CONTRACT NAS9-9953 MSC 02472
DRL NO: MSC-T-575, LINE ITEM 69

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~~NASA CR-115306~~

SD 71-219

MODULAR space station

PHASE B EXTENSION

MASS PROPERTIES FINAL REPORT

PREPARED BY PROGRAM ENGINEERING
5 NOVEMBER 1971

Space Division
North American Rockwell
12214 LAKEWOOD BOULEVARD
DOWNEY, CALIFORNIA 90241

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Approved by

Earl G. Cole

E.G. Cole
Program Manager
Space Station Program

Space Division
North American Rockwell

12214 LAKEWOOD, BOULEVARD, DOWNEY, CALIFORNIA 90241

FOREWORD

This document is one of a series required by Contract NAS9-9953, Exhibit C, Statement of Work for Phase B Extension-Modular Space Station Program Definition. It has been prepared by the Space Division, North American Rockwell Corporation, and is submitted to the National Aeronautics and Space Administration's Manned Spacecraft Center, Houston, Texas, in accordance with the requirements of Data Requirements List (DRL) MSC-T-575, Line Item 69.

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

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

This document is the final mass properties report of the Modular Space Station Phase B preliminary design.

TECHNICAL REPORT INDEX/ABSTRACT

ACCESSION NUMBER							DOCUMENT SECURITY CLASSIFICATION	

TITLE OF DOCUMENT

MODULAR SPACE STATION MASS PROPERTIES FINAL

LIBRARY USE ONLY

AUTHOR(S)

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DESCRIPTIVE TERMS

Modular Space Station Mass Properties

ABSTRACT

This report is the final mass properties for the Modular Space Station Program, Phase B Definition. The configuration used is the preliminary design configuration from the study.

CONTENTS

ILLUSTRATIONS

TABLES

1.0 INTRODUCTION & SUMMARY

1. INTRODUCTION AND SUMMARY

This report presents the final mass properties for the Modular Space Station Program Phase B Definition. The format of the document facilitates the review of the mass properties by following the intent of MIL-M-38310A (USAF). The new MSC Summary Weight Statement form was used as requested to report Modular Space Station Summary Weights. The new MSC group weight statement forms with design data summaries were used as requested to report Modular Group Weights. All weights reported are target weights.

The modular Space Station used for determining the mass properties was the preliminary design configuration from the study.

During the study phase, the weights were coded by the NR functional breakdown so that the data could be used directly by cost analyses and by project for group responsibility status weights. The first tables in this introduction present the summary of these weights while the main body of this report is coded by MSC (NASA) coding.

INITIAL SPACE STATION CONCEPT

The MSS system consists of a cluster of four common station modules, two special modules (core and power), and a cargo module arranged in a cruciform configuration as shown in Figure 1-1 and with dimensional characteristics as shown in Figure 1-2. Each module of the system is capable of being transported to and from orbit internal to the space shuttle for on-orbit assembly.

The initial station system has the capability to support at least six crewmen, has a general purpose laboratory (GPL) capability, and has the ability to accommodate two attached or detached research and application modules. The GPL capability includes two airlocks, one earth oriented, and the other zenith oriented.

The MSS system is designed and sized for operation at an altitude of 240 nm and an inclination of 55 degrees. The basic flight mode is with the X-axis perpendicular to the orbit plane, the Z-axis along the local vertical, and the Y-axis opposite to the velocity vector (X-POP, Z-LV, Y-OVV). This mode will be flown at all times except for short periods of inertial flight for solar/stellar viewing and shuttle approach and berthing/unberthing operations. The system is capable of operating at altitudes between 240 and 270 nm at an inclination of 55 degrees in either a local vertical hold or inertial hold flight mode.

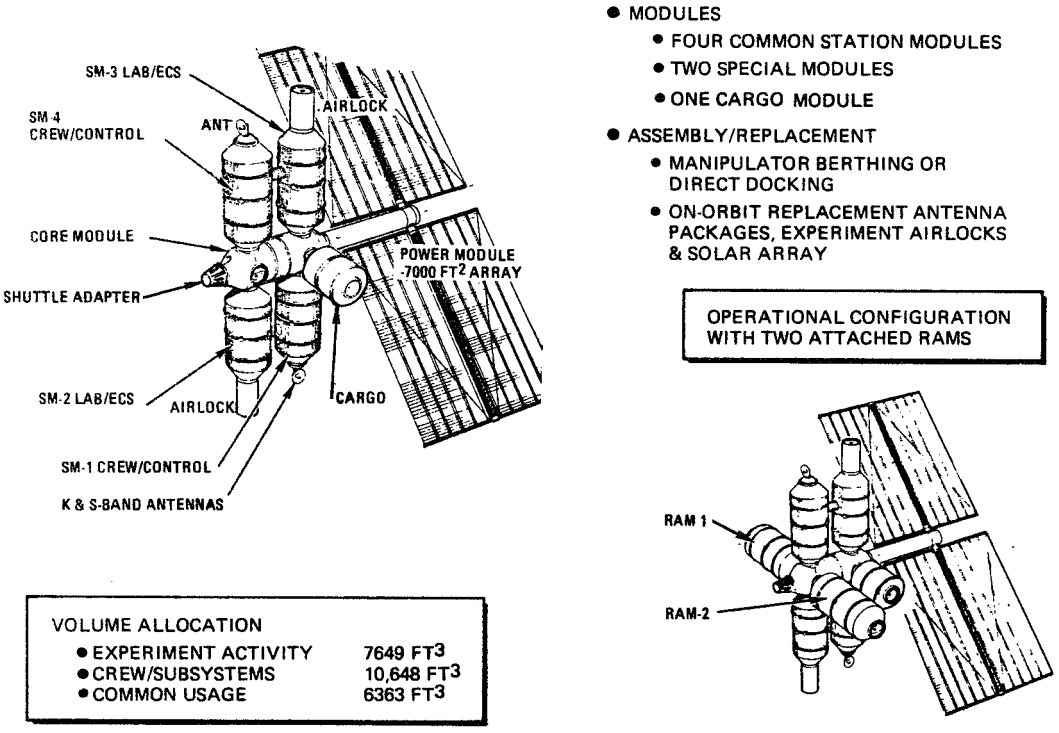


Figure 1-1. Space Station Configuration

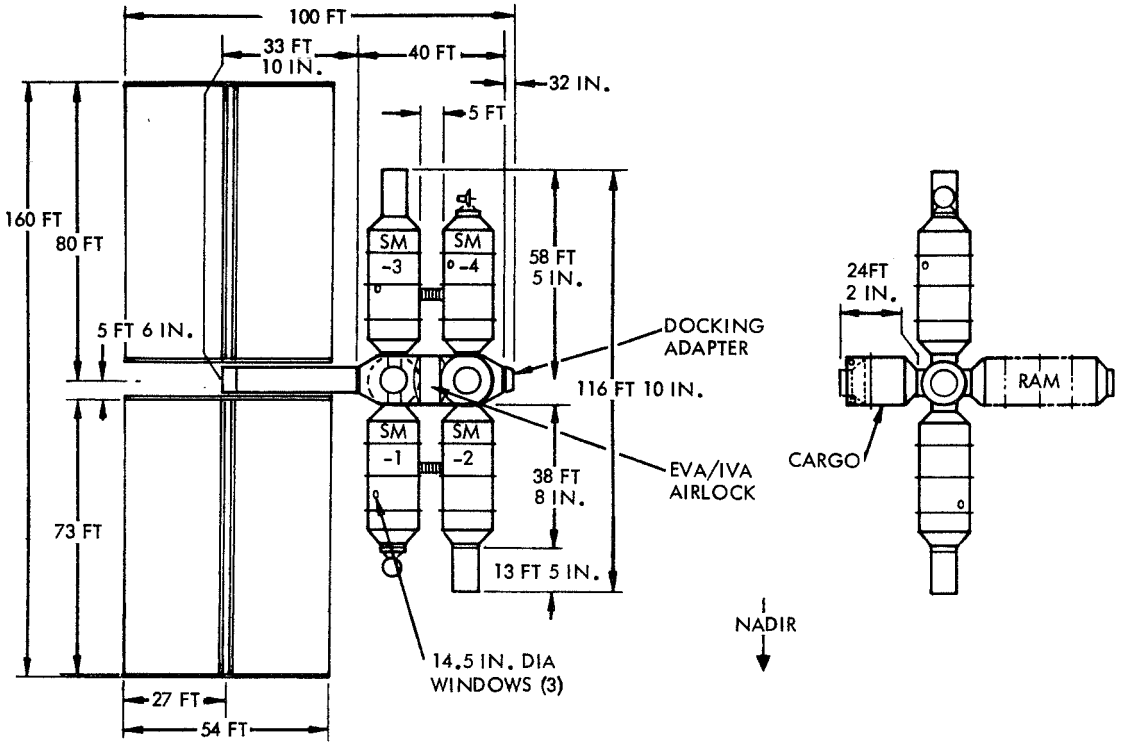


Figure 1-2. Station Dimensional Characteristics

Initial Space Station Buildup

The Modular Space Station Buildup phase begins with the shuttle launch and delivery to orbit of the first module.

Seven module launches, Figure 1-3 and 1-4 are required to reach the Initial Operational Capability (IOC) of the six-man space station. All initial manning capability exists following the fourth launch. The modular cluster at this point has a minimum of one complete set of subsystems, Volume 1 (V_1) and Volume 2 (V_2), and dual egress capability. This assembly of modules also includes part of the GPL capability.

Space Station Subsystems

The space station system contains seven functional subsystems as shown in Figure 1-5. A brief functional description of the subsystems is presented in the following paragraphs.

Structural and Mechanical Subsystems

The structural and mechanical subsystem provides the space station pressure enclosure as well as the living and working quarters contained within the structure. It provides for the mounting of associated subsystem hardware and the general purpose laboratory provisions and provides storage facilities. It also provides berthing ports and mechanisms for crew and equipment transfer.

Environmental Control Life Support Subsystem

The environmental control life support subsystem (ECLSS) provides essential atmospheric gases, temperature, pressure, and humidity control, food storage and preparation provisions, water and waste management, and personal hygiene facilities and materials for modular space station operation with a crew of six. The subsystem maintains thermal balance of the MSS as well as emergency reactant storage for the electrical power and reaction control subsystems. In addition, special life support capabilities are provided for emergency conditions.

Electrical Power Subsystem

The electrical power subsystem shall store, generate, regulate, control, and condition electrical power required by the MSS for the full duration of the mission, including backup and emergency contingencies (except for emergency fuel cell reactants which are stored by the ECLSS). In addition, the electrical power subsystem shall be capable of transferring power to docking logistics vehicles and research and applications modules through electrical interfaces, besides power distribution, the electrical power subsystem provides the electrical distribution wiring of all subsystem interfaces.

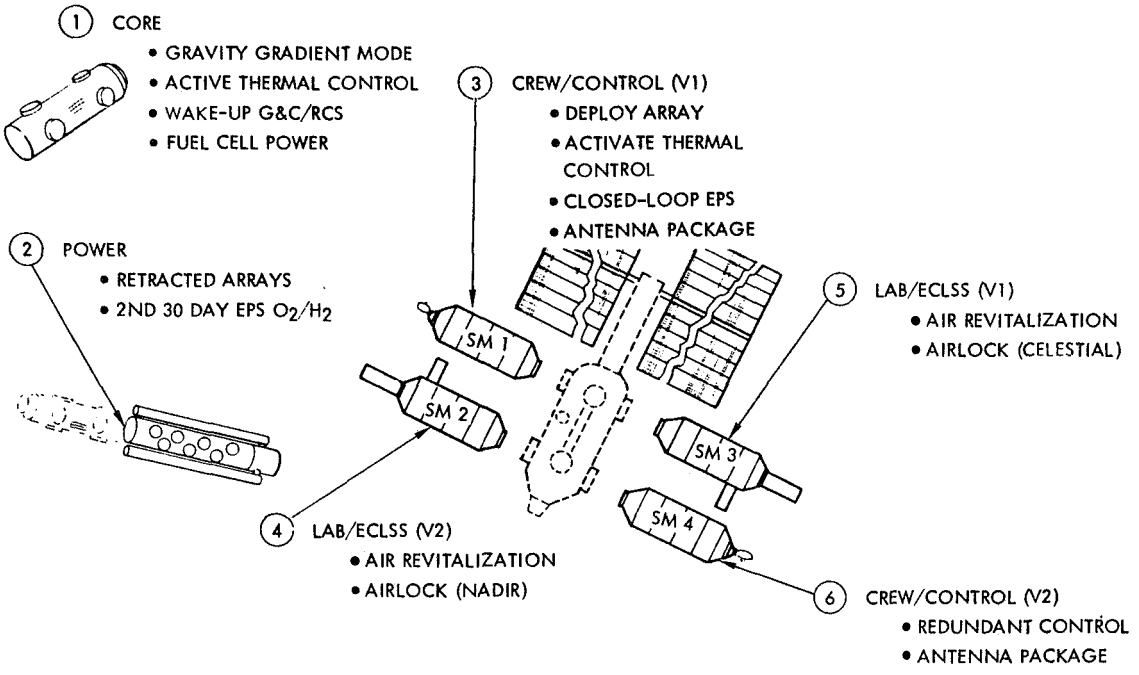
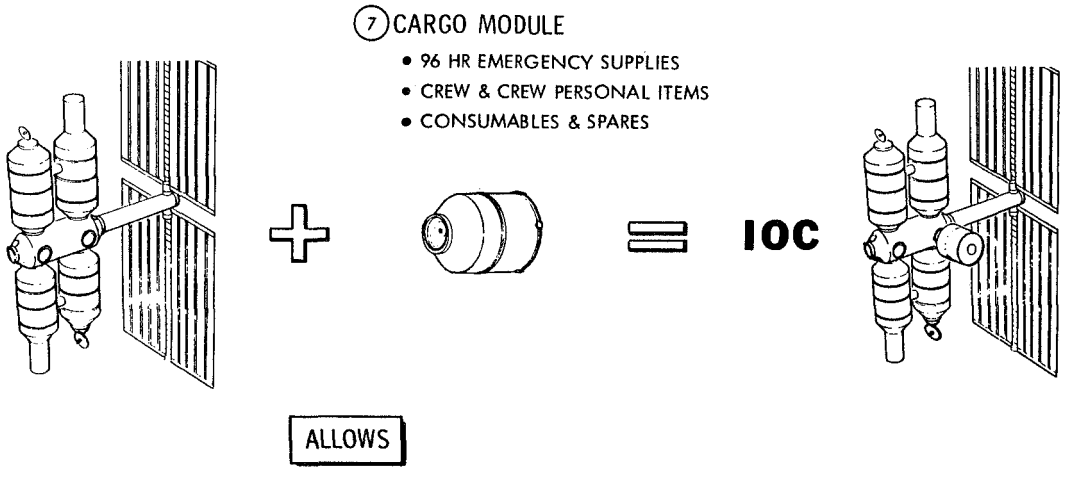


Figure 1-3. Initial Station Buildup Approach



ALLOWS

- SIMPLE LIGHTWEIGHT POWER BOOM
- MINIMUM SUBSYSTEM SCAR
- EARLY MANNED CAPABILITY

Figure 1-4. Initial Operating Capability (IOC)

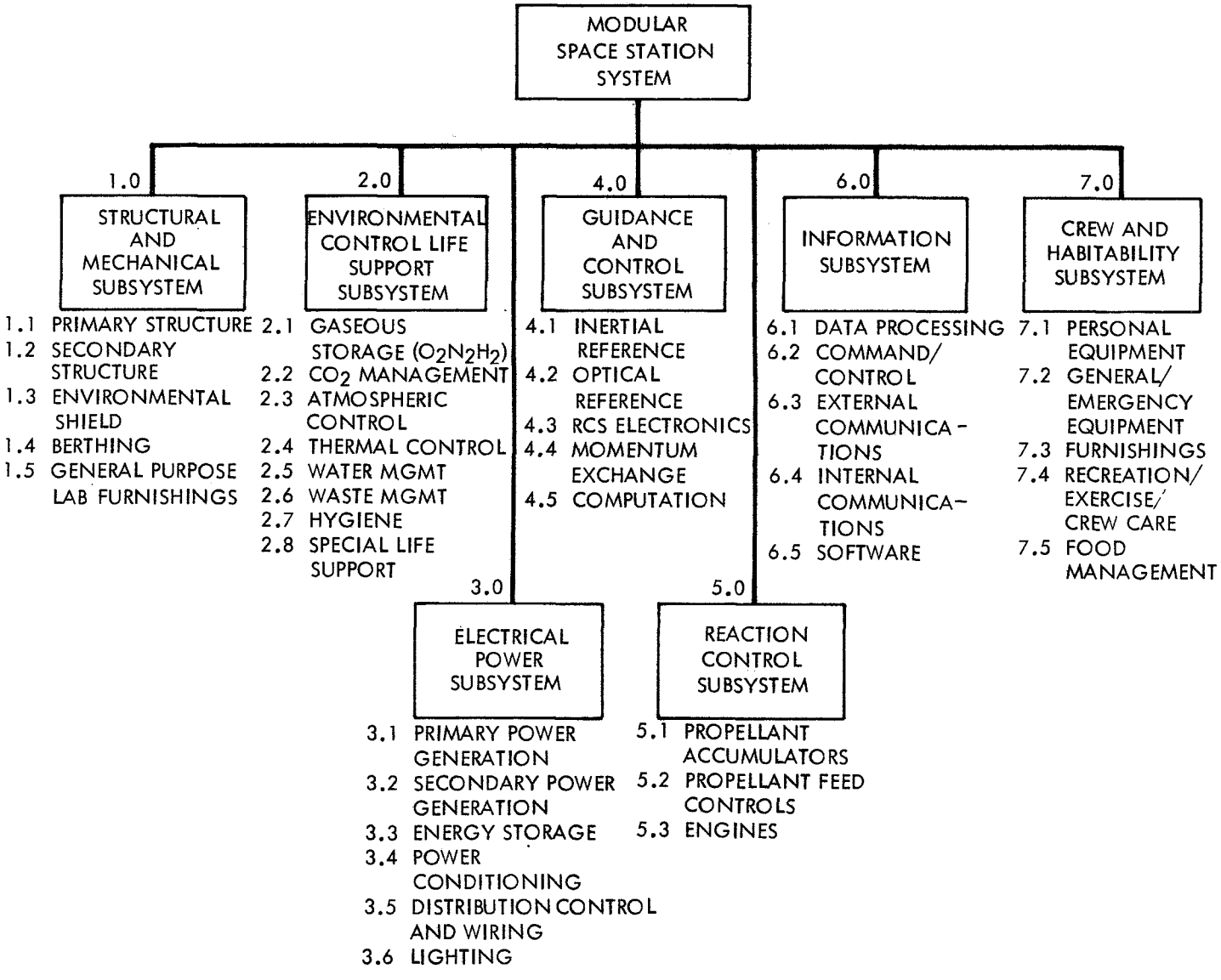


Figure 1-5. Space Station Subsystems

The electrical power subsystem shall provide for the general lighting needs throughout the interior and exterior of the space station.

Guidance and Control Subsystem

The guidance and control subsystem (G and C) determines the actual and desired station state vector, provides stable attitude for the conduct of experiment operations, and provides commands to the reaction control subsystem to maneuver the station to the desired state vector.

Reaction Control Subsystem

The reaction control subsystem (together with the torques supplied by the control moment gyroscopes) provides the forces and moments necessary for attitude control of the space station and those forces required for orbit altitude maintenance.

Information Subsystem

The MSS information subsystem provides the effective acquisition, processing, distribution, and analysis of data. It serves mission planning and operations scheduling, command control, checkout, monitor and alarm, configuration control, inventory control, flight control, data management, support between MSS subsystems, the ground network, docked vehicles (space shuttle, RAM's, and cargo modules), integral experiments and the crew using communications, displays and controls, data processing, software, and special support equipment.

Crew Habitability Subsystem

The crew habitability subsystem specifies metabolic, atmospheric, and habitability criteria and provides food supplies, clothing and furnishings necessary for crew comfort, well being, and survival. The subsystem provides general equipment including tools, mobility aids, emergency O_2 masks and radiation monitoring devices for the crew. In addition, equipment is provided for crew recreation, exercise, and medical care. The subsystem also provides pressure suits, portable life support systems, and related equipment for EVA/IVA operations.

System Weight

MSS system weights are built up in three distinct levels depicted in Figure 1-6, Design-to-Weight, Closeout Weight, and Shuttle Payload Weight. Shuttle payload weight is the maximum allowable payload launch weight of a module.

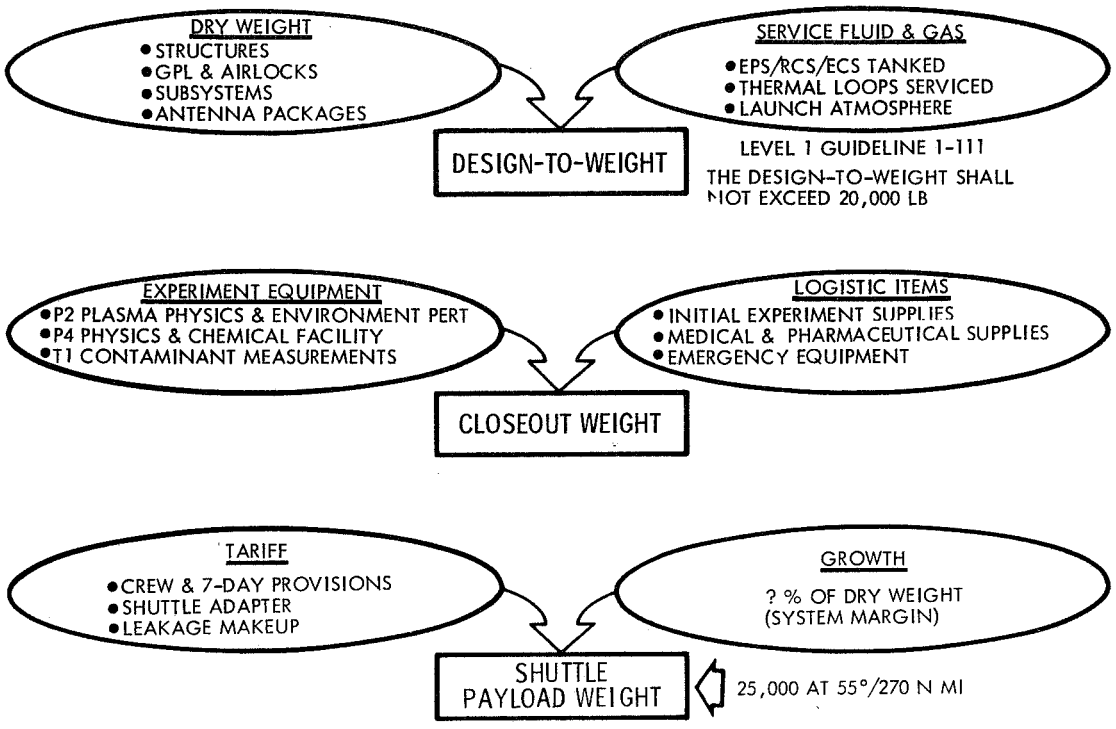


Figure 1-6. System Weight

The 20,000 pound design-to-weight is comprised of both dry weight and the fluids and gases required to make the modules operational. This design-to-weight includes both airlock and antenna packages as well as the entire GPL furnishings.

Experiment equipment, supplies, and crew logistic items are added to select modules to provide a fully operational facility when manned. The resultant closeout weight also was held to the 20,000 pound guideline. This closeout weight represents the current module launch weight at this point in the development schedule. The closeout weights include all hardware items and the necessary mounting provisions. Shuttle payload weight must include tariff items due to the buildup operations. The difference between the closeout weight plus the tariff items and the shuttle payload weight is the system margin allocated for weight growth as the program matures from Phase B to Phase D. The system weight summary is presented as Table 1-1.

The shuttle design reference mission (DRM) baseline configuration (Figure 1-7) has the ability to insert a 20,000 pound target payload weight into orbit, executing various maneuvers and finally deorbiting and landing using 27,730 pounds of OMS + ACPS propellant. Two of the normal on-orbit maneuvers include rendezvous and docking which consume nearly 5,000 pounds of OMS propellant.

Table 1-1. System Weight Summary

CATEGORY	CORE	POWER	SM-1	SM-2	SM-3	SM-4	TOTAL
	* 01	02	03	04	05	06	
* 1. STRUCTURAL & MECHANICAL	12690	3670	10160	12330	10700	9490	59040
2. ENVIRONMENTAL CONTROL & LIFE SUPPORT	1619	849	3690	3310	3415	3420	16303
3. ELECTRICAL POWER	3790	7800	1762	545	545	1762	16204
4. GUIDANCE & CONTROL	1470	0	0	0	0	0	1470
5. REACTION CONTROL	180	0	0	153	153	0	486
6. INFORMATION	462	116	2740	134	161	2640	6253
7. CREW & HABITABILITY	733	125	503	233	1271	990	3855
SUBSYSTEM DRY WEIGHT	20944	12560	18855	16705	16245	18302	103611
8. SERVICE FLUIDS & GASSES	1004	956	1131	699	699	1131	5620
DESIGN TO WEIGHT	21948	13516	19986	17404	16944	19433	109231
9. EXPERIMENT EQUIPMENT	0	0	0	807	1869	0	2676
10. LOGISTIC ITEMS	0	0	0	414	112	510	1036
CLOSEOUT WEIGHT	21948	13516	19986	18625	18925	19943	112943
11. SHUTTLE TARIFF	1264	2764	2344	2232	2232	2260	
12. WEIGHT GROWTH MARGIN ALLOWANCE	6513	8720	2670	4143	3843	2797	
PAYLOAD LAUNCH WEIGHT	29725	25000	25000	25000	25000	25000	
SPARES & CONSUMABLES CREW & CREW PERSONAL ITEMS		ALL ITEMS DELIVERED VIA CARGO MODULE					

* WORK BREAKDOWN STRUCTURE CODE

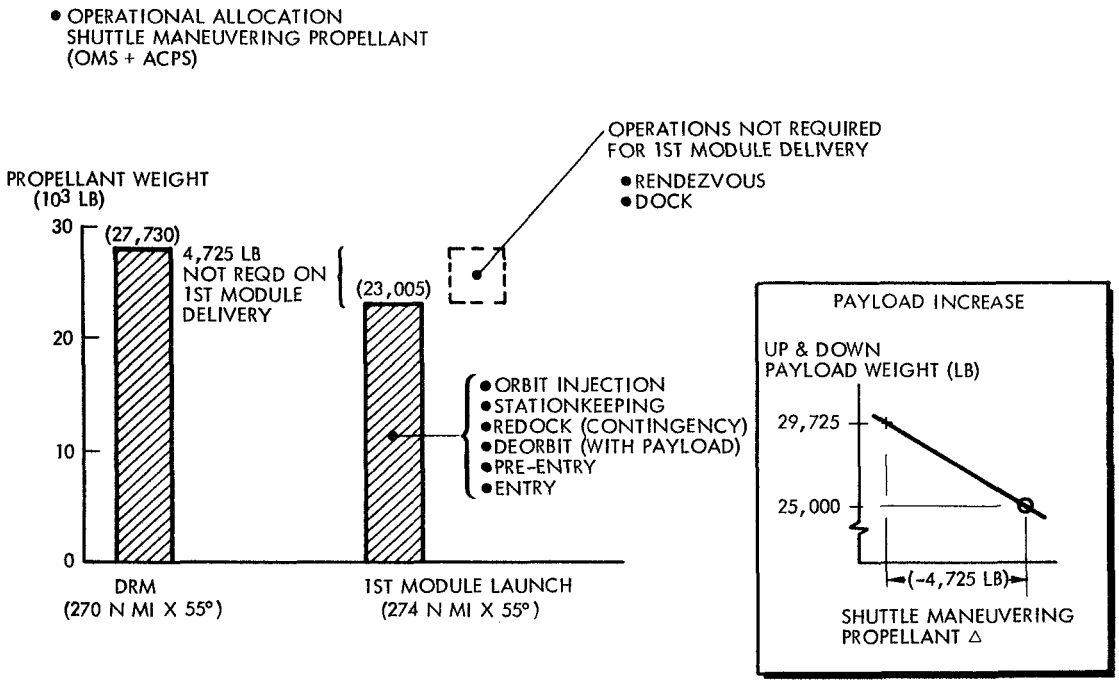


Figure 1-7. MSS Buildup - First Launch Capability

The first MSS launch does not require this propellant allowance since the maneuvers are not required. Even though the first launch is inserted at about 274 nautical miles (and allowed to decay to 270 nautical miles over a 3-month period), the propellant weight saved could be converted to payload weight with no increase in launch vehicle weight or change in ΔV performance. It is therefore shown that the first MSS launch could be targeted for up to 29,725 pounds rather than 25,000 pounds.

A dry weight summary is displayed as Table 1-2. The space station dry weight is apportioned to seven functional subsystem groupings. The two-digit codes are the Level 6 major assemblies. The dry weight includes mounting and installation provisions as well as standard utilities such as wiring, ducts, and tubing.

The number identification is consistent with the MSS program and project level costing.

The operational weight summary is included as Table 1-3. It identifies the weight items that must be added to the dry weight to arrive at the launch weight. The Experiment Equipment (9.0) and Logistic Items (10.0) are the only weights that can be transferred, if necessary, to the cargo module launches.

