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S-IVB STATION MODULE STUDY

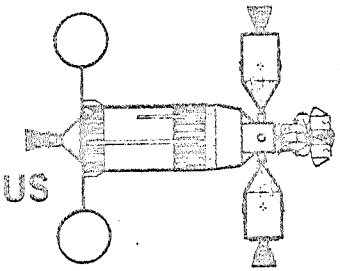
FINAL BRIEFING

OCTOBER 1967

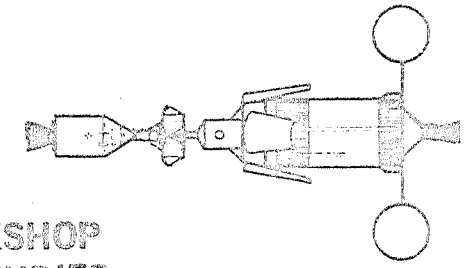
DOUGLAS
MISSILE & SPACE SYSTEMS DIVISION

M-46738

STUDY CONFIGURATIONS

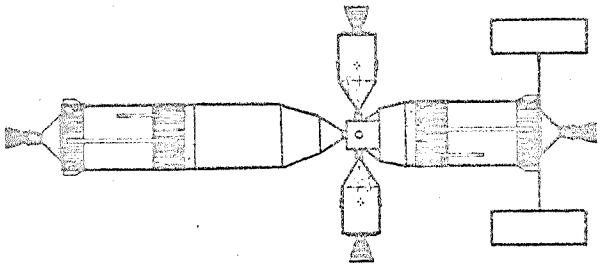


SYNCHRONOUS ORBIT

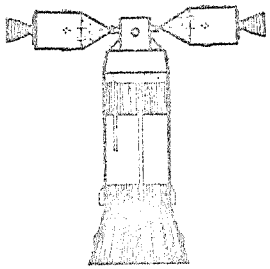


LO-B

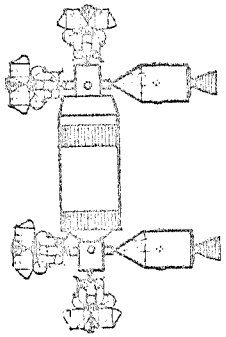
ADVANCED WORKSHOP POINT DESIGN STUDIES



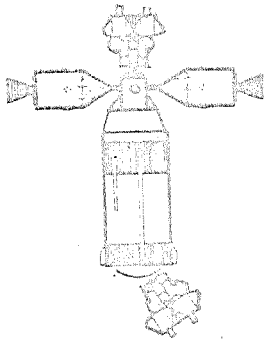
LO-C
DUAL SPENT STAGE



EOSS INTEGRATED EXPERIMENTS (STUDY BASELINE)



EOSS MODULAR EXPERIMENTS



EOSS HYBRID

GROUND FURNISHED STATIONS

ONE-YEAR SPACE STATION SYSTEM AND PROGRAM FEASIBILITY STUDIES

S-IVB STATION MODULE STUDY

FINAL BRIEFING

DAC-58042
OCTOBER 1967

PREFACE

This manual contains a copy of the S-IVB Station Module Study Final Briefing presented to the National Aeronautics and Space Administration's George C. Marshall Space Flight Center (NASA-MSFC), Huntsville, Alabama on 16 October 1967. This briefing presents the results, conclusions, and recommendations resulting from a 6-month, $400,000 contract conducted by the Douglas Missile and Space Systems Division (MSSD) for MSFC under Contract No. NAS8-21064. This presentation was also made at the Manned Space Center (MSC) at Houston, Texas, on 18 October 1967 and at NASA's Office of Manned Space Flight (OMSF), Washington, D. C., on 20 October 1967.

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TED GORDON

DIRECTOR

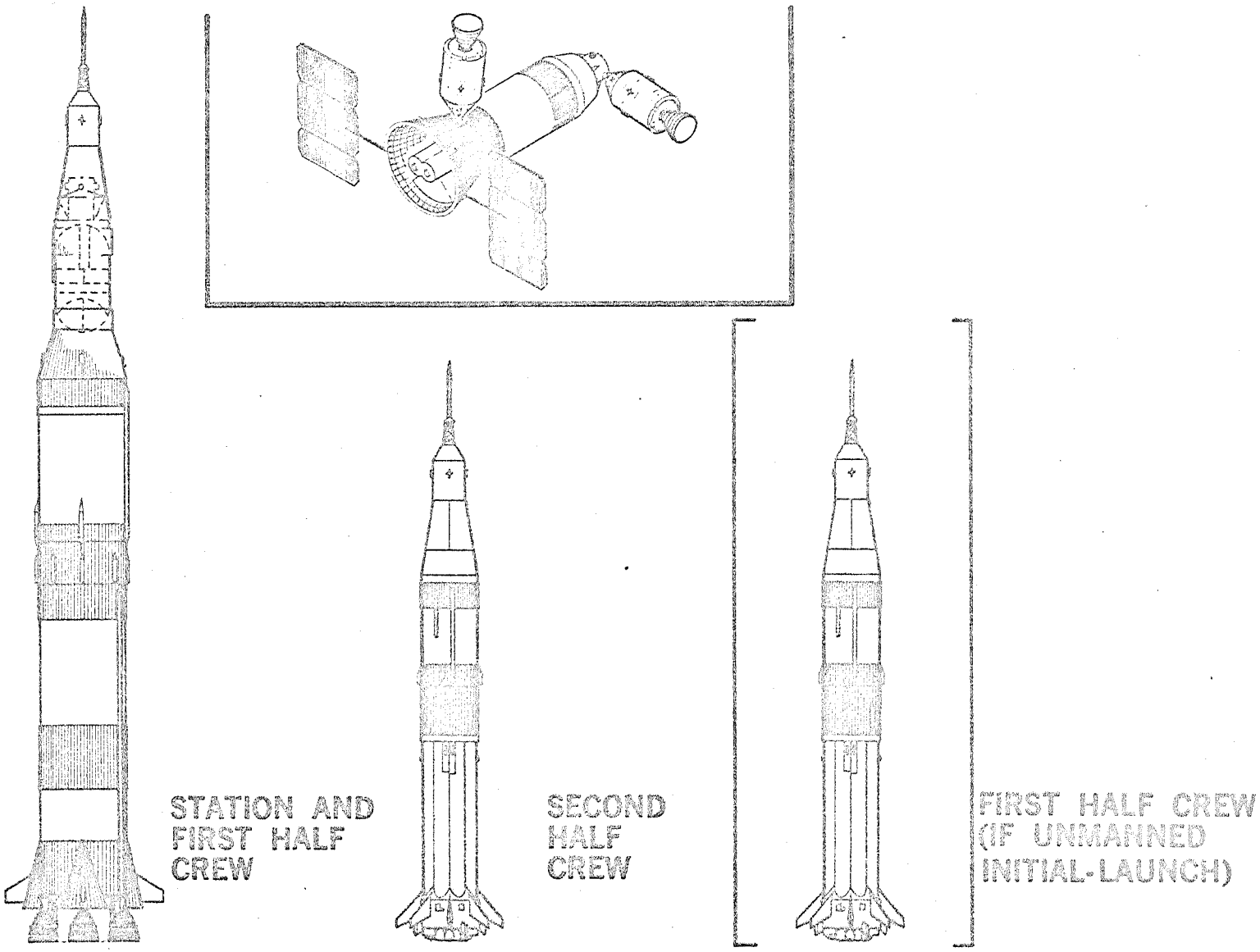
ADVANCE SPACE STATIONS AND PLANETARY SYSTEMS

THIS SECTION PRESENTED BY

FRITZ RUNGE
STUDY DIRECTOR

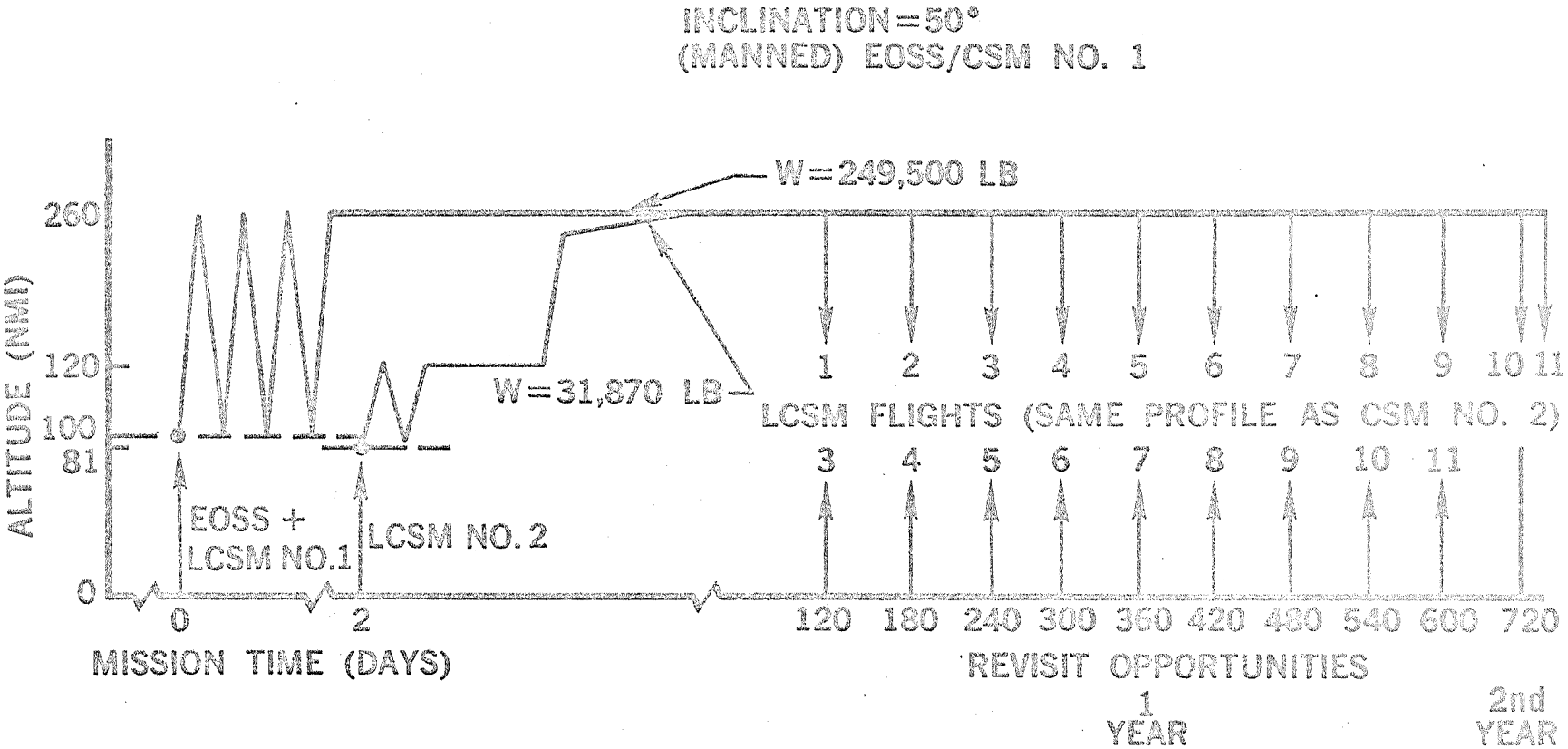
EARLY ORBITAL SPACE STATION
INTEGRATED EXPERIMENTS

M-46470



EOSS PRELIMINARY MISSION PROFILE (2 YEARS)*

*1-YEAR MISSION
ENDS WITH
FLIGHT NO. 5



EOSS CHARACTERISTICS

- PAYLOAD TO 50° INCLINATION — 260-NMI ORBIT

TOTAL TO ORBIT	249,484	
EXPERIMENTS AND SUPPORT	48,445	(INCL. 15,360 LB EXP. SUPPORT)
BASIC STATION	97,255	
CSM	28,829	
GROWTH/CONTINGENCY	20,850	
UNASSIGNED	54,095	

- AVAILABLE VOLUME TOTAL -25,330 CU FT
  EXPERIMENTAL -15,800 CU FT
- ATMOSPHERE
  7.0 PSIA- O_2/N_2; PARTIAL H_2O RECOVERY; CO_2 MOL SIEVE
- POWER
  19.6-KW DESIGN SOLAR PANELS
  5.4-KW AVERAGE, 10.8KW PEAK FOR 1.5 HRS
- DATA
  PCM T/M (4 AND/OR 32 KILOBITS/SEC. RATES)
  1,376 CHANNELS
  24 RE-ENTRY CAPSULES (40-LB P/L) (16 VIA RESUPPLY)
- STABILIZATION:

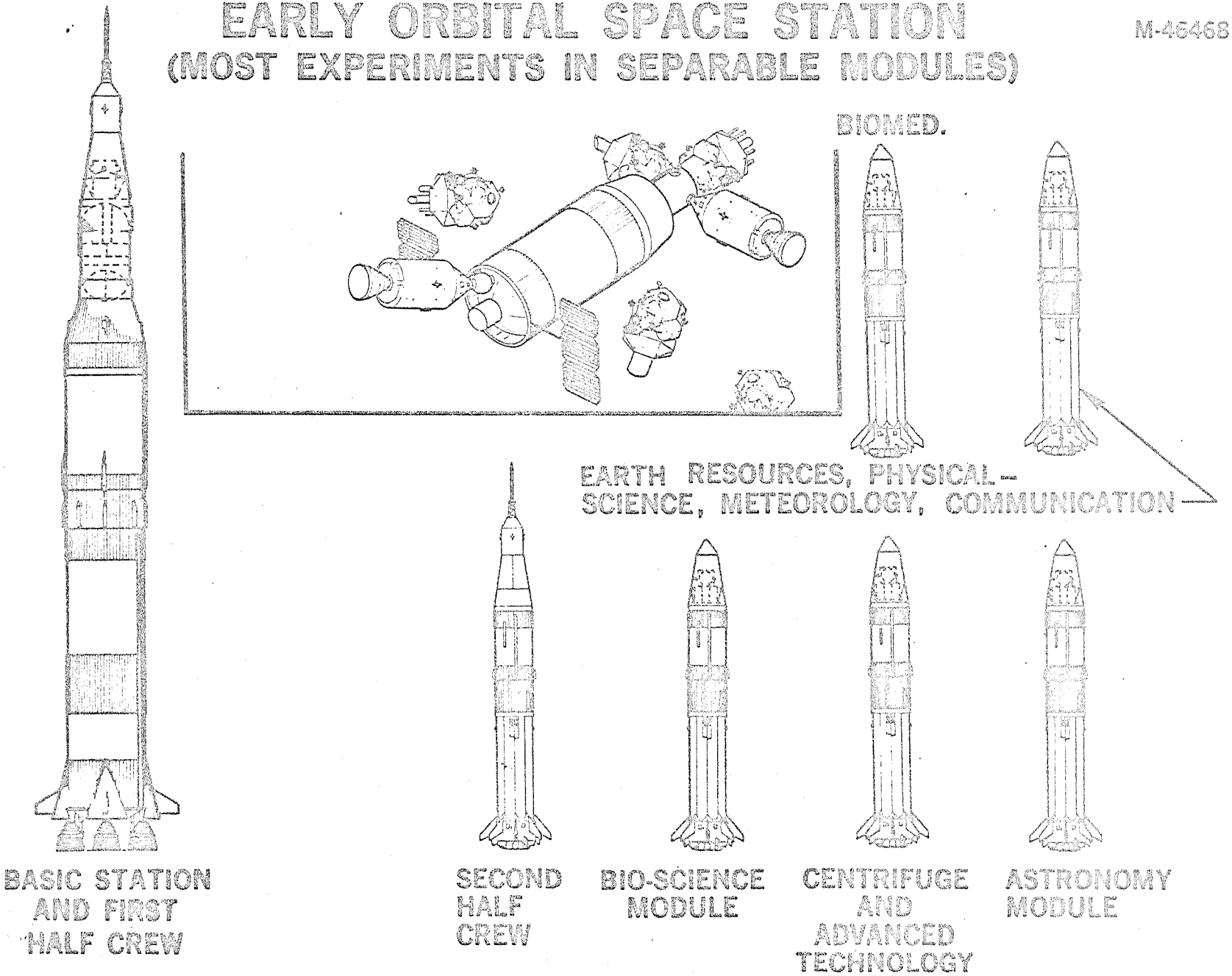
STATION-NINE CMG'S PLUS RCS:	70-120 ARC SEC
EXP BEAM HORIZ. SENSORS:	30-360
EXP BEAM STAR TRACKER:	1.0-30
EXP GIMBALS:	30-360
EXP STAR TRACKER:	1.0-30
EXP INTEGRAL OPTICAL:	.1-1.0

EXISTING HARDWARE EMPLOYED

APOLLO/SATURN	AAP WORKSHOP	OAO	MOL
(L) CSM	MDA SHELL	STAR TRACKERS	DATA COMPUTATION SUBSYSTEM
SLA	AM BOOT		DATA ACQUISITION SUBSYSTEM
IU	SOLAR PANEL MECHANISM		MONITOR AND ALARM
S-IVB	SOLAR-CELL SUBPANELS		COMMAND SUBSYSTEM
S-II	AM ELECTRICAL SYSTEM		GYRO PACKAGES
S-IC	TELEVISION SUBSYSTEM		HORIZON SENSORS
S-IB	EVA ANTENNAS		P/RCS THRUSTERS
AGE	CONTROL MOMENT GYROS		TANKAGE
MCC	CMG CONTROL LOGIC		PRESS. SYSTEM
TRACKING STATIONS	CRYOGENIC STORAGE TANKS		HYGIENE MODULE
RECOVERY SYSTEM	GASEOUS STORAGE TANKS		
COMMUNICATIONS SUBSYSTEMS	S-IVB SHELL DECK SANDWICH STRUCTURE		
	S-IVB SKIRTS		
	S-IVB/S-II INTERSTAGE		
	SLEEP STATION		

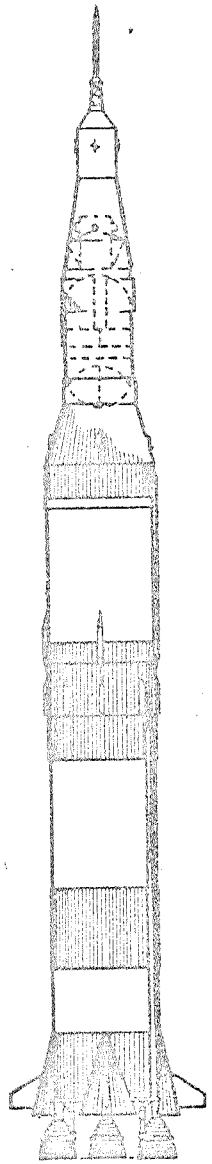
EARLY ORBITAL SPACE STATION
(MOST EXPERIMENTS IN SEPARABLE MODULES)

M-46468

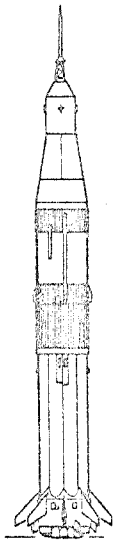


M-46812

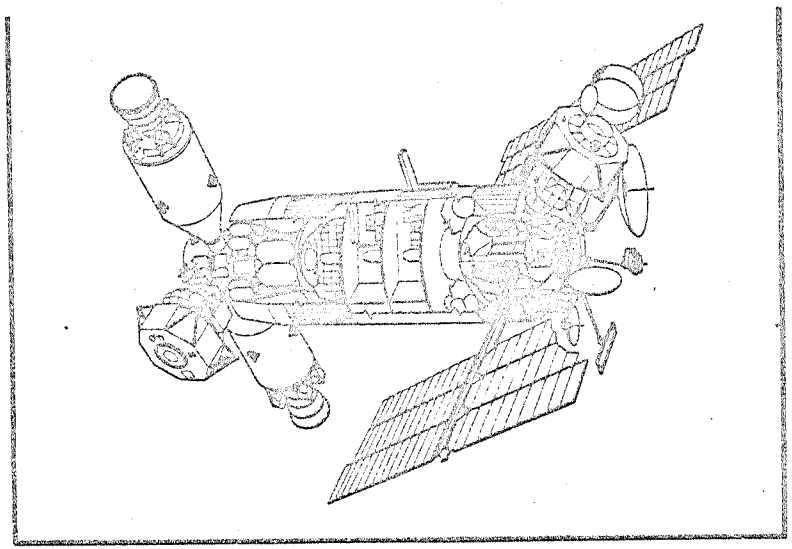
HYBRID EOSS
(INTEGRATED - MODULAR)

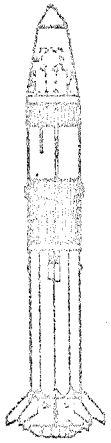


STATION AND FIRST HALF CREW



SECOND HALF CREW





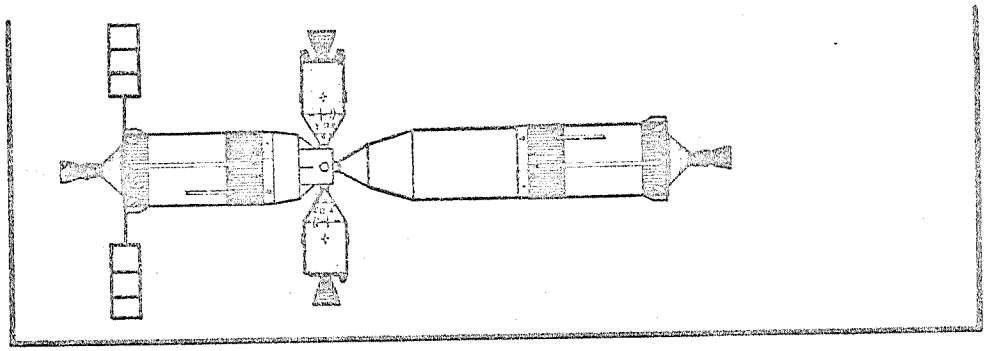
ASTRONOMY MODULE

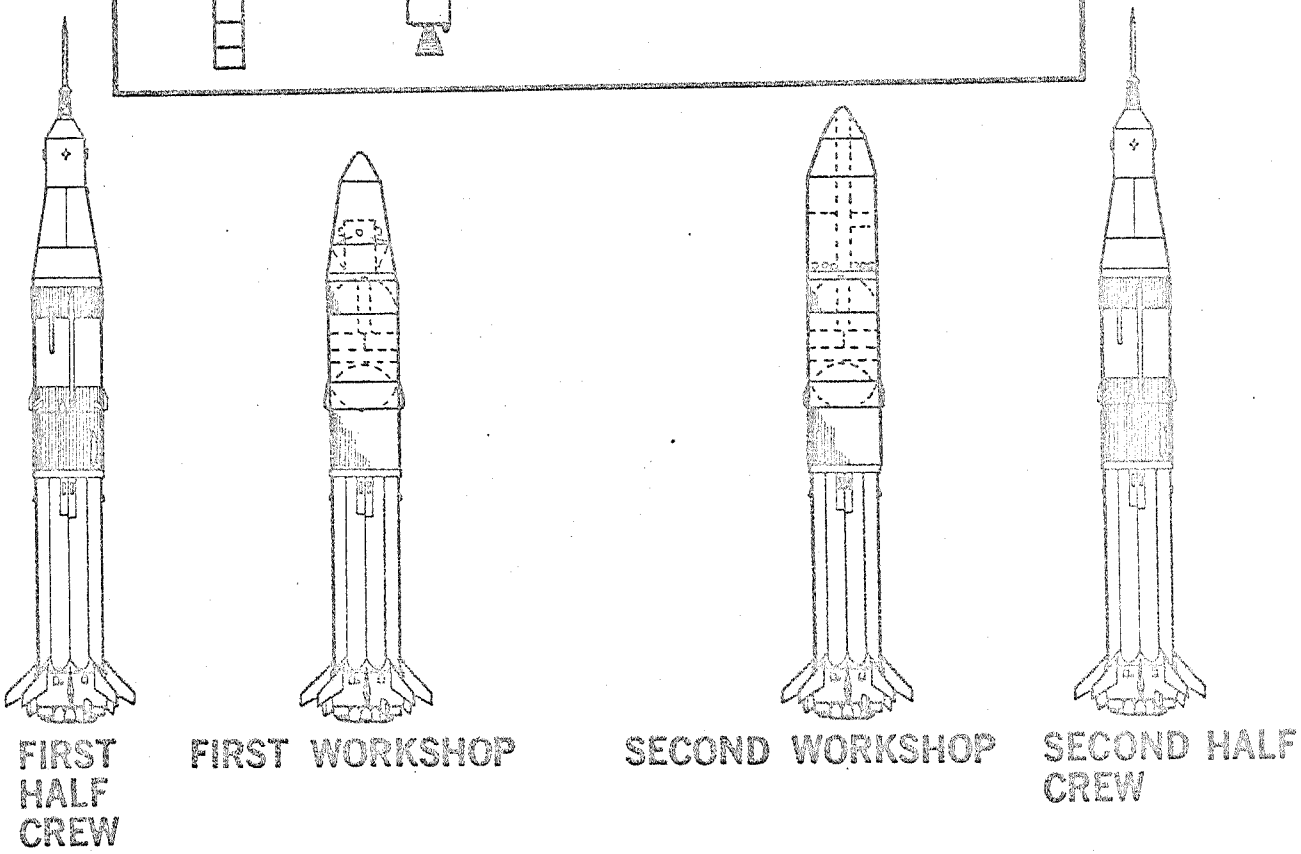
BIOLAB

ADVANCED WORKSHOP LO-C

M-46469

(EXPERIMENTS IN LONG NOSE MODULE)





