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MODULAR
space station
PHASE B EXTENSION

PROGRAM COST AND SCHEDULES

Volume II - Appendixes



PREPARED BY:
PROGRAM BUSINESS MANAGEMENT

JANUARY 1972



Space Division
North American Rockwell

SD 71-226 -2

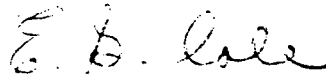
MODULAR **space station** PHASE B EXTENSION

PROGRAM COST AND SCHEDULES Volume II - Appendixes

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PROGRAM BUSINESS MANAGEMENT

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TECHNICAL REPORT INDEX/ABSTRACT

ACCESSION NUMBER						DOCUMENT SECURITY CLASSIFICATION UNCLASSIFIED	
TITLE OF DOCUMENT MODULAR SPACE STATION COST AND SCHEDULES						LIBRARY USE ONLY	
AUTHOR(S) FRASSINELLI, G.J., WOLFINGER, H.W.							
CODE QN085282	ORIGINATING AGENCY AND OTHER SOURCES SPACE DIVISION, NORTH AMERICAN ROCKWELL CORP. DOWNEY, CALIFORNIA				DOCUMENT NUMBER SD71-226-2		
PUBLICATION DATE 00JAN72		CONTRACT NUMBER NAS9-9953					
DESCRIPTIVE TERMS *MODULAR SPACE STATION, *COST AND SCHEDULE ESTIMATES, *COST ESTIMATING RELATIONSHIPS (CER's), *WORK BREAKDOWN STRUCTURE, *COST AVOIDANCE/SAVINGS, *FUNDING ESTIMATES							

ABSTRACT COST ESTIMATES AND FUNDING SCHEDULES ARE PRESENTED FOR THE EARTH ORBITAL MODULAR SPACE STATION PROGRAM, FOR A GIVEN CONFIGURATION AND COSTING GROUND RULES. COST METHODOLOGY IS DESCRIBED AND THE COST EVOLUTION FROM A BASELINE CONFIGURATION TO A SELECTED CONFIGURATION IS PRESENTED, EMPHASIZING CASES IN WHICH COST WAS A DESIGN DRIVER. PROGRAMMATIC COST AVOIDANCE TECHNIQUES ARE DISCUSSED. A WORK BREAKDOWN STRUCTURE AND DICTIONARY, ESTIMATED SUBCONTRACTOR COSTS, AND TECHNICAL CHARACTERISTICS DATA ARE PRESENTED.
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FOREWORD

This document is one of a series required by Contract NAS9-9953, Exhibit C, Statement of Work for Phase B Extension-Modular Space Station Program Definition. It has been prepared by the Space Division, North American Rockwell Corporation, and is submitted to the National Aeronautics and Space Administration's Manned Spacecraft Center, Houston, Texas, in accordance with the requirements of Data Requirements List (DRL) MSC-T-575, Line Item 77.

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

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

This document consists of two volumes: Volume I - Cost Estimating Process and Cost, Schedule and Funding Summaries, presents cost methodology and describes the evolution of cost beginning with a reference configuration and progressing to a selected configuration. The impacts of various cost avoidance techniques are discussed. Costs, schedules, and summaries



of funding are given. Volume II - Appendices presents the Work Breakdown Structure (WBS) and dictionary, subcontractor and prime contractor costs for WBS items. Supporting data for the reference configuration and selected configurations are also given. |

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A WORK BREAKDOWN STRUCTURE AND DICTIONARY



APPENDIX A. WORK BREAKDOWN STRUCTURE AND DICTIONARY

1. PROGRAM BASELINES

1.1 WORK BREAKDOWN STRUCTURE (WBS)

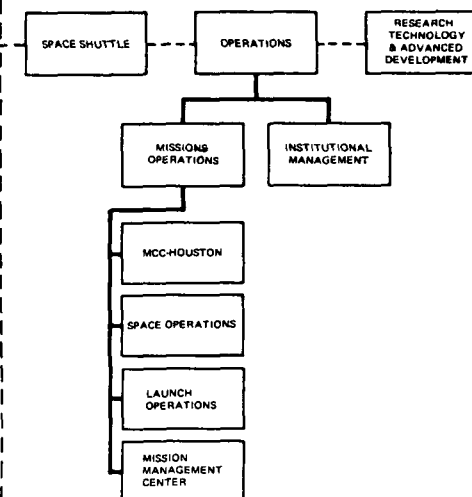
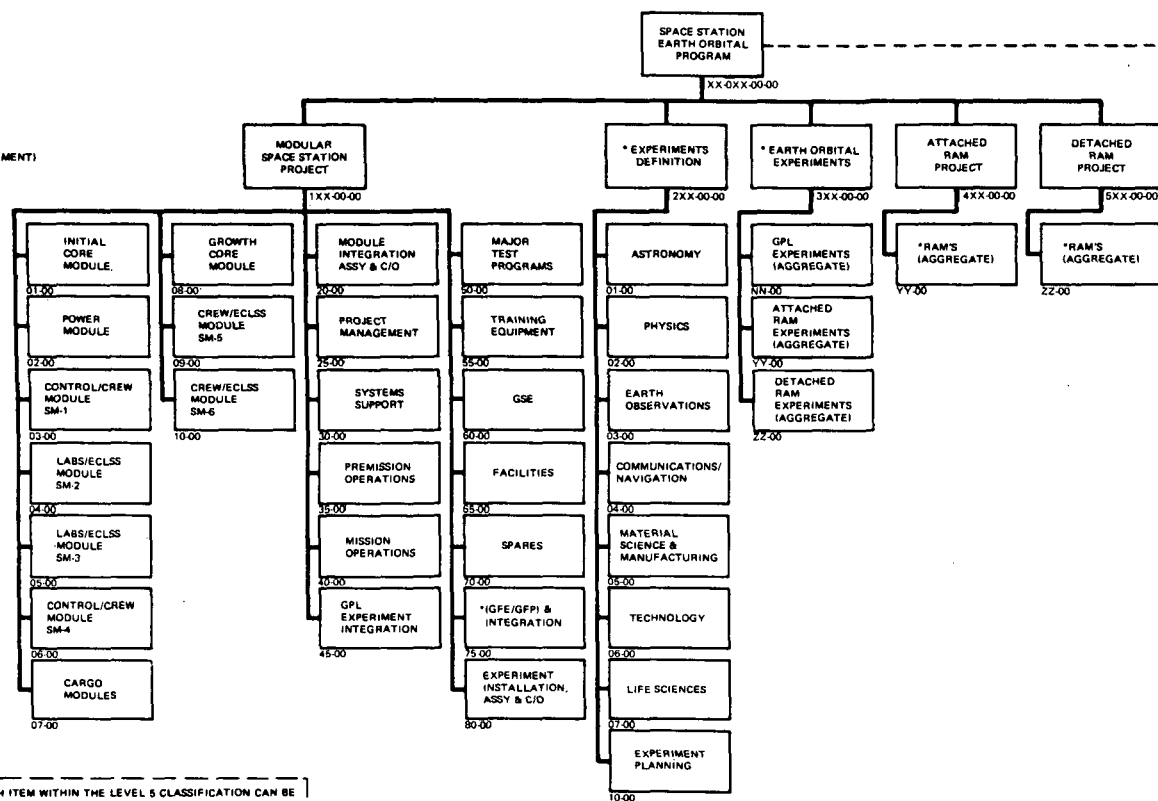
The NASA-MSC WBS for the Space Station Earth Orbital Program is reproduced as Figure A-1. Listed therein are the principal categories of products (hardware, services, functions) involved in overall NASA program development, production and operations. The program, at WBS Level 2, is subdivided into five (5) program elements, or projects, at Level 3. Included on the graphic WBS, but not defined in the dictionary, are the other NASA programs and functions necessary to support the Space Station Earth Orbital Program.

1.2 MODULAR SPACE STATION (MSS) PROJECT DEFINITION

To assist in establishing baselines for the MSS project, the MSS system has been expressed in terms of subsystems and hardware/software functions. These are defined in Table A-1, which includes subsystems (Level 5), assemblies (Level 6), and components (Level 7) as they may be applicable to modules of the initial space station. Table A-1 does not necessarily apply to growth station modules or cargo modules, since those modules have not been defined to the Phase B preliminary design level.

NAS 9-9953
MODULAR SPACE STATION
WORK BREAKDOWN STRUCTURE

CONTRACTOR ONLY WBS

LEVEL 2
(PROGRAM)XX-
LEVEL 3
(PROGRAM ELEMENT)
(PROJECT)XX-NXX-
LEVEL 4
(SYSTEM)

*NOTE:
THE CONTRACTOR WILL USE NASA FURNISHED COST DATA FOR THESE ITEMS. THESE COST SUMMARIES WILL BE SHOWN AS PROGRAM REFERENCES IN APPENDICES TO DRL 77.

THE CONTRACTOR WILL REFLECT THE ESTIMATED COST OF SCHEDULED EXPERIMENTS IN A TIME PHASED PROGRAM COST RELATIONSHIP.

EACH ITEM WITHIN THE LEVEL 5 CLASSIFICATION CAN BE USED TO SUPPORT ANY LEVEL 4 SYSTEM IF APPLICABLE

XX-NXX-NN-
LEVEL 5
SUBSYSTEMS

STRUCTURAL & MECHANICAL SUBSYSTEM 01
ECLSS SUBSYSTEM 02
ELECTRICAL POWER SUBSYSTEM 03
GUIDANCE & CONTROL SUBSYSTEM 04
REACTION CONTROL SUBSYSTEM 05
INFORMATION SUBSYSTEM 06
CREW HABITABILITY SUBSYSTEM 07
SUBSYSTEM INSTALLATION ASSY & C/O 08
MODULE REFURBISHMENT 09

A.1 X-RAY STELLAR ASTRONOMY
A.2 ADVANCED STELLAR ASTRONOMY
A.3 ADVANCED SOLAR ASTRONOMY
A.4 INTERMEDIATE SIZE UV TELESCOPE
A.5 HIGH ENERGY STELLAR ASTRONOMY
A.6 INFRARED ASTRONOMY
P.1 SPACE PHYSICS RESEARCH LABORATORY
P.2 PLASMA PHYSICS AND ENVIRON. PERTURB. LAB.
P.3 COSMIC RAY PHYSICS LABORATORY
P.4 PHYSICS AND CHEMISTRY LABORATORY

ES.1 EARTH OBSERVATION FACILITY
C/N.I. COMMUNICATIONS AND NAVIGATION RESEARCH FACILITY
MS.1 MATERIALS SCIENCE AND MANUFACTURING FACILITY
T.1 CONTAMINATION MEASUREMENTS
T.2 FLUID MANAGEMENT
T.3 EXTRAVEHICULAR ACTIVITY
T.4 ADVANCED SPACECRAFT SYSTEM TEST
T.5 TELEOPERATION

LS.1 MEDICAL RESEARCH FACILITY
LS.2 VERTEBRATE RESEARCH FACILITY
LS.3 PLANT RESEARCH FACILITY
LS.4 CELLS AND TISSUES RESEARCH FACILITY
LS.5 INVERTEBRATE RESEARCH FACILITY
LS.6 LIFE SUPPORT AND PROTECTIVE SYSTEM
LS.7 MAN-SYSTEM INTEGRATION

FLIGHT CONTROL
MISSION PLANNING
COMPUTER PROGRAMMING
COMPUTER AND OTHER LEASEHOLD PAYMENTS
TRAINING DEVICES
PROGRAM MANAGEMENT
CENTER OPERATIONS SUPPORT
MAINTENANCE FACILITIES
TRANSPORTATION
PROPELLANTS AND GASES
SAFETY OPERATIONS
PRE/POST FLIGHT DATA ANALYSIS AND REPORTS

CONTRACTOR AND GOVERNMENT USE

GOVERNMENT USE ONLY

NASA-MSC

Figure A-1. Program Summary Work Breakdown Structure

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H A R D W A R E F U N C T I O N T R E E

Table A-1. Subsystems Hardware Function Tree

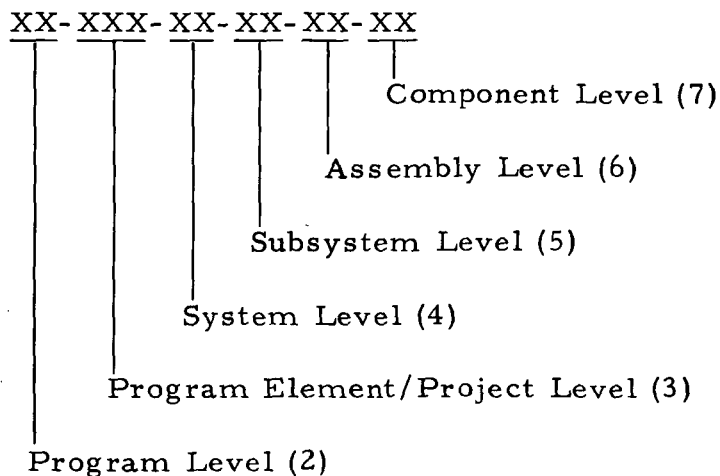
1.0	2.0	3.0	4.0	5.0	6.0	7.0
STRUCTURAL & MECHANICAL SUBSYSTEM	ENVIRONMENTAL CONTROL LIFE SUPPORT SUBSYSTEM	ELECTRICAL POWER SUBSYSTEM	GUIDANCE & CONTROL SUBSYSTEM	REACTION CONTROL SUBSYSTEM	INFORMATION SUBSYSTEM	CREW HABITABILITY SUBSYSTEM
1.1 PRIMARY STRUCTURE SIDEWALLS BULKHEADS FITTINGS (TRUNNION) AIRLOCK 1.2 SECONDARY STRUCTURE PARTITIONS FLOORS UTILITY DISTRIBUTION DOORS/HATCHES WINDOWS CARGO HANDLING FLEXPORTS STORAGE 1.3 ENVIRONMENTAL SHIELD THERMAL SHIELD MICROMETEOROID SHIELD RADIATION PROTECTION 1.4 BERTHING MATING RING/LATCHES UTILITIES INTERFACES 1.5 GENERAL PURPOSE LAB FURNISHINGS AIRLOCKS MEDICAL/BIOLOGICAL AREA PHYSICS AREA DATA ANALYSIS AREA OPTICAL SUPPLY & MAINTENANCE AREA ELECTRICAL/ELECTRONICS MAINTENANCE AREA PHOTOGRAPHIC PROCESSING AREA MECHANICAL MAINTENANCE AREA	2.1 GASEOUS STORAGE (O_2, H_2) O_2 SUPPLY H_2 SUPPLY H_2 SUPPLY PUMPDOWN 2.2 O_2 MANAGEMENT CO_2 REMOVAL CO_2 REDUCTION WATER ELECTROLYSIS 2.3 ATMOSPHERIC CONTROL CIRCULATION TEMPERATURE CONTROL HUMIDITY CONTROL PRESSURE CONTROL CONTAMINANT CONTROL 2.4 THERMAL CONTROL INTERNAL COOLANT LOOP RAM HX WATER PUMP PKG COLDPLATES HEAT REJECTION LOOP RADIATORS FREON/WATER INTERCOOLER FREON PUMP PKG FREON RESERVOIR 2.5 WATER MANAGEMENT WATER RECLAMATION WATER STORAGE PURITY CONTROL 2.6 WASTE MANAGEMENT FECAL COLLECTION URINE COLLECTION TRASH PROCESSING 2.7 HYGIENE FULL BODY WASHING PARTIAL BODY WASHING HOUSEKEEPING	3.1 PRIMARY POWER GENERATION SOLAR ARRAY ORIENTATION DRIVE & POWER TRANSFER 3.2 SECONDARY POWER GENERATION FUEL CELLS ** 3.3 ENERGY STORAGE FUEL CELLS ELECTROLYSIS UNIT STORAGE TANKS 3.4 POWER CONDITIONING INVERTERS REGULATORS AUTOTRANSFORMERS RECTIFIER - FILTER 3.5 DISTRIBUTION, CONTROL & WIRING BUSES WIRING FEEDERS EPS CONTROLS CIRCUIT BREAKERS CONTACTORS 3.6 LIGHTING INTERNAL EXTERNAL ** ENERGY STORAGE FUEL CELLS UTILIZED IN SECONDARY POWER GENERATION (EMERGENCY/BUILDUP POWER SOURCE)	4.1 INERTIAL REFERENCE STRAPDOWN IMU IMU PREPROCESSOR 4.2 OPTICAL REFERENCE HORIZON TRACKER (OPTICS & ELECTRONICS) STAR TRACKER (OPTICS & ELECTRONICS) SEXTANT/TELESCOPE OPTICAL REFERENCE PREPROCESSOR ALIGNMENT LINKS 4.3 RCS ELECTRONICS JET DRIVER ELECTRONICS RCS PREPROCESSOR 4.4 MOMENTUM EXCHANGE CONTROL MOMENT GYROS CMG PREPROCESSOR 4.5 COMPUTATION SOFTWARE	5.1 PROPELLANT ACCUMULATORS H_2 ACCUMULATORS O_2 ACCUMULATORS 5.2 PROPELLANT FEED CONTROLS VALVES REGULATORS 5.3 ENGINES ENGINES/MOUNTS	6.1 DATA PROCESSING DATA BUS CONTROL CENTRAL TIMING CENTRAL PROCESSOR REMOTE PROCESSOR RACU BUILDUP DATA PROCESSOR 6.2 COMMAND/CONTROL AND MONITORING OPERATIONAL CONTROL CONSOLE COMMANDERS CONTROL CONSOLE EMERGENCY GAC CONTROL PORTABLE CONTROL UNIT LOCAL MONITOR ALARM MICROFILM PROJECTOR SHUTTLE MOUNTED MONITOR 6.3 EXTERNAL COMMUNICATIONS KU BAND ANTENNA KU BAND ANTENNA MOUNTED ELECTRONICS KU BAND NON-INTEGRATED ELECTRONICS S-BAND ANTENNA S-BAND TRANSPONDER VHF ANTENNA VHF TRANSPONDER BUILDUP COMMUNICATIONS 6.4 INTERNAL COMMUNICATIONS COMMUNICATIONS RACK RECORDING UNITS AUDIO VIDEO UNITS HARD WIRE INTERCOM SHUTTLE/MODULE INTERFACE UNIT TV CAMERAS COLOR TV CAMERAS B&W TV MONITORS COLOR 6.5 SOFTWARE COMPUTER PROGRAMS MICROFILM PRINTER/FACSIMILE PAPER	7.1 PERSONAL EQUIPMENT CLOTHING/LINENS GROOMING AIDS PERSONAL DOSIMETERS 7.2 GENERAL/EMERGENCY EQUIPMENT TOOLS PORTABLE LIGHTS RADIATION DETECTION EMERGENCY O_2 MASKS PGA & SUPPORT IVA UNSILICALS PLSS + OPS MOBILITY AIDS & RESTRAINTS FIRST AID KITS 7.3 FURNISHINGS SLEEPING RESTRAINTS/BUNKS SEATING RESTRAINTS/CHAIRS WORK SURFACES/DESKS WORK SURFACES/TABLES DINING SURFACE/TABLE 7.4 RECREATION/EXERCISE/CREW CARE ACTIVE RECREATION DEVICES PASSIVE RECREATION DEVICES ERGOMETER/ISOTONIC EQUIP MEDICAL/DENTAL EQUIP 7.5 FOOD MANAGEMENT SUPPLY STORAGE PREPARATION SERVING AND CLEANUP INVENTORY CONTROL

2. WBS INDEX

The WBS index, Table A-2, provides a tabular, indentured listing of program elements to the levels established for cost reporting.

In addition, it establishes the WBS identification numbers and cost applicability of each item (nonrecurring - DDT&E; recurring production; recurring operations). This index is the baseline for preparation of all cost data forms.

The WBS identification numbers are based on the NASA Agency-wide 13-digit coding system as follows:



Only the first 9 characters are used to establish the required Level 5 identifiers (XX-NXX-NN-NN), where XX is a program level designator reserved for NASA use.

For accountability purposes, and where certain subsystems do not apply to certain space station modules, the term Not Applicable (N/A) is used in the Activity Type column.

**Table A-2. Space Station Earth Orbital Program Work Breakdown
Structure Index**

WBS IDENT NO.	WBS LEVEL	WBS ELEMENTS	ACTIVITY TYPE		
			DDT&E	PROD	OPNS
XX-0XX-00-00	2	Space Station Earth Orbital Program	X	X	X
1XX-00-00	3	Modular Space Station Project	X	X	X
01-00	4	Initial Core Module	X	X	
01	5	Structural & Mechanical Subsystem	X	X	
02	5	ECLS Subsystem	X	X	
03	5	Electrical Power Subsystem	X	X	
04	5	Guidance and Control Subsystem	X	X	
05	5	Reaction Control Subsystem	X	X	
06	5	Information Subsystem	X	X	
07	5	Crew Habitability Subsystem	X	X	
08	5	Subsystem Installation, Assy & C/O	X	X	
09	5	Module Refurbishment	N / A		
02-00	4	Power Module	X	X	
01	5	Structural & Mechanical Subsystem	X	X	
02	5	ECLS Subsystem	X	X	
03	5	Electrical Power Subsystem	X	X	
04	5	Guidance and Control Subsystem	N / A		
05	5	Reaction Control Subsystem	N / A		
06	5	Information Subsystem	X	X	
07	5	Crew Habitability Subsystem	X	X	
08	5	Subsystem Installation, Assy & C/O	X	X	
09	5	Module Refurbishment	N / A		
03-00	4	Control/Crew Module (SM-1)	X	X	
01	5	Structural & Mechanical Subsystem	X	X	
02	5	ECLS Subsystem	X	X	
03	5	Electrical Power Subsystem	X	X	
04	5	Guidance and Control Subsystem	N / A		
05	5	Reaction Control Subsystem	N / A		
06	5	Information Subsystem	X	X	
07	5	Crew Habitability Subsystem	X	X	
08	5	Subsystem Installation, Assy & C/O	X	X	
09	5	Module Refurbishment	N / A		
04-00	4	Labs/ECLSS Module (SM-2)	X	X	
01	5	Structural & Mechanical Subsystem	X	X	
02	5	ECLS Subsystem	X	X	
03	5	Electrical Power Subsystem	X	X	
04	5	Guidance and Control Subsystem	N / A		
05	5	Reaction Control Subsystem	X	X	
06	5	Information Subsystem	X	X	
07	5	Crew Habitability Subsystem	X	X	
08	5	Subsystem Installation, Assy & C/O	X	X	
09	5	Module Refurbishment	N / A		

**Table A-2. Space Station Earth Orbital Program Work Breakdown
Structure Index (Cont)**

WBS IDENT NO.	WBS LEVEL	WBS ELEMENTS	ACTIVITY TYPE		
			DDT&E	PROD	OPNS
XX-1XX-05-00	4	Labs/ECLSS Module (SM-3)	X	X	
01	5	Structural & Mechanical Subsystem	X	X	
02	5	ECLS Subsystem	X	X	
03	5	Electrical Power Subsystem	X	X	
04	5	Guidance and Control Subsystem	N /	A	
05	5	Reaction Control Subsystem	X	X	
06	5	Information Subsystem	X	X	
07	5	Crew Habitability Subsystem	X	X	
08	5	Subsystem Installation, Assy & C/O	X	X	
09	5	Module Refurbishment	N /	A	
06-00	4	Control/Crew Module (SM-4)	X	X	
01	5	Structural & Mechanical Subsystem	X	X	
02	5	ECLS Subsystem	X	X	
03	5	Electrical Power Subsystem	X	X	
04	5	Guidance and Control Subsystem	N /	A	
05	5	Reaction Control Subsystem	X	X	
06	5	Information Subsystem	X	X	
07	5	Crew Habitability Subsystem	X	X	
08	5	Subsystem Installation, Assy & C/O	X	X	
09	5	Module Refurbishment	N /	A	
07-00	4	Cargo Module	X	X	X
01	5	Structural & Mechanical Subsystem	X	X	
02	5	ECLS Subsystem	X	X	
03	5	Electrical Power Subsystem	X	X	
04	5	Guidance and Control Subsystem	N /	A	
05	5	Reaction Control Subsystem	N /	A	
06	5	Information Subsystem	X	X	
07	5	Crew Habitability Subsystem	X	X	
08	5	Subsystem Installation, Assy & C/O	X	X	
09	5	Module Refurbishment			X
08-00	4	Growth Core Module	X	X	
01	5	Structural & Mechanical Subsystem	X	X	
02	5	ECLS Subsystem	X	X	
03	5	Electrical Power Subsystem	X	X	
04	5	Guidance and Control Subsystem	N /	A	
05	5	Reaction Control Subsystem	X	X	
06	5	Information Subsystem	X	X	
07	5	Crew Habitability Subsystem	X	X	
08	5	Subsystem Installation, Assy & C/O	X	X	
09	5	Module Refurbishment	N /	A	

**Table A-2. Space Station Earth Orbital Program Work Breakdown
Structure Index (Cont)**

WBS IDENT NO.	WBS LEVEL	WBS ELEMENTS	ACTIVITY TYPE		
			DDT&E	PROD	OPNS
XX-1XX-09-00	4	Crew/ECLSS Module (SM-5)	X	X	
01	5	Structural & Mechanical Subsystem	X	X	
02	5	ECLS Subsystem	X	X	
03	5	Electrical Power Subsystem	X	X	
04	5	Guidance and Control Subsystem	N /	A	
05	5	Reaction Control Subsystem	X	X	
06	5	Information Subsystem	X	X	
07	5	Crew Habitability Subsystem	X	X	
08	5	Subsystem Installation, Assy & C/O	X	X	
09	5	Module Refurbishment	N /	A	
10-00	4	Crew/ECLSS Module (SM-6)	X	X	
01	5	Structural & Mechanical Subsystem	X	X	
02	5	ECLS Subsystem	X	X	
03	5	Electrical Power Subsystem	X	X	
04	5	Guidance and Control Subsystem	N /	A	
05	5	Reaction Control Subsystem	X	X	
06	5	Information Subsystem	X	X	
07	5	Crew & Habitability Subsystem	X	X	
08	5	Subsystem Installation, Assy & C/O	X	X	
09	5	Module Refurbishment	N /	A	
20-00	4	Module Integration, Assy & C/O		X	
25-00	4	Project Management	X	X	X
30-00	4	Systems Support	X	X	X
35-00	4	Prepermission Operations	X		X
40-00	4	Mission Operations	X		X
45-00	4	GPL Experiment Integration (Sys Eng)	X		
50-00	4	Major Test Programs	X		
55-00	4	Training Equipment	X		
60-00	4	Ground Support Equipment	X		
65-00	4	Facilities	X		
70-00	4	Spares			X
75-00	4	GFE/GFP & Integration		X	
80-00	4	Experiment Installation, Assy & C/O		X	
2XX-00-00	3	Experiments Definition	X		
01-00	4	Astronomy (A)	X		
02-00	4	Physics (P)	X		
03-00	4	Earth Observations (ES)	X		
04-00	4	Communications/Navigation (C/N)	X		
05-00	4	Material Science & Manufacturing (MS)	X		
06-00	4	Technology (T)	X		
07-00	4	Life Sciences (LS)	X		
10-00	4	Experiment Planning	X		

**Table A-2. Space Station Earth Orbital Program Work Breakdown
Structure Index (Cont)**

WBS IDENT NO.	WBS LEVEL	WBS ELEMENTS	ACTIVITY TYPE		
			DDT&E	PROD	OPNS
XX-3XX-00-00	3	Earth Orbital Experiments	X	X	X
NN-00	4	GPL Experiments (Aggregate)	X	X	X
YY-00	4	Attached RAM Experiments (Aggregate)	X	X	X
ZZ-00	4	Detached RAM Experiments (Aggregate)	X	X	X
XX-4XX-00-00	3	Attached RAM Project	X	X	X
YY-00	4	RAM's (Aggregate)	X	X	X
XX-5XX-00-00	3	Detached RAM Project	X	X	X
ZZ-00	4	RAM's (Aggregate)	X	X	X

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3. WBS DICTIONARY

The WBS dictionary describes the composition of each element of the WBS at the cost reporting level.

