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MDC H0533

SPACE STATION NEEDS, ATTRIBUTES, AND ARCHITECTURAL OPTIONS

Mission Requirements

MCDONNELL DOUGLAS ASTRONAUTICS COMPANY

MCDONNELL DOUGLAS CORPORATION

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MDC H0533

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CONTRACT NO. NASW-3687

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PREFACE

The McDonnell Douglas Astronautics Company has been engaged in a study for the National Aeronautics and Space Administration to determine Space Station needs, attributes, and architecture. The study, which emphasized mission validation by potential users, and the benefits a Space Station would provide to its users, was divided into the following three tasks:

Task 1: Mission Requirements
Task 2: Mission Implementation Concepts
Task 3: Cost and Programmatics Analysis

In Task 1, missions and potential users were identified; the degree of interest on the part of potential users was ascertained, especially for commercial missions; benefits to users were quantified; and mission requirements were defined.

In Task 2, a range of system and architectural alternatives encompassing the needs of all missions identified in Task 1 were developed. Functions, resources, support, and transportation necessary to accomplish the missions were described.

Task 3 examined the programmatic options and the impact of alternative program strategies on cost, schedule and mission accommodation.

This report, which discusses mission requirements, was prepared for the National Aeronautics and Space Administration under contract NASw-3687 as part of the Task 1 activities.

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Section 1
INTRODUCTION AND SUMMARY

The major portion of the space station study dealt with the determination of potential space station missions and their requirements. Each of the mission areas was analyzed in depth and is separately reported. This document reports on the analyses of the total mission data base, which was constructed from inputs generated by engineers cognizant of each mission area, and the resultant requirements that were extracted and combined from these missions.

A McDonnell Douglas Astronautics Company (MDAC) computer program, used to maintain and analyze data, was invaluable in that it continuously modified, updated, sorted, and integrated the data as needed for the specific analyses that followed. Several tapes of the data base were input to the Langley Research Center (LRC) data library.

Another valuable tool was the benefits analyses technique. It was used to prioritize the great number of missions so they could be ordered into groups for later accommodation. The prioritization allowed overall and orderly comparisons of missions accomplished, architecture needed, and budget requirements.

The requirements determined by the study dictate a very strong need for a manned space station to satisfy the majority of the missions. The station is best located at a 28.5-deg inclination and initially (1992 era) requires a crew of four (three for mission payloads) and a mission power of 25 kW. A space platform in a polar orbit is needed to augment the station capability; it initially would be a 15-kW system, located in a sun-synchronous orbit.

Requirements for evolutionary growth of each of these space station system elements, and for augmentation at other locations, were determined. Space station and platform facility elements with a total capability of 80 kW, eight men, and over 200 Mbps data rate are foreseen by the end of this century.

The techniques employed provided a reasonable requirements definition. They also demonstrated capabilities that could be applied in future endeavors, especially in the areas of user involvement, computerized data base, benefits analysis techniques, mission prioritization, and requirements integration.

Section 2
MISSION MODEL ANALYSES

Development of the mission model had begun prior to the space station study ATP. The model was expanded, analyzed, and updated throughout the course of the study. The methodology used for this sustained effort, the evolution of the mission model, and the study product data base are discussed here.

2.1 METHODOLOGY

The 20 years of space station mission data that were available, reaching back to the Manned Orbital Research Laboratory study of 1962, necessitated a technique for rapidly processing and evaluating large amounts of data. This was accomplished by assigning a cognizant engineer to each of the mission categories, providing evaluation and data definition formats to be used, loading data, and using a computerized data processing technique. Initially, hundreds of potential missions were found to be candidates for consideration. The missions were evaluated and summarized on Mission Disposition Sheets (Figure 2-1). The Mission Disposition Sheets made possible the rapid assessment of mission candidates as potential space station applications while traceable referencing was retained. (This was found to be of value when missions were combined to form specific mission sets.) The Mission Disposition Sheets were used primarily for the Science and Applications missions because of their large number and the many references available.

NASA-provided mission data sheet format (Figure 2-2), reflecting the next level of definition, was used for all mission categories. Early in the study, over 100 missions were defined on these sheets with data available for over half the entries requested. Many of the entry requests, however, were at a level not available at the definition status of these missions.

As the study progressed, the data base was found to require continuous updating, i.e., additions, deletions, parameter value changes, and data sheet format changes. These changes, coupled with the need to provide numerous data sorts for subsequent study task analyses, necessitated the use of the

File No: ______________________ Title: ______________________

Category: ______________________

Description: ______________________

____

____

Space Attributes Used: ______________________

____

Manned Involvement: ______________________

____

Benefit Potential - Mission: ______________________

- Space Station: ______________________

Critical Requirements: ______________________

____

Program Status: ______________________

Data Source and Contact: ______________________

____

Disposition: ______________________

FILE CODES

S - Science
A - Applications
C - Commercial
D - National Security
O - Space Operations
(S) - Secret

SPACE ATTRIBUTES (PARTIAL LIST)

- Broad Field of View
- Global Coverage
- Repeatable Ground Track
- Low or Zero Gravity
- Space Vacuum
- Exoatmospheric
- Flight Duration

POTENTIAL MANNED INVOLVEMENT

- Real-Time Data Analysis and Evaluation
- Multiple Sensor Use
- Sensor Mode and Parameter Selection
- Target Selection
- Sensor Operation and Parameter Variation
- Evaluation of Sensor Design and Performance
- Equipment Setup, Checkout, Maintenance, Calibration, Etc.
- Consumables Servicing

FIGURE 2-1. MISSION DISPOSITION SHEET

Page 1 of 3

PAYLOAD ELEMENT NAME | CODE | TYPE

CONTACT
Name
Address

Telephone

☐ Science & Applications (non-commercial)
☐ Commercial
☐ Technology Development
☐ Operations

Type Number ______
(see Table A)

STATUS
☐ Operational ☐ Planned
☐ Approved ☐ Candidate
☐ Opportunity

First flight, yr ______
No. of flights ______
Duration of flight, days ______

Importance of the Space Station to this Element
1 = low value but could use
10 = vital

OBJECTIVE

DESCRIPTION

Page 2 of 3

ORBIT CHARACTERISTICS
Apogee, km ______ Perigee, km ______ Tolerance + ______ -
Inclination deg ______ Tolerance + ______ -
Nodal Angle, deg ______ Ephemeris Accuracy, m ______
Escape dV Required, m/s ______

POINTING/ORIENTATION
View direction ☐ Inertial ☐ Solar ☐ Earth
Truth Sites (if known)
Pointing accuracy, arc sec ______ Field of view, deg ______
Pointing Stability (Jitter) arc sec/sec ______
Special Restrictions (Avoidance) ______

POWER
☐ AC ☐ DC
Power, W Duration, hrs/day
Operating ______ ______ ☐ Continuous
Standby ______ ______
Peak ______ ______
Voltage, V ______ Frequency, Hz ______

DATA/COMMUNICATIONS
Monitoring requirements:
☐ None ☐ Realtime ☐ Offline ☐ Other ______
☐ Encryption/Decryption Required
☐ Uplink Req.: Command Rate (KBS) ______ Frequency (MHZ) ______
☐ On-Board Data Processing Required
Description ______

Data Types: ☐ Analog ☐ Digital ☐ Hrs/Day ______
Film (Amount)
Live TV (Hrs/D
On-Board Stora
Data Dump Freq
Recording Rate

Page 3 of 3

THERMAL
☐ Active ☐ Passive
Temperature, deg C operational min ______ max ______
non-operational min ______ max ______
Heat Rejection, w operational min ______ max ______
non-operational min ______ max ______

EQUIPMENT PHYSICAL CHARACTERISTICS
Location: ☐ Internal ☐ External ☐ Remote
Equipment ID/Function ☐ Pressurized ☐ Unpressurized
L, m ______ W, m ______ H, m ______ Stowed
L, m ______ W, m ______ H, m ______ Deployed
Launch mass, kg ______
Consumables Types ______
Acceleration sensitivity, g min ______ max ______

CREW REQUIREMENTS
Crew Size ______ Task Assignment ______
Skills (See Table B)

SKILL						
LEVEL						
Hrs/Day						

EVA ☐ YES ☐ NO Reason ______ Hrs/EVA ______

SERVICING/MAINTENANCE
SERVICE: Interval, days ______ Consumables, kg ______
Returnables, kg ______ Man Hours ______
CONFIGURATION CHANGES: Interval, day ______ Man/Hrs Req. ______
Deliverables, kg ______ Returnables, kg ______

SPECIAL CONSIDERATIONS/See Instructions

FIGURE 2-2. MISSION DATA SHEETS

computerized data base as repository for all the mission data. This was done in such a way that our data base would be compatible with the LRC computerized data base. (Magnetic tapes of our data bases were sent to LRC as needed.)

The computerized data base that resulted was a matrix that included 44 parameters for each mission. The 44 parameters are in response to the specific items circled on the NASA mission data sheet shown in Figure 2-2, plus additional items needed for the study task analyses that followed. The computer data base technique also implemented analyses of those data items that would most influence system architecture and cost. The objectives and descriptions of the missions are separately reported.

The capability of the MDAC analyses programs, developed with company funds, is summarized in Figure 2-3. These programs were used in the study. The data base analyses (Task 1) were done by the Accent R program, an interactive program that provides the means for various modules to operate on a data base library. Its editing capabilities implement rapid data modifications, changes, and sorting of the data base. Process modules are developed and called as appropriate for various hard-copy outputs, and command modules are used for the formation of specific data sets for architecture studies. These data sets included integrated time-phased outputs such as power, crew time, and volume. The specific data sets are retained on files and called up as needed by the Architecture Definition Evaluation Program (see Figure 2-3). This program calculates the characteristics needed by the architecture to meet the data base requirements. In turn, these architectural characteristics are used in the cost model to compare program costs to available budgets. The results are then used to rapidly adjust the mission sorts and the architecture to meet the budget restrictions. During the space station study, over 200 data-base sorts were compiled for analyses in the subsequent study tasks.

2.2 MISSION DATA BASE

The evolution of the data base through the study is illustrated in Figure 2-4. Early in the study, 365 missions were identified as potential space station candidates, and by midterm (November 1982), these were compiled into 95 space station missions in five categories:

FIGURE 2-3.

VGB579

COMPUTERIZED DATA FLOW

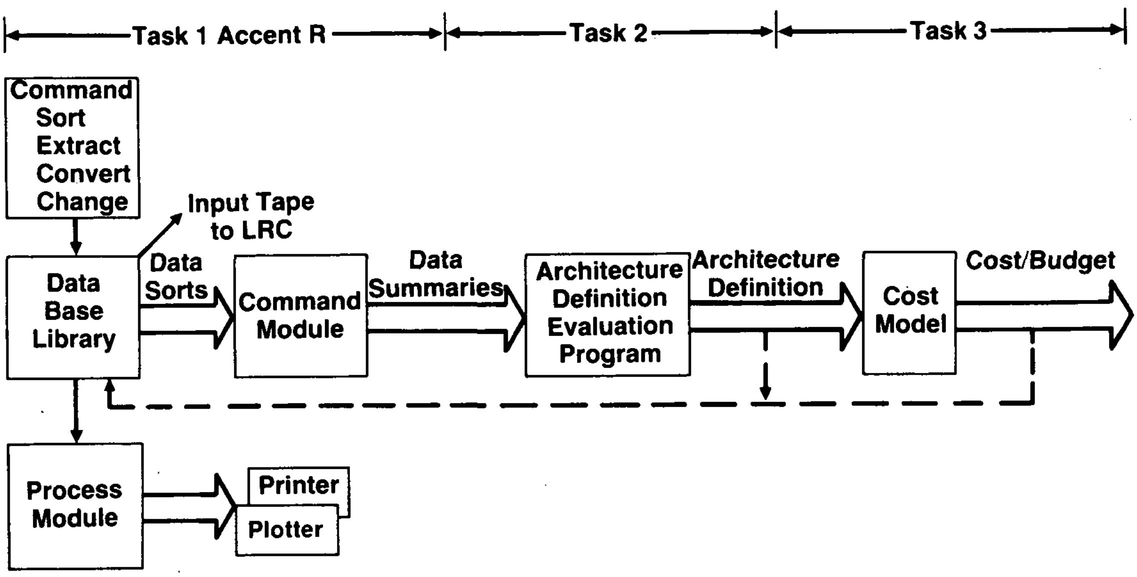
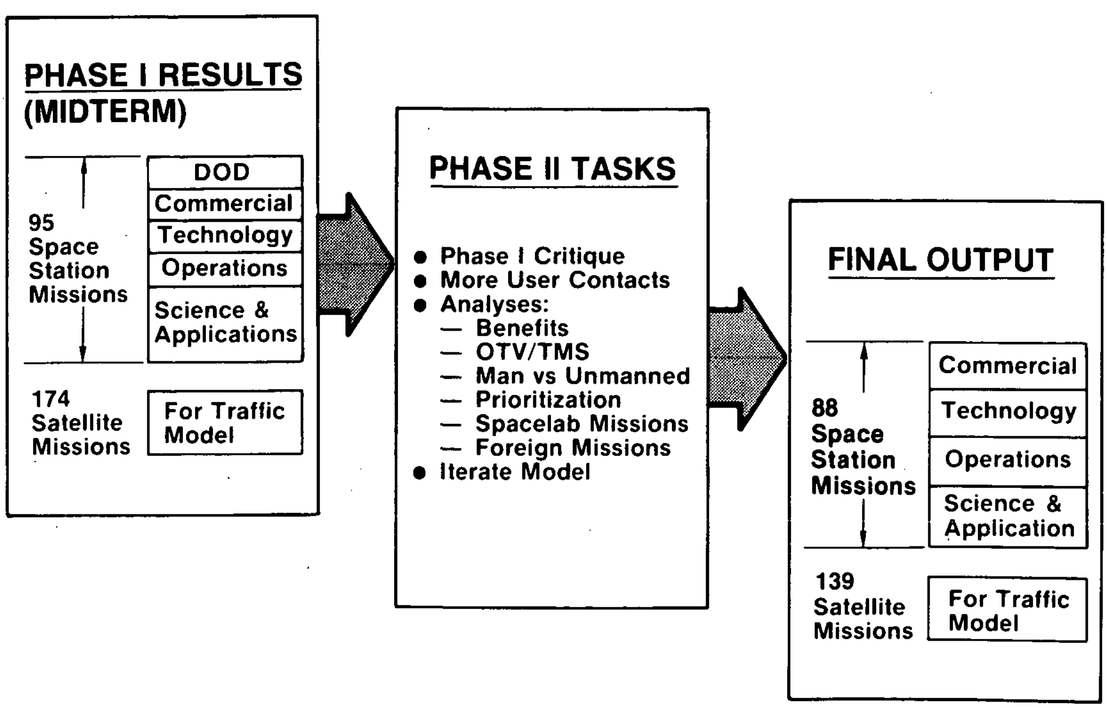


FIGURE 2-4.

VGB389

MISSION MODEL EVOLUTION



- Science and Applications - 40
- Commercial - 12
- National Security - 6
- Operations - 25
- Technology - 12.

In Phase II of the study, the data base was continuously updated in response to mission definition analyses, feedback received from the midterm review, additional user contacts, and later data additions. The final study data base included 88 space station missions in the four categories shown.

The National Security missions were removed from the study proper and separately reported. A traffic model with 139 satellites to be delivered to geostationary orbit was also included in the data base for analysis of orbit transfer vehicle needs, Shuttle flight schedules, and orbital selections.

The study data base is summarized in Figure 2-5. The 88 missions are distributed as shown:

- Commercial - 18
- Technology - 14
- Operation - 10
- Science and Applications - 57.

Six servicing missions are common to the latter two categories. The type and format of the data included are shown. For each mission, the 44 defined parameters include orbit needs, physical integration requirements (e.g., space station, platform, attach points), utility resource needs, and crew requirements. A copy of the complete data base is in Appendix A.

Each of the 88 missions was defined on a summary page such as the one illustated in Figure 2-6. The mission characteristics and special considerations were included, as well as the mission requirements data and study disposition of each mission. The priority rating shown is discussed in Section 4. Summary pages for all 88 missions are included in Appendix A.

FIGURE 2-5.

MISSION DATA BASE

VGB394

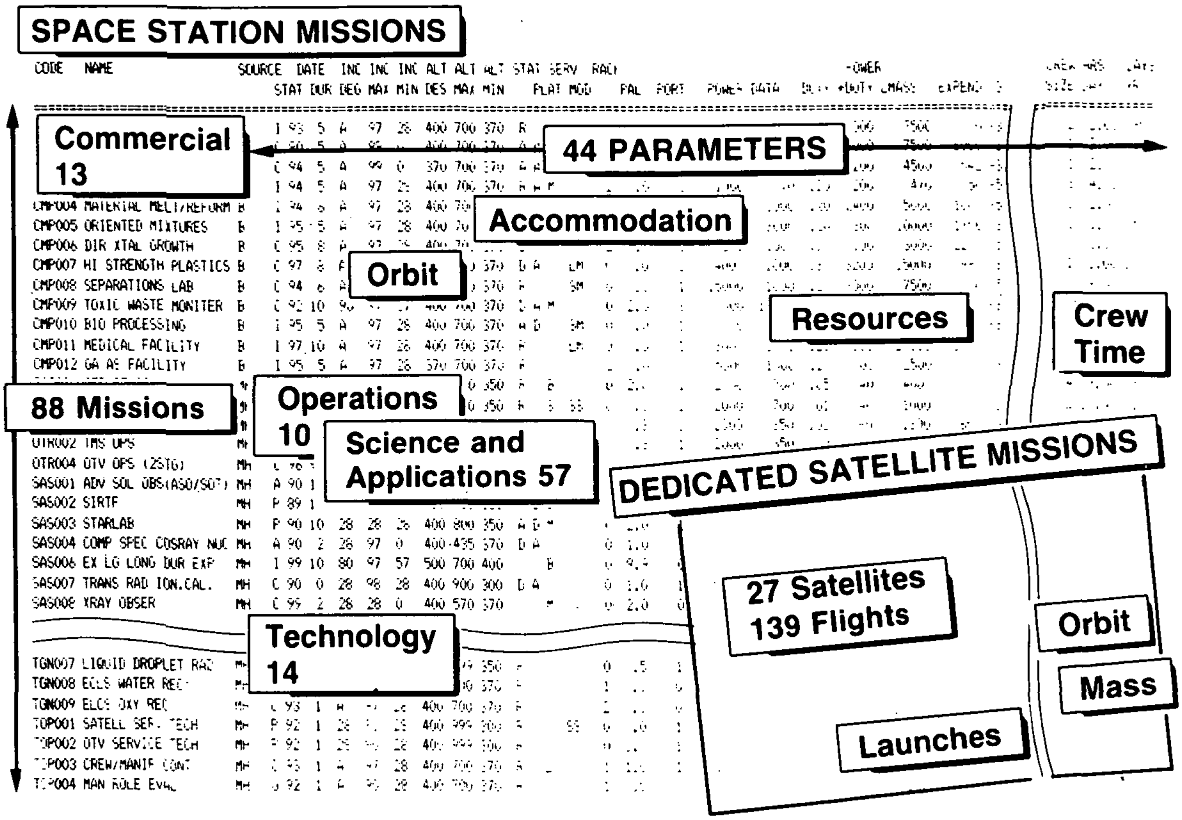
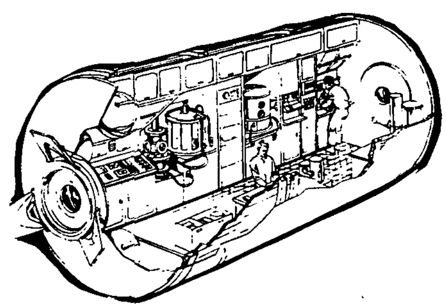


FIGURE 2-6.

MATERIALS PROCESSING LABORATORY SMP001

VGB770



CHARACTERISTICS

- Manned Laboratory
- Materials R&D
- Small-Scale; Production

CONSIDERATIONS AND REQUIREMENTS

- Capability for Limited Evaluation of Test Results
- 10^{-3} to 10^{-6} g Required for Many Experiments
- Access to Space Vacuum Required for Some Processes
- Flexibility to Make Many Different Test Setups From Basic Equipment

MISSION DATA

Status:	Candidate
Earlist Launch:	1993
Mass:	12300 kg
Preferred Orbit:	Any
Power:	12 kW Peak, 6 kW Average
Data Rate:	10 kbps Peak, 5 kbps Average
Accommodation:	Station — R Platform — U Satellite — U

		Hr /Year	Ops/Yr
Operations:	Scientist/Observer —	400	100
	Operator/Engineer —	400	100
	Technician —	400	100

Launch Volume;	Long Module (6 m)
Peak Rate Duty Cycle:	0.5
Priority Rating:	2

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Section 3
MISSION ANALYSIS SUMMARY

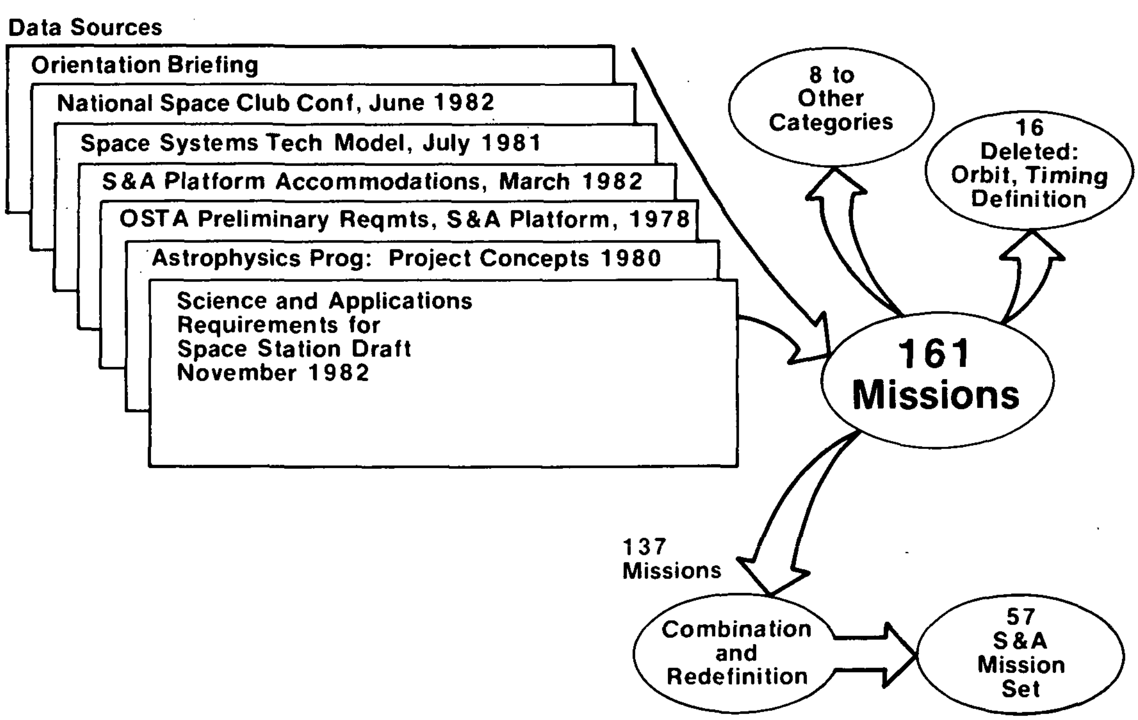
Analyses of the four mission categories are summarized here. These analyses, as well as those of the National Security Missions, are reported in detail in separate volumes.

3.1 SCIENCE AND APPLICATIONS MISSIONS

The derivations of the Science and Applications missions is illustrated in Figure 3-1. The data sources used span those received at the orientation briefing to the midterm inputs. The 161 missions identified were reduced to 57, primarily by combining similar missions, but also by allocating 8 missions to other categories and deleting 16 missions because of program incompatibilities.

FIGURE 3-1
SCIENCE AND APPLICATIONS MISSION MODEL DERIVATION

VGC196



The 57 Science and Applications missions defined are listed in Figure 3-2. They include:

- Nineteen missions in Solar and Astrophysics
- Three missions in Communications Research
- Eight missions in Earth Environment
- Sixteen missions in Earth and Planetary Exploration
- Six missions in Life Science
- Five missions in Materials Processing

These missions present basic questions of science that can profit from on-orbit measurements and observations. The full 25 decades of wavelength emitted by the sun and cosmos will be observed, as compared to the six decades observable from the earth. This will enable better understanding of the universe, the solar system, and the interaction between the sun and the earth's weather and climate.

The Science and Applications missions will advance the utilization of the earth's resources and environment to the general benefit of society. The cost of communications, for example, has dropped by an order of magnitude, and volume has grown even more rapidly because of satellite relay systems.

FIGURE 3-2.
SCIENCE AND APPLICATIONS MISSION
57 TOTAL

VGB580

MCDONNELL DOUGLAS

ASTROPHYSICS 19	SAS001 ADV SOL OBS(ASO/SOT) SAS002 SIRTF SAS003 STARLAB SAS004 COMP SPEC COSRAY NUC SAS006 EX LG LONG DUR EXP SAS007 TRANS RAD ION.CAL. SAS008 XRAY OBSER SAS009 SPACE TELESC SAS010 HIRES X&G-RAY SPEC SAS011 XRAY TIMING EXPL SAS012 SOLAR INT DYNAMICS SAS013 ADV XRAY ASTROFAC SAS014 LAMAR(HTM) SAS015 VLBI SAS016 LRG DELP REFL SAS017 GAMMA RAY OBS SAS018 HIGH ENER ISO EXP SAS019 SOLAR COR DYN SAS020 COSMIC RAY OBS
COMMUNICATIONS 3	SCM001 REMOTE SENSING RFI SCM002 ORB STANDARDS PACK SCM003 COMM RESEARCH FAC
ENVIRONMENTAL 8	SEE001 OCEAN PAYLOAD SEE002 ATMOS COMP SEE003 UPPER ATMOS RES SEE004 SPACE PLASMA PHYSICS SEE005 ZERO G CLOUD PHYSICS SEE006 MET. RES. PKG SEE007 ATM DYNAMICS&RAD SEE008 OP CIVIL MET
EARTH AND PLANETARY 16	SEP001 SAR SEP002 MULTISPECT LIN ARRAY SEP003 MAG FIELD MAPPER SEP004 PASS MICROWAVE RAD SEP005 LARGE FORMAT CAMERA SEP006 IMAGE SPECTROMETER SEP007 LUMINESCENCE DET SEP008 LASER RANGING SEP009 LANDSAT D-D' SEP010 RADAR ALT SEP011 ACT FLUOR SPECT SEP012 PLAN SPECT TELE SEP013 IR SPECT SEP014 FAR IR SPECT SEP015 EXTRA SS DET SEP016 PLANETARY PROC LAB
LIFE SCIENCES 6	SLS001 PRIMATE EXP FAC SLS002 PLANT BIO/LS FACIL SLS003 RODENT EXP FACIL SLS004 ORB QUARANTINE SLS005 EXP MED TREAT FAC SLS006 HUMAN EXP FAC
MATERIALS PROCESSING 5	SMP001 MATERIALS PROC LAB SMP002 MATERIALS EXP CARR SMP003 MATERIALS EXP ASS SMP004 WAKE SHIELD EXP SMP005 ULTRAVACUUM FAC

Continued growth of communications will require better utilization of facilities and extension of capability. In addition, space research and processing will result in new products for health care, better understanding of biological sciences, and new materials for electronics, which will benefit all of society. Observation of the earth's environment and resources will aid in control of the environment, management of resources, conservation of fragile ecosystems, and development of renewable resources.

A manned space station will be of enormous value in helping to achieve Science and Applications objectives. For some mission groups, such as Life Science and Materials Processing, a manned space station is a practical necessity, for their rate of progress is severely limited by using intermittent, short-duration Orbiter flights.

For the majority of Science and Applications missions, a space station will provide high-value operational support. This support will reduce the cost of hardware and operations; enable the maintenance, repair, and servicing of free-flying payloads; and provide manned interaction to enhance data acquisition and interpretation.

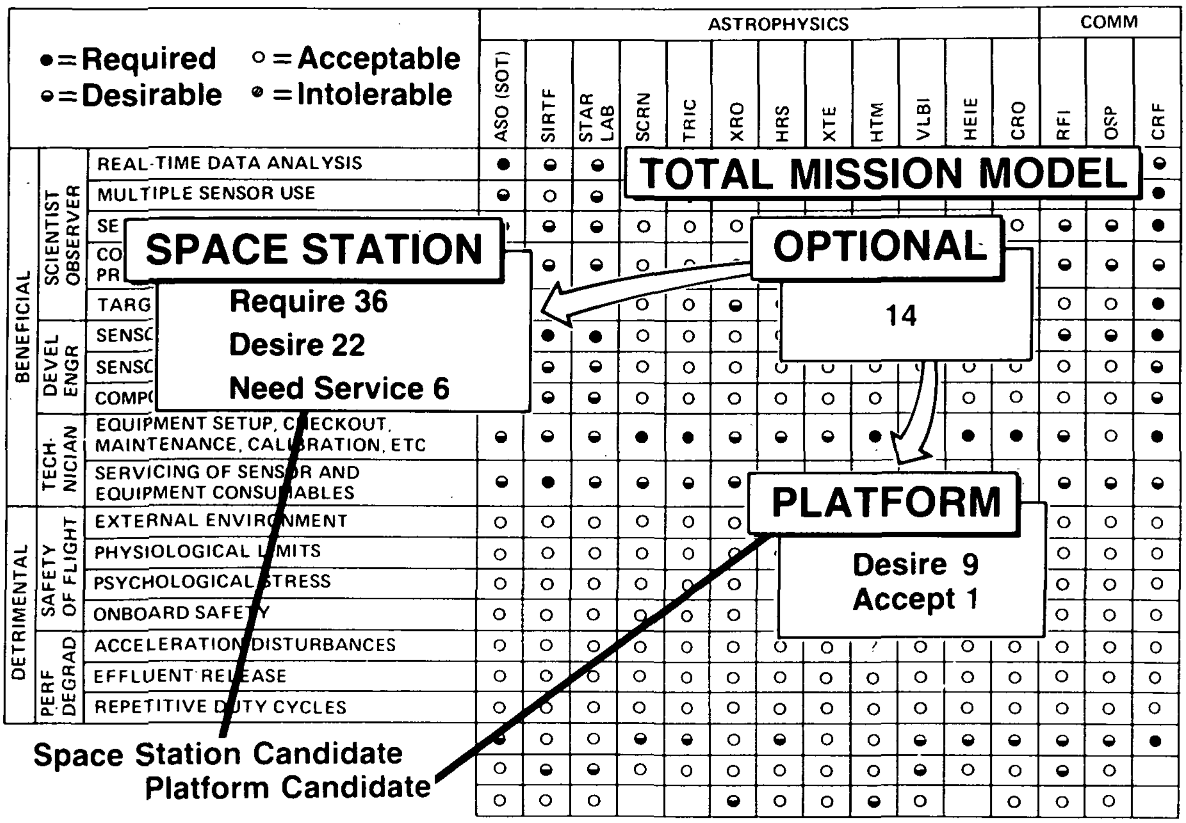
The unique capabilities of man offer a major benefit to many missions. As a scientist/observer, man has proved his worth on Skylab and Shuttle missions, for which his capabilities of special value have been pattern recognition, judgmental decision-making, and flexibility in responding to changing needs. As a development engineer, man's tactile and manipulative skills are valuable; as a service technician, his judgment and his tactile and manipulative skills can be used to service a wide variety of equipment. Man also brings to orbit some performance limitations that must be dealt with. Chief among these are acceleration disturbances and effluent release.

Seventeen parameters relating to the beneficial and detrimental effects of man in orbit were evaluated for each mission. Figure 3-3 shows a summary of these evaluations. The parameters were then examined to determine mission accommodation requirements in categories of required, desired, or acceptable for accommodation on a space station, a platform, or a dedicated satellite.

FIGURE 3-3.
EVALUATION OF MAN IN-ORBIT INFLUENCES

MCDONNELL DOUGLAS

VGB813

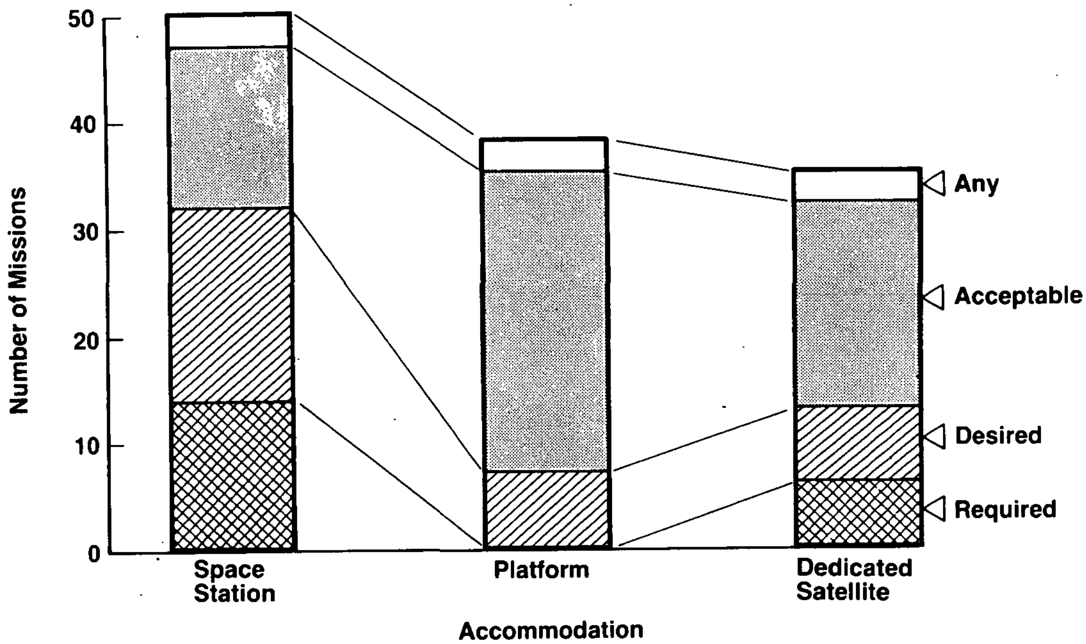


There are six missions in our model that are committed to dedicated satellites. The mission equipment is designed for on-orbit maintenance and can be serviced from space station. There are 13 missions that require accommodation on a space station because of the key role played by man. An additional 18 missions will substantially benefit from manned presence. There are eight missions that prefer the disturbance- and effluent-free environment of a platform but will benefit from close support by man in orbit. Twelve missions can be accommodated on either a space station or platform.

Figure 3-4 illustrates a more detailed distribution of these accommodation needs. Three levels of need are illustrated: required (mandatory accommodation), desired (preferred accommodation), and acceptable (satisfactory accommodation). Many of the missions are acceptable for any of the accommodation types (i.e., space station, platform, or dedicated satellite), as shown before; however, most of the missions (31) require or desire manned space station accommodation.

FIGURE 3-4.
ACCOMMODATION REQUIREMENTS — SCIENCE AND APPLICATIONS MISSIONS
57 TOTAL

VGB769



3.1.1 Orbital Inclination

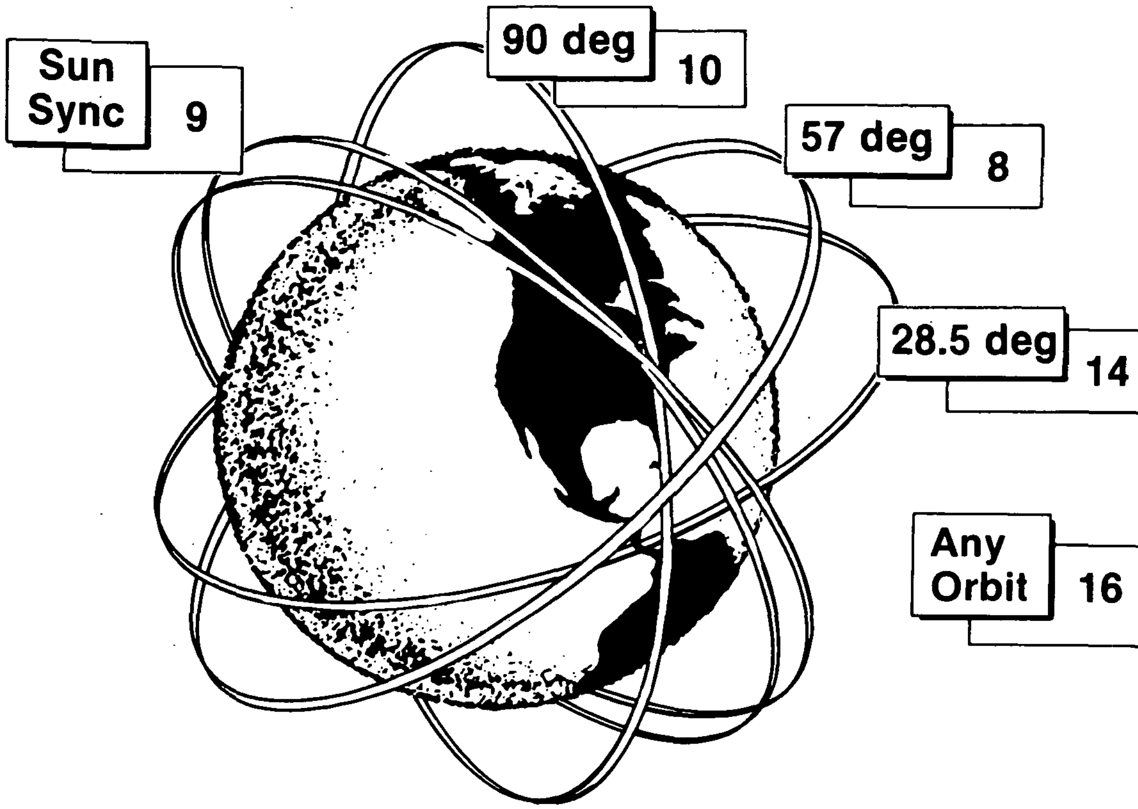
Orbital inclination affects the value of Science and Applications missions in several ways. Earth- and environment-observation missions prefer high inclination to increase coverage of the earth's surface. Solar observation missions can profit by the continuous view of the sun afforded by a sun-synchronous orbit, which is preferred to achieve constant sun angle. Astronomy missions tend to prefer the low charged-particle radiation environment of low inclination to limit noise and the possibility of saturation of sensitive detectors. Infrared, microwave, and radio astronomy missions all profit from higher inclination because (1) constancy of solar heating helps maintain alignment of large optical systems, (2) high inclination provides longer north-south baselines for very long baseline interferometry, and (3) rapid precession provides the desired range of baseline inclination in a short time.

A summary of the orbit inclination requirements by mission count is illustrated in Figure 3-5. The majority of the missions are insensitive to orbit inclination from a mission standpoint. These can be accommodated in

FIGURE 3-5.

ORBIT REQUIREMENTS SCIENCE AND APPLICATIONS MISSIONS

MCDONNELL DOUGLAS VGB562



facilities at orbit inclinations dictated by other missions and/or where extensive traffic could be used to advantage. The next largest set of missions (14) requires 28.5-deg inclination. The remaining missions have preferences nearly evenly distributed among the three high inclinations. Figure 3-6 illustrates a more detailed distribution of the inclination requirements. As stated above, the majority of the missions accept a wide range of orbit inclinations.

The mission set was further analyzed to determine the relative value of mission accomplishment at the preferred orbit inclination versus other orbit inclinations. The analysis is illustrated and summarized in Figure 3-7. The value scale is based on a value of 100 at the preferred locations. The examples given indicate preferred orbits at each of the four primary locations--28.5 deg, 57 deg, 90 deg, and sun-synchronous. Many of the missions have a high tolerance for a wide range of alternative inclinations.

FIGURE 3-6.
INCLINATION REQUIREMENTS — SCIENCE AND APPLICATIONS MISSIONS

VGB768

MCDONNELL DOUGLAS

57 TOTAL

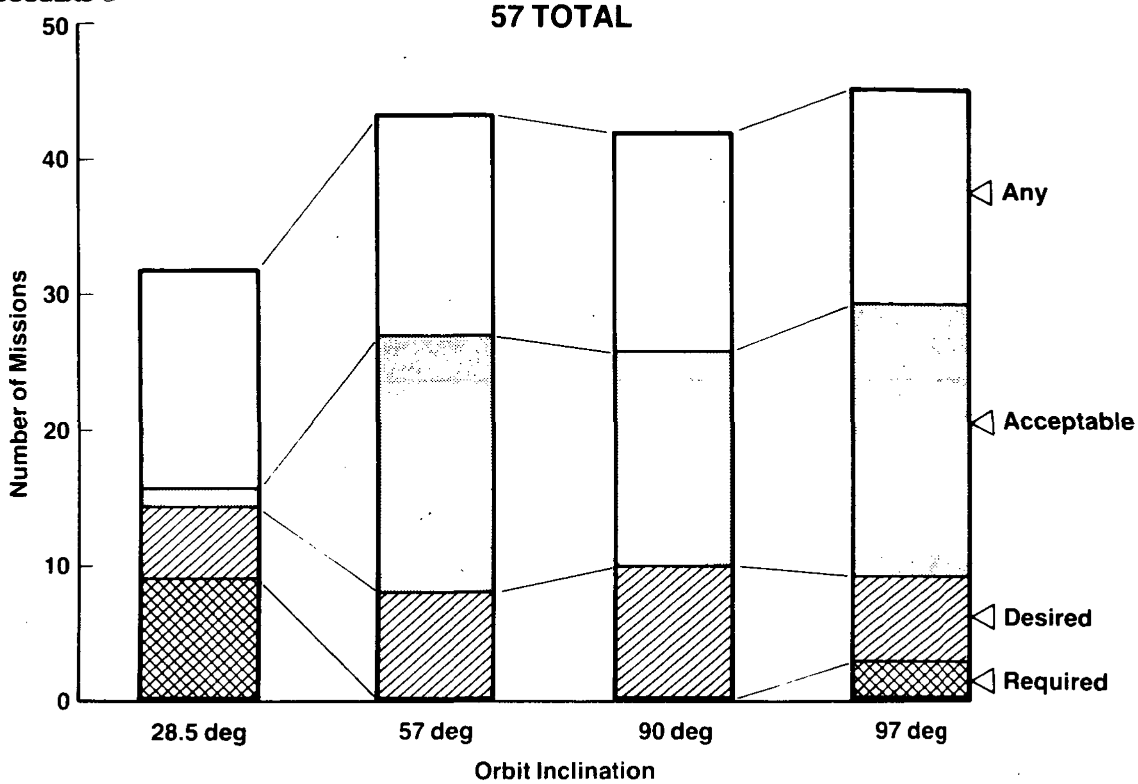


FIGURE 3-7.
MISSION VALUE DEPENDENCE ON ORBITAL INCLINATION

VGC180

MISSION	CODE	PREFERRED ACCOMMODATION	PREFERRED INCLINATION	LEGACY MISSION?	RESIDUAL VALUE AT INCLINATION			
					28	57	90	SS
ASO	SAS001	A	97	S	90	95	95	100
SIRTF	SAS002	P	ANY	S	100	100	100	100
STARLAB	SAS003	P	28	S	100	0	0	0
SCRN	SAS004	A	28	S	100	100	100	100
XLLDEF	SAS006	[illegible]	57		50	100	100	100
TRIC	SAS00[illegible]	[illegible]	28	S	100	100	100	100
XRO	[illegible]	[illegible]	28	[illegible]	100	0	0	0
ST	[illegible]	[illegible]	28	[illegible]	100	0	0	0
HRS	[illegible]	[illegible]	28	[illegible]	100	40	40	30
XTE	[illegible]	[illegible]	[illegible]	[illegible]	100	0	0	0
SIDM	[illegible]	[illegible]	[illegible]	[illegible]	0	0	100	50
AXAF	[illegible]	[illegible]	[illegible]	[illegible]	100	0	0	0
HTM	[illegible]	[illegible]	[illegible]	[illegible]	100	40	30	30
VLBI	[illegible]	P	[illegible]	[illegible]	20	100	50	75
LDR	[illegible]	S	[illegible]	[illegible]	90	90	90	100
GRO	SAS017	S	[illegible]	[illegible]	[illegible]	0	0	0
HEIE	SAS018	A	[illegible]	[illegible]	0	100	100	100
SCDM	SAS019	A	[illegible]	[illegible]	100	100	100	100
CRO	SAS020	A	[illegible]	[illegible]	50	100	100	90
RFI	SCM001	P	[illegible]	[illegible]	20	90	100	100
OSP	SCM002	A	57	O	20	100	100	100

Single Space Station
28.5 deg — 65
57.0 deg — 73
90.0 deg — 80
97.0 deg — 77

Two Space Stations in Different Orbits
28.5 deg + 57 deg — 88
28.5 deg + 90 deg — 98
28.5 deg + 97 deg — 95
57.0 deg + 90 deg — 83
57.0 deg + 97 deg — 80

ACCOMODATION CODES:
- A – ATTACHED TO SPACE STATION
- P – COORBITING PLATFORM
- S – DEDICATED SATELLITE

LEGACY CODES:
- S – SPACELAB
- O – OTHER

The average value for the mission model using a single-element (i.e., space station) or a two-element space station system is also summarized. A two-element system, at 28.5-deg and sun-synchronous inclinations, achieves an average relative value of 95 out of 100 for the sum total of all the Science and Applications missions. The 90-deg location, in combination with the 28.5-deg location, has a summary value of 98, due to the potential for accessing the sun-synchronous satellites for servicing. This requires an extended-capability teleoperator maneuvering system (TMS). The sun-synchronous orbit combination was selected because the platform placed there could accommodate more of the missions than could be accommodated at 90 deg.

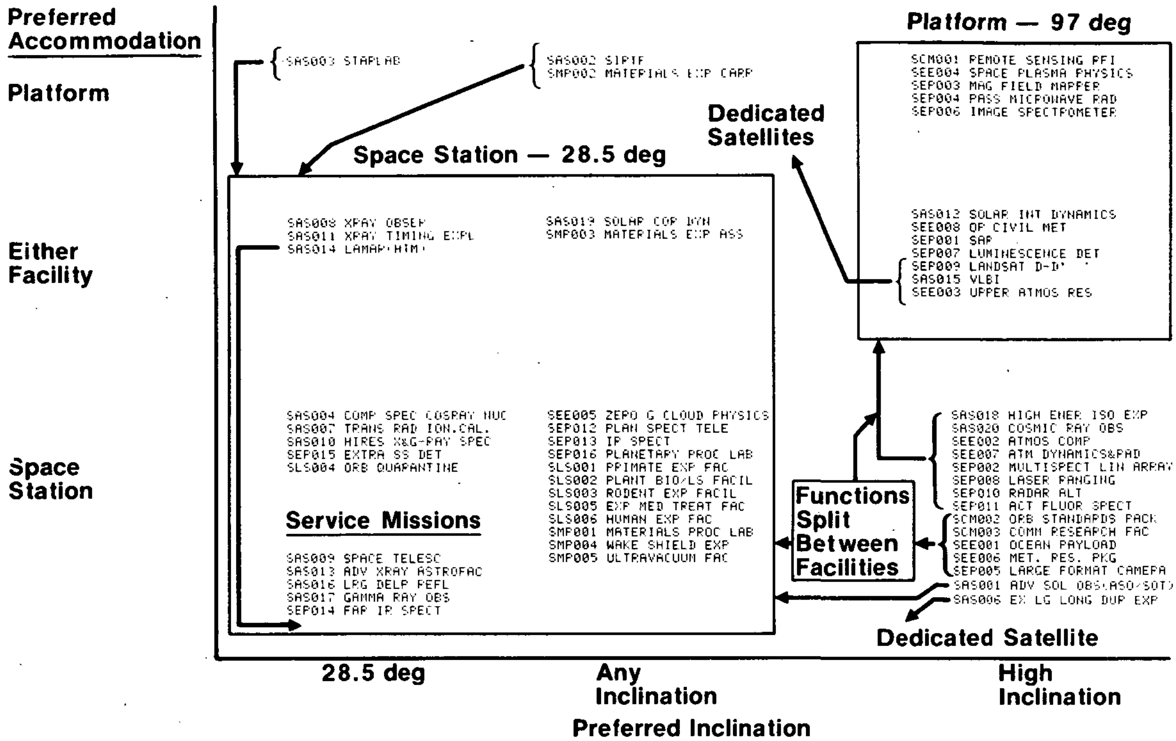
The initial space station architecture selected by the study, in response to all the mission requirements, consists of a manned space station at 28.5-deg inclination and an unmanned platform in sun-synchronous orbit. It would later be augmented with additional capabilities at both locations. The accommodation of the 57 Science and Applications missions for the initial architecture is shown in Figure 3-8. The chart locates the preferred characteristics of each mission in terms of space station or platform and in terms of orbit inclination.