EOSS EXPERIMENT ANALYSIS

DATA BANK

- 3,000 EXPERIMENTS-1,200 UNIQUE

ANALYTICAL TOOL

- COMPUTER STORAGE AND RETRIEVAL

REFERENCE

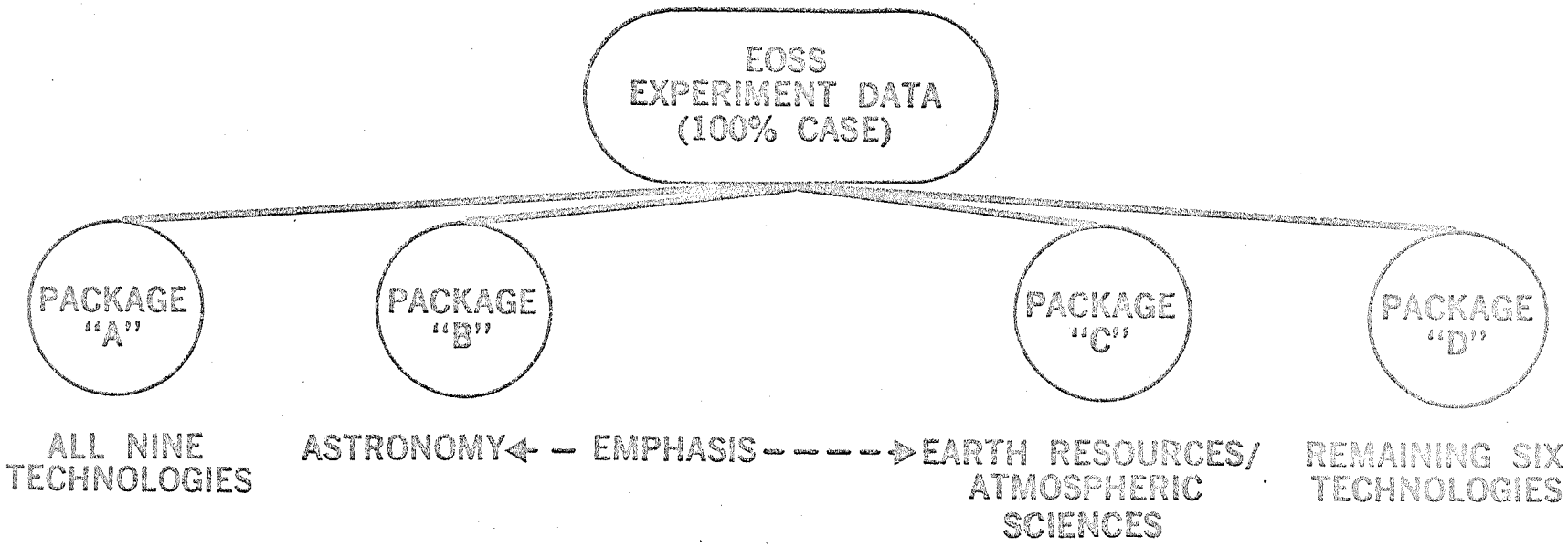
- EOSS BASELINE PACKAGE:
  1971-1972 NASA TIME-PHASED EXPERIMENT SUMMARY SHEETS;
  413 ACTIVITIES; 283 EXPERIMENTS

RESULTS

- 283 EXPERIMENT DESCRIPTIONS AND SKETCHES
- REPRESENTATIVE EXPERIMENT PACKAGES (A, B, C, D)
- DETAIL OF REQUIREMENTS OF A, B, C, AND D,
- PACKAGE A (199 EXPERIMENTS-MIX OF ALL TECHNOLOGIES)
- INTEGRATION OF 2-YEAR PACKAGE A PROGRAM INTO SYSTEM

M-46626

EOSS EXPERIMENT PROGRAM



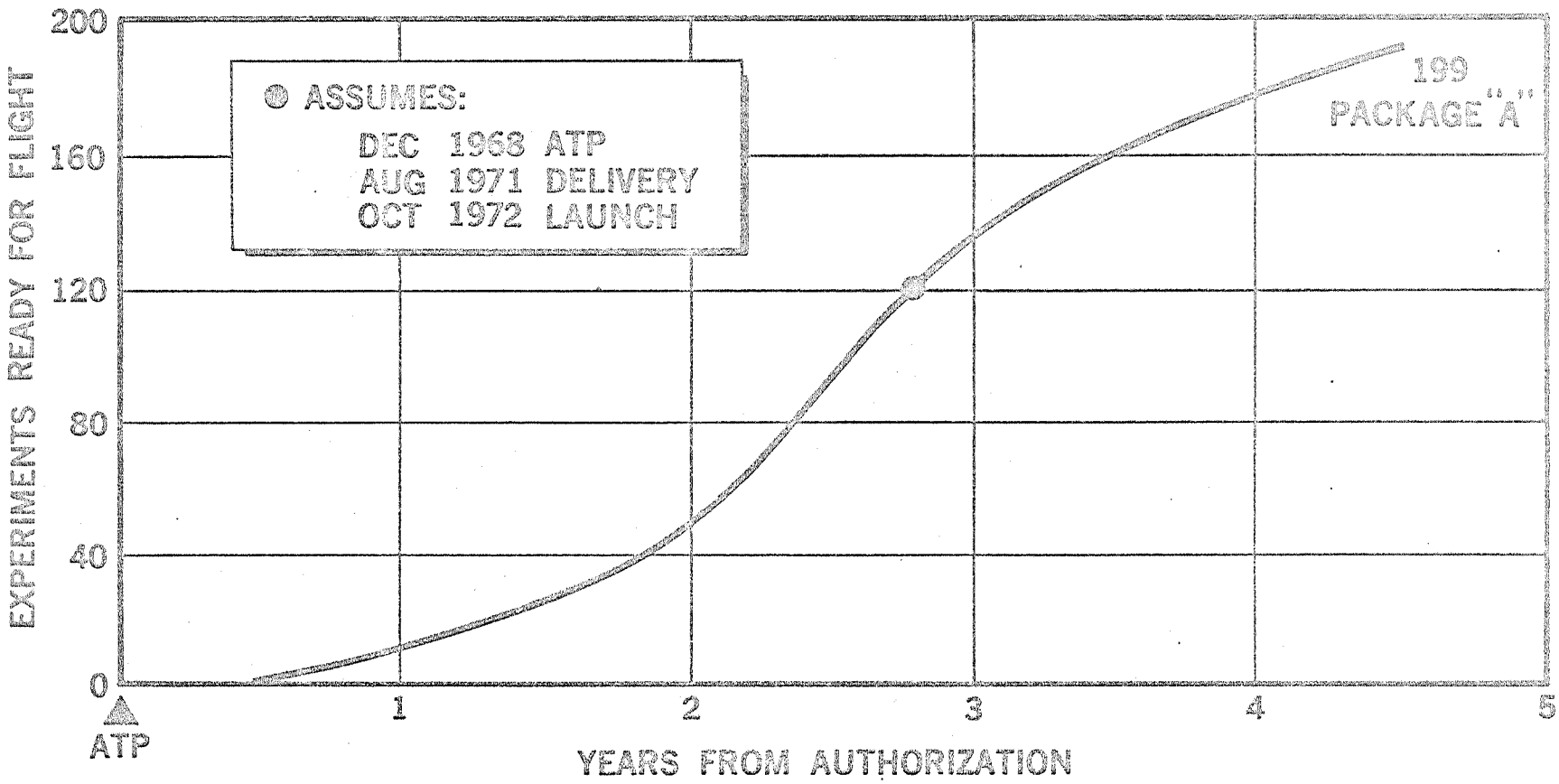
M-46731

EXPERIMENT CHARACTERISTICS
PACKAGE A

TECHNOLOGY	NUMBER OF EXPERIMENTS	WEIGHT (LB)	VOLUME (CU FT)	POWER (KW-HR)	CREW TIME (MAN-HOURS)	CREW SKILLS
BIOMEDICAL/BEHAVIORAL	44	1,241	509	2,116	3,899	3
ASTRONOMY/ASTROPHYSICS	17	9,900	427	374	4,100	1
ATMOSPHERIC SCIENCES	17	2,340	137	5,134	4,063	2
EARTH RESOURCES	28	2,000	150	925	1,777	1
BIOSCIENCE	32	2,356	420	809	3,597	1
PHYSICAL SCIENCE	19	1,143	78	478	3,356	4
COMMUNICATION AND NAVIGATION TRAFFIC CONTROL	9	3,135	158	385	1,278	2
ADVANCED TECHNOLOGY AND SUBSYSTEM	18	5,545	1,187	20	242	6
MANNED SPACE OPERATIONS AND LOGISTICS	15	5,425	1,380	44	868	3
SUBTOTALS	199	33,085	4,446	10,285	23,180	8
TOTAL WITH SUPPORT		48,445	9,185	13,348	24,791	

M-46728

EXPERIMENT AVAILABILITY



CRITICAL EXPERIMENT REQUIREMENTS

ASTRONOMY/ASTROPHYSICS:	.1-10 ARC SEC ATT. HOLD/20-120 MIN./DAY 4,200 CREW HOURS. (10,000 LB HEAVY DATA)
COMB. BIOM/BEH/BIOS:	840 CU FT VOLUME (50% FOR ISOLATED LAB) 8,700 CREW HOURS
TERRESTRIAL & ATMOS:	ACCESSIBLE CAMERA BAY, 6,000 KWH, 6,800 CREW HOURS. HEAVY DATA
PHYSIC. SCIENCE:	EJECTABLE PKGS., VIEWPORTS, AIRLOCK,
COMM./NAVIG.:	LARGE, DEPLOYABLE STRUCTURES, 3,100 LB, PEAK POWER
ADV. TECH/OPS/LOG:	10,000 LB, 2,500 CU FT, MUCH EVA TIME

INFLUENTIAL ASPECTS OF EXPERIMENT PROGRAM

THE EXPERIMENT PROGRAM WILL PRESENT SUBSTANTIAL CHALLENGES IN:

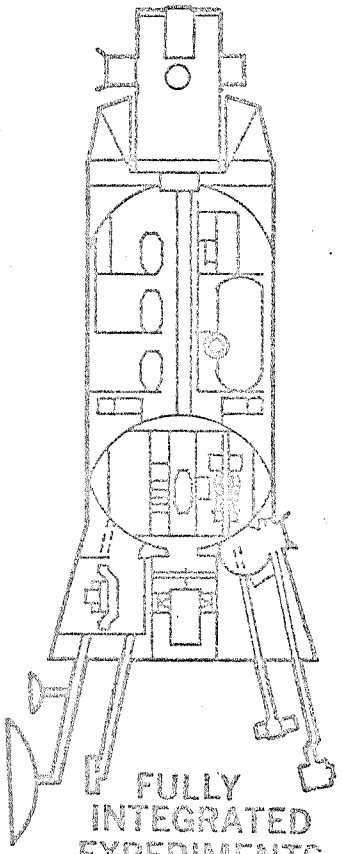
- IMPLEMENTATION, COST AND SCHEDULE
- STATION VOLUME FOR ACCESSIBILITY AND ACCESSORIES
- EXCLUSIVE ACCOMMODATIONS AND OPERATIONAL FLEXIBILITY
- DATA ANALYSIS APPLICATION

THUS, EXPERIMENT REQUIREMENTS MUST DICTATE BASIC APPROACH TO SYSTEM CONFIGURATION, ...NOT VICE VERSA

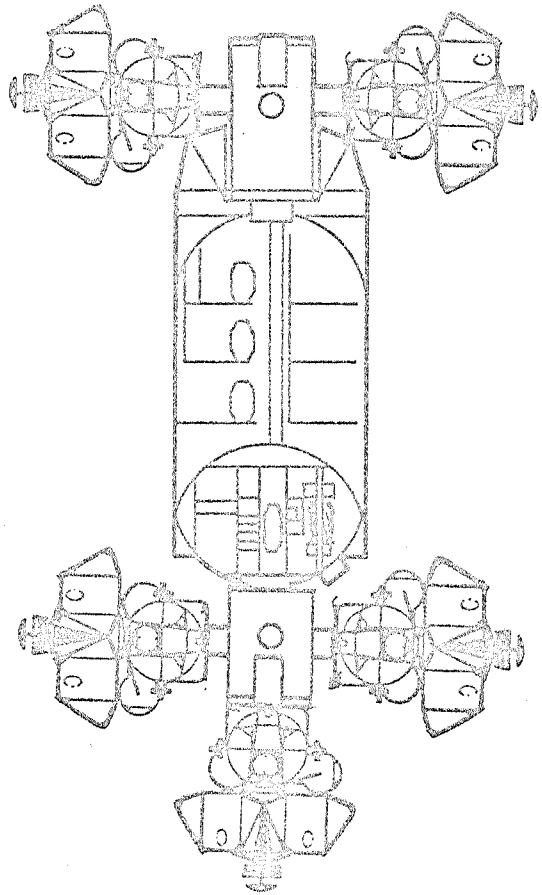
M-45758

EXPERIMENT ACCOMMODATION OPTIONS

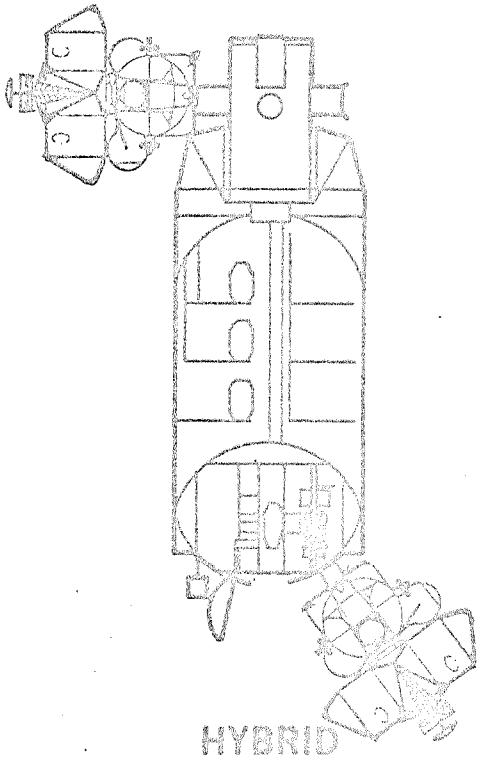
MANNED LAUNCH



FULLY INTEGRATED EXPERIMENTS A PACKAGE



MOST EXPERIMENTS IN SEPARABLE MODULES "A" PACKAGE

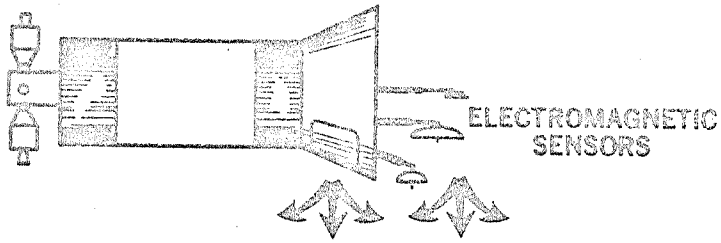


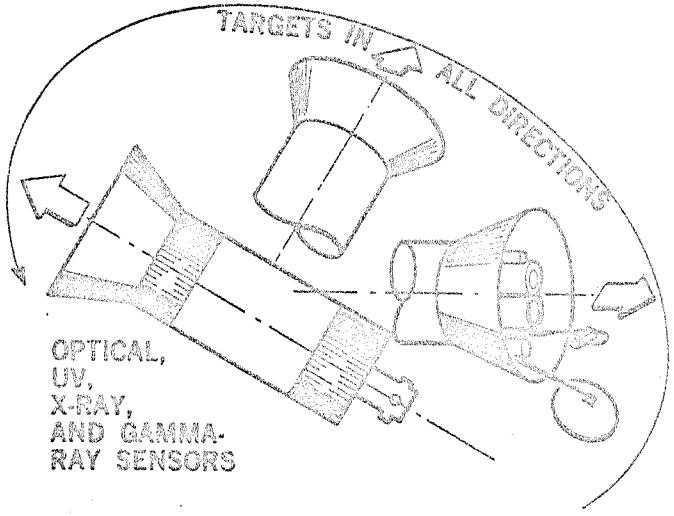
HYBRID INTEGRATED EXPERIMENTS AND EXTERNAL MODULES 70% OF PACKAGE "A"

EOSS/FULLY INTEGRATED EXPERIMENTS EXPERIMENT VIEWING

TERRESTRIAL VIEWING
(235 DAYS/YEAR)

	OPTICAL	ELECTRO
VIEWTIME/DAY	2 OUT OF 24 HR	4 OUT OF 24 HR
% OF TOTAL DATA	95%	5%
ATT. HOLD TIME/YR	500 OUT OF 8,700 HR	1,000 OUT OF 8,700 HR



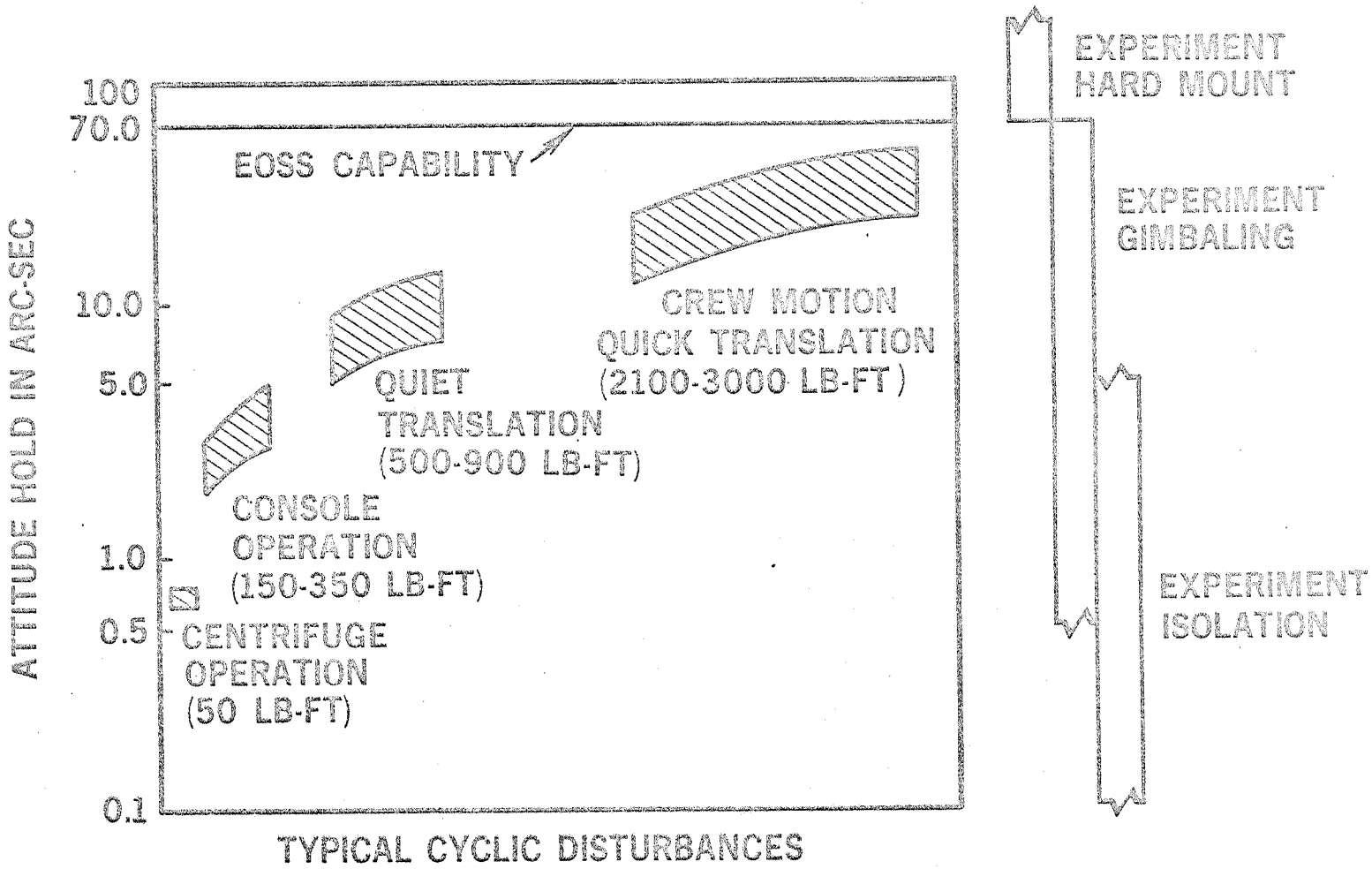


CELESTIAL VIEWING
(130 DAYS/YEAR)