The dictionary provides definitions of each WBS element by WBS identification number, provides a brief description of the technical characteristics of the element, states exactly what is included in each element and, where necessary for clarification, states specific exclusions. For convenience, the cost applicability is repeated from the WBS index and the next higher and next lower (if applicable) WBS elements are identified.

Included in this section are NASA-furnished definitions for each discipline involved in experiments definition, and for each functional program element (FPE) identified under Earth Orbital Experiments.

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XX-0XX-00-00

X DDT&E
X PRODUCTION
X OPERATIONS

SPACE STATION EARTH ORBITAL PROGRAM (LEVEL 2)

The Level 2 Space Station Earth Orbital Program is comprised of the modular space station, experiments definition, earth orbital experiments, attached research applications module (RAM) and detached RAM projects. These project elements, when combined, cover all effort necessary to design, develop, and operate a modular space station consisting of a semi-permanent cluster of modules, each of which can be transported to and from orbit internal to the space shuttle. This elements exclude the NASA Center operations and related research, technology and advanced development activities. It further excludes the Space Shuttle Program, and sortie experiment effort in support of the Modular Space Station Program.

NEXT HIGHER LEVEL ELEMENTS

XX-XXX-00-00 NASA - OMSF Programs (Reference only)

NEXT LOWER LEVEL ELEMENTS (LEVEL 3)

XX-1XX-00-00	Modular Space Station Project
XX-2XX-00-00	Experiments Definition
XX-3XX-00-00	Earth Orbital Experiments
XX-4XX-00-00	Attached RAM Project
XX-5XX-00-00	Detached RAM Project

XX-0XX-00-00

XX-1XX-00-00

X DDT&E
X PRODUCTION
X OPERATIONS

MODULAR SPACE STATION PROJECT (LEVEL 3)

The Level 3 Modular Space Station Project element includes all of the hardware, software, services and facilities required to design, develop, produce and support the Modular Space Station capable of supporting a crew and, which with the use of integral (GPL) experiments, will provide an early benefit return experiment program for extended mission durations. It summarizes all lower level elements identifiable and peculiar to the Modular Space Station Project including all modules, subsystems, module integration, project management, systems support, premission and mission operations; GPL experiment integration, major test programs, training equipment, GSE, facilities, spares, GFE/GFP and integration elements; and experiment installation, assembly, and checkout.

NEXT HIGHER LEVEL ELEMENTS (LEVEL 2)

XX-0XX-00-00 Space Station Earth Orbital Program

NEXT LOWER LEVEL ELEMENTS (LEVEL 4)

XX-1XX-01-00	Initial Core Module	
XX-1XX-02-00	Power Module	
XX-1XX-03-00	Control/Crew Module SM-1	
XX-1XX-04-00	Labs/ECLSS Module SM-2	
XX-1XX-05-00	Labs/ECLSS Module SM-3	
XX-1XX-06-00	Control/Crew Module SM-4	
XX-1XX-07-00	Cargo Modules	
XX-1XX-08-00	Growth Core Module	
XX-1XX-09-00	Crew/ECLSS Module SM-5	} Growth Station Modules
XX-1XX-10-00	Crew/ECLSS Module SM-6	
XX-1XX-20-00	Module Integration, Assembly, and Checkout	
XX-1XX-25-00	Project Management	
XX-1XX-30-00	Systems Support	
XX-1XX-35-00	Premission Operations	
XX-1XX-40-00	Mission Operations	
XX-1XX-45-00	GPL Experiment Integration	
XX-1XX-50-00	Major Test Hardware	
XX-1XX-55-00	Training Equipment	
XX-1XX-60-00	Ground Support Equipment	
XX-1XX-65-00	Facilities	
XX-1XX-70-00	Spares	
XX-1XX-75-00	GFE/GFP and Integration	
XX-1XX-80-00	Experiment Installation, Assembly and Checkout	

XX-1XX-00-00



XX-1XX-01-00

X DDT&E
X PRODUCTION
X OPERATIONS

INITIAL CORE MODULE (LEVEL 4)

This element refers to the complete Initial Core Module to be launched internal to the Space Shuttle. It includes the design, manufacturing, test, tooling, special test equipment, and quality control effort associated with the development of all production units which satisfy the requirements of the applicable specification. It includes all subsystems and the installation and checkout of all subsystem elements into the complete module as well as all changes and tool maintenance and module refurbishment. This element excludes the effort associated with producing specially fabricated test hardware as identified under the Major Test Programs WBS element. It also excludes the physical integration of GFE/GFP and experiments.

NEXT HIGHER LEVEL ELEMENTS (LEVEL 3)

XX-1XX-00-00 Modular Space Station Project

NEXT LOWER LEVEL ELEMENTS (LEVEL 5)

XX-1XX-01-01 Structural & Mechanical Subsystem
XX-1XX-01-02 ECLS Subsystem
XX-1XX-01-03 Electrical Power Subsystem
XX-1XX-01-04 Guidance and Control Subsystem
XX-1XX-01-05 Reaction Control Subsystem
XX-1XX-01-06 Information Subsystem
XX-1XX-01-07 Crew Habitability Subsystem
XX-1XX-01-08 Subsystem Installation, Assembly & Checkout
XX-1XX-01-09 Module Refurbishment (Not Applicable)

XX-1XX-01-00

XX-1XX-02-00

X DDT&E
X PRODUCTION
OPERATIONS

POWER MODULE (LEVEL 4)

This element refers to the complete power module to be launched internal to the space shuttle. It includes the design, manufacturing, test, tooling, special test equipment, and quality control effort associated with the development of all production units which satisfy the requirements of the applicable specification. It includes all subsystems and the installations and checkout of all subsystem elements into the complete module as well as all changes and tool maintenance and module refurbishment. The hardware required to reconfigure the power module for growth station operations (i. e. replacement solar array package) is included in the electrical power subsystem. This element excludes the effort associated with producing specially fabricated test hardware as identified under the Major Test Programs WBS element. It also excludes the physical integration of GFE/GFP and experiments.

NEXT HIGHER LEVEL ELEMENTS (LEVEL 3)

XX-1XX-00-00 Modular Space Station Project

NEXT LOWER LEVEL ELEMENTS (LEVEL 5)

XX-1XX-02-01	Structural & Mechanical Subsystem
XX-1XX-02-02	ECLS Subsystem
XX-1XX-02-03	Electrical Power Subsystem
XX-1XX-02-04	Guidance and Control Subsystem (Not Applicable)
XX-1XX-02-05	Reaction Control Subsystem (Not Applicable)
XX-1XX-02-06	Information Subsystem
XX-1XX-02-07	Crew Habitability Subsystem
XX-1XX-02-08	Subsystem Installation, Assembly & Checkout
XX-1XX-02-09	Module Refurbishment (Not Applicable)

XX-1XX-02-00

XX-1XX-03-00

X DDT&E
X PRODUCTION
OPERATIONS

CONTROL/CREW MODULE SM-1 (LEVEL 4)

This element refers to the complete control/crew module SM-1 to be launched internal to the space shuttle. It includes the design, manufacturing, test tooling, special test equipment, and quality control effort associated with the development of all production units which satisfy the requirements of the applicable specification. It includes all subsystems and the installation and checkout of all subsystem elements into the complete module as well as all changes and tool maintenance and module refurbishment. This element excludes the effort associated with producing specially fabricated test hardware as identified under the Major Test Programs WBS element. It also excludes the physical integration of GFE/GFP and experiments.

NEXT HIGHER LEVEL ELEMENTS (LEVEL 3)

XX-1XX-00-00 Modular Space Station Project

NEXT LOWER LEVEL ELEMENTS (LEVEL 5)

XX-1XX-03-01	Structural & Mechanical Subsystem
XX-1XX-03-02	ECLS Subsystem
XX-1XX-03-03	Electrical Power Subsystem
XX-1XX-03-04	Guidance and Control Subsystem (Not Applicable)
XX-1XX-03-05	Reaction Control Subsystem (Not Applicable)
XX-1XX-03-06	Information Subsystem
XX-1XX-03-07	Crew Habitability Subsystem
XX-1XX-03-08	Subsystem Installation, Assembly & Checkout
XX-1XX-03-09	Module Refurbishment (Not Applicable)

XX-1XX-03-00

XX-1XX-04-00

X DDT&E
X PRODUCTION
OPERATIONS

LABORATORIES/ECLSS MODULE SM-2 (LEVEL 4)

This element refers to the complete laboratories/ECLSS module SM-2 to be launched internal to the space shuttle. It includes the design, manufacturing, test, tooling, special test equipment, and quality control effort associated with the development of all production units which satisfy the requirements of the applicable specification. It includes all subsystems and the installation and checkout of all subsystem elements into the complete module as well as all changes and tool maintenance and module refurbishment. This element excludes the effort associated with producing specially fabricated test hardware as identified under the Major Test Programs WBS element. It also excludes the physical integration of GFE/GFP and experiments.

NEXT HIGHER LEVEL ELEMENTS (LEVEL 3)

XX-1XX-00-00 Modular Space Station Project

NEXT LOWER LEVEL ELEMENTS (LEVEL 5)

XX-1XX-04-01	Structural & Mechanical Subsystem
XX-1XX-04-02	ECLS Subsystem
XX-1XX-04-03	Electrical Power Subsystem
XX-1XX-04-04	Guidance and Control Subsystem (Not Applicable)
XX-1XX-04-05	Reaction Control Subsystem
XX-1XX-04-06	Information Subsystem
XX-1XX-04-07	Crew Habitability Subsystem
XX-1XX-04-08	Subsystem Installation, Assembly & Checkout
XX-1XX-04-09	Module Refurbishment (Not Applicable)

XX-1XX-04-00

XX-1XX-05-00

X DDT&E
X PRODUCTION
OPERATIONS

LABORATORIES/ECLSS MODULE SM-3 (LEVEL 4)

This element refers to the complete laboratories/ECLSS module SM-3 to be launched internal to the space shuttle. It includes the design, manufacturing, test, tooling, special test equipment, and quality control effort associated with the development of all production units which satisfy the requirements of the applicable specification. It includes all subsystems and the installation and checkout of all subsystem elements into the complete module as well as all changes and tool maintenance and module refurbishment. This element excludes the effort associated with producing specially fabricated test hardware as identified under the Major Test Programs WBS element. It also excludes the physical integration of GFE/GEP and experiments.

NEXT HIGHER LEVEL ELEMENTS (LEVEL 3)

XX-1XX-00-00 Modular Space Station Project

NEXT LOWER LEVEL ELEMENTS (LEVEL 5)

XX-1XX-05-01 Structural & Mechanical Subsystems

NEXT LOWER LEVEL ELEMENTS (LEVEL 5)

XX-1XX-05-01	Structural & Mechanical Subsystems
XX-1XX-05-02	ECLS Subsystem
XX-1XX-05-03	Electrical Power Subsystem
XX-1XX-05-04	Guidance and Control Subsystem (Not Applicable)
XX-1XX-05-05	Reaction Control Subsystem
XX-1XX-05-06	Information Subsystem
XX-1XX-05-07	Crew Habitability Subsystem
XX-1XX-05-08	Subsystem Installation, Assembly & Checkout
XX-1XX-05-09	Module Refurbishment (Not Applicable)

XX-1XX-05-00



XX-1XX-06-00

X DDT&E
X PRODUCTION
OPERATIONS

CONTROL/CREW MODULE SM-4 (LEVEL 4)

This element refers to the complete control/crew module SM-4 to be launched internal to the space shuttle. It includes the design, manufacturing, test, tooling, special test equipment, and quality control effort associated with the development of all production units which satisfy the requirements of the applicable specification. It includes all subsystems and the installation and checkout of all subsystem elements into the complete module as well as all changes and tool maintenance and module refurbishment. This element excludes the effort associated with producing specially fabricated test hardware as identified under the Major Test Programs WBS element. It also excludes the physical integration of GFE/GFP and experiments.

NEXT HIGHER LEVEL ELEMENTS (LEVEL 3)

XX-1XX-00-00 Modular Space Station Project

NEXT LOWER LEVEL ELEMENTS (LEVEL 5)

XX-1XX-06-01	Structural & Mechanical Subsystem
XX-1XX-06-02	ECLS Subsystem
XX-1XX-06-03	Electrical Power Subsystem
XX-1XX-06-04	Guidance and Control Subsystem (Not Applicable)
XX-1XX-06-05	Reaction Control Subsystem (Not Applicable)
XX-1XX-06-06	Information Subsystem
XX-1XX-06-07	Crew Habitability Subsystem
XX-1XX-06-08	Subsystem Installation, Assembly & Checkout
XX-1XX-06-09	Module Refurbishment (Not Applicable)

XX-1XX-06-00

XX-1XX-07-00

X DDT&E
X PRODUCTION
X OPERATIONS

CARGO MODULES (LEVEL 4)

This element refers to complete cargo modules to be launched internal to the space shuttle. It includes the design, manufacturing, test, tooling, special test equipment, and quality control effort associated with the development of all production units which satisfy the requirements of the applicable specification. It includes all subsystems and the installation and checkout of all subsystem elements into the complete module as well as all changes and tool maintenance and module refurbishment. This element excludes the effort associated with producing specially fabricated test hardware as identified under the Major Test Programs WBS element. It also excludes the physical integration of GFE/GFP and experiments.

NEXT HIGHER LEVEL ELEMENTS (LEVEL 3)

XX-1XX-00-00 Modular Space Station Project

NEXT LOWER LEVEL ELEMENTS (LEVEL 5)

XX-1XX-07-01	Structural & Mechanical Subsystem
XX-1XX-07-02	ECLS Subsystem
XX-1XX-07-03	Electrical Power Subsystem
XX-1XX-07-04	Guidance and Control Subsystem (Not Applicable)
XX-1XX-07-05	Reaction Control Subsystem (Not Applicable)
XX-1XX-07-06	Information Subsystem
XX-1XX-07-07	Crew Habitability Subsystem
XX-1XX-07-08	Subsystem Installation, Assembly and Checkout
XX-1XX-07-09	Module Refurbishment

XX-1XX-07-00



XX-1XX-08-00

X DDT&E
X PRODUCTION
OPERATIONS

GROWTH CORE MODULE (LEVEL 4)

This element refers to the complete growth core module to be launched internal to the space shuttle. It includes the design, manufacturing, test, tooling, special test equipment, and quality control effort associated with the development of all production units which satisfy the requirements of the applicable specification. It includes all subsystems and the installation and checkout of all subsystem elements into the complete module as well as all changes and tool maintenance and module refurbishment. This element excludes the effort associated with producing specially fabricated test hardware as identified under the Major Test Programs WBS element. It also excludes the physical integration of GFE/GFP and experiments.

NEXT HIGHER LEVEL ELEMENTS (LEVEL 3)

XX-1XX-00-00 Modular Space Station Project

NEXT LOWER LEVEL ELEMENTS (LEVEL 5)

XX-1XX-08-01	Structural & Mechanical Subsystem
XX-1XX-08-02	ECLS Subsystem
XX-1XX-08-03	Electrical Power Subsystem
XX-1XX-08-04	Guidance and Control Subsystem (Not Applicable)
XX-1XX-08-05	Reaction Control Subsystem
XX-1XX-08-06	Information Subsystem
XX-1XX-08-07	Crew Habitability Subsystem
XX-1XX-08-08	Subsystem Installation, Assembly and Checkout
XX-1XX-08-09	Module Refurbishment (Not Applicable)

XX-1XX-08-00

XX-1XX-09-00

X DDT&E
X PRODUCTION
OPERATIONS

CREW/ECLSS MODULE SM-5 (LEVEL 4)

This element refers to the complete crew/ECLSS module SM-5 to be launched internal to the space shuttle. It includes the design, manufacturing, test, tooling, special test equipment, and quality control effort associated with the development of all production units which satisfy the requirements of the applicable specification. It includes all subsystems and the installation and checkout of all subsystem elements into the complete module as well as all changes and tool maintenance and module refurbishment. This element excludes the effort associated with producing specially fabricated test hardware as identified under the Major Test Programs WBS element. It also excludes the physical integration of GFE/GFP and experiments.

NEXT HIGHER LEVEL ELEMENTS (LEVEL 3)

XX-1XX-00-00 Modular Space Station Project

NEXT LOWER LEVEL ELEMENTS (LEVEL 5)

XX-1XX-09-01	Structural & Mechanical Subsystem
XX-1XX-09-02	ECLS Subsystem
XX-1XX-09-03	Electrical Power Subsystem
XX-1XX-09-04	Guidance and Control Subsystem (Not Applicable)
XX-1XX-09-05	Reaction Control Subsystem
XX-1XX-09-06	Information Subsystem
XX-1XX-09-07	Crew Habitability Subsystem
XX-1XX-09-08	Subsystem Installation, Assembly and Checkout
XX-1XX-09-09	Module Refurbishment (Not Applicable)

XX-1XX-09-00

XX-1XX-10-00

X DDT&E
X PRODUCTION
OPERATIONS

CREW/ECLSS MODULE SM-6 (LEVEL 4)

This element refers to the complete crew/ECLSS module SM-6 to be launched internal to the space shuttle. It includes the design, manufacturing, test, tooling, special test equipment, and quality control effort associated with the development of all production units which satisfy the requirements of the applicable specification. It includes all subsystems and the installation and checkout of all subsystem elements into the complete module as well as all changes and tool maintenance and module refurbishment. This element excludes the effort associated with producing specially fabricated test hardware as identified under the Major Test Programs WBS element. It also excludes the physical integration of GFE/GFP and experiments.

NEXT HIGHER LEVEL ELEMENTS (LEVEL 3)

XX-1XX-00-00 Modular Space Station Project

NEXT LOWER LEVEL ELEMENTS (LEVEL 5)

XX-1XX-10-01	Structural and Mechanical Subsystem
XX-1XX-10-02	ECLS Subsystem
XX-1XX-10-03	Electrical Power Subsystem
XX-1XX-10-04	Guidance and Control Subsystem (Not Applicable)
XX-1XX-10-05	Reaction Control Subsystem
XX-1XX-10-06	Information Subsystem
XX-1XX-10-07	Crew Habitability Subsystem
XX-1XX-10-08	Subsystem Installation, Assembly and Checkout
XX-1XX-10-09	Module Refurbishment (Not Applicable)

XX-1XX-10-00



XX-1XX-NN-01

X DDT&E
X PRODUCTION
OPERATIONS

STRUCTURAL AND MECHANICAL SUBSYSTEM (LEVEL 5)

This WBS element refers to the design, development, test, tooling, special test equipment, fabrication, procurement and quality control effort for the structural and mechanical subsystem through completion of qualification testing. It includes primary structure, secondary structure, environmental shielding, berthing, and general purpose laboratory furnishings to the extent that they are required by the specific module.

NEXT HIGHER LEVEL ELEMENTS (LEVEL 4)

XX-1XX-01-00	Initial Core Module
XX-1XX-02-00	Power Module
XX-1XX-03-00	Control/Crew Module (SM-1)
XX-1XX-04-00	Labs/ECLSS Module (SM-2)
XX-1XX-05-00	Labs/ECLSS Module (SM-3)
XX-1XX-06-00	Control/Crew Module (SM-4)
XX-1XX-07-00	Cargo Modules
XX-1XX-08-00	Growth Core Module
XX-1XX-09-00	ECLSS/Crew Module (SM-5)
XX-1XX-10-00	ECLSS/Crew Module (SM-6)

NEXT LOWER LEVEL ELEMENTS (LEVEL 6)

To be determined in next phase.

XX-1XX-NN-01

XX-1XX-NN-02

X DDT&E
X PRODUCTION
OPERATIONS

ENVIRONMENTAL CONTROL/LIFE SUPPORT (ECLS) SUBSYSTEM
(LEVEL 5)

This WBS element refers to the design, development, test, tooling, special test equipment, fabrication, procurement and quality control effort for the environmental control/life support subsystem through completion of qualification testing. It includes gaseous storage, CO₂ management, atmospheric control, thermal control, water management, waste management, hygiene, and special life support to the extent that they are required by the specific module.

NEXT HIGHER LEVEL ELEMENTS (LEVEL 4)

XX-1XX-01-00	Initial Core Module
XX-1XX-02-00	Power Module
XX-1XX-03-00	Control/Crew Module (SM-1)
XX-1XX-04-00	Labs/ECLSS Module (SM-2)
XX-1XX-05-00	Labs/ECLSS Module (SM-3)
XX-1XX-06-00	Control/Crew Module (SM-4)
XX-1XX-07-00	Cargo Modules
XX-1XX-08-00	Growth Core Module
XX-1XX-09-00	ECLSS/Crew Module (SM-5)
XX-1XX-10-00	ECLSS/Crew Module (SM-6)

NEXT LOWER LEVEL ELEMENTS (LEVEL 6)

To be determined in next phase.

XX-1XX-NN-02



XX-1XX-NN-03

X DDT&E
X PRODUCTION
OPERATIONS

ELECTRICAL POWER SUBSYSTEM (LEVEL 5)

This WBS element refers to the design, development, test, tooling, special test equipment, manufacturing, procurement and quality control effort for the electrical power subsystem through completion of qualification testing. It includes primary and secondary power generation, energy storage, power conditioning, distribution, control and wiring, and lighting to the extent that they are required by that module. Primary power generation includes both initial and growth station solar arrays.

NEXT HIGHER LEVEL ELEMENTS (LEVEL 4)

XX-1XX-01-00	Initial Core Module
XX-1XX-02-00	Power Module
XX-1XX-03-00	Control/Crew Module (SM-1)
XX-1XX-04-00	Labs/ECLSS Module (SM-2)
XX-1XX-05-00	Labs/ECLSS Module (SM-3)
XX-1XX-06-00	Control/Crew Module (SM-4)
XX-1XX-07-00	Cargo Modules
XX-1XX-08-00	Growth Core Module
XX-1XX-09-00	ECLSS/Crew Module (SM-5)
XX-1XX-10-00	ECLSS/Crew Module (SM-6)

NEXT LOWER LEVEL ELEMENTS (LEVEL 6)

To be determined in next phase.

XX-1XX-NN-03



XX-1XX-NN-04

X DDT&E
X PRODUCTION
OPERATIONS

GUIDANCE AND CONTROL SUBSYSTEM (LEVEL 5)

This WBS element refers to the design, development, test, tooling, special test equipment, fabrication, procurement and quality control effort for the guidance and control subsystem through completion of qualification testing. It includes inertial reference, optical reference, reaction control system electronics, momentum exchange, and computation to the extent that they are required by the specific module.

NEXT HIGHER LEVEL ELEMENTS (LEVEL 4)

XX-1XX-01-00	Initial Core Module
XX-1XX-02-00	Power Module (Not Applicable)
XX-1XX-03-00	Control/Crew Module (SM-1) (Not Applicable)
XX-1XX-04-00	Labs/ECLSS Module (SM-2) (Not Applicable)
XX-1XX-05-00	Labs/ECLSS Module (SM-3) (Not Applicable)
XX-1XX-06-00	Control/Crew Module (SM-4) (Not Applicable)
XX-1XX-07-00	Cargo Modules (Not Applicable)
XX-1XX-08-00	Growth Core Module (Not Applicable)
XX-1XX-09-00	ECLSS/Crew Module (SM-5) (Not Applicable)
XX-1XX-10-00	ECLSS/Crew Module (SM-6) (Not Applicable)

NEXT LOWER LEVEL ELEMENTS (LEVEL 6)

To be determined in next phase.

XX-1XX-NN-04



XX-1XX-NN-05

X DDT&E
X PRODUCTION
OPERATIONS

REACTION CONTROL SUBSYSTEM (LEVEL 5)

This WBS element refers to the design, development, test, tooling, special test equipment, fabrication, procurement and quality control effort for the reaction control subsystem through completion of qualification testing. It includes propellant accumulator, propellant feed controls, and engines to the extent that they are required by the specific module.

NEXT HIGHER LEVEL ELEMENTS (LEVEL 4)

XX-1XX-01-00	Initial Core Module
XX-1XX-02-00	Power Module (Not Applicable)
XX-1XX-03-00	Control/Crew Module (SM-1) (Not Applicable)
XX-1XX-04-00	Labs/ECLSS Module (SM-2)
XX-1XX-05-00	Labs/ECLSS Module (SM-3)
XX-1XX-06-00	Control/Crew Module (SM-4) (Not Applicable)
XX-1XX-07-00	Cargo Modules (Not Applicable)
XX-1XX-08-00	Growth Core Module
XX-1XX-09-00	ECLSS/Crew Module (SM-5)
XX-1XX-10-00	ECLSS/Crew Module (SM-6)

NEXT LOWER LEVEL ELEMENTS (LEVEL 6)

To be determined in next phase.

XX-1XX-NN-05



XX-1XX-NN-06

X DDT&E
X PRODUCTION
OPERATIONS

INFORMATION SUBSYSTEM (LEVEL 5)

This WBS element refers to the design, development, test, tooling, special test equipment, fabrication, procurement and quality control effort for the information subsystem through completion of qualification testing. It includes data processing, command/control and monitoring, software, and external and internal communications to the extent that they are required by the specific module.

NEXT HIGHER LEVEL ELEMENTS (LEVEL 4)

XX-1XX-01-00	Initial Core Module
XX-1XX-02-00	Power Module
XX-1XX-03-00	Control/Crew Module (SM-1)
XX-1XX-04-00	Labs/ECLSS Module (SM-2)
XX-1XX-05-00	Labs/ECLSS Module (SM-3)
XX-1XX-06-00	Control/Crew Module (SM-4)
XX-1XX-07-00	Cargo Modules
XX-1XX-08-00	Growth Core Module
XX-1XX-09-00	ECLSS/Crew Module (SM-5)
XX-1XX-10-00	ECLSS/Crew Module (SM-6)

NEXT LOWER LEVEL ELEMENTS (LEVEL 6)

To be determined in next phase.

XX-1XX-NN-06



XX-1XX-NN-07

X DDT&E
X PRODUCTION
OPERATIONS

CREW HABITABILITY SUBSYSTEM (LEVEL 5)

This WBS element refers to the design, development, test, tooling, special test equipment, manufacturing, procurement and quality control effort for the crew habitability subsystem through completion of qualification testing. It includes personal equipment, general/emergency, furnishings, recreation/exercise/crew care, and food management to the extent that they are required by the specific module.

NEXT HIGHER LEVEL ELEMENTS (LEVEL 4)

XX-1XX-01-00	Initial Core Module
XX-1XX-02-00	Power Module
XX-1XX-03-00	Control/Crew Module (SM-1)
XX-1XX-04-00	Labs/ECLSS Module (SM-2)
XX-1XX-05-00	Labs/ECLSS Module (SM-3)
XX-1XX-06-00	Control/Crew Module (SM-4)
XX-1XX-07-00	Cargo Modules
XX-1XX-08-00	Growth Core Module
XX-1XX-09-00	ECLSS/Crew Module (SM-5)
XX-1XX-10-00	ECLSS/Crew Module (SM-6)

NEXT LOWER LEVEL ELEMENTS (LEVEL 6)

To be determined in next phase.

XX-1XX-NN-07



XX-1XX-NN-08

X DDT&E
X PRODUCTION
OPERATIONS

SUBSYSTEM INSTALLATION, ASSEMBLY AND CHECKOUT (LEVEL 5)

This WBS element includes the design, development, test, tooling, special test equipment, fabrication, procurement and quality control effort associated with the installation of all subsystems into, and the checkout and acceptance testing of completely assembled modules prior to shipment from the development contractor's plant. It also includes engineering effort such as final assembly drawings, packaging and transportability design, and CEI (Part II) product specifications.

NEXT HIGHER LEVEL ELEMENTS (LEVEL 4)

XX-1XX-01-00	Initial Core Module
XX-1XX-02-00	Power Module
XX-1XX-03-00	Control/Crew Module (SM-1)
XX-1XX-04-00	Labs/ECLSS Module (SM-2)
XX-1XX-05-00	Labs/ECLSS Module (SM-3)
XX-1XX-06-00	Control/Crew Module (SM-4)
XX-1XX-07-00	Cargo Modules
XX-1XX-08-00	Growth Core Module
XX-1XX-09-00	ECLSS/Crew Module (SM-5)
XX-1XX-10-00	ECLSS/Crew Module (SM-6)

NEXT LOWER LEVEL ELEMENTS (LEVEL 6)

To be determined in next phase.

