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15 MAY 1971
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Lunar Base Synthesis Study

FINAL REPORT

VOLUME IV

Cost and Resource Estimates

Space Division
North American Rockwell

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APPROVED BY

J.M. MANSFIELD, PROGRAM MANAGER
LUNAR BASE SYNTHESIS

Space Division
North American Rockwell

FOREWORD

The Lunar Base Synthesis Study was conducted by the Space Division of North American Rockwell under Contract NAS8-26145 for the George C. Marshall Space Flight Center of the National Aeronautics and Space Administration. The work was administered under the technical direction of the Program Development Directorate of the George C. Marshall Space Flight Center.

This document is Volume IV, Cost and Resource Estimates, which constitutes part of the final report on the study. The following additional documents comprise the entire final report:

Volume I - Executive Summary

Volume II - Mission Analysis and Lunar Base Synthesis

- Part 1 - Mission Analysis
- Part 2 - Lunar Base Synthesis

Volume III - Shelter Design

- Part 1 - Optimized Shelter
- Part 2 - Space Station Derivative Shelter
- Part 3 - Support Operations and Systems

ACKNOWLEDGMENTS

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The Study Manager and Contracting Officer Representative (COR) for the National Aeronautics and Space Administration was James B. Brewer of the Program Development Directorate of the George C. Marshall Space Flight Center. Milton A. Page of the same Directorate was the Alternate COR. T. N. V. Karlstrom and R. D. Regan of the United States Geological Survey, Astrogeology Center, provided assistance to the National Aeronautics and Space Administration regarding geological exploration. The Program Manager for the National Aeronautics and Space Administration Headquarters was S. S. DiMaggio of the Manned Space Flight Lunar Exploration Office.

The NR study team was managed by J. M. Mansfield, Advanced Programs. Principal contributors included:

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INTRODUCTION

The objectives of the Lunar Base Synthesis Study were to define and analyze lunar exploration missions to establish the role of a semi-permanent lunar surface base (LSB) as an element of an integrated space program, and to prepare conceptual designs for two different lunar surface shelters. One shelter concept was to be optimized for the LSB mission requirements whereas the other represented a potential adaptation of a specified space station module.

The study was oriented towards a lunar surface base which would support a two to five-year program of scientific and exploration activities in the 1980's by a crew of up to 12 men at any location on the moon which might be selected. The principal program option involved considering the operation of the LSB concurrently with an operational Orbiting Lunar Station (OLS) or without the existence of the OLS. The space station module which was designated as the candidate for adaptation to an LSB shelter configuration was the Shuttle Launched Modular Space Station as defined by North American Rockwell, Space Division (NR/SD) under Contract NAS9-9953 for the Manned Spacecraft Center and documented in NR report, SD 70-546-1, January 1971.

The basic approach adopted for the study involved the identification of scientific and exploration activities appropriate to a single, semi-permanent base on the lunar surface from an examination of the consensus of previous studies of lunar scientific missions. A typical distribution of these activities on the lunar surface was derived from a detailed examination of several potentially desirable areas and operational/design requirements were defined to accomplish the various classes of activities. The activities were found to fall into two main categories: main base activities which included astronomy and deep drilling as well as the regular logistics and housekeeping functions and the selenological explorations at multiple sites in an expanded region around the base site.

The definition of a program encompassing these activities, the associated operational and design requirements, the logistics operational concepts, and the precursor surface and orbit missions comprised study tasks 1 and 2, Mission Analysis and Lunar Base Synthesis, respectively.

A lunar surface base configuration which included a main shelter, major science elements, and surface mobility system elements was conceptually defined. The initial design considered the probable state-of-the-art and the operational and design requirements in arriving at a shelter configuration optimized for the spectrum of lunar surface missions. The subsystem options were identified and tradeoffs performed in arriving at the selected configuration. The potential emergency situations were considered and the implications delineated including a maintenance and repair philosophy. Maintenance, repair and housekeeping functions were described and typical tool requirements identified.

Following the definition of the optimized LSB shelter, a conceptual design of a lunar shelter derived from the specified space station module was developed. The degree of modification required, including specific additions for the lunar mission and environment was identified.

These two conceptual designs and the definition of the characteristics of the mobility concept and its interfaces with the shelter comprised study task 3, Shelter Design.

Cost and resource estimates were prepared for the design and development of each of the shelter configurations and for the science, mobility, and power source elements of the LSB program. The shelter development costs were generated utilizing cost estimating relationships from other space programs. Cost estimates for the science mobility and power source elements were primarily derived by adjusting prior studies of these elements for the recommended concept modifications and the passage of time. These cost estimates together with program schedules and milestone data comprised study task 4, Cost and Resource Estimates.

The study was accomplished and documented in an 11-month period between 15 June 1970 and 15 May 1971. The study results are documented in four basic volumes: Volume I is an executive summary which briefly outlines the objectives, summarizes the results, conclusions, and recommendations; Volume II contains a comprehensive description of the analysis and synthesis results of tasks 1 and 2; Volume III presents the LSB configurations including the conceptual designs of the optimized and derivative shelters which resulted from study task 3; and Volume IV describes the cost estimates derived in task 4.

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ILLUSTRATIONS

TABLES

1.0 SUMMARY

The results of the cost and resource estimates study are presented in this volume for both the baseline Lunar Base Shelter configuration and the Modular Space Station (MSS) derivative shelter configuration, and for the related scientific, mobility, and power supply equipments. One of the key purposes of this study effort is to provide NASA MSFC with information and a data base to: (1) enable NASA management to decide whether or not to proceed with subsequent phases of the Lunar Base Program, and (2) guide NASA management to the key program phasing decisions to be made, and to make them aware of the critical technology development requirements.

As elements of the cost and resource estimate, certain basic planning documents (PD's) were prepared for both a baseline configuration and a modular space station (MSS) derivative configuration. The PD's describe a logical integrated set of activities and events necessary to accomplish mission and operational requirements for each configuration. The PD's include schedules and cost estimates for budgetary and planning purposes and cover essential related program information used as a basis for costing an economical and effective development program.

The PD's cover the program elements of preliminary analysis, definition, design, manufacturing, testing, ground operations, launch operations, mission operations, and related activities for both configurations. The time period covered in this effort for the baseline configuration is from the start of Phase B, with an assumed starting date of January 1, 1977, through Phase C and D, ending in December 31, 1984, with an Initial Operational Capability (IOC) in mid-April 1985. The added program complexity involved in utilizing the MSS modules in a derivative shelter configuration required a six months earlier start date for Phases B, C, and D to arrive at the same IOC date of April 15, 1985.

The planning documents consist of eight principal elements:

1. Hardware Trees
2. Work Breakdown Structures
3. Program Development Schedules
4. Hardware Utilization Lists
5. Shelter Program Cost Estimates
6. Cost Estimates Breakdown for Baseline Shelters

7. Cost Estimates Breakdown for MSS Derivative Shelters

8. Scientific, Mobility, and Power Supply Equipment Cost and Resource Estimates

Provisions are made for a soft mockup to facilitate design engineering and manufacturing planning and to familiarize personnel with the Lunar Base Shelter design. This will be provided during the definition and design phases and updated during the Phase D development.

Production requirements for operational shelters are based on anticipated mission and operational requirements. The production schedules were based on the usage of one set of master tooling and one manufacturing checkout and test station.

The cost and resource data for the scientific, mobility, and power supply equipments were compiled and projected from previously generated lunar base study data and updated for this report. While the source documents in general were not directed to this lunar base configuration, the major scientific, mobility, and power supply equipment data sheets contained directly applicable cost, technical, and schedule data, including development time phasing in months and was used for planning and costing purposes.

The summary cost estimates for the two shelter options and the science, mobility, and power source quipments are shown in Table 1.0-1.

Table 1.0-1. LSB Program Summary Costs

Cost Element	Optimized Baseline	MSS Derivative
Shelter project	$ 876.0 M	$ 861.2 M
LSB science equipment	833.0	833.0
Mobility equipment	645.5	645.5
Electrical power source equipment	191.2	191.2
Total	$2545.7 M	$2530.9 M

2.0 HARDWARE TREES

Hardware trees were made for both the selected baseline Lunar Base Shelter configuration design and for the Modular Space Station (MSS) derivative configuration design. The hardware trees were prepared as a basic approach to programming analyses and provided a means for assuring that all systems, subsystems, and major components were being considered for costing and development analyses. The hardware tree is also used later to prepare the Hardware Utilization Lists (HUL), which show total program hardware requirements for major systems and components needed for testing and operational usage. The hardware tree provides visibility on the usage of existing and new hardware and is the basic listing of components by WBS identification number for program costing and preparation of detailed cost information sheets.

2.1 BASELINE SHELTER CONFIGURATION HARDWARE TREE

Figure 2.1-1 shows the hardware tree prepared for the selected baseline shelter configuration. A detailed listing of each system and subsystem is made for each module of the shelter base. These are grouped by major module segment such as prime structure, furnishings and secondary structure, atmospheric management and crew services, communications and monitoring, EPS distribution and control, and the various specialty labs and functions. This detailed listing provides assurance that all systems, subsystems, and major components are included in the pricing of shelter modules and supporting operational equipment.

2.2 MODULAR SPACE STATION (MSS) DERIVATIVE SHELTER CONFIGURATION HARDWARE TREE

Figure 2.2-1 shows the hardware tree prepared for the MSS derivative shelter configuration. The detail listing of systems and subsystems reflects the differences in the modified MSS modules and the shelter support modules. The major module segment grouping is the same as the baseline configuration to facilitate comparison of the two configurations. The hardware tree provides a visual presentation of the hardware requirements for each type of module and the relationships between them.

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North American Rockwell

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HARDWARE TREE
(BASELINE CONFIGURATION)

LUNAR SURFACE BASE SHELTER 1XX-00-00-00-00

CREW & MEDICAL MODULE 1XX-01-00-00-00

PRIME STRUCTURE
- Module Cylinder
- Elliptical Bulkheads
- Wall Cover
- Docking Port
- Pressure Door Assy
- Ceiling & Floor Assy

FURNISHINGS & SECONDARY STRUCTURE
- Brackets, Mountings & Supports
- Storage Cabinets
- Chairs/Desks/Bunks/Cabinets

ATMOSPHERIC MGT & CREW SERVICES
- H_2 Depol.Cell/Sebatier Reactor
- Electrolysis Cell/N_2H_4 Dissa.
- $H_2/O_2/N_2$ Tanks
- Catalytic Burner/Regen.Charcoal
- N_2H_4 Tanks
- Clean/Potable/Waste Water Tanks
- Reverse Osmosis
- Thermal Control Assy/Radiator Assy
- Pressure Control Assy
- Urinal/Dry John/Shower
- Emergency Pressurization Assy
- First Aid Kit
- Temperature & Humidity Control
- Air Circularization Sys
- Food Reconstitution/Fountain

COMMUNICATIONS & MONITORING
- TV Monitor
- Intercomm
- Remote Data Station

ELECTRICAL POWER SYS DISTRIB & CONTROL
- Power Cabling & Busses
- Power Switching & Breakers
- Lights & Emergency Battery
- Terminals & Connectors

MEDICAL FACILITY
- Body/Specimen Mass Measurement
- Chair/Litter
- Body Pressure Equip
- Bicycle Ergometer
- Freezer/Refrigerator
- Oven/Sterilizer
- X-ray & Diagnostic Equip
- Table & Emergency Battery

CREW & OPERATIONS MODULE 1XX-02-00-00-00

PRIME STRUCTURE
- Module Cylinder
- Elliptical Bulkheads
- Wall Cover
- Docking Port
- Pressure Door Assy
- Ceiling & Floor Assy

FURNISHINGS & SECONDARY STRUCTURE
- Brackets, Mountings & Supports
- Storage Cabinets
- Chairs/Desks/Bunks

ATMOSPHERIC MGT & CREW SERVICES
- H_2 Depol.Cell/Sebatier Reactor
- Electrolysis Cell/N_2H_4 Dissa.
- $H_2/O_2/N_2$ Tanks
- Catalytic Burner/Regen.Charcoal
- N_2H_4 Tanks
- Clean/Potable/Waste Water Tanks
- Reverse Osmosis
- Thermal Control Assy/Radiator Assy
- Pressure Control Assy
- Urinal/Dry John/Shower
- Emergency Repressurization Assy
- First Aid Kit
- Temperature & Humidity Control
- Air Circularization Sys
- Food Reconstitution/Fountain

COMMUNICATIONS & MONITORING
- TV Monitor
- Intercomm

ELECTRICAL POWER SYS DISTRIB & CONTROL
- Power Cabling & Busses
- Power Switching & Breakers
- Lights & Emergency Battery
- Terminals & Connectors

COMMAND & CONTROL
- Data Mgt Control Console
- Data Processor
- Operating & Mass Memory
- Archival Memory
- Central Timming Unit
- Map & Status Board
- Intercomm Control
- S-Band Transceiver & Antenna
- VHF Transceiver & Antenna
- LF Transceiver & Antenna
- Modulators

SORTIE & TRANSIENT CREW MODULE 1XX-03-00-00-00

PRIME STRUCTURE
- Module Cylinder
- Elliptical Bulkheads
- Wall Cover
- Docking Port
- Pressure Door Assy
- Ceiling & Floor Assy

FURNISHINGS & SECONDARY STRUCTURE
- Brackets, Mountings & Supports
- Storage Cabinets
- Chairs/Desks/Bunks

ATMOSPHERIC MGT & CREW SERVICES
- H_2 Depol.Cell/Sebatier Reactor
- Electrolysis Cell/N_2H_4 Dissa.
- $H_2/O_2/N_2$ Tanks
- Catalytic Burner/Regen.Charcoal
- N_2H_4 Tanks
- Clean/Potable/Waste Water Tanks
- Reverse Osmosis/Vapor Compression
- Thermal Control Assy/Radiator Assy
- Pressure Control Assy
- Urinal/Dry John/Shower
- Emergency Repressurization Assy
- First Aid Kit
- Temperature & Humidity Control
- Air Circularization Sys

COMMUNICATIONS & MONITORING
- TV Monitor
- Intercomm
- Remote Data Station

ELECTRICAL POWER SYS DISTRIB & CONTROL
- Power Cabling & Busses
- Power Switching & Breakers
- Lights & Emergency Battery
- Terminals & Connectors

BACKUP GALLEY
- Food Reconstitution/Hot Plate
- Microwave Oven/Fountain
- Refrigerator (small)

PHOTO LAB
- Photo Processor & Chemicals
- Camera/Enlarger
- Film & Camera Storage

BIOSCIENCE LAB
- Organic Carbon Analyzer
- Multivator/Incubator
- Microscope/Electron Microscope
- Photomicrographic Camera
- Gas Chromatograph/J-Band Spectro

LAB & BACKUP COMMAND POST MODULE 1XX-04-00-00-00

PRIME STRUCTURE
- Module Cylinder
- Elliptical Bulkheads
- Wall Cover
- Docking Port
- Pressure Door Assy
- Ceiling & Floor Assy

FURNISHINGS & SECONDARY STRUCTURE
- Brackets, Mountings & Supports
- Storage Cabinets
- Chairs/Desks/Tables/Benches

ATMOSPHERIC MGT & CREW SERVICES
- H_2 Depol.Cell/Sebatier Reactor
- $H_2/O_2/N_2$ Tanks
- Catalytic Burner/Regen.Charcoal
- N_2H_4 Tanks
- Clean & Waste Water Tanks
- Reverse Osmosis
- Thermal Control Assy/Radiator Assy
- Pressure Control Assy
- Emergency Repressurization Assy
- First Aid Kit
- Temperature & Humidity Control
- Air Circularization Sys

COMMUNICATIONS & MONITORING
- TV Monitor
- Intercomm

ELECTRICAL POWER SYS DISTRIB & CONTROL
- Power Cabling & Busses
- Power Switching & Breakers
- Lights & Emergency Battery
- Terminals & Connectors

GEO-SCIENCE LAB
- X-ray, IR, UV, Mass Spectrometers
- X-ray Diffractometer
- Nuclear Magnetic Resonance

DATA ANALYSES LAB & BACKUP CMD & CONTROL
- Microfilm Viewer
- Data File Storage
- Multiprocessor
- Data Mgt Control Console
- Data Processor
- Operating & Mass Memory
- Archival Memory
- Central Timming Unit
- Intercomm Control
- S-Band Transceiver & Ant
- VHF Transceiver & Ant
- Modulators

ASSEMBLY & RECREATION MODULE 1XX-05-00-00-00

PRIME STRUCTURE
- Module Cylinder
- Elliptical Bulkheads
- Wall Cover
- Docking Port
- Pressure Door Assy
- Ceiling & Floor Assy
- Air Lock Assy
- Secondary Pressure Wall

FURNISHINGS & SECONDARY STRUCTURE
- Brackets, Mountings & Supports
- Storage Cabinets
- Chairs/Desks/Tables/Benches

ATMOSPHERIC MGT & CREW SERVICES
- H_2 Depol.Cell/Sebatier Reactor
- Emergency Repressurization Sys
- Air Shower Assy
- Dust Mgt Assy
- Pump Down Assy
- APLSS Recharge Sys
- Clean/Potable/Waste Water Tanks
- Reverse Osmosis
- Vapor Compression
- Air Circularization Sys

COMMUNICATIONS & MONITORING
- TV Monitor
- Intercomm
- Remote Data Station

ELECTRICAL POWER SYS DISTRIB & CONTROL
- Power Cabling & Busses
- Power Switching & Breakers
- Lights & Emergency Battery
- Terminals & Connectors

MAIN GALLEY
- Stoves/Ovens
- Freezer/Refrigerator
- Dishwasher
- Food Reconstitution Unit
- Hot Plates

BASE MAINTENANCE MODULE 1XX-06-00-00-00

PRIME STRUCTURE
- Module Cylinder
- Elliptical Bulkheads
- Wall Cover
- Docking Port
- Pressure Door Assy
- Ceiling & Floor Assy
- Air Lock Assy
- Secondary Pressure Wall

FURNISHINGS & SECONDARY STRUCTURE
- Brackets, Mountings & Supports
- Storage Cabinets
- Chairs/Desks/Benches/Fixtures

ATMOSPHERIC MGT & CREW SERVICES
- Air Circularization Sys
- Emergency Repressurization Sys
- Air Shower Assy/Dust Mgt Assy
- Pump Down Assy/APLSS Recharge Sys

COMMUNICATIONS & MONITORING
- TV Monitor
- Intercomm
- Remote Data Terminal

ELECTRICAL POWER SYS DISTRIB & CONTROL
- Power Cabling & Busses
- Power Switching & Breakers
- Lights & Emergency Battery
- Terminals & Connectors

BASE MAINTENANCE FACILITY
- Shelter M&R Equip
- Mobility M&R Equip
- Suit M&R Equip

DRIVE-IN GARAGE MODULE 1XX-07-00-00-00

PRIME STRUCTURE
- Module Cylinder
- Elliptical Bulkheads
- Wall Cover
- Docking Port
- Pressure Door Assy
- Drop Panel/Jack & Tracks
- Foldout Tracks

FURNISHINGS & SECONDARY STRUCTURE
- Brackets, Mountings & Supports
- Storage Cabinets/Benches

ATMOSPHERIC MGT & CREW SERVICES
- Air Circularization Sys
- Emergency Repressurization Sys

COMMUNICATIONS & MONITORING
- Intercomm
- Remote Data Station

ELECTRICAL POWER SYS DISTRIB & CONTROL
- Power Cabling & Busses
- Power Switching & Breakers
- Lights & Emergency Battery
- Terminals & Connectors

DRIVE-IN WAREHOUSE MODULE 1XX-08-00-00-00

PRIME STRUCTURE
- Module Cylinder
- Elliptical Bulkheads
- Wall Cover
- Docking Port
- Pressure Door Assy
- Ceiling & Floor Assy

FURNISHINGS & SECONDARY STRUCTURE
- Brackets, Mountings & Supports
- Storage Cabinets

ATMOSPHERIC MGT & CREW SERVICES
- Air Circularization Sys
- Emergency Repressurization Sys

COMMUNICATIONS & MONITORING
- Intercomm
- Remote Data Station

ELECTRICAL POWER SYS DISTRIB & CONTROL
- Power Cabling & Busses
- Power Switching & Breakers
- Lights & Emergency Battery
- Terminals & Connectors

MOBILE CARGO SUPPLY MODULE (16 EACH) 1XX-09-00-00-00

PRIME STRUCTURE
- Module Cylinder
- Elliptical Bulkheads
- Wall Cover
- Docking Ring
- Ceiling & Floor Assy

FURNISHINGS & SECONDARY STRUCTURE
- Brackets, Mountings & Supports
- Storage Cabinets

SUPPORT OPERATIONS EQUIPMENT HARDWARE 1XX-11-00-00-00

ELECTRICAL POWER SYS DISTRIB & CONTROL
- Wiring & Plugs
- Distrib & Control Assy

RELIQUEFACTION SYS UNIT
- Mounting Structure
- H_2/O_2 Refrigeration/Compressor
- H_2/O_2 Accumulator

LAUNCH & LANDING FACILITY EQUIP
- Beacon/Lights
- Landing Aids

EXTERNAL COMMUNICATIONS EQUIP
- Remote Comm Antenna

MOBILITY EQUIPMENT TRANSPORTATION MODULES (7 EA) 1XX-13-00-00-00

PRIME STRUCTURE
- Module Cylinder
- Elliptical Bulkheads
- Docking Ring/Foldout Tracks
- Floor & Pressure Door Assy

FURNISHINGS & SECONDARY STRUCTURE
- Brackets, Mountings & Supports

DEEP DRILL COVER MODULE 1XX-10-00-00-00

PRIME STRUCTURE
- Module Cylinder
- Elliptical Bulkheads
- Wall Cover
- Docking Ring
- Pressure Door Assy

FURNISHINGS & SECONDARY STRUCTURE
- Brackets, Mountings & Supports

ATMOSPHERIC MGT & CREW SERVICES
- Air Circularization Sys
- Emergency Repressurization Sys

ELECTRICAL POWER SYS DISTRIB & CONTROL
- Power Cabling & Busses
- Power Switching & Breakers
- Lights & Emergency Battery
- Terminals & Connectors

OBSERVATORY SHELL MODULES (2 EACH) 1XX-12-00-00-00

PRIME STRUCTURE
- Module Cylinder
- Elliptical Bulkheads
- Wall Cover /Docking Ring
- Pressure Door Assy

FURNISHINGS & SECONDARY STRUCTURE
- Brackets,Mountings & Supports

ATMOSPHERIC MGT & CREW SERVICES
- Air Circularization Sys
- Emergency Repressurization Sys

ELECTRICAL POWER SYS DISTRIB & CONTROL
- Power Cabling & Busses
- Power Switching & Breakers
- Lights & Emergency Battery
- Terminals & Connectors

Figure 2.1-1. Baseline Shelter Configuration Hardware Tree

HARDWARE TREE
(MSS DERIVATIVE CONFIGURATION)

Space Division
North American Rockwell

10 MAR '71

LUNAR SURFACE BASE SHELTER
1XX-00-00-00-00

CORE MODULE CM # 1
1XX-01-00-00-00

PRIME STRUCTURE
- Module Cylinder
- Elliptical Bulkheads
- Outerwall Cover
- Docking Ports
- Pressure Door Assy
- Ceiling & Floor Assy

FURNISHINGS & SECONDARY STRUCTURE
- Brackets, Mountings & Supports
- Storage Cabinets
- Chairs/Desks/Tables/Bunks
- Partitions

ATMOSPHERIC MGT & CREW SERVICES
- Air Circularization Sys
- Emergency Repressurization Sys
- Clean/Potable/Waste Water Tanks
- $H_2/O_2/N_2$ Tanks
- Thermal Control Assy

COMMUNICATIONS & MONITORING
- TV Monitor
- Intercomm
- Remote Data Station

ELECTRICAL POWER SYS DISTRIB & CONTROL
- Power Cabling & Busses
- Power Switching & Breakers
- Lights & Emergency Battery
- Terminals & Connectors

DATA ANALYSES LAB
- Microfilm Viewer
- Data File Storage
- Multiprocessor
- Central Data Processor
- Archival Memory
- Central Timing Unit
- Displays & Console

BIOSCIENCE LAB
- Organic Carbon Analyzer
- Multivator/Incubator
- Microscope/Electron Microscope
- Photomicrographic Camera
- Gas Chromatograph/J-Band Spectro

LAB & BACKUP CONTROL MODULE CCM# 1
1XX-02-00-00-00

PRIME STRUCTURE
- Module Cylinder
- Elliptical Bulkheads
- Outerwall Cover
- Docking Ports
- Pressure Door Assy
- Ceiling & Floor Assy
- Flex Tunnel Provisions

FURNISHINGS & SECONDARY STRUCTURE
- Brackets, Mountings & Supports
- Storage Cabinets
- Chairs/Desks/Tables/Bunks
- Partitions

ATMOSPHERIC MGT & CREW SERVICES
- Air Circularization Sys
- Emergency Repressurization Sys
- Clean/Potable/Waste Water Tanks
- $H_2/O_2/N_2$ Tanks
- Thermal Control Assy

ELECTRICAL POWER SYS DISTRIB & CONTROL
- Power Cabling & Busses
- Power Switching & Breakers
- Lights & Emergency Battery
- Terminals & Connectors

BACKUP COMMAND & CONTROL
- Communications Control Rack
- Intercomm Control
- S-Band Transceiver & Antenna
- VHF Transceiver & Antenna
- Modulator/Processor
- TV Monitor/Camera
- Video/Audio Recorder
- Central Switch Unit

GEOSCIENCE LAB
- X-ray,IR,UV mass Spectrometer
- X-ray Diffractometer
- Nuclear Magnetic Resonance

PHOTO LAB
- Photo Processor & Chemicals
- Camera/Enlarger
- Film & Camera Storage

LAB & CONTROL MODULE CCM # 2
1XX-03-00-00-00

PRIME STRUCTURE
- Module Cylinder
- Elliptical Bulkheads
- Outerwall Cover
- Docking Ports
- Pressure Door Assy
- Ceiling & Floor Assy
- Flex Tunnel Provisions

FURNISHINGS & SECONDARY STRUCTURE
- Brackets, Mountings & Supports
- Storage Cabinets
- Chairs/Desks/Tables/Bunks
- Partitions

ATMOSPHERIC MGT & CREW SERVICES
- Air Circularization Sys
- Emergency Repressurization Sys
- Clean/Potable/Waste Water Tanks
- $H_2/O_2/N_2$ Tanks
- Thermal Control Assy

ELECTRICAL POWER SYS DISTRIB & CONTROL
- Power Cabling & Busses
- Power Switching & Breakers
- Lights & Emergency Battery
- Terminals & Connectors

COMMAND & CONTROL
- Data Mgt Control Console
- Central Data Processor
- Archival Memory
- Central Timing Unit
- Displays & Console
- Communications Control Rack
- Intercomm Control
- S-Band Transceiver & Antenna
- VHF Transceiver & Antenna
- LF Transceiver & Antenna
- Modulator/Processor
- TV Monitor/Camera
- Video/Audio Recorder
- Central Switch Unit

MEDICAL & DENTAL FACILITY
- X-ray & Med Unit
- Dental Unit

BASE MAINTENANCE FACILITY
- Shelter M&R Equip
- Mobility M&R Equip
- Suit M&R Equip

CREW QUARTERS MODULE CQM # 1
1XX-04-00-00-00

PRIME STRUCTURE
- Module Cylinder
- Elliptical Bulkheads
- Outerwall Cover
- Docking Port
- Pressure Door Assy
- Ceiling & Floor Assy
- Flex Tunnel Provisions

FURNISHINGS & SECONDARY STRUCTURE
- Brackets, Mountings & Supports
- Storage Cabinets
- Chairs/Desks/Tables/Bunks
- Partitions

ATMOSPHERIC MGT & CREW SERVICES
- Air Circularization Sys
- Temperature & Humidity Control
- Emergency Repressurization Sys
- Pressurization Control Assy
- Clean/Potable/Waste Water Tanks
- $H_2/O_2/N_2$ Tanks
- Thermal Control Assy/Radiator Assy
- H_2 Depol.Cell/Sebatier Reactor
- Electrolysis Cell/N_2H_4 Dissa.
- Catalytic Burner/Regen. Charcoal
- Reverse Osmosis/Vapor Compression
- Urinal/Dry John/Shower
- ECS Monitor

COMMUNICATIONS & MONITORING
- TV Monitor
- Intercomm
- Remote Data Terminal
- Preprocessors/RACU

ELECTRICAL POWER SYS DISTRIB & CONTROL
- Power Cabling & Busses
- Power Switching & Breakers
- Lights & Emergency Battery
- Terminals & Connectors

BACKUP GALLEY
- Food Reconstitution/Hot Plate
- Microwave Oven/Fountain
- Refrigerator

GALLEY MODULE GM # 1
1XX-05-00-00-00

PRIME STRUCTURE
- Module Cylinder
- Elliptical Bulkheads
- Outerwall Cover
- Docking Port
- Pressure Door Assy
- Ceiling & Floor Assy

FURNISHINGS & SECONDARY STRUCTURE
- Brackets, Mountings & Supports
- Storage Cabinets
- Chairs/Desks/Tables/Bunks
- Partitions

ATMOSPHERIC MGT & CREW SERVICES
- Air Circularization Sys
- Temperature & Humidity Control
- Emergency Repressuriaation Sys
- Pressure Control Assy
- Clean/Potable/Waste Water Tanks
- $H_2/O_2/N_2$ Tanks
- Thermal Control Assy
- H_2 Depol.Cell/Sebatier Reactor
- Electrolysis Cell/N_2H_4 Dissa.
- Catalytic Burner/Regen.Charcoal
- Reverse Osmosis/Vapor Compression
- Urinal/Dry John/Shower
- ECS Monitor

COMMUNICATIONS & MONITORING
- TV Monitor
- Preprocessors/RACU

ELECTRICAL POWER SYS DISTRIB & CONTROL
- Power Cabling & Busses
- Power Switching & Breakers
- Lights & Emergency Battery
- Terminals & Connectors

MAIN GALLEY
- Stoves/Ovens
- Freezer/Refrigerator
- Sink
- Food Reconstitution Unit
- Hot Plates

CREW QUARTERS MODULE CQM# 3 (2 EACH)
1XX-06-00-00-00

PRIME STRUCTURE
- Module Cylinder
- Elliptical Bulkheads
- Outerwall Cover
- Docking Port
- Pressure Door Assy
- Ceiling & Floor Assy
- Flex Tunnel Provisions

FURNISHINGS & SECONDARY STRUCTURE
- Brackets, Mountings & Supports
- Storage Cabinets
- Chairs/Desks/Tables/Bunks
- Partitions

ATMOSPHERIC MGT & CREW SERVICES
- Air Circularization Sys
- Temperature & Humidity Control
- Emergency Repressurization Sys
- Pressure Control Assy
- Clean/Potable/Waste Water Tanks
- $H_2/O_2/N_2$ Tanks
- Thermal Control Assy/Radiator Assy
- H_2 Depol.Cell/Sebatier Reactor
- Electrolysis Cell/N_2H_4 Dissa.
- Catalytic Burner/Regen. Charcoal
- Reverse Osmosis/Vapor Compression
- Urinal/Dry John/Shower
- ECS Monitor

COMMUNICATIONS & MONITORING
- TV Monitor
- Remote Data Terminal
- Preprocessors/RACU

ELECTRICAL POWER SYS DISTRIB & CONTROL
- Power Cabling & Busses
- Power Switches & Breakers
- Lights & Emergency Battery
- Terminals & Connectors

DRIVE-IN GARAGE MODULE
1XX-07-00-00-00

PRIME STRUCTURE
- Module Cylinder
- Elliptical Bulkheads
- Outerwall Cover
- Docking Port
- Pressure Door Assy
- Ceiling & Floor Assy
- Full Diam. Door Provisions
- Drop Panel/Jack & Tracks
- Air Lock Assy

FURNISHINGS & SECONDARY STRUCTURE
- Brackets, Mountings & Supports
- Storage Cabinets
- Benches

ATMOSPHERIC MGT & CREW SERVICES
- Air Circularization Sys
- Temperature & Humidity Control
- Emergency Repressurization Sys
- Pressure Control Assy
- Air Shower Assy
- Dust Mgt Assy
- APLSS Recharge Sys

COMMUNICATIONS & MONITORING
- TV Monitor
- Intercomm
- Remote Data Station

ELECTRICAL POWER SYS DISTRIB & CONTROL
- Power Cabling & Busses
- Power Switches & Breakers
- Lights & Emergency Battery
- Terminals & Connectors

DRIVE-IN WAREHOUSE MODULE
1XX-08-00-00-00

PRIME STRUCTURE
- Module Cylinder
- Elliptical Bulkheads
- Outerwall Cover
- Docking Ring
- Pressure Door Assy
- Ceiling & Floor Assy
- Full Diam. Door Provisions
- Air Lock Assy

FURNISHINGS & SECONDARY STRUCTURE
- Brackets, Mountings & Supports
- Storage Cabinets
- Benches

ATMOSPHERIC MGT & CREW SERVICES
- Air Circularization Sys
- Temperature & Humidity Control
- Emergency Repressurization Sys
- Pressure Control Assy
- Air Shower Assy
- Dust Mgt Assy
- APLSS Recharge Sys

COMMUNICATIONS & MONITORING
- TV Monitor
- Intercomm
- Remote Data Station

ELECTRICAL POWER SYS DISTRIB & CONTROL
- Power Cabling & Busses
- Power Switches & Breakers
- Lights & Emergency Battery
- Terminals & Connectors

MOBILE CARGO SUPPLY MODULE (16 EACH)
1XX-09-00-00-00

PRIME STRUCTURE
- Module Cylinder
- Elliptical Bulkheads
- Outerwall Cover
- Docking Ring
- Ceiling & Floor Assy

FURNISHINGS & SECONDARY STRUCTURE
- Brackets, Mountings & Supports
- Storage Cabinets

SUPPORT OPERATIONS EQUIPMENT HARDWARE
1XX-11-00-00-00

ELECTRICAL POWER SYS DISTRIB & CONTROL
- Wiring & Plugs
- Distrib & Control Assy

RELIQUEFACTION SYS UNIT
- Mounting Structure
- H_2/O_2 Refrigeration/Compressor
- H_2/O_2 Accumulator

LAUNCH & LANDING FACIL EQUIP
- Beacon/Lights
- Landing Aids

EXTERNAL COMMUNICATIONS EQUIP
- Remote Comm Antenna

MOBILITY EQUIPMENT TRANSPORTATION MODULES (7EA)
1XX-13-00-00-00

PRIME STRUCTURE
- Module Cylinder
- Elliptical Bulkheads
- Docking Ring/Foldout Tracks
- Pressure Door Assy

FURNISHINGS & SECONDARY STRUCTURE
- Brackets, Mountings & Supports

DEEP DRILL COVER MODULE
1XX-10-00-00-00

PRIME STRUCTURE
- Module Cylinder
- Elliptical Bulkheads
- Outerwall Cover
- Docking Ring
- Pressure Door Assy

FURNISHINGS & SECONDARY STRUCTURE
- Brackets, Mountings & Supports

ATMOSPHERIC MGT & CREW SERVICES
- Air Circularization Sys
- Emergency Repressurization Sys

ELECTRICAL POWER SYS DISTRIB & CONTROL
- Power Cabling & Busses
- Power Switching & Breakers
- Lights & Emergency Battery
- Terminals & Connectors

OBSERVATORY SHELL MODULES (2 EACH)
1XX-12-00-00-00

PRIME STRUCTURE
- Module Cylinder
- Elliptical Bulkheads
- Outerwall Cover/Docking Ring
- Pressure Door Assy/Floor

FURNISHINGS & SECONDARY STRUCTURE
- Brackets, Mountings & Supports

ATMOSPHERIC MGT & CREW SERVICES
- Air Circularization Sys
- Emergency Repressurization Sys

ELECTRICAL POWER SYS DISTRIB & CONTROL
- Power Cabling & Busses
- Power Switching & Breakers
- Lights & Emergency Battery
- Terminals & Connectors

Figure 2.2-1. MSS Derivative Shelter Configuration Hardware Tree

3.0 WORK BREAKDOWN STRUCTURES

The Work Breakdown Structure (WBS) lists the program elements related to the Lunar Surface Base (LSB) Program for both the baseline shelter configuration and the Modular Space Station (MSS) derivative shelter configuration. The elements include the principal categories of hardware, software, services, and related work tasks involved in the development and production of the Lunar Surface Base (LSB) Program.

The WBS is hardware-oriented to the major subsystem level (Level 5) and is used to assure that all elements of costs are considered. It provides a frame of reference for the preparation of the program development schedules and plans, Hardware Utilization Lists, and program cost estimates for Phases C/D planning.