The figure also shows the accommodation of each mission with the selected architecture. The manned space station accommodates those missions that require it at 28.5 deg, those that are insensitive to inclination, and those that could use either a space station or a platform at 28.5 deg. The three low-inclination platform missions found to be compatible with the manned space station were therefore assigned to the station for accommodation. The platform, at sun-synchronous inclination, can accommodate the high-inclination platform missions and some (eight) of those missions that prefer a manned accommodation at high inclination. Four of the high-inclination missions would be transferred to dedicated satellites, and one to the 28.5-deg space station; five would be redesigned to split their accommodation between a space station at 28.5 deg and a platform at sun-synchronous orbit.

FIGURE 3-8.

SCIENCE AND APPLICATION MISSION ACCOMMODATION — SPACE STATION AT 28.5 DEG AND PLATFORM AT 97 DEG

VGC101



3.1.2 Time Phasing

The time-phasing and relative priorities for all the Science and Applications missions are shown in Figure 3-9. (The determination of relative priorities is discussed in Section 4.2.) The missions would be accommodated in order of priority. The integrated mission activity for all the Science and Applications missions is shown in Figure 3-10. The availability dates were chosen considering the orderly progression of missions, without considering budget constraints. A majority of the missions were found to be candidates for a space station initial operating capability (IOC) in 1992. Thus, the number of active missions on orbit by year shows a high onset rate (most missions desired an early IOC) and a high activity level of about 35 in any year (most missions desire long duration).

The missions defined in the study have three sources. Twenty of the missions are derived from the Spacelab program; of these, 10 are from fully operational missions and 10 from Spacelab-developed equipment. Eleven

FIGURE 3-9.
SCIENCE AND APPLICATIONS MISSIONS PRIORITIES AND TIME PHASING

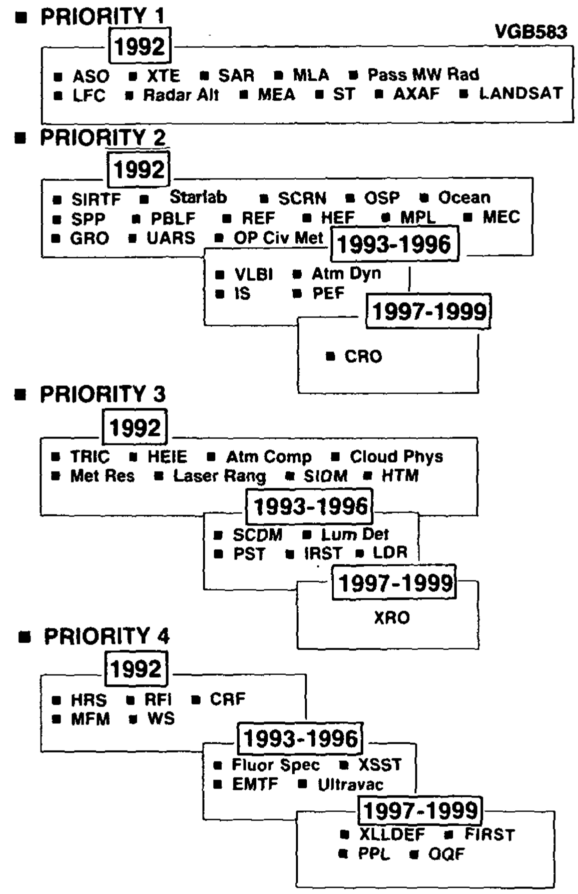
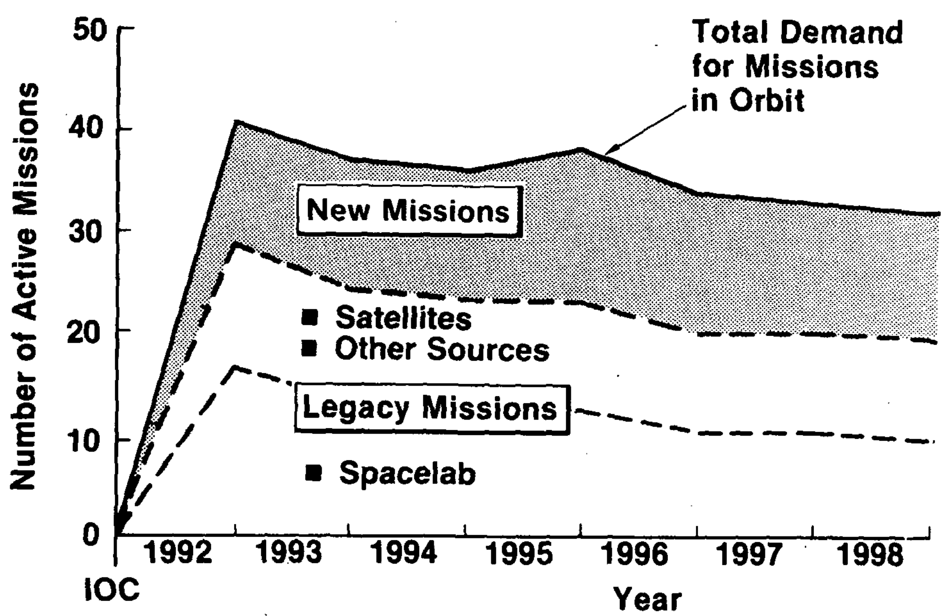


FIGURE 3-10.
MISSION DEMAND SCIENCE AND APPLICATIONS

VGB563



missions stem from equipment that has been flown on other satellites. Twenty new missions and six designated as dedicated satellites complete the 57-mission model.

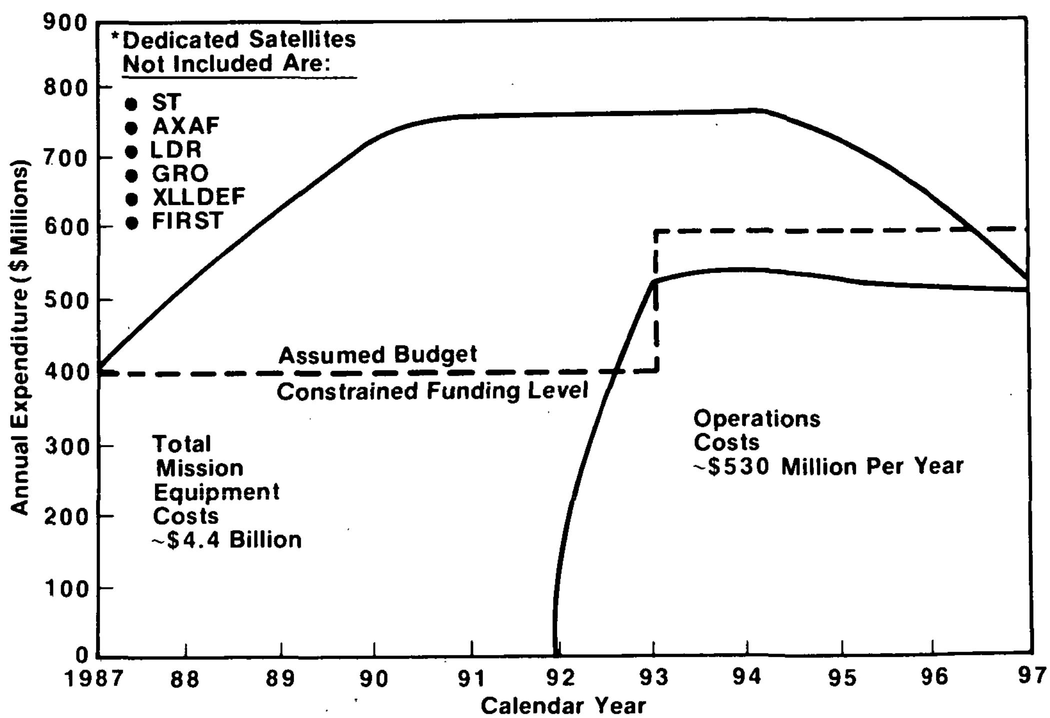
Neglecting budget constraints, 43 missions can be ready to incorporate into a space station in 1992. The remaining 14 missions from our 57-mission Science and Applications Mission Model would phase in over the next decade. In order to produce equipment for the 1992 missions, there must be three Spacelab transfer starts, two starts of previously flown equipment, and two completely new starts per year, beginning in 1986. This level of activity is inconsistent with a realistic budget projection, and steps were taken to reduce the number of missions in the set.

3.1.3 Budget Constraints

The funding requirements to accomplish all the missions are high, as seen in Figure 3-11. To gain some insight into a budget-constrained program, a $400-million-per-year budget for mission equipment was assumed to begin in 1988. The budget was increased to $600 million per year in 1993 to allow for operating costs. Mission starts were programmed considering priority

FIGURE 3-11.
ESTIMATED COST TO MEET SCIENCE AND APPLICATIONS MISSION DEMAND — 51-MISSION MODEL

VGC192



category, time phasing, and estimated cost. The mission equipment cost estimates were derived using the Aerospace Spacecraft Cost Estimating Model. Adjustments were made for the degree of previous development. Annual on-orbit operations cost was estimated at 10% of the equipment fabrication cost. For legacy missions with reduced fabrication cost, operations cost was estimated as though the mission were a new start. A ground operations cost of $9 million per year per mission was assumed for all missions.

Over the six-year equipment development period (1987 through 1992), there are 8 new equipment starts, 16 Spacelab legacy starts, and 9 other legacy starts. During the operating period after 1992, there are about 25 operational missions at a cost of $360 million per year. The $120 million remaining in the budget allows for about 1.2 new equipment starts per year. An additional $30 million (approximately) is available for upgrading existing equipment or for other legacy mission starts.

The resulting reduced activity, shown in Figure 3-12, includes 16 Sciences and Applications missions in 1992 and growth to 25 in 1993. The number of missions active after 1993 averages about 25. Thirty-four of the 36 missions in the top three priority groups are implemented by 1996. The 34 missions

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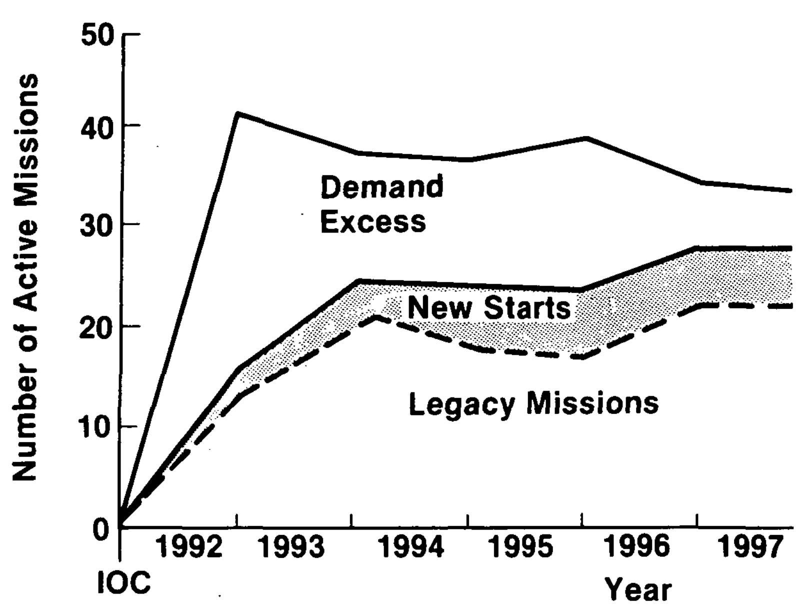
FIGURE 3-12.
BUDGET-CONSTRAINED SCIENCE APPLICATIONS PROGRAM



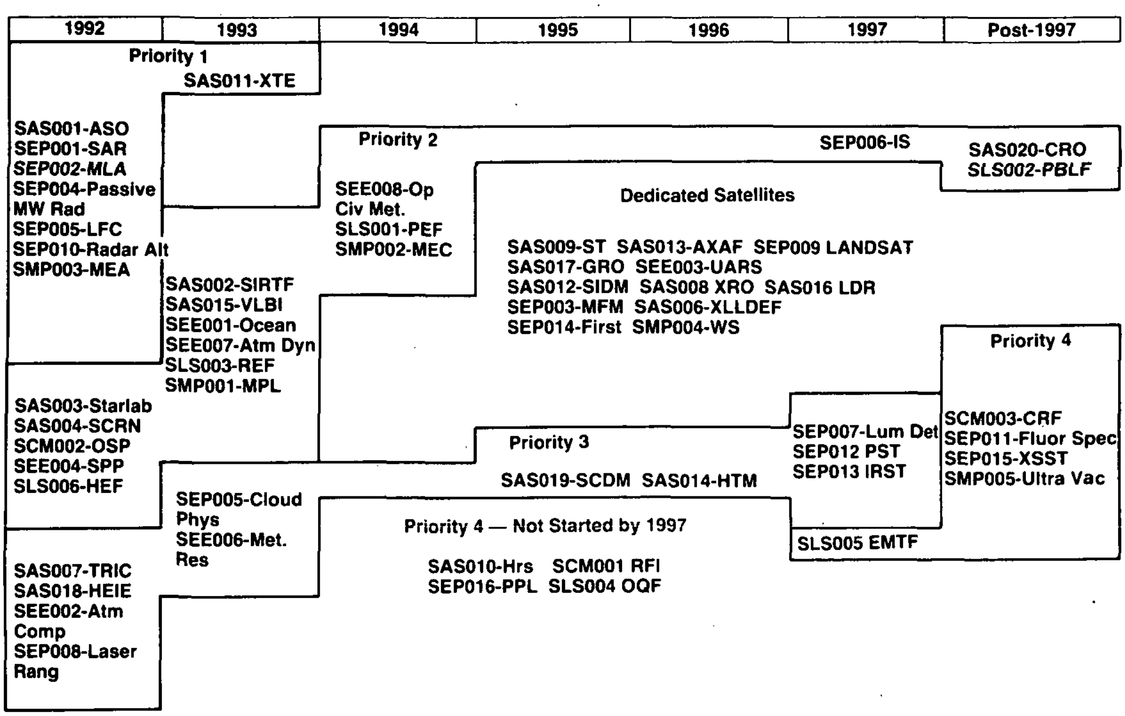
include 11 from Astrophysics, 1 from Communications, 7 from Earth Environment, 10 from Earth and Planetary Exploration, 4 from Life Sciences, and 3 from Material Processing. The remaining 2 missions are started by 1996 and ready for flight in the late 1990s. The missions on orbit in 1993 include 14 Spacelab and Spacelab-derivative missions, 7 other satellite-legacy missions, and 5 new-program-start missions.

This budget-constrained space station equipment development program provides a very representative set of high-value missions with adequate time phasing and provides the funding for comprehensive operational support.

This mission set and schedule shown in Figure 3-12 was used to derive the Science and Applications mission requirements that would be imposed in the system architecture. In Figure 3-13, all the Priority 1 missions are accommodated by 1993, and all but two Priority 2 and all Priority 3 missions, by 1997. Of the Priority 4 missions, five were begun, with one launched in 1977. This data combined with the accommodation disposition of Figure 3-8

FIGURE 3-13.
RECOMMENDED SCIENCE AND APPLICATIONS MISSIONS TIME PHASING
BUDGET CONSTRAINED

VGC359



illustrates the recommended Science and Applications mission disposition for the study. It is anticipated that these dispositions can be continuously adjusted as the Science and Applications program comes to fruition.

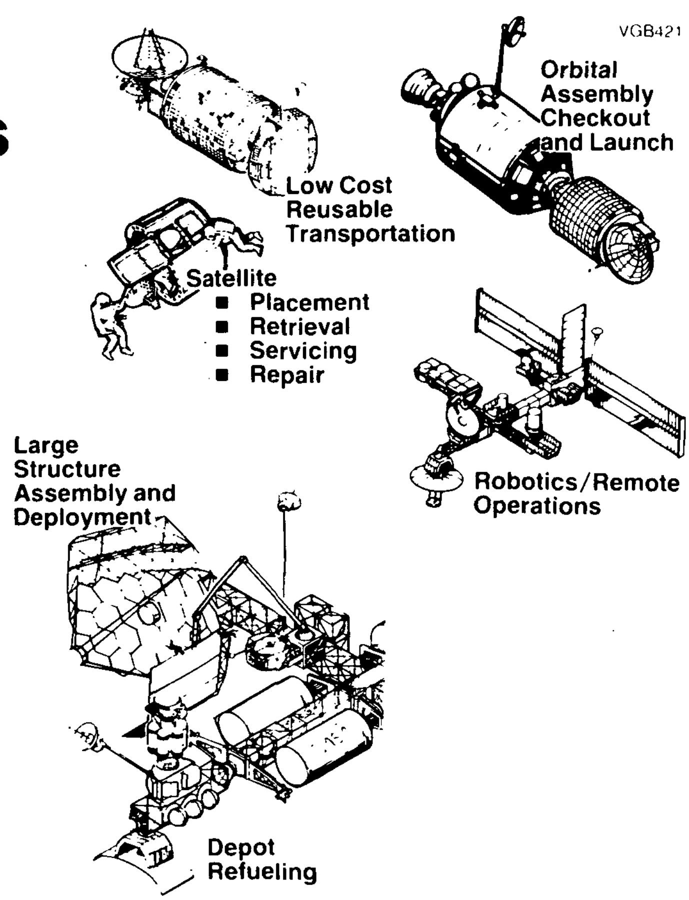
3.2 SPACE OPERATIONS MISSIONS

Space Operations is a broad category of missions with orbit activities that benefit other missions (Figure 3-14). The earliest opportunities will be satellite servicing. Maintenance and repair from a space station base can keep extremely valuable facilities (such as a space telescope) operating at peak performance, with fewer Space Shuttle launches required. The transportation mission allows a reusable orbital transfer vehicle to operate primarily between near-earth and geostationary orbits. Fuel can be carried up on the Space Shuttle or even scavenged from the external tanks of the Shuttle. The benefits are measured in reduced Shuttle launches.

On-orbit assembly or construction of large structures will open the door to several extremely valuable missions. Candidates include the Large Deployable Reflector (high-resolution infrared and microwave astronomy) and a

FIGURE 3-14.

SPACE OPERATIONS



Benefits:
Economic
Technological

- Reduced STS Flights
- Lower Transportation Costs
- Spacecraft Reuse
- Larger Systems
- Multiuse Systems
- Commercial Attraction
- Enabling Technology

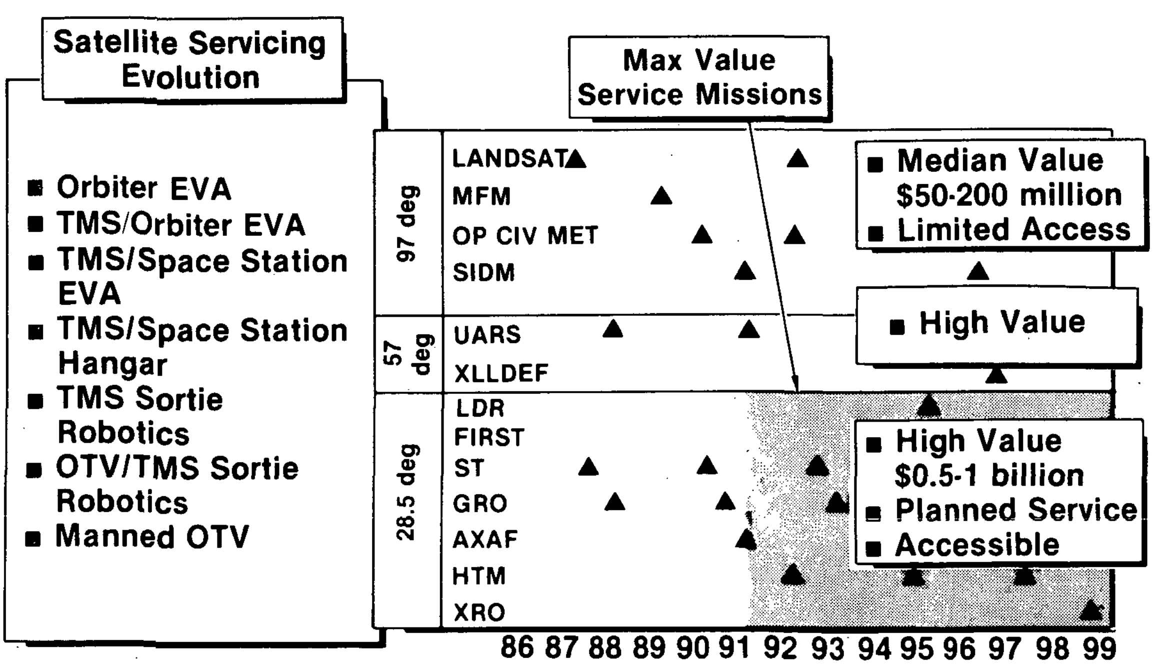
communications platform for geostationary orbit. The scientific and commercial objectives of these missions, which would otherwise be unattainable, can be met because of the activities of Space Operations missions.

Robotics operations are an alternative to manned extravehicular activity. Potential benefits are increased efficiency, reduced hazards to man, and extension of Space Operations to orbits (such as geostationary) that would not be planned for manned access in the near term.

3.2.1 Satellite Servicing

On-orbit servicing of low-earth-orbit (LEO) satellites is a logical first Space Operations mission for the space station. In the years 1992 to 2000, 13 satellites have been identified as candidates for servicing (Figure 3-15). These satellites are of high value and are accessible to a space station in the indicated orbit. Most are designed for on-orbit servicing to some degree.

FIGURE 3-15.
SATELLITE SERVICING MISSIONS



Seven of the satellites are in a 28.5-deg orbit. Six of these have been designated as orbital service missions in the mission model for the space station. The average interval between scheduled maintenance activities is about 2.5 years. When all satellites are simultaneously on orbit, there are over two service missions per year. Each would require a dedicated launch if serviced from the Space Shuttle only. Repair of failed equipment (unscheduled servicing) would add to the number of service missions and required Shuttle launches.

Dedicated launches are not required for service performed from the space station. Replacement parts, supplies, and equipment can be taken to the space station in advance of the service mission, when space is available on the Shuttle. Hence, most Shuttle launches for service would be saved. In addition, repairs can be performed in a timely manner without perturbing the Shuttle launch schedule. The net savings in Shuttle launches is estimated at two to three per year.

A typical satellite servicing mission is illustrated in Figure 3-16. A teleoperator maneuvering system (TMS) is dispatched from the space station to retrieve a satellite in need of servicing. The satellite, after being returned and berthed with the space station (about 15 hours required), is serviced as needed. The time period available is not constrained as it would be for a Shuttle-based service mission. Upon completion of the servicing and checkout, the satellite is redeployed to its desired location by the TMS, which would then return to the space station.

3.2.2 Orbital Transfer

The role of a space station in transferring payloads to high-altitude (such as geosynchronous) orbits was examined. The factors analyzed included the traffic model, various orbital transfer vehicle (OTV) concepts, the availability of cryogens, and comparative costs leading to requirements that would be imposed on the space station.

3.2.2.1 Traffic Model. A traffic model for dedicated satellite missions was developed to compare the economics of alternative OTV concepts (Figure 3-17). References for this model were the NASA Space System Technology Model, July 1981, and Battelle's Outside User's Payload Model, BCL-NLVPL-1M-82-1, July

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FIGURE 3-16.

SATELLITE SERVICING

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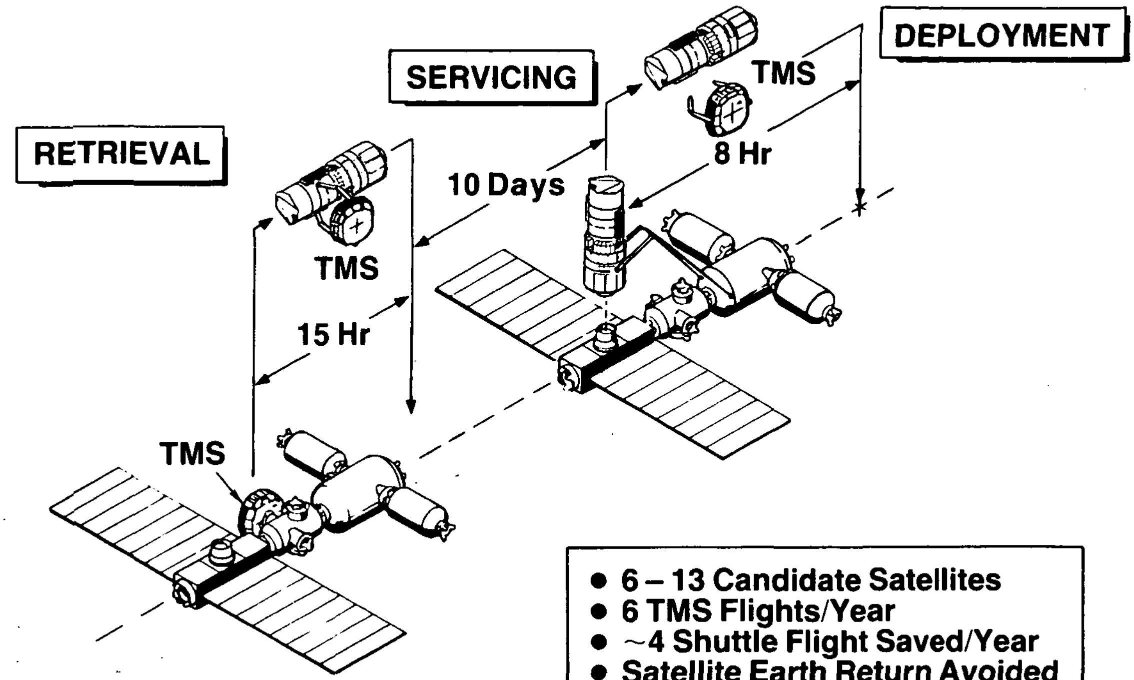

- 6 – 13 Candidate Satellites
- 6 TMS Flights/Year
- ~4 Shuttle Flight Saved/Year
- Satellite Earth Return Avoided

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FIGURE 3-17.

DEDICATED SATELLITE MISSIONS

VGB395

Reusable OTV Candidates

		#LAUNCHES PER YEAR 90	91	92	93	94	95	96	97	98	99	10 YR TOTAL 00	INC DEG	ALT KM	MASS KG
XAS01[illegible]	SIMUL'T ASTRO EXP	1	0	0	0	0	0	0	0	0	0	1	0	GEO	2000
XAS013	FAR UV SPECT EXP	1	0	0	0	0	0	0	0	0	0	1	0	GEO	1000
XCM001	INTELSAT VI	2	1	2	2	0	0	0	0	0	0	7	0	GEO	2004
XCM002	INTELSAT VII	0	0	0	0	1	2	3	2	0	0	8	0	GEO	3636
XCM004	TEL	0	0	0	0	1	0	0	0	0	0	1	0	GEO	702
XCM005	WESTAR	0	0	2	1	0	0	0	0	0	0	3	0	GEO	626
XCM006	TDRS/ADV WESTAR	0	1	0	1	1	1	1	0	0	0	5	0	GEO	2273
XCM007	SATCOM	0	0	1	1	1	1	0	0	0	0	4	0	GEO	895
XCM008	SBS	0	1	0	0	1	1	1	0	0	0	4	0	GEO	550
XCM009	GALAXY														32
XCM010	SYNCOM														14
XCM011	GSTAR														02
XCM013	STC														02
XCM014	DBS														36
XCM016	DATA TRANS														36
XCM017	BANKING														36
XCM018	MAIL														36
XCM019	SATCOL														15
XCM021	TELESAT	1	0	2	0	1	0	0	1	0	0	5	0	GEO	702
XCM022	CHICOMSAT	1	0	0	0	1	1	0	1	0	0	4	0	GEO	702
XCM023	PALAPA	0	1	0	1	0	0	1	0	0	0	3	0	GEO	632
XCM024	MISC	0	1	1	0	1	1	0	0	0	0	4	0	GEO	702
XCM025	NATO	0	0	0	0	0	1	1	0	0	0	2	0	GEO	432
XCM026	TRACK/DATA ACQUISIT	0	0	1	0	0	0	0	0	0	0	1	0	GEO	3000
XEE004	GEO OP/ENV SAT	0	0	1	0	0	0	0	1	0	0	2	0	GEO	874
XEP001	GEOS	2	0	0	0	2	0	0	2	0	0	6	0	GEO	400
XXX002	INSAT	0	1	0	0	1	0	0	0	0	0	2	0	GEO	591

- 139 Payload Deliveries to GEO
- 27 Payload Types
- 165,000 kg Delivered
- 13/Year Average at 1200 kg Each

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1982. Battelle projected two models, one with a low and one with a high number of payloads delivered, with the high number about 40% greater than the low. MDAC's analysis was based on the low-number model data.

The traffic model includes those payloads to be delivered to geosynchronous orbit by the Space Shuttle and upper stages; it excludes those that are projected to be launched on non-Shuttle vehicles such as Delta and Ariane. The model projects 100 payloads to be launched through the year 1997. It was extrapolated at a rate of 13 payloads per year through the year 2000, resulting in 139 payloads to be delivered to geosynchronous orbit. There are 27 payload types, the majority of which are commercial in nature and have a payload mass less than 3600 kg; the average payload mass is 1200 kg.

3.2.2.2 Expendable Versus Reusable OTVs. Characteristics of expendable-OTV and reusable-OTV delivery to high-altitude orbit are shown in Figure 3-18. In the expendable mode the stage and payload combination are usually delivered via the Orbiter to LEO, and then the payload is transferred to higher (i.e.,

FIGURE 3-18.

VGB645

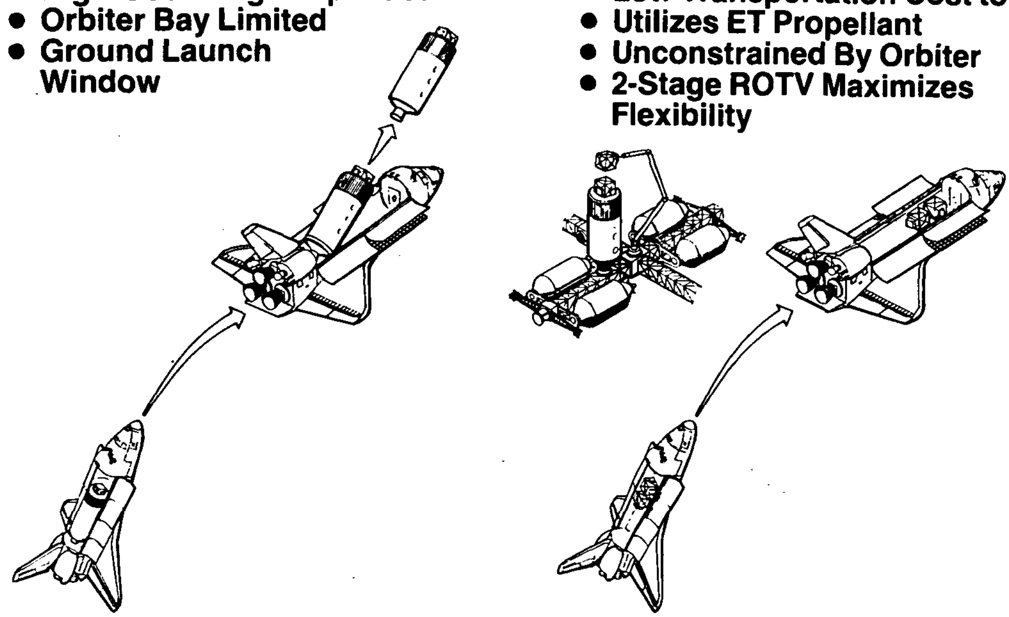
GEOSYNCHRONOUS TRANSPORTATION

EXPENDABLE OTV

- High-Cost Stage Expended
- Orbiter Bay Limited
- Ground Launch Window

REUSABLE OTV

- Low Transportation Cost to GEO
- Utilizes ET Propellant
- Unconstrained By Orbiter
- 2-Stage ROTV Maximizes Flexibility



geosynchronous) altitude by the expendable stage. The space station can play a role in this mode by providing on-orbit storage of stages or payloads or by supplying assembly/checked capability prior to launch. In the reusable OTV (ROTV) mode, the ROTV can be berthed to the space station on orbit, attached to appropriate payloads, fueled, checked out, and launched. After delivering the payload to its intended orbit, the ROTV would return to the space station to await another mission.

Candidate expendable OTVs range from a PAM-D to a cryogen stage that has a 4000-kg delivery capability to geosynchronous orbit (Figure 3-19). The ROTV candidates (single-stage, two-stage, and single-stage with aerobraking) are fully reusable for 20 missions (Figure 3-20). Each candidate ROTV is sized to a 4000-kg delivery capability since this is the value needed to best satisfy the anticipated traffic model.

The distribution of required payloads is indicated by the 19 OTVs scheduled for a 1995 launch (Figure 3-21). A 4000-kg delivery capability necessitates a single launch for each of the two 3636-kg payloads; the others can be combined within the 4000-kg capability, as shown. Seven flights are

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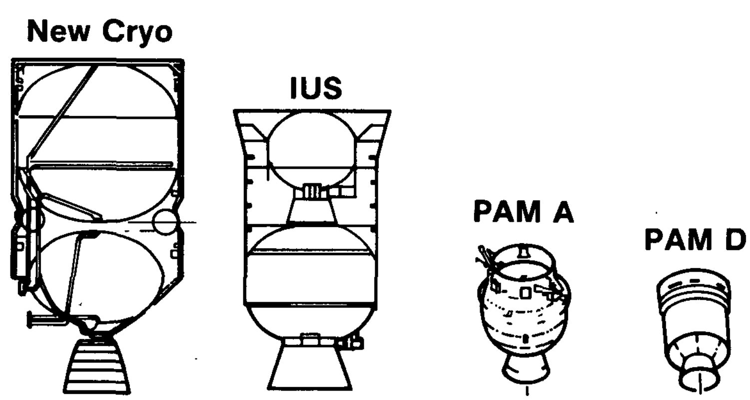
FIGURE 3-19.
CANDIDATE EXPENDABLE OTV

VGB642



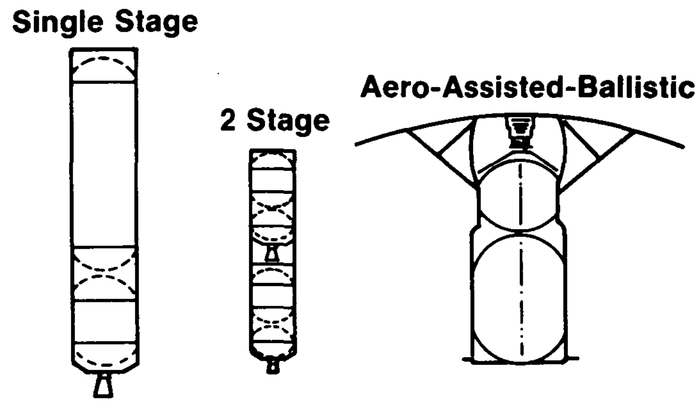
	New Cryo	IUS	PAM A	PAM D
Propellant (kg)	8770	12,454	3,500(1)	2,000(1)
Stage (kg)	9774	14,550	3860(1)	2,180(1)
ASE (kg)	3300	3,340	1,910	1,140
λ'	0.90			
Payload Into GEO (kg)	4000	2,273	1,000	636

(1) Does Not Include AKM

FIGURE 3-20.

VGB643

CANDIDATE REUSABLE OTV



	Single Stage	2 Stage	Aero-Assisted-Ballistic
Propellant (kg)	26,840	2 x 6250	15,460
λ'	0.90	0.90	0.86
GEO Delivery (kg)*	4,000	4,000	4,000
GEO Retrieval (kg)	1,448	860	4,471
GEO Round Trip (kg)	1,063	720	2,112
GEO Delivery, Expendable (kg)	12,240	6,000**	6,252

*Design Condition
**One Stage Expended

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FIGURE 3-21.

VGB641

TYPICAL MANIFEST - 1995

OTV Flight Number		1	2	3	4	5	6	7
PLD (kg)	1	3636	3636	2273	632	1314	1136	702
	2			636	1314	1136	895	702
	3			550	702	432	702	636
	4				702	636		
Total (kg)		3636	3636	3459	3350	3518	2733	2040

then needed to deliver the 19 payloads. If some singular flights are required, they can be matched to a commensurate-capability expendable OTV or delivered by an off-loaded ROTV. The number of 4000-kg-capability flights (using multiple payloads) needed to satisfy the traffic model for the 10-year span 1990 to 1999 is shown in Figure 3-22. A typical number of flights is less than six per year.

3.2.2.3 Orbital Transfer Costs. The transportation costs to deliver to geosynchronous orbit the 139 payloads in the traffic model are compared for the OTV concepts described (Figure 3-23). The costs include OTV hardware cost, launch operations cost, and STS delivery charges of all deliverables including propellant. The left bar shows a $6.85-billion cost for delivering each of the 139 payloads one at a time using the appropriate, performance-matched, expendable OTV. The cost is reduced to $6.09 billion by using a multiple payload delivery approach. The difference here is not great because the savings caused by the reduced number of flights is offset by the more expensive and expendable cryogen stage. Reusable OTV cost comparisons are illustrated with multiple payload deliveries on a single-stage ROTV

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FIGURE 3-22.

VGB644

NUMBER OF OTV FLIGHTS

4000-kg Capability, ≤ 4 Payload/Flight

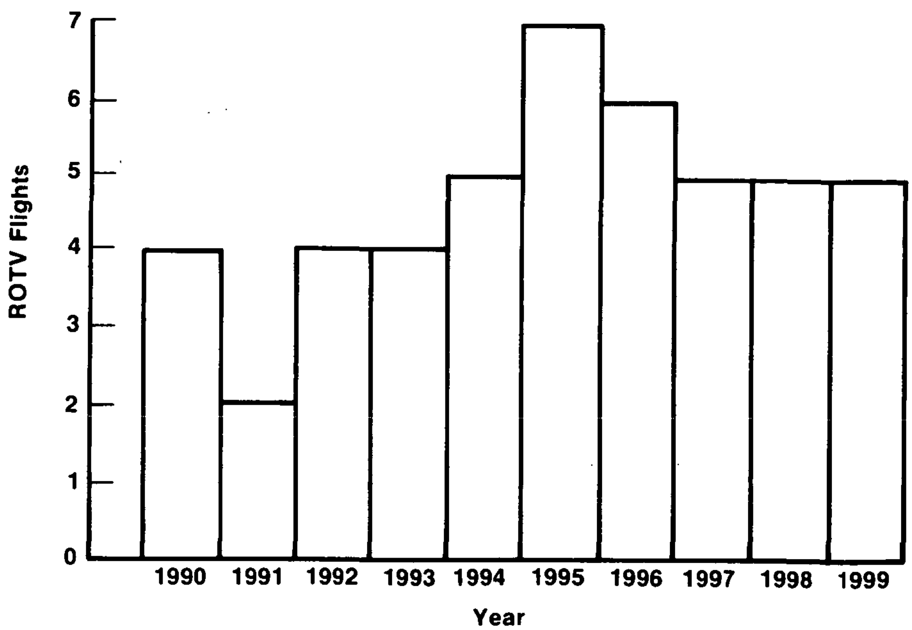
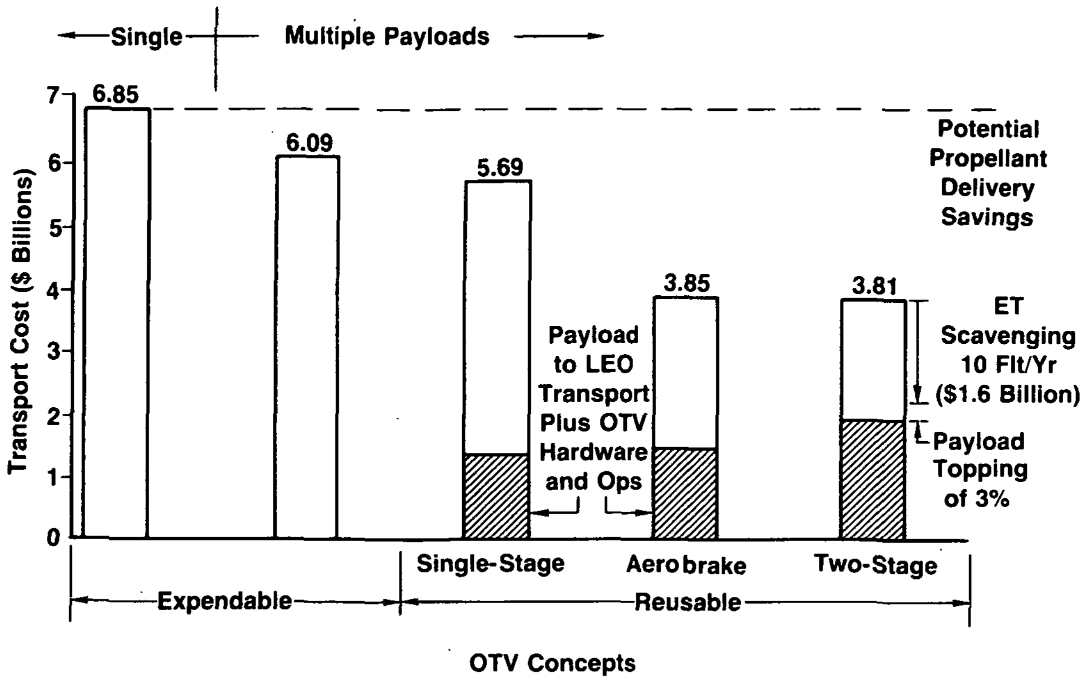


FIGURE 3-23.
GEO TRANSPORT COST COMPARISON
1990-2000 MISSION MODEL

VGB715



costing $5.69 billion, a $0.4 billion reduction over the equivalent expendable approach. The use of an aerobrake ROTV and a two-stage ROTV reduces the costs much more, to $3.8 billion. The two-stage concept (both stages are the same design) was selected for this study since it requires a lower development cost and offers lower risk than the aerobrake design.

A further cost advantage can be incurred by taking advantage of potential ullage and flight performance reserve cryogen propellant in the Shuttle external tank (ET) through scavenging. The use of scavenged propellant (4300 kg per flight) from 10 Shuttle flights per year (assumed to be in the vicinity of the space station) can furnish an additional $1.6 billion cost savings. The delivery charge for remaining propellant is small, and in fact the propellant can be provided by the judicious use of payload topping (i.e., utilizing the Shuttle cryogens remaining due to a less-than-100% load factor utilization). Only 3% topping on 10 flights (97% load factor) is needed to supply the remaining propellant requirement.

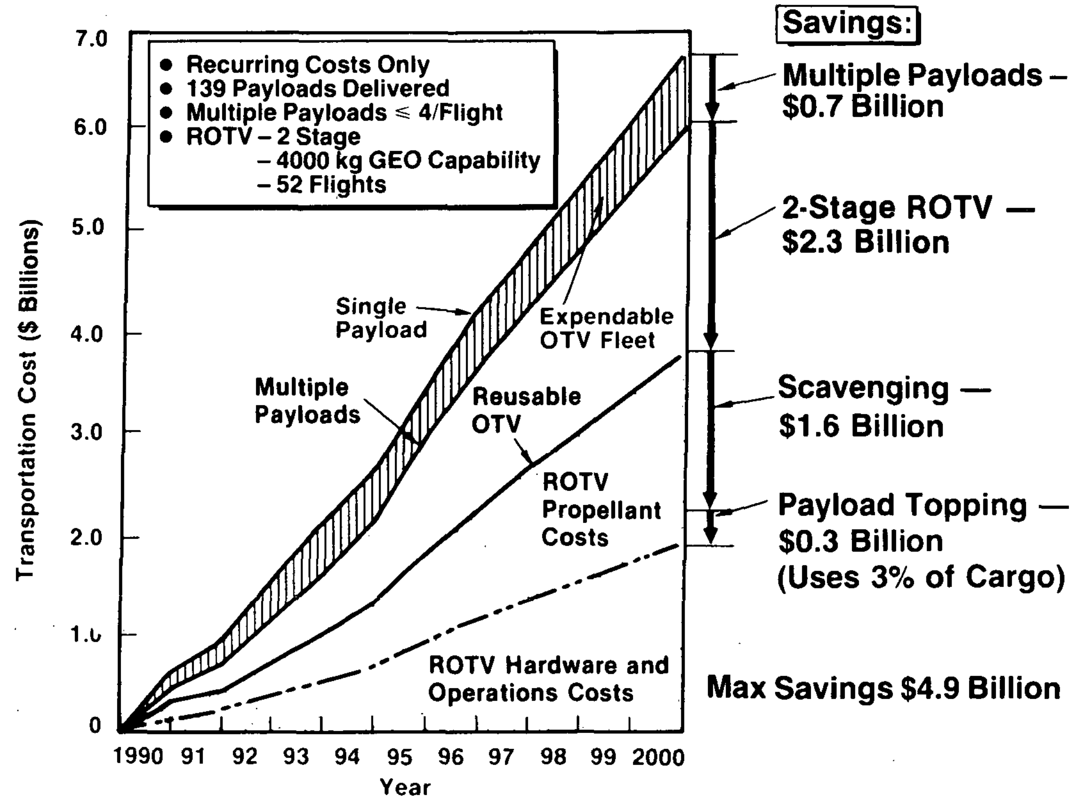
In Figure 3-24, the cumulative transport costs for the expandable OTV and the two-stage ROTV are shown on a yearly basis. The expendable OTV incurs $6.1 to $6.8 billion in transportation costs for the delivery of the 139 payloads. The upper line of the cost band indicates the cost of delivering payloads singly on the particular expendable OTV best matched to performance needs (i.e., PAM, IUS, or a cryogenic stage). The lower line of the cost band, indicating cost of multiple payload delivery (up to four per mission) on an expendable cryogen stage, results in a savings of $7 billion.

An additional savings of at least $2.3 billion can be realized by using a two-stage ROTV, for which the cost of the stage is averaged over its life (20 missions).

As shown, a maximum total cost savings of $4.9 billion over 11 years can be realized by implementing the two-stage ROTV rather than the expendable OTV. This savings is more than adequate to offset the development of the ROTV and the costs of an orbiting propellant depot. Because of the potential high

FIGURE 3-24.

GEO MISSION MODEL TRANSPORT COSTS



value of this two-stage ROTV with multiple payload capability, it is recommended that in-depth system studies be performed to further develop it. In addition, the two-stage ROTV appears to be a prime candidate for a future commercial enterprise.

3.2.3 Requirements for Space Operations Missions

The number of Orbiter flights needed to satify the needs of the Space Operations missions is shown in Figure 3-25. These flights include space station delivery and logistics flights, delivery of all payloads to 28.5-deg orbit, delivery of payloads headed for geosynchronous orbit, delivery of consumables for projected commercial processing missions, and delivery of needed ROTV propellant. All flights would be candidates for the ET scavenging previously discussed. More than 10 flights per year would be available. If the space station, along with commercial processing missions, were placed at 47-deg orbit, the traffic potential for ET scavenging at 28.5 deg would be small (Figure 3-26), and the costs for propellant delivery needed for ROTV operation would increase.