XX-1XX-NN-08



XX-1XX-NN-09

DDT&E
PRODUCTION
X OPERATIONS

MODULE REFURBISHMENT (LEVEL 5)

This element, if applicable, refers to the effort associated with refurbishment of modules returned to the development contractor for scheduled and unscheduled maintenance, repair, subsystem update and/or reconfiguration. This effort begins with module receipt from the shuttle landing site and ends with shipment of the refurbished module to the launch site. Included is the effort to test, remove, replace and check out, transportation, and module storage if required. This element excludes the effort of providing ground replacement units covered under the spares WBS element.

NEXT HIGHER LEVEL ELEMENTS (LEVEL 4)

XX-1XX-01-00	Initial Core Module
XX-1XX-02-00	Power Module
XX-1XX-03-00	Control/Crew Module (SM-1)
XX-1XX-04-00	Labs/ECLSS Module (SM-2)
XX-1XX-05-00	Labs/ECLSS Module (SM-3)
XX-1XX-06-00	Control/Crew Module (SM-4)
XX-1XX-07-00	Cargo Modules
XX-1XX-08-00	Growth Core Module
XX-1XX-09-00	ECLSS/Crew Module (SM-5)
XX-1XX-10-00	ECLSS/Crew Module (SM-6)

NOTE: This WBS element is applicable, on a planned basis, to cargo modules only.

NEXT LOWER LEVEL ELEMENTS (LEVEL 6)

To be determined in next phase.

XX-1XX-NN-09



XX-1XX-20-00

X DDT&E
 PRODUCTION
 OPERATIONS

MODULE INTEGRATION, ASSEMBLY AND CHECKOUT (LEVEL 4)

This element refers to the physical integration, assembly, and checkout activities associated with mating and conducting integrated systems tests on the first four space station flight modules to demonstrate operational readiness of the initial space station prior to the first module launch. This element excludes the integrated test effort of non-flight hardware associated with the Major Test Programs element as well as the flight hardware development and acceptance testing effort in direct support of individual modules.

NEXT HIGHER LEVEL ELEMENTS (LEVEL 3)

XX-1XX-00-00 Modular Space Station Project

NEXT LOWER LEVEL ELEMENTS (LEVEL 5)

To be determined in next phase.

XX-1XX-20-00



XX-1XX-25-00

X	DDT&E
X	PRODUCTION
X	OPERATIONS

PROJECT MANAGEMENT (LEVEL 4)

The project management element refers to the overall management and administrative planning, staffing, organizing, directing, coordinating, controlling, and approval actions designed to accomplish overall project objectives which are not associated with specific hardware elements. Examples of these activities are performance management (cost/schedule/technical), program plans, configuration management, data management, safety management, contract management, associate contractor interface, subcontract management, facilities management, production management, quality assurance management, and publications.

NEXT HIGHER LEVEL ELEMENTS (LEVEL 3)

XX-1XX-00-00 Modular Space Station Project

NEXT LOWER LEVEL ELEMENTS (LEVEL 5)

To be determined in next phase.

XX-1XX-25-00



XX-1XX-30-00

X DDT&E
X PRODUCTION
X OPERATIONS

SYSTEMS SUPPORT (LEVEL 4)

This element refers to the effort of directing and controlling a totally integrated engineering effort including systems engineering, and specialty fields (i. e., reliability, maintainability, systems effectiveness, safety engineering, human factors, etc.). It includes mission and systems definition and requirements, interface and change integration, verification, engineering controls, technical program planning, and project engineering activities. This element includes the preparation of development and product specifications for equipment and components, but excludes the design effort associated with such hardware.

NEXT HIGHER LEVEL ELEMENTS (LEVEL 3)

XX-1XX-00-00 Modular Space Station Project

NEXT LOWER LEVEL ELEMENTS (LEVEL 5)

To be determined in the next phase.

XX-1XX-30-00



XX-1XX-35-00

X DDT&E
PRODUCTION
X OPERATIONS

PRE-MISSION OPERATIONS (LEVEL 4)

Pre-mission operations include the necessary services and materials to conduct pre-mission operations support system site activation and maintenance, transportation and handling, equipment receiving and checkout at the launch site, MSS module checkout and integration with the space shuttle, logistics and technical support for launch operations up to the point of initial MSS IOC. This element excludes the fabrication or construction of GSE and facilities, and also any effort associated with experiment integration, as identified under those WBS elements.

The sites involved with pre-mission operations are:

Management, Administrative, and Development Laboratory Site
Manufacturing Site
Acceptance and Delivery Site
Assembly Site
Launch Site

NEXT HIGHER LEVEL ELEMENTS (LEVEL 3)

XX-1XX-00-00 Modular Space Station Project

NEXT LOWER LEVEL ELEMENTS (LEVEL 5)

To be determined in next phase.

XX-1XX-35-00



XX-1XX-40-00

X	DDT&E
	PRODUCTION
X	OPERATIONS

MISSION OPERATIONS (LEVEL 4)

This element refers to the effort and material required to conduct sustaining launch operations after initial MSS IOC, and perform mission operations support system site activation and maintenance, mission and experiment operations planning, and ground command, control, tracking, and communications with the modular space station. It includes flight control, telemetry, communications, data processing, data analysis, and logistics inventory management support including IFRU replacement. It also includes any contractor effort to conduct crew training. This element excludes the fabrication or construction of GSE, training equipment, facilities, or spares as identified under those WBS elements.

The sites involved with mission operations are:

- Launch Site
- Mission Management Site
- Mission Support Site
- Crew Training Site

NEXT HIGHER LEVEL ELEMENTS (LEVEL 3)

XX-1XX-00-00 Modular Space Station Project

NEXT LOWER LEVEL ELEMENTS (LEVEL 5)

To be determined in next phase.

XX-1XX-40-00



XX-1XX-45-00

X DDT&E
PRODUCTION
OPERATIONS

GPL EXPERIMENT INTEGRATION (LEVEL 4)

This element refers to the systems engineering effort of directing and controlling a totally integrated GPL experiment program. It includes the preparation of performance and interface (P&I) specifications for GPL experiments, but does not include the design effort associated with such hardware.

NEXT HIGHER LEVEL ELEMENTS (LEVEL 3)

XX-1XX-00-00 Modular Space Station Project

NEXT LOWER LEVEL ELEMENTS (LEVEL 5)

To be determined in next phase.

XX-1XX-45-00



XX-1XX-50-00

X DDT&E
PRODUCTION
OPERATIONS

MAJOR TEST PROGRAMS (LEVEL 4)

This element refers to the effort of providing and using specially fabricated hardware to obtain or validate engineering data on the performance of the space station flight or ground systems or individual Level 4 module elements through structural and dynamic testing, compatibility assessment, and buildup of the mission support vehicle (MSV). This element includes the detail planning, test conduct, support, data reduction and reports from such operations, and all hardware items which are consumed, or planned to be consumed, in the conduct of such operations. It also includes all effort associated with the design and production of models, specimens, fixtures and instrumentation in support of the test programs. Test articles which are functionally configured as required by the specification (i. e., production hardware) and all development, component acceptance, qualification, etc., testing which can be specifically associated with the production hardware elements are excluded.

NEXT HIGHER LEVEL ELEMENTS (LEVEL 3)

XX-1XX-00-00 Modular Space Station Project

NEXT LOWER LEVEL ELEMENTS (LEVEL 5)

To be determined in next phase.

XX-1XX-50-00



XX-1XX-55-00

X DDT&E
PRODUCTION
OPERATIONS

TRAINING EQUIPMENT (LEVEL 4)

The training equipment element includes the devices, accessories, aids, equipment, and parts used to facilitate instruction through which flight and ground crew personnel will acquire sufficient concepts, skills, and aptitudes to operate and maintain the systems with maximum efficiency. This element includes all contractor effort associated with the design, development, and production of training equipment. The training equipment element refers to those distinctive end items of training equipment required to meet specific training objectives, including for example, operational trainers, maintenance trainers, and other items such as cutaways, mockups, and models. This element excludes preparation of course data, handbooks, and the conduct of crew training (covered under Mission Operations).

NEXT HIGHER LEVEL ELEMENTS (LEVEL 3)

XX-1XX-00-00 Modular Space Station Project

NEXT LOWER LEVEL ELEMENTS (LEVEL 5)

To be determined in next phase.

XX-1XX-55-00



XX-1XX-60-00

X DDT&E
PRODUCTION
OPERATIONS

GROUND SUPPORT EQUIPMENT (GSE) (LEVEL 4)

This element refers to the provisioning, design, and production of checkout, launch, and handling equipment required at the sites for acceptance test and flight activities, including equipment at the plant, test site, and launch site for checkout and maintenance of systems or subsystems, and for support of premission and mission operations. It also includes ground-based equipment/software associated with the MSS on-board information subsystem. This element excludes site activation and GSE maintenance (covered under Pre-mission and Mission Operations) and spares for GSE.

NEXT HIGHER LEVEL ELEMENTS (LEVEL 3)

XX-1XX-00-00 Modular Space Station Project

NEXT LOWER LEVEL ELEMENTS (LEVEL 5)

To be determined in next phase.

XX-1XX-60-00



XX-1XX-65-00

X DDT&E
PRODUCTION
OPERATIONS

FACILITIES (LEVEL 4)

This element includes industrial facilities, test facilities, and operational facilities.

Industrial facilities include the construction, conversion, or expansion of facilities for production, inventory, and maintenance. The element includes, for example, equipment acquisition or modernization, but does not include site activation or maintenance of the above facilities or equipment.

Test facilities refer to those special test facilities required for performance of the various developmental tests necessary to prove the design and reliability of systems and/or subsystems. This element includes, for example, engine test fixtures, white rooms, test chambers, etc. The brick-and-mortar type facilities allocable to industrial facilities are excluded as is site activation and maintenance.

Operational facilities refer to the real estate, construction, conversion, utilities, and equipment to provide all facilities required to house, service, and launch prime mission equipment. This element does not include site activation or maintenance.

NEXT HIGHER LEVEL ELEMENTS (LEVEL 3)

XX-1XX-00-00 Modular Space Station Project

NEXT LOWER LEVEL ELEMENTS (LEVEL 5)

To be determined in next phase.

XX-1XX-65-00



XX-1XX-70-00

DDT&E
PRODUCTION
X OPERATIONS

SPARES (LEVEL 4)

This element refers to the production and refurbishment of all spares and repair parts used for replacement purposes in end items of flight and ground equipment; and for use as in-flight replaceable units (IFRU) and ground replaceable units (GRU) to support module refurbishment. Provisioning, fabrication, procurement, test, packaging, handling and transportability design is included. This element excludes logistics inventory management effort which is covered under the Mission Operations WBS element.

NEXT HIGHER LEVEL ELEMENTS (LEVEL 3)

XX-1XX-00-00 Modular Space Station Project

NEXT LOWER LEVEL ELEMENTS (LEVEL 5)

To be determined in next phase.

XX-1XX-70-00



XX-1XX-75-00

X DDT&E
PRODUCTION
OPERATIONS

GFE/GFP & INTEGRATION (LEVEL 4)

This element includes the effort associated with the physical integration (receipt, acceptance test, modification, installation and checkout) of GFE/GFP into the end items. It also includes NASA-provided costs of the GFE/GFP items. This element includes all GFE/GFP required to satisfy the end item specification, and specifically excludes the effort of providing and installing GPL experiments.

NEXT HIGHER LEVEL ELEMENTS (LEVEL 3)

XX-1XX-00-00 Modular Space Station Project

NEXT LOWER LEVEL ELEMENTS (LEVEL 5)

To be determined in next phase.

XX-1XX-75-00



XX-1XX-80-00

	DDT&E
X	PRODUCTION
X	OPERATIONS

EXPERIMENT INSTALLATION, ASSEMBLY & CHECKOUT (LEVEL 4)

This element includes all of the modular space station contractor's effort associated with the physical installation of Government-furnished GPL (integral) experiments into the space station modules. It also includes installation of selected GPL experiments at the launch site, when required.

NEXT HIGHER LEVEL ELEMENTS (LEVEL 3)

XX-1XX-00-00 Modular Space Station Project

NEXT LOWER LEVEL ELEMENTS (LEVEL 5)

To be determined in next phase.

XX-1XX-80-00



XX-2XX-00-00

X DDT&E
PRODUCTION
OPERATIONS

EXPERIMENTS DEFINITION (LEVEL 3)

This Level 3 element summarizes the conceptual and definition activities required for the following experiment disciplines:

Astronomy (A)
Physics (O)
Earth Observations (ES)
Communications/Navigation (C/N)
Material Science and Manufacturing (MS)
Technology (T)
Life Sciences (LS)

It also includes the effort associated with overall experiment planning activities. Descriptions of each of the above activities as furnished by the NASA are contained in the addendum to this dictionary.

NEXT HIGHER LEVEL ELEMENTS (LEVEL 2)

XX-0XX-00-00 Space Station Earth Orbital Program

NEXT LOWER LEVEL ELEMENTS (LEVEL 4)

XX-2XX-01-00	Astronomy (A)
XX-2XX-02-00	Physics (P)
XX-2XX-03-00	Earth Observations (ES)
XX-2XX-04-00	Communications/Navigation (C/N)
XX-2XX-05-00	Material Science and Manufacturing (MS)
XX-2XX-06-00	Technology (T)
XX-2XX-07-00	Life Sciences (LS)
XX-2XX-10-00	Experiment Planning

XX-2XX-00-00



XX-3XX-00-00

X DDT&E
X PRODUCTION
X OPERATIONS

EARTH ORBITAL EXPERIMENTS (LEVEL 3)

This WBS element summarizes the GPL, attached, and detached experiment groups which provide the functional program elements (FPE) for the modular space station, attached, and detached RAM projects.

NEXT HIGHER LEVEL ELEMENTS (LEVEL 2)

XX-0XX-00-00 Space Station Earth Orbital Program

NEXT LOWER LEVEL ELEMENTS (LEVEL 4)

XX-3XX-NN-00 GPL Experiments (Aggregate)
XX-3XX-YY-00 Attached RAM Experiments (Aggregate)
XX-3XX-ZZ-00 Detached RAM Experiments (Aggregate)

XX-3XX-00-00

XX-3XX-NN-00

X DDT&E
X PRODUCTION
X OPERATIONSGPL EXPERIMENTS (LEVEL 4)

This element is an aggregate of the following Level 4 FPE's:

- P. 1 Space Physics Research Laboratory
- P. 2 Plasma Physics and Environmental Perturbation Laboratory
- P. 4 Physics and Chemistry Laboratory
- ES. 1 Earth Observations Facility
- C/N. 1 Communications/Navigation Research Facility
- MS. 1 Material Science and Manufacturing in Space
- T. 1 Contamination Measurements
- T. 3 Extravehicular Activity (EVA)
- T. 4 Advanced Spacecraft System Test
- T. 5 Teleoperation
- LS. 1 Medical Research Facility
- LS. 2 Vertebrate Research Facility
- LS. 3 Plant Research Facility
- LS. 4 Cells and Tissues Research Facility
- LS. 5 Invertebrate Research Facility
- LS. 7 Man-System Integration

The above FPE's are identified as General Purpose Laboratory (GPL) experiments due to their mode of accommodation in the experiment program. This element combines all of the design, provisioning, manufacturing, test, tooling, special test equipment, and quality control activities associated with the development, production, and operation of the FPE's. It also includes the effort of installing and refurbishing experiments in orbit or returned from orbit, but excludes the installation, assembly and checkout of experiments into the GPL facility prior to MSS module launch.

Descriptions of the above FPE's as furnished by the NASA are contained in the addendum to this dictionary.

NEXT HIGHER LEVEL ELEMENTS (LEVEL 3)

XX-3XX-00-00 Earth Orbital Experiments

NEXT LOWER LEVEL ELEMENTS (LEVEL 5)

To be determined in next phase.

XX-3XX-NN-00

XX-3XX-YY-00

X DDT&E
X PRODUCTION
X OPERATIONSATTACHED RAM EXPERIMENTS (LEVEL 4)

This element is an aggregate of the following Level 4 FPE's:

- A. 3 Advanced Solar Astronomy
- A. 4 Intermediate Size UB Telescope
- A. 5 High Energy Stellar Astronomy
- A. 6 Infrared Astronomy
- P. 3 Cosmic Ray Physics Laboratory
- P. 4 Physics and Chemistry Laboratory
- ES. 1 Earth Observations Facility
- LS. 2 Vertebrate Research Facility
- LS. 3 Plant Research Facility
- LS. 4 Cells and Tissues Research Facility
- LS. 5 Invertebrate Research Facility
- LS. 6 Life Support and Protective Systems
- LS. 7 Man-System Integration

The above listed FPE's are identified as attached experiments due to their mode of accommodation in the experiment program. This element combines all of the design, provisioning, manufacturing, test, tooling, special test equipment, and quality control activities associated with the development, production, and operation of the FPE's. It also includes the effort of installing and refurbishing experiments in orbit or returned to earth, but excludes the installation, assembly and checkout of experiments into the RAM's prior to launch.

Descriptions of the above FPE's as furnished by the NASA are contained in the addendum to this dictionary.

NEXT HIGHER LEVEL ELEMENTS (LEVEL 3)

XX-3XX-00-00 Earth Orbital Experiments

NEXT LOWER LEVEL ELEMENTS (LEVEL 5)

To be determined in next phase.

XX-3XX-YY-00



XX-3XX-ZZ-00

X DDT&E
X PRODUCTION
X OPERATIONS

DETACHED RAM EXPERIMENTS (LEVEL 4)

This element is an aggregate of the following Level 4 FPE's:

- A. 1 X-Ray Stellar Astronomy
- A. 2 Advanced Stellar Astronomy
- A. 3 Advanced Solar Astronomy
- A. 4 Intermediate Size UV Telescope
- A. 5 High Energy Stellar Astronomy
- A. 6 Infrared Astronomy
- T. 2 Fluid Management
- T. 4 Advanced Spacecraft Systems Test

The above listed FPE's are identified as detached experiments due to their mode of accommodation in the experiment program.

This element combines all of the design, provisioning, manufacturing, test, tooling, special test equipment and quality control activities associated with the development, production, and operation of the FPE's. It also includes the effort of installing and refurbishing experiments in orbit, or returned to earth, but excludes the installation, assembly and checkout of experiments into the RAM's prior to their launch.

Descriptions of the above FPE's as furnished by the NASA are contained in the addendum to this dictionary.

NEXT HIGHER LEVEL ELEMENTS (LEVEL 3)

XX-3XX-00-00 Earth Orbital Experiments

NEXT LOWER LEVEL ELEMENTS (LEVEL 5)

To be determined in next phase.

XX-3XX-ZZ-00



XX-4XX-00-00

X DDT&E
X PRODUCTION
X OPERATIONS

ATTACHED RAM PROJECT (LEVEL 3)

The Level 3 Attached RAM project WBS element summarizes all of the effort required to develop and produce a group of experiment modules (RAM's) for attachment to the space station complex. This element specifically excludes the effort associated with producing FPE's as identified under the Earth Orbital Experiment elements.

NEXT HIGHER LEVEL ELEMENTS (LEVEL 2)

XX-0XX-00-00 Space Station Earth Orbital Program

NEXT LOWER LEVEL ELEMENTS (LEVEL 4)

XX-4XX-YY-00 RAM's (Aggregate)

XX-4XX-00-00

XX-4XX-YY-00

X DDT&E
X PRODUCTION
X OPERATIONSRAM's (LEVEL 4)

This WBS element is an aggregate of all Level 4 activities required to produce experiment modules (RAM's) for attachment to the modular space station complex. This element includes the design, manufacturing, test procurement, special test equipment, and quality control effort associated with the individual RAM's. It also includes all Level 4 floating items identifiable and peculiar to the attached RAM project (i. e., project management, systems support, experiment installation and checkout, pre-mission operations, mission operations, major test programs, training equipment, etc.). The following ten Level 4 RAM's are identified:

- High Energy Stellar Astronomy RAM
- Advanced Solar Astronomy RAM
- Cosmic Ray Physics Lab RAM
- Infrared Astronomy RAM
- Intermediate Size UV Telescope RAM
- Earth Observations RAM
- Man-Systems Integration RAM
- Bioscience Research Lab RAM
- Physics & Chemistry Lab RAM
- Life Support & Protective System RAM

NEXT HIGHER LEVEL ELEMENTS (LEVEL 3)

XX-4XX-00-00 Attached RAM Project

NEXT LOWER LEVEL ELEMENTS (LEVEL 5)

To be determined in next phase.

XX-4XX-YY-00

XX-5XX-00-00

X	DDT&E
X	PRODUCTION
X	OPERATIONS

DETACHED RAM PROJECT (LEVEL 3)

The Level 3 detached RAM project WBS element summarizes all of the effort required to develop and produce a group of experiment modules (RAM's) for placement into orbit in conjunction with but detached from the space station complex. It specifically excludes the effort associated with producing FPE's as identified under the Earth Orbital Experiment elements.

NEXT HIGHER LEVEL ELEMENTS (LEVEL 2)

XX-0XX-00-00 Space Station Earth Orbital Program

NEXT LOWER LEVEL ELEMENTS (LEVEL 4)

XX-5XX-ZZ-00 RAM's (Aggregate)

XX-5XX-00-00



XX-5XX-ZZ-00

X DDT&E
X PRODUCTION
X OPERATIONS

RAM's (LEVEL 4)

This WBS element is an aggregate of all Level 4 activities required to produce experiment modules (RAM's) for placement into orbit in conjunction with, but detached from the modular space station complex. This element includes the design, manufacturing, modification, test, procurement, special test equipment, and quality control effort associated with the individual RAM's. It also includes all Level 4 floating items identifiable and peculiar to the detached RAM project (i. e., project management, systems support, experiment installation and checkout, pre-mission operations, mission operations, major test programs, training equipment, etc.) The following seven Level 4 RAM's are identified:

- X-Ray Stellar Astronomy RAM
- Advanced Stellar Astronomy RAM
- Advanced Solar Astronomy RAM (Modified Attached RAM)
- Intermediate Size UV Telescope RAM (Modified Attached RAM)
- High Energy Stellar Astronomy RAM (Modified Attached RAM)
- Infrared Astronomy RAM (Modified Attached RAM)
- Fluid Management RAM

Also included are three support section modules (SSM).

NEXT HIGHER LEVEL ELEMENTS (LEVEL 3)

XX-5XX-00-00 Detached RAM Project

NEXT LOWER LEVEL ELEMENTS (LEVEL 5)

To be determined in next phase.

XX-5XX-ZZ-00

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ADDENDUM

NARRATIVES FOR WBS - EXPERIMENTS DEFINITION (XX-2XX-00-00)

Astronomy (XX-2XX-01-00) - The functional program elements (FPE) in astronomy provide means for implementing a long-range program. Astronomical facilities and instruments located in space can reach regions of the electromagnetic spectrum that are obscured or distorted by the earth's atmosphere. The experiment definition activity in astronomy concerns the technology associated with the multiwave length, multisensor approach needed to locate, observe, and interpret radiation from extragalactic, galactic, solar, and planetary sources in the different parts of the spectrum with spectral, angular, and temporal resolution not achievable from earth sites. Six functional program elements are included in the astronomy discipline: X-ray stellar, advanced solar, intermediate-size UV telescopes, high-energy stellar, and IR astronomy.

Physics (XX-2XX-02-00) - The physics discipline includes four functional program elements: (1) Space Physics Research Laboratory, (2) Plasma Physics and Environmental Perturbation Laboratory, (3) Cosmic Ray Physics Laboratory, and (4) Physics and Chemistry Laboratory. The experiment definition activities in the physics discipline relate to the precursor developments necessary to establish the instrument technology, techniques, and processes by which these functional program elements can be performed in space.

Earth Observations (XX-2XX-03-00) The earth observations discipline consists of a single functional program element: Earth Observations Facility. This facility will provide the means for making observations of earth utilizing the unique capabilities that man can provide within the laboratory.

Experiment definition activities relate to the development of sensor technology, data analysis and interpretation techniques, and measurement programs in seven areas in which earth observation experiments will be done. These are: meteorology and the atmospheric sciences, world land use mapping, air and water pollution, resource recognition and identification, natural disaster assessment, ocean resources, and special research.

Communications/Navigation (XX-2XX-04-00) - The communications/navigation discipline contains one functional program element: The Communications/Navigation Research Facility. The experiment definition activities relate to the definition of laboratory functions and equipments that would be provided in such a facility within certain defined constraints.

Material Science and Manufacturing (XX-2XX-05-00) - The basic objective of the material science and manufacturing discipline will be to secure scientific results that will expand the knowledge of physical and chemical processes in materials and provide a basis for new process inventions. Precursor experiment definition activities in this discipline treats the definition of modular equipments that can be used together in many different ways to perform a wide variety of experiments ultimately evolving into a dedicated facility for commercial application.

Technology (XX-2XX-06-00) - The five functional program elements in this discipline are devoted to the development of new technology for application to future generation spacecraft and experiments. These functional program elements are: contamination, fluid management, extravehicular activity, advanced spacecraft systems tests, and teleoperations. The experiment definition activities relate to the definition of various items of suitcase, "carry-on" type equipments in each functional program element area to conduct the measurement program.

Life Sciences (XX-2XX-07-00) - The NASA Life Sciences Program encompasses all of the individual program areas covering operational and medical questions associated with manning and operating an earth orbital research facility or facilities; the development, testing and incorporation into such facilities as the advanced technology for life support and protective systems; and fundamental biological and biomedical research. This discipline contains the following functional program elements: Medical Research Facility, Vertebrate Research Facility, Plant Research Facility, Cells Tissues Research Facility, Invertebrate Research Facility, Life Support and Protective Systems, and Man-System Integration.

Experiment Planning (XX-2XX-10-00) - Experiment planning relates to those activities associated with the prime space station contractor's responsibility to support various and continuing payload studies. These activities shall include: definition of space station performance and interface characteristics, definition of space station support provisions with user community, participation in mission/flight operations, crew integration studies also in support of candidate payload definitions, interpretation of payloads specification requirements—including development, testing, checkout, environmental criteria, and other miscellaneous involvements with user groups during early phases of experiment studies. A typical product of this activity is the "Experiment User's Handbook."



NARRATIVES FOR WBS - EARTH ORBITAL EXPERIMENTS
(XX-3XX-00-00)

- A. 1 X-Ray Stellar Astronomy - Consists of independent X-ray collection and detector assemblies installed in a common supporting structure. This facility will provide capabilities for extending the range of observable objects to extreme cosmological distances with improved angular, spectral, flux level, and polarization measurement resolution.
- A. 2 Advanced Stellar Astronomy - Consists of a large, diffraction-limited telescope (2 or 3 m diameter) to observe both discrete and extended stellar objects, using imaging, spectrographic, photometric, and polarimetry supporting instruments. This facility will provide capabilities for greatly improved angular, spectral, photometric, and polarization measurement resolution and accuracy in the 1 mm to 0.09 m spectral range.
- A. 3 Advanced Solar Astronomy - Consists of a 1.5 m photoheliograph, 0.25 m spectroheliograph, 0.5 m X-ray telescope, and coronagraphs. Correlated narrow band imaging, high resolution spectroscopy, and solar magnetic field mapping are provided within capabilities of these instruments. This facility will provide capabilities for more continued solar observation the the 1.1 m to 2×10^{-10} m spectral region with better resolutions than obtainable from large observatory sites on earth.
- A. 4 Intermediate Size UV Telescopes - Consists of a narrow-field 0.94 m Cassegrain-type telescope and a 0.3 m wide-field UV telescope. Each equipped with a variety of imaging devices and spectrographic instruments, to be employed for spectrally selective imaging and spectrography of galactic emissions, star cluster, and planets of the solar system from 0.4 m to 0.013 m.
- A. 5 High-Energy Stellar Astronomy - Consists of grazing incidence and X-ray telescopes, narrow band spectrometer, X-ray counter array, low background detector array, gamma ray spectrometer, and spark chamber, for time-correlated measurements (from 0.1 KEV to 30 GEV) on the physical processes occurring within X-ray sources.