The WBS is structured in a manner similar to other current NASA space programs to facilitate comparing programs. The hardware portion of the WBS reflects the hardware tree derived from an analysis of the Lunar Surface Base design concepts. To aid in the identification of development (non-recurring) costs and production (recurring) costs, the WBS contains separate breakdowns for system test and operational mission hardware.

3.1 WORK BREAKDOWN STRUCTURE FOR BASELINE SHELTER CONFIGURATION

Figure 3.1-1 presents the WBS for the Lunar Surface Base baseline configuration. All program tasks, schedule, and cost elements for the selected shelter base configuration are keyed to the WBS segments. The shelter hardware portion of the WBS reflects the system and subsystem hardware requirements based on the shelter design analysis. The WBS contains separate breakdowns for testing and operational hardware. The system test hardware will be used to meet the requirements for development and qualification testing, integrated systems tests, and later for operational training and mission support operations.

The functional elements of the WBS (Program Management, System Engineering Support, Logistics and Training Equipment, Facilities Support, Launch Operations Support, Mission Operations Support and Ground Support Equipment) are used to accumulate task efforts for the LSB program and are described more fully in the following paragraphs:

Program Management. The purpose of program management is to ensure economical and effective overall planning, organization, staffing, direction, and control of the LSB program activities. It covers the responsibilities for program-wide cost and schedule control, interface and integration management, subcontractor management and configuration control. Program management operations include directing the program toward successful completion, program planning and control, and schedule control.

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WORK BREAKDOWN STRUCTURE
(BASELINE CONFIGURATION)

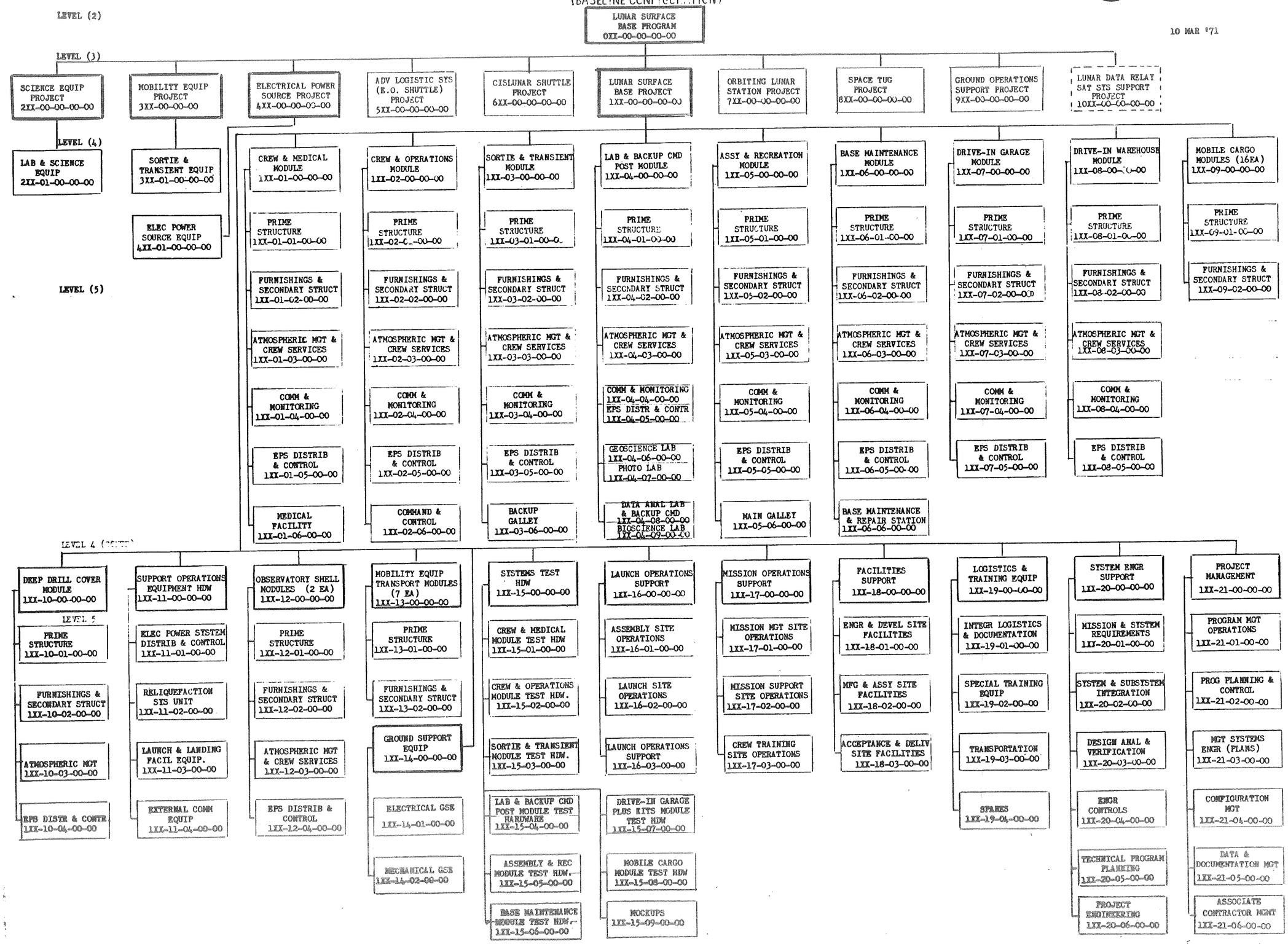

Figure 3.1-1. Baseline Shelter Configuration Work Breakdown Structure

System Engineering Support. This covers the engineering activities of system requirements, systems analyses, system performance definition, configuration requirements, mission analyses, subsystem analyses and definition, design analysis, and system integration requirements. System definition includes mission requirements, system constraints, and subsystem interface requirements. Design requirements definition includes design concepts, preliminary design definition, and design analysis. System integration includes interrelationships between the subsystems, subcontractors, and integration of major GFE projects.

Logistics and Training Equipment. Integrated logistics provides for optimization of personnel, equipment, and facilities to minimize total system requirements and costs. In support of the operational training activities conducted with the system test hardware, training aids and devices will be provided for simulation of lunar site activities. The logistics activities will include defining the lunar base spares requirements for maintaining lunar base equipment during the operational phase.

Facilities Support. Facility requirements definition includes engineering and development site facilities, the manufacturing and checkout facilities, combined system test facilities, and the launch site ground test facilities.

Launch Operations Support. Launch operations support functions include ground assembly site operations, ground launch site operations, and launch readiness preparation support. Included in physical and functional integration with the launch vehicle.

Mission Operations Support. Mission support operations covers the planning, control, and base buildup operations including command, telemetry and video functions. Lunar base buildup operations and problems will be coordinated closely with crew training activities being conducted with the mission support system test hardware. The costs for the mission operations are not included since it is assumed that this function will be performed by NASA personnel and only costs that will be incurred by contractors were shown in the cost estimates.

Ground Support Equipment. The GSE covers the requirements for the ground support equipment, checkout and test equipment, and the ground handling equipment necessary to support the Lunar Surface Base modules through all phases of functional performance tests, ground operations, pre-launch testing, and mission operations. The requirements for fabrication tooling and special test equipment (STE) are not included in the GSE but are part of the production requirements.

3.2 WORK BREAKDOWN STRUCTURE FOR MSS DERIVATIVE SHELTER CONFIGURATION

Figure 3.2-1 presents the WBS prepared for the MSS derivative shelter configuration. The WBS layout and major module segment grouping is the same as the baseline configuration to provide an effective base for comparing the configurations.

WORK BREAKDOWN STRUCTURE
(MSS DERIVATIVE CONFIGURATION)

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LEVEL (2)

LEVEL (3)

LEVEL (4)

LEVEL (5)

LEVEL 4 (COND)

LEVEL 5

- LUNAR SURFACE BASE PROGRAM 0XX-00-00-00-00
  - SCIENCE EQUIPMENT PROJECT 2XX-00-00-00-00
    - LAB & SCIENCE EQUIP 2XX-01-00-00-00
  - MOBILITY EQUIPMENT PROJECT 3XX-00-00-00-00
    - SORTIE & TRANSIENT EQUIP 3XX-01-00-00-00-00
  - ELECTRICAL POWER SOURCE PROJECT 4XX-00-00-00-00
    - ELEC POWER SOURCE EQUIP 4XX-01-00-00-00
  - ADV LOGIS SYS (E.O.SHUTTLE)PROJ 5XX-00-00-00-00
  - CISLUNAR SHUTTLE PROJECT 6XX-00-00-00-00
  - LUNAR SURFACE BASE PROJECT 1XX-00-00-00-00
    - CORE MODULE CM #1 1XX-01-00-00-00
      - PRIME STRUCTURE 1XX-01-01-00-00
      - FURNISHINGS & SECONDARY STRUCTURE 1XX-01-02-00-00
      - ATMOSPHERIC MGT & CREW SERVICES 1XX-01-03-00-00
      - COMM & MONITORING 1XX-01-04-00-00
      - EPS DISTRIB & CONTROL 1XX-01-05-00-00
        - DEEP DRILL COVER MODULE 1XX-10-00-00-00
          - PRIME STRUCTURE 1XX-10-01-00-00
          - FURNISHINGS & SECONDARY STRUCT 1XX-10-02-00-00
          - ATMOSPHERIC MGT & CREW SERVICES 1XX-10-03-00-00
          - EPS DISTRIB & CONTROL 1XX-10-04-00-00
        - SUPPORT OPERATIONS EQUIP HARDWARE 1XX-11-00-00-00
          - ELEC POWER SYS DISTRIB & CONTROL 1XX-11-01-00-00
          - RELIQUEFICATION SYS UNIT 1XX-11-02-00-00
          - LAUNCH & LANDING FACIL EQUIP 1XX-11-03-00-00
          - EXTERNAL COMMUNICATIONS EQUIP 1XX-11-04-00-00
        - OBSERVATORY SHELL MODULES (2 EA) 1XX-12-00-00-00
          - PRIME STRUCTURE 1XX-12-01-00-00
          - FURNISHINGS & SECONDARY STRUCTURE 1XX-12-02-00-00
          - ATMOSPHERIC MGT & CREW SERVICES 1XX-12-03-00-00
          - EPS DISTRIB & CONTROL 1XX-12-04-00-00
        - MOBILITY EQUIP TRANSPORTATION MOD (7 EA) 1XX-13-00-00-00
          - PRIME STRUCTURE 1XX-13-01-00-00
          - FURNISHINGS & SECONDARY STRUCT 1XX-13-02-00-00
          - GROUND SUPPORT EQUIPMENT 1XX-14-00-00-00
            - ELECTRICAL GSE 1XX-14-01-00-00
            - MECHANICAL GSE 1XX-14-02-00-00
        - SYSTEMS TEST HARDWARE 1XX-15-00-00-00
          - CORE MODULE TEST HDW 1XX-15-01-00-00
          - LAB & BACKUP CMD MODULE TEST HDW 1XX-15-02-00-00
          - LAB & CONT MODULE TEST HDW 1XX-15-03-00-00
          - CREW QTRS TEST HDW 1XX-15-04-00-00
          - GALLEY MOD TEST HDW 1XX-15-05-00-00
          - CREW QTRS TEST HDW 1XX-15-06-00-00
          - DRIVE-IN GARAGE 1XX-15-07-00-00
          - MOBILE CARGO TEST HDW 1XX-15-08-00-00
          - MOCKUPS 1XX-15-09-00-00
        - LAUNCH OPERATIONS SUPPORT 1XX-16-00-00-00
          - ASSEMBLY SITE OPERATIONS 1XX-16-01-00-00
          - LAUNCH SITE OPERATIONS 1XX-16-02-00-00
          - LAUNCH OPERATIONS SUPPORT 1XX-16-03-00-00
        - MISSION OPERATIONS SUPPORT 1XX-17-00-00-00
          - MISSION MGT SITE OPERATIONS 1XX-17-01-00-00
          - MISSION SUPPORT SITE OPERATIONS 1XX-17-02-00-00
          - CREW TRAINING SITE OPERATIONS 1XX-17-03-00-00
        - FACILITIES SUPPORT 1XX-18-00-00-00
          - ENGR & DEVEL SITE FACILITIES 1XX-18-01-00-00
          - MFG & ASSY SITE FACILITIES 1XX-18-02-00-00
          - ACCEPTANCE & DELIV SITE FACILITIES 1XX-18-03-00-00
        - LOGISTICS & TRAINING EQUIP 1XX-19-00-00-00
          - INTEGR LOGISTICS & DOCUMENTATION 1XX-19-01-00-00
          - SPECIAL TRAINING EQUIP 1XX-19-02-00-00
          - TRANSPORTATION 1XX-19-03-00-00
          - SPARES 1XX-19-04-00-00
        - SYSTEM ENGINEERING SUPPORT 1XX-20-00-00-00
          - MISSION & SYSTEM REQUIREMENTS 1XX-20-01-00-00
          - SYSTEM & SUBSYSTEM INTEGRATION 1XX-20-02-00-00
          - DESIGN ANAL & VERIFICATION 1XX-20-03-00-00
          - ENGR. CONTROLS 1XX-20-04-00-00
          - TECHNICAL PROGRAM PLANNING 1XX-20-05-00-00
          - PROJECT ENGINEERING 1XX-20-06-00-00
        - PROJECT MANAGEMENT 1XX-21-00-00-00
          - PROGRAM MGT OPERATIONS 1XX-21-01-00-00
          - PROG PLANNING & CONTROL 1XX-21-02-00-00
          - MGT SYSTEMS ENGR (PLANS) 1XX-21-03-00-00
          - CONFIGURATION MGT 1XX-21-04-00-00
          - DATA & DOCUMENTATION MGT 1XX-21-05-00-00
          - ASSOCIATE CONTRACTOR MGT 1XX-21-06-00-00
    - LAB & BACKUP CONTR MODULE CCM # 1 1XX-02-00-00-00
      - PRIME STRUCTURE 1XX-02-01-00-00
      - FURNISHINGS & SECONDARY STRUCT 1XX-02-02-00-00
      - ATMOSPHERIC MGT & CREW SERVICES 1XX-02-03-00-00
      - EPS DISTRIB & CONTR 1XX-02-04-00-00
      - BACKUP CMD & CONTR 1XX-02-05-00-00
      - GEOSCIENCE LAB 1XX-02-06-00-00
      - PHOTO LAB 1XX-02-07-00-00
      - DATA ANAL LAB 1XX-02-08-00-00
      - BIOSCIENCE LAB 1XX-02-09-00-00
    - LAB & CONTROL MODULE CCM # 2 1XX-03-00-00-00
      - PRIME STRUCTURE 1XX-03-01-00-00
      - FURNISHINGS & SECONDARY STRUCT 1XX-03-02-00-00
      - ATMOSPHERIC MGT & CREW SERVICES 1XX-03-03-00-00
      - EPS DISTRIB & CONTROL 1XX-03-04-00-00
      - COMMAND & CONTROL 1XX-03-05-00-00
      - MEDICAL & DENTAL 1XX-03-06-00-00
      - BASE MAINT.FACIL. 1XX-03-07-00-00
    - CREW QUARTERS MODULE CQM # 1 1XX-04-00-00-00
      - PRIME STRUCTURE 1XX-04-01-00-00
      - FURNISHINGS & SECONDARY STRUCTURE 1XX-04-02-00-00
      - ATMOSPHERIC MGT & CREW SERVICES 1XX-04-03-00-00
      - COMM & MONITORING 1XX-04-04-00-00
      - EPS DISTRIB & CONTROL 1XX-04-05-00-00
      - BACKUP GALLEY 1XX-04-06-00-00
    - GALLEY MODULE GM # 1 1XX-05-00-00-00
      - PRIME STRUCTURE 1XX-05-01-00-00
      - FURNISHINGS & SECONDARY STRUCT. 1XX-05-02-00-00
      - ATMOSPHERIC MGT & CREW SERVICES 1XX-05-03-00-00
      - COMM & MONITORING 1XX-05-04-00-00
      - EPS DISTRIB & CONTROL 1XX-05-05-00-00
      - MAIN GALLEY 1XX-05-06-00-00
    - CREW QUARTERS (2) MODULE CQM # 3 1XX-06-00-00-00
      - PRIME STRUCTURE 1XX-06-01-00-00
      - FURNISHINGS & SECONDARY STRUCT. 1XX-06-02-00-00
      - ATMOSPHERIC MGT & CREW SERVICES 1XX-06-03-00-00
      - COMM & MONITORING 1XX-06-04-00-00
      - EPS DISTRIB & CONTROL 1XX-06-05-00-00
    - DRIVE-IN GARAGE MODULE 1XX-07-00-00-00
      - PRIME STRUCTURE 1XX-07-01-00-00
      - FURNISHINGS & SECONDARY STRUCT 1XX-07-02-00-00
      - ATMOSPHERIC MGT & CREW SERVICES 1XX-07-03-00-00
      - COMM & MONITORING 1XX-07-04-00-00
      - EPS DISTRIB & CONTROL 1XX-07-05-00-00
    - DRIVE-IN WAREHOUSE MODULE 1XX-08-00-00-00
      - PRIME STRUCTURE 1XX-08-01-00-00
      - FURNISHINGS & SECONDARY STRUCT 1XX-08-02-00-00
      - ATMOSPHERIC MGT & CREW SERVICES 1XX-08-03-00-00
      - COMM & MONITORING 1XX-08-04-00-00
      - EPS DISTRIB & CONTROL 1XX-08-05-00-00
    - MOBILE CARGO SUPPLY MODULE (16 EACH) 1XX-09-00-00-00
      - PRIME STRUCTURE 1XX-09-01-00-00
      - FURNISHINGS & SECONDARY STRUCT 1XX-09-02-00-00
  - ORBITING LUNAR STATION PROJECT 7XX-00-00-00-00
  - SPACE TUG PROJECT 8XX-00-00-00-00
  - GROUND OPERATING SUPPORT PROJECT 9XX-00-00-00-00
  - LUNAR DATA RELAY SAT SYS SUPT PROJ 10XX-00-00-00-00

Figure 3.2-1. MSS Derivative Shelter Configuration Work Breakdown Structure

4.0 PROGRAM DEVELOPMENT SCHEDULES

This section contains the overall program development plan for both the selected Lunar Surface Base baseline configuration and the Modular Space Station (MSS) derivative configuration. Included are Summary Program Schedules and detailed Master Program Development Schedules for both configurations. These schedules show the activities, events, and major milestones for the definition, design, development, testing, and production of the Lunar Surface Base shelter elements.

The program development plan for the Lunar Surface Base Project provides a programmatic approach to the shelter modules development and test to accomplish the program objectives and technical approach. It includes the development and qualification efforts, test requirements, launch and mission requirements, and management concepts in a logical, integrated, and economical sequence of activities and major milestones. All program tasks and schedule elements for both configurations are keyed to the Work Breakdown Structure identification numbers.

The following developmental guidelines and constraints were established to provide a common baseline and frame of reference in the preparation of the detailed program development schedules for both configurations:

1. Consideration of the NASA MSFC furnished guidelines and program objectives.

2. Phasing of the Lunar Surface Base Program into NASA's integrated space program plans. (Either with or without the Orbiting Lunar Station (OLS)).

3. Low-cost economical funding approach for shelter development, fabrication, and testing.

4. Application of schedule data indicating a Lunar Surface Base to be established in early 1985.

5. Extensive use of hardware and equipment developed for other programs including the Earth Orbital Space Station (EOSS).

6. Compatibility with the Earth Orbit Shuttle, Space Tug, and other space vehicles.

7. Use of applicable data from the Modular Space Station (MSS) definition study for the MSS derivative concept.

8. Existing contractor and government facilities used with requirements for additional or modified facilities minimized.

9. Production time spans based on a selective two-shift, five day work week, with essentially one set of structural fabrication tooling and a sequential fabrication buildup concept.

10. Fabrication of test vehicles limited to one structural test article of a typical module, one dynamic test article of a typical module, and one full up system test article of each of the unique shelter modules. For the MSS derivative configuration, dynamic and thermal vacuum tests of the MSS module structure were not repeated.

4.1 BASELINE SHELTER SUMMARY SCHEDULE

The overall summary program schedule for the baseline LSB is shown in Figure 4.1-1. It provides a broad identification of tasks, schedule elements, and major milestones for the shelter modules development and test. The Phase B System Definition is scheduled to start on January 1, 1977, followed by the Phase C Detail Design on January 1, 1978. Phase D Development/Production/Operations will start on January 1, 1979. The total time from start of Phase D to the first lunar flight is 72 months. The initial operational capability (IOC) is planned for April 1985, at the end of four months LSB buildup.

4.2 BASELINE SHELTER PRELIMINARY PROGRAM DEVELOPMENT SCHEDULE

The detailed Preliminary Program Development Schedule for the LSB program is shown in Figure 4.2-1. It covers an integrated set of activities and major program milestones for the definition, design, development, and production of the baseline LSB. The schedule is based on an analysis of the technical configuration and subsystems described in the technical portion of the final report and shows an orderly evolution of events leading to the LSB buildup on the lunar surface. The schedule of tasks and program elements are keyed to the Work Breakdown Structure identification numbers.

The schedule is based on the fabrication of one structural test article of a typical module (Crew & Medical Module), one dynamic test article of a typical module (Crew & Medical Module), and one full up system test hardware of each of seven shelter modules (Crew & Medical, Crew & Operations, Sortie & Transient Crew, Lab & Backup Command Post, Assembly & Recreation, Base Maintenance, and Drive-In Garage). Included in the system test hardware will be one typical support module (Mobile Cargo Module) with prototype kits of specialized furnishings of the other support modules. The fabrication time spans for the test hardware and the operational hardware are based on the use of one set of structural fabrication tooling and one manufacturing checkout and test station.

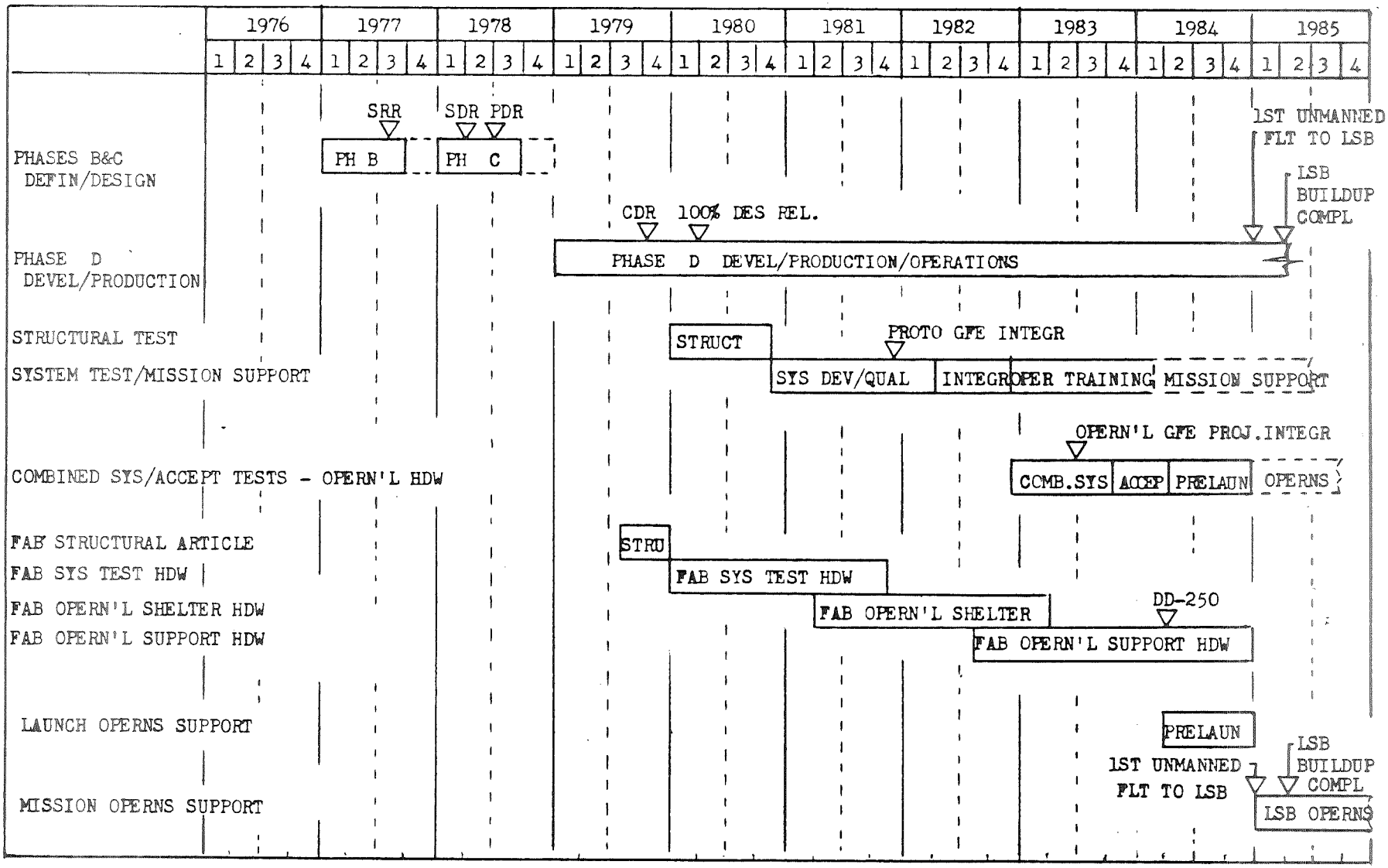

Figure 4.1-1. Baseline Shelter Configuration Summary Program Schedule

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15 MAR '77

LUNAR SURFACE BASE PROJECT

PRELIMINARY PROGRAM DEVELOPMENT SCHEDULE

(BASELINE CONFIGURATION)

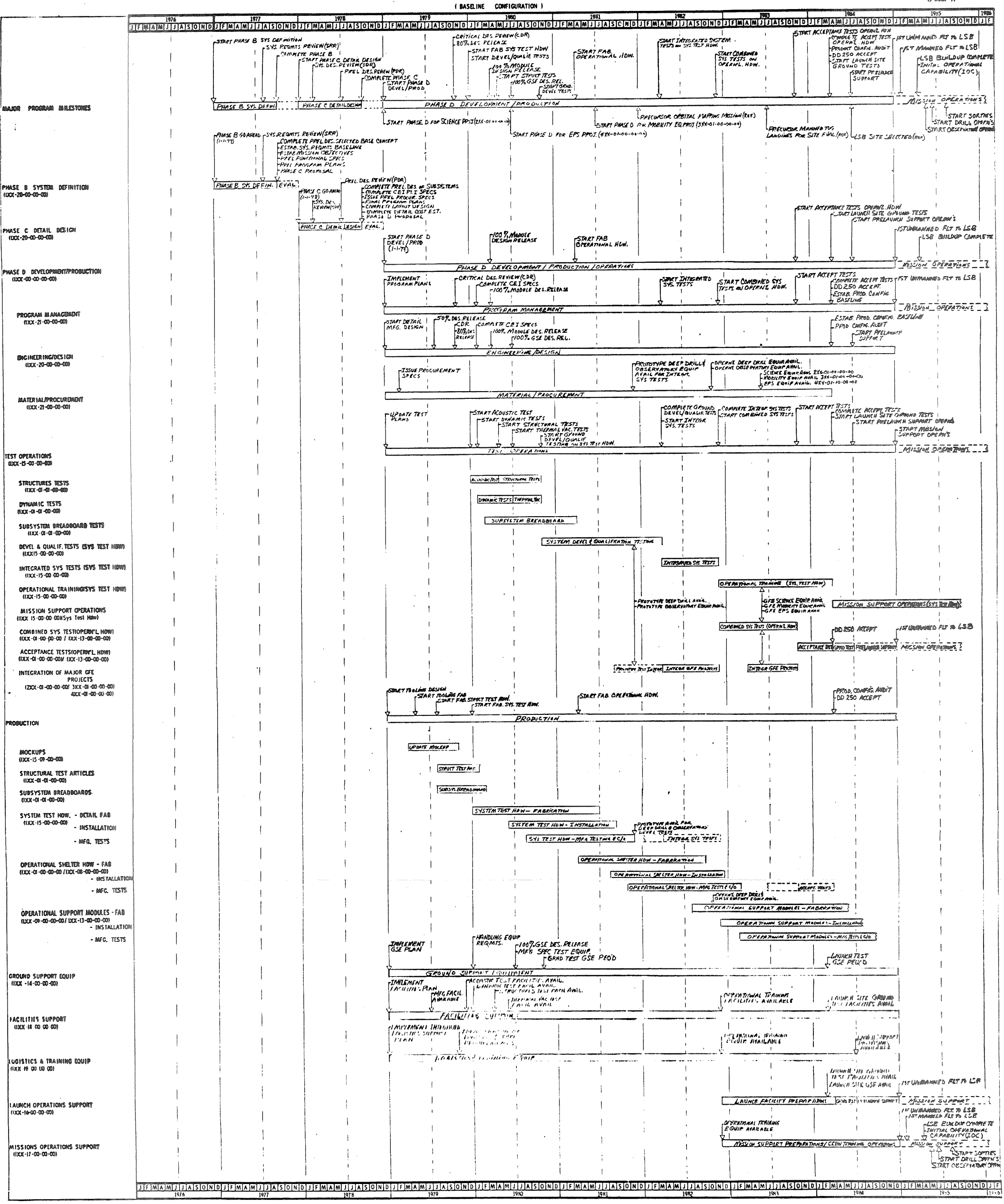

Figure 4.2-1. Baseline Shelter Configuration Preliminary Program Development Schedule

The Preliminary Program Development Schedule for the baseline LSB defines the required milestones for each of the major program functions. Hardware deliveries and other tasks necessary to coordinate the program are shown. The phasing of the program is as follows:

1. A nine month Phase B System Definition will start on January 1, 1977. This covers the definition of the modules and includes system and subsystem requirements analyses and final definition of design requirements. At the end of seven months a system requirements review (SRR) will be held to obtain approval of the design concept. During this period the major accomplishments will include: preliminary design of the selected base concept, establishment of the system requirements baseline and mission objectives, preparation of preliminary functional specifications and preliminary program plans. Completion of the System Definition Phase B study will be followed by a three months NASA review and evaluation period.

2. A nine months Phase C Detail Design effort will start on January 1, 1978. During this phase the subsystem performance requirements will be defined and procurement requests and specifications sent to subcontractors. Detail drawings will be prepared for the fabrication of the test hardware and the operational hardware. After two months of the design phase, the first of three design reviews will be held. This System Design Review (SDR) covers the early preliminary design effort and provides approval to proceed with the preliminary design effort. At the end of six months, the second design review will be held. This Preliminary Design Review (PDR) covers the system design effort and provides approval to proceed with the preliminary design of the subsystems. The major accomplishments during this Phase C Design will include: preliminary design of the module subsystems, preparation of CEI Part I specifications, preliminary procurement specifications, final program plans, complete layout designs of the modules, and detail cost estimates for Phase D. Completion of Detail Design Phase C will be followed by a three months NASA review and evaluation period.

3. The Phase D Development/Production starts on January 1, 1979. The first 15 months of this Phase D covers the preparation and release of detail production drawings. At the end of 10 months, the third design review will be held when approximately 80 percent of the detail fabrication drawings are complete. This Critical Design Review (CDR) covers the detail fabrication drawings and results in approval to proceed with the fabrication of the test hardware.

4. The production effort covers a time span of approximately five years for fabrication, assembly, system installation, and checkout for the mockup, test articles, system test hardware, and operational hardware. The time spans for the various test articles vary in length depending on the amount of structure to be fabricated. The

five years of production time, from 1980 to 1984, results from the approach of using one set of time-shared tooling and one checkout and test station for economy. Structural fabrication of a different module is started through the structural fabrication tooling every two months on a time-shared basis.

5. The test operations activity shown on the development schedule depicts the approximate start and completion dates for the major program tests. The ground tests are scheduled on a time-phased basis to make maximum utilization of the test articles. The ground testing program covers a span of three years and includes the structural testing and the system development testing. The sequence of major test is as follows: acoustic test, dynamic test, structural test, thermal test, system development/qualification test, and integrated system test.

6. The development schedule shows the activities and some of the key milestones for program management, engineering/design, material/procurement, ground support equipment (GSE), facilities, logistics, and launch and mission operations. Facilities milestones indicate when manufacturing and operational facilities will be available. GSE milestones indicate when test and launch GSE is required and when handling equipment is required. Logistics milestones show the need dates for training equipment and spares provisioning.

7. At the end of the acceptance tests of the operational hardware, a contract hardware review will be held and the DD 250 signed. This will provide for transferring the operational modules to the launch site for launch site ground tests and prelaunch operations. At the end of the prelaunch support operations, the modules will be readied for mission support operations.

8. The first unmanned flight of the operational hardware to the Lunar Surface Base is planned for January 1, 1985, to be followed by the first manned flight to the LSB on February 1, 1985. The LSB buildup is planned to be completed by April 1985, providing for the initial operational capability (IOC) at that time. Observatory operations are planned to start in May 1985, with the deep drill operations to start in June 1985. Mobile sortie operations are scheduled to start in August 1985.

4.3 MSS DERIVATIVE SHELTER SUMMARY SCHEDULE

The overall summary program schedule for the MSS derivative shelter is shown in Figure 4.3-1 and provides a broad identification of schedule elements and major milestones. The additional program complexity of the Lunar Surface Base when utilizing the MSS derivative modules in the shelter configuration requires a longer manufacturing time, and hence, requires a six months earlier start for Phases B, C, and D to arrive at the same IOC date of April 1985. One additional module is required and more structural

LUNAR SURFACE BASE PROJECT

SUMMARY PROGRAM SCHEDULE

(MSS DERIVATIVE CONFIGURATION)

Space Division
North American Rockwell

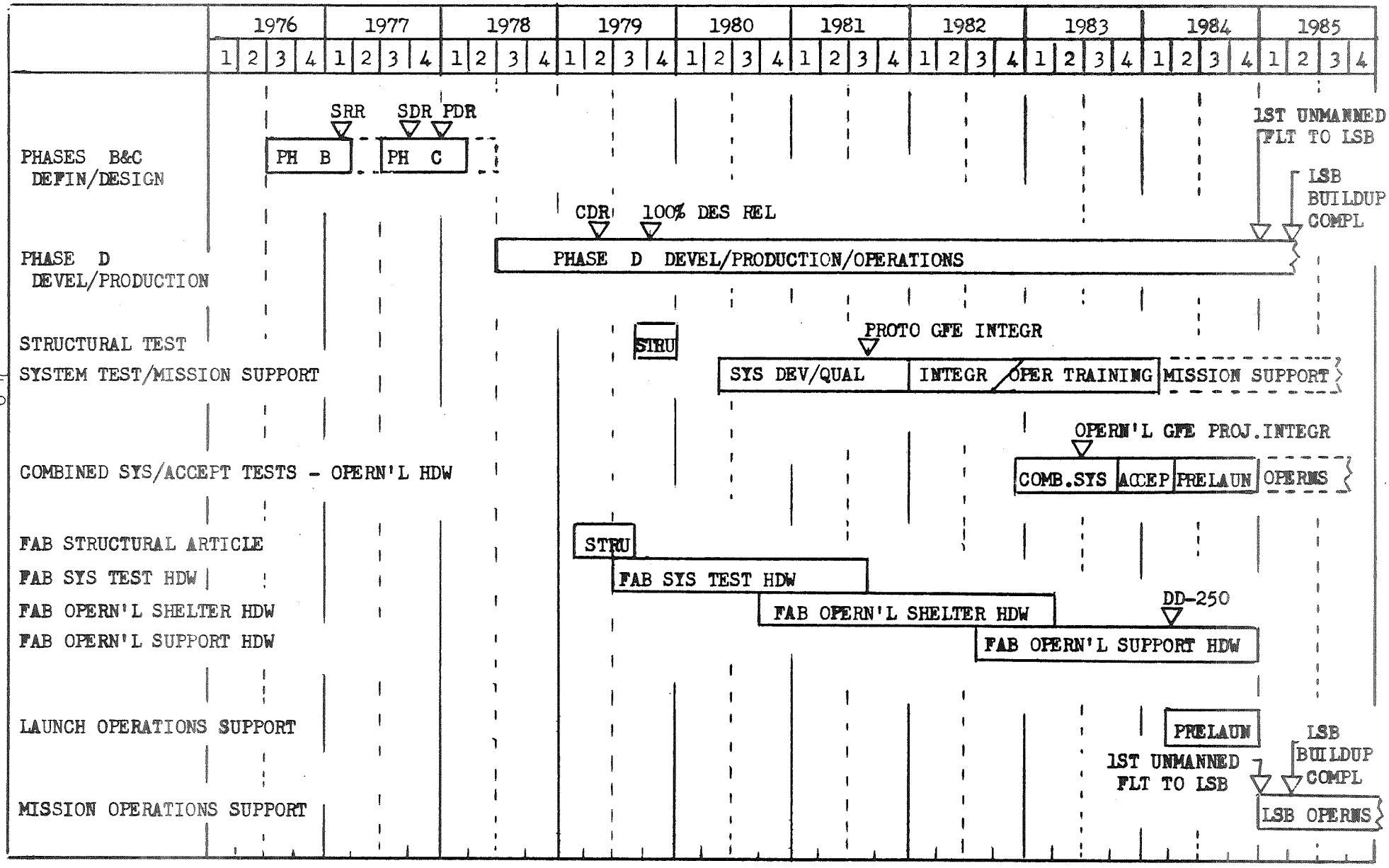

Figure 4.3 - 1 , MSS Derivative Shelter Configuration Summary Program Schedule

configurations are involved compared to the baseline configuration. The schedule assumes a new module is started every two months on the time-shared MSS structural fabrication tooling.