Shuttle tariff weights are substantial and their addition leaves a weight growth allowance less than prior single launch station growth margins.

Table 1-2. Module Dry Weight Summary

WBS *	SUBSYSTEM/MAJOR ASSEM MODULE WBS *	CORE 01	POWER 02	SM-1 03	SM-2 04	SM-3 05	SM-4 06	TOTAL
1	STRUCTURAL & MECHANICAL	12690	3670	10160	12330	10700	9490	59040
1.1	PRIMARY STRUCTURE	5742	1878	4700	4700	4700	4700	26420
1.2	SECONDARY STRUCTURE	3399	410	3218	3350	3446	3378	17201
1.3	ENVIRONMENTAL SHIELD	1119	582	746	735	746	746	4674
1.4	BERTHING	2430	800	490	490	490	490	5190
1.5	GENERAL PURPOSE LAB FURNISH	0	0	1006	3055	1318	176	5555
2	ENVIRONMENTAL CONTROL/LIFE SUPPORT	1619	849	3690	3310	3415	3420	16303
2.1	GASEOUS STORAGE	42	765	0	11	11	0	829
2.2	CO_2 MANAGEMENT	4	0	4	741	741	4	1494
2.3	ATMOSPHERIC CONTROL	750	84	587	876	876	554	3727
2.4	THERMAL CONTROL	681	0	1969	1570	1570	1969	7759
2.5	WATER MANAGEMENT	20	0	638	23	23	638	1342
2.6	WASTE MANAGEMENT	0	0	86	0	79	163	328
2.7	HYGIENE	0	0	370	27	53	56	506
2.8	SPECIAL LIFE SUPPORT	122	0	36	62	62	36	318
3	ELECTRICAL POWER	3790	7800	1762	545	545	1762	16204
3.1	PRIMARY POWER GEN	0	6676	0	0	0	0	6676
3.2	SECONDAY POWER GEN	0	0	0	0	0	0	0
3.3	ENERGY STORAGE	2449	985	766	0	0	766	4966
3.4	POWER CONDITIONING	379	0	16	16	16	16	443
3.5	DISTRIB. CONTROL & WIRING	776	115	834	383	383	834	3325
3.6	LIGHTING	186	24	146	146	146	146	794
4	GUIDANCE & CONTROL	1470	0	0	0	0	0	1470
4.1	INERTIAL REFERENCE	65						65
4.2	OPTICAL REFERENCE	346						346
4.3	RCS ELECTRONICS	75						75
4.4	MOMENTUM EXCHANGE	984						984
4.5	COMPUTATION	0						0
5	REACTION CONTROL	180	0	0	153	153	0	486
5.1	PROPELLANT ACCUMULATOR				88	88		176
5.2	PROP FEED CONTROLS	60			65	65		190
5.3	ENGINES	120						120
6	INFORMATION	462	116	2740	134	161	2640	6253
6.1	DATA PROCESSING	171	91	692	64	64	692	1774
6.2	COMMAND/CONTROL & MONITOR	59	4	478	40	40	478	1099
6.3	EXTERNAL COMMUNICATIONS	193	0	849	0	0	749	1791
6.4	INTERNAL COMMUNICATIONS	39	21	641	30	57	641	1429
6.5	SOFTWARE	0	0	80	0	0	80	160
7	CREW HABITABILITY	733	125	503	233	1271	990	3855
7.1	PERSONAL EQUIPMENT	0	0	0	0	0	0	0
7.2	GENERAL/EMERG EQUIP	733	125	145	145	145	145	1438
7.3	FURNISHINGS	0	0	220	0	160	206	586
7.4	RECREATION/EXER/CREW CARE	0	0	138	0	210	639	987
7.5	FOOD MANAGEMENT	0	0	0	88	756	0	844
SUBTOTAL (DRY WEIGHT)		20944	12560	18855	16705	16245	18302	103611

* WORK BREAKDOWN STRUCTURE CODE

Table 1-3. Operational Weight Summary

CATEGORY	CORE * 01	POWER 02	SM-1 03	SM-2 04	SM-3 05	SM-4 06	TOTAL
8. SERVICE FLUIDS & GASSES							
REPRESS O_2		194					194
REPRESS N_2		381					381
LAUNCH ATMOSPHERE	285	74	322	322	322	322	1647
ELECTROLYSIS ACCUM. H_2O				50	50		100
INTERNAL THERMAL LOOP H_2O	148		199	98	98	199	742
EXTERNAL THERMAL LOOP FREON	191		604	223	223	604	1845
WATER MANAGEMENT LOOP H_2O	5		6	6	6	6	29
EPS & RCS BUILDUP O_2	333	273					606
EPS & RCS BUILDUP H_2	42	34					76
TOTAL	1004	956	1131	699	699	1131	5620
9. EXPERIMENT EQUIPMENT							
P-2 PLASMA PHY & ENVIR PORT					1003		1003
P-4 PHYSICS & CHEMICAL FACILITY					866		866
T-1 CONTAMINATION MEASUREMENT				807			807
TOTAL	0	0	0	807	1869		2676
10. LOGISTICS ITEMS							
POTABLE H_2O						400	400
96-HR EMERGENCY LiOH				112	112		224
MED. & PHARM SUPPLIES						110	110
P-2, P-4, T-1 EXP CONSUM				302			302
TOTAL	0	0	0	414	112	510	1036
11. SHUTTLE TARIFF							
2 CREW	400	400	400	400	400	400	
2 CREW PROVISIONS	300	300	300	300	300	300	
2 PLSS & 2 PGA	354	354	354	354	354	354	
PASSENGER PROVISIONS	63	155	190	160	160	166	
LEAKAGE MAKEUP O_2/N_2	0	165	180	210	210	210	
SHUTTLE EPS REACTANTS	50	365	495	383	383	405	
Δ TANK WEIGHT	97	425	425	425	425	425	
MSS/SHUTTLE ADAPTER		600					
TOTAL	1264	2764	2344	2232	2232	2260	

* WORK BREAKDOWN STRUCTURE CODE

SUMMARY WEIGHT STATEMENTS

The new MSC Summary Weight Statement form was used to present summary weight statements. The summary weight statement for the Initial Station (6 men) is shown in Table 1-4. These statements and all subsequent forms are in the MSC (NASA) codes. The weight information was coded from the detail functional statements.

The cumulative buildup weight of the initial station for 6 men is shown in Table 1-5. The initial station of 173,543 lbs includes a complete initial station for crew of 6 with logistics and experiments for initial manned operation, two RAM's and one cargo module. The initial cargo module payload will provide crew, initial spares, and supplies. Subsequent cargo module payloads provide additional experiments and resupply spares and consumables. Figure 1-11 presents the external configuration for the initial station.

The cargo module was filled to 20,000 lb target weight and the research and application modules were assigned a 20,000 lb target weight. No modules exceed the target weight and none will have to be off-loaded or equipment reallocated to meet the shuttle payload requirements with growth/margin allowance. Modules that are less than the target weight may be increased by adding additional consumables or experiments weight.

Table 1-4. Initial Station Launch Weight Summary

SPACE DIVISION

NORTH AMERICAN ROCKWELL CORPORATION

SPACECRAFT SUMMARY WEIGHT STATEMENT

CONFIGURATION: Initial Station Launch Weight | BY: Space Station Engineering | DATE: November 1971

CODE	SYSTEM	MODULE A	B	C	D	E	F	G	H
1.0	WING GROUP								
2.0	TAIL GROUP								
3.0	BODY GROUP	9141	2288	7918	8050	8146	8078		43621
4.0	INDUCED ENVIR. PROT.	1119	582	746	735	746	746		4674
5.0	LANDING, RECOV. & DKG	2430	800	490	490	490	490		5190
6.0	PROPULSION ASCENT								
7.0	PROPULSION CRUISE								
8.0	PROPULSION - AUXIL.	1164			153	153			1470
9.0	PRIME POWER	2449	7661	766			766		11642
10.0	ELEC. CONV. & DISTR.	1341	139	996	545	545	996		4562
11.0	HYDRA CONV. & DISTR.								
12.0	SURFACE CONTROLS								
13.0	AVIONICS	948	116	2740	134	161	2640		6739
14.0	ENVIRONMENTAL CONTROL	1477	849	2560	3198	3198	2527		13809
15.0	PERSONNEL PROVISIONS	875	125	2639	3400	2806	2059		11904
16.0	RANGE SAFETY & ABORT								
17.0	BALLAST								
18.0	GROWTH/UNCERTAINTY								
19.0									
	SUBTOTAL (DRY WEIGHT)	20944	12560	18855	16705	16245	18302		103611
20.0	PERSONNEL						510		510
21.0	CARGO				1109	1869			2978
22.0	ORDNANCE								
23.0	RESIDUAL FLUIDS	629	74	1131	699	699	1131		4363
24.0									
	SUBTOTAL (INERT WT.)	21573	12634	19986	18513	18813	19943		111462
25.0	RESERVE FLUIDS		575		112	112			799
26.0	IN FLIGHT LOSSES	375	307						682
27.0	PROPELLANT ASCENT								
28.0	PROPELLANT CRUISE								
29.0	PROPELLANT - AUXIL.								
30.0									
	TOTAL (GROSS WT.) LB.	21948	13516	19986	18625	18925	19943		112943
	WBS CODE	01	02	03	04	05	06		

DESIGNATIONS:

MODULES

A Core Module

B Power Module

C SM-1 Station Module with Ant. Pkg.

D SM-2 Station Mod. with Exp. Airlock Pkg

E SM-3 Sta. Mod. with Exp. Airlock Pkg.

F SM-4 Sta. Mod. with Ant. Pkg.

G

H. Subtotal = A + B + C + D + E + F

NOTES & SKETCHES:

Shuttle Adapter	600
Cargo Mod. with Initial Crew	20000
Two Initial Station RAM's	40000
INITIAL STATION	173543

* MSC (NASA) Codes

** Closeout Weight in NR Functional Code

FORM 3945-A-2 NEW 8-70

Table 1-5. Sequenced Mass Properties

SEQUENCE MASS PROPERTIES STATEMENT

CONFIGURATION: Initial Station Launch Weight | BY: Space Sta. Engr. | DATE: November 1971 | PAGE 1 OF 1

STEP NO.	MISSION EVENT	WEIGHT LB.	CENTER OF GRAVITY INCHES			MOMENT OF INERTIA SLUG FT^2 X 10^{-6}			PRODUCT OF INERTIA SLUG FT^2 X 10^{-6}		
			X	Y	Z	I_{x-x}	I_{y-y}	I_{z-z}	I_{xy}	I_{xz}	I_{yz}
1	Core Module	21948	776.5	- 0.4	0.1						
	Power Module (Retracted)	13516	286.3	0.2	1.5						
2	Sub-Total	35464	589.7	- 0.2	0.6						
	SM-1 Module with Ant. Pkg.	19986	657.0	2.2	-308.9						
	Extend Solar Array	--	*	--	--						
3	Sub-Total	55450	607.4	0.7	-111.0						
	SM-2 Module with Airlock	18625	895.6	1.0	-326.2						
4	Sub-Total	74075	679.9	0.8	-165.1						
	SM-3 Module with Airlock	18925	658.0	0.8	333.8						
5	Sub-Total	93000	675.4	0.8	- 63.6						
	SM-4 Module with Ant. Pkg.	19943	893.6	1.8	309.2						
6	Sub-Total	112943	713.9	0.9	2.2	2.26	3.51	1.32	0	0.0034	0
	Shuttle Adapter	600	1026	0	0						
	Cargo Mod. with Init. Crew	20000	650	221	0						
	RAM	20000	890	-308	0						
	RAM	20000	890	308	0						
	INITIAL STATION **	173543	748.2	26.1	1.4	3.71	3.87	3.00			

NOTES: * 4320 lbs -84 in. x Sta.
CG's in Station Coordinate System

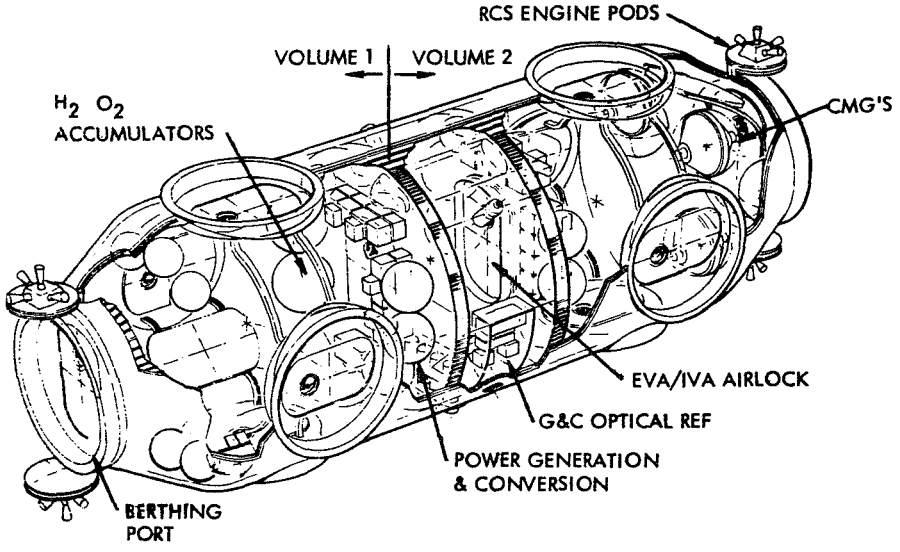
** Complete Initial Station for 6 Men with Logistics and Experiments for Initial Manned Operations.

2.0 CORE MODULE MASS PROPERTIES

2.0 CORE MODULE MASS PROPERTIES

The core module (Figure 2-1) is 40 feet long between berthing interfaces and is 12 feet 8 inches outside diameter. The 15-foot diameter envelope intersects the edges of the side berthing ports cluster. Lightweight skin (0.040-inch aluminum) and stringer construction is utilized. The eight side-berthing ports are spaced 20 feet apart, which allows a 5-foot clearance between the station modules. The four side ports are provided with thermal covers. Thermal control of the vertical ports is provided during buildup with special insulation panels.

The installed subsystems are distributed between the V1 and V2 volumes separated by the EVA/IVA airlock. The airlock provides an equivalent floor of approximately 5 feet by 7 feet. All of the hatches open outward from the airlock. The EVA hatch (40-inch diameter clear opening) is located at a 45-degree angle which provides the maximum clearance between attached modules. The G-C optical reference and CMG's are located adjacent to the RAM berthing ports.



MAX DIMENSIONS
LENGTH - 40 FT
DIA - 15 FT

- ALL SUBSYSTEMS ON-ORBIT REPLACEABLE
- MODULE SPACING FOR DIRECT DOCKING OR BERTHING (5 FT)
- FIRST MODULE LAUNCHED - MINIMIZES COMPLEXITY OF POWER MODULE
  - REDUCES BUILDUP SCARS

Figure 2-1. Core Module

Certain buildup equipment is accommodated such as the antennas, thermal control radiators, RCS propellant, and initial power. All subsystem components are installed with on-orbit shirtsleeve maintenance accommodations including maintenance of the RCS engine assemblies. The utilities routing throughout the module from berthing port to berthing port and end to end of the module are redundant and separated for damage containment and safety.

MODULAR WEIGHT STATEMENTS

The weights presented in this section are based on the preliminary design configuration from the current study and are coded by the MSC (NASA) coding.

Table 2.1 presents the Core Module Group Weight Statement. These weights are on the new MSC Group Weight forms. Figure 2.1 presents the core module configuration. The core module mass properties are shown in Table 2.2. The center of gravity stations are in the module coordinate system which is shown in Section 8. Table 2.3 presents the weight changes from the last report to this report. The last report was "Modular Space Station Mass Properties Initial Summary," dated July 1971. Details of the weight changes are shown on discussion pages of Table 2.3.

Table 2-1. Core Module Weight Statement

GROUP WEIGHT STATEMENT					PAGE 1 of 4
CONFIGURATION Core Module Launch	BY Space Station Engr.			DATE Nov. 1971	
	FWD	CTR	AFT		
1. WING GROUP - Not Applicable					
2. TAIL GROUP - Not Applicable					
3. BODY STRUCTURE (Common Modules)					9141
Basic Structure	( )	(5742)	( )	5742	
Side Walls		2050			
Bulkheads		3512			
Partitions (Structural)					
Floors (Structural)					
Fittings		180			
Secondary Structure				3399	
Crew Compartment (Partitions & Floors)					
Cargo Compartment (Rails & Storage)			143		
Equipment Compartment (Utility)			416		
Doors/Hatches/Windows & Access Domes			2440		
Airlock (Auxiliary Passage)					
Brackets, Doublers			400		
4. INDUCED ENVIRONMENT PROTECTION (Common Modules)					1119
Thermal Protection				470	
Radiative Panels/Coatings					
Insulation (Includ. Port & Window Covers)			470		
Coolant System					
Noise Protection					
Meteoroid Protection (Integral Rad./Meteor.			Not	649	
Radiation Protection			includ.)		
5. LAUNCH, RECOVERY & DOCKING (Common Modules)					2430
Launch Support					
Tie Down					
Handling					
Docking					
Berthing (10) Ports				2030	
Utility Interfaces				400	
6. PROPULSION ASCENT - Not Applicable					
7. PROPULSION-CRUISE - Not Applicable					

Table 2-1. Core Module Weight Statement (Cont)

GROUP WEIGHT STATEMENT					PAGE 2 of 4
CONFIGURATION Core Module Launch	BY Space Station Engr.				DATE Nov. 1971
8. PROPULSION-AUXILIARY					1164
Thruster System (Common Modules)				180	
	Attitude Control (180)	Orbit Maint. ( )	CMG Desat. ( )	Spin & Despin ( )	
Thruster	120				
Thruster Install					
Propellant Sys.	60				
Tankage					
Control Moment Gyro (Common Modules)				984	
Roll					
Pitch				774	
Yaw					
Magnetic Unloading System (Prepro. & Elect)				49	
Support Structure				161	
Manipulator System (Common Modules)				0	
Actuator, motor					
Mechanism					
Support Structure					
Locks					
9. PRIME POWER					2449
Batteries (Common Modules)				70	
Battery				70	
Container & Supports					
Electrical Coupling					
Voltage Controls					
Recharge Controls					
Thermal Control					
Solar Array (Common Modules)				0	
Solar Cells					
Substrates					
Deployment Devices					
Orientation Controls					
Voltage Controls					
Cooling System					
Panel Structure/Mounts & Supports					
Fuel Cells/Electrolysis Units				2379	
Fuel Cells				808	
Supports/Installation/Tankage				1571	
Electrolysis Units					
10. ELECTRICAL CONVERSION & DISTRIBUTION (Common Modules)					1341
	Supply	Conversion	Control Units		
Equipment		264	240	(504)	
Distribution & Control Circuitry				545	
Utility Systems				186	
Supports/Installation				106	
11. HYDRAULIC CONVERSION & DISTRIBUTION - Not Applicable					
12. SURFACE CONTROLS - Not Applicable					

Table 2-1. Core Module Weight Statement (Cont)

GROUP WEIGHT STATEMENT							PAGE 3 of 4
CONFIGURATION Core Module Launch			BY Space Station Engr.			DATE Nov. 1971	
13. AVIONICS (Common Modules)							948
	Units	Circuitry	Cooling	Antennas	Install		
	(849)	(11)	( )	(4)	(84)		
Guidance & Nav.	428				58	486	
Flight Control							
Manipulator Control							
Data Mgmt.	160	3			8	171	
Communication	205	8		4	15	232	
Instrumentation							
Displays	56				3	59	
14. ENVIRONMENTAL CONTROL (Common Modules)							1477
Atmospheric Gas Supply					42		
Gas Management/Processing					754		
Heat Transport (Integral Radiator/Meteoroid)					681		
15. PERSONNEL PROVISIONS (Common Modules)							875
Accommodations						155	
Chairs, bunks, tables							
Recreation & Exercise							
Medical & Dental Equipment							
Mobility Aids & Restraints					120		
Supports					35		
Fixed Life Support Equipment						20	
Water Management					20		
Waste Management							
Personal Hygiene							
Food Management							
Cargo Handling							
Furnishings - General Purpose Lab							
Emergency & Safety Equipment						700	
16. RANGE SAFETY & ABORT (Common Modules)							0
17. BALLAST (Common Modules)							0
18. GROWTH/UNCERTAINTY							0
19. OPEN							
SUBTOTAL (Dry Weight)							(20944)

Table 2-1. Core Module Weight Statement (Cont)

GROUP WEIGHT STATEMENT			PAGE 4 of 4
CONFIGURATION Core Module Launch	BY Space Station Engr.	DATE Nov. 1971	
20. PERSONNEL (Common Modules)			0
Crew			
Personal Gear (Clothing, Linens, Etc.)			
Life Support			
Food			
Water (Potoble Fill)			
Portable Equipment (PLSS & PGA)			
Accessories (Med. Supplies & Drugs)			
21. CARGO (Common Modules)			0
Experiments			
Supplies			
22. ORDNANCE (Common Modules)			0
23. RESIDUAL FLUIDS & SERVICE ITEMS (Common Modules)			629
Auxiliary Propulsion			
Environmental Control (Atmos., Accum. & Thermal Fluids)		624	
Life Support		5	
Electrical Power			
24. OPEN			
SUBTOTAL INERT WEIGHT			(21573)
25. RESERVE FLUIDS & SERVICE ITEMS (Common Modules)			0
Auxiliary Propulsion			
Environmental Control (Repress. O_2 & N_2)			
Life Support (L_iOH Canisters - Emerg.)			
Electrical Power			
26. INFLIGHT LOSSES (Common Modules)			375
Auxiliary Propulsion			
Environmental Control			
Life Support (Utensils)			
Electrical Power (Buildup HP O_2 & N_2)		375	
Avionics (Printer Facsimile Paper)			
27. PROPELLANT-ASCENT - Not Applicable			
28. PROPELLANT-CRUISE - Not Applicable			
29. PROPELLANT-AUXILIARY (Common Modules)			
Attitude Control			
Orbit Maintenance			
CMG Desaturation			
Spin & Despin			
TOTAL (GROSS WEIGHT)			(21948)

Table 2-2. Core Module Mass Properties

SYSTEMS MASS PROPERTIES

CONFIGURATION	BY	DATE	PAGE
Core Module Launch	Space Sta. Engr.	Nov. 1971	1 OF 1

* NO.	SYSTEM	WEIGHT LB	CENTER OF GRAVITY INCHES			MOMENT OF INERTIA SLUG FT^2 X 10^4			PRODUCT OF INERTIA SLUG FT^2 X 10^4		
			X	Y	Z	I_{x-x}	I_{y-y}	I_{z-z}	I_{xy}	I_{xz}	I_{yz}
1.	WING GROUP										
2.	TAIL GROUP										
3.	BODY	9141	340	0	0						
4.	INDUC ENV PROTECT	1119	340	0	0						
5.	LANDING & DOCKING	2430	340	0	0						
6.	ASCENT PROPULSION										
7.	CRUISE PROPULSION										
8.	AUXILIARY PROPULSION	1164	494	-8	0						
9.	PRIME POWER	2449	334	6	2						
10.	ELECTRICAL CONV & DIST	1341	337	1	0						
11.	HYDRAULIC CONV & DIST										
12.	SURFACE CONTROLS										
13.	AVIONICS	948	362	-17	-12						
14.	ENVIRO CONTROL	1477	334	2	9						
15.	PERSONNEL PROVISIONS	875	316	- 4	0						
16.	RANGE SAFETY										
17.	BALLAST										
18.	GROWTH										
19.											
	SUBTOTAL (DRY WEIGHT)	20944	347.2	- 0.5	0.3						
20.	PERSONNEL										
21.	CARGO										
22.	ORDNANCE										
23.	RESIDUAL FLUIDS	629	328	0	- 8						
24.											
	SUBTOTAL (INERT WEIGHT)	21573	346.6	- 0.5	0.1						
25.	RESERVE FLUIDS										
26.	INFLIGHT LOSSES	375	340	5	0						
27.	PROPELLANT - ASCENT										
28.	PROPELLANT - CRUISE										
29.	PROPELLANT - MANEUV/ACS										
30.											
	TOTAL (GROSS WT) LB	21948	346.5	- 0.4	0.1	2.11	10.68	10.49	0	0	0

NOTES: CG's in Module Coordinate System

* MSC (NASA) Codes

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Table 2-3. Core Module Weight Change

WEIGHT/C.G. CHANGE ANALYSIS

CONFIGURATION	BY	DATE	PAGE
Core Module Launch	Space Sta. Engr.	Nov. 1971	1 of 3

CODE	SYSTEM	* LAST REPORT (July 1971)		CURRENT REPORT (Nov. 1971)		CHANGE		CHANGE NOTE
		WEIGHT	C.G.	WEIGHT	C.G.	WEIGHT	C.G.	
1.0	WING GROUP							
2.0	TAIL GROUP							
3.0	BODY GROUP	6990	343	9141	340	+2151		1
4.0	INDUCED ENVIR PROTECTION	1240	340	1119	340	- 121		2
5.0	LANDING, RECOVERY, DOCKING	1620	340	2430	340	+ 810		3
6.0	PROPULSION-ASCENT							
7.0	PROPULSION-CRUISE							
8.0	PROPULSION-AUXILIARY	2976	397	1164	494	-1812		4
9.0	PRIME POWER	2725	260	2449	334	- 276		5
10.0	ELECTRICAL CONVER & DISTR	1025	340	1341	337	+ 316		6
11.0	HYDRALIC CONVER & DISTR							
12.0	SURFACE CONTROLS							
13.0	AVIONICS	2684	390	948	362	-1736		7
14.0	ENVIRONMENTAL CONTROL	1066	340	1477	334	+ 411		8
15.0	PERSONNEL PROVISIONS	174	340	875	316	+ 701		9
16.0	RANGE SAFETY							
17.0	BALLAST							
18.0	GROWTH							
19.0								
	SUBTOTAL (DRY WT)	20500	345.3	20944	347.2	+ 444		
20.0	PERSONNEL							
21.0	CARGO							
22.0	ORDNANCE							
23.0	RESIDUAL FLUIDS	1209	220	629	328	- 580		10
24.0								
	SUBTOTAL (INERT WT)	21709	338.4	21573	346.6	- 136		
25.0	RESERVE FLUIDS							
26.0	INFLIGHT LOSSES	431	220	375	340	- 56		11
27.0	PROPELLANT-ASCENT							
28.0	PROPELLANT-CRUISE							
29.0	PROPELLANT-MANEUV/ACS	410	220			- 410		12
30.0								
	TOTAL (GROSS-WEIGHT) LB.	22550	333.9	21948	346.5	- 602		

* Core Module No. 1 of the Dual Core Station.

Table 2-3. Core Module Weight Change (Cont)

WEIGHT/C.G. CHANGE ANALYSIS - CONT.		
CHANGE NOTE	DISCUSSION	PAGE 2 of 3
1	BODY GROUP	+ 2151
	Remove increased core skin thickness for radiation protection (-530). Add two pressure bulkheads for EVA/IVA airlock plus four inertia bulkheads (+1642). Remove floors from Sec structure (-570). Increase utility distribution weight (+256). Add four berthing hatches (+600), two pressure bulkhead hatches (+278), one EVA hatch (+99). Add domes to two RCS quads for in-flight maintenance and revise mounting doors (+376).	
2	INDUCED ENVIRONMENT PROTECTION	- 121
	Remove one thermal cover and insulation revisions reduces insulation weight (-54). Addition of radiator reduces meteoroid protection (-67).	
3	LANDING, RECOVERY & DOCKING	+ 810
	Add four berthing ports on sides plus revisions in other ports (+810).	
4	PROPULSION - AUXILIARY	- 1812
	Remove RCS propellant tankage from core (-870) and revise propellant system (-100). Reduce control moment gyros from 4 to 3 and reduce size (-842).	
5	PRIME POWER	- 276
	Increase size starting batteries (+55). Increase fuel cells to four in core and revise (+318). Remove electrolysis units from core (-520). Revisions in storage tanks and plumbing system (-129).	
6	ELECTRICAL CONVERSION & DISTRIBUTION	+ 316
	Transferring items to single core increases this core EPS controls (+80), feeders (+21), contactors (+20), and wiring & busses (+50). Increases in external lighting (+36). Increase in power conditioning equipment (+109).	

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Table 2-3. Core Module Weight Change (Cont)

WEIGHT/C.G. CHANGE ANALYSIS - CONT.			
CHANGE NOTE	DISCUSSION		PAGE 3 of 3
7	AVIONICS		- 1736
	Transferring the control center to station modules revises following:		
	Single core increases guid. & nav. ----------	+ 52	
	Decreases Data Management in core ----------	-674	
	Decreases communications in core ----------	-703	
	Decreases displays in core ----------	-411	
8	ENVIRONMENTAL CONTROL		+ 411
	Increase circulation ducts and fans ----------	+128	
	Increase O_2/N_2 line allowance ----------	+ 57	
	Add buildup radiator to core increases integral radiator/meteoroid weight ----------	+176	
	Add emergency water pump, freon pump & intercooler	+ 97	
	Reduce RAM HX weight ----------	- 25	
	Misc. plumbing revisions ----------	- 22	
9	PERSONNEL PROVISIONS		+ 701
	Add fire detectors ----------	+ 12	
	Add IVA support ----------	+ 95	
	Transfer tool set to single core ----------	+150	
	Transfer radiation detection ----------	+ 10	
	Add IVA umbilicals ----------	+400	
	Increase mounts & supports ----------	+ 34	
10	RESIDUAL FLUIDS		- 580
	Reduction in thermal fluid allowance.		
11	INFLIGHT LOSSES		- 56
	EPS reactants reduced to 1st 30 days.		
12	PROPELLANT - MANEUVER/ACS		- 410
	Remove RCS propellant.		