- A. 6 Infrared Astronomy - Consists of one-meter IR telescope, linear detector array, and interferometer for greatly improved capabilities for survey and detailed observation of cosmic, galactic, planetary, and diffuse IR sources in the 1.000 μm to 1 μm spectral region.
- P. 1 Space Physics Research Laboratory - Four scientific categories of experiments will be conducted using the facilities of this laboratory. These categories are: atmospheric and magnetospheric science, cometary cloud, meteoroid science, and small telescope astronomy. At the full facility level, 25 scientific instruments are installed as general support instruments for the conduct of experiments in these four categories.
- P. 2 Plasma Physics and Environmental Perturbation Laboratory - The objective of this function program element is to establish an orbital laboratory for the performance of a variety of plasma physics experiments. Four experiments groups are represented: plasma wake around orbital bodies, plasma resonances and their harmonics, wake particle interactions with VIF, and electron and ion beam propagation. The major elements of this laboratory include a family of surface- and boom-mounted instruments, airlocks for deployment of subsatellites, and TV and particle accelerators.
- P. 3 Cosmic Ray Physics Laboratory - This facility consists of instrumentation to advance the understanding of astrophysical phenomena through accurate measurements of: cosmic ray nuclei flux and energy spectra, cosmic ray nuclei charge composition, electron-positron energy spectra, and isotopic composition of light nuclei. The concept described is one of a dedicated orbital facility.
- P. 4 Physics and Chemistry Laboratory - This is an orbital laboratory to be used for performing physics and chemistry experiments that make optimum use of the environmental conditions available: zero gravity, high vacuum, particle and gas-surface interactions, etc. This laboratory will have work stations that receive experiments as carry-on packages for plug-in to various multipurpose equipments and provisions of the physics and chemistry laboratory.
- ES. 1 Earth Observations Facility - The objectives of the earth observations facility are to utilize the unique capabilities of man in the orbital survey of the earth and its environment. The objectives include: (1) defining the earth's geometry, surface characteristics, and dynamic body properties, (2) understanding the physics of the atmosphere, weather prediction, modification, and control, and (3) responsible management of the earth's resources and the human environment. The earth observations facility is an orbital laboratory that

provides the necessary provisions for accommodating a large group of multidiscipline sensors and the support of man in carrying out these investigations.

- C/N. 1 Communications/Navigation Research Facility - The objectives of this facility are to provide an orbital laboratory to facilitate expanded applications of space technology and satellite systems to: (1) better serve the national/international needs for communications with and between earthbound/airborne/spaceborne terminals, and (2) to improve the capabilities for terrestrial, air, and space vehicle navigation and traffic control. This facility provides the necessary equipment and assemblies to conduct these investigations.
- MS. 1 Materials Science and Manufacturing Facility - The objectives of this functional program element are: (1) to accomplish a wide variety of research experiments leading to capabilities to manufacture materials in space, (2) conduct experimentation to define these prospects, and (3) develop specific processes to the point of commercial feasibility. Modular equipments will be provided within this facility to perform the widest possible variety of experiments.
- T. 1 Contamination Measurements - The objectives of the experiments in this functional program elements are to: (1) monitor and trace the movement of external contaminants, (2) evaluate light scattering effects on the performance of optical sensors, (3) measure amount and effect of contaminants deposited on optical components, and (4) evaluate removal techniques. These observations/measurements involve periodically scheduled activities using a variety of instruments in suitcase "carry-on" fashion.
- T. 2 Fluid Management - Experiments included in this functional program element are related to the understanding of fundamentals of design techniques for advanced spacecraft fluid systems. Experiment equipment items range in size from small "carry-on" packages to large cryogenic storage tanks. Trace experiments are designed to yield parametric information over the entire range of flows, temperatures, acceleration levels, heat transfer rates, etc. which may be encountered in future vehicle designs.
- T. 3 Extravehicular Activity (EVA) - The two experiments included in this functional program element describe the development and evaluation of an astronaut maneuvering unit (AMU) and a maneuverable work platform (MWP). These experiments describe one phase of an orbital test program for the development and evaluation of these advanced mobility aid systems.

- T. 4 Advanced Spacecraft Systems Tests - This functional program element describes typical types of tests that will be performed in orbit to develop and qualify hardware for future spacecraft.
- T. 5 Teleoperation - The goal of this functional program element is to develop and evaluate an experimental teleoperator system for use with future space activities. Such a system would be a precursor to an operational system and would provide a means for evaluating teleoperator system performance and applications.
- LS. 1 Medical Research Facility - Medical experiments will be devoted to the evaluation of changes in human function and capabilities which may be induced by long-duration space flight. The goals shown are oriented toward the support and enhancement of man and his abilities in manned space flight. There is an additional objective to obtaining scientific information of value to conventional medical research and practice.
- LS. 2 Vertebrate Research Facility - The Vertebrate Research Facility will permit a broad spectrum of specific and general experiments in support of the goals and objectives in space biology:
- a. To understand the role of gravity in life processes and the capability of living organisms to adapt to gravitational changes.
 - b. To understand the role of time in biology, including the effects of time-varying environmental parameters on biological rhythms and aging.
 - c. To determine the potential applications and develop the techniques to utilize advances in theory and space technology to advance medicine, biology, public health, agriculture, and space exploration. The facility provides holding and rearing accommodations as well as research instrumentation for a wide variety of vertebrates. The rearing accommodations will permit establishing a "weightlessness adapted" strain of animals considered essential in studying adaptive processes.
- LS. 3 Plant Research Facility - The program in Plant Research covers the effects of space environment (weightlessness, subgravity, ionizing radiation, etc.) on all major aspects of plant biochemistry, physiology, and genetics. Particular emphasis is placed on morphology, growth, development, maturation, longevity, reproduction, and cyclic phenomena. Experiments will encompass photographic histories from sprouting through to death, microscopic examinations



of cells and tissues, and biochemical analyses for composition and distribution of enzymes, hormones, metabolic substrates, and synthesized plant products.

- LS. 4 Cells and Tissues Research Facility - The research to be supported by this functional program element includes a study of the growth, reproduction, morphology, biochemistry, and genetics of a variety of single-cell organisms and tissues in culture. Some of the objectives are evident in the titles of the experiment classes. In more detail, the objectives include: discerning the role gravity plays in the cellular functions of growth and replication; discerning whether cultured cellular and tissue development, structures, and function are altered by the space environment; developing the capability to predict extent of cellular variability as a function of time in the space environment; establishing whether the space environment significantly alters the genetic coding mechanisms; describing the interaction of the environment with subcellular structure and function; investigating biochemical phenomena; and investigating environmental factors in control of rhythmic phenomena by the removal of these factors.
- LS. 5 Invertebrate Research Facility - The objectives are generally the same as stated for other biology functional program elements except that they are applied to invertebrates. In more detail, these objectives are to detect, quantify, and determine the mechanisms of alterations in the basic life processes of invertebrates exposed to weightlessness; to detect, quantify, and determine the mechanisms involved in the modification of invertebrate behavior by exposure to the space environment; and to detect modifications in the genetics of invertebrates and discover the mechanisms underlying these changes.
- LS. 6 Life Support and Protective Systems - The objective of life support and protective systems (LSPS) technology is to provide a controlled and physiologically acceptable environment for flight crews during all phases of a space mission. The objective of this functional program element is to provide critical information of human environmental requirements, the design criteria for LSPS, and the technology which will enable men to perform future space missions effectively and in safety.
- LS. 7 Man-System Integration - The goals and objectives in man-system integration (MSI) are related to the experiment classes: behavioral effects; performance capability; habitability and proficiency; and rotogravitation. Behavioral effects include those experiments designed to determine the effects of prolonged exposure to the space-flight environment on man's individual and group behavior. The performance capability assessment class is designed to evaluate



man-system performance capabilities in the space-flight environment. The habitability and proficiency maintenance class is designed to evaluate man-system characteristics that maintain and/or prevent degradation of that performance. The rotogravitation experiments are designed to evaluate man's behavior and performance capabilities in artificial gravity.

B ESTIMATED SUBCONTRACTOR AND PRIME
CONTRACTOR COSTS, MODULAR SPACE
STATION PROJECT

B ESTIMATED SUBCONTRACTOR AND PRIME CONTRACTOR COSTS,
MODULAR SPACE STATION PROJECT



APPENDIX B. ESTIMATED SUBCONTRACTOR AND PRIME CONTRACTOR COSTS, MODULAR SPACE STATION PROJECT

This section presents Cost Estimate Data Form B for the Modular Space Station Project (XX-1XX-00-00) in an abbreviated format that is consistent with an agreement reached during the study period between NASA/ MSC and the Contractor.

The abbreviated format deviates from the standard Form B to the extent that it provides a split of the total cost by only two categories, namely prime in-house and subcontractor WBS item cost. The standard Form B on the other hand provides WBS item cost by subdivision of work and by element of cost as described under Cost Methodology in Section 3.

The subcontractor category contains all cost associated with major and minor subcontracting, including the material procurement cost (MPC) and general and administrative (G&A) expenses associated with these elements. The in-house category contains all other WBS item costs.

The basis for calculating the total amount shown in each category was to estimate by assembly (WBS Level 6) the hardware most likely to be subcontracted. The cost of these assemblies were then accumulated and reported at the subsystem (WBS Level 5) under the subcontract category. The in-house category, as reported, is the difference between total WBS item cost and the subcontract cost category, if any.

Cost estimate data forms B have not been prepared for the Experiments Definition Project (XX-2XX-00-00), Earth Orbital Experiments Project (XX-3XX-00-00), Attached RAM Project (XX-4XX-00-00) and Detached RAM Project (XX-5XX-00-00). The nature of these costs, either from NASA/ MSC or previous study data, are not detailed enough to support this type of breakdown.

Table B-1. Cost Estimate Data - Form B

WBS Level	WBS Identification Number	WBS Item Name	In-House	Sub-Contract	WBS Item Cost
Nonrecurring (DDT&E)					
3	XX-1XX-00-00	Modular Space Station Project	1,025.2	568.7	1,593.9
4	XX-1XX-01-00	Initial Core Module	125.7	94.0	219.7
5	XX-1XX-01-01	Structural and mechanical subsystem	52.4	13.0	65.4
5	XX-1XX-01-02	ECLS subsystem	16.7	7.7	24.4
5	XX-1XX-01-03	Electrical power subsystem	17.1	7.1	24.2
5	XX-1XX-01-04	Guidance and control subsystem	21.7	39.2	60.9
5	XX-1XX-01-05	Reaction control subsystem	8.2	10.5	18.7
5	XX-1XX-01-06	Information subsystem	5.5	10.8	16.3
5	XX-1XX-01-07	Crew habitability subsystem	4.1	5.7	9.8
4	XX-1XX-02-00	Power Module	68.7	103.6	172.3
5	XX-1XX-02-01	Structural and mechanical subsystem	20.7	5.2	25.9
5	XX-1XX-02-01	Structural and mechanical subsystem (growth)	15.3	-	15.3
5	XX-1XX-02-02	ECLS subsystem	4.7	6.7	11.4
5	XX-1XX-02-03	Electrical power subsystem	26.5	91.5	118.0
5	XX-1XX-02-03	Electrical power subsystem (growth)	1.0	-	1.0
5	XX-1XX-02-06	Information subsystem	0.2	0.2	0.4
5	XX-1XX-02-07	Crew habitability subsystem	0.3	-	0.3
4	XX-1XX-03-00	Control/Crew Module (SM-1)	110.9	139.8	250.7
5	XX-1XX-03-01	Structural and mechanical subsystem	23.5	5.9	29.4
5	XX-1XX-03-02	ECLS subsystem	40.7	32.0	72.7
5	XX-1XX-03-03	Electrical power subsystem	5.6	2.1	7.7
5	XX-1XX-03-06	Information subsystem	37.0	97.4	134.4
5	XX-1XX-03-07	Crew habitability subsystem	4.1	2.4	6.5
4	XX-1XX-04-00	Lab/ECLSS Module (SM-2)	68.2	40.5	108.7
5	XX-1XX-04-01	Structural and mechanical subsystem	23.8	6.0	29.8
5	XX-1XX-04-02	ECLS subsystem	38.5	33.1	71.6
5	XX-1XX-04-03	Electrical power subsystem	2.6	-	2.6
5	XX-1XX-04-05	Reaction control subsystem	1.5	0.2	1.7
5	XX-1XX-04-06	Information subsystem	0.8	0.4	1.2
5	XX-1XX-04-07	Crew habitability subsystem	1.0	0.8	1.8

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Table B-1. Cost Estimate Data - Form B (Cont)

WBS Level	WBS Identification Number	WBS Item Name	In-House	Sub-Contract	WBS Item Cost
Nonrecurring (DDT&E) (Continued)					
4	XX-1XX-05-00	Lab/ECLSS Module (SM-3)	28.8	19.9	48.7
5	XX-1XX-05-01	Structural and mechanical subsystem	13.4	3.3	16.7
5	XX-1XX-05-02	ECLS subsystem	8.1	9.3	17.4
5	XX-1XX-05-03	Electrical power subsystem	0.5	-	0.5
5	XX-1XX-05-05	Reaction control subsystem	0.4	0.1	0.5
5	XX-1XX-05-06	Information Subsystem	0.4	0.2	0.6
5	XX-1XX-05-07	Crew habitability subsystem	6.0	7.0	13.0
4	XX-1XX-06-00	Control/Crew Module (SM-4)	28.6	31.8	60.4
5	XX-1XX-06-01	Structural and mechanical subsystem	9.8	2.4	12.2
5	XX-1XX-06-02	ECLS subsystem	8.6	10.1	18.7
5	XX-1XX-06-03	Electrical power subsystem	1.1	0.4	1.5
5	XX-1XX-06-06	Information subsystem	4.9	13.1	18.0
5	XX-1XX-06-07	Crew habitability subsystem	4.2	5.8	10.0
4	XX-1XX-07-00	Cargo Modules	33.8	17.7	51.5
5	XX-1XX-07-01	Structural and mechanical subsystem	11.7	2.9	14.6
5	XX-1XX-07-02	ECLS subsystem	18.4	13.8	32.2
5	XX-1XX-07-03	Electrical power subsystem	1.3	0.5	1.8
5	XX-1XX-07-06	Information subsystem	0.5	0.2	0.7
5	XX-1XX-07-07	Crew habitability subsystem	1.9	0.3	2.2
4	XX-1XX-08-00	Growth Core Module	51.4	-	51.4
5	XX-1XX-08-01	Structural and mechanical subsystem	31.4	-	31.4
5	XX-1XX-08-02	ECLS subsystem	6.3	-	6.3
5	XX-1XX-08-03	Electrical power subsystem	6.7	-	6.7
5	XX-1XX-08-05	Reaction control subsystem	2.6	-	2.6
5	XX-1XX-08-06	Information subsystem	3.7	-	3.7
5	XX-1XX-08-07	Crew habitability subsystem	0.7	-	0.7

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Table B-1. Cost Estimate Data - Form B (Cont)

WBS Level	WBS Identification Number	WBS Item Name	In-House	Sub-Contract	WBS Item Cost
Nonrecurring (DDT&E) (Continued)					
4	XX-1XX-09-00	Crew/ECLSS Module (SM-5)	34.6	-	34.6
5	XX-1XX-09-01	Structural and mechanical subsystem	7.0	-	7.0
5	XX-1XX-09-02	ECLS subsystem	9.5	-	9.5
5	XX-1XX-09-03	Electrical power subsystem	1.2	-	1.2
5	XX-1XX-09-05	Reaction control subsystem	0.8	-	0.8
5	XX-1XX-09-06	Information subsystem	14.9	-	14.9
5	XX-1XX-09-07	Crew habitability subsystem	1.2	-	1.2
4	XX-1XX-10-00	Crew/ECLSS Module (SM-6)	10.7	-	10.7
5	XX-1XX-10-01	Structural and mechanical subsystem	6.8	-	6.8
5	XX-1XX-10-02	ECLS subsystem	2.7	-	2.7
5	XX-1XX-10-03	Electrical power subsystem	0.3	-	0.3
5	XX-1XX-10-05	Reaction control subsystem	0.3	-	0.3
5	XX-1XX-10-06	Information subsystem	0.3	-	0.3
5	XX-1XX-10-07	Crew habitability subsystem	0.3	-	0.3
4	XX-1XX-25-00	Project Management	98.7	-	98.7
4	XX-1XX-30-00	Systems Support	84.8	-	84.8
4	XX-1XX-35-00	Premission Operations	25.0	-	25.0
4	XX-1XX-45-00	GPL Experiment Integration	21.1	-	21.1
4	XX-1XX-50-00	Major Test Programs	162.8	90.0	252.8
4	XX-1XX-60-00	Ground Support Equipment	67.8	16.9	84.7
4	XX-1XX-65-00	Facilities	3.6	14.5	18.1
Recurring (Production)					
3	XX-1XX-00-00	Modular Space Station Project	226.0	192.0	418.0
4	XX-1XX-01-00	Initial Core Module	21.0	17.0	38.0
5	XX-1XX-01-01	Structural and mechanical subsystem	5.3	0.6	5.9
5	XX-1XX-01-02	ECLS subsystem	1.6	1.2	2.8
5	XX-1XX-01-03	Electrical power subsystem	6.0	3.7	9.7
5	XX-1XX-01-04	Guidance and control subsystem	2.7	7.6	10.3
5	XX-1XX-01-05	Reaction control subsystem	1.0	0.8	1.8
5	XX-1XX-01-06	Information subsystem	0.5	1.9	2.4
5	XX-1XX-01-07	Crew habitability subsystem	0.4	1.2	1.6
5	XX-1XX-01-08	Subsystem instal., assy and C/O	3.5	-	3.5

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Table B-1. Cost Estimate Data - Form B (Cont)

WBS Level	WBS Identification Number	WBS Item Name	In-House	Sub-Contract	WBS Item Cost
Recurring (Production) (Continued)					
4	XX-1XX-02-00	Power Module	30.0	83.7	113.7
5	XX-1XX-02-01	Structural and mechanical subsystem	1.2	0.1	1.3
5	XX-1XX-02-01	Structural and mechanical subsystem (growth)	1.0	0.1	1.1
5	XX-1XX-02-02	ECLS subsystem	0.4	1.0	1.4
5	XX-1XX-02-03	Electrical power subsystem	11.6	41.5	53.1
5	XX-1XX-02-03	Electrical power subsystem (growth)	9.3	39.2	48.5
5	XX-1XX-02-06	Information subsystem	0.6	1.8	2.4
5	XX-1XX-02-07	Crew habitability subsystem	0.1	-	0.1
5	XX-1XX-02-08	Subsystem instal, assy and C/O	5.8	-	5.8
4	XX-1XX-03-00	Control/Crew Module (SM-1)	16.2	22.1	38.3
5	XX-1XX-03-01	Structural and mechanical subsystem	2.7	0.3	3.0
5	XX-1XX-03-02	ECLS subsystem	3.2	4.2	7.4
5	XX-1XX-03-03	Electrical power subsystem	1.8	1.1	2.9
5	XX-1XX-03-06	Information subsystem	4.7	16.0	20.7
5	XX-1XX-03-07	Crew habitability subsystem	0.3	0.5	0.8
5	XX-1XX-03-08	Subsystem instal., assy and C/O	3.5	-	3.5
4	XX-1XX-04-00	Lab/ECLSS Module (SM-2)	10.8	4.6	15.4
5	XX-1XX-04-01	Structural and mechanical subsystem	5.3	0.5	5.8
5	XX-1XX-04-02	ECLS subsystem	3.0	3.7	6.7
5	XX-1XX-04-03	Electrical power subsystem	0.4	-	0.4
5	XX-1XX-04-05	Reaction control subsystem	0.4	0.1	0.5
5	XX-1XX-04-06	Information subsystem	0.3	0.2	0.5
5	XX-1XX-04-07	Crew habitability subsystem	0.3	0.1	0.4
5	XX-1XX-04-08	Subsystem instal., assy and C/O	1.1	-	1.1
4	XX-1XX-05-00	Lab/ECLSS Module (SM-3)	9.3	5.8	15.1
5	XX-1XX-05-01	Structural and mechanical subsystem	3.3	0.3	3.6
5	XX-1XX-05-02	ECLS subsystem	2.9	4.0	6.9
5	XX-1XX-05-03	Electrical power subsystem	0.4	-	0.4
5	XX-1XX-05-05	Reaction control subsystem	0.4	0.1	0.5
5	XX-1XX-05-06	Information subsystem	0.5	0.6	1.1
5	XX-1XX-05-07	Crew habitability subsystem	0.7	0.8	1.5
5	XX-1XX-05-08	Subsystem instal., assy and C/O	1.1	-	1.1

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Table B-1. Cost Estimate Data - Form B (Cont)

WBS Level	WBS Identification Number	WBS Item Name	In-House	Sub-Contract	WBS Item Cost
Recurring (Production) (Continued)					
4	XX-1XX-06-00	Control/Crew Module (SM-4)	15.0	21.1	36.1
5	XX-1XX-06-01	Structural and mechanical subsystem	1.7	0.2	1.9
5	XX-1XX-06-02	ECLS subsystem	3.3	3.7	7.0
5	XX-1XX-06-03	Electrical power subsystem	1.3	0.9	2.2
5	XX-1XX-06-06	Information subsystem	4.5	15.7	20.2
5	XX-1XX-06-07	Crew habitability subsystem	0.8	0.6	1.4
5	XX-1XX-06-08	Subsystem instal., assy and C/O	3.4	-	3.4
4	XX-1XX-07-00	Cargo Modules	16.5	13.4	29.9
5	XX-1XX-07-01	Structural and mechanical subsystem	4.8	0.5	5.3
5	XX-1XX-07-02	ECLS subsystem	6.9	12.2	19.1
5	XX-1XX-07-03	Electrical power subsystem	1.0	0.2	1.2
5	XX-1XX-07-06	Information subsystem	0.4	0.4	0.8
5	XX-1XX-07-07	Crew habitability subsystem	0.3	0.1	0.4
5	XX-1XX-07-08	Subsystem instal., assy and C/O	3.1	-	3.1
4	XX-1XX-08-00	Growth Core Module	12.5	6.8	19.3
5	XX-1XX-08-01	Structural and mechanical subsystem	3.4	0.3	3.7
5	XX-1XX-08-02	ECLS subsystem	0.9	0.6	1.5
5	XX-1XX-08-03	Electrical power subsystem	4.5	2.9	7.4
5	XX-1XX-08-05	Reaction control subsystem	0.6	0.5	1.1
5	XX-1XX-08-06	Information subsystem	1.0	2.3	3.3
5	XX-1XX-08-07	Crew habitability subsystem	0.4	0.2	0.6
5	XX-1XX-08-08	Subsystem instal., assy and C/O	1.7	-	1.7
4	XX-1XX-09-00	Crew/ECLSS Module (SM-5)	12.7	12.6	25.3
5	XX-1XX-09-01	Structural and mechanical subsystem	1.7	0.2	1.9
5	XX-1XX-09-02	ECLS subsystem	4.8	4.8	9.6
5	XX-1XX-09-03	Electrical power subsystem	0.4	-	0.4
5	XX-1XX-09-05	Reaction control subsystem	0.2	-	0.2
5	XX-1XX-09-06	Information subsystem	2.4	7.2	9.6
5	XX-1XX-09-07	Crew habitability subsystem	0.5	0.4	0.9
5	XX-1XX-09-08	Subsystem instal., assy and C/O	2.7	-	2.7

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Table B-1. Cost Estimate Data - Form B (Cont)

WBS Level	WBS Identification Number	WBS Item Name	In-House	Sub-Contract	WBS Item Cost
Recurring (Production) (Continued)					
4	XX-1XX-10-00	Crew/ECLSS Module (SM-6)	7.8	4.9	12.7
5	XX-1XX-10-01	Structural and mechanical subsystem	1.3	0.1	1.4
5	XX-1XX-10-02	ECLS subsystem	4.1	4.1	8.2
5	XX-1XX-10-03	Electrical power subsystem	0.3	-	0.3
5	XX-1XX-10-05	Reaction control subsystem	0.2	-	0.2
5	XX-1XX-10-06	Information subsystem	0.4	0.4	0.8
5	XX-1XX-10-07	Crew habitability subsystem	0.5	0.3	0.8
5	XX-1XX-10-08	Subsystem instal., assy and C/O	1.0	-	1.0
4	XX-1XX-20-00	Module Integration, Assy and C/O	18.6	-	18.6
4	XX-1XX-25-00	Project Management	41.8	-	41.8
4	XX-1XX-30-00	Systems Support	13.8	-	13.8
Recurring (Operations)					
3	XX-1XX-00-00	Modular Space Station Project	338.2	23.0	361.2
4	XX-1XX-07-00	Cargo Modules	37.9	15.0	52.9
5	XX-1XX-07-09	Module refurbishment	37.9	15.0	52.9
4	XX-1XX-25-00	Project Management	66.0	-	66.0
4	XX-1XX-30-00	Systems Support	16.5	-	16.5
4	XX-1XX-40-00	Mission Operations	201.3	-	201.3
4	XX-1XX-70-00	Spares	16.5	8.0	24.5

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C TECHNICAL CHARACTERISTICS DATA

APPENDIX C. TECHNICAL CHARACTERISTICS DATA

This section provides Technical Characteristics Data Form C, a summary of the technical, physical, and mission characteristics that may have a significant effect on costs.

The scope of this section is limited to the Modular Space Station Project, Initial Station only.

Since subsystems characteristics are more meaningful when taken as a whole, rather than describing each module's contribution to the subsystem performance, the data are presented by subsystem except for the structural and mechanical subsystems.

Only preliminary definition effort was expended on cargo modules and the data presented represents the baseline for costing only.

Table C-1 shows a weight allocation, by module, of the subsystem and assemblies described herein. For specific definition of equipment allocation to modules, refer to DRL MSC T-575, Line Item 66, SD 71-215-1. Cargo module estimated weights are shown on the Form C (Table C-2) for the cargo module.

Table C-1. Module Dry Weight Summary

Subsystem/ Assembly ID No.	Module ID No.	01	02	03	04	05	06	TOTAL
	SUBSYSTEM/MAJOR ASSEM	CORE	POWER	SM-1	SM-2	SM-3	SM-4	
1.0	STRUCTURAL & MECHANICAL	12690	3670	10160	12330	10700	9490	59040
1.1	PRIMARY STRUCTURE	5742	1878	4700	4700	4700	4700	26420
1.2	SECONDARY STRUCTURE	3399	410	3218	3350	3446	3378	17201
1.3	ENVIRONMENTAL SHIELD	1119	582	746	735	746	746	4674
1.4	BERTHING	2430	800	490	490	490	490	5190
1.5	GENERAL PURPOSE LAB FURNISH	0	0	1006	3055	1318	176	5555
2.0	ENVIRONMENTAL CONTROL/LIFE SUPPORT	1619	849	3690	3310	3415	3420	16303
2.1	GASEOUS STORAGE	42	765	0	11	11	0	829
2.2	CO ₂ MANAGEMENT	4	0	4	741	741	4	1494
2.3	ATMOSPHERIC CONTROL	750	84	587	876	876	554	3727
2.4	THERMAL CONTROL	681	0	1969	1570	1570	1969	7759
2.5	WATER MANAGEMENT	20	0	638	23	23	638	1342
2.6	WASTE MANAGEMENT	0	0	86	0	79	163	328
2.7	HYGIENE	0	0	370	27	53	56	506
2.8	SPECIAL LIFE SUPPORT	122	0	36	62	62	36	318
3.0	ELECTRICAL POWER	3790	7800	1762	545	545	1762	16204
3.1	PRIMARY POWER GEN	0	6676	0	0	0	0	6676
3.2	SECONDARY POWER GEN	0	0	0	0	0	0	0
3.3	ENERGY STORAGE	2449	985	766	0	0	766	4966
3.4	POWER CONDITIONING	379	0	16	16	16	16	443
3.5	DISTRIB. CONTROL & WIRING	776	115	834	383	383	834	3325
3.6	LIGHTING	186	24	146	146	146	146	794
4.0	GUIDANCE & CONTROL	1470	0	0	0	0	0	1470
4.1	INERTIAL REFERENCE	65						65
4.2	OPTICAL REFERENCE	346						346
4.3	RCS ELECTRONICS	75						75
4.4	MOMENTUM EXCHANGE	984						984
4.5	COMPUTATION	0						0
5.0	REACTION CONTROL	180	0	0	153	153	0	486
5.1	PROPELLANT ACCUMULATOR				88	88		176
5.2	PROP FEED CONTROLS	60			65	65		190
5.3	ENGINES	120						120
6.0	INFORMATION	462	116	2740	134	161	2640	6253
6.1	DATA PROCESSING	171	91	692	64	64	692	1774
6.2	COMMAND/CONTROL & MONITOR	59	4	478	40	40	478	1099
6.3	EXTERNAL COMMUNICATIONS	193	0	849	0	0	749	1791
6.4	INTERNAL COMMUNICATIONS	39	21	641	30	57	641	1429
6.5	SOFTWARE	0	0	80	0	0	80	160
7.0	CREW HABITABILITY	733	125	503	233	1271	990	3855
7.1	PERSONAL EQUIPMENT	0	0	0	0	0	0	0
7.2	GENERAL/EMERG EQUIP	733	125	145	145	145	145	1438
7.3	FURNISHINGS	0	0	220	0	160	206	586
7.4	RECREATION/EXER/CREW CARE	0	0	138	0	210	639	987
7.5	FOOD MANAGEMENT	0	0	0	88	756	0	844
SUBTOTAL (DRY WEIGHT)		20944	12560	18855	16705	16245	18302	103611

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**Table C-2. Modular Space Station Project - Technical Characteristics
Data Form C**

Identification Number	WBS Identification	WBS Level	Units of Measure	Characteristics
XX-1XX-00-00	Modular space station project	3	5 years 6 crewmen 240-260 n mi 55 degrees 2 2 5 days 30 day intervals 48 hrs from notification 90 days 30 days 96 hours	Mission Duration Initial station operations Manning Level Earth orbital altitude Orbit inclination No. of separate pressure isolatable volumes No. of egress paths from habitable volumes Full crew overlap duration (shuttle in near vicinity) Max shuttle launch frequency required Emergency crew rescue time allowance Nominal resupply period Consumables reserve beyond scheduled resupply Single volume life sustaining capability (full crew)
XX-1XX-01-00	Initial core module	4	} Refer to subsystems for technical characteristics data	
XX-1XX-02-00	Power module	4		
XX-1XX-03-00	Control/crew module (SM-1)	4		
XX-1XX-04-00	Labs/ECLSS module (SM-2)	4		
XX-1XX-05-00	Labs/ECLSS module (SM-3)	4		
XX-1XX-06-00	Control/crew module (SM-4)	4		
XX-1XX-07-00	Cargo module	4		

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Table C-2. Modular Space Station Project - Technical Characteristics
Data Form C (Cont)

Identification Number	WBS Identification	WBS Level	Units of Measure	Characteristics
XX-1XX-01-00	Initial core module	4	First module launched HP gas RF control/monitoring fuel cells	Number in buildup sequence Special RCS buildup equipment Quiescent OPS/"wake-up equip. Build-up electrical power Length Diameter - main structure Max. dia - including berthing ports
XX-1XX-01-01	Structural and mechanical subsystem	5	40 ft 12 ft 8 in. 15 ft Skin stringer Skin stringer - Cassinian curve Flat built-up honeycomb 3 14.7 psia 0.5 lb O ₂ H ₂ /day Al alloy Al alloy 10 4 0.9 for 10 years 1000 Btu/hr max. 2000 Btu/hr max.	Type of Structure Cylindrical walls End bulkheads Pressure bulkheads (2) Floors Pressure isolated volumes Internal pressure - design Atmosphere leak rate goal Structure Material Primary Secondary Berthing ports Manipulator sockets Environmental Shield Probability of no micro- meteoroid penetration Limit module heat load gain Limit module heat loss

**Table C-2. Modular Space Station Project - Technical Characteristics
Data Form C (Cont)**

Identification Number	WBS Identification	WBS Level	Units of Measure	Characteristics
XX-1XX-02-00	Power module	4	33 ft 10 in. Second 30 days HP gas for fuel cells (arrays) not deployed)	Overall length including orientation drive Number in buildup sequence Time lapse after core module delivery to orbit Build-up provisions
XX-1XX-02-01	Structural and mechanical subsystem	5	27 ft 6 in. 88 in. Monocoque Berthing ports 14.7 psia Al alloy Al alloy 4 8 0.9 for 10 years 1000 Btu/hr max. 2000 Btu/hr max.	Length Diameter Type of Structure Cylindrical Walls End bulkheads Internal design pressure Structure, Material Primary Secondary Docking/berthing ports Manipulator sockets Environmental Shield Probability of no micro- meteoroid penetration Limit module heat load gain Limit module heat loss

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**Table C-2. Modular Space Station Project - Technical Characteristics
Data Form C (Cont)**

Identification Number	WBS Identification	WBS Level	Units of Measure	Characteristics
XX-1XX-03-00	Control/crew module (station Module -1)	4	Third 60 days Provisions	Number in buildup sequence Time lapse after core module delivery to orbit Solar array control
XX-1XX-03-01	Structural and mechanical subsystem	5	38 ft 8 in. 13 ft 8 in. 15 ft Monocoque Monocoque Cassinian curve Honeycomb 14.7 psia 0.5 lb O ₂ N ₂ /day Al alloy Al alloy 2 1 4 0.9 for 10 years 1000 Btu/hr max. 2000 Btu/hr max.	Length Inside dia (clear) Max outside diameter Type of Structure Cylindrical walls End bulkheads Floors Internal pressure design Atmosphere leak rate goal Structure, material Primary Secondary Berthing ports Auxiliary passage port Manipulator sockets Environmental Shield Probability of no micro-meteoroid penetration Limit module heat load gain Limit module heat loss

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**Table C-2. Modular Space Station Project - Technical Characteristics
Data Form C (Cont)**

Identification Number	WBS Identification	WBS Level	Units of Measure	Characteristics
XX-1XX-03-01	Structural and mechanical subsystem	5	590 lb 416 lb	General Purpose Lab Furnishings Data analysis equipment weight Photographic process equipment weight
XX-1XX-04-00	Labs/ECLSS module (station Module -2)	4	Fourth 90 days	Number in buildup reference Time lapse after core module delivery to orbit
XX-1XX-04-01	Structural and mechanical subsystem	5	38 ft 8 in. 13 ft 8 in. 15 ft 36 in. Monocoque Monocoque Cassinian curve Honeycomb Monocoque 14.7 psia 0.5 lb O ₂ N ₂ /day Al alloy Al alloy 2 4	Length not including airlock (see (GPL furnishings) Inside dia (clear) Max. outside dia Auxiliary Passage Port inside dia. Type of Structure Cylindrical walls End bulkheads Floors Auxiliary passage (cylinder) Internal pressure design Atmosphere leak rate goal Structure, Material Primary Secondary Berthing ports Manipulator Socket

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Table C-2. Modular Space Station Project - Technical Characteristics
Data Form C (Cont)

Identification Number	WBS Identification	WBS Level	Units of Measure	Characteristics
XX-1XX-04-01	Structural and mechanical subsystem	5	0.9 for 10 years 1000 Btu/hr max, 2000 Btu/hr max,	Environmental Shield - Includes airlock and auxiliary passage (Ref, GPL) Probability of no micro-meteoroid penetration Limit module heat lead gain Limit module heat loss
		5	805 lb 550 lb 12 ft, 6 in. 88 in. 80 in. 1200 lb Monocoque Honeycomb Al alloy Al alloy 1 4 14 in.	General Purpose Lab Furnishings Optical supply and maintenance equip. weight Electrical/electronic maintenance equip. weight Airlock - GPL Length Outside dia Inside dia (clear) Weight Type of Structure Cylindrical walls Outer end hatch Structure Material Primary Secondary Berthing ports Manipulator sockets Outer end hatch window dia

**Table C-2. Modular Space Station Project - Technical Characteristics
Data Form C (Cont)**

Identification Number	WBS Identification	WBS Level	Units of Measure	Characteristics
XX-1XX-05-00	Labs/ECLSS (station Module 3)	4	Fifth 120 days	Number in buildup sequence Time lapse after core module delivery to orbit
XX-1XX-05-01	Structural and mechanical subsystem	5	38 ft 8 in. 13 ft 8 in. 15 ft Monocoque Monocoque Cassinian Curve Honeycomb 14.7 psia 0.5 lb O ₂ N ₂ /day Al alloy Al alloy 2 1 4 0.9 for 10 years 1000 Btu/hr max. 2000 Btu/hr max.	Length not including airlock - (see GPL furnishings) Inside dia (clear) Max. outside diameter Type of Structure Cylindrical walls End bulkheads Floors Internal pressure design Atmosphere leak rate goal Structure, Material Primary Secondary Berthing ports Auxiliary passage port Manipulator sockets Environmental Shield - Including GPL Airlock Probability of no micro-meteoroid penetration Limit module heat load gain Limit module heat loss

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Table C-2. Modular Space Station Project - Technical Characteristics
Data Form C (Cont)

Identification Number	WBS Identification	WBS Level	Units of Measure	Characteristics
XX-1XX-05-01	Structural and mechanical subsystem	5	118 lb 12 ft 8 in. 88 in. 80 in. 1200 lb Monocoque Honeycomb 0.145 Al alloy Al alloy 1 4 14 inches	General Purpose Lab Furnishings Physics area equip. weight Airlock - GPL Length Outside dia Inside dia (clear) Weight Type of Structure Cylindrical walls Outer end hatch Structure, Material Primary Secondary Berthing ports Manipulator sockets Outer end hatch window dia
XX-1XX-06-00	Control/crew module (station Module 4)	4	Sixth 150 days	Number in buildup sequence Time lapse after core module delivery to orbit
XX-1XX-06-01	Structural and mechanical subsystem	5	38 ft 8 in. 13 ft 8 in. 15 ft 36 in.	Length Inside dia (clear) Max. outside dia Auxiliary passage port inside dia

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**Table C-2. Modular Space Station Project - Technical Characteristics
Data Form C (Cont)**

Identification Number	WBS Identification	WBS Level	Units of Measure	Characteristics
XX-1XX-06-01	Structural and mechanical subsystem	5	Monocoque Monocoque Cassinian curve Honeycomb Monocoque 14.7 psia 0.5 lb O₂N₂/day 0.145 in. Al alloy Al alloy 2 4 0.9 for 10 years 1000 Btu/hr max. 2000 Btu/hr max. 176 lb	Type of Structure Cylindrical End bulkheads Floors Auxiliary passage (cylinder) Internal pressure (design) Atmosphere leak rate goal Structure, Material Primary Secondary Berthing ports Manipulator sockets Environmental Shield Includes Auxiliary Passage Probability of no micro-meteoroid penetration Limit module heat load gain Limit module heat loss General Purpose Lab Furnishings Medical/biological equipment weight

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**Table C-2. Modular Space Station Project - Technical Characteristics
Data Form C (Cont)**

Identification Number	WBS Identification	WBS Level	Units of Measure	Characteristics
XX-1XX-01-02	Environmental control and life support subsystem	5		HP Gas Storage
XX-1XX-02-02			1365 lb	HPGN ₂ storage qty
XX-1XX-03-02			23 lb	HPGH ₂ storage qty
			604 lb	HPGO ₂ storage qty
XX-1XX-04-02				CO ₂ Management
XX-1XX-05-02			2.25 lb/man/day	CO ₂ processing rate crew produced-nominal
XX-1XX-06-02			3.0 lb/man/day	CO ₂ processing rate crew produced maximum
XX-1XX-07-02			27 lb/day	CO ₂ processing - max. rate
			3.0 mm Hg	CO ₂ partial pressure nominal
			7.6 mm Hg	CO ₂ partial pressure max. 14 ² day
			15.0 mm hg	CO ₂ partial pressure emergency 8 hr maximum
			14 hr light/10 hr dark	CO ₂ reduction & O ₂ H ₂ gen oper. cycle
			27.27 lb/day	O ₂ production - nominal
			56.24 lb/day	O ₂ production - max. capability
			3.53 lb/day	H ₂ production
			1.83 lb	CH ₄ 12 hr storage
			1.70 lb	CO ₂ 12 hr storage
				Atmospheric Control
			14.7 psia	Total pressure nominal
			3.5 psia max.	O ₂ partial pressure
			3.1 psia min	
			100 fpm max.	Air circulation velocity
			15 fpm min.	

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**Table C-2. Modular Space Station Project - Technical Characteristics
Data Form C (Cont)**

Identification Number	WBS Identification	Wbs Level	Units of Measure	Characteristics
XX-1XX-01-02	ECLS subsystem	5		Water Management
XX-1XX-02-02			5.58 lb/man/day	Potable water for food and drinking
XX-1XX-03-02			4.0 lb/man/day	Washing use
XX-1XX-04-02			0.4 lb/min/day	Housekeeping
XX-1XX-05-02			32.2 lb/day	Showers
XX-1XX-06-02			3.5 lb/man/day	Urinal flushing (potable water)
XX-1XX-07-02			50 ± 5 F	Cold water supply temperature
			154± 4 F	Water temperature for food preparation
			322 lb/day	Maximum water processing rate
			161 lb/day	Potable water recovery rate nominal
			11.6 lb/day	Electrolysis water resupply rate
			35 lb/day	Water available for experiment support
			12 hr	Storage time for vapor compression vent gases
				Waste Management and Hygiene
			3.45 lb/man/day - nominal	Urine processing
			4.48 lb/man/day - max.	Water
			0.13 lb/man/day	Solids
			0.25 lb/man day nominal	Fecal collection and processing
			0.33 lb/man day	Water (not reclaimed)
			0.13 lb/man day	Solids
			Provide capability	Accommodation of mixed male/female crew
			15 lb/day	Mixed solid waste processing rate
			67 lb/month	Experiment waste processing rate

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**Table C-2. Modular Space Station Project - Technical Characteristics
Data Form C (Cont)**

Identification Number	WBS Identification	WBS Level	Units of Measure	Characteristics
XX-1XX-01-02	ECLS subsystem	5	60-75 F	Temperature control ranges
XX-1XX-02-02			65-80 F	
XX-1XX-03-02			65-80 F	
XX-1XX-04-02			65-75 F	Exercise areas
XX-1XX-05-02				Personal hygiene areas
XX-1XX-06-02				Medical treatment area
XX-1XX-07-02				All other areas
			57 F max, 8-12 mm Hg 6.5 lb/hr	Humidity control
			6 men	Dew point
				H ₂ O partial pressure
				Max humidity condensate processing rate
				Max crew in any one module
				Thermal Control
			105 F max	Internal wall temp manned operations
			57 F min	
			135 F max	Internal wall temp unmanned operations
			40 F min	
			1000 Btu/module	Heat load gain ext. induced (excluding power mod)
			2000 Btu/module	Heat load loss (excluding power mod)
			105,000 Btu/hr max, 10,140 Btu/hr min	Heat load limits (total)
			3.5 kw	Air heat load
			4.5 kw	
			118,842 Btu/hr	
				Attached RAM heat load
				Maximum heat rejection capability
				Special Life Support
			8 lb/man/hr	EVA/IVA support
			22 lb/man/hr	
			40-64 F	IVA nominal O ₂ flow
			2000 Btu/man/hr	IVA emerg O ₂ flow - 30 min
				O ₂ inlet temp
				Heat load peak

**Table C-2. Modular Space Station Project - Technical Characteristics
Data Form C (Cont)**

Identification Number	WBS Identification	WBS Level	Units of Measure	Characteristics
XX-1XX-01-02	ECLS subsystem	5	1,6 lb/recharge	PLSS O ₂ recharge
XX-1XX-02-02			10,8 lb/recharge	PLSS H ₂ O recharge
XX-1XX-03-02			1410±30 psi	PLSS O ₂ recharge pressure
XX-1XX-04-02			2 per month	Recharge frequency
XX-1XX-05-02				Power Requirements (24 hr avg)
XX-1XX-06-02			8059 watts	Normal operations
XX-1XX-07-02			1095 watts	Emergency operations
XX-1XX-01-03	Electrical power subsystem	5	19,267 watts	Normal 24-hr average load
XX-1XX-02-03			13,465 watts	Degraded 24-hr average load
XX-1XX-03-03			25,027 watts	14-hr crew day light period power
XX-1XX-04-03			19,497 watts	14-hr crew day dark period power
XX-1XX-05-03				Primary Power Generation
XX-1XX-06-03			Solar arrays (7Kft ²)	Primary power source
XX-1XX-07-03			5 years	Operational life
				Secondary Power Generation
			Regenerative fuel cell system	Secondary power source
			O ₂ /H ₂ electrolysis	Energy storage source
				Power Distribution
			416/240 vac, 400 hz - 3 phase	Primary bus
			120/208 vac, 400 Hz - 3 phase	Secondary bus
			56 vdc	DC bus

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Table C-2. Modular Space Station Project - Technical Characteristics
Data Form C (Cont)

Identification Number	WBS Identification	WBS Level	Units of Measure	Characteristics
	Electrical power subsystem	5	2000 ft 2 ft-candles 7 ft-candles	Lighting-Exterior Recognition of MSS orientation Intensity along EVA surface paths Intensity at EVA work stations
XX-1XX-01-03		5		Lighting-Interior
XX-1XX-02-03			254	No. of lights
XX-1XX-03-03			1750 watts	Emergency power
XX-1XX-04-03			96 hours	Duration of emergency (minimum)
XX-1XX-05-03			HP gas from ECLSS	Source of emergency power
XX-1XX-06-03			60 watts avg	reactants Emergency lighting
XX-1XX-07-03			4500 watts (24-hr avg) 800 watts (24-hr avg)	Experiment Provisions EPS normal operation - power to bus EPS degraded operation - power to bus
			7.0 KW 120/208 vac, 400 Hz, 3 phase MIL-STD-704 or better	1 hr sustained peak power Power characteristics
			1848 watts	EPS Power Requirements (24-hr avg)
XX-1XX-01-04	Guidance and control subsystem	5	X-POP level X-POP inertial	Lighting Design-to flight mode Additional capability

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**Table C-2. Modular Space Station Project - Technical Characteristics
Data Form C (Cont)**

Identification Number	WBS Identification	WBS Level	Units of Measure	Characteristics
XX-1XX-01-04	Guidance and control subsystem	5	±1.0 degree ±0.05 deg/sec Provided by shuttle ±1500 ft, 1 sigma ±3800 ft, 1 sigma ±2200 ft, 1 sigma ±3.5 ft/sec 1/12 hr ≤ 0.2 deg/sec ±0.05 deg/sec ±0.01 deg/sec 30 min max. ±0.1 degrees 0.00014 G max. for 140 sec 0.04 G max. for 0.3 sec 0.0001 G max. 0.00001 G max. 487 watts 205 watts	Attitude Stabilization for Berthing Attitude hold Angular rate limits Post-berthing stabilization provisions State Vector & Orientation Altitude In-track Cross-track Orbit velocity Frequency of momentum exchange desaturation 3-axis reorientation rate Experiment Provisions Stability-continuous Stability-fine pointing Fine pointing mode-hold time Fine pointing-accuracy rel to local vertical Accelerations CMG desat and orbit makeup Docking/berthing 6 hr continuous 2 hr continuous Power Requirements (24-hr avg) Normal Emergency

**Table C-2. Modular Space Station Project - Technical Characteristics
Data Form C (Cont)**

Identification Number	WBS Identification	WBS Level	Units of Measure	Characteristics
XX-1XX-01-05	Reaction control subsystem	5		Total Impulse (120 days)
XX-1XX-04-05			166,000 lb sec	Orbit makeup
XX-1XX-05-05			47,740 lb sec	CMG desaturation
XX-1XX-06-05			28,000 lb sec	Attached orbiter
			47,750 lb sec	Contingency
				Propellant Storage
			1200 lb sec	Impulse capacity (12 hr ops)
			300 psia	Accumulator pressure
			H ₂ O electrolysis (ECLSS)	Main propellant source
				Engines
			16 (4 per assy)	No. of engines
			10 lb	Engine thrust
			320 sec	Specific impulse
			8 to 1	O ₂ /H ₂ Ratio
			60 sec for 2 engines	Firing duty cycle (12 hr)
			13 watts	Power Requirements (24-hr avg)
XX-1XX-01-06	Information subsystem	5		Internal Communications
XX-1XX-02-06			3	Voice channels
XX-1XX-03-06			300 to 4 KHz	Voice data rate
XX-1XX-04-06			1	Music channels
XX-1XX-05-06			30 to 10 KHz	Music data rate
XX-1XX-06-06			3	CCTV channels - color or B&W
XX-1XX-07-06			4.5 MHz	CCTV data rate
			30 to 4.5 MHz	Record/playback-audio/video

**Table C-2. Modular Space Station Project - Technical Characteristics
Data Form C (Cont)**

Identification Number	WBS Identification	WBS Level	Units of Measure	Characteristics
XX-1XX-01-06	Information subsystem	5		External Communications
XX-1XX-02-06			3 - full duplex 300 to 4KHz	Voice channels - T/R Voice data rate (baseband)
XX-1XX-03-06			1 simplex time-shared 30 to 10KHz	Music channels (rec only) Music data rate
XX-1XX-04-06			1 half duplex time-shared 2.9 MHz	TV B/W T/R channels TV B/W data rate
XX-1XX-05-06			1 simplex 4.5 MHz	TV color (trans only) TV color data rate
XX-1XX-06-06			2 simplex time-shared	System telemetry channels (trans only)
XX-1XX-07-06			0.05 and 0.5 mbps	System telemetry data rate (2 channels)
			1 simplex time-shared	System telemetry channels (rec only) EVA
			200 bps 1 duplex	System telemetry EVA support
			0.5 mbps 1 ch simplex time-shared	Computer data channels T/R Computer data rate
			1000 bps 1 ch simplex 0.5 MHz 1 simplex simult 1000 bps	Text/graphic digital data (rec only) Text/graphic digital data rate Text/graphic facsimile (trans only) Text/graphic facsimile data rate Ground command (rec only) Ground command data rate
			2 simplex simult 2.9 MHz 1 simplex time-shared	External Comm Exper Support TV B/W T/R channels det RAM TV B/W data rate Exp telemetry to ground (trans only)
			2.0 mbps 2 simplex simult	Exp telemetry to ground data rate Exp telemetry (rec only) D RAM

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**Table C-2. Modular Space Station Project - Technical Characteristics
Data Form C (Cont)**

Identification Number	WBS Identification	WBS Level	Units of Measure	Characteristics
XX-1XX-01-06	Information subsystem	5	0.05 mbps	Exp telemetry (D RAM) data rate D RAM control (trans only) channels D RAM control data rate
XX-1XX-02-06			2 simplex simult	
XX-1XX-03-06			10.0 kbps	
XX-1XX-04-06				Ranging
XX-1XX-05-06			4 full duplex	Ranging channels T/R
XX-1XX-06-06			0.5 mbps	Ranging data rate
XX-1XX-07-06				Tracking
			±500 ft	Position uncertainty
			±5 ft/sec	Range rate uncertainty
			450 n mi to 1000 ft	Range of tracking
				Data Processing Assy (DPA)
				Memory - 32-bit words (station)
				Operations
				Mass
				Archive (includes data base storage)
				Computer speed-Equiv/ops/sec
				Data bus rate
				Digital data bus capability
				DPA Experiment Support
				Memory - 32-bit words
				Operating-expandable in 16 K word modules
				Mass expandable-in 64 K word modules

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**Table C-2. Modular Space Station Project - Technical Characteristics
Data Form C (Cont)**

Identification Number	WBS Identification	WBS Level	Units of Measure	Characteristics
XX-1XX-01-06	Information subsystem	5	As required tape cartridge	Archive
XX-1XX-02-06			1,045 x 10 ³	Computer speed - equiv ops/sec
XX-1XX-03-06			2.0 mbps	Data bus rate
XX-1XX-04-06			3764 watts	ISS power requirements (24-hr avg)
XX-1XX-05-06				
XX-1XX-06-06				
XX-1XX-07-06				
XX-1XX-01-07	Crew and habitability subsystem	5		Food Storage Capability (120 days/6 men)
XX-1XX-02-07				
XX-1XX-03-07			780 lb/37.5 ft ³	Frozen food - wt/volume
XX-1XX-04-07			130 lb/6.5 ft ³	Fresh foods - wt/volume
XX-1XX-05-07			1690 lb/76.0 ft ³	Dry, freeze dried and thermo-stabilized food wt/volume
XX-1XX-06-07			4	Press. garment assy - qty
				On-Orbit Weight
			1438 lb	General/emergency equip.
			586 lb	Furnishings
			987 lb	Recreation/exercise/crew care
			844 lb	Food management
			112.8 watts	Power required (24-hr avg)
			Ref ECLSS data	EVA/IVA support

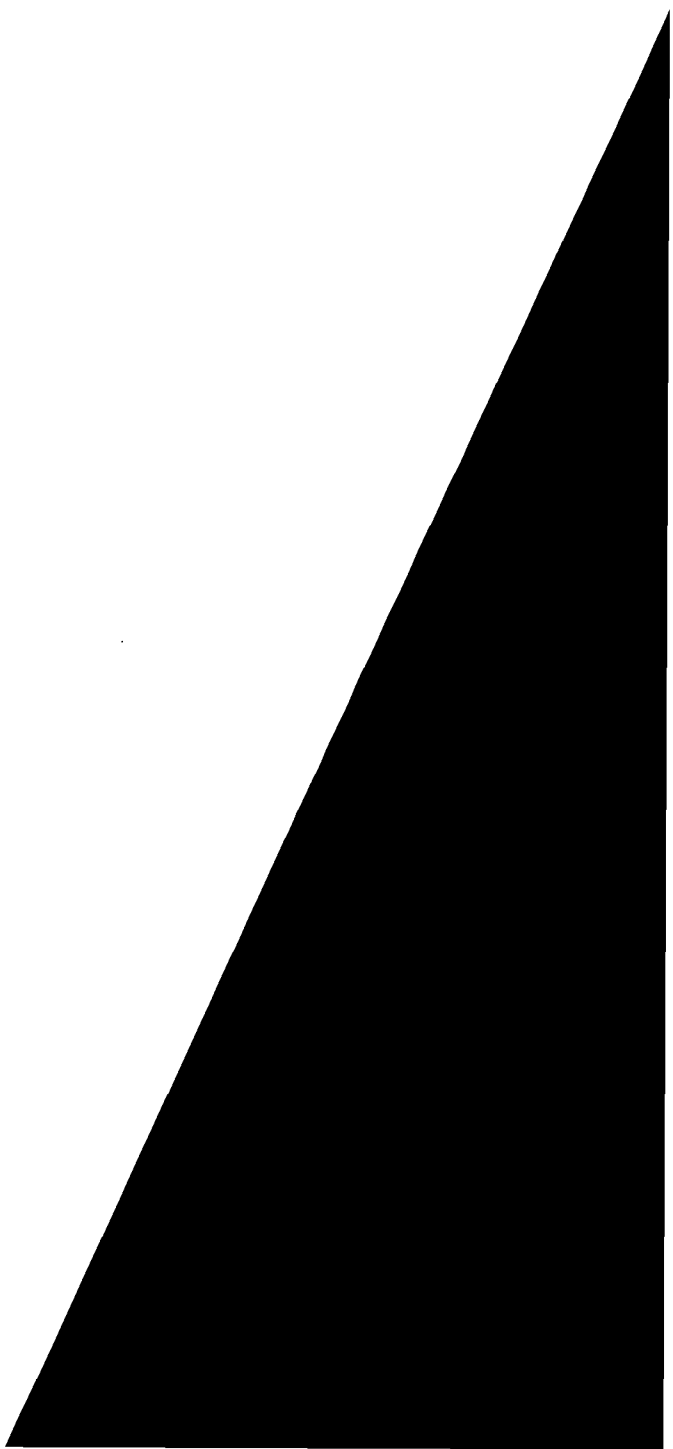
**Table C-2. Modular Space Station Project - Technical Characteristics
Data Form C (Cont)**

Identification Number	WBS Identification	WBS Level	Units of Measure	Characteristics
XX-1XX-01-07	Crew and habitability subsystem	5	5 to 95 percentile 5 to 95 percentile	Crew Dimensional Accommodation
XX-1XX-02-07				Male Female
XX-1XX-03-07				Emergency Personal O ₂ Masks
XX-1XX-04-07				Quantity
XX-1XX-05-07				O ₂ supply (self-contained)
XX-1XX-06-07				Crew and equipment restraint devices
			Provisions	Emergency/Maintenance Lighting
			Supported by others 100-ft candles @ 10 ft 50-ft candles @ 10 ft main	Power module Core module and station module Illumination at start Illumination after 3 hr control operation Recharge capability
			Provisions	Radiation Monitoring Provisions
			1 per crewman Provisions at selected locations	Personal dosimeters Ambient and cumulative radiation level measurement
			Provided Provided	Crew Exercise Bicycle ergometer Isotonic exercise equipment
			Provided Provided	Medical Care First aid kits General medical & dental equip.