The schedule activities for the MSS derivative shelter configuration are shown in greater detail in the following Preliminary Program Development Schedule.

4.4 MSS DERIVATIVE SHELTER PRELIMINARY PROGRAM DEVELOPMENT SCHEDULE

The detailed Preliminary Program Development Schedule for the MSS derivative shelter configuration is shown in Figure 4.4-1. The schedule covers an integrated set of activities and major program milestones for the definition, design, development and production of the MSS derivative shelter. The schedule is based on an analysis of the MSS derivative shelter technical description covered in the technical portion of the final report. The tasks and program elements are keyed to the Work Breakdown Structure identification numbers.

The schedule is based on the fabrication of one structural test article of a typical non-MSS module (Drive-In Garage Module), one dynamic test article of a typical non-MSS module (Drive-In Garage Module), and one full up system test hardware of each of seven shelter modules (Core Module CM1, Lab & Backup Control CCM1, Lab & Control CCM2, Crew Quarters CQM1, Galley Module GM1, Crew Quarters CQM3, and Drive-In Garage). Acoustic, dynamic and thermal vacuum tests on the MSS derivative modules will not be repeated since they will have been accomplished on the Modular Space Station program. Included in the system test hardware will be one typical support module (Mobile Cargo Module) with prototype kits of specialized furnishings of the other support modules. The fabrication time spans for the test hardware and the operational hardware are based on the use of one set of structural fabrication tooling and one manufacturing checkout and test station.

The Preliminary Program Development Schedule for the MSS derivative shelter shows the required milestones for each of the major program functions. The phasing of the program is as follows:

1. A nine months Phase B System Definition starting on July 1, 1976 will cover the definition of the modules and will include system and subsystem requirements analyses and final definition of design requirements. At the end of seven months a system requirements review (SRR) will be held to obtain approval of the design concept. Completion of the System Definition Phase B study will be followed by a three months NASA review and evaluation period.

2. A nine months Phase C Detail Design effort starting on July 1, 1977 will cover the definition of the subsystem performance requirements. After two months into the design phase the System Design Review (SDR) will be held to provide

Space Division
North American Rockwell

15 MAR'77

LUNAR SURFACE BASE PROJECT
PRELIMINARY PROGRAM DEVELOPMENT SCHEDULE
(MSS DERIVATIVE CONFIGURATION)

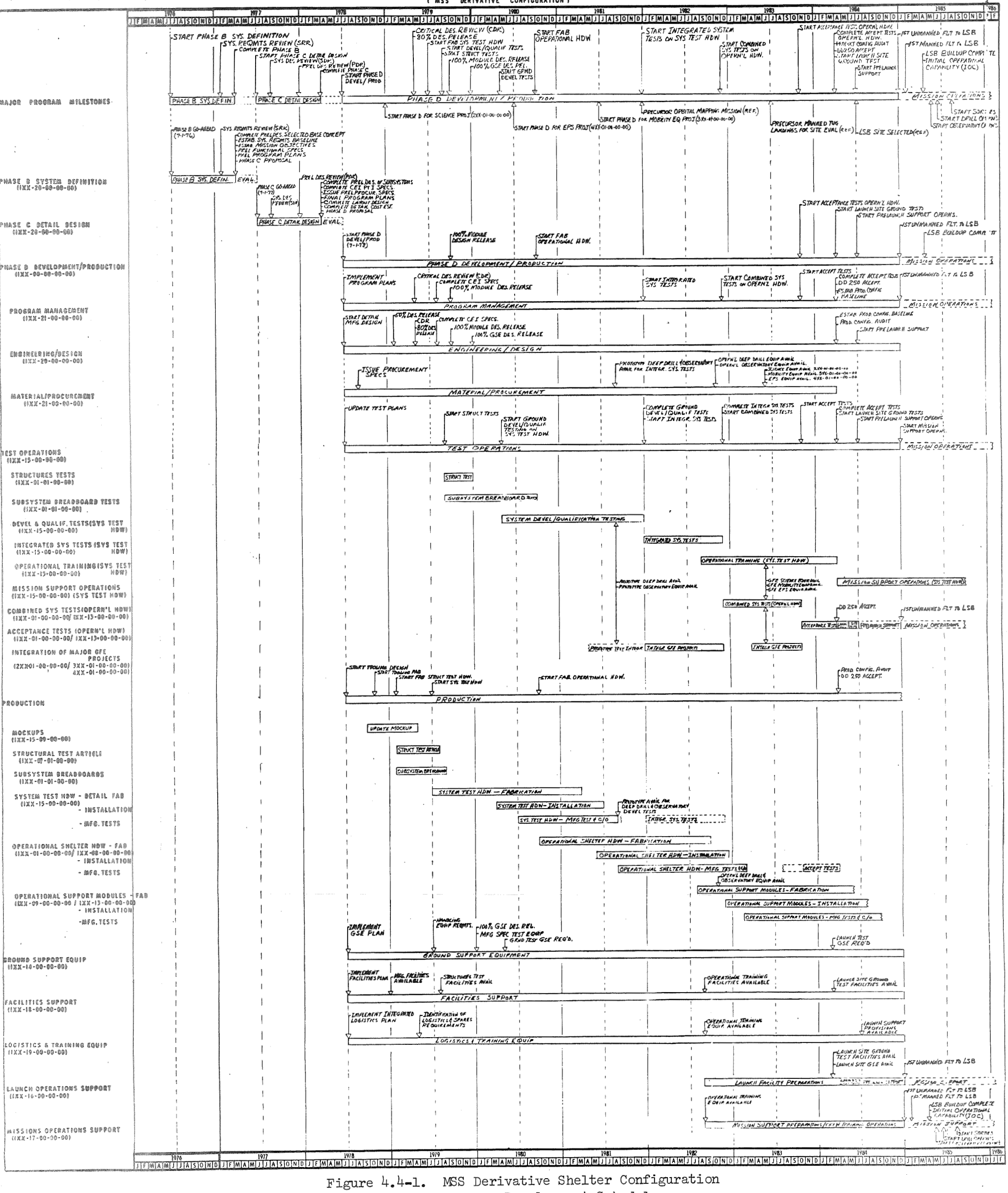

Figure 4.4-1. MSS Derivative Shelter Configuration
Preliminary Program Development Schedule

approval to proceed with the preliminary design effort. At the end of six months the Preliminary Design Review (PDR) will be held to provide approval to proceed with the preliminary design of the subsystems. Completion of Detail Design Phase C will be followed by a three months NASA review and evaluation period.

3. The Phase D Development/Production starts on July 1, 1978. The first 15 months of this Phase D covers the preparation and release of detail manufacturing drawings. At the end of ten months, the Critical Design Review (CDR) will be held when approximately 80 percent of the detail manufacturing drawings are complete.

4. The production effort covers a time span of approximately five and one-half years with fabrication, assembly, system installation, and checkout for the mockups, test articles, system test hardware, and operational hardware. The five and one-half years of fabrication time from 1979 to 1984 results from the economical approach of using one set of time-shared tooling and one checkout and test station. Structural fabrication of a different module is started through the structural fabrication tooling every two months on a time-shared basis.

5. The ground testing program covers a span of three and one-half years and includes the structural testing and the system development testing. The ground tests are scheduled on a time-phased basis to make maximum use of the test articles and GSE.

6. The development schedule shows the key milestones of the related activities including program management, engineering/design, material/procurement, ground support equipment (GSE), facilities, logistics, and launch and mission operations.

7. The operational hardware will be processed through acceptance testing, launch site ground tests, and prelaunch support operations before being readied for mission operations and mating with the launch vehicle.

8. The first unmanned flight of the operational hardware to the Lunar Surface Base is planned for January 1, 1985, to be followed by the first manned flight to the LSB on February 1, 1985. The LSB buildup is planned to be completed by April 1985, providing for the initial operational capability (IOC) at that time. Observatory operations are planned to start in May 1985, with the deep drill operations to start in June 1985. Mobile sortie operations are scheduled to start in August 1985.

5.0 HARDWARE UTILIZATION LISTS

The Hardware Utilization Lists (HUL) for both the baseline Lunar Surface Base shelter configuration and the MSS derivative shelter configuration are broken down into two categories, equivalent subsystem test hardware requirements and operational mission hardware requirements for each design concept. Quantities of major hardware components required for mockups, simulation, design verification testing, full system testing, and operational missions are identified in detail. Included are considerations for GFE requirements.

5.1 BASELINE SHELTER HARDWARE UTILIZATION LIST

The quantities of major hardware items required for system and subsystem testing of the baseline shelter configuration are shown in Table 5.1-1. The operational mission hardware requirements are shown in Table 5.1-2. A breakdown of the systems and subsystems for the design verification test and full system test requirements consist of: prime structure, furnishings and secondary structure, atmospheric management and crew services, communications and monitoring, EPS distribution and control, medical facility, command and control, backup galley, geoscience lab, photo lab, data analysis lab, bioscience lab, main galley, and base maintenance equipment. Equivalent percentages of each of the systems and subsystems were determined for the design verification testing and for the full system testing. These percentages are used in pricing the test articles and determining the costs for system test hardware.

Structural testing will be done with the primary and secondary structure of a typical module (Crew & Medical Module), while the dynamic test article will consist of a typical module (Crew & Medical Module) structure with simulated mass weights of on-board systems and subsystems. The full up system test hardware will consits of one each of seven shelter modules (Crew & Medical, Crew & Operations, Sortie & Transient Crew, Lab & Backup Command Post, Assembly & Recreation, Base Maintenance, and Drive-In Garage) and one typical support module (Mobile Cargo Module). The single shelter module with a garage door (Drive-In Garage) will be reconfigured to simulate the other similar modules (Drive-In Warehouse, Deep Drill Cover, Observatory Shell, and Mobile Equipment Transportation) during the system testing with prototype kits of specialized furnishings and equipment of the other support modules.

BASELINE CONFIGURATION

REPRESENTATIVE LUNAR SURFACE BASE - HARDWARE UTILIZATION LIST

TYPICAL PRIMARY & SECONDARY STRUCTURES

I. EQUIVALENT SUBSYSTEM TEST HARDWARE REQUIREMENTS

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A. EQUIVALENT LUNAR SURFACE BASE MODULE SUBSYSTEMS - ONE MODULE STRUCTURE ONLY - CREW & MEDICAL MODULE

Prime Struct	Furn & Second Struct	Atmos Mgt/Crew Services	Comm & Monitor	EPS Distrib & Contr	Medical Facil	Command & Control	Backup Galley	Geochem Lab	Photo Lab	Data Anal Lab	Bio-scien Lab	Main Galley	Base Maint Equip	Design Verification Test Requirements
Sim	Sim	Sim	Sim	Sim	Sim	Sim	Sim	Sim	Sim	Sim	Sim	Sim	Sim	- LUNAR SURFACE BASE WOOD MOCKUP (Simulated)
1.0(F)	0.5(F)	-	-	-	-	-	-	-	-	-	-	-	-	- STRUCTURAL TEST ARTICLE
1.0 (F)	0.75(F)	0.75(S)	0.75(S)	0.75(S)	-	0.75(S)	-	-	-	-	-	-	-	- DYNAMIC TEST ARTICLE
0.2(F)	0.2(F)	-	-	-	-	-	-	-	-	-	-	-	-	- DOCKING PORT, PRESSURE DOOR & AIR LOCK TEST
2.20	1.45	0.75	0.75	0.75	-	0.75	-	-	-	-	-	-	-	SUBTOTALS

B. LUNAR SURFACE BASE - FULL SYSTEM TEST HARDWARE EACH MODULE

1.0(P)	0.7(P)	0.9(F)	1.0(F)	1.0(F)	0.5(P)	-	-	-	-	-	-	-	-	CREW & MEDICAL MODULE
1.0(P)	0.7(P)	0.9(F)	1.0(F)	1.0(F)	-	1.0(F)	-	-	-	-	-	-	-	CREW & OPERNS MODULE
1.0(P)	0.7(P)	0.9(F)	1.0(F)	1.0(F)	-	-	0.5(S)	-	-	-	-	-	-	SORTIE & TRANS MODULE
1.0(P)	0.7(P)	0.9(F)	1.0(F)	1.0(F)	-	-	-	0.8(P)	0.8(P)	0.8(P)	0.8(P)	-	-	LAB & BACKUP CMD MOD.
1.0(P)	0.7(P)	0.9(F)	1.0(F)	1.0(F)	-	-	-	-	-	-	-	0.5(P)	-	ASSEM & RECREA MODULE
1.0(P)	0.7(P)	0.9(F)	1.0(F)	1.0(F)	-	-	-	-	-	-	-	-	0.5(S)	BASE MAINTAIN MODULE
1.0(P)	0.7(P)	0.9(F)	1.0(F)	1.0(F)	-	-	-	-	-	-	-	-	-	DRIVEIN GARAGE MODULE
-	0.7(P)	-	-	-	-	-	-	-	-	-	-	-	-	DRIVEIN WAREHSE MODULE
1.0(P)	0.7(P)	-	-	-	-	-	-	-	-	-	-	-	-	MOBILE CARGO MODULE
-	0.7(P)	-	-	-	-	-	-	-	-	-	-	-	-	DEEP DRILL MODULE
-	0.7(P)	-	-	-	-	-	-	-	-	-	-	-	-	OBSERVATORY SHELL MODS.
8.0	7.7	6.3	7.0	7.0	0.5	1.0	0.5	0.8	0.8	0.8	0.8	0.5	0.5	SUBTOTALS

S = Simulated Hardware
P = Prototype Hardware
F = Flight Hardware

Table 5.1-1. Baseline Shelter Configuration Hardware Utilization List - Subsystem Test Requirements

BASELINE CONFIGURATION

REPRESENTATIVE LUNAR SURFACE BASE - HARDWARE UTILIZATION LIST

II. OPERATIONAL FLIGHT HARDWARE

Prime Struct	Furn.& Second Struct	Atmos Mgt/Crew Services	Comm & Monitor	EPS Distrib & Contr	Medical Facil	Command & Control	Backup Galley	Geochem Lab	Photo Lab	Data Anal Lab	Bio-scien Lab	Main Galley	Reli-quefac. Unit	Landing & Remote Comm	Eq	Base Maint Equip
LUNAR SURFACE BASE - FULL SYSTEMS HARDWARE EACH MODULE																
1.0(F)	1.0(F)	1.0(F)	1.0(F)	1.0(F)	1.0(F)	-	-	-	-	-	-	-	-	-	-	CREW & MEDICAL MODULE
1.0(F)	1.0(F)	1.0(F)	1.0(F)	1.0(F)	-	1.0(F)	-	-	-	-	-	-	-	-	-	CREW & OPERNS MODULE
1.0(F)	1.0(F)	1.0(F)	1.0(F)	1.0(F)	-	-	1.0(F)	-	-	-	-	-	-	-	-	SORTIE & TRANS MODULE
1.0(F)	1.0(F)	1.0(F)	1.0(F)	1.0(F)	-	-	-	1.0(F)	1.0(F)	1.0(F)	1.0(F)	-	-	-	-	LAB & BACKUP CMD MODULE
1.0(F)	1.0(F)	1.0(F)	1.0(F)	1.0(F)	-	-	-	-	-	-	-	1.0(F)	-	-	-	ASSEMBLY & RECREA. MODULE
1.0(F)	1.0(F)	1.0(F)	1.0(F)	1.0(F)	-	-	-	-	-	-	-	-	-	-	1.0(F)	BASE MAINTAIN MODULE
1.0(F)	1.0(F)	1.0(F)	1.0(F)	1.0(F)	-	-	-	-	-	-	-	-	-	-	-	DRIVE-IN GARAGE MODULE
1.0(F)	1.0(F)	1.0(F)	1.0(F)	1.0(F)	-	-	-	-	-	-	-	-	-	-	-	DRIVE-IN WAREHOUSE MODULE
16.0(F)	16.0(F)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	MOBILE CARGO MODULE
1.0(F)	1.0(F)	1.0(F)	-	1.0(F)	-	-	-	-	-	-	-	-	-	-	-	DEEP DRILL MODULE
-	-	-	-	-	-	-	-	-	-	-	-	-	1.0(F)	1.0(F)	-	SUPPORT EQUIP OPERN HDW
2.0(F)	2.0(F)	2.0(F)	-	2.0(F)	-	-	-	-	-	-	-	-	-	-	-	OBSERVATORY SHELL MODULE
7.0(F)	7.0(F)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	MOBILITY EQUIP TRANS MOD.
34.0	34.0	11.0	8.0	11.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	TOTAL OPERATIONAL HARDWARE

F=Flight Hardware

Table 5.1-2. Baseline Shelter Configuration Hardware Utilization List - Operational Mission Hardware

5.2 MSS DERIVATIVE SHELTER HARDWARE UTILIZATION LIST

The quantities of major hardware items required for system and subsystem testing of the MSS derivative shelter configuration are shown in Table 5.2-1. The operational mission hardware requirements for this configuration are shown in Table 5.2-2. The breakdown of the system and subsystem groups are similar to those of the baseline configuration to provide for comparing the configurations. Equivalent percentages of each of the systems and subsystems were also set up on the same basis to provide for comparisons.

Structural testing will be done with the primary and secondary structures of a typical non-MSS derivative module (Drive-In Garage Module), while the dynamic test article will consist of a typical non-MSS module (Drive-In Garage Module) structure with simulated mass weights of on-board systems and equipment. The acoustic, dynamic and thermal vacuum tests for the MSS derivative modules (Core Module and Crew Quarters Module) will not be repeated since they will have been previously performed on the Modular Space Station program. The full up system test hardware will consist of one each of seven shelter modules (Core Module CM1, Lab & Backup Control CCM1, Lab & Control CCM2, Crew Quarters CQM1, Galley Module GM1, Crew Quarters CQM3, and Drive-In Garage) and one typical support module (Mobile Cargo Module). As in the Baseline Shelter Program, the single shelter module with a garage door (Drive-In Garage) will be reconfigured to simulate the other similar modules during the system testing, with prototype kits of specialized furnishings and equipment of the other support modules.

MSS DERIVATIVE CONFIGURATION

REPRESENTATIVE LUNAR SURFACE BASE - HARDWARE UTILIZATION LIST

TYPICAL PRIMARY & SECONDARY STRUCTURES

10 MAR '71

I. EQUIVALENT SUBSYSTEM TEST HARDWARE REQUIREMENTS

A. EQUIVALENT LUNAR SURFACE BASE MODULE SUBSYSTEMS - ONE MODULE STRUCTURE ONLY - DRIVE-IN GARAGE MODULE

Prime Struct	Furn & Second Struct	Atmos Mgt/Crew Services	Comm & Monitor	EPS Distrib & Contr	Backup Cmd & Contr	Geo-Chem Lab	Photo Lab	Data Anal Lab	Bio scien Lab	Cmd & Contr	Med & Dent.	Base Maint Facil	Backup Galley	Main Galley	Design Verification Test Requirements
Sim	Sim	Sim	Sim	Sim	Sim	Sim	Sim	Sim	Sim	Sim	Sim	Sim	Sim	Sim	- LUNAR SURFACE BASE WOOD MOCKUP (Simulated)
1.0(F)	0.5(F)	-	-	-	-	-	-	-	-	-	-	-	-	-	- STRUCTURAL TEST ARTICLE
1.0 (F)	0.75(F)	0.75(S)	0.75(S)	0.75(S)	0.75(S)	-	-	-	-	0.75(S)	-	-	-	-	- DYNAMIC TEST ARTICLE
0.2(F)	0.2(F)	-	-	-	-	-	-	-	-	-	-	-	-	-	- DOCKING PORT, PRESSURE DOOR & AIR LOCK TEST
2.20	1.45	0.75	0.75	0.75	0.75	-	-	-	-	0.75	-	-	-	-	SUBTOTALS

B. LUNAR SURFACE BASE - FULL SYSTEM TEST HARDWARE EACH MODULE

1.0(P)	0.7(P)	0.9(F)	1.0(F)	1.0(F)		-	-	-	-	-	-	-	-	-	CORE MODULE, CM#1
1.0(P)	0.7(P)	0.9(F)	1.0(F)	1.0(F)	1.0(F)	0.8(P)	0.8(P)	0.8(P)	0.8(P)	-	-	-	-	-	LAB & BACKUP CMD, CCM#1
1.0(P)	0.7(P)	0.9(F)	1.0(F)	1.0(F)	-	-	-	-		1.0(F)	0.5(P)	0.5(S)	-	-	LAB & CONTROL, CCM #2
1.0(P)	0.7(P)	0.9(F)	1.0(F)	1.0(F)	-	-	-	-	-	-	-	-	0.5(S)	-	CREW QTRS MOD, CQM #1
1.0(P)	0.7(P)	0.9(F)	1.0(F)	1.0(F)	-	-	-	-	-	-	-	-	-	0.5(P)	GALLEY MOD, GM#1
1.0(P)	0.7(P)	0.9(F)	1.0(F)	1.0(F)	-	-	-	-		-	-	-	-	-	CREW QTRS MOD, CQM#3
1.0(P)	0.7(P)	0.9(F)	1.0(F)	1.0(F)	-	-	-	-		-	-	-	-	-	DRIVEIN GARAGE MODULE
-	0.7(P)	-	-	-	-	-	-	-		-	-	-	-	-	DRIVEIN WAREHSE MODULE
1.0(P)	0.7(P)	-	-	-	-	-	-	-		-	-	-	-	-	MOBILE CARGO MODULE
-	0.7(P)	-	-	-	-	-	-	-		-	-	-	-	-	DEEP DRILL MODULE
-	0.7(P)	-	-	-	-	-	-	-		-	-	-	-	-	OBSERVATORY SHELL MODS.
8.0	7.7	6.3	7.0	7.0	1.0	0.8	0.8	0.8	0.8	1.0	0.5	0.5	0.5	0.5	SUBTOTALS

S = Simulated Hardware
P = Prototype Hardware
F = Flight Hardware

Table 5.2-1. MSS Derivative Shelter Configuration Hardware Utilization List - Subsystem Test Requirements

MSS DERIVATIVE CONFIGURATION
REPRESENTATIVE LUNAR SURFACE BASE - HARDWARE UTILIZATION LIST

10 MAR '71

II. OPERATIONAL FLIGHT HARDWARE

Prime Struct	Furn.& Second Struct	Atmos Mgt/Crew Services	Comm & Monitor	EPS Distrib & Contr	Backup Cmd & Contr	Geo-chem Lab	Photo Lab	Data Anal Lab	Bio-scien Lab	Cmd & Contr	Med & Dent.	Base Maint Facil	Backup Galley	Main Galley	Reli-quefac. Unit	Landing Eq & Remote Comm	
LUNAR SURFACE BASE - FULL SYSTEMS HARDWARE EACH MODULE																	
1.0(F)	1.0(F)	1.0(F)	1.0(F)	1.0(F)	-	-	-	-	-	-	-	-	-	-	-	-	CORE MODULE, CM#1
1.0(F)	1.0(F)	1.0(F)	1.0(F)	1.0(F)	1.0(F)	1.0(F)	1.0(F)	1.0(F)	1.0(F)	-	-	-	-	-	-	-	LAB & BACKUP CMD, CCM#1
1.0(F)	1.0(F)	1.0(F)	1.0(F)	1.0(F)	-	-		-	-	1.0(F)	1.0(F)	1.0(F)	-	-	-	-	LAB & CONTROL, CCM#2
1.0(F)	1.0(F)	1.0(F)	1.0(F)	1.0(F)	-	-	-	-	-	-	-	-	1.0(F)	-	-	-	CREW QTRS MOD, CQM#1
1.0(F)	1.0(F)	1.0(F)	1.0(F)	1.0(F)	-	-	-	-	-	-	-	-	-	1.0(F)	-	-	GALLEY MOD, GM#1
2.0(F)	2.0(F)	2.0(F)	2.0(F)	2.0(F)	-	-	-	-	-	-	-	-	-	-	-		CREW QTRS MOD, CQM#3
1.0(F)	1.0(F)	1.0(F)	1.0(F)	1.0(F)	-	-	-	-	-	-	-	-	-	-	-	-	DRIVE-IN GARAGE MODULE
1.0(F)	1.0(F)	1.0(F)	1.0(F)	1.0(F)	-	-	-	-	-	-	-	-	-	-	-	-	DRIVE-IN WAREHOUSE MODULE
16.0(F)	16.0(F)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	MOBILE CARGO MODULE
1.0(F)	1.0(F)	1.0(F)	-	1.0(F)	-	-	-	-	-	-	-	-	-	-	-	-	DEEP DRILL MODULE
-	-	-	-	-	-	-	-	-	-	-	-	-	-		1.0(F)	1.0(F)	SUPPORT EQUIP OPERN HDW
2.0(F)	2.0(F)	2.0(F)	-	2.0(F)	-	-	-	-	-	-	-	-	-	-	-	-	OBSERVATORY SHELL MODULE
7.0(F)	7.0(F)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	MOBILITY EQUIP TRANS MOD.
35.0	35.0	12.0	9.0	12.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	TOTAL OPERATIONAL HARDWARE

F=Flight Hardware

Table 5.2-2. MSS Derivative Shelter Configuration Hardware Utilization List - Operational Mission Hardware

6.0 SHELTER PROGRAM COST ESTIMATES

This section of the report contains the ground rules, methodology, and summary of the costs of the Lunar Surface Base Project. The summary costs with the Baseline Configuration are compared with those for the MSS Derivative Configuration.

6.1 COST ESTIMATING GROUND RULES, COVERAGE, AND DATA FORMATS

The significant ground rules, coverage, and data formats associated with the preparation of the cost estimates were as follows:

6.1.1 Ground Rules

Parametric cost estimating techniques, based upon Cost Estimating Relationships (CER's) were used.

Costs reflect GFY 1970 dollars and include all elements of cost through the general and administrative (G&A) level.

No fee or profit by the prime contractor is included.

Only costs that will be incurred by contractors are included.

DDT&E (non-recurring) and production (recurring) costs are identified.

Costs are reported at WBS Level 5 for operational and test hardware, but at Level 4 for GSE and support activities (WBS item IXX-14-00-00-00 and IXX-16-00-00-00 through IXX-21-00-00-00).

Costs include all of Phase C and Phase D effort.

Non-recurring costs include design and development, major test hardware, captive and ground tests, tooling and special test equipment, test operations, ground support equipment, facilities, training equipment and simulators, system design and evaluation, and program management.

Recurring costs include operational hardware, acceptance testing and test operations, sustaining tooling and special test equipment, sustaining ground support equipment, launch operations, initial flight spares, system engineering, and program management.

For purposes of reporting operational hardware systems to WBS Level 5, non-recurring subsystems costs include design and development and tooling and special test equipment. Recurring costs for subsystems include fabrication and assembly costs for operational hardware, plus acceptance testing and test operations, and sustaining tooling and special test equipment.

For purposes of reporting systems test hardware to Level 5, non-recurring costs include major test hardware, captive ground test, and test operations. Assignment of design verification test articles to specific modules is discussed under the respective configurations.

The cost estimates are consistent with the system description, the program development schedule, the production schedule, and operations schedule.

The cost estimates are consistent with current subsystem weight estimates. No allowance is included for weight growth.

The Lunar Surface Base follows the Space Station project in time, and hardware development and state-of-the-art advancements made by that program are considered.

6.1.2 Coverage and Exclusions

Hardware, software, services and other work tasks are included. Hardware includes operational hardware and test hardware.

Costs excluded from the analysis are:

NASA Costs

Costs of supporting research and technology

Costs of consumables including food, cryogenics, radioisotopic fuel, clothing and other personnel provisions, and propellant.

Costs of the Science Equipment Project, Mobility Equipment Project, and Electrical Power Source Project, WBS items 2XX-00-00-00-00, 3XX-00-00-00-00, and 4XX-00-00-00-00, respectively, which are derived separately in Section 9.0.

Costs of the Geochemistry Lab and the Bioscience Lab are limited to integration and assembly. These items are assumed to be GFE, with the subcontractor costs in WBS item number 2XX-01-00-00-00. The same assumptions apply to the deep drill.

Costs of integrating the Observatory Shell equipment into the Observatory Shell Module have been omitted. It is assumed that the structural shell will be shipped to the observatory equipment contractor who will perform the necessary integration. These costs are included in WBS item number 2XX-01-00-00-00.

Mission operations support is not included.

Costs of transporting the modules to the moon and erecting the bases have not been included. Base installation has been assumed to be performed by the crew.

6.2 COST ESTIMATING METHODOLOGY

The basic building block in generating DDT&E (non-recurring) costs is the design and development (D&D) effort associated with each subsystem in a module of flight hardware. In generating production (recurring) costs, the basic building block is the recurring theoretical first unit (TFU) fabrication and assembly cost for each subsystem in a given module. With few exceptions, costs associated with subdivisions of work in support of the D&D and production activities are derived from these basic building blocks.

6.2.1 Basic Building Blocks

The costs of the basic D&D and TFU building blocks were derived parametrically using Cost Estimating Relationships (CER's), expressed in terms of 1970 dollar values as indicated by the ground rules. These CER's are based primarily upon the Earth Orbit Space Station studies performed by North American Rockwell, which in turn are based upon 1968 Apollo CSM and Saturn S-II cost studies. In addition, other cost data from industry are included. In particular, the Apollo CSM D&D CER's have been adjusted to remove certain redesign effort peculiar to the CSM program so that costs pertinent to well-controlled phased procurement can be reflected. The resulting D&D and TFU CER's are plotted as straight lines on log-log paper for each subsystem, with dollars per pound measured along the ordinate and weight along the abscissa. To arrive at the cost of each Lunar Surface Base subsystem, these CER data are adjusted for weight, complexity, and know-how differences between the Lunar Surface Base subsystem and the subsystem for which CER data are available, which we term the "Comparative" Subsystem.

Weight scaling of costs for a given subsystem and type of cost is accomplished by moving along the applicable line until the abscissa location corresponding to the subsystem weight is reached. The point reached in this fashion determined the dollar per pound applicable to a subsystem of the same weight as that of the Lunar Surface Base and of the same "complexity" and "know-how" as that of the comparative subsystem.

Differences in complexity and know-how between the Lunar Surface Base and the CER source data were significant in determining the final costs and had to be quantified. The complexity is defined as a measure of the intrinsic features of a subsystem which specifies the effort needed to design and develop that subsystem. It is expressed in terms of a percentage of a known comparative subsystem represented by the D&D CER data, assuming that weight and the know-how, as described in Table 8, are the same for both subsystems. The complexity for the Lunar Surface Base was determined by interviewing the responsible subsystem engineers and, to a first approximation, was assumed to apply also to the TFU costs.

Differences in know-how level between the Lunar Surface Base and the CER data were also determined by interviewing the responsible subsystem engineers. Know-how level ratings, based on a composite of the state-of-the-art, production experience, specification status, and operating program characteristics (Table 6.2-1) were established for both what the subsystem will be, and what the CER comparative subsystem was, at the inception of the development phases of the respective programs. Assumptions as to how much development on programs such as Space Station, for example, will contribute directly to Lunar Surface Base were also included. Each know-how level has an amount of effort assigned to it which increases as the know-how level rating number decreases. Unlike the complexity factor effort, this effort applies only to the design and development and not to production. The rationale here is that know-how sufficient to produce the item will have been developed during the design phase, and that both the CER data and the Lunar Surface Base will be at the same level of know-how at the start of production.

One of the most significant features of the present cost analysis is the assumption that Space Station technology and subassembly components will be used to the utmost in the design of the Lunar Surface Base. As a result of this integrated approach to space vehicle design, cost savings due to increased know-how are anticipated.

The factors developed for both relative complexity and relative know-how between the Lunar Surface Base and the CER source data were multiplied by the D&D value derived by the weight scaling process to obtain dollars per pound for design and development. The complexity factor above was applied to the TFU value obtained by weight scaling to arrive at dollars per pound for first unit recurring costs.

Costs of multiple recurring operational hardware items were derived by the use of learning curves. A Wright 90% curve was used in such instances.

Certain features of the cost derivations which are peculiar to each configuration are discussed in sections dealing with the respective configuration.

6.2.2 Supporting Effort

In addition to the basic building block effort related to the non-recurring design and development and production, supporting effort must be included. The subdivisions of work for the supporting effort are as follows:

Non-recurring (included with design and development subsystem costs)

- Major Test Hardware (MTH)
- Captive and Ground Tests
- Ground Support Equipment (GSE)
- Tooling and Special Test Equipment (STE)
- Test and Operations
- Trainers
- System Support - System Engineering and Integration
- Program Management
- Facilities

Table 6.2-1. Subsystem Know-How Status*

Know-How Level	State of the Art	Production Experience	Specification Status	Operating Program Characteristics (OPC)
1	The item is substantially beyond the current state of the art. Major development work is required.	No production of any kind has been started.	No work on a specification has started.	None of the OPC for using the items has been formulated.
2	The item is slightly beyond the current state of the art. Some development work is required.	Experimental laboratory fabrication of a similar item is in process.	Work on a specification is in an early stage and only general requirements are identified.	The general outline of OPC under which the item will be used has been only tentatively defined and many specific details are lacking.
3	The item is within the state of the art but no commercial counterpart exists.	A prototype of the item has been produced.	A specification for the item has not been completed but a specification on a similar item is applicable.	The general outline of OPC has been formulated, but many specific details are lacking.
4	The item will involve a minor modification of commercial or standard aerospace issue items.	The item has been produced in limited quantity.	A specification for the item has been prepared but is under review or revision.	The OPC have been substantially defined, but are under review or revision.
5	The item will require no modification.	The item has been produced in production quantities.	The specification is for the item as produced.	The OPC have been defined and are met by the item.

*Adapted from AFSCM 173-1.

Recurring (included with first unit costs)

Test and Test Operations
Sustaining Tooling and STE
System Support - System Engineering
Sustaining GSE
Spares
Program Management

The sequence in which these costs are listed is somewhat dependent upon the manner in which the costs are derived. For the baseline configuration, the method of derivation is outlined in Table 6.2-2 and 6.2-3. In addition to the basic D&D building block, major test hardware and captive and ground test costs are part of the base. Factors used are from Apollo CSM experience with adjustments in those areas, based on Space Station studies, in which less activity is expected or cost avoidance through more advanced management techniques can be expected to result in significant reductions. The factors are identical for both configurations with the notable exception of non-recurring tooling and special test equipment (STE). In the case of the MSS Derivative configuration, the identity of structures and other subsystems with that Space Station configuration indicate savings in tooling which are relatively independent of test hardware quantities. In other words, the assumption is made that tooling from the MSS Space Station is used to fabricate the Lunar Surface Base. In the MSS derivative configuration, therefore, the factor for tooling and special test equipment is reduced to 10% on a revised base of design and development only. All other savings in non-recurring costs of supporting efforts which are attendant to availability of items from Space Station are assumed to accrue through an unchanged percentage factor applied to a smaller cost base which results due to savings in design and development.

For purposes of reporting to WBS Level 5 in the operational hardware, tooling and special test equipment is added to design and development in the non-recurring costs. In the case of recurring costs, sustaining tooling and special test equipment, and test and test operations are added to fabrication and assembly and checkout costs in the basic production costs. These costs cover items in WBS IXX-01-00-00-00 through IXX-13-00-00-00 to Level 5. These costs at Level 5 are based upon the percentage in Tables 6.2-2 and 6.2-3, prorated by dollar value of the cost base by subsystem, except for tooling and STE. In the case of tooling and STE, studies on Space Station have shown that approximately 50% of tooling and STE will go against primary and secondary structure, and 50% against other subsystems for integration and assembly. Accordingly, the tooling and STE is derived as a total per module, and is split 50-50 in accordance with the Space Station studies. The first 50% is prorated against the primary structure subsystem and against the furnishings and secondary structure subsystem in accordance with their respective dollar values of cost base. The remaining 50% is prorated among all other subsystems in accordance with their respective dollar values of cost base.