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3.0 POWER MODULE MASS PROPERTIES

3. POWER MODULE MASS PROPERTIES

The power module (Figure 3-1) consists of two assemblies, a power boom and a solar array. The solar array assembly consists of the arrays and orientation drive and power transfer mechanism. Shirtsleeve maintenance of the mechanisms is provided. The solar array assembly is replaceable and utilizes the standard berthing port.

The power boom is 88 inches outside diameter by 27 feet 6 inches long. The 88-inch diameter boom allows the solar array panels to stow within the 15-foot diameter shuttle payload envelope. The boom is of monocoque construction utilizing 0.145-inch thick aluminum which increases its stiffness and consequently increases the natural frequency of the total space station assembly. High pressure gas storage bottles for repressurization are placed in the boom. Shirtsleeve maintenance and replacement is provided even though the module is normally operated unpressurized.

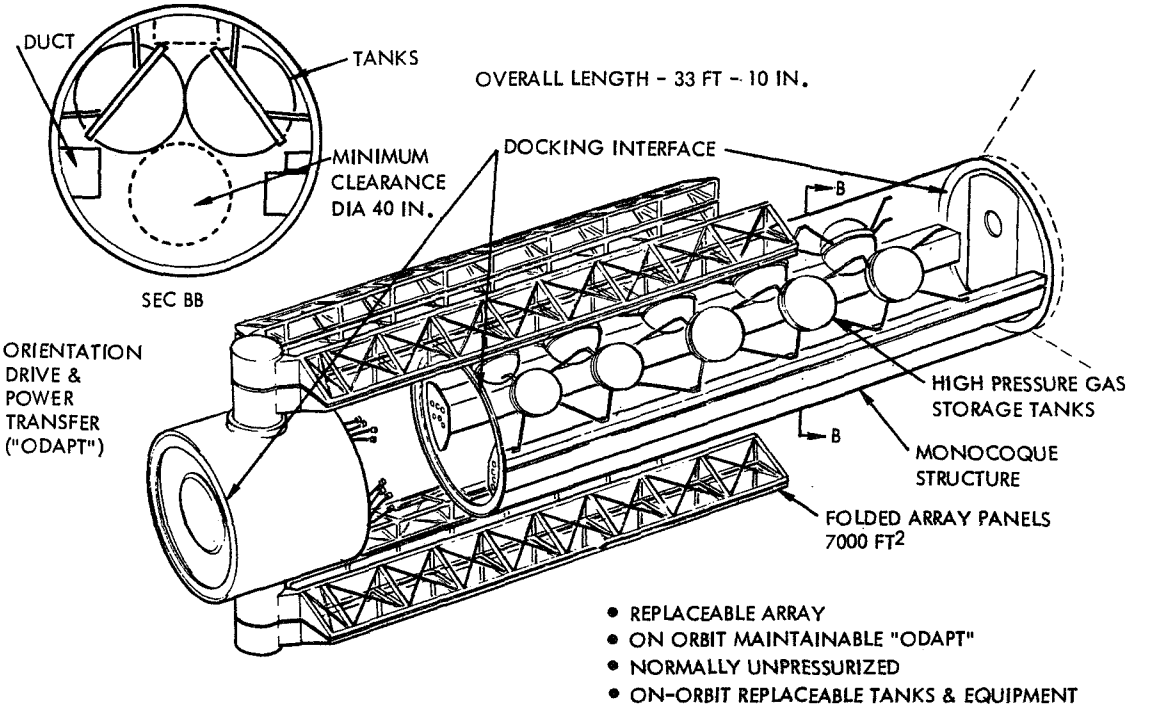

Figure 3-1. Power Module

MODULAR WEIGHT STATEMENTS

The weights presented in this section are based on the preliminary design configuration from the current study and are coded by the MSC (NASA) codings.

Table 3.1 presents the Power Module Group Weight Statement. These weights are on the new MSC Group Weight forms. The power module mass properties are shown in Table 3.2, with the center of gravity stations in the module coordinate system. Table 3.3 presents the weight changes from the last report to this report, with details of these changes shown on discussion pages.

Table 3-1. Power Module Weight Statement

GROUP WEIGHT STATEMENT					PAGE 1 of 4
CONFIGURATION Power Module Launch	BY Space Station Engr.			DATE Nov. 1971	
	FWD	CTR	AFT		
1. WING GROUP - Not Applicable					
2. TAIL GROUP - Not Applicable					
3. BODY STRUCTURE (Common Modules)					2288
Basic Structure	( )	(1878)	( )	1878	
Side Walls		1287			
Bulkheads		351			
Partitions (Structural)					
Floors (Structural)					
Fittings		240			
Secondary Structure				410	
Crew Compartment (Partitions & Floors)					
Cargo Compartment (Rails & Storage)			60		
Equipment Compartment (Utility)			31		
Doors/Hatches/Windows & Access Domes			212		
Airlock (Auxiliary Passage)					
Brackets, Doublers			107		
4. INDUCED ENVIRONMENT PROTECTION (Common Modules)					582
Thermal Protection				158	
Radiative Panels/Coatings					
Insulation			158		
Coolant System					
Noise Protection					
Meteoroid Protection (Integ. Rad./Meteor. Not incl.)				424	
Radiation Protection					
5. LAUNCH, RECOVERY & DOCKING (Common Modules)					800
Launch Support					
Tie Down					
Handling					
Docking					
Berthing (4 Ports)				760	
Utility Interfaces				40	
6. PROPULSION ASCENT - Not Applicable					
7. PROPULSION-CRUISE - Not Applicable					

Table 3-1. Power Module Weight Statement (Cont)

GROUP WEIGHT STATEMENT					PAGE 2 of 4
CONFIGURATION Power Module Launch	BY Space Station Engr.			DATE Nov. 1971	
8. PROPULSION-AUXILIARY					0
Thruster System (Common Modules)					
	Attitude Control ( )	Orbit Maint. ( )	CMG Desat. ( )	Spin & Despin ( )	
Thruster					
Thruster Install					
Propellant Sys.					
Tankage					
Control Moment Gyro (Common Modules)					
Roll					
Pitch					
Yaw					
Magnetic Unloading System (Prepro. & Elect.)					
Support Structure					
Manipulator System (Common Modules)					
Actuator, motor					
Mechanism					
Support Structure					
Locks					
9. PRIME POWER					7661
Batteries (Common Modules)				0	
Battery					
Container & Supports					
Electrical Coupling					
Voltage Controls					
Recharge Controls					
Thermal Control					
Solar Array (Common Modules)				6676	
Solar Cells				4320	
Substrates					
Deployment Devices					
Orientation Controls				2100	
Voltage Controls					
Cooling System					
Panel Structure/Mounts & Supports				256	
Fuel Cells/Electrolysis Units				985	
Fuel Cells					
Supports/Installation/Tankage				985	
10. ELECTRICAL CONVERSION & DISTRIBUTION (Common Modules)					139
	Supply	Con-version	Control Units		
Equipment				(0)	
Distribution & Control Circuitry				105	
Utility Systems				24	
Supports/Installation				10	
11. HYDRAULIC CONVERSION & DISTRIBUTION - Not Applicable					
12. SURFACE CONTROLS - Not Applicable					

Table 3-1. Power Module Weight Statement (Cont)

GROUP WEIGHT STATEMENT							PAGE 3 of 4
CONFIGURATION Power Module Launch			BY Space Station Engr.			DATE Nov. 1971	
13. AVIONICS (Common Modules)							116
	Units (107)	Circuitry (3)	Cooling ( )	Antennas ( )	Install (6)		
Guidance & Nav.							
Flight Control							
Manipulator Control							
Data Mgmt.	85	2			4	91	
Communication	19	1			1	21	
Instrumentation							
Displays	3				1	4	
14. ENVIRONMENTAL CONTROL (Common Modules)							849
Atmospheric Gas Supply					765		
Gas Management/Processing					84		
Heat Transport (Integral Radiator/Meteoroid)							
15. PERSONNEL PROVISIONS (Common Modules)							125
Accommodations						125	
Chairs, bunks, tables							
Recreation & Exercise							
Medical & Dental Equipment							
Mobility Aids & Restraints					120		
Supports 5					5		
Fixed Life Support Equipment							
Water Management							
Waste Management							
Personal Hygiene							
Food Management							
Cargo Handling							
Furnishings - General Purpose Lab							
Emergency & Safety Equipment							
16. RANGE SAFETY & ABORT (Common Modules)							0
17. BALLAST (Common Modules)							0
18. GROWTH/UNCERTAINTY							0
19. OPEN							
SUBTOTAL (Dry Weight)							(12560)

Table 3-1. Power Module Weight Statement (Cont)

GROUP WEIGHT STATEMENT			PAGE 4 of 4
CONFIGURATION Power Module Launch	BY Space Station Engr.	DATE Nov. 1971	
20. PERSONNEL (Common Modules)			0
Crew			
Personal Gear (Clothing, Linens, Etc.)			
Life Support			
Food			
Water (Potoble Fill)			
Portable Equipment (PLSS & PGS)			
Accessories (Med. Supplied & Drugs)			
21. CARGO (Common Modules)			0
Experiments			
Supplies			
22. ORDNANCE (Common Modules)			74
23. RESIDUAL FLUIDS & SERVICE ITEMS (Common Modules)			
Auxiliary Propulsion			
Environmental Control (Atmos., Accum. & Therm. Fluids)		74	
Life Support			
Electrical Power			
24. OPEN			
SUBTOTAL INERT WEIGHT			(12634)
25. RESERVE FLUIDS & SERVICE ITEMS (Common Modules)			575
Auxiliary Propulsion			
Environmental Control (Repress. O_2 & N_2)		575	
Life Support (LiOH Canisters - Emerg.)			
Electrical Power			
26. INFLIGHT LOSSES (Common Modules)			307
Auxiliary Propulsion			
Environmental Control			
Life Support			
Electrical Power (Buildup HP O_2 & H_2)		307	
Avionics (Printer Facsimile Paper)			
27. PROPELLANT-ASCENT - Not Applicable			
28. PROPELLANT-CRUISE - Not Applicable			
29. PROPELLANT-AUXILIARY (Common Modules)			0
Attitude Control			
Orbit Maintenance			
CMG Desaturation			
Spin & Despin			
TOTAL (GROSS WEIGHT)			(13516)

Table 3-2. Power Module Mass Properties

SYSTEMS MASS PROPERTIES

CONFIGURATION	BY	DATE	PAGE
Power Module Launch	Space Sta. Engr.	Nov. 1971	1 OF 1

* NO.	SYSTEM	WEIGHT LB	CENTER OF GRAVITY INCHES			MOMENT OF INERTIA SLUG FT^2 X 10^4			PRODUCT OF INERTIA SLUG FT^2 X 10^4		
			X	Y	Z	I_{x-x}	I_{y-y}	I_{z-z}	I_{xy}	I_{xz}	I_{yz}
1.	WING GROUP										
2.	TAIL GROUP										
3.	BODY	2288	265	0	0						
4.	INDUC ENV PROTECT	582	227	0	0						
5.	LANDING & DOCKING	800	207	0	0						
6.	ASCENT PROPULSION										
7.	CRUISE PROPULSION										
8.	AUXILIARY PROPULSION										
9.	PRIME POWER	7661	131	0	2						
10.	ELECTRICAL CONV & DIST	139	260	0	0						
11.	HYDRAULIC CONV & DIST										
12.	SURFACE CONTROLS										
13.	AVIONICS	116	250	0	0						
14.	ENVIRO CONTROL	849	319	1	12						
15.	PERSONNEL PROVISIONS	125	275	0	0						
16.	RANGE SAFETY										
17.	BALLAST										
18.	GROWTH										
19.											
	SUBTOTAL (DRY WEIGHT)	12560	181.4	0.1	0.8						
20.	PERSONNEL										
21.	CARGO										
22.	ORDNANCE										
23.	RESIDUAL FLUIDS	74	230	0	0						
24.											
	SUBTOTAL (INERT WEIGHT)	12634	181.6	0.1	0.8						
25.	RESERVE FLUIDS	575	318	2	12						
26.	INFLIGHT LOSSES	307	132	5	12						
27.	PROPELLANT - ASCENT										
28.	PROPELLANT - CRUISE										
29.	PROPELLANT - MANEUV/ACS										
30.											
	TOTAL (GROSS WT) LB	13516	186.3	0.2	1.5	0.61	4.54	4.11	0	0.03	0

NOTES: CG's in Module Coordinate System

* MSC (NASA) Codes

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Table 3-3. Power Module Weight Change

WEIGHT/C.G. CHANGE ANALYSIS

CONFIGURATION	BY	DATE	PAGE
Power Module Launch	Space Sta. Engr.	Nov. 1971	1 of 2

CODE	SYSTEM	LAST REPORT (July 1971)		CURRENT REPORT (Nov. 1971)		CHANGE		CHANGE NOTE
		WEIGHT	C.G.	WEIGHT	C.G.	WEIGHT	C.G.	
1.0	WING GROUP							
2.0	TAIL GROUP							
3.0	BODY GROUP	1780	344	2288	265	+ 508		1
4.0	INDUCED ENVIR PROTECTION	270	353	582	227	+ 312		2
5.0	LANDING, RECOVERY, DOCKING	630	291	800	207	+ 170		3
6.0	PROPULSION-ASCENT							
7.0	PROPULSION-CRUISE							
8.0	PROPULSION-AUXILIARY							
9.0	PRIME POWER	7630	248	7661	131	+ 31		4
10.0	ELECTRICAL CONVER & DISTR	240	353	139	260	- 101		5
11.0	HYDRALIC CONVER & DISTR							
12.0	SURFACE CONTROLS							
13.0	AVIONICS	270	353	116	250	- 154		6
14.0	ENVIRONMENTAL CONTROL	5110	316	849	319	-4261		7
15.0	PERSONNEL PROVISIONS	170	476	125	275	- 45		8
16.0	RANGE SAFETY							
17.0	BALLAST							
18.0	GROWTH							
19.0								
	SUBTOTAL (DRY WT)	16100	289.1	12560	181.4	-3540		
20.0	PERSONNEL							
21.0	CARGO							
22.0	ORDNANCE							
23.0	RESIDUAL FLUIDS	249	316	74	230	- 175		9
24.0								
	SUBTOTAL (INERT WT)	16349	289.5	12634	181.6	-3715		
25.0	RESERVE FLUIDS			575	318	+ 575		10
26.0	INFLIGHT LOSSES	2251	316	307	132	-1944		11
27.0	PROPELLANT-ASCENT							
28.0	PROPELLANT-CRUISE							
29.0	PROPELLANT-MANEUV/ACS							
30.0								
	TOTAL (GROSS-WEIGHT) LB.	18600	292.7	13516	186.3	-5084		

Table 3-3. Power Module Weight Change (Cont)

WEIGHT/C.G. CHANGE ANALYSIS - CONT.		
CHANGE NOTE	DISCUSSION	PAGE 2 of 2
1	BODY GROUP	+ 508
	Increase sidewall thickness to increase stiffness (+547). Remove one berthing hatch (-150). Add shuttle trunnion fitting and two manipulator sockets (+105) and miscellaneous changes (+6).	
2	INDUCED ENVIRONMENT PROTECTION	+ 312
	Shorter boom reduces insulation weight (-17) and removal of boom radiator increases meteoroid protection (+329).	
3	LANDING, RECOVERY & DOCKING	+ 170
	Add berthing port on turret end (+155) plus revisions in other ports (+15).	
4	PRIME POWER	+ 31
	Reduce solar array area reduces the solar weight (-618) and reduces the turret weight (-300). Transferring the H_2 and O_2 storage tanks for the EPS gas increases weight (+985). Miscellaneous mounts (-36).	
5	ELECTRICAL CONVERSION & DISTRIBUTION	- 101
	Reallocation of wiring reduces power module wiring allowance.	
6	AVIONICS	- 154
	Reduce number RACU's (-45), remove remote processor (-109).	
7	ENVIRONMENTAL CONTROL	- 4261
	Reallocate storage tanks leaving only ECS Repress. tanks (-3265). Remove heat exchanger and revise ducts (-53). Remove radiator and thermal control system on boom (-943).	
8	PERSONNEL PROVISIONS	- 45
	Remove fire extinguisher and emergency equipment.	
9	RESIDUAL FLUIDS	- 175
	Remove thermal loop fluids as radiator was removed from boom.	
10	RESERVE FLUIDS	+ 575
	Reallocated Repress. O_2 & N_2 to reserve.	
11	INFLIGHT LOSSES	- 1944
	Reallocated integrated gas supply leaving only buildup high pressure O_2 & H_2.	

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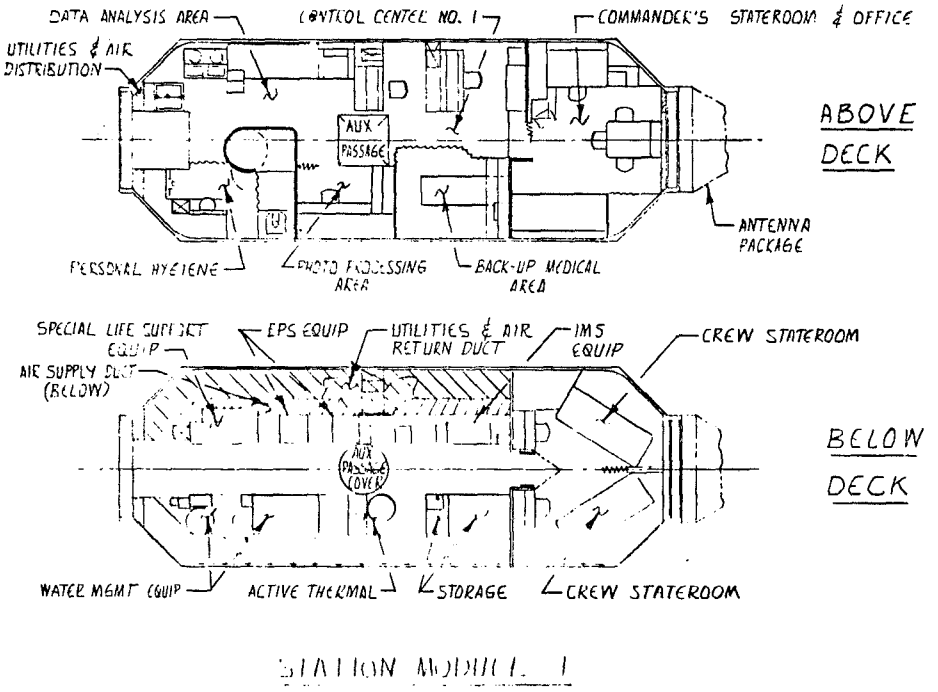
4.0 SM-1 MODULE MASS PROPERTIES

4.0 SM-1 MODULE MASS PROPERTIES

All of the station modules are 38 feet 8 inches long between berthing interfaces and provide a 13-foot 8-inch clear inside diameter. The external frames and attach points extend to 15 feet. An active berthing port is provided at the core module interface and a passive port at the other end. The interface provisions across the berthing ports are identical. Each module contains four manipulator sockets for shuttle deployment and four shuttle bay attach fittings. Radiators cover the exterior of the cylindrical portion of the modules.

The longitudinal floor provides a single structural component for mounting of equipment both above and below decks, greatly simplifying the manufacturing installation and design details. The longitudinal orientation also simplifies other ground operations of module assembly, checkout, and shuttle installation.



STATION MODULE 1

Figure 4-1. Crew/Control Module SM-1

The crew/control module (Figure 4-1) SM-1 has common functional allocations and equipment locations with SM-4. Each module performs a similar function in each of the two pressure-isolatable volumes of the station. Where backup functions are provided, they are located in similar areas in the module of the opposite volume.

Both SM-1 and SM-4 contain a commander/executive type stateroom and two crew staterooms in a split-level arrangement. Control centers are located on the upper deck of each module outside the stateroom. The personal hygiene facilities are in similar locations; however, only SM-1 contains a shower. The waste management equipment is located below deck near the personnel hygiene facility to simplify sewage transport and processing.

The area above deck in SM-1 contains the experiment data analysis equipment, including a data analysis control console, a photo-processing lab, and an isotonic exercise area. The exercise areas are also equipped to serve as a backup medical facility.

MODULAR WEIGHT STATEMENTS

The weights presented in this section are based on the preliminary design configuration from the current study and are coded by the MSC (NASA) coding.

Table 4.1 presents the SM-1 Station Module Group Weight Statement. These weights are on the new MSC Group Weight forms. The SM-1 Station Module Mass Properties are shown in Table 4.2 with the center of gravity stations in the module coordinate system. Table 4.3 presents the weight changes from the last report to this report with details of these changes shown on discussion pages.

Table 4-1. SM-1 Station Module Weight Statement

GROUP WEIGHT STATEMENT					PAGE 1 of 4
CONFIGURATION SM-1 Launch			BY Space Station Engr.		DATE Nov. 1971
	FWD	CTR	AFT		
1. WING GROUP - Not Applicable					
2. TAIL GROUP - Not Applicable					
3. BODY STRUCTURE (Common Modules)					7918
Basic Structure	( )	(4700)	( )	4700	
Side Walls		3780			
Bulkheads		740			
Partitions					
Floors (Structural)					
Fittings		180			
Secondary Structure				3218	
Crew Compartment (Partitions & Floors)			1895		
Cargo Compartment (Rails & Storage)			138		
Equipment Compartment (Utility)			275		
Doors/Hatches/Windows & Access Domes			408		
Airlock (Auxiliary Passage)			135		
Brackets, Doublers			367		
4. INDUCED ENVIRONMENT PROTECTION (Common Modules)					746
Thermal Protection				359	
Radiative Panels/Coatings					
Insulation (Including Window Covers)			359		
Coolant System					
Noise Protection					
Meteoroid Protection (Integ. Rad./Meteor. Not Incl.)				387	
Radiation Protection					
5. LAUNCH, RECOVERY & DOCKING (Common Modules)					490
Launch Support					
Tie Down					
Handling					
Docking					
Berthing (2 Ports)				410	
Utility Interfaces				80	
6. PROPULSION ASCENT - Not Applicable					
7. PROPULSION-CRUISE - Not Applicable					

Table 4-1. SM-1 Station Module Weight Statement (Cont)

GROUP WEIGHT STATEMENT					PAGE 2 of 4
CONFIGURATION SM-1 Launch	BY Space Station Engr.			DATE Nov. 1971	
8. PROPULSION-AUXILIARY					0
Thruster System (Common Modules)					
	Attitude Control ( )	Orbit Maint. ( )	CMG Desat. ( )	Spin & Despin ( )	
Thruster					
Thruster Install					
Propellant Sys.					
Tankage					
Control Moment Gyro (Common Modules)					
Roll					
Pitch					
Yaw					
Magnetic Unloading System					
Support Structure					
Manipulator System (Common Modules)					
Actuator, motor					
Mechanism					
Support Structure					
Locks					
9. PRIME POWER					766
Batteries (Common Modules)				0	
Battery					
Container & Supports					
Electrical Coupling					
Voltage Controls					
Recharge Controls					
Thermal Control					
Solar Array (Common Modules)				0	
Solar Cells					
Substrates					
Deployment Devices					
Orientation Controls					
Voltage Controls					
Cooling System					
Panel Structure/Mounts & Supports					
Fuel Cells/Electrolysis Units				766	
Fuel Cells					
Supports/Installation/Tankage			122		
Electrolysis Units			644		
10. ELECTRICAL CONVERSION & DISTRIBUTION (Common Modules)					996
	Supply	Conversion	Control Units		
Equipment		14		(14)	
Distribution & Control Circuitry				756	
Utility Systems				146	
Supports/Installation				80	
11. HYDRAULIC CONVERSION & DISTRIBUTION - Not Applicable					
12. SURFACE CONTROLS - Not Applicable					

Table 4-1. SM-1 Station Module Weight Statement (Cont)

GROUP WEIGHT STATEMENT						PAGE 3 of 4
CONFIGURATION SM-1 Launch			BY Space Station Engr.			DATE Nov. 1971
13. AVIONICS (Common Modules)						2740
	Units (1901)	Circuitry (36)	Cooling ( )	Antennas (234)	Install (569)	
Guidance & Nav.						
Flight Control						
Manipulator Control						
Data Mgmt.	727	13			32	772
Communication	719	23		234	514	1490 *
Instrumentation						
Displays	455				23	478
14. ENVIRONMENTAL CONTROL (Common Modules)						2560
Atmospheric Gas Supply					0	
Gas Management/Processing					591	
Heat Transport (Integral Radiator/Meteoroid)					1969	
15. PERSONNEL PROVISIONS (Common Modules)						2639
Accommodations						485
Chairs, bunks, tables					206	
Recreation & Exercise					0	
Medical & Dental Equipment					125	
Mobility Aids & Restraints					120	
Supports					34	
Fixed Life Support Equipment						1094
Water Management					638	
Waste Management					86	
Personal Hygiene					370	
Food Management					0	
Cargo Handling						0
Furnishings - General Purpose Lab						1006
Emergency & Safety Equipment						54
16. RANGE SAFETY & ABORT (Common Modules)						0
17. BALLAST (Common Modules)						0
18. GROWTH/UNCERTAINTY						0
19. OPEN						
SUBTOTAL (Dry Weight)						(18855)

* Includes steerable antenna package of 710 pounds

Table 4-1. SM-1 Station Module Weight Statement (Cont)

GROUP WEIGHT STATEMENT			PAGE 4 of 4
CONFIGURATION SM-1 Launch	BY Space Station Engr.	DATE Nov. 1971	
20. PERSONNEL (Common Modules)			0
Crew		*	
Personal Gear (Clothing, Linens, Etc.)		*	
Life Support			
Food			
Water (Potoble Fill)	*		
Portable Equipment (PLSS & PGA)	*		
Accessories		*	
21. CARGO (Common Modules)			0
Experiments			
Supplies			
22. ORDNANCE (Common Modules)			0
23. RESIDUAL FLUIDS & SERVICE ITEMS (Common Modules)			1131
Auxiliary Propulsion			
Environmental Control (Atmos., Accum. & Therm. Fluids)		1125	
Life Support		6	
Electrical Power			
24. OPEN			
SUBTOTAL INERT WEIGHT			(19986)
25. RESERVE FLUIDS & SERVICE ITEMS (Common Modules)			0
Auxiliary Propulsion			
Environmental Control (Repress. O_2 & N_2)			
Life Support (LiOH Canisters - Emerg.)			
Electrical Power			
26. INFLIGHT LOSSES (Common Modules)			0
Auxiliary Propulsion			
Environmental Control			
Life Support (Utensils)			
Electrical Power (Buildup HP O_2 & H_2)			
Avionics (Printer Facsimile Paper)		*	
27. PROPELLANT-ASCENT - Not Applicable			
28. PROPELLANT-CRUISE - Not Applicable			
29. PROPELLANT-AUXILIARY (Common Modules)			0
Attitude Control			
Orbit Maintenance			
CMG Desaturation			
Spin & Despin			
TOTAL (GROSS WEIGHT)			(19986)

* Items delivered via Cargo Module

Table 4-2. SM-1 Station Module Mass Properties

SYSTEMS MASS PROPERTIES

CONFIGURATION	BY	DATE	PAGE
SM-1 Launch	Space Sta. Engr.	Nov. 1971	1 OF 1

* NO.	SYSTEM	WEIGHT LB	CENTER OF GRAVITY INCHES			MOMENT OF INERTIA SLUG FT^2 X 10^4			PRODUCT OF INERTIA SLUG FT^2 X 10^4		
			X	Y	Z	I_{x-x}	I_{y-y}	I_{z-z}	I_{xy}	I_{xz}	I_{yz}
1.	WING GROUP										
2.	TAIL GROUP										
3.	BODY	7918	330.3	0	- 4.0						
4.	INDUC ENV PROTECT	746	332.0	0	0						
5.	LANDING & DOCKING	490	332.0	0	0						
6.	ASCENT PROPULSION										
7.	CRUISE PROPULSION										
8.	AUXILIARY PROPULSION										
9.	PRIME POWER	766	263.2	32.7	-40.5						
10.	ELECTRICAL CONV & DIST	996	306.3	17.8	- 9.3						
11.	HYDRAULIC CONV & DIST										
12.	SURFACE CONTROLS										
13.	AVIONICS **	2740	449.3	33.3	4.9						
14.	ENVIRO CONTROL	2560	317.5	-12.7	-15.4						
15.	PERSONNEL PROVISIONS	2639	271.0	-11.5	- 4.4						
16.	RANGE SAFETY										
17.	BALLAST										
18.	GROWTH										
19.											
	SUBTOTAL (DRY WEIGHT)	18855	333.7	3.8	- 5.8						
20.	PERSONNEL										
21.	CARGO										
22.	ORDNANCE										
23.	RESIDUAL FLUIDS	1131	318.8	-23.6	-26.7						
24.											
	SUBTOTAL (INERT WEIGHT)	19986	332.9	2.2	- 7.0						
25.	RESERVE FLUIDS										
26.	INFLIGHT LOSSES										
27.	PROPELLANT - ASCENT										
28.	PROPELLANT - CRUISE										
29.	PROPELLANT - MANEUV/ACS										
30.											
	TOTAL (GROSS WT) LB	19986	332.9	2.2	- 7.0	2.09	16.16	9.49	0	-0.19	0

