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BRIEFING TO PSAC BIOASTRONAUTICS PANEL

30 September 1966

by

S. M. Tennant

Attendees:

Dr. William Ross Adey,  
Dr. Loren Carlson, and  
Dr. Melvin Calvin of  
PSAC Medical Panel  
Jon Kirk, DDR&E  
Gen Evans  
Dr. Steininger  
Dr. Golivin

C: L. Olson, Aerospace  
Col A. I. Karstens, SL-10

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POSSIBLE UTILIZATION OF MOL HARDWARE  
FOR LONG DURATION BIOASTRONAUTICS TEST MISSIONS

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POTENTIAL APPROACHES FOR BIOASTRONAUTIC TESTING

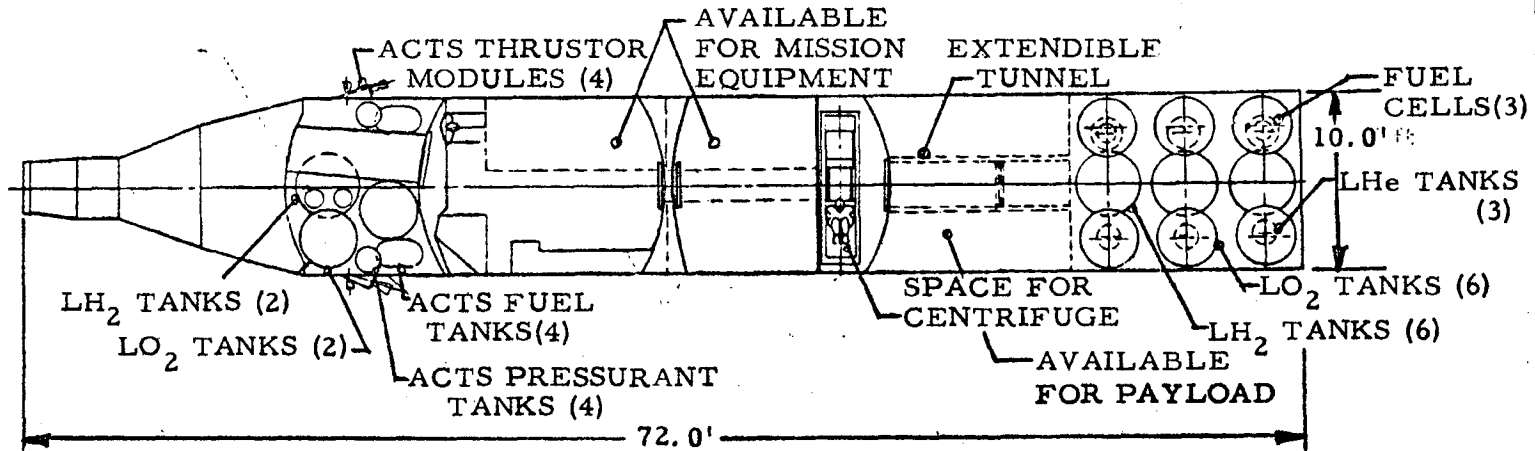
- 60 TO 90 DAY DURATION
  - ✓ INTEGRAL LAUNCH MODE - SINGLE OR DUAL COMPARTMENT MODULE
  
- DURATIONS EXCEEDING 90 DAYS
  - ✓ RENDEZVOUS MODE - 4 MAN DUAL COMPARTMENT LABORATORY CONFIGURATION
  
  - ✓ 2 MAN DUAL COMPARTMENT LABORATORY CONFIGURATION (COMBINED MISSION)

ETR

INTEGRAL LAUNCH DUAL COMPARTMENT LABORATORY

(CONFIGURATION AND PERFORMANCE)

o CONFIGURATION



o PERFORMANCE

TOTAL PRESSURIZED VOLUME (SHIRT SLEEVE ENVIRONMENT)	2,000 FT <sup>3</sup>
AVAILABLE PRESSURIZED VOLUME FOR CREW	1,200 FT <sup>3</sup>
AVAILABLE PRESSURIZED VOLUME FOR EXPERIMENT EQUIPMENT	600 FT <sup>3</sup>
AVAILABLE UNPRESSURIZED VOLUME FOR EXPERIMENT EQUIPMENT	~ 700 FT <sup>3</sup>
EXPERIMENT PAYLOAD CAPACITY (ETR, 1 = 28.5°, 180 N M CIR)	~ 5,900 LB
(WTR, 1 = 80°, 180 N M CIR)	~ 1,000 LB
ELECTRICAL POWER (AVERAGE)	1,650 WATTS*
MISSION DURATION	90 DAYS