FIGURE 3-25.
STS FLIGHT HISTORY SPACE STATION AT 28.5°

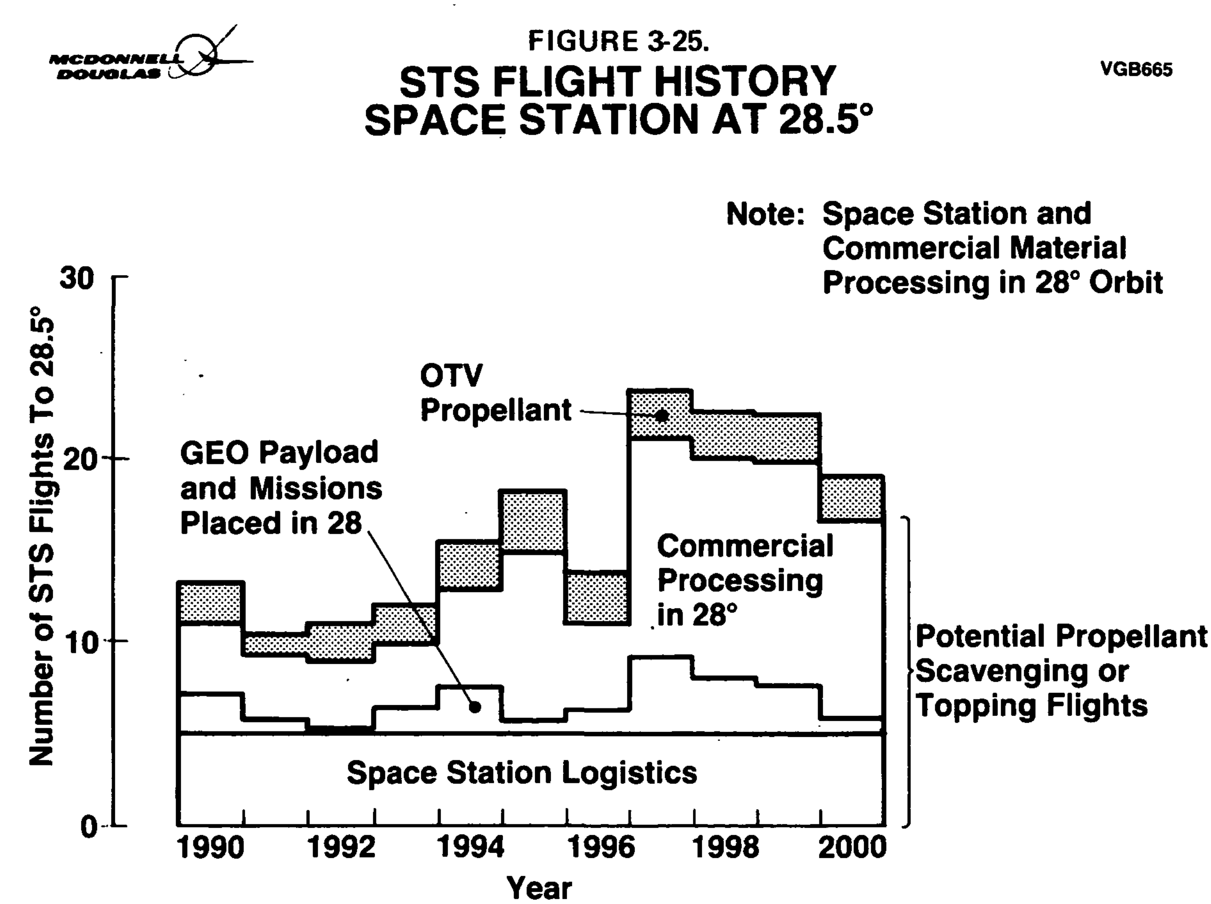
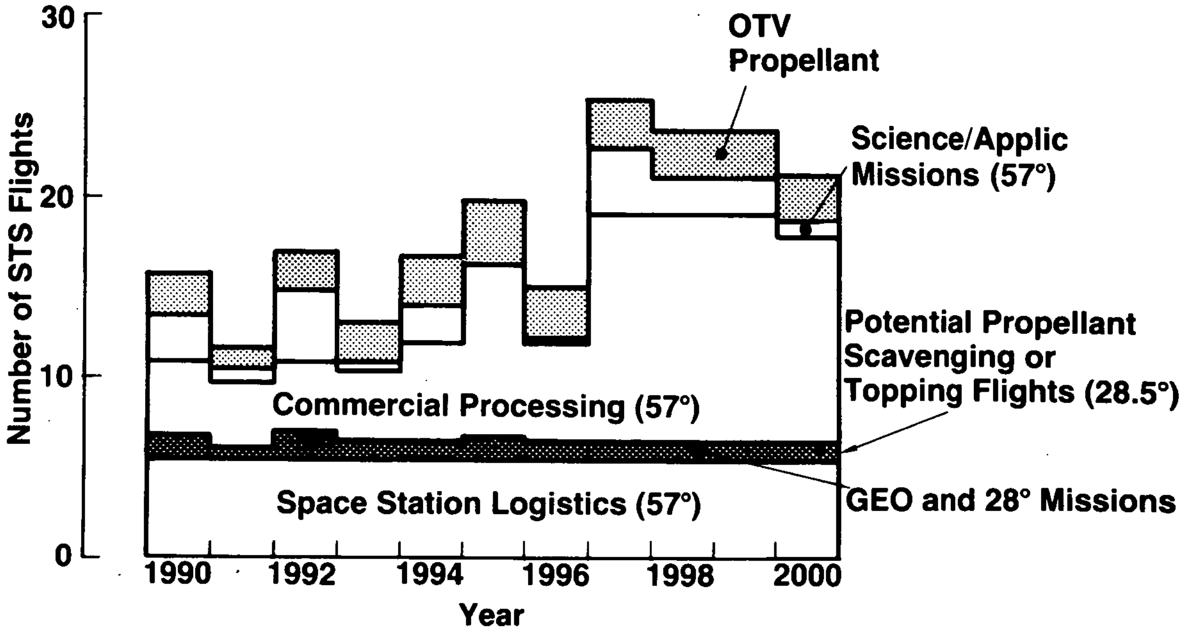


FIGURE 3-26.
STS FLIGHT HISTORY SPACE STATION AT 57°

VGB666



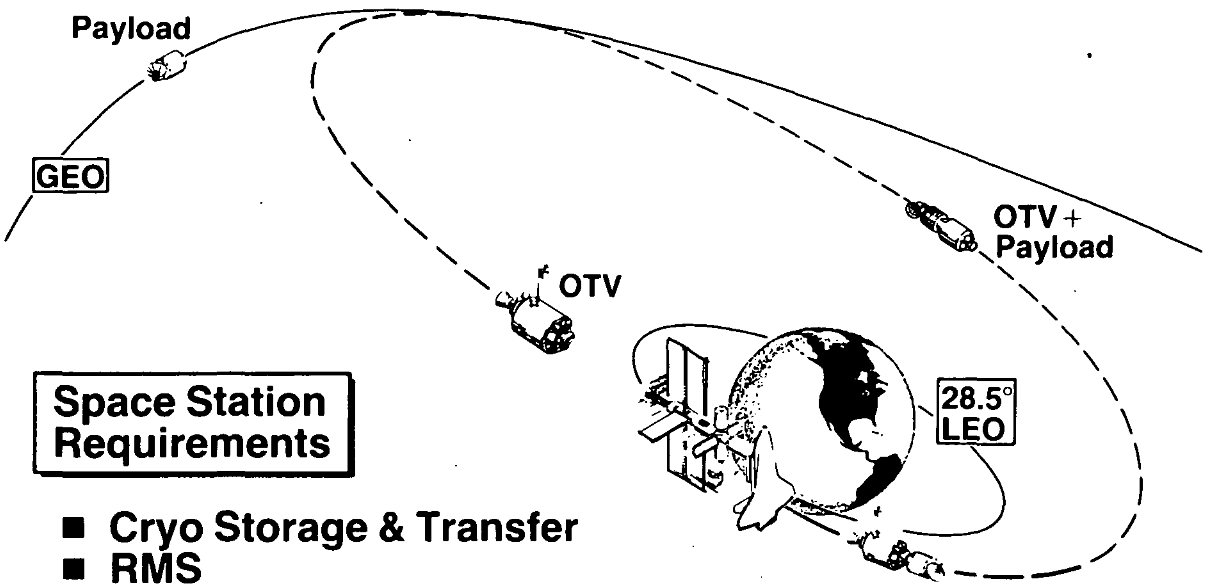
The ROTV is an important contributor to cost-effective transportation of payloads into high-energy orbits including geosynchronous placement/retrieval and planetary injection. The space station is a necesssry operating base for the ROTV, offering opportunties for assembling mission vehicles, conducting launch operations, and performing routine service and maintenance of the ROTV, as well as being a propellant depot. An ROTV mission scenario is shown in Figure 3-27. To support these ROTV operations, the station must have a remote manipulator system; assembly, berthing, and docking provisions; propellant storage and transfer capability; and checkout and launch equipment.

The space station concept includes an orbital propellant depot capability that allows the ROTV to maximize the use of ET residual propellant by scavenging. It also provides a facility for transfer and storage of cryogenics that would be carried in special tanks in the Orbiter cargo bay. These tanks would take advantage of any excess payload capability on Shuttle flights that are essentially volume-limited. This feature is described as "payload topping." A functional sketch of a space station geared for ROTV servicing (service station) is illustrated in Figure 3-28.

FIGURE 3-27.

REUSABLE ORBIT TRANSFER VEHICLE OPERATED FROM SPACE STATION

VGB679



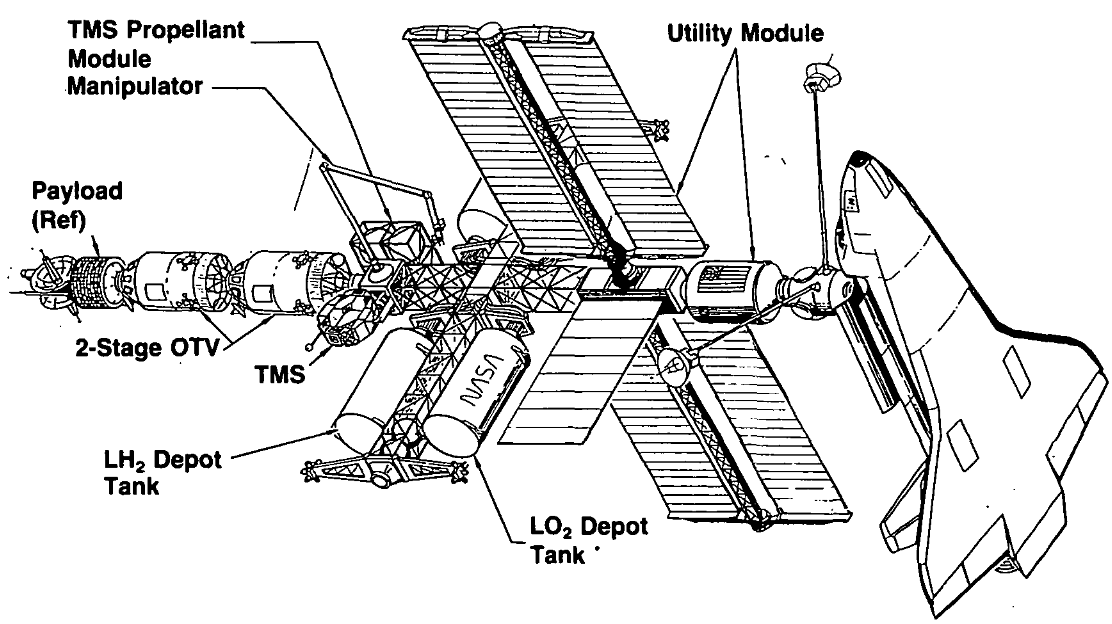
Space Station Requirements

- Cryo Storage & Transfer
- RMS
- EVA/MMU
- Automated Functions
- Assembly Fixture
- Checkout/Launch Equipment

FIGURE 3-28.

ROTV SERVICE STATION CONCEPT

VGB837



The requirements imposed on a space station by these Space Operations missions are listed in Table 3-1.

Table 3-1. Space Operations Requirements for Space Station

Function	Requirement
ROTV (two-stage)	
Flight/year	6-12
Propellant usage/year	75,000-150,000 kg
Turnaround labor	200 man-hours
Electric power	2 kW peak
Communication	Hardwire and RF link
Facilities	RMS, berthing, control console
TMS	
Flights/year	6
Propellant usage/year	6500 kg
Turnaround labor	120 man-hours
Electric power	1.3 kW peak
Communication	Hardwire and RF link
Facilities	RMS, berthing, control console
Satellite Servicing	
Control retrieval	CDMS functions, rendezvous, avionics
Provide retrieval/deployment	TMS, TMS servicing, crane
Satellite servicing	EVA, CDMS for checkout and diagnostics, hangar, propellant tanks
Payload Integration	
Number of integrations	6-12
Manpower	20 man-hours
Facilities	RMS, storage hangar, control console

The facility requirements for assembly of large structures were examined for generic examples such as the large deployable reflector (LDR). The need for space, assembly jigs, manipulators, material depot, extension, EVA, etc., has been identified in previous studies and is not repeated here. Specific configuration would be effected to provide these capabilities; resources (i.e., power, crew hours) are not great, on the average, because of the intermittent nature of this mission.

3.3 TECHNOLOGY MISSIONS

The technology development missions are separated into those necessary to develop a growth space station (Subsystem Technology missions) and those necessary to develop advance missions/payloads to be supported by the space station (Misson Technology missions).

3.3.1 Mission Technology Missions

The final list of technology development missions was selected from about 75 possibilities identified by NASA and MDAC. This list was refined to a total of 14 technology development missions covering both categories. An EVA mission that can be done on the Shuttle was added, rounding out the necessary technology development. The criteria for refining the mission list included combining redundant missions and selecting those most responsive to critical needs or "mission drivers."

Figure 3-29 identifies the Mission Technology missions required for advance mission/payloads development. The primary drivers for these missions are ROTV, satellite servicing, large structures, and antennas. Five of these missions, plus the unlisted EVA mission, relate to ROTV and satellite servicing:

- Evaluation of Man's Role
- Fluid Storage and Management
- Satellite Service Technology
- Crew Manipulator/Robotics
- OTV Service Technology

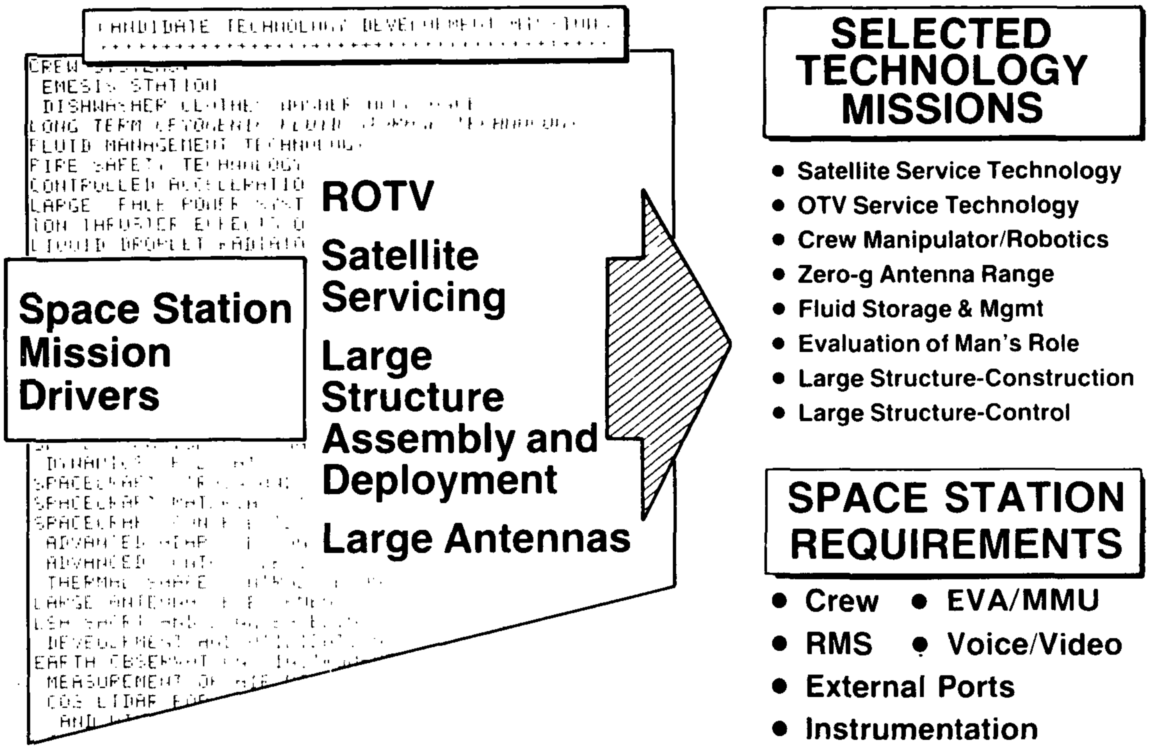
The first three, plus the EVA Mission, provide the components and functional capabilities development necessary for OTV and satellite servicing,

FIGURE 3-29.

TECHNOLOGY DEVELOPMENT IN ORBIT

VGB660

MISSION TECHNOLOGY



including man/machine relationships. The last two combine the requisite components into subsystems and then develop the integrated subsystems (e.g., by allocating tasks to EVA, manipulators, or robotics). The space station portion of the missions will be to complete the development and to verify and demonstrate the respective servicing capabilities.

The other branch of the Mission Technology effort is the development of the capability to assemble and/or deploy large structures and antennas. These are covered by the Large Structure Construction, Large Structure Control, and Zero g Antenna Range missions. The first two are a necessary ingredient in a growth space station, so they are also included in the Subsystem Technology mission list.

3.3.2 Subsystem Technology Missions

The growth space station requires Subsystem Technology missions. The "program drivers" for these missions are cost, logistics, long life, reliability, and performance. Nine Subsystem Technology missions have been selected for inclusion in the space station mission model on the basis of their importance to the key program issues (Figure 3-30). The H_2O Recovery, O_2 Recovery, Advanced Radiator, and Tether Dynamics missions relate to the cost and logistics drivers. The others relate to lifetime, reliability, and performance. The Subsystems Technology missions of Large Structure Construction and Evaluation of Man's Role are also included in the Mission Technology missions because they support advanced missions as well as growth versions of the space station.

Requirements imposed on the space station by the technology missions are listed in Figure 3-31. All but one of the 14 missions require manned involvement and thus need to be accommodated on the space station. The exception, Materials and Coating, can also be allocated to the space station, which would be in the initial recommended architecture. The characteristics of a technology mission are that it can be performed in nearly any orbit, it is generally short in duration (less than one year), it has low power requirements (less than 1.5 kW), and it requires intermittent crew attention.

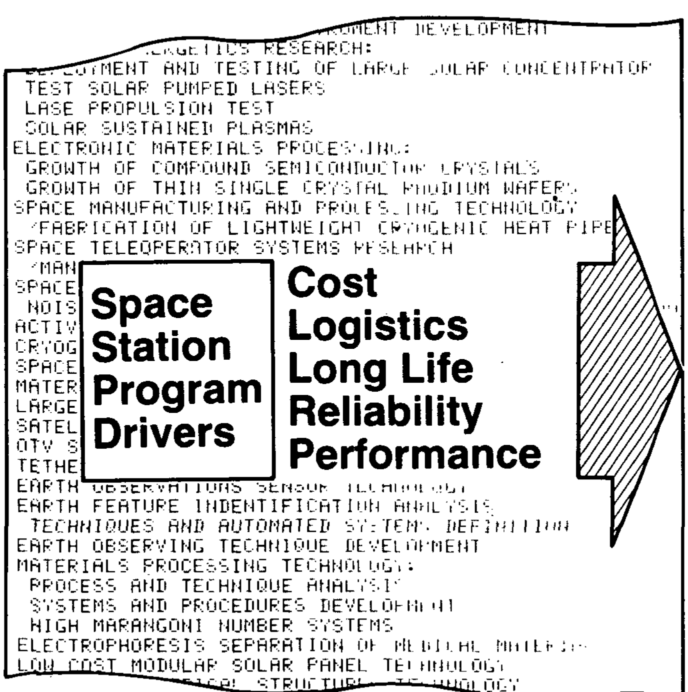
MCDONNELL DOUGLAS

FIGURE 3-30.

TECHNOLOGY DEVELOPMENT IN ORBIT

VGB661

SUBSYSTEM TECHNOLOGY



SELECTED TECHNOLOGY MISSIONS

- ECLS H_2O Recovery
- ECLS O_2 Recovery
- Advanced Technology Radiator
- Materials and Coating Technology
- Laser Comm and Tracking
- Tether Dynamics
- Evaluation of Man's Role
- Large Structure-Construction
- Large Structure-Control

SPACE STATION REQUIREMENTS

- Crew • EVA/MMU
- Modular Subsystems
- Shop and Test Equip.
- Voice/Video • Inst.

FIGURE 3-31.

SPACE STATION DATA BASE
MCDONNELL DOUGLAS ASTRONAUTICS HUNTINGTON BEACH
TECHNOLOGY MISSIONS
May 3, 1983

STATUS	ACCOMMODATION		VIEW		LEGACY
O=operational	R=required	S=supply	A=any	M=multiple	S=spacelab
P=planned	D=desired	L=launch	E=earth	S=solar	G=other legacy
C=candidate	A=acceptable	M=maint/repair	I=inertial	V=velocity	
I=opportunity		B=assemb/build		Z=anti earth	

CODE	NAME	SOURCE	STAT	DATE	DUR	INC DEG	INC MAX	INC MIN	ALT DES	ALT MAX	ALT MIN	STAT	SERV PLAT	MOD	RACK	PAL	PORT	POWER	DATA	DUTY	POWER *DUTY	LMASS	EXPEND	G	CODE	VIEW	CREW SIZE	HRS DAY	DAYS YR	BEN	SAVE CONS	SAVE RISK	BEN* CONS	SAV* RISK	PRIORTY	LEGACY
TFM001	LASER COMM&TRACK DEV	MH	I	92	1	28	97	0	400	999	300	R			0	.5	1	1000	10	.05	50	200	0	0	TFM001	M	2	3.00	20	14	4 28	23	56	644	4.00	
TGN001	LSS CONTR EXP	MH	C	93	1	28	90	0	400	999	300	R			0	2.0	1	500	0	.02	10	600	0	0	TGN001	A	1	1.00	30	18	4 28	24	72	672	3.00	
TGN002	ZERO G ANT RANGE	MH	I	92	1	28	90	28	400	999	300	R			0	2.0	1	1000	1	.04	40	1000	0	0	TGN002	V	2	8.00	10	21	5 25	25	105	625	2.00	
TGN003	MATERIALS&COAT TECH	MH	I	92	5	28	97	28	400	600	300		D	M	0	1.0	1	100	0	.01	0	1400	0	0	TGN003	A	2	4.00	10	15	4 32	26	60	832	4.00	
TGN004	TETHER DYNAMICS	MH	C	94	1	28	97	0	400	600	300	R			0	.5	1	1000	0	.01	10	250	0	0	TGN004	E	2	4.00	30	18	4 31	24	72	744	3.00	
TGN005	LRG STRUCT CONSTR	MH	C	94	1	28	57	28	400	999	350	R			0	2.0	1	500	1	.03	15	600	0	0	TGN005	E	3	8.00	60	21	5 23	24	105	552	1.00	
TGN006	FLUID STORE&MANAG	MH	C	92	1	28	97	28	400	999	300	R			0	3.0	1	500	0	.02	10	9000	0	0	TGN006	A	1	4.00	30	17	4 28	24	68	672	1.00	
TGN007	LIQUID DROPLET RAD	MH	I	94	1	28	97	0	400	999	350	R			0	.5	1	200	0	.01	2	400	0	0	TGN007	A	1	4.00	30	15	4 32	22	60	736	4.00	
TGN008	ECLS WATER REC	MH	C	93	1	A	97	28	400	700	370	R			1	.0	0	150	10	.01	2	80	0	0	TGN008	A	1	.15	180	14	5 33	25	70	825	2.00	
TGN009	ELCS OXY REC	MH	C	93	1	A	97	28	400	700	370	R			2	.0	0	500	10	.01	5	100	0	0	TGN009	A	1	.14	180	18	5 29	22	90	638	2.00	
TOP001	SATELL SERV TECH	MH	P	92	1	28	90	28	400	999	300	R		SS	0	.0	1	1000	0	.05	50	500	0	0	TOP001	A	2	8.00	60	19	5 26	25	95	650	1.00	
TOP002	OTV SERVICE TECH	MH	P	92	1	28	90	28	400	999	300	R			0	3.0	1	1500	0	.05	75	500	0	0	TOP002	A	2	4.00	60	18	5 26	23	90	598	1.00	
TOP003	CREW/MANIP CONT	MH	C	93	1	A	97	28	400	700	370	R	L		1	1.0	1	150	10	.06	9	550	0	0	TOP003	A	2	4.00	60	18	4 29	23	72	667	3.00	
TOP004	MAN ROLE EVAL	MH	O	92	1	A	90	28	400	700	370	R			1	.0	0	50	5	.03	2	100	0	0	TOP004	A	1	1.00	260	22	5 30	26	110	780	1.00	

TOTALS ARE= 8150 47 15280

NUMBER OF MISSIONS= 14

3.4 COMMERCIAL MISSIONS

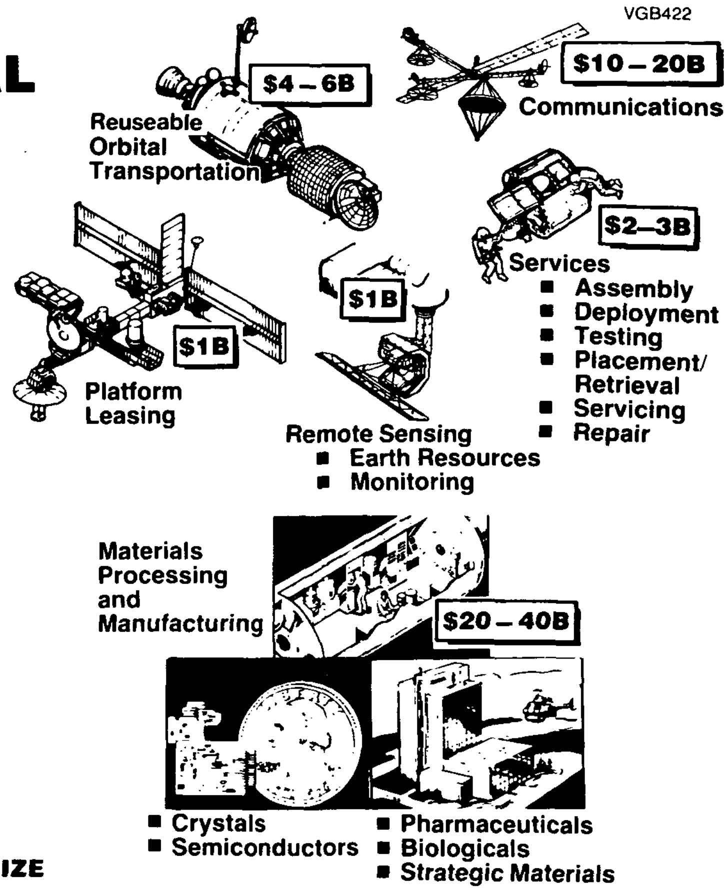
A commercial activity is one undertaken for profit in the public marketplace. The term "commercialization" implies the transfer of technology from an R&D and/or federally supported activity to a trade activity, usually under private ownership and control.

The opportunities for the commercialization of space include not only communications, remote sensing, and materials processing, but also commercial launch and transportation services, satellite servicing, and other support services for the growing numbers of general users. In the field of space transportation, MDAC is leading this transition with its company-furnished Delta 3914 launch vehicle and its Payload Assist Module (PAM) series of upper stages. The potential 10-year market from all candidate commercial ventures is projected to be in the $40- to $50-billion range. Individual market areas are shown in Figure 3-32.

FIGURE 3-32.
COMMERCIAL MISSIONS

Benefits:
- Economic
- Social
- Technological

- Applies NASA R&D
- Stimulates Economy
- Improves Quality of Life
- Increases US World Leadership
- Provides Return on Investment
- Applies High Technology
- Shifts Investment to Private Industry



$B 10 YEAR MARKET SIZE

Corporate investment in the development of a new product or service is generally undertaken only after a critical appraisal of the relevant technology, anticipated development cost, anticipated return, and market demand. The role of the government has traditionally been to serve as a stimulus to economic development by supporting research in high-risk pursuits. (Such pursuits usually have potentially longer pay-back times than are acceptable by private-venture capitalists.) The government has also suported technological developments having obvious social benefits to the populace.

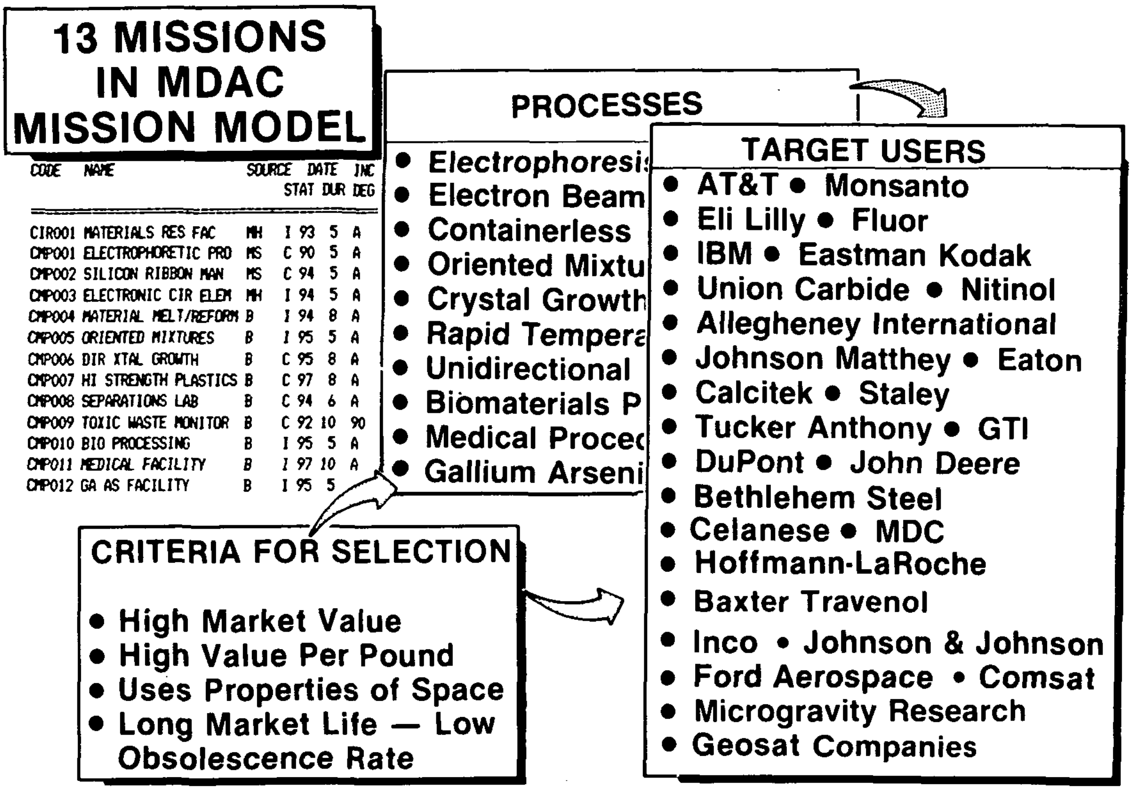
By taking the lead in reducing the risks of space operation, NASA can halp to achieve the economic, social, and technological growth necessary to secure the future of the people in the United States and the remainder of the free world. If we are successful in fully commercializing space activities, we will open the door to new, high-technology industries representing a broad range of medical, technological, economic, and consumer product benefits. In addition to demonstrating US world leadership in high technology and free enterprise, we will begin to shift the burden of investment in space from government to private industry, just as we already have done in the case of satellite communications.

Each of the major commercial areas illustrated in Figure 3-32 was studied by the MDAC team to determine potential markets, products, roles of a manned space station, and constituency support. Study results are treated in-depth in the Commercial Opportunities in Space report. The largest potential markets are in materials processing and communications areas ($10 to $40 billion in 10 years compared to $1 to $6 billion in the other areas).

Thirteen commercially oriented missions were included in the MDAC mission model (Figure 3-33). One of these was a materials research facility for general industrial leasing or service-for-fee operations; the remaining 12 were typical examples of specific facilities likely to be required by one or more members of the emerging population of potential users. In the judgment of the study team, these 13 missions were a reasonable representation of the various classes of products and services that were identified in the contacts made with potential users.

FIGURE 3-33.

COMMERCIAL MISSION OPPORTUNITIES



When discussing the potential of manned and unmanned space platforms with potential users, a concerted effort was made to characterize products and services in terms understandable to the users. The criteria for selecting areas of interest included concentration on products having a high market value or having a market life long enough, with obsolescence rates low enough, that implementation of R&D activities on a manned space station would be feasible and would allow a sustained production period for recapture of investment. One or more of 40 potential processes, products, or services were discussed with representatives of 47 companies and interested organizations.

The results of our investigations have suggested that significant interest in space facilities can be found among a number of commercial users. The potential market opportunities during the next decade are projected to be in the tens of billions of dollars.

In order to develop and maintain the involvement of potential users, however, space demonstrations will be required, and commercial growth or evolution will be highly dependent upon the results obtained in early R&D activities. As evidenced by the MDAC experience in EOS, the concept-to-implementation time cycle for the introduction of a new product to commerical market can easily take 5 to 10 years. Manned facilities will be required especially for conceptual R&D phases and for maintenance and servicing operations during production or operational missions. An essential requirement for encouraging the growth of commercial markets for space-developed products and services is that space facilities be easily accessible by dependable and regularly scheduled transportation systems. Above all, potential users need (1) incentives to remove the space-systems risk from candidate commercial ventures, (2) the potential for private ownership, (3) guarantees of intellectual property rights, (4) proprietary protection, and (5) access to manned space facilities.

The requirements imposed on a space station by the Commercial missions are primarily in the areas of power, facilities, crew, and resupply. The 13 commercial missions identified are believed to be representative of those that will eventually mature. The number of such missions that will come to fruition is now unknown and is dependent on the successful completion of some of the prerequisite R&D missions. The requirements from all the missions are high power (up to 25 kW), equivalent total of seven short Spacelab modules and two long ones, and individual resupply requirements as high as 10,000 kg/month (totaling 30,000 kg/month for all missions). The requirements selected to be imposed on the space station were drawn from those highest priority missions that were believed to be actual candidates (i.e., EOS, Toxic Waste Monitor, and Materials Research Facility).

The other missions, though very promising, have a power priority and were not considered driver missions. These are now fitted within the projected space station capabilities. As their stature matures, these lower priority missions will move up and become driver missions themselves.

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Section 4
INTEGRATED MISSION REQUIREMENTS ANALYSES

This section discusses the collection, integration, and analyses of the mission requirements from each of the four mission areas; the analysis of mission benefits and prioritized missions; and the overall time-phased requirements of prioritized missions.

4.1 MISSION DATA SET

The 88 missions that resulted from the nearly continuous analyses made during the study are listed in Figure 4-1 along with the pertinent data in the data base. Each of these missions is summarized in Appendix A. The distribution of these into the four mission areas is as follows:

- Commercial - 13
- Space Operations - 4
- Science and Application - 57
- Technology - 14

A set of 109 missions (104 in low earth orbit) was received from the European consortium late in the study. These were analyzed, and their requirements are shown in Figure 4-2. Compared to the set developed by MDAC in this study, the international missions set has a higher percentage of Life Science and Materials Processing missions. In addition, the missions are defined at the level of singular objectives rather than at group level, as those developed in the MDAC study were defined. This is indicated by lower average permission requirements for power, crew, mass, and duration.

The requirements boundaries of the MDAC mission set envelop those of the European missions. Therefore, the capabilities of the space station architecture designed in response to the needs of that mission set would be more than adequate to satisfy the needs of the international missions.

FIGURE 4-1 (PAGE 1 OF 2)

SPACE STATION DATA BASE
MCDONNELL DOUGLAS ASTRONAUTICS HUNTINGTON BEACH
Apr 27, 1983

STATUS
O=operational
P=planned
C=candidate
I=opportunity

ACCOMMODATION
R=required
D=desired
A=acceptable

S=supply
L=launch
M=maint/repair
B=assemb/build

VIEW
A=any
E=earth
I=inertial

M=multiple
S=solar
V=velocity
Z=anti earth

LEGACY
S=spacelab
O=other legacy

CODE	NAME	SOURCE	STAT	DATE	DUR	INC DEG	INC MAX	INC MIN	ALT DES	ALT MAX	ALT MIN	STAT	PLAT	SERV	MOD	RACK	PAL	PORT	POWER	DATA	DUTY	POWER *DUTY	LMASS	EXPEND	G	CODE	VIEW	CREW SIZE	HRS DAY	DAYS YR	BEN	SAVE CONS	SAVE RISK	BEN# CONS	SAV# RISK	PRIORTY	LEGACY
CIR001	MATERIALS RES FAC	MH	I	93	5	A	97	28	400	700	370	R			SM	0	.0	1	25000	10000	.20	5000	7500	10	-3	CIR001	A	2	2.00	60	23	7	21	27	161	567	2.00	
CMP001	ELECTROPHORETIC PRO	MS	C	90	5	A	99	0	400	700	370	A	A	M	SM	0	.0	1	15000	1000	.80	12000	7500	6000	-3	CMP001	A	1	2.00	50	29	9	21	30	261	630	1.00	0
CMP002	SILICON RIBBON MAN	MS	C	94	5	A	99	0	370	700	370	A	A		SM	0	.0	1	15000	1000	.80	12000	4500	542	-3	CMP002	A	1	2.00	50	22	7	22	22	154	484	4.00	
CMP003	ELECTRONIC CIR ELEM	MH	I	94	5	A	97	28	400	700	370	R	A	M		2	.0	0	1000	10	.20	200	470	50	-5	CMP003	A	1	4.00	70	19	6	24	22	114	528	3.00	
CMP004	MATERIAL MELT/REFORM	B	I	94	8	A	97	28	400	700	370	R			SM	0	.0	1	12000	1000	.20	2400	5000	1000	-5	CMP004	A	1	2.00	260	22	7	20	23	154	460	4.00	
CMP005	ORIENTED MIXTURES	B	I	95	5	A	97	28	400	700	370	D	A		SM	0	.0	1	1500	1000	.20	300	10000	1100	-3	CMP005	A	1	1.00	50	22	7	22	22	154	484	4.00	
CMP006	DIR XTAL GROWTH	B	C	95	8	A	97	28	400	700	370	D	A			2	.0	0	500	1000	.20	100	3000	2200	-5	CMP006	A	1	1.00	260	21	7	24	22	147	528	3.00	
CMP007	HI STRENGTH PLASTICS	B	C	97	8	A	97	28	400	700	370	D	A		LM	0	.0	1	4000	1000	.80	3200	15000	9999	-3	CMP007	A	1	1.00	260	22	7	22	23	154	506	4.00	
CMP008	SEPARATIONS LAB	B	C	94	6	A	97	28	400	700	370	R			SM	0	.0	1	15000	1000	.20	3000	7500	3000	-5	CMP008	A	1	8.00	200	23	8	18	25	184	450	4.00	
CMP009	TOXIC WASTE MONITOR	B	C	92	10	90	97	57	400	700	370	D	A	M		0	2.0	1	1000	12000	.30	300	1500	0	-3	CMP009	E	1	1.00	365	21	7	29	25	147	725	1.00	
CMP010	BIO PROCESSING	B	I	95	5	A	97	28	400	700	370	A	D		SM	0	.0	1	15000	1000	1.00	0	30000	500	-3	CMP010	A	1	.10	365	20	7	24	23	140	552	3.00	
CMP011	MEDICAL FACILITY	B	I	97	10	A	97	28	400	700	370	R			LM	0	.0	1	3000	5000	.20	600	20000	5000	-2	CMP011	A	3	8.00	365	19	6	18	21	114	378	4.00	
CMP012	GA AS FACILITY	B	I	95	5	A	97	28	370	700	370	R				2	.0	0	5000	1000	.20	1000	2500	0	-3	CMP012	A	2	4.00	50	20	6	22	23	120	506	4.00	
OAI001	STRUCT ASSY & TEST	MH	C	95	99	28	28	28	400	700	350	R		B		0	2.0	1	2000	700	.05	100	4000	0	0	OAI001	E	4	8.00	60	23	5	19	22	115	418	3.00	
OSR001	SAT SERV OPS	MH	P	92	99	28	28	28	400	700	350	R		S	SS	0	.1	1	2000	700	.01	20	1000	0	0	OSR001	A	2	10.00	10	21	6	23	24	126	552	1.00	
OTR001	TMS OPS	MH	P	92	99	28	28	28	400	700	350	R		L		0	.3	1	2000	350	.02	40	1300	650	0	OTR001	A	2	10.00	30	20	6	24	24	120	576	1.00	
OTR004	OTV OPS (2STG)	MH	C	96	99	28	28	28	400	700	350	R		L		0	.3	1	3000	500	.07	210	1400	13000	0	OTR004	A	3	10.00	60	22	5	22	20	110	440	2.00	
SAS001	ADV SOL OBS(ASO/SOT)	MH	A	90	10	97	97	28	400	600	350	D	A	S		0	3.0	1	5000	2500	1.00	5000	12500	0	0	SAS001	S	2	1.50	365	24	6	24	26	144	624	1.00	S
SAS002	SIRTF	MH	P	89	10	57	57	0	400	430	350	A	D	S		0	3.0	1	1300	1000	.50	650	8103	12	0	SAS002	I	2	8.00	3	23	5	25	24	115	600	2.00	S
SAS003	STARLAB	MH	P	90	10	28	28	28	400	800	350	A	D	M		0	2.0	1	2220	7000	.80	1776	3280	0	0	SAS003	I	2	.57	180	23	5	24	24	115	576	2.00	S
SAS004	COMP SPEC COSRAY NUC	MH	A	90	2	28	97	0	400	435	370	D	A			0	1.0	1	731	102	.98	716	3082	30	0	SAS004	Z	1	1.02	365	20	5	29	25	100	725	2.00	S
SAS006	EX LG LONG DUR EXP	MH	I	99	10	57	97	28	500	700	400			B		0	9.9	0	1	1	.00	0	99999	0	0	SAS006	A	2	11.00	1	21	3	28	21	63	588	4.00	
SAS007	TRANS RAD ION.CAL.	MH	C	90	2	28	98	28	400	900	300	D	A			0	1.0	1	60	2	.98	59	2000	0	0	SAS007	Z	1	1.02	365	19	3	30	21	57	630	3.00	S
SAS008	XRAY OBSER	MH	C	99	2	28	28	0	400	570	370	A	A	M		0	2.0	0	900	1000	.00	0	3550	0	0	SAS008	I	2	9.00	2	20	4	28	22	80	616	3.00	
SAS009	SPACE TELESC	MH	A	85	15	28	28	28	600	600	600			M	SS	0	4.0	0	2100	0	.00	0	11070	0	0	SAS009	I	2	8.00	2	24	6	24	28	144	672	1.00	
SAS010	HIRES X&G-RAY SPEC	MH	C	90	2	28	45	0	400	500	350	D	A	M		0	.5	1	530	35	.80	424	1668	10	0	SAS010	I	2	7.00	1	20	3	28	21	60	588	4.00	S
SAS011	XRAY TIMING EXPL	MH	A	89	5	28	45	0	400	600	300	A	A	M		0	2.0	1	600	1000	.80	480	1000	0	0	SAS011	I	2	2.00	1	19	5	30	23	95	690	1.00	0
SAS012	SOLAR INT DYNAMICS	MH	C	91	5	98	98	57	575	575	300	A	A	M		0	3.0	1	800	0	.99	792	2600	0	0	SAS012	S	2	3.00	1	19	4	27	23	76	621	3.00	0
SAS013	ADV XRAY ASTROFAC	MH	P	91	15	28	28	0	500	600	400			M		0	5.0	0	2000	0	.00	0	11000	0	0	SAS013	I	2	13.00	1	23	5	25	22	115	550	1.00	
SAS014	LAMAR(HTM)	MH	C	92	10	28	28	0	400	435	200	A	A	S		0	4.0	1	3400	130	.80	2720	9516	18	0	SAS014	I	2	13.00	1	22	4	24	21	88	504	3.00	S
SAS015	VLBI	MH	C	89	10	57	98	45	400	600	350	A	A	B		0	2.0	1	900	12000	.50	450	1354	0	0	SAS015	I	2	3.00	1	19	5	28	23	95	644	2.00	S
SAS016	LRG DELP REFL	MH	C	95	10	57	57	28	700	800	400			M		0	10.0	0	3000	0	.00	0	20500	0	0	SAS016	I	2	13.00	1	22	4	25	21	88	525	3.00	
SAS017	GAMMA RAY OBS	MH	A	88	5	28	28	28	400	400	400			M		0	5.0	0	2000	0	.00	0	11000	0	0	SAS017	I	2	13.00	1	21	6	24	24	126	576	2.00	
SAS018	HIGH ENER ISO EXP	MH	P	90	2	57	98	57	400	900	300	D	A			0	1.0	1	250	100	.98	245	2000	0	0	SAS018	Z	1	1.02	365	18	3	28	21	54	588	3.00	S
SAS019	SOLAR COR DYN	MH	P	93	2	A	97	28	400	900	300	A	A	M		0	3.0	1	1000	0	.50	500	3500	0	0	SAS019	S	2	3.00	1	18	4	30	21	72	630	3.00	0
SAS020	COSMIC RAY OBS	MH	C	98	5	57	97	57	400	400	400	D	A	S		0	5.0	1	2000	1000	.98	1960	18000	0	0	SAS020	Z	1	1.02	365	22	4	26	22	88	572	2.00	
SCM001	REMOTE SENSING RFI	MH	I	92	10	90	97	57	400	700	400	A	D	A		0	2.0	1	120	5	.05	6	2500	0	0	SCM001	M	2	3.00	1	18	4	28	21	72	588	4.00	
SCM002	ORB STANDARDS PACK	MH	I	90	10	57	97	57	400	700	350	D	A	A		0	.5	1	150	100	.05	8	100	0	0	SCM002	M	2	2.00	1	17	5	32	23	85	736	2.00	0
SCM003	COMM RESEARCH FAC	MH	I	92	15	57	97	57	400	999	300	R			SM	0	.0	1	5000	120000	.05	250	5000	0	0	SCM003	M	3	1.93	100	18	4	23	20	72	460	4.00	
SEE001	OCEAN PAYLOAD	MH	P	88	10	98	98	57	400	700	250	D	A			0	3.0	1	1000	120000	.20	200	10000	0	0	SEE001	E	3	.85	365	28	7	23	24	196	552	2.00	0
SEE002	ATMOS COMP	MH	P	90	3	90	98	57	600	780	400	D	A			0	2.0	1	4000	500	.01	40	2500	0	0	SEE002	M	2	11.00	4	21	5	25	21	105	525	3.00	
SEE003	UPPER ATMOS RES	MH	P	88	6	57	97	28	400	400	400	A	A	M		0	2.0	1	1339	18	.03	0	2367	0	0	SEE003	M	2	10.00	2	20	5	25	23	100	575	2.00	
SEE004	SPACE PLASMA PHYSICS	MH	P	88	5	90	97	57	400	500	250	A	D			0	1.0	1	2665	7510	.10	267	3183	0	0	SEE004	M	2	10.00	2	20	4	25	22	80	550	2.00	S
SEE005	ZERO G CLOUD PHYSICS	MH	P	92	5	A	97	0	400	600	350	R				3	.0	0	1360	500	.02	27	474	10	-5	SEE005	A	2	4.25	50	26	5	28	23	130	644	3.00	S
TOTALS ARE=																			166426	312763			374016															
NUMBER OF MISSIONS=	44																																					

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FIGURE 4-1 (PAGE 2 OF 2)