**Table C-2. Modular Space Station Project - Technical Characteristics
Data Form C (Cont)**

Identification Number	WBS Identification	WBS Level	Units of Measure	Characteristics
<u>Note:</u> For costing purposes, the cargo module has been characterized by similarity to station modules and subsystems - definition is to a lesser level than station modules.				
XX-1XX-07-00	Cargo module	4	3 72 hr 6-man max. Provisions 9660 lb	Quantity provided Duration of self sufficient operations in shuttle Crew occupancy during orbital operations Conversion to all cargo capability Total dry weight
XX-1XX-07-01	Structural and mechanical	5	24 ft 6260 lb	Length Dry weight
XX-1XX-07-02	Environment control and life support subsystem	5	2950 lb	Dry Weight
XX-1XX-07-03	Electrical power subsystem	5	235 lb	Dry weight
XX-1XX-07-06	Information subsystem	5	75 lb	Dry weight
XX-1XX-07-07	Crew and habitability	5	140 lb	Dry Weight

D SPACE STATION EARTH ORBITAL PROGRAM FUNDING SCHEDULE



APPENDIX D. SPACE STATION EARTH ORBITAL PROGRAM FUNDING SCHEDULE

Time-phased cost estimates of the resources, in millions of dollars, required to accomplish a Phase C/D Earth Orbital Space Station Program, subject to the operations cutoff, work-in-process exclusions, and other cost ground rules and assumptions described in Section 2 of this report, are presented in Table D-1, Cost Estimate Data Forms D.

Separate funding schedules are provided for nonrecurring (DDT&E), recurring (Production), and recurring (Operations) and are summarized graphically by procurement phases in Figure 1-3 of the Introduction and Summary section of this report.

Each Work Breakdown Structure (WBS) Level 5 and Level 4 FIL item cost estimate for the Modular Space Station (MSS) Project (XX-1XX-00-00) was time-phased by Government fiscal year against the anticipated development, production, or operations plan by application of the appropriate spreading factors. Level 5 items are first summarized to Level 4 and finally to the MSS project WBS Level 3.

The Experiments Definition Project (XX-2XX-00-00), Earth Orbital Experiments (XX-3XX-00-00), Attached RAM Project (XX-4XX-00-00) and Detached RAM Project (XX-5XX-00-00) are time-phased at WBS Level 4 and summed at Level 3.

All WBS Level 3 projects are then summed to the Space Station Earth Orbital Program, Level 2.

The forms contain the WBS level, identification number, item name, item cost and the Government fiscal years to which the costs are allocated. The information needed to develop the funding schedule is provided on Cost Estimate Data Form A as reported in Section 7.

Figures D-1 and D-2 illustrate the spreading functions used.

Table D-1. Cost Estimate Data - Form D

X Nonrecurring (DDT&E)
 — Recurring (Production)
 — Recurring (Operations)

Level	Identification Number	WBS Item Name	WBS Item Cost	Government Fiscal Year																		
				75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	
2	XX-0XX-00-00	Space Station Earth Orbital Program	3,853.7	9.1	87.5	267.7	469.0	645.5	533.7	418.7	269.7	257.6	245.6	176.2	208.2	192.2	63.0	5.1	2.7	1.4	0.8	
3	XX-1XX-00-00	Modular Space Station Project	1,593.9		35.9	127.3	272.3	497.5	389.5	116.5	9.7	24.8	45.2	43.4	21.6	4.6	1.7	1.4	1.2	0.7	0.6	
4	XX-1XX-01-00	Initial Core Module	219.7		10.8	27.5	44.3	65.4	54.1	17.6												
5	XX-1XX-01-01	Structural & mechanical subsystem	65.4		7.3	10.3	9.2	15.2	18.6	4.8												
5	XX-1XX-01-02	ECLS subsystem	24.4		0.6	2.7	5.6	7.9	5.6	2.0												
5	XX-1XX-01-03	Electrical power subsystem	24.2		0.5	2.7	5.5	7.9	5.6	2.0												
5	XX-1XX-01-04	Guidance & control subsystem	60.9		1.4	6.8	13.8	19.8	14.0	5.1												
5	XX-1XX-01-05	Reaction control subsystem	18.7		0.4	2.1	4.3	6.1	4.3	1.5												
5	XX-1XX-01-06	Information subsystem	16.3		0.4	1.8	3.7	5.3	3.7	1.4												
5	XX-1XX-01-07	Crew habitability subsystem	9.8		0.2	1.1	2.2	3.2	2.3	0.8												
4	XX-1XX-02-00	Power Module	172.3		6.5	20.0	33.4	45.5	36.2	14.4	3.2	5.0	5.4	2.4	0.3							
5	XX-1XX-02-01	Structural & mechanical Subsystems	25.9		3.5	5.4	3.8	3.3	6.3	3.6												
5	XX-1XX-02-01	Structural & mechanical subsystem (growth)	15.3								3.2	4.8	5.1	2.1	0.1							
5	XX-1XX-02-02	ECLS subsystem	11.4		0.3	1.3	2.6	3.7	2.6	0.9												
5	XX-1XX-02-03	Electrical power subsystem	118.0		2.7	13.2	26.8	38.3	27.1	9.9												
5	XX-1XX-02-03	Electrical power subsystems (growth)	1.0									0.2	0.3	0.3	0.2							
5	XX-1XX-02-06	Information subsystem	0.4			0.1	0.1	0.1	0.1													
5	XX-1XX-02-07	Crew habitability subsystem	0.3				0.1	0.1	0.1													
4	XX-1XX-03-00	Control/Crew Module (SM-1)	250.7		5.7	28.2	57.1	81.2	57.7	20.8												
5	XX-1XX-03-01	Structural & mechanical subsystem	29.4		0.7	3.3	6.7	9.5	6.8	2.4												
5	XX-1XX-03-02	ECLS subsystem	72.7		1.6	8.2	16.5	23.6	16.7	6.1												
5	XX-1XX-03-03	Electrical power subsystem	7.7		0.2	0.9	1.8	2.4	1.8	0.6												
5	XX-1XX-03-06	Information subsystem	134.4		3.0	15.1	30.6	43.6	30.9	11.2												
5	XX-1XX-03-07	Crew habitability subsystem	6.5		0.2	0.7	1.5	2.1	1.5	0.5												
4	XX-1XX-04-00	Labs/ECLSS Module (SM-2)	108.7		2.5	12.1	24.8	35.2	25.0	9.1												
5	XX-1XX-04-01	Structural & mechanical subsystem	29.8		0.7	3.3	6.8	9.7	6.8	2.5												
5	XX-1XX-04-02	ECLS subsystem	71.6		1.6	8.0	16.3	23.2	16.5	6.0												
5	XX-1XX-04-03	Electrical power subsystem	2.6		0.1	0.3	0.6	0.8	0.6	0.2												
5	XX-1XX-04-05	Reaction control subsystem	1.7		0.1	0.2	0.4	0.5	0.4	0.1												
5	XX-1XX-04-06	Information subsystem	1.2			0.1	0.3	0.4	0.3	0.1												
5	XX-1XX-04-07	Crew habitability subsystem	1.8			0.2	0.4	0.6	0.4	0.2												
4	XX-1XX-05-00	Labs/ECLSS Module (SM-3)	48.7		1.1	5.7	11.1	15.8	11.1	3.9												
5	XX-1XX-05-01	Structural & mechanical subsystem	16.7		0.4	1.9	3.8	5.4	3.8	1.4												
5	XX-1XX-05-02	ECLS subsystem	17.4		0.4	2.0	4.0	5.6	4.0	1.4												
5	XX-1XX-05-03	Electrical power subsystem	0.5			0.1	0.1	0.2	0.1													
5	XX-1XX-05-05	Reaction control subsystem	0.5			0.1	0.1	0.2	0.1													
5	XX-1XX-05-06	Information subsystem	0.6			0.1	0.1	0.2	0.1	0.1												
5	XX-1XX-05-07	Crew habitability subsystem	13.0		0.3	1.5	3.0	4.2	3.0	1.0												
4	XX-1XX-06-00	Control/Crew Module (SM-4)	60.4		1.2	5.8	11.7	18.0	15.0	7.8	0.9											
5	XX-1XX-06-01	Structural & mechanical subsystem	12.2		0.2	1.2	2.4	3.6	3.0	1.6	0.2											
5	XX-1XX-06-02	ECLS subsystem	18.7		0.4	1.8	3.6	5.6	4.6	2.4	0.3											
5	XX-1XX-06-03	Electrical power subsystem	1.5			0.1	0.3	0.4	0.4	0.2	0.1											
5	XX-1XX-06-06	Information subsystem	18.0		0.4	1.7	3.5	5.4	4.5	2.3	0.2											
5	XX-1XX-06-07	Crew habitability subsystem	10.0		0.2	1.0	1.9	3.0	2.5	1.3	0.1											
4	XX-1XX-07-00	Cargo Module	51.5		1.5	6.6	11.8	15.0	10.6	5.3	0.7											
5	XX-1XX-07-01	Structural & mechanical subsystem	14.6		0.4	1.9	3.4	4.3	3.0	1.5	0.1											
5	XX-1XX-07-02	ECLS subsystem	32.2		1.0	4.1	7.4	9.4	6.6	3.3	0.4											
5	XX-1XX-07-03	Electrical power subsystem	1.8			0.2	0.4	0.5	0.4	0.2	0.1											
5	XX-1XX-07-06	Information subsystem	0.7			0.1	0.1	0.2	0.1	0.1	0.1											
5	XX-1XX-07-07	Crew habitability subsystem	2.2		0.1	0.3	0.5	0.6	0.5	0.2												

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Table D-1. Cost Estimate Data - Form D (Cont)

X Nonrecurring (DDT&E)
 Recurring (Production)
 Recurring (Operations)

WBS Level	WBS Identification Number	WBS Item Name	WBS Item Cost	Government Fiscal Year																	
				75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92
4	XX-1XX-0F-00	Growth Core Module	51.4									0.5	7.8	17.3	17.2	7.9	0.7				
5	XX-1XX-0F-01	Structural & mechanical subsystem	31.4									0.3	4.8	10.6	10.6	4.8	0.3				
5	XX-1XX-0F-02	ECLS subsystem	6.3									0.1	0.9	2.1	2.1	1.0	0.1				
5	XX-1XX-0F-03	Electrical power subsystem	6.7									0.1	1.0	2.3	2.2	1.0	0.1				
5	XX-1XX-0F-05	Reaction control subsystem	2.6										0.4	0.9	0.9	0.4					
5	XX-1XX-0F-06	Information subsystem	3.7										0.6	1.2	1.2	0.6	0.1				
5	XX-1XX-0F-07	Crew habitability subsystem	0.7										0.1	0.2	0.2	0.1	0.1				
4	XX-1XX-09-00	Crew/ECLS Module (SM-5)	34.6									0.3	4.9	10.5	11.8	6.2	0.9				
5	XX-1XX-09-01	Structural & mechanical subsystem	7.0									0.1	1.0	2.1	2.4	1.2	0.2				
5	XX-1XX-09-02	ECLS subsystem	9.5									0.1	1.3	2.9	3.2	1.7	0.3				
5	XX-1XX-09-03	Electrical power subsystem	1.2										0.2	0.4	0.4	0.2					
5	XX-1XX-09-05	Reaction control subsystem	0.8										0.1	0.2	0.3	0.2					
5	XX-1XX-09-06	Information subsystem	14.9									0.1	2.1	4.5	5.1	2.7	0.4				
5	XX-1XX-09-07	Crew habitability subsystem	1.2										0.2	0.4	0.4	0.2					
4	XX-1XX-10-00	Crew/ECLS Module (SM-6)	10.7									0.1	1.3	3.3	3.6	2.1	0.3				
5	XX-1XX-10-01	Structural & mechanical subsystem	6.8									0.1	0.9	2.1	2.3	1.2	0.2				
5	XX-1XX-10-02	ECLS subsystem	2.7										0.4	0.8	0.9	0.5	0.1				
5	XX-1XX-10-03	Electrical power subsystem	0.3											0.1	0.1	0.1					
5	XX-1XX-10-05	Reaction control subsystem	0.3											0.1	0.1	0.1					
5	XX-1XX-10-06	Information subsystem	0.3											0.1	0.1	0.1					
5	XX-1XX-10-07	Crew habitability subsystem	0.3											0.1	0.1	0.1					
4	XX-1XX-25-00	Project Management	98.7		2.4	8.8	17.6	29.3	22.6	7.4	0.7	1.8	3.2	3.0	1.4	0.2	0.1	0.1	0.1		
4	XX-1XX-30-00	Systems Support	84.8		2.0	7.5	15.2	25.2	19.4	6.3	0.6	1.5	2.8	2.6	1.2	0.2	0.1	0.1	0.1		
4	XX-1XX-35-00	Permission Operations	25.0		0.3	1.5	3.6	6.7	7.7	4.6	0.6										
4	XX-1XX-45-00	GPL Experiment Integration	21.1		0.1	0.3	0.6	0.8	1.1	1.4	1.6	1.9	2.2	2.3	2.0	1.8	1.5	1.2	1.0	0.7	0.6
4	XX-1XX-50-00	Major Test Programs	252.8				34.4	133.5	84.4	0.5											
4	XX-1XX-60-00	Ground Support Equipment	84.7				2.4	22.9	43.1	16.3											
4	XX-1XX-65-00	Facilities	18.1		1.8	3.3	4.3	3.0	1.5	1.1	0.5	0.6	0.5	0.5	0.5	0.5					
3	XX-2XX-00-00	Experiment Definition	114.6	6.1	12.0	12.0	12.0	12.0	12.0	10.6	9.0	9.0	8.7	6.7	3.7	0.8					
4	XX-2XX-01-00	Astronomy (A)	16.0	0.8	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	0.2						
4	XX-2XX-02-00	Physics (P)	14.0	0.8	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.2							
4	XX-2XX-03-00	Earth Observations (ES)	9.1	0.7	1.5	1.5	1.5	1.5	1.5	0.9											
4	XX-2XX-04-00	Communications/Navigation (C/N)	17.6	0.7	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	0.4					
4	XX-2XX-05-00	Material Science & Manufacturing (MS)	9.0	0.8	1.5	1.5	1.5	1.5	1.5	0.7											
4	XX-2XX-06-00	Technology (T)	15.0	0.8	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	0.7							
4	XX-2XX-07-00	Life Sciences (LS)	16.3	0.8	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	0.5						
4	XX-2XX-10-00	Experiment Planning	17.6	0.7	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	0.4					
3	XX-3XX-00-00	Earth Orbital Experiment	1,863.5	3.0	39.6	128.4	182.4	127.8	103.4	227.4	229.9	202.9	163.3	87.6	150.8	167.2	49.6	9.2			
4	XX-3XX-NN-00	GPL Experiment (Aggregate)	480.6	3.0	31.9	95.4	101.3	33.1	8.9	42.9	52.8	43.7	37.7	12.0	3.6	8.7	5.4	9.2			
4	XX-3XX-YY-00	Attached RAM Experiments (Aggregate)	789.3		7.7	33.0	81.1	94.7	49.6	28.5	25.0	71.7	90.9	55.7	101.2	115.6	34.6				
4	XX-3XX-ZZ-00	Detached RAM Experiments (Aggregate)	593.6						44.9	156.0	152.1	87.5	34.7	19.9	46.0	42.9	9.6				
3	XX-4XX-00-00	Attached RAM Project	158.4				2.3	8.2	12.8	12.6	11.1	14.5	20.4	29.8	24.1	13.8	6.0	1.5	0.8	0.4	0.1
4	XX-4XX-YY-00	RAM's (Aggregate)	158.4				2.3	8.2	12.8	12.6	11.1	14.5	20.4	29.8	24.1	13.8	6.0	1.5	0.8	0.4	0.1
3	XX-5XX-00-00	Detached RAM Project	123.3						16.0	51.6	10.0	6.4	8.0	8.7	8.0	5.8	5.7	2.0	0.7	0.3	0.1
4	XX-5XX-ZZ-00	RAM's (Aggregate)	123.3						16.0	51.6	10.0	6.4	8.0	8.7	8.0	5.8	5.7	2.0	0.7	0.3	0.1

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Table D-1. Cost Estimate Data - Form D (Cont)

Nonrecurring (DDT&E)
 X Recurring (Production)
 Recurring (Operations)

WBS		WBS Item Name	WBS Item Cost	Government Fiscal Year																		
Level	Identification Number			75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	
2	XX-0XX-00-00	Space Station Earth Orbital Program	708.9				5.4	79.8	134.7	90.1	21.6	33.8	62.1	89.6	74.8	37.3	14.2	28.2	32.2	4.4	0.7	
3	XX-1XX-00-00	Modular Space Station Project	418.0				5.4	79.3	126.3	74.9	8.0		10.8	58.6	46.1	8.6						
4	XX-1XX-01-00	Initial Core Module	38.0				1.9	14.8	16.9	4.4												
5	XX-1XX-01-01	Structural & mechanical subsystem	5.9						5.6	0.3												
5	XX-1XX-01-02	ECLS subsystem	2.8				0.2	1.5	1.1													
5	XX-1XX-01-03	Electrical power subsystem	9.7				0.6	5.1	3.8	0.2												
5	XX-1XX-01-04	Guidance & control subsystem	10.3				0.7	5.3	4.1	0.2												
5	XX-1XX-01-05	Reaction control subsystem	1.8				0.1	0.9	0.7	0.1												
5	XX-1XX-01-06	Information subsystem	2.4				0.2	1.2	1.0													
5	XX-1XX-01-07	Crew habitability subsystem	1.6				0.1	0.8	0.6	0.1												
5	XX-1XX-01-08	Subsystem instal, assem & C/O	3.5							3.5												
4	XX-1XX-02-00	Power Module	113.7				1.7	25.0	28.1	9.3			4.9	25.1	18.4	1.2						
5	XX-1XX-02-01	Structural & mechanical subsystem	1.3						0.4	0.9												
5	XX-1XX-02-01	Structural & mechanical subsystem (growth)	1.1										0.2	0.8	0.1							
5	XX-1XX-02-02	ECLS subsystem	1.4					0.6	0.7	0.1												
5	XX-1XX-02-03	Electrical power subsystem	53.1				1.6	23.4	25.7	2.4												
5	XX-1XX-02-03	Electrical power subsystem (growth)	48.5										4.7	24.3	18.3	1.2						
5	XX-1XX-02-06	Information subsystem	2.4				0.1	1.0	1.2	0.1												
5	XX-1XX-02-07	Crew habitability subsystem	0.1						0.1													
5	XX-1XX-02-08	Subsystem instal, assem & C/O	5.8							5.8												
4	XX-1XX-03-00	Control/Crew module (SM-1)	38.3				0.9	14.1	17.8	5.5												
5	XX-1XX-03-01	Structural & mechanical subsystem	3.0						2.4	0.6												
5	XX-1XX-03-02	ECLS subsystem	7.4				0.2	3.3	3.6	0.3												
5	XX-1XX-03-03	Electrical power subsystem	2.9				0.1	1.3	1.4	0.1												
5	XX-1XX-03-06	Information subsystem	20.7				0.6	9.1	10.0	1.0												
5	XX-1XX-03-07	Crew habitability subsystem	0.8					0.4	0.4													
5	XX-1XX-03-08	Subsystem instal, assem & C/O	3.5							3.5												
4	XX-1XX-04-00	Labs/ECLSS Module (SM-2)	15.4				0.1	3.5	8.3	3.5												
5	XX-1XX-04-01	Structural & mechanical subsystem	5.8						3.8	2.0												
5	XX-1XX-04-02	ECLS subsystem	6.7				0.1	2.7	3.5	0.4												
5	XX-1XX-04-03	Electrical power subsystem	0.4					0.2	0.2													
5	XX-1XX-04-05	Reaction control subsystem	0.5					0.2	0.3													
5	XX-1XX-04-06	Information subsystem	0.5					0.2	0.3													
5	XX-1XX-04-07	Crew habitability subsystem	0.4					0.2	0.2													
5	XX-1XX-04-08	Subsystem install, assem & C/O	1.1							1.1												
4	XX-1XX-05-00	Labs/ECLSS Module (SM-3)	15.1					2.7	6.9	5.1	0.4											
5	XX-1XX-05-01	Structural & mechanical subsystem	3.6						0.9	2.7												
5	XX-1XX-05-02	ECLS subsystem	6.9					1.8	4.0	1.1												
5	XX-1XX-05-03	Electrical power subsystem	0.4					0.1	0.2	0.1												
5	XX-1XX-05-05	Reaction control subsystem	0.5					0.1	0.3	0.1												
5	XX-1XX-05-06	Information subsystem	1.1					0.3	0.6	0.2												
5	XX-1XX-05-07	Crew habitability subsystem	1.5					0.4	0.9	0.2												
5	XX-1XX-05-08	Subsystem instal, assem & C/O	1.1							0.7	0.4											
4	XX-1XX-06-00	Control/Crew Module (SM-4)	36.1					5.7	18.4	8.9	3.1											
5	XX-1XX-06-01	Structural & mechanical subsystem	1.9						0.1	1.8												
5	XX-1XX-06-02	ECLS subsystem	7.0					1.3	4.2	1.5												
5	XX-1XX-06-03	Electrical power subsystem	2.2					0.4	1.3	0.5												
5	XX-1XX-06-06	Information subsystem	20.2					3.7	12.0	4.5												
5	XX-1XX-06-07	Crew habitability subsystem	1.4					0.3	0.8	0.3												
5	XX-1XX-06-08	Subsystem instal, assem & C/O	3.4							0.3	3.1											
4	XX-1XX-07-00	Cargo Module	29.9					2.5	12.3	11.8	3.3											
5	XX-1XX-07-01	Structural & mechanical subsystem	5.3							5.0	0.3											
5	XX-1XX-07-02	ECLS subsystem	19.1					2.2	10.9	5.9	0.1											
5	XX-1XX-07-03	Electrical power subsystem	1.2					0.1	0.7	0.4												
5	XX-1XX-07-06	Information subsystem	0.8					0.1	0.5	0.2												
5	XX-1XX-07-07	Crew habitability subsystem	0.4					0.1	0.2	0.1												
5	XX-1XX-07-08	Subsystem instal, assem & C/O	3.1							0.2	2.9											

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Table D-1. Cost Estimate Data - Form D (Cont)

				Nonrecurring (DDT&E)																	
				Recurring (Production)																	
				Recurring (Operations)																	
WBS Level	WBS Identification Number	WBS Item Name	WBS Item Cost	Government Fiscal Year																	
				75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92
4	XX-1XX-08-00	Growth Core Module	19.3											2.1	8.9	6.5	1.8				
5	XX-1XX-08-01	Structural & mechanical subsystem	3.7												0.9	2.7	0.1				
5	XX-1XX-08-02	ECLS subsystem	1.5											0.2	0.9	0.4					
5	XX-1XX-08-03	Electrical power subsystem	7.4											1.1	4.3	2.0					
5	XX-1XX-08-05	Reaction control subsystem	1.1											0.2	0.6	0.3					
5	XX-1XX-08-06	Information subsystem	3.3											0.5	1.9	0.9					
5	XX-1XX-08-07	Crew habitability subsystem	0.6											0.1	0.3	0.2					
5	XX-1XX-08-08	Subsystem instal, assem & C/O	1.7														1.7				
5	XX-1XX-09-00	Crew/ECLSS Module (SM-5)	25.3											1.9	11.4	9.0	3.0				
5	XX-1XX-09-01	Structural & mechanical subsystem	1.9													1.8	0.1				
5	XX-1XX-09-02	ECLS subsystem	9.6											0.9	5.3	3.3	0.1				
5	XX-1XX-09-03	Electrical power subsystem	0.4													0.2	0.2				
5	XX-1XX-09-05	Reaction control subsystem	0.2													0.1	0.1				
5	XX-1XX-09-06	Information subsystem	9.6											0.9	5.3	3.3	0.1				
5	XX-1XX-09-07	Crew habitability subsystem	0.9											0.1	0.5	0.3					
5	XX-1XX-09-08	Subsystem instal, assem & C/O	2.7														2.7				
4	XX-1XX-10-00	Crew/ECLSS Module (SM-6)	12.7											0.4	5.1	5.8	1.4				
5	XX-1XX-10-01	Structural & mechanical subsystem	1.4													1.2	0.2				
5	XX-1XX-10-02	ECLS subsystem	8.2											0.4	4.0	3.6	0.2				
5	XX-1XX-10-03	Electrical power subsystem	0.3													0.2	0.1				
5	XX-1XX-10-05	Reaction control subsystem	0.2													0.1	0.1				
5	XX-1XX-10-06	Information subsystem	0.8													0.4	0.4				
5	XX-1XX-10-07	Crew habitability subsystem	0.8													0.4	0.4				
5	XX-1XX-10-08	Subsystem instal, assem & C/O	1.0														1.0				
4	XX-1XX-25-00	Project Management	41.8				0.6	8.3	13.2	5.9	0.9		1.1	6.1	4.8	0.9					
4	XX-1XX-30-00	Systems Support	13.8				0.2	2.7	4.4	1.9	0.3		0.4	2.0	1.6	0.3					
4	XX-1XX-20-00	Module Integration, Assy & C/O	18.6							18.6											
3	XX-3XX-00-00	Earth Orbital Experiments	176.3					0.5	8.4	12.5	7.2	11.2	25.5	17.4	21.6	14.1	4.6	22.0	29.4	1.9	
4	XX-3XX-NN-00	GPL Experiments (Aggregate)	41.3					0.3	5.8	7.8	1.0	0.6	4.9	7.4	7.7	2.5	0.8	0.4	1.9	0.2	
4	XX-3XX-YY-00	Attached RAM Experiments (Aggregate)	87.2					0.2	2.6	4.7	6.2	1.9	6.1	3.2	6.6	9.8	3.5	17.2	23.6	1.6	
4	XX-3XX-ZZ-00	Detached RAM Experiments (Aggregate)	47.8									8.7	14.5	6.8	7.3	1.8	0.3	4.4	3.9	0.1	
3	XX-4XX-00-00	Attached RAM Project	49.9							2.7	3.0	4.8	1.8	5.0	3.8	11.7	8.4	5.1	1.7	1.4	
4	XX-4XX-YY-00	RAM's (Aggregate)	49.9							2.7	3.0	4.8	1.8	5.0	3.8	11.7	8.4	5.1	1.7	1.4	
3	XX-5XX-00-00	Detached RAM Project	64.7								3.4	17.8	24.0	8.6	3.3	2.9	1.2	1.1	1.1	0.2	
4	XX-5XX-ZZ-00	RAM's (Aggregate)	64.7								3.4	17.8	24.0	8.6	3.3	2.9	1.2	1.1	1.1	0.2	

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Table D-1. Cost Estimate Data - Form D (Cont)