\*INCLUDES 200 WATTS FOR EXPERIMENTS

APPROACH TO INTEGRAL LAUNCH EXTENDED DURATION

	<u>30 DAY</u> <u>MOL BASELINE</u> (80/180 N MI ORBIT, $i=80^\circ$ )	<u>90 DAY</u> <u>EXTENDED DURATION VEHICLE*</u> (180 N MI CIR. ORBIT, $i=80^\circ$ )
● <u>PROPULSION</u>		
PROPELLANTS	2,000 LBS	1,450 LBS
TANKAGE	4 FUEL + 4 OXID.	4 FUEL + 4 OXID.
● <u>PRIME POWER</u>	3 FUEL CELLS 1,650 WATTS	6 FUEL CELLS 1,650 WATTS
● <u>CRYOGENICS</u>		
ELUID ( $LO_2$ , $LH_2$ , $LH_e$ )	1,330 LBS	5,320 LBS
TANKAGE	2 $LO_2$ + 2 $LH_2$ + 1 $H_e$	8 $LO_2$ + 8 $LH_2$ + 4 $H_e$
● <u>PERSONNEL PROVISIONS</u>		
FOOD & PERSONAL GEAR	148 LBS	445 LBS
● <u>SUBSYSTEM SPARES</u>	160 LBS	410 LBS

\*DUAL COMPARTMENT LABORATORY

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MISSION DURATIONS EXCEEDING 90 DAYS

(RENDEZVOUS)

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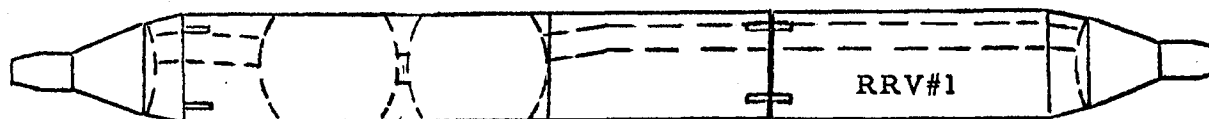
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4 MAN DUAL COMPARTMENT LABORATORY



- INITIAL LAUNCH CONFIGURATION (2 MAN OPS)



- FIRST RENDEZVOUS RESUPPLY (4 MAN OPS)



- ON-ORBIT CONFIGURATION (4 MAN OPS)