SPACE STATION DATA BASE
MCDONNELL DOUGLAS ASTRONAUTICS HUNTINGTON BEACH
Apr 27, 1983

STATUS
O=operational
P=planned
C=candidate
I=opportunity

ACCOMMODATION
R=required
D=desired
A=acceptable

S=supply
L=launch
M=maint/repair
B=assemb/build

VIEW
A=any
E=earth
I=inertial

M=multiple
S=solar
V=velocity
Z=anti earth

LEGACY
S=spacelab
O=other legacy

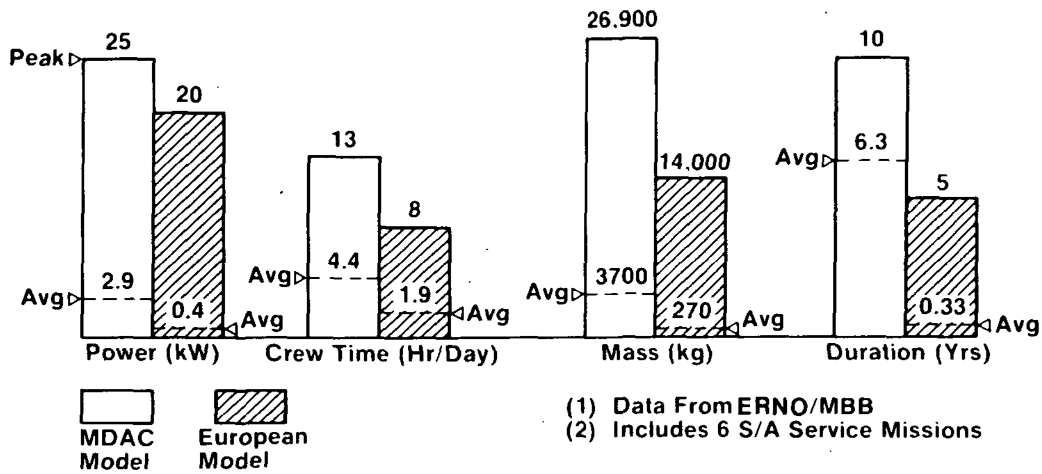
CODE	NAME	SOURCE	STAT	DATE	DUR	INC DEG	INC MAX	INC MIN	ALT DES	ALT MAX	ALT MIN	STAT PLAT	SERV	RACK MOD	PAL	PORT	POWER	DATA	DUTY	POWER *DUTY	LMASS	EXPEND	G	CODE	VIEW	CREW SIZE	HRS DAY	DAYS YR	BEN	SAVE CONS	SAVE RISK	BEN* CONS	SAV* RISK	PRIORTY	LEGACY
SEE006	MET. RES. PKG	MH	P	92	10	57	97	57	500	800	400	R			0	1.0	1	1200	14	.20	240	1500	0	0	SEE006	E	3	.85	365	24	5	25	20	120	500	3.00	
SEE007	ATM DYNAMICS&RAD	MH	C	93	5	90	97	57	400	600	350	D	A M		0	2.0	1	5000	2500	.10	500	2300	0	0	SEE007	M	2	13.00	1	25	5	25	22	125	550	2.00	S
SEE008	OP CIVIL MET	MN	O	88	10	98	98	98	833	870	830	A	A M		0	1.0	1	415	2700	.99	411	700	0	0	SEE008	E	2	5.00	2	22	5	26	24	110	624	2.00	O
SEP001	SAR	MH	P	84	10	90	97	57	400	700	250	A	A M		0	1.0	1	6486	120000	.20	1297	1876	0	0	SEP001	E	1	.51	360	26	6	25	25	156	625	1.00	O
SEP002	MULTISPECT LIN ARRAY	MH	P	89	5	98	98	57	705	705	400	D	A S		0	.5	1	500	250000	.20	100	315	0	0	SEP002	E	1	.51	360	24	5	29	23	120	667	1.00	
SEP003	MAG FIELD MAPPER	MH	P	89	5	97	97	57	300	400	300		A L		0	.5	1	120	230	.99	119	890	0	0	SEP003	E	2	13.00	1	17	3	30	24	51	720	4.00	
SEP004	PASS MICROWAVE RAD	MH	P	92	2	90	99	45	465	900	300	A	D		0	2.0	1	1200	200	.20	240	475	0	0	SEP004	E	2	3.00	1	22	5	29	22	110	638	1.00	
SEP005	LARGE FORMAT CAMERA	MH	P	90	5	90	97	57	250	500	180	R			0	.2	0	1	1	.20	0	70	0	0	SEP005	E	1	1.00	13	24	6	30	26	144	780	1.00	S
SEP006	IMAGE SPECTROMETER	MH	C	95	10	97	97	50	400	700	250	A	D M		0	1.0	1	500	100000	.20	100	1938	0	0	SEP006	E	1	1.02	180	20	5	29	22	100	638	2.00	S
SEP007	LUMINESCENCE DET	MH	C	94	2	98	98	57	400	800	200	A	A		0	.1	0	150	2500	.20	30	60	0	0	SEP007	E	1	1.02	180	18	4	32	20	72	640	3.00	
SEP008	LASER RANGING	MH	P	89	15	90	97	57	400	600	300	D	A		0	.1	0	500	10	.20	100	185	0	0	SEP008	E	2	2.00	1	17	4	33	24	68	792	3.00	O
SEP009	LANDSAT D-D'	MH	O	82	15	98	98	98	705	705	705	A	A M	SS	0	.0	1	750	0	.00	0	1600	0	0	SEP009	E	2	9.00	1	21	6	27	24	126	648	1.00	O
SEP010	RADAR ALT	MH	C	92	10	90	98	57	400	800	350	D	A M		0	.2	0	100	2500	.20	20	100	0	0	SEP010	E	2	3.00	1	20	4	30	23	80	690	1.00	O
SEP011	ACT FLUOR SPECT	MH	C	95	10	90	98	57	400	500	250	D	A M		0	1.0	1	2000	40000	.20	400	1900	0	0	SEP011	E	1	1.02	180	17	3	27	19	51	513	4.00	
SEP012	PLAN SPECT TELE	MN	I	90	10	A	98	28	400	999	250	D	A M		0	2.0	1	3000	50000	.80	2400	3000	0	0	SEP012	I	2	.58	40	21	4	25	21	84	525	3.00	S
SEP013	IR SPECT	MN	I	91	10	A	98	28	400	999	250	D	A S		0	2.0	1	3000	50000	.80	2400	8100	0	0	SEP013	I	2	.67	40	20	4	27	21	80	567	3.00	
SEP014	FAR IR SPECT	MH	I	95	10	28	57	28	700	999	400		A M		0	10.0	1	3000	50000	.80	2400	20000	0	0	SEP014	I	2	.58	40	20	4	25	20	80	500	4.00	
SEP015	EXTRA SS DET	MH	I	92	20	28	28	28	500	600	400	D	A M		0	2.0	1	3000	100	.80	2400	3000	0	0	SEP015	I	1	1.14	180	20	4	26	19	80	494	4.00	
SEP016	PLANETARY PROC LAB	MH	I	99	10	A	98	28	400	999	250	R		SM	0	.0	1	1000	500	1.00	1000	2500	1	0	SEP016	I	1	8.50	50	21	3	24	18	63	432	4.00	S
SLS001	PRIMATE EXP FAC	MH	P	95	10	A	98	28	400	98	350	R		LM	0	.0	1	4000	50	1.00	4000	1700	0	-3	SLS001	A	2	1.53	360	22	4	26	25	88	650	2.00	S
SLS002	PLANT BIO/LS FACIL	MH	P	92	10	A	97	28	400	700	350	R		SM	0	.0	1	4400	50	1.00	4400	1800	0	-5	SLS002	A	2	3.00	12	23	5	27	23	115	621	2.00	S
SLS003	RODENT EXP FACIL	MH	P	92	10	A	97	28	400	700	350	R		SM	0	.0	1	4200	50	1.00	4200	1600	0	-4	SLS003	A	3	.78	360	23	4	26	25	92	650	2.00	S
SLS004	ORB QUARANTINE	MH	I	99	1	28	57	28	400	700	350	R		SM	0	.0	1	1700	50	.10	170	6600	0	0	SLS004	A	1	4.00	30	16	3	26	20	48	520	4.00	
SLS005	EXP MED TREAT FAC	MH	I	95	10	A	97	28	400	700	350	R		SM	0	.0	1	1000	50	1.00	1000	3200	0	-3	SLS005	A	2	4.00	30	18	3	27	23	54	621	4.00	
SLS006	HUMAN EXP FAC	MH	P	92	10	A	97	28	400	700	350	R		SM	0	.0	1	2900	50	1.00	2900	3000	1	-3	SLS006	A	5	1.00	52	24	4	28	27	96	756	2.00	S
SMP001	MATERIALS PROC LAB	MH	C	92	10	A	97	28	400	999	300	R		LM	0	.0	1	12000	10	.50	6000	5500	0	0	SMP001	A	3	4.00	100	26	7	22	25	182	550	2.00	
SMP002	MATERIALS EXP CARR	MH	C	90	10	A	99	0	ANY	999	300	A	D		0	2.0	1	10000	500	.80	8000	13600	30	0	SMP002	A	2	6.50	26	25	7	23	25	175	575	2.00	
SMP003	MATERIALS EXP ASS	MH	P	88	10	A	99	0	ANY	999	300	A	A		0	1.0	1	4000	6	.50	2000	2215	0	-5	SMP003	A	2	6.50	26	23	7	27	24	161	648	1.00	O
SMP004	WAKE SHIELD EXP	MH	I	90	1	A	97	0	400	700	350	R			0	1.0	1	500	10	.20	100	600	0	0	SMP004	V	2	5.00	10	16	3	33	24	48	792	4.00	
SMP005	ULTRAVACUUM FAC	MH	I	95	10	A	97	0	400	700	350	D	A		0	1.5	1	3000	10	.50	1500	1200	0	0	SMP005	V	3	5.00	26	18	3	31	24	54	744	4.00	
TFM001	LASER COMM&TRACK DEV	MH	I	92	1	28	97	0	400	999	300	R			0	.5	1	1000	10	.05	50	200	0	0	TFM001	M	2	3.00	20	14	4	28	23	56	644	4.00	
TGN001	LSS CONTR EXP	MH	C	93	1	28	90	0	400	999	300	R			0	2.0	1	500	0	.02	10	600	0	0	TGN001	A	1	1.00	30	18	4	28	24	72	672	3.00	
TGN002	ZERO G ANT RANGE	MH	I	92	1	28	90	28	400	999	300	R			0	2.0	1	1000	1	.04	40	1000	0	0	TGN002	V	2	8.00	10	21	5	25	25	105	625	2.00	
TGN003	MATERIALS&COAT TECH	MH	I	92	5	28	97	28	400	600	300		D M		0	1.0	1	100	0	.01	0	1400	0	0	TGN003	A	2	4.00	10	15	4	32	26	60	832	4.00	
TGN004	TETHER DYNAMICS	MH	C	94	1	28	97	0	400	600	300	R			0	.5	1	1000	0	.01	10	250	0	0	TGN004	E	2	4.00	30	18	4	31	24	72	744	3.00	
TGN005	LRG STRUCT CONSTR	MH	C	94	1	28	57	28	400	999	350	R			0	2.0	1	500	1	.03	15	600	0	0	TGN005	E	3	8.00	60	21	5	23	24	105	552	1.00	
TGN006	FLUID STORE&MANAG	MH	C	92	1	28	97	28	400	999	300	R			0	3.0	1	500	0	.02	10	9000	0	0	TGN006	A	1	4.00	30	17	4	28	24	68	672	1.00	
TGN007	LIQUID DROPLET RAD	MH	I	94	1	28	97	0	400	999	350	R			0	.5	1	200	0	.01	2	400	0	0	TGN007	A	1	4.00	30	15	4	32	23	60	736	4.00	
TGN008	ECLS WATER REC	MH	C	93	1	A	97	28	400	700	370	R			1	.0	0	150	10	.01	2	80	0	0	TGN008	A	1	.15	180	14	5	33	25	70	825	2.00	
TGN009	ELCS OXY REC	MH	C	93	1	A	97	28	400	700	370	R			2	.0	0	500	10	.01	5	100	0	0	TGN009	A	1	.14	180	18	5	29	22	90	638	2.00	
TOP001	SATELL SERV TECH	MH	P	92	1	28	90	28	400	999	300	R		SS	0	.0	1	1000	0	.05	50	500	0	0	TOP001	A	2	8.00	60	19	5	26	25	95	650	1.00	
TOP002	OTV SERVICE TECH	MH	P	92	1	28	90	28	400	999	300	R			0	3.0	1	1500	0	.05	75	500	0	0	TOP002	A	2	4.00	60	18	5	26	23	90	598	1.00	
TOP003	CREW/MANIP CONT	MH	C	93	1	A	97	28	400	700	370	R	L		1	1.0	1	150	10	.06	9	550	0	0	TOP003	A	2	4.00	60	18	4	29	23	72	667	3.00	
TOP004	MAN ROLE EVAL	MH	O	92	1	A	90	28	400	700	370	R			1	.0	0	50	5	.03	2	100	0	0	TOP004	A	1	1.00	260	22	5	30	26	110	780	1.00	
TOTALS ARE=																		87772	672138			106804															
NUMBER OF MISSIONS=		44																																	

FIGURE 4-2.

EUROPEAN MISSIONS

VGB810

MDAC Mission Model		European Mission Model (1)	
88 Missions		104 Missions	
Science and Application	57	Science and Application	89
Operations	10(2)	Operations	4
Technology	14	Commercial Technology	11
Commercial	13		



(1) Data From ERNO/MBB
(2) Includes 6 S/A Service Missions

4.1.1 Mission Accommodation

All 88 missions were analyzed to determine the preferred accommodation for each in terms of a manned space station, a platform, or a dedicated satellite. Three levels of preference were noted: required, desired, and acceptable. The preferences are summarized in Figure 4-3. From this data it is clear that a manned space station should be a part of the initial system and that a platform judiciously placed will greatly augment this basic capability.

The orbit requirements are summarized in Figure 4-4. The largest fraction of missions, 33, have no preferred orbit inclination; the next largest set, 27, requires a 28.5-deg orbit. Although these groupings are expressed as "requirements," the missions have some flexibility in degrees of acceptability across the entire band of inclination from 28.8-deg to sun-synchronous.

FIGURE 4-3.

EVALUATION OF MAN IN-ORBIT INFLUENCES

VGB617

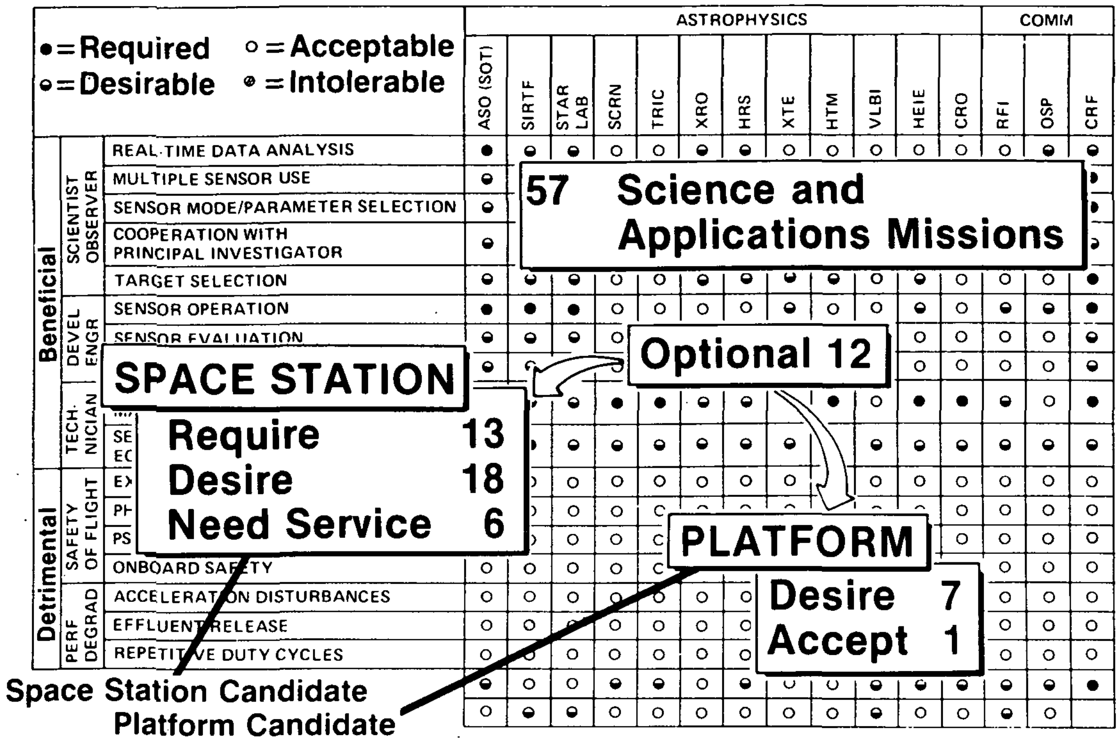
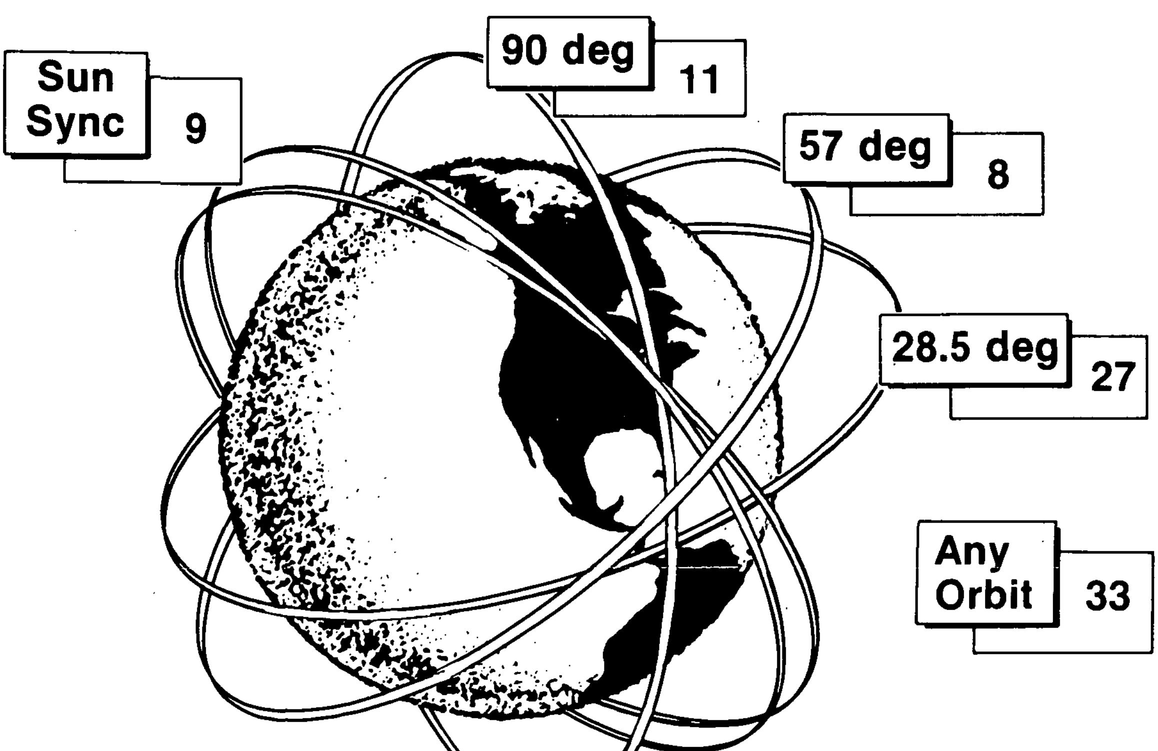


FIGURE 4-4.

ORBIT REQUIREMENTS — ALL MISSIONS

VGB662

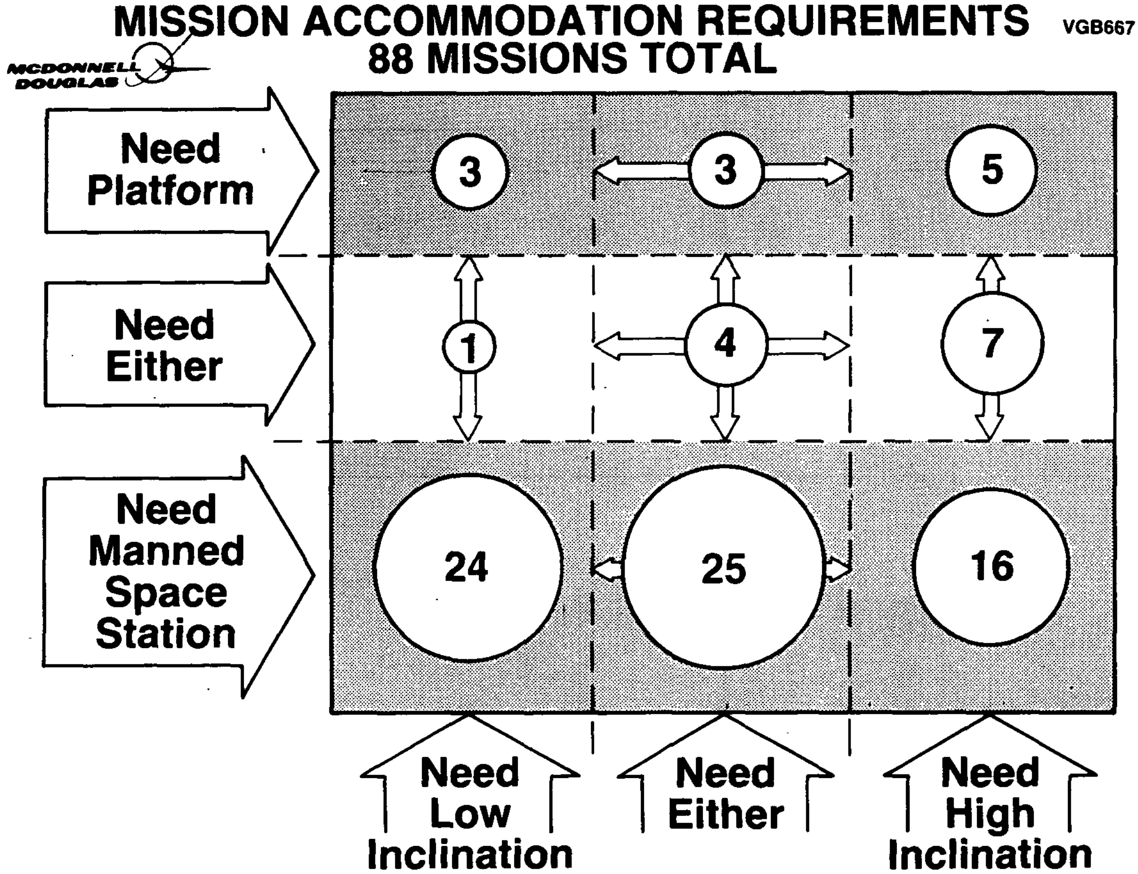


Orbit inclination selections considered these requirements, their flexibility for accepting other inclinations, the relative cost (Shuttle performance) of achieving each orbit, and the location of planned traffic corridors.

The distribution of combined mission accommodation, i.e., facility (space station or platform) and inclination requirements, is illustrated in Figure 4-5. The majority of the missions can be accommodated by a manned space station at low inclination. A space station at 28.5-deg orbit can accommodate 54 of the 88 missions. Of the remaining missions, 15 can be accommodated by a high-inclination platform.

In a budget-constrained environment, it will be essential to achieve the highest degree of mission accommodation for the least program cost. Although the range of requirements included in our mission model demands both manned and unmanned facilities in every major orbit regime, a very high percentage of

FIGURE 4-5.
MISSION ACCOMMODATION REQUIREMENTS
88 MISSIONS TOTAL



the total mission set can be satisfied by a single manned space station supplemented by a single unmanned platform.

Figure 4-6 illustrates the accommodation offered by a just a few of the architectural options investigated in this study. A single space station at 28.5-deg orbit, with an unmanned platform operated at high inclination (preferably sun-synchronous or 90-deg) offers the best accommodation potential of any space station/platform combination. Sixty-seven missions have 100% of their required needs satisfied. An additional 17 missions have 75% to 100% of their required needs satisfied. The total of 84 missions represents a capture ratio of 95%. To capture the remaining 5%, and to satisfy 100% of all mission needs, requires additional major facilities in space.

The 21 missions that cannot be fully accommodated by a 28.5-deg-inclination space station and a sun-synchronous-orbit platform were dispositioned as shown in Figure 4-7. Six missions can be accommodated by

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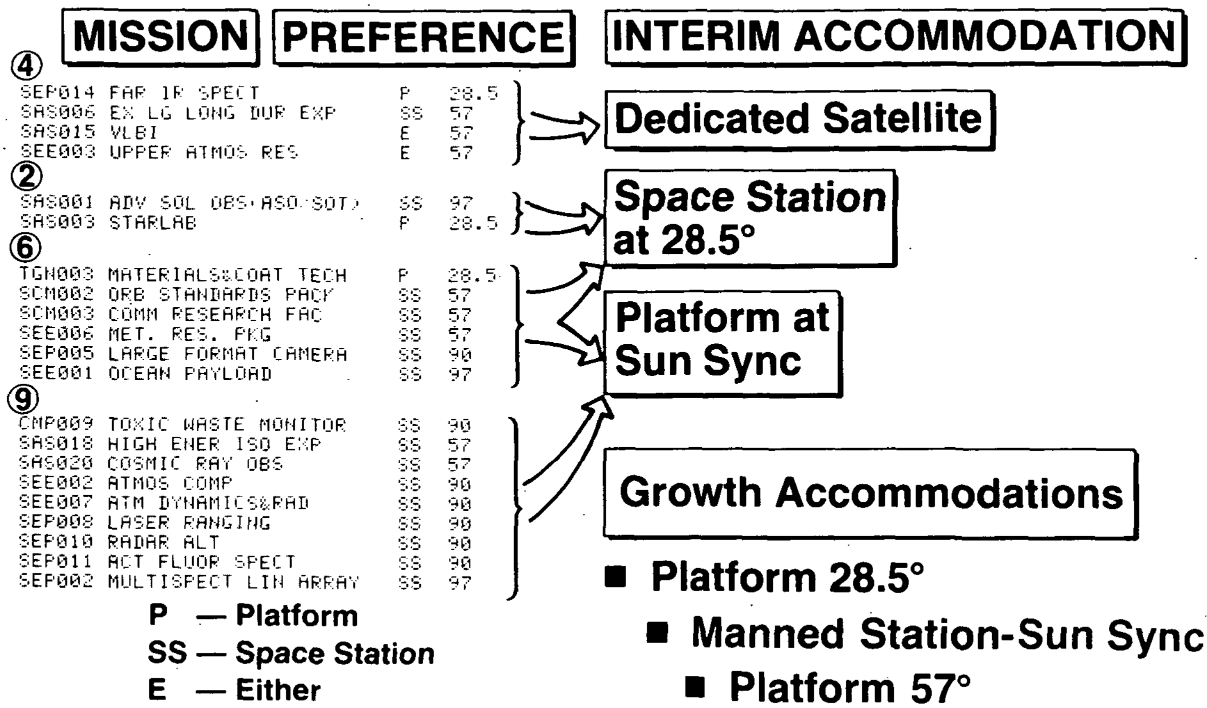
FIGURE 4-6.
MISSION ACCOMMODATION
Prioritized Mission Model (88 Missions)

VGB664

Architecture		Missions Accommodated		Total Missions Captured
Space Station	Platform	100%	75%-100%	
28.5°	—	54	10	64
28.5°	57°	57	26	83
	90° or Sun Sync	67	17	84 ← 95%
57°	28.5°	60	18	78
	90° or Sun Sync	65	10	75

FIGURE 4-7.
UNIQUE MISSION ACCOMMODATION
SPACE STATION-28°,
PLATFORM-SUN SYNC

VGB668



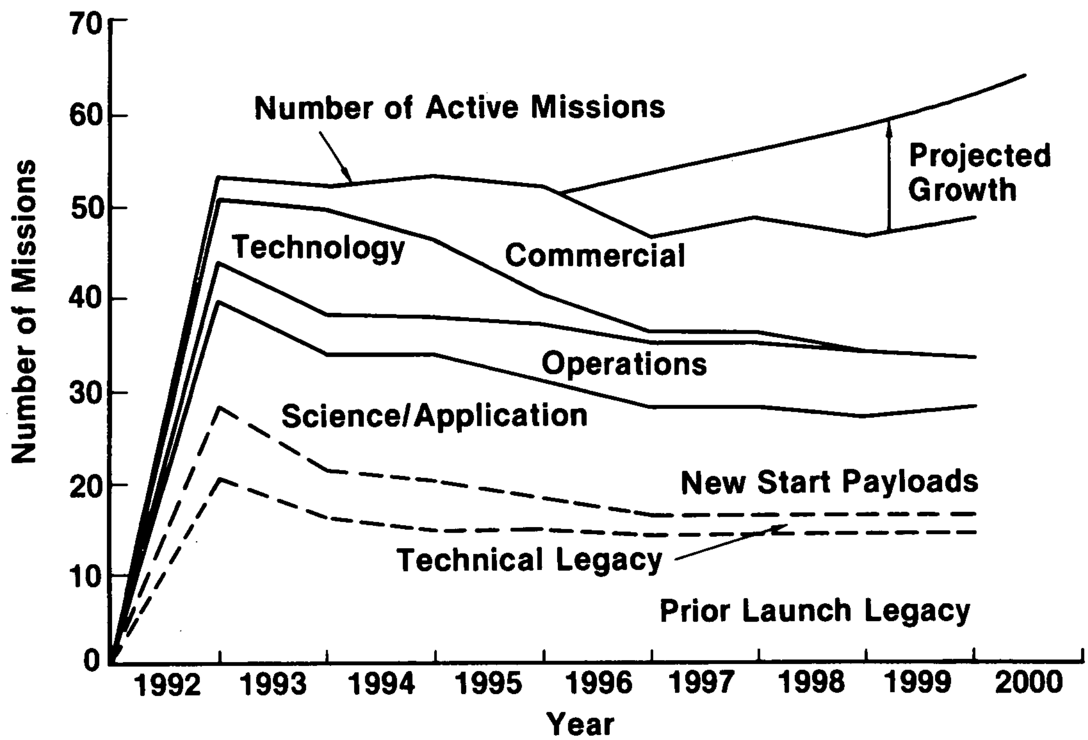
redefining them to be split with part of each on both the platform and the space station. This interim solution would be appropriate pending the addition of growth capability at 28.5-deg orbit, manned presence at sun-synchronous orbit, and manned or unmanned capability at 57-deg inclination.

4.1.2 Activity Level

The total on-orbit mission activity that would result if all the missions were scheduled when desired is shown in Figure 4-8. Budget analyses have shown that the costs associated with mission payloads and the facilities needed to accommodate them are outside reasonable budget allocations. In addition, activity in the latter half of the decade will probably be increased beyond our estimates (as indicated by the projected growth) because of our inability to predict accurately. These high activity levels lead to the need to prioritize the missions.

FIGURE 4-8.
MISSION ACTIVITY

VGB547



4.2 BENEFITS AND PRIORITIZATION ANALYSES

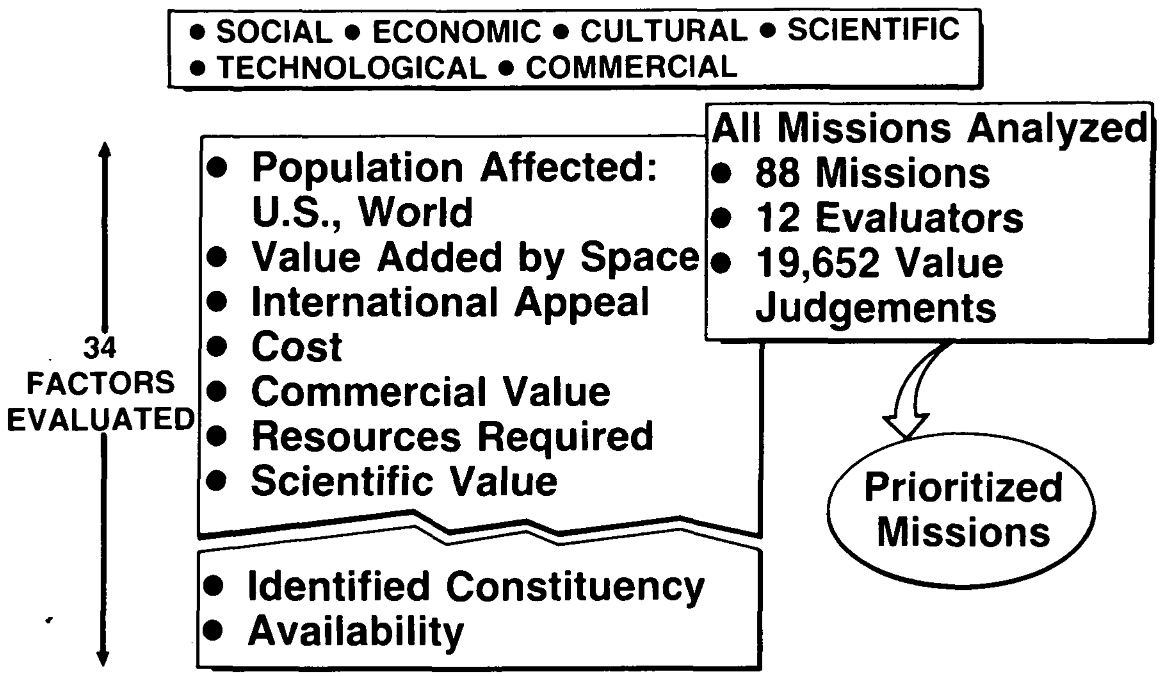
The large number of viable missions necessitated that a mechanism be implemented that would allow their orderly accommodation. To achieve this ordering, benefits and prioritization analyses were conducted. The process used is summarized in Figure 4-9. Thirty-four parameters that measure the relative benefits of each mission were selected. These included the broad categories of social and economic benefits, cost, constituency, and availability. Each of the 34 parameters was numerically scaled so that each mission could be measured. The relative positions of each mission on each scale were summed, resulting in a prioritized list.

Some of the factors included were the following:

- Demographic data such as the percentage of the population affected.
- Value added in terms of the numeric factor increase in product output on the space mission compared to a nonspace solution.
- Procurement and supporting costs, including STS flights and amount of utility resources needed.

VGB825

FIGURE 4-9.
BENEFITS AND PRIORITIZATION ANALYSES



- Constituency--the identified support of a constituency or sponsor group.
- Availability--the relative development maturity, legacy, or sponsor planning priority that would indicate not only when the mission might be achieved but also the confidence in it being achieved.

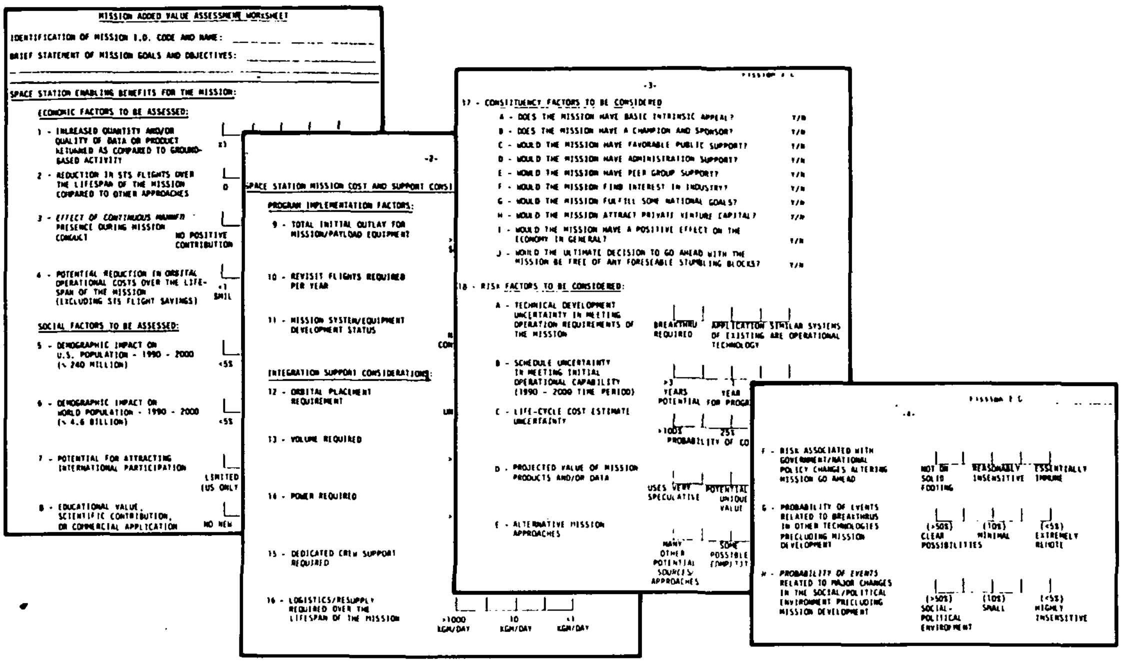
The evaluators were selected from the MDAC study team (including subcontractor and Mission Advisory personnel) for their particular expertise in the areas being evaluated. Twelve individuals averaging 25 years experience in space systems analyses were involved; four have PhDs in the related sciences and one has a doctorate in medicine.

The evaluation data collection technique used was the four-page format shown in Figure 4-10. Figure 4-11 shows a detail of some of the factors to demonstrate how they were scaled. The analysis technique is fully reported in the Benefits Analysis Report.

MCDONNELL DOUGLAS

VGB721

FIGURE 4-10.
BENEFITS ANALYSIS PARAMETERS



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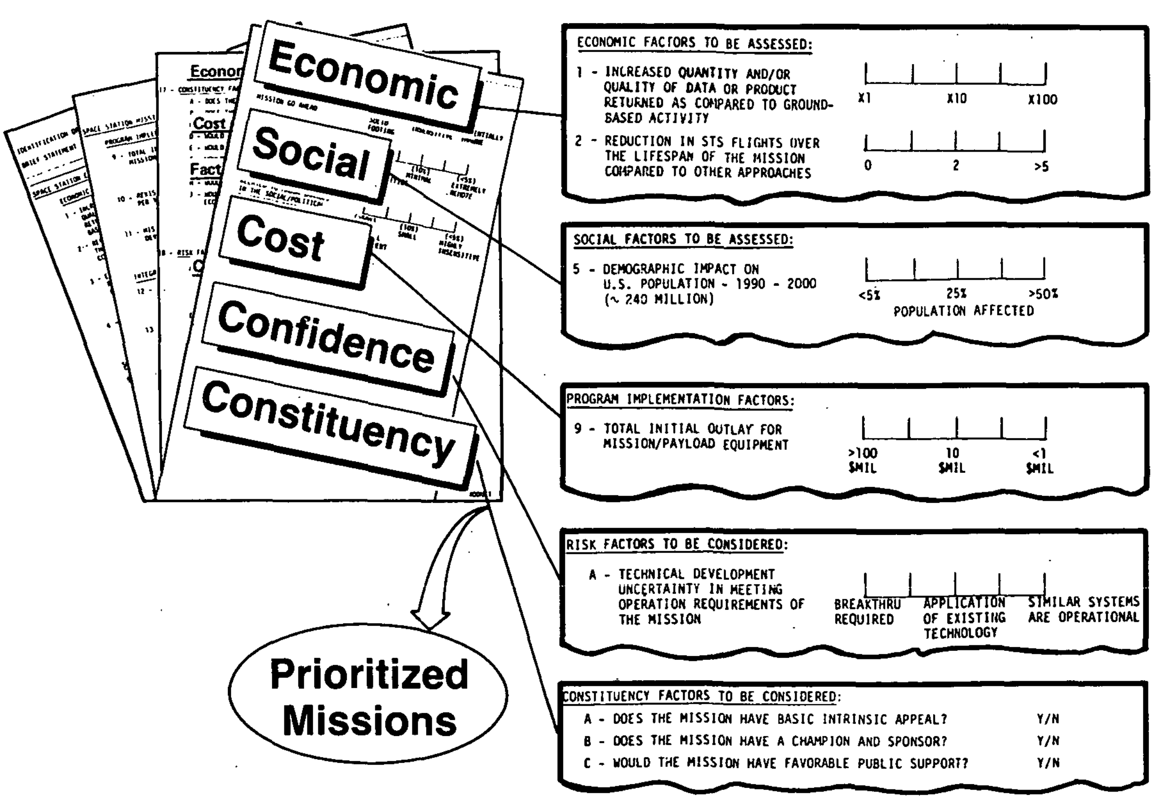
VGB816

FIGURE 4-11.
BENEFITS/PRIORITIZATION ANALYSIS



The resultant benefit rating for the 88 missions is shown in Figure 4-12. The ordinate is a measure of the evaluated benefit and constituency factor, and the abscissa is a relative measure of the mission cost and uncertainty. The scatter data is the placement of each mission on this evaluation scale. The scale's directions are such that the highest value missions are up and to the right.

These relative values were analyzed for biases among the evaluators and for other sensitivities. The missions were then prioritized by sequentially selecting groups of missions in the far upper right portion of the map and then proceeding across to the lower left in incremental steps. Various step sizes were used (including semiquartile increments and a mission distribution matrix scoring technique). These resulted in the four mission priority groups shown in Figure 4-13. The high-priority missions (Groups 1 and 2) included missions from all the categories, specifically the high-value Commercial missions (i.e., EOS), servicing of high-value satellites, enabling technology missions, and Science and Applications. The purpose of mission prioritization was to provide an orderly mechanism for monotonically increasing the mission

FIGURE 4-12.
MISSION VALUE DISTRIBUTION

VGC198

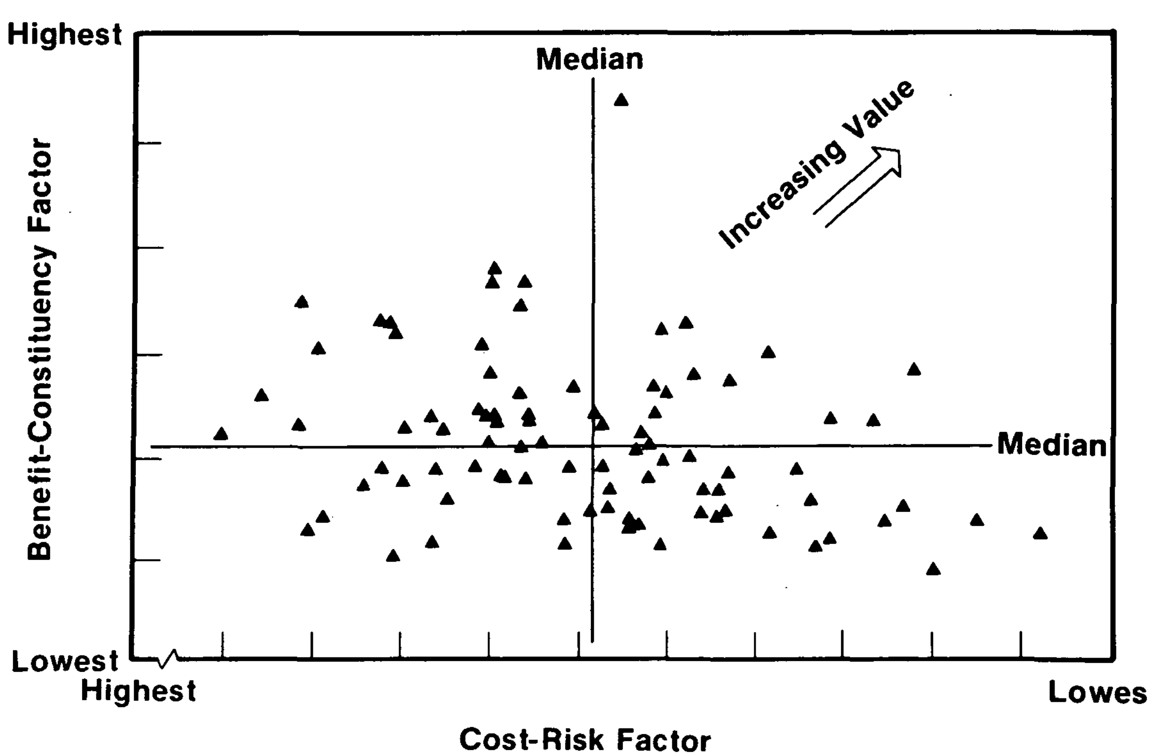
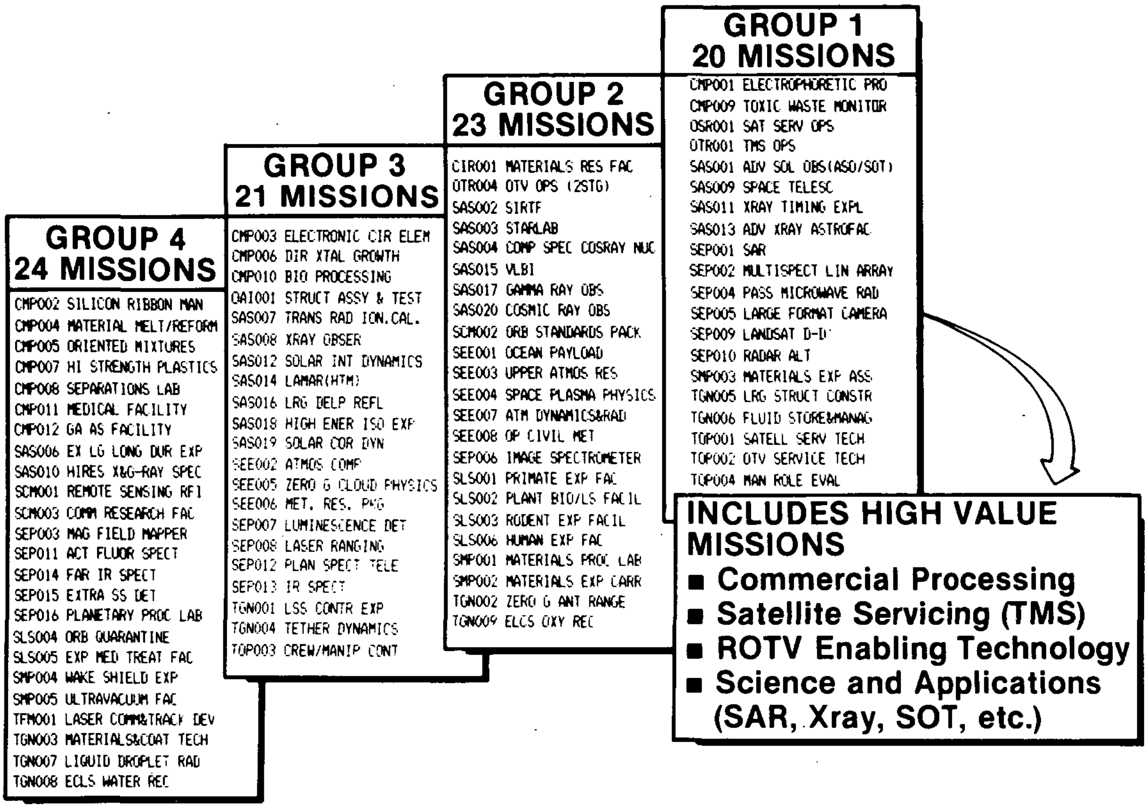


FIGURE 4-13.
PRIORITIZED MISSION MODEL

VGB558



requirements, observing the degree of mission accomplishment, and comparing this to the needed architecture and its cost. The cost was then compared to projected budgets available. Thus, in a budget-constrained program, the mission priority groups would be sequentially accommodated until a budget ceiling was reached. Those missions remaining would be deferred until they could be accommodated.

