ENVIRONMENTAL CONTROL AND LIFE SUPPORT (MC DONNELL-DOUGLAS ONLY)

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Figure 20

In addition to the basic guidelines which have been summarized, each contractor was asked to put special emphasis on ten areas of his study effort. These areas are listed on this chart together with additional special emphasis tasks which were proposed by, and included in, each contractor's effort. Note that, in general, most of the special emphasis tasks embody considerations which would impact the station design or program concepts across the board, rather than in one specific area of the study.

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