BELLCOMM, INC.

SUBJECT: Coupled vs. Decoupled LM/ATM Mission Concepts: System Configuration Aspects - Case 620

DATE: February 14, 1968

FROM: R. K. McFarland

MEMORANDUM FOR FILE

A review of "Coupled vs. Decoupled LM/ATM Mission Concept: System Configuration Aspects" was presented by the author at the Apollo Application Program Review, NASA Headquarters on January 27, 1968. This review summarized the system configuration aspects of operating the LM/ATM independently of the OWS. Copies of the vu-graphs used in the presentation are attached.

R. K. McFarland

1022-RKM-mm

Attachments

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(NASA-CR-95424) COUPLED VS. DECOUPLED LM/ATM MISSION CONCEPTS SYSTEM CONFIGURATION ASPECTS (Bellcomm, Inc.) 13 p
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Unclas
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RECEIVED NASA STI FACILITY INPUT BRANCH

COUPLED VS. DECOUPLED LM/ATM MISSION CONCEPTS
SYSTEM CONFIGURATION ASPECTS

CSM

- LM/ATM COUPLED MISSION CONFIGURATION
- LM/ATM DECOUPLED MISSION CONFIGURATION
- 56-DAY OWS MISSION CONFIGURATION

OWS

- ATTITUDE CONTROL IMPACT

LM/ATM

- COUPLED MISSION CONFIGURATION
- DECOUPLED MISSION CONFIGURATION
    - SINGLE MISSION
    - STORAGE AND REUSE MISSION

IMPACT ON CSM CONFIGURATION FOR LM/ATM COUPLED MISSION

SUBSYSTEM

G&C: COMPUTER COUPLING BETWEEN CM AND LM-A. RCS LOGIC FOR Y AND Z TRANSLATION AND SUPRESSION OF INBOARD JETS.

PROPULSION: IMPACT DETERMINED BY COMPARING PROPULSION REQUIREMENTS OF CSM-LM/ATM-OWS MISSION TO CSM-OWS MISSION.

ASSUMPTIONS:

- CSM LIFT-OFF WEIGHT = 36,000 LBS.
- RCS CAPACITY = 3678 LBS.
- 2 X RSS OF 1σ VALUES INCLUDED
- GAGING ERRORS OF 6% RCS AND 1% SPS
- CONTINGENCY OF 10% SPS RENDEZVOUS AND 15% RCS
- EQUIPERIOD MANEUVER INCLUDED IN COUPLED MISSION

	ASCENT & RDVZ		DE-ORBIT		BACKUP DE-ORBIT		TOTAL		COMPARATIVE
	SPS	RCS	SPS	RCS	RCS	SOLID	SPS	RCS	TOTAL WTS.
CSM LM/ATM-OWS	2490	2540	1149	226	-	1271	3639	2766	7676
CSM-OWS	1753	1132	1149	226	1246	-	2902	2604	5506
								Δ WEIGHT	2170 LBS.

AAP-3 CSM WEIGHT SUMMARY

AAP WEIGHT AND PERFORMANCE REPORT, DEC. 6, 1967

CM:	EMPTY (SOLID RETRO)		13041	
	NON-EXPENDABLE LOAD		1809	
	CREW SYSTEMS (56 DAYS)	1457		
	RCS RESIDUAL	45		
	ECS (28 DAY LIOH)	307		
	EXPENDABLE LOAD		301	
	RCS	225		
	ECS	76		
	TOTAL CM			15151
SM:	EMPTY (1 N_2, 3 O_2, 3 H_2)		11008	
	NON-EXPENDABLE LOAD		839	
	SPS RESIDUAL	562		
	RCS RESIDUAL	208		
	CRYO RESIDUAL	69		
	EXPENDABLE LOAD		10638	
	SPS	3887		
	RCS	3678		
	O_2	2392		
	H_2	225		
	N_2	456		
	TOTAL SM			22485
	TOTAL CSM			37636 LBS.
	SLA + L.V. MODS			3915
	TOTAL			41551 LBS.