_____ Nonrecurring (DDT&E)
 _____ Recurring (Production)
 X Recurring (Operations)

WBS Level	WBS Identification Number	WBS Item Name	WBS Item Cost	Government Fiscal Year																	
				75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92
2	XX-0XX-00-00	Space Station Earth Orbital Program	984.4				1.1	2.1	2.1	13.1	29.0	75.8	75.0	75.9	70.5	87.5	93.5	120.3	145.5	90.6	102.4
3	XX-1XX-00-00	Modular Space Station Project	361.2				1.1	2.1	2.1	13.1	26.9	31.8	31.8	31.6	31.6	31.6	31.6	31.5	31.5	31.5	31.4
4	XX-1XX-07-00	Cargo Modules	52.9								1.7	5.2	5.2	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1
5	XX-1XX-07-00	Module refurbishment	52.9								1.7	5.2	5.2	5.1	5.1	5.1	5.1	5.1	5.1	5.1	5.1
4	XX-1XX-25-00	Project Management	66.0				0.2	0.3	0.3	2.1	4.5	5.9	5.9	5.9	5.9	5.9	5.9	5.8	5.8	5.8	5.8
4	XX-1XX-30-00	Systems Support	16.5				0.1	0.1	0.1	0.5	1.5	1.5	1.5	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
4	XX-1XX-40-00	Mission Operations	201.3							8.8	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5
4	XX-1XX-70-00	Spares	24.5				0.8	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.6
3	XX-3XX-00-00	Earth Orbital Experiments	561.9								2.1	44.0	43.2	43.7	31.6	45.2	53.6	81.0	102.9	50.9	63.7
4	XX-3XX-NN-00	GPL Experiments (Aggregate)	336.8								2.1	41.1	41.1	41.1	21.4	32.8	29.3	33.3	36.3	27.0	31.3
4	XX-3XX-YY-00	Attached RAM Experiments (Aggregate)	168.0									2.9	2.1	2.6	3.6	4.9	14.0	36.5	55.1	20.6	25.7
4	XX-3XX-ZZ-00	Detached RAM Experiments (Aggregate)	57.1												6.6	7.5	10.3	11.2	11.5	3.3	6.7
3	XX-4XX-00-00	Attached RAM Project	0.4															0.1	0.1	0.1	0.1
4	XX-4XX-YY-00	RAM's (Aggregate)	0.4															0.1	0.1	0.1	0.1
3	XX-5XX-00-00	Detached RAM Project	60.9											0.6	7.3	10.7	8.3	7.7	11.0	8.1	7.2
4	XX-5XX-ZZ-00	RAM's (Aggregate)	60.9											0.6	7.3	10.7	8.3	7.7	11.0	8.1	7.2

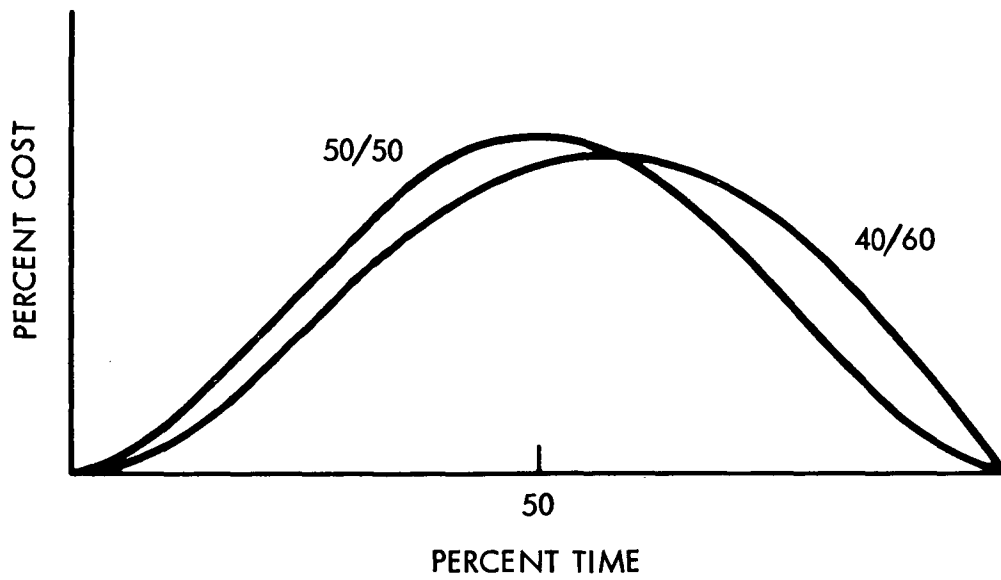


Figure D-1. 50/50 and 40/60 Cost Spreading Functions

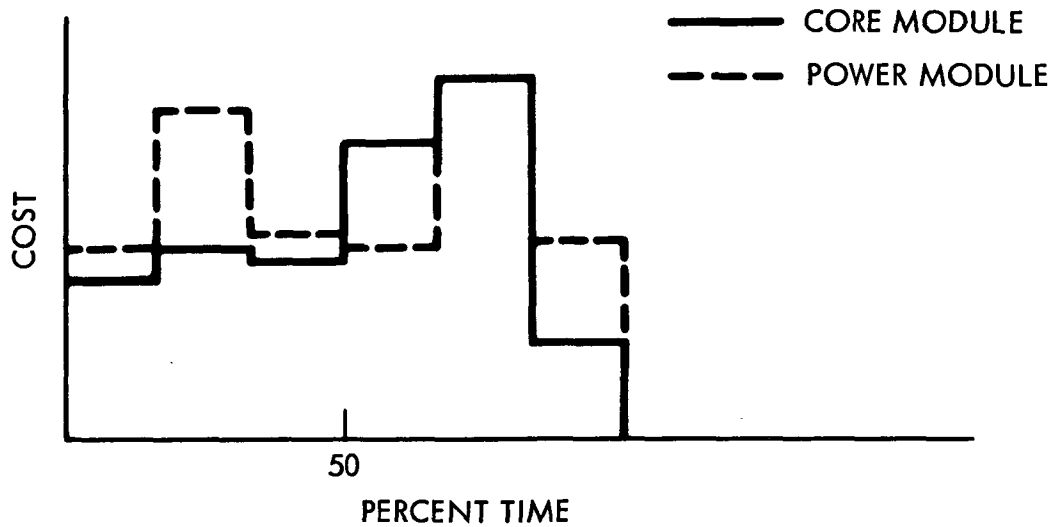


Figure D-2. Structural and Mechanical Subsystem, Core and Power Module DDT&E Spreading Functions

E REFERENCE MSS D&D AND TFU COSTS TO WBS LEVEL 7

APPENDIX E. REFERENCE MMS D&D & TFU COSTS TO WBS LEVEL 7

The D&D and TFU costs to WBS Levels 6 and 7 are presented in Tables E-1 through E-7 for each of the subsystems of the Reference MSS configuration described in Section 4. The TFU costs, of course, refer to the first units at the space station level, although there may be numerous subassemblies in each such unit. The unit costs at the subassembly level represent an average cost. All costs in the tables are in terms of GFY 1971 dollar values, having been prepared before the agreement to show Cost Form A of Section 7 in 1972 dollar values. A conversion factor of 1.05 is footnoted in each table to call attention to this change.

Table E-1. Reference MSS Structures Costs
(\$ Million, 1971 Cost Index)*

	Core		Control Center		Crew		Power	Total
	No. 1	No. 2	No. 1	No. 2	No. 1	No. 2		
Design & Development								
Primary	\$ 5.073	3.102	3.872	2.569	2.570	2.570	2.204	\$21.960
Secondary	5.369	2.578	2.686	0.770	0.918	1.090	0.849	14.260
Shield	9.644	2.411	5.555	1.389	0.556	0.556	1.572	21.683
Docking	2.618	4.242	1.624	0.812	0.812	0.812	0.602	11.522
Crew Furnishings	0.111	0.151	0.158	0.158	0.259	0.259	0.090	1.186
General Purpose			0.276	0.348				0.624
TOTAL	\$22.815	12.484	14.171	6.046	5.115	5.287	5.317	\$71.235
Production TFU (Qty)								
Primary	\$ 1.209	1.041	0.812	0.731	0.688	0.658	0.525	\$ 5.664
Secondary	1.233	0.900	0.627	0.440	0.488	0.575	0.323	4.586
Shield	1.723	1.550	0.992	0.893	0.840	0.804	0.950	7.752
Docking	0.790	1.016	0.515	0.485	0.450	0.364	0.345	3.965
Crew Furnishings	0.029	0.040	0.042	0.042	0.070	0.070	0.023	0.316
General Purpose			0.048	0.062				0.110
TOTAL	\$ 4.984	4.547	3.036	2.653	2.536	2.471	2.166	\$22.393
*Multiply by 1.05 to obtain 1972 dollar value								

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Table E-2. Reference MSS ETC/LSS Costs
(\$ Million, 1971 Cost Index)*

	Design and Development	Production TFU (Qty)			
		Qty	@	Unit Cost	Total
ATMOSPHERIC STORAGE					
N ₂ Conditioning	\$ 2,270	(2)	@	0.080	\$ 0.160
Pumpdown (Airlock)	2,280	(1)	@	0.475	0.475
Mounts, Supports, Plumbing	0.300				0.046
	<u>4.850</u>				<u>0.681</u>
Eng and Mfg Support	1,820				0.289
	<u>\$ 6,670</u>				<u>\$ 0.970</u>
CO₂ MANAGEMENT					
H ₂ Depolarizer	\$ 8,080	(2)	@	0.560	\$ 1.120
Sabatier Reactor	3,000	(2)	@	0.245	0.490
Electrolysis	7,770	(2)	@	0.820	1.640
Mounts and Supports	0.460				0.072
	<u>19,310</u>				<u>3.322</u>
Eng and Mfg Support	7,540				1.468
	<u>\$26,850</u>				<u>\$ 4.790</u>
ATMOSPHERIC CONTROL					
Circulation (Ducts)	\$ 2,750				\$ 0.430
Temperature, Humidity Control and Fans	10,160				1.550
Pressure Control	2,400	(2)	@	0.315	\$ 0.630
Contaminant Removal and Monitor	9,050	(2)	@	0.300	0.600
Mounts, Supports, Plumbing, Misc. Containers	0.800				0.125
	<u>25,160</u>				<u>3.335</u>
Eng and Mfg Support	8,640				1.255
	<u>\$33,800</u>				<u>\$ 4.590</u>

*Multiply by 1.05 to obtain 1972 dollar values

Table E-2. Reference MSS ETC/LSS Costs (Cont)
 (\$ Million, 1971 Cost Index)*

	Design and Development	Production TFU (Qty)			
		Qty	@	Unit Cost	Total
THERMAL CONTROL					
Water Loop	\$ 7.450	(10)	@	0.140	\$ 1.400
Intercooler	4.200	(4)	@	0.165	0.660
Freon Loop	3.970	(4)	@	0.165	0.660
Radiator Panels and Control Valves	4.170	(4)	@	0.490	1.960
Mounts and Supports	0.520				0.083
	<u>20.310</u>				<u>4.763</u>
Eng and Mfg Support	7.920				2.107
	<u>\$28.230</u>				<u>\$ 6.870</u>
WATER MANAGEMENT					
Vapor Compression	\$ 7.250	(2)	@	0.675	\$ 1.350
Reverse Osmosis	3.150	(2)	@	0.100	0.200
Water Storage Purity Monitor	8.600	(2)	@	0.890	1.780
Mounts, Supports, Distribution Plumbing, etc.	1.500				0.240
	<u>20.500</u>				<u>3.570</u>
Eng and Mfg Support	7.600				1.500
	<u>\$28.100</u>				<u>\$ 5.070</u>
WASTE MANAGEMENT					
Fecal Collection	\$ 2.100	(2)	@	0.200	\$ 0.400
Urine Collection	1.360	(2)	@	0.130	0.260
Waste Processor	1.700	(2)	@	0.160	0.320
Mounts and Supports	0.180				0.028
	<u>5.340</u>				<u>1.008</u>
Eng and Mfg Support	2.060				0.442
	<u>\$ 7.400</u>				<u>\$ 1.450</u>

*Multiply by 1.05 to obtain 1972 dollar values

Table E-2. Reference MSS ETC/LSS Costs (Cont)
(\$ Million, 1971 Cost Index)*

	Design and Development	Production TFU (Qty)			
		Qty	@	Unit Cost	Total
HYGIENE					
Shower	\$ 6.630	(1)	@	0.375	\$ 0.375
Sink	2.750	(5)	@	0.075	0.375
Housekeeping	0.750	(2)	@	0.0275	0.055
Mounts and Supports	0.250				0.040
	10.380				0.845
Eng and Mfg Support	4.050				0.365
	\$14.430				\$ 1.210
FOOD MANAGEMENT					
Freezer/Refrigerator	\$ 3.150				\$ 0.450
Food	(GFP)				(GFP)
Oven-Resistance and Microwave	1.960				0.280
Utensils	(GFP)				(GFP)
Reconstitution Unit	0.400				0.060
Mounts and Supports	0.650				0.102
	6.160				0.892
Eng and Mfg Support	2.200				0.358
	\$ 8.360				\$ 1.250
NOTE: Food and Utensils not costed (expendables).					
SPECIAL LIFE SUPPORT					
IVA/EVA Provisions	\$ 3.950				\$ 0.340
Fire Control	0.720	(10)	@	0.027	0.270
Mounts and Supports	0.130				0.020
PLSS (Backpacks)	(GFP)				(GFP)
	4.800				0.630
Eng and Mfg Support	1.870				0.270
	\$ 6.670				\$ 0.900
*Multiply by 1.05 to obtain 1972 dollar values					

Table E-2. Reference MSS ETC/LSS Costs (Cont)
 (\$ Million, 1971 Cost Index)

	Design and Development	Production TFU (Qty)			
		Qty	@	Unit Cost	Total
CREW PROVISIONS					
Pressure Suit	\$ (GFP)				\$ (GFP)
Clothing	(GFP)				(GFP)
Crew Equipment	0.530				0.075
Crew Consumables	(GFP)				(GFP)
Lower Body Negative Pressure	2.240	(1)			0.224
Mass. Measure	1.500	(1)			0.150
Physiological Console	3.240	(1)			0.700
Ergometer	0.070	(1)			0.010
Examination Table	0.350	(1)			0.050
Refrigerator/Freezer	1.220	(1)			0.175
Surgical Instr. and Sterilizer	0.420				0.060
Mobile X-Ray	0.680	(1)			0.068
Repair Tools	0.350				0.050
Mounts and Supports	0.580				0.090
	<u>11.180</u>				<u>1.654</u>
Eng and Mfg Support	4.240				0.706
	<u>\$ 15.420</u>				<u>\$ 2.360</u>
TOTALS	<u><u>\$175.930</u></u>				<u><u>\$29.460</u></u>
NOTE: These totals exclude power module active thermal requirements that were identified since ERB 20.					
*Multiply by 1.05 to obtain 1972 dollar values					



Table E-3. Reference MSS EPS Costs
(\$ Million, 1971 Cost Index)*

	Design and Development	Production TFU (Qty)			
		Qty	@	Unit Cost	Total
PRIMARY GENERATION					
Solar Array	\$18.023				\$32.232
Power Trans. and Orient.	8.297	(2)	@	1.873	3.745
Support Structure	2.835				0.517
	<u>29.155</u>				<u>36.494</u>
Eng and Mfg Support	10.528				9.534
	<u>\$39.683</u>				<u>\$46.028</u>
SECONDARY GENERATION					
Fuel Cells	\$ 2.432	(4)	@	0.425	\$ 1.702
Plumbing	1.902				0.771
Mounts	0.371				0.084
	<u>4.705</u>				<u>2.557</u>
Eng and Mfg Support	0.973				0.817
	<u>\$ 5.678</u>				<u>\$ 3.374</u>
ENERGY STORAGE					
Primary Batteries	\$ 0.396	(14)	@	0.0089	\$ 0.125
Secondary Batteries	1.089	(168)	@	0.0124	2.086
Mounts	0.751				0.603
	<u>2.236</u>				<u>0.603</u>
Eng and Mfg Support	0.594				1.060
	<u>\$ 2.830</u>				<u>\$ 3.874</u>
*Multiply by 1.05 to obtain 1972 dollar values					

Table E-3. Reference MSS EPS Costs (Cont)
 (\$ Million, 1971 Cost Index)

	Design and Development	Production TFU (Qty)			
		Qty	@	Unit Cost	Total
POWER CONDITIONING					
Chargers	\$ 1.124	(8)	@	0.0345	\$ 0.276
Controls	4.498	(4)	@	0.138	0.551
Solar Inverters	1.687	(8)	@	0.0516	0.413
Inverters	1.124	(8)	@	0.0516	0.413
Secondary Bus	2.249	(12)	@	0.103	1.239
Mounts	0.399				0.151
	<u>11.081</u>				<u>3.043</u>
Eng and Mfg Support	4.274				1.338
	<u>\$15.355</u>				<u>\$ 4.381</u>
DISTRIBUTION CONTROL					
Feeders	\$ 0.047	(4)	@	0.002	\$ 0.008
Contactors	0.075	(4)	@	0.007	0.028
Bus Structure	0.216	(2)	@	0.010	0.020
Wiring	9.560				0.439
Mounts	0.617				0.227
	<u>10.515</u>				<u>0.722</u>
Eng and Mfg Support	3.960				0.237
	<u>\$14.475</u>				<u>\$ 0.959</u>
LIGHTING					
Fixtures	\$ 0.187				\$ 0.148
Mounts	0.114				0.072
	<u>0.301</u>				<u>0.220</u>
Eng and Mfg Support	0.075				0.071
	<u>\$ 0.376</u>				<u>0.291</u>
TOTAL	<u>\$78.397</u>				<u>\$58.907</u>
*Multiply by 1.05 to obtain 1972 dollar values					

Table E-4. Reference MSS G and C Costs
 (\$ Million, 1971 Cost Index)*

	Design and Development	Production TFU (Qty)			
		Qty	@	Unit Cost	Total
OPTICAL REFERENCE ASSEMBLY					
Horizon Tracker Optics/Elect	\$ 0.820				\$ 0.330
Star Tracker Optics/Elect	0.750				0.250
Sextant/Telescope	3.100	(1)	@	0.590	0.590
Preprocessor(1)	0.090	(1)	@	0.065	0.065
Navigation Base	0.120	(1)	@	0.015	0.015
Alignment Links	0.530	(2)	@	0.125	0.250
Mounts and Supports	1.350				0.170
	6.760				1.670
Eng and Mfg Support	2.170				0.830
	\$ 8.930				\$ 2.500
INERTIAL REFERENCE ASSEMBLY					
Strapdown Inrtl Measurement Unit	\$ 3.000	(1)	@	0.390	\$ 0.390
Preprocessor	0.090	(1)	@	0.065	0.065
Mounts and Supports	0.060				0.009
	3.150				0.464
Eng and Mfg Support	1.240				0.256
	\$ 4.390				\$ 0.720
CONTROL MOMENT GYRO ASSEMBLY					
Control Moment Gyro	\$ 9.900	(3)	@	0.600	\$ 1.800
Preprocessor	2.100	(1)	@	0.100	0.100
Mounts and Supports	1.000				0.140
	13.000				2.040
Eng and Mfg Support	4.800				1.050
	\$17.800				\$ 3.090

*Multiply by 1.05 to obtain 1972 dollar values

Table E-4. Reference MSS G and C Costs (Cont)
 (\$ Million, 1971 Cost Index)*

	Design and Development	Production T FU (Qty)			
		Qty	@	Unit Cost	Total
RCS ELECTRONICS ASSEMBLY					
Jet Driver Unit	\$ 2.600	(4)	@	0.160	\$ 0.640
Preprocessor(1)	0.090	(1)	@	0.065	0.065
Mounts and Supports	0.060				0.008
	<u>2.750</u>				<u>0.713</u>
Eng and Mfg Support	1.080				0.387
	<u>\$ 3.830</u>				<u>\$ 1.100</u>
G AND C SOFTWARE					
Software(2) (incl. in-house Eng support of 10%)	\$19.600				\$ 3.400
Total	<u>\$54.550</u>				<u>\$10.810</u>
(1) Same preprocessor is used in IRA, and RCS/EA assemblies.					
(2) Non-recurring to recurring costs assumed to be in an 85/15 ratio.					
*Multiply by 1.05 to obtain 1972 dollar values					



Table E-5. Reference MSS RCS Costs
(\$ Million, 1971 Cost Index)*

	Design and Development	Production TFU (Qty)			
		Qty	@	Unit Cost	Total
CRYO STORAGE					
Onboard Tanks (Cargo Module Tank Derivative)	\$ 3.700	(5)	@	0.155	\$ 0.775
Gauging Onboard	11.600	(5)	@	0.079	0.395
Mounts and Supports	0.570				0.083
	<u>15.870</u>				1.253
Eng and Mfg Support	6.120				1.067
	<u>\$21.990</u>				\$ 2.320
PROPELLANT CONDITIONING					
Heat Exchangers	\$ 0.950	(4)	@	0.009	\$ 0.036
Blowers	2.100	(4)	@	0.0133	0.053
Mounts and Supports	0.070				0.009
	<u>3.120</u>				0.098
Eng and Mfg Support	1.220				0.132
	<u>\$ 4.340</u>				\$ 0.230
FEED CONTROL					
Lines, Valves, Regulators	\$ 6.350				\$ 1.900
Mounts and Supports	0.360				0.050
	<u>\$ 6.710</u>				\$ 1.950
ACCUMULATORS					
O ₂	\$ 0.095	(4)	@	0.0101	\$ 0.040
H ₂	0.190	(8)	@	0.020	0.160
Mounts and Supports	0.420				0.121
	<u>0.705</u>				0.321
Eng and Mfg Support	0.115				0.479
	<u>0.820</u>				\$ 0.800
*Multiply by 1.05 to obtain 1972 dollar values					



Table E-5. Reference MSS RCS Costs (Cont)
(\$ Million, 1971 Cost Index)*

	Design and Development	Production TFU (Qty)			
		Qty	@	Unit Cost	Total
ENGINE QUADS					
Engines	\$24.500	(16)	@	0.0745	\$ 1.192
Engines Housing	1.200	(4)	@	0.017	0.068
Mounts and Supports	0.170				0.025
	<u>\$25.870</u>				<u>\$ 1.285</u>
Eng and Mfg Support	9.800				0.315
	<u>35.670</u>				<u>1.600</u>
TOTAL, MSS	<u>\$69.530</u>				<u>\$ 6.900</u>
CARGO TANKAGE					
Cryo Tanks	\$ 7.800	(27) ⁽¹⁾	@	0.195	\$ 5.265
Eng and Mfg Support	3.120				4.475
	<u>\$10.920</u>				<u>\$ 9.740</u>
TOTAL, MSS AND CARGO MODULES	<u>\$80.450</u>				<u>\$16.640</u>
(1) Nine per cargo module, three modules					
*Multiply by 1.05 to obtain 1972 dollar values					

Table E-6. Reference MSS ISS Hardware Costs
(\$ Million, 1971 Cost Index)*

	Design and Development	Production TFU (Qty)			
		Qty	@	Unit Cost	Total
Data Processing					
Data Bus Control Unit	\$ 1,302	(4)	@	0.141	\$ 0.563
RACU	2,279	(58)	@	0.010	0.588
Central Timing Unit	0.072	(2)	@	0.066	0.131
Central Processor	15.134	(2)	@	2.984	5.967
(Including integration @ 11%)					
Local Processor	0.524	(4)	@	0.066	0.262
Terminal Unit	0.114	(4)	@	0.029	0.114
Preprocessor	0.572	(4)	@	0.036	0.143
	<u>19.997</u>				<u>7.768</u>
Integration by Subcontractor ⁽¹⁾	3.999				1.333
	<u>23.996</u>				<u>9.101</u>
Mounts and Supports	0.348				0.052
Mfg and Eng. Support	9.598				5.006
Subtotal	<u>33.942</u>				<u>14.159</u>
Display/Control					
Command Console	2.792	(2)	@	0.934	1.867
(Including integration @ 11%)					
Remote Terminal Unit	0.114	(4)	@	0.029	0.114
Microfilm Projector	0.007	(4)	@	0.0005	0.002
Printer	0.057	(2)	@	0.0035	0.007
Facsimile Unit	4.892	(2)	@	0.408	0.815
Wall Clocks	0.002	(16)	@	0.0001	0.002
Local Monitor Alarm	0.272	(20)	@	0.017	0.339
	<u>8.136</u>				<u>3.146</u>
Integration by Subcontractor ⁽¹⁾	1.627				---
	<u>9.763</u>				<u>3.146</u>
Mounts and Supports	0.174				0.031
Mfg. and Eng. Support	3.905				1.731
Subtotal	<u>13.842</u>				<u>4.908</u>
*Multiply by 1.05 to get 1972 value					

Table E-6. Reference MSS ISS Hardware Costs (Cont)
 (\$ Million, 1971 Cost Index)*

	Design and Development	Production TFU (Qty)			
		Qty	@	Unit Cost	Total
Communications					
Parabolic Antenna (Included per Action Item 20-3)	\$ 2,270	(2)	@	0.668	\$ 1,335
Semi-Dr. Antenna	0.179	(8)	@	0.027	0.215
Transponder	2,432	(8)	@	0.274	2,193
Approach Radar (Deleted per Action Item 20-28)	---				---
Modulation Processor	4,183	(2)	@	0.369	0.739
Central Switching Unit	0.191	(2)	@	0.024	0.048
Video Recorder	1,144	(2)	@	0.286	0.572
Audio and Entmt. Rec.	0.019	(3)	@	0.0048	0.014
Audio/Video Unit	1,087	(26)	@	0.136	3,533
TV Camera	0.543	(3)	@	0.136	0.408
TV Monitor	0.272	(8)	@	0.017	0.136
Paging Amplifier	0.010	(2)	@	0.0004	0.001
	12,330				9,194
Integration by Subc. (1)	2,466				---
	14,796				9,194
Mounts, Supports & Equip. Rack	1,748				0,257
Mfg. and Eng. Support	5,918				5,057
Subtotal	22,462				14,508
Total ISS	\$70,246				\$33,575

(1) Per ERB Action Item 20-13 and IL 192-100-CWR-71-169, D&D integration by subcontractor is 20% for D&D for all assemblies; flight hardware assembly & integration by subcontractor is 40% for data processing, applied to one unit of each item, and zero for other assemblies. Subcontractor effort in D&D is needed to connect all components of DPA, D/C, & comm. assemblies, and make them "play" together. Absence of subcontractor assembly & integration for D/C & comm. assemblies assumes that effort in D&D will result in preparation of specifications & test procedure to sufficient depth to enable delivery of subassemblies to prime contractor for assembly & installation by him.