Table 6.2-2. Nonrecurring Costs for Supporting Effort

	Factor %	Cost Base To Which % is Applied	Rationale
Major test hardware (MTH) Captive and ground test	--		Estimate is made of "equivalen TFU articles"
Tooling and STE	13.5	D&D + Item 1	Same as Apollo CSM
Ground support equipment	10.0	"	Same as Apollo CSM
Test operations	7.2	"	Same as Apollo CSM
Trainers and simulators	3.0	"	Far less ambitious than Apollo CSM
System engineering	6.0	D&D + Items 1 through 5	Cost avoidance versus Apollo through advanced management techniques
Program management	6.0	"	Cost avoidance versus Apollo through advanced management techniques
Facilities	8.7	D&D + Item 1	Same as space station

Table 6.2-3. Recurring Costs for Supporting Effort

	Factor %	Cost Base To Which % is Applied	Rationale
Test and test operations	19.8	First unit recurring	Same as Apollo CSM
Sustaining tooling and STE	4.6	"	Same as Apollo CSM
System engineering	4.0	"	Cost avoidance versus Apollo through advanced management techniques
Program management	4.5	"	Cost avoidance versus Apollo through advanced management techniques
Flight spares	4.7	"	Similar to Apollo CSM
Sustaining GSE	2.5	"	Significantly less ambitious than Apollo CSM

6.3 COST ESTIMATES SUMMARY AND COMPARISON

This section presents a summarization and analysis of data compiled from the following Sections: 7.0 Baseline Shelter Cost Estimate Breakdown, 8.0 MSS Derivative Shelter Cost Estimate Breakdown, and 9.0 Scientific, Mobility, and Power Source Equipment Cost Estimate Breakdown. The cost data from Section 9.0 are common to both the Baseline Lunar Surface Base Program and the MSS Derivative LSB Program. In accumulating the scientific, mobility, and power source cost data, only the preferred systems cost data are included, since the delta cost to the alternate systems is less than 3% and do not significantly affect the cost comparisons.

The cost comparisons are made at Work Breakdown Structure Level 2, however, any major differences are highlighted at the level at which the differences are most apparent, primarily at Level 3. The technical characteristics that account for the differences are identified.

6.3.1 Cost Estimates Summary for the Baseline Lunar Surface Base Program

The cost estimates for the baseline shelters with the supporting scientific, mobility, and power source equipment is summarized as follows:

Project	WBS Identification	Funding	WBS Level
Laboratory and Science Equipment	(2XX-00-00-00-00)	833.0\overline{M}$	3
Sortie and Transient Equipment	(3XX-00-00-00-00)	645.5\overline{M}$	3
Electrical Power Source	(4XX-00-00-00-00)	191.2\overline{M}$	3
Lunar Surface Base Project, Baseline	(1XX-00-00-00-00)	876.0\overline{M}$	3
Lunar Surface Base Program, Baseline	(0XX-00-00-00-00)	$2,545.7$\overline{M}$	2

6.3.2 Cost Estimates for the Modular Space Station (MSS) Derivative LSB Program

The cost estimates for the MSS derivative shelters with the supporting scientific, mobility, and power source equipment is summarized as follows:

Project	WBS Identification	Funding	WBS Level
Laboratory and Science Equipment	(2XX-00-00-00-00)	833.0\overline{M}$	3
Sortie & Transient Equipment	(3XX-00-00-00-00)	645.5\overline{M}$	3
Electrical Power Source	(4XX-00-00-00-00)	191.2\overline{M}$	3
Lunar Surface Base Project, Baseline	(1XX-00-00-00-00)	861.2\overline{M}$	3
Lunar Surface Base Program, Baseline	(0XX-00-00-00-00)	$2,530.9$\overline{M}$	2

6.3.3 Cost Comparison

Since the scientific, mobility, and power source cost data are common to both programs, the only difference in the two programs is found within the LSB shelter costs. The LSB program, using MSS derivative shelters, reflects a $15.1 million cost savings or a 1 percent advantage over the baseline LSB. This cost difference is due to the lower development cost gained by using the MSS modules as a follow-on development from the Modular Space Station program.

A comparison of the DDT&E and recurring costs of the primary shelter LSB modules is shown in Table 6.3-1. The modules shown are those which comprise the habitate for the 12-man crew.

Table 6.3-1. Cost Comparison, Baseline Versus MSS Derivative LSB Shelter Modules

Baseline LSB Shelter Cost ($ Millions)			MSS Derivative Shelter Cost ($ Millions)		
Module	Nonrec.	Rec.	Module	Nonrec.	Rec.
Crew and medical	63.1	14.8	Core (CM1)	18.2	10.9
Crew and operations	48.5	25.6	Lab and backup control (CCM1)	23.2	27.7
Sortie and transient	25.0	17.1			
Lab and backup command	40.3	23.7	Lab and control (CCM 2)	35.8	29.8
Assy and recreation	23.0	11.0	Crew quarters (CQM1)	36.5	16.0
Base maintenance	13.1	7.1	Galley module (GM1)	13.6	15.4
Drive-in garage	9.6	4.3	Crew quarters (CQM3)(2)	5.6	25.4
Drive-in warehouse	8.0	4.6	Drive-in garage	25.8	7.9
			Drive-in warehouse	6.0	8.0
Total baseline*	230.6	108.2	Total derivative*	164.7	141.1

*Support effort not included

It should be noted that in the MSS derivative, the development costs reflect the modifications necessary to configure the MSS modules to an LSB shelter module. These modifications are set forth in both the Technical Data Sheets (Form C) which follow (Sections 7.0 and 8.0), and in previous technical volumes of this report. The MSS derivative shelter is less expensive in the nonrecurring phase by about $66 million. There is a greater savings than that amount in the atmospheric management and crew services subsystem alone, but this is offset by the greater number of primary structure configurations in the MSS derivative shelter, and the attendant increase in system test hardware costs which result.

In the case of recurring costs, the MSS derivative shelter is actually higher in cost than the baseline shelter by almost $33 million This increase stems primarily from the fact that the derivative configuration requires an extra module to complete the operational complex (two crew quarters modules CMQ-3), and from the fact that weight estimates for each of the subsystems are generally higher than those for the baseline shelter. The net effort is that the development and production of the MSS derivative configuration

provides a cost advantage over the baseline shelter configurations of only $23 million. It should be noted that a significant portion of the advantages which might have been anticipated from the adaptation of the MSS had already been included in the baseline by utilization of the MSS subsystems and technology.

The comparison of the DDT&E and recurring costs of the LSB support modules and support operations equipment hardware is shown in Table 6.3-2.

Table 6.3-2. Cost Comparison, Baseline Versus MSS Derivative LSB Support Modules

Baseline LSB Support Cost ($ Million)			MSS Derivative Support Cost ($ Million)		
Module	Nonrec.	Rec.	Module	Nonrec.	Rec.
Mobile cargo module (16)	5.8	10.1	Mobile cargo module (16)	5.8	10.1
Deep drill module	7.1	4.3	Deep drill module	11.3	4.7
Observatory shells (2)	2.7	5.4	Observatory shells (2)	.8	6.7
Mobility equip. transport (7)	.3	16.1	Mobility equip. transport (7)	.7	15.2
Support ops. equip. hdw.	98.4	56.3	Support ops. equip. hdw.	98.4	56.3
Total baseline*	114.3	92.2	Total MSS derivative*	117.0	93.0

*Support effort not included

It can be seen that the baseline and MSS derivative LSB include identical support modules; i.e., mobile cargo supply, drill cover, observatory shells, mobility equipment transport, and support operations equipment hardware. The baseline LSB program shows a cost advantage of $3.5 million over the MSS derivative LSB program due to the similarity of the support modules to the baseline shelter modules. The MSS derivative requires more extensive design changes as reflected in the deep drill module.

A comparison of the support effort, i.e., system test hardware, ground support equipment, facility support, logistic and training, and system engineering and project management is shown in Table 6.3-3.

Table 6.3-3. Cost Comparison, Baseline Versus MSS Derivative LSB Support Effort

Baseline Items Cost ($ Millions)			MSS Derivative Items Cost ($ Millions)		
Item	Nonrec.	Rec.	Item	Nonrec.	Rec.
Ground support equip.	40.2	2.8	Ground support equip.	38.6	3.1
System test hardware	140.4	-	System test hardware	162.3	-
Facility support	42.2	-	Facility support	38.6	-
Logistic and training	12.0	5.3	Logistic and training	11.6	5.9
System engineering	32.2	4.5	System engineering	29.6	5.0
Project management	32.2	5.0	Project management	29.6	5.6
Launch support ops.	-	13.9	Launch support ops.	-	15.5
Total baseline	299.2	31.5	Total MSS derivative	310.3	35.1

The difference in cost of $14.9 million is a reflection of the module saving in the baseline project, since these costs are directly relatable to the modules. This is most apparent in the system test hardware which indicates a cost difference of $21.9 million between the baseline and MSS derivative.

It should be noted that the facility support cost is less for the MSS derivative project. This is primarily due to the reduction in overall development cost which reflects the manpower loading and hence reduces the facility support costs.

6.3.4 Annual and Cumulative Funding Comparisons

The Lunar Surface Base Annual GFY Funding Comparison Schedule is shown in Figure 6.3-1, and summarizes the annual funding requirements for both the baseline LSB shelter and the MSS derivative LSB Shelter programs. Funding requirements are portrayed in DDT&E and Production. Operations costs have been excluded since these costs depend on various factors such as the vehicles utilized for transport and resupply and the level of effort desired by NASA from the LSB Shelter contractor and other subcontractors involved. For this reason, only the DDT&E and production costs incurred by the LSB Shelter contractor are shown. Maximum funding for both shelters occurs in GFY 1981. These peak funding requirements reach $201 million for the baseline shelter and $188 million for the MSS derivative.

From the schedule discussion in Section 4.0, the MSS derivative LSB program was established to be six months longer than the baseline LSB due to the added program complexity of converting the MSS derivative shelter configuration and the addition of one additional module.

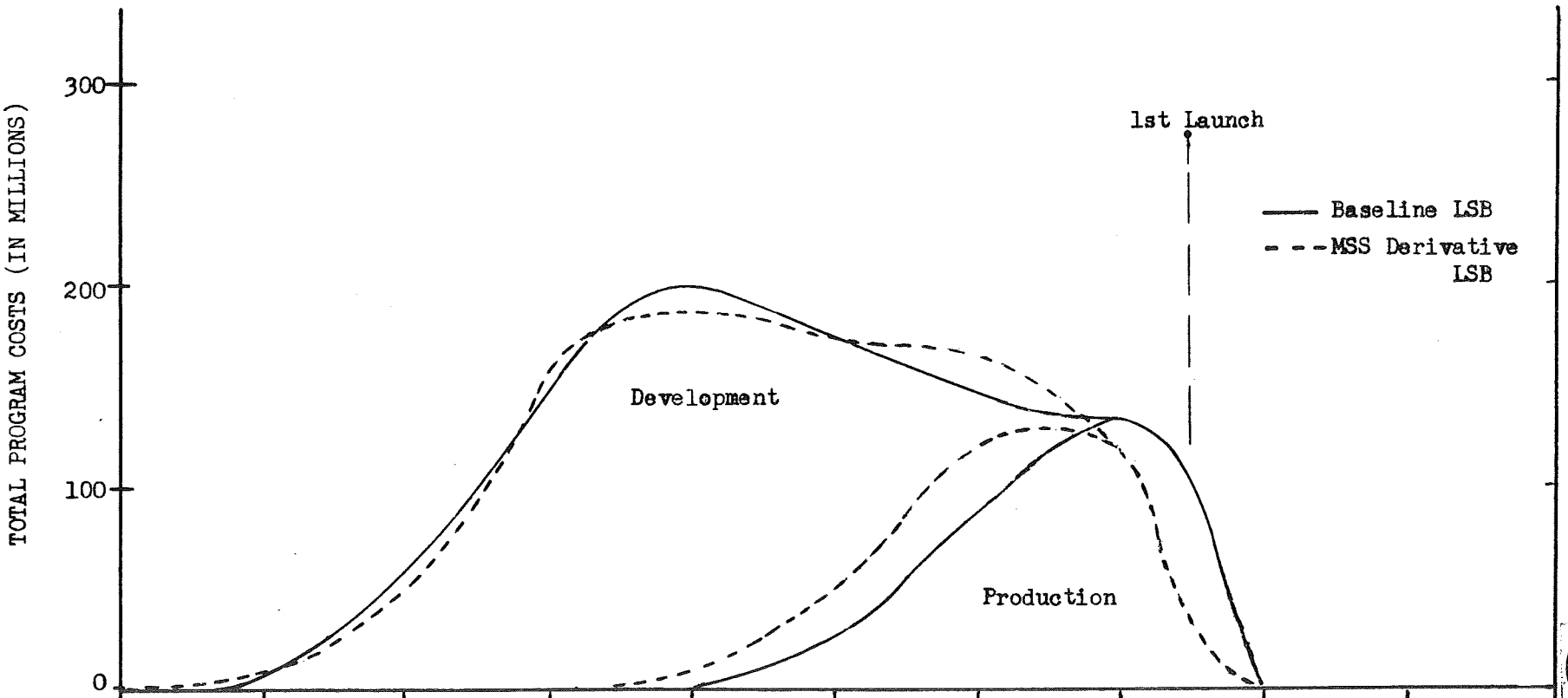
The cumulative funding comparison for both the baseline LSB and MSS derivative LSB is shown in Figure 6.3-2. The funding requirements are shown for DDT&E and production. The MSS derivative LSB project indicates a net cost saving of $15.1 million or a 2 percent advantage over the baseline LSB.

6.3.5 Conclusions

Further details of the costs and technical characteristics data are found in Sections 7.0 and 8.0 for the baseline and MSS derivative respectively. Section 9.0 discusses the costs for the science, mobility, and power sources.

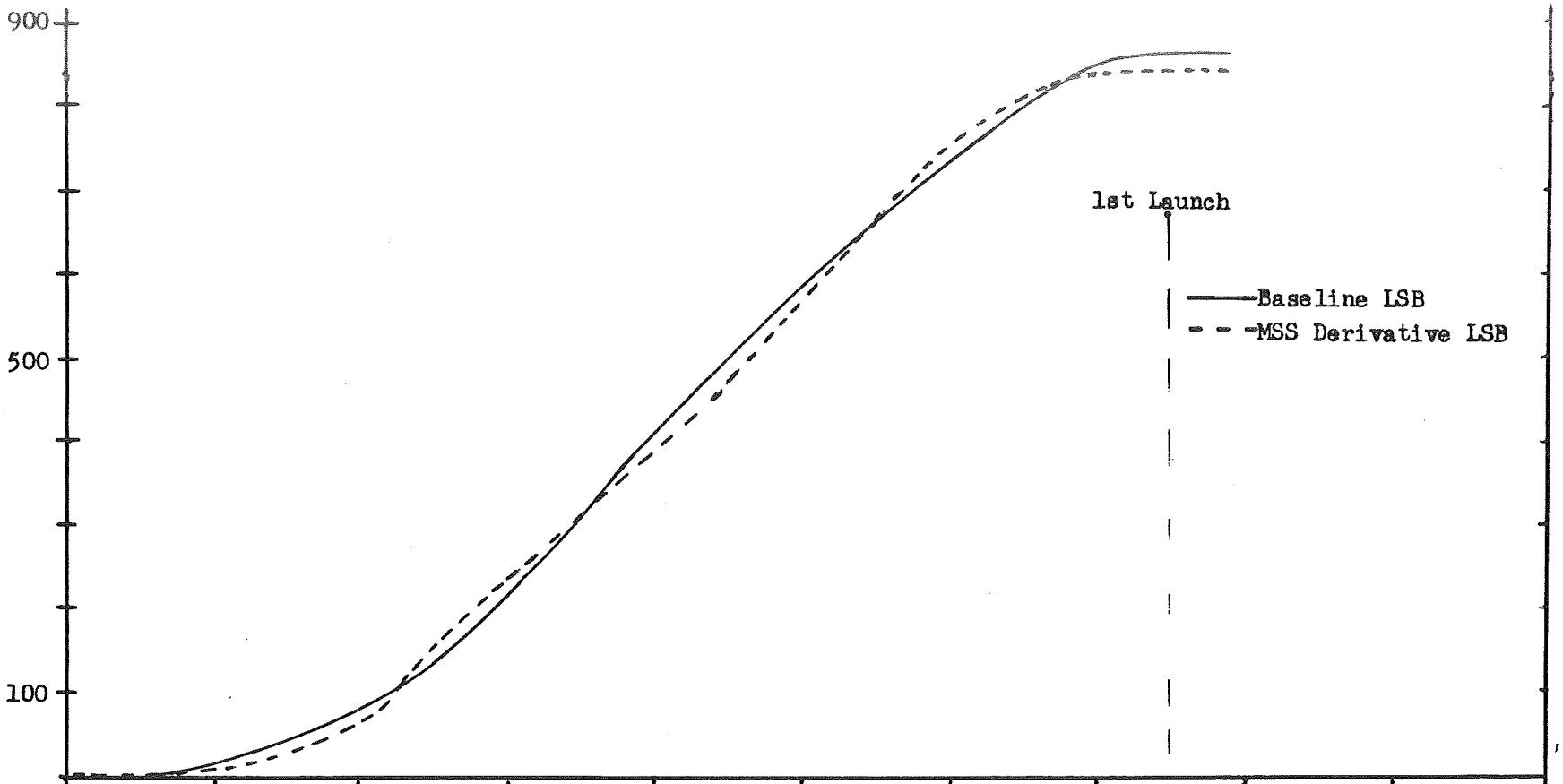
The two configurations considered are within a small percentage of each other in total cost. The total cost, however, is considerably less than might be expected for such a program. This is principally due to the advantage gained by assuming utilization of the Modular Space Station technology and subsystems. In other words, the costs illustrate the advantages of commonality and derivative systems resulting from the Integrated Space Program.

Factors which should be borne in mind in assessing these costs include the premises on the Cost Estimating Relationships (CER's) and estimating factors and the validity of the technical data.



GFY	1978		1979		1980		1981		1982		1983		1984		1985		1986		TOTALS	
	Base	MSS	Base	MSS	Base	MSS	Base	MSS	Base	MSS	Base	MSS	Base	MSS	Base	MSS	Base	MSS	Base	MSS
DDT&E	7.2	7.2	58.5	56.1	142.4	157.1	200.7	185.9	157.2	128.9	61.5	45.3	15.2	10.2	1.5	1.1	-	-	644.1	591.8
PRODUCTION	-	-	-	-	-	-	.3	2.1	22.2	48.6	88.2	122.3	113.3	95.3	7.9	.8	-	-	231.9	269.1
TOTAL	7.2	7.2	58.5	56.1	142.4	157.1	201.0	188.0	179.4	177.5	149.7	167.6	128.5	105.5	9.4	1.9	-	-	876.0	860.9

Figure 6.3-1. Lunar Surface Base Annual Funding Comparison



GFY	1978		1979		1980		1981		1982		1983		1984		1985		1986		TOTALS	
	Base	MSS	Base	MSS	Base	MSS	Base	MSS	Base	MSS	Base	MSS	Base	MSS	Base	MSS	Base	MSS	Base	MSS
DDT&E	7.2	7.2	65.7	63.3	208.1	220.4	408.8	406.3	566.0	535.2	627.5	580.5	642.7	590.7	644.1	591.8	-	-	644.1	591.8
PRODUCTION	-	-	-	-	-	-	.3	2.1	22.5	50.7	110.7	173.0	224.0	268.3	231.9	269.1	-	-	231.9	269.1
TOTAL	7.2	7.2	65.7	63.3	208.1	220.4	409.1	408.4	588.5	585.9	738.2	753.5	866.7	859.0	876.0	860.9	-	-	876.0	860.9

Figure 6.3-2. Lunar Surface Base Cumulative Funding Comparison

The cost estimating relationships (and the schedule) assume that a disciplined phased procurement program will be conducted and that design changes will be cut off once all features necessary to complete integrated testing on schedule have been incorporated. Maximum use is made of space station features, especially in some of the MSS derivative modules. The supporting effort factors assume improvements in performance in system engineering and program management through phased procurement, management systems automation, and other advanced management techniques.

The costs represent weight estimates, plus complexity and know-how relationships estimated relative to space station and historical programs. To the extent that these parameters change as the requirements of this program become more evident with the passage of time, the costs will also change.

7.0 COST AND FUNDING ESTIMATES FOR BASELINE SHELTER

Significant assumptions affecting the costs of the Baseline Configuration Shelter are outlined. Cost estimates by elements of the Work Breakdown Structure, to the levels previously defined, are presented in Data Form A. Pertinent technical characteristics are given in Data Form C. Finally, funding schedules by government fiscal year are shown in Data Form D.

7.1 COST ESTIMATES

Significant cost assumptions are presented and a summary is given, including Data Form A.

7.1.1 Significant Assumptions Affecting Costs of the Baseline Shelter

The major assumptions employed in arriving at Baseline Shelter costs are as follows:

The baseline configuration does not utilize any items off-the-shelf from Space Station except for the Communications and Monitoring subsystem.

All other subsystems, except for certain items listed below, are further along in know-how status (see Table 6.2-1) than they were for comparable systems at the inception of the Space Station program and involve either redesign of, or minor modification to, Space Station hardware.

Notable exceptions to the previous statement are the Furnishings and Secondary Structure subsystems, holographic memory subassembly of the Command and Control Subsystem, and the Reliquefaction Subsystem. All of these are considered to be at the same stage of development at the inception of the Lunar Surface Base project as the comparative subsystems were at the initiation of their respective projects.

The majority of subsystems of the Lunar Surface Base are considered to be of either equivalent or lesser complexity than the comparative subsystems. Of lesser complexity than the Space Station are the Atmospheric Management and Crew Services, Communications, Medical Facilities, Galleys, and Photo Lab.

More complexity is noted relative to the comparative CER's in certain portions of the primary structure subsystems of various modules; i.e., airlocks, drill provisions, and observatory provisions. Also, the holographic memory portion of the Command and Control subsystem of the Crew and Operations Module and the Reliquefaction Unit of Support Equipment Operational Hardware are markedly more complex than comparative subsystems.

In allocating non-recurring costs among the various modules, it was decided to treat one of the modules as a basic module for a particular subsystem, and to allocate the basic design and development effort for the subsystem to that module. Costs to other similar modules were limited to integration effort for identical components assembled in different ways, or minor modifications to designs in the base module. This procedure was used in lieu of one which all similar modules are assumed to share more or less proportionally (to weight, say) in the design and development

To cope with learning curve effects in which the primary structure is used in several modules and integration effects are practically nil, or where large portions of structure are common to several modules, it was necessary to assume a sequence of module design and development. The base module and sequence of similar subsystems by module are summarized in Table 7.1-1.

The Base Maintenance Station subsystem in the Base Maintenance Module is assumed to consist of items carried along only as loose equipment for usage in the Lunar Surface Base. Engineering judgement indicates that no redesign of any of the items will be required and that space qualification effort will be nil.

In subsystem other than primary structure listed in Table 7.1-1, it was assumed that, after the initial design effort, the configuration of the components would be somewhat different in each module in the furnishings and secondary structure, necessitating minor design modifications. In the case of electrical power distribution and control, the components following the initial design effort were assumed to be identical but arranged differently in each and every subassembly, necessitating integration effort. Sequence by module is, therefore, optional after the first design effort. The data processing equipment has some elements requiring modification and others necessitating simple integrations. The modules in which the basic design and development effort were assumed to be accomplished for these subsystems are Crew and Medical for the first two subsystems, and the Crew and Operations Module for the data processing assemblies.

Table 7.1-1. Base Modules and Sequences Assumed in Allocating Costs, Baseline Shelter

Subsystem	Assembly	Base Module	Sequence by Module
Primary structure	Module cylinder Elliptical bulkhead Pressure door Ceiling floor	Crew and medical	1. Crew and medical 2. Crew and operations 3. Sortie and transport 4. Lab and backup command 5. Assembly and recreation 6. Base maintenance 7. Drive-in garage 8. Drive-in warehouse 9. Deep drill cover 10. Observatory shell 11. Mobility equipment transport
Primary structure	Airlock	Assembly and recreation	1. Assembly and recreation 2. Base maintenance
Primary structure	Door assembly	Drive-in garage	1. Drive-in garage 2. Drive-in warehouse 3. Deep drill cover 4. Observatory shell 5. Mobility equipment transport
Furnishings and secondary structure	N/A	Crew and medical	1. Crew and medical 2. All other modules optional in sequence
Atmospheric management and crew services	N/A	Crew and medical	1. Crew and medical 2. All other modules optional in sequence
Command and control	Data management	Crew and operations	1. Crew and operations 2. Lab and backup command

The quantities of major test hardware and operational flight hardware used in the analysis are given in the Hardware Utilization List in Section 5.0. It should be noted that costs of all design verification test articles are assigned to the Crew and Medical Module, except for the Command and Control Subsystem verification test articles, which are assigned to the Crew and Operations Module.

7.1.2 Summary of Cost Estimates for Baseline Shelter

The estimated costs, in millions of dollars for a GFY 1970 cost index, are summarized in Table 7.1-2. These amount to $644 million in non-recurring costs, and $232 million in recurring costs, or a total of $876 million. As might be expected, the high-cost modules are those for which it is assumed that the initial development work is performed, according to ground rules of Table 7.1-1, or those which contain numerous high-cost subsystems. Modules meeting these criteria are the Crew and Medical, Crew and Operations, Laboratory and Backup Command modules, and the Support Equipment Operations Hardware. Table 7.1-3 shows that the subsystem cost drivers for initial development effort are: the Reliquefaction Unit, the Atmospheric Management and Crew Services in the Crew and Operations Module, External Communications in the Support Operations Equipment, and the Primary Structure in the Crew and Medical Module - in that order. Table 7.1-4 shows the corresponding recurring costs and the totals by subsystem. When all modules and both recurring and non-recurring costs are taken into account, Atmospheric Management and Crew Services becomes the most expensive subsystem. Next come Primary Structure, External Communications, Reliquefaction Unit, Command Control, and Data Analysis, and Furnishings and Secondary Structure, respectively.

Table 7.1-2. Cost Summary, Baseline Shelter
($ Million, GFY 1970 Cost Index)

	Nonrecurring	Recurring	Total
Crew and medical module	$ 63.1	$ 14.8	$ 77.9
Crew and operations module	48.5	25.6	74.1
Sortie and transient module	25.0	17.1	42.1
Lab and backup command module	40.3	23.7	64.0
Assembly and recreation module	23.0	11.0	34.0
Base maintenance module	13.1	7.1	20.2
Drive-in garage module	9.6	4.3	13.9
Drive-in warehouse module	8.0	4.6	12.6
Mobile cargo modules	5.8	10.1	15.9
Deep drill cover module	7.1	4.3	11.4
Support operations equipment module	98.4	56.3	154.7
Observatory shell modules	2.7	5.4	8.1
Mobility equipment transport modules	0.3	16.1	16.4
Ground support equipment	40.2	2.8	43.0
Systems test hardware	140.4	-	140.4
Launch support operations	-	13.9	13.9
Facilities	42.2	-	42.2
Logistics and training equipment	12.0	5.3	17.3
System engineering support	32.2	4.5	36.7
Project management	32.2	5.0	37.2
TOTAL	$ 644.1	$ 231.9	$ 876.0

Table 7.1-3. Operational Hardware Costs by Subsystem, Baseline Shelter Nonrecurring ($ Million GFY 1970 Cost Index)

Module	Primary Structure	Furnishing and Secondary Structure	Atmosphere Management and Crew Services	Command Control and Data Analysis	Reliquefaction Unit	External Communications	All Other	Total
Crew and medical	$16.4	$ 8.1	$ 33.6	-	-	-	$ 5.0	$ 63.1
Crew and operations	1.5	6.5	11.0	$ 26.7	-	-	2.8	48.5
Sortie and transient	0.6	5.6	16.3	16.3	-	-	2.5	25.0
Lab and backup CMD	0.8	8.7	7.8	10.8	-	-	12.2	40.3
Assembly and recreation	6.1	2.9	9.4	-	-	-	4.7	23.0
Base maintenance	4.5	2.7	2.0	-	-	-	3.9	13.1
Drive-in garage	7.5	0.3	0.6	-	-	-	1.2	9.6
Drive-in warehouse	2.7	3.9	0.5	-	-	-	0.9	8.0
Mobile cargo	5.1	0.7	-	-	-	-	-	5.8
Deep drill cover	5.3	0.2	0.9	-	-	-	0.7	7.1
Support operations equipment	-	-	-	-	64.0	29.0	5.3	98.4
Observatory shell	1.9	0.1	0.4	-	-	-	0.3	2.7
Mobility equipment transport	-	0.3	-	-	-	-	-	0.3
Total, Nonrecurring	$52.4	$ 40.0	$ 82.5	$37.5	$64.0	$29.0	$39.5	$344.9

Table 7.1-4. Operational Hardware Costs by Subsystem, Baseline Shelter Recurring ($ Million, 1970 Cost Index)

Module	Primary Structure	Furnishing and Secondary Structure	Atmosphere Management and Crew Services	Command Control and Data Analysis	Reliquefaction Unit	External Communications	All Other	Total
Crew and medical	$ 3.2	$ 1.1	$ 9.2	-	-	-	$ 1.2	$ 14.8
Crew and operations	2.9	1.2	9.2	10.6	-	-	1.7	25.6
Sortie and transient	2.6	1.2	11.9	-	-	-	1.4	17.1
Lab and backup CMD	2.6	1.8	6.8	8.4	-	-	4.1	23.6
Assembly and recreation	3.1	0.8	4.4	-	-	-	2.7	11.0
Base maintenance	3.3	0.7	1.5	-	-	-	1.6	7.1
Drive-in garage	3.3	0.1	0.3	-	-	-	0.6	4.3
Drive-in warehouse	3.0	0.8	0.3	-	-	-	0.5	4.6
Mobile cargo	8.7	1.4	-	-	-	-	-	10.1
Deep drill cover	3.5	0.1	0.3	-	-	-	0.4	4.3
Support ops. equip. hardware	-	-	-	-	6.4	47.9	2.0	56.3
Observatory shell	4.4	0.1	0.4	-	-	-	0.5	5.4
Mobility equipment transport	11.0	5.1	-	-	-	-	-	16.1
Total Recurring	$51.6	$14.4	$ 44.3	$19.0	$ 6.4	$47.9	$ 16.7	$200.3
Total, Nonrecurring plus Recurring	$104.0	$54.4	$136.8	$56.5	$70.4	$76.9	$ 56.2	$545.2

COST ESTIMATE DATA FORM A

X NON-RECURRING (DDT & E)
___ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
3	IXX-00-00-00-00	Lunar Surface Base Project, Baseline Configuration	$644.1							
4	IXX-01-00-00-00	Crew & Medical Module	63.1				59(1)	84	40/60	Jan 85
5	IXX-01-01-00-00	Prime Structure	16.4							
5	IXX-01-02-00-00	Furnishings & Secondary Structure	8.1							
5	IXX-01-03-00-00	ATM Mgt. & Crew Services	33.6							
5	IXX-01-04-00-00	Comm. & Monitoring	1.8							
5	IXX-01-05-00-00	EPS Distr. & Control	1.0							
5	IXX-01-06-00-00	Medical Facility	2.2							

(1) From Inception of Phase C to Completion of Integrated Systems Tests

COST ESTIMATE DATA FORM A

X NON-RECURRING (DDT & E)
___ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-02-00-00-00	Crew & Operations Module	$48.5				59	84	40/60	Jan 85
5	IXX-02-01-00-00	Prime Structure	1.5							
5	IXX-02-02-00-00	Furnishings & Secondary Structure	6.5							
5	IXX-02-03-00-00	Atmospheric Mgt. & Crew Services	11.0							
5	IXX-02-04-00-00	Comm. & Monitoring	1.8							
5	IXX-02-05-00-00	EPS Distr. & Control	1.0							
5	IXX-02-06-00-00	Command & Control	26.7							

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COST ESTIMATE DATA FORM A

X NON-RECURRING (DDT & E)
___ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-03-00-00-00	Sortie & Transient Module	$25.0				59	84	40/60	Jan 85
5	IXX-03-01-00-00	Prime Structure	0.6							
5	IXX-03-02-00-00	Furnishings & Secondary Structure	5.6							
5	IXX-03-03-00-00	Atmospheric Mgt. & Crew Services	16.3							
5	IXX-03-04-00-00	Comm. & Monitoring	1.8							
5	IXX-03-05-00-00	EPS Distr. & Control	0.3							
5	IXX-03-06-00-00	Backup Galley	0.4							

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COST ESTIMATE DATA FORM A

X NON-RECURRING (DDT & E)
___ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-04-00-00-00	Lab & Backup Command Module	$40.3				59	84	40/60	Jan 85
5	IXX-04-01-00-00	Prime Structure	0.8							
5	IXX-04-02-00-00	Furnishings & Secondary Structure	8.7							
5	IXX-04-03-00-00	Atmospheric Mgt. & Crew Services	7.8							
5	IXX-04-04-00-00	Comm. & Monitoring	4.8							
5	IXX-04-05-00-00	EPS Distr. & Control	0.9							
5	IXX-04-06-00-00	Geochem. Lab	1.5							
5	IXX-04-07-00-00	Photo Lab	4.3							
5	IXX-04-08-00-00	Data Analy. Lab & Backup Command	10.8							
5	IXX-04-09-00-00	Bioscience Lab	9.8							

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COST ESTIMATE DATA FORM A

X NON-RECURRING (DDT & E)
___ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-05-00-00-00	Assy. & Recreation Module	$23.0				59	84	40/60	Jan 85
5	IXX-05-01-00-00	Prime Structure	6.1							
5	IXX-05-02-00-00	Furnishings & Secondary Structure	2.9							
5	IXX-05-03-00-00	Atmospheric Mgt. & Crew Services	9.4							
5	IXX-05-04-00-00	Comm. & Monitoring	3.0							
5	IXX-05-05-00-00	EPS Distr. & Control	0.3							
5	IXX-05-06-00-00	Main Galley	1.4							

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X NON-RECURRING (DDT & E)
___ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-06-00-00-00	Base Maintenance Module	$13.1				59	84	40/60	Jan 85
5	IXX-06-01-00-00	Prime Structure	4.5							
5	IXX-06-02-00-00	Furnishings & Secondary Structure	2.7							
5	IXX-06-03-00-00	Atmospheric Mgt. & Crew Services	2.0							
5	IXX-06-04-00-00	Comm. & Monitoring	3.5							
5	IXX-06-05-00-00	EPS Distr. & Control	0.4							
5	IXX-06-06-00-00	Base Maintenance & Repair Station								

COST ESTIMATE DATA FORM A

X NON-RECURRING (DDT & E)
___ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-07-00-00-00	Drive-In Garage Module	$9.6				59	84	40/60	Jan 85
5	IXX-07-01-00-00	Prime Structure	7.5							
5	IXX-07-02-00-00	Furnishings & Secondary Structure	0.3							
5	IXX-07-03-00-00	Atmospheric Mgt. & Crew Services	0.6							
5	IXX-07-04-00-00	Comm & Monitoring	0.8							
5	IXX-07-05-00-00	EPS Distr. & Control	0.4							

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COST ESTIMATE DATA FORM A

X NON-RECURRING (DDT & E)
___ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-08-00-00-00	Drive-In Warehouse Module	$8.0				59	84	40/60	Jan 85
5	IXX-08-01-00-00	Prime Structure	2.7							
5	IXX-08-02-00-00	Furnishings & Secondary Structure	3.9							
5	IXX-08-03-00-00	Atmospheric Mgt. & Crew Services	0.5							
5	IXX-08-04-00-00	Comm. & Monitoring	0.7							
5	IXX-08-05-00-00	EPS Distr. & Control	0.2							

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COST ESTIMATE DATA FORM A

X NON-RECURRING (DDT & E)
___ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-09-00-00-00	Mobile Cargo Modules	$5.8				59	84	40/60	Jan 85
5	IXX-09-01-00-00	Prime Structure	5.1							
5	IXX-09-02-00-00	Furnishings & Secondary Structure	0.7							