NOTES: CG's in Module Coordinate System

** Includes Steerable Antenna Package of 710 lbs. @ X = 598, Y = 0 & Z = 0

* MSC (NASA) Codes

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Table 4-3. SM-1 Station Module Weight Change

WEIGHT/C.G. CHANGE ANALYSIS

CONFIGURATION	BY	DATE	PAGE
SM-1 Launch	Space Sta. Engr.	Nov. 1971	1 of 3

* CODE	SYSTEM	LAST REPORT (July 1971) WEIGHT	LAST REPORT (July 1971) C.G.	CURRENT REPORT (Nov. 1971) WEIGHT	CURRENT REPORT (Nov. 1971) C.G.	CHANGE WEIGHT	CHANGE C.G.	CHANGE NOTE
1.0	WING GROUP							
2.0	TAIL GROUP							
3.0	BODY GROUP	7900	332	7918	330	+ 18		1
4.0	INDUCED ENVIR PROTECTION	1060	332	746	332	- 314		2
5.0	LANDING, RECOVERY, DOCKING	460	332	490	332	+ 30		3
6.0	PROPULSION-ASCENT							
7.0	PROPULSION-CRUISE							
8.0	PROPULSION-AUXILIARY							
9.0	PRIME POWER			766	263	+ 766		4
10.0	ELECTRICAL CONVER & DISTR	660	332	996	306	+ 336		5
11.0	HYDRALIC CONVER & DISTR							
12.0	SURFACE CONTROLS							
13.0	AVIONICS **	1030	564	2740	449	+1710		6
14.0	ENVIRONMENTAL CONTROL	1421	332	2560	318	+1139		7
15.0	PERSONNEL PROVISIONS	1749	332	2639	271	+ 890		8
16.0	RANGE SAFETY							
17.0	BALLAST							
18.0	GROWTH							
19.0								
	SUBTOTAL (DRY WT)	14280	348.7	18855	333.7	+4575		
20.0	PERSONNEL	1656	220			-1656		9
21.0	CARGO							
22.0	ORDNANCE							
23.0	RESIDUAL FLUIDS	636	332	1131	319	+ 495		10
24.0								
	SUBTOTAL (INERT WT)	16572	335.2	19986	332.9	+3414		
25.0	RESERVE FLUIDS							
26.0	INFLIGHT LOSSES	128	332			- 128		11
27.0	PROPELLANT-ASCENT							
28.0	PROPELLANT-CRUISE							
29.0	PROPELLANT-MANEUV/ACS							
30.0								
	TOTAL (GROSS-WEIGHT) LB.	16700	335.2	19986	332.9	+3286		

* MSC (NASA) Codes

** Includes Antenna Package

Table 4-3. SM-1 Station Module Weight Change (Cont)

WEIGHT/C.G. CHANGE ANALYSIS - CONT.		
CHANGE NOTE	DISCUSSION	PAGE 2 of 3
1	BODY GROUP	+ 18
	Revised internal arrangement with increase in partitions & floors (+145), auxiliary passage tunnel transferred to SM-2 (-130) and other revisions & changes (+3).	
2	INDUCED ENVIRONMENTAL PROTECTION	- 314
	Remove and revise thermal covers (-31). Increased radiator area reduces meteoroid protection (-283).	
3	LANDING, RECOVERY & DOCKING	+ 30
	Calculations of layouts increased berthing allowance (+30).	
4	PRIME POWER	+ 766
	Electrolysis units transferred to SM-1 from the core (+766).	
5	ELECTRICAL CONVERSION & DISTRIBUTION	+ 366
	Reallocation of wiring weight to SM-1 with the transfer of functions to SM-1 (+340). Revisions in electrical equipment (+26).	
6	AVIONICS	+ 1710
	Control center transferred to SM-1 from the core.	
	Increase Data Management in SM-1 ---------- + 721	
	Increase communications in SM-1 ---------- + 515	
	Increase displays in SM-1 ---------- + 474	
7	ENVIRONMENTAL CONTROL	+ 1139
	Increase circulation ducts weight and revisions in gas management/processing ---------- + 108	
	Increase radiator area increases integral radiator/ meteoroid weight ---------- + 390	
	Transfer pump pakcages, intercoolers and reservoir to SM-1 from SM-2 ---------- + 245	
	Increase coldplates, tubing and valves ---------- + 396	

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Table 4-3. SM-1 Station Module Weight Change (Cont)

WEIGHT/C.G. CHANGE ANALYSIS - CONT.		
CHANGE NOTE	DISCUSSION	PAGE 3 of 3
8	PERSONNEL PROVISIONS	+ 890
	Revised internal arrangement results in following changes:	
	Water reclamation transferred to SM-1 from SM-2 (+757) and weight revisions (-137) increases water management ---------- + 620	
	Transfer shower to SM-1 from SM-2 increases personal hygiene ---------- + 342	
	Transfer food management out SM-1 to SM-3 ---------- - 680	
	Reallocation of general purpose lab furnishings ---- +1006	
	Reallocation of emergency equipment ---------- - 375	
	Miscellaneous changes ---------- - 23	
9	PERSONNEL	-1656
	Crew's clothing, linen, food, etc., will be delivered via cargo module on crew delivery flights.	
10	RESIDUAL FLUIDS	+ 495
	Increase in thermal fluids in the thermal control coolant loops.	
11	INFLIGHT LOSSES	- 128
	Galley transferred out of SM-1 removes life support (utensils).	

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5.0 SM-2 MODULE MASS PROPERTIES

5. SM-2 MODULE MASS PROPERTIES

The two lab/ECS modules, SM-2 and SM-3, are in different isolatable volumes of the station. Where backup functions are provided, they are located in similar areas in the module of the opposite volume. The lower deck area of station modules SM-2 and -3 contain environmental control subsystem assemblies for air revitalization (CO_2 management and atmosphere control). Common installation arrangements provide easy access for maintenance and service. The remaining lower deck area is for storage of station and experiment supplies. The above deck area in SM-2 contains primarily general purpose laboratory installations; however, a small backup galley is installed at the inboard end of the module. GPL equipment and areas for mechanical, electrical, and optical maintenance are provided. Figure 5-1 presents Lab/ECS Module SM-2. A general purpose airlock is attached to these lab modules. The one on SM-2 points to nadir on SM-3 to zenith. An experiment operations area and airlock loading access space is provided in each module at the airlock end.

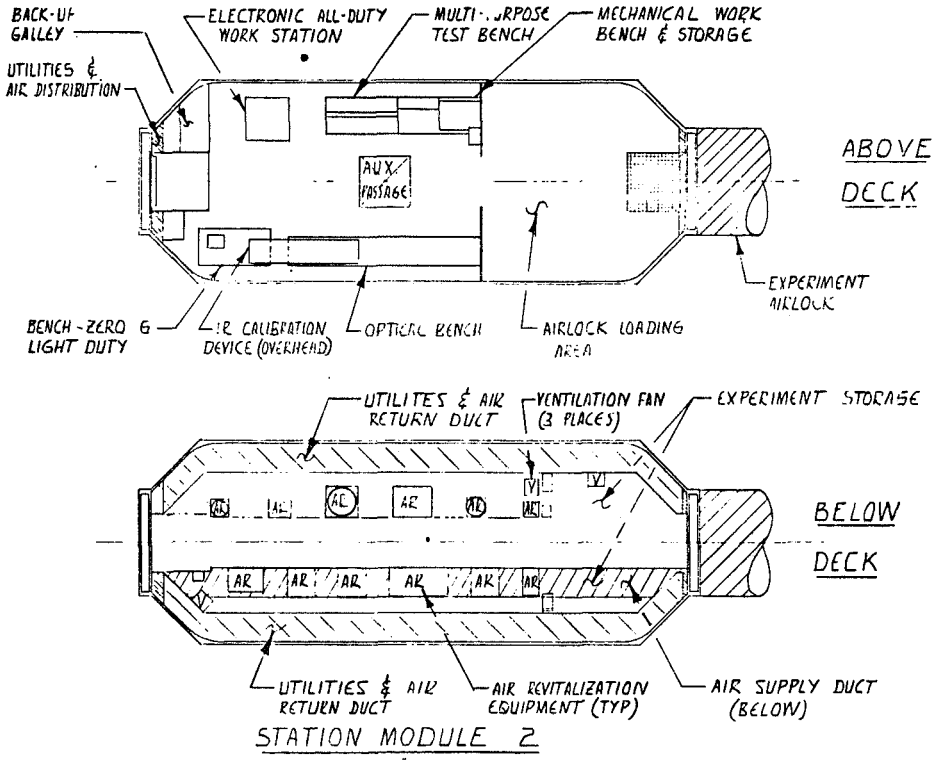

Figure 5-1. Lab/ECS Module SM-2

MODULAR WEIGHT STATEMENTS

The weights presented in this section are based on the preliminary design configuration from the current study and are coded by the MSC (NASA) coding.

Table 5-1 presents the SM-2 Module Group Weight Statement. These weights are on the new MSC Group Weight forms. Figure 5-1 presents the SM-2 module configuration. The SM-2 module mass properties are shown in Table 5-2. The center of gravity stations are in the module coordinate system which is shown in Section 8. Table 5-3 presents the weight changes from the last report to this report. The last report was "Modular Space Station Mass Properties Initial Summary," dated July 1971. Details of the weight changes are shown on discussion pages of Table 5-3.

Table 5-1. SM-2 Station Module Weight Statement

GROUP WEIGHT STATEMENT					PAGE 1 of 4
CONFIGURATION SM-2 Launch	BY Space Station Engr.			DATE Nov. 1971	
	FWD	CTR	AFT		
1. WING GROUP - Not Applicable					
2. TAIL GROUP - Not Applicable					
3. BODY STRUCTURE (Common Modules)					8050
Basic Structure	( )	(4700)	( )	4700	
Side Walls		3780			
Bulkheads		740			
Partitions					
Floors (Structural)					
Fittings		180			
Secondary Structure				3350	
Crew Compartment (Partitions & Floors)			1750		
Cargo Compartment (Rails & Storage)			260		
Equipment Compartment (Utility)			343		
Doors/Hatches/Windows & Access Domes			360		
Airlock (Auxiliary Passage)			265		
Brackets, Doublers			372		
4. INDUCED ENVIRONMENT PROTECTION (Common Modules)					735
Thermal Protection				348	
Radiative Panels/Coatings					
Insulation			348		
Coolant System					
Noise Protection					
Meteoroid Protection (Integ. Rad./Meteor. Not Incl.)				387	
Radiation Protection					
5. LAUNCH, RECOVERY & DOCKING (Common Modules)					490
Launch Support					
Tie Down					
Handling					
Docking					
Berthing				410	
Utility Interfaces				80	
6. PROPULSION ASCENT - Not Applicable					
7. PROPULSION-CRUISE - Not Applicable					

Table 5-1. SM-2 Station Module Weight Statement (Cont)

GROUP WEIGHT STATEMENT					PAGE 2 of 4
CONFIGURATION SM-2 Launch			BY Space Station Engr.		DATE Nov. 1971
8. PROPULSION-AUXILIARY					153
Thruster System (Common Modules)				153	
	Attitude Control (153)	Orbit Maint. ( )	CMG Desat. ( )	Spin & Despin ( )	
Thruster	0				
Thruster Install	0				
Propellant Sys.	65				
Tankage (Accumul.)	88				
Control Moment Gyro (Common Modules)				0	
Roll					
Pitch					
Yaw					
Magnetic Unloading System (Prepro. & Elect)					
Support Structure					
Manipulator System (Common Modules)				0	
Actuator, motor					
Mechanism					
Support Structure					
Locks					
9. PRIME POWER					0
Batteries (Common Modules)					
Battery					
Container & Supports					
Electrical Coupling					
Voltage Controls					
Recharge Controls					
Thermal Control					
Solar Array (Common Modules)					
Solar Cells					
Substrates					
Deployment Devices					
Orientation Controls					
Voltage Controls					
Cooling System					
Panel Structure/Mounts & Supports					
Fuel Cells/Electrolysis Units					
Fuel Cells					
Supports/Installation/Tankage					
Electrolysis Units					
10. ELECTRICAL CONVERSION & DISTRIBUTION (Common Modules)					545
	Supply	Con-version	Control Units		
Equipment		14		(14)	
Distribution & Control Circuitry				350	
Utility Systems				146	
Supports/Installation				35	
11. HYDRAULIC CONVERSION & DISTRIBUTION - Not Applicable					
12. SURFACE CONTROLS - Not Applicable					

Table 5-1. SM-2 Station Module Weight Statement (Cont)

GROUP WEIGHT STATEMENT							PAGE 3 of 4
CONFIGURATION SM-2 Launch			BY Space Station Engr.			DATE Nov. 1971	
13. AVIONICS (Common Modules)							134
	Units	Circuitry	Cooling	Antennas	Install		
	(126)	(2)	( )	( )	(6)		
Guidance & Nav.							
Flight Control							
Manipulator Control							
Data Mgmt.	60	1			3	64	
Communication	28	1			1	30	
Instrumentation							
Displays	38				2	40	
14. ENVIRONMENTAL CONTROL (Common Modules)							3198
Atmospheric Gas Supply					11		
Gas Management/Processing					1617		
Heat Transport (Integral Radiator/Meteoroid)					1570		
15. PERSONNEL PROVISIONS (Common Modules)							3400
Accommodations						127	
Chairs, bunks, tables							
Recreation & Exercise							
Medical & Dental Equipment							
Mobility Aids & Restraints					120		
Supports					7		
Fixed Life Support Equipment						138	
Water Management					23		
Waste Management					0		
Personal Hygiene					27		
Food Management					88		
Cargo Handling						0	
Furnishings - General Purpose Lab						3055 *	
Emergency & Safety Equipment						80	
16. RANGE SAFETY & ABORT (Common Modules)							0
17. BALLAST (Common Modules)							0
18. GROWTH/UNCERTAINTY							0
19. OPEN							
SUBTOTAL (Dry Weight)							(16705)

* Includes Experiment Airlock Package of 1200 Pounds

Table 5-1. SM-2 Station Module Weight Statement (Cont)

GROUP WEIGHT STATEMENT			PAGE 4 of 4
CONFIGURATION SM-2 Launch	BY Space Station Engr.	DATE Nov. 1971	
20. PERSONNEL (Common Modules)			0
Crew			
Personal Gear (Clothing, Linens, Etc.)			
Life Support			
Food Backup Galley Supply	*		
Water (Potoble Fill)			
Portable Equipment (PLSS & PGA)			
Accessories			
21. CARGO (Common Modules)			1109
Experiments (T-1 Contam. Meas.)	807		
Supplies (P-2, P-4 & T-1 Exp. Consum.)	302		
22. ORDNANCE (Common Modules)			0
23. RESIDUAL FLUIDS & SERVICE ITEMS (Common Modules)			699
Auxiliary Propulsion			
Environmental Control (Atmos., Accum. & Ther. Fluids)		693	
Life Support		6	
Electrical Power			
24. OPEN			
SUBTOTAL INERT WEIGHT			(18513)
25. RESERVE FLUIDS & SERVICE ITEMS (Common Modules)			112
Auxiliary Propulsion			
Environmental Control (Repress. O_2 & N_2)			
Life Support (LiOH Canisters--Emerg.)96 hr. Emerg./2		112	
Electrical Power			
26. INFLIGHT LOSSES (Common Modules)			0
Auxiliary Propulsion			
Environmental Control			
Life Support (Utensils) Backup Galley Supply		*	
Electrical Power (Buildup HP O_2 & H_2)			
Avionics (Printer Facsimile Paper)			
27. PROPELLANT-ASCENT - Not Applicable			
28. PROPELLANT-CRUISE - Not Applicable			
29. PROPELLANT-AUXILIARY (Common Modules)			0
Attitude Control			
Orbit Maintenance			
CMG Desaturation			
Spin & Despin			
TOTAL (GROSS WEIGHT)			(18625)

* Items delivered by Cargo Module

Table 5-2. SM-2 Station Module Mass Properties

SYSTEMS MASS PROPERTIES

CONFIGURATION	BY	DATE	PAGE
SM-2 Launch	Space Sta. Engr.	Nov. 1971	1 OF 1

NO.	SYSTEM	WEIGHT LB	CENTER OF GRAVITY INCHES			MOMENT OF INERTIA SLUG FT^2 X 10^4			PRODUCT OF INERTIA SLUG FT^2 X 10^4		
			X	Y	Z	I_{x-x}	I_{y-y}	I_{z-z}	I_{xy}	I_{xz}	I_{yz}
1.	WING GROUP										
2.	TAIL GROUP										
3.	BODY	8050	330	0	- 1						
4.	INDUC ENV PROTECT	735	332	0	0						
5.	LANDING & DOCKING	490	332	0	0						
6.	ASCENT PROPULSION										
7.	CRUISE PROPULSION										
8.	AUXILIARY PROPULSION	153	402	32	-38						
9.	PRIME POWER										
10.	ELECTRICAL CONV & DIST	545	311	15	0						
11.	HYDRAULIC CONV & DIST										
12.	SURFACE CONTROLS										
13.	AVIONICS	134	250	0	0						
14.	ENVIRO CONTROL	3198	317	0	-15						
15.	PERSONNEL PROVISIONS **	3400	400	3	5						
16.	RANGE SAFETY										
17.	BALLAST										
18.	GROWTH										
19.											
	SUBTOTAL (DRY WEIGHT)	16705	341.3	1.4	- 2.7						
20.	PERSONNEL										
21.	CARGO	1109	500	0	-50						
22.	ORDNANCE										
23.	RESIDUAL FLUIDS	699	319	- 3	- 2						
24.											
	SUBTOTAL (INERT WEIGHT)	18513	350.0	1.2	- 5.5						
25.	RESERVE FLUIDS	112	390	-30	-30						
26.	INFLIGHT LOSSES										
27.	PROPELLANT - ASCENT										
28.	PROPELLANT - CRUISE										
29.	PROPELLANT - MANEUV/ACS										
30.											
	TOTAL (GROSS WT) LB	18625	350.2	1.0	- 5.6	1.56	12.84	8.04	0	0	0

NOTES: CG's in Module Coordinate System.

** Includes Experiment Airlock Package of 1200 lbs. @ X = 655, Y = 0, & Z = 0

* MSC (NASA) Codes

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Table 5-3. SM-2 Station Module Weight Change

WEIGHT/C.G. CHANGE ANALYSIS

CONFIGURATION	BY	DATE	PAGE
SM-2 Launch	Space Sta. Engr.	Nov. 1971	1 of 3

** CODE	SYSTEM	LAST REPORT (July 1971) WEIGHT	LAST REPORT (July 1971) C.G.	CURRENT REPORT (Nov. 1971) WEIGHT	CURRENT REPORT (Nov. 1971) C.G.	CHANGE WEIGHT	CHANGE C.G.	CHANGE NOTE
1.0	WING GROUP**							
2.0	TAIL GROUP	9100 *	373	8050	330	-1050		1
3.0	BODY GROUP	1060	332	735	332	- 325		2
4.0	INDUCED ENVIR PROTECTION	460	332	490	332	+ 30		3
5.0	LANDING, RECOVERY, DOCKING							
6.0	PROPULSION-ASCENT							
7.0	PROPULSION-CRUISE							
8.0	PROPULSION-AUXILIARY			153	402	+ 153		4
9.0	PRIME POWER							
10.0	ELECTRICAL CONVER & DISTR	660	332	545	311	- 115		5
11.0	HYDRALIC CONVER & DISTR							
12.0	SURFACE CONTROLS							
13.0	AVIONICS	210	332	134	250	- 76		6
14.0	ENVIRONMENTAL CONTROL	2938	332	3198	317	+ 260		7
15.0	PERSONNEL PROVISIONS	4932	332	3400 *	400	-1532		8
16.0	RANGE SAFETY							
17.0	BALLAST							
18.0	GROWTH							
19.0								
	SUBTOTAL (DRY WT)	19360	351.0	16705	341.3	-2655		
20.0	PERSONNEL	412	332			- 412		9
21.0	CARGO			1109	500	+1109		10
22.0	ORDNANCE							
23.0	RESIDUAL FLUIDS	1161	332	699	319	- 462		11
24.0								
	SUBTOTAL (INERT WT)	20933	349.6	18513	350.0	-2420		
25.0	RESERVE FLUIDS			112	390	+ 112		12
26.0	INFLIGHT LOSSES	467	332			- 467		13
27.0	PROPELLANT-ASCENT							
28.0	PROPELLANT-CRUISE							
29.0	PROPELLANT-MANEUV/ACS							
30.0								
	TOTAL (GROSS-WEIGHT) LB.	21400	349.2	18625	350.2	-2775		

* Includes Experiment Airlock

** MSC (NASA) Codes

Table 5-3. SM-2 Station Module Weight Change (Cont)

WEIGHT/C.G. CHANGE ANALYSIS - CONT.		
CHANGE NOTE	DISCUSSION	PAGE 2 of 3
1	BODY GROUP	- 1050
	Transferred experiment arilock package from secondary structure to general purpose lab furnishings in personnel provisions ---------- -1200	
	Revised internal arrangement with increases in utility distribution and miscellaneous changes ---- + 150	
2	INDUCED ENVIRONMENT PROTECTION	- 325
	Remove thermal covers and increase radiator area which reduces meteoroid protection.	
3	LANDING, RECOVERY, & DOCKING	+ 30
	Calculations of layouts. Increased berthing allowance.	
4	PROPULSION - AUXILIARY	+ 153
	Transfer one-half accumulators for RCS system to SM-2 from core (balance to SM-3).	
5	ELECTRICAL CONVERSION & DISTRIBUTION	- 115
	Revision in electrical equipment (-53). Reallocation of wiring reduces the SM-2 wiring allowance (-62).	
6	AVIONICS	- 76
	Reduce the number of audio/video units ---------- - 54	
	Remove TV monitor, increase number RACU's and miscellaneous changes ---------- - 22	
7	ENVIRONMENTAL CONTROL	+ 260
	Increase radiator area which increases integral radiator/meteoroid weight ---------- + 390	
	Transfer pump packages, intercoolers and reservoir to SM-1 from SM-2 ---------- - 245	
	Increase coldplates, tubing and valves ---------- + 115	

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Table 5-3. SM-2 Station Module Weight Change (Cont)

WEIGHT/C.G. CHANGE ANALYSIS - CONT.			
CHANGE NOTE	DISCUSSION		PAGE 3 of 3
8	PERSONNEL PROVISIONS		- 1532
	Medical & Dental equipment removed from SM-2 -----	- 381	
	Water reclamation transferred to SM-1 from SM-2 reduced water management ----------	- 757	
	Toilet and urinal removed from SM-2 ----------	- 84	
	Shower and sink removed from SM-2 reduced personal hygiene ----------	- 367	
	Add backup galley to SM-2 ----------	+ 88	
	Transfer experiment airlock from sec. structure to general purpose lab furnishings ----------	+1200	
	Remove Data Analysis area furnishings (-696), photo process area furnishings (-240) and miscellaneous (-209 ----------	-1245	
	Miscellaneous changes ----------	+ 14	
9	PERSONNEL		- 412
	Potable water removed from SM-2.		
10	CARGO		+ 1109
	Add experiment equipment for T-1 contaminate measurement ----------	+ 807	
	Add experiment consumables for P-2, P-4, & T-1 ---	+ 302	
11	RESIDUAL FLUIDS		- 462
	Reduce thermal fluids when coolant hardware transferred to SM-1.		
12	RESERVE FLUIDS		+ 112
	Add emergency LiOH canisters.		
13	INFLIGHT LOSSES		- 467
	Removed from SM-2.		

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6.0 SM-3 MODULE MASS PROPERTIES

6. SM-3 MODULE MASS PROPERTIES

The two lab/ECS modules, SM-2 and SM-3, are in different isolatable volumes of the station. Where backup functions are provided, they are located in similar areas in the module of the opposite volume. The lower deck area of station modules SM-2 and -3 contain environmental control subsystem assemblies for air revitalization (CO_2 management and atmosphere control). Common installation arrangements provide easy access for maintenance and service. The remaining lower deck area is for storage of station and experiment supplies. The above deck area in SM-3 contains the primary galley/dining and recreation areas as well as general purpose laboratory facilities. The lab capability is designed to support both physics and biomedical experiments. Figure 6-1 presents Lab/ECS Module SM-3. A general purpose airlock is attached to these lab modules. The one on SM-2 points to nadir on SM-3 to zenith. An experiment operations area and airlock loading access space is provided in each module at the airlock end.

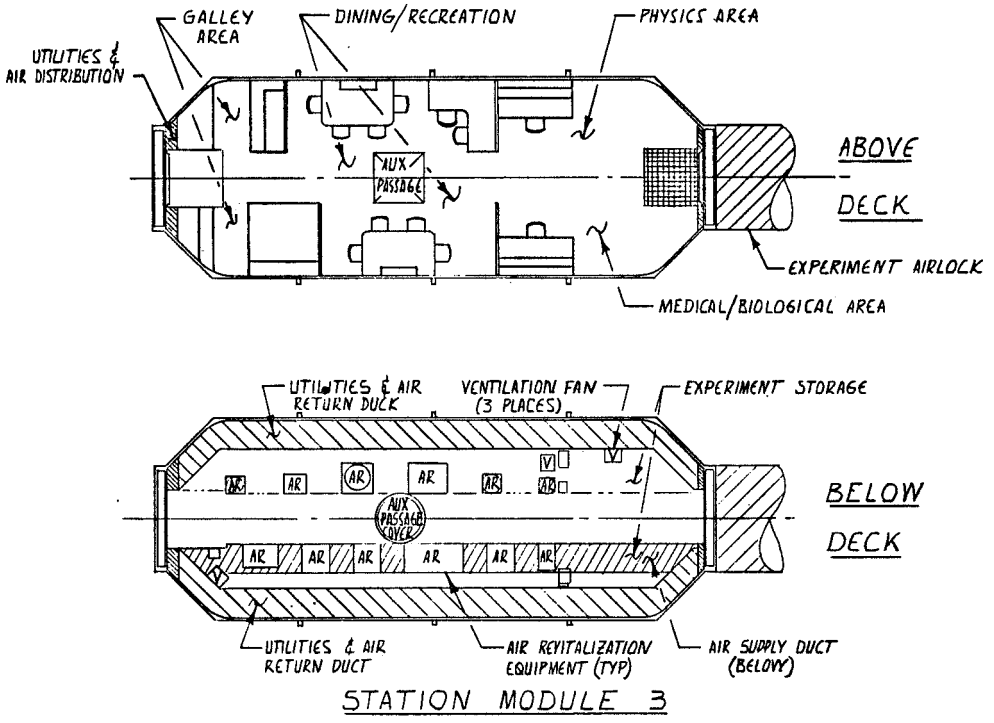

Figure 6-1. Lab/ECS Module SM-3

MODULAR WEIGHT STATEMENTS

The weights presented in this section are based on the preliminary design configuration from the current study and are coded by the MSC (NASA) coding.

Table 6-1 presents the SM-3 Module Group Weight Statement. These weights are on the new MSC Group Weight forms. Figure 6-1 presents the SM-3 module configuration. The SM-3 module mass properties are shown in Table 6-2. The center of gravity stations are in the module coordinate system which is shown in Section 8. Table 6-3 presents the weight changes from the last report to this report. The last report was "Modular Space Station Mass Properties Initial Summary," dated July 1971. Details of the weight changes are shown on discussion pages of Table 6-3.

Table 6-1. SM-3 Station Module Weight Statement

GROUP WEIGHT STATEMENT					PAGE 1 of 4
CONFIGURATION SM-3 Launch	BY Space Station Engr.			DATE Nov. 1971	
		FWD	CTR	AFT	
1. WING GROUP - Not Applicable					
2. TAIL GROUP - Not Applicable					
3. BODY STRUCTURE (Common Modules)					8146
Basic Structure		( )	(4700)	( )	4700
Side Walls			3780		
Bulkheads			740		
Partitions					
Floors (Structural)					
Fittings			180		
Secondary Structure					3446
Crew Compartment (Partitions & Floors)				1926	
Cargo Compartment (Rails & Storage)				260	
Equipment Compartment (Utility)				343	
Doors/Hatches/Windows & Access Domes				408	
Airlock (Auxiliary Passage)				135	
Brackets, Doublers				374	
4. INDUCED ENVIRONMENT PROTECTION (Common Modules)					746
Thermal Protection					359
Radiative Panels/Coatings					
Insulation (Includ. Window Cover)				359	
Coolant System					
Noise Protection					
Meteoroid Protection (Integ. Rad./Meteor. Not includ.)					387
Radiation Protection					
5. LAUNCH, RECOVERY & DOCKING (Common Modules)					490
Launch Support					
Tie Down					
Handling					
Docking					
Berthing (2 Ports)					410
Utility Interfaces					80
6. PROPULSION ASCENT - Not Applicable					
7. PROPULSION-CRUISE - Not Applicable					

Table 6-1. SM-3 Station Module Weight Statement (Cont)

GROUP WEIGHT STATEMENT			PAGE 2 of 4
CONFIGURATION SM-3 Launch	BY Space Station Engr.	DATE Nov. 1971	

8. PROPULSION-AUXILIARY			153
Thruster System (Common Modules)		153	
Attitude Control (153) / Orbit Maint. ( ) / CMG Desat. ( ) / Spin & Despin ( )			
Thruster			
Thruster Install			
Propellant Sys.	65		
Tankage (Accum.)	88		
Control Moment Gyro (Common Modules)		0	
Roll			
Pitch			
Yaw			
Magnetic Unloading System (Prepro. & Elect.)			
Support Structure			
Manipulator System (Common Modules)		0	
Actuator, motor			
Mechanism			
Support Structure			
Locks			
9. PRIME POWER			0
Batteries (Common Modules)			
Battery			
Container & Supports			
Electrical Coupling			
Voltage Controls			
Recharge Controls			
Thermal Control			
Solar Array (Common Modules)			
Solar Cells			
Substrates			
Deployment Devices			
Orientation Controls			
Voltage Controls			
Cooling System			
Panel Structure/Mounts & Supports			
Fuel Cells/Electrolysis Units			
Fuel Cells			
Supports/Installation/Tankage Electrolysis Units			
10. ELECTRICAL CONVERSION & DISTRIBUTION (Common Modules)			545
Supply / Conversion / Control Units			
Equipment	14	(14)	
Distribution & Control Circuitry		350	
Utility Systems		146	
Supports/Installation		35	
11. HYDRAULIC CONVERSION & DISTRIBUTION - Not Applicable			
12. SURFACE CONTROLS - Not Applicable			

Table 6-1. SM-3 Station Module Weight Statement (Cont)

GROUP WEIGHT STATEMENT							PAGE 3 of 4
CONFIGURATION SM-3 Launch			BY Space Station Engr.			DATE Nov. 1971	
13. AVIONICS (Common Modules)							161
	Units (151)	Circuitry (3)	Cooling ( )	Antennas ( )	Install (7)		
Guidance & Nav.							
Flight Control							
Manipulator Control							
Data Mgmt.	60	1			3	64	
Communication	53	2			2	57	
Instrumentation							
Displays	38				2	40	
14. ENVIRONMENTAL CONTROL (Common Modules)							3198
Atmospheric Gas Supply					11		
Gas Management/Processing					1617		
Heat Transport (Integral Radiator/Meteoroid)					1570		
15. PERSONNEL PROVISIONS (Common Modules)							2806
Accommodations						497	
Chairs, bunks, tables					152		
Recreation & Exercise					200		
Medical & Dental Equipment							
Mobility Aids & Restraints					120		
Supports					25		
Fixed Life Support Equipment						911	
Water Management					23		
Waste Management					79		
Personal Hygiene					53		
Food Management					756		
Cargo Handling						0	
Furnishings - General Purpose Lab						1318 *	
Emergency & Safety Equipment						80	
16. RANGE SAFETY & ABORT (Common Modules)							0
17. BALLAST (Common Modules)							0
18. GROWTH/UNCERTAINTY							0
19. OPEN							
SUBTOTAL (Dry Weight)							(16245)

* Includes Experiment Airlock Package of 1200 pounds.

Table 6-1. SM-3 Station Module Weight Statement (Cont)

GROUP WEIGHT STATEMENT			PAGE 4 of 4
CONFIGURATION SM-3 Launch	BY Space Station Engr.	DATE Nov. 1971	
20. PERSONNEL (Common Modules)			0
Crew			
Personal Gear (Clothing, Linens, Etc.)			
Life Support			
Food Galley Supply (6-Man 120 days)	*		
Water (Potoble Fill)			
Portable Equipment (PLSS & PGA)			
Accessories (Med. Supplies & Drugs)			
21. CARGO (Common Modules)			1869
Experiments (P-2 Plasma Phy. & Envir. Pert.	1869		
Supplies P-4 Physics & Chem. Facility)	0		
22. ORDNANCE (Common Modules)			0
23. RESIDUAL FLUIDS & SERVICE ITEMS (Common Modules)			699
Auxiliary Propulsion			
Environmental Control(Atmos., Accum. & Therm. Fluids)		693	
Life Support		6	
Electrical Power			
24. OPEN			
SUBTOTAL INERT WEIGHT			(18813)
25. RESERVE FLUIDS & SERVICE ITEMS (Common Modules)			112
Auxiliary Propulsion			
Environmental Control (Repress. O_2 & N_2)			
Life Support (LiOH Canisters - Emerg.)96 hr. Emerg/2		112	
Electrical Power			
26. INFLIGHT LOSSES (Common Modules)			0
Auxiliary Propulsion			
Environmental Control			
Life Support(Utensils) Galley Supply(6 Men-120 days)		*	
Electrical Power (Buildup HP O_2 & N_2)			
Avionics (Printer Facsimile Paper)			
27. PROPELLANT-ASCENT - Not Applicable			
28. PROPELLANT-CRUISE - Not Applicable			
29. PROPELLANT-AUXILIARY (Common Modules)			0
Attitude Control			
Orbit Maintenance			
CMG Desaturation			
Spin & Despin			
TOTAL (GROSS WEIGHT)			(18925)

* Items delivered by Cargo Module

Table 6-2. SM-3 Station Module Mass Properties

SYSTEMS MASS PROPERTIES

CONFIGURATION	BY	DATE	PAGE
SM-3 Launch	Space Sta. Engr.	Nov. 1971	1 OF 1

* NO.	SYSTEM	WEIGHT LB	CENTER OF GRAVITY INCHES			MOMENT OF INERTIA SLUG FT^2 X 10^4			PRODUCT OF INERTIA SLUG FT^2 X 10^4		
			X	Y	Z	I_{x-x}	I_{y-y}	I_{z-z}	I_{xy}	I_{xz}	I_{yz}
1.	WING GROUP										
2.	TAIL GROUP										
3.	BODY	8146	330	0	- 1						
4.	INDUC ENV PROTECT	746	332	0	0						
5.	LANDING & DOCKING	490	332	0	0						
6.	ASCENT PROPULSION										
7.	CRUISE PROPULSION										
8.	AUXILIARY PROPULSION	153	402	32	-38						
9.	PRIME POWER										
10.	ELECTRICAL CONV & DIST	545	311	15	0						
11.	HYDRAULIC CONV & DIST										
12.	SURFACE CONTROLS										
13.	AVIONICS	161	250	0	0						
14.	ENVIRO CONTROL	3198	317	0	-15						
15.	PERSONNEL PROVISIONS **	2806	423	3	3						
16.	RANGE SAFETY										
17.	BALLAST										
18.	GROWTH										
19.											
	SUBTOTAL (DRY WEIGHT)	16245	342.9	1.3	- 3.3						
20.	PERSONNEL										
21.	CARGO	1869	500	0	-50						
22.	ORDNANCE										
23.	RESIDUAL FLUIDS	699	319	- 3	- 2						
24.											
	SUBTOTAL (INERT WEIGHT)	18813	357.6	1.0	- 7.9						
25.	RESERVE FLUIDS	112	390	-30	-30						
26.	INFLIGHT LOSSES										
27.	PROPELLANT - ASCENT										
28.	PROPELLANT - CRUISE										
29.	PROPELLANT - MANEUV/ACS										
30.											
	TOTAL (GROSS WT) LB	18925	357.8	0.8	- 8.0	1.59	13.75	8.27	0	0.01	0

NOTES: CG's in Module Coordinate System

** Includes Experiment Airlock Package of 1200 lbs. @ X = 655, Y = 0, & Z = 0

* MSC (NASA) Codes

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Table 6-3. SM-3 Station Module Weight Change

WEIGHT/C.G. CHANGE ANALYSIS

CONFIGURATION SM-3				BY Space Sta. Engr.		DATE Nov. 1971		PAGE 1 of 3
**		LAST REPORT (July 1971)		CURRENT REPORT (Nov. 1971)		CHANGE		CHANGE
CODE	SYSTEM	WEIGHT	C.G.	WEIGHT	C.G.	WEIGHT	C.G.	NOTE
1.0	WING GROUP							
2.0	TAIL GROUP							
3.0	BODY GROUP	9100 *	373	8146	330	- 954		1
4.0	INDUCED ENVIR PROTECTION	1060	332	746	332	- 314		2
5.0	LANDING, RECOVERY, DOCKING	460	332	490	332	+ 30		3
6.0	PROPULSION-ASCENT							
7.0	PROPULSION-CRUISE							
8.0	PROPULSION-AUXILIARY			153	402	+ 153		4
9.0	PRIME POWER							
10.0	ELECTRICAL CONVER & DISTR	660	332	545	311	- 115		5
11.0	HYDRALIC CONVER & DISTR							
12.0	SURFACE CONTROLS							
13.0	AVIONICS	190	332	161	250	- 29		6
14.0	ENVIRONMENTAL CONTROL	2938	332	3198	317	+ 260		7
15.0	PERSONNEL PROVISIONS	2552	332	2806 *	423	+ 254		8
16.0	RANGE SAFETY							
17.0	BALLAST							
18.0	GROWTH							
19.0								
	SUBTOTAL (DRY WT)	16960	353.7	16245	342.9	- 715		
20.0	PERSONNEL	412	332			- 412		9
21.0	CARGO			1869	500	+1869		10
22.0	ORDNANCE							
23.0	RESIDUAL FLUIDS	1161	332	699	319	- 462		11
24.0								
	SUBTOTAL (INERT WT)	18533	351.9	18813	357.6	+ 280		
25.0	RESERVE FLUIDS			112	390	+ 112		12
26.0	INFLIGHT LOSSES	467	332			- 467		13
27.0	PROPELLANT-ASCENT							
28.0	PROPELLANT-CRUISE							
29.0	PROPELLANT-MANEUV/ACS							
30.0								
	TOTAL (GROSS-WEIGHT) LB.	19000	351.4	18925	357.8	- 75		

* Includes Experiment Airlock

** MSC (NASA) Codes

Table 6-3. SM-3 Station Module Weight Change (Cont)

WEIGHT/C.G. CHANGE ANALYSIS - CONT.		
CHANGE NOTE	DISCUSSION	PAGE 2 of 3
1	BODY GROUP	- 954
	Transferred experiment airlock package from secondary structure to general purpose lab furnishings in personnel provisions ---------- -1200	
	Revised internal arrangement with increase in partitions & floors (+176), increase in utility distribution (+299), auxiliary passage tunnel transferred to SM-4 (-130) and other revisions and changes (-99). ---------- + 246	
2	INDUCED ENVIRONMENT PROTECTION	- 314
	Remove and revise thermal covers (-31) and increase radiator area which reduced meteoroid protection (-283).	
3	LANDING, RECOVER & DOCKING	+ 30
	Calculations of layouts increased berthing allowance (+30).	
4	PROPULSION - AUXILIARY	+ 153
	Transfer one-half accumulators for RCS system from core to SM-3 (balance to SM-2).	
5	ELECTRICAL CONVERSION & DISTRIBUTION	- 115
	Reallocation of wiring reduces the SM-3 wiring allowance (-62). Revisions in electrical equipment (-53).	
6	AVIONICS	
	Reduce number audio/video units ---------- - 63	
	Increase number RACU's ---------- + 40	
	Miscellaneous equipment revisions ---------- - 6	
7	ENVIRONMENTAL CONTROL	+ 260
	Increase radiator area which increases integral radiator/meteoroid weight ---------- + 390	
	Transfer pump packages, intercoolers, and reservoir to SM-4 from SM-3 ---------- - 245	
	Increase coldplates, tubing, and valves ---------- + 115	

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Table 6-3. SM-3 Station Module Weight Change (Cont)

WEIGHT/C.G. CHANGE ANALYSIS - CONT.		
CHANGE NOTE	DISCUSSION	PAGE 3 of 3
8	PERSONNEL PROVISIONS	+ 254
	Seating restraints and tables added to SM-3 ------ + 152	
	All recreation & exercise transferred to SM-3 + 150	
	Medical & Dental removed from SM-3 ---------- - 633	
	Water reclamation transferred to SM-4 from SM-3 reduces water management ---------- - 757	
	Toilet and urinal removed from SM-3 (-84) and trash processor added (+79) to reduce waste management -- - 5	
	Shower and sink removed from SM-3 reduces personal hygiene ---------- - 371	
	Add galley to SM-3 ---------- + 756	
	Transfer exper. airlock from sec. structure to general purpose lab furnishings ---------- +1200	
	Remove med. biological area furnishings (252) ----- - 252	
	Miscellaneous changes ---------- + 14	
9	PERSONNEL	- 412
	Potable water removed from SM-3	
10	CARGO	+ 1869
	Add experiment equipment for P-2 plasma ph-. & envir. pert. and P-4 physics & chem. facility.	
11	RESIDUAL FLUIDS	- 462
	Reduce thermal fluids when coolant hardware transferred to SM-4.	
12	RESERVE FLUIDS	+ 112
	Add emergency LiOH canisters.	
13	INFLIGHT LOSSES	- 467
	Removed from SA-3.	

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7.0 SM-4 MODULE MASS PROPERTIES

7. SM-4 MODULE MASS PROPERTIES

The crew/control module (Figure 7-1) SM-4 has common functional allocations and equipment locations with SM-1. Each module performs a similar function in each of the two pressure-isolatable volumes of the station. Where backup functions are provided, they are located in similar areas in the module of the opposite volume.

Both SM-1 and SM-4 contain a commander/executive type stateroom and two crew staterooms in a split-level arrangement. Control centers are located on the upper deck of each module outside the stateroom. The personal hygiene facilities are in similar locations; however, only SM-1 contains a shower. The waste management equipment is located below deck near the personnel hygiene facility to simplify sewage transport and processing. The area above deck in SM-4 contains the primary medical and crew care facilities.

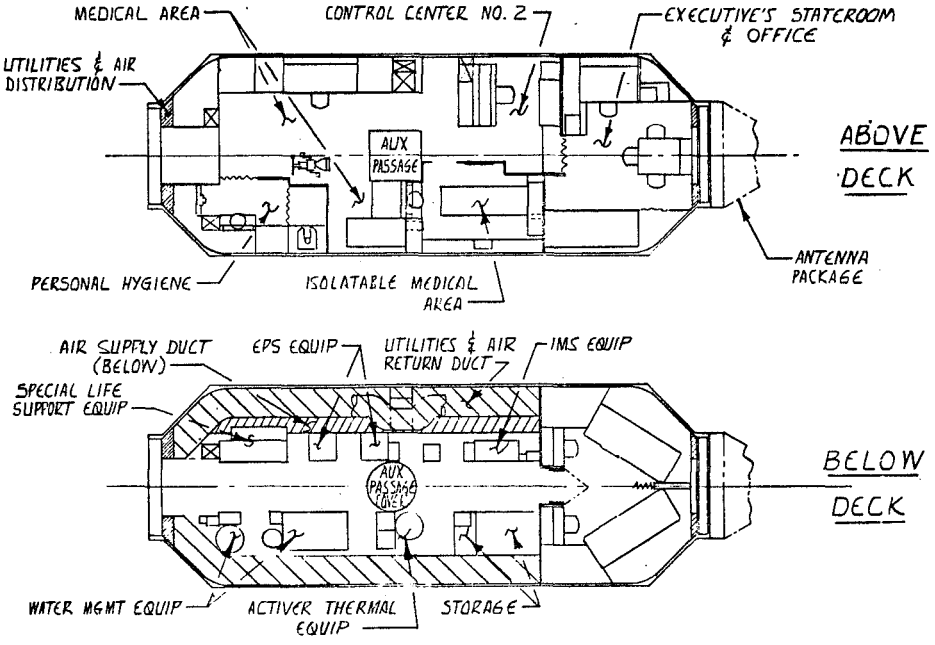

Figure 7-1. Crew/Control Module SM-4

MODULAR WEIGHT STATEMENTS

The weights presented in this section are based on the preliminary design configuration from the current study and are coded by the MSC (NASA) coding.

Table 7-1 presents the SM-4 Module Group Weight Statement. These weights are on the new MSC Group Weight forms. Figure 7-1 presents the SM-4 module configuration. The SM-4 module mass properties are shown in Table 7-2. The center of gravity stations are in the module coordinate system which is shown in Section 8. Table 7-3 presents the weight changes from the last report to this report. The last report was "Modular Space Station Mass Properties Initial Summary," dated July 1971. Details of the weight changes are shown on discussion pages of Table 7-3.

Table 7-1. SM-4 Station Module Weight Statement

GROUP WEIGHT STATEMENT					PAGE 1 of 4
CONFIGURATION SM-4 Launch			BY Space Station Engr.		DATE Nov. 1971
	FWD	CTR	AFT		
1. WING GROUP - Not Applicable					
2. TAIL GROUP - Not Applicable					
3. BODY STRUCTURE (Common Modules)					8078
Basic Structure	( )	(4700)	( )	4700	
Side Walls		3780			
Bulkheads		740			
Partitions					
Floors (Structural)					
Fittings		180			
Secondary Structure				3378	
Crew Compartment (Partitions & Floors)			1899		
Cargo Compartment (Rails & Storage)			160		
Equipment Compartment (Utility)			275		
Doors/Hatches/Windows & Access Domes			408		
Airlock (Auxiliary Passage)			265		
Brackets, Doublers			371		
4. INDUCED ENVIRONMENT PROTECTION (Common Modules)					746
Thermal Protection				359	
Radiative Panels/Coatings					
Insulation (Includ. Window Cover)			359		
Coolant System					
Noise Protection					
Meteoroid Protection(Integ. Rad./Meteor. Not incld.)				387	
Radiation Protection					
5. LAUNCH, RECOVERY & DOCKING (Common Modules)					490
Launch Support					
Tie Down					
Handling					
Docking					
Berthing (2 Ports)				410	
Utility Interfaces				80	
6. PROPULSION ASCENT - Not Applicable					
7. PROPULSION-CRUISE - Not Applicable					

Table 7-1. SM-4 Station Module Weight Statement (Cont)

GROUP WEIGHT STATEMENT					PAGE 2 of 4
CONFIGURATION SM-4 Launch			BY Space Station Engr.		DATE Nov. 1971
8. PROPULSION-AUXILIARY					0
Thruster System (Common Modules)					
	Attitude Control ( )	Orbit Maint. ( )	CMG Desat. ( )	Spin & Despin ( )	
Thruster					
Thruster Install					
Propellant Sys.					
Tankage					
Control Moment Gyro (Common Modules)					
Roll					
Pitch					
Yaw					
Magnetic Unloading System (Prepro. & Elect.)					
Support Structure					
Manipulator System (Common Modules)					
Actuator, motor					
Mechanism					
Support Structure					
Locks					
9. PRIME POWER					766
Batteries (Common Modules)				0	
Battery					
Container & Supports					
Electrical Coupling					
Voltage Controls					
Recharge Controls					
Thermal Control					
Solar Array (Common Modules)				0	
Solar Cells					
Substrates					
Deployment Devices					
Orientation Controls					
Voltage Controls					
Cooling System					
Panel Structure/Mounts & Supports					
Fuel Cells/Electrolysis Units				766	
Fuel Cells					
Supports/Installation/Tankage				122	
Electrolysis Units				644	
10. ELECTRICAL CONVERSION & DISTRIBUTION (Common Modules)					996
	Supply	Con-version	Control Units		
Equipment		14		(14)	
Distribution & Control Circuitry				756	
Utility Systems				146	
Supports/Installation				80	
11. HYDRAULIC CONVERSION & DISTRIBUTION - Not Applicable					
12. SURFACE CONTROLS - Not Applicable					

Table 7-1. SM-4 Station Module Weight Statement (Cont)

GROUP WEIGHT STATEMENT							PAGE 3 of 4
CONFIGURATION SM-4 Launch			BY Space Station Engr.			DATE Nov. 1971	
13. AVIONICS (Common Modules)	Units	Cir-cuitry	Cooling	An-tennas	Install		2640
	(1801)	(36)	( )	(234)	(569)		
Guidance & Nav.							
Flight Control							
Manipulator Control							
Data Mgmt.	727	13			32	722	
Communication	619**	23		234	514	1390 *	
Instrumentation							
Displays	455				23	478	
14. ENVIRONMENTAL CONTROL (Common Modules)							2527
Atmospheric Gas Supply							
Gas Management/Processing					558		
Heat Transport (Integral Radiator/Meteoroid)					1969		
15. PERSONNEL PROVISIONS (Common Modules)							2059
Accommodations						972	
Chairs, bunks, tables					196		
Recreation & Exercise					50		
Medical & Dental Equipment					554		
Mobility Aids & Restraints					120		
Supports					52		
Fixed Life Support Equipment						857	
Water Management					638		
Waste Management					163		
Personal Hygiene					56		
Food Management							
Cargo Handling							
Furnishings - General Purpose Lab						176	
Emergency & Safety Equipment						54	
16. RANGE SAFETY & ABORT (Common Modules)							0
17. BALLAST (Common Modules)							0
18. GROWTH/UNCERTAINTY							0
19. OPEN							
SUBTOTAL (Dry Weight)							(18302)

* Includes Steerable Antenna Package of 710 pounds.

** 100 lbs. Communication Units not included (will be transferred from Core during buildup)

Table 7-1. SM-4 Station Module Weight Statement (Cont)

GROUP WEIGHT STATEMENT			PAGE 4 of 4
CONFIGURATION SM-4 Launch	BY Space Station Engr.	DATE Nov. 1971	
20. PERSONNEL (Common Modules)			510
Crew			
Personal Gear (Clothing, Linens, Etc.)		*	
Life Support		400	
Food			
Water (Potoble Fill)	400		
Portable Equipment (PLSS & PGA)	*		
Accessories (Med. Supplies & Drugs)		110	
21. CARGO (Common Modules)			0
Experiments			
Supplies			
22. ORDNANCE (Common Modules)			0
23. RESIDUAL FLUIDS & SERVICE ITEMS (Common Modules)			1131
Auxiliary Propulsion			
Environmental Control (Atmos., Accum. & Ther. Fluids)		1125	
Life Support		6	
Electrical Power			
24. OPEN			
SUBTOTAL INERT WEIGHT			(19943)
25. RESERVE FLUIDS & SERVICE ITEMS (Common Modules)			
Auxiliary Propulsion			
Environmental Control (Repress. O_2 & N_2)			
Life Support (LiOH Canisters - Emerg.)			
Electrical Power			
26. INFLIGHT LOSSES (Common Modules)			
Auxiliary Propulsion			
Environmental Control			
Life Support (Utensils)			
Electrical Power (Buildup HP O_2 & H_2)			
Avionics (Printer Facsimile Paper)		*	
27. PROPELLANT-ASCENT - Not Applicable			
28. PROPELLANT-CRUISE - Not Applicable			
29. PROPELLANT-AUXILIARY (Common Modules)			
Attitude Control			
Orbit Maintenance			
CMG Desaturation			
Spin & Despin			
TOTAL (GROSS WEIGHT)			(19943)

* Items delivered via Cargo Module

Table 7-2. SM-4 Station Module Mass Properties

SYSTEMS MASS PROPERTIES

CONFIGURATION	BY	DATE	PAGE
SM-4 Launch	Space Sta. Engr.	Nov. 1971	1 OF 1

* NO.	SYSTEM	WEIGHT LB	CENTER OF GRAVITY INCHES			MOMENT OF INERTIA SLUG FT^2 X 10^4			PRODUCT OF INERTIA SLUG FT^2 X 10^4		
			X	Y	Z	I_{x-x}	I_{y-y}	I_{z-z}	I_{xy}	I_{xz}	I_{yz}
1.	WING GROUP										
2.	TAIL GROUP										
3.	BODY	8078	329.8	0	- 0.6						
4.	INDUC ENV PROTECT	746	332.0	0	0						
5.	LANDING & DOCKING	490	332.0	0	0						
6.	ASCENT PROPULSION										
7.	CRUISE PROPULSION										
8.	AUXILIARY PROPULSION										
9.	PRIME POWER	766	263.2	32.7	-40.5						
10.	ELECTRICAL CONV & DIST	996	306.3	17.8	- 9.3						
11.	HYDRAULIC CONV & DIST										
12.	SURFACE CONTROLS										
13.	AVIONICS **	2640	450.0	33.4	5.1						
14.	ENVIRO CONTROL	2527	316.9	-12.7	-16.5						
15.	PERSONNEL PROVISIONS	2059	306.7	-22.7	-12.1						
16.	RANGE SAFETY										
17.	BALLAST										
18.	GROWTH										
19.											
	SUBTOTAL (DRY WEIGHT)	18302	338.8	2.8	- 3.1						
20.	PERSONNEL	510	163.0	21.0	29.0						
21.	CARGO										
22.	ORDNANCE										
23.	RESIDUAL FLUIDS	1131	318.8	-23.6	-26.7						
24.											
	SUBTOTAL (INERT WEIGHT)	19943	333.2	1.8	- 3.6						
25.	RESERVE FLUIDS										
26.	INFLIGHT LOSSES										
27.	PROPELLANT - ASCENT										
28.	PROPELLANT - CRUISE										
29.	PROPELLANT - MANEUV/ACS										
30.											
	TOTAL (GROSS WT) LB	19943	333.2	1.8	- 3.6	2.08	16.10	9.48	0	-0.19	0

NOTES: CG's in Module Coordinate System

** Includes Steerable Antenna Package of 710 lbs. @ X = 598, Y = 0, & Z = 0

* MSC (NASA) Codes

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Table 7-3. SM-4 Station Module Weight Change

WEIGHT/C.G. CHANGE ANALYSIS

CONFIGURATION	BY	DATE	PAGE
SM-4 Launch	Space Sta. Engr.	Nov. 1971	1 of 3

* CODE	SYSTEM	LAST REPORT (July 1971)		CURRENT REPORT (Nov. 1971)		CHANGE		CHANGE NOTE
		WEIGHT	C.G.	WEIGHT	C.G.	WEIGHT	C.G.	
1.0	WING GROUP							
2.0	TAIL GROUP							
3.0	BODY GROUP	7900	332	8078	330	+ 178		1
4.0	INDUCED ENVIR PROTECTION	1060	332	746	332	- 314		2
5.0	LANDING, RECOVERY, DOCKING	460	332	490	332	+ 30		3
6.0	PROPULSION-ASCENT							
7.0	PROPULSION-CRUISE							
8.0	PROPULSION-AUXILIARY							
9.0	PRIME POWER			766	263	+ 766		4
10.0	ELECTRICAL CONVER & DISTR	660	332	996	306	+ 336		5
11.0	HYDRALIC CONVER & DISTR							
12.0	SURFACE CONTROLS							
13.0	AVIONICS **	1090	563	2640	450	+1550		6
14.0	ENVIRONMENTAL CONTROL	1421	332	2527	317	+1106		7
15.0	PERSONNEL PROVISIONS	1789	332	2059	307	+ 270		8
16.0	RANGE SAFETY							
17.0	BALLAST							
18.0	GROWTH							
19.0								
	SUBTOTAL (DRY WT)	14380	349.5	18302	338.8	+3922		
20.0	PERSONNEL	1656	220	510	163	-1146		9
21.0	CARGO							
22.0	ORDNANCE							
23.0	RESIDUAL FLUIDS	636	332	1131	319	+ 495		10
24.0								
	SUBTOTAL (INERT WT)	16672	336	19943	333.2	+3271		
25.0	RESERVE FLUIDS							
26.0	INFLIGHT LOSSES	128	332			- 128		11
27.0	PROPELLANT-ASCENT							
28.0	PROPELLANT-CRUISE							
29.0	PROPELLANT-MANEUV/ACS							
30.0								
	TOTAL (GROSS-WEIGHT) LB.	16800	336.0	19943	333.2	+3143		

* MSC (NASA) Codes

** Includes Antenna Package

Table 7-3. SM-4 Station Module Weight (Cont)

WEIGHT/C.G. CHANGE ANALYSIS - CONT.		
CHANGE NOTE	DISCUSSION	PAGE 2 of 3
1	BODY GROUP	
	Revised internal arrangements with increase in partitions & floors (+149), increase in utility distribution (+231), reduce storage (-60), reduce brackets & doublers (-128), and other revisions (-14).	+ 178
2	INDUCED ENVIRONMENT PROTECTION	- 314
	Remove and revise thermal covers (-31) and increase radiator area which reduces meteoroid protection (-283).	
3	LANDING, RECOVER & DOCKING	+ 30
	Calculations of layouts increased berthing allowance (+30).	
4	PRIME POWER	+ 766
	Electrolysis Units transferred to SM-4 from the core (+766).	
5	ELECTRICAL CONVERSION & DISTRIBUTION	+ 336
	Reallocation of wiring increases the SM-4 wiring allowance (+340). Revisions in electrical equipment (-4).	
6	AVIONICS	+ 1550
	Control Center transferred to SM-4 from the core.	
	Increase Data Management in SM-4 ---------- +721	
	Increase communications in SM-4 ---------- +472	
	Increase displays in SM-4 ---------- +357	
7	ENVIRONMENTAL CONTROL	+ 1106
	Increase circulation ducts and revisions in Gas Management/Processing ---------- + 75	
	Increased radiator area increases integral radiator/ meteoroid weight ---------- +390	
	Transfer pump packages, intercoolers and reservoir to SM-4 from SM-3 ---------- +245	
	Increase coldplates, tubing and valves ---------- +396	
8	PERSONNEL PROVISIONS	+ 270
	Seating restraints and tables reduced in SM-4 ----- -105	
	Passive recreation devices reduced in SM-4 -------- - 50	
	Medical & dental equipment added to SM-4 ---------- +554	
	Water reclamation transferred to SM-1 from SM-2 (+757) & weight revisions (-137) increases water management ---------- +620	

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Table 7-3. SM-4 Station Module Weight (Cont)

WEIGHT/C.G. CHANGE ANALYSIS - CONT.		
CHANGE NOTE	DISCUSSION	PAGE 3 of 3
8 (Cont)	Toilet and urinal added to SM-4 ---------- + 84 Remove Galley from SM-4 ---------- -695 Add medical/biological area general lab furnishings +176 Remove emergency equipment ---------- -375 Miscellaneous changes ---------- + 61	
9	PERSONNEL Crew, clothing, linens, food, etc., will be delivered via cargo module on crew delivery flights.	- 1146
10	RESIDUAL FLUIDS Increase in thermal fluids in thermal control coolant loops.	+ 495
11	INFLIGHT LOSSES Galley transferred out of SM-4 removes life support (utensils).	- 128

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8.0 SYNTHESIS & ANALYSIS

8. SYNTHESIS & ANALYSIS

The weight information presented in this section is supplementary to the data in the previous sections, and presents the development of Modular Space Station weights. This also continues the documentation per intent of MIL-M-38310A (USAF).

TRADE DATA

During the Modular Space Station program extension, many trade studies were made. These studies are documented in the following Modular Space Station Preliminary System Design reports:

SD71-217-5	Configuration Analyses
SD71-217-6	Trades and Analyses

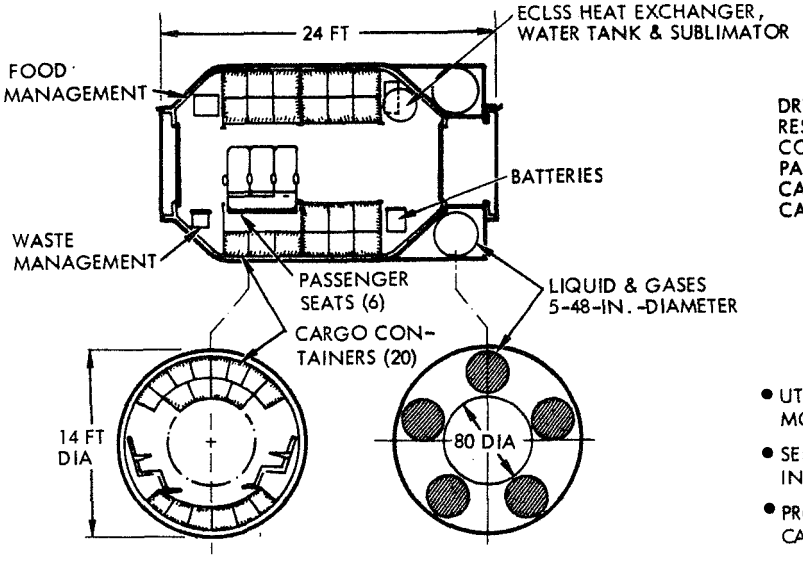
The Modular Space Station used for determining the mass properties was the preliminary design configuration from these studies.

DESIGN AND SUBSTANTIATING DATA

Core Module Design data is shown in Table 8-1 on the Design Data Summary forms. Table 8-2 presents design data for the power module. SM-1 station module design data is shown in Table 8-3 as typical for the station modules. Table 8-4 is an inventory of the fluids in the core, power and station modules at initial launch. During the study phase, all weight data from layout calculation and detail equipment lists were maintained on NR Functional Detail Weight Statements so that the data could be used directly by cost analyses and by project for group responsibility status. These functional statements were cross coded to the MSC (NASA) coding for the body of this report. Some details of a typical module are shown in Table 8-5 which presents substantiation data for SM-1 Station Module in the MSC (NASA) coding.

CARGO MODULE

The cargo module concept (Figure 8-1) utilizes the MSS universal structure except that it is 24 feet in length compared to a station module length of about 39 feet. It is self-sufficient on orbit for six men for 72 hours when in the shuttle cargo bay. Up to 11,800 pounds of cargo can be carried with an up crew load of six passengers. Passengers would occupy the cargo module only during orbital periods, and transfer to the station would be accomplished through the orbiter. One hundred twenty cargo containers, located as shown, provide sufficient dry cargo storage capacity to meet resupply and the 120-day storage capacity requirements. Five 48-inch diameter tanks provide sufficient capacity for all anticipated liquid and gas resupply requirements. Should this requirement ever increase, up to nine tanks can be carried in the annular volume shown.



WEIGHT (LB)

DRY	9660
RESIDUALS	210
CONSUMABLES	460
PASSENGERS & PROVISIONS	2560
CARGO CONTAINERS	350
CARGO	11,800
TOTAL	25,000

DESIGN FEATURES

- UTILIZES MSS UNIVERSAL MODULE STRUCTURE
- SELF-SUFFICIENT (72 HR) WHEN IN SHUTTLE
- PROVIDES SHUTTLE BERTHING CAPABILITY FOR MSS RESCUE
- EASY CREW AND CARGO UNLOADING
- EASILY CONVERTIBLE TO ALL CARGO
- CREW OCCUPANCY ONLY DURING ORBITAL FLIGHT

Figure 8-1. Cargo Module Concept

DIAGRAMS AND COORDINATE SYSTEMS

The coordinate system on the individual modules and the space station are both left-handed axis systems. A conversion is needed to go from module coordinate system to the station coordinate system. This conversion is summarized as follows:

Space Station X Sta. = Core Module X Sta. + 430
Space Station Y Sta. = Core Module Y Sta.
Space Station Z Sta. = Core Module Z Sta.

Space Station X Sta. = Power Module X Sta. + 100
Space Station Y Sta. = Power Module Y Sta.
Space Station Z Sta. = Power Module Z Sta.

Space Station X Sta. = -1 (SM-1 Module Z Sta.) + 650
Space Station Y Sta. = SM-1 Module Y Sta.
Space Station Z Sta. = -1 (SM-1 Module X Sta. - 24)

Space Station X Sta. = -1 (SM-2 Module Z Sta.) + 890
Space Station Y Sta. = SM-2 Module Y Sta.
Space Station Z Sta. = -1 (SM-2 Module X Sta. - 24)

Space Station X Sta. = -1 (SM-3 Module Z Sta.) + 650
Space Station Y Sta. = SM-3 Module Y Sta.
Space Station Z Sta. = SM-3 Module X Sta. - 24

Space Station X Sta. = -1 (SM-4 Module Z Sta.) + 890
Space Station Y Sta. = SM-4 Module Y Sta.
Space Station Z Sta. = SM-4 Module X Sta. - 24

Figure 8-2 presents a diagram of the coordinate system used in establishing the space station center of gravity and moments of inertia data. Figure 8-3 presents diagrams of the module coordinate systems used in establishing the module center of gravities and moments of inertia data.

Figure 8-4 presents a portion of the Core Module assembly drawing to show the significant dimensions and principal structural interface locations. The Power Module dimensions and structural arrangement is shown in Figure 8-5. Figure 8-6 presents the same information on the Station Modules. Additional data will be found in MSS drawings technical report number SD71-216.

Table 8-1. Core Module Design Data

DESIGN DATA SUMMARY | PAGE 1 of 4

CONFIGURATION Core Module Launch | BY Space Station Engr. | DATE Nov. 1971

1. Wing Group - Not Applicable

Module Target Weight 20000 lbs.

2. Tail Group - Not Applicable

3. Body Group (Common Modules Core Module)

Design Condition	Ultimate Load Factor Nx	Ny	Nz	@	Weight, lb.
Orbiter Boost	-4.95	± 0.90	0.825		25000
Orbiter Landing	+1.8 - 1.44	± 0.90	4.5		25000
Crash Condition	+8.0 - 1.5	± 1.5	+4.5 - 2.0		25000

Basic Structure Wetted Area - ft^2	Fwd ( )	Ctr ( )	Aft ( )	
Sidewalls		1086 Sq.Ft.		
Bulkheads		190 Sq.Ft.		
Partitions				
Body Volume - cu.ft.(Total)		Pressurized Volume (4000 Cu.Ft).		
Primary Structural Material		Aluminum		

Structural Floor Area, Sq.Ft. 380 Ult. Design Load Eqp. Ld.#/Sq.Ft.
(Four Inertia)

Miscellaneous	Wetted Area-Sq.Ft.	Volume Cu. Ft.	Limit Press. Diff.-psi	
Crew Compartment	1435 Sq. Ft.	4000 Cu.Ft.	14.9 psi	F.S. = 2.0
Equipment Compartment				
Cargo Compartment Envelope	1891 Sq.Ft.	4649 Cu.Ft.		

4. Induced Environment Protection (Common Modules Core Module)

Thermal Protection	Area-Sq.Ft.	Type	Material
Radiative			
Insulation	1418 Sq.Ft.	Multi-layer(1") Myler + Env.	Covers
Coolant System			
Noise Protection			
Radiation			
Meteoroid	1243 Sq.Ft.	Bumper	Fiberglass
Fixed or deployable Fixed		Skin thickness 0.030"	

5. Launch, Recovery & Docking (Common Modules Core Module)

Docking:
- Max. Closing Rate _____ feet/sec.
- Number of Ports _____ Diameter _____ feet
- Length of Docking Tunnel _____ feet

Berthing:
- Number of Ports 10 Diameter (80" Dia.) 6.67 feet
- Length of Access Tunnel (10") 0.83 feet

6. Propulsion Ascent - Not Applicable

7. Propulsion Cruise - Not Applicable

Table 8-1. Core Module Design Data (Cont)

DESIGN DATA SUMMARY		PAGE 2 of 4
CONFIGURATION Core Module Launch	BY Space Station Engr.	DATE Nov. 1971

8. Propulsion - Auxiliary

Thrusters (Common Modules Core Module)

Thrust (Vac)-lb	I_{sp}-Sec	ACS	Quantity Req Orbit Maint.	CMG Desaturation	
10 lb.	320	16 Thrusters (4 Quads)	8	2	( )
					( )
					( )
					( )
					( )

Propellant Sys.	Type	Tank Vol-ft^3	Tank Matl	Tank Pres-psi	Burst Factor	No. of Tanks
Fuel	H_2					
Oxidizer	O_2					
Fuel Pressurant						
Oxidizer Press.						

Control Moment Gyro (Common Modules Core Module)
Rotor Angular Momentum ____ lb.sec. (3) 40" O.D. CMG's
Rotor Speed ____ RPM
May. Torque Capability ____ ft.lb.

Manipulator System (Common Modules ____)
Max. Module Size: Dia. ____ ft., Length ____ ft.
Max. Module Weight ____ lb.
Max. Reach ____ ft.
Type Repositioning Capability ____

9. Prime Power (Common Modules Core Module)

	Specific Power		Total Power		Type
Batteries Start-up only		Watt-hrs/lb		Watt-hrs	
Fuel Cell	1220	Watt-hrs/lb Fuel	48800	Watt-hrs	H_2/O_2
	34.3	Watts/lb of Fuel Cell	28000	Watts	

EPS Gas Tanks (4) H_2 @ 33" I.D., (4) O_2 Tanks @ 26" Dia. & (2) H_2O Tanks @ 26"
Solar Cell Total Area ____ sq.ft.; Effective Area ____ sq.ft.
Rated Power @ 55°C. ____ KW
Battery Depletion Ratio ____

10. Electrical Power Conversion/Distribution
(Common Modules ____)

System Voltage = 120/208 Volts
Peak Power = ____ Watts
Average Power = 3100 Watts

11. Hydraulic Conversion & Distribution - Not Applicable

12. Surface Controls - Not Applicable

Table 8-1. Core Module Design Data (Cont)

DESIGN DATA SUMMARY			PAGE 3 of 4
CONFIGURATION Core Module Launch	BY Space Station Engr.	DATE Nov. 1971	

13. Avionics (Common Modules _____)

14. Environmental Control (Common Modules _____)

	Tot. Stor Vol.-ft^3	Storage Pres.	Tank Matl	No. of Tanks
Gas Supply System	(_____)	_____	_____	(_____)
Primary Oxygen	_____	_____	_____	_____
Secondary Oxygen	_____	_____	_____	_____
Diluent	_____	_____	_____	_____

Gas Requirement Average Rates
- Metabolic = 1.84 lb. Man-Day
- Leakage = _____ lb. Day
- Repressurize = _____ lb. Repressurize
- Pressurized Surface Area - ft^3 1435 Sq.Ft.

Heat Transport System Capacity = _____ BTU hr (Peak)
= _____ BTU hr (Ave)

Radiator Area = 185 sq.ft. Aluminum Material

15. Personnel Provisions (Common Modules _____)

Water Management System Capacity

Drinking Water = _____ lb. Man-Day x _____ Man Days
Washing = _____ lb. Man-Day x _____ Man Days
Cooling = _____ lb. BTU x _____ BTU's

Quarters for _____ officers _____ men = _____ total personnel

16. Range Safety and Abort (Common Modules _____)

17. Ballast (Common Modules No ballast)

Design C.G. Envelope Fwd = _____ %L Aft = _____ %L
Nominal C.G. Without Ballast = _____ %L
Nominal C.G. With _____ lb. Ballast = _____ %L

18. Growth/Uncertainty (Common Modules None in Target Weight)

Current Allowance = _____ lb.
Contractors Est. of Allowance Needed to Guarantee
Gross Wt. = _____ lb.*
Remaining Growth Allowance for
Customer Changes = _____ lb.

*For System Requirements as Defined by _____

19. Open

Table 8-1. Core Module Design Data (Cont)

DESIGN DATA SUMMARY		PAGE 4 of 4
CONFIGURATION Core Module Launch	BY Space Station Engr.	DATE Nov. 1971

20. Personnel (Common Modules _____)

No. of Crew = _____ ; Ave Percentile Man = _____

21. Cargo (Common Modules _____)

22. Ordnance (Common Modules _____)

23-26.	23. Residuals Fluids	24. Reserves	26. In-flight Losses
Common Modules % of Total	( )	( )	( )
Auxiliary Propulsion			
Environmental Control	624		
Life Support	5		
Electrical Power			375

27. Propellant Ascent - Not Applicable

28. Propellant Cruise - Not Applicable

29. Propellants Expended (Common Modules _____)

	Spin/ Despin	Orbit Maint.	CMG Saturation	Attitude
Oxidizer/Fuel Ratio		8/1	8/1	8/1
Fuel Density - PCF				0.0056 #/Ft.^{3}
Oxidizer Density - PCF				0.083 #/Ft.^{3}
Incremental Velocity				
Ave I_{sp}		320	320	320
Mission Performance Reserve	____ %	of ____	lb. Wp	

Table 8-2. Power Module Data

DESIGN DATA SUMMARY			PAGE 1 of 4
CONFIGURATION Power Module Launch	BY Space Station Engr.		DATE Nov. 1971

1. Wing Group - Not Applicable

2. Tail Group - Not Applicable — Module Target Weight 20000 lb.

3. Body Group (Common Modules Power Module)

Design Condition	Ultimate Load Factor Nx	Ny	Nz	@ Weight, lb.
Orbiter Boost	-4.95	+ 0.165	0.825	25000
Orbiter Landing	+1.8 - 1.44	+ 0.90	4.5	25000
Crash Condition	+8.0 - 1.5	+ 1.5	+4.5 - 2.0	25000

Basic Structure Wetted Area - ft^2	Fwd ( )	Ctr ( )	Aft ( )	
Sidewalls		541 Sq.Ft.		
Bulkheads		Ring Frames		
Partitions		--		
Body Volume - cu.ft.(Total)		Pressurized Volume (980 Cu.Ft.)		
Primary Structural Material		Aluminum		

Structural Floor Area, Sq.Ft. -- Ult. Design Load -- #/Sq.Ft.

Miscellaneous	Wetted Area-Sq.Ft.	Volume Cu. Ft.	Limit Press. Diff.-psi	
Crew Compartment	645 Sq.Ft.	980 Cu.Ft.	14.9 psi	F.S. = 2.0
Equipment Compartment				
Cargo Compartment Envelope	855 Sq.Ft.	1400 Cu.Ft.		

4. Induced Environment Protection (Common Modules Power Module)

Thermal Protection	Area-Sq.Ft.	Type	Material
Radiative			
Insulation	811 Sq.Ft.	Multi-layer(1")	Myler
Coolant System			
Noise Protection			
Radiation			
Meteoroid	811 Sq.Ft.	Bumper	Fiberglass
Fixed or deployable		Skin thickness	0.030"

5. Launch, Recovery & Docking (Common Modules Power Module)

Docking:
- Max. Closing Rate ____ feet/sec.
- Number of Ports ____ Diameter ____ feet
- Length of Docking Tunnel ____ feet

Berthing:
- Number of Ports 4 Diameter (80" Dia.) 6.67 feet
- Length of Access Tunnel (10") 0.83 feet

6. Propulsion Ascent - Not Applicable

7. Propulsion Cruise - Not Applicable

Table 8-2. Power Module Data (Cont)

DESIGN DATA SUMMARY | PAGE 2 of 4

CONFIGURATION Power Module Launch | BY Space Station Engr. | DATE Nov. 1971

8. Propulsion - Auxiliary

Thrusters (Common Modules _____)

Thrust (Vac)-lb	I_{sp}-Sec	ACS	Quantity Req Orbit Maint.	CMG Desaturation	
					( )
					( )
					( )
					( )
					( )

Propellant Sys.	Type	Tank Vol-ft^3	Tank Matl	Tank Pres-psi	Burst Factor	No. of Tanks
Fuel						
Oxidizer						
Fuel Pressurant						
Oxidizer Press.						

Control Moment Gyro (Common Modules _____)
Rotor Angular Momentum _____ lb.sec.
Rotor Speed _____ RPM
May. Torque Capability _____ ft.lb.

Manipulator System (Common Modules _____)
Max. Module Size: Dia. _____ ft., Length _____ ft.
Max. Module Weight _____ lb.
Max. Reach _____ ft.
Type Repositioning Capability _____

9. Prime Power (Common Modules Power Module)

	Specific Power	Total Power	Type
Batteries	_____ Watt-hrs/lb	_____ Watt-hrs	_____
Fuel Cell	_____ Watt-hrs/lb Fuel	_____ Watt-hrs	_____
	_____ Watts/lb of Fuel Cell	_____ Watts	

EPS Gas Tanks (3) H_2 @ 33" 1.0., (3) O_2 @ 10.
Solar Cell Total Area 7560 sq.ft.; Effective Area 7000 sq.ft.
Rated Power @ 55°C. 46.8 KW E.O.L. (66 KW B.O.L.)
Battery Depletion Ratio _____

10. Electrical Power Conversion/Distribution
(Common Modules _____)

System Voltage = 120/208 Volts
Peak Power = _____ Watts
Average Power = 132 Watts

11. Hydraulic Conversion & Distribution - Not Applicable

12. Surface Controls - Not Applicable

Table 8-2. Power Module Data (Cont)

DESIGN DATA SUMMARY		PAGE 3 of 4
CONFIGURATION Power Module Launch	BY Space Station Engr.	DATE Nov. 1971

13. Avionics (Common Modules _____)

14. Environmental Control (Common Modules _____)

	Tot. Stor Vol.-ft^3	Storage Pres.	Tank Matl	No. of Tanks
Gas Supply System	(_____)	_____	_____	(_____)
Primary Oxygen	_____	_____	_____	_____
Secondary Oxygen	_____	_____	_____	_____
Diluent	_____	_____	_____	_____
Repress. Gas	(1) O_2 @ 33"I.D. & (3) N_2 @ 33"I.D.			

Gas Requirement Average Rates
- Metabolic = _____ lb. Man-Day
- Leakage = _____ lb. Day
- Repressurize = _____ lb. Repressurize
- Pressurized Surface Area - ft^3 _____

Heat Transport System Capacity = _____ BTU hr (Peak)
= _____ BTU hr (Ave)

Radiator Area = _____ sq.ft. _____ Material

15. Personnel Provisions (Common Modules _____)

Water Management System Capacity

Drinking Water = _____ lb. Man-Day x _____ Man Days
Washing = _____ lb. Man-Day x _____ Man Days
Cooling = _____ lb. BTU x _____ BTU's

Quarters for _____ officers _____ men = _____ total personnel

16. Range Safety and Abort (Common Modules _____)

17. Ballast (Common Modules No ballast)

Design C.G. Envelope Fwd = _____ %L Aft = _____ %L
Nominal C.G. Without Ballast = _____ %L
Nominal C.G. With _____ lb. Ballast = _____ %L

18. Growth/Uncertainty (Common Modules None in Target Weight)

Current Allowance = _____ lb.
Contractors Est. of Allowance Needed to Guarantee
Gross Wt. = _____ lb.*
Remaining Growth Allowance for
Customer Changes = _____ lb.

*For System Requirements as Defined by _____

19. Open

Table 8-2. Power Module Data (Cont)

DESIGN DATA SUMMARY		PAGE 4 of 4
CONFIGURATION Power Module Launch	BY Space Station Engr.	DATE Nov. 1971

20. Personnel (Common Modules _____)

No. of Crew = _____ ; Ave Percentile Man = _____

21. Cargo (Common Modules _____)

22. Ordnance (Common Modules _____)

23-26.	23. Residuals Fluids	25. Reserves	26. In-flight Losses
Common Modules % of Total	( )	( )	( )
Auxiliary Propulsion			
Environmental Control	74	575	
Life Support			
Electrical Power			307

27. Propellant Ascent - Not Applicable

28. Propellant Cruise - Not Applicable

29. Propellants Expended (Common Modules _____)

	Spin/ Despin	Orbit Maint.	CMG Saturation	Attitude
Oxidizer/Fuel Ratio				
Fuel Density - PCF				
Oxidizer Density - PCF				
Incremental Velocity				
Ave I_{sp}				

Mission Performance Reserve _____ % of _____ lb. Wp

Table 8-3. SM-1 Station Module Design Data

DESIGN DATA SUMMARY | PAGE 1 of 4

CONFIGURATION SM-1 Launch | BY Space Station Engr. | DATE Nov. 1971

1. Wing Group - Not Applicable

2. Tail Group - Not Applicable

Module Target Weight 20000 lbs.

3. Body Group (Common Modules Typical of Station Modules)

Design Condition	Ultimate Load Factor Nx	Ny	Nz	@	Weight, lb.
Orbiter Boost	-4.95	± 0.165	0.825		25000
Orbiter Landing	+1.8 - 1.44	± 0.90	4.5		25000
Crash Condition	+8.0 - 1.5	± 1.5	+4.5 - 2.0		25000

Basic Structure Wetted Area - ft^2	Fwd	Ctr	Aft	
	( )	( )	( )	
Sidewalls		1577 Sq.Ft.		
Bulkheads		Ring Frames		
Partitions		1120 Sq.Ft.		
Body Volume - cu.ft.(Total)		Pressurized Volume	(4920 Cu.Ft)	
Primary Structural Material		Aluminum		

Structural Floor Area, Sq.Ft. 400 Ult. Design Load 150-500 #/Sq.Ft.
(Longitudinal)

Miscellaneous	Wetted Area-Sq.Ft.	Volume Cu. Ft.	Limit Press. Diff.-psi	
Crew Compartment	1640 Sq.Ft.	4920 Cu.Ft.	14.9 psi	F.S. = 2.0
Equipment Compartment				
Cargo Compartment				
Envelope	1760 Sq.Ft.	5310 Cu.Ft.		

4. Induced Environment Protection (Common Modules Typical of Station Modules)

Thermal Protection	Area-Sq.Ft.	Type	Material
Radiative			
Insulation	1794 Sq.Ft.	Multi-layer	(1") Mylar + Envir. Covers
Coolant System			
Noise Protection			
Radiation			
Meteoroid	564 Sq.Ft.	Bumper	Aluminum
Fixed or deployable	Fixed	Skin thickness	0.030"

5. Launch, Recovery & Docking (Common Modules Typical of Station Modules)

Docking:
- Max. Closing Rate _____ feet/sec.
- Number of Ports _____ Diameter _____ feet
- Length of Docking Tunnel _____ feet

Berthing:
- Number of Ports 2 Diameter(80" Dia.) 6.67 feet
- Length of Access Tunnel (10") 0.83 feet

6. Propulsion Ascent - Not Applicable

7. Propulsion Cruise - Not Applicable

Table 8-3. SM-1 Station Module Design Data (Cont)

DESIGN DATA SUMMARY			PAGE 2 of 4
CONFIGURATION SM-1 Launch		BY Space Station Engr.	DATE Nov. 1971

8. Propulsion - Auxiliary

Thrusters (Common Modules _____)

Thrust (Vac)-lb	I_{sp}-Sec	ACS	Quantity Req Orbit Maint.	CMG Desaturation	
					( )
					( )
					( )
					( )
					( )

Propellant Sys.	Type	Tank Vol-ft^3	Tank Matl	Tank Pres-psi	Burst Factor	No. of Tanks
Fuel						
Oxidizer						
Fuel Pressurant						
Oxidizer Press.						

Control Moment Gyro (Common Modules _____)
Rotor Angular Momentum _____ lb.sec.
Rotor Speed _____ RPM
May. Torque Capability _____ ft.lb.

Manipulator System (Common Modules _____)
Max. Module Size: Dia. _____ ft., Length _____ ft.
Max. Module Weight _____ lb.
Max. Reach _____ ft.
Type Repositioning Capability _____

9. Prime Power (Common Modules _____)

	Specific Power	Total Power	Type
Batteries	_____ Watt-hrs/lb	_____ Watt-hrs	_____
Fuel Cell	_____ Watt-hrs/lb Fuel	_____ Watt-hrs	_____
	_____ Watts/lb of Fuel Cell	_____ Watts	

Solar Cell Total Area _____ sq.ft.; Effective Area _____ sq.ft.
Rated Power @ 55°C. _____ KW
Battery Depletion Ratio _____

10. Electrical Power Conversion/Distribution
(Common Modules _____)

System Voltage = 120/208 Volts
Peak Power = _____ Watts
Average Power = 2300 Watts

11. Hydraulic Conversion & Distribution - Not Applicable

12. Surface Controls - Not Applicable

Table 8-3. SM-1 Station Module Design Data (Cont)

DESIGN DATA SUMMARY			PAGE 3 of 4
CONFIGURATION SM-1 Launch	BY Space Station Engr.	DATE Nov. 1971	

13. Avionics (Common Modules _____)

14. Environmental Control (Common Modules No Commonality)

	Tot. Stor Vol.-ft^3	Storage Pres.	Tank Matl	No. of Tanks
Gas Supply System	(_____)	_____	_____	(_____)
Primary Oxygen	_____	_____	_____	_____
Secondary Oxygen	_____	_____	_____	_____
Diluent	_____	_____	_____	_____

Gas Requirement Average Rates
- Metabolic = 1.84 lb. Man-Day
- Leakage = _____ lb. Day
- Repressurize = _____ lb. Repressurize
- Pressurized Surface Area - ft^3 1640

Heat Transport System Capacity = _____ BTU hr (Peak)
= _____ BTU hr (Ave)

Radiator Area = 1230 sq.ft. Aluminum Material

15. Personnel Provisions (Common Modules SM-1 and SM-4)

Water Management System Capacity

Drinking Water = 5.80 lb. Man-Day x _____ Man Days
Washing = 9.15 lb. Man-Day x _____ Man Days
Cooling = -- lb. BTU x _____ BTU's

Quarters for 1 officers 2 men = 3 total personnel

16. Range Safety and Abort (Common Modules _____)

17. Ballast (Common Modules No Ballast)

Design C.G. Envelope Fwd = _____ %L Aft = _____ %L
Nominal C.G. Without Ballast = _____ %L
Nominal C.G. With _____ lb. Ballast = _____ %L

18. Growth/Uncertainty (Common Modules None in Target Weight)

Current Allowance = _____ lb.
Contractors Est. of Allowance Needed to Guarantee
Gross Wt. = _____ lb.*
Remaining Growth Allowance for
Customer Changes = _____ lb.

*For System Requirements as Defined by _____

19. Open

Table 8-3. SM-1 Station Module Design Data (Cont.)

