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[redacted] OSPACE CORPORATION

INTEROFFICE CORRESPONDENCE

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CC: Noted Below

DATE: 27 October 1964

SUBJECT: MOL Weight History (JO 5107-30)

FROM: S. E. Rice
Bldg. A2/2043
Ext. 85591

References: See Table III

Recent events, such as internal briefings, review of the MOL system specification, and various discussions have prompted the preparation of this memorandum. The specific objectives are to illustrate the term "experiments weight" and to clearly indicate a potential "experiments weight" problem.

Table I is a weight summary representing our interpretation of the MOL specification and included in Table III. The weight now available for experiments as shown in Table I is 3,613 pounds. Of this, 1,028 as shown in Table I is for propellants, fuel cell reactants, data handling equipment, and structure. This total has been charged to the experiments as its proportionate share of the total of these quantities.

Recent studies show that complex space vehicles have increased 22 percent in weight from the contract phase to final hardware development. The current MOL weight estimates includes for contingencies 5 percent (300 pounds) for the re-entry vehicle and 15 percent (2,000 pounds) for the laboratory excluding experiments. These low contingency weights will require very extensive and detailed weight control procedures to prevent further reduction in weight available for experiments.

Figure 1 illustrates the variation in weight available for experiments on the MOL program since 2 January 1964. The payloads shown in

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this Figure have been adjusted to coincide with the booster capability predicted by the current MOL specification for a circular orbit at 160 nautical miles and an inclination of 32 degrees (22,200 pounds). The experiments weights have also been adjusted to a common reaction control system propellant loading of 35 pounds.

Table I is a weight summary representing the current vehicle configuration. The weights associated with the experiment provisions is supplied with this Table.

Table II summarizes the weights shown in Figure 1 and notes the major reasons for the changes.

Table III references the documents which form the basis for this memorandum and summarizes the more important design constraints associated with our estimates.

APPROVED: C. R. Pullen
C. R. Pullen, Manager
Weight Prediction Section

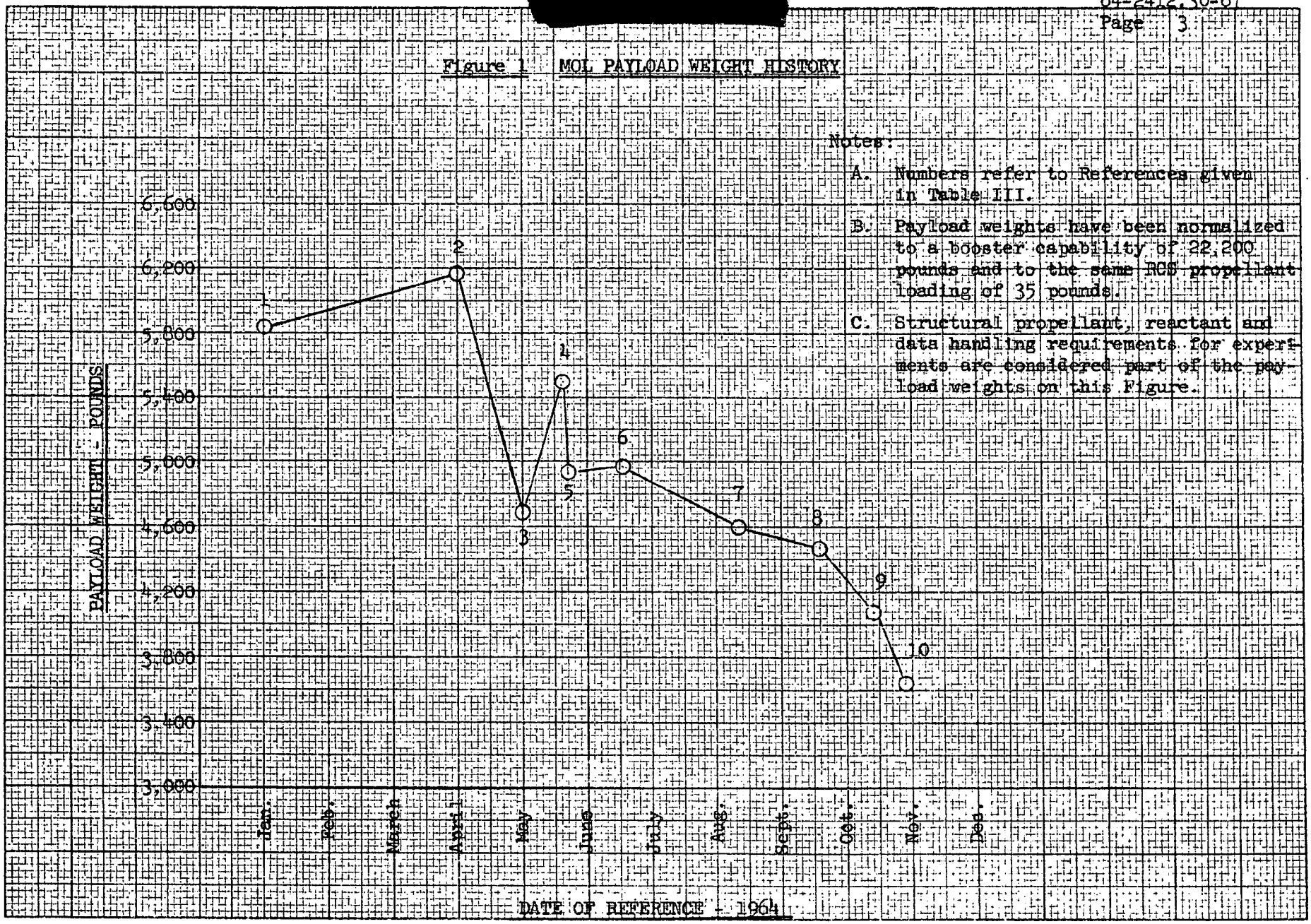
APPROVED: J. Steinman
J. Steinman, Head
Vehicle Systems Department

SER:mn

cc: J. E. Bennett
H. Bernstein
J. M. Brown
J. W. Duroux
K. G. Graff
J. R. Henry
C. J. Holden
J. G. Krisilas
E. L. La Porte
B. P. Leonard
C. A. Lindley
A. Mager
N. W. Nordyke
C. L. Olson
C. R. Precious
J. E. Roberts
E. R. Ryder
T. Silva
C. Stewart
W. P. Targoff
D. E. Wilkins
D. Willens
W. C. Williams
M. G. Wolfe

[redacted]

Figure 1 MOL PAYLOAD WEIGHT HISTORY



Notes:

A. Numbers refer to References given in Table III.

B. Payload weights have been normalized to a booster capability of 22,200 pounds and to the same RCS propellant loading of 35 pounds.

C. Structural propellant, reactant and data handling requirements for experiments are considered part of the payload weights on this Figure.

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TABLE I
ORBITING VEHICLE WEIGHT SUMMARY

Based on Retro Rocket Abort Configuration, and
Basic Structural Provisions only for Rendezvous and Docking

	Weight-Pounds	
GEMINI B SEGMENT	6,325	
Re-entry Vehicle (Includes Crew)	4,545	
Adapter Section - 15°, 6 Rockets	1,480	
Contingency	300	
LABORATORY VEHICLE SEGMENT	12,985	
Structure (Docking provisions in basic structure)	2,960	(1)
Orientation Control System (Less Propellant)	690	
Electrical Power (Less Reactants)	2,230	
Instrumentation	130	
Communications	735	(2)
Environmental Control System (Less Expendables)	890	
Personnel Accommodations	630	
Displays and Controls	315	
Spare Parts	140	
Expendables	(2,265)	
Food	120	
Oxygen - Supercritical	285	
Oxygen - High Pressure	10	
Nitrogen - Supercritical	100	
Water - Reserve	15	
Lithium Hydroxide	215	
Disposable Clothing, Tissues, Chemicals	35	
Reactants for Electrical Power - 1800 Watts Average	1,350	(3)
Propellants	135	(4)
Contingency	2,000	
EXPERIMENT SEGMENT - WEIGHT AVAILABLE	2,585	(5)
TRANSTAGE MODIFICATIONS	305	
30 Day MOL - Δ Weight	60	(6)
Redundant Auto Pilot System	245	
GROSS WEIGHT AT LAUNCH	22,200	(7)

Notes

(1) Includes Provisions for Experiments (240 lbs.)
(2) Includes Data Handling System for Experiments (500 lbs.)
(3) Includes Reactants for Experiments (250 Watts) (188 lbs.)
(4) Includes Propellant Allowance for Experiment Maneuvers (100 lbs.)

} 1,028 lbs.

(5) Weight Available for Experiments is in addition to Items (1) to (4).

(6) Δ Weight is the difference between the predicted weight of the transtage for the 30-day MOL and the weight used in the performance analysis.

(7) Specification performance for an inclination of 32°, and a circular 160 nautical mile orbit.

TABLE II
MOL PAYLOAD WEIGHT HISTORY

Reference	Date 1964	Primary Reason for Weight Change	Δ Weight Change	Normalized * Payload
(1)	2 January	Change from two 500 cu. ft. compartments to a 750 cu. ft. compartment.	-340	5,845
(2)	30 March	Minimum change MOL concept. Gemini fuel cells in lieu of fully oriented solar array.	+1,488	6,185
(3)	30 April	Replace fuel cells with roll controlled solar array.	-820	4,697
(4)	19 May	Increase pressurized volume from 750 cu.ft. to 1300 cu. ft.	+592	5,517
(5)	20 May	Reduce pressurized volume to 1200 cu. ft. Replace solar array with fuel cells. Reduce length of mission from 40 to 35 days.	-32	4,925
(6)	17 June	Reduce length of mission from 35 to 33 days. Increase power level from 1,500 watts to 1,600 watts. Increase reactant rate from 1.0 to 1.16 pounds/KW hour and increase number of fuel cells from 4 to 12.	+357	4,957
(7)	11 August	Structural revisions	+125	4,600
(8)	17 September	Reduce reactant rate from 1.16 pounds/KW hour to 0.95 pounds/KW hour. Increase average power requirement from 1.6 KW to 1.8 KW. Provide for 2 gas system at 7 psi in place of 1 gas system at 5 psi. Increase reaction control system weights. Increase reactant tank weights.	+398	4,475
(9)	13 October	Use retro rocket abort configuration in place of tower abort system.	+464	4,077
(10)	27 October			3,613

* Payload weights have been "normalized" to a booster capability of 22,200 pounds and to the same RCS propellant loading [redacted]

Reference	Gross Weight Pounds	Payload Weight Pounds	Average Power Requirements (Kilowatts)	R.C.S. Propellant Loading (Pounds)	Pressurized Volume (Cu. Ft.)	Number of Pressure Compartments	Length of Mission (Incl. Reserves) (Days)	Power Source	"Normalized" Payload Weight * (Pounds)
1) MOL Program Backup Detailed Information, 2 January 1964, Dr. B. P. Leonard.	21,000	4,600	1.4	80	1,000	2	60	Fully Oriented Solar Array	5,845
2) MOL Vehicle Configuration Development Data Summary, 30 March 1964, T. H. Silva	21,000	5,940	1.4	80	750	1	60	Fully Oriented Solar Array	6,185
3) Preliminary IMOL Weight Summary, 30 April 1964, S. E. Rice.	21,545	3,357	1.5	720	750	1	40	Fuel Cell	4,697
4) MOL Weight and Balance Summaries, 19 May 1964, S. E. Rice.	21,000	3,992	1.5	360	750	1	40	Roll Control Solar Array	5,517
5) MOL Weight and Balance Summary for the 1300 cubic foot laboratory, 20 May 1964, S. E. Rice.	21,000	3,400	1.5	360	1,300	2	40	Roll Control Solar Array	4,925
6) MOL Weight and Balance Summaries, 17 June 1964, S. E. Rice.	21,000	3,432	1.5	360	1,200	2	35	Fuel Cells	4,957
7) MOL Weight Summaries, 11 August 1964, S. E. Rice.	21,400	3,575	1.6	260	1,200	2	33	Fuel Cells	4,600
8) MOL Center of Gravity, 17 September 1964, S. E. Rice.	21,400	3,450	1.6	260	1,200	2	33	Fuel Cells	4,475
9) MOL Weight Summaries, 13 October 1964, S. E. Rice.	21,700	3,577	1.8	35	1,200	2	33	Fuel Cells	4,077
10) MOL Weight Summary, 27 October 1964, S. E. Rice, See Table I.	22,200	3,613	1.8	35	1,200	2	33	Fuel Cells	3,613

* Payload weights have been "normalized" to a booster capability of 22,200 pounds and to the RCS propellant loading of 35 pounds.