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COST ESTIMATE DATA FORM A

X NON-RECURRING (DDT & E)
___ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-10-00-00-00	Deep Drill Cover Module	$7.1				59	84	40/60	Jan 85
5	IXX-10-01-00-00	Prime Structure	5.3							
5	IXX-10-02-00-00	Furnishings & Secondary Structure	0.2							
5	IXX-10-03-00-00	Atmospheric Mgt. & Crew Services	0.9							
5	IXX-10-04-00-00	EPS Distr. & Control	0.7							

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COST ESTIMATE DATA FORM A

X NON-RECURRING (DDT & E)
___ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-11-00-00-00	Support Operations Equipment Module	98.4				59	84	40/60	Jan 85
5	IXX-11-01-00-00	EPS Distr. & Control	.4							
5	IXX-11-02-00-00	Reliquifaction System Unit	64.0							
5	IXX-11-03-00-00	Launch & Landing Facility Eqmt.	4.9							
5	IXX-11-04-00-00	External Communication Eqmt.	29.0							

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COST ESTIMATE DATA FORM A

X NON-RECURRING (DDT & E)
___ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-12-00-00-00	Observatory Shell Modules	$2.7				59	84	40/60	Jan 85
5	IXX-12-01-00-00	Prime Structure	1.9							
5	IXX-12-02-00-00	Furnishings & Secondary Structure	0 1							
5	IXX-12-03-00-00	Atmospheric Mgt. & Crew Services	0.4							
5	IXX-12-04-00-00	Comm. & Monitoring								
5	IXX-12-05-00-00	EPS Distr. & Control	0.3							

DATE _____
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COST ESTIMATE DATA FORM A

X NON-RECURRING (DDT & E)
___ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-13-00-00-00	Mobility Eqmt. Transport Modules	0.3				24	85		Jan 85
5	IXX-13-01-00-00	Prime Structure	-							
5	IXX-13-02-00-00	Furnishings & Secondary Structure	0.3							

COST ESTIMATE DATA FORM A

X NON-RECURRING (DDT & E)
___ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-15-00-00-00	Major Test Hardware	$140.4				52	60	60/40	Jan 85
5	IXX-15-01-00-00	Crew & Medical	29.4							
5	IXX-15-02-00-00	Crew & Operations	30.8							
5	IXX-15-03-00-00	Sortie & Transient	14.6							
5	IXX-15-04-00-00	Lab & Backup Command	26.6							
5	IXX-15-05-00-00	Assy. & Recreation	9.2							
5	IXX-15-06-00-00	Base Maintenance	6.4							
5	IXX-15-07-00-00	Drive-In Garage	4.0							
5	IXX-15-08-00-00	Drive-In Warehouse	0.6							
5	IXX-15-09-00-00	Mobile Cargo	1.3							
5	IXX-15-10-00-00	Deep Drill Cover	0.6							
5	IXX-15-11-00-00	Supp. Opns. Eqmt.	16.7							
5	IXX-15-12-00-00	Observatory Shell	0.2							

COST ESTIMATE DATA FORM A

X NON-RECURRING (DDT & E)
___ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-14-00-00-00	Ground Support Eqmt.	$40.7				48(1)	72	60/40	Jan 85
4	IXX-16-00-00-00	Launch Support Operations	-							
4	IXX-17-00-00-00	Mission Operations Support	-							
4	IXX-18-00-00-00	Facilities	42.2				72	72	60/40	Jan 85
4	IXX-19-00-00-00	Logistics & Training Eqmt.	12.0				48(2)	72	60/40	Jan 85
4	IXX-20-00-00-00	System Engr. Support	32.2				84	84	40/60	Jan 85
4	IXX-21-00-00-00	Project Management	32.2				84	84	40/60	Jan 85

(1) 26 Mos. After 1st Ground Test GSE Required
(2) Terminates When Oper. Trng. Eqmt. Available

DATE _____
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COST ESTIMATE DATA FORM A

____ NON-RECURRING (DDT & E)
__X__ RECURRING (PRODUCTION)
____ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
3	IXX-00-00-00-00	Lunar Surface Base Project, Baseline Configuration								
4	IXX-01-00-00-00	Crew & Medical Module	14.8	1	1	90	39	45	50/50	Jan 85
5	IXX-01-01-00-00	Prime Structure	3.2							
5	IXX-01-02-00-00	Furnishings & Secondary Structure	1.1							
5	IXX-01-03-00-00	Atmospheric Mgt. & Crew Services	9.2							
5	IXX-01-04-00-00	Comm. & Monitoring	.7							
5	IXX-01-05-00-00	EPS Distr. & Control	.4							
5	IXX-01-06-00-00	Medical Facility	.2							

COST ESTIMATE DATA FORM A

___ NON-RECURRING (DDT & E)
_X_ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-02-00-00-00	Crew & Operations Module	25.6	1	1	90	37	43	50/50	Jan 85
5	IXX-02-01-00-00	Prime Structure	2.9			90				
5	IXX-02-02-00-00	Furnishings & Secondary Structure	1.2							
5	IXX-02-03-00-00	Atmospheric Mgt. & Crew Services	9.2							
5	IXX-02-04-00-00	Comm. & Monitoring	.6							
5	IXX-02-05-00-00	EPS Distr. & Control	1.1							
5	IXX-02-06-00-00	Command & Control	10.6							

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COST ESTIMATE DATA FORM A

___ NON-RECURRING (DDT & E)
_X_ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-03-00-00-00	Sortie & Transient Module	17.1	1	1	90	35	41	50/50	Jan 85
5	IXX-03-01-00-00	Prime Structure	2.6							
5	IXX-03-02-00-00	Furnishings & Secondary Structure	1.2							
5	IXX-03-03-00-00	Atmospheric Mgt. & Crew Services	11.9							
5	IXX-03-04-00-00	Comm. & Monitoring	.7							
5	IXX-03-05-00-00	EPS Distr. & Control	.3							
5	IXX-03-06-00-00	Backup Galley	.4							

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COST ESTIMATE DATA FORM A

___ NON-RECURRING (DDT & E)
X RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-04-00-00-00	Lab & Backup Command Post Module	28.7	1	1	90	33	39	50/50	Jan 85
5	IXX-04-01-00-00	Prime Structure	2.6							
5	IXX-04-02-00-00	Furnishings & Secondary Structure	1.8							
5	IXX-04-03-00-00	Atmospheric Mgt. & Crew Services	6.8							
5	IXX-04-04-00-00	Comm. & Monitoring	2.0							
5	IXX-04-05-00-00	EPS Distr. & Control	.9							
5	IXX-04-06-00-00	Geochem. Lab	0.3							
5	IXX-04-07-00-00	Photo Lab	.7							
5	IXX-04-08-00-00	Data Analysis & Backup Command	8.4							
5	IXX-04-09-00-00	Bioscience Lab	0.2							

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COST ESTIMATE DATA FORM A

X NON-RECURRING (DDT & E)
RECURRING (PRODUCTION)
RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-05-00-00-00	Assy. & Recreation Module	11.0	1	1	90	31	37	50/50	Jan 85
5	IXX-05-01-00-00	Prime Structure	3.1							
5	IXX-05-02-00-00	Furnishings & Secondary Structure	.8							
5	IXX-05-03-00-00	Atmospheric Mgt. & Crew Services	4.4							
5	IXX-05-04-00-00	Comm. & Monitoring	1.2							
5	IXX-05-05-00-00	EPS Distr. & Control	.4							
5	IXX-05-06-00-00	Main Galley	1.2							

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COST ESTIMATE DATA FORM A

X NON-RECURRING (DDT & E)
___ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-06-00-00-00	Base Maintenance Module	7.1	1	1	90	29	35	50/50	Jan 85
5	IXX-06-01-00-00	Prime Structure	3.3							
5	IXX-06-02-00-00	Furnishings & Secondary Structure	.7							
5	IXX-06-03-00-00	Atmospheric Mgt. & Crew Services	1.5							
5	IXX-06-04-00-00	Comm. & Monitoring	1.3							
5	IXX-06-05-00-00	EPS Distr. & Control	.4							
5	IXX-06-06-00-00	Base Maintenance and Repair Station	-							

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COST ESTIMATE DATA FORM A

X NON-RECURRING (DDT & E)
___ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-07-00-00-00	Drive-In Garage Module	4.3	1	1	90	27	33	50/50	Jan 85
4	IXX-07-01-00-00	Prime Structure	3.3							
5	IXX-07-02-00-00	Furnishings & Secondary Structure	.1							
5	IXX-07-03-00-00	Atmospheric Mgt. & Crew Services	.3							
5	IXX-07-04-00-00	Comm. & Monitoring	.2							
5	IXX-07-05-00-00	EPS Distr. & Control	.3							

COST ESTIMATE DATA FORM A

___ NON-RECURRING (DDT & E)
_X_ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-08-00-00-00	Drive-In Warehouse Module	4.6	1	1	90	25	31	50/50	Jan 85
5	IXX-08-01-00-00	Prime Structure	3.0							
5	IXX-08-02-00-00	Furnishings & Secondary Structure	.8							
5	IXX-08-03-00-00	Atmospheric Mgt. & Crew Services	.3							
5	IXX-08-04-00-00	Comm. & Monitoring	.2							
5	IXX-08-05-00-00	EPS Distr. & Control	.2							

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COST ESTIMATE DATA FORM A

___ NON-RECURRING (DDT & E)
_X_ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-09-01-00-00	Mobile Cargo Modules	10.1	16	1	90	11	11	50/50	Jan 85
5	IXX-09-01-00-00	Prime Structure	8.7	16	1					
5	IXX-09-02-00-00	Furn. & Secondary Structure	1.4	16	1					

Temp. Fm. AP-84A, Exp. 5-3-71

Space Division
North American Rockwell

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COST ESTIMATE DATA FORM A

____ NON-RECURRING (DDT & E)
__X__ RECURRING (PRODUCTION)
____ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-10-00-00-00	Deep Drill Cover Module	4.3	1	1	90	23	29	50/50	Jan 85
5	IXX-10-01-00-00	Prime Structure	3.5							
5	IXX-10-02-00-00	Furnishings & Secondary Structure	.1							
5	IXX-10-03-00-00	Atmospheric Mgt.	.3							
5	IXX-10-04-00-00	EPS Distr. & Control	.4							

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COST ESTIMATE DATA FORM A

X NON-RECURRING (DDT & E)
___ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-11-00-00-00	Support Operations Eqmt. Hrdw.	56.3	1	1	90	17	23	50/50	Jan 85
5	IXX-11-01-00-00	EPS Distrib. & Control	.3							
5	IXX-11-02-00-00	Reliquifaction System Unit	6.4							
5	IXX-11-03-00-00	Launch & Landing Facility Eqmt.	1.7							
5	IXX-11-04-00-00	External Comm. Eqmt.	47.9							

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COST ESTIMATE DATA FORM A

___ NON-RECURRING (DDT & E)
_X_ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-12-00-00-00	Observatory Shell Modules	5.4	2	1	90	21	27	50/50	Jan 85
5	IXX-12-01-00-00	Prime Structure	4.4							
5	IXX-12-02-00-00	Furnishings & Secondary Structure	.1							
5	IXX-12-03-00-00	Atmospheric Mgt & Crew Services	.4							
5	IXX-12-04-00-00	EPS Distr. & Control	.5							

DATE _____
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COST ESTIMATE DATA FORM A

___ NON-RECURRING (DDT & E)
_X_ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-13-00-00-00	Mobility Equipment Transport Modules	76.1	7	1	90	13	19	50/50	Jan 85
5	IXX-13-01-00-00	Prime Structure	11.0							
5	IXX-13-02-00-00	Furnishings & Secondary Structure	5.1							

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COST ESTIMATE DATA FORM A

____ NON-RECURRING (DDT & E)
__X__ RECURRING (PRODUCTION)
____ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-14-00-00-00	Ground Support Eqmt.	2.8	3/ sets	1		36(1)	36	50/50	Jan 85
4	IXX-15-00-00-00	Systems Test Hdwre.	-							
4	IXX-16-00-00-00	Launch Support Opns.	13.9				24	24	50/50	Jan 85
4	IXX-17-00-00-00	Mission Opns. Support	-							
4	IXX-18-00-00-00	Facilities Support	-							
4	IXX-19-00-00-00	Logistics & Training Equipment	5.3				48(2)	48	50/60	Jan 85
4	IXX-20-00-00-00	System Eng'g. Support	4.5				36(3)	36(3)	60/40	Jan 85
4	IXX-21-00-00-00	Project Management	5.0				36(3)	36(3)	60/40	Jan 85

(1) 26 Mos. Lead Time to Design & Build for Launch Test GSE Requirement
(2) 24 Mos. Lead Time to Availability of Trng. Eqmt.
(3) Begins at Start of Operational Hardware Fabrication

7.2 DATA FORM C, TECHNICAL CHARACTERISTICS DATA

This section presents the technical, physical and mission characteristics of the Baseline Shelter elements which may have a significant effect on the cost of items.

The technical characteristics are presented by Work Breakdown Structure (WBS) item and include sizing parameters; i.e., weight, power, volume; performance parameters such as position location, environment, crew safety, etc.; reliability mission duration; and operating distances.

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-00-00-00-00	Lunar Base Complex	3	5 years	Mission duration on lunar surface
			6 inches	Minimum depth of soil cover
			.999 probability	No micrometeoroid penetration
			.99 probability	Radiation protection
			200 RAD	Limit of radiation of skin during one crew cycle
			100 RAD	Limit of radiation to blood forming organs during one crew cycle
			12 men	Crew size (nominal)
			18 men	Max. overlap (30 days)
1XX-01-00-00-00	Crew and Medical Module	4	5 years	Mission duration on lunar surface
			6 inches	Minimum depth of soil cover
			4 men	Crew size
			8291 pounds	Gross dry weight

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-01-01-00-00	Prime Structure Subsystem	5	10 years	Structural life without replacement or extensive reconditioning of primary structure
			15 feet	Diameter
			30 feet	Overall length
			4800 cubic feet	Overall volume
			Ellipsoidal	End bulkheads
			Welded skin stringer	Cylinder walls
			Aluminum alloy skin with structural foam	Primary structure
			1414 square feet	Internal skin area
			10 psi	Internal pressure design limit
			1.0 inches	Average wall thickness
			3 x 5 feet	Ellipsoidal air tight doors
			3596 pounds	Primary structural weight

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-01-02-00-00	Furnishings and Secondary Structure	5	5 years	Structural life without replacement or extensive reconditioning of structure
			Aluminum alloy	Bracketry, mounting & supports
			Aluminum and stainless	Storage cabinets, chairs, desks and bunks
			720 pounds	Secondary structure weight
1XX-01-03-00-00	Atmospheric Management and Crew Services	5	4 men	Nominal crew size
			13,000 Btu/man-day	Metabolic load
			5.0 mm Hg	Nominal CO_2 concentration
			65 - 75 F	Temperature
			15 - 40 ft/minute	Ventilation rate
			12.24 pounds/day	Atmospheric leakage
			25,000 Btu/hour	Radiation heat rejection
			35 pounds/day	Water recovery
			4708 watts	Nominal thermal load

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-01-03-00-00 (continued)			1.02 cubic feet	Emergency oxygen system volume
			Titanium alloy	Tankage structure
			41.4 cubic feet	O_2, H_2, N_2 tanks
			8.5 cubic feet	Potable water tanks volume
			4.8 cubic feet	Wash water tanks volume
			5.1 cubic feet	Waste water tanks volume
			1000 watts	Emergency food reconstitution unit
			3230 pounds	Dry weight
			3533 pounds	Wet weight
1XX-01-04-00-00	Communication and Monitoring	5	3 kHz	Internal communications
			10 channel	Intercomm
			6 MHz	CCTV
			9 inches	T.V. monitor
			5 MHz	Remote data station
			71 watts	Power requirement
			33 pounds	Dry weight

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-01-05-00-00	Electrical Power Distribution Subsystem	5	4796 watts	Continuous power requirement
			2000 watts	Intermittent
			6796 watts	Peak power requirement
			235 pounds	Dry weight power cabling, buses, conversion, power switches, breakers, lights, terminal connectors, emergency battery
1XX-01-06-00-00	Medical Facility Subsystem		5 years	Structural life without replace- or extensive reconditioning of structure; situated within the crew and medical module that provides life support system
			990 cubic feet	Gross volume of the medical laboratory
			60 pounds	Furnishings
			477 pounds	Medical equipment
			537 pounds	Total weight
				The laboratory is delivered with all major items of medical equip- ment installed & secured in place.

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-02-00-00-00	Crew and Operations Module	4	5 years	Mission duration on lunar surface
			6 inches	Minimum depth of soil cover
			4 men	Crew size
			9292 pounds	Gross dry weight
1XX-02-01-00-00	Prime Structure Subsystem	5	10 years	Structural life without replacement or extensive reconditioning of primary structure
			15 feet	Diameter
			30 feet	Overall length
			4800 cubic feet	Overall volume
			Ellipsoidal	End bulkheads
			Welded skin stringer	Cylinder walls
			Aluminum alloy skin with structural foam	Primary structure
			1414 square feet	Internal skin area
			10 psi	Internal pressure design limit

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-02-01-00-00 (continued)			1.0 inch	Average wall thickness
			3 x 5 feet	Ellipsoidal air tight doors
			3596 pounds	Primary structure weight
1XX-02-02-00-00	Furnishings and Secondary Structure	5	5 years	Structural life without replacement or extensive reconditioning of structure
			Aluminum alloy	Bracketry, mounting & supports
			Aluminum and stainless steel	Storage cabinets, chairs, desks, and bunks
			731 pounds	Secondary structure weight
1XX-02-03-00-00	Atmospheric Management and Crew Services	5	4 men	Nominal crew size
			13,000 Btu/man-day	Metabolic load
			5.0 mm Hg	Nominal CO_2 concentration
			65 - 75 F	Temperature
			15 - 40 ft/minute	Ventilation rate
			12.24 pounds/day	Atmospheric leakage

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-02-03-00-00 (continued)			25,000 Btu/hour	Radiator heat rejection
			35 pounds/day	Water recovery
			4708 watts	Nominal thermal load
			1.02 cubic feet	Emergency oxygen system volume
			Titanium alloy	Tankage structure
			41.4 cubic feet	O_2, H_2, N_2 tanks volume
			8.5 cubic feet	Potable water tanks volume
			5.1 cubic feet	Waste water tanks volume
			1000 watts	Emergency food reconstitution unit
			10 pounds	First-aid provisions
			3240 pounds	Dry weight
			3533 pounds	Wet weight
1XX-02-04-00-00	Communication and Monitoring	5	3 kHz	Internal communications
			10 channels	Intercomm
			6 MHz	CCTV

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-02-04-00-00 (continued)			9 inches	T.V. monitor
			67 watts	Power requirements
			25 pounds	Dry weight
1XX-02-05-00-00	Electrical Power Distribution Subsystem	5	4851 watts	Continuous power requirement
			3366 watts	Intermittent power requirement
			8217 watts	Peak power requirement
			930 pounds	Dry weight Power cabling, buses, conversion, power switches, breaker, lights, terminal connectors, emergency battery
1XX-02-06-00-00	Command and Control	5	3 kHz	Internal communications/dist. voice data 120 channels, 10 channels intercomm
			6 MHz	CCTV 10 channels
			5 MHz	Digital data
			9 x 9	CRT

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-02-06-00-00 (continued)			15 lines, 50 characters	Discrete alphanumeric Light emitting diode
			Monitor alarm	Discrete events lights
			600 lines/minute	Hardware text-hard copy viewer
			1×10^7 equiv. add per second	Data processor computation rate
			3 crew stations	
			2000	Measurements
			32,000 32-bit words	Operating memory
			10^8 bit memory	Mass memory
			10^9 bits stored	Archival memory holographic
				Other storage requirements
			25 watts	S-band transmitters
			10 watts	VHF transmitters
			1 kw	Low frequency transmitter
			113 watts	Power requirement communication
			2366 watts	Total power requirement

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-02-06-00-00 (continued)			127 pounds	Dry weight communication equipment (27 units)
			643 pounds	Dry weight data management equipment (7 units)
			770 pounds	Total dry weight
1XX-03-00-00-00	Sortie Crew and Transients Module	4	5 years	Mission duration on lunar surface
			6 inches	Minimum depth of soil cover
			4 men	Crew size nominal
			8 men	Crew size during overlap
			8818 pounds	Gross dry weight
1XX-03-01-00-00	Prime Structure Subsystem	5	10 years	Structural life without replacement or extensive reconditioning of primary structure
			15 feet	Diameter
			30 feet	Overall length
			4800 cubic feet	Overall volume

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-03-01-00-00 (continued)			Ellipsoidal	End bulkheads
			Welded skin stringer	Cylinder walls
			Aluminum alloy skin with structural foam	Primary structure
			1414 square feet	Internal skin area
			10 psi	Internal pressure design limit
			1.0 inch	Average wall thickness
			3 x 5 feet	Ellipsoidal air tight doors
			3596 pounds	Primary structural weight
1XX-03-02-00-00	Furnishings and Secondary Structure	5	5 years	Structural life without replacement or extensive reconditioning of structure
			Aluminum alloy	Bracketry, mounting and supports
			Aluminum and stainless steel	Chairs, desks and bunks
			760 pounds	Secondary structure weight

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-03-03-00-00	Atmospheric Management and Crew Services	5	4 men	Nominal crew size
			13,000 Btu/man-day	Metabolic load
			5.0 mm Hg	Nominal CO_2 concentration
			65 - 75 F	Temperature
			15 - 40 ft/minute	Ventilation rate
			12.24 pounds/day	Atmospheric leakage
			25,000 Btu/hour	Radiator heat rejection
			35 pounds/day	Water recovery
			4858 watts	Nominal thermal load
			1.02 cubic feet	Emergency oxygen system volume
			Titanium alloy	Tankage structure
			41.4 cubic feet	O_2, H_2, N_2 tanks volume
			25.5 cubic feet	Potable water tank volume
			20.0 cubic feet	Wash water tank volume
			20.7 cubic feet	Waste water tank volume
			10 pounds	First-aid provisions

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-03-03-00-00 (continued)			3875 pounds	Dry weight
			4594 pounds	Wet weight
1XX-03-04-00-00	Communication and Monitoring	5	3 kHz	Internal communications
			10 channels	Intercomm
			6 MHz	CCTV
			9 inches	T.V. monitor
			5 MHz	Remote data station
			71 watts	Power requirement
			33 pounds	Dry weight
1XX-03-05-00-00	Electrical Power Distribution Subsystem	5	4932 watts	Continuous power requirement
			1550 watts	Intermittent power requirement
			6482 watts	Peak power requirement
			225 pounds	Dry weight Power cabling, buses, conversion, power switches, breakers, lights, terminal connectors, emergency battery

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-03-06-00-00	Back-up Galley	5	12 men	Crew size
			20 days	Emergency provisions
			933 pounds	Food required 12 men, 20 days
			46.3 cubic feet	Galley volume
			1500 watts	Nominal power
			329 pounds	Dry weight galley Food reconstitution, hot plate, microwave oven, refrigerator/ freezer, sink
1XX-04-00-00-00	Laboratory and Back-up Command Post	4	5 years	Mission duration on lunar surface
			6 inches	Minimum depth of soil cover
			8640 pounds	Gross dry weight
1XX-04-01-00-00	Prime Structure Subsystem	5	10 years	Structural life without replacement or extensive reconditioning of primary structure
			15 feet	Diameter
			30 feet	Overall length

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-04-01-00-00 (continued)			4800 cubic feet	Overall volume
			Ellipsoidal	End bulkheads
			Welded skin stringer	Cylinder walls
			2.0	Manned operation
			Aluminum alloy skin with structural foam	Primary structure
			1414 square feet	Internal skin area
			10 psi	Internal pressure design limit
			1.0 inch	Average wall thickness
			3 x 5 feet	Ellipsoidal air tight doors
			3596 pounds	Primary structural weight
1XX-04-02-00-00	Furnishings and Secondary Structure	5	5 years	Structural life without replacement or extensive reconditioning of structure
			Aluminum alloy	Bracketry, mounting and supports
			Aluminum and stainless steel	Storage cabinets, chairs, desks
			1202 pounds	Secondary structure weight

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-04-03-00-00	Atmospheric Management and Crew Services	5	4 men	Crew size (intermittent)
			13,000 Btu/man-day	Metabolic load
			5.0 mm Hg	Nominal CO_2 concentration
			65 - 75 F	Temperature
			15 - 40 ft/minute	Ventilation rate
			12.24 pounds/day	Atmospheric leakage
			17 pounds/day	Water recovery
			25,000 Btu/hour	Radiator heat rejection
			1410 watts	Nominal thermal load
			1.02 cubic feet	Emergency oxygen system volume
			Titanium alloy	Tankage structure
			18.6 cubic feet	O_2, H_2, N_2 tankage volume
			8.5 cubic feet	Potable water tank volume
			4.8 cubic feet	Wash water tank volume
			5.1 cubic feet	Waste water tank volume
			Medical	First-aid provisions

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-04-03-00-00 (continued)			1668 pounds	Dry weight
			1886 pounds	Wet weight
1XX-04-04-00	Communications and Monitoring	5	3 kHz	Internal communications
			10 channels	Intercomm
			6 MHz	CCTV
			9 inches	T.V. monitor
			63 watts	Power requirement
			27 pounds	Dry weight
1XX-04-05-00-00	Electrical Power Distribution Subsystem	5	1551 watts	Continuous power requirement
			1663 watts	Intermittent power requirement
			3214 watts	Peak power requirement
			770 pounds	Dry weight Power cabling, buses, conversion, switches, breakers, lights, terminals connectors, emergency battery

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-04-06-00-00	Geo-Chemical Laboratory Subsystem	5	5 years	Structural life without replacement or extensive reconditioning of structure. Situated within the laboratory module that provides life support systems.
			224 cubic feet	Gross volume of laboratory
			705 pounds	Scientific equipment for analysis of lunar material using a variety of techniques such as X-ray fluorescence, gamma ray, infrared, and mass spectrometry, differential thermal analysis, nuclear magnetic resonance and neutron activity. See Section 9.0
1XX-04-07-00-00	Photographic Laboratory Subsystem	5	5 years	Structural life without replacement or extensive reconditioning of the structure. Situated within the laboratory module which provides life support systems.
			294 cubic feet	Gross volume of photographic laboratory
			670 pounds	Photographic equipment

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-04-08-00-00	Data Analysis Laboratory and Back-up Command and Control	5	5 years	Structural life without replacement or extensive reconditioning of structure. Situated within the laboratory module which provides life support systems.
			434 cubic feet	Gross volume of data analysis laboratory
			3 kHz	Internal communications/dist. Voice data 120 channels, 10 channels intercomm
			6 MHz	CCTV 10 channels
			5 MHz	Digital data
			9 x 9	CRT
			15 lines, 50 characters	Discrete alphanumeric light emitting diode
			Monitor alarm	Discrete events lights
			600 lines/minute	Hardware text-hard copy viewer
			1 x 10^7 equiv. add per second	Data processor computation rate
			3 crew stations	
			2000	measurements

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-04-08-00-00 (continued)			32,000 32-bit words	Operating memory
			10^8 bit memory	Mass memory
			10^9 bits stored	Archival memory holographic
				Other storage requirements
			25 watts	S-band transmitters
			10 watts	VHF transmitters
			2366 watts	Power requirement
			70 pounds	Dry weight communication equipment (15 units)
			613 pounds	Dry weight data management equipment (6 units)
			25 pounds	Microfilm viewer and desk film viewer/enlarger
			708 pounds	Dry weight data analysis and back-up command and control
1XX-04-09-00-00	Bio-Science Laboratory	5	5 years	Structural life without replacement or extensive reconditioning of structure
			308 cubic feet	Gross volume of laboratory

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-04-09-00-00 (continued)			438 pounds	Scientific equipment for analysis of life detection, terrestial contamination, behavior rhythm, lunar effects on plants, and ecological experiments. See Section 9.0
1XX-05-00-00-00	Assembly and Recreation Module	4	5 years	Mission duration on lunar surface
			6 inches	Minimum depth of soil cover
			7574 pounds	Gross dry weight
1XX-05-01-00-00	Prime Structure Subsystem	5	10 years	Structural life without replacement or extensive reconditioning of primary structure.
			15 feet	Diameter
			30 feet	Overall length
			4800 cubic feet	Overall volume
			Ellipsoidal	End bulkheads
			Welded skin stringer	Cylinder walls
			Aluminum alloy skin with structural foam	Primary structure

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-05-01-00-00 (continued)			1414 square feet	Internal skin area
			10 psi	Internal pressure design limit
			1.0 inch	Average wall thickness
			3 x 5 feet	Ellipsoidal air tight doors
			5-foot diameter	Airlock doors
			300 cubic feet	Airlock (small)
			4096 pounds	Primary structure weight
1XX-05-02-00-00	Furnishings and Secondary Structure	5	5 years	Structural life without replacement or extensive reconditioning of structure
			Aluminum alloy	Bracketry, mounting and supports
			Aluminum and stainless steel	Chairs and tables
			467 pounds	Secondary structure weight
1XX-05-03-00-00	Atmospheric Management and Crew Services	5	4 men	Crew size (intermittent)
			5.0 mm Hg	Nominal CO_2 concentration

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
LXX-05-03-00-00 (continued)			15 - 40 ft/minute	Ventilation rate
			12.24 pounds/day	Atmospheric leakage
			35 pounds/day	Water recovery
			540 watts	Nominal thermal load
			1.02 cubic feet	Emergency oxygen system volume
			300 cubic feet	Airlock volume
			30 minutes	Time to evacuate to one pound remaining
			Titanium alloy	Tankage structure
			25.5 cubic feet	Potable water tank volume
			20.0 cubic feet	Wash water tank volume
			20.7 cubic feet	Waste water tank volume
			1217 pounds	Dry weight
			2072 pounds	Wet weight

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-05-04-00-00	Communication and Monitoring	5	3 kHz	Internal communications
			10 channels	Intercomm
			6 MHz	CCTV
			14 inches	T.V. monitor
			5 MHz	Remote data station
			96 watts	Power requirement
			58 pounds	Dry weight
1XX-05-05-00-00	Electrical Power Distribution Subsystem	5	1695 watts	Continuous power requirement
			3500 watts	Intermittent power requirement
			5195 watts	Peak power requirement
			280 pounds	Dry weight Power cabling, buses, conversion, switches, breakers, lights, terminal connectors, emergency battery

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-05-06-00-00	Main Galley	5	8400 pounds	Food required 12 men, 180 days
			220.5 cubic feet	Galley volume
			2300 watts	Nominal power
			1456 pounds	Total weight Freezer, refrigerator, resistance oven, microwave oven, reconstitution unit, preparation utensils, serving trays, dishwasher/dryer, and inventory control
1XX-06-00-00-00	Base Maintenance Module	4	5 years	Mission duration on lunar surface
			6 inches	Minimum depth of soil cover
			6297 pounds	Gross dry weight
1XX-06-01-00-00	Prime Structure Subsystem	5	10 years	Structural life without replacement or extensive reconditioning of primary structure
			15 feet	Diameter
			30 feet	Overall length
			4800 cubic feet	Overall volume

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-06-01-00-00 (continued)			Ellipsoidal	End bulkheads
			Welded skin stringer	Cylinder walls
			Aluminum alloy skin with structural foam	Primary structure
			1414 square feet	Internal skin area
			10 psi	Internal pressure design limit
			1.0 inch	Average wall thickness
			3 x 5 feet	Ellipsoidal air tight doors
			5-foot diameter	Airlock doors
			500 cubic feet	Airlock (large)
			4296 pounds	Primary structure weight
1XX-06-02-00-00	Furnishings and Secondary Structure	5	5 years	Structural life without replacement or extensive reconditioning of structure
			Aluminum alloy	Bracketry, mounting and supports
			Aluminum and stainless steel	Storage cabinets, chairs, desks
			392 pounds	Secondary structure weight

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-06-03-00-00	Atmospheric Management and Crew Services	5	15 - 40 ft/minute	Ventilation rate
			150 watts	Nominal thermal load
			1.02 cubic feet	Emergency oxygen system
			500 cubic feet	Airlock volume
			60 minutes	Time to evacuate to one pound remaining
			376 pounds	Dry weight
1XX-06-04-00-00	Communication and Monitoring	5	3 kHz	Internal communications
			10 channels	Intercomm
			6 MHz	CCTV
			9 inches	T.V. monitor
			5 MHz	Remote data terminal
			317 watts	Power requirement
			67 pounds	Dry weight

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-06-05-00-00	Electrical Power Distribution Subsystem	5	467 watts	Continuous power requirement
			2250 watts	Intermittent power requirement
			2717 watts	Peak power requirement
			235 pounds	Dry weight Power cabling, buses, conversion, switches, breakers, lights, terminal connectors, emergency battery
1XX-06-06-00-00	Base Maintenance Equipment	5	5 years	Equipment life without replacement or extensive reconditioning
			931 pounds	Equipment dry weight (22 pieces) Shelter, mobility, and pressure suit repair
1XX-07-00-00-00	Drive-in Garage Module	4	5 years	Mission duration on lunar surface
			6 inches	Minimum depth of soil cover
			4807 pounds	Gross dry weight

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-07-01-00-00	Prime Structure Subsystem	5	10 years	Structural life without replacement or extensive reconditioning of primary structure
			15 feet	Diameter
			30 feet	Overall length
			4800 cubic feet	Overall volume
			Ellipsoidal	End bulkheads
			Welded Skin Stringer	Cylinder walls
			Aluminum alloy skin with structural foam	Primary structure
			1414 square feet	Internal skin area
			10 psi	Internal pressure design limit
			1.0 inch	Average wall thickness
			3 x 5 feet	Ellipsoidal air tight doors
			15 feet	Diameter garage door (pressure tight)
			24 feet	Internal track with jacks

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-07-01-00-00 (continued)			20 feet	Hinged track (large pressure door protection)
			4471 pounds	Primary structure weight
1XX-07-02-00-00	Furnishings and Secondary Structure	5	15 years	Structural life without replacement or extensive reconditioning of structure
			Aluminum alloy	Bracketry, mounting and supports
			52 pounds	Secondary structure weight
1XX-07-03-00-00	Atmospheric Management and Crew Services	5	15 - 40 ft/minute	Ventilation rate
			150 watts	Nominal thermal load
			1.02 cubic feet	Emergency oxygen system
			101 pounds	Dry weight
1XX-07-04-00-00	Communication and Monitoring	5	3 kHz	Internal communications
			10 channels	Intercomm
			5 MHz	Remote data station
			12 watts	Power requirement
			8 pounds	Dry weight

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-07-05-00-00	Electrical Power Distribution Subsystem	5	162 watts	Continuous power requirement
			50 watts	Intermittent power requirement
			212 watts	Peak power requirement
			175 pounds	Dry weight Power cabling, buses, conversion, switches, breakers, lights, terminal connectors, emergency battery
1XX-08-00-00-00	Drive-in Warehouse Module	4	5 years	Mission duration on lunar surface
			6 inches	Minimum depth of soil cover
			5024 pounds	Gross dry weight
1XX-08-01-00-00	Prime Structure Subsystem	5	10 years	Structural life without replacement or extensive reconditioning of primary structure
			15 feet	Diameter
			30 feet	Overall length
			4800 cubic feet	Overall volume
			Ellipsoidal	End bulkheads

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-08-01-00-00 (continued)			Welded skin stringer	Cylinder walls
			Aluminum alloy skin with structural foam	Primary structure
			1414 square feet	Internal skin area
			10 psi	Internal pressure design limit
			1.0 inch	Average wall thickness
			3 x 5 feet	Ellipsoidal air tight doors
			15 feet	Garage door (pressure tight)
			20 feet	Hinged track (large pressure door protection)
			4271 pounds	Primary structural weight
1XX-08-02-00-00	Furnishings and Secondary Structure	5	5 years	Structural life without replacement or extensive reconditioning of structure
			Aluminum alloy	Bracketry, mounting and supports
			Aluminum and stainless steel	Storage cabinets, chairs, desks
			544 pounds	Secondary structure weight

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-08-03-00-00	Atmospheric Management and Crew Services	5	15 - 40 ft/minute	Ventilation rate
			150 watts	Nominal thermal load
			1.02 cubic feet	Emergency oxygen system
			101 pounds	Dry weight
1XX-08-04-00-00	Communication and Monitoring	5	3 kHz	Internal communications
			10 channels	Intercomm
			5 MHz	Remote data station
			12 watts	Power requirement
			8 pounds	Dry weight
1XX-08-05-00-00	Electrical Power Distribution Subsystem	5	154 watts	Continuous power requirement
			8 watts	Intermittent power requirement
			162 watts	Peak power requirement
			100 pounds	Dry weight Power cabling, buses, conversion, switches, breakers, lights, terminal connectors, emergency battery