DESIGN DATA SUMMARY		PAGE 4 of 4
CONFIGURATION SM-1 Launch	BY Space Station Engr.	DATE Nov. 1971

20. Personnel (Common Modules SM-1 & SM-4)

No. of Crew = 3 ; Ave Percentile Man = _____

21. Cargo (Common Modules Initial Exper. in SM-2 & SM-3

22. Ordnance (Common Modules _____)

23-26. Common Modules % of Total	23. Residuals Fluids SM-1 & SM-4 ( )	24. Reserves ( )	26. In-flight Losses ( )
Auxiliary Propulsion			
Environmental Control	1125		
Life Support	6		
Electrical Power			

27. Propellant Ascent - Not Applicable

28. Propellant Cruise - Not Applicable

29. Propellants Expended (Common Modules _____)

	Spin/ Despin	Orbit Maint.	CMG Saturation	Attitude
Oxidizer/Fuel Ratio				
Fuel Density - PCF				
Oxidizer Density - PCF				
Incremental Velocity				
Ave I_{sp}				

Mission Performance Reserve _____ % of _____ lb. Wp

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Table 8-4. Inventory of Fluids and Propellants

CURRENT INVENTORY OF FLUIDS AND PROPELLANTS

CONFIGURATION		BY	DATE
Initial Launch	Core, Power, SM-1, SM-2, SM-3 & SM-4	Space Sta. Engr.	Nov. 1971

SYSTEM	DENSITY LB/FT^3	CAPACITY LB	TOTAL WT LB	EXPENDABLE (NOMINAL)	RESERVES LB	RESIDUALS LB
PROPULSION - ASCENT						
OXIDIZER (LOX)						
FUEL (LH)						
PRESSURANT ( )						
PROPULSION - CRUISE						
FUEL (LH)						
PRESSURANT						
PROPULSION - AUXILIARY						
OXIDIZER (LOX)			*			
MANEUVER						
ATTITUDE CONTROL						
FUEL (LH)			*			
MANEUVER						
ATTITUDE CONTROL						
PRESSURANT						
MANEUVER						
ATTITUDE CONTROL						
ENVIRONMENTAL CONTROL						
RADIATOR FLUID (Freon)	--		1845	--	--	1845
ATMOSPHERE ( )						
OXYGEN (H.P. O_2)	O_2 Gas	--	194	--	194	--
DILUENT (H.P. N_2)	N_2 Gas	--	381	--	381	--
WATER	62.4					
COOLING LOOP	--		742	--	--	742
DRINKING	--	829	429	400	--	29
ELECTROLYSIS ACCUMULATOR	--	--	100	--	--	100
MODULE ATMOSPHERE	0.0753	--	1647	--	--	1647
PRIME POWER						
RADIATOR FLUID ( )						
FUEL CELL REACTANTS						
OXIDIZER (H.P. O_2)	O_2 Gas	--	606	606	--	--
FUEL (H.P. N_2)	H_2 Gas	--	76	76	--	--
APU REACTANTS						
OXIDIZER (LOX)						
FUEL (LH)						
HYDRA CONVER & DISTRIB						
HYDRAULIC FLUID						
MISCELLANEOUS						
TOTAL			6020	1082	575	4363

* Initial Buildup with EPS Gas

Table 8-5. SM-1 Station Module Substantiation Data

3.0 BODY STRUCTURE

The structures subsystem provides the module pressure enclosure as well as the living and working quarters contained within the structure. It provides for the mounting of subsystem hardware and provides storage facilities.

Basic Structure weights were estimated from preliminary structural sizings, and include the following items:

Side Walls		3780
Outer Walls t = 0.145" Al. Monocoque 1577 Sq. Ft. @ 2.025 #/Sq. Ft.	3193	
Drag Longerons (2) 2.50 Sq. In. Max. Section 300" Long	114	
Increased Thickness @ Ports & Aux. Pass. (2) Ports & (1) Aux. Package	126	
Weld lands, ineffective material, etc. Allowance @ 10.1% of 3433# = 347#	347	
Bulkheads		740
Hatch Bulkheads @ 2 Berthing Ports 80" Dia. less hatch = 17.4 Sq. Ft. each Builtup Struc. @ 6.0 #/Sq.Ft. x 17.4 Sq.Ft. = 104# each	208	
Ring Frames (3) 2.50 Sq.In. Section x 528" Circum. = 136# each	408	
Aux. Passage Bulkhead (1) 48" Dia. less hatch = 5.5 Sq. Ft. Builtup Struc. @ 11.0 #/Sq. Ft. x 5.5 Sq. Ft. = 61#	61	
Attachments & Mounting Provisions Allowance @ 9.3% of 677# = 63#	63	
Fittings		180
Shuttle Trunnion Fittings (4) Builtup Forging @ 30# each	120	

Basic Structure (continued)

Manipulator Sockets (4) Buildup Forging @ 15# each	60	
Total Basic Structure		4700

Secondary Structure weights were estimated from preliminary structural sizings and include following items:

Crew Compartment		1895
Ceilings Foam-filled fiberglass honeycomb false ceilings @ 0.60 #/Sq. Ft. x 260 Sq. Ft. = 156#	156	
Partitions Foam-filled fiberglass honeycomb partitions @ 0.36 #/Sq. Ft. x 1120 Sq. Ft. = 404#	404	
Floors Aluminum Honeycomb Sandwich Floor t = 4" @ 2.67 #/Sq. Ft. x 270 Sq. Ft. = 721# t = 2" @ 1.99 #/Sq. Ft. x 130 Sq. Ft. = 259# Perimeter Ring = 43#	1029	
Catwalks @ 1.0 #/Sq. Ft. x 135 Sq. Ft. = 135#	135	
Attachments and Mounts Allowance @ 9.9% of 1724# = 171#	171	
Cargo Compartment		138
Cargo Handling Rails @ 2.0 #/Ft. x 35 Ft.	70	
Storage Panels @ 0.72 #/Sq. Ft. x 75 Sq. Ft.	54	
Attachments & Mounts @ 10%	14	
Equipment Compartment		275
Utility Ducts @ 0.44 #/Sq. Ft. x 570 Sq. Ft.	250	
Attachments & Mounts @ 10%	25	
Doors/Hatches/Windows & Access Domes		408
Berthing Port Hatches (2) Alum. Honeycomb Sandwich Hatch 42" x 66" with window 14" Dia. @ 7.75 #/Sq. Ft. x 17.5 Sq. Ft. = 136# each	272	

Secondary Structure (continued)

Auxiliary Passage Hatch (1) Alum. Honeycomb Sandwich Hatch 36" Dia. with window 4" Dia. @ 7.50 #/Sq. Ft. x 7.07 Sq. Ft. = 53#	53	
Window (1) 14" Dia. Three Pane window with frames & seals	44	
Mounting Provisions @ 10.5%	39	
Auxiliary Passage		135
Auxiliary Passage Hardware 40" Dia. Seal Ring Aux. Port Hardware including Seal Ring, Ring Mount, Seals and Latches	135	
Brackets, Doublers, etc. 4.9% Body Structure Items = 367#		367
Total Secondary Structure		3218

4.0 INDUCED ENVIRONMENT PROTECTION

The environment protection subsystem provides temperature and heat control by passive thermal design techniques, and shielding to break up and/or deflect micrometeoroids which may otherwise endanger the station module.

Thermal Protection weights were estimated from preliminary design studies and include following items:

Insulation		359
Insulation Blanket Assembly t = 1" 4 0.25" thick assem. of 10 layers of Myler separated by spacers @ 0.1135 #/Sq. Ft. x 1794 Sq. Ft. = 204#	204	
Liner/Bumper of 10 mil Kapton @ 0.0734 #/Sq. Ft. x 1794 Sq. Ft. = 132#	132	
Vent Fittings, etc. @ 0.0071 #/Sq. Ft. x 1794 Sq. Ft. = 12#	12	
Window Pressure Cover & Envir. Shield 14" Dia. Window & 20" Dia. Envir. Shield	11	
Total Thermal Protection		359

Meteoroid Protection weights were estimated from preliminary design drawings and structural sizing. The primary bumper meteoroid protection in radiator area is not included here as is integral with radiator. The remaining includes the following:

Primary Bumper t = 0.030" Alum. 1794 Sq. Ft. - 1230 Sq. Ft. Radiator = 564 Sq. Ft. @ 0.4450 #/Sq. Ft. x 564 Sq. Ft. = 250#	250
Reinforcements @ 0.1185 #/Sq. Ft. x 564 Sq. Ft. = 67#	67
Closeouts and Supports @ 0.1234 #/Sq. Ft. x 564 Sq. Ft. = 70#	70
Total Meteoroid Protection	387

5.0 LAUNCH, RECOVERY & DOCKING

The berthing subsystem provides for the coupling and uncoupling of all modules. An area for shirtsleeve environment to transfer crew, cargo and equipment between modules is provided.

Berthing weights were estimated from sizing, construction and materials as developed by the Design Group on drawing number V030-942004, "Berthing Port Assembly," and includes following items:

(2) End Ports @ 80" Dia. & 10" Long

	(1) Active Port +	(1) Passive Port	
Mating Ring (80" Dia.)	97	97	
Tunnel (10" Long)	44	44	
Seals (80" Dia.)	10	0	
Alignment Guides (4)	32	4	
Utility Liner	20	0	
Berthing Latches (12)	36	0	
Hardware & Min.	16	10	
Total Berthing	255 @ 1 +	155 @ 1 =	410

Utility Interfaces weight is allowance for supplying utilities through the Berthing Ports.

Hardware	2 Ports @ 36# each	72
Attachments	11.1% (72) = 8#	8
	Total Utility Interfaces	80

9.0 PRIME POWER

The only items of electrical power source in SM-1 are the electrolysis units and their associated plumbing. Fuel cells are in core and tankage is in core and power boom.

Fuel Cells/Electrolysis Units weight was estimated from systems group studies and includes following items:

Supports/Installation/Tankage		122
Plumbing, Regulators & Valves	51	
Mounts & Supports 10.2% (695) = 71#	71	
Electrolysis Units (2) @ 322#		644
Total Fuel Cells/Electrolysis Units		766

10.0 ELECTRICAL CONVERSION & DISTRIBUTION

Main items of electrical conversion and distribution in SM-1 are the wiring and the lighting.

Equipment weights were estimated from the Electrical Power Subsystems equipment list and includes following items:

Conversion	14
(2) Autotransformers & Rectifier Filters @ 7# = 14#	

Distribution & Control Circuitry weights were estimated from the equipment list.

Buses (2) @ 31# = 62#	62
Wiring 30% (2300#) = 690# in SM-1	690
Feeders	4
Total Distribution & Control	756

Utility Systems weights were estimated from EPS studies and include following:

Internal Lighting (50) @ 2.5# = 125#	125
Recognition Lights	8
Mounts & Supports 9.8% (133) = 13	13
Total Utility Systems	146

Supports/Installation allowance includes the above equipment mounts and supports (excluding Utility System).

Mounts & Supports	10.3% (770) = 80#	80

13.0 AVIONICS

Data Management weight in SM-1 Module was estimated from Information System detail studies and included:

Units		727
Data Bus Control Unit	15	
Central Timing Unit	18	
Central Processor	554	
Remote Acquisition Control (12) @ 5# =	60	
Computer Programs	65	
Microfilm	15	
Circuitry (Internal Cabling)		13
Installation 4.3% (740#) =		32
Total Data Management		772

Communication weight in SM-1 Module was estimated from studies and includes:

Units		719
Ku-Band Non-Integ. Electron.	20	
S-Band Transponder (2)	60	
VHF Transponder (2)	40	
Communications Rack	291	
Recording Units	135	
Audio Video Units (6)	54	
Hardwire Intercommunication	10	
TV Camera - Color	5	
TV Camera - Black & White	4	
TV Monitor - Color (4)	100	
Circuitry (Misc. Internal Cabling)		23
Antennas		234
Ku-Band Antenna (1)	150	
Ku-Band Antenna Mounted Elect.	80	
S-Band Semi-Directive Ant. (2)	2	
VHF Antenna (2)	2	

Communication (continued)

Installation		514
Ku-Band Ant. Extension Structure	480	
Mounts & Supports 4.5% (742) =	34	
Total Communications		1490

Displays weight in SM-1 Module

Units		455
Operational Control Console	331	
Commanders Control Console	67	
Portable Control Console	57	
Installation 5.0% (455) =		23
Total Displays		478

14.0 ENVIRONMENTAL CONTROL

This subsystem and the remaining subsystems were all estimated from detail equipment lists from subsystem studies.

The detailed characteristics of the individual equipment items that formed the basis for the weights are included in the system specification, DRL 66, Vol. SD71-215.

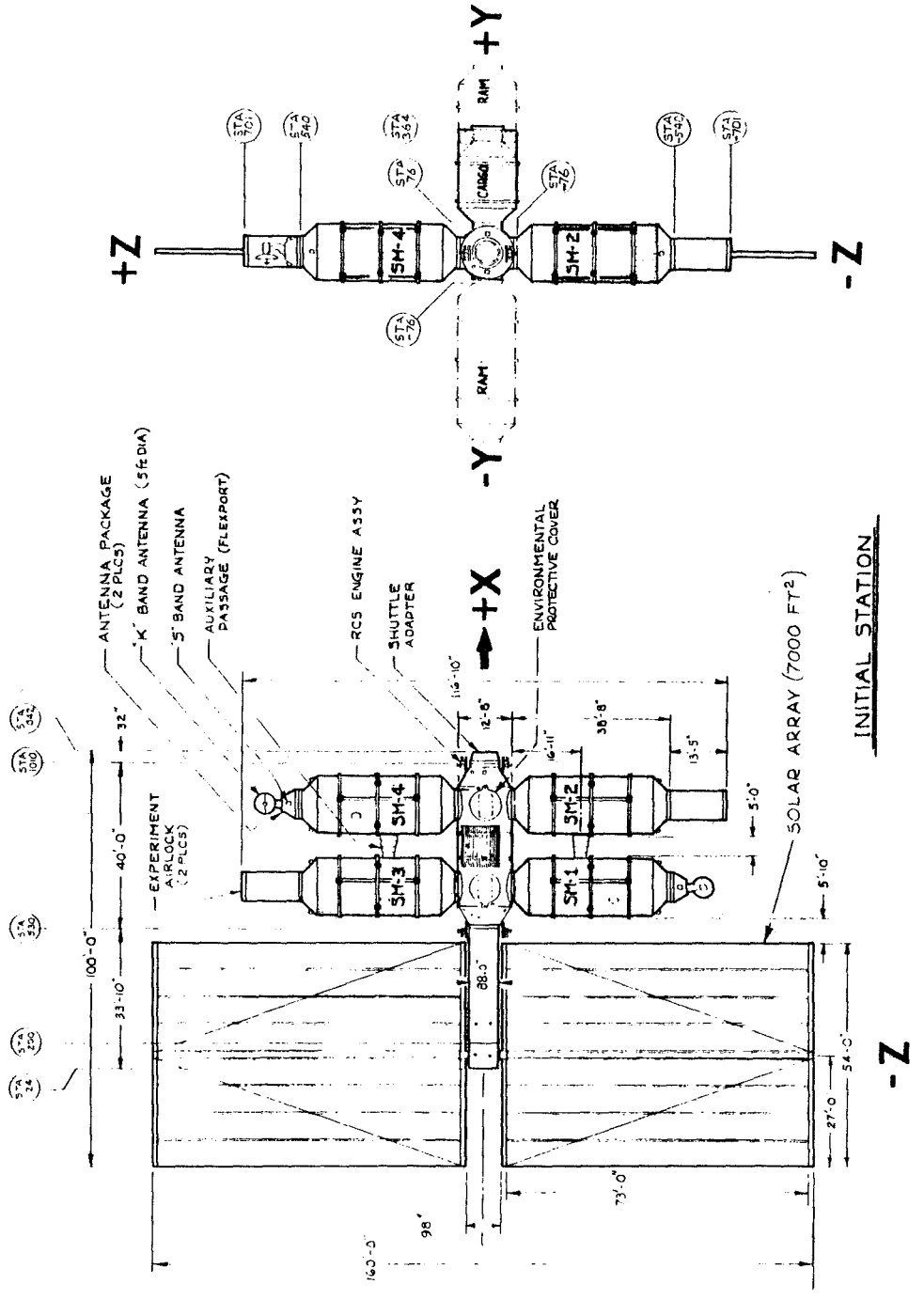


Figure 8-2. Station Coordinate System

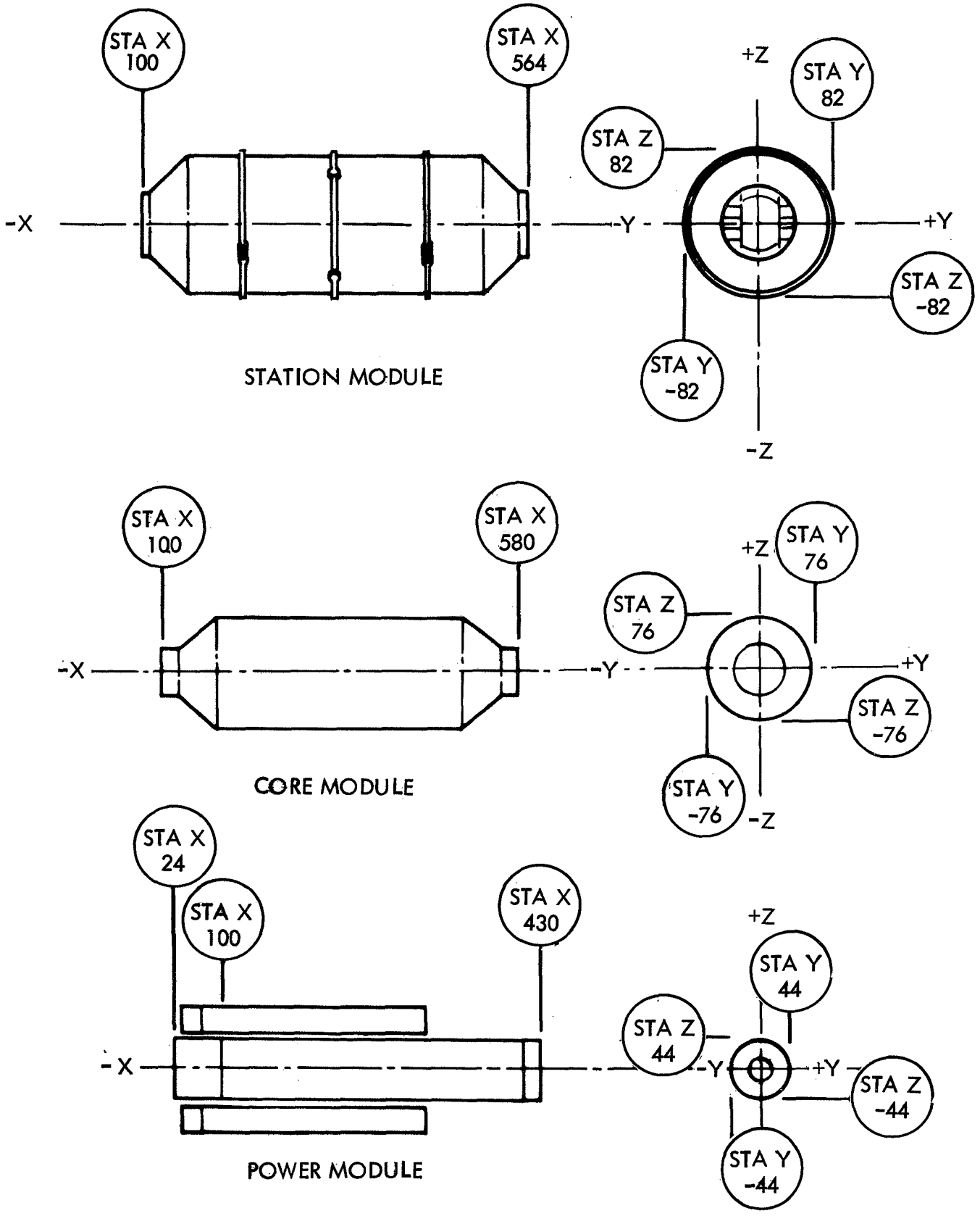


Figure 8-3. Module Coordinate Systems

HUMIDITY DUCTING SYS. (ECLSS)
9.0 (TYP)
8.0 (TYP)
AIRLOCK CONTROLS
UTILITIES
RETURN
15" I.D.
STAR TRACKER (2) G&C
RADIATOR
120 (10'-0")
TRACKER SUPPORT (2)
IVA UMBILICAL (CREW & HABITABILITY)
SENSIBLE DUCTING SYS. 15" I.D. (177"²) (ECLSS) (SUPPLY & RETURN)
CREW EQUIP STORAGE
22.5
33°
12" LOC
+Y
UTILITIES
35°
SUPPLY
IMU PRE-PROC
ELEC
HUMIDITY DUCTING SYS (ECLSS)
SENSIBLE DUCTING SYS 15" I.D. (177"²) (ECLSS)
RADIATOR
-Z
44 DIA
EVA HATCH-40 CLEAR OPENING
20 DIA THERMAL COVER
14 DIA. WINDOW
26.5
5.0
5.5 DIA. (TYP)
8.0
16.0
(TYP)
9.0 DIA. (TYP)
SEXTANT
STA 340
6.0
TELESCOPE
TRACKER SUPPORT
HORIZON TRACKER OPTICS (4) (G&C)

SECTION E-E LOOKING AFT

IML-PRESS WALL
OML-ENVIRONMENTAL SHIELD
BERTHING INTERFACE (TYP)
HUMIDITY DUCTING SYS (ECLSS)
RETURN 15" I.D.
UTILITIES
9" I.D.
RCS ENGINE PROTECTIVE COVER (REMOVABLE FOR ENGINE MAINTENANCE)
PRESSURE HATCH (TYP)
+Y
-Z
PRESSURE HATCH-STOWED (TYP)
BERTHING PORT UTILITY DISTRIBUTION AREA. (TYP)
SUPPLY 15" I.D.
SENSIBLE DUCTING SYS (SUPPLY & RETURN) (ECLSS)
ENVIRONMENTAL COVER 2 PLCS
HUMIDITY DUCTING SYS (ECLSS)

SECTION H-H LOOKING AFT
(TYP 2 PL'CS)

BERTHING INTERFACE
480 (40'-0")
STA 100
STA 220
STA 340
PUMP DOWN UNIT (ECLSS)
ENVIRONMENTAL COVER DRIVE MECH. (TYP)
STAR TRACKER ASSY (2-NEAR & FAR SIDES) (G
RCS ENGINE - RETRACTED POSITION (MAINTENANCE/SHUTTLE DELIVERY)
H_2O STORAGE & PUMP PKG (27" I.D.) (EPS)
SECONDARY BUS (COLDPLATED)
80 DIA
2.8
10.0
60 (EVA/IVA AIRLOCK)
30
F/C (COLD-PLATED)
INV (COLD-PLATED)
2.0
IVA UMBIL PKG
IVA UMBIL. PKG
ELEC
IMU
SENSIBLE
DUCTING
VENT FAN
HUMIDITY DUCT
RCS DRIVER ELECTRONICS (2) & PREPROCESSOR (1)
H_2 ACCUM-33" I.D. (2) (EPS)
B/U COMM (2)
B/U DATA PROC (1) (ISS)
O_2 ACCUM-2... (2) (EPS)
H_2 ACCUM-33" I.D.
O_2 ACCUM-27" I.D. (2) (EPS)
HORIZON TRACKER OPTICS (4) (G...
SEXTANT, TELESCOPE & ASSOC. EQUIP (G&C ...
B/U H_2O PUMP PKG, FREON/H_2O INTERCO...
PUMP PKG & RES, EMERG FREON PUMP PKG ...
PUMP PKG (ECLSS)
RCS ENGINE (4) - OPERABLE POSITION
BERTHING INTERFACE (TYP)
SEE DWG # V030-392004

.040 AL ALLOY
PRESS BULKHEAD
10
DETAIL P SCALE

B/U IN...
NOTE:

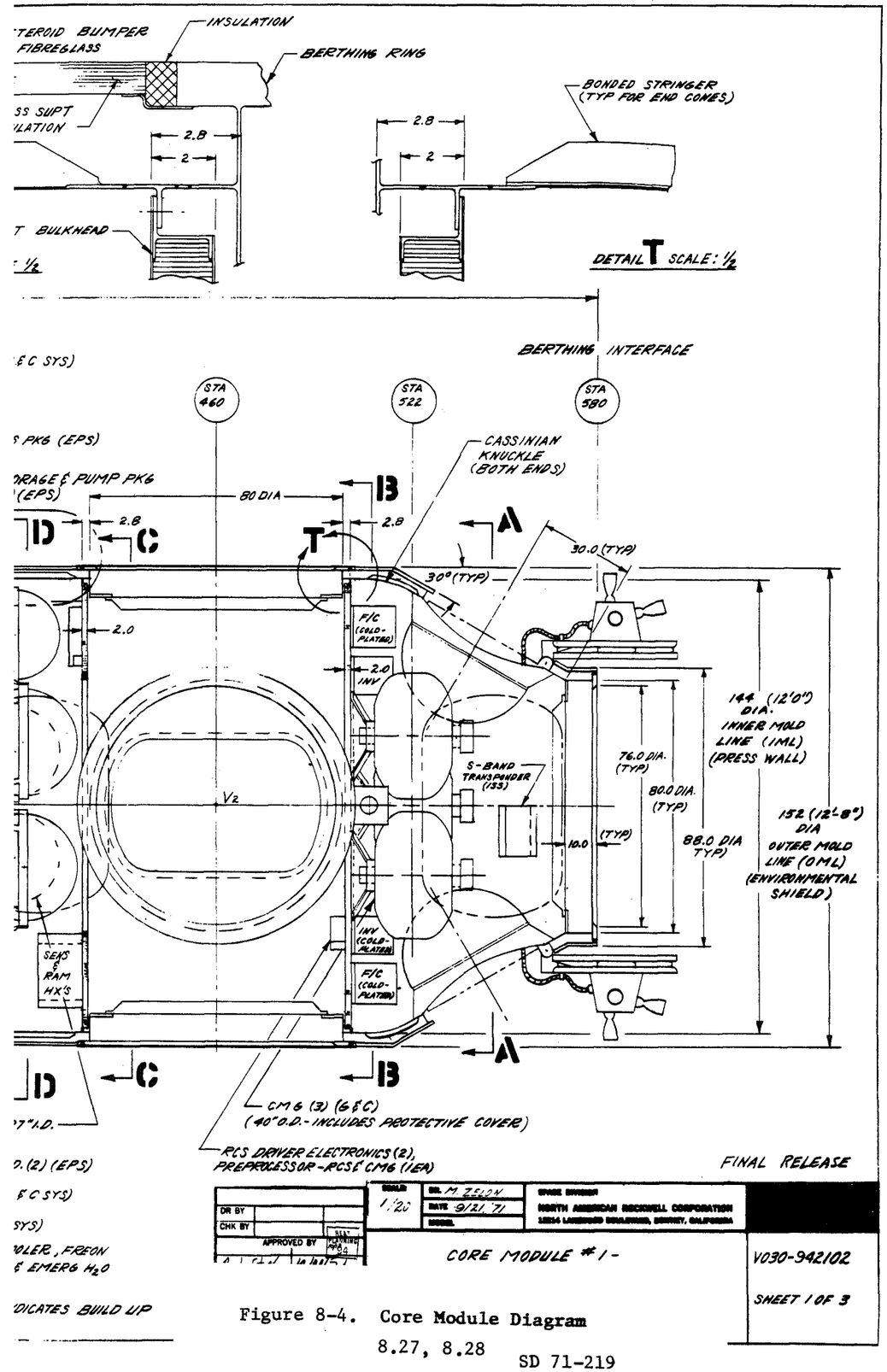


Figure 8-4. Core Module Diagram

METEOROID BUMPER & INSULATION

1.0

FIBREGLASS SUPT (TYP)

.10

1.76

125 R.

58 EQ SPACES
STRINGER SPACING

.040

144 DIA (INNER M.L.)

152 DIA.

DETAIL O SCALE 1/2

BERTHING INTERFACE

S-BAND TRANSPONDER

FIBREGLASS SUPT

METEOROID BUMPER & INSULATION

SUPPORT

S-BAND ANTENNA (2)

120°

60°

℄ ANTENNA

SECTION K-K SCALE 1/4

S-BAND ANTENNA INSTL
TYP 2 PLACES

54 (TYP)

27 (TYP)

EVA HATCH

+Z

120 (TRUE)

℄

70

135

STA 340

STAR TRAC

BONDED STRINGERS (TYP BOTH END CONES)

114

57

ACQUISITION LIGHT (SEE SECTION L-L)

45°

45°

(ACQUISITION LIGHT LOC. - FAR END)

O2 LINE

H2 LINE

H2 LINE

+Y

AIR

-Z

ROTATE TO CLOSE-NEAR SIDE

-Z

ROTATE TO CLOSE-FAR SIDE

120 (TRUE)

12 (TYP 3 PLCS)

12 (TYP 3 PLCS)

DATA (2 PLCS)

180 (15'-0") DIA SHUTTLE PAYLOAD ENV.

POWER (4 PLCS)

O2 LINE

H2 LINE

ENVIRONMENTAL COVER (2)

SEE DWG V030-942004 FOR BERTHING PORT & MATCH DETAILS

RUNNING LIGHT (RED)

STA 100

BERTHING INTERFACE

ENVIRONMENTAL COVER - OPEN

PAYLOAD BAY PICKUP POINT

STA 220

LONGERON (2 PLACES)

TELESCOPE

SEXTANT

HORIZON TRACKE

MANIPULATOR PICK UP FIT
CONFIG - 78D

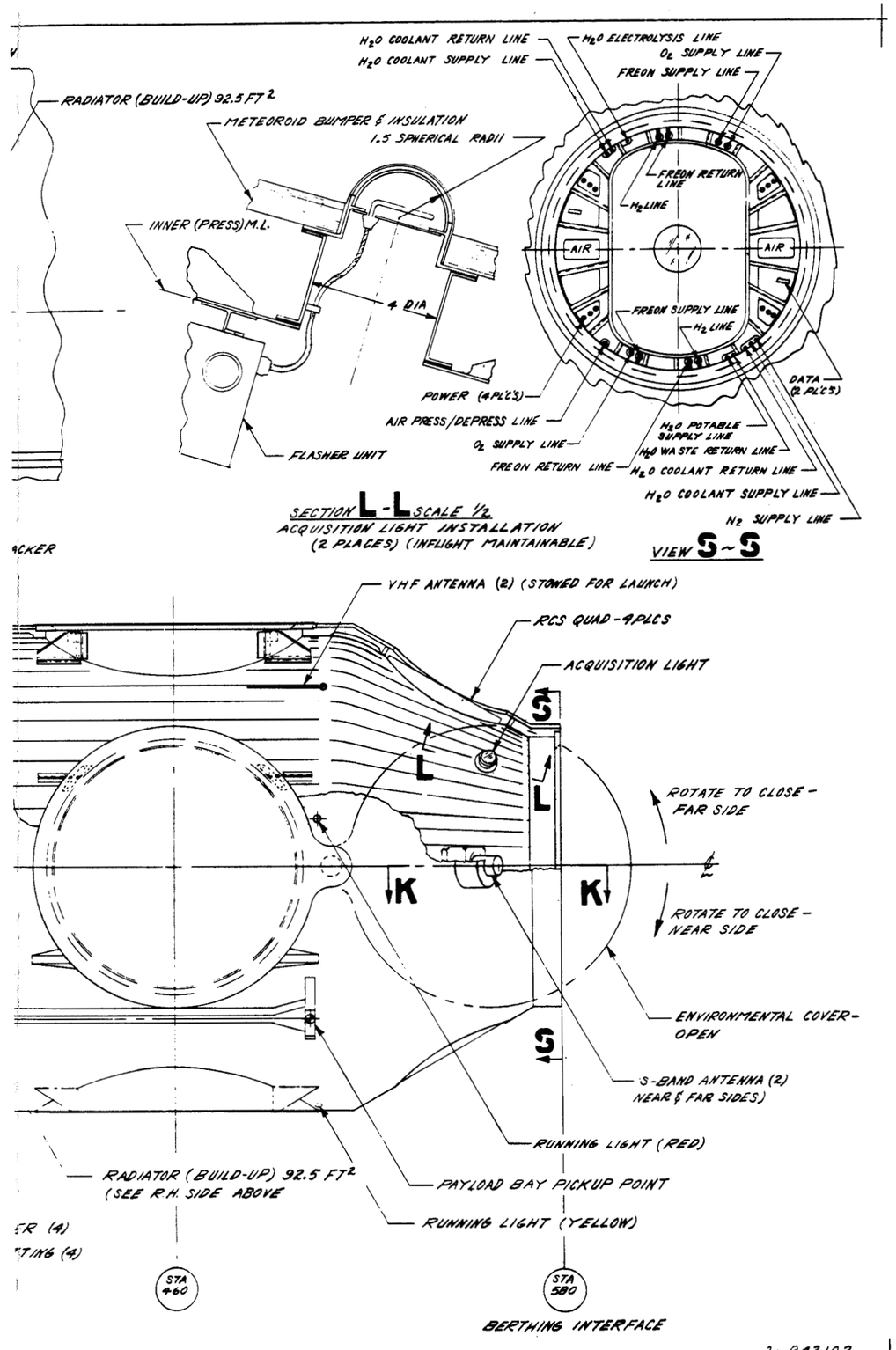
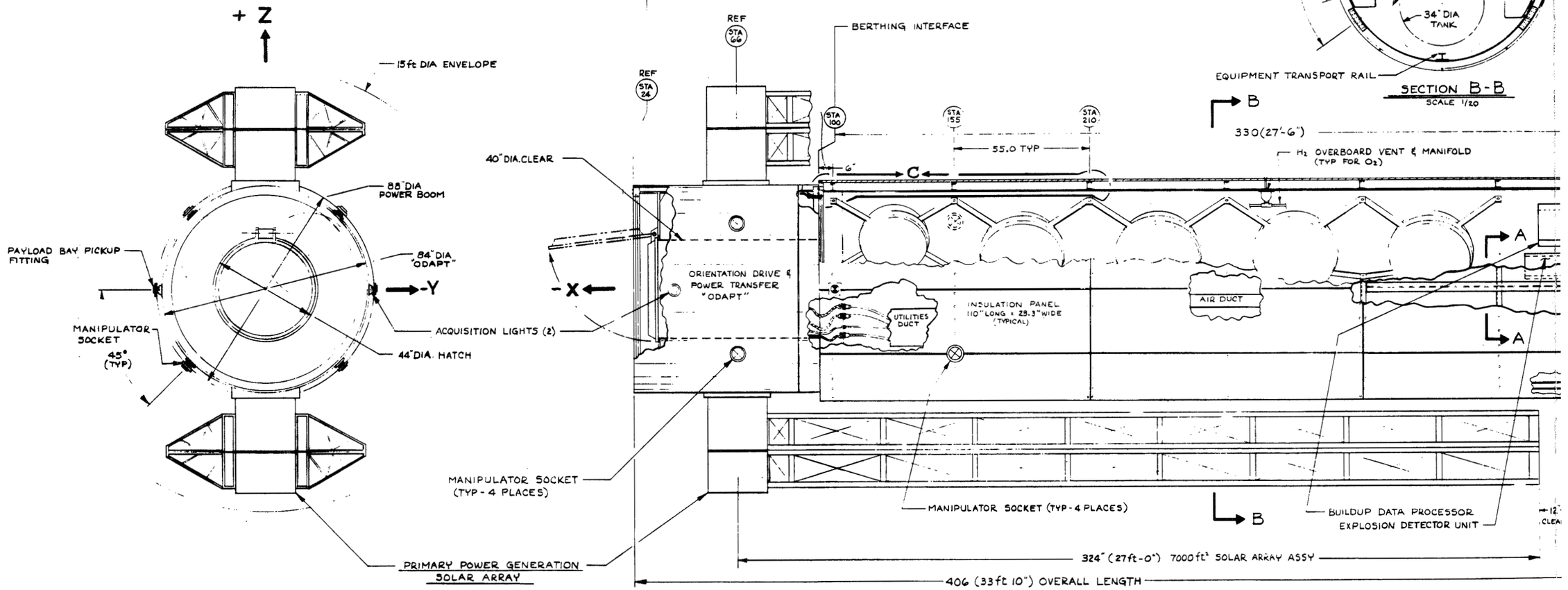
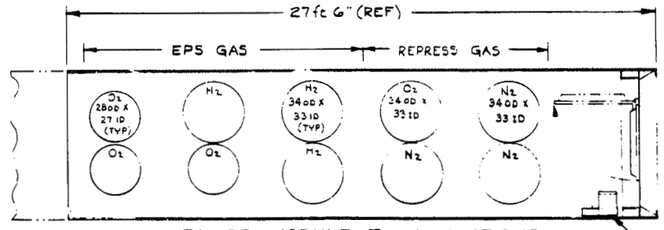


Figure 8-4. Core Module Diagram (Cont)



SECTION B-B
SCALE 1/20

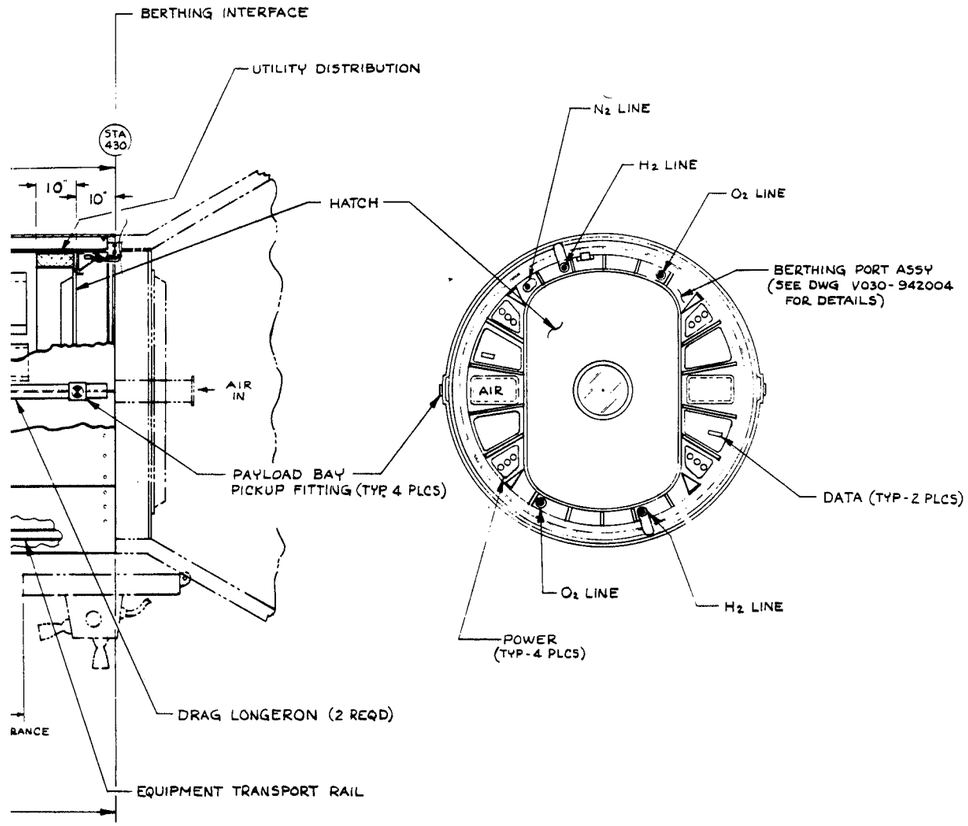


POWER MODULE TANK LOCATIONS
SCALE 1/40

EXPLOSION DETECTO
& BUILDUP DATA PR

E SPLICE (TYP)

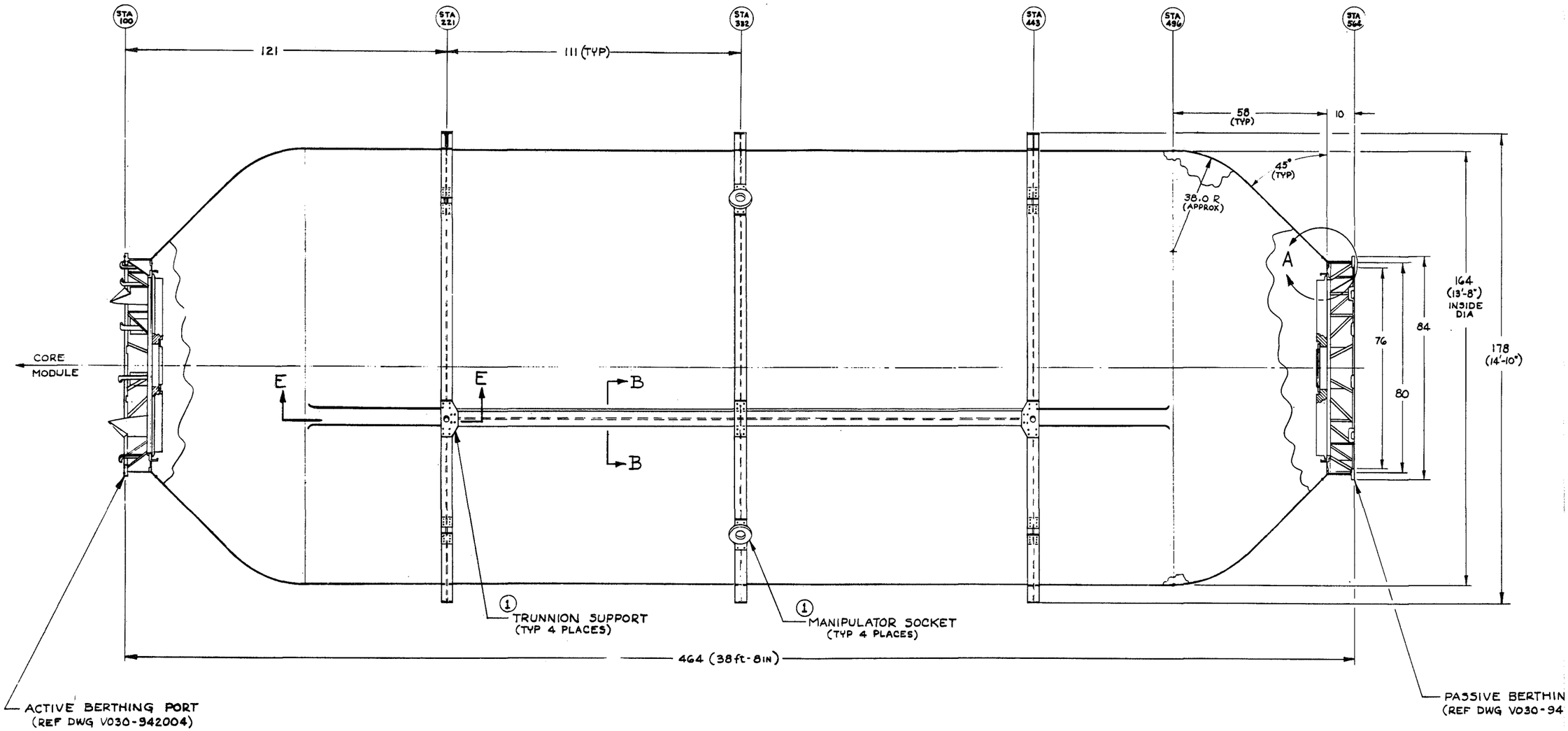
UTILITIES DISTRIBUTION AREA (TYP)



FINAL RELEASE

DR BY J.F. KAUPPI 9/30/71	SCALE 1/20 & NOTED	ENG. J.F. KAUPPI	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION 12214 LAKEWOOD BOULEVARD, DOWNEY, CALIFORNIA
CHK BY		DATE 30 SEPT 1971	
APPROVED BY 10/13/71		MODEL	
10/18/71 RELEASED 94	POWER MODULE ASSEMBLY,		V030-942101 SHEET 1 OF 2

Figure 8-5. Power Module Diagram


STA 100
STA 221
STA 332
STA 443
STA 496
STA 564
121
111 (TYP)
58 (TYP)
10
45° (TYP)
38.0 R (APPROX)
A
164 (13'-8") INSIDE DIA
178 (14'-10")
84
76
80
CORE MODULE
E
E
B
B
1 TRUNNION SUPPORT (TYP 4 PLACES)
1 MANIPULATOR SOCKET (TYP 4 PLACES)
464 (38ft-8IN)
ACTIVE BERTHING PORT (REF DWG V030-942004)
PASSIVE BERTHIN (REF DWG V030-94

G PORT
2004)

1. FITTING CONFIGURATIONS T.B.D; COMPATIBLE WITH SHUTTLE PAYLOAD INTERFACE & MANIPULATOR CONFIGURATION

NOTES:

FINAL RELEASE

DR BY J.F.KAUPPI 10/7/71	SCALE: 1/20 & NOTED	DR. J.F. KAUPPI	SPACE DIVISION NORTH AMERICAN ROCKWELL CORPORATION 12214 LAKEWOOD BOULEVARD, DOWNEY, CALIFORNIA
CHK BY		DATE 7 OCT 1971	
APPROVED BY		MODEL	
REAT PLANNING 94			COMMON MODULE STRUCTURE | V030-

Figure 8-6. Station Module Diagram

8.33, 8.34

SD 71-219

V030-942201 REF

FRAME COVER
ENVIRONMENTAL SHIELD

RADIATOR

ENVIRONMENTAL SHIELD ASSY
TYPICAL UNDER RADIATOR

RADIATOR MANIFOLD
TYP

164.0 DIA REF

10 MIL KAPTON, SECONDARY BUMPER/SHIELD

NON-METALLIC SPACER LAYERS

4 .25 THICK INSULATION BLANKET ASSYS OF
10 LAYERS OF .15 MIL MYLAR

3 TO 5 MIL KAPTON

1.0

DETAIL C
SCALE: 1/2

RUNNING LIGHT (REF)

16 CONSTANT

RUNNING LIGHT
(REF).

VIEW B
TYP FOR SM 2 & SM 3

COMMON MODULE
STRUCTURE ASSY
REF DWG V030-942201

B

SH 1 C

C

ACTIVE
BERTHING PORT

B

A

WINDO

THERMAL CONTROL COATING
ON EXTERIOR OF ALL EXPOSED
ENVIRONMENTAL SHIELD SURFACES

203.0

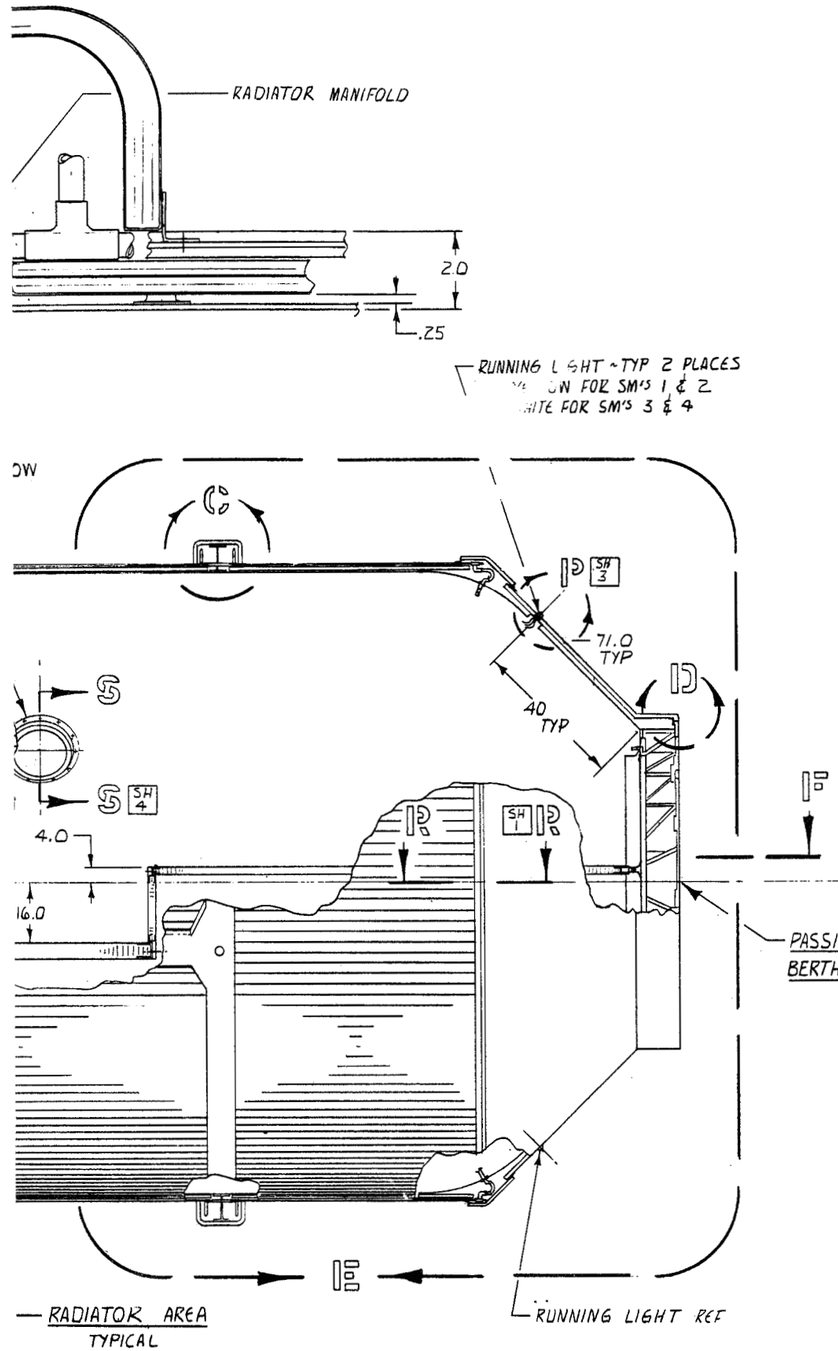
RADIATOR THERMAL CONTROL COATING
ON EXTERIOR OF ALL RADIATER SURFACES

TRUNNION SUPPORT
TYP - REF DWG V030-942201

AUXILIARY PASSAGE

A SH 1

SM 1 SHOWN
SM 2, 3 & 4 SAME EX



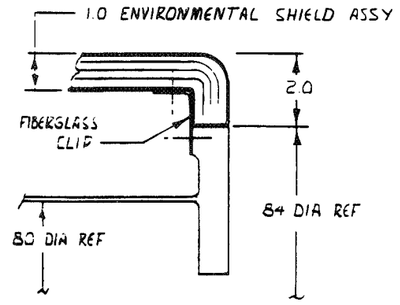
XCEPT AS NOTED

8.35, 8.36

SD 71-219

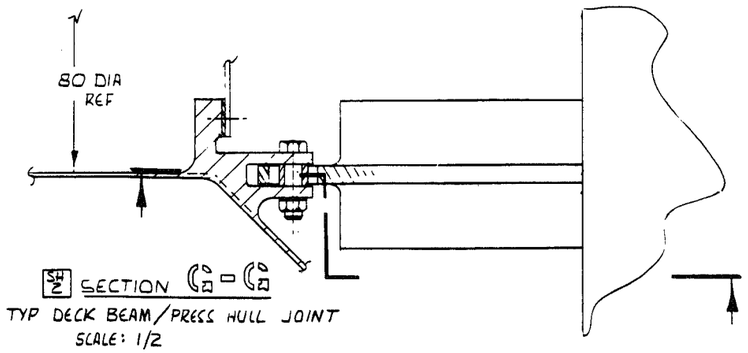
Figure 8-6. Station Module Diagram (Cont)

V030-942205
SH 2 OF 4



DETAIL [D] [SH 2]

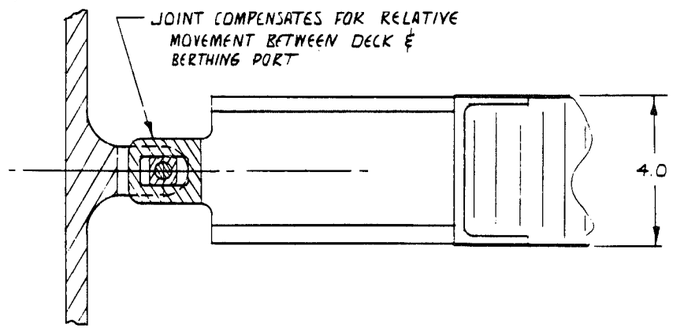
SCALE: 1/2

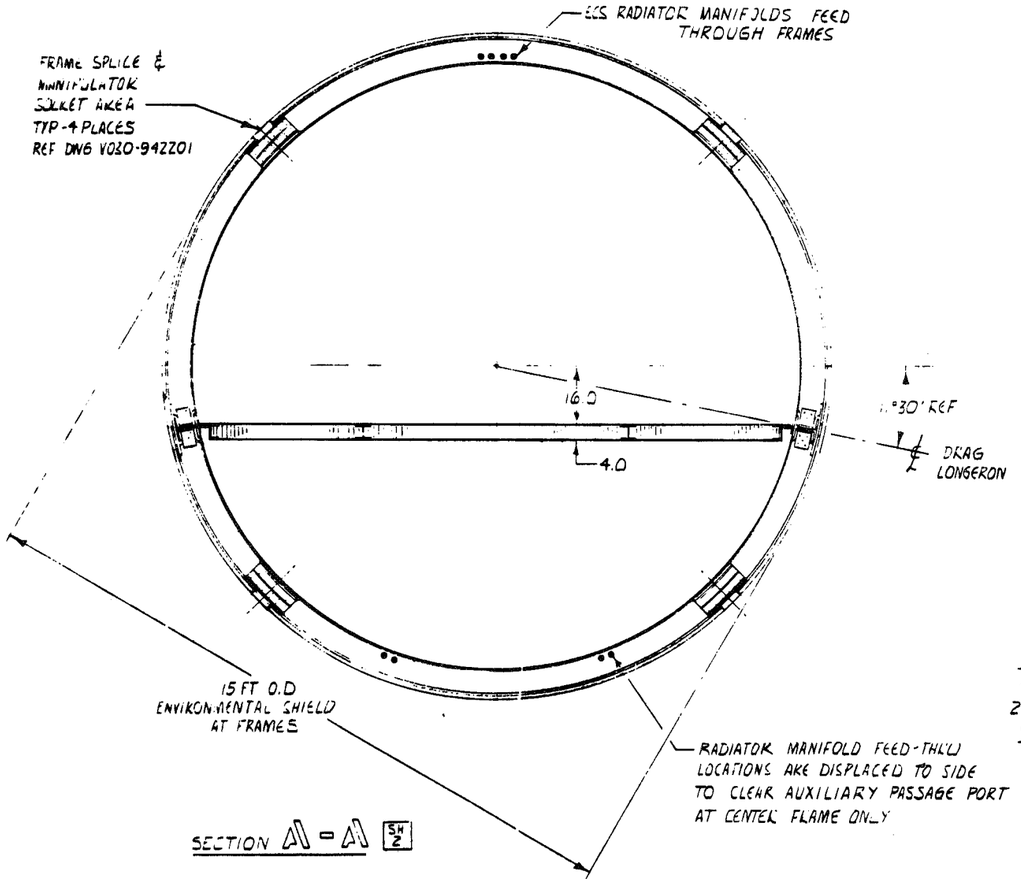


[SH 2] SECTION [C] - [C]

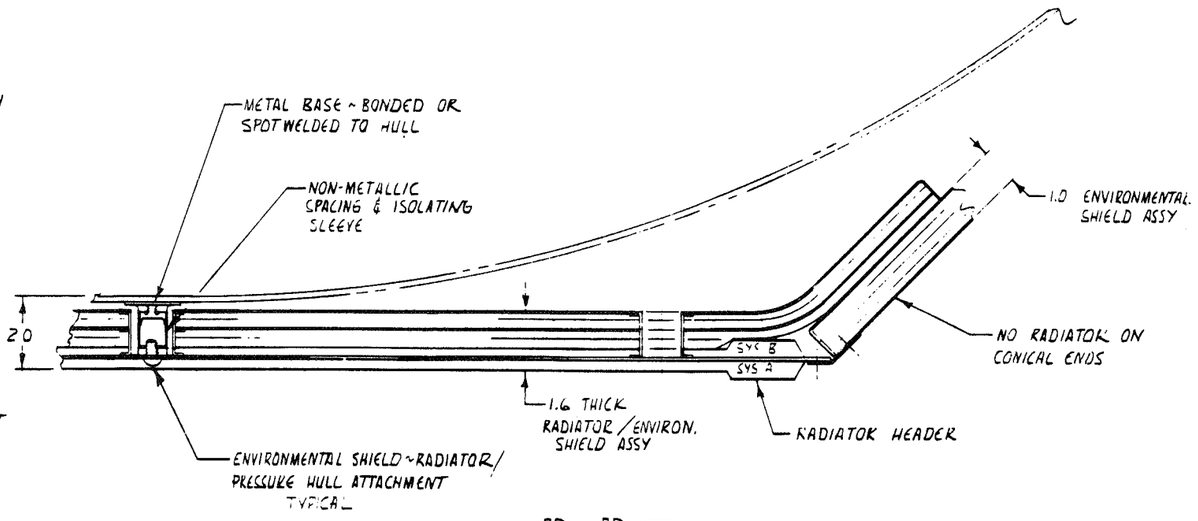
TYP DECK BEAM/PRESS HULL JOINT

SCALE: 1/2



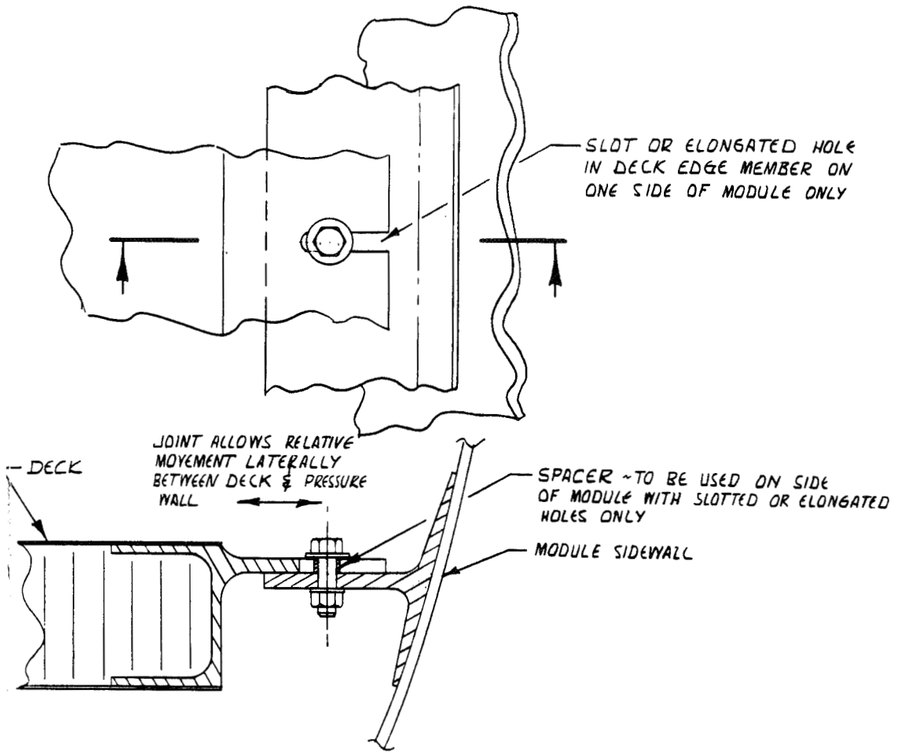


SECTION [A] - [A] [SH 2]



SECTION [B] - [B] [SH 2]

SCALE: 1/2



DETAIL T

DECK / SIDEWALL TEE ATTACH METHOD ~ APPLICABLE ALONG ONE SIDE OF MODULE ONLY ~ ELIMINATES INDUCED LOADS IN PRESSURE HULL. STANDARD FASTENERS & HOLES TO BE USED ALONG OTHER SIDE OF MODULE.

FINAL RELEASE

DR. BY	L E SMITH	10-22-71
CHK. BY		

L E SMITH

V030-942205
SHEET 1 OF 4

Figure 8-6. Station Module Diagram (Cont)