NASA-CR-118531) LEM MASS PROPERTY REPORT (Grumman Aircraft Engineering Corp.) 29 p

N79-76487

Unclas
00/18 11585

(ACCESSION NUMBER) (THRU)

21
(PAGES)

(CODE)

NASA-CR-118531
(NASA CR OR TMX OR AD NUMBER)

(CATEGORY)

FF No. 602(A)

AVAILABLE TO NASA OFFICES AND NASA
[redacted] RESEARCH CENTERS ONLY

C66-2992

[redacted]

COPY NO. 21

CONTRACT REQUIREMENTS	CONTRACT ITEM	MODEL	CONTRACT NO.	DATE
Exhibit E, Para. 5.2	Line Item 13	LEM	NAS 9-1100	1/14/63

TYPE II

Primary Code 713

REPORT

NO. LED-490-28

DATE: 1 January 1966

LEM MASS PROPERTY REPORT (U)

CODE 26512

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DATE	REV. BY	REVISIONS & ADDED PAGES	REMARKS

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GRUMMAN AIRCRAFT ENGINEERING CORPORATION

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INTRODUCTION

This report contains the LEM Mass Properties status as of December 19, 1965 for the Lunar Landed Vehicle. The total weight at Separation is 32,204.8 pounds, which is 26.5 pounds lighter than that previously reported in LED-490-27, dated 1 December 1965.

A summary of changes since the last report is as follows:

A.	Ascent Stage inert * weight	+ 14.8 pounds
B.	Ascent Stage propellant	- 31.8 pounds
C.	Descent Stage inert * weight	- 6.8 pounds
D.	Descent Stage propellant	- 2.7 pounds

Total LEM Weight Change at Separation -26.5 pounds

A more detailed breakdown of the changes since the last report is included on page 12 . Changes included in this report are as follows:

A. Additional Super Weight Improvement Program weight savings.
B. Revision of Attitude Control Propellant.
C. Incorporation of Contract Change Authorization (CCA) weight changes.
D. General updating of weight based on current data.

Portions of the weight changes incurred by CCA's 131, 146 and 156 were incorporated in previous weight reports as changes in vendor weights and GFE weights with no reference to the applicable CCA. Any necessary adjustment of responsibility for these weight changes were made in this report.

The assumed ΔV Budget of 13,918 fps. for the LEM Reference Mission remains unchanged since the last report. The distribution of this budget is Ascent ΔV= 6586 fps. and Descent ΔV= 7332 fps.. The reference mission requires more propellant than the critical abort mission, which was defined in the August LEM Mass Property Report, LED-490-23.

Scrape effort on 1032 pounds of ascent structure indicates a current potential weight saving of 135 pounds. The 8.7 pounds of saving incorporated in this report brings the total incorporated ascent structure weight saving to 106.9 pounds. The 923 pounds of descent structure, reviewed and scraped, currently indicates a current potential weight saving of 112 pounds. The 9.2 pounds of saving incorporated in this report brings the total incorporated descent structure weight saving to 30.5 pounds.

* Inert weight includes all non-propulsion expendables.

INTRODUCTION - Cont.

Exclusive of the scrape effort, the total incorporated SWIP items reduce the weight of the ascent stage 19.2 pounds and the descent stage 58.0 pounds. The ascent stage SWIP weight reduction of 19.2 pounds reflects only the weight increase portion (+13 pounds) of SWIP item LWSS 270B-16, Delete Baffles in LEM Propellant Tanks. The weight reduction portion of this trade-off type item (see Pending Changes) will be incorporated in subsequent reports.