IMPACT ON CSM CONFIGURATION FOR LM/ATM DECOUPLED MISSION

ASSUMPTIONS

NO REUSE OF LM/ATM
180 NM CIRCULAR ORBIT (90 DAY ORBIT LIFE)
ALL CRYOGENICS ON CSM
1200 WATTS PROVIDED TO THE CSM FROM THE ATM EPS. (3000 WATT CSM REQUIREMENT)
70 DAY MISSION
4 EVA'S

CM:	EMPTY (NO SOLID RETRO)		11770	
	NON-EXPENDABLE LOAD		1606	
	CREW SYSTEM (14 DAYS)	1380		
	RCS RESIDUALS	45		
	ECS (14 DAY LIOH)	181		
	EXPENDABLE LOAD		301	
	RCS	225		
	ECS	76		
	TOTAL CM			13677
SM:	EMPTY (1 N_2, 3 O_2, 4 H_2)		11325	
	NON-EXPENDABLE LOAD		842	
	SPS RESIDUAL	562		
	RCS RESIDUAL	208		
	CRYO RESIDUAL	72		
	EXPENDABLE LOAD		8975	
	SPS	2150		
	RCS* (INCLUDE DE-ORBIT)	2700		
	O_2	3600		
	H_2	300		
	N_2	225		
	TOTAL SM			21142
	TOTAL CSM			34819
	SLA + L.V. MODS			3915
	TOTAL			38734 LBS.
	L.V. CAPABILITY (81 x 120 NM)			40200
	MARGIN			1466 LBS.

*ASSUMES GRAVITY-GRADIENT MOMENTUM DUMP FOR ATM ACS.
RCS MOMENTUM DUMP REQUIRES ADDITIONAL 365 LBS PROPELLANT.

IMPACT ON CSM CONFIGURATION FOR LM/ATM DECOUPLED MISSION

ASSUMPTIONS

- REUSE OF LM/ATM
  - 220 NM CIRCULAR ORBIT (350 DAY ORBIT LIFE)
- ALL CRYOGENICS ON CSM
- 1200 WATTS PROVIDED TO THE CSM FROM THE ATM EPS
- 70-DAY MISSION

CSM PERFORMANCE

SPS ΔW =	760
RCS ΔW =	70
	830 LBS.
MARGIN	638 LBS.

IMPACT ON CSM FOR OWS DECOUPLED MISSION

ASSUMPTIONS

230 NM ORBIT
ALL CRYOGENICS ON CSM
900 WATTS PROVIDED TO THE CSM FROM THE OWS EPS
(2700 WATT CSM REQUIREMENT)
56-DAY MISSION
4 EVA'S

CM:	EMPTY (NO SOLID RETRO)		11770	
	NON-EXPENDABLE LOAD		1809	
	CREW SYSTEMS (56 DAYS)	1457		
	RCS RESIDUAL	45		
	ECS (28 DAY LIOH)	307		
	EXPENDABLE LOAD		301	
	RCS	225		
	ECS	76		
	TOTAL CM			13880
SM:	EMPTY (1 N_2, 3 O_2, 3 H_2)		11008	
	NON-EXPENDABLE LOAD		842	
	SPS RESIDUAL	562		
	RCS RESIDUAL	208		
	CRYO RESIDUAL	72		
	EXPENDABLE LOAD		9571	
	SPS	2902		
	RCS*	2604		
	O_2	3412		
	H_2	225		
	N_2	428		
	TOTAL SM			21421
TOTAL CSM				35301
SLA + L.V. MODS				3915
TOTAL				39216 LBS.
L.V. CAPABILITY (81 x 120)				40200
	MARGIN			984 LBS.

*NO PROVISION FOR EXPERIMENT REQUIREMENTS.

IMPACT ON OWS FOR DECOUPLED MISSION

ASSUMPTIONS

ATTITUDE CONTROL REQUIREMENTS ONLY AFFECTED BY DECOUPLING

OWS WILL BE EQUIPPED WITH AACS SYSTEM OR CMG SYSTEM

56-DAY MISSION

	Δ PROPELLANT FOR AACS SYSTEM	Δ PROPELLANT FOR CMG SYSTEM
1 CSM MISS DOCK	31.0	31.0
POP MODE, 56 DAYS	473.2	-
INERTIAL MODE, 56 DAYS	-	0.0
UNDOCK CSM, ACQUIRE AND MAINTAIN L.V., 3-MONTH STORAGE	7.4	.4
TOTAL PROPELLANT, LBS.	511.6	31.4

AACS TANKER MODULE: 400

LBS. STRUCTURE, 230 LBS. PROPELLANT

IMPACT ON LM-A CONFIGURATION FOR COUPLED MISSION

SUBSYSTEM

G&C: COMPUTER COUPLING BETWEEN CM AND LM-A. RCS LOGIC FOR Y AND Z TRANSLATION AND INBOARD JETS.

PROPULSION: ADDITIONAL RCS SHIPSET REQUIRED

STRUCTURE	185
PROPELLANT	445
	630 LBS.

EPS: PRIMARY BATTERIES TO PROVIDE SUPPLEMENTARY POWER DURING RENDEZVOUS AND DOCKING

STRUCTURE	85
BATTERIES (4)	540
	625 LBS.

ECS: CRYO O_2 TANKS, PLUMBING AND CONTROLS

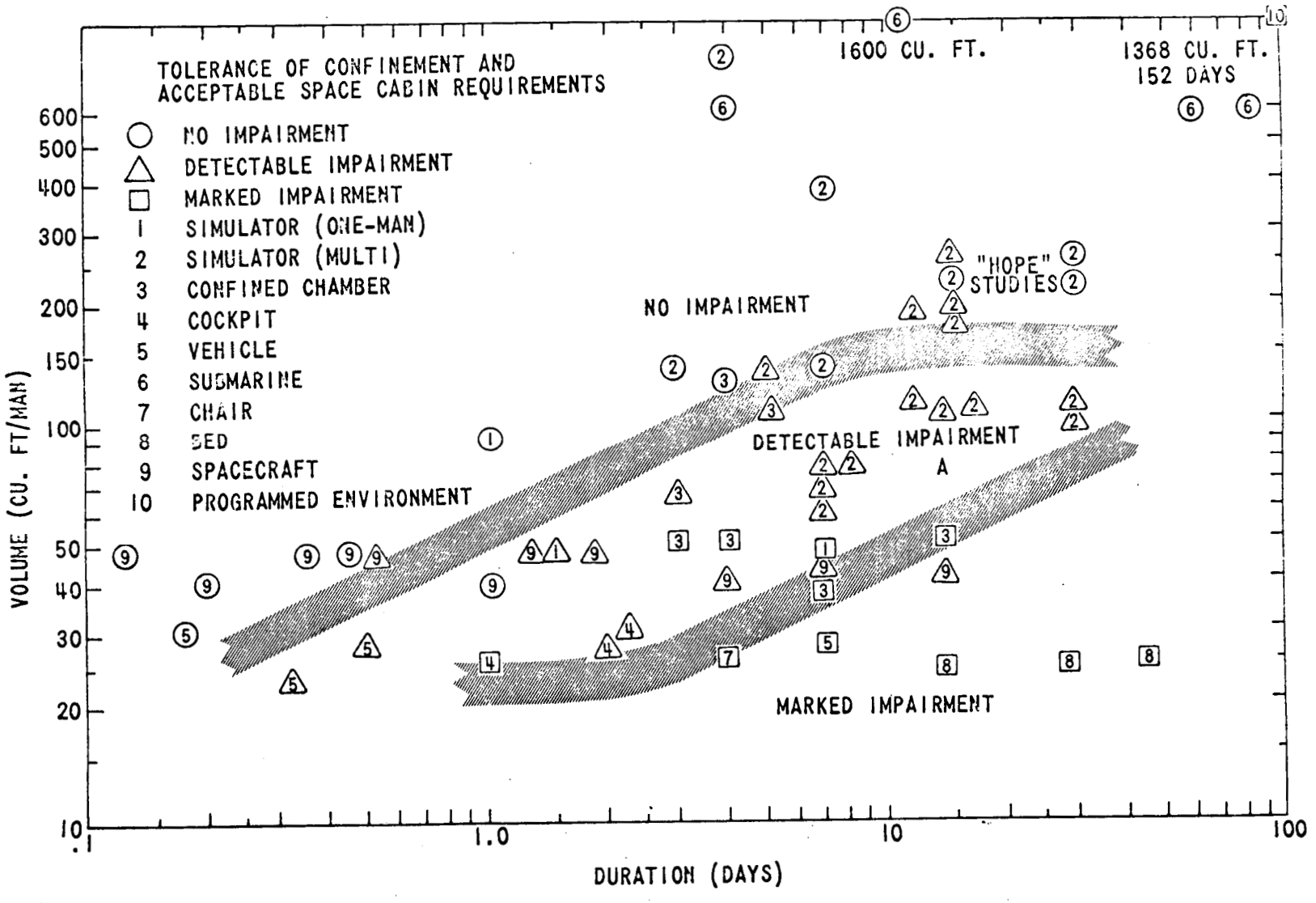
TANK & STRUCTURE	350
O_2	1200
	1550 LBS.

STRUCTURE: PLUME DEFLECTORS AND SUPPORTS

PROVISION FOR PROBE/DROGUE DOCKING CAPABILITY AND INCREASED STRUCTURAL CAPABILITY.

PLUME DEFLECTORS	150
PROBE/DROGUE STRUCTURE	320
	470 LBS.

"THE EFFECTS OF CONFINEMENT AS A FACTOR IN MANNED SPACE FLIGHT"
T.M. FRAZER JULY 1966 NASA CR-511



TOLERANCE OF CONFINEMENT AND ACCEPTABLE SPACE CABIN REQUIREMENTS

LM/ATM CONFIGURATION REQUIREMENTS FOR OPERATION WITH CSM

SUBSYSTEM	PRESENT 12/6/67	CONFIGURATIONS PROPOSED (NO REUSE)	CONFIGURATIONS PROPOSED (REUSE)
LM-A			
STRUCTURE	1896	- 215	- 215
S & C	78	- 78	- 73
N & G	106	- 106	- 106
CREW PROV.	190	-	-
ECS	564	- 20	- 20
INST.	146	-	-
EPS	1171	- 335	- 335
RCS	444	- 370	- 215
COMM	100	- 56	- 56
C & D	224	-	-
EXPL. DEV.	0	- 5	- 5
GFE	1836	- 350	- 350
LIQUIDS & GASES	1403	-1253	-1253
RCS PROPELLANTS	1065	-1065	-1015
	9223 LBS	-3853 LBS	-3643 LBS
LM-A TOTAL		5370	5580
ATM RACK*		18241	18241
SLA/N.C.		4967	4967
L.V MODS		750	750
TOTAL		29,328	29,538
L.V CAPABILITY (180 NM CIR)		36,000	
MARGIN		6,672 LBS	
L.V CAPABILITY (220 NM CIR)			32,250
MARGIN			2,712 LBS.

LM/ATM ELECTRICAL POWER

	PRR 1/23/68 (ORBIT AVG)		DECOUPLED 180 NM 90 DAY		MISSION ESTIM. 220 NM 10 MO.	
ATM		2804				2654
PCS	1006			1006		
EPS	133			133		
MEASURING SYSTEM	64			64		
TM	360			360		
COMMAND SYSTEM	27			27		
DISPLAY SYSTEM	201			201		
EXPTS	113			113		
THERMAL	700			565 (1)		
LINE LOSS	200			185 (2)		
LM-A		600				340
COMM				24		
CREW PROV				55		
EPS				114		
D&C				12		
ECS				68		
INSTR				67		
TOTAL LM/ATM		3404	WATTS			2994 WATTS
AVAILABLE POWER						
P_{SA}	9720		9200 (3)		8760 (3)	
P_{SA}/P_L	2.56		2.37		2.32	
P_L	3800		3800		3780	
SYSTEM MARGIN	+396 WATTS		+806 WATTS		+786 WATTS	

NOTE: 1 SOLAR ARRAY PANEL + CBRM, 215W, 273 LBS.

(1) 350W FOR FLUID SYSTEM PLUS 215W FOR EXPT. HEATERS
(2) 7.5% LINE LOSS
(3) 360 MODULES, 34.3W/MODULE, 24% MISC. LOSSES, 0.5%/MO. RADIATION LOSS

CONCLUSIONS

DECOUPLING IS FEASIBLE WITHIN THE FRAMEWORK OF THE MISSION OBJECTIVES, HOWEVER:

- DECOUPLING ELIMINATES THE OPPORTUNITY TO DEVELOP THE ORBITAL ASSEMBLY TECHNIQUES INITIALLY CONCEIVED AS AN OBJECTIVE OF THE EARLY AAP MISSIONS

- DECOUPLING REQUIRES THE DEVELOPMENT OF ORBITAL STORAGE AND REUSE CAPABILITY FOR THE LM/ATM, IF MORE THAN ONE LM/ATM MISSION IS DESIRED

DECOUPLING ELIMINATES THE PRESENT WEIGHT PROBLEM ON AAP-3, THE DUAL PROBE-DROGUE PROBLEM ON THE LM-A, AND THE DOCKING LOADS PROBLEM ON THE LM-A

DECOUPLING PROVIDES ONE MEANS OF REDUCING THE NUMBER OF CSM VERSIONS TO BE USED IN THE EARLY AAP PROGRAM