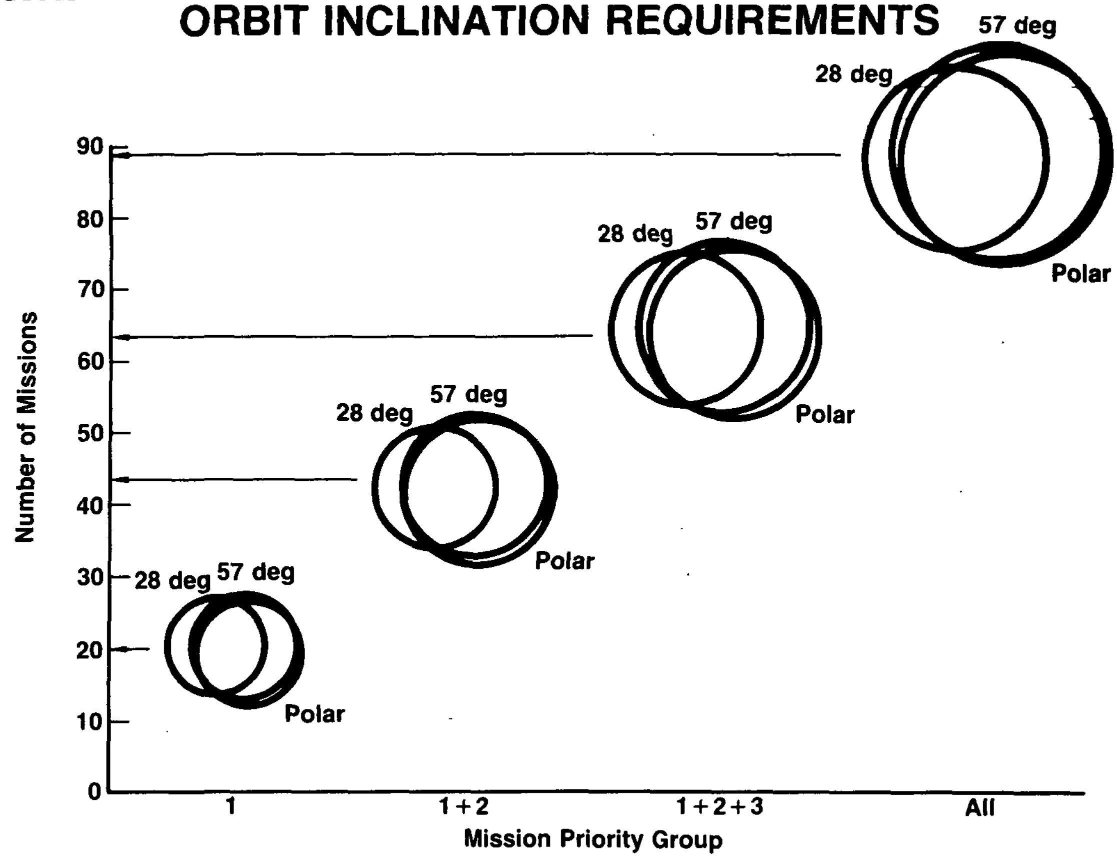
As programs mature, there will be shifts in emphasis and other factors that will affect the relative group priorities. The groups established for this study are certainly expected to reflect these adjustments in the future.

4.3 TIME-PHASED REQUIREMENTS--PRIORITIZED MISSIONS

The orbit inclination, mission accommodation, and utility resource sizing requirements were analyzed for the mission priority groups discussed previously. The orbit inclination requirements of various priority mission groupings are illustrated in Figure 4-14. The size of the intersecting circles is representative of the number of missions having that orbit

FIGURE 4-14.

ORBIT INCLINATION REQUIREMENTS



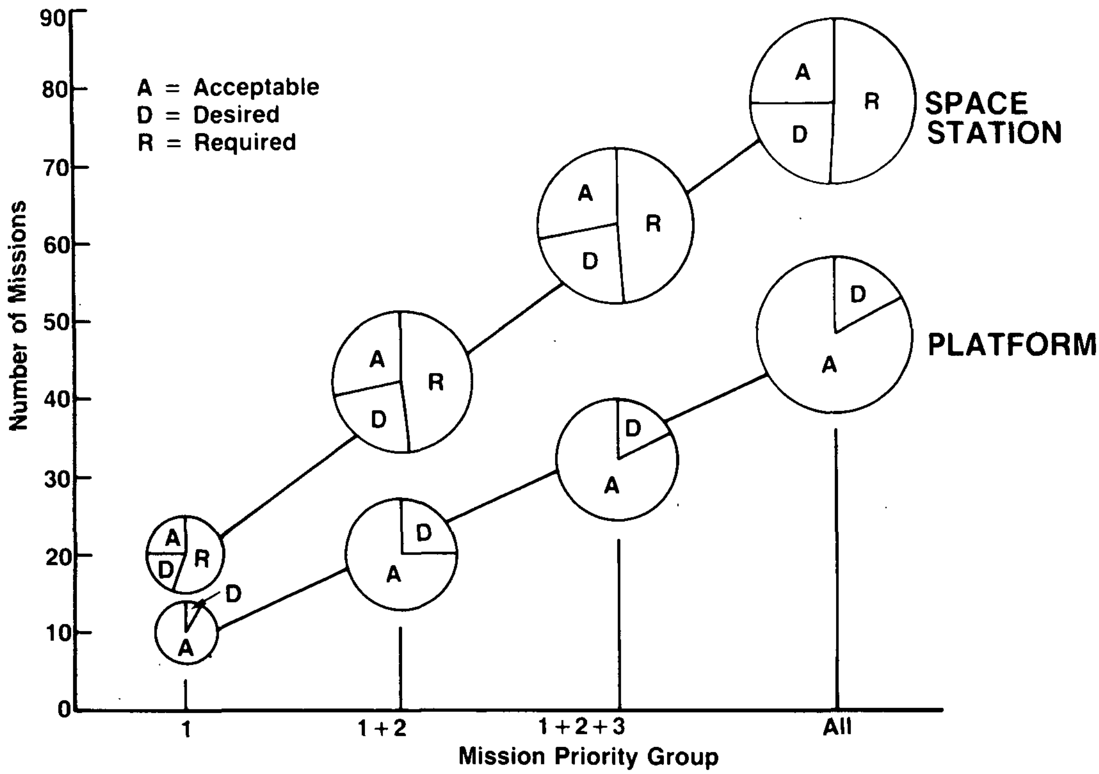
inclination requirement. The polar category includes the 90-deg-inclination and sun-synchronous orbit missions.

Of the 88 missions included in the circle set in the upper right of Figure 4-14, a single facility located in a 28.5-deg orbit would acceptably satisfy 61 of those missions. A single facility located in either 57-deg or 90-deg orbit would acceptably satisfy 73 and 72 missions respectively. Two facilities in separate locations increase the mission capture ratio as indicated earlier--84 missions for an architecture of a 28.5-deg-inclination space station and a polar-orbit platform. These capture ratios remain nearly constant through all the priority groups.

The facility requirements for accommodation of each priority group (Figure 4-15) are based on R (required), D (desirable), and A (acceptable). In the upper right circle, 42 missions require space station accommodation, 22 desire it, and 24 find it acceptable. The 42 missions requiring space station accommodation include the 36 shown in Figure 4-3 plus the 6 service missions.

FIGURE 4-15.
MISSION FACILITY REQUIREMENTS

VGB72(



Similarly, 9 missions were found to desire a space platform, and 38 would find it acceptable if there is no other solution. The ratios of accommodation needs hold through all the priority groups.

A space station in 28.5-deg orbit and a platform in polar orbit are needed to satisfy the mission requirements. The ability of this potential architecture to accommodate the prioritized mission model is shown in Figure 4-16. Each of the four missions not accommodated by the space station would be allocated to a dedicated satellite. The dashed line indicates the number of missions fully (100%) accommodated in each priority group (i.e., 15, 30, 48, and 67). Those remaining would be dispositioned to dedicated satellites (the four mentioned above) or to the space station or platform, thus being acceptably, but not fully, accommodated. The disposition of those 21 missions not fully accommodated by this architecture are displayed in Figure 4-7.

The time-phased requirements for the prioritized mission groups are presented in Figure 4-17. These total requirements are determined

FIGURE 4-16.
MISSION CAPTURE BY PRIORITY GROUP

VGB391

Space Station at 28.5 deg. Platform at High Inclination

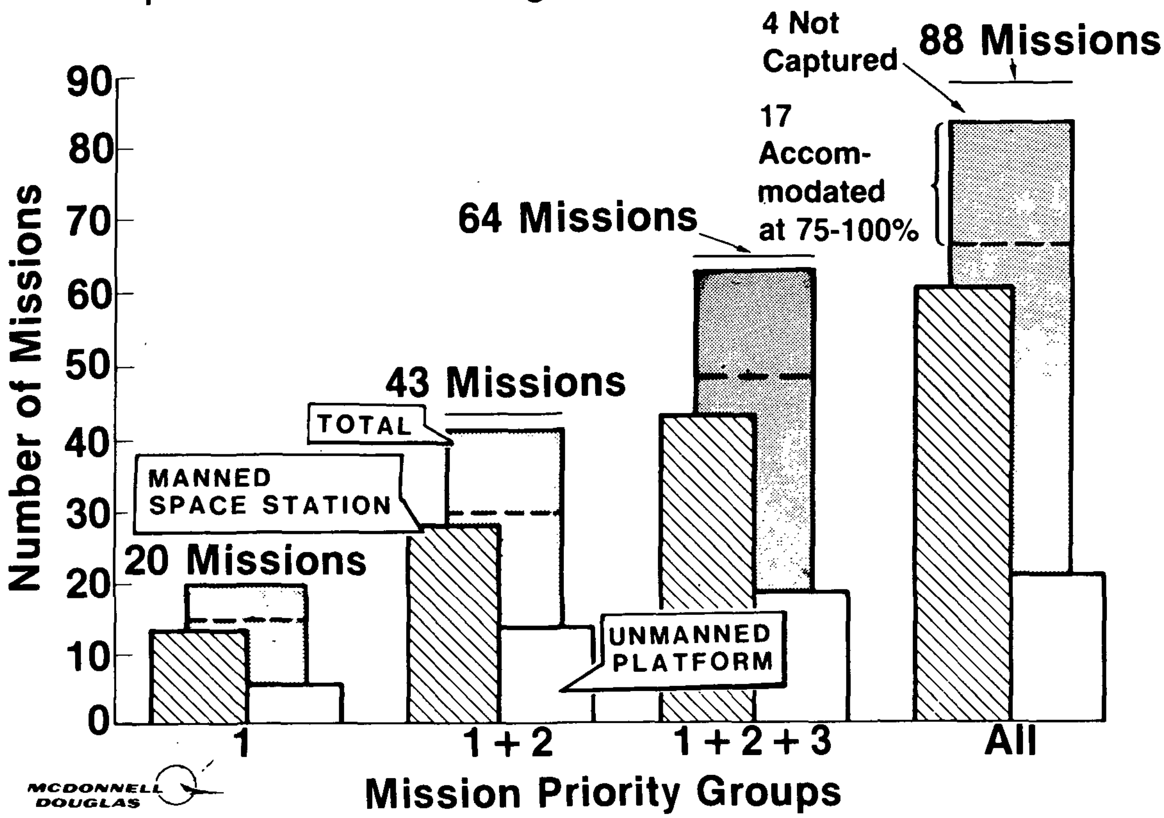
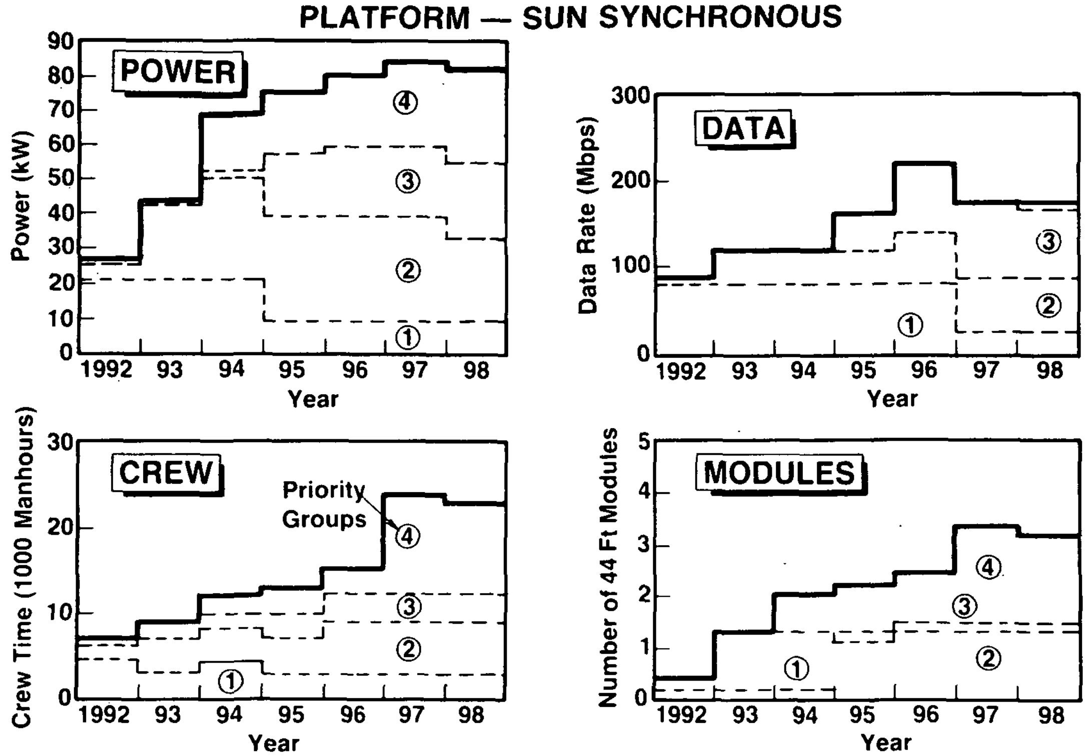


FIGURE 4-17.
TIME-PHASED PRIORITIZED MISSION REQUIREMENTS

VGB817

SPACE STATION — 28 deg
PLATFORM — SUN SYNCHRONOUS

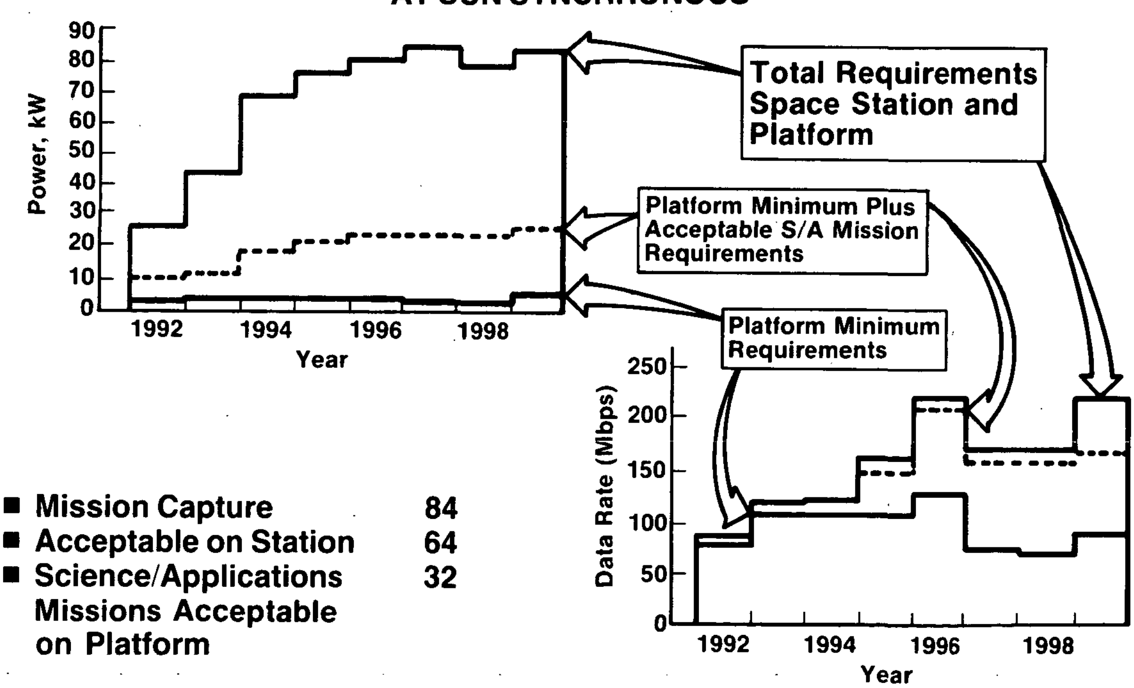


irrespective of the allocation between manned space station and platform, or the orbit location. For example, the mission payload power needs begin at 25 kW and increase by steps to about 80 kW. Facility power requirements must be added to these numbers for total power requirements. The mission payload crew size needed is initially about 7000 man-hours/year (approximately 3 men), growing to 23,000 man-hours/year (8 crewmen).

The allocation of power and data requirements between a space station and a platform is illustrated in Figure 4-18. The upper power requirement line corresponds to the total from Figure 4-17. The lower power line (2 kW) is the power required for missions needing a platform, leaving 23 to 78 kW needed for the space station. The intermediate dashed line is power required for those missions needing a platform plus that required for the Science and Applications missions that could well utilize it. This platform power requirement is about 20 kW, leaving 60 kW for the space station. Requirement allocations were given in this manner to the architectural option tasks for analysis. The corresponding data allocation shown in Figure 4-18 indicates that the 200-Mbps data rate required could be shifted from half on the platform and half on the space station to more on the platform than on the space station, if desired.

FIGURE 4-18.
TOTAL MISSION REQUIREMENTS
STATION AT 28.5°, PLATFORM AT SUN SYNCHRONOUS

VGB787



- Mission Capture 84
- Acceptable on Station 64
- Science/Applications Missions Acceptable on Platform 32

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Figure 4-19 shows the total requirements with a candidate architecture capability (cross-hatched area). The steps in capability correspond to these planned growth steps in the architecture:

1992	28.5-deg-inclination space station - 25 kW, 3 men (4 total)
1993	Sun-synchronous-orbit platform - 15 kW, 300 Mbps
1994	Expanded space station - 40 kW, 8 men (total)
1995	Platform at 28.5-deg inclination, 75 kW
1996	Add ROTV Capability to space station

Potential evolution would include:

1998	Expand sun-synchronous-orbit platform - 25 kW, 4 men, Platform at 57 deg

The schedule for this architecture is compatible with budget availability projections. This architecture provides sufficient resources for Priority 1, 2, and 3 missions except for small deficiencies in power and in pressurized modules for the first two years.

FIGURE 4-19.
TIME-PHASED PRIORITIZED MISSION REQUIREMENTS
SPACE STATION — 28 deg
PLATFORM — SUN SYNCHRONOUS

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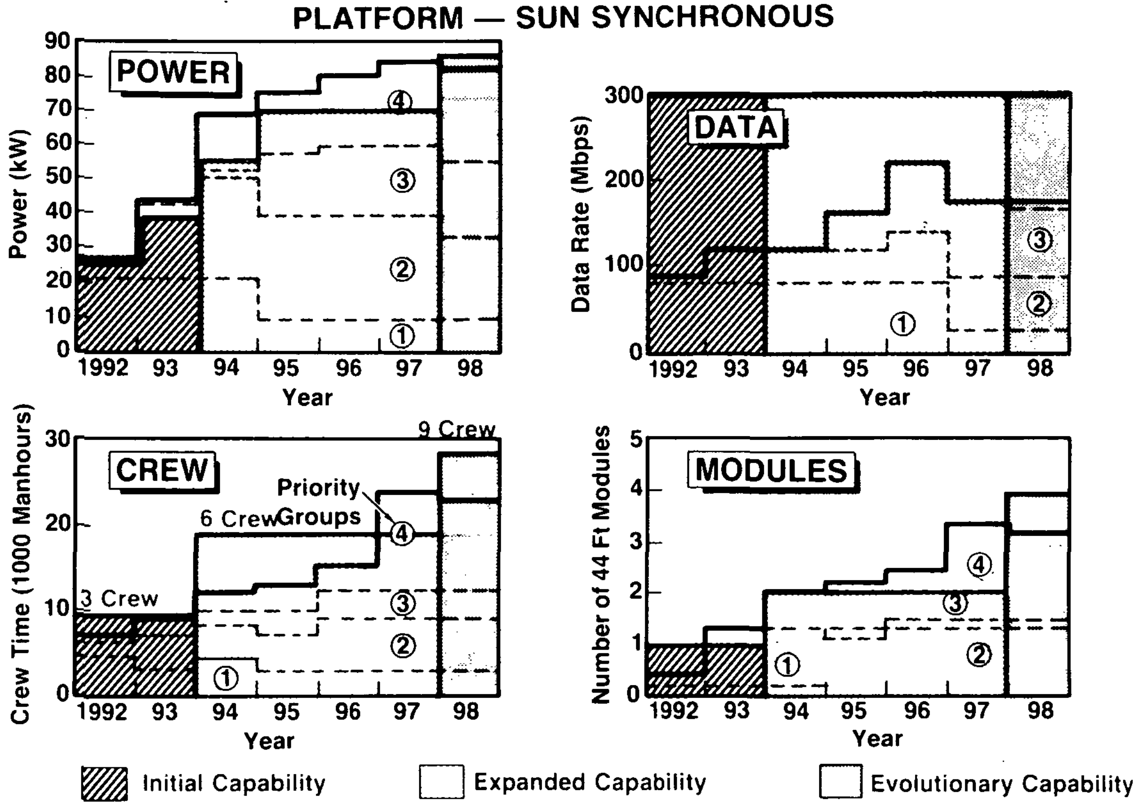
VGB817



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In the middle years of the decade, sufficient resources to capture all Priority 4 missions are not provided, since these are largely commercial missions that may or may not be required, depending on the success of earlier R&D activities. If needed, these large-scale production/manufacturing facilities are expected to operate at profit-making levels and to be privately financed. They can be accommodated on dedicated, separately funded facilities and can receive periodic servicing from the central space station.

A 300-Mbps data rate capability is provided for the entire time span in order to minimize the cost of down-linking the data via the TDRSS.

The evolutionary capability step provides the facilities and resources to accommodate all missions as they mature in the late 1990s.

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Appendix A
MISSION DATA BASE

The computerized mission data base generated in the study is shown in Figure A-1. The columns are defined as follows.

The six-place code (XYYNNN) indicates the following:

X - Category
YY - Subcategory
NNN - Number

The categories (X) are defined:

C - Commercial
O - Space Operations
S - Science and Applications
T - Technology Development

The subcategories (YY) are defined:

C-EO	Earth and Ocean Operations
-CM	Communications
-IR	Industrial Research
-MP	Materials Processing
O-A	Assembly
-SR	Service
-TR	Transportation
S-AS	Astrophysics
-CM	Communications
-EE	Environmental Observations

FIGURE A-1 (PAGE 1 OF 2)

SPACE STATION DATA BASE
MCDONNELL DOUGLAS ASTRONAUTICS HUNTINGTON BEACH
Apr 27, 1983

STATUS
O=operational
P=planned
C=candidate
I=opportunity

ACCOMMODATION
R=required S=supply
D=desired L=launch
A=acceptable M=maint/repair
B=assemb/build

VIEW
A=any M=multiple
E=earth S=solar
I=inertial V=velocity
Z=anti earth

LEGACY
S=spacelab
O=other legacy

CODE	NAME	SOURCE	STAT	DATE	DUR	INC DEG	INC MAX	INC MIN	ALT DES	ALT MAX	ALT MIN	STAT	SERV	PLAT	MOD	RACK	PAL	PORT	POWER	DATA	DUTY	POWER *DUTY	LMASS	EXPEND	G	CODE	VIEW	CREW SIZE	HRS DAY	DAYS YR	BEN	CONS	SAVE	RISK	BEN* CONS	SAV* RISK	PRIORTY	LEGACY
CIR001	MATERIALS RES FAC	MH	I	93	5	A	97	28	400	700	370	R			SM	0	.0	1	25000	10000	.20	5000	7500	10	-3	CIR001	A	2	2.00	60	23	7	21	27	161	567	2.00	
CMP001	ELECTROPHORETIC PRO	MS	C	90	5	A	99	0	400	700	370	A	A	M	SM	0	.0	1	15000	1000	.80	12000	7500	6000	-3	CMP001	A	1	2.00	50	29	9	21	30	261	630	1.00	O
CMP002	SILICON RIBBON MAN	MS	C	94	5	A	99	0	370	700	370	A	A		SM	0	.0	1	15000	1000	.80	12000	4500	542	-3	CMP002	A	1	2.00	50	22	7	22	22	154	484	4.00	
CMP003	ELECTRONIC CIR ELEM	MH	I	94	5	A	97	28	400	700	370	R	A	M		2	.0	0	1000	10	.20	200	470	50	-5	CMP003	A	1	4.00	70	19	6	24	22	114	528	3.00	
CMP004	MATERIAL MELT/REFORM	B	I	94	8	A	97	28	400	700	370	R			SM	0	.0	1	12000	1000	.20	2400	5000	1000	-5	CMP004	A	1	2.00	260	22	7	20	23	154	460	4.00	
CMP005	ORIENTED MIXTURES	B	I	95	5	A	97	28	400	700	370	D	A		SM	0	.0	1	1500	1000	.20	300	10000	1100	-3	CMP005	A	1	1.00	50	22	7	22	22	154	484	4.00	
CMP006	DIR XTAL GROWTH	B	C	95	8	A	97	28	400	700	370	D	A			2	.0	0	500	1000	.20	100	3000	2200	-5	CMP006	A	1	1.00	260	21	7	24	22	147	528	3.00	
CMP007	HI STRENGTH PLASTICS	B	C	97	8	A	97	28	400	700	370	D	A		LM	0	.0	1	4000	1000	.80	3200	15000	9999	-3	CMP007	A	1	1.00	260	22	7	22	23	154	506	4.00	
CMP008	SEPARATIONS LAB	B	C	94	6	A	97	28	400	700	370	R			SM	0	.0	1	15000	1000	.20	3000	7500	3000	-5	CMP008	A	1	8.00	200	23	8	18	25	184	450	4.00	
CMP009	TOXIC WASTE MONITOR	B	C	92	10	90	97	57	400	700	370	D	A	M		0	2.0	1	1000	12000	.30	300	1500	0	-3	CMP009	E	1	1.00	365	21	7	29	25	147	725	1.00	
CMP010	BIO PROCESSING	B	I	95	5	A	97	28	400	700	370	A	D		SM	0	.0	1	15000	1000	1.00	0	30000	500	-3	CMP010	A	1	.10	365	20	7	24	23	140	552	3.00	
CMP011	MEDICAL FACILITY	B	I	97	10	A	97	28	400	700	370	R			LM	0	.0	1	3000	5000	.20	600	20000	5000	-2	CMP011	A	3	8.00	365	19	6	18	21	114	378	4.00	
CMP012	GA AS FACILITY	B	I	95	5	A	97	28	370	700	370	R				2	.0	0	5000	1000	.20	1000	2500	0	-3	CMP012	A	2	4.00	50	20	6	22	23	120	506	4.00	
OAI001	STRUCT ASSY & TEST	MH	C	95	99	28	28	28	400	700	350	R		B		0	2.0	1	2000	700	.05	100	4000	0	0	OAI001	E	4	8.00	60	23	5	19	22	115	418	3.00	
OSR001	SAT SERV OPS	MH	P	92	99	28	28	28	400	700	350	R		S	SS	0	.1	1	2000	700	.01	20	1000	0	0	OSR001	A	2	10.00	10	21	6	23	24	126	552	1.00	
OTR001	TMS OPS	MH	P	92	99	28	28	28	400	700	350	R		L		0	.3	1	2000	350	.02	40	1300	650	0	OTR001	A	2	10.00	30	20	6	24	24	120	576	1.00	
OTR004	OTV OPS (2STG)	MH	C	96	99	28	28	28	400	700	350	R		L		0	.3	1	3000	500	.07	210	1400	13000	0	OTR004	A	3	10.00	60	22	5	22	20	110	440	2.00	
SAS001	ADV SOL OBS(ASO/SOT)	MH	A	90	10	97	97	28	400	600	350	D	A	S		0	3.0	1	5000	2500	1.00	5000	12500	0	0	SAS001	S	2	1.50	365	24	6	24	26	144	624	1.00	S
SAS002	SIRTF	MH	P	89	10	57	57	0	400	430	350	A	D	S		0	3.0	1	1300	1000	.50	650	8103	12	0	SAS002	I	2	8.00	3	23	5	25	24	115	600	2.00	S
SAS003	STARLAB	MH	P	90	10	28	28	28	400	800	350	A	D	M		0	2.0	1	2220	7000	.80	1776	3280	0	0	SAS003	I	2	.57	180	23	5	24	24	115	576	2.00	S
SAS004	COMP SPEC COSRAY NUC	MH	A	90	2	28	97	0	400	435	370	D	A			0	1.0	1	731	102	.98	716	3082	30	0	SAS004	Z	1	1.02	365	20	5	29	25	100	725	2.00	S
SAS006	EX LG LONG DUR EXP	MH	I	99	10	57	97	28	500	700	400			B		0	9.9	0	1	1	.00	0	99999	0	0	SAS006	A	2	11.00	1	21	3	28	21	63	588	4.00	
SAS007	TRANS RAD ION,CAL.	MH	C	90	2	28	98	28	400	900	300	D	A			0	1.0	1	60	2	.98	59	2000	0	0	SAS007	Z	1	1.02	365	19	3	30	21	57	630	3.00	S
SAS008	XRAY OBSER	MH	C	99	2	28	28	0	400	570	370	A	A	M		0	2.0	0	900	1000	.00	0	3550	0	0	SAS008	I	2	9.00	2	20	4	28	22	80	616	3.00	
SAS009	SPACE TELESC	MH	A	85	15	28	28	28	600	600	600			M	SS	0	4.0	0	2100	0	.00	0	11070	0	0	SAS009	I	2	8.00	2	24	6	24	28	144	672	1.00	
SAS010	HIRES X&G-RAY SPEC	MH	C	90	2	28	45	0	400	500	350	D	A	M		0	.5	1	530	35	.80	424	1668	10	0	SAS010	I	2	7.00	1	20	3	28	21	60	588	4.00	S
SAS011	XRAY TIMING EXPL	MH	A	89	5	28	45	0	400	600	300	A	A	M		0	2.0	1	600	1000	.80	480	1000	0	0	SAS011	I	2	2.00	1	19	5	30	23	95	690	1.00	O
SAS012	SOLAR INT DYNAMICS	MH	C	91	5	98	98	57	575	575	300	A	A	M		0	3.0	1	800	0	.99	792	2600	0	0	SAS012	S	2	3.00	1	19	4	27	23	76	621	3.00	O
SAS013	ADV XRAY ASTROFAC	MH	P	91	15	28	28	0	500	600	400			M		0	5.0	0	2000	0	.00	0	11000	0	0	SAS013	I	2	13.00	1	23	5	25	22	115	550	1.00	
SAS014	LAMAR(HTM)	MH	C	92	10	28	28	0	400	435	200	A	A	S		0	4.0	1	3400	130	.80	2720	9516	18	0	SAS014	I	2	13.00	1	22	4	24	21	88	504	3.00	S
SAS015	VLBI	MH	C	89	10	57	98	45	400	600	350	A	A	B		0	2.0	1	900	12000	.50	450	1354	0	0	SAS015	I	2	3.00	1	19	5	28	23	95	644	2.00	S
SAS016	LRG DELP REFL	MH	C	95	10	57	57	28	700	800	400			M		0	10.0	0	3000	0	.00	0	20500	0	0	SAS016	I	2	13.00	1	22	4	25	21	88	525	3.00	
SAS017	GAMMA RAY OBS	MH	A	88	5	28	28	28	400	400	400			M		0	5.0	0	2000	0	.00	0	11000	0	0	SAS017	I	2	13.00	1	21	6	24	24	126	576	2.00	
SAS018	HIGH ENER ISO EXP	MH	P	90	2	57	98	57	400	900	300	D	A			0	1.0	1	250	100	.98	245	2000	0	0	SAS018	Z	1	1.02	365	18	3	28	21	54	588	3.00	S
SAS019	SOLAR COR DYN	MH	P	93	2	A	97	28	400	900	300	A	A	M		0	3.0	1	1000	0	.50	500	3500	0	0	SAS019	S	2	3.00	1	18	4	30	21	72	630	3.00	O
SAS020	COSMIC RAY OBS	MH	C	98	5	57	97	57	400	400	400	D	A	S		0	5.0	1	2000	1000	.98	1960	18000	0	0	SAS020	Z	1	1.02	365	22	4	26	22	88	572	2.00	
SCM001	REMOTE SENSING RFI	MH	I	92	10	90	97	57	400	700	400	A	D	A		0	2.0	1	120	5	.05	6	2500	0	0	SCM001	M	2	3.00	1	18	4	28	21	72	588	4.00	
SCM002	ORB STANDARDS PACK	MH	I	90	10	57	97	57	400	700	350	D	A	A		0	.5	1	150	100	.05	8	100	0	0	SCM002	M	2	2.00	1	17	5	32	23	85	736	2.00	O
SCM003	COMM RESEARCH FAC	MH	I	92	15	57	97	57	400	999	300	R			SM	0	.0	1	5000	120000	.05	250	5000	0	0	SCM003	M	3	1.93	100	18	4	23	20	72	460	4.00	
SEE001	OCEAN PAYLOAD	MH	P	88	10	98	98	57	400	700	250	D	A			0	3.0	1	1000	120000	.20	200	10000	0	0	SEE001	E	3	.85	365	28	7	23	24	196	552	2.00	O
SEE002	ATMOS COMP	MH	P	90	3	90	98	57	600	780	400	D	A			0	2.0	1	4000	500	.01	40	2500	0	0	SEE002	M	2	11.00	4	21	5	25	21	105	525	3.00	
SEE003	UPPER ATMOS RES	MH	P	88	6	57	97	28	400	400	400	A	A	M		0	2.0	1	1339	18	.03	0	2367	0	0	SEE003	M	2	10.00	2	20	5	25	23	100	575	2.00	
SEE004	SPACE PLASMA PHYSICS	MH	P	88	5	90	97	57	400	500	250	A	D			0	1.0	1	2665	7510	.10	267	3183	0	0	SEE004	M	2	10.00	2	20	4	25	22	80	550	2.00	S
SEE005	ZERO G CLOUD PHYSICS	MH	P	92	5	A	97	0	400	600	350	R				3	.0	0	1560	500	.02	27	474	10	-5	SEE005	A	2	4.25	50	26	5	28	23	130	644	3.00	S
TOTALS ARE=																			166426	312763			374016															
NUMBER OF MISSIONS=	44																																					

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FIGURE A-1 (PAGE 2 OF 2)

SPACE STATION DATA BASE
MCDONNELL DOUGLAS ASTRONAUTICS HUNTINGTON BEACH
Apr 27, 1983

STATUS
O=operational
P=planned
C=candidate
I=opportunity

ACCOMMODATION
R=required S=supply
D=desired L=launch
A=acceptable M=maint/repair
B=assemb/build

VIEW
A=any M=multiple
E=earth S=solar
I=inertial V=velocity
Z=anti earth

LEGACY
S=spacelab
O=other legacy

CODE	NAME	SOURCE	STAT	DATE	DUR	INC DEG	INC MAX	INC MIN	ALT DES	ALT MAX	ALT MIN	STAT	PLAT	SERV	MOD	RACK	PAL	PORT	POWER	DATA	DUTY	POWER *DUTY	LMASS	EXPEND	G	CODE	VIEW	CREW SIZE	HRS DAY	DAYS YR	BEN	SAVE CONS	SAVE RISK	BEN* CONS	SAV* RISK	PRIORTY	LEGACY
SEE006	MET. RES. PKG	MH	P	92	10	57	97	57	500	800	400	R				0	1.0	1	1200	14	.20	240	1500	0	0	SEE006	E	3	.85	365	24	5	25	20	120	500	3.00	
SEE007	ATM DYNAMICS&RAD	MH	C	93	5	90	97	57	400	600	350	D	A	M		0	2.0	1	5000	2500	.10	500	2300	0	0	SEE007	M	2	13.00	1	25	5	25	22	125	550	2.00	S
SEE008	OP CIVIL MET	MN	O	88	10	98	98	98	833	870	830	A	A	M		0	1.0	1	415	2700	.99	411	700	0	0	SEE008	E	2	5.00	2	22	5	26	24	110	624	2.00	0
SEP001	SAR	MH	P	84	10	90	97	57	400	700	250	A	A	M		0	1.0	1	6486	120000	.20	1297	1876	0	0	SEP001	E	1	.51	360	26	6	25	25	156	625	1.00	0
SEP002	MULTISPECT LIN ARRAY	MH	P	89	5	98	98	57	705	705	400	D	A	S		0	.5	1	500	250000	.20	100	315	0	0	SEP002	E	1	.51	360	24	5	29	23	120	667	1.00	
SEP003	MAG FIELD MAPPER	MH	P	89	5	97	97	57	300	400	300		A	L		0	.5	1	120	230	.99	119	890	0	0	SEP003	E	2	13.00	1	17	3	30	24	51	720	4.00	
SEP004	PASS MICROWAVE RAD	MH	P	92	2	90	99	45	465	900	300	A	D			0	2.0	1	1200	200	.20	240	475	0	0	SEP004	E	2	3.00	1	22	5	29	22	110	638	1.00	
SEP005	LARGE FORMAT CAMERA	MH	P	90	5	90	97	57	250	500	180	R				0	.2	0	1	1	.20	0	70	0	0	SEP005	E	1	1.00	13	24	6	30	26	144	780	1.00	S
SEP006	IMAGE SPECTROMETER	MH	C	95	10	97	97	50	400	700	250	A	D	M		0	1.0	1	500	100000	.20	100	1938	0	0	SEP006	E	1	1.02	180	20	5	29	22	100	638	2.00	S
SEP007	LUMINESCENCE DET	MH	C	94	2	98	98	57	400	800	200	A	A			0	.1	0	150	2500	.20	30	60	0	0	SEP007	E	1	1.02	180	18	4	32	20	72	640	3.00	
SEP008	LASER RANGING	MH	P	89	15	90	97	57	400	600	300	D	A			0	.1	0	500	10	.20	100	185	0	0	SEP008	E	2	2.00	1	17	4	33	24	68	792	3.00	0
SEP009	LANDSAT D-D'	MH	O	82	15	98	98	98	705	705	705	A	A	M	SS	0	.0	1	750	0	.00	0	1600	0	0	SEP009	E	2	9.00	1	21	6	27	24	126	645	1.00	0
SEP010	RADAR ALT	MH	C	92	10	90	98	57	400	800	350	D	A	M		0	.2	0	100	2500	.20	20	100	0	0	SEP010	E	2	3.00	1	20	4	30	23	80	690	1.00	0
SEP011	ACT FLUOR SPECT	MH	C	95	10	90	98	57	400	500	250	D	A	M		0	1.0	1	2000	40000	.20	400	1900	0	0	SEP011	E	1	1.02	180	17	3	27	19	51	513	4.00	
SEP012	PLAN SPECT TELE	MN	I	90	10	A	98	28	400	999	250	D	A	M		0	2.0	1	3000	50000	.80	2400	3000	0	0	SEP012	I	2	.58	40	21	4	25	21	84	525	3.00	S
SEP013	IR SPECT	MN	I	91	10	A	98	28	400	999	250	D	A	S		0	2.0	1	3000	50000	.80	2400	8100	0	0	SEP013	I	2	.67	40	20	4	27	21	80	567	3.00	
SEP014	FAR IR SPECT	MH	I	95	10	28	57	28	700	999	400		A	M		0	10.0	1	3000	50000	.80	2400	20000	0	0	SEP014	I	2	.58	40	20	4	25	20	80	500	4.00	
SEP015	EXTRA SS DET	MH	I	92	20	28	28	28	500	600	400	D	A	M		0	2.0	1	3000	100	.80	2400	3000	0	0	SEP015	I	1	1.14	180	20	4	26	19	80	494	4.00	
SEP016	PLANETARY PROC LAB	MH	I	99	10	A	98	28	400	999	250	R			SM	0	.0	1	1000	500	1.00	1000	2500	1	0	SEP016	I	1	8.50	50	21	3	24	18	63	432	4.00	S
SLS001	PRIMATE EXP FAC	MH	P	95	10	A	98	28	400	98	350	R			LM	0	.0	1	4000	50	1.00	4000	1700	0	-3	SLS001	A	2	1.53	360	22	4	26	25	88	650	2.00	S
SLS002	PLANT BIO/LS FACIL	MH	P	92	10	A	97	28	400	700	350	R			SM	0	.0	1	4400	50	1.00	4400	1800	0	-5	SLS002	A	2	3.00	12	23	5	27	23	115	621	2.00	S
SLS003	RODENT EXP FACIL	MH	P	92	10	A	97	28	400	700	350	R			SM	0	.0	1	4200	50	1.00	4200	1600	0	-4	SLS003	A	3	.78	360	23	4	26	25	92	650	2.00	S
SLS004	ORB QUARANTINE	MH	I	99	1	28	57	28	400	700	350	R			SM	0	.0	1	1700	50	.10	170	6600	0	0	SLS004	A	1	4.00	30	16	3	26	20	48	520	4.00	
SLS005	EXP MED TREAT FAC	MH	I	95	10	A	97	28	400	700	350	R			SM	0	.0	1	1000	50	1.00	1000	3200	0	-3	SLS005	A	2	4.00	30	18	3	27	23	54	621	4.00	
SLS006	HUMAN EXP FAC	MH	P	92	10	A	97	28	400	700	350	R			SM	0	.0	1	2900	50	1.00	2900	3000	1	-3	SLS006	A	5	1.00	52	24	4	28	27	96	756	2.00	S
SMP001	MATERIALS PROC LAB	MH	C	92	10	A	97	28	400	999	300	R			LM	0	.0	1	12000	10	.50	6000	5500	0	0	SMP001	A	3	4.00	100	26	7	22	25	192	550	2.00	
SMP002	MATERIALS EXP CARR	MH	C	90	10	A	99	0	ANY	999	300	A	D			0	2.0	1	10000	500	.80	8000	13600	30	0	SMP002	A	2	6.50	26	25	7	23	25	175	575	2.00	
SMP003	MATERIALS EXP ASS	MH	P	88	10	A	99	0	ANY	999	300	A	A			0	1.0	1	4000	6	.50	2000	2215	0	-5	SMP003	A	2	6.50	26	23	7	27	24	161	648	1.00	0
SMP004	WAKE SHIELD EXP	MH	I	90	1	A	97	0	400	700	350	R				0	1.0	1	500	10	.20	100	600	0	0	SMP004	V	2	5.00	10	16	3	33	24	48	792	4.00	
SMP005	ULTRAVACUUM FAC	MH	I	95	10	A	97	0	400	700	350	D	A			0	1.5	1	3000	10	.50	1500	1200	0	0	SMP005	V	3	5.00	26	18	3	31	24	54	744	4.00	
TFM001	LASER COMM&TRACK DEV	MH	I	92	1	28	97	0	400	999	300	R				0	.5	1	1000	10	.05	50	200	0	0	TFM001	M	2	3.00	20	14	4	28	23	56	644	4.00	
TGN001	LSS CONTR EXP	MH	C	93	1	28	90	0	400	999	300	R				0	2.0	1	500	0	.02	10	600	0	0	TGN001	A	1	1.00	30	18	4	28	24	72	672	3.00	
TGN002	ZERO G ANT RANGE	MH	I	92	1	28	90	28	400	999	300	R				0	2.0	1	1000	1	.04	40	1000	0	0	TGN002	V	2	8.00	10	21	5	25	25	105	625	2.00	
TGN003	MATERIALS&COAT TECH	MH	I	92	5	28	97	28	400	600	300		D	M		0	1.0	1	100	0	.01	0	1400	0	0	TGN003	A	2	4.00	10	15	4	32	26	60	832	4.00	
TGN004	TETHER DYNAMICS	MH	C	94	1	28	97	0	400	600	300	R				0	.5	1	1000	0	.01	10	250	0	0	TGN004	E	2	4.00	30	18	4	31	24	72	744	3.00	
TGN005	LRG STRUCT CONSTR	MH	C	94	1	28	57	28	400	999	350	R				0	2.0	1	500	1	.03	15	600	0	0	TGN005	E	3	8.00	60	21	5	23	24	105	552	1.00	
TGN006	FLUID STORE&MANAG	MH	C	92	1	28	97	28	400	999	300	R				0	3.0	1	500	0	.02	10	9000	0	0	TGN006	A	1	4.00	30	17	4	28	24	68	672	1.00	
TGN007	LIQUID DROPLET RAD	MH	I	94	1	28	97	0	400	999	350	R				0	.5	1	200	0	.01	2	400	0	0	TGN007	A	1	4.00	30	15	4	32	23	60	736	4.00	
TGN008	ECLS WATER REC	MH	C	93	1	A	97	28	400	700	370	R				1	.0	0	150	10	.01	2	30	0	0	TGN008	A	1	.15	180	14	5	33	25	70	825	2.00	
TGN009	ELCS OXY REC	MH	C	93	1	A	97	28	400	700	370	R				2	.0	0	500	10	.01	5	100	0	0	TGN009	A	1	.14	180	18	5	29	22	90	638	2.00	
TOP001	SATELL SERV TECH	MH	P	92	1	28	90	28	400	999	300	R			SS	0	.0	1	1000	0	.05	50	500	0	0	TOP001	A	2	8.00	60	19	5	26	25	95	650	1.00	
TOP002	OTV SERVICE TECH	MH	P	92	1	28	90	28	400	999	300	R				0	3.0	1	1500	0	.05	75	500	0	0	TOP002	A	2	4.00	60	18	5	26	23	90	598	1.00	
TOP003	CREW/MANIP CONT	MH	C	93	1	A	97	28	400	700	370	R		L		1	1.0	1	150	10	.06	9	550	0	0	TOP003	A	2	4.00	60	18	4	29	23	72	667	3.00	
TOP004	MAN ROLE EVAL	MH	O	92	1	A	90	28	400	700	370	R				1	.0	0	50	5	.03	2	100	0	0	TOP004	A	1	1.00	260	22	5	30	26	119	780	1.00	
TOTALS ARE=																			87772	672138			106804															

NUMBER OF MISSIONS= 44

-EP	Earth and Planetary Exp.
-LS	Life Sciences
-MP	Materials

T-FM	Flight Missions
-GN	Generic
-OP	Operations
-PC	Basic Physics and Chemistry

Orbital inclinations are in degrees, with A standing for Any. Orbital altitudes are in kilometers. Mission accommodation codes for station, platform, and service are:

- R - Required as the only practical accommodation
- D - Desired as preferable to other options
- A - Acceptable but other options may be preferred
- U - Unacceptable
- S - Supply as the principal service mission
- M - Maintain or repair as the principal service mission
- B - Build or assemble as the principle service mission

Launch volume is indicated by equivalent Spacelab module, rack, and pallet codes:

- SM - Short Spacelab module
- LM - Long Spacelab module
- Rack - Equivalent number of single racks
- Pal - Equivalent number of Spacelab pallets

The entry under PORT indicates the number of attach ports required for accommodation on a space station or platform.

Operating power is indicated in watts and data rate in kilobits per second. The duty cycle represents the portion of time at the indicated power and data rate. The launch mass is in kilograms and, in the case of pressurized volume, represents only equipment mass. Expended mass is in kilograms per month.

Limiting acceleration requirements are indicated, where applicable. View direction codes are:

A	-	Any direction
E	-	Earth, either nadir or near nadir
I	-	Inertial or celestial
M	-	Multiple view directions
S	-	Solar
V	-	Along the space station velocity vector
Z	-	Zenith or anti-Earth

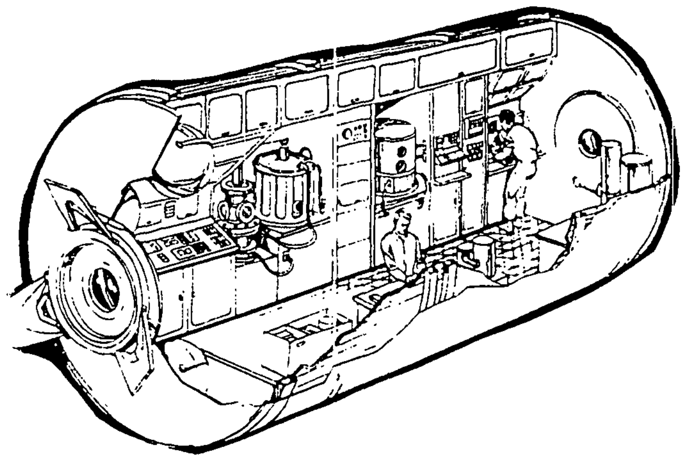
Crew requirements are given in days per year during which important activities occur. The average hours for each activity and crew size are given so that the product of days per year, hours per day, and crew size gives crew hours per year.