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-09-00-00-00	Mobile Cargo Module	4	180 days	Mission duration on lunar surface Support for mobile sortie exploration
			16,200 pounds	Capacity full load based on 17 pounds/cubic foot
			978 pounds	Gross dry weight
1XX-09-01-00-00	Primary Structure Subsystem	5	180 days	Structural life without replacement or extensive reconditioning of primary structure
			9 feet	Diameter
			17 feet	Overall length
			952 cubic feet	Interior volume
			Aluminum alloy	Primary structure
			Ellipsoidal	End bulkheads
			Welded skin stringer	Cylinder walls
			1	Deck
			4.6 feet diameter (2)	Passive docking rings
			898 pounds	Primary structural weight

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-09-02-00-00	Furnishings and Secondary Structures	5	180 days	Structural life without replacement or extensive reconditioning of structure
			Aluminum	Storage cabinets
			80 pounds	Secondary structure weight
1XX-10-00-00-00	Deep Drill Cover Module	4	5 years	Mission duration on lunar surface
			Horizontal	Emplacement to house deep drill. Depends on prime mover for life support functions.
			4582 pounds	Gross dry weight
			4200 pounds	Deep drill weight
				Also used to contain an element of mobility equipment during transit to the moon.
1XX-10-01-00-00	Prime Structure Subsystem	5	10 years	Structural life without replacement or extensive reconditioning of primary structure
			15 feet	Diameter
			30 feet	Overall length

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-10-01-00-00 (continued)			4800 cubic feet	Overall volume
			Ellipsoidal	End bulkheads
			Welded skin stringer	Cylinder walls
			Aluminum alloy skin with structural foam	Primary structure
			1414 square feet	Internal skin area
			10 psi	Internal pressure design limit
			1.0 inch	Average wall thickness
			3 x 5 feet	Ellipsoidal air tight doors
			15 feet	Diameter garage door (air tight)
			3911 pounds	Primary structural weight
1XX-10-02-00-00	Furnishings and Secondary Structure	5	5 years	Structural life without replacement or extensive reconditioning of structure
			Aluminum alloy	Bracketry, mounting and supports
			10 pounds	Secondary structure weight

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-10-03-00-00	Atmospheric Management and Crew Services	5	15 - 40 ft/minute	Ventilation rate
			150 watts	Nominal thermal load
			1.02 cubic feet	Emergency oxygen system
			101 pounds	Dry weight Power cabling, buses, conversion, switches, breakers, lights, terminal connectors, emergency battery
1XX-11-00-00-00	Support Equipment Operational Hardware	4	5 years	Mission duration on lunar surface
			3685 pounds	Gross dry weight Electrical distribution and J-box, liquefaction unit, landing facility equipment, external communication equip.
1XX-11-01-00-00	Electrical Distribution J-Box and Distribution Lines	5	21 kw	J-box
			60 pounds	6-access J-box
			12 BX	Cable
			75 feet	Length
			90 pounds	Cable
			150 pounds	Dry weight

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-11-02-00-00	Liquefaction System	5	2.5 kw	Average power requirement
			0.750 pounds/hour	H_2 liquefaction rate
			1.250 pounds/hour	O_2 liquefaction rate
			250 pounds	H_2 refrigeration unit and lines
			100 pounds	O_2 refrigeration unit and lines
			84.8 cubic feet	LH_2 accumulator
			8.7 cubic feet	LOX accumulator
			Titanium alloy	Tankage
			1119 pounds	LH_2 accumulator
			193 pounds	LOX accumulator
			Aluminum stringer	Mounting structure
			156 pounds	Mounting structure
			1818 pounds	Dry weight
1XX-11-03-00-00	Landing Facility Equipment	5	25 x 12 feet	Latticed reflector panels
			60 x 3 feet	White plastic sheeting

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-11-03-00-00 (continued)			15 pounds	Reflector panels (6) and plastic sheeting
			7000 lm/square foot	High intensity flashers
			10 pounds	High intensity flashers (19)
			1 kw	J-box and distribution lines
			1100 feet	Distribution lines buried 12 in.
			1350 pounds	J-box and distribution lines
			108 - 112 MH z	CW omni beacon
			20 channels	Flexibility
			30 revolutions per second	Antenna rotation
			40 pounds	Landing omni beacon (2)
			1415 pounds	Dry weight landing facility equipment
1XX-11-04-00-00	External Communication Equipment	5	2.3 GHz	Directional S-band antenna
			10 feet	Parabolic dish
			60 watts	RTG power requirement

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-11-04-00-00 (continued)			30 pounds	10-foot S-band directional antenna
			25 pounds	Powered drive
			60 pounds	60-watt RTG power
			100 feet	Vertical low frequency antenna
			12 pounds	Vertical 100-foot LF antenna
			10 watts	VHF relay transmitter
			25 watts	RTG power source
			20 pounds	VHF relay transceiver (200)
			25 pounds	25-watt RTG power (200)
			25 watts	S-band relays
			40 watts	RTG power source
			35 pounds	S-band transceiver (3)
			15 pounds	Mast structure
			40 pounds	40-watt RTG power
			262 pounds	Dry weight external communication equipment

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-12-00-00-00	Observatory Shell Module	4	5 years	Mission duration on lunar surface
				Houses 2.5-meter telescope elements. Depends on main shelter for life support.
			4582 pounds	Gross dry weight
				Also used to contain an element of mobility equipment during transit to the moon.
1XX-12-01-00-00	Prime Structure Subsystem	5	10 years	Structural life without replacement or extensive reconditioning of primary structure
			15 feet	Diameter
			30 feet	Overall length
			4800 cubic feet	Overall volume
			Ellipsoidal	End bulkhead
			Welded skin stringer	Cylinder walls
			Aluminum alloy skin with structural foam	Primary structure
			1414 square feet	Internal skin area

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-12-01-00-00 (continued)			10 psi	Internal pressure design limit
			1.0 inch	Average wall thickness
			3 x 5 feet	Ellipsoidal air tight door (1)
			15 feet	Diameter garage door (air tight)
			20 feet	Hinged track (large pressure door protection)
			4271 pounds	Primary structural weight
1XX-12-02-00-00	Furnishings and Secondary Structures	5	5 years	Structural life without replacement or extensive reconditioning of structure
			Aluminum alloy	Bracketry, mounting and supports
			10 pounds	Secondary structure weight
1XX-12-03-00-00	Atmospheric Management and Crew Services	5	15 - 40 ft/minute	Ventilation rate
			150 watts	Nominal thermal load
			1.02 cubic feet	Emergency oxygen system
			101 pounds	Dry weight

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-12-04-00-00	Electrical Power Distribution Subsystem	5	150 watts	Continuous power requirement
			2900 watts	Intermittent telescope power requirement
			3050 watts	Peak power requirement
			200 pounds	Dry weight Power cabling, buses, conversion, switches, breakers, lights, terminal connectors, emergency battery
1XX-13-00-00-00	Mobility Equipment Transportation Modules	4	90 days	Mission duration to lunar surface
			4087 pounds	Dry weight
				Same basic design used to minimize new development.
1XX-13-01-00-00	Prime Structure	5	90 days	Structural life without replacement or extensive reconditioning of prime structure
			15 feet	Diameter
			30 feet	Overall length
			4800 cubic feet	Overall volume

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-13-01-00-00 (continued)			Ellipsoidal	End bulkheads
			Welded skin stringer	Cylinder walls
			Aluminum alloy skin with structural foam	Primary structure
			1.0 inch	Average wall thickness
			3 x 5 feet	Ellipsoidal air tight doors
			15 feet	Diameter end door (pressure tight)
			20 feet	Hinged track (large pressure door protection)
			4035 pounds	Primary structural weight
1XX-13-02-00-00	Furnishings and Secondary Structure	5	90 days	Structural life without replacement or extensive reconditioning of structure
			Aluminum alloy	Bracketry, mounting and supports
			52 pounds	Secondary structure weight

7.3 FUNDING SCHEDULE FOR THE BASELINE SHELTER

Funding schedules have been developed on Data Form D in accordance with the T_d and T_s values in Form A. The term T_d denotes the duration of cost expenditures in months, and T_s is the starting time, measured in months to the launch milestone, for each Level 4 item. All Level 5 items are assumed to be on the same schedule as the Level 4 item for spreading costs versus time. The schedule presupposes a disciplined phased procurement where no design modifications are made after the completion of integrated system tests.

COST ESTIMATE DATA FORM D

DATE _____
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X NON-RECURRING (DDT&E)
___ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	GFY '78	GFY '79	GFY '80	GFY '81	GFY '82	GFY '83	GFY '84	GFY'85
3	IXX-00-00-00-00	Lunar Surface Base Project Baseline	$644.1	7.2	58.5	142.4	200.7	157.2	61.5	15.2	1.5
4	IXX-01-00-00-00	Crew and Medical	63.1	.38	7.24	7.24	17.62	14.51	2.01	-	-
4	IXX-02-00-00-00	Crew and Operations	48.5	.29	5.57	13.54	16.40	11.15	1.56	-	-
4	IXX-03-00-00-00	Sortie and Transient	25.0	.15	2.87	6.98	8.45	5.75	.80	-	-
4	IXX-04-00-00-00	Lab and Backup	40.3	1.67	8.15	13.13	12.27	4.97	-	-	-
4	IXX-05-00-00-00	Assy. & Recreation	23.0	.14	2.64	6.42	7.78	5.29	.73	-	-
4	IXX-06-00-00-00	Base Maintenance	13.1	.08	1.50	3.66	4.43	3.01	.42	-	-
4	IXX-07-00-00-00	Drive-In Garage	9.6	.06	1.10	2.68	3.25	2.21	.30	-	-
4	IXX-08-00-00-00	Drive-In Warehouse	8.0	.05	.92	2.23	2.70	1.84	.26	-	-
4	IXX-09-00-00-00	Mobile Cargo	5.8	.03	.67	1.62	1.96	1.33	.19	-	-
4	IXX-10-00-00-00	Deep Drill Cover	7.1	.04	.81	1.98	2.40	1.63	.27	-	-
4	IXX-11-00-00-00	Support Opns. Eqmt.	98.4	4.08	19.89	32.30	29.96	12.15	-	-	-
4	IXX-12-00-00-00	Observatory Shell	2.7	.02	.31	.75	.91	.62	.09	-	-
4	IXX-13-00-00-00	Mobile Equip. Transport	.3	.05	.20	.05	-	-	-	-	-

Space Division
North American Rockwell

DATE _____
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COST ESTIMATE DATA FORM D

X NON-RECURRING (DDT&E)
___ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	GFY '78	GFY '79	GFY '80	GFY '81	GFY '82	GFY '83	GFY '84	GFY'85
4	IXX-14-00-00-00	Ground Support Eqmt.	40.2	-	1.98	13.48	16.32	7.96	.45	-	
4	IXX-15-00-00-00	System Test Hdwre.	140.4	-	-	6.17	42.62	54.97	32.43	4.14	-
4	IXX-16-00-00-00	Launch Ops. Support	-	-	-	-	-	-	-	-	-
4	IXX-17-00-00-00	Mission Ops. Support	-	-	-	-	-	-	-	-	-
4	IXX-18-00-00-00	Facility Ops. Support	42.2	-	.94	6.98	11.35	11.60	8.12	3.03	.15
4	IXX-19-00-00-00	Logistics Training Equipment	12.0	-	.58	3.99	4.84	2.36	.13	-	-
4	IXX-20-00-00-00	System Engineering	32.2	.07	1.54	4.38	6.89	7.90	6.89	4.01	.52
4	IXX-21-00-00-00	Project Mgmt.	32.2	.07	1.54	4.38	6.89	7.90	6.89	4.01	.52

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COST ESTIMATE DATA FORM D

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_____ NON-RECURRING (DDT&E)
X RECURRING (PRODUCTION)
_____ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	GFY '78	GFY '79	GFY '80	GFY '81	GFY '82	GFY '83	GFY '84	GFY'85
3	IXX-00-00-00-00	Lunar Surface Base Baseline Configur.	$231.9				.3	22.2	88.2	113.3	7.9
4	IXX-01-00-00-00	Crew & Medical Module	14.8				.1	4.2	7.9	2.6	-
4	IXX-02-00-00-00	Crew & Operations	25.6				.1	7.4	13.7	4.4	-
4	IXX-03-00-00-00	Sortie & Transient	17.1				-	3.6	9.9	3.6	-
4	IXX-04-00-00-00	Lab & Backup Cmd.	23.7				-	3.1	14.6	6.0	-
4	IXX-05-00-00-00	Assy. & Recreation	11.0				-	1.1	6.8	3.1	-
4	IXX-06-00-00-00	Base Maintenance	7.1				-	.7	4.4	2.0	-
4	IXX-07-00-00-00	Drive-In Garage	4.3				-	.1	2.5	1.7	-
4	IXX-08-00-00-00	Drive-In Warehouse	4.6				-	.1	2.7	1.8	-
4	IXX-09-00-00-00	Mobile Cargo	10.1				-	-	-	4.2	5.9
4	IXX-10-00-00-00	Deep Drill Cover	4.3				-	-	2.1	2.2	-
4	IXX-11-00-00-00	Support Equipment Opns. Eqmt.	56.3				-	-	11.8	44.5	-

COST ESTIMATE DATA FORM D

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PAGE 2 OF 2

___ NON-RECURRING (DDT&E)
_X_ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	GFY '78	GFY '79	GFY '80	GFY '81	GFY '82	GFY '83	GFY '84	GFY'85
4	IXX-12-00-00-00	Observatory Shell	5.4				-	-	1.9	3.5	
4	IXX-13-00-00-00	Mobility Eqmt. Transport	16.1				-	-	.1	16.0	
4	IXX-14-00-00-00	Ground Support Eqmt.	2.8				-	.1	1.3	1.3	.1
4	IXX-15-00-00-00	Systems Test Hardware	-				-	-	-	-	-
4	IXX-16-00-00-00	Launch Support Opns.	13.9				-	-	1.5	11.0	1.4
4	IXX-17-00-00-00	Mission Opns. Support	-				-	-	-	-	-
4	IXX-18-00-00-00	Facilities Support	-				-	-	-	-	-
4	IXX-19-00-00-00	Logistics & Training Support	5.3				.1	1.0	2.1	1.8	.3
4	IXX-20-00-00-00	System Engnr. Support	4.5				-	.4	2.3	1.7	.1
4	IXX-21-00-00-00	Project Mgmt.	5.0				-	.4	2.6	1.9	.1

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8.0 COST AND FUNDING ESTIMATES FOR MSS DERIVATIVE SHELTER

Cost data for the derivative configuration are presented in the same sequence as in the case of the baseline configuration.

8.1 COST ESTIMATES

Significant cost assumptions are presented and a summary is given, including data forms A.

8.1.1 Significant Assumptions Affecting Costs of the Modular Space Station Derivative Shelter

The major assumptions in arriving at the Modular Space Station Derivative Shelter are as follows.

As a derivative of the Modular Space Station, all subsystems are either of the same complexity as the Space Station or less.

Modules 1XX-01-00-00-00 through 1XX-06-00-00-00 are minor modifications to the primary structure for the initial design effort. Modules 1XX-07-00-00-00 and 1XX-08-00-00-00 are a new design for the Lunar Surface Base, as are Modules 1XX-09-00-00-00 through 1XX-13-00-00-00. However, modules 1XX-10-00-00-00, 1XX-12-00-00-00 and 1XX-13-00-00-00 have some structure that is common to 1XX-07-00-00-00 and 1XX-08-00-00-00.

In the atmospheric management and crew subsystem, the command and control subsystem, and the electrical power distribution and control subsystems, it was assumed that there was considerable commonality with the Space Station. Thus it was assumed that except for redesign of some assemblies, that the common subsystem items were identical at the assembly level as well as component level. The weight statements corroborate this identity.

In allocating non-recurring costs among the various modules for the MSS Derivative configuration, the sequence in design assumed is shown in Table 8.1-1.

The Support Operations Equipment Hardware and the Mobile Cargo Supply Modules are identical to those for the Baseline Shelter and carry the same costs.

Table 8.1-1. Base Modules and Sequences Assumed in Allocating Costs, MSS Derivative Shelter

Subsystem	Base Module	Sequence by Module
Primary structure	Crew quarters CQM-1	1. Crew quarters CQM-1 2. Lab & backup command CCM-1 3. Lab & control CCM-2 4. Galley CM-1 5. Crew quarters CQM-2
Primary structure	Drive-in garage	1. Drive-in garage 2. Drive-in warehouse
Primary structure	Deep drill cover	1. Deep drill cover 2. Observatory shell 3. Mobility equipment transport
Primary structure	Core module	1. Core module only
Atmospheric management and crew services	Lab & backup command CCM-	1. Lab & backup command CCM-1* 2. Core module CM-1* 3. Lab & control CCM-2*
Atmospheric management and crew services	Crew quarters CQM-1	1. Crew quarters CQM-1 2. Galley GM-1 3. Crew quarters CQM-3
Atmospheric management and crew services	Drive-in garage	1. Drive-in garage 2. Drive-in warehouse
Command and control	Lab & control CCM-2	1. Lab & control CCM-2 2. Lab & backup control
EPS distribution and control	Crew quarters CQM-1	1. Crew quarters CQM-1 2. All other modules 01 - 06, sequence optional
EPS distribution and control	Drive-in garage	1. Drive-in garage 2. Drive-in warehouse
EPS distribution and control	Deep drill cover	1. Deep drill cover 2. Observatory shell

*Differences in total weight do not affect identity of assemblies

The quantities of major test hardware and flight operational hardware are given in the Hardware Utilization List in Section 5.0. In the case of the MSS Derivative Shelter, the design verification test articles are charged against the Drive-In Garage Module, except for the Command and Control Subsystem verification test articles. These are assigned to the Lab and Control Module CCM-2.

8.1.2 Summary of Cost Estimates for MSS Derivative Shelter

The estimated costs, in millions of dollars for a GFY 1970 cost index, are summarized in Table 8.1-2. These amount to $592 million in non-recurring costs and $269 for recurring costs, or a total of $861 million. The high cost modules tend to be those in which redesign or modification first take place as defined in Table 8.1-1 and evidenced by subsystem costs in Tables 8.1-3 and 8.1-4. The major subsystem or assembly cost drivers for initial development, in order of ranking, are the Reliquefaction Unit, External Communications, the Command and Control in the Lab and Control Module, Primary Structure in the Drive-In Garage, Primary Structure in the Core Module and Atmospheric Management and Crew Services in the Crew Quarters CQM-1. When both recurring and non-recurring costs are considered (Table 8.1-4), the most expensive subsystem is Primary Structure. Next in ranking came External Communications, the Reliquefaction Unit, Atmospheric Management and Crew Services, Command, Control and Data Analysis and Furnishings and Secondary Structure, respectively.

Table 8.1-2. Cost Summary, MSS Derivative Shelter
($ Million, GFY 1970 Cost Index)

	Nonrecurring	Recurring	Total
Core module	$ 18.2	$ 10.9	$ 29.1
Lab and backup control module	23.2	27.7	50.9
Lab and control module	35.8	29.8	65.6
Crew quarters module CQM-1	36.5	16.0	52.5
Galley module	13.6	15.4	29.0
Crew quarters module CQM-3	5.6	25.4	31.0
Drive-in garage module	25.8	7.9	33.7
Drive-in warehouse	6.0	8.0	14.0
Mobile cargo supply	5.8	10.1	15.9
Deep drill cover module	11.3	4.7	16.0
Support operations equipment module	98.4	56.3	154.7
Observatory shell module	0.8	6.7	7.5
Mobility equipment transport module	0.7	15.2	15.9
Ground support equipment	38.6	3.1	41.7
System test hardware	162.3	-	162.3
Launch support operations	-	15.5	15.5
Mission support operations	-	-	-
Facilities	38.6	-	38.6
Logistics and training equipment	11.6	5.9	17.5
System engineering support	29.6	5.0	34.6
Project management	29.6	5.6	35.2
TOTAL	$ 592.0	$ 269.2	$ 861.2

Table 8.1-3. Operational Hardware Costs by Subsystem, MSS Derivative Shelter
Nonrecurring ($ Million, 1970 Cost Index)

Module	Primary Structure	Furnishing and Secondary Structure	Atmosphere Management and Crew Services	Command Control and Data Analysis	Reliquefaction Unit	External Communications	All Other	Total
Crew module	$ 10.6	$ 3.0	$ 1.5	-	-	-	$ 3.1	$ 18.2
Lab and backup	1.0	6.6	6.2	4.4	-	-	5.0	23.2
Lab and control	0.6	7.5	0.7	23.7	-	-	3.3	35.8
Crew quarters, CQM-1	9.5	6.6	9.8	-	-	-	10.6	36.5
Galley module	0.4	6.8	1.6	-	-	-	4.8	13.6
Crew quarters, CQM-3	0.4	3.0	1.1	-	-	-	1.0	5.5
Drive-in garage	20.1	0.6	3.5	-	-	-	1.6	25.8
Drive-in warehouse	2.0	3.0	0.6	-	-	-	0.4	6.0
Mobile cargo	5.1	0.7	-	-	-	-	-	5.8
Deep drill cover	9.8	0.1	0.5	-	-	-	0.9	11.3
Support ops. equip. hardware	-	-	-	-	64.0	29.0	5.4	98.4
Observatory shell	0.6	-	-	-	-	-	0.2	0.8
Mobility equipment transport	0.4	0.3	-	-	-	-	-	0.7
Total, Nonrecurring	$ 60.5	$38.4	$ 25.5	$28.1	$64.0	$29.0	$ 36.3	$ 281.7

Table 8.1-4. Operational Hardware Costs by Subsystem, MSS Derivative Shelter
Recurring ($ Million, 1970 Cost Index)

Module	Primary Structure	Furnishing and Secondary Structure	Atmosphere Management and Crew Services	Command Control and Data Analysis	Reliquefaction Unit	External Communications	All Other	Total
Core module	$ 3.6	$ 0.9	$ 4.0	-	-	-	$ 2.4	$ 10.9
Lab and backup	3.2	1.9	2.4	11.6	-	-	8.6	27.7
Lab and control	3.3	2.0	3.5	19.9	-	-	1.1	29.8
Crew quarters, CQM-1	3.1	2.0	7.0	-	-	-	3.9	16.0
Galley module	3.0	2.0	6.3	-	-	-	4.0	15.4
Crew quarters, CQM-3	4.5	3.2	12.2	-	-	-	5.6	25.4
Drive-in garage	4.5	0.1	1.6	-	-	-	1.8	7.9
Drive-in warehouse	4.4	0.8	1.6	-	-	-	1.1	8.0
Mobile cargo	8.7	1.4	-	-	-	-	-	10.1
Deep drill cover	3.9	-	0.4	-	-	-	-	4.7
Support opns. equip. hardware	0.3	-	-	-	6.4	47.9	1.8	56.3
Observatory shell	5.6	-	0.5	-	-	-	0.5	6.7
Mobility equipment transport	14.7	0.5	-	-	-	-	-	15.2
Total Recurring	$62.8	$14.8	$ 39.5	$ 31.5	$ 6.4	$47.9	$31.2	$ 234.1
Total Nonrecurring plus recurring	$123.3	$53.2	$ 65.0	$ 59.6	$70.4	$76.9	$67.5	$ 515.8

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COST ESTIMATE DATA FORM A

X NON-RECURRING (DDT & E)
___ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
3	IXX-00-00-00-00	Lunar Surface Base Project MSS Derivative								
4	IXX-01-00-00-00	Core Module CM1	$18.16				65	90	40/60	Jan 85
5	IXX-01-01-00-00	Prime Structure	10.64							
5	IXX-01-02-00-00	Furnishings and Secondary Structures	2.96							
5	IXX-01-03-00-00	Atmospheric Mgmt. & Crew Services	1.53							
5	IXX-01-04-00-00	Communications & Monitoring	.39							
5	IXX-01-05-00-00	EPS Distribution & Control	2.64							

COST ESTIMATE DATA FORM A

X NON-RECURRING (DDT & E)
RECURRING (PRODUCTION)
RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-02-00-00-00	Lab and Backup Control Moudle CCM1	$23.17				65	90	40/60	Jan 85
5	IXX-02-01-00-00	Prime Structure	.95							
5	IXX-02-02-00-00	Furnishing and Secondary Structure	6.62							
5	IXX-02-03-00-00	Atmospheric Mgmt. and Crew Services	6.20							
5	IXX-02-04-00-00	EPS Distribution and Control	.15							
5	IXX-02-05-00-00	Backup Command and Control	4.36							
5	IXX-02-06-00-00	Geo Chem Laboratory	1.10							
5	IXX-02-07-00-00	Photographic Laboratory	2.80							
5	IXX-02-08-00-00	Data Analysis Laboratory	.45							
5	IXX-02-09-00-00	Bioscience Laboratory	.53							

COST ESTIMATE DATA FORM A

X NON-RECURRING (DDT & E)
___ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-03-00-00-00	Laboratory and Control Module CCM2	$35.78				65	90	40/60	Jan 85
5	IXX-03-01-00-00	Prime Structure	.64							
5	IXX-03-02-00-00	Furnishings and Secondary Structure	7.47							
5	IXX-03-03-00-00	Atmospheric Mgmt. and Crew Services	.70							
5	IXX-03-04-00-00	EPS Distribution & Control	.16							
5	IXX-03-05-00-00	Command and Control	23.73							
5	IXX-03-06-00-00	Medical and Dental	3.08							
5	IXX-03-07-00-00	Base Maintenance Facility	-							

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COST ESTIMATE DATA FORM A

X NON-RECURRING (DDT & E)
___ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-04-00-00-00	Crew Quarters Module CQM1	$36.48				65	90	40/60	Jan 85
5	IXX-04-01-00-00	Prime Structure	9.51							
5	IXX-04-02-00-00	Furnishings and Secondary Structure	6.54							
5	IXX-04-03-00-00	Atmospheric Mgmt. and Crew Services	9.82							
5	IXX-04-04-00-00	Communications and Monitoring	8.23							
5	IXX-04-05-00-00	EPS Distribution and Control	1.55							
5	IXX-04-06-00-00	Backup Galley	.83							

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COST ESTIMATE DATA FORM A

X NON-RECURRING (DDT & E)
___ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-05-00-00-00	Galley Module GM1	$13.62				65	90	40/60	Jan 85
5	IXX-05-01-00-00	Prime Structure	.44							
5	IXX-05-02-00-00	Furnishings and Secondary Structure	6.84							
5	IXX-05-03-00-00	Atmospheric Mgmt. and Crew Services	1.56							
5	IXX-05-04-00-00	Communications and Monitoring	.44							
5	IXX-05-05-00-00	EPS Distribution and Control	.16							
5	IXX-05-06-00-00	Main Galley	4.18							

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COST ESTIMATE DATA FORM A

X NON-RECURRING (DDT & E)
___ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-06-00-00-00	Crew Quarters Module CQM3	$5.55				65	90	40/60	Jan 85
5	IXX-06-01-00-00	Prime Structure	.42							
5	IXX-06-02-00-00	Furnishings and Secondary Structure	3.02							
5	IXX-06-03-00-00	Atmospheric Mgmt. and Crew Services	1.14							
5	IXX-06-04-00-00	Communication and Monitoring	.81							
5	IXX-06-05-00-00	EPS Distribution and Control	.16							

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COST ESTIMATE DATA FORM A

X NON-RECURRING (DDT & E)
___ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-07-00-00-00	Drive-In Garage Module	$25.82				65	90	40/60	Jan 85
5	IXX-07-01-00-00	Prime Structure	20.09							
5	IXX-07-02-00-00	Furnishings and Secondary Structure	.61							
5	IXX-07-03-00-00	Atmospheric Mgmt. and Crew Services	3.49							
5	IXX-07-04-00-00	Communication and Monitoring	.50							
5	IXX-07-05-00-00	EPS Distribution and Control	1.13							

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COST ESTIMATE DATA FORM A

X NON-RECURRING (DDT & E)
___ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-08-00-00-00	Drive-In Warehouse Module	$5.95				65	90	40/60	Jan 85
5	IXX-08-01-00-00	Prime Structure	1.99							
5	IXX-08-02-00-00	Furnishings and Secondary Structure	2.95							
5	IXX-08-03-00-00	Atmospheric Mgmt. and Crew Services	.60							
5	IXX-08-04-00-00	Communication and Monitoring	.29							
5	IXX-08-05-00-00	EPS Distribution and Controls	.12							

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COST ESTIMATE DATA FORM A

X NON-RECURRING (DDT & E)
___ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-09-00-00-00	Mobile Cargo Supply Module	$5.76				65	90	40/60	Jan 85
5	IXX-09-01-00-00	Prime Structure	5.08							
5	IXX-09-02-00-00	Furnishings and Secondary Structure	.68							

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COST ESTIMATE DATA FORM A

X NON-RECURRING (DDT & E)
___ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-10-00-00-00	Deep Drill Cover Module	$11.28				65	90	40/60	Jan 85
5	IXX-10-01-00-00	Prime Structure	9.78							
5	IXX-10-02-00-00	Furnishings and Secondary Structure	.08							
5	IXX-10-03-00-00	Atmospheric Mgmt and Crew Services	.52							
5	IXX-10-04-00-00	EPS Distribution and Controls	.90							

COST ESTIMATE DATA FORM A

X NON-RECURRING (DDT & E)
___ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-11-00-00-00	Support Operations Equipment Hardware	$98.40				65	90	40/60	Jan 85
5	IXX-11-01-00-00	Electrical Power Distribution	.44							
5	IXX-11-02-00-00	Reliquifaction System Unit	64.00							
5	IXX-11-03-00-00	Launch and Landing Facility Equipment	4.90							
5	IXX-11-04-00-00	External Communications Equipment	29.00							

COST ESTIMATE DATA FORM A

X NON-RECURRING (DDT & E)
___ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-12-00-00-00	Observatory Shell Module	$.79				65	90	40/60	Jan 85
5	IXX-12-01-00-00	Prime Structure	.59							
5	IXX-12-02-00-00	Furnishings and Secondary Structures	.03							
5	IXX-12-03-00-00	Atmospheric Mgmt. and Crew Services	.04							
5	IXX-12-04-00-00	EPS Distribution and Controls	.13							

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COST ESTIMATE DATA FORM A

X NON-RECURRING (DDT & E)
___ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-13-00-00-00	Mobility Equipment Transportation Modules	$.69				65	90	40/60	Jan 85
5	IXX-13-01-00-00	Prime Structure	.36							
5	IXX-13-02-00-00	Furnishing and Secondary Structure	.33							

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COST ESTIMATE DATA FORM A

X NON-RECURRING (DDT & E)
RECURRING (PRODUCTION)
RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-15-00-00-00	System Test Hardware	$162.3				46	71	60/40	Jan 85
5	IXX-15-01-00-00	Core Module	10.01							
5	IXX-15-02-00-00	Lab & Backup	30.18							
5	IXX-15-03-00-00	Lab & Control	28.76							
5	IXX-15-04-00-00	Crew Quarters CQM1	14.93							
5	IXX-15-05-00-00	Galley	12.32							
5	IXX-15-06-00-00	Crew Quarters CQM3	12.76							
5	IXX-15-07-00-00	Drive-In Garage	33.53							
5	IXX-15-08-00-00	Drive-In Warehouse	.90							
5	IXX-15-09-00-00	Mobile Cargo	1.32							
5	IXX-15-10-00-00	Deep Drill Cover	.75							
5	IXX-15-11-00-00	Supp. Eqmt. Hardware	16.68							
5	IXX-15-12-00-00	Observatory Shell	.06							
5	IXX-15-13-00-00	Mobility Equip. Trans.	.05							

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COST ESTIMATE DATA FORM A

X NON-RECURRING (DDT & E)
___ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-14-00-00-00	Ground Support Equipment	$38.61				48	78	60/40	Jan 85
4	IXX-16-00-00-00	Launch Operations Support	-				-	-		Jan 85
4	IXX-17-00-00-00	Mission Operations Support	-				-	-		Jan 85
4	IXX-18-00-00-00	Facilities Support	38.60				78	78	60/40	Jan 85
4	IXX-19-00-00-00	Logistics & Training Equipment	11.59				50	78	60/40	Jan 85
4	IXX-20-00-00-00	System Engineering Support	29.63				90	90	40/60	Jan 85
4	IXX-21-00-00-00	Project Mgmt	29.63				90	90	40/60	Jan 85

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COST ESTIMATE DATA FORM A

_____ NON-RECURRING (DDT & E)
__X__ RECURRING (PRODUCTION)
_____ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
3	IXX-00-00-00-00	Lunar Surface Base MSS Derivative								
4	IXX-01-00-00-00	Core Module CM1	$10.90	1	1	90	45	51	50/50	Jan 85
5	IXX-01-01-00-00	Prime Structure	3.58	1						
5	IXX-01-02-00-00	Furnishings and Secondary Structure	.88	1						
5	IXX-01-03-00-00	Atmospheric Mgmt. and Crew Services	3.95	1						
5	IXX-01-04-00-00	Communication and Monitoring	1.07	1						
5	IXX-01-05-00-00	EPS Distribution and Controls	1.42	1						

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Space Division
North American Rockwell

COST ESTIMATE DATA FORM A

X NON-RECURRING (DDT & E)
___ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-02-00-00-00	Laboratory and Backup Control Module CCM1	$27.70	1	1	90	43	49	50/50	Jan 85
5	IXX-02-01-00-00	Prime Structure	3.16	1						
5	IXX-02-02-00-00	Furnishings and Secondary Structure	1.94	1						
5	IXX-02-03-00-00	Atmospheric Mgmt. and Crew Services	2.39	1						
5	IXX-02-04-00-00	EPS Distribution and Controls	.92	1						
5	IXX-02-05-00-00	Backup Command and Control	11.63	1						
5	IXX-02-06-00-00	Geochem Laboratory	.30	1						
5	IXX-02-07-00-00	Photographic Laboratory	.43	1						
5	IXX-02-08-00-00	Data Analysis Laboratory	6.75	1						
5	IXX-02-09-00-00	Bioscience Laboratory	.18	1						

COST ESTIMATE DATA FORM A

___ NON-RECURRING (DDT & E)
X RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-03-00-00-00	Laboratory and Control Module CCM2	$29.81	1	1	90	41	47	50/50	Jan 85
5	IXX-03-01-00-00	Prime Structure	3.29	1						
5	IXX-03-02-00-00	Furnishings and Secondary Structure	2.00	1						
5	IXX-03-03-00-00	Atmospheric Mgmt. and Crew Services	3.46	1						
5	IXX-03-04-00-00	EPS Distribution and Control	.90	1						
5	IXX-03-05-00-00	Command and Control	19.93	1						
5	IXX-03-06-00-00	Medical and Dental	.22	1						
5	IXX-03-07-00-00	Base Maintenance Facility	.01	1						

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COST ESTIMATE DATA FORM A

X NON-RECURRING (DDT & E)
___ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-04-00-00-00	Crew Quarters Module CQM1	$16.04	1	1	90	39	45	50/50	Jan 85
5	IXX-04-01-00-00	Prime Structure	3.13	1						
5	IXX-04-02-00-00	Furnishings and Secondary Structure	1.99	1						
5	IXX-04-03-00-00	Atmospheric Mgmt. and Crew Services	7.03	1						
5	IXX-04-04-00-00	Communication and Monitoring	2.61	1						
5	IXX-04-05-00-00	EPS Distribution and Controls	.91	1						
5	IXX-04-06-00-00	Backup Galley	.37	1						

DATE _____
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COST ESTIMATE DATA FORM A

___ NON-RECURRING (DDT & E)
X RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-05-00-00-00	Galley Module GM1	$15.42	1	1	90	37	43	50/50	Jan 85
5	IXX-05-01-00-00	Prime Structure	3.01	1						
5	IXX-05-02-00-00	Furnishings and Secondary Structure	2.04	1						
5	IXX-05-03-00-00	Atmospheric Mgmt. & Crew Services	6.29							
5	IXX-05-04-00-00	Communication and Monitoring	1.33	1						
5	IXX-05-05-00-00	EPS Distribution and Control	.91	1						
5	IXX-05-06-00-00	Main Galley	1.84	1						

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COST ESTIMATE DATA FORM A

___ NON-RECURRING (DDT & E)
_X_ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-06-00-00-00	Crew Quarters Module CQM3	$25.38	2	1	90	35	41	50/50	Jan 85
5	IXX-06-01-00-00	Prime Structure	4.46	2						
5	IXX-06-02-00-00	Furnishings and Secondary Structure	3.15	2						
5	IXX-06-03-00-00	Atmospheric Mgmt. and Crew Services	12.20	2						
5	IXX-06-04-00-00	Communications and Monitoring	4.07	2						
5	IXX-06-05-00-00	EPS Distribution and Controls	1.50	2						

DATE _____
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COST ESTIMATE DATA FORM A

X NON-RECURRING (DDT & E)
___ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-07-00-00-00	Drive-In Garage Module	$7.90	1	1	90	29	35	50/50	Jan 85
5	IXX-07-01-00-00	Prime Structure	4.46	1						
5	IXX-07-02-00-00	Furnishings and Secondary Structure	.13	1						
5	IXX-07-03-00-00	Atmospheric Mgmt. and Crew Services	1.60	1						
5	IXX-07-04-00-00	Communication and Monitoring	1.36	1						
5	IXX-07-05-00-00	EPS Distribution and Controls	.35	1						

COST ESTIMATE DATA FORM A

___ NON-RECURRING (DDT & E)
_X_ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-08-00-00-00	Drive-In Warehouse Module	$7.97	1	1	90	27	33	50/50	Jan 85
5	IXX-08-01-00-00	Prime Structure	4.42	1						
5	IXX-08-02-00-00	Furnishings and Secondary Structure	.84	1						
5	IXX-08-03-00-00	Atmospheric Mgmt. and Crew Services	1.61	1						
5	IXX-08-04-00-00	Communication and Monitoring	.74	1						
5	IXX-08-05-00-00	EPS Distribution and Controls	.36	1						

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COST ESTIMATE DATA FORM A

___ NON-RECURRING (DDT & E)
_X_ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-09-00-00-00	Mobile Cargo Supply Module	$10.07	16	1	90	15	21	50/50	Jan 85
5	IXX-09-01-00-00	Prime Structure	8.67	16						
5	IXX-09-02-00-00	Furnishing and Secondary Structure	1.40	16						

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COST ESTIMATE DATA FORM A

____ NON-RECURRING (DDT & E)
__X__ RECURRING (PRODUCTION)
____ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-10-00-00-00	Deep Drill Cover Module	$4.67	1	1	90	25	31	50/50	Jan 85
5	IXX-10-01-00-00	Prime Structure	3.90	1						
5	IXX-10-02-00-00	Furnishings and Secondary Structure	.03	1						
5	IXX-10-03-00-00	Atmospheric Mgmt. and Crew Services	.37	1						
5	IXX-10-04-00-00	EPS Distribution and Controls	.37	1						

COST ESTIMATE DATA FORM A

___ NON-RECURRING (DDT & E)
X RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-11-00-00-00	Support Operations Equipment Hardware	$56.3	1	1	90	19	25	50/50	Jan 85
5	IXX-11-01-00-00	Elec. Power Distribution	.30	1						
5	IXX-11-02-00-00	Reliquifaction System	6.44	1						
5	IXX-11-03-00-00	Launch and Landing Facilities Equipment	1.78	1						
5	IXX-11-04-00-00	External Comm. Equipment	47.9	1 set						

COST ESTIMATE DATA FORM A

___ NON-RECURRING (DDT & E)
_X_ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-12-00-00-00	Observatory Shell Modules	6.70	2	1	90	23	29	50/50	Jan 85
5	IXX-12-01-00-00	Prime Structure	5.62	2						
5	IXX-12-02-00-00	Furnishings and Secondary Structure	.03	2						
5	IXX-12-03-00-00	Atmospheric Mgmt. and Crew Services	.52	2						
5	IXX-12-04-00-00	EPS Distribution and Control	.53	2						

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COST ESTIMATE DATA FORM A

___ NON-RECURRING (DDT & E)
_X_ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-13-00-00-00	Mobility Equipment Transportation Module	$15.19	7	1	90	17	23	50/50	Jan 85
5	IXX-13-01-00-00	Prime Structure	14.74	7						
5	IXX-13-02-00-00	Furnishings and Secondary Structure	.45	7						

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COST ESTIMATE DATA FORM A

___ NON-RECURRING (DDT & E)
_X_ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	No. of Units d	Refer. Unit e	Learn Index f	T_d g	T_s h	SPREAD FUNC. i	MILESTONE DATE j
4	IXX-14-00-00-00	Ground Support Equipment	3.116	3 sets	1		36(1)	36	50/50	Jan 85
4	IXX-15-00-00-00	Systems Test Hardware	--							
4	IXX-16-00-00-00	Launch Support Operations	15.474	--	NA		24	24	50/50	Jan 85
4	IXX-17-00-00-00	Mission Operations Support	--	--			--	--	--	--
4	IXX-18-00-00-00	Facilities Support	--							
4	IXX-19-00-00-00	Logistics and Training Equipment	5.86	--	NA		48(2)	48	40/60	Jan 85
4	IXX-20-00-00-00	System Engineering Support	4.99	--	NA		36(3)	36	60/40	Jan 85
4	IXX-21-00-00-00	Project Mgmt.	5.61	--	NA		36(3)	36	60/40	Jan 85

(1) 26 Mos. Lead Time to Design and Build Launch GSE
(2) 24 Mos. Lead Time for Training Equipment
(3) Begins at Start of Operations Hardware Fabrication

8.2 DATA FORM C, TECHNICAL CHARACTERISTICS DATA

This section presents the technical, physical, and mission characteristics of the MSS Derivative Shelter elements which may have a significant effect on the cost of the items.