	STELLAR IMAGING	GENERAL VIEWING AND SURVEYS
SET-UP AND VIEWING TIME	1 TO 3 HR	CONTINUOUS
PERCENTAGE OF EXPERIMENTATION ACTIVITY	10% (1 TO 2 VIEWS/DAY)	90%
STATION CONDITION	HIGH-ACCURACY ATTITUDE HOLD, QUIESCENT OPERATION	COARSE ATTITUDE HOLD, NORMAL OPERATION

M-46818

EOSS ATTITUDE CONTROL



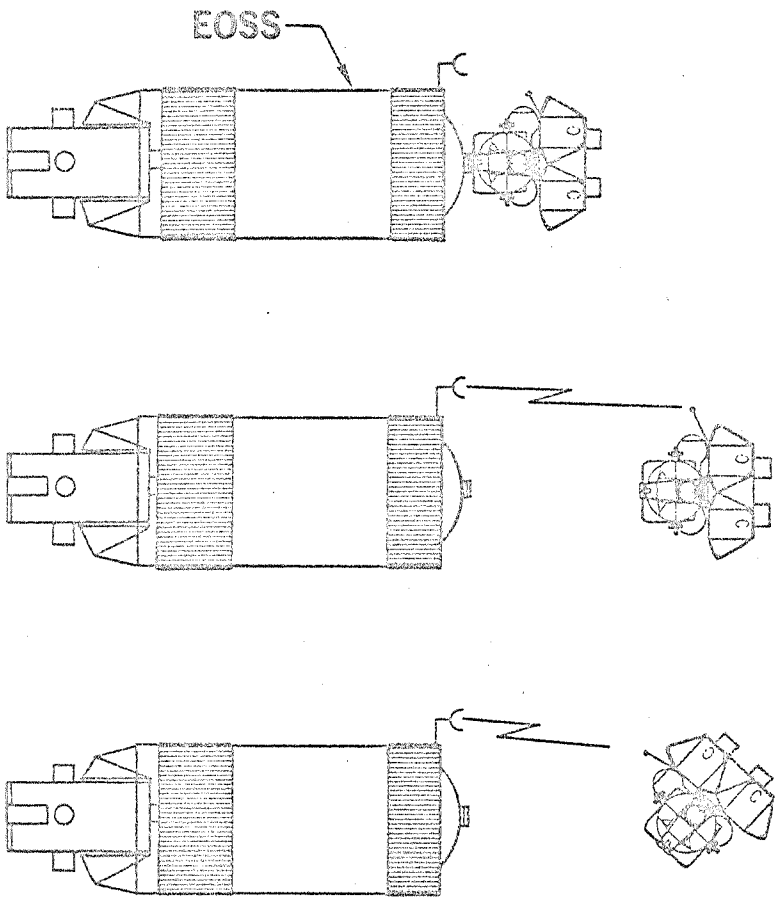
M-46730

EOSS SEPARABLE MODULE CONFIGURATIONS

RACK	NUMBER OF EXPERIMENTS	WEIGHT (LB)	VOLUME (CU FT)	POWER (Kwh)	REQ POINTING ACCURACY	REQ VEHICLE ORIENTATION
BIOMEDICINE/BEHAVIOR/ MANNED SPACE OPERATIONS AND LOGISTICS RACK NO. 1	54	6,546	1,523	1,401	NONE	NONE
ASTRONOMY/ ASTROPHYSICS RACK NO. 2	17	9,900	381	374	<.1 SEC.	SOLAR OR STELLAR
ANIMAL BIOLABORATORY RACK NO. 3	39	2,909	419	820	NONE	NONE
ADVANCED TECHNOLOGY AND SUBSYSTEMS RACK NO. 4	19	4,725	1,214	426	NONE	NONE
EARTH RESOURCES, PHYSICAL SCIENCES, AND COMMUNICATIONS RACK NO. 5	64	9,258	456	6,504	1 SEC.	EARTH

M-46736

ASTRONOMY-MODULE OPERATIONS



DOCKED MODE

- SUPPORTING SYSTEMS CHECKOUT
- BATTERY RECHARGING
- MAINTENANCE
- HARD-COPY DATA TRANSFER
- EXPERIMENT SETUP

TRANSFER MODE

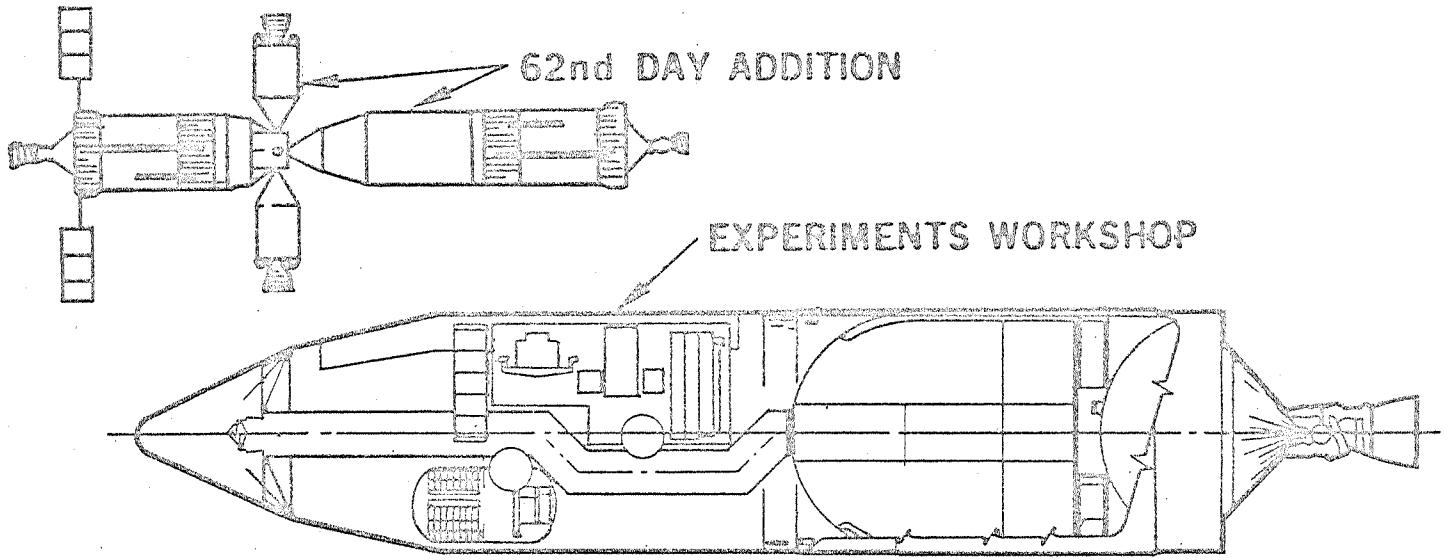
- UNDOCK AND TRANSLATION THROUGH SPACE STATION COMMAND
- TARGET ACQUISITION THROUGH SPACE STATION COMMAND
- TV MONITORING

OPERATIONS MODE

- TV MONITORING
- DIGITAL DATA TRANSFER
- EXPERIMENT COMMANDS

M-46822

LO -"C" EXPERIMENT MODULE



NUMBER OF EXPERIMENTS 120

EXPERIMENT WEIGHT 14,000 LB

SUPPORT WEIGHT 11,000 LB

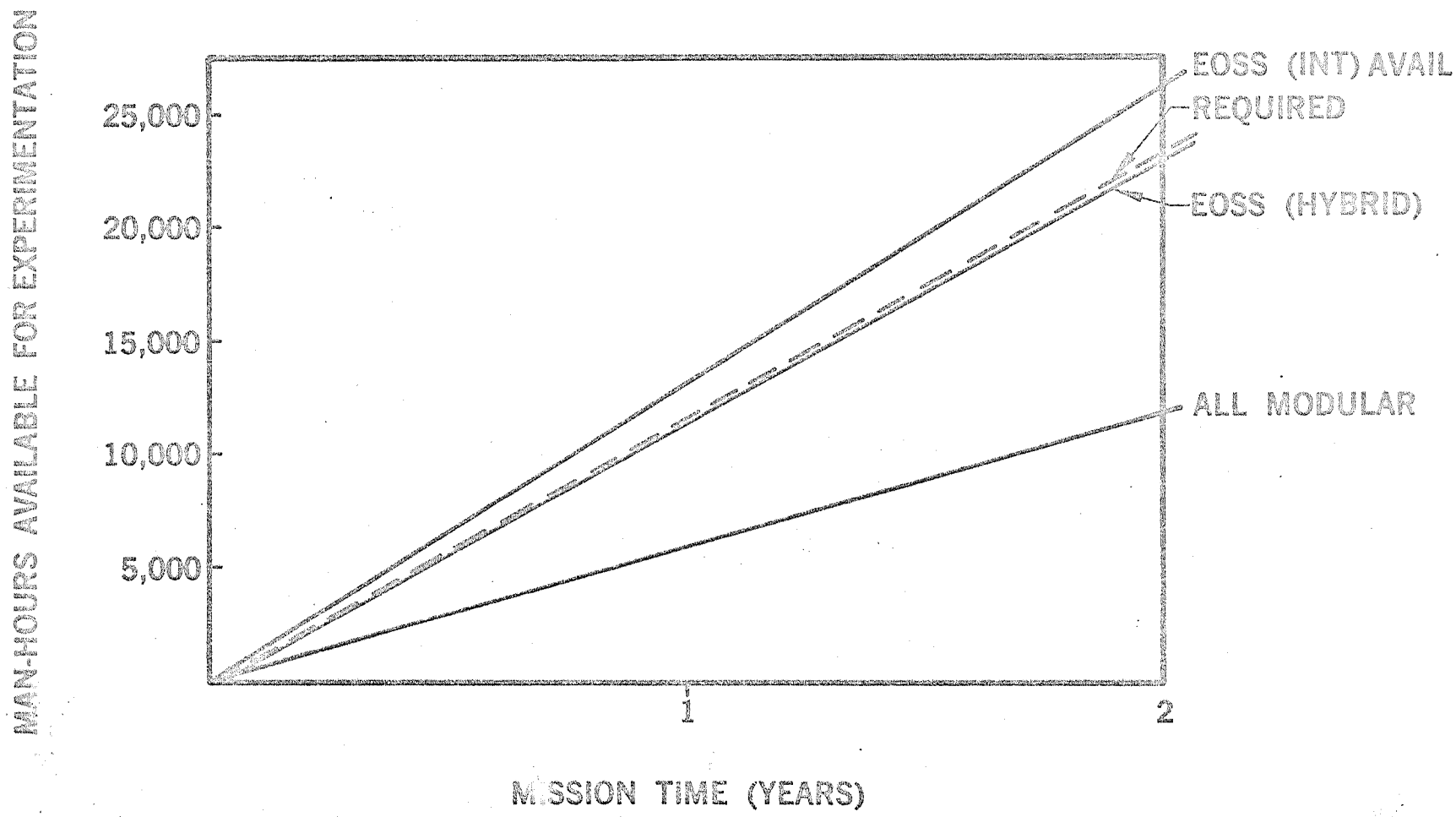
CREW

3 MEN - FIRST 62 DAYS

6 MEN - 63 DAYS TO ONE YEAR

M-46720

EXPERIMENT MISSION TIME



M-46725

EXPERIMENT ACCOMMODATIONS CAPABILITY SUMMARY (PACKAGE "A")

	ACCOMMODATION	COMMENTS
AWS-LO-C	60 TO 70%	WEIGHT LIMITED
EOSS (FULLY INTEGRATED)	100%	FULL CAPABILITY EXPERIMENT ISOLATION PROBLEMS
EOSS (FULLY MODULAR)	82%	RELATIVELY EXPENSIVE
EOSS (HYBRID)	73%	OPTIMUM CHOICE REDUCED EXPERIMENT LOAD RECOMMENDED

SPACE STATION COMPARISON

		EOSS		
	LO-C	INTEGRATED	MODULARIZED	HYBRID
STATION LAUNCH VEHICLE	1 - SAT IB	1 - SAT V	1 - SAT V	1 - SAT V
CREW VEHICLE	6 - SAT IB	5 - SAT IB	5 - SAT IB	5 - SAT IB
EXP. MODULE VEH.	1 - SAT IB	—	5 - SAT IB	2 - SAT IB
CAPABILITY:				
DISCRETIONARY PAYLOAD	25,000 LBS	102,540 LBS	80,000 LBS	132,540 LBS
EXPERIMENT VOLUME				
PRESSURIZED	22,500 CU FT	9,700 CU FT	6,290 CU FT	10,000 CU FT
UNPRESSURIZED	18,000 CU FT	6,100 CU FT	2,000 CU FT	2,400 CU FT
NUMBER OF EXPERIMENTS	120	199	163	145
PROGRAM COST (BILLIONS)				
EXPERIMENTS*	.645	1.520	1.244	.790
PROGRAM	2.122	2.072	2.707	2.326
TOTAL PROGRAM COST	2.767	3.592*	3.951	3.116

*2 SETS OF EXPERIMENTS

*$2.862 WITH ONLY 145 EXPERIMENTS

EOSS PROGRAM ELEMENTS COSTS

STATION MODULE (1)	677	
LOGISTIC SYSTEMS (3)	975	
FACILITIES	51	
SYSTEM GSE	16	
FLIGHT CREW SYSTEM	353	
SUBTOTAL	2,072	
EXPERIMENTS (2)	1,520	
TOTAL	3,591	MILLION (4)

NOTE: (1) COSTS ARE FOR ONE PROTOTYPE AND ONE FLIGHT VEHICLE.

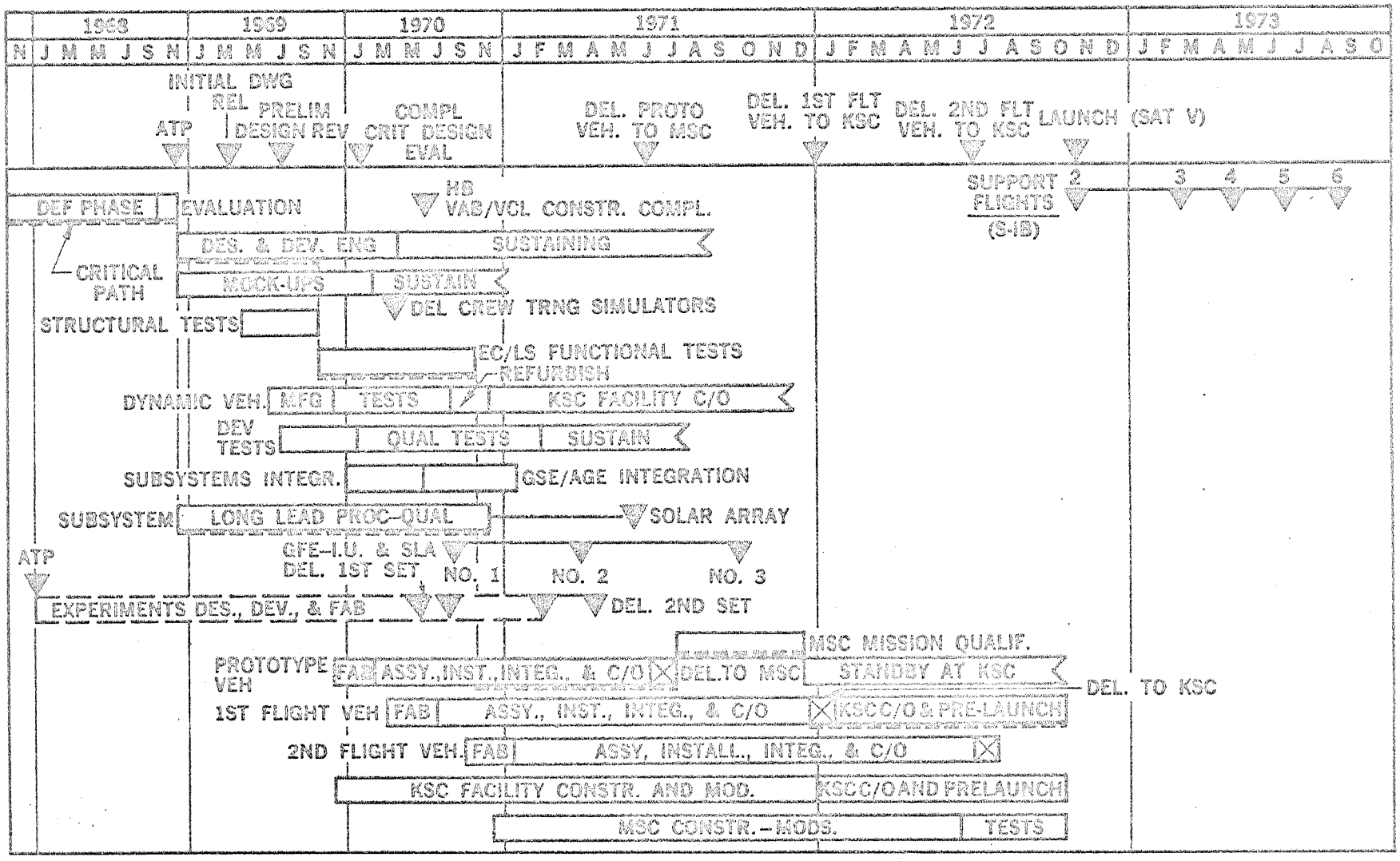
(2) INCLUDES ONE MANNING FLIGHT, FOUR LOGISTIC FLIGHTS AND TWO SPARES

(3) COST INCLUDES TWO SETS OF HARDWARE, EXPERIMENT INTEGRATION AND ACCOMMODATIONS

(4) INCLUDES PROGRAM MANAGEMENT AND MISSION SUPPORT.

M-46744

EOSS
MASTER PHASING SCHEDULE



M-46699

CRITICAL PROGRAM AND TECHNICAL AREAS

- EXPERIMENT SELECTIONS, DEVELOPMENT AND FUNDING
- INTEGRATED EXPERIMENTS VERSUS SEPARABLE EXPERIMENT MODULES
- CREW INVOLVEMENT IN EXPERIMENTS
- ATITUDE CONTROL PROVISION
- LONG-LIFE MAINTAINABLE SUBSYSTEMS
- OPERATIONS: KSC, MSC AND RECOVERY
- EMERGENCY PROCEDURES AND RESCUE
- LONG-TERM CREW PERFORMANCE

THIS SECTION PRESENTED BY

NEIL HARKLEROAD
DEPUTY STUDY DIRECTOR

SECOND BASELINE
EARLY ORBITAL SPACE STATION INTEGRATED EXPERIMENTS

M-46716

EARLY ORBITAL SPACE STATION (EOSS) OBJECTIVES

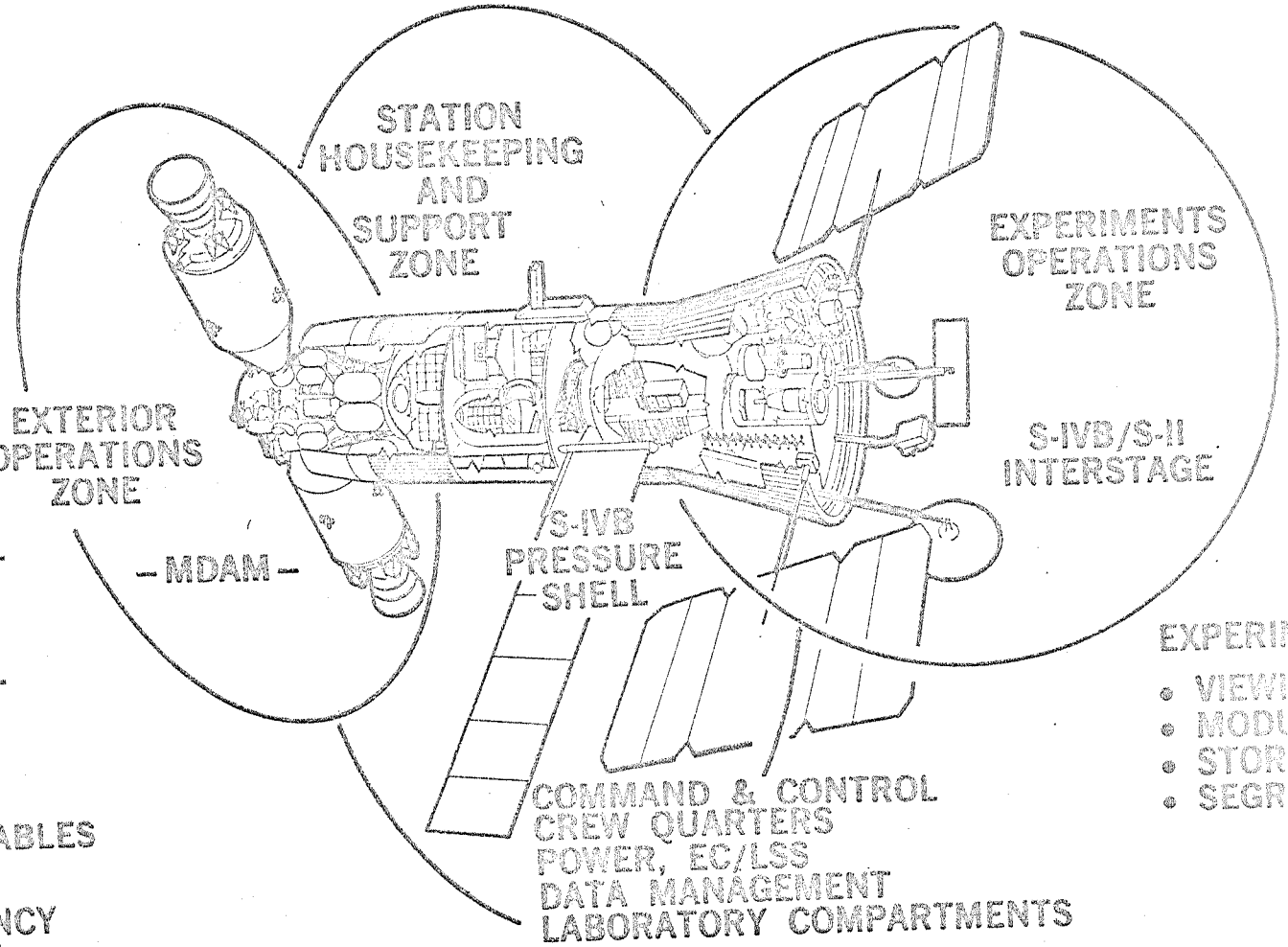
- ACCOMMODATE 199 NASA-SELECTED EXPERIMENTS (PKG "A") ONBOARD EOSS, FOR A 2-YEAR PROGRAM
- OPERATE AT 50° INCLINATION WITH 6 MEN FOR 1 YEAR WITHOUT RESUPPLY
- DEVELOP FROM WORKSHOP/ATM/MOL HARDWARE
- OPTIMIZE DESIGN FOR CREW HABITATION, MAINTENANCE, AND INVOLVEMENT IN EXPERIMENTS

CONFIGURATION APPROACH CRITERIA

1	EXPERIMENTS:	LOCALIZED FOR COMMON SUPPORT SEGREGATED AS REQUIRED FOR ISOLATION SPACE FOR ADEQUATE ACCESS
2	ACTIVATION:	IMMEDIATELY AFTER INJECTION
3	FLEXIBILITY:	MANNED/UNMANNED LAUNCH OPTION CHANGE AND GROWTH
4	SUPPORT LAUNCHES:	SATURN IB PAD ALWAYS AVAILABLE
5	OPTICAL SENSORS:	LOCALIZED FOR POSITION REFERENCE REMOVE FROM RCS/ECS EXHAUSTS
6	DEPLOYABLE SENSORS:	SIZEABLE STOWAGE VOLUME, REMOTE FROM DOCKING AREA
7	RETREAT COMPARTMENTS:	TWO MANDATORY; QUICK ACCESS TO CSM'S

M-46743

SPACE STATION ZONES

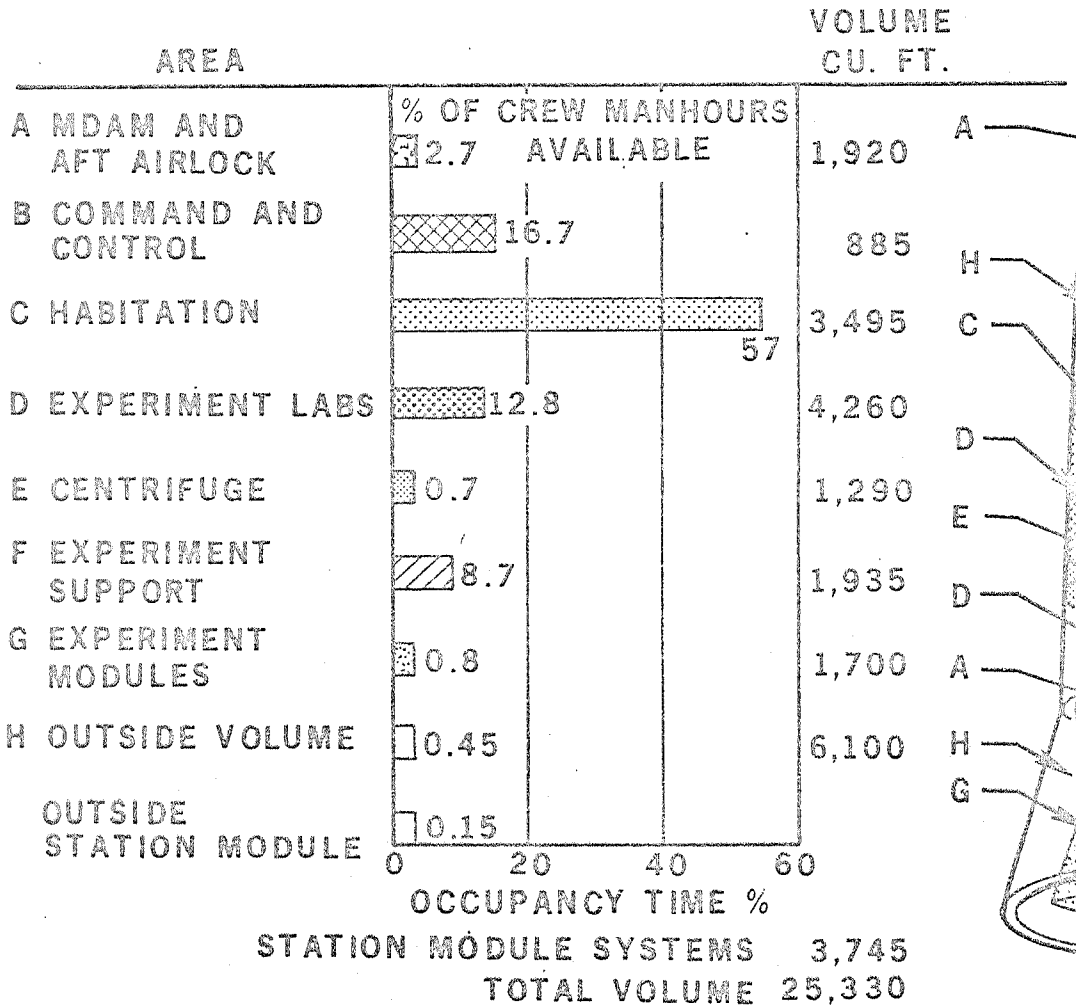


- EXTERNAL MODULES
- RCS EFFLUENT
- EVA
- CONSUMABLES STORAGE
- EMERGENCY RETREAT

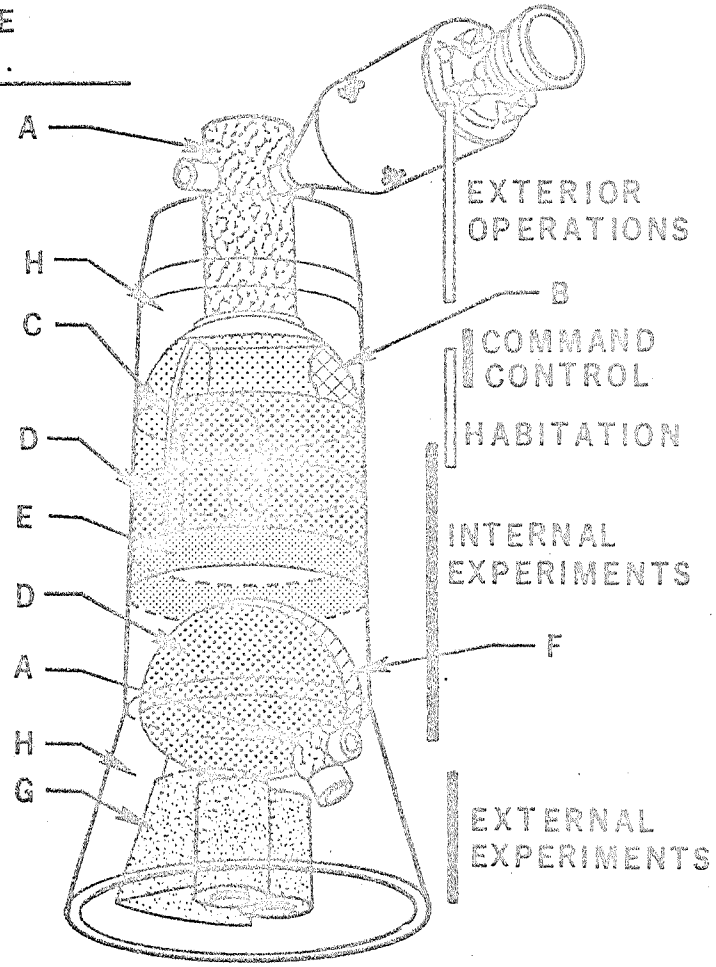
EXPERIMENT

- VIEWING
- MODULES
- STORAGE
- SEGREGATION

VOLUME AND OCCUPANCY DISTRIBUTION

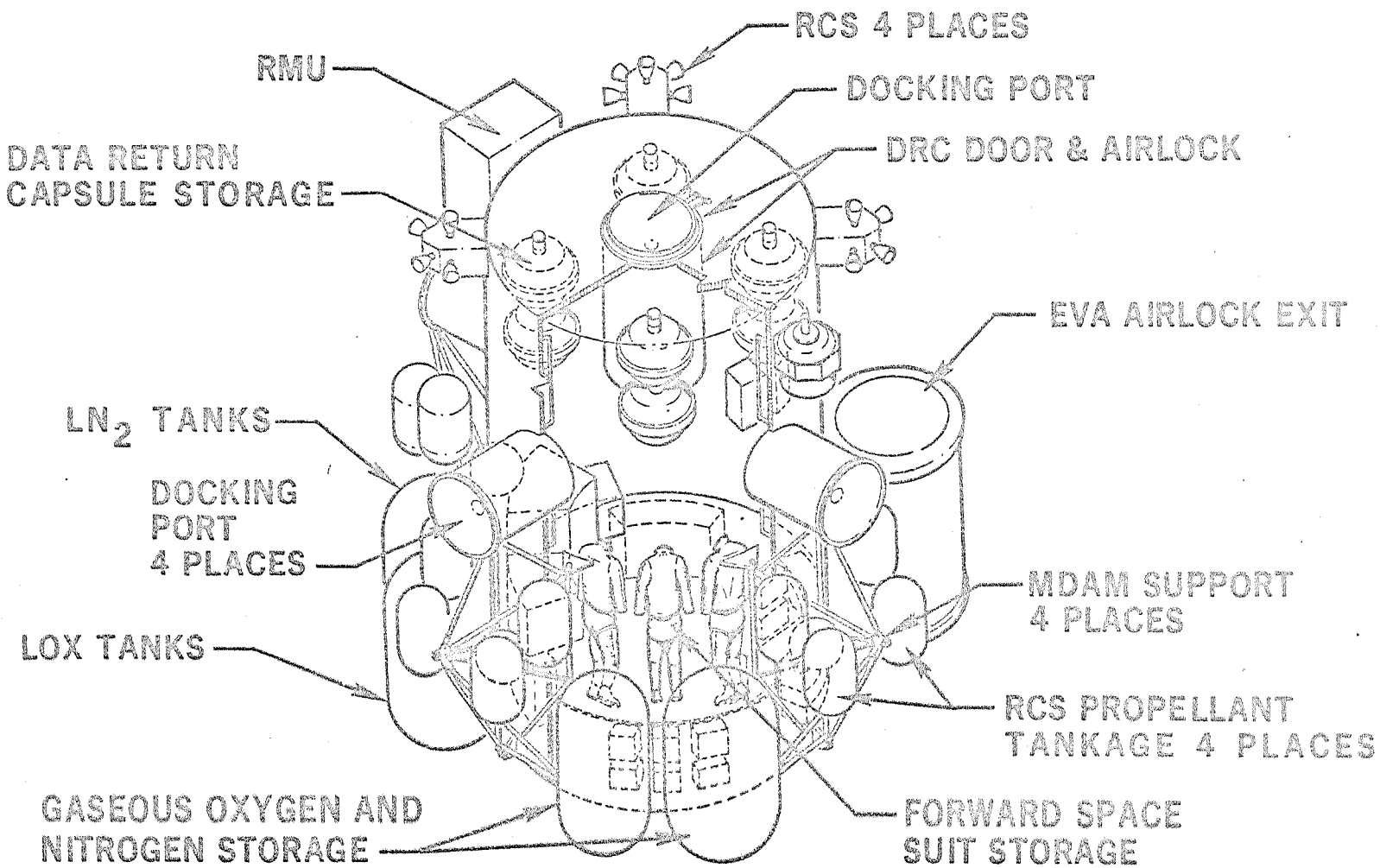


STATION MODULE SYSTEMS 3,745
TOTAL VOLUME 25,330



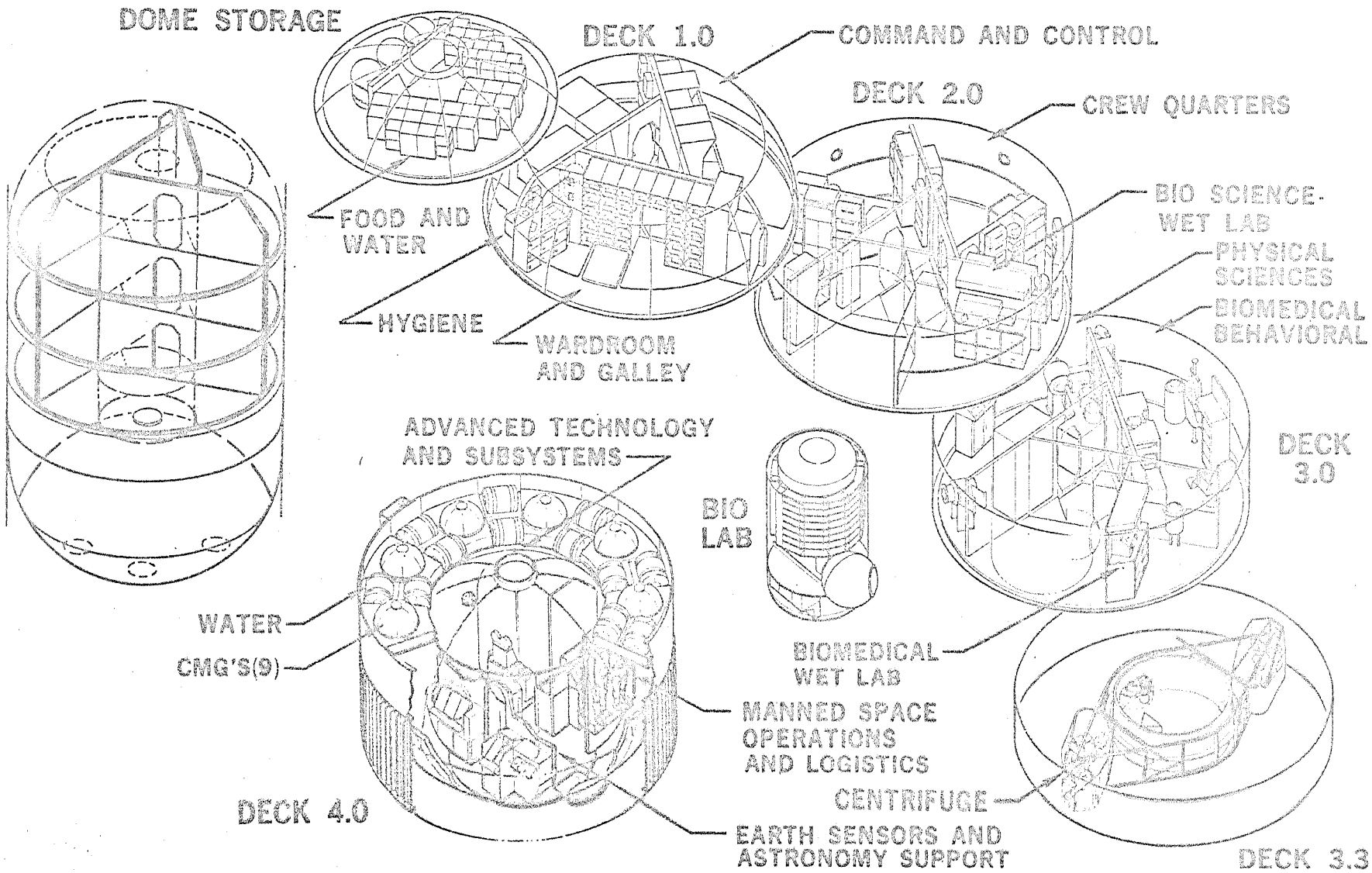
M-46780

MULTIPLE DOCKING AIRLOCK MODULE



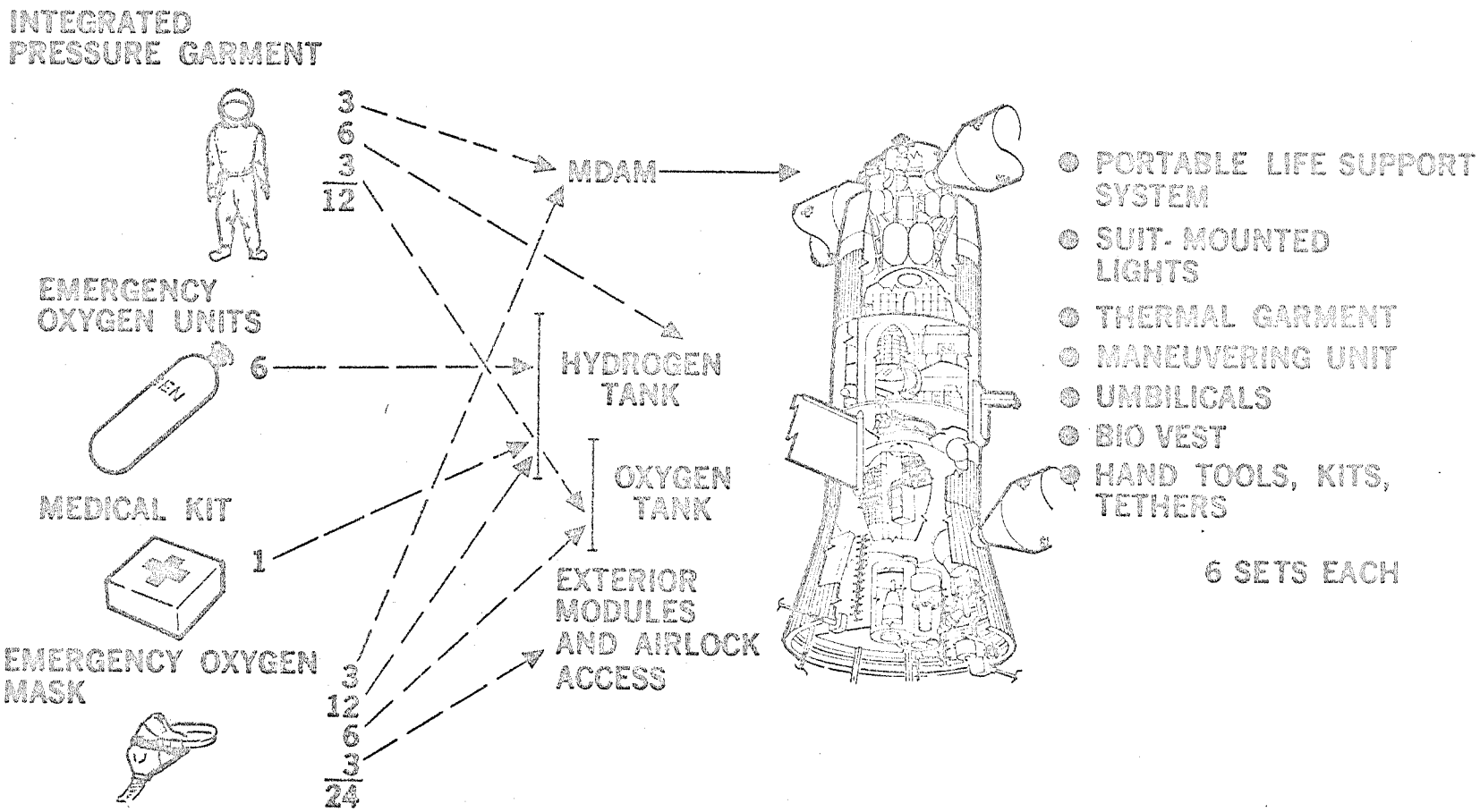
M-46813

STATION MODULE INTERIORS



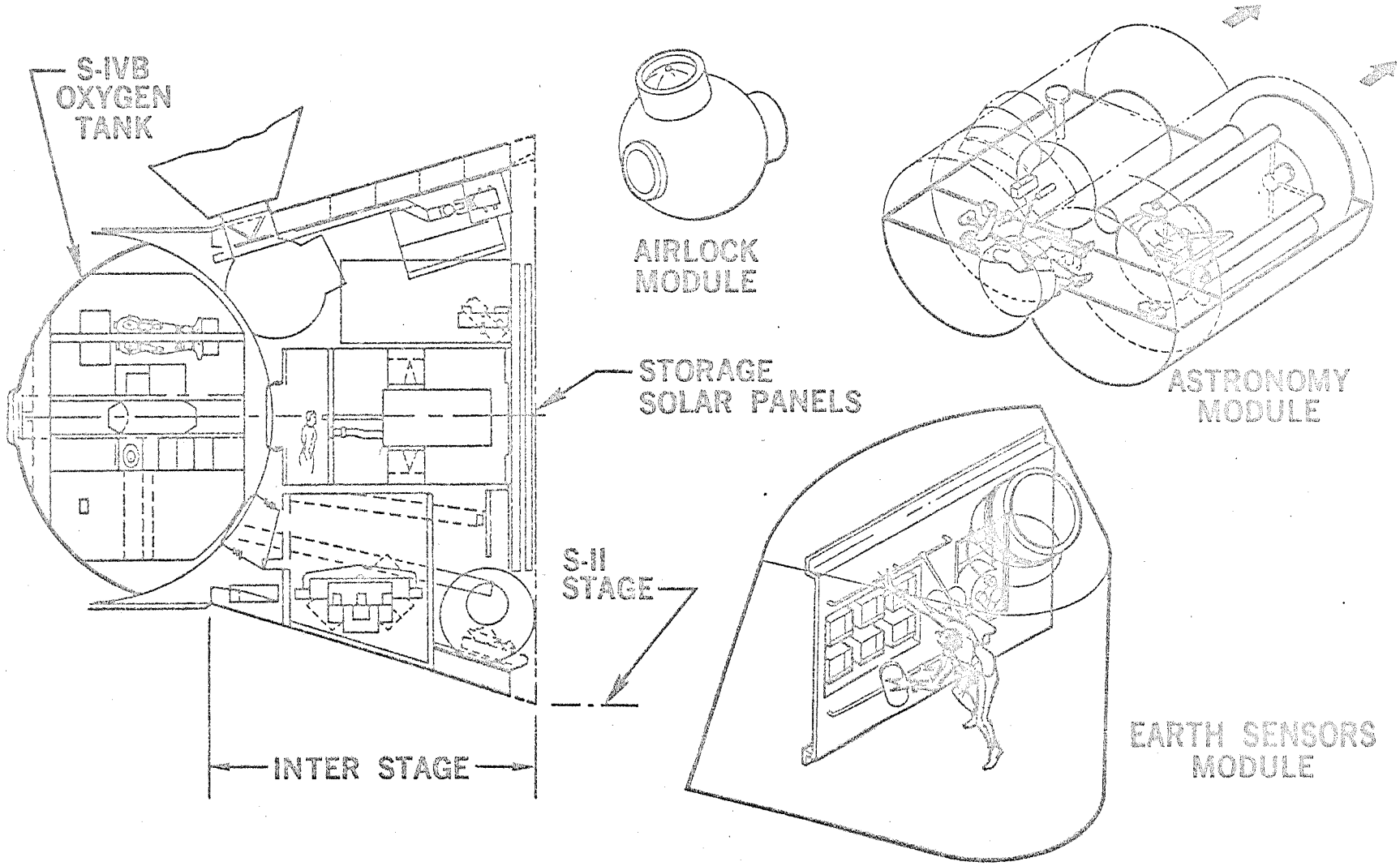
M-46788

CREW SYSTEMS PERSONAL EQUIPMENT



M-45762

AFT END EXPERIMENTS INSTALLATION



M-46749

WEIGHT SUMMARY
BASELINE EOSS MISSION

	POUNDS
MAXIMUM LIFTOFF CAPABILITY (ABOVE S-II STAGE)	271,547
LES	8,700
SLA PETALS	3,540
SPS AND RCS PROPELLANT TO CIRCULARIZE	9,015
AFT INTERSTAGE SEPARATION ADAPTER	807
NET PAYLOAD	249,484
MARGIN AVAILABLE FOR LATER INSTALLATIONS	49,149
EXPERIMENTS WEIGHT – PACKAGE A	33,085
EXPERIMENT SUPPORT EQUIPMENT	15,360
SUBSYSTEMS, AIRLOCKS, MDAM, EXPENDABLES LCSM, ETC.	130,559
CONTINGENCY	15,040
GROWTH	6,290
EOSS WEIGHT IN ORBIT (WITH ONE LCSM)	200,335
ORBITAL EOSS WEIGHT WITH TWO LCSM'S	228,009

EXPERIMENT PACKAGE CHARACTERISTICS

PACKAGE	NUMBER OF EXPERIMENTS	WEIGHT (LB) EXPER	WEIGHT (LB) EXPER SUPP	VOLUME (CU FT)	POWER (kWh)	CREW TIME (MAN-HOURS)
(100%)	283	51,285	24,600	6,285	13,886	31,990
"A"	199	33,085	15,360	4,446	10,285	23,180
"B"	161	27,125	13,030	4,126	7,964	22,770
"C"	189	30,080	14,470	4,201	11,241	19,599
"D"	220	40,405	10,400	5,524	8,588	21,567
EOSS CAPABILITY		102,000		6,000	20,800	34,627

GROUPING CRITERIA

PACKAGE

BASELINE (100% CASE) COMPLETELY RESPONSIVE TO NASA 1971/1972 EARTH ORBITAL EXPERIMENT PROGRAM

"A" REPRESENTATIVE MIX FROM ALL NINE TECHNOLOGIES

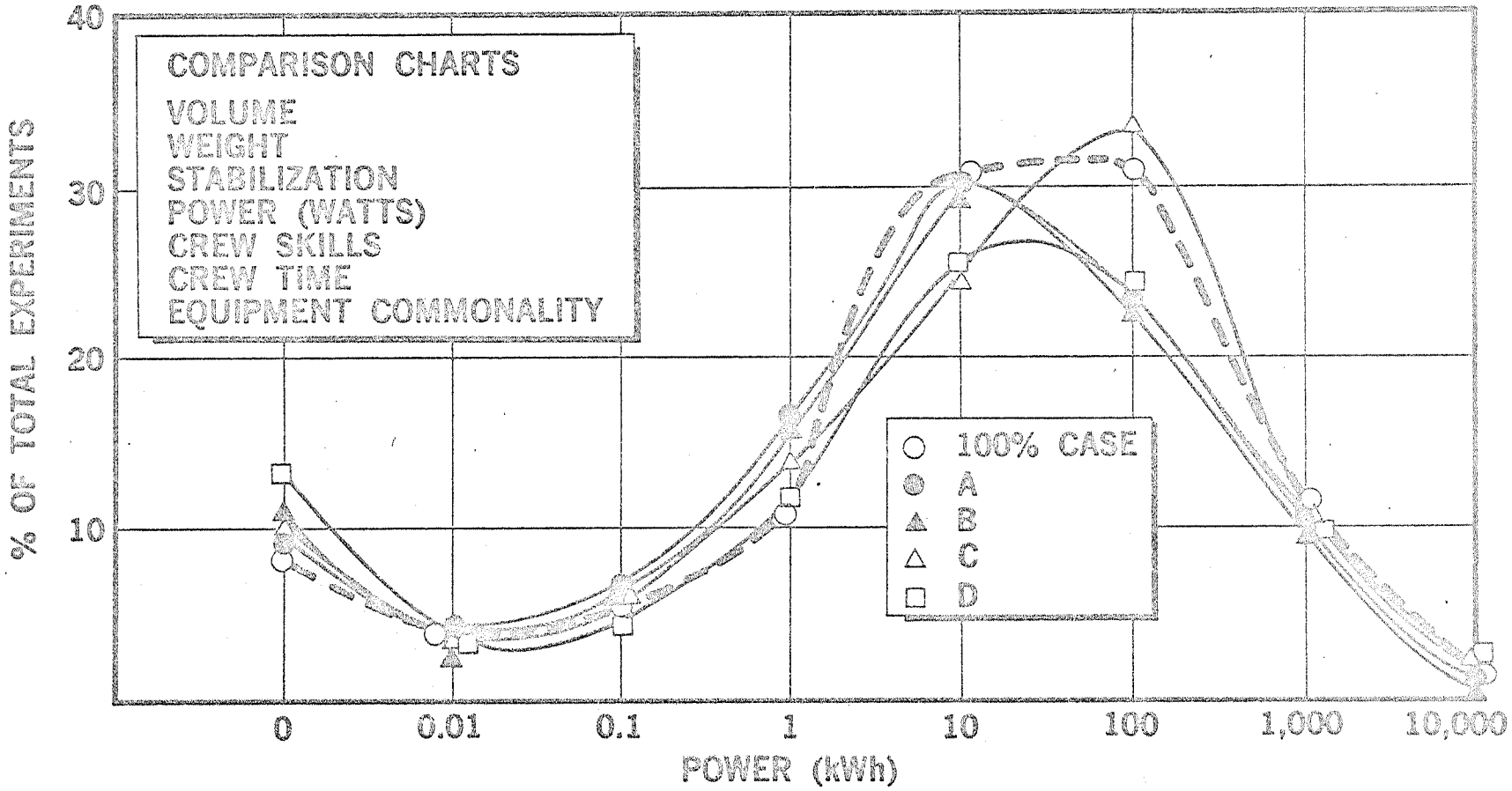
"B" ASTRONOMY EMPHASIS

"C" EARTH-RESOURCES EMPHASIS

"D" EMPHASIS ON OTHER SIX TECHNOLOGIES

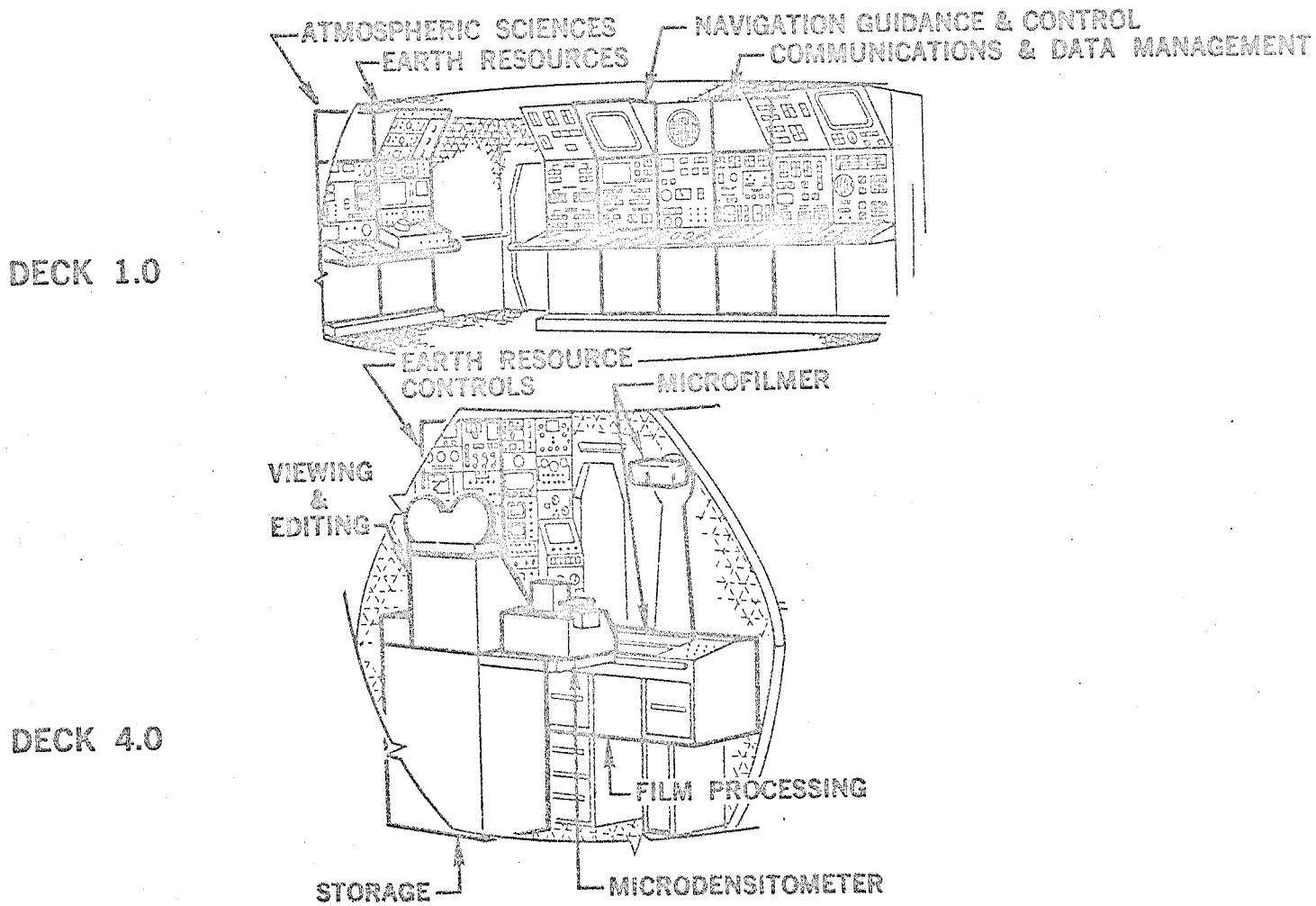
EXPERIMENT PACKAGE CHARACTERISTICS COMPARISON CHART

M-46771



M-46811

EARTH RESOURCES EXPERIMENT SUPPORT EQUIPMENT



FLIGHT-CREW SCHEDULE

- 1 COMMAND PILOT, 1 DEPUTY, AND 4 EXPERIMENTERS
- 9 HOURS PER DAY COMMAND AND CONTROL (STATION-KEEPING COMMUNICATIONS, DATA HANDLING, ETC.)
- 1 CREWMAN IN CONTROL CENTER AT ALL TIMES (MAY BE PERFORMING ANY ACTIVITY)

TIME ALLOCATION:

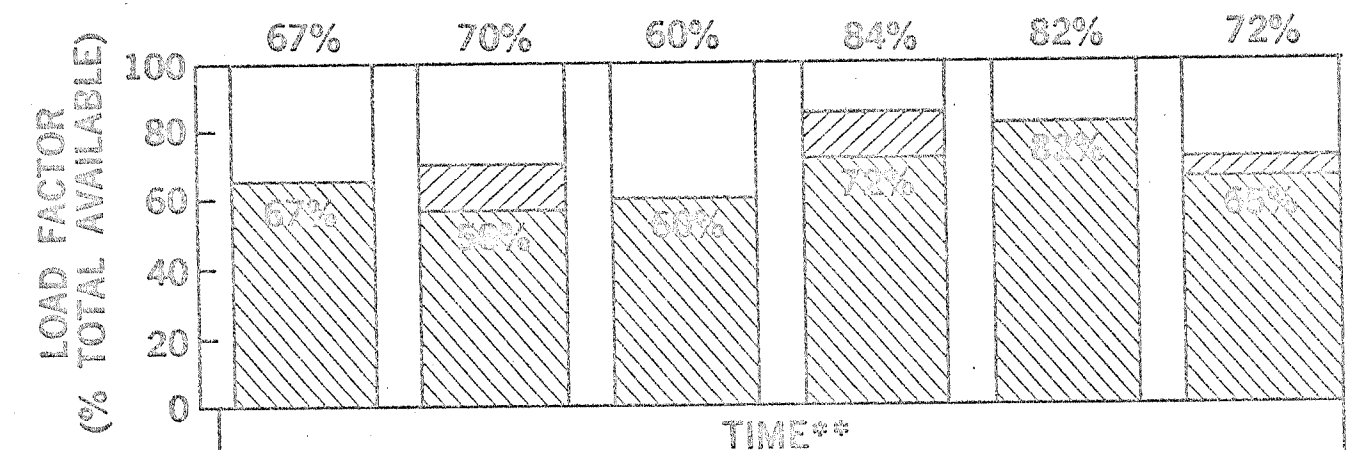
SLEEP – ONE 8-HOUR PERIOD/MAN/DAY
EATING AND PERSONAL HYGIENE – THREE 1-HOUR PERIODS/MAN/DAY
REST AND RECREATION – ONE 2-HOUR PERIOD/MAN/DAY FOR 6 DAYS AND 1 DAY/MAN/WEEK

- EXPERIMENT TIME AVAILABLE:

57	HOURS, 1 DAY/WEEK
46	HOURS, 6 DAYS/WEEK
34,627	HOURS AVAILABLE FOR 2-YEAR EXPERIMENT PROGRAM
24,791	REQUIRED TO ACCOMPLISH "A" PACKAGE

M-46710

UTILIZATION OF CREW SKILLS FOR EXPERIMENT PACKAGE "A"



DISCIPLINE	ELEC/ MECH. ENGR *	BIO	MD	PHYS/ CHEM	PHYS SCIEN	OPT PHYS
CREW SKILLS	• ELEC ENGR • MICRO WAVE SPEC • ELEC MECH TECH • MECH TECH • THER-MAL DYNAM.	• BIO TECH • MICRO BIO TECH • BIOCHEM	• MD • PSYCH	• PHYS • NUC PHYS	• METEOR-OLOGIST • OCEANO-GRAPHER • GEO.	• ASTRON • PHOTO TECH • OPT TECH • OPT SCIEN

*COMMANDER

** 13,963 HOURS 1st YEAR

12,964 HOURS 2nd YEAR

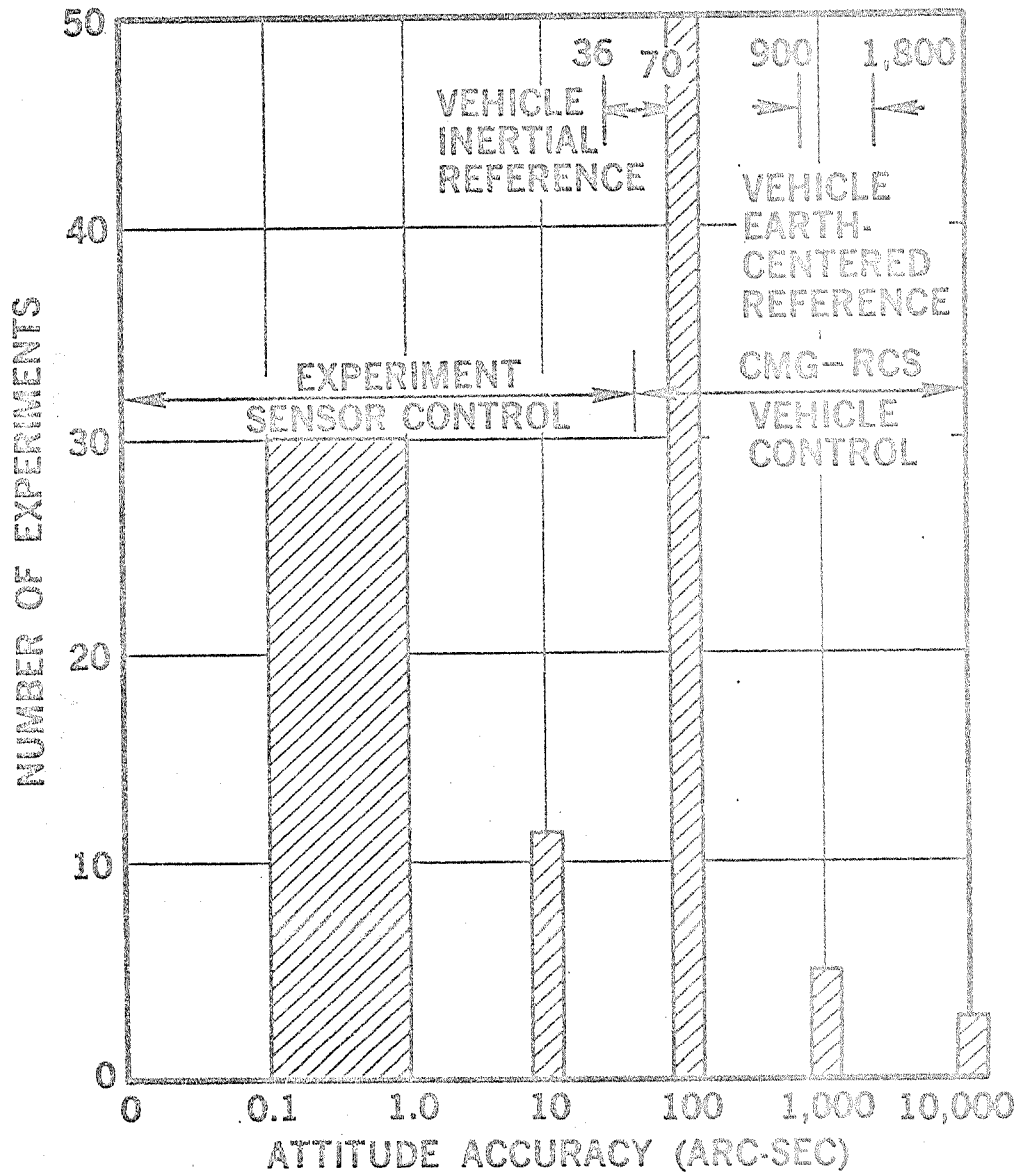
EXPERIMENT LOAD FACTOR

SUBJECT LOAD FACTOR

MAX. LOAD FACTOR

M-46773

EXPERIMENT REQUIREMENTS



M-46745

SCS PERFORMANCE AND ACTUATION REQUIREMENTS 260 NMI ORBIT

SYSTEM	PERFORMANCE	ORIENTATIONS		FUNCTIONS		TOTAL (LB)
		LOCAL HORIZONTAL 470 DAYS (LB)	INERTIAL 260 DAY (LB)	MANEUVERS 2/DAY (LB)	CENTRIFUGE OPERATION 2-1 HOUR RUNS/DAY (LB)	
CMG AND RCS CMG WEIGHT (9-2,000 LB-FT-SEC GYROS)	ATTITUDE HOLD ±0.03° CONTINUOUS	4,200				4,200
ATTITUDE CONTROL PROPELLANT		100	8,480			8,580
ORBIT KEEPING TOTAL WEIGHT (2 YRS)		226	142			368
						13,148
PURE RCS ATTITUDE CONTROL	ATTITUDE HOLD ±0.1° - 110 DAYS ±3° - 620 DAYS	10,940	21,140	1,800	3,550	37,430
ORBIT KEEPING TOTAL WEIGHT (2 YRS)		226	142			368
						37,798

P/RCS CHARACTERISTICS

PERFORMANCE

FUNCTION	TOTAL IMPULSE (LB-SEC)	DUTY CYCLE	THRUST/ENGINE (LB)	ACCUMULATED BURN TIME/ENGINE (SEC)
ATTITUDE CONTROL				
PITCH	1,020,000	RANDOM PULSES AS REQUIRED (RPAR)	100	5,100
YAW	24,000	RPAR	100	120
ROLL	(1)	RPAR	22	—
ORBIT KEEPING	88,400	CONTINUOUS	100	442

DESIGN

THRUSTORS: (MARQUARDT)

- FOUR MODULES – 5 THRUSTORS EACH
- BIPROPELLANT
  OXIDIZER – NITROGEN TETROXIDE
  FUEL – MONOMETHYL HYDRAZINE
- MIXTURE RATIO – 1.6 (°/F)
- RADIATION / FILM-COOLED

TANKS: (ROCKETDYNE)

- 10 TOTAL – 5 OXIDIZER, 5 FUEL, EQUAL VOLUME ($\sim$7,100 IN^3)
- POSITIVE EXPULSION BLADDERS
  OXIDIZER – TEFLON
  FUEL – EPR 132 (RUBBER)
- TITANIUM ALLOY – 6 A1-4 V
- LARGEST POSITIVE EXPULSION TANKS AVAILABLE

(1) REQUIRED ONLY IN EVENT OF CMG FAILURE

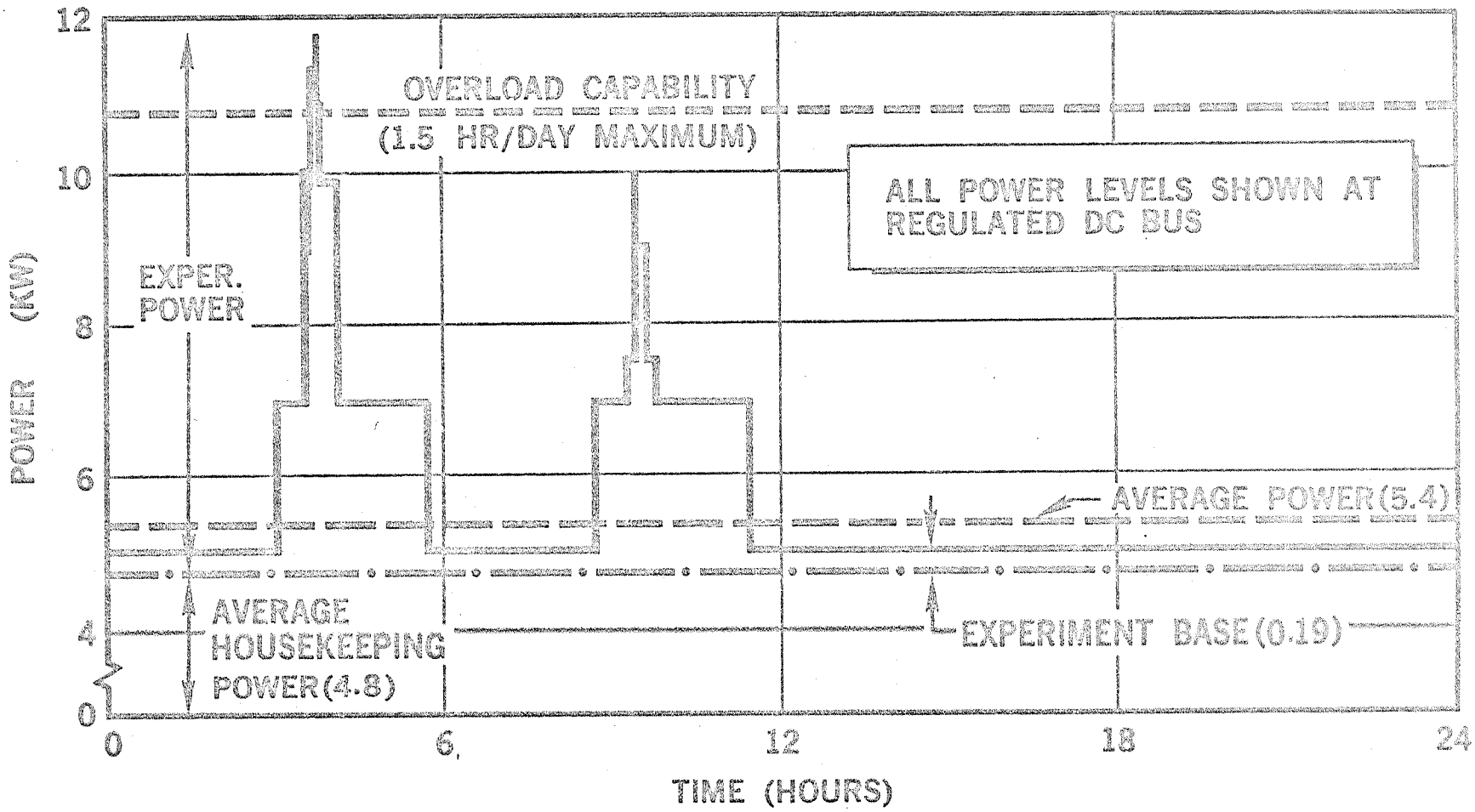
M-46747

ELECTRICAL LOAD REQUIREMENTS
AVERAGE POWER-KW

	NORMAL OPERATION		MANNED EMERGENCY	
	28 VDC	115/200 VAC 400 HZ	28 VDC	115/200 VAC 400 HZ
ENVIRONMENTAL CONTROL/LIFE SUPPORT	1.35	—	0.53	—
COMMUNICATIONS, DATA, DISPLAY, CONTROLS, AND LIGHTING	0.49	0.20	0.13	0.15
STABILIZATION AND CONTROL AND REACTION CONTROL	0.36	0.29	0.23	0.05
CREW SYSTEMS	0.06	—	—	—
LOGISTICS (2 LCSM'S)	1.04	—	1.04	—
EXPERIMENTS	0.35	0.20	—	—
SUBTOTAL	3.65	0.69	1.93	0.20
REFLECTED AC	0.84		0.25	
SUBTOTAL	4.49		2.18	
CONTINGENCY	0.91		0.22	
TOTAL	5.40		2.40	

M-46776

ELECTRICAL LOAD PROFILE



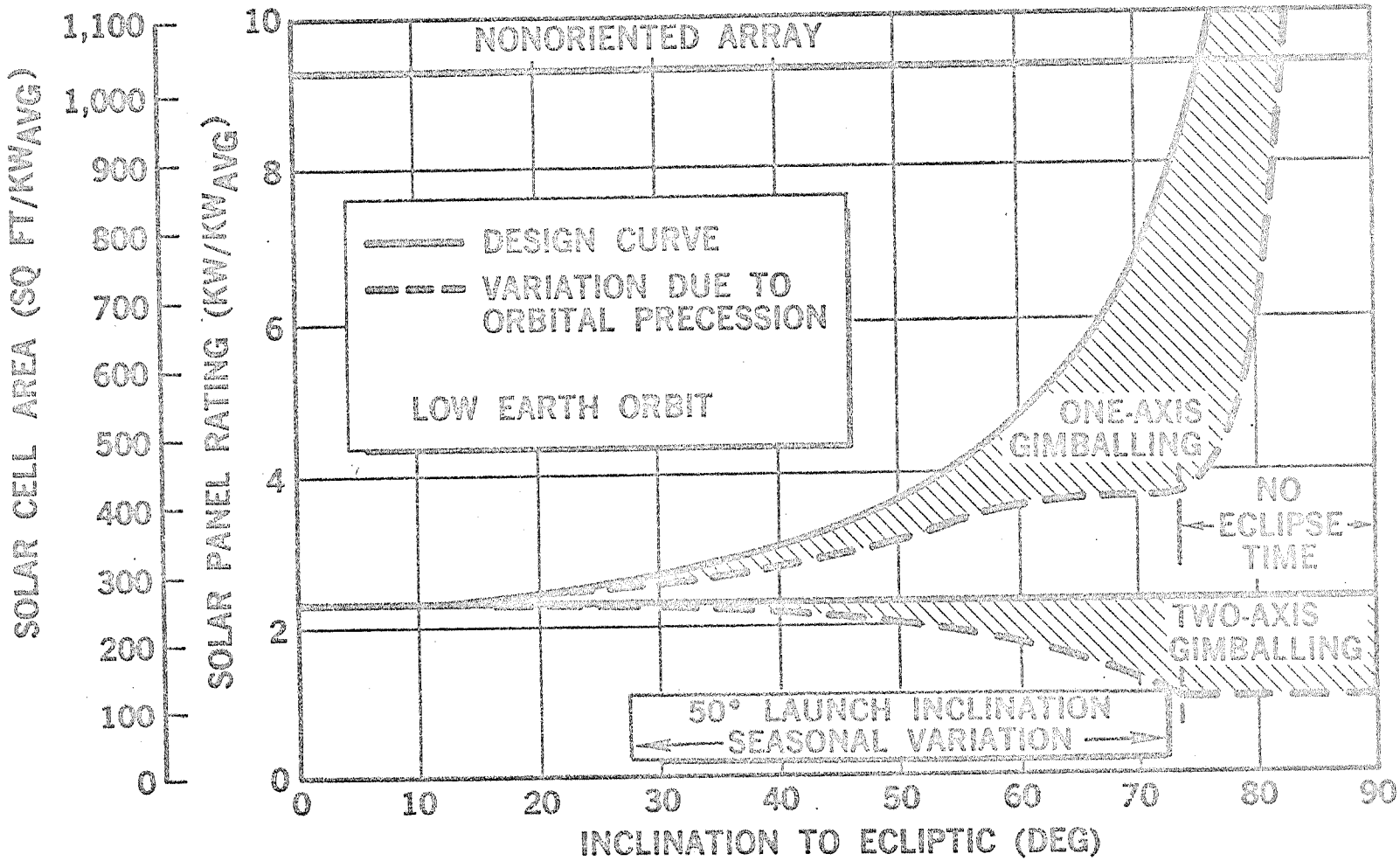
POWER SYSTEM COMPARISON SUMMARY
EOSS-ONE YEAR MISSION

	SOLAR CELL/ BATTERY (1)	FUEL CELL	HYBRID SOLAR CELL/ FUEL CELL
VOLUME (CU FT)	225	1,880	1,000
PANEL AREA (SQ FT)	2,080	—	1,290
LAUNCH WEIGHT (LB)			
SOURCE	2,440	3,620	5,910
REACTANTS AND STORAGE	—	62,910	24,350
BATTERIES	1,600	—	—
POWER CONDITION, CONTROL, DISTRIB.	1,580	1,580	1,580
SINGLE LAUNCH – TOTAL	5,620	68,110	31,840
90-DAY RESUPPLY – INITIAL LAUNCH	5,620	23,570	11,390
RESUPPLY LAUNCH	—	16,790	7,280

(1) A 600W POWER PENALTY FOR A CLOSED CYCLE WATER RECOVERY SYSTEM IS APPLIED TO THE SOLAR CELL / BATTERY

M-40760

SOLAR-CELL PANEL GIMBALLING EFFECTS

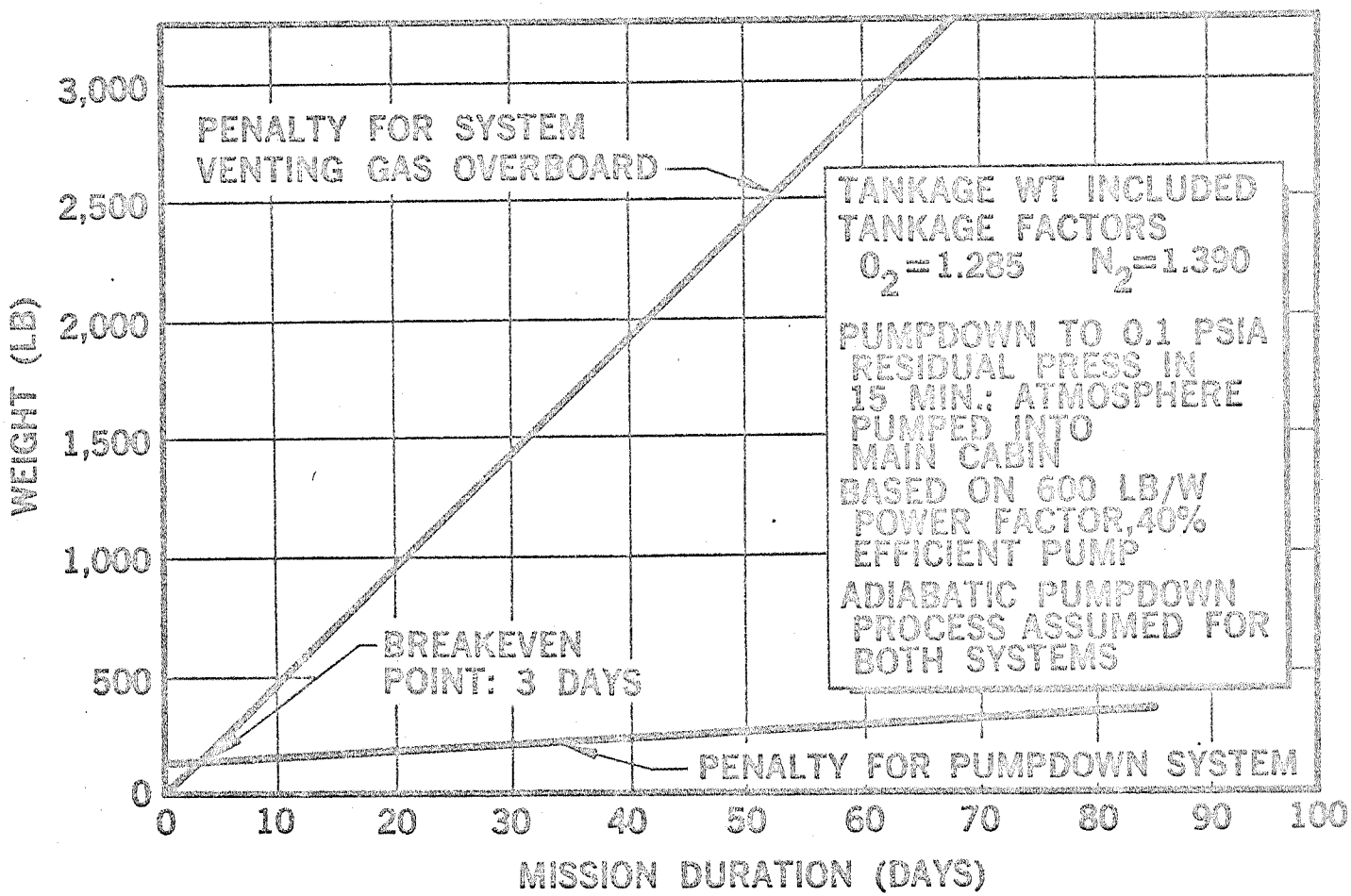


M-46634

ATMOSPHERE STORAGE SYSTEM REQUIREMENTS

REQUIREMENT (ONE YEAR)	FLUID WEIGHTS (LB)	
	O_2	N_2
METABOLIC	4,870	—
INITIAL PRESSURIZATION	(290 AIR)	(1,097 AIR)
EMERGENCY PRESSURIZATION	660	—
EXPERIMENTS (CHAMBER, AIRLOCK, SUITS)	468	312
EVA (AIRLOCK, SUITS)	103	8
LEAKAGE	976	790
MOLECULAR SIEVE ULLAGE	299	243
MARGIN 10%	672	135
TOTALS	7,388	1,488
SUPERCRITICAL O_2	7,388	
SUPERCRITICAL N_2	1,488	
GASEOUS O_2	660	
INITIAL/PRESSURIZATION (AIR)	1,387	

PUMPDOWN SYSTEM TRADEOFF



REQUIRED EC/LS CAPABILITIES

ENVIRONMENTAL CONTROL AND LIFE SUPPORT FOR 6 MEN FOR 1 YEAR WITH 3 ADDITIONAL MEN FOR A 7-DAY PERIOD 4 TIMES PER YEAR.

SHIRTSLEEVE ENVIRONMENT 75° ±5°F

P_{CO_2}=4 mm Hg NOMINAL

DEW POINT 60°F OF MAXIMUM WITH NO FROST OR CONDENSATION ON WALLS

PRESSURE AND COMPOSITION 7 PSIA TOTAL PRESSURE, 3.5 PSIA O_2 AND 3.5 PSIA N_2

SAFE CONTAMINANT LEVELS (FOR EXAMPLE, P_{CO_2}=50 ppm)

SAFE BACTERIOLOGICAL ENVIRONMENT

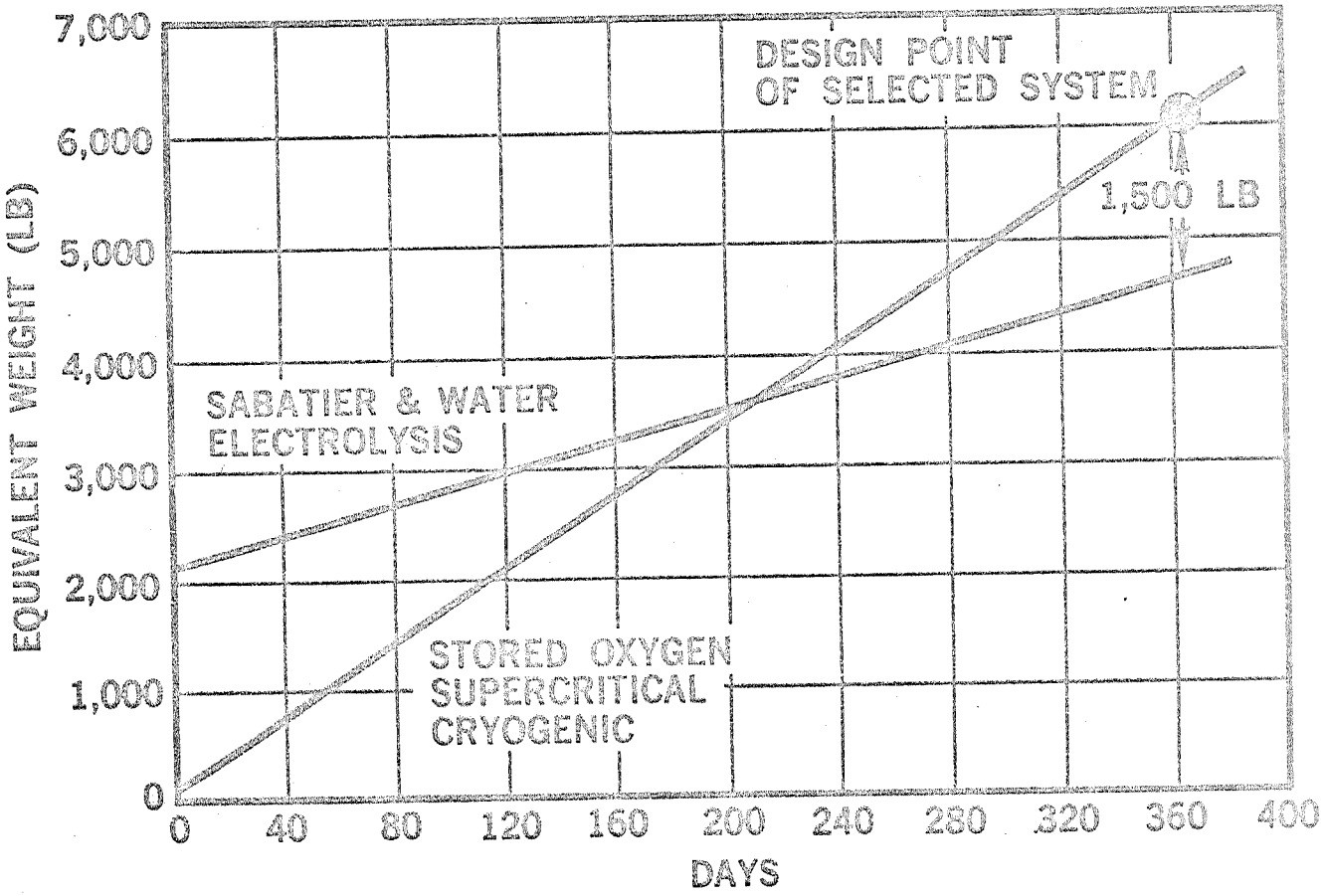
ECS SUPPLY FOR EVA PRESSURE SUIT

OXYGEN MASK O_2–100-PSIA SUPPLY

METABOLIC WATER

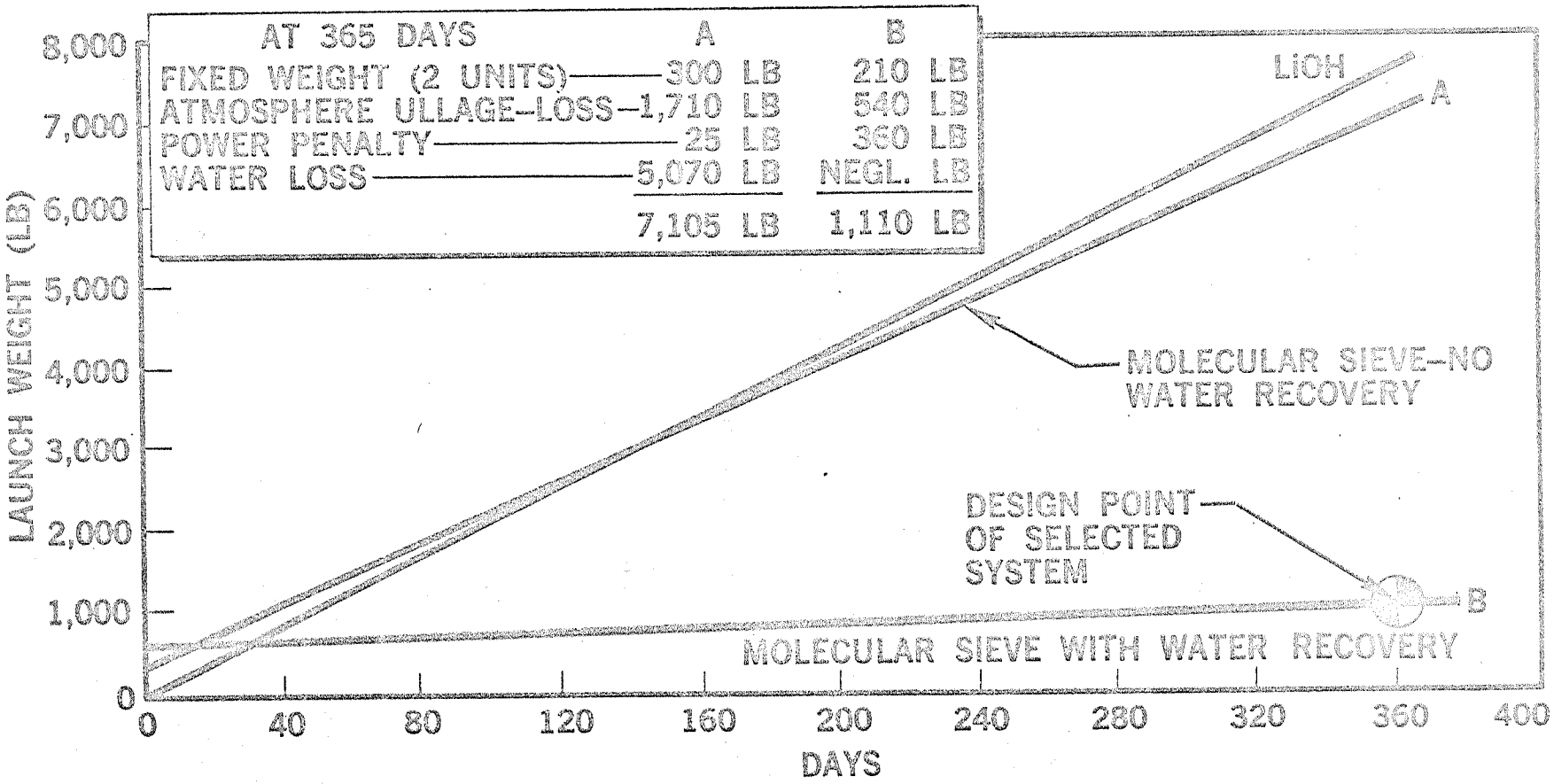
M-46754

OXYGEN RECOVERY TRADEOFF



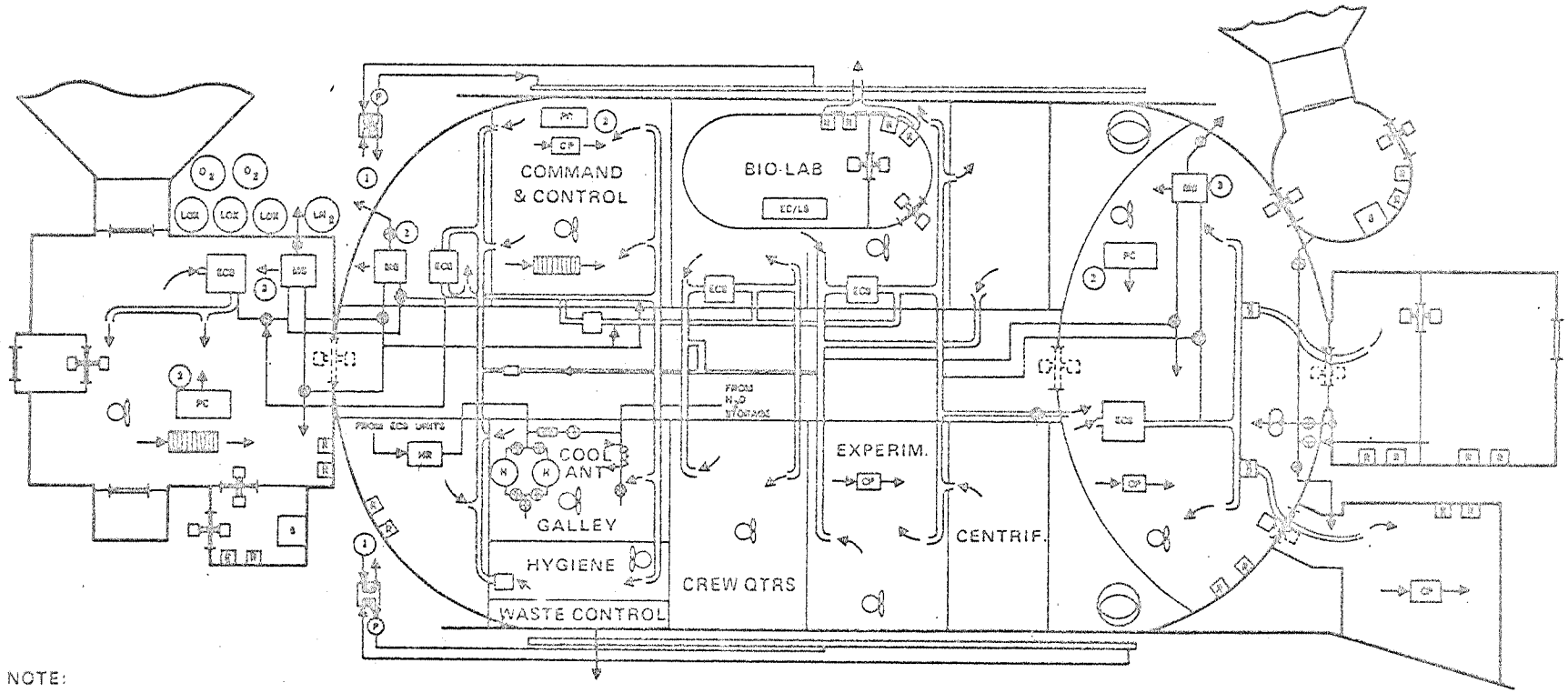
M-46769

CO_2 REMOVAL TRADEOFF



M-46781

EOSS EC/LS

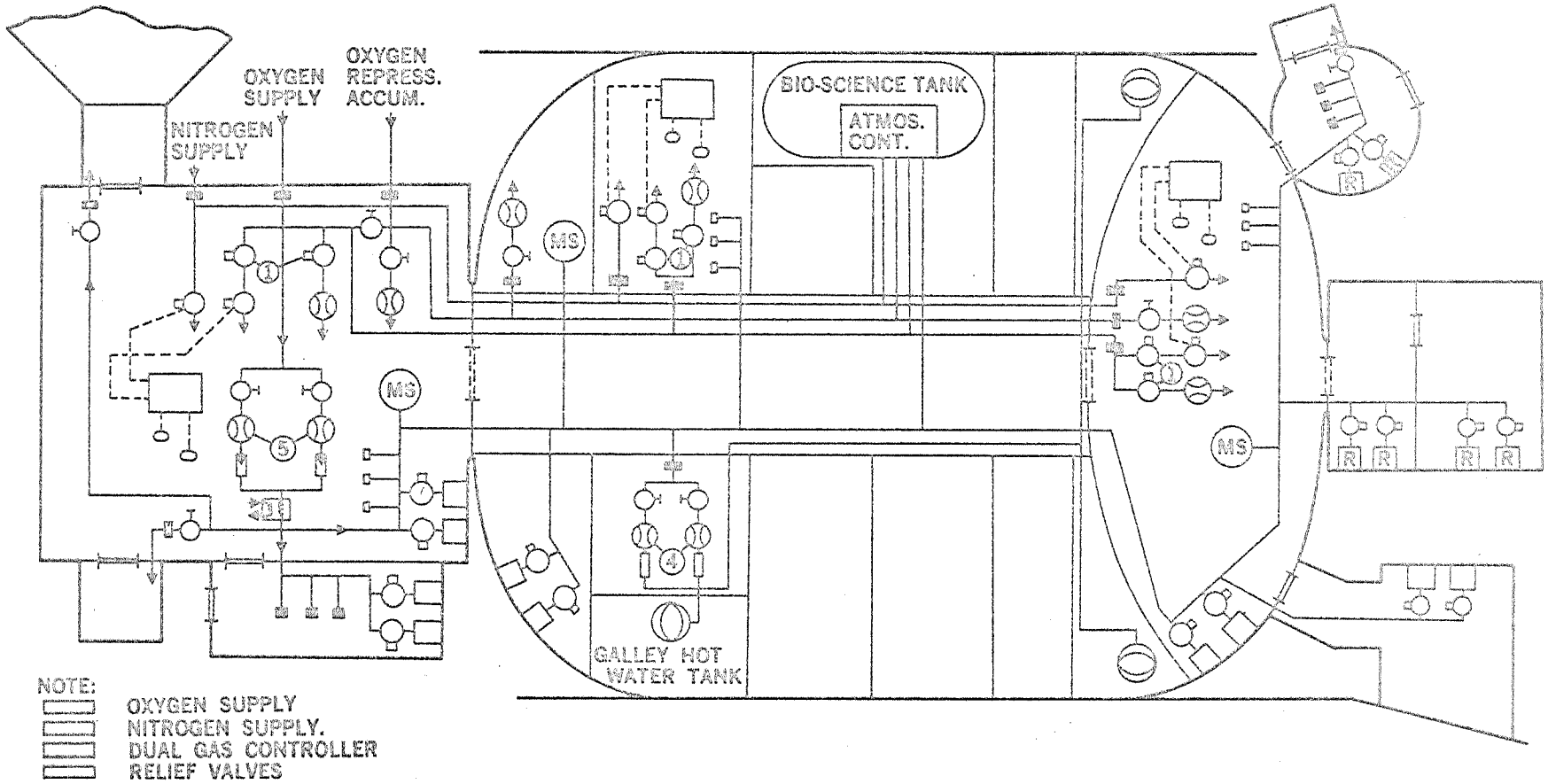


NOTE:

- ECS/THERMAL/HUMIDITY CONTROL & ATMOSPHERE DISTRIBUTION
- CONTAMINANT/CO REMOVAL & DISTRIBUTION SYSTEM
- WATER MANAGEMENT
- PRESSURE/COMPOSITION CONTROL

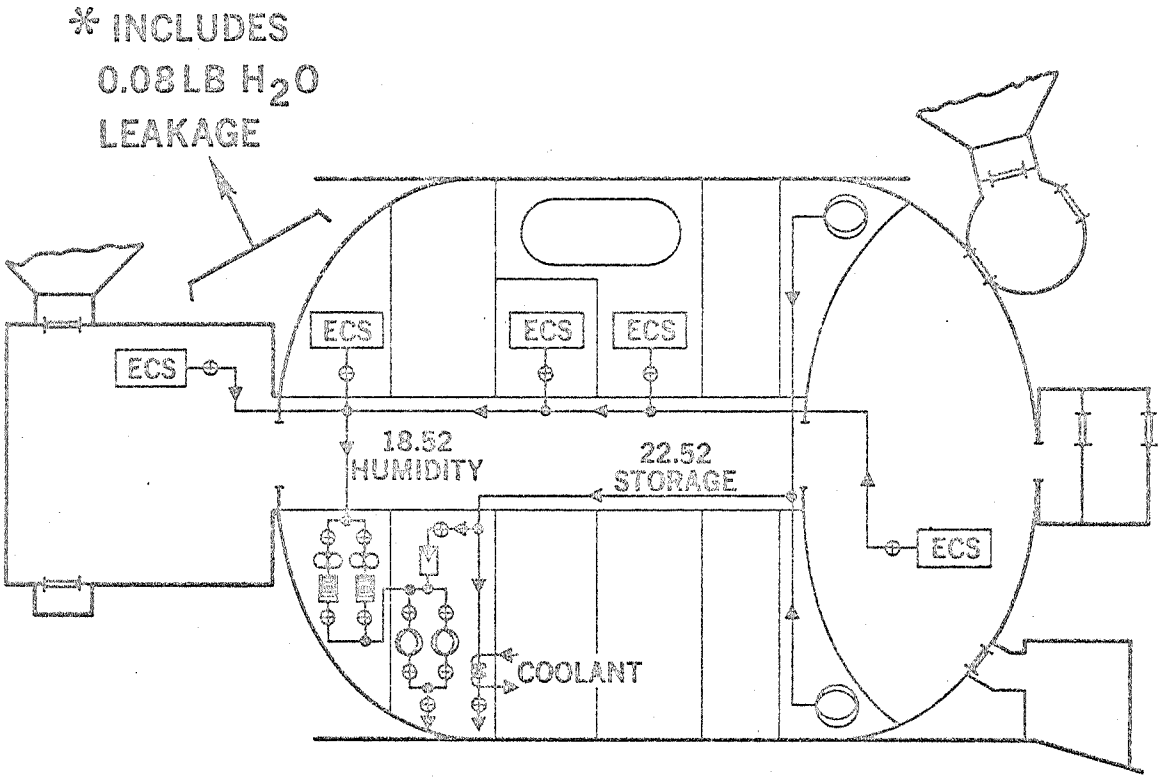
M-46785

EOSS ATMOSPHERE



M-46783

EOSS WATER MANAGEMENT



6-MAN CREW
WATER BALANCE, LB/DAY

WATER OUTPUT	
URINE	26.03
HUMIDITY	18.60 *
FECAL	1.68
TOTAL	46.31

WATER SOURCES	
METABOLIC H_2O	5.27
HUMIDITY RECOVERY	18.52
STORAGE	22.52 *
TOTAL	46.31

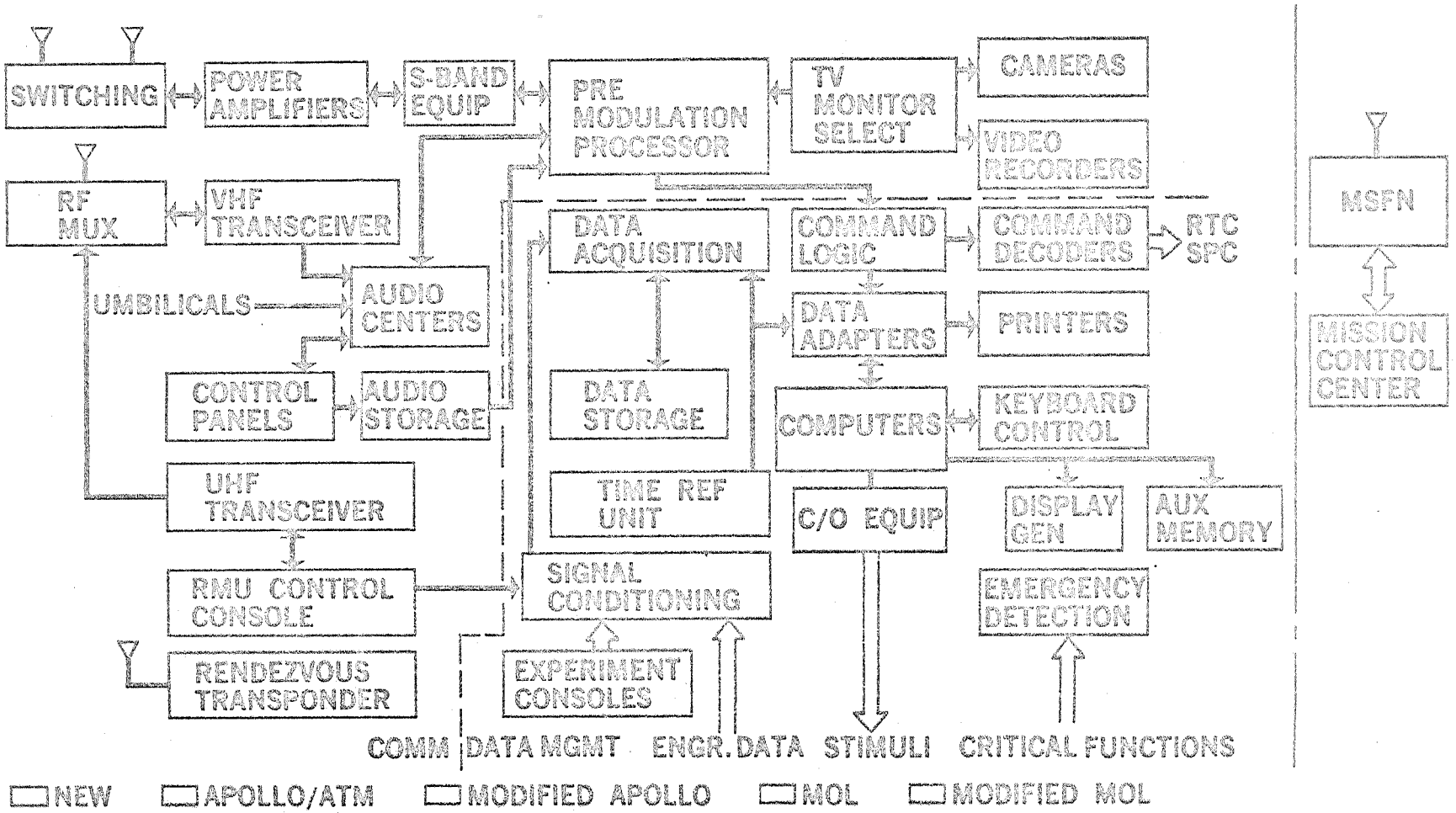
CHANNEL REQUIREMENTS

COMMANDS	POWER	EC/LS	G & S	PROP.	DATA MGMT	COMM	TOTAL
• DISCRETE (RT)	20	20	24	20	20	20	124
• DISCRETE (SPC)	40	20	30	–	40	5	135
• DIGITAL	–	–	3		4	1	8
STATUS MEASMT							
• EVENTS	45	53	48	48	51	28	280
• ANALOG (2)	30	67	3	79	6	3	210
• DIGITAL	–	–	10	–	10	–	20
EXPMT MEASMT	COMM/ NAV	ADV TECH	SPACE OP./ LOG.	ASTRO	EARTH/ ATM. SCI.	BIO./ BEH.	TOTAL
EVENTS	(1)	(1)	(1)	12	2	(1)	–
ANALOG	216	1	6	–	133	52	408
DIGITAL	2	10	–	10	22	3	45
TV	2-500 LVR	1-500 LVR	1-500 LVR	–	1-800 LVR	1-500 LVR	N/A

NOTE: (1) – UNDEFINED
LVR – LINES VERTICAL RESOLUTION
(2) – DOES NOT INCLUDE FAULT ISOLATION

M-46784

COMMUNICATIONS AND DATA MANAGEMENT



NEW APOLLO/ATM MODIFIED APOLLO MOL MODIFIED MOL

EXPERIMENT DATA SUMMARY-ONE DAY

TECHNOLOGY	EXP. NO.	RUN TIME (MIN)	DATA TYPE	NO. OF CHANNELS OR WORDS	SAMPLE RATE (SPS)	BITS/ WORD	BIT RATE (BPS)	TOTAL BITS
PHYSICAL SCIENCE	110	167	DIGITAL	1	100	10	1000	1×10^7
	303	167	ANALOG	1	10	N.A.	600	6×10^6
	359	167	ANALOG	1	10	N.A.	60	6×10^5
	360	167	ANALOG	1	10	N.A.	60	6×10^5
	452	167	ANALOG	1	10	N.A.	60	6×10^5
	2515	167	ANALOG	3	10	N.A.	180	1.8×10^6
BEHAVIORAL SCIENCE	86	120	DIGITAL	261	N.A.	24	N.A.	6.26×10^3
COMM & NAV	1030	376	ANALOG	190	10	8	1.52×10^4	7.3×10^7
			DIGITAL	2	N.A.	100	200	9.6×10^5

TOTAL RUN TIME $\cong$ 10 HOURS
TOTAL BIT ACCUMULATION $\cong 9.4 \times 10^7$
TOTAL REPRODUCE TIME (AT 1 MEGABIT RATE) = 1.5 MIN

FILM DATA (EARTH RESOURCES) 8,000 FT/YR REQUIRES 24 MIN/DAY
TV DATA (HIGH RESOLUTION) 1,500 FR/DAY REQUIRED 17.5 MIN/DAY

MAJOR SYSTEM EQUIPMENT MATRIX

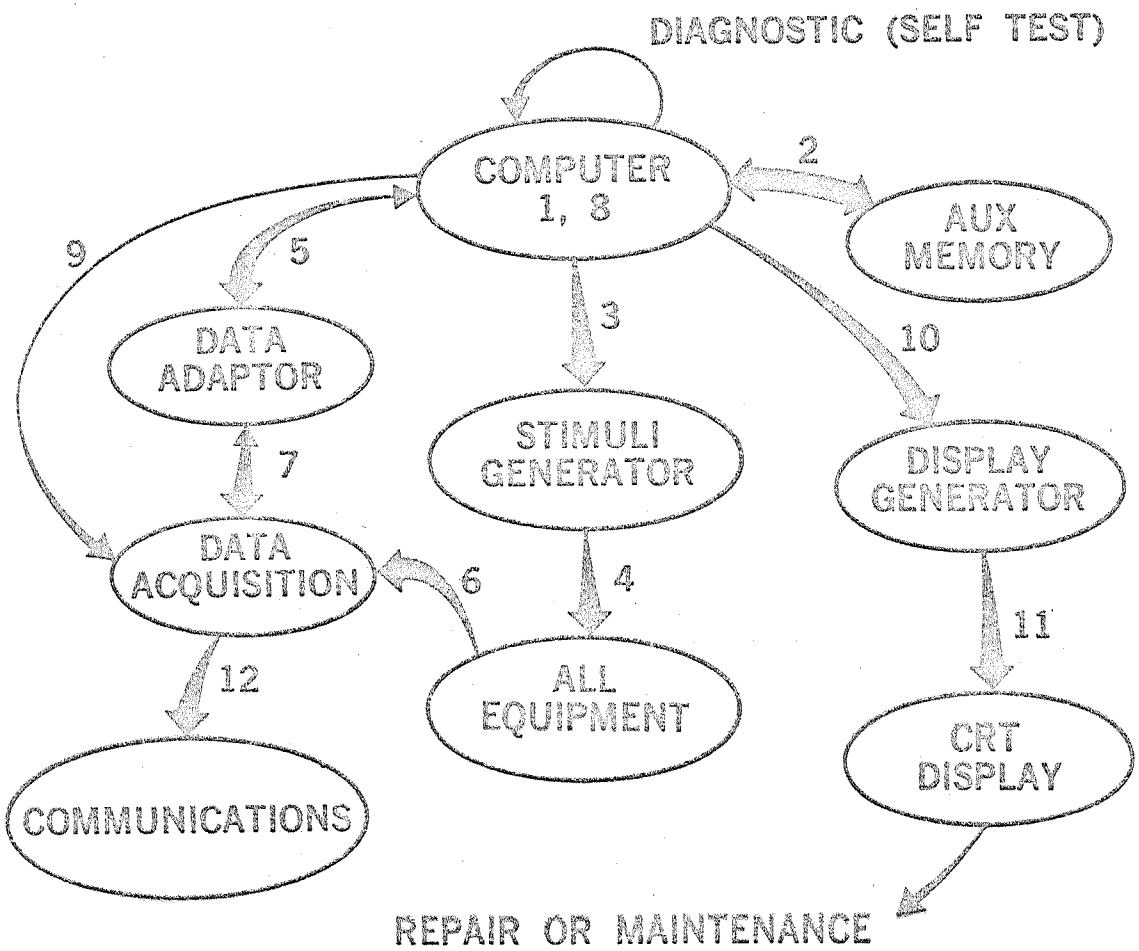
EQUIPMENT	REQUIREMENT	AVAILABLE EQUIPMENT				
		MOL	APOLLO	SATURN/ATM		GEMINI/ CLUSTER* A
RF COMMUNICATIONS	UNIFIED SYSTEM CARRIERS: UP – 2105 MHZ DWN. – 2272, 2287 MHZ 8W PER CARRIER	YES 1762-1842 2200-2300 3W	YES YES YES 10/2.5	NO VHF (N.A.)		NO VHF (N.A.)
PCM ASSY	FORMAT FLEXIBILITY RATE FLEXIBILITY REMOTE MULTIPLEXING	YES YES YES	NO NO NO	PARTIAL PARTIAL YES		NO NO YES
COMPUTER	24K WORD, RAPID ACCESS MEMORY 10 μSEC. ADD TIME AUX. MEMORY	16K TO 24K (32 BPW) 2.1 YES	18K (16 BPW) 23.4 PROTOTYPE ONLY	33K (28 BPW) 82 NONE	ATM SEE MOL	4K (39 BPW) 140 YES
DIGITAL RECORDER	OUTPUT BIT RATE $>1 \times 10$ BPS 6 CAPACITY $>1 \times 10$ BITS 8 DUAL SPEED RECORD	1.024 1.6×10^8 YES	 9.25×10^7 YES	7.2×10^4 UNKNOWN NO		1.13×10^5 7.4×10^8 BITS NO
TELEVISION	525 LINES PER FRAME 30 FRAMES/SEC	NONE	320 10	525 30		N.A.

* SEPARATE VHF S-IVB SYSTEM NOT INCLUDED.

SELECTION SYSTEM

M-46740

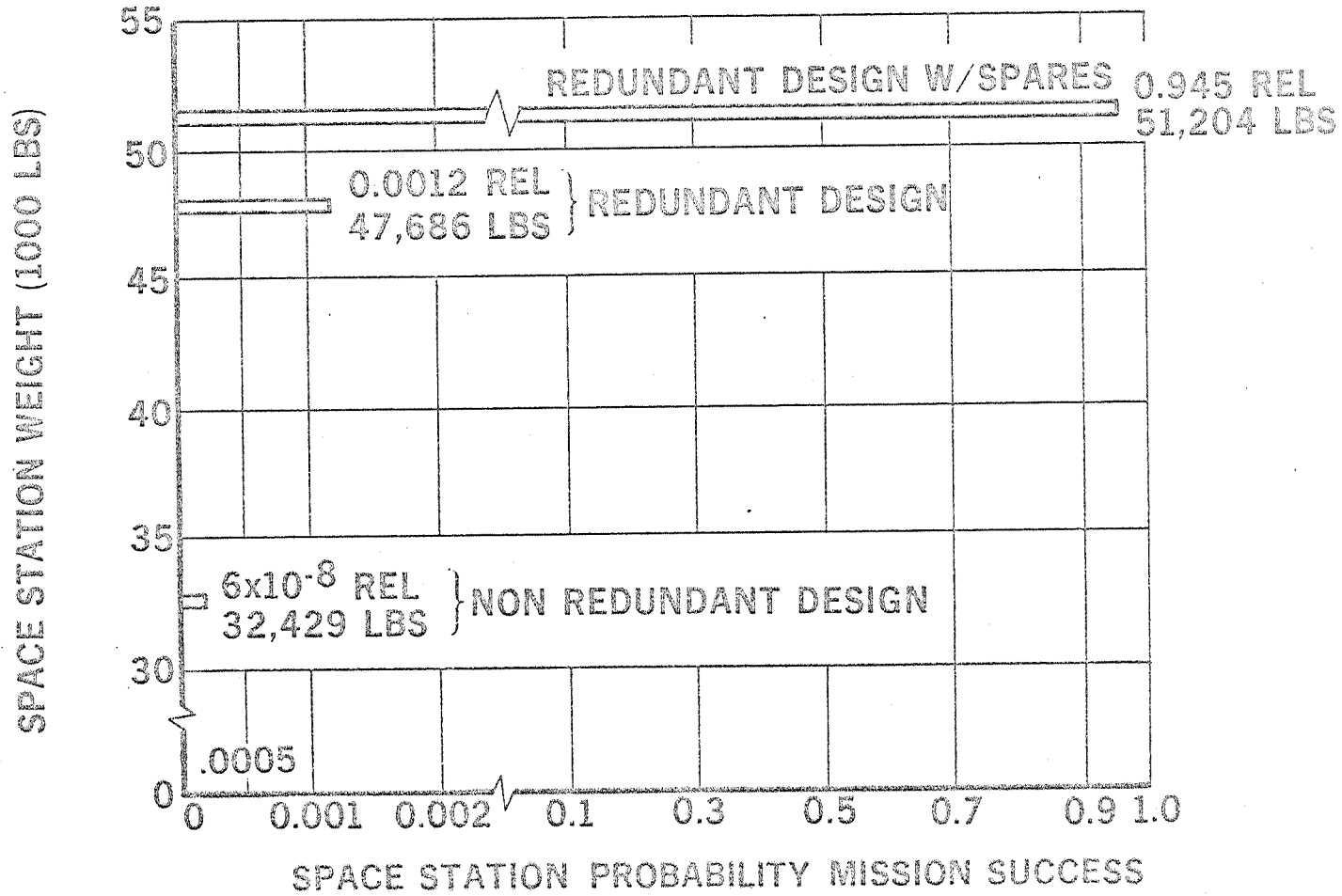
AUTOMATIC CHECKOUT SYSTEM



1. TIMER
2. LOAD PROGRAM
3. STIMULI TYPE & ADDRESS
4. VOLTAGE/CURRENT
5. MEASUREMENT ADDRESS
6. MEASUREMENT
7. DIGITAL DATA
8. COMPARE
9. CHANNEL CHECK
10. GENERATE DISPLAY
11. DISPLAY FAULT & SOLUTION
12. REQUIRES GROUND ASSIST