RRV FUNCTIONS

- ACTS PROPULSION
- PRIME ELECTRICAL POWER
- LIFE SUPPORT EXPENDABLES
- EXPERIMENTS
- SPARE EQUIPMENT

LABORATORY FUNCTIONS

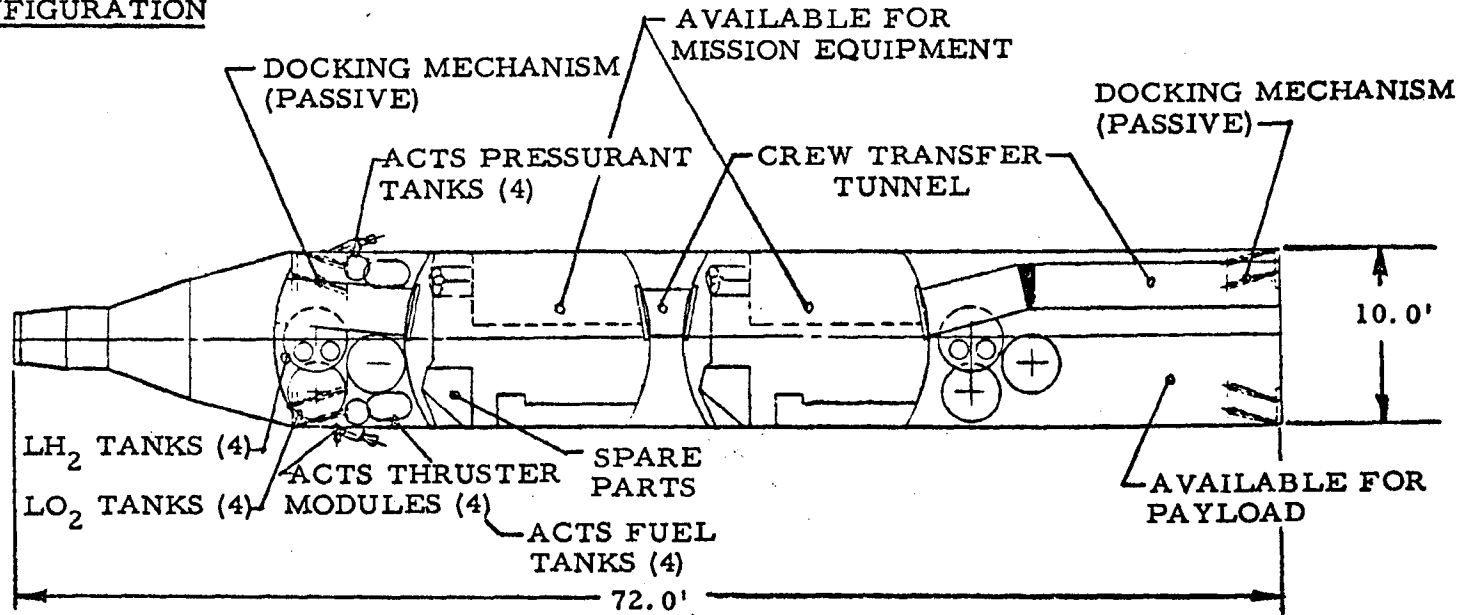
- LIFE SUPPORT/ENVIRONMENTAL CONTROL
- ACTS - REFERENCE
- COMMUNICATIONS/DATA
- BIO-MEDICAL EQUIPMENT
- EXPERIMENTS

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4 MAN DUAL COMPARTMENT LABORATORY

(CONFIGURATION AND PERFORMANCE)

o CONFIGURATION



o PERFORMANCE

TOTAL PRESSURIZED VOLUME (SHIRT SLEEVE ENVIRONMENT)	2,000 FT <sup>3</sup>
AVAILABLE PRESSURIZED VOLUME FOR CREW	1,200 FT <sup>3</sup>
AVAILABLE PRESSURIZED VOLUME FOR EXPERIMENT EQUIPMENT	600 FT <sup>3</sup>
AVAILABLE UNPRESSURIZED VOLUME FOR EXPERIMENT EQUIPMENT	950 FT <sup>3</sup>
EXPERIMENT PAYLOAD CAPACITY (WTR, i = 80°, 180 N M CIR)	5,700 LBS
ELECTRICAL POWER (AVERAGE)	2,000 WATTS*
RESUPPLY CYCLE	60 DAYS