Rounded raw scores are shown for the MDAC mission advisory panel evaluations of the missions benefits, constituency, savings, and risk. All parameters are arranged so that larger values are good, i.e., a large number represents a low risk or a high benefit.

Priority is the final sorting into four priority groups. Legacy indicates which missions are derived from Spacelab (S) and other satellites or Orbiter flights (O).

The remaining pages of Appendix A are one-page synopses of each of the 88 missions. Where applicable, codes are consistent with those in the computer data base. The study disposition gives the IOC date in a budget-constrained model and the allocation to space station (28.5-deg orbit), platform (97-deg orbit), or dedicated satellites for the initial space station architecture.

CIR001 MATERIALS RESEARCH FACILITY



Characteristics

Commercial, Manned Laboratory

Fee for Use Materials Research

Secure CCTV Voice and Data Transmission

Considerations/Requirements

Disturbances Less Than 10^{-3}g

Class 10,000 Cleanroom Environment

Acceptable to Ultravacuum

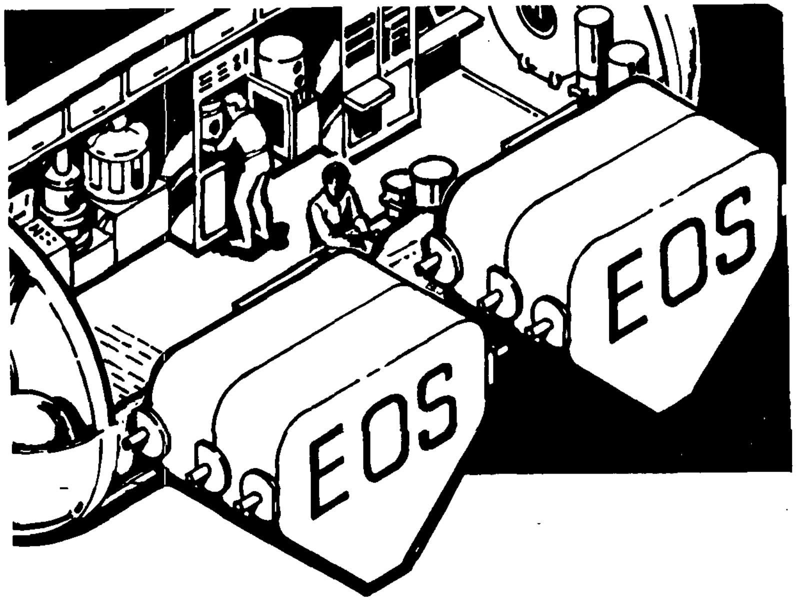
Temperature and Humidity Control

Mission Data

Status:	
Earliest Availability:	1993
Mass:	7500 kg
Preferred Orbit:	Any
Power:	25 kW Peak, 5 kW Average
Data Rate:	10 Mbps peak, 2 Mbps Average
Accommodation:	Station - R Platform - U Satellite - U
Crew Hours/ Operations Per Year:	Scientist/Observer - 600/300 Operator/Engineer - 600/300 Technician
Launch Volume:	Short Module (3 m)
Peak Rate Duty Cycle:	0.2
Priority Rating:	2
Study Disposition:	1993 IOC, Space Station (28.5°)

MCDONNELL DOUGLAS

CMP001 ELECTROPHORETIC PROCESSING FACILITY



Characteristics

Manned Commercial Facility

Separation of Biological Materials

Private CCTV Voice and Secure Data Transmission

Considerations/Requirements

Less than 10^{-3}g

Class 10,000 Cleanroom

Sea-Level Standard Atmosphere

Temperature and Humidity Control

Mission Data

Status:	
Earliest Availability:	1990
Mass:	7500 kg
Preferred Orbit:	Any
Power:	15 kW
Data Rate:	1 kbps
Accommodation:	Station - A Platform - A Satellite - A
Crew Hours/ Operations Per Year:	Scientist/Observer - 200/200 Operator/Engineer - 400/200 Technician
Launch Volume:	Short Module (3 m)
Peak Rate Duty Cycle:	0.8
Priority Rating:	1
Study Disposition:	1992 IOC, Space Station (28.5°)

CMP002 SILICON RIBBON MANUFACTURING

Characteristics

Manned or Man Tended Facility

Production of High Purity Silicon Crystals

Considerations/Requirements

Less than 10^{-3}g

Class 10,000 Cleanroom

Mission Data

Status:	
Earliest Availability:	1994
Mass:	4500 kg
Preferred Orbit:	Any
Power:	15 kW
Data Rate:	1 Mbps Peak, 10 kbps Average
Accommodation:	Station - A Platform - A Satellite - U
Crew Hours/ Operations Per Year:	Scientist/Observer - 0/0 Operator/Engineer - 0/50 Technician - 0/0
Launch Volume:	Short Module (3 m)
Peak Rate Duty Cycle:	0.8
Priority Rating:	4
Study Disposition:	Post 1997 IOC, Space Station (28.5°)

CMP003 ELECTRONIC CIRCUIT ELEMENTS

Characteristics

Dedicated Manned Facility

Production of Microcircuit Elements

Considerations/Requirements

Very Low Vibration Levels

Class 10,000 Cleanroom

Mission Data

Status:	
Earliest Availability:	1994
Mass:	470 kg
Preferred Orbit:	Any
Power:	1 kW Peak, 200 W Average
Data Rate:	10 kbps Peak, 2 kbps Average
Accommodation:	Station - R Platform - U Satellite - U
Crew Hours/ Operations Per Year:	Scientist/Observer Operator/Engineer - 560/70 Technician
Launch Volume:	2 Racks (6 m^3)
Peak Rate Duty Cycle:	0.2
Priority Rating:	3
Study Disposition:	1995 IOC, Space Station (28.5°)

MCDONNELL DOUGLAS

CMP004 MATERIAL MELTING/REFORMING

Characteristics

Manned, Commercial Facility
Melting and Regreezing to Enhance Properties of Materials such as Crystal Structure, Directional Properties, and Homogeneity.

Considerations/Requirements

Less than 10^{-3}
Low Vibration
Access to Space Vacuum
Inert, Clear Environment Capability

Mission Data

Status:	
Earliest Availability:	1994
Mass:	5000 kg
Preferred Orbit:	Any
Power:	12 kW Peak, 2.4 kW Average
Data Rate:	1 Mbps Peak, 200 kbps Average
Accommodation:	Station - R Platform - U Satellite - U
Crew Hours/ Operations Per Year:	Scientist/Observer Operator/Engineer 520/260 Technician
Launch Volume:	Short Module (3M)
Peak Rate Duty Cycle:	0.2
Priority Rating:	4
Study Disposition:	Post 1997 IOC, Space Station (28.5°)

MCDONNELL DOUGLAS

CMP005 HOMOGENEOUS AND ORIENTED MIXTURES

Characteristics

Manned or Man-Tended, Flexible Facility
Production of Homogeneous Mixtures, including Miscibility Gap Alloys, Pore Size Films and Polymers
Production of Directional, Metal and Fiber Matrix Materials.

Consideration/Requirements

Less than 10^{-3} g
Low Vibration and Disturbance

Mission Data

Status:	
Earliest Availability:	1995
Mass:	10,000 kg
Preferred Orbit:	Any
Power:	1.5 kW Peak, 300 W Average
Data Rate:	1 Mbps Peak, 200 kbps Average
Accommodation:	Station - D Platform - A Satellite - U
Crew Hours/ Operations Per Year:	Scientist/Observer Operator/Engineer 50/50 Technician
Launch Volume:	Short Module (3M)
Peak Rate Duty Cycle:	0.2
Priority Rating:	4
Study Disposition:	Post 1997 IOC, Space Station (28.5°)

CMP006 DIRECTIONAL CRYSTAL GROWTH

Characteristics

Manned or Man-Tended Commercial Facility
Directional Grown Crystals to Achieve Large Size, Uniformity Low Defect Anisotropy, and Other Unique Characteristics.

Considerations/Requirements

Less than 10^{-3} g
Containerless Processing Capability
Class 10,000 Clean Room
Access to Space Vacuum

Mission Data

Status:	
Earliest Availability:	1995
Mass:	1000 kg
Preferred Orbit:	Any
Power:	500W Peak, 100W Average
Data Rate:	1 Mbps Peak, 200 kbps Average
Accommodation:	Station - D Platform - A Satellite - U
Crew Hours/ Operations Per Year:	Scientist/Observer Operator/Engineer 260/260 Technician
Launch Volume:	2 Racks ($6M^3$)
Peak Rate Duty Cycle:	0.2
Priority Rating:	3
Study Disposition:	IOC, Space Station (28.5°)

MCDONNELL DOUGLAS

CMP007 HIGH STRENGTH PLASTICS

Characteristics

Manned Commercial Facility Producing
High Strength Plastics For Small Structures

Considerations/Requirements

10^{-3} g

Mission Data

Status:	
Earliest Availability:	1997
Mass:	15,000 kg
Preferred Orbit:	Any
Power:	4 kW
Data Rate:	1 Mbps
Accommodation:	Station - D Platform - A Satellite - U
Crew Hours/ Operations Per Year:	Scientist/Observer Operator/Engineer 260/260 Technician
Launch Volume:	Long Module (6M)
Peak Rate Duty Cycle:	0.8
Priority Rating:	4
Study Disposition:	Post 1997 IOC, Space Station (28.5°)

CMP008 SEPARATIONS LABORATORY

Characteristics

Multi Use Manned Separations Laboratory
Secure CCTV and Data

Considerations/Requirements

Less Than 10^{-3} g
Class 10,000 Clean

Mission Data

Status:	
Earliest Availability:	1994
Mass:	7500 kg
Preferred Orbit:	Any
Power:	15 kW Peak, 3 kW Average
Data Rate:	1 Mbps Peak, 200 kbps Average
Accommodation:	Station - R Platform - U Satellite - U
Crew Hours/ Operations Per Year:	Scientist/Observer Operator/Engineer 1600/200 Technician
Launch Volume:	Short Module (3M)
Peak Rate Duty Cycle:	0.2
Priority Rating:	4
Study Disposition:	Post 1997 IOC, Space Station (28.5°)

MCDONNELL DOUGLAS

CMP009 TOXIC WASTE MONITOR

Characteristics

Orbiting Surveillance of Appearance, Concentrations, and Migration of Toxic Materials in the Environment.

Considerations/Requirements

Earth View
Multispectral Observation
With Specific Signatures of Materials to be Monitored

Mission Data

Status:	
Earliest Availability:	1992
Mass:	1500 kg
Preferred Orbit:	400 km at 90°
Power:	1 kW Peak, 300W Average
Data Rate:	12 Mbps Peak, 3.6 Mbps Average
Accommodation:	Station - D Platform - A Satellite - A
Crew Hours/ Operations Per Year:	Scientist/Observer 365/365 Operator/Engineer Technician
Launch Volume:	2 Pallets
Peak Rate Duty Cycle:	0.3
Priority Rating:	1
Study Disposition:	1992 IOC, Space Station (28.5°)

MCDONNELL DOUGLAS

CMP010 BIOLOGICAL PROCESSING

Characteristics

Economical Facility Specializing in Biological Separation

Considerations/Requirements

Less Than 10^{-3} g

Mission Data

Status:	
Earliest Availability:	1995
Mass:	7,500 kg
Preferred Orbit:	Any
Power:	15 kW
Data Rate:	1 Mbps
Accommodation:	Station - A Platform - D Satellite - U
Crew Hours/ Operations Per Year:	Scientist/Observer 37/365 Operator/Engineer Technician
Launch Volume:	Short Module (3M)
Peak Rate Duty Cycle:	1.0
Priority Rating:	3
Study Disposition:	IOC, Space Station (28.5°)

CMP011 MEDICAL FACILITY

Characteristics

Medical Treatment Center Specializing in Areas Amenable to Zero g Environment

Considerations/Requirements

Cleanliness
Transient Crew Capability

Mission Data

Status:	
Earliest Availability:	1997
Mass:	20,000 kg
Preferred Orbit:	Any
Power:	3 kW
Data Rate:	50 Mbps Peak, 1 Mbps Average
Accommodation:	Station - R Platform - U Satellite - U
Crew Hours/ Operations Per Year:	Scientist/Observer - 2920/365 Operator/Engineer Technician
Launch Volume:	Long Module (6M)
Peak Rate Duty Cycle:	0.2
Priority Rating:	4
Study Disposition:	Post 1997 IOC, Space Station (28.5°)

MCDONNELL DOUGLAS

CMP012 GALLIUM ARSENIDE FACILITY

Mission Data

Status:	
Earliest Availability:	1995
Mass:	5000 kg
Preferred Orbit:	Any
Power:	5 kW Peak, 1 kW Average
Data Rate:	1 Mbps Peak, 200 kbps Average
Accommodation:	Station - R Platform - U Satellite - U
Crew Hours/ Operations Per Year:	Scientist/Observer 200/50 Operator/Engineer 200/50 Technician
Launch Volume:	2 Racks ($6M^3$)
Peak Rate Duty Cycle:	0.2
Priority Rating:	4
Study Disposition:	Post 1997 IOC, Space Station (28.5°)

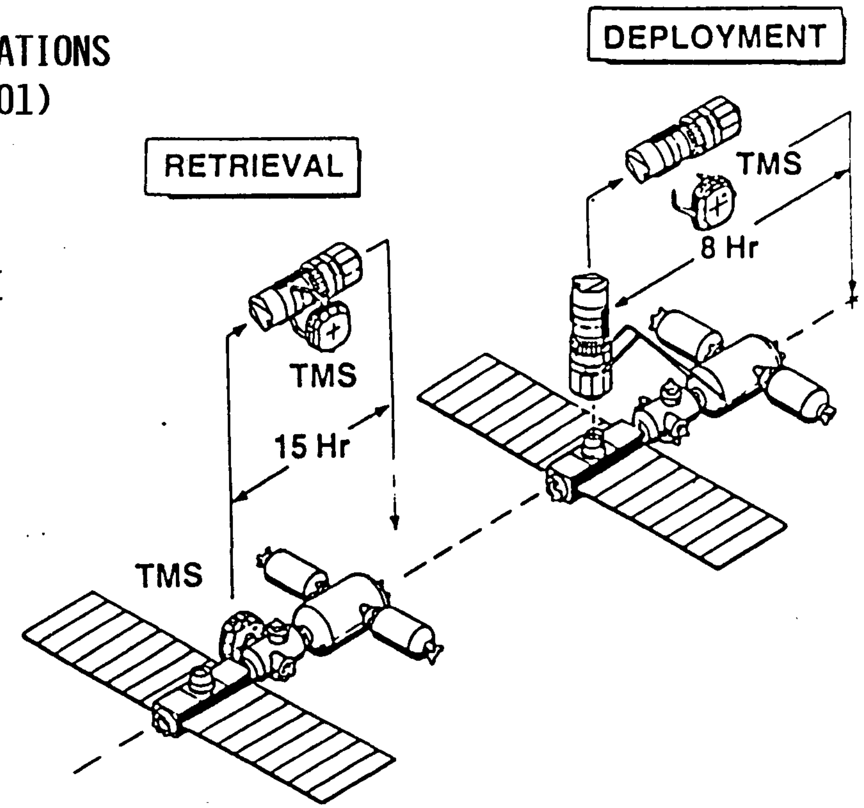
Characteristics

Manned, Commercial Facility
Owned or Leased by User
Private CCTV Voice and Secure Data Transmission

Considerations/Requirements

Disturbances Less than $10^{-3}g$
Class 10,000 Clean Room Environment
Temperature and Humidity Control

TMS OPERATIONS
(OTR001)



OBJECTIVE - PROVIDE TRANSPORT TO LOW ENERGY ORBITS

BENEFIT - ALLOWS THE FULL UTILIZATION OF SPACE STATION FOR DEPLOYMENT, RETRIEVAL & SERVICING OF DEDICATED SATELLITES. REDUCES STS TRANSPORTATION CHARGES & FREES ORBITER FOR OTHER MISSIONS.

CHARACTERISTICS - BIPROPELLANT, SPACE-BASED WITH GROWTH POTENTIAL FOR PLATFORM IN SITU SERVICING. CAPABLE OF ACCOMMODATING A VARIETY OF SATELLITES (COOPERATIVE & NON-COOPERATIVE)

SPACE FACILITY REQUIREMENTS

- PROPELLANT STORAGE - 6500 KG/YR
- VEHICLE/PAYLOAD INTEGRATION PLATFORM
- ELECTRIC POWER - 1.3 KW PEAK
- CONTROL CONSOLE
- REMOTE MANIPULATOR
- CREW EVA
- COMMUNICATION
- CHECKOUT EQUIPMENT

PRIORITY RATING - 1

STUDY DISPOSITION - 1994 IOC, SPACE STATION (28.5°)

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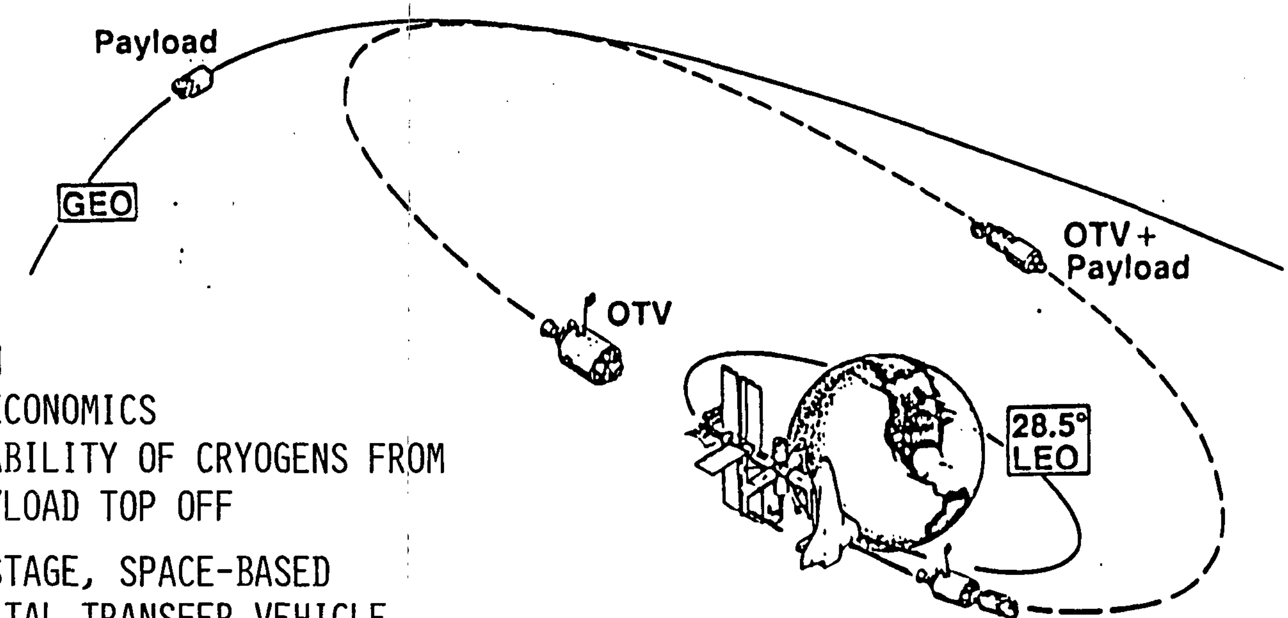
OTV OPERATIONS (2 STAGES)
(OTR004)



OBJECTIVE - PROVIDE THE CAPABILITY FOR SPACE-BASED TRANSPORT TO HIGH ENERGY ORBITS

BENEFIT - MINIMIZES TRANSPORTATION FUNCTION COST BY INCORPORATING ECONOMICS OF REUSABILITY & AVAILABILITY OF CRYOGENS FROM ET SCAVENGING & STS PAYLOAD TOP OFF

CHARACTERISTICS - TWO-STAGE, SPACE-BASED REUSABLE CRYOGENIC ORBITAL TRANSFER VEHICLE, CAPABLE OF DELIVERING MULTIPLE PAYLOADS ON ONE FLIGHT (4000KG TO GEOSYNCHRONOUS). COMMON STAGE DESIGN, 6250 KG PROPELLANT PER STAGE.

SPACE FACILITY REQUIREMENTS

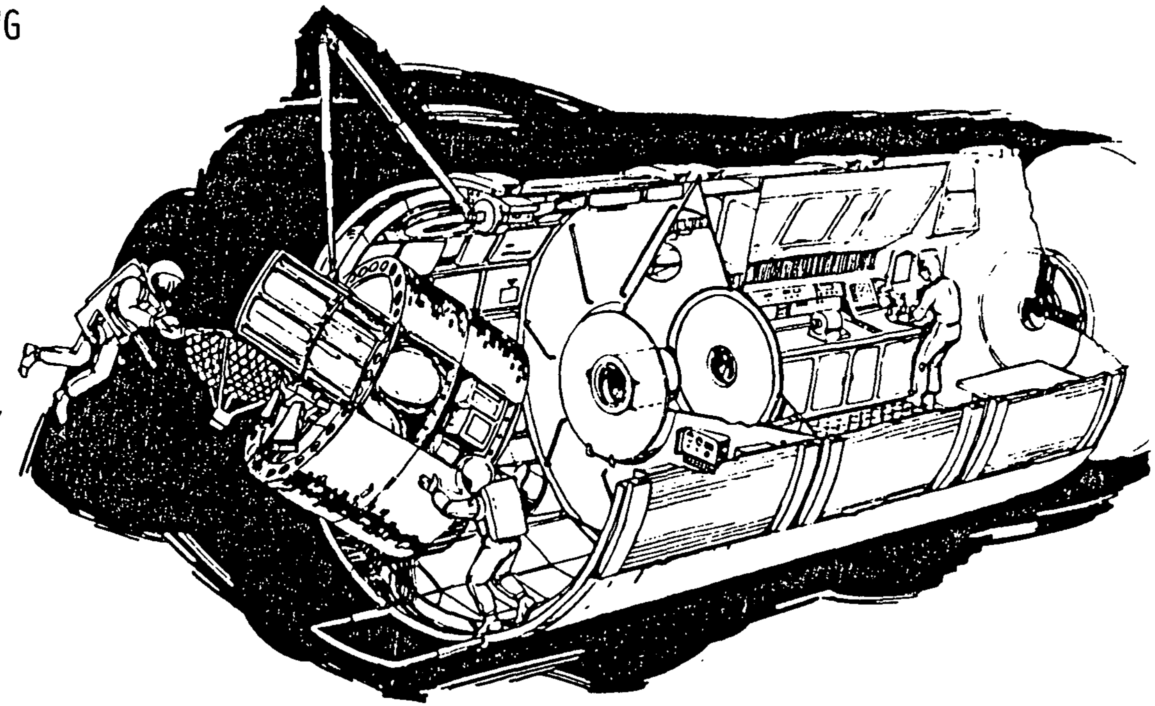
- PROPELLANT DEPOT - 27000 KG CAPACITY
- VEHICLE/PAYLOAD INTEGRATION PLATFORM
- ELECTRIC POWER - 2 KW PEAK
- CONTROL CONSOLE
- REMOTE MANIPULATOR
- CREW - 200 MAN HOURS/MISSION
- COMMUNICATION (HARDWIRE & RF LINK)
- CHECKOUT EQUIPMENT

PRIORITY RATING _ 2

STUDY DISPOSITION - 1996 IOC, SPACE STATION (28.5°)

SATELLITE SERVICING OPERATIONS
(OSR001)

OBJECTIVE - PROVIDE AN ORBITING BASE FOR PERFORMING FUELING, REPAIR, TEST, & CONFIGURATION CHANGES TO USER SATELLITES



BENEFIT - AVOIDS EARTH RETURN FOR SERVICING, FREES ORBITER FOR OTHER MISSIONS, REDUCES RESPONSE TIME TO FAILURES, INCREASE SATELLITE RELIABILITY & LONGEVITY

CHARACTERISTICS - CREW PARTICIPATION, REMOTE MANIPULATION, AUTONOMOUS DIAGNOSTICS & TESTING

SPACE FACILITY REQUIREMENTS

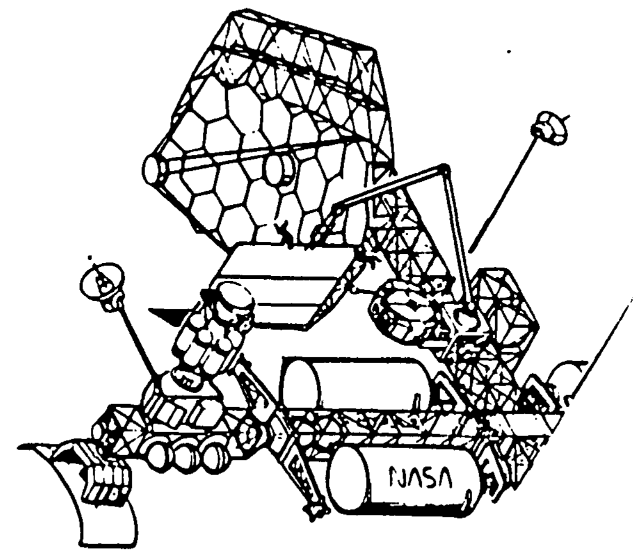
- DEDICATED VOLUME & SUPPORT EQUIPMENT & SERVICING TOOLS
- REMOTE MANIPULATOR(S)
- CONTROL STATION
- FLUIDS TO BE TRANSFERRED
- STORAGE FOR ORUs
- CREW EVA
- COMMUNICATION & VIDEO COVERAGE
- ELECTRIC POWER

PRIORITY RATING - 1

STUDY DISPOSITION - 1992 IOC, SPACE STATION (28.5°)

MCDONNELL DOUGLAS

LARGE STRUCTURE ASSEMBLY AND TEST
(OAI001)



OBJECTIVE - PROVIDE AN ORBITING BASE FOR CONSTRUCTING & TESTING LARGE STRUCTURES TO BE DEPLOYED IN SPACE

BENEFIT - ELIMINATES PACKAGING CONSTRAINTS PLACED BY THE STS. ASSURES PROPER ALIGNMENTS PRIOR TO SATELLITE DEPLOYMENT

CHARACTERISTICS - CREW PARTICIPATION, REMOTE MANIPULATION, AUTONOMOUS OPERATIONS

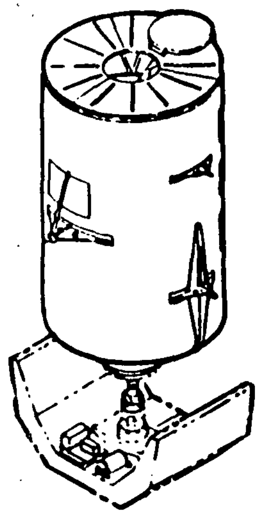
SPACE FACILITY REQUIREMENTS

- CREW EVA
- COMMUNICATION & VIDEO COVERAGE
- TEST EQUIPMENT & SERVICING TOOLS
- ASSEMBLY PLATFORM
- REMOTE MANIPULATORS
- ALIGNMENT FIXTURES
- CONTROL CONSOLE

PRIORITY - 4

STUDY DISPOSITION - 1994 IOC, SPACE STATION (28.5°)

Table A-1 SAS001 Advanced Solar Observatory (ASO)
(Includes SOT, SSXT and Others)



Characteristics

High Resolution Solar Observation

Near IR Through Hard x-ray

Growth Version of SOT

Considerations/Requirements

Solar View

0.1 Arc Sec Stability or 15 Min.

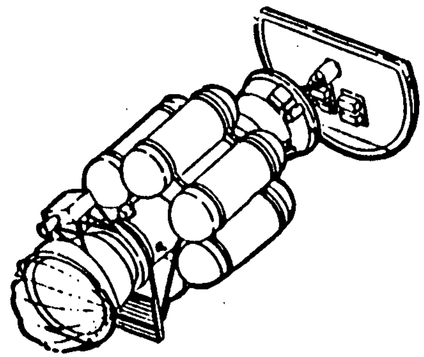
High Data Rate Operation ~50 Times per Year

Manned Involvement Highly Desirable

Mission Data

Status:	Approved, Spacelab, in ϕB
Earliest Availability:	1990
Mass:	12,500 kg
Preferred Orbit:	S.S. at Terminator
Power:	5 kW
Data Rate:	50 Mbps Peak, 2.5 Mbps Avg.
Accommodation:	Station - D Platform - A Satellite - A
Crew Hours/ Operations Per Year:	Scientist/Observer - 730/730 Operator/Engineer - 360/360 Technician - 56/2.4
Launch Volume:	3 Pallets (9 m)
Peak Rate Duty Cycle:	0.05
Priority Rating:	1
Study Disposition:	1992 IOC, Space Station (28.5°)

Table A-2 SAS002 Shuttle Infrared Telescope Facility (SIRTF)



Characteristics

Astronomical Telescope

Near to Far IR Spectroscopy

Cryo-Cooled Optics and Detectors

Considerations/Requirements

Inertial View

Cryogen Resupply

Optics Contamination

1 - 2 Arc Sec Stability, 20 Min.

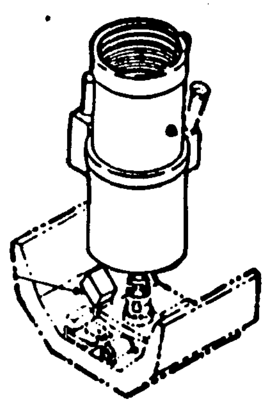
90° Solar Avoidance

60° Earth, Moon and Structure Avoidance

Mission Data

Status:	Planned, Spacelab
Earliest Availability:	1989
Mass:	8100 kg
Preferred Orbit:	400 km, 57°
Power:	1.3 kW
Data Rate:	1 Mbps Peak, 500 kbps Avg.
Accommodation:	Station - A Platform - D Satellite - A
Crew Hours/ Operations Per Year:	Scientist/Observer - 0 Operator/Engineer - 0 Technician - 46/2.4
Launch Volume:	3 Pallets (9 m)
Peak Rate Duty Cycle:	0.5
Priority Rating:	2
Study Disposition:	1993 IOC, Space Station (28.5°)

Table A-3 SAS003 Starlab



Considerations

1 m Class, Visible to UV Telescope

Wide Field of View Complement to ST

Considerations/Requirements

Inertial View

10 Arc Sec Stability Pointing Mount Over 30 Min.

Image Motion Compensation to <1 Arc Sec.

Condensation on Optics

Sensitive to UV Scattering in 1.6° FOV

Mission Data

Status:	Planned/Spacelab
Earliest Availability:	1990
Mass:	3280 kg
Preferred Orbit:	400 km at 28°
Power:	2.2 kW
Data Rate:	7 Mbps
Accommodation:	Station - A Platform - D Satellite - A
Crew Hours/ Operations Per Year:	Scientist/Observer - 0 Operator/Engineer - 180/180 Technician - 26/0.4
Launch Volume:	2 Pallets (6 m)
Peak Rate Duty Cycle:	0.8
Priority Rating:	2
Study Disposition:	1992 IOC, Space Station (28.5°)

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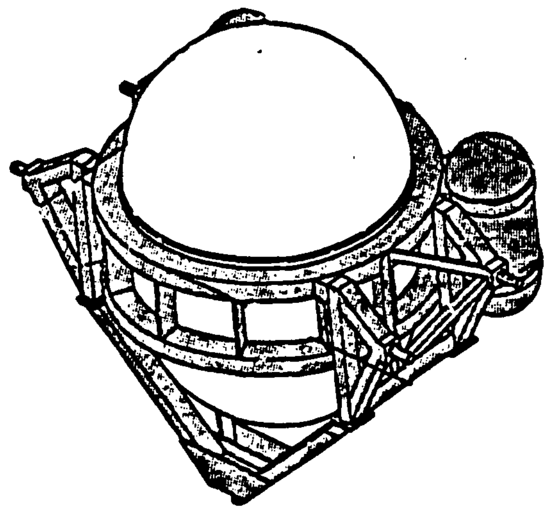
Table A-4 SAS004 Elemental Composition and Energy Spectra of Cosmic Ray Nuclei (SCRN)



Characteristics

Spectrum of Abundant Cosmic Ray Elements

Energies Above 1 Tev

Considerations/Requirements

Anti-Earth View

Avoid Radiation Belts and South Atlantic Anomaly

2 - 15 to 30 Min. Calibrations per Day

Vents He, Xe, CH_4 and Ne, CO_2

Mission Data

Status:	Spacelab, ϕA Completed
Earliest Availability:	1990
Mass:	3082 kg
Preferred Orbit:	400 km at 28°
Power:	731 W
Data Rate:	102 kbps
Accommodation:	Station - D Platform - A Satellite- U
Crew Hours/ Operations Per Year:	Scientist/Observer - 0 Operator/Engineer - 0 Technician - 372/730
Launch Volume:	1 Pallet (3 m)
Peak Rate Duty Cycle:	0.98
Priority Rating:	2
Study Disposition:	1992 IOC, Space Station (28.5°)

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Table A-5 SAS006 Extra Large Long Duration Exposure Facility (XLLDEF)

Characteristics

Very Large, Plastic Cosmic Ray Detector

On Orbit Assembly, Disassembly

Considerations/Requirements

Anti-Earth View

Inclination $\geq 57°$

Up to 1 km^2 Detector Area.

Two Years On Orbit.

Mission Data

Status:	
Earliest Availability:	Late 1990s
Mass:	TBD
Preferred Orbit:	500 km at - 80°
Power:	Low
Data Rate:	Low
Accommodation:	Station - U Platform - U Satellite - R
Crew Hours/ Operations Per Year:	Scientist/Observer - 0 Operator/Engineer - 0 Technician - 22/0.5
Launch Volume:	TBD
Peak Rate Duty Cycle:	1.0
Priority Rating:	4
Study Disposition:	Post 1997 IOC, Dedicated Satellite

Table A-6 SAS007 Transition Radiation and Ionization Calorimeter (TRIC)

Characteristics

Electrons, Protons and Helium Nuclei

Energies Up to 100 TeV

Considerations

Anti-Earth View

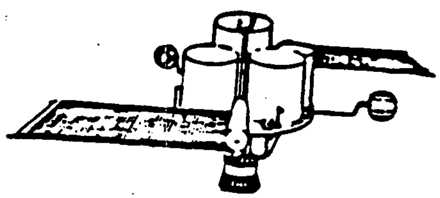
Vents He, Xe, CH_4 and Ne, CO_2.

Mission Data

Status:	Spacelab 2 Instrument
Earliest Availability:	1984
Mass:	2000 kg
Preferred Orbit:	Any
Power:	60W
Data Rate:	2 kbps
Accommodation:	Station - D Platform - A Satellite - U
Crew Hours/ Operations Per Year:	Scientist/Observer - 0 Operator/Engineer - 0 Technician - 372/730
Launch Volume:	1 Pallet (3 m)
Peak Rate Duty Cycle:	0.98
Priority Rating:	3
Study Disposition:	1992 IOC, Space Station (28.5)

MCDONNELL DOUGLAS

Table A-7 SAS008 X-Ray Observatory (XRO)



Characteristics

Astronomical Observatory

X-Ray Imaging, Spectroscopy, Polarity

X-Ray Background Measurement

Considerations

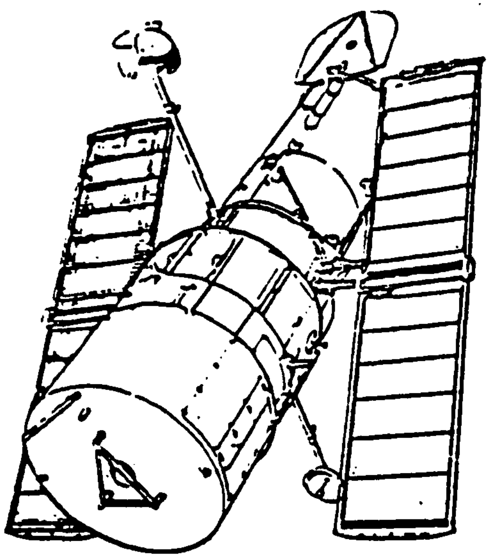
Inertial View

Annual Cryogen Replacement Assumed.

Mission Data

Status:	Candidate
Earliest Availability:	Late 1990s
Mass:	3550 kg
Preferred Orbit:	400 km, 28°
Power:	900 W
Data Rate:	1 Mbps
Accommodation:	Station - A Platform - A Satellite - D
Crew Hours/ Operations Per Year:	Scientist/Observer - 0 Operator/Engineer - 0 Technician - 35/0.4
Launch Volume:	2 Pallets (6 m)
Peak Rate Duty Cycle:	0.8
Priority Rating:	3
Study Disposition:	Post 1997 IOC, Dedicated Satellite (28.5°) Service From Space Station

Table A-8 SAS009 Space Telescope (ST)



Characteristics

Space Station Service Mission

Astronomical Observatory, Near IR Through UV

2.4 M Optics

Considerations

Inertial View

Maintenance Every 2-1/2 Years

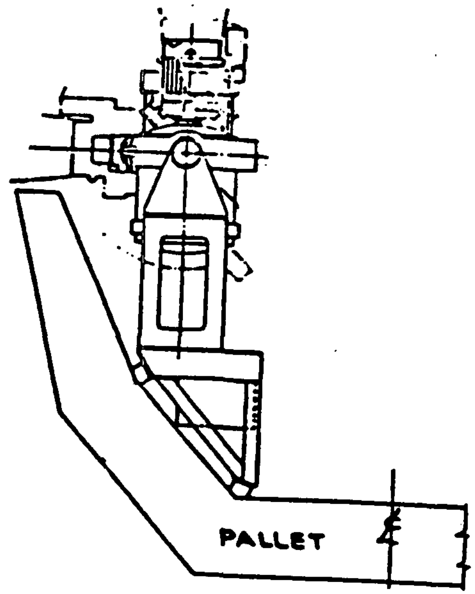
Refurbishment Every 5 Years

On Orbit Servicing Desired.

Mission Data

Status:	Fabrication
Earliest Availability:	1985
Mass:	11,000 kg
Preferred Orbit:	600 km, 28°
Power:	2.1 kW
Data Rate:	
Accommodation:	Station - U Platform - U Satellite - R
Crew Hours/ Operations Per Year:	Scientist/Observer - 0 Operator/Engineer - 0 Technician - 31/0.4
Launch Volume:	4 Pallets (12 m)
Peak Rate Duty Cycle:	0.8
Priority Rating:	1
Study Disposition:	1985 IOC, Dedicated Satellite (28.5°) Service From Space Station

Table A-9 SAS010 High Resolution and X and γ Ray Spectrometer (Hrs)



Characteristics

100 KeV to 10 MeV Spectroscopy

Considerations

Inertial View

Cryogen Replacement Required 6 - 12 Month Intervals.

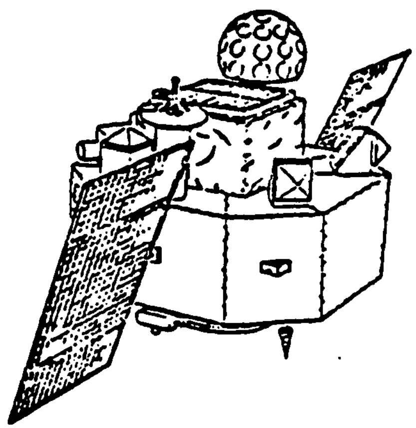
Optical Surfaces Subject to Contamination.

36 Arc Second Stability.

Mission Data

Status:	Spacelab Derivations
Earliest Availability:	1990
Mass:	1668 kg
Preferred Orbit:	400 km, 28°
Power:	530 W
Data Rate:	35 kbps
Accommodation:	Station - D Platform - D Satellite - A
Crew Hours/ Operations Per Year:	Scientist/Observer - 0 Operator/Engineer - 0 Technician - 13/0.4
Launch Volume:	1/2 Pallet (∼1.5 m Equivalent)
Peak Rate Duty Cycle:	0.8
Priority Rating:	4
Study Disposition:	Post 1997 IOC, Space Station (28.5°)

Table A-10 SAS011 X-Ray Timing Explorer



Characteristics

Dedicated Explorer Class Satellite

Temporal Variation of X-Ray Emitting Objects.

Considerations

Inertial View

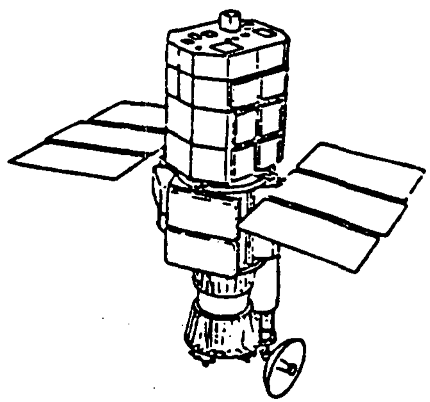
Shuttle Retrieval Planned.

Could Be Relaunched With Space Station if Extended Need Exists.

Mission Data

Status:	Planned
Earliest Availability:	1992 (Relaunch)
Mass:	1000 kg
Preferred Orbit:	400 km, 28°
Power:	600 W
Data Rate:	1 Mbps
Accommodation:	Station - A Platform - A Satellite - A
Crew Hours/ Operations Per Year:	Scientist/Observer - 0 Operator/Engineer - 0 Technician - 5/0.4
Launch Volume:	2 Pallets (6 m)
Peak Rate Duty Cycle:	0.8
Priority Rating:	1
Study Disposition:	1993 IOC, Space Station (28.5°)

Table A-11 SAS012 Solar Interior Dynamics Mission (SIDM)



Characteristics

Solar Observatory

Considerations

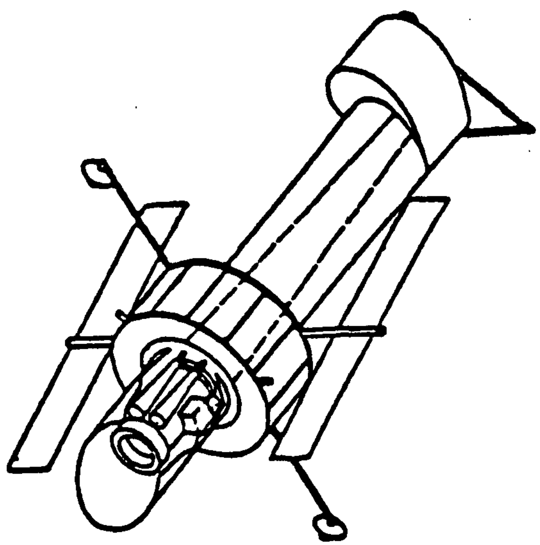
Solar View

Life Extension Beyond 2 Years Possible by Retrieval or On Orbit Service.

Mission Data

Status:	Candidate
Earliest Availability:	1991
Mass:	2600 kg
Preferred Orbit:	S.S. Terminator
Power:	800 W
Data Rate:	
Accommodation:	Station - A Platform - A Satellite - ~~D~~
Crew Hours/ Operations Per Year:	Scientist/Observer - 0 Operator/Engineer - 0 Technician - 6/0.5
Launch Volume:	3 Pallets (9 m)
Peak Rate Duty Cycle:	0.95
Priority Rating:	3
Study Disposition:	1991 IOC, Dedicated Satellite (97°)

Table A-12 SAS013 Advanced X-Ray Astrophysics Facility (AXAF)



Characteristics

Space Station Service Mission

Astronomical Observatory, X-Rays

Considerations

Inertial View

On Orbit Maintenance Estimated at Every 2.5 Years.

Mission Data

Status:	Planned
Earliest Availability:	1991
Mass:	11,000 kg
Preferred Orbit:	500 km, 28°
Power:	2 kW
Data Rate:	
Accommodation:	Station - U Platform - U Satellite - R
Crew Hours/ Operations Per Year:	Scientist/Observer - 0 Operator/Engineer - 0 Technician - 26/0.4
Launch Volume:	5 Pallets (15 m)
Peak Rate Duty Cycle:	0.8
Priority Rating:	1
Study Disposition:	1991 IOC, Dedicated Satellite (28.5°) Service From Space Station

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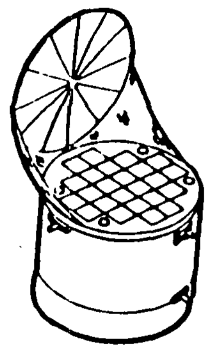
Table A-13 SAS014 High Throughput Mission (HTM) (LAMAR)



Characteristics

Multireflector X-Ray Observatory

Faint or Rapidly Varying Sources

Potential Orbital Assembly Mission

Considerations

Xe, CH_4 Emission.

3 Year Resupply of Gas.

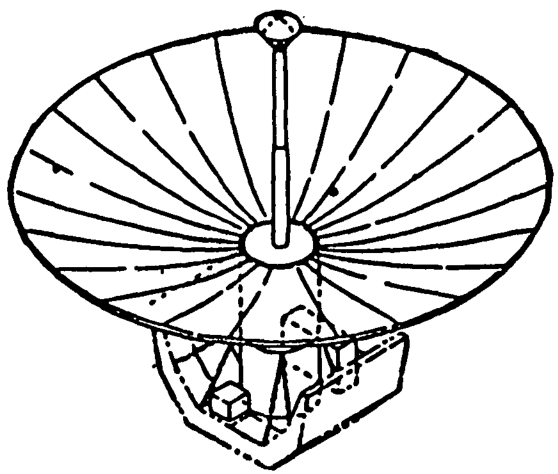
10 Arc Sec. Stability.

Mission Data

Status:	Candidate, Spacelab Derivative
Earliest Availability:	1992
Mass:	9516
Preferred Orbit:	400 km, 28°
Power:	3.4 kW
Data Rate:	130 kbps
Accommodation:	Station - A Platform - A Satellite - D
Crew Hours/ Operations Per Year:	Scientist/Observer - 0 Operator/Engineer - 0 Technician - 26/0.4
Launch Volume:	4 Pallets (12 m)
Peak Rate Duty Cycle:	0.8
Priority Rating:	3
Study Disposition:	1996 IOC, Dedicated Satellite (28.5°) Service From Space Station

MCDONNELL DOUGLAS

Table A-14 SAS015 Very Long Baseline Interferometry Observatory (VLBI)



Characteristics

15 to 60 m Radio Telescope.

Use With Ground Stations for RF Interferometry

Considerations

Inertial View

Large Antenna May Screen Celestial View From Space Station or Platform.

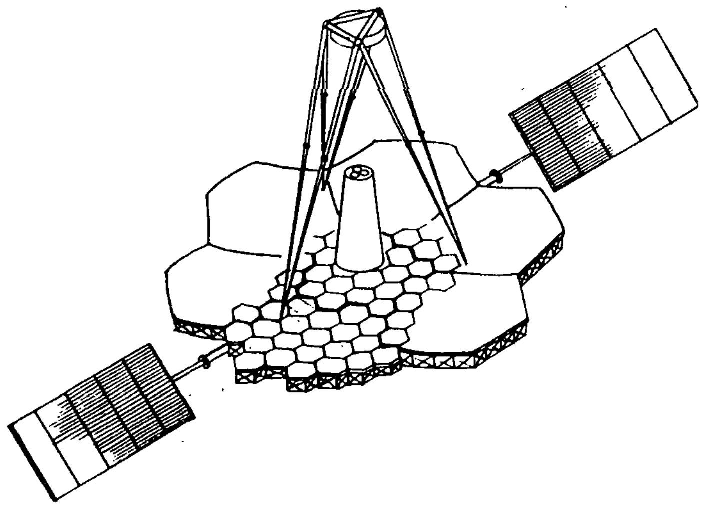
Subject to RF Interference

Mission Data

Status:	Candidate, Spacelab Derivative
Earliest Availability:	1989
Mass:	1354 kg
Preferred Orbit:	400 km, 57°
Power:	900 W Peak, 450 W Avg.
Data Rate:	12 Mbps Peak, 6 Mbps Avg.
Accommodation:	Station - A Platform - A Satellite - A
Crew Hours/ Operations Per Year:	Scientist/Observer - 0 Operator/Engineer - 0 Technician - 6/0.4
Launch Volume:	2 Pallets (6 m)
Peak Rate Duty Cycle:	0.5
Priority Rating:	2
Study Disposition:	1993 IOC, Dedicated Satellite (57°)

MCDONNELL DOUGLAS

Table A-15 SAS016 Large Deployable Reflector (LDR)



Characteristics

IR Astronomical Observatory

Microwave to Near IR
Orbital Assembly Desirable
Space Station Service Mission

Considerations

Inertial View

On Orbit Assembly Highly Desirable.