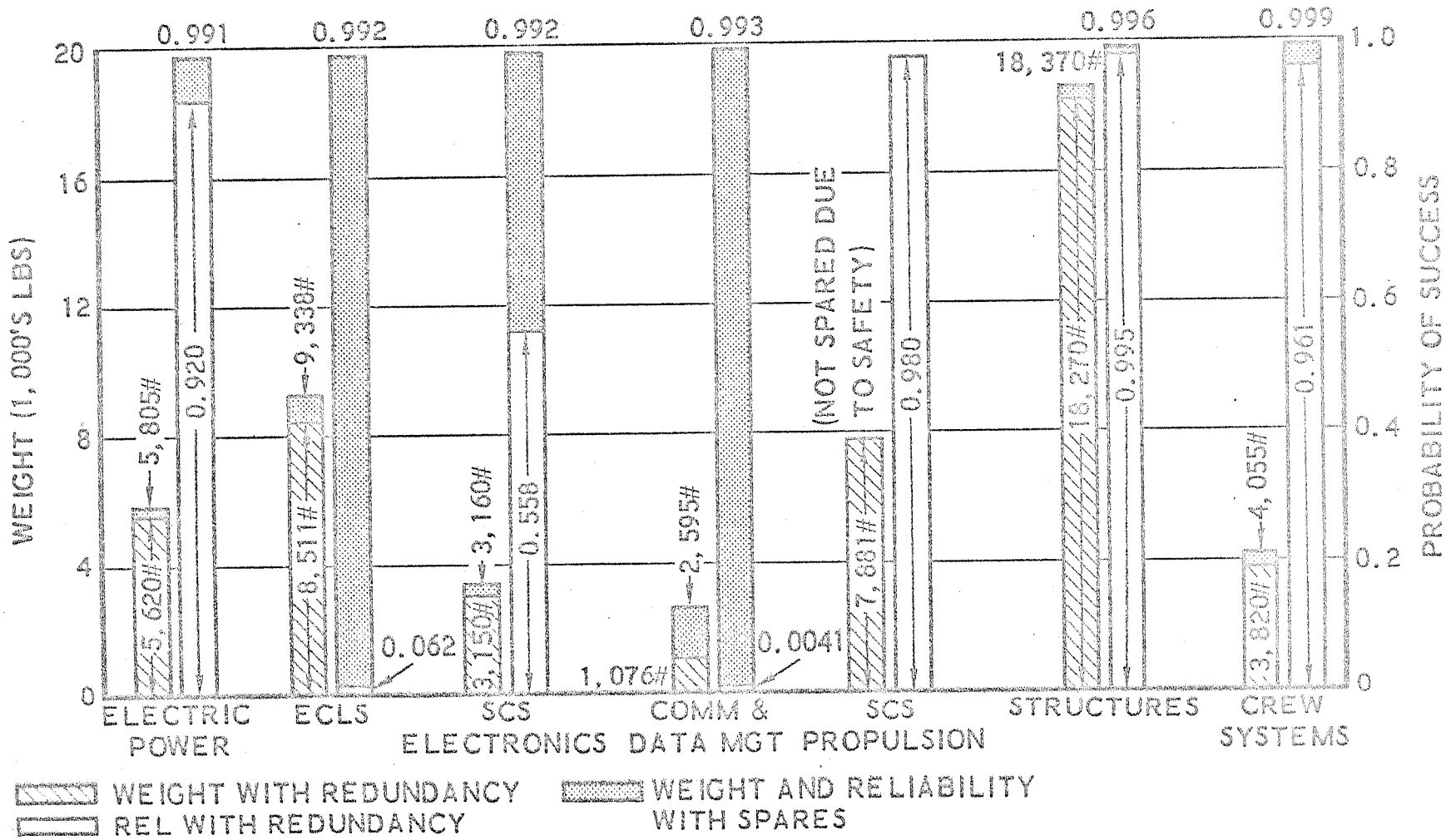
M-46860

SYSTEM ANALYSIS PROBABILITY OF SUCCESS
EOSS ONE YEAR MISSION



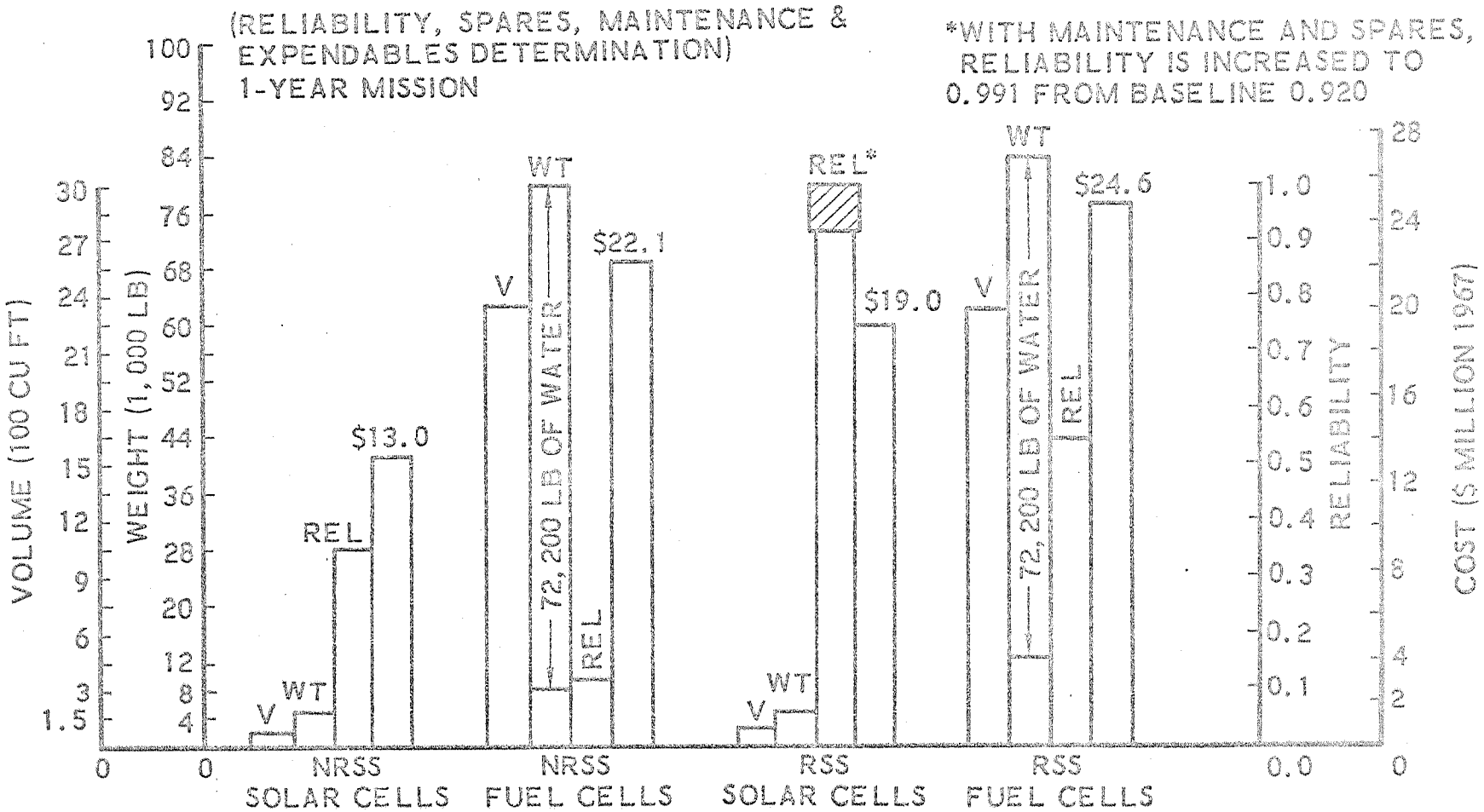
M-46861

SUBSYSTEM ANALYSIS PROBABILITY OF SUCCESS EOSS ONE YEAR MISSION



M-46862

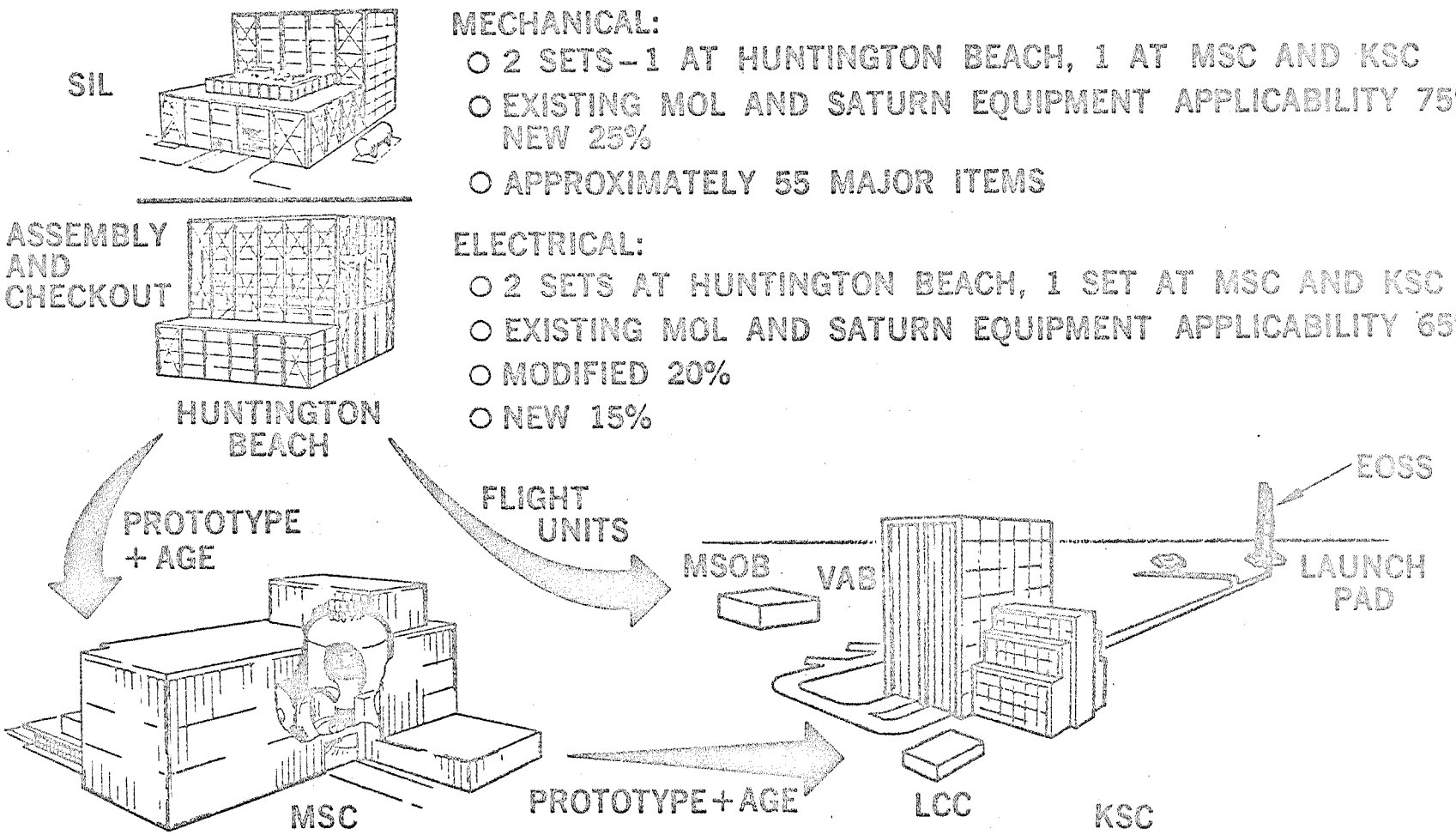
ELECTRIC POWER SUBSYSTEMS OPTIONS



THIS SECTION PRESENTED BY

FRITZ RUNGE
STUDY DIRECTOR

GROUND EQUIPMENT



MECHANICAL:

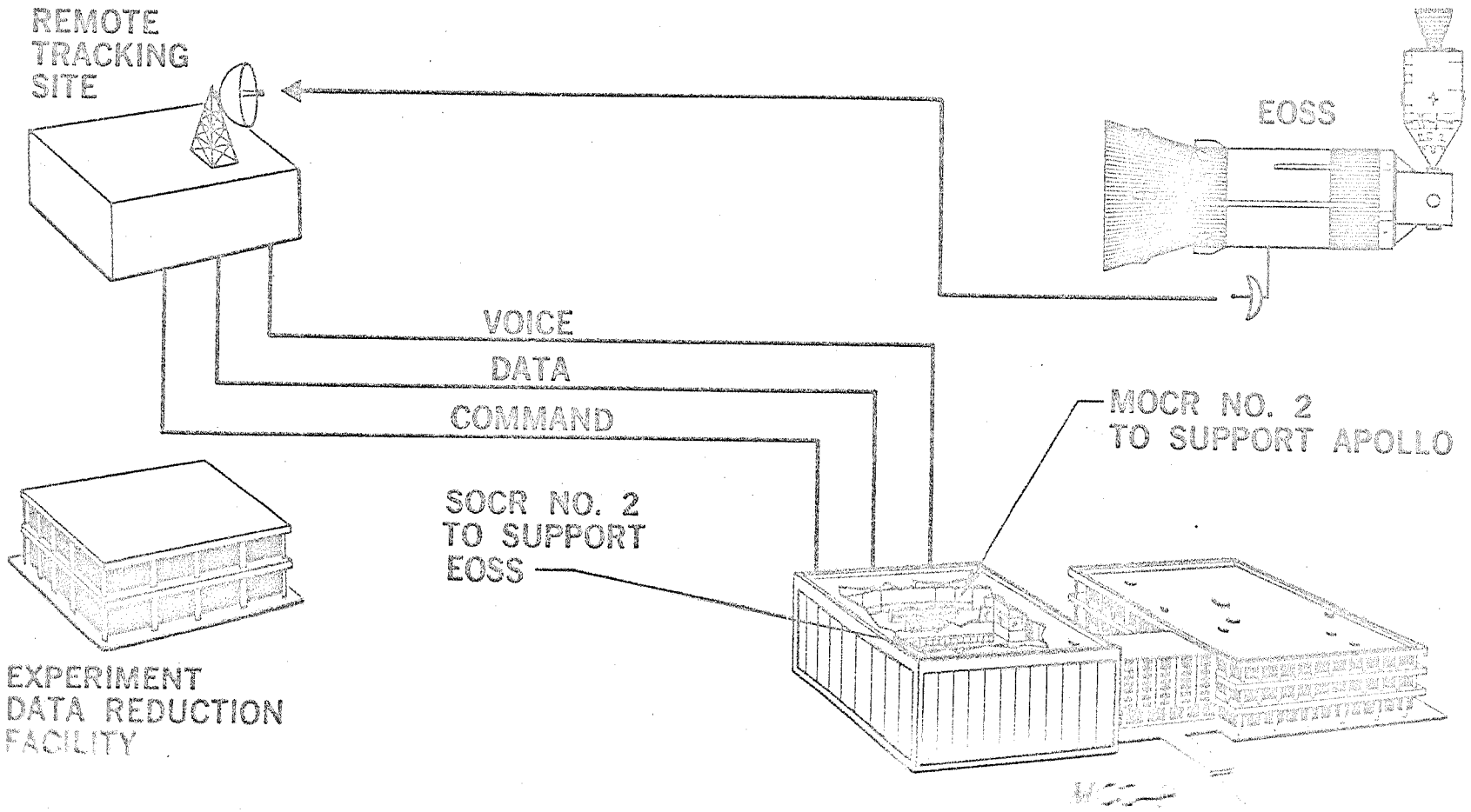
- 2 SETS – 1 AT HUNTINGTON BEACH, 1 AT MSC AND KSC
- EXISTING MOL AND SATURN EQUIPMENT APPLICABILITY 75% NEW 25%
- APPROXIMATELY 55 MAJOR ITEMS

ELECTRICAL:

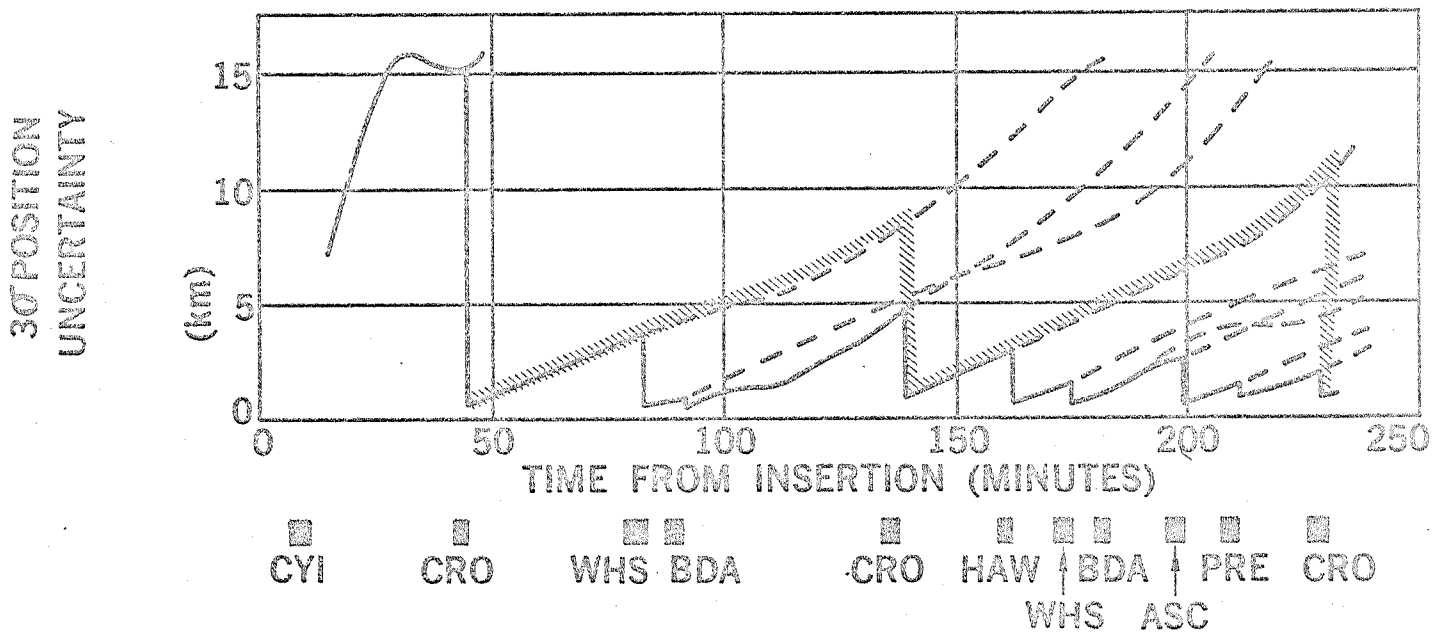
- 2 SETS AT HUNTINGTON BEACH, 1 SET AT MSC AND KSC
- EXISTING MOL AND SATURN EQUIPMENT APPLICABILITY 65%
- MODIFIED 20%
- NEW 15%

M-46604

MISSION CONTROL FACILITY REQUIREMENTS



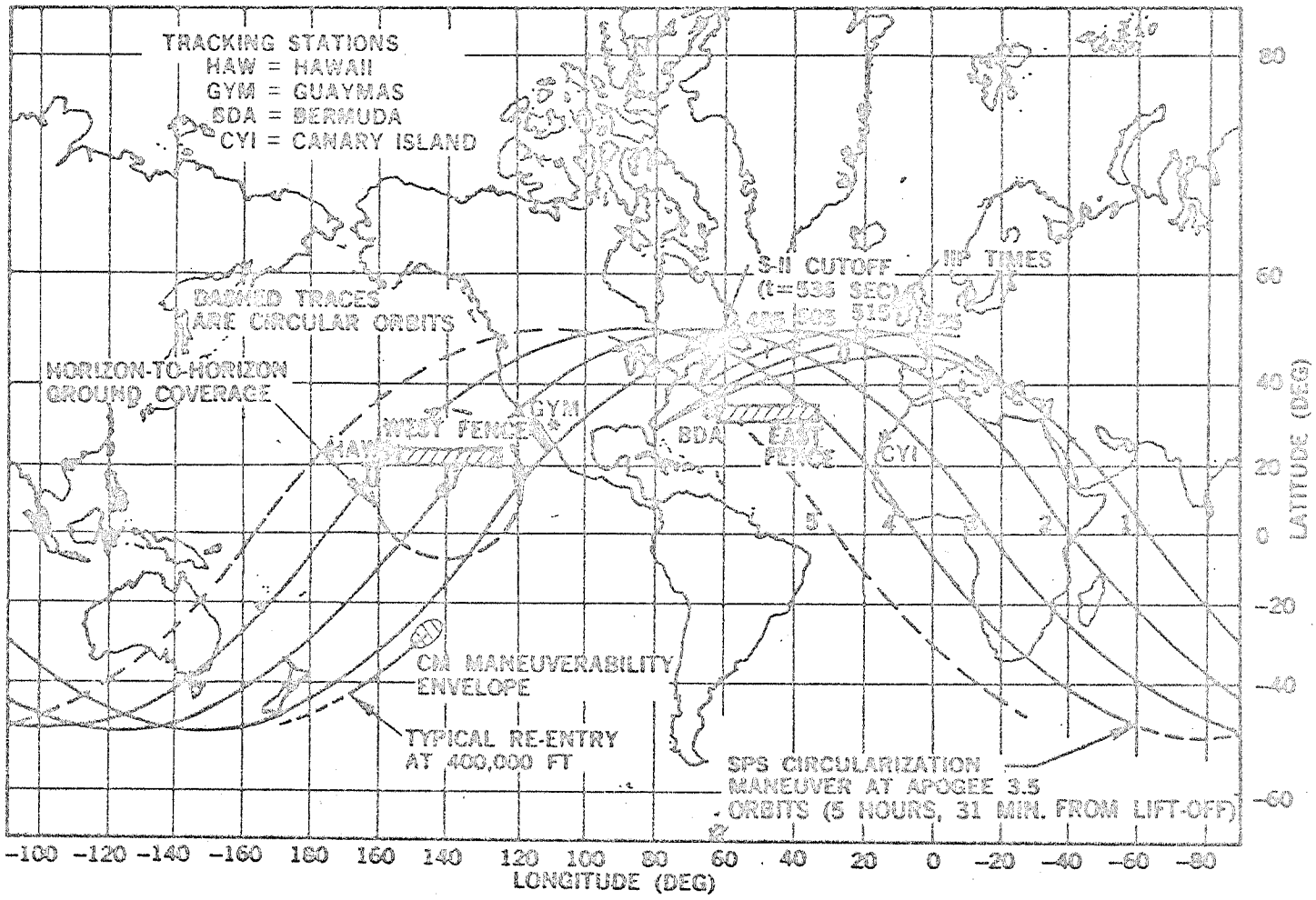
NAVIGATION SYSTEM ACCURACY



EXPERIMENT ACCURACY REQUIREMENTS

EXPERIMENT AREA	0 TO 1 nmi	1 TO 4 nmi	OVER 4 nmi
ASTRONOMY			X
ATMOSPHERIC SCIENCES			X
EARTH RESOURCES		X	
PHYSICAL SCIENCES		X	
COMM/NAV/TRAFFIC CONTROL	X	X	
ADV TECH & SUBSYSTEM DEVELOPMENT	X	X	

ORBIT TRACE AND COVERAGE AND RECOVERY ZONES



MAJOR CONCLUSIONS

- S-IVB STATION MODULE IS FEASIBLE IN 1972; BASED ON AAP AND MOL
- PROPERLY-SIZED EXPERIMENT PROGRAM MUST BE INITIATED EARLY
- SEPARABLE MODULES MAY BE DESIRED FOR ASTRONOMY AND BIOLAB
- S-IVB STATION MODULE:
  1. FULFILLS CRITICAL VOLUME AND HABITABILITY NEEDS
  2. ACCOMMODATES EXPERIMENT PACKAGE A, (BUT 73% OF PACKAGE A IS RECOMMENDED)