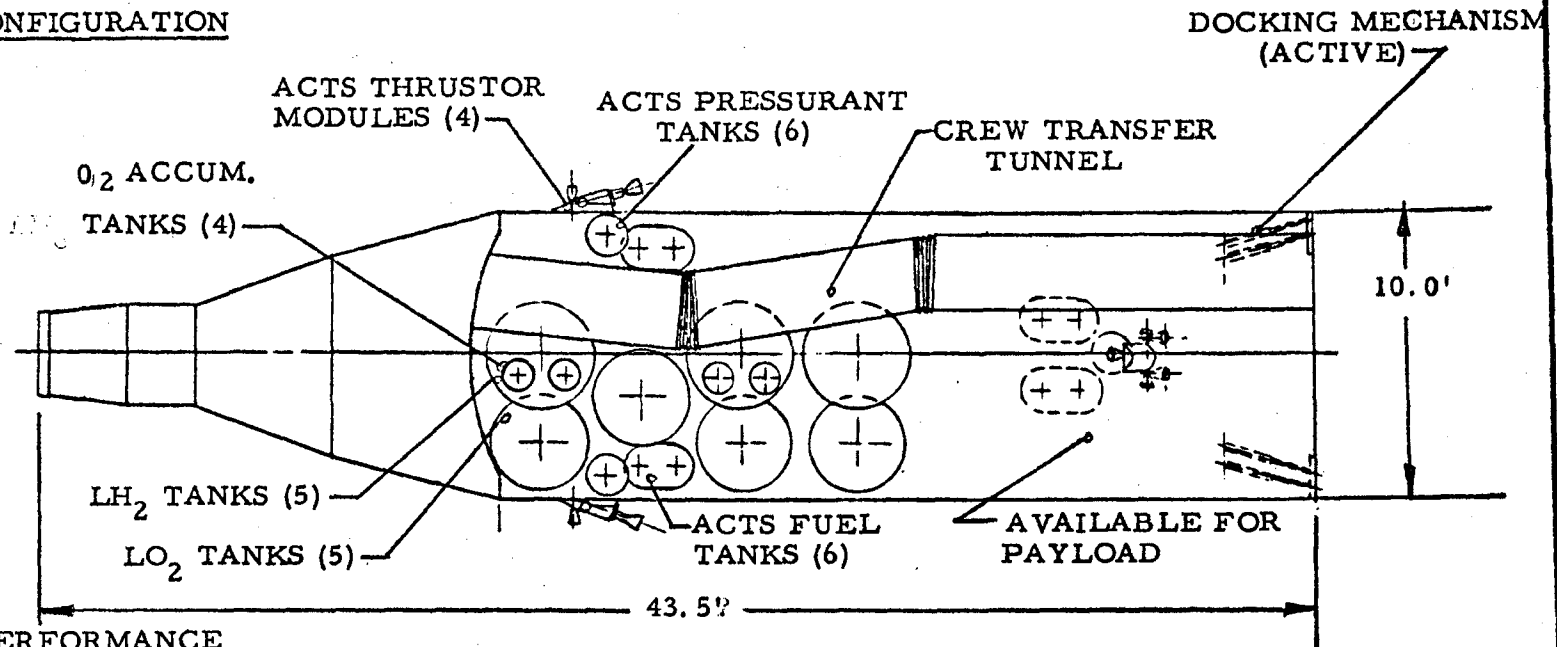
\* 200 WATTS AVAILABLE FOR EXPERIMENTS



RENDEZVOUS RESUPPLY VEHICLE

(CONFIGURATION AND PERFORMANCE)