The technical characteristics are presented by Work Breakdown Structure (WBS) item and include sizing parameters (weight, power, volume), and performance parameters such as location, environment, crew safety, mission duration, etc.

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-00-00-00-00	Lunar Base	3	5 years	Mission duration on lunar surface
			6 inches	Minimum depth of soil cover
			.999 probability	No micrometeoroid penetration
			.99 probability	Radiation protection
			200 RAD	Limit of radiation to skin during one crew cycle
			100 RAD	Limit of radiation to blood forming organs during one crew cycle
			12 men	Crew size (nominal)
			18 men	Maximum overlap (30 days)
1XX-01-00-00-00	Core Module #1 (CM 1)	4	5 years	Mission duration on lunar surface
			6 inches	Minimum depth of soil cover
	Major Subsystem Deletions		(-) 2390 pounds	Delete orientation controls sep and ullage
			(-) 1730 pounds	Delete guidance system
			(-) 8245 pounds	Delete power source
			9906 pounds	Gross dry weight

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-01-01-00-00	Prime Structure	5	10 years	Structural life without replacement or extensive reconditioning of primary structure
			12 feet	Diameter
			41 feet	Overall length
			5019 cubic feet	Overall volume
			Cone knuckle	End bulkheads
			Welded skin stringer	Cylinder walls
			Aluminum alloy	Primary structure
			14.7 psi	Internal pressure design limit
			1	Habitable deck
			(-) 1545 pounds	Delete CMG compartment
			(-) 792 pounds	Delete 4 hatches and structure
			(-) 1116 pounds	Delete meteoroid protection
			(-) 200 pounds	Delete RCS domes
			(-) 1000 pounds	Delete 4 passive docking rings
			(-) 194 pounds	Delete MLI insulation

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-01-01-00-00 (continued)			(+) 315 pounds	Add wall cover - spray-on foam with fiberglass cover
			(+) 175 pounds	Add standard end closure
			(+) 350 pounds	Add floor and ceiling
			5955 pounds	Prime structure weight
1XX-01-02-00-00	Furnishings and Secondary Structure	5	5 years	Structural life without replacement or extensive reconditioning of secondary structure
			Aluminum alloy	Bracketry, mounting and supports
			(-) 793 pounds	Delete mounting supports
			(-) 70 pounds	Delete mobility aids and cargo handling
			1015 pounds	Secondary structure weight
1XX-01-03-00-00	Atmospheric Management and Crew Services	5	4 men	Crew size (intermittent)
			13,000 Btu/man-day	Metabolic load
			5.0 mm Hg	Nominal CO_2 concentration
			65 - 75 F	Temperature

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-01-03-00-00 (continued)			15 - 40 ft/minute	Ventilation rate
			12.24 pounds/day	Atmosphere leakage
			(-) 85 pounds	Delete heat rejection loop (freon)
			Titanium alloy	Tankage structure
			9.0 cubic feet	O_2, N_2, H_2 tanks volume
			(+) 24.5 cubic feet	Added O_2, N_2, H_2 tanks volume for 180-day storage
			2.4 cubic feet	Potable water tank volume
			2.0 cubic feet	Wash water tank volume
			2.0 cubic feet	Waste water tank volume
			1636 pounds	Dry weight
			1750 pounds	Wet weight
1XX-01-04-00-00	Communication and Monitoring	5	3 kHz	Internal communications
			10 channels	Intercomm
			6 MHz	CCTV

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-01-04-00-00 (continued)			5 MHz	RACU (2)
			(-) 87 pounds	Delete S-band transponder
			(-) 55 pounds	Delete local processor
			(-) 24 pounds	Delete preprocessor
			(-) 24 pounds	Delete 8 RACU's
			(-) 3 pounds	Delete 3 semi-directive antennas
			150 watts	Power requirement
			52 pounds	Dry weight
1XX-01-05-00-00	Electrical Power Distribution Subsystem	5	551 watts	Continuous power requirement
			1663 watts	Intermittent power requirement
			2214 watts	Peak power requirement
			(-) 32 pounds	Delete 2 lighting fixtures
			(+) 100 pounds	Emergency batteries 120 kwh
			1248 pounds	Dry weight Power cabling, buses, conversion, switches, breakers, lights, terminal connectors, emergency battery

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-02-00-00-00	Laboratory and Back-up Control Module #1 (CCM 1)	4	5 years	Mission duration on lunar surface
			6 inches	Minimum depth of soil cover
			4 men	Crew size
			(-) 35 pounds	Delete guidance system
			9689 pounds	Gross dry weight
1XX-02-01-00-00	Prime Structure	5	10 years	Structural life without replacement or extensive reconditioning of primary structure
			14 feet	Diameter
			32 feet	Overall length
			4770 cubic feet	Overall volume
			Cone knuckle	End bulkhead
			Welded skin stringer	Cylinder walls
			Aluminum alloy	Primary structure
			14.7 psi	Internal pressure design limit
			1	Habitable deck

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-02-01-00-00 (continued)			(-) 353 pounds	Delete meteoroid protection
			(-) 152 pounds	Delete MLI insulation
			(-) 429 pounds	Delete airlock assembly
			(+) 253 pounds	Add wall cover - spray-on foam with fiberglass cover
			3934 pounds	Prime structure weight
1XX-02-02-00-00	Furnishings and Secondary Structure	5	5 years	Structural life without replacement or extensive reconditioning of structure
			Aluminum alloy	Bracketry, mounting and supports
			Aluminum and stainless steel	Storage cabinets, chairs, desks, tables and bunks
			(-) 140 pounds	Delete mobility aids and cargo handling
			1331 pounds	Secondary structure weight
1XX-02-03-00-00	Atmospheric Management and Crew Serives	4	4 men	Crew size (intermittent)
			13,000 Btu/man-day	Metabolic load

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-02-03-00-00 (continued)			5.0 mm Hg	Nominal CO_2 concentration
			65 - 75 F	Temperature
			15 - 40 ft/minute	Ventilation rate
			12.24 pounds/day	Atmospheric leakage
			(-) 930 pounds	Delete heat rejection loop (freon)
			Titanium alloy	Tankage structure
			12.2 cubic feet	Added O_2, N_2, H_2 tank volume for 180-day storage
			3.0 cubic feet	Potable water tank volume
			2.5 cubic feet	Wash water tank volume
			2.5 cubic feet	Waste water tank volume
			903 pounds	Dry weight
			1041 pounds	Wet weight
1XX-02-04-00-00	Electrical Power Distribution Subsystem	5	1551 watts	Continuous power requirements
			1663 watts	Intermittent power requirements

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-02-04-00-00 (continued)			3214 watts	Peak power requirements
			(-) 325 pounds	Delete lighting fixtures
			(+) 100 pounds	Added emergency battery, 120 kwh
			739 pounds	Dry weight Power cabling, buses, conversion, switches, breakers, lights, terminal connectors, emergency battery
1XX-02-05-00-00	Backup-up Command and Control Less Data Management	5	3 kHz	Internal communications/dist. voice data 120 channels, 10 channels intercomm
			6 MHz	CCTV 10 channels
			5 MHz	Digital data
			9 x 9	CRT
			(-) 50 pounds	Delete 2 approach radars
			(-) 58 pounds	Delete 2 S-band transponders
			(+) 25 watts	Added 2 S-band transmitter/ receivers

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-02-05-00-00 (continued)			(+) 10 watts	Added 2 UHF transmitters/ receivers
			360 watts	Power requirement
			849 pounds	Dry weight 22 units comm. equipment 3 units display and controls
1XX-02-06-00-00	Geo-chemical Laboratory Subsystem	5	5 years	Structural life without replacement or extensive reconditioning of structure. Situated within the laboratory module that provides life support systems.
			224 cubic feet	Gross volume of the laboratory
			705 pounds	Scientific equipment for analysis of lunar material using a variety of techniques such as X-ray fluorescence, gamma ray, infrared, and mass spectrometry differential thermal analysis, nuclear magnetic resonance and neutron activity; see Section 9.0

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-02-07-00-00	Photgraphic Laboratory Subsystem	5	5 years	Structural life without replacement or extensive reconditioning of the primary structure. Situated within the laboratory module which provides life support systems.
			294 cubic feet	Gross volume of photographic laboratory
			417 pounds	Photographic equipment
1XX-02-08-00-00	Data Analysis Laboratory Subsystem	5	5 years	Structural life without replacement or extensive reconditioning of the primary structure. Situated within the laboratory module which provides life support systems.
			434 cubic feet	Gross volume of data analysis laboratory
			15 lines, 50 characters	Discrete alphanumeric light emitting diode
			Monitor alarm	Discrete events lights
			600 lines/minute	Hardware text-hard copy viewer
			1×10^7 equiv. add per second	Data processor computation rate

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-02-08-00-00 (continued)			3 crew stations	
			2000	Measurements
			32,000 32-bit words	Operating memory
			10^8 bit memory	Mass memory
			10^9 bits stored	Archival memory
			1365 watts	Power requirement
			562 pounds	Dry weight 16 units data management and analysis
1XX-02-09-00-00	Bio-science Laboratory	5	5 years	Structural life without replacement or extensive reconditioning of structure
			308 cubic feet	Gross volume of laboratory
			438 pounds	Scientific equipment for analysis life detection, terrestial contamination, behavior rhythm, lunar effects on plants, and ecological experiments. See Section 9.0

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-03-00-00-00	Laboratory and Control Module #2 (CCM 2)	4	5 years	Mission duration on lunar surface
			6 inches	Minimum depth of soil cover
			(-) 35 pounds	Delete guidance system
			9862 pounds	Gross dry weight
1XX-03-01-00-00	Prime Structure	5	10 years	Structural life without replacement of extensive reconditioning of primary structure
			14 feet	Diameter
			32 feet	Overall length
			4770 cubic feet	Overall volume
			Cone knuckle	End bulkhead
			Welded skin stringer	Cylinder walls
			Aluminum alloy	Primary structure
			14.7 psi	Internal pressure design limit
			1	Habitable deck
			(-) 383 pounds	Delete meteoroid protection

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-03-01-00-00 (continued)			(-) 157 pounds	Delete MLI insulation
			(+) 253 pounds	Add wall cover - spray-on foam with fiberglass cover
			3934 pounds	Primary structure weight
1XX-03-02-00-00	Furnishings and Secondary Structure	5	5 years	Structural life without replacement or extensive reconditioning of structure
			Aluminum alloy	Bracketry, mounting and supports
			Aluminum and stainless steel	Storage cabinets, chairs, desks, tables, and bunks
			(-) 70 pounds	Mobility aids and cargo handling
			(-) 35 pounds	Supports and mounting
			1236 pounds	Secondary structure weight
1XX-03-03-00-00	Atmospheric Management and Crew Services	5	4 men	Crew size (intermittent)
			13,000 Btu/man-day	Metabolic load
			5.0 mm Hg	Nominal CO_2 concentration
			65 - 75 F	Temperature

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-03-03-00-00 (continued)			15 - 40 ft/minute	Ventilation rate
			12.24 pounds/day	Atmospheric leakage
			(-) 930 pounds	Delete heat rejection loop (freon)
			Titanium alloy	Tankage
			(+) 24.5 cubic feet	Added O_2, H_2, N_2 tank volume for 180-day storage
			6.3 cubic feet	Potable water tank volume
			5.2 cubic feet	Wash water tank volume
			5.2 cubic feet	Waste water tank volume
			1364 pounds	Dry weight
			1460 pounds	Wet weight
1XX-03-04-00-00	Electrical Power Distribution Subsystem	5	1550 watts	Continuous power requirement
			1663 watts	Intermittent power requirement
			3214 watts	Peak power requirement
			(-) 325 pounds	Deleted lighting fixtures

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-03-04-00-00 (continued)			(+) 100 pounds	Added emergency battery 120 kwh
			739 pounds	Dry weight Power cabling, buses, conversion, switches, breakers, lights, terminal connectors, emergency battery
1XX-03-05-00-00	Command and Control	5	3 kHz	Internal communications/dist. voice data 120 channels, 10 channels intercomm
			6 MHz	CCTV 10 channels
			5 MHz	Digital data
			9 x 9	CRT
			15 lines, 50 characters	Discrete alphanumeric light emitting diode
			Monitor alarm	Discrete events lights
			600 lines/minute	Hardware text-hard copy viewer
			1×10^7 equiv. add per second	Data processor computation rate
			3 crew stations	
			2000	Measurements

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-03-05-00-00 (continued)			32,000 32-bit words	Operating memory
			10^8 bit memory	Mass memory
			10^9 bits stored	Archival memory
				Other storage requirements
			25 watts	S-band transmitter
			10 watts	VHF transmitter
			1 kw	Low frequency transmitter
			(-) 87 pounds	Delete 3 S-band transmitters
			(-) 40 pounds	Delete 1 facsimile unit
			(-) 1 pounds	Delete 1 semi-directive antenna
			213 watts	Power requirement communication
			2366 watts	Power requirement data management
			499 pounds	Dry weight communication equipment (23 units)
			1002 pounds	Dry weight data management equipment (18 units)
			1624 pounds	Dry weight total

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-03-06-00-00	Medical Facility Subsystem	5	5 years	Structural life without replacement or extensive reconditioning of primary structure. Situated within the crew and medical module that provides life support.
			990 cubic feet	Gross volume of the medical lab.
			750 pounds	Total weight medical equipment
				The laboratory is delivered with all major items of medical equipment installed & secured in place.
1XX-03-07-00-00	Base Maintenance Equipment	5	5 years	Equipment life without replacement or extensive reconditioning
			931 pounds	Equipment dry weight* 22 pieces for shelter, mobility, and pressure suit repair
1XX-04-00-00-00	Crew Quarters Module #1 (CQM 2)	4	5 years	Mission duration on lunar surface
			6 inches	Minimum depth of soil cover
			(-) 35 pounds	Delete guidance system
			9914 pounds	Gross dry weight

*Will not be in module initially

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-04-01-00-00	Prime Structure	5	10 years	Structural life without replacement or extensive reconditioning of primary structure
			14 feet	Diameter
			32 feet	Overall length
			4770 cubic feet	Overall volume
			Cone knuckle	End bulkhead
			Welded skin stringer	Cylinder walls
			Aluminum alloy	Primary structure
			14.7 psi	Internal pressure design limit
			1	Habitable deck
			(-) 383 pounds	Delete meteoroid protection
			(-) 157 pounds	Delete MLI insulation
			(+) 253 pounds	Add wall cover - spray-on foam with fiberglass cover
			4212 pounds	Primary structure weight

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-04-02-00-00	Furnishings and Secondary Structure	5	5 years	Structural life without replacement or extensive reconditioning of structure
			Aluminum alloy	Bracketry, mounting and supports
			Aluminum and stainless steel	Storage cabinets, chairs, desks, tables and bunks
			(-) 70 pounds	Delete mobility aids and cargo handling
			(-) 57 pounds	Delete mounts and supports
			1428 pounds	Secondary structure weight
1XX-04-03-00-00	Atmospheric Management and Crew Services	5	13,000 Btu/man-day	Metabolic load
			5.0 mm Hg	Nominal CO_2 concentration
			65 - 75 F	Temperature
			15 - 40 ft/minute	Ventilation rate
			12.24 pounds/day	Atmospheric leakage
			25,000 Btu/hour	Radiator heat rejection
			35 pounds/day	Water recovery

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-04-03-00-00 (continued)			(-) 1350 pounds	Delete heat rejection loop
			(+) 170 pounds	Add external radiator
			Titanium alloy	Tankage structure
			(+) 18.4 cubic feet	Added O_2, H_2, N_2 tank volume for 180-day storage
			12.1 cubic feet	Potable water tank volume
			9.8 cubic feet	Wash water tank volume
			9.8 cubic feet	Waste water tank volume
			3284 pounds	Dry weight
			3511 pounds	Wet weight
1XX-04-04-00-00	Communication and Monitoring	5	3 kHz	Internal communications
			10 channels	Intercomm
			6 MHz	CCTV
			5 MHz	Remote data terminal
			(-) 55 pounds	Delete local processor
			(-) 9 pounds	Delete 3 preprocessors

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-04-04-00-00 (continued)			(-) 6 pounds	Delete 2 RACU's
			160 watts	Power requirement
			150 pounds	Dry weight
1XX-04-05-00-00	Electrical Power Distribution Subsystem	5	3700 watts	Continuous power requirement
			2000 watts	Intermittent power requirement
			5700 watts	Peak power requirement
			(-) 325 pounds	Deleted lighting fixtures
			(+) 100 pounds	Added emergency battery 120 kwh
			740 pounds	Dry weight Power cabling, buses, conversion, switches, breakers, lights, terminal connectors, emergency battery
1XX-05-00-00-00	Galley Module	4	5 years	Mission duration on lunar surface
			6 inches	Minimum depth of soil cover
			4 men	Crew size
			(-) 35 pounds	Delete guidance system
			9728 pounds	Gross dry weight

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-05-01-00-00	Prime Structure	5	10 years	Structural life without replacement or extensive reconditioning of primary structure
			14 feet	Diameter
			32 feet	Overall length
			4770 cubic feet	Overall volume
			Cone knuckle	End bulkhead
			Welded skin structure	Cylinder walls
			Aluminum alloy	Primary structure
			14.7 psi	Internal pressure design limit
			(-) 383 pounds	Delete meteoroid protection
			(-) 157 pounds	Delete MLI insulation
			(-) 490 pounds	Delete airlock assembly
			(+) 253 pounds	Add wall cover - spray-on foam with fiberglass cover
			3937 pounds	Primary structural weight

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-05-02-00-00	Furnishings and Secondary Structure	5	5 years	Structural life without replacement or extensive reconditioning of structure
			Aluminum alloy	Bracketry, mounting and supports
			Aluminum and stainless steel	Storage cabinets, chairs, desks, tables, and bunks
			(-) 70 pounds	Delete mobility aids and cargo handling
			1489 pounds	Secondary structure weight
1XX-05-03-00-00	Atmospheric Management and Crew Services	5	4 men	Crew size
			13,000 Btu/man-day	Metabolic load
			5.0 mm Hg	Nominal CO_2 concentration
			65 - 75 F	Temperature
			15 - 40 ft/minute	Ventilation rate
			12.24 pounds/day	Atmospheric leakage
			35 pounds/day	Water recovery
			(-) 1352 pounds	Delete heat rejection loop (freon)

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-05-03-00-00 (continued)			Titanium alloy	Tankage structure
			(+) 9.9 cubic feet	Added O_2, H_2, N_2 tank volume for 180-day storage
			12.1 cubic feet	Potable water tank volume
			9.4 cubic feet	Wash water tank volume
			10.3 cubic feet	Waste water tank volume
			2837 pounds	Dry weight
			3217 pounds	Wet weight
1XX-05-04-00-00	Communication and Monitoring	5	3 kHz	Internal communications
			10 channels	Intercomm
			6 MHz	CCTV
			5 MHz	Remote data terminal
			(-) 12 pounds	Delete 4 RACU's
			(-) 15 pounds	Delete 5 preprocessors
			(-) 55 pounds	Delete local processor
			100 watts	Power requirement
			68 pounds	Dry weight

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-05-05-00-00	Electrical Power Distribution Subsystem	5	2400 watts	Continuous power requirement
			1500 watts	Intermittent power requirement
			3900 watts	Peak power requirement
			(-) 325 pounds	Deleted lighting fixtures
			(+) 100 pounds	Add emergency battery 120 kwh
			740 pounds	Dry weight Power cabling, buses, conversion, switches, breakers, lights, terminal connectors, emergency battery
1XX-05-06-00-00	Main Galley	5	5 years	Structural life without replacement or extensive reconditioning of the primary structure. Situated within the galley module which provides life support systems.
			8400 pounds	Food frozen and freeze-dried
			662 pounds	Dry weight

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-06-00-00-00	Crew Quarters Module 3 (CQM 3)	4	5 years	Mission duration on lunar surface
			6 inches	Minimum depth of soil cover
	2 required		(-) 35 pounds	Delete guidance system
			9910 pounds	Gross dry weight
1XX-06-01-00-00	Prime Structure	5	10 years	Structural life without replacement or extensive reconditioning of primary structure
			14 feet	Diameter
			32 feet	Overall length
			4770 cubic feet	Overall volume
			Cone knuckle	End bulkhead
			Welded skin stringer	Cylinder walls
			Aluminum alloy	Primary structure
			14.7 psi	Internal pressure design limit
			1	Habitable deck
			(-) 383 pounds	Delete meteoroid protection

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-06-01-00-00 (continued)			(-) 157 pounds	Delete MLI insulation
			(+) 253 pounds	Add wall cover - spray-on foam with fiberglass cover
			4215 pounds	Primary structure weight
1XX-06-02-00-00	Furnishings and Secondary Structure	5	5 years	Structural life without replacement or extensive reconditioning of structure
			Aluminum alloy	Bracketry, mounting and supports
			Aluminum and stainless steel	Storage cabinets, chairs, desks, tables, and bunks
			(-) 70 pounds	Delete mobility aids and cargo handling
			1436 pounds	Secondary structure weight
1XX-06-03-00-00	Atmospheric Management and Crew Services	5	4 men	Nominal crew size
			13,000 Btu/man-day	Metabolic load
			5.0 mm Hg	Nominal CO_2 concentration
			65 - 75 F	Temperature

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-06-03-00-00 (continued)			15 - 40 ft/minute	Ventilation rate
			12.24 pounds/day	Atmospheric leakage
			25,000 Btu/hour	Radiator heat rejection
			35 pounds/day	Water recovery
			(-) 1352 pounds	Delete heat rejection loop (freon)
			(+) 170 pounds	External radiator
			Titanium alloy	Tankage structure
			(+) 20.8 cubic feet	Added O_2, H_2, N_2 tank volume for 180-day storage
			12.1 cubic feet	Potable water tank volume
			9.4 cubic feet	Wash water tank volume
			10.3 cubic feet	Waste water tank volume
			3382 pounds	Dry weight
			3619 pounds	Wet weight

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-06-04-00-00	Communication and Monitoring	5	3 kHz	Internal communications
			10 channels	Intercomm
			6 MHz	CCTV
			5 MHz	Remote data terminal
			(-) 55 pounds	Delete local processor
			(-) 9 pounds	Delete 3 preprocessors
			(-) 6 pounds	Delete 2 RACU's
			130 watts	Power requirements
			140 pounds	Dry weight
1XX-06-05-00-00	Electrical Power Distribution Subsystem	5	4700 watts	Continuous power requirement
			1000 watts	Intermittent power requirement
			5700 watts	Peak power requirement
			(-) 360 pounds	Deleted lighting fixtures
			(+) 100 pounds	Added emergency battery 120 kwy
			740 pounds	Dry weight Power cabling, buses, conversion, switches, breakers, lights, terminal connectors, emergency battery

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-07-00-00-00	Drive-in Garage Module	4	5 years	Mission duration on lunar surface
			6 inches	Minimum depth of soil cover
			6942 pounds	Gross dry weight
1XX-07-01-00-00	Prime Structure	5	10 years	Structural life without replacement or extensive reconditioning of primary structure
			15 feet	Diameter
			40 feet	Overall length
			6556 cubic feet	Overall volume
			Ellipsoidal	End bulkheads
			Welded skin stringers	Cylinder walls
			Aluminum alloy	Primary structure
			Spray-on foam with fiberglass cover	Wall cover
			2036 square feet	Internal skin area
			10 psi	Internal pressure design limit
			1.0 inch	Average wall thickness

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-07-01-00-00 (continued)			3 x 5 feet	Ellipsoidal air tight doors (4)
			15 feet	Diameter garage door
			24 feet	Internal tracks with jacks
			20 feet	Hinged external tracks
			300 cubic feet	Airlock (small)
			6015 pounds	Primary structure weight
1XX-07-02-00-00	Furnishings and Secondary Structure	5	5 years	Structural life without replacement or extensive reconditioning of structure
			Aluminum alloy	Bracketry, mounting and supports
			68 pounds	Secondary structure weight
1XX-07-03-00-00	Atmospheric Management and Crew Services	5	4 men	Intermittent
			5.0 mm Hg	Nominal CO_2 concentration
			65 - 75 F	Temperature
			15 - 40 ft/minute	Ventilation rate
			585 watts	Nominal thermal control

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-07-03-00-00 (continued)			1.02 cubic feet	Emergency oxygem system volume
			300 cubic feet	Airlock volume
			30 minutes	Time to evacuate to one pound remaining
			Titanium alloy	Tankage structure
			558 pounds	Dry weight
1XX-07-04-00-00	Communication and Monitoring	5	3 kHz	Internal communications
			10 channels	Intercomm
			6 MHz	CCTV
			9 inches	T.V. monitor
			5 MHz	Remote data terminal
			71 watts	Power requirement
			67 pounds	Dry weight
1XX-07-05-00-00	Electrical Power Distribution Subsystem	5	300 watts	Continuous power requirement
			2300 watts	Intermittent power requirement

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-07-05-00-00 (continued)			2608 watts	Peak power requirement
			235 pounds	Dry weight Power cabling, buses, conversion, switches, breakers, lights, terminal connectors, emergency battery
1XX-08-00-00-00	Drive-in Warehouse Module	4	5 years	Mission duration on lunar surface
			6 inches	Minimum depth of soil cover
			7332 pounds	Gross dry weight
1XX-08-01-00-00	Prime Structure	5	10 years	Structural life without replacement or extensive reconditioning of primary structure
			15 feet	Diameter
			40 feet	Overall length
			6556 cubic feet	Overall volume
			Ellipsoidal	End bulkhead
			Welded skin stringer	Cylinder walls
			2.0	Manned operation

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-08-01-00-00 (continued)			Aluminum alloy	Primary structure
			Spray-on foam with fiberglass cover	Wall cover
			2036 square feet	Internal skin area
			10 psi	Internal pressure design limit
			1.0 inch	Average wall thickness
			3 x 5 feet	Ellipsoidal air tight doors (4)
			15 feet	Diameter garage door
			20 feet	Hinged internal track
			500 cubic feet	Airlock (large)
			5965 pounds	Primary structure weight
1XX-08-02-00-00	Furnishings and Secondary Structure	5	5 years	Structural life without replacement or extensive reconditioning of structure
			Aluminum alloy	Bracketry, mounting and supports
			Aluminum and stainless steel	Storage cabinets, chairs and desks
			541 pounds	Secondary structure weight

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-08-03-00-00	Atmospheric Management and Crew Services	5	5.0 mm Hg	Nominal CO_2 concentration
			65 - 75 F	Temperature
			15 - 40 ft/minute	Ventilation rate
			585 watts	Nominal thermal control
			1.02 cubic feet	Emergency oxygen system volume
			500 cubic feet	Airlock volume
			60 minutes	Time to evacuate to one pound remaining
			Titanium alloy	Tankage structure
			558 pounds	Dry weight
1XX-08-04-00-00	Communication and Monitoring	5	3 kHz	Internal communications
			10 channels	Intercomm
			6 MHz	CCTV
			9 inches	T.V. monitor
			5 MHz	Remote data station
			69 watts	Power requirement
			33 pounds	Dry weight

PROGRAM - TECHNICAL CHARACTERISTICS, DATA FORM C

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	UNITS OF MEASURE	CHARACTERISTICS
1XX-08-05-00-00	Electrical Power Distribution Subsystem	5	308 watts	Continuous power requirement
			2058 watts	Intermittent power requirement
			2366 watts	Peak power requirement
			235 pounds	Dry weight Power cabling, buses, conversion, switches, breakers, lights, terminal connectors, emergency battery

The Technical Data Sheets for:

Mobile Cargo Supply Module,	1XX-09-00-00-00
Deep Drill Cover Module,	1XX-10-00-00-00
Support Equipment Operation Hardware,	1XX-11-00-00-00
Observatory Shell Modules,	1XX-12-00-00-00
Mobility Equipment Transportation Modules,	1XX-13-00-00-00

are identically the same as the baseline data and are not repeated for the space station derivative.

8.3 FUNDING SCHEDULE FOR THE MSS DERIVATIVE SHELTER

Funding schedules have been developed in a matter analogous to that for the baseline configuration, adhering to the program development schedule presented in Section 4.0.

COST ESTIMATE DATA FORM D

DATE _____
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X NON-RECURRING (DDT&E)
___ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	GFY '78	GFY '79	GFY '80	GFY '81	GFY '82	GFY '83	GFY '84	GFY'85
3	IXX-00-00-00-00	Lunar Surface Base Project MSS Derivative	$591.8	7.2	56.1	157.1	185.9	128.9	45.3	10.2	1.1
4	IXX-01-00-00-00	Core Module CM2	18.16	.46	2.39	4.41	5.17	4.15	1.58		
4	IXX-02-00-00-00	Laboratory and Backup Control Module CCM2	23.17	.59	3.05	5.64	6.58	5.29	2.02		
4	IXX-03-00-00-00	Laboratory and Control Module CCM2	35.78	.90	4.72	8.68	10.19	8.17	3.12		
4	IXX-04-00-00-00	Crew Quarters Module CQM1	36.48	.92	4.81	8.85	10.39	8.33	3.18		
4	IXX-05-00-00-00	Galley Module GM2	13.62	.34	1.80	3.30	3.88	3.11	1.19		
4	IXX-06-00-00-00	Crew Quarters Module CQM3	5.55	.14	.73	1.35	1.58	1.26	.49		
4	IXX-07-00-00-00	Drive In Garage Module	25.82	.65	3.41	6.27	7.35	5.89	2.25		
4	IXX-08-00-00-00	Drive In Warehouse Module	5.95	.15	.79	1.45	1.69	1.36	.51		

COST ESTIMATE DATA FORM D

DATE _____
PAGE 2 OF 2

X NON-RECURRING (DDT&E)
___ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	GFY '78	GFY '79	GFY '80	GFY '81	GFY '82	GFY '83	GFY '84	GFY'85
4	IXX-09-00-00-00	Mobile Cargo Supply Module	5.76	.15	.76	1.40	1.64	1.31	.50		
4	IXX-10-00-00-00	Deep Drill Cover Module	11.28	.28	1.49	2.74	3.21	2.57	.99		
4	IXX-11-00-00-00	Support Opns.Hdwre.	98.38	2.48	12.99	23.88	28.00	22.48	8.55		
4	IXX-12-00-00-00	Observatory Shell Modules	.80	.02	.11	.19	.23	.18	.07		
4	IXX-13-00-00-00	Mobility Equip. Trans. Modules	.70	.02	.09	.17	.20	.16	.06		
4	IXX-14-00-00-00	Ground Supp.Equip.	38.61	--	5.80	13.70	13.00	5.80	.31		
4	IXX-15-00-00-00	System Test Hdwre.	162.27	--	7.84	56.46	65.75	31.97	.25		
4	IXX-16-00-00-00	Launch Opns. Support	--	--	--	--	--	--	--		
4	IXX-17-00-00-00	Mission Opns.Support	--	--	--	--	--	--	--		
4	IXX-18-00-00-00	Facilities Opns. Support	38.60	--	.86	6.39	10.38	10.61	7.43	2.78	.15
4	IXX-19-00-00-00	Logistics & Trng. Equipment	11.58	--	1.69	4.10	4.00	1.69	.10		
4	IXX-20-00-00-00	Sys. Engr'g. Supp.	29.63	.06	1.42	4.03	6.34	7.27	6.34	3.69	.48
4	IXX-21-00-00-00	Project Mgmt.	29.63	.06	1.42	4.03	6.34	7.27	6.34	3.69	.48

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___ NON-RECURRING (DDT&E)
_X_ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	GFY '78	GFY '79	GFY '80	GFY '81	GFY '82	GFY '83	GFY '84	GFY'85
3	IXX-00-00-00-00	Lunar Surface Base Project MSS Derivative	269.1				2.1	48.6	122.3	95.3	.8
4	IXX-01-00-00-00	Core Module CM1	10.90				.26	3.76	5.31	1.57	
4	IXX-02-00-00-00	Laboratory and Backup Mod. CCM1	27.70				.65	9.54	13.50	4.01	
4	IXX-03-00-00-00	Laboratory and Control Mo. CCM2	29.81				.70	10.27	14.52	4.32	
4	IXX-04-00-00-00	Crew Quarters Module CQM1	16.04				.38	5.53	7.82	2.31	
4	IXX-05-00-00-00	Galley Module GM1	15.42				.06	4.43	8.25	2.68	
4	IXX-06-00-00-00	Crew Quarters Module CQM3	25.38					5.33	14.72	5.33	
4	IXX-07-00-00-00	Drive-In Garage Module	7.90					.84	4.89	2.17	
4	IXX-08-00-00-00	Drive-In Warehouse Module	7.97					.83	4.95	2.19	
4	IXX-09-00-00-00	Module Cargo Supply Module	10.07						2.12	7.95	
4	IXX-10-00-00-00	Deep Drill Cover Module	4.67					.06	2.76	1.85	

COST ESTIMATE DATA FORM D

DATE _____
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___ NON-RECURRING (DDT&E)
_X_ RECURRING (PRODUCTION)
___ RECURRING (OPERATIONS)

WBS Level	WBS IDENT. NUMBER a	WBS ITEM NAME b	WBS ITEM COST c	GFY '78	GFY '79	GFY '80	GFY '81	GFY '82	GFY '83	GFY '84	GFY'85
4	IXX-11-00-00-00	Support Opns. Hdwre.	56.30					6.27	15.52	34.51	
4	IXX-12-00-00-00	Observatory Shell Modules	6.70						3.35	3.35	
4	IXX-13-00-00-00	Mobility Equipment Trans. Modules	15.19						5.59	9.60	
4	IXX-14-00-00-00	Ground Support Equipment	3.12					.24	2.23	.65	
4	IXX-15-00-00-00	System Test Hdwre.	--								
4	IXX-16-00-00-00	Launch Opns.Support	15.47					1.18	11.04	3.25	
4	IXX-17-00-00-00	Mission Opns. Support	--								
4	IXX-18-00-00-00	Facilities Opns. Support	--								
4	IXX-19-00-00-00	Logistics & Train'g Equipment	5.86					.32	3.74	1.80	
4	IXX-20-00-00-00	System Eng.Support	4.99						.94	3.67	.38
4	IXX-21-00-00-00	Project Mgmt.	5.61						1.06	4.12	.43

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9.0 SCIENTIFIC, MOBILITY AND POWER SUPPLY

9.1 COSTING METHODOLOGY

Cost estimating for the scientific and mobility equipment was handled more directly than the shelter concepts. Since this equipment was not subjected to the same level of conceptual design effort, the basic approach followed was to depend strongly on cost data derived in previous studies of candidate concepts. Further, as detailed in Volume III, it was found that the optimum approach for the electrical power source for the lunar surface activities involved a mobile, modular unit which could be utilized both at the main shelter and at the various remote and mobile locations. Accordingly, these mobile power units have been included in this section of the report as a separate, Level 3, project. The costs are described in this section for each of the following areas:

1. Scientific Equipment - The candidate experiment and scientific equipment to accomplish the lunar base observations were identified under Task 1.2. These experiments are set forth in Volume II by discipline, experiment number, experiment title, candidate experiment number, and equipment description. Each of the candidate experiments is also described by weight, volume, and average power.