Optics Susceptible to Contamination.

Alignment of Segmented Optics.

Focal Plane Optics

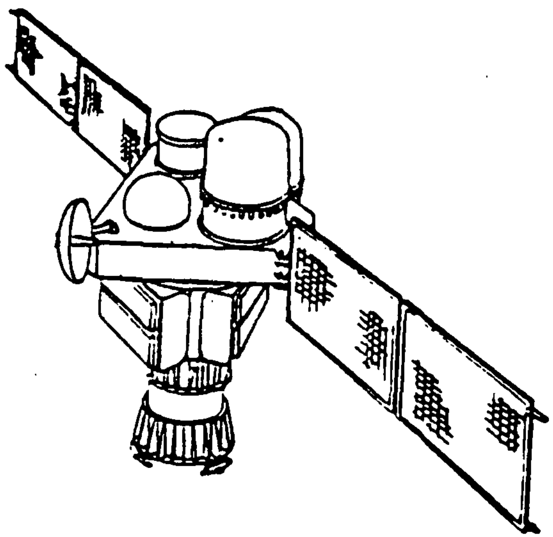
Cryogenically Cooled (15 to 20°K)

Mission Data

Status:	Candidate
Earliest Availability:	1995
Mass:	20,500 kg
Preferred Orbit:	700 km, 28 to 50°
Power:	3 kW
Data Rate:	100 kbps
Accommodation:	Station - U Platform - U Satellite - R
Crew Hours/ Operations Per Year:	Scientist/Observer - 0 Operator/Engineer - 0 Technician - 26/0.4
Launch Volume:	∿ 10 Pallets (2 Shuttles)
Peak Rate Duty Cycle:	0.8
Priority Rating:	3
Study Disposition:	1995 IOC, Dedicated Satellite (28.5°) Assemble and Service from Space Station

MCDONNELL DOUGLAS

Table A-16 SAS017 Gamma Ray Observatory (GRO)



Characteristics

Gamma Ray Astrophysical Observatory

Space Station Service Mission

Considerations

Inertial View

Mission Data

Status:	Approved
Earliest Availability:	1988
Mass:	11,000 kg
Preferred Orbit:	400 km, 28°
Power:	2 kW
Data Rate:	
Accommodation:	Station - U Platform - U Satellite - R
Crew Hours/ Operations Per Year:	Scientist/Observer - 0 Operator/Engineer - 0 Technician - 26/0.4
Launch Volume:	5 Pallets
Peak Rate Duty Cycle:	0.8
Priority Rating:	2
Study Disposition:	1988 IOC, Dedicated Satellite (28.5°) Service From Space Station

MCDONNELL DOUGLAS

Table A-17 SAS018 High Energy Isotope Experiment (HEIE)

Characteristics

Cosmic Ray Observatory

Low Energy (> 1 GeV) Particles

Considerations

Anti-earth View

2 - 15 to 30 Minute Calibrations per Day.

Vents He, Xe, CH_4 and Ne, CO_2.

Mission Data

Status:	Spacelab
Earliest Availability:	1990
Mass:	2000
Preferred Orbit:	400 km, 57°
Power:	250 W
Data Rate:	100 kbps
Accommodation:	Station - D Platform - A Satellite - U
Crew Hours/ Operations Per Year:	Scientist/Observer - 0 Operator/Engineer - 0 Technician - 372/730
Launch Volume:	1 Pallet (3 m)
Peak Rate Duty Cycle:	0.98
Priority Rating:	3
Study Disposition:	1993 IOC, Platform (97°)

MCDONNELL DOUGLAS

Table A-18 *SAS019 Solar Coronal Dynamics Mission* (SCDM)

Characteristics

Solar Observatory

Study of Coronal Heating Mechanism(s)

Considerations

Solar View

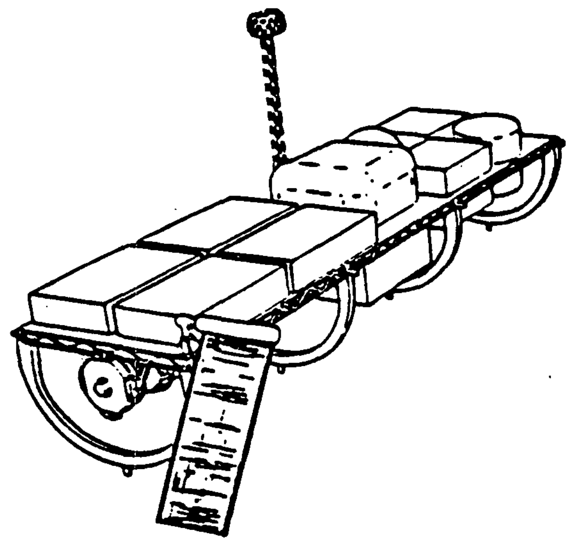
Biannual Maintenance Assumed

Mission Data

Status:	
Earliest Availability:	1993
Mass:	3500 kg
Preferred Orbit:	400 km. any
Power:	1 kW Peak, 500 W Average
Data Rate:	
Accommodation:	Station - A Platform - A Satellite - D
Crew Hours/ Operations Per Year:	Scientist/Observer - 0 Operator/Engineer - 0 Technician - 5/0.5
Launch Volume:	3 Pallets (9 m)
Peak Rate Duty Cycle:	0.5
Priority Rating:	3
Study Disposition:	1955 IOC, Space Station (28.5°)

MCDONNELL DOUGLAS

Table A-19 SAS020 Cosmic Ray Observatory (CRO)



Characteristics

Advanced State of the Art Observatory

Considerations

Anti-Earth View

2 - 15 to 30 Minute Calibration per Day.

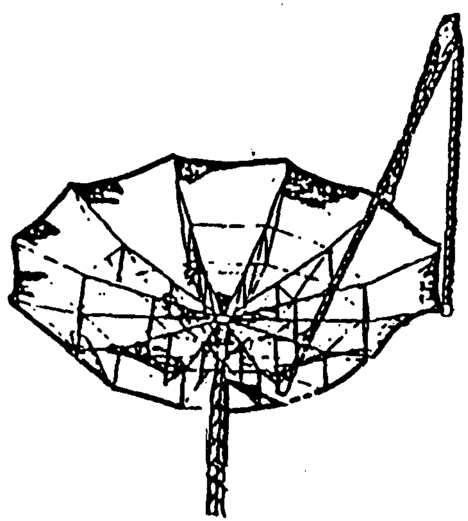
Vents He, Xe, CH_4 and Ne, CO_2.

Constitutent Instruments Can be Separated

Mission Data

Status:	Candidate
Earliest Availability:	Late 1990s
Mass:	18000 kg
Preferred Orbit:	400 km, 57°
Power:	2 kW
Data Rate:	1 Mbps
Accommodation:	Station - D Platform - A Satellite - A
Crew Hours/ Operations Per Year:	Scientist/Observer - 0 Operator/Engineer - 0 Technician - 372/730
Launch Volume:	5 Pallets (1 Shuttle)
Peak Rate Duty Cycle:	0.98
Priority Rating:	2
Study Disposition:	Post 1997 IOC, Platform (97°)

Table A-20 SCM001 Remote Sensing and RFI Measurements (RFI)



Characteristics

Passive Radiometer

RF and Microwave Bands

Considerations

Earth and Geostationary Views

RF ensitivity 0.6 - 10 GHz.

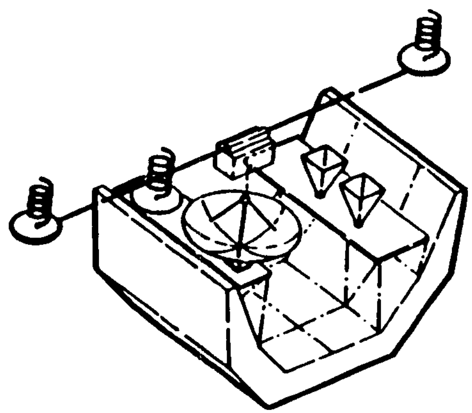
Possible use in Hydrology.

Large Antenna Area Screens Earth View.

Mission Data

Status:	
Earliest Availability:	1992
Mass:	2500 kg
Preferred Orbit:	400 km, 90°
Power:	120 W Peak, 6 W Average.
Data Rate:	5 kbps Peak, .25 kbps Average.
Accommodation:	Station - A Platform - A Satellite - A
Crew Hours/ Operations Per Year:	Scientist/Observer - 0 Operator/Engineer - 0 Technician - 6/0.4
Launch Volume:	2 pallets (6 m)
Peak Rate Duty Cycle:	0.05
Priority Rating:	4
Study Disposition:	Post 1997 IOC, Platform (97°)

Table A-21 SCM002 Orbiting Standards Package (OSP)



Characteristics

UHF to Ku Band Calibration Standards

Considerations

Earth, Geostationary, and Horizontal View

C and Ku Band Sensitivities.

Mission Data

Status:	
Earliest Availability:	1990
Mass:	100 kg
Preferred Orbit:	400 km, 57°
Power:	150 W Peak 7.5 W Average.
Data Rate:	100 kbps Peak, 5 kbps Average.
Accommodation:	Station - D Platform - A Satellite - A
Crew Hours/ Operations Per Year:	Scientist/Observer - 0 Operator/Engineer - 0 Technician - 5/0.4
Launch Volume:	0.5 Pallet (1.5 m Equivalent)
Peak Rate Duty Cycle:	0.05
Priority Rating:	2
Study Disposition:	1992/3 IOC, Functions Split Between Space Station (28.5°) and Platform (97°)

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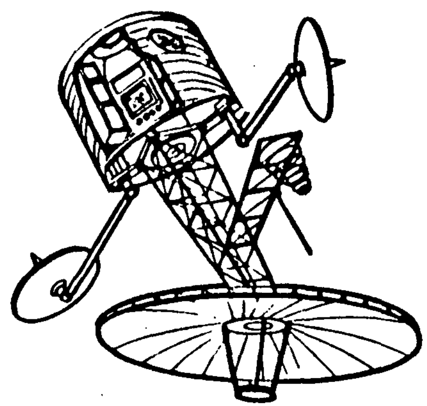
Table A-22 SCM003 Communications and Navigation Research Facility (CRF)



Characteristics

Manned Laboratory

Communications Experiment R&D

Propagation Measurements

Considerations

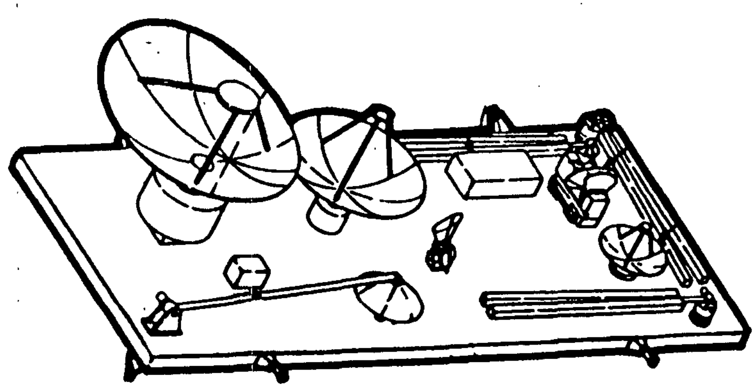
Earth, Geostationary, and Horizontal Views

RF Susceptibilities

Mission Data

Status:	
Earliest Availability:	1992
Mass:	15000 kg
Preferred Orbit:	400 km, 57°
Power:	5 kW Peak, 250 W Average.
Data Rate:	120 Mbps Peak, 2.4 Mbps Average.
Accommodation:	Station - R Platform - U Satellite - U
Crew Hours/ Operations Per Year:	Scientist/Observer - 100/100 Operator/Engineer - 400/100 Technician - 80/10
Launch Volume:	Short Module (3 m)
Peak Rate Duty Cycle:	0.05
Priority Rating:	4
Study Disposition:	Post 1997 IOC, Functions Split Between Space Station (28.5°) and Platform (97°)

Table A-23 SEE001 Ocean Payload



Characteristics

Coordinated Multiple Instrument Package

Nature and Dynamics of Oceans

Relationship to Atmosphere and Climate

Considerations

Earth View

RF Radiation/Sensitivity.

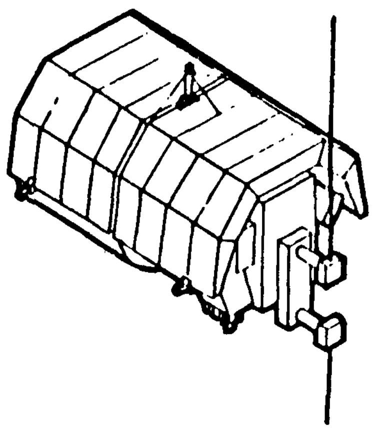
Visible/IR Sensitivity.

Sensitive to Condensation on Optics.

Mission Data

Status:	
Earliest Availability:	1988
Mass:	10000 kg
Preferred Orbit:	S.S. AM or PM
Power:	1 kW Peak, 200 W Average
Data Rate:	120 Mbps Peak, 24 Mbps Average
Accommodation:	Station - D Platform - A Satellite - U
Crew Hours/ Operations Per Year:	Scientist/Observer - 730/730 Operator/Engineer - 180/360 Technician - 26/0.4
Launch Volume:	3 Pallets (9 m)
Peak Rate Duty Cycle:	0.2
Priority Rating:	2
Study Disposition:	1993 IOC, Functions Split Between Space Station (28.5°) and Platform (97°)

Table A-24 SEE002 Atmospheric Composition



Characteristics

Atmospheric Species Measurements

Temporal and Spatial Dynamics

Considerations

Earth and Limb Views

Requires Twice per Orbit LIDAR Calibration.

Susceptible to Condensation on Optics.

Cryo Cooled Detectors Require Servicing.

Mission Data

Status:	
Earliest Availability:	1990
Mass:	2500
Preferred Orbit:	600 km, 90°
Power:	4 kW Peak, 40 W Average
Data Rate:	500 kbps Peak, 5 kbps Average
Accommodation:	Station - D Platform - A Satellite - A
Crew Hours/ Operations Per Year:	Scientist/Observer - 0 Operator/Engineer - 0 Technician - 85/8
Launch Volume:	2 Pallets (6 m)
Peak Rate Duty Cycle:	0.01
Priority Rating:	3
Study Disposition:	1993 IOC, Platform (97°)

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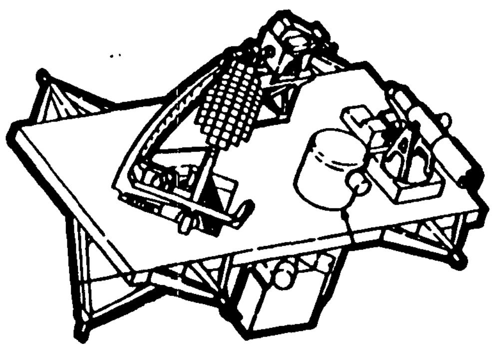
Table A-25 SEE003 Upper Atmospheric Research Satellite (UARS)



Characteristics

Radiation Chemistry and Dynamics of the Upper Atmosphere.

Two Satellites in Different Orbits Planned.

Considerations

Vents H_2.

Sensitive to Optical/MW Emission, Scattering.

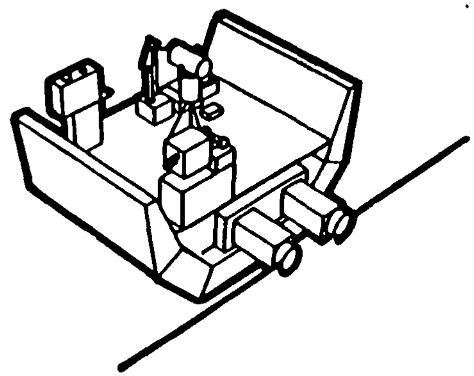
Sensitive to Condensation on Optical Surfaces.

Can Split into Solar and Low Inclination Orbits Also.

Mission Data

Status:	Planned
Earliest Availability:	1988
Mass:	2367 kg
Preferred Orbit:	400 km, 57° and 70°
Power:	1.3 kW Peak, 390 W Average
Data Rate:	18 kbps Peak, 5.4 kbps Average
Accommodation:	Station - A Platform - A Satellite - A
Crew Hours/ Operations Per Year:	Scientist/Observer - 0 Operator/Engineer - 0 Technician - 40/0.4
Launch Volume:	2 Pallets (6 m)
Peak Rate Duty Cycle:	0.3
Priority Rating:	2
Study Disposition:	1988 IOC, Dedicated Satellite

Table A-26 SEE004 Space Plasma Physics Payload (SPP)



Characteristics

Space Plasma Interactive Experiments

Sun - Atmosphere Relationships

Considerations

Earth and Limb Views

E-Beam and He or Ar Plasma Jet Emissions.

High Power VLF, HF Emissions.

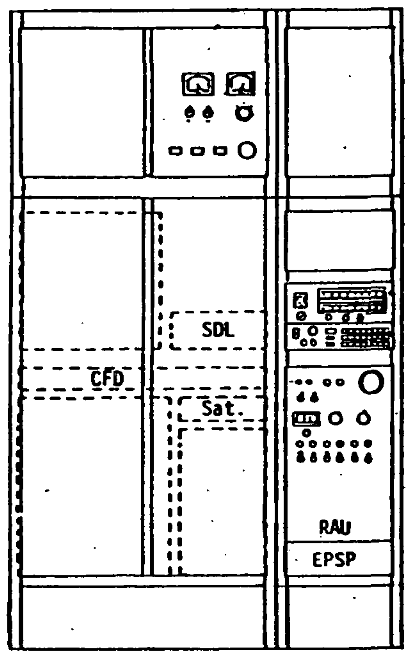
45° Avoidance Cone Around SEPAC.

Optical Surfaces Subject to Contamination.

Mission Data

Status:	Planned, Spacelab, ϕA Complete
Earliest Availability:	1988
Mass:	3183 kg
Preferred Orbit:	400 km, 90°
Power:	2.7 kW Peak, 270 W Average.
Data Rate:	7.51 Mbps Peak, 750 kbps Average.
Accommodation:	Station - A Platform - D Satellite - U
Crew Hours/ Operations Per Year:	Scientist/Observer - 0 Operator/Engineer - 0 Technician - 40/0.4
Launch Volume:	1 Pallet (3 m)
Peak Rate Duty Cycle:	0.1
Priority Rating:	2
Study Disposition:	1993 IOC, Platform (97°)

Table A-27 SEE005 Zero G Cloud Physics



Characteristics

Manned Orbital Laboratory

Atmospheric Microscale Processes

Considerations

"G" Sensitive $\leq 10^{-5}$ (0(10) Min Test)

Occasional Impulse Tolerable.

Low Level Radiation Background.

Mission Data

Status:	Planned, Spacelab Derivative
Earliest Availability:	1992
Mass:	474 kg
Preferred Orbit:	Any
Power:	1.4 kW Peak, 28 Average.
Data Rate:	500 kbps Peak, 10 kbps Average.
Accommodation:	Station - R Platform - U Satellite - U
Crew Hours/ Operations Per Year:	Scientist/Observer - 25/50 Operator/Engineer - 200/50 Technician - 200/50
Launch Volume:	3 racks (3 m^3)
Peak Rate Duty Cycle:	0.02
Priority Rating:	3
Study Disposition:	1993 IOC, Space Station (28.5°)

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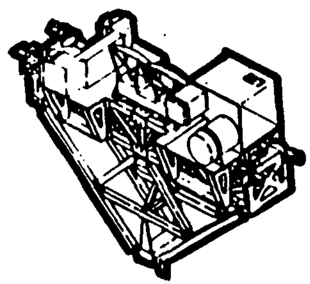
Table A-28 SEE006 Meteorological Research Package (MET RES)



Characteristics

Manned Laboratory

External Instrument Package

Instrument Development and Test

Weather and Climate Research

Considerations

Earth View

Manned OPS to Perform Meteorological Research.

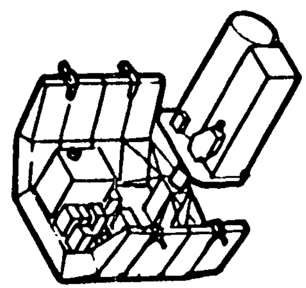
RF Emissions.

RF, IR and Condensation Susceptibility.

Mission Data

Status:	
Earliest Availability:	1992
Mass:	1500 kg
Preferred Orbit:	500 km, 57°
Power:	1.2 kW Peak, 240 W Average.
Data Rate:	14·kbps Peak, 2.8 Mbps Average
Accommodation:	Station - R Platform - U Satellite - U
Crew Hours/ Operations Per Year:	Scientist/Observer - 730/730 Operator/Engineer - 180/360 Technician - 26/0.4
Launch Volume:	1 Pallet (3 m)
Peak Rate Duty Cycle:	0.2
Priority Rating:	3
Study Disposition:	1993 IOC, Functions Split Between Space Station (28.5°) and Platform (97°)

Table A-29 SEE007 Atmospheric Dynamics and Radiation



Characteristics

Multiinstrument Atmospheric Observation Package

Monitor and Model Atmospheric Dynamics

Considerations

Earth and Limb Views

Men Required for Repair, Calibration Services.

Microwave and IR Susceptibilities.

Mission Data

Status:	Spacelab Derivative
Earliest Availability:	1993
Mass:	2300 kg
Preferred Orbit:	400 km, 90°
Power:	5 kW Peak, 500 W Average.
Data Rate:	2.5 Mbps Peak, 250 kbps Average.
Accommodation:	Station - D Platform - A Satellite - A
Crew Hours/ Operations Per Year:	Scientist/Observer - 0 Operator/Engineer - 0 Technician - 26/0.4
Launch Volume:	2 Pallets (6 m)
Peak Rate Duty Cycle:	0.1
Priority Rating:	2
Study Disposition:	1993 IOC, Platform (97°)

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Table A-30 SEE008 Operational Civil Meteorology Station

Characteristics

Man Tended Meteorology Package

Considerations

Earth View

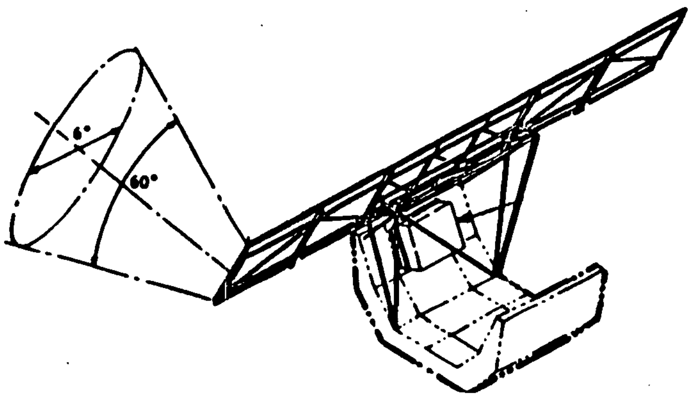
Man Tending to Maximize Instrument Life.

Susceptible to Condensation on Optical Surfaces.

Mission Data

Status:	
Earliest Availability:	1988
Mass:	700 kg
Preferred Orbit:	S.S. AM/PM
Power:	415 W
Data Rate:	2.7 Mbps
Accommodation:	Station - A Platform - A Satellite - A
Crew Hours/ Operations Per Year:	Scientist/Observer - 0 Operator/Engineer - 0 Technician - 22/1
Launch Volume:	1 Pallet (3 m)
Peak Rate Duty Cycle:	0.99
Priority Rating:	2
Study Disposition:	1994 IOC, Dedicated Satellite

Table A-31 SEP001 Synthetic Aperture Radar (SAR)



Characteristics

Dual Band, Side Looking Radar

Monitor Vegetative Cover, Hydrological Cycle Water Resources, and Geological Resources

Considerations

Side Looking Earth View

High Power RF Emissions.

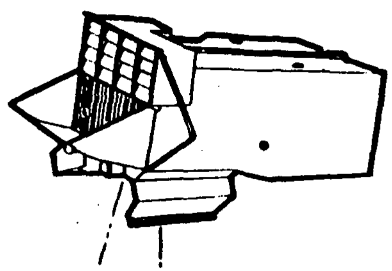
RF susceptibility.

High Data Rate Requires Selective Targeting.

Mission Data

Status:	Spacelab, in ϕB
Earliest Availability:	1984
Mass:	1876 kg
Preferred Orbit:	400 km, 90°
Power:	6.5 kW Peak, 1.3 kW Average.
Data Rate:	120 Mbps Peak, 24 Mbps Average.
Accommodation:	Station - A Platform - A Satellite - A
Crew Hours/ Operations Per Year:	Scientist/Observer - 0 Operator/Engineer - 180/360 Technician - 5/0.4
Launch Volume:	1 Pallet (3 m)
Peak Rate Duty Cycle:	0.2
Priority Rating:	1
Study Disposition:	1993 IOC, Platform (97°)

Table A-32 SEP002 Multispectral Linear Array (MLA)



Characteristics

Thermal IR to visible, Multichannel Spectrometer

Monitor Vegetative Cover, Hydrological Cycle

Water Resources, and Geological Resources

Observe Same Targets as SAR

Considerations

Earth View

Cryogenic Detectors Required for TIR.

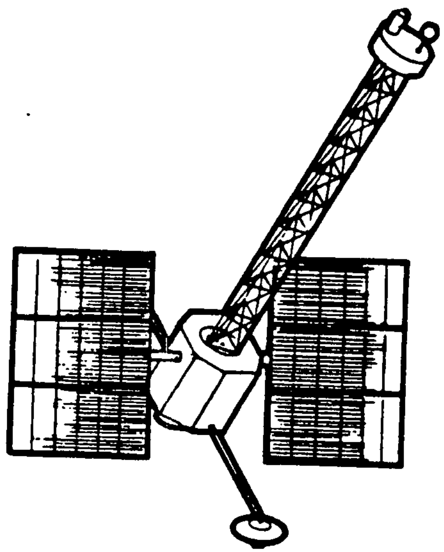
Susceptible to Contamination.

High Data Rate Requires Selective Targeting.

Mission Data

Status:	Planned
Earliest Availability:	1989
Mass:	315 kg
Preferred Orbit:	S.S. Daylight
Power:	500 W Peak, 100 W Average
Data Rate:	200-300 Mbps Peak, 40-60 Mbps Average
Accommodation:	Station - D Platform - A Satellite - A
Crew Hours/ Operations Per Year:	Scientist/Observer - 0 Operator/Engineer - 180/360 Technician - 5/1
Launch Volume:	1/2 Pallet (1.5 m Equivalent)
Peak Rate Duty Cycle:	0.2
Priority Rating:	1
Study Disposition:	1993 IOC, Platform (97°)

Table A-33 SEP003 Magnetic Field Mapper (MFM)



Characteristics

Refined Measurements of Earth's Magnetic Field

Geological Resource Mapping

Considerations

Earth View

Cryogenic Resupply.

Sensitive to Disturbances.

Mission Data

Status:	Planned
Earliest Availability:	1989
Mass:	890 kg
Preferred Orbit:	300 km, 97°
Power:	120 W
Data Rate:	230 kbps
Accommodation:	Station - U Platform - A Satellite - A
Crew Hours/ Operations Per Year:	Scientist/Observer - 0 Operator/Engineer - 0 Technician - 26/0.4
Launch Volume:	1/2 Pallet (1.5 m Equivalent)
Peak Rate Duty Cycle:	0.99
Priority Rating:	4
Study Disposition:	1989 IOC, Dedicated Satellite (97°)

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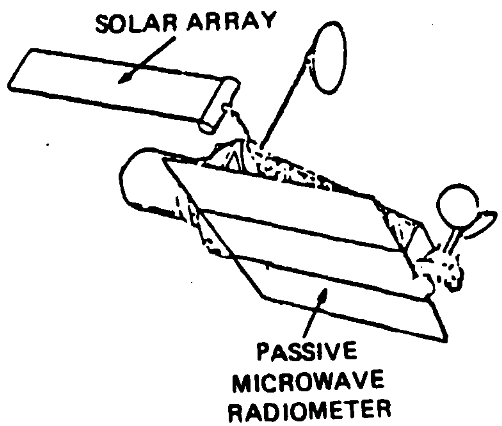
Table A-34 SEP004 Passive Microwave Radiometer (Pass MW Rad)



Characteristics

Microwave Emission Imaging

10 Bands from 1.4 to 94 GHz

Snow and Moisture Inventory, Hydrological Cycle, Meteorology, Polar Ice, and Shipping

Considerations

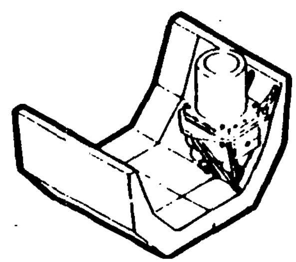
Earth View

Susceptible to RF Interference.

Mission Data

Status:	Planned
Earliest Availability:	1992
Mass:	475 kg
Preferred Orbit:	465 km, 90°
Power:	1.2 kW Peak, 240 W Average
Data Rate:	200 kbps Peak, 40 kbps Average
Accommodation:	Station - A Platform - D Satellite - U
Crew Hours/ Operations Per Year:	Scientist/Observer - 0 Operator/Engineer - 0 Technician - 5/0.4
Launch Volume:	2 Pallets (6 m)
Peak Rate Duty Cycle:	0.2
Priority Rating:	1
Study Disposition:	1993 IOC, Platform (97°)

Table A-35 SEP005 Large Format Camera (LFC)



Characteristics

High Resolution Photography

Considerations

Earth View

Film Change.

High Output Requires Selective Targeting.

Mission Data

Status:	Planned, Spacelab ϕA Complete
Earliest Availability:	1990
Mass:	70 kg
Preferred Orbit:	250 km, 90°
Power:	Low
Data Rate:	Low
Accommodation:	Station - R Platform - U Satellite - U
Crew Hours/ Operations Per Year:	Scientist/Observer - 0 Operator/Engineer - 0 Technician - 10/12
Launch Volume:	0.2 Pallet (0.6 m Equivalent)
Peak Rate Duty Cycle:	0.2
Priority Rating:	1
Study Disposition:	1982/3 IOC, Instruments on Both Space Station (28.5°) and Platform (97°)

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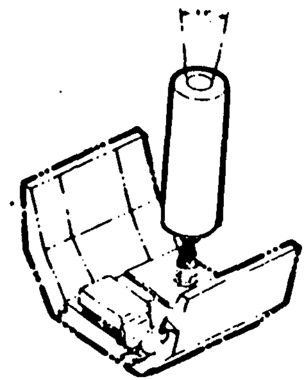
Table A-36 SEP006 Imaging Spectrometer (IS)



Characteristics

Up to 128 Channel, High Rresolution Spectrometer

Vegetative, Hydrological and Geological Studies

Considerations

Earth View

0.04 Arc Sec. Stability for 5 Sec.

Sensitive to IR and Visible Emission, Scattering.

Susceptible to Contamination.

Mission Data

Status:	Candidate, Spacelab Derivative
Earliest Availability:	1995
Mass:	1938 kg
Preferred Orbit:	400 km, 90°
Power:	500 W Peak, 100 W Average
Data Rate:	100 Mbps Peak, 20 Mbps Average
Accommodation:	Station - A Platform - D Satellite - A
Crew Hours/ Operations Per Year:	Scientist/Observer - 0 Operator/Engineer - 180/360 Technician - 4/1
Launch Volume:	1 Pallet (3 m)
Peak Rate Duty Cycle:	0.2
Priority Rating:	2
Study Disposition:	1997 IOC, Platform (97°)

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Table A-37 SEP007 Luminescence Detector (Lum Det)

Characteristics

Passive Measurement of Luminescence in Fraunhoffer Lines

Resources Observation

Considerations

Earth View

Mission Data

Status:	Candidate
Earliest Availability:	1994
Mass:	60 kg
Preferred Orbit:	S.S Daylight
Power:	150 W Peak, 30 W Average
Data Rate:	2.5 Mbps Peak, 500 kbps Average
Accommodation:	Station - A Platform - A Satellite - U
Crew Hours/ Operations Per Year:	Scientist/Observer - 0 Operator/Engineer - 180/360 Technician - 4/1
Launch Volume:	0.1 Pallet (0.3 m Equivalent)
Peak Rate Duty Cycle:	0.2
Priority Rating:	3
Study Disposition:	1997 IOC, Platform (97°)

Table A-38 SEP008 Space Based Laser Ranging (Laser Range)

Characteristics

Crustal Dynamics Monitor

Triangulation on Ground Based Corner Reflectors

Considerations

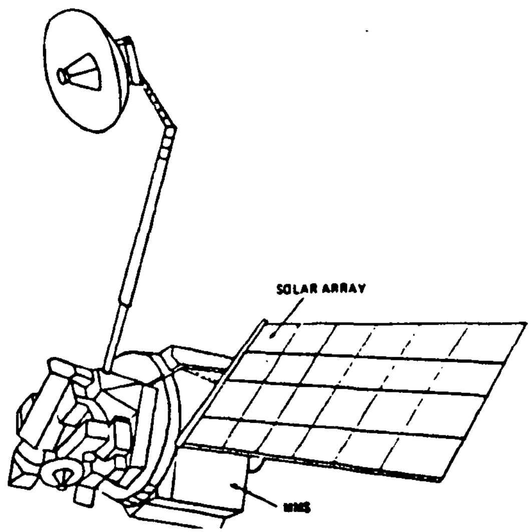
Earth View

May Require Alignment and Calibration.

Mission Data

Status:	Planned
Earliest Availability:	1989
Mass:	185 kg
Preferred Orbit:	400 km, 90°
Power:	500 W Peak, 100 W Average
Data Rate:	10 kbps Peak, 2 kbps Average
Accommodation:	Station - A Platform - A Satellite - A
Crew Hours/ Operations Per Year:	Scientist/Observer - 0 Operator/Engineer - 0 Technician - 4/1
Launch Volume:	0.1 Pallet (0.3 m Equivalent)
Peak Rate Duty Cycle:	0.2
Priority Rating:	3
Study Disposition:	1993 IOC, Platform (97°)

Table A-39 SEP009 LANDSAT D-D'



Characteristics

Space Station Service Mission

Could be Attached to Platform or Station.

Considerations

Earth View

Requires Retrieval, Refurbishment and Relaunch on 5 Year Intervals.

Mission Data

Status:	Operational
Earliest Availability:	1982
Mass:	1600 kg
Preferred Orbit:	S.S. AM/PM
Power:	750 W Peak, 150 W Average
Data Rate:	100 Mbps Peak, 20 Mbps Average
Accommodation:	Station - A Platform - A Satellite - D
Crew Hours/ Operations Per Year:	Scientist/Observer - 0 Operator/Engineer - 0 Technician - 18/0.2
Launch Volume:	2 Pallets (6 m)
Peak Rate Duty Cycle:	0.2
Priority Rating:	1
Study Disposition:	1982 IOC, Dedicated Satellite (97°)

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Table A-40 SEP010 Radar Altimeter

Characteristics

Companion to SAR, MLA, and Pass MW Rad

Considerations

Earth View

Used in Conjunction with Other Vegetative Cover Sensors.

Emits RF.

Susceptible to RFI.

Mission Data

Status:	Candidate
Earliest Availability:	1992
Mass:	100 kg
Preferred Orbit:	400 km, 90°
Power:	100 W Peak, 20 W Average
Data Rate:	2.5 Mbps Peak, 500 kbps Average
Accommodation:	Station - D Platform - A Satellite - A
Crew Hours/ Operations Per Year:	Scientist/Observer - 0 Operator/Engineer - 0 Technician - 5/0.4
Launch Volume:	0.2 Pallet (0.6 m Equivalent)
Peak Rate Duty Cycle:	0.2
Priority Rating:	1
Study Disposition:	1993 IOC, Platform (97°)

Table A-41 SEP011 Active Fluorescence Spectrometer

Characteristics

Laser Induced Fluorescence Measurement

Identification of Surface Composition

Considerations

Earth View

Susceptible to Visible Emission and Scattering.

Optics Susceptible to Contamination.

Mission Data

Status:	Candidate
Earliest Availability:	1995
Mass:	1900 kg
Preferred Orbit:	400 km, 90°
Power:	2 kW Peak, 400 W Average
Data Rate:	40 Mbps Peak, 8 Mbps Average
Accommodation:	Station - D Platform - A Satellite - A
Crew Hours/ Operations Per Year:	Scientist/Observer - 0 Operator/Engineer - 180/360 Technician - 8/1
Launch Volume:	1 Pallet (3 m)
Peak Rate Duty Cycle:	0.2
Priority Rating:	4
Study Disposition:	Post 1997 IOC, Platform (97°)

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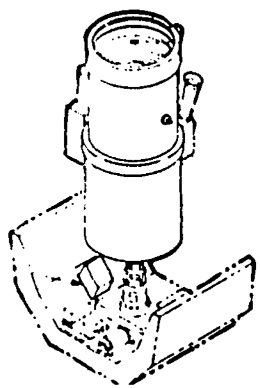
Table A-42 SEP012 Planetary Spectroscopy Telescope (PST)



Characteristics

Starlab Class Telescope

Near IR to UV Spectroscopy of Solar System Objects

Considerations

Inertial View

May Use Starlab

5 Arc Stability for 100 sec.

Mission Data

Status:	Spacelab Derivative
Earliest Availability:	1990
Mass:	3000 kg
Preferred Orbit:	Any
Power:	3 kW
Data Rate:	50 Mbps
Accommodation:	Station - D Platform - A Satellite - A
Crew Hours/ Operations Per Year:	Scientist/Observer - 0 Operator/Engineer - 20/40 Technician - 26/0.4
Launch Volume:	2 (Pallet) (6 m)
Peak Rate Duty Cycle:	0.8
Priority Rating:	3
Study Disposition:	1997 IOC, Space Station (28.5°)

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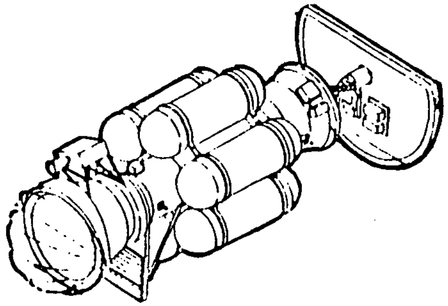
Table A-43 SEP013 Infrared Spectroscopy (IRST)



Characteristics

SIRTF Class Telescope

Thermal to Far IR Spectroscopy of Solar System Objects

Considerations

Inertial View

Cryogen Replacement.

Similar to SIRTF.

0.2 are Sec. Stability.

Mission Data

Status:	Spacelab Derivative
Earliest Availability:	
Mass:	8100 kg
Preferred Orbit:	Any
Power:	3 kW
Data Rate:	50 Mbps
Accommodation:	Station - D Platform - A Satellite - A
Crew Hours/ Operations Per Year:	Scientist/Observer - 0 Operator/Engineer - 20/40 Technician - 34/1.4
Launch Volume:	3 Pallets (9 m)
Peak Rate Duty Cycle:	0.8
Priority Rating:	3
Study Disposition:	1997 IOC, Space Station (28.5°)

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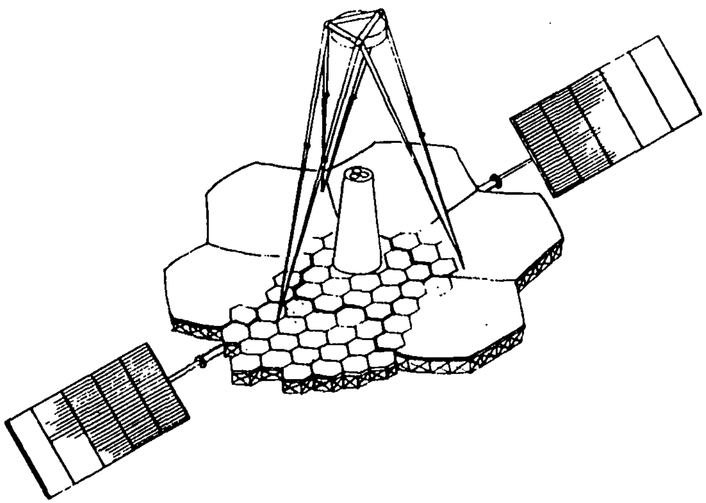
Table A-44 SEP014 Far-Infrared and Submillimeter Spectroscopy and Radiometry (FIRST)



Characteristics

LDR Class IR Telescope

Microwave to Near IR Spectroscopy of Solar System Objects

Considerations

Inertial View

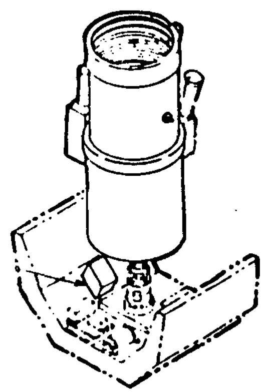
On Orbit Construction

Could use LDR.

Mission Data

Status:	
Earliest Availability:	1995
Mass:	20000 kg
Preferred Orbit:	700 km, 28°
Power:	3 kW
Data Rate:	50 Mbps
Accommodation:	Station - U Platform - U Satellite - A
Crew Hours/ Operations Per Year:	Scientist/Observer - 0 Operator/Engineer - 20/40 Technician - 26/0.4
Launch Volume:	10 Pallets (2 Shuttles)
Peak Rate Duty Cycle:	0.8
Priority Rating:	4
Study Disposition:	Post 1997 IOC, Dedicated Satellite (28.5° Assemble and Service From Space Station

Table A-45 SEP015 Extra Solar System Detection (XSST)



Characteristics

Starlab Class Telescope

Scanning Ronchi Ruling to Detect Relative Star Motion

Considerations

Inertial View

1 Hour Continuous Observation for Each Target.

0.2 Arc. Min. Stability.

Mission Data

Status:	
Earliest Availability:	
Mass:	3000 kg
Preferred Orbit:	500 km, 28°
Power:	3 kW
Data Rate:	100 kbps
Accommodation:	Station - D Platform - A Satellite - A
Crew Hours/ Operations Per Year:	Scientist/Observer - 0 Operator/Engineer - 180/360 Technician - 26/0.4
Launch Volume:	2 Pallets (6 m)
Peak Rate Duty Cycle:	0.8
Priority Rating:	4
Study Disposition:	Post 1997 IOC, Space Station (28.5°)

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Table A-46 SEP016 Planetary Physical Processes Laboratory (PPL)

Characteristics

Manned Laboratory

Simulation of Planetary Geological Processes

Space Environment Effects on Materials

Considerations

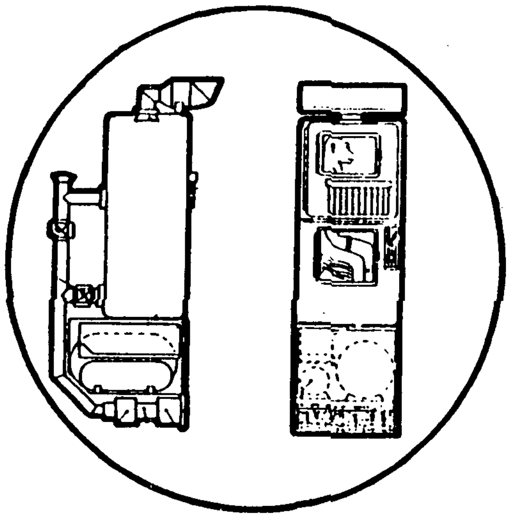
Some Hazardous or Toxic Materials.

Low, Controlled "G" levels Required.

Mission Data

Status:	Spacelab Derivative
Earliest Availability:	
Mass:	2500 kg
Preferred Orbit:	Any
Power:	1 kW
Data Rate:	500 kbps
Accommodation:	Station - R Platform - U Satellite - U
Crew Hours/ Operations Per Year:	Scientist/Observer - 25/50 Operator/Engineer - 200/50 Technician - 200/50
Launch Volume:	Short Module (3 m)
Peak Rate Duty Cycle:	1.00
Priority Rating:	4
Study Disposition:	Post 1997 IOC, Space Station (28.5°)

Table A-47 SLS001 Primate Experimental Facility (PEF)



Characteristics

Manned Laboratory

Primate Experiments on Effects of Weightlessness

Considerations

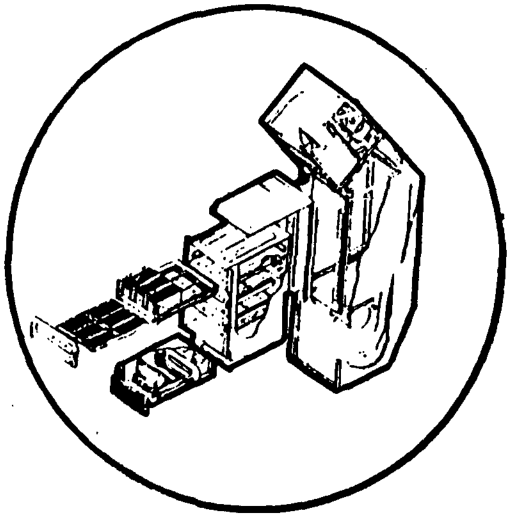
Size Varies with Number of Specimens.

Unit Sized for 4 Specimens.

Mission Data

Status:	Planned, Spacelab Derivative, φC
Earliest Availability:	1992
Mass:	5100 kg
Preferred Orbit:	Any
Power:	4 kW
Data Rate:	50 kbps
Accommodation:	Station - R Platform - U Satellite - U
Crew Hours/ Operations Per Year:	Scientist/Observer - 397/369 Operator/Engineer - 0 Technician - 720/360
Launch Volume:	1/2 Short Module (1.5 m)
Peak Rate Duty Cycle:	1.00
Priority Rating:	2
Study Disposition:	1994 IOC, Space Station (28.5°)

Table A-48 SLS002 Plant Biology/Life Support Cycle Facility (PBLF)



Characteristics

Manned Laboratory

Botany and Life Support Cycle Studies in Zero-G

Considerations

Size Varies with Number of Specimens.

Needs Centrifuge for 0 to 1.5" g's.

Unit Sized for 4 Specimen Racks.

Mission Data

Status:	Planned, Spacelab Derivative
Earliest Availability:	1992
Mass:	5200 kg
Preferred Orbit:	Any
Power:	4.4 kW
Data Rate:	50 kbps
Accommodation:	Station - R Platform - U Satellite - U
Crew Hours/ Operations Per Year:	Scientist/Observer - 48/12 Operator/Engineer - 0 Technician - 24/12
Launch Volume:	1/2 Short Module (1.5 m)
Peak Rate Duty Cycle:	1.00
Priority Rating:	2
Study Disposition:	Post 1997 IOC, Space Station (28.5°)

Table A-49 SLS003 Rodent Experiment Facility (REF)

Characteristics

Manned Laboratory

Radar Experiments on Effects of Weightlessness and Radiation

Considerations

Size Varies with Number of Specimens.

Exposure to Radiation Environment Desired.

Unit Sized for Specimens.