o CONFIGURATION



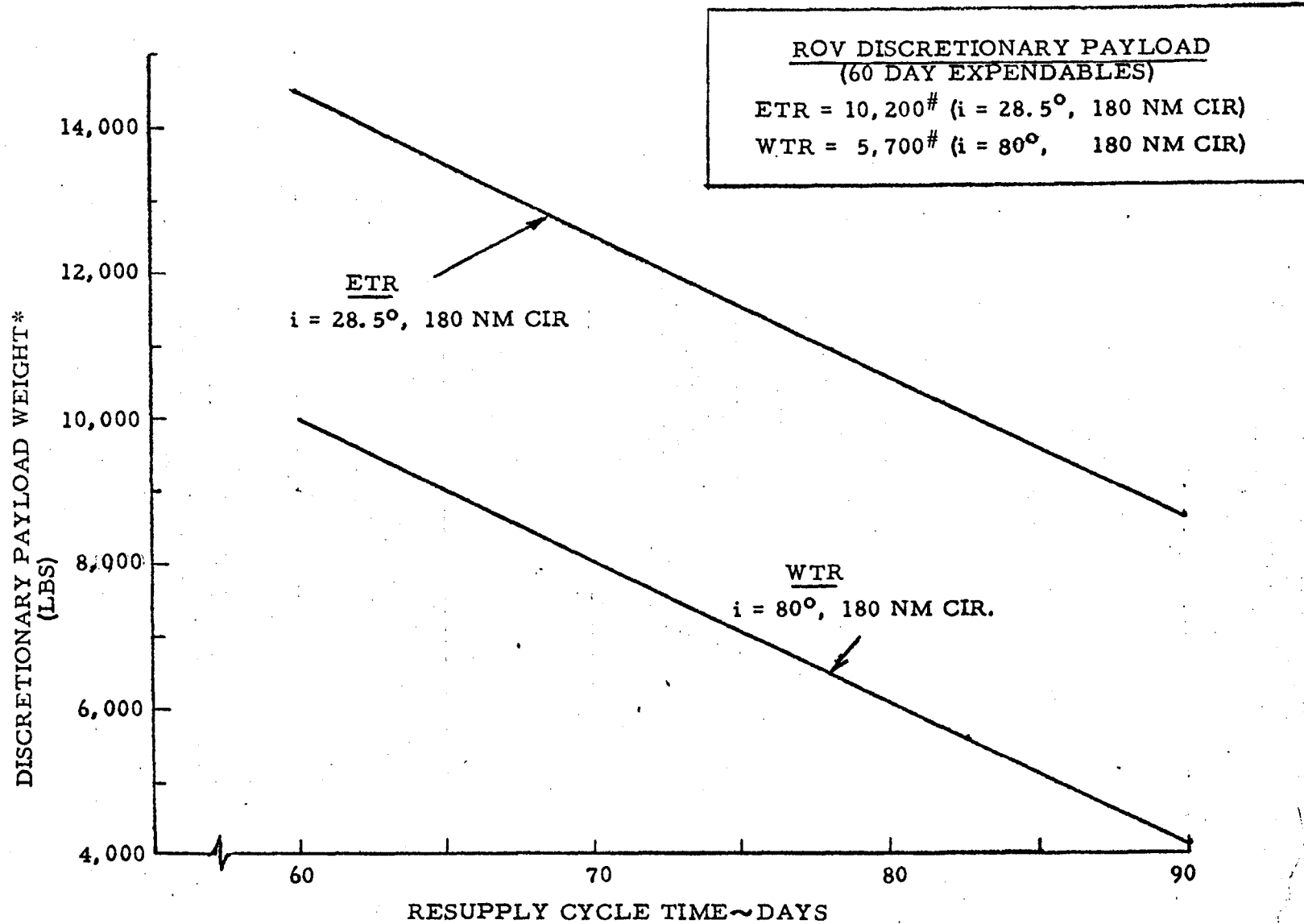
o PERFORMANCE

UNPRESSURIZED VOLUME FOR EXPERIMENT EQUIPMENT	2,000 FT <sup>3</sup>
EXPERIMENT PAYLOAD CAPACITY (WTR, $i = 80^\circ$ , 180°N M CIR)	10,000 LBS
ELECTRICAL POWER (AVERAGE)	2,000 WATTS*
RESUPPLY CYCLE (TO SUPPLY 4 MAN CREW)	60 DAYS

\*200 WATTS AVAILABLE FOR EXPERIMENTS

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RESUPPLY VEHICLE DISCRETIONARY PAYLOAD