*Multiply by 1.05 to get 1972 value

Table E-7. Summary of Reference MSS Configuration Costs - ISS
ISS Software Costs (\$ Million)

PROGRAMMING:	Type of Program				
	Supervisor	Application ⁽¹⁾	Data Base ⁽¹⁾	Total	
	Station, ISS Hardware Development, Validation and Test	\$12,580	\$5,960	\$37,110	\$55,650
	MPC and G&A	N/A	1,140	7,130	8,270
		12,580	7,100	44,240	63,920
	Engineering and Program Support (10%)	--	0,710	4,420	5,130
	\$12,580	\$7,810	\$48,660	\$69,050	

COMPUTER RUNNING TIME COSTS (DEBUGGING AND CHECKOUT): (GE ESTIMATE)	In-House	Subc.	Total
Station, ISS Hardware Development, Validation and Test	\$1,780	\$6,110	\$7,890
MPC and G&A	--	1,172	1,172
Engineering and Program Support (10%)	--	0,728	0,728
	\$1,780	\$8,010	\$9,790

⁽¹⁾Subcontracted Programs

F SELECTED MSS CONFIGURATION DDT&E AND RECURRING PRODUCTION
COSTS BY MODULES AND SUBSYSTEMS



APPENDIX F

SELECTED MSS CONFIGURATION DDT&E AND RECURRING
PRODUCTION COSTS BY MODULES AND SUBSYSTEMS

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Table F-1. Selected MSS Structural and Mechanical Subsystem Costs
(\$Million, 1971 Dollar Value)

	Core Mod.	Pwr. Mod.	SM-1	SM-2	SM-3	SM-4	Total
Design and Development							
Primary Structure	\$ 3.979	\$ 0.740	\$ 0.677	\$ 0.677	\$ 0.677	\$0.677	\$ 7.427
Secondary Structure	5.474	1.732	5.660	3.613	3.698	3.757	23.934
Environmental Shield	18.725	6.984	5.132	2.587	2.566	2.566	38.560
Berthing	11.176	6.200	1.745	0.873	0.873	0.873	21.740
GPL Furnishings	-	-	5.500	13.700	4.500	0.900	24.600
Total	\$39.354	\$15.656	\$18.714	\$21.450	\$12.314	\$8.773	\$116.261
Theoretical First Unit (Qty)							
Primary Structure	\$ 3.445	\$ 0.394	\$ 0.663	\$ 0.504	\$ 0.457	\$0.430	\$ 5.893
Secondary Structure	0.676	0.141	0.703	0.502	0.485	0.472	2.979
Environmental Shield	1.219	0.582	0.567	0.507	0.483	0.461	3.819
Berthing	0.468	0.201	0.105	0.100	0.096	0.093	1.063
GPL Furnishings	-	-	0.700	3.900	1.800	0.300	6.700
Total	\$ 5.808	\$ 1.318	\$ 2.738	\$ 5.513	\$ 3.321	\$1.756	\$ 20.454
*Multiply by 1.05 to obtain 1972 dollar value							

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SD 71-226-2

Table F-2. Structural and Mechanical Subsystem, Selected MSS Solar
Array Replacement Mechanical Aid D&D and TFU Costs
(\$Million, 1971 Dollar Value)

	Launch Support	Replacement Aid	Adapter	Total
Design and Development				
Primary Structure	\$0.677	\$0.296	\$0.459	\$1.432
Secondary Structure	0.965	0.285	0.542	1.792
Environmental Shield	N/A	N/A	2.605	2.605
Berthing	<u>0.295</u>	<u>2.085</u>	<u>0.995</u>	<u>3.375</u>
Total	\$1.937	\$2.666	\$4.601	\$9.204
Theoretical First Unit				
Primary Structure	\$0.257	\$0.069	\$0.110	\$0.436
Secondary Structure	0.032	0.004	0.042	0.078
Environmental Shield	N/A	N/A	0.150	0.150
Berthing	<u>0.020</u>	<u>0.076</u>	<u>0.084</u>	<u>0.180</u>
Total	\$0.309	\$0.149	\$0.386	\$0.844
*Multiply by 1.05 to obtain 1972 dollar value				

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Table F-3. Tooling and STE and Acceptance Testing Costs by Module,
Initial Station, Selected Configuration
(\$Million, 1971 Dollar Value)

	Core	Power	SM-1	SM-2	SM-3	SM-4	Total
Design and Development (Initial Tooling and STE)							
Structural and Mechanical	\$22.9	\$ 9.1	\$ 9.2	\$ 6.9	\$3.5	\$2.7	\$ 54.3
ECLS	2.5	1.2	7.4	7.3	-	-	18.4
Electrical Power	2.5	12.0	0.8	0.8	-	-	16.1
Guidance and Control	6.2	-	-	-	-	-	6.2
Reaction Control	1.9	-	-	0.2	-	-	2.1
Information	1.7	-	6.6	0.1	-	-	8.4
Crew Habitability	1.0	-	1.0	-	0.7	0.3	3.0
Total	\$38.7	\$22.3	\$25.0	\$15.3	\$4.2	\$3.0	\$108.5
Production (Recurring Tooling, STE, and Acceptance Testing)							
Structural and Mechanical	\$ 1.0	\$ 0.2	\$ 0.5	\$ 1.0	\$0.6	\$0.3	\$ 3.6
ECLS	0.5	0.2	1.2	1.1	1.1	1.1	5.2
Electrical Power	1.6	8.1	0.5	0.1	0.1	0.4	10.8
Guidance and Control	1.7	-	-	-	-	-	1.7
Reaction Control	0.3	-	-	0.1	0.1	-	0.5
Information	0.4	0.4	3.4	0.1	0.2	3.4	7.9
Crew Habitability	0.3	-	0.1	0.1	0.2	0.2	0.9
Total	\$ 5.8	\$ 9.9	\$ 5.7	\$ 2.5	\$2.3	\$5.4	\$ 30.6
*Multiply by 1.05 to obtain 1972 dollar value							

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**Table F-4. Breakdown of Theoretical First Unit (Or Quantity Adjusted)
Plus Tooling, STE and Acceptance Testing Costs By
Module, Selected Configuration**

Subsystem	Initial Core				Power				SM-1				SM-2				SM-3				SM-4			
	F/H	M/I	S/S		F/H	M/I	S/S		F/H	M/I	S/S		F/H	M/I	S/S		F/H	M/I	S/S		F/H	M/I	S/S	
Structural and Mechanical	5.9	0.8	0.4		1.1 1.3	0.2 0.2	0.1 0.1	Ⓢ Ⓢ	3.0	0.3	0.2		5.8	0.6	0.4		3.6	0.4	0.2		1.9	0.2	0.1	
ECLSS	2.8	0.2	0.3		1.4	-	0.1		7.4	0.5	0.8		6.7	0.4	0.7		6.9	0.4	0.7		7.0	0.4	0.7	
EPS	9.7	0.6	1.0		48.5 53.1	1.6 1.7	2.5 2.7	Ⓢ Ⓢ	2.9	0.1	0.3		0.4	-	-		0.4	-	-		2.2	0.2	0.3	
G&C	10.3	0.7	1.1																					
RCS	1.8	0.1	0.2										0.5	-	-		0.5	-	-					
Information	2.4	0.2	0.3		2.4	0.2	0.3		20.7	1.3	2.2		0.5	-	-		1.1	-	0.1		20.2	1.4	2.2	
Crew Habitability	1.6	0.1	0.2		0.1	-	-		0.8	-	-		0.4	-	-		1.5	-	0.1		1.4	-	0.1	
Totals	34.5	2.7	3.5		107.9	3.9	5.8		34.8	2.2	3.5		14.3	1.0	1.1		14.0	0.8	1.1		32.7	2.2	3.4	
Module Total	40.7				117.6				40.5				16.4				15.9				38.3			

Notes:

F/H = Flight Hardware
M/I = Module Integration
S/S = Subsystem Instal, Assy. and C/O

Ⓢ = Growth
Ⓢ = Initial

*Does not include programmatic factors other than M/I and S/S which are extracted from the TFU (Qty) Costs.

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**Table F-4. Breakdown of Theoretical First Unit (Or Quantity Adjusted)
Plus Tooling, STE and Acceptance Testing Costs By
Module, Selected Configuration(Cont)**

	Cargo Modules				Core-Growth				SM-5				SM-6				Totals					
	F/H	M/I	S/S		F/H	M/I	S/S		F/H	M/I	S/S		F/H	M/I	S/S		F/H	M/I	S/S			
Structural and Mechanical	5.3	1.1	0.4		3.7	0.5	0.2		1.9	0.2	0.1		1.4	0.1	0.1		34.9	4.6	2.3			
ECLSS	19.1	1.1	2.3		1.5	-	0.1		9.6	0.7	1.1		8.2	0.6	0.8		70.6	4.3	7.6			
EPS	1.2	0.1	0.2		7.4	0.5	0.9		0.4	-	-		0.3	-	-		126.5	4.8	7.9			
G&C																	10.3	0.7	1.1			
RCS					1.1	0.1	0.1		0.2	-	-		0.2	-	-		4.3	0.2	0.3			
Information	0.8	-	0.1		3.3	0.3	0.4		9.6	0.5	1.5		0.8	-	0.1		61.8	3.9	7.2			
Crew Habitability	0.4	-	0.1		0.6	-	-		0.9	-	-		0.8	-	-		8.5	0.1	0.5			
Totals	26.8	2.3	3.1		17.6	1.4	1.7		22.6	1.4	2.7		11.7	0.7	1.0		316.9	18.6	26.9			
Module Total	32.2				20.7				26.7				13.4				362.4					

Notes:

F/H = Flight Hardware
M/I = Module
Integration
S/S = Subsystem Instal,
Assy. and C/O

Recap -

F/H \$316.9
S/S 26.9
343.8
M/I 18.6
\$362.4

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**Table F-5. Design and Development + Tooling and STE for All Modules
of Initial Station Selected Configuration**

	1	2	3	4	5
	D&D Estimate (Base)	Eng. & Mfg. Support	D&D '71 \$	Tooling and S. T. E.	'72 \$
Structure and Mechanical			(116.6)	(54.3)	(179.4)
Primary			7.5		11.8
Secondary	N/A	N/A	24.0		36.0
Envir. Shield			38.6		61.3
Berthing			21.9		35.4
Gen. Purpose Lab			24.6		34.9
ECLSS	(125.8)	(61.7)	(187.5)	(18.4)	(216.2)
Gaseous Storage	6.4		9.9		11.6
CO ₂ Mgmt.	27.3		41.8		48.3
Atmos. Control	29.7		43.1		49.4
Thermal Control	26.8		38.1		44.1
Water Mgmt.	17.4		26.7		30.8
Waste Mgmt.	5.9		9.0		10.0
Hygiene	9.7		14.9		17.4
Sp. Life Support	2.6		4.0		4.6
Electrical Power	(114.9)	(16.1)	(131.0)	(16.1)	(154.5)
Pri. Power Gen.	84.3		96.1		112.9
Energy Storage	12.0		16.3		19.2
Power Conditioning	8.5		8.5		10.1
Dist. Control and Wiring	9.3		9.3		11.4
Lighting	0.8		0.8		0.9
Guidance and Control	(41.4)	(10.4)	(51.8)	(6.2)	(60.9)
Inertial Reference	3.2		4.7		5.5
Optical Reference	6.8		10.1		11.9
RCS Electronics	2.8		4.1		4.8
Momentum Exchange	9.0		13.3		15.7
Software	19.6		19.6		23.0
Reaction Control	(15.9)	(1.9)	(17.8)	(2.1)	(20.9)
Propellant Accum.	0.3		0.3		0.4
Propellant Feed Control	4.2		4.2		4.9
Engines	11.4		13.3		15.6
Information			(154.3)	(8.4)	(170.9)
Data Processing			37.8		41.2
Command/Control	N/A	N/A	1.3		1.4
External Commun.			32.1		36.2
Internal Commun.			16.3		18.0
Software			66.8		74.1
Crew/Habitability	(24.8)	(11.6)	(36.4)	(3.0)	(41.4)
Gen./Emergency Equip.	7.0		10.9		12.7
Furnishings	3.3		3.3		3.9
Recreation/Exercise	7.0		10.7		12.0
Food Management	7.5		11.5		12.8
Total (Millions)					\$844.2

Table F-5. TFU (Qty) Plus Tooling & STE Plus Acceptance Testing for All Modules (Initial Station) (Cont)

	1	2	3	4	5
	TFU Base Estimate (Base)	Eng. & Mfg. Support	TFU '71 \$	Tooling \$ STE Acceptance Test	'72 \$
Structure and Mechanical			(20.6)	(3.6)	(25.4)
Primary			5.9		7.3
Secondary	N/A	N/A	3.0		3.7
Envir. Shield			3.9		4.7
Berthing			1.1		1.3
Gen. Purpose Lab			6.7		8.4
ECLSS	(24.8)	(5.5)	(30.3)	(5.3)	(37.4)
Gaseous Storage	1.2		1.5		2.0
CO ₂ Mgmt.	4.7		5.8		7.1
Atmos. Control	5.2		6.3		7.8
Thermal Control	6.4		7.8		9.3
Water Mgmt.	4.9		6.0		7.3
Waste Mgmt.	1.1		1.3		1.7
Hygiene	0.8		1.0		1.3
Sp. Life Support	0.5		0.6		0.9
Electrical Power	(48.7)	(12.6)	(61.3)	(10.7)	(75.6)
Pri. Power Gen.	38.1		43.8		54.0
Energy Storage	6.9		13.8		17.0
Power Conditioning	2.3		2.3		2.9
Dist. Control and Wiring	0.9		0.9		1.1
Lighting	0.5		0.5		0.6
Guidance and Control	(8.0)	(1.8)	(9.8)	(1.7)	(12.1)
Inertial Reference	0.5		0.7		0.9
Optical Reference	1.8		2.5		3.1
RCS Electronics	0.8		1.1		1.4
Momentum Exchange	1.5		2.1		2.6
Software	3.4		3.4		4.1
Reaction Control	(2.2)	(0.3)	(2.5)	(0.5)	(3.1)
Propellant Accum.	0.2		0.2		0.2
Propellant Feed Control	0.9		0.9		1.2
Engines	1.1		1.4		1.7
Information			(45.0)	(7.9)	(55.5)
Data Processing			17.0		21.0
Command/Control	N/A	N/A	0.6		0.7
External Commun.			20.1		24.8
Internal Commun.			17.3		9.0
Software					
Crew/Habitability	(4.2)	(0.9)	(5.1)	(0.9)	(6.3)
Gen. /Emergency Equip.	2.1		2.6		3.3
Furnishings	0.3		0.3		0.3
Recreation/Exercise	0.9		1.0		1.2
Food Management	0.9		1.2		1.5
Total (Millions)					\$215.4

**Table F-6. Cost Summary for Modular Space Station
(XX-1XX-00-00)**

Subsystem (WBS Level 5) Subsystem Fil (WBS Level 4)		Cost in Millions (1972 \$)										
		Initial Core	Power	SM-1	SM-2	SM-3	SM-4	Cargo	Growth Core	SM-5	SM-6	Total
		WBS ID No.	-01-00	-02-00	-03-00	-04-00	-05-00	-06-00	-07-00	-08-00	-09-00	-10-00
Non-Recurring: Design and Development Plus Tooling and STE												
Structural and Mechanical		65.4	41.2	29.4	29.8	16.7	12.2	14.6	31.4	7.0	6.8	254.5
Environmental Cont. / Life Support		24.4	11.4	72.7	71.6	17.4	18.7	32.2	6.3	9.5	2.7	266.9
Electrical Power		24.2	119.0	7.7	2.6	0.5	1.5	1.8	6.7	1.2	0.3	165.5
Guidance and Control		60.9										60.9
Reaction Control		18.7			1.7	0.5			2.6	0.8	0.3	24.6
Information		16.3	0.4	134.4	1.2	0.6	18.0	0.7	3.7	14.9	0.3	190.5
Crew Habitability		9.8	0.3	6.5	1.8	13.0	10.0	2.2	0.7	1.2	0.3	45.8
Subtotal		219.7	172.3	250.7	108.7	48.7	60.4	51.5	51.4	34.6	10.7	1,008.7
Project Management												98.7
Systems Support												84.8
Pre-mission Operations												25.0
GPL Experiment Integration												21.0
Major Test Programs												252.8
Ground Support Equipment												84.7
Facilities												18.1
Total MSS (WBS Level 3)		\$1,593.9										
Production Recurring: TFU (Qty) Plus Tooling and STE Plus Acceptance Testing, but Without Module Integration, Assembly and Checkout:												
Structural and Mechanical		5.9	2.4	3.0	5.8	3.6	1.9	5.3	3.7	1.9	1.4	34.9
Environmental Cont. / Life Support		2.8	1.4	7.4	6.7	6.9	7.0	19.1	1.5	9.6	8.2	70.6
Electrical Power		9.7	101.6	2.9	0.4	0.4	2.2	1.2	7.4	0.4	0.3	126.5
Guidance and Control		10.3										10.3
Reaction Control		1.8			0.5	0.5			1.1	0.2	0.2	4.3
Information		2.4	2.4	20.7	0.5	1.1	20.2	0.8	3.3	9.6	0.8	61.8
Crew Habitability		1.6	0.1	0.8	0.4	1.5	1.4	0.4	0.6	0.9	0.8	8.5
Subsystem Instal., Assy and C/O		3.5	5.8	3.5	1.1	1.1	3.4	3.1	1.7	2.7	1.0	26.9
Subtotal		38.0	113.7	38.3	15.4	15.1	36.1	29.9	19.3	25.3	12.7	343.8
Project Management												41.8
System Support												13.8
Module Integration, Assy and C/O												18.6
Total MSS (WBS Level 3)		\$ 418.0										

Table F-7. Structural and Mechanical Subsystem Cost Summary For Modular Space Station
(XX-1XX-00-00)

Assembly (WBS Level 6) Module WBS ID No.	Cost in Millions (1972 \$)										
	Initial Core	Power	SM-1	SM-2	SM-3	SM-4	Cargo	Growth Core	SM-5	SM-6	Total
	-01-01	-02-01	-03-01	-04-01	-05-01	-06-01	-07-01	-08-01	-09-01	-10-01	-00-01
Design and Development Plus Tooling and STE											
Primary Structure	6.6	3.6	1.1	1.0	0.9	1.0	1.5	4.9	0.2	0.2	21.0
Secondary Structure	9.1	5.8	8.9	5.0	5.0	5.2	5.1	7.6	5.6	5.6	62.9
Environmental Shield	31.0	15.9	8.0	3.6	3.5	3.6	7.4	15.1	0.4	0.3	88.8
Berthing	18.7	15.9	2.8	1.2	1.2	1.2	0.6	3.8	0.8	0.7	46.9
General Purpose Lab Furnishings			8.6	19.0	6.1	1.2					34.9
Total Subsystem Cost (WBS Level 5)	65.4	41.2	29.4	29.8	16.7	12.2	14.6	31.4	7.0	6.8	254.5
TFU Plus Tooling and STE Plus Acceptance Testing, but Without Subsystem Installation, Assembly and Checkout and Module Integration Assembly and Checkout.											
Primary Structure	3.5	0.9	0.8	0.5	0.5	0.4	1.3	1.8	0.6	0.4	10.7
Secondary Structure	0.7	0.2	0.7	0.5	0.5	0.5	1.3	0.6	0.6	0.4	6.0
Environmental Shield	1.2	0.8	0.6	0.5	0.5	0.5	2.3	1.0	0.6	0.5	8.5
Berthing	0.5	0.5	0.2	0.2	0.2	0.2	0.4	0.3	0.1	0.1	2.7
General Purpose Lab Furnishings			0.7	4.1	1.9	0.3					7.0
Total Subsystem Cost (WBS Level 5)	5.9	2.4	3.0	5.8	3.6	1.9	5.3	3.7	1.9	1.4	34.9

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Table F-8. ECLS Subsystem Cost Summary for Modular Space Station (XX-1XX-00-00)

Assembly (WBS Level 6) Module WBS ID No.	Cost in Millions (1972 \$)										
	Initial Core	Power	SM-1	SM-2	SM-3	SM-4	Cargo	Growth Core	SM-5	SM-6	Total
	-01-02	-02-02	-03-02	-04-02	-05-02	-06-02	-07-02	-08-02	-09-02	-10-02	-00-02
Design and Development Plus Tooling and STE											
Gaseous Storage	1.0	10.2		0.2	0.2		22.4	0.5	0.1	0.1	34.7
CO ₂ Management	0.4		0.2	40.1	7.4	0.2	4.1	0.1	0.1	0.1	52.7
Atmospheric Control	12.6	1.2	9.9	14.7	2.6	8.4	2.5	3.4	1.9	0.5	57.7
Thermal Control	6.2		17.9	14.2	2.5	3.3	1.1	1.8	1.8	0.5	49.3
Water Management	0.7		24.5	0.9	0.2	4.5	1.0	0.4	3.3	0.8	36.3
Waste Management			4.7		3.7	1.6	0.9		0.2	0.1	11.2
Hygiene			15.3	1.1	0.5	0.5			2.0	0.5	19.9
Special Life Support	3.5		0.2	0.4	0.3	0.2	0.2	0.1	0.1	0.1	5.1
Total Subsystem Cost (WBS Level 5)	24.4	11.4	72.7	71.6	17.4	18.7	32.2	6.3	9.5	2.7	\$ 266.9
Flight Hardware W/O Subsystem I, A, and C/O Plus Tooling and STE											
Gaseous Storage	0.2	1.3		0.2	0.2		15.4	0.2	0.2	0.2	17.9
CO ₂ Management	0.2		0.2	2.9	2.7	0.2	0.8	0.1	0.2	0.2	7.5
Atmospheric Control	1.4	0.1	1.0	1.5	1.5	1.0	0.7	0.5	1.9	1.6	11.2
Thermal Control	0.7		2.0	1.5	1.5	2.0	0.6	0.4	2.0	1.7	12.4
Water Management	0.2		3.0	0.2	0.2	2.8	0.7	0.2	3.6	3.0	13.9
Waste Management			0.4		0.4	0.6	0.8		0.8	0.7	3.7
Hygiene			0.6	0.2	0.2	0.2			0.8	0.7	2.7
Special Life Support	0.1		0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	1.3
Total Subsystem Cost (WBS Level 5)	2.8	1.4	7.4	6.7	6.9	7.0	19.1	1.5	9.6	8.2	\$ 70.6

Table F-9. Electrical Power Subsystem Cost Summary For Modular Space Station (XX-1XX-00-00)

Assembly (WBS Level 6) Module WBS ID No.	Cost in Millions (1972 \$)										
	Initial Core	Power	SM-1	SM-2	SM-3	SM-4	Cargo	Growth Core	SM-5	SM-6	Total
	-01-03	-02-03	-03-03	-04-03	-05-03	-06-03	-07-03	-08-03	-09-03	-10-03	-00-03
Design and Development Plus Tooling and STE											
Primary Power Generation		112.9									112.9
Energy Storage	11.0	4.5	3.2			0.5	0.8	3.7			23.7
Power Conditioning	9.3		0.4	0.2	0.1	0.1	0.6	1.0	0.1	0.1	11.9
Distribution Control and Wiring	3.7	1.5	3.9	2.2	0.3	0.8	0.3	1.9	1.0	0.1	15.7
Lighting	0.2	0.1	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	1.3
Total Subsystem Cost (WBS Level 5)	24.2	119.0	7.7	2.6	0.5	1.5	1.8	6.7	1.2	0.3	165.5
Flight Hardware W/O Subsystem I, A, and C/O Plus Tooling and STE											
Primary Power Generation		98.3									98.3
Energy Storage	7.4	3.1	2.5			1.8	0.5	6.6			21.9
Power Conditioning	2.0		0.1	0.1	0.1	0.1	0.5	0.4	0.1	0.1	3.5
Distribution Control and Wiring	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.3	0.2	0.1	1.9
Lighting	0.1		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.9
Total Subsystem Cost (WBS Level 5)	9.7	101.6	2.9	0.4	0.4	2.2	1.2	7.4	0.4	0.3	126.5

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**Table F-10. Guidance and Control Subsystem Cost Summary
For Modular Space Station (XX-1XX-00-00)**

Assembly (WBS Level 6) Module	Cost in Millions (1972 \$)										
	Initial Core	Power	SM-1	SM-2	SM-3	SM-4	Cargo	Growth Core	SM-5	SM-6	Total
WBS ID No.	-01-04										-00-04
Design and Development Plus Tooling and STE											
Inertial Reference	5.5										5.5
Optical Reference	11.9										11.9
RCS Electronics	4.8										4.8
Momentum Exchange	15.7										15.7
Computation Software	23.0										23.0
Total Subsystem Cost (WBS Level 5)	60.9										\$ 60.9
Flight Hardware W/O Subsystem I, A, and C/O Plus Tooling and STE											
Inertial Reference	0.8										0.8
Optical Reference	2.6										2.6
RCS Electronics	1.2										1.2
Momentum Exchange	2.2										2.2
Computation Software	3.5										3.5
Total Subsystem Cost (WBS Level 5)	10.3										10.3

**Table F-11. Reaction Control Subsystem Cost Summary For
Modular Space Station (XX-1XX-00-00)**

Assembly (WBS Level 6) Module	Cost in Millions (1972 \$)										
	Initial Core	Power	SM-1	SM-2	SM-3	SM-4	Cargo	Growth Core	SM-5	SM-6	Total
WBS ID No.	-01-05			-04-05	-05-05			-08-05	-09-05	-10-05	-00-05
Design and Development Plus Tooling and STE											
Propellant Accumulators				0.3	0.1				0.2	0.1	0.7
Propellant Feed Controls	3.1			1.4	0.4			1.1	0.6	0.2	6.8
Engines	15.6							1.5			17.1
Total Subsystem Cost (WBS Level 5)	18.7			1.7	0.5			2.6	0.8	0.3	\$ 24.6
Flight Hardware W/O Subsystem I, A and C/O Plus Tooling and STE											
Propellant Accumulators				0.1	0.1				0.1	0.1	0.4
Propellant Feed Controls	0.3			0.4	0.4			0.2	0.1	0.1	1.5
Engines	1.5							0.9			2.4
Total Subsystem Cost (WBS Level 5)	1.8			0.5	0.5			1.1	0.2	0.2	\$ 4.3

**Table F-12. Information Subsystem Cost Summary For
Modular Space Station (XX-1XX-00-00)**

Assembly (WBS Level 6) Module WBS ID No.	Cost in Millions (1972 \$)										
	Initial Core	Power	SM-1	SM-2	SM-3	SM-4	Cargo	Growth Core	SM-5	SM-6	Total
	-01-06	-02-06	-03-06	-04-06	-05-06	-06-06	-07-06	-08-06	-09-06	-10-06	-00-06
Design and Development Plus Tooling and STE											
Data Processing	0.8	0.3	28.4	0.4	0.3	11.0	0.3	1.4	9.0	0.1	52.0
Command/Control and Monitoring			0.8	0.1	0.1	0.4	0.2	0.1	0.2	0.1	2.0
External Communications	15.3		17.9			3.0		2.1			38.3
Internal Communications	0.2	0.1	13.2	0.7	0.2	3.6	0.2	0.1	0.2	0.1	18.6
Software			74.1						5.5		79.6
Total Subsystem Cost (WBS Level 5)	16.3	0.4	134.4	1.2	0.6	18.0	0.7	3.7	14.9	0.3	190.5
Flight Hardware W/O Subsystem I, A, and C/O Plus Tooling and STE											
Data Processing	0.3	0.3	8.3	0.4	0.4	8.2	0.1	0.7	8.7	0.3	27.7
Command/Control and Monitoring			0.3		0.1	0.2	0.2	0.1	0.4	0.1	1.4
External Communications	1.9	1.9	8.6			8.6		2.2			23.2
Internal Communications	0.2	0.2	3.5	0.1	0.6	3.2	0.5	0.3	0.5	0.4	9.5
Software											
Total Subsystem Cost (WBS Level 5)	2.4	2.4	20.7	0.5	1.1	20.2	0.8	3.3	9.6	0.8	61.8

**Table F-13. Crew Habitability Subsystem Cost Summary
For Modular Space Station (XX-1XX-00-00)**

Assembly (WBS Level 6) Module	Cost in Millions (1972 \$)										
	Initial Core	Power	SM-1	SM-2	SM-3	SM-4	Cargo	Growth Core	SM-5	SM-6	Total
	WBS ID No.	-01-07	-02-07	-03-07	-04-07	-05-07	-06-07	-07-07	-08-07	-09-07	-10-07
Design and Development Plus Tooling and STE											
General/Emergency Equipment	9.8	0.3	1.7	0.5	0.2	0.2	0.2	0.7	0.6	0.1	14.3
Furnishings			2.1		1.1	0.7	1.5		0.3	0.1	5.8
Recreation/Exercise/ Crew Care			2.7		0.2	9.1					12.0
Food Management				1.3	11.5		0.5		0.3	0.1	13.7
Total Subsystem Cost (WBS Level 5)	9.8	0.3	6.5	1.8	13.0	10.0	2.2	0.7	1.2	0.3	45.8
Flight Hardware W/O Subsystem I, A, and C/O Plus Tooling and STE											
General/Emergency Equipment	1.6	0.1	0.5	0.2	0.1	0.4	0.1	0.6	0.5	0.5	4.6
Furnishings			0.1		0.1	0.1	0.2		0.2	0.1	0.8
Recreation/Exercise/ Crew Care			0.2		0.1	0.9					1.2
Food Management				0.2	1.2		0.1		0.2	0.2	1.9
Total Subsystem Cost (WBS Level 5)	1.6	0.1	0.8	0.4	1.5	1.4	0.4	0.6	0.9	0.8	8.5