Mission Data

Status:	Planned, Spacelab Derivative, ϕC
Earliest Availability:	1992
Mass:	5000 kg
Preferred Orbit:	Any
Power:	4.2 kW
Data Rate:	50 kbps
Accommodation:	Station - R Platform - U Satellite - U
Crew Hours/ Operations Per Year:	Scientist/Observer - 480/120 Operator/Engineer - 0 Technician - 360/360
Launch Volume:	1/2 Short Module (1.5 m)
Peak Rate Duty Cycle:	1.00
Priority Rating:	2
Study Disposition:	1993 IOC, Space Station (28.5°)

Table A-50 SLS004 Orbiting Quarantine Facility (OQF)

Characteristics

Manned Laboratory

Isolation and Analysis of Extraterrestrial Materials

Considerations

Orbit Consistent with Planetary Return Trajectory

Mission Data

Status:	
Earliest Availability:	Late 1990s
Mass:	6600 kg
Preferred Orbit:	400 km, 28°
Power:	1.7 kW Peak, 1 kbps Average
Data Rate:	50 kbps Peak, 1 kbps Average
Accommodation:	Station - R Platform - U Satellite - U
Crew Hours/ Operations Per Year:	Scientist/Observer - 100/10 Operator/Engineer - 0 Technician - 20/10
Launch Volume:	Short Module (3 m)
Peak Rate Duty Cycle:	0.1
Priority Rating:	4
Study Disposition:	Post 1997 IOC, Space Station (28.5°)

Table A-51 SLS005 Experimental Medical Treatment Facility (EMTF)

Characteristics

Manned Laboratory

Develop Medical Procedures for Minor and Emergency Treatment of Crew

Considerations

Mission Data

Status:	
Earliest Availability:	
Mass:	3200 kg
Preferred Orbit:	Any
Power:	1 kW
Data Rate:	50 kbps
Accommodation:	Station - R Platform - U Satellite - U
Crew Hours/ Operations Per Year:	Scientist/Observer - 200/20 Operator/Engineer - 0 Technician - 40/20
Launch Volume:	1/2 Short Module (1.5 m)
Peak Rate Duty Cycle:	1.00
Priority Rating:	4
Study Disposition:	1997 IOC, Space Station (28.5°)

Table A-52 SLS006 Human Experimental Facility (HEF)

Characteristics

Manned Laboratory

Monitor Effects of Weightlessness on Crew

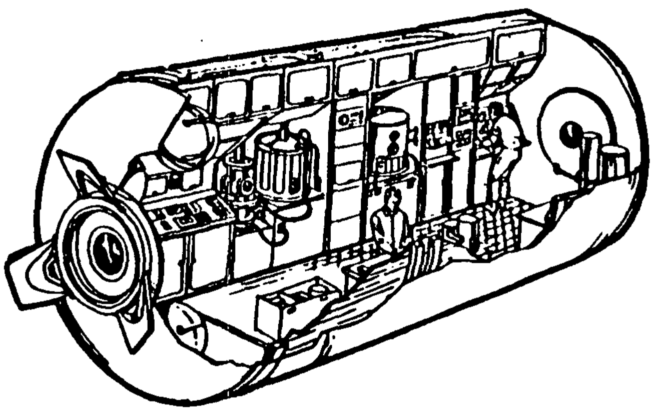
Monitor Effectiveness of Countermeasures

Considerations

Mission Data

Status:	Spacelab Derivative
Earliest Availability:	1990
Mass:	3000 kg
Preferred Orbit:	Any
Power:	2.9 kW
Data Rate:	50 kbps
Accommodation:	Station - R Platform - U Satellite - U
Crew Hours/ Operations Per Year:	Scientist/Observer - 208/52 Operator/Engineer - 0 Technician - 52/52
Launch Volume:	1/2 Short Module (1.5 m)
Peak Rate Duty Cycle:	1.00
Priority Rating:	2
Study Disposition:	1992 IOC, Space Station (28.5°)

Table A-53 SMP001 Materials Processing Laboratory (MPL)



Characteristics

Manned Laboratory

Materials Processing Research

Production of R&D Quantities of Materials

Considerations

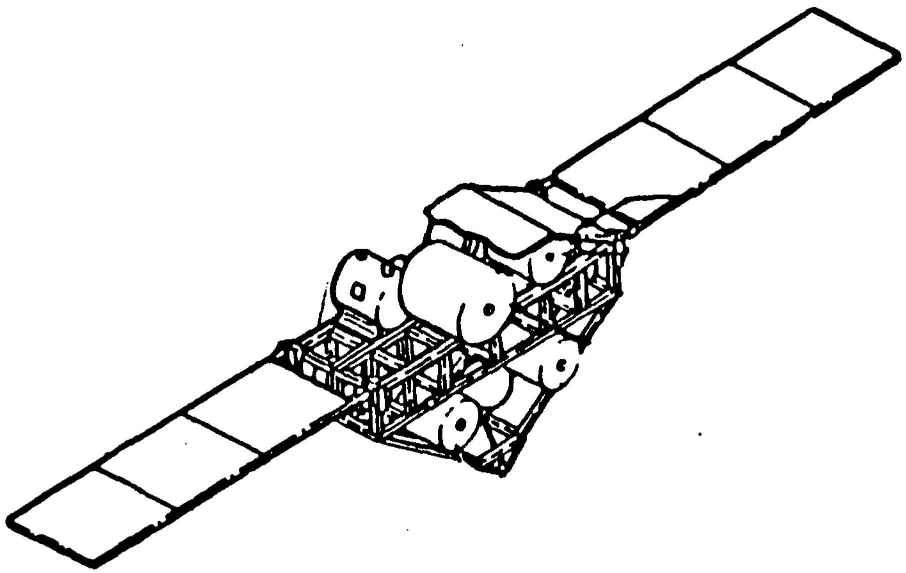
10^{-3} to 10^{-6} "g's" Required for Many Experiments.

Access to Space Vacuum Required for Some Processes.

Mission Data

Status:	*Candidate*
Earliest Availability:	1993
Mass:	12300 kg
Preferred Orbit:	Any
Power:	12 kW Peak, 6 kW Average
Data Rate:	10 kbps Peak, 5 Kbps Average
Accommodation:	Station - R Platform - U Satellite - U
Crew Hours/ Operations Per Year:	Scientist/Observer - 400/100 Operator/Engineer - 400/100 Technician - 400/100
Launch Volume:	Long Module (6 m)
Peak Rate Duty Cycle:	0.5
Priority Rating:	2
Study Disposition:	1993 IOC, Space Station (28.5°)

Table A-54 SMP002 Materials Experiment Carrier (MEC)



Characteristics

Unmanned, Preproduction Facility

Preproduction, Clinical, Band Small Production Quantities of Space Processed Materials

Considerations

10^{-3} to 10^{-6} g's Required for Some Processes.

Access to Vacuum Required for Some Processes.

Frequent Manned Tending Desired.

Mission Data

Status:	
Earliest Availability:	1993
Mass:	13600 kg
Preferred Orbit:	Any
Power:	10 kW
Data Rate:	500 kbps
Accommodation:	Station - A Platform - D Satellite - A
Crew Hours/ *Operations Per Year:*	Scientist/Observer - 52/26 Operator/Engineer - 0 Technician - 26/26
Launch Volume:	2 Pallets (6 m)
Peak Rate Duty Cycle:	0.8
Priority Rating:	2
Study Disposition:	1994 IOC, Space Station (28.5°)

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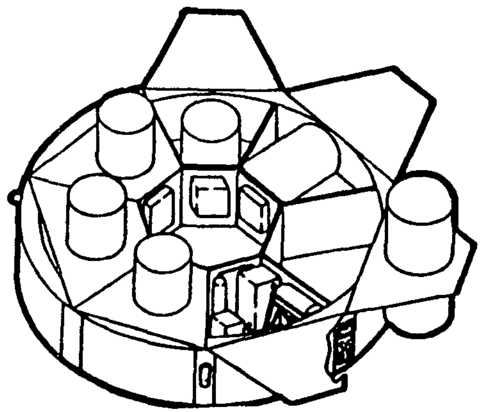
Table A-55 SMP003 Materials Experiment Assembly (MEA)



Characteristics

Unmanned Facility

Materials Processing Demonstration

Considerations

10^{-3} to 10^{-6} g's Required for Some Experiments.

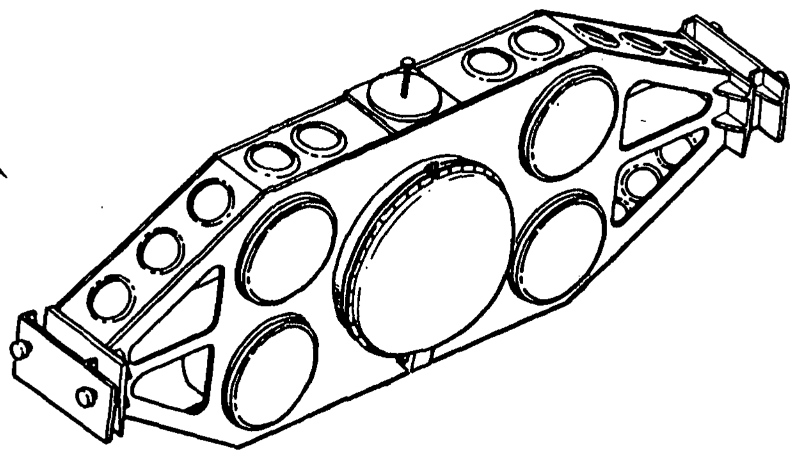
Access to Space Vacuum Required for Some Experiments.

Frequent Man Tending Desirable.

Mission Data

Status:	Planned
Earliest Availability:	1988
Mass:	2215 kg
Preferred Orbit:	Any
Power:	7 kW Peak, 3.5 kW Average.
Data Rate:	6 kbps Peak, 3 kbps Average.
Accommodation:	Station - A Platform - A Satellite - U
Crew Hours/ Operations Per Year:	Scientist/Observer - 200/50 Operator/Engineer - 0/0 Technician - 416/52
Launch Volume:	1 Pallet (3 m)
Peak Rate Duty Cycle:	0.5
Priority Rating:	1
Study Disposition:	1992 IOC, Space Station (28.5°)

Table A-56 SMP004 Wake Shield Experiment (WS)



Characteristics

Unmanned Facility for Ultra-Low Vacuum

Measurement of Vacuum Achievable

Quantity and Composition of Molecules and Ions in Wake Shield

Considerations

Velocity Vector View.

Ultrahigh Vacuum.

Deployed on Boom.

Can be Done on Shuttle Sortie Mission.

Mission Data

Status:	
Earliest Availability:	1990
Mass:	600 kg
Preferred Orbit:	Any
Power:	500 W Peak, 100 W Average
Data Rate:	10 kbps Peak, 2 kbps Average
Accommodation:	Station - R Platform - U Satellite - U
Crew Hours/ Operations Per Year:	Scientist/Observer - 0 Operator/Engineer - 0 Technician - 100/10
Launch Volume:	1 Pallet (3 m)
Peak Rate Duty Cycle:	0.2
Priority Rating:	4
Study Disposition:	1990 IOC, Shuttle Sortie

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Table A-57 SMP005 Ultravacuum Facility

Characteristics

Unmanned Processing Facility

Materials Processing in Ultravacuum

Considerations

Velocity Vector View

$\leq 10^{-10}$ Torr Vacuum

10^{-3} to 10^{-6} g's Required for Many Processes.

Mission Data

Status:	
Earliest Availability:	1995
Mass:	1200 kg
Preferred Orbit:	Any
Power:	3 kW Peak, 1.5 kW Average
Data Rate:	10 kbps Peak, 5 kbps Average
Accommodation:	Station - D Platform - A Satellite - U
Crew Hours/ Operations Per Year:	Scientist/Observer - 114/26 Operator/Engineer - 0 Technician - 280/26
Launch Volume:	1.5 Pallet (4.5 m)
Peak Rate Duty Cycle:	0.5
Priority Rating:	4
Study Disposition:	Post 1997 IOC, Space Station (28.5°)

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LASER COMMUNICATION AND TRACKING DEVELOPMENT

(TFM001, PRIORITY 5)

VGB464

OBJECTIVE

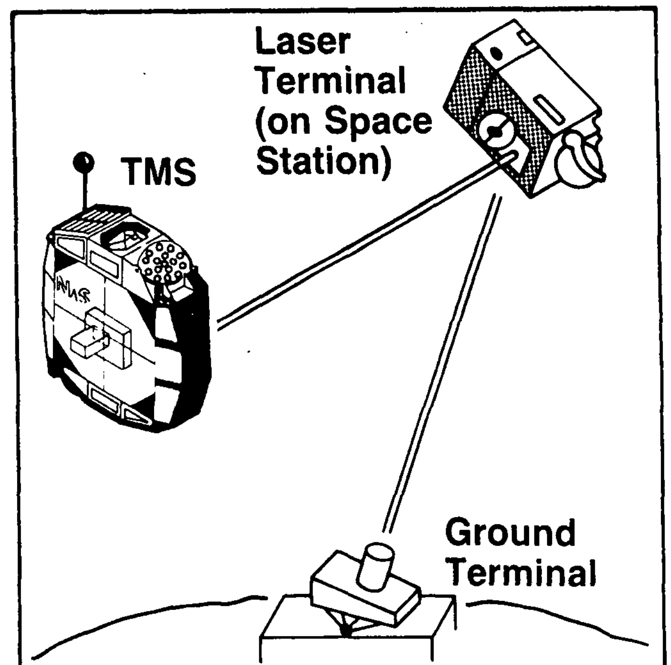
- Demonstrate Space-to-Space Laser Communication and Tracking System. Investigate Propagation Effects for Space-to-Ground Laser Link

BENEFITS

- Improved Bandwidth and Security for Space-to-Space and Space-to-Ground Communication Links; Improved Rendezvous/Docking Support

CRITICAL ENVIRONMENTS

- Low-g, Vacuum and Free Space



SPACE FACILITY REQUIREMENTS

- TMS
- Crew Interaction/Support
- Attitude Stability/Knowledge

MISSION/HARDWARE

- Laser Communication Terminals
- Laser Tracker
- Laser Reflector System
- Ground Laser Communicaion Terminals

MISSION DESCRIPTION

- User Space-Station-Mounted Laser Communication Unit to Communicate with Second Terminal on TMS. Perform Tracking Experiments Using TMS and Targets of Opportunity. Measure Space-to-Ground Link Performance (e.g., Pulse Dispersion an Attenuation

MCDONNELL DOUGLAS

VGB408

LARGE SPACE STRUCTURES CONTROL EXPERIMENTS MISSION (TGN001, PRIORITY 3)

OBJECTIVE — To Validate Large Space Structures Modeling and Controlling Techniques

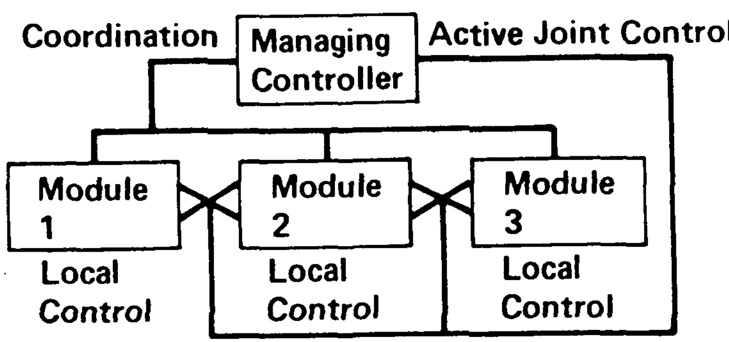
BENEFIT — Provides Test Data Leading to Better Control Performance for Growth Space Stations and Attached Payloads

CRITICAL ENVIRONMENTS — Low-g, Low Aero Damping, Large Test Volume, Low Vibration, Space Thermal Environment

SPACE FACILITY REQUIREMENTS
- Mounting Mechanisms
- Construction and Deployment
- Data Monitor and Test Control

MISSION/HARDWARE
- IOC 1992
- Large Deployed Volume
- More Than One Mission

Example Test Architecture



MISSION DESCRIPTION — Experiment With Large Structures With Distributed Actuators and Sensors. Sensor Outputs Used for System Identification and Control Feedbacks. Thermal and Mechanical Disturbances to be Evaluated. Low-g Environment Allows Nonlinear Structural Characteristics to be Evident

ZERO-G ANTENNA RANGE
(TGN002, PRIORITY 2)

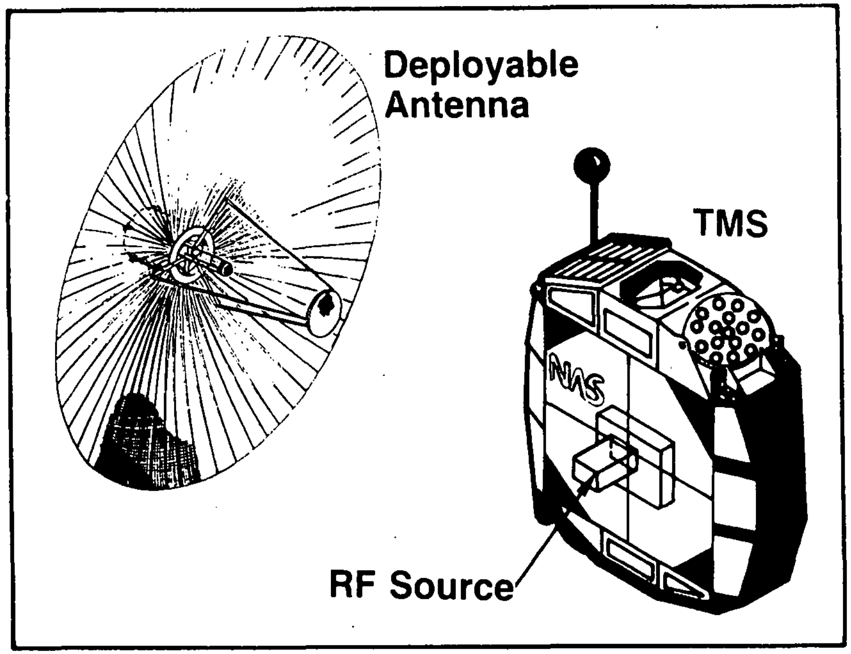
OBJECTIVE
- Evaluate Performance and Measure Antenna Pattern of Spacecraft Antennas

BENEFIT
- Improved Performance/Life Cycle Cost of COMSATS and Imaging Radar Satellites (e.g., SEE001, Ocean Payload) by Elimination of Ground Test Constraints

CRITICAL ENVIRONMENTS
- Zero-g, Reflection-Free Environment

SPACE FACILITY REQUIREMENTS
- TMS
- Attitude Stability/Knowledge
- Crew Interaction
- 10-Day Mission/Year

MISSION HARDWARE
- TMS-Mounted RF Source
- Deployable Antenna
- Optical Alignment Tools



MISSION DESCRIPTION
- Deploy Antenna on Station; Use TMS at Far-Field Range to Measure Antenna Radiation Patterns. Use Optical Tools to Measure Reflector Dimensional Accuracy

MCDONNELL DOUGLAS

VGB404

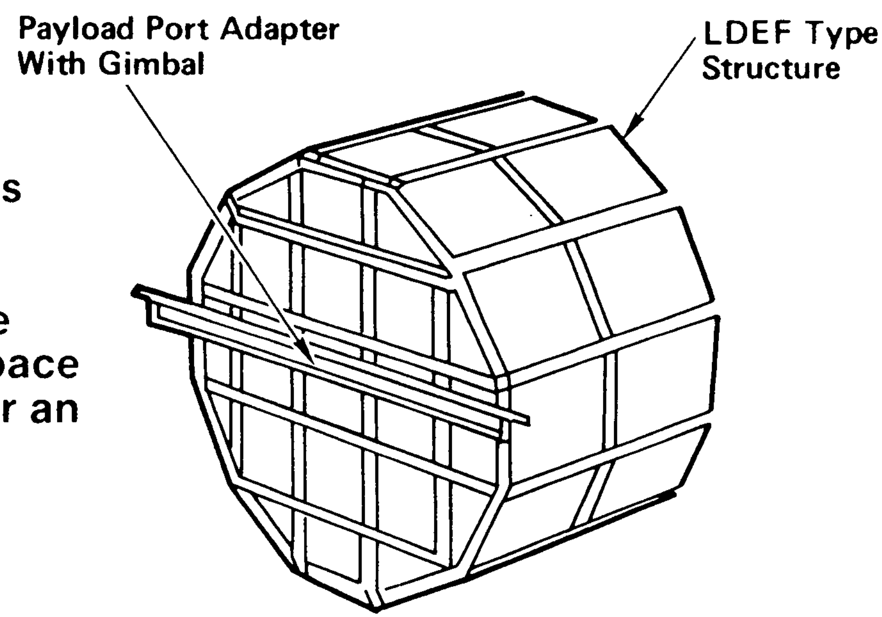
MATERIALS AND COATINGS TECHNOLOGY MISSION
(TGN003, PRIORITY 4)

OBJECTIVE — Determine the Space Environment Effects on Critical Physical Properties of Various Materials and Coatings
BENEFIT — Provide Realistic and Low-Cost Data on Long-Term Exposure to Combined Space Environments (Vacuum, Radiation, Temp, and Effluents); Lead to More Cost-Effective Spacecraft/Advanced Space Stations

CRITICAL ENVIRONMENTS — Long-Term Exposure to the Combined Natural and Induced Space Environments
SPACE FACILITY REQUIREMENTS
- 5-Yr Duration
- Manned Interaction/Support
- Controlled Proximity to Environmental Contamination Sources

MISSION/HARDWARE
- IOC 1992
- LDEF-Type Carrier
- Various Material/Coating Experiments
- Instrumentation
- 1400 kg

MISSION DESCRIPTION — Expose the Material/Coating Experiments to the Space Environment in Varying Orientations for an Extended Period of Time. Periodic Measurements Will be Reocrded to Establish Time-Integrated Cumulative Effects on the Measured Physical Parameters



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TETHER DYNAMICS MISSION

(TGN004, PRIORITY 3)

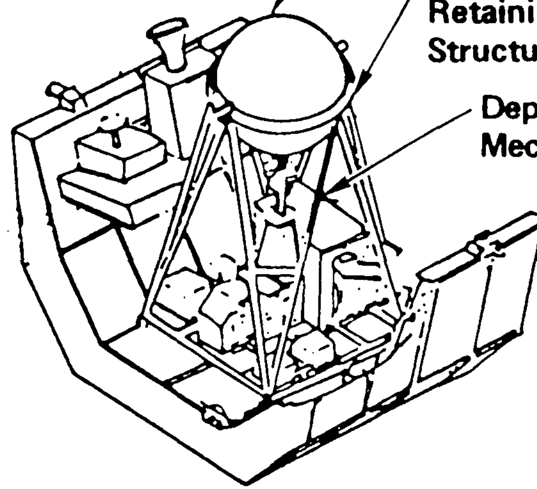
VGB409

OBJECTIVE — Test Electrodynamic Force Characteristics of Conducting Tethers

BENEFIT — Data Base and Theory Validation for Conducting Tethers With Potential for Application to Space Station Station-Keeping

CRITICAL ENVIRONMENTS — Needs Realistic Low-g, Gravity Gradient, Thermal, Electromagnetic, Large Test Volume, and Atmospheric LC Drag of Space

SPACE FACILITY REQUIREMENTS
- Stable Earth Referenced Orientation for Several Orbits
- Tether and Spacecraft Visible from Space Station
- 30-Day Duration for Two Separate Missions



MISSION/HARDWARE
- IOC 1992
- 250 kg
- 1 Pallet

MISSION DESCRIPTION — Deployment and Retrieval Tests of Electrodynamic Forces for Tether Control, and Thrust and Drag Generation

MCDONNELL DOUGLAS

VGB401

LARGE SPACE STRUCTURE CONSTRUCTION

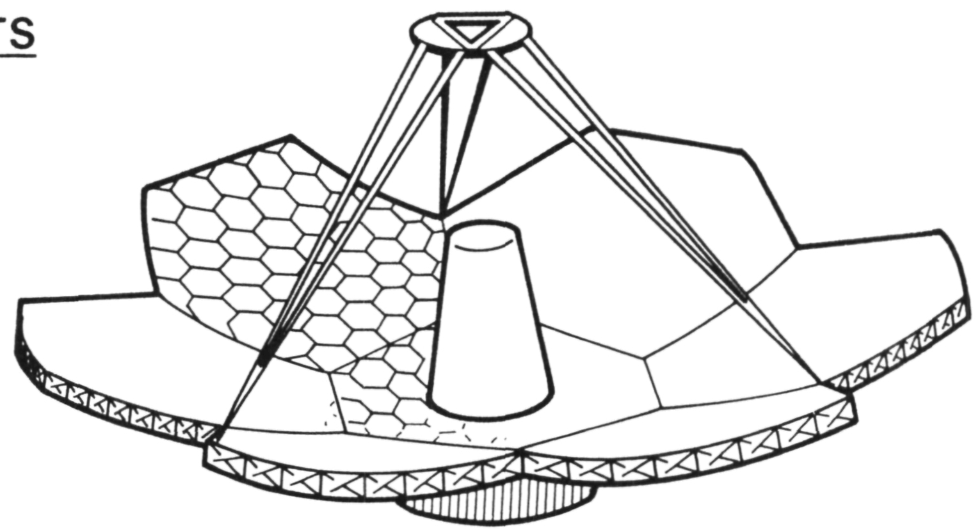
(TGN005, PRIORITY 1)

OBJECTIVE — Provide a Technology Base for Design/Analysis of Very Large Space Structures

BENEFIT — Future Space Missions Depend on Assembly and Testing of Very Large, Lightweight Space Structures (e.g., Stellar Astronomy Using the NASA Large Deployable Reflector Optics Concept)

CRITICAL ENVIRONMENTS — 10^{-6} to 10^{-3} g's, Vacuum and Space Radiation

SPACE FACILITY REQUIREMENTS
- Unlimited Space
- Stable Platform
- Remote Manipulator/EVA
- Crew, 60 Manhours/Mission



MISSION/HARDWARE
- IOC 1992
- 600 kg
- Deployable and Erectable Structural Elements
- Instrumentation

MISSION DESCRIPTION — Launch Packaged Structural Elements and Modules for Assembly of a Portion of a Large Space Structure Using the Manipulator and EVA Crewmen. Accomplish Structural Response Testing to Determine Mode Shapes, Damping/Influence Coefficients, and Other Design Parameters

MCDONNELL DOUGLAS

VGB537

FLUID STORAGE AND MANAGEMENT MISSION
(TGN006, PRIORITY 1)

OBJECTIVE — Demonstrate Cryogenic Fluid Storage, Acquisition, and Transfer

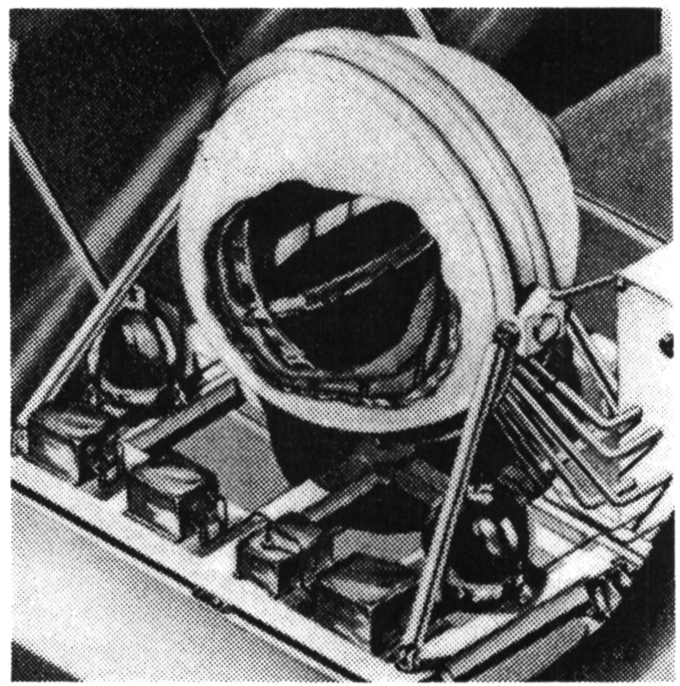
BENEFIT — Cryogenic ROTV Depot - Cost, Weight, and Reliability (Eliminate Artificial gs)

CRITICAL ENVIRONMENTS — 10^{-6} to 10^{-5} g; 10^{-4} to 10^{-3} Transients; Heat Flux and Vacuum

SPACE FACILITY REQUIREMENTS
- 10^{-6} to 10^{-3} gs (Quasi-Controllable)
- Crew Interaction/Support
- 6-Month Duration

MISSION/HARDWARE
- IOC 1992
- Subcritical LH_2Tanks (2)
- 2000 kg
- 1 pallet

MISSION DESCRIPTION
Stabilize LH_2 in Tank With Various Steady State and Transient g-Levels and Solar Heating; Measure Fluid Transfer and Long-Term Storage Performance



LIQUID DROPLET RADIATOR MISSION

(TGN007, PRIORITY 4)

MCDONNELL DOUGLAS

VGB409A

OBJECTIVE — Demonstrate Liquid Droplet Radiator (LDR) Operation in Space

BENEFIT — Enables Significant Heat Rejection Capability for Spacecraft. Reduces Weight by Factor of 3 to 5

CRITICAL ENVIRONMENTS — LEO Atmosphere and Microgravity

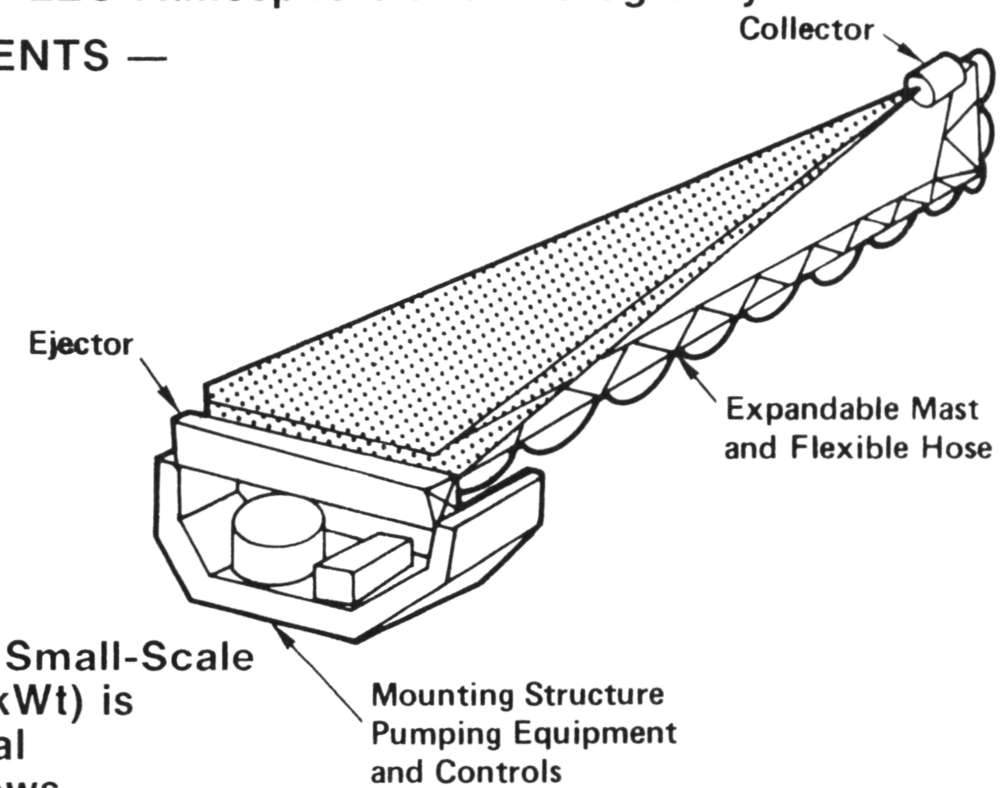
SPACE FACILITY REQUIREMENTS —

- 30 to 90-Day Duration
- 10^{-6} to 10^{-3} g's
- 10^{-6} to 10^{-7} torr, Vacuum
- 20 x 3 x 3m Deployed Volume
- LEO Plasma

MISSION/HARDWARE

- IOC 1994
- Small-Scale Prototype
- 200-W Average Power
- 400 kg
- 1/2 Pallet Launch Volume

MISSION DESCRIPTION — A Small-Scale Electrically Heated LDR (~ 2 kWt) is Deployed and Tested at Several Ejection Temperatures and Flows. Temperatures, Flows, Pressures, Fluid Loss, and Contamination of Adjacent Test Surfaces are Measured



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EC/LS WASTE WATER RECOVERY MISSION (TGN008 PRIORITY 2)

VGB405

OBJECTIVE — Demonstrate Water Recovery Operation in Space

BENEFIT: Long-Duration Mission Life Cycle Cost Reduction Due to Reduced Resupply Weight and Volume

CRITICAL ENVIRONMENTS — Microgravity for Extended Duration

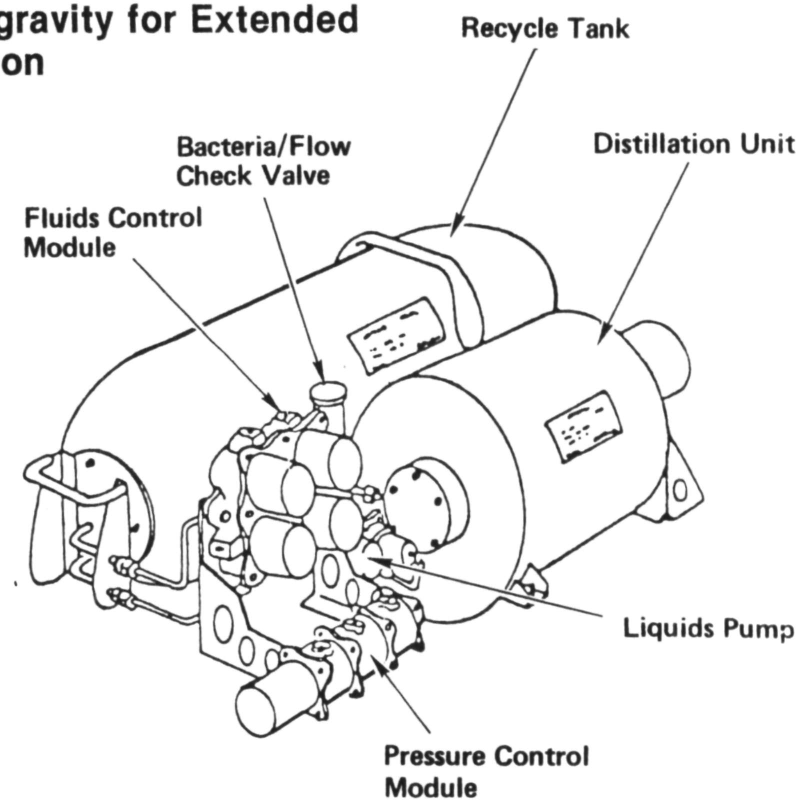
SPACE FACILITY REQUIREMENTS

- 30- to 90-Day Duration
- 10^{-6} to 10^{-5}g
- Pressurized Cabin
- Crew Metabolism

MISSION/HARDWARE

- IOC 1990
- Weight 70 kg
- Power 100 W

DESCRIPTION — A Small-Scale Prototype Vapor Compression Water Recovery Unit to Handle 6 Crewmen. The Unit Would Provide Station Drinking Water as Long as Monitoring Instrumentation Indicates Potability



EC/LS O_2 RECOVERY MISSION
(TGN009, PRIORITY 2)

OBJECTIVE — Demonstrate Oxygen Recovery Operation in Space

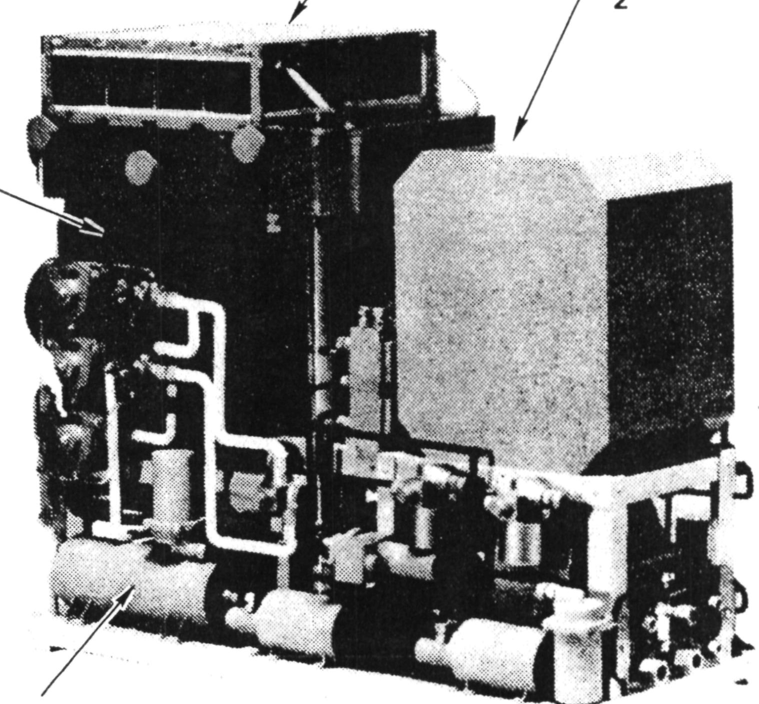
BENEFIT — Long-Duration Manned Mission Life-Cycle Cost Reduction Due to Reduced Resupply Weight and Volume

CRITICAL ENVIROMENTS: Microgravity for Extended Duration

SPACE FACILITY REQUIREMENTS
- 30- to 90-Day Duration
- 10^{-6} to 10^{-5} g
- Crew Metabolism
- Pressurized Cabin

MISSION/HARDWARE
- IOC 1993
- Small Scale Prototype

DESCRIPTION — A 1-Crewman Rated Unit Run in Parallel With the Station Atmosphere Revitalization System. Consists of an Electrochemical Depolarized CO_2 Concentrator, Sabatier CO_2 Reduction Subsystem, Electrolysis O_2 Generator, and Dedicated Microprocessor Controller



MCDONNELL DOUGLAS

VGB465

SATELLITE SERVICING TECHNOLOGY
(TOP001 PRIORITY 1)

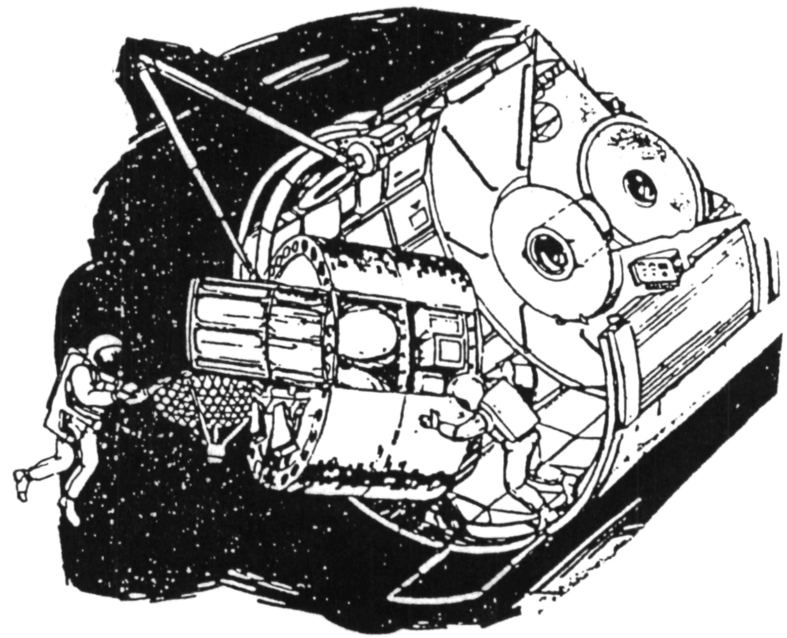
MISSION OBJECTIVES
- Develop On-Orbit Satellite Servicing Technology for Free Flying and Space Platform Payloads

BENEFIT
- Space Program Cost Improvements by Developing Technology for Satellite Servicing

CRITICAL ENVIRONMENT
- Operation Orbit Characteristics

SPACE FACILITY REQUIREMENTS
- Satellite Service Module/Platform
- 60-Day Mission Duration
- TMS and/or EVA Equipment

MISSION/HARDWARE
- IOC 1992
- Servicing Tools/Fixtures; Instruments
- Satellite Mockups



MISSION DESCRIPTION
- Conduct Tests Using Manned and/or Automated Facilities for Subsystem Module Replacement, Checkout, Grapple/Attachment Techniques, Fluid Transfer, Servicing, and Repair of Satellites

MCDONNELL DOUGLAS

VGB466

OTV SERVICE TECHNOLOGY
(TOP002 PRIORITY 1)

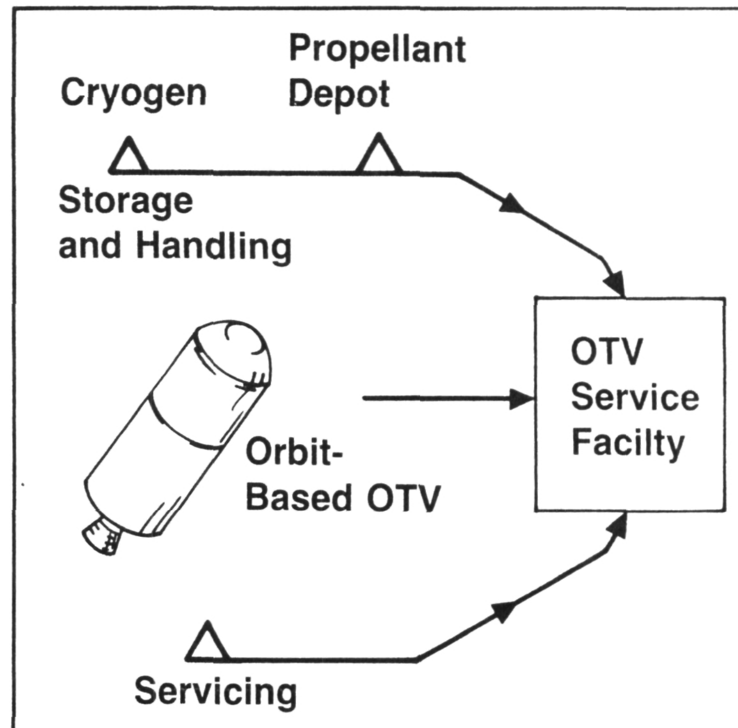
MISSION OBJECTIVE
- Develop Technology Required to Maintain Orbit Transfer Vehicles (OTV) On-Orbit Between Flights

BENEFIT
- Space Program Cost Improvements by Developing Technology for Servicing and Maintaining the OTV at the Space Station

CRITICAL ENVIRONMENT
- Operational Orbit Characteristics

SPACE FACILITY REQUIREMENTS
- OTV Service Depot/Platform; TMS and/or EVA Equipment Mission/Hardware
- IOC 1992
- Tools and Handling Equipment

MISSION DESCRIPTION
- Technology Development Associated with Manned OTV Service Operations Including Refueling, Gaging, and Preservation of Propellants, Maintenance. Replacement and Checkout of Components, Installation, Integration, and Checkout of OTV and Other Stages and Payloads



MCDONNELL DOUGLAS

CREW/MANIPULATOR CONTROLS

VGB402

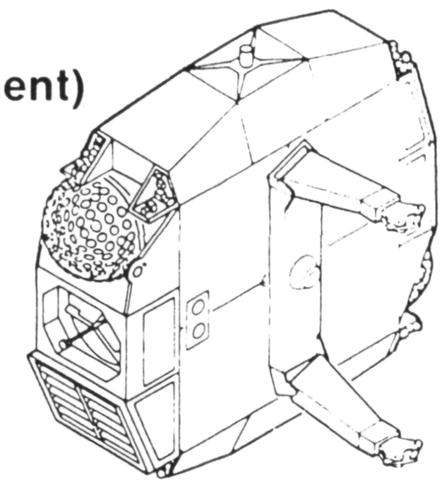
(TOP003, PRIORITY 3)

OBJECTIVE — To Obtain Space Performance Data for: (1) Dual Arm Teleoperator Manipulators and (2) Integrated Manipulator/TMS Systems

BENEFITS — Space Program Cost/Performance Improvements (e.g., Dedicated Satellites and Space Platforms) Via Understanding of Teleoperator Utility/Performance Capability (vs EVA)

CRITICAL ENVIRONMENTS — Microgravity; TMS/Manipulator/Satellite Control Interactions in 6 Degree-of-Freedom Environment

SPACE FACILITY REQUIREMENTS
- Zero G Space Station Laboratory (Shirt-Sleeve Environment)
- Crew/Control Interactions
- TMS System



MISSION/HARDWARE
- Remote Manipulator Test System
- Laboratory Control and Display System
- Manipulator End-Effectors for TMS
- Task Boards/Satellite Substitutes
- TMS/Manipulator Control Station

MISSION DESCRIPTION — Initial Testing of Operator/Manipulator Capabilities in Space Station O-G Laboratory; Subsequent Testing of Manipulator System on TMS in Conjunction With Satellite Substitute

MCDONNELL DOUGLAS

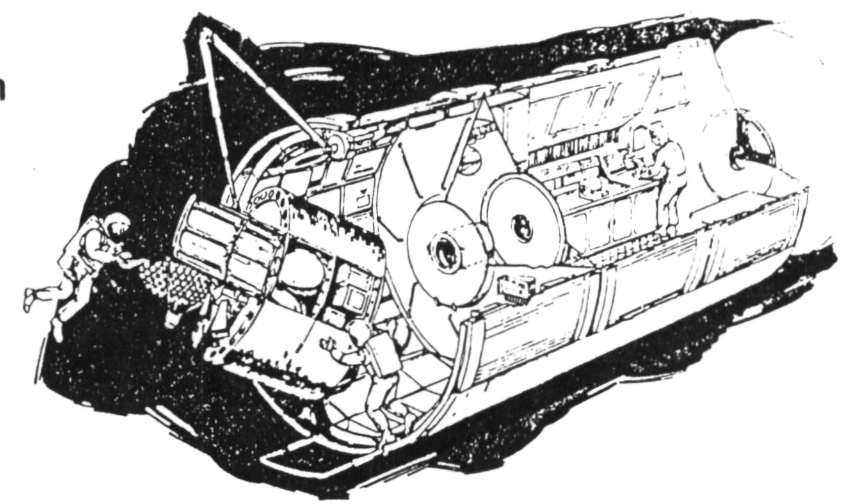
VGB399

MAN'S ROLE IN SPACE
(TOP004, PRIORITY 1)

OBJECTIVE — Establish Effects of Extended Spaceflight on Men's Sensory, Cognitive, and Psychomotor Behaviour

BENEFIT — Specifications for Optimal Design of Future Systems

CRITICAL ENVIRONMENTS — Extended Duration ;in Weightlessness of Space



SPACE FACILITY REQUIREMENTS —
Dedicated Volume (1000 ft^3) Isolated From Visual and Auditory Distractions
Habitability Module and Life Support Facilities Missions to 180-Day Duration

MISSION/HARDWARE (IOC 1992) —
Psychophysical Measurement Equipment
TV Cameras
Video Tape Recorders
Control/Display Consoles
Task Boards and Various Performance Aids

MISSION DESCRIPTION — Investigate: Human Capabilities to Perform Complex Tasks in Space; Acquisition and Retention of Critical Skills; Problems of Locomotion and Restraint; Work-Rest-Sleep Cycles; and Design of Performance Aids

MCDONNELL DOUGLAS

VGB462

EVA CAPABILITY TECHNOLOGY MISSION

OBJECTIVE

- Establish Capabilities/Limits for EVA Crewman to Perform Work in Space

BENEFIT

- More Cost Effective Spacecraft Via Optimum Application of EVA to Facilitate Various Spacecraft Operations (i.e., Deployment, Construction, Servicing, and Maintenance)

CRITICAL ENVIRONMENTS

- Zero g, Thermal/Vacuum, and Lighting

SPACE FACILITY REQUIREMENTS

- Multiple 2-Crewman, 6 Hour EVA Missions
- Space Shuttle Support
  - — 8 psia Suit
  - — RMS Assist
  - — Video Coverage
  - — Manned Support (Personnel and Equipment)

MISSION/HARDWARE

- IOC 1985
- EVA Support Equipment
- Various Task Hardware
- Shuttle Mission Planning

MISSION DESCRIPTION

- Perform Various EVA Tasks Which Have Been Previously Developed in a Simulated 0-g Environment to Expand/Define EVA Capabilities/Limits

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