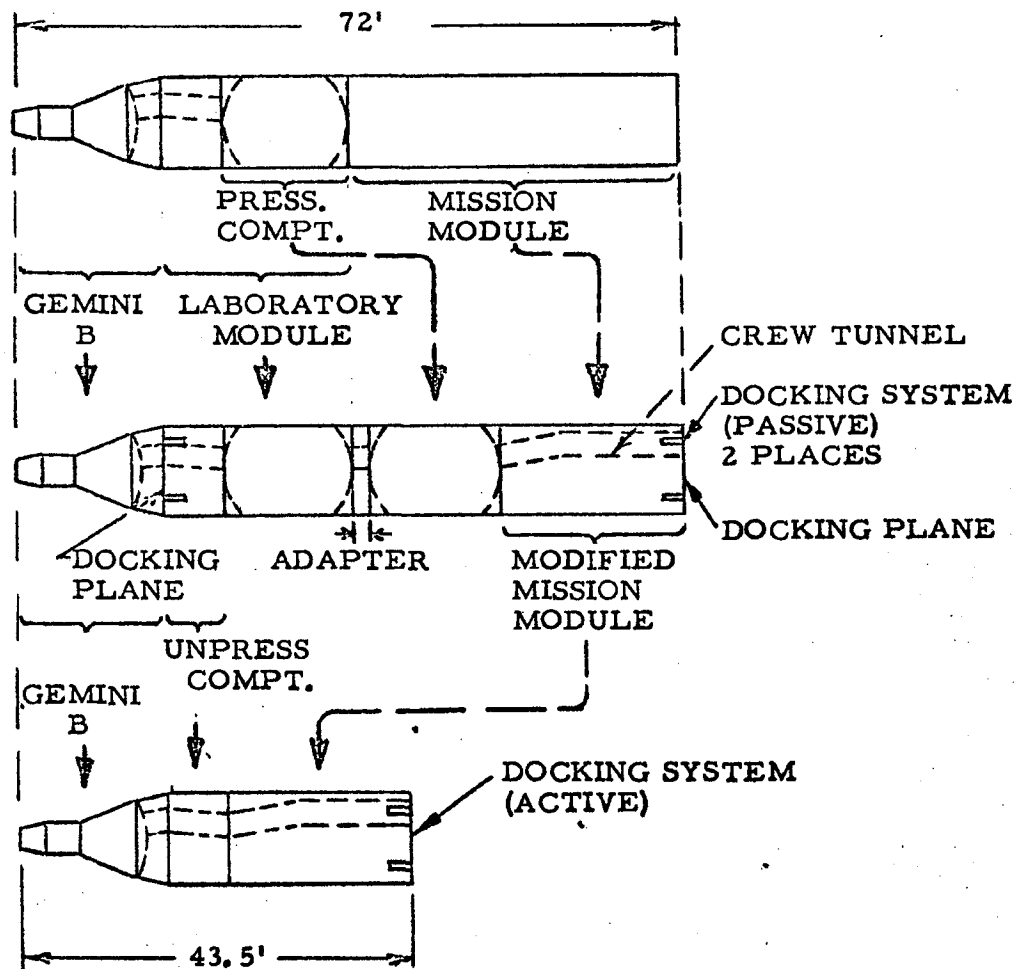
\*DISCRETIONARY PAYLOAD = BOOSTER CAPABILITY LESS WEIGHT OF LOADED RRV

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UTILIZATION OF MOL HARDWARE FOR  
4 MAN DUAL COMPARTMENT LABORATORY CONFIGURATION

○ MOL BASELINE VEHICLE

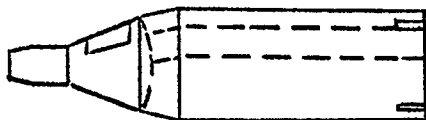
○ RENDEZVOUS INITIAL VEHICLE  
(RDV)

○ RENDEZVOUS RESUPPLY VEHICLE  
(RRV)



2 MAN DUAL COMPARTMENT LABORATORY CONFIGURATION

(COMBINED MISSION)



RENDEZVOUS  
RESUPPLY VEHICLE  
(RRV)



INITIAL LAUNCH RENDEZVOUS  
LABORATORY VEHICLE (RIV)

POSSIBLE CREW  
TRANSFER FROM  
SUBSEQUENT RRV'S



RENDEZVOUS ORBITING VEHICLE  
(ROV)

RRV FUNCTIONS

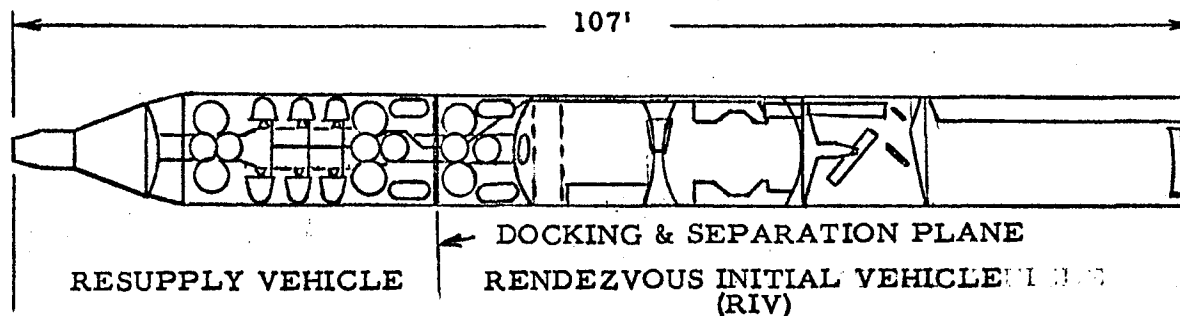
- CREW TRANSPORT VEHICLE
- ACTS PROPULSION
- PRIME POWER
- LIFE SUPPORT EXPENDABLES
- DATA RETURN SYSTEM
- SUBSYSTEM SPARES/REPLACEMENTS

RIV FUNCTIONS

- LIFE SUPPORT SYSTEM
- ATTITUDE CONTROL REF. ELECTRONICS
- COMMUNICATIONS AND DATA HANDLING
- ENVIRONMENTAL CONTROL
- PERFORMANCE DATA

2 MAN DUAL COMPARTMENT LABORATORY  
CONFIGURATION AND PERFORMANCE SUMMARY  
(COMBINED MISSION)

● CONFIGURATION



● PERFORMANCE DATA

TOTAL PRESSURIZED VOLUME (SHIRT SLEEVE ENVIRONMENT)	2,060 FT <sup>3</sup>
AVAILABLE PRESSURIZED VOLUME FOR CREW	1,200 FT <sup>3</sup>
AVAILABLE PRESSURIZED VOLUME FOR EXPERIMENT EQUIPMENT	210 FT <sup>3</sup>
R. I. V. EXP. PAYLOAD CAPACITY ( $i = 96.4^\circ$ , 80/180 NM)	3,000 LBS
ELECTRICAL POWER (AVERAGE)	1,950 WATTS
RESUPPLY CYCLE	60 DAYS

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COMBINED MISSION OPERATIONS  
TYPICAL WORKCYCLE FOR A NORMAL DAY

SUBCYCLE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
P/L ACTIVITY AREAS				▨	▨	▨	▨	▨	▨	▨	▨			▨	Z1	Z1
CREW REQ'D FOR P/L OPS				2	2	2	2	2	2	2	2			1		
READOUT						X								X		
CREW #1	REST/SLEEP			PAYLOAD OPERATIONS												
CREW #2	PAYLOAD OPERATIONS										REST/SLEEP					
DAILY SEQUENCE LOAD			↑													
UPDATE EPHEMERIS (+ WEATHER, PROGRAMMING CHANGES?)			▲	▲	▲	▲	▲	▲	▲	▲						
POSSIBLE TIMES AVAILABLE FOR CREW TESTING AND VEHICLE HOUSEKEEPING																
CREW #1				▨	▨	▨					▨					
CREW #2	▨			▨	▨	▨										▨

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POTENTIAL BIOASTRONAUTICS TEST PROGRAMS

4 MAN - DUAL COMPARTMENT LAB

<u>LAUNCH</u>	<u>DURATION</u> <u>(MONTHS)</u>	<u>ON-ORBIT</u>	<u>TEST DATA</u>
1 & 2	2	2, 2, 2, 0	2
3	4	4, 4, 0, 2	4
4	6	6, 0, 2, 4	6
5	8	8, 2, 4, 6	-
6	10	10, 4, 6, 8	-
7	12	12, 4, 8, 10	12, 6, 8, 10

TEST DATA TOTALS

1 MAN X 2 MO.  
1 MAN X 4 MO.  
2 MEN X 6 MO.  
1 MAN X 8 MO.  
1 MAN X 10 MO.  
1 MAN X 12 MO.

2 MAN - DUAL COMPARTMENT LAB

<u>LAUNCH</u>	<u>DURATION</u> <u>(MONTHS)</u>	<u>ON-ORBIT</u>	<u>TEST DATA</u>
1 & 2	2	2, 0	2
3	4	0, 2	4
4	6	0, 4	2
5	8	2, 0	6
6	10	4, 0	2
7	12	6, 2	-
8 & 9	14	0, 2	8
10	16	0, 4	2
11	18	2, 6	-
12	20	0, 10	4
13	22	2, 12	2, 12

TEST DATA TOTALS

5 MEN X 2 MO.  
2 MEN X 4 MO.  
1 MAN X 6 MO.  
1 MAN X 8 MO.  
1 MAN X 12 MO.

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COST RANGE SUMMARY - WTR  
INCREMENTS ABOVE MOL BASELINE\*

<u>PROGRAM</u>	<u>NONRECURRING COST, M\$</u>	<u>RECURRING COST, M\$</u>	<u>TOTAL** COST, M\$</u>
● 60 TO 90 DAY BIOASTRONAUTICS TESTING			
● 2 MAN - DUAL COMPARTMENT LAB (INTEGRAL LAUNCH)	285	332	617
● 1 YEAR BIOASTRONAUTICS TESTING			
● 1 YEAR PROGRAM	515	466	981
4 MAN - DUAL COMPARTMENT LAB (INTEGRAL LAUNCH)			
● 2 YEAR COMBINED MISSION PROGRAM	299	97	396
2 MAN - DUAL COMPARTMENT LAB (RENDEZVOUS)			

\* 2 MANNED AND 3 UNMANNED LAUNCHES PER YEAR ASSUMED FOR BASELINE  
FOLLOW-ON PROGRAM

\*\* NOT INCLUDING NASA PAYLOAD ELEMENTS

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AVAILABILITY OF ALTERNATE SYSTEMS-WTR

MONTH FROM  
PH II ATP

21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57
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MOL BASELINE (REFERENCE)

△    △    ▲    ▲    ▲    □    □

LAUNCH FACILITIES ACTIVATION

VEH. ENGG. DESIGN / QUAL. TESTING

1<sup>st</sup> M/AM    FAB    ASSY    INSTL & d/b  
1<sup>st</sup> AM    FAB    ASSY    I & C/O

INTEGRAL LAUNCH-DUAL COMPARTMENT LAB (90 DAYS)

DES. MOD/TEST DES. / TEST

1<sup>st</sup> NASA FLT VEH. FAB    ASSY    I & C/O

▲ LAUNCH

ADD'L LAUNCH FACIL CONSTR. / ACTIVATION

4-MAN DUAL COMPARTMENT LAB (RENDEZVOUS)

DES. MOD/TEST DESIGN / TEST

ADD'L LAUNCH FACIL'S CONSTR. / ACTIVATION

RRV UNMANNED FLT. TEST FAB    ASSY    I & C/O

UNMANNED  
LAUNCH

1<sup>st</sup> MANNED RRV FAB    ASSY    I & C/O

◆ LAUNCH

1<sup>st</sup> MANNED RIV FAB    ASSY    I & C/O

RIV

▲ LAUNCH

DOD 2-MAN DUAL COMPARTMENT LAB (COMBINED MISSION - RENDEZVOUS)

DESIGN MOD/TEST DESIGN / TEST

ADD'L LAUNCH FACIL CONSTR. / ACTIVATION

RRV UNMANNED FLT. TEST FAB    ASSY    I & C/O

UNMANNED  
LAUNCH

1<sup>st</sup> MANNED RRV FAB    ASSY    I & C/O

LAUNCH  
RIV  
RRV

1<sup>st</sup> MANNED RIV FAB    ASSY    I & C/O

◆

▲

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MONTH

21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56
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CONCLUSION

- TEST DURATIONS UP TO 90 DAYS APPEAR POSSIBLE WITH  
MOL INTEGRALLAUNCH APPROACH
- MOL RENDEZVOUS APPROACHES PROVIDE FLEXIBILITY  
FOR LONGER DURATION TESTING
- COMBINED MISSION APPROACH APPEARS PROMISING  
BASED ON PRELIMINARY ANALYSIS

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CONCEPT OF LONG DURATION SYSTEM LIFE

- COMPLETE REPLACEMENT
  - / FUEL CELLS
  - / CRYOGENIC TANKAGE
  - / THRUST CHAMBER ASSY.
  - / PROPELLENT TANKS/FUEL SYSTEMS
- INTENSE APPLICATION OF SPARES FOR MANNED MAINTENANCE/  
REPAIRS/REPLACEMENT
- UTILIZATION OF MAN IN TROUBLE-SHOOTER ROLE
- ELIMINATION OF MAJOR EQUIPMENT PROBLEMS DURING INITIAL  
MOL DEVELOPMENT PROGRAM

RELIABILITY CONSIDERATIONS

INITIAL LAUNCH VEHICLE (RIV)	60 DAY PROBABILITY OF SUCCESS (NONREPAIRABLE FAILURES)	=	.97
	60 DAY PROBABILITY OF SUCCESS FOR REPAIRABLE FAILURES	=	.99
LAUNCH VEHICLE PROBABILITY		=	.97
RESUPPLY VEHICLE (RRV) - 60 DAY PROBABILITY OF SUCCESS		=	.98
PROBABILITY OF SUCCESSFUL DOCKING		=	.995
PROBABILITY OF ONE RIV GOING 360 DAYS		=	.53
PROBABILITY OF TWO RIVS GOING 360 DAYS		=	.91
PROBABILITY OF SUCCESSFUL 360 DAY PROGRAM*		=	.86

\*ASSUMES 2 RIVS AND 7 RRV'S

APPLICATION OF BASELINE COMPONENTS FOR 2 MAN  
DUAL COMPARTMENT LABORATORY  
(COMBINED MISSION)

AUTOMATIC MODE VEHICLE (AMV)