2. Mobility Equipment - The mobility equipment is described in Volume III and includes a 2-man prime mover, powered trailers with the same frame and drive as the prime mover, and ancillary equipment such as skiploader/backhoe/power shovel and a crane. Other mobility equipment includes a portable shelter for 4 men for 90 days, which may be either a rigid and expandable version, and a one-man flying vehicle.

3. Power Systems - The power systems were comprised of either a 3.5 kwe organic Rankine or Brayton cycle power plant and fuel capsule subsystems for either Plutonium 238 (Pu 238) and Polonium 210 (Po 210) isotopes. Further definition is contained in Volume III.

Applicable reference data were examined to establish the relevant hardware and to extract cost data. The reference source is identified in the cost data which follows.

After determining the applicability of the proposed equipment within the referenced documents, it was necessary to correlate and update and analyze the costs. Particular consideration was given to probable prior development of certain items and subsequent application to the lunar base. In the scientific equipment area, some experiment equipment is similar to that used

on the Earth Orbit Space Station. However, the specifications for the particular equipment used for the Lunar Surface Base varies sufficiently in the packaging, transportation, and lunar surface environment to preclude a major benefit from prior development.

In addition to research of prior studies, it was necessary within the electrical power area to obtain estimates on nuclear power systems from Garrett Corporation, Sundstrand Corporation, and Aerojet General Corporation. The estimate for the expandable shelter structure was obtained from International Latex Corporation.

In all cost estimates, the following ground rules and assumptions were followed:

1. All costs are in 1970 dollars.

2. Cost from previous studies were updated to 1970, principally by adjustment of labor costs.

3. Eighty percent of the scientific equipment will be used outside the shelter.

4. Training costs are not included.

5. Spares costs are not included.

6. Isotope costs are not included.

7. Fee has not been included.

8. All costs presented herein are preliminary cost estimates and are not meant for other than comparative purposes for the Lunar Base Synthesis. They are subject to change as the systems are more fully defined.

9.2 COST ESTIMATES SUMMARY

The summary cost for the scientific equipment, the mobility equipment and the power systems are shown in Tables 9.2-1, 9.2-2, and 9.2-3.

Table 9.2-1. Scientific Equipment Summary Cost Estimates

	Nonrecurring (Millions)	Recurring (Millions)
Astronomy	$630.0	$ 60.6
Geochemistry	81.9	12.9
Biomedical	16.1	4.7
Geodesy and Physics	10.2	2.3
Lunar Atmosphere	7.1	2.1
Engineering Technology	4.3	.8
Total	$749.6	$ 83.4

Table 9.2-2. Mobility Equipment Cost Estimates

	Nonrecurring (Millions)	First Unit Recurring (Millions)	Number Required	Total Recurring (Millions)
Prime Mover	$ 221.4	18.6	4	$ 71.7
Powered Trailers	-	4.6	10	41.7
Appendages				
Skiploader/Backhoe	5.2	.9	1	.9
Crane	2.2	.4	1	.4
Portable Shelter				
Rigid	215.6	24.4	2	52.8
Expandable (Reference)	(178.6)	(21.4)	2	(44.8)
Lunar Flying Vehicle	29.8	1.9	2	3.8
Totals	$ 474.2			$ 171.3
Program Total = $645.5				

Table 9.2-3. LSB Power System Cost Estimates - Modular 3.5 kwe Nuclear

	Nonrecurring (Millions)	First Unit Recurring (Millions)	Number Required	Total Recurring (Millions)
Organic Rankine	$ 54.7	8.9	6	$ 52.1
Brayton Cycle (Reference)	(62.6)	(10.3)	(6)	(60.4)
Fuel Subsystem (w/o Isotope)				
Po 210	42.0	2.0	54	42.4
Pu 238 (Reference)	(44.8)	(2.4)	(6)	(9.5)
Totals	$ 96.7			$ 94.5
Program Total = $191.2				

9.3 SCIENTIFIC EQUIPMENT COST DATA

The complete list of scientific equipment is set forth in Tables 9.3-1, 9.3-2, 9.3-3, 9.3-4, 9.3-5, and 9.3-6 by discipline. The experiment number, experiment title, equipment description, equipment number, and the nonrecurring and recurring costs for each piece of equipment are indicated. In addition, the reference document or source from which the basic data were obtained is indicated by numerical reference to the following list.

1. Scientific Mission Support for Extended Lunar Exploration (ELE), NAS8-20258, SD 66-957
2. Mission Modes and System Analysis (MIMOSA), NAS8-20262, LMSC AB47943
3. Space Probes and Planetary Exploration, William Corlis
4. Research Program on Radio Astronomy and Plasma for AAP Lunar Surface Missions, NAS8-20190, SID 66-381
5. Candidate Experiments Program for Manned Space Station (Blue Book) NHB 7150, NASA
6. Leach Corporation (2000 Series)
7. Optical Instrument Corporation
8. Beckman Instrument Corporation
9. General Electric Corporation
10. Hercules Powder Company

Within the scientific experiments, there are ten pieces of equipment with nonrecurring costs over $5 million and considered to be major cost drivers. Seven of these items are in astronomy, two in geochemistry, and one in bioscience. The wide disparity between these elements is illustrated in Figure 9.3-1 which shows that the 100-inch telescope (36 percent), the 50-inch telescope (18 percent) and the X-ray telescope (17 percent) comprise 71 percent of the total scientific equipment cost and that the ten major cost items comprise almost 86 percent of the total.

Because of the impact of the major cost drivers, Table 9.3-7 sets forth the item, its nonrecurring cost, number of test items, recurring cost, the number of units, the development and production time by month, the spread function, reference document or source, and the total cost for each of the major xcientific cost drivers.

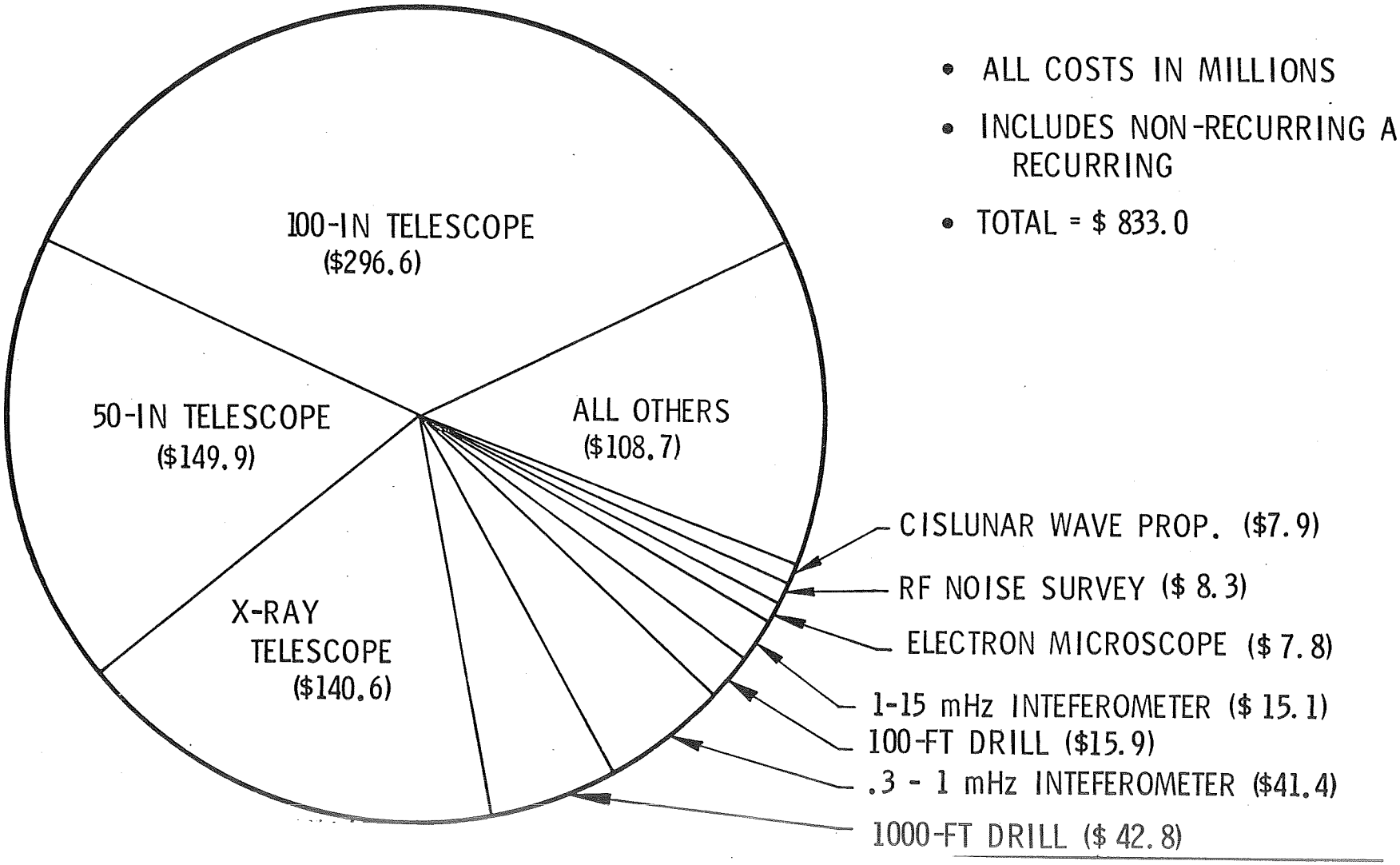


Figure 9.3-1. Distribution of Major Scientific Equipment Costs

Table 9.3-1. LSB Experiment List - Astronomy

Experiment I.D.	Experiment Title	Equipment Description	Equipments I.D.	Nonrecurring Cost $\overline{M}$	Recurring Cost $\overline{M}$	Ref. Doc.
4024	Lunar plasma effect	Plasma probe assembly	15018	.012	.011	1
		Electrometer assembly	15020	.240	.036	1
4025	Antenna dust accumulation	Antenna	11064	.600	.100	1
		Electrometer assembly	10520	-	-	1
4026	Cislunar wave propagation	Transponder 3 freq. with antennas	30008	5.500	1.400	1
4027	Strong discrete sources exhibiting	Antenna set	11108	1.677	.150	1
		Interferometer	30011	.241	.062	4
4028	Observations for correlation with E.O.	Yagi antennas system	11109	.600	.150	4
		Sweep freq. radiometer	11110	1.211	.072	1
4029	IR Astronomy	Telescope, 50-inch	11095a	137.700	12.200	2
4029	IR Astronomy	Interferometer	11095b	.530	.031	5
4029	IR Astronomy	D.C. radiometer	11095c	.160	.009	5
4029	IR Astronomy	IR detector array	11095d	.213	.012	5
4016	Optical measurements	Telescope, 50-inch	11095a	-	-	
4016	IR Astronomy	Field image videograph	11095e	1.200	.197	5
4016	IR Astronomy	225mm plate camera	11095f	3.500	.292	5
4016	IR Astronomy	70mm plate camera	11095g	1.300	.110	5
4016	IR Astronomy	Concave grating spectrograph	11095h	1.500	.122	5
4017	Optical effects from environment	Convex mirror, 12-inch	90004	.360	.073	1
		Flat mirror, 12-inch	90005	.240	.060	1
		Concave mirror, 12-inch	90006	.360	.073	1
4030	Nonsolar optical	Telescope, 100-inch	11096a	275.400	21.200	2
4030	Nonsolar optical	Field image videograph	11096b	-	.195	5
4030	Nonsolar optical	225mm plate camera	11096c	-	.295	5
4030	Nonsolar optical	70mm plate camera	11096d	-	.110	5
4030	Nonsolar optical	Concave grating spectrograph	10096e	-	.122	5
4012	X-ray sources	X-ray telescope, G.I.	11092a	129.200	11.400	2
4012	X-ray sources	X-ray polarimeter	11092b	2.300	.500	5
4012	X-ray sources	Curved crystal X-ray spectrometer	11092c	2.000	.470	5
4012	X-ray sources	Max. sensitivity X-ray detector	11092d	1.900	.350	5
4014	300-1000 kHz flux densities	300-1000 kHz 2-element interferometer radio telescope	11093a	36.500	4.900	2
4014	300-1000 kHz flux densities	Broad band receiver, 300-1000 kHz	11093b	1.400	.415	4
4014	300-1000 kHz flux densities	Calibration source	11093c	.600	.195	4
4014	300-1000 kHz flux densities	Dual radiometer and analyzer	11093d	1.300	.325	4
4014	300-1000 kHz flux densities	Meter and recorder	11093e	.100	.075	4
4015	1000 kHz - 15 mHz flux densities	1000 kHz - 15 mHz 2-element interferometer radio telescope	11094a	12.500	2.700	2
4015	1000 kHz - 15 mHz flux densities	Broadband receiver 1000 kHz - 15 mHz	11094b	.900	.375	4
4015	1000 kHz - 15 mHz flux densities	Calibration source	11094c	.100	.195	4
4015	1000 kHz - 15 mHz flux densities	Dual radiometer and analyzer	11094d	.700	.325	4
4015	1000 kHz - 15 mHz flux densities	Meter and recorder	11094c	.050	.075	4
4021	Noise survey	RF noise survey system	15013	6.550	.450	1
4022	Radio propagation	Transmitter antennas	15014	.365	.070	1
		Field strength meter	15019	.121	.024	1

Table 9.3-1. LSB Experiment List - Astronomy (Cont'd)

Experiment I.D.	Experiment Title	Equipment Description	Equipments I.D.	Nonrecurring Cost $\overline{M}$	Recurring Cost $\overline{M}$	Ref. Doc.
4023	Impedance measure-mets of antennas	Dipole antenna (2 km)	15015	.600	.540	4
		Dipole antenna (20 m)	15016	.160	.114	4
		Whip antenna (10 m)	15017	.120	.015	4
		Tape recorder	30005	.010	.030	6
		Vector impedance meter	11091	.001	.001	4
TOTAL				630.021	60.625	

Table 9.3-2. LSB Experiment List - Geology and Geochemistry

Experiment I.D.	Experiment Title	Equipment Description	Equipment I.D.	Nonrecurring Cost $\overline{M}$	Recurring Cost $\overline{M}$	Ref. Doc.
4032	Geological mapping and analysis	IR radiometer (port.)	11111	1.500	.131	1
		Mapping kit	90018	.060	.050	1
		Geological tool kit	90019	.050	.048	1
		UV light portable	90020	.035	.010	7
		Auger spectrometer	14025	2.500	.231	1
4033	Subsurface drill and sampling	Drill, 100-foot	50009	13.700	2.200	2
		Geological tool kit	90019	-	.048	1
		Auger spectrometer	14025	-	.231	1
		Port. mass spectr.	14027	2.400	.486	1
		Portable gas chrom.	14028	1.100	.112	1
4037	Petrographic analysis rock in lab	Petrographic microscope	90008	1.607	.160	1
4037	Petrographic analysis rock in lab	Sample prep. device	50006	.010	.010	2
4038	Mineralogical identification and chemical analysis	Neutron activ. anal.	11086	4.500	.972	1
		Auger spectrometer	14025	-	.231	1
		Mass spectrometer	14026	1.160	.120	1
4039	Investigation of sites of trans. activity	Mass spectrometer	14005	1.100	.225	1
		Ionization pressure sensor	12001	.030	.013	8
		Seismometer (4 comp Lamont)	11088	1.300	.162	1
4048	Deep drilling and sampling	Drill, 1000-foot	50008	38.000	4.800	2
4057	In situ measurement of natural radiation	Gamma ray spectrom.	11005	1.200	.220	1
4059	Subsurface logging	Downhole geophy. probe	11079	1.610	1.200	1
4060	Mineralogical analysis in lab	X-ray diffractometer	11096	1.200	.150	1
		Petrographic microscope	90008	-	-	1
		Sample prep. device	50006	-	-	2
4061	Instrumental chem. analysis in lab	X-ray diffractometer	11096	-	-	1
		Neutron act. anal.	11086	-	-	1
		Gas chromatograph	14018	1.175	.115	1
		Mass spect. (lab)	14026	-	.120	1
		X-ray spectrometer	11114	2.500	.500	1
		IR spectrometer	11115	2.400	.450	1
		UV spectrometer	11113	2.800	.265	1
TOTAL				81.937	12.860	

Table 9.3-3. LSB Experiment List - Biomedical

Experiment I.D.	Experiment Title	Equipment Description	Equipment I.D.	Nonrecurring Cost M	Recurring Cost M	Ref. Doc.
4001	Life detection	J-band spectrophoto.	11103	2.400	.250	1
		Electron microscope	11104	5.300	2.500	9
		Mass spectr. (lab)	14026	-	.120	1
		Gas chromatograph	14018	-	.115	1
		Photo micrographic camera	11083	1.160	.260	1
		Multivator	14017	1.000	.150	3
		Field bioscience kit	90014	.060	.011	1
		Incubator	90015	.148	.016	1
4003	Terrestrial contam.	Gas chromatograph	14018	-	.115	1
		Mass spectr. (lab)	14026	-	-	1
		Organic carbon analyz.	14022	4.077	.401	1
4006	Behavior/rhythm	Time lapse camera	90016	.112	.022	1
		Microscope	90017	1.200	.103	1
4064	Biological monitor	Biomon. & ecol. exp.	90012	.240	.060	1
4066	Lunar effect on plants	Plant life exp. equip.	90022	.400	.500	1
TOTAL				16.097	4.723	

Table 9.3-4. LSB Experiment List - Geodesy and Geophysics

4044	Geodetic grid constr.	Absolute gravimeter	11112	1.200	.112	1
		Photographic astro transit	11082	2.150	.100	1
		Gravimeter (Coste Romberg)	11081	2.430	.120	1
4045	Gravity profiling	Absolute gravimeter	11112	-	-	1
4046	Seismic activity	Time base generator	40005	.160	.020	1
		Seismic ampl.	11087	.163	.025	1
		Seismic energy source	50010	.001	.001	10
		Geophones	50012	.024	.004	1
4047	Seismicity, passive	Seismometer (4 Comp Lamont)	11088	-	.162	1
4051	Magnetic field temporal variations	Search coil magnetometer	15011	.350	.050	1
		Fluxgate magnetometer	15008	.175	.121	1
		Helium magnetometer	15010	1.000	.124	1
		Electric field detector	15012	.990	.600	1
4058	Magnetic profiling	Fluxgate traverse magnetometer	15021	.350	.132	1
		Magnetometer proton precision	15022	.900	.600	1
4088	Near surfact temp. grad.	Heat flow probe	11116	.120	.002	1
		Electronics	40009	.200	.130	1
TOTAL				10.213	2.303	

Table 9.3-5. LSB Experiment List - Particles and Fields, and Lunar Atmosphere

Experiment I.D.	Experiment Title	Equipment Description	Equipment I.D.	Nonrecurring Cost M	Recurring Cost M	Ref. Doc.
4050	Solar wind and energy	Particle counter (low energy)	14001	.600	.120	1
	Particle measurement	Particle counter (high energy)	14002	.365	.130	1
		Particle spectrometer	14020	.685	.150	1
		Cosmic ray spectr. telescope	11098	1.210	.240	1
4053	Total pressure	Ionization press. sen.	12001	-	.013	8
		Mass spectrometer	14005	-	.225	1
		Mass spect. (quad)	14019	2.100	.600	1
4055	Escape and transport rates	Mass spectrometer (directional)	14020	1.500	.480	1
		Suprathermal ion det.	14030	.610	.130	8
TOTAL				7.070	2.088	

Table 9.3-6 LSB Experiment List - Engineering Technology and Operations

4071	Thin film bearings	Thin film bearing eq.	90023	.620	.140	1
4074	Mining and transport					
4078	Lunar strata EM prop.	Lunar strata EM prop. equip.	90024	1.100	.230	1
4079	Lunar surf. trans.	Lunar surf. trans. line ext.	90025	.121	.060	1
4081	Heat trans. liquids	Liquid heat transfer equipment	90026	.250	.060	1
4082	Heat trans. film	Film and drop heat trans. equip.	90027	.250	.060	1
4084	Metal joining	Metal joining equip.	90028	.364	.097	1
4085	Diff. thermal anal.	Diff. thermal anal. equipment	90029	.730	.045	1
4086	Character of lunar ores	Character of lunar ores equipment	90030	.210	.021	1
4087	Lunar dry cement and concrete	Lunar dry cement and concrete	90031	.610	.121	1
TOTAL				4.255	.834	

Table 9.3-7. Scientific Equipment Major Cost Drivers

Item (I.D. Number)	Nonrecurring Cost M	No. Test Items	Recurring Cost M	No. Units	T_D	Spread Function	Ref. Doc.*	Total Cost M
X-ray grazing incidence telescope (11092)	129.2	5	11.4	1	54 30	4 3	2	140.6
0.3 - 1 mHz radio telescope (11093)	36.5	4	4.9	1	30 18	4 3	2	41.4
1 - 15 mHz radio telescope (11094)	12.4	4	2.7	1	24 15	4 3	2	15.1
50-inch telescope (11095)	137.7	5	12.2	1	54 30	4 3	2	149.9
100-inch telescope (11096)	275.4	6	21.2	1	72 42	4 3	2	296.6
Electron microscope (11104)	5.3	3	2.5	1	27 18	4 3	9	7.8
Transponder, 3 freq. with antennas (30008)	5.5	4	1.4	1	18 24	4 3	2	7.9
RF noise survey system (15013)	6.5	4	1.8	1	18 24	4 3	2	8.3
100-foot drill (5009)	13.7	4	2.2	1	36 18	4 3	2	15.9
1000-foot drill (5008)	38.0	5	4.8	1	42	4 3	2	42.8
							*Ref. para. 9.3	

9.4 MOBILITY EQUIPMENT COST DATA

The elements of the surface mobility system are shown in Figure 9.4-1. The mobility system includes the prime movers, powered trailers, appendages, portable shelters (rigid or expandable), and lunar flying vehicles. It should be noted that all equipment except the lunar flyer is ultimately power dependent on the power supply modules. Limited individual battery power is included in each unit for some autonomous operation and for emergency.

The mobility equipment data were derived from previous studies except when specific contractors were consulted. Prior development was considered in the prime mover and the portable shelters. In the prime mover, consideration was given to the Lunar Rover developed for the Apollo mission. For the portable shelter, consideration was given to the prior development of the ECLSS equipment utilized in the Earth Orbit Space Station and lunar base shelters which was applicable in the portable shelter.

The sources utilized for the mobility equipment included the following:

1. Lunar Surface Mobility Systems Comparison and Evaluation Study (MOBEV), NAS8-20334, BSR 1441 and 1448

2. Study of One Man Lunar Flying Vehicle, NAS9-9045, SD 69-419

3. Mission Modes and System Analysis (MIMOSA), NAS8-20262, LMSC AB47943

4. International Latex Corporation

The mobility equipment is tabulated in Table 9.4-1, indicating the item, the nonrecurring cost, the number of test items, recurring cost, the number of units, the development and production time in months, the spread function, reference document, and total cost for each mobility equipment item.

9.5 POWER SUPPLY EQUIPMENT COST DATA

The elements of the power supply equipment are shown in Figure 9.5-1. This includes the powered trailers (dotted for reference) since the power supply equipment will be mounted on the trailers for greater flexibility on the lunar surface. It should be noted that the 3.5 kwe organic Rankine cycle power system is preferred with the Brayton cycle shown only for an alternate. Preference was given to the Polonium 210 thermal isotope based on availability; however, Plutonium 238 would be a better choice and would reduce the resupply requirements.

The power supply systems are tabulated in Table 9.5-1. This table indicates the item, nonrecurring cost, number of test items, recurring cost, the number of units, the development and production time in months, the spread function, reference document, and the total cost for each power system. The reference document column refers to the following list.

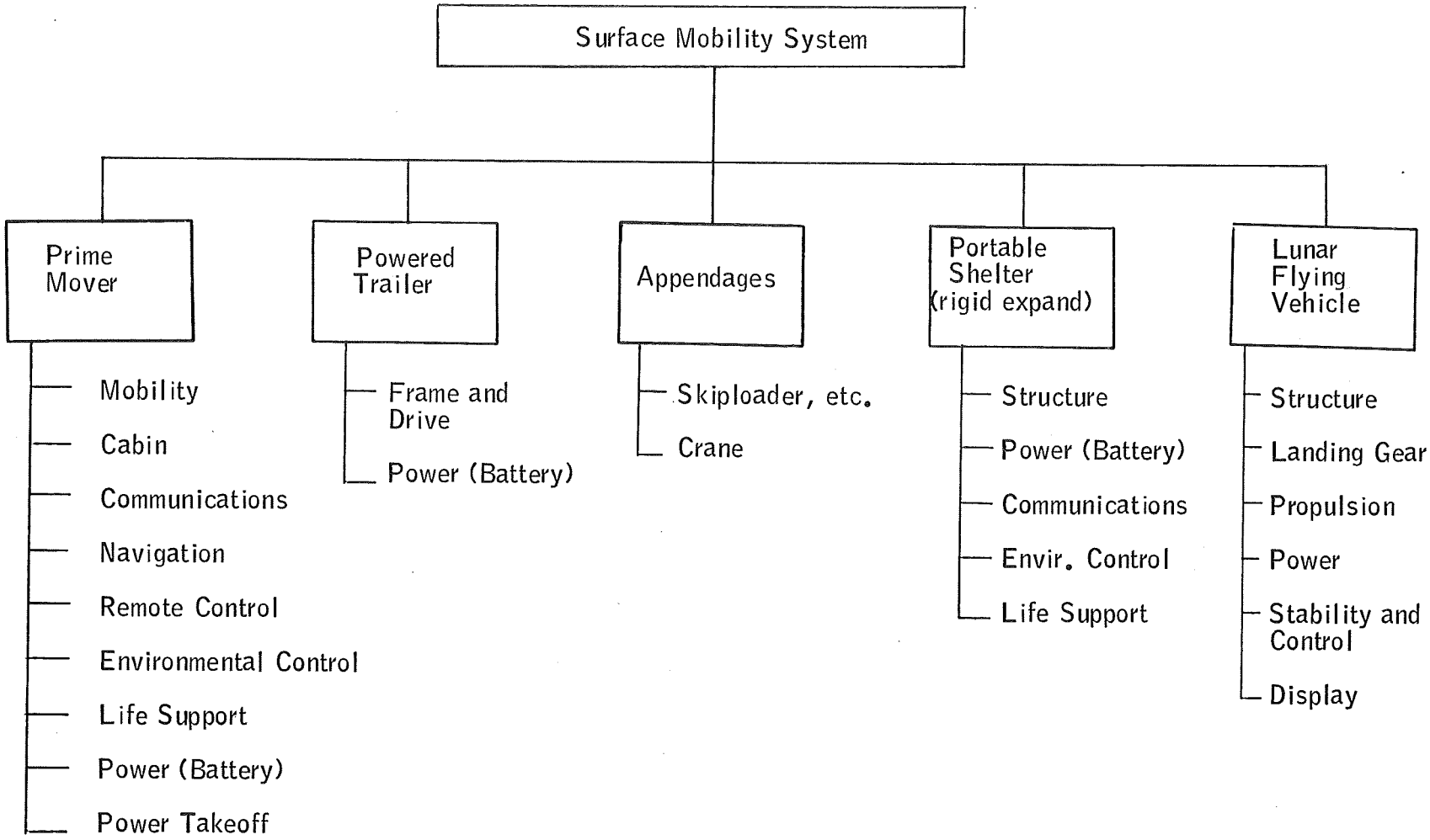
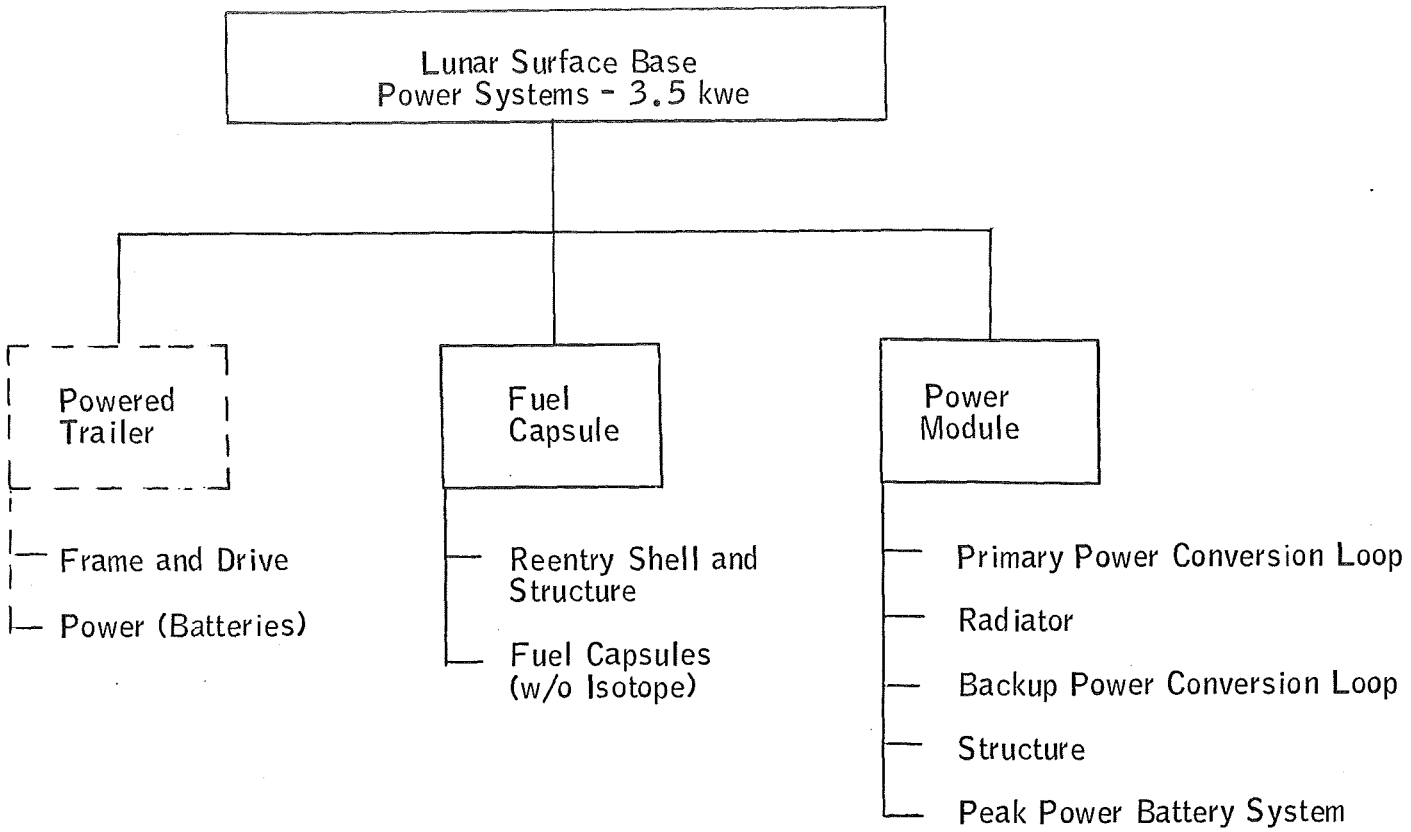


Figure 9.4-1. Surface Mobility System

Table 9.4-1. Mobility Equipment Cost Data

Item	Nonrecurring Cost $\overline{M}$	No. Test Units	Recurring Cost $\overline{M}$	No. Units	T_D	Spread Function	Ref.* Doc.	Total Cost $\overline{M}$
Prime mover	221.4	4	71.7	4	42	4	1,3	293.1
Powered trailers	-	-	41.7	10	36	3	1	41.7
Skiploader/backhoe/power shovel	5.2	2	.9	1	18 6	4 3	1	6.1
Crane	2.2	2	.4	1	18 6	4 3	1	2.6
Portable shelter (rigid)	215.6	5	52.8	2	42 18	4 3	3	268.4
Portable shelter (expandable)	178.6	5	44.8	2	42 18	4 3	3	223.4
Lunar flying vehicle (one man)	29.8	5	3.8	2	36 18	4 3	2,3	33.6
							*Ref. para. 9.4	



NOTE: The power module will be mounted on the powered trailer to increase its flexibility at the lunar base

Figure 9.5-1. Lunar Surface Base Power Systems - 3.5 kwe

Table 9.5-1. Power Plant Cost Data

Item	Nonrecurring Cost $\overline{M}$	No. Test Units	Recurring Cost $\overline{M}$	No. Units	T_D	Spread Function	Ref. Doc. ***	Total Cost $\overline{M}$
(PREFERRED)								
3.5 kwe organic Rankine cycle*	54.7	5			42	4	1	
			52.1	6	36	3		106.8
(ALTERNATE)								
3.5 kwe radioisotope Brayton cycle*	62.6	5			54	4	1	
			60.4	6	42	3		123.0
Fuel Capsule** Polonium 210	42.0	3			42	4	2	
			42.4	54	42	3		84.4
(ALTERNATE)								
Fuel Capsule** Plutonium 238	44.8	3			42	4	2	
			9.5	6	30	3		54.3

* The power plants will be mounted on the powered trailers shown in the mobility data
** The isotope cost is not included in the fuel capsule cost
*** Reference para. 9.5

1. Garret, Sundstrand, and Aerojet Corporations

2. Mission Modes and System Analysis (MIMOSA), NAS8-20262, LMSC AB47943