A breakdown of the SWIP items incorporated to date in the LEM weight report is as follows:

LWSS Number	SWIP Items	Inert Weight By Stages Ascent	Inert Weight By Stages Descent	Effective Weight
	LED-490-25 Scrape Effort	-22.1		-93.0
	LED-490-26 Scrape Effort	-62.2	-12.5	-288.2
	LED-490-27 Scrape Effort	-13.9	- 8.8	-77.3
	LED-490-28 Scrape Effort	- 8.7	- 9.2	-56.1
510A-1	Replace thermal paint with etched surface treatment on thermal shields.	-24.0	-24.0	-150.0
270B-8	Remove redundancy of helium pressurization regulators.		- 4.0	- 8.5
520B-1	Landing velocity envelope reduction to: 10-7-4 Design.		-26.6	-56.7
370A-2	Eliminate stroke adjustment on gimbal drive actuator.		- .4	- .8
310B-2	Reduction in safety factor on RCS pressurization bottles from 2.0 to 1.5.	- 5.4		-22.6
270B-16	Delete baffles in LEM propellant tanks. (Partially incorporated - Part (e))	+13.0		+25.5
390B-12 (Phase 2)	Eliminate automatic switchover circuitry for ECS glycol pumps.	- 1.5		- 6.3
380B-2	Delete 80-foot cable for use of external TV. Also delete tripod and 10-inch cable.	- 1.3	- 3.0	-10.2
	Total Weight-Incorporated SWIP Changes	-126.1	-88.5	-744.2

INTRODUCTION - Cont.

The information for the Critical Design Reviews (CDR) is based on this January 1st Report. However, the weight distribution by subsystem will differ since the explosive devices were broken out separately for the CDR.

Subsystems affected by this are noted as follows:

Subsystem		Hardware Weight LED-490-28	Δ Weight	CDR
Structure	- Ascent	1212.0	- 8.0	1204.0
	- Descent	1381.8	- 9.3	1372.5
Landing Gear		483.5	- 4.0	479.5
E.P.S.		1421.9	- 7.0	1414.9
Explosive Devices	- Ascent	0*	+ 8.0	8.0
	- Descent	0*	+20.3	20.3

* Integrated in other Subsystems.

FIGURE 1

LEM ALLOWABLE STAGE WEIGHT APPORTIONMENT

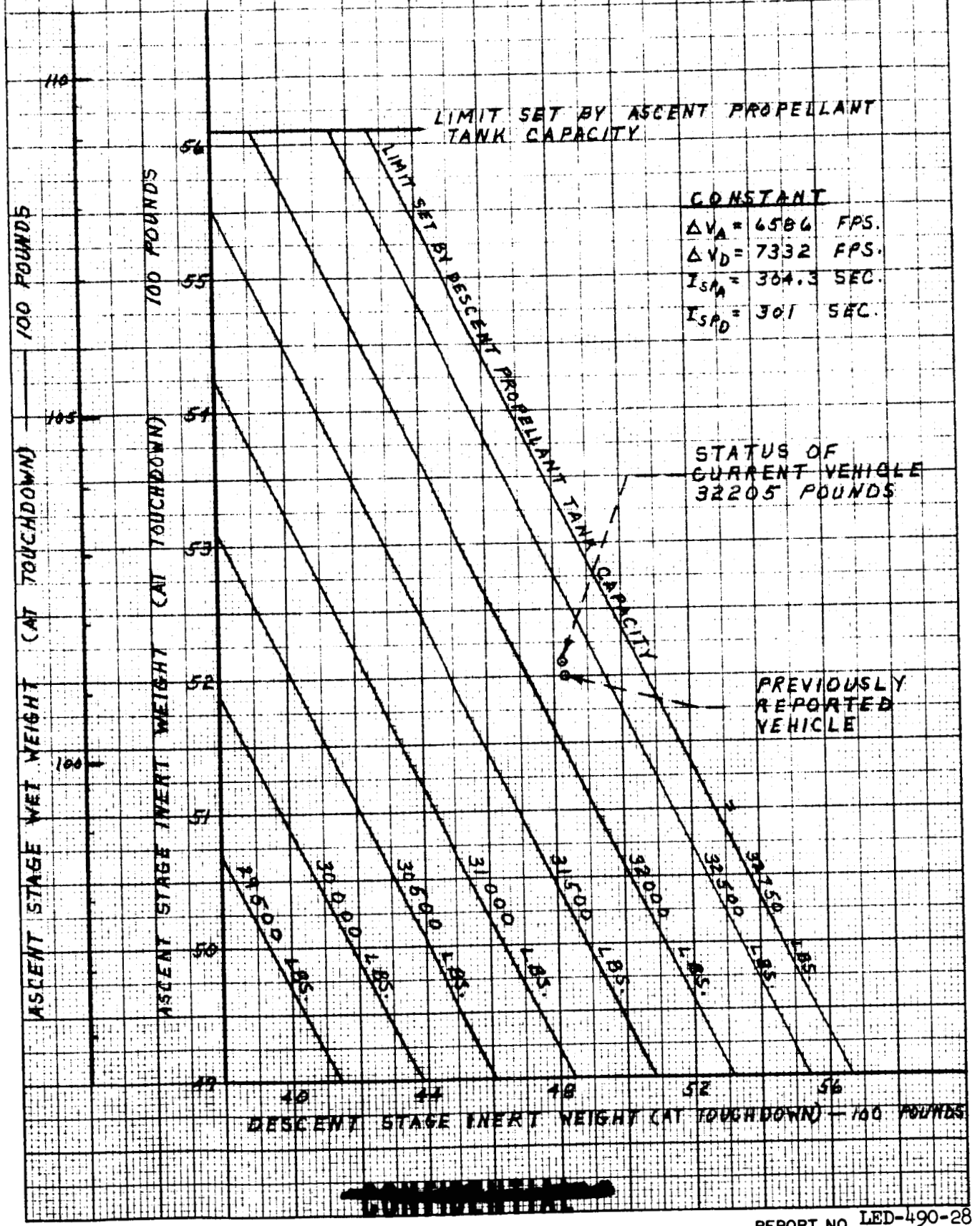

Table 1

LEM MASS PROPERTY HISTORY - CURRENT WEIGHT

MISSION PHASE	WEIGHT EARTH POUNDS	CENTER OF GRAVITY			MOMENTS OF INERTIA			PRODUCTS OF INERTIA		
		STATION INCHES	DISTANCE FROM THRUST AXIS		SLUG FT^2			SLUG FT^2		
		X	Y	Z	I_{xx}	I_{yy}	I_{zz}	I_{yz}	I_{xz}	I_{xy}
Translunar Injection	31599	183.9	1.0	-0.8	21588	23952	24187	493	147	138
LEM/CSM Separation	32205	185.3	1.0	0.1	23041	25388	25397	481	483	157
End Insertion to Hohman -Descent	31788	185.0	1.0	0.1	22778	25092	25133	483	484	159
Begin Hover	16757	204.2	1.9	0.3	12975	15847	18021	503	454	39
Lunar Touchdown	14958	212.4	2.1	0.3	11775	12872	15273	506	446	-17
Lunar Launch (lift-off)	10030	242.4	0.5	1.5	6298	3347	5589	22	131	81
End Insertion to Hohman -Ascent	5345	254.4	0.9	2.9	3082	2790	1886	27	91	69
Burnout (docked)	5038	255.0	1.0	3.1	2900	2651	1584	35	89	68
Completion of Crew Transfer	4411	255.5	0.7	-2.2	2578	2342	1454	39	126	61

Table 2
SUMMARY OF LEM WEIGHT REPORTING MISSION

MISSION PHASE	ELAPSED TIME FROM EARTH LAUNCH		REPORTING MISSION (Day Landing) For Loading Expendables			
Description	Hours	Minutes	Hours	Minutes		
Prelaunch (Launch Vehicle Fueling)	-10	0	10		Pre-Separation Period	Dormant Period
Launch	0	0		12		
Earth Parking Orbit		12	2	49		
Translunar Injection	3	1		5		
Translunar Coast- Prior to Transposition	3	6		15		
-During Transposition	3	21		30		
-Subsequent to Transposition	3	51	60	24		
Lunar Orbit- Insertion	64	15		6		
-Coast Prior to Separation	64	21	1	26		
-Checkout	65	47	2	17		
LEM Separation and Insertion to Descent Transfer Orbit	68	4		20	Descent*	Active Period
Coast in Descent Transfer Orbit	68	24		58		
Powered Descent (& Hover)	69	22		10		
Lunar Staytime	69	32	34	45		
Powered Ascent	104	17		7	Ascent**	
Parking Orbit Contingency ***	104	24				
Coasting Ascent Transfer				47		
Rendezvous	105	11		8		
Docking	105	19		15		
Crew Transfer	105	34		10		
	105	44				
Dormant LEM Time			75	47		
Active LEM Time			39	57		
Post-Separation LEM Time			(37)	(40)		
Total LEM Period			115	44		

* Descent Period - 1 Hour 28 Minutes
**Ascent Period - 1 Hour 27 Minutes
***The Design Reference Mission (DRM) does not appear to have any Parking Orbit Contg..

Table 3

LEM WEIGHT BY STAGES AT EARTH LAUNCH AND LUNAR ORBIT SEPARATION AND DISTRIBUTION OF THE INERT WEIGHT BY PERCENTAGE

		WEIGHT			PERCENTAGE				
		ASCENT	DESCENT	TOTAL	ESTIMATE	LAYOUT	CALCULATION	ACTUAL	GFE
1.0	Structure	(1212.0)	(1381.8)	(2593.8)	32.6	23.1	44.3		--
	-Ascent	1212.0	--	1212.0	21.3	15.2	63.5	--	--
	-Descent	--	1381.8	1381.8	42.6	30.0	27.4		--
2.0	Stabilization and Control	81.6	15.3	96.9	100.0	--	--	--	--
3.0	Navigation and Guidance	305.4	39.0	344.4	32.8	--	--	--	67.2
4.0	Crew Provisions *	208.7	20.0	228.7	14.9	1.1	15.2	--	68.8
5.0	Environmental Control	(393.9)	(381.6)	(775.5)	41.0	7.2	51.1	.7	--
	-Hardware	275.7	108.1	383.8					
	-Expendables **	118.2	273.5	391.7					
6.0	Landing Gear	--	483.5	483.5	69.8	3.9	26.3	--	--
7.0	Instrumentation	151.9	175.1	327.0	4.7	43.3	--	--	52.0
8.0	Electrical Power Supply	754.0	667.9	1421.9	41.1	--	58.4	.5	--
9.0	Propulsion	(698.8)	(1667.8)	(2366.6)	34.3	8.0	50.2	7.5	--
	-Ascent Hardware	555.5	--	555.5					
	-Descent Hardware	--	1145.4	1145.4					
	-Helium	13.0	48.6	61.6					
	-Propellant-Trapped	130.3	473.8	604.1					
10.0	Reaction Control	(616.5)	--	(616.5)	27.0	--	57.1	15.9	--
	-Hardware	303.2	--	303.2					
	-Helium	2.1	--	2.1					
	-Propellant-Trapped, Attitude and Contingency	311.2	--	311.2					
11.0	Communications	119.0	18.0	137.0	95.5	--	3.2	--	1.3
12.0	Controls and Displays	211.6	--	211.6	58.5	2.7	29.6	--	9.2
	Inert-Sub-Total - Hardware	3790.3	3864.1	7654.4					
	- Expendables and GFE	963.1	985.9	1949.0					
	Inert Totals	4753.4	4850.0	9603.4	37.3	10.5	43.2	3.0	6.0
	ΔV Propellant	(4944.0)	(17051.4)	(21995.4)					
	-Main Propulsion	4660.8	17051.4	21712.2					
	-Reaction Control	283.2	--	283.2					
	Totals-Earth Launch	9697.4	21901.4	31598.8					
4.0	Crew Provisions	538.8	--	538.8					
5.0	Environmental Control	-1.0	-15.2	-16.2					
7.0	Instrumentation	80.0	--	80.0					
10.0	Reaction Control - Attitude Propellant	-4.4	--	-4.4					
11.0	Communications	7.8	--	7.8					
	Totals - Separation	10318.6	21886.2	32204.8					

* Without crew, suits, PLSS, radiation dosimeters, etc. (538.8 pounds).
** Includes trapped, LiOH cartridges, oxygen, coolant and water.

Table 4

LEM CURRENT WEIGHT MISSION HISTORY BY STAGES

MISSION PHASE AND CONSUMABLE DESCRIPTION	ASCENT STAGE		DESCENT STAGE		TOTAL WEIGHT (LBS)
	DRY WEIGHT (LBS)	ΔV-PROPELL WEIGHT (LBS)	DRY WEIGHT (LBS)	ΔV-PROPELL WEIGHT (LBS)	
EARTH LAUNCH AND TRANSLUNAR INJECTION	4753.6	4944.0	4849.8	17051.4	31598.8
Crew and Equipment	+538.8				
RCS - Checkout Propellant	-4.4				
ECS - Umbilical Hardware	-1.0				
- Oxygen			-1.5		
- Water			-13.7		
Scientific Equipment	+80.0				
Comm - TV Camera	+7.8				
SEPARATION	5374.8	4944.0	4834.6	17051.4	32204.8
Water and Oxygen			-9.9		
Descent ΔV Propellant					
- Main				-17051.4	
- RCS		-20.2			
RCS - Attitude	-165.6				
LUNAR TOUCHDOWN	5209.2	4923.8	4824.7		14957.7
Scientific Samples & Equip.			-170.0		
Jettisoned on Lurain	-98.4		-4654.7		
RCS - Checkout Propellant	-4.4				
LUNAR LIFT-OFF	5106.4	4923.8			10030.2
ECS - GOX	-.8				
- Water	-11.5				
Ascent ΔV Propellant					
- Main		-4660.8			
- RCS		-263.0			
RCS - Attitude Propellant	-56.6				
BURNOUT (DOCKING)	5037.5				5037.5

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LEM
WEIGHT STATEMENT

CODE	ITEM	12/1/65 WEIGHT AT SEPARATION	CURRENT WEIGHT STATUS: BURN OUT	CONS'D ON ASCENT	JET. ON LURAIN	CONS'D ON DESCENT	TOTAL SEPARATION	X-LUNAR EXPEND-ABLES	EARTH LAUNCH TOTAL
1.0	Structure	2620.0	1212.0		1381.8		2593.8		2593.8
2.0	Stabilization and Control	98.3	81.6		15.3		96.9		96.9
3.0	Navigation and Guidance	335.8	305.4		39.0		344.4		344.4
4.0	Crew Provisions	(768.0)	(661.3)		(106.2)		(767.5)	(-538.8)	(228.7)
	-Inert	733.6	661.3		71.8		733.1	-538.8	194.3
	-Expendables	34.4	0		34.4		34.4		34.4
5.0	Environmental Control	(741.4)	(371.4)	(12.3)	(365.7)	(9.9)	(759.3)	(16.2)	(775.5)
	-Inert	411.0	319.5	0	109.4	0	428.9		428.9
	-Expendables	330.4	51.9	12.3	256.3	9.9	330.4	16.2	346.6
6.0	Landing Gear	496.8			483.5		483.5		483.5
7.0	Instrumentation	423.2	231.9		175.1		407.0	-80.0	327.0
8.0	Electrical Power	1427.9	754.0		667.9		1421.9		1421.9
9.0	Propulsion	(24086.3)	(698.8)	(4660.8)	(1667.8)	(17051.4)	(24078.8)		(24078.8)
	-Inert	2359.8	698.8	0	1667.8	0	2366.6		2366.6
	-Expendables - ΔV Propellant	21726.5	0	4660.8	0	17051.4	21712.2		21712.2
10.0	Reaction Control	(878.6)	(385.5)	(319.6)	(4.4)	(185.8)	(895.3)	(4.4)	(899.7)
	-Inert	343.9	340.3	0		0	340.3		340.3
	-Expendables - Att. Prop.	227.9	45.2	56.6	4.4	165.6	271.8	4.4	276.2
	- ΔV Propellant	306.8		263.0		20.2	283.2		283.2

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LEM
WEIGHT STATEMENT

CODE	ITEM	12/1/65 WEIGHT AT SEPARATION	CURRENT WEIGHT STATUS: BURN OUT	CONS'D ON ASCENT	JET. ON LURAIN	CONS'D ON DESCENT	TOTAL SEPARATION	X-LUNAR EXPEND-ABLES	EARTH LAUNCH TOTAL
11.0	Communications	141.0	124.0		20.8		144.8	-7.8	137.0
12.0	Controls and Displays Total	214.0	211.6				211.6		211.6
	-Inert	9605.3	4940.4	0	4632.4	0	9572.8	-626.6	8946.2
	-Expend. - W/O ΔV Prop.	592.7	97.1	68.9	295.1	175.5	636.6	20.6	657.2
	- ΔV Prop. Only	22033.3		4923.8		17071.6	21995.4		21995.4
		32231.3	5037.5	4992.7	4927.5	17247.1	32204.8	-606.0	31598.8
	Burnout Weight	5059.8	5037.5 lbs.						
	Lift-off Weight	10057.1		10030.2 lbs.					
	Touchdown Weight	14991.4			14957.7 lbs.				
	Separation Weight	32231.3					32204.8	lbs.	
	Earth Launch Weight	31625.3							31598.8 lbs.

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Table 5

LEM WEIGHT COMPARISON
AT SEPARATION BY STAGES

Subsystem	Item	12/1/65 Weight	Current Weight	Weight
A.	Ascent Stage Weight at Separation	10335.6	10318.6	-17.0
1.0	Structure	1229.0	1212.0	-17.0
2.0	Stabilization and Control	82.9	81.6	-1.3
3.0	Navigation and Guidance	302.5	305.4	+2.9
4.0	Crew Provisions	748.0	747.5	- .5
5.0	Environmental Control	383.3	392.9	+9.6
6.0	Landing Gear	--	--	--
7.0	Instrumentation - Operational	166.6	151.9	-14.7
	- Scientific	80.0	80.0	0
8.0	Electrical Power Supply	760.0	754.0	-6.0
9.0	Propulsion System	(5368.2)	(5359.6)	(-8.6)
	Propulsion Inert	565.5	568.5	+3.0
	Propellant (Includes 130.3# trapped)	4802.7	4791.1	+11.6
10.0	Reaction Control	(878.6)	(895.3)	(+16.7)
	Propulsion Inert	285.9	300.9	+15.0
	Propellant (Includes 58.0# trapped)	592.7	594.4	+1.7
11.0	Communications	122.5	126.8	+4.3
12.0	Controls and Displays	214.0	211.6	-2.4
B.	Descent Stage Weight at Separation	21895.7	21886.2	-9.5
1.0	Structure	1391.0	1381.8	-9.2
2.0	Stabilization and Control	15.4	15.3	- .1
3.0	Navigation and Guidance	33.3	39.0	+5.7
4.0	Crew Provisions	20.0	20.0	0
5.0	Environmental Control	358.1	366.4	+8.3
6.0	Landing Gear	496.8	483.5	-13.3
7.0	Instrumentation - Operational	6.6	5.1	-1.5
	- Scientific	170.0	170.0	0
8.0	Electrical Power Supply	667.9	667.9	0
9.0	Propulsion System	(18718.1)	(18719.2)	(+1.1)
	Propulsion Inert	1190.2	1194.0	+3.8
	Propellant (Includes 473.8# trapped)	17527.9	17525.2	-2.7
11.0	Communications (Portable)	18.5	18.0	- .5
	Total Separation Weight (A & B)	32231.3	32204.8	-26.5

[redacted]

DISCUSSION OF WEIGHT CHANGES BY RESPONSIBILITY AND STAGES SINCE LAST REPORT - AT SEPARATION

	Inert * Wt. Chgs. By Stages		Effective Weight By Responsibility	
	Ascent	Descent	GAEC	NASA
Super Weight Improvement Program				
The current effects of the Super Weight Improvement Program (SWIP) are decreases of 10.1 pounds in the descent stage and 3.1 pounds in the ascent stage. A more detailed breakdown of the SWIP changes are as follows:				
Scrape effort on 10 descent structure drawings and 125 ascent structure drawings indicate weight reductions of 9.2 pounds and 8.7 pounds respectively.				
1.0 Structure	-8.7	- 9.2	-56.1	
Incorporation of gimbal drive actuator SWIP change LWSS 370A-2 reduces weight .4 pounds.				
2.0 Stabilization and Control		- .4	- .8	
Reduction of the safety factor from 2.0 to 1.5 for the Reaction Control helium tanks, SWIP change LWSS 310 B-2 reduces tank weights 5.0 pounds and tank support structure .4 pounds.				
1.0 Structure	- .4			-1.7
10.0 Reaction Control	-5.0			-20.9
This is a partial incorporation of the SWIP change LWSS 270B-16 that deletes baffles from the propellant tanks. The portion incorporated is the RCS propellant required to compensate for fuel sloshing. The remainder of this change will appear in subsequent reports.				
10.0 Reaction Control	+13.0		+25.5	

* Inert weight excludes ΔV propellant.

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DISCUSSION OF WEIGHT CHANGES BY RESPONSIBILITY AND STAGES SINCE LAST REPORT - AT SEPARATION - Cont.

	Inert* Wt. Chgs. By Stages		Effective Weight By Responsibiltiy	
	Ascent	Descent	GAEC	NASA
Super Weight Improvement Program- Cont.				
Deletion of Automatic Pump Switch is the incorporation of SWIP change LWSS 390B-12.				
5.0 Environmental Control	-1.5		-6.3	
Operation on the TV camera is confined to the LEM vehicle while on the lunar surface. This television restriction is SWIP change LWSS 380B-2 and permits the removal of some ascent and descent stage vehicle wiring and provisions. The GFE television tripod and cable removed in the previous weight report are also part of this SWIP change.				
11.0 Communications	- .5	-.5		-3.2
RCS Propellant Revisions				
The RCS non-ΔV propellant requirements as outlined in ref. 15 are incorporated in this report. Using Design Reference Mission #1 as a typical mission and generally designing for the worst case, the non-ΔV propellant quantity increased 27.5 pounds, this excludes the previously mentioned RCS propellant (13 pounds) required to compensate for propellant sloshing. The effective weight of this change is reduced due to the use of 306.3 sec. rather than 306.0 sec. for the I_{sp} of the ascent engine and use of the higher average I_{sp} values for the RCS engines during translational thrusting.				
10.0 Reaction Control	+27.5		+72.5	
Further CCA #103 Weight Change				
Current information on the gaseous oxygen installation indicates the descent stage controls are packaged in a high pressure module. Other changes include the deletion and addition of valves, filters, fittings, etc..				
5.0 Environmental Control	+ .3	+7.3		+16.8

* Inert weight excludes ΔV propellant.

[redacted]

DISCUSSION OF WEIGHT CHANGES BY RESPONSIBILITY AND STAGES SINCE LAST REPORT - AT SEPARATION - Cont.

	Inert* Wt. Chgs. By Stages		Effective Weight By Responsibility	
	Ascent	Descent	GAEC	NASA
Miscellaneous CCA's Weight Changes				
The EMU oxygen recharge and the water recharge connectors are deleted from Environmental Control as these items were incorporated under Crew Provision as government furnished equipment in the previous report, ref. 10 . CCA 131, ref. 6 , directed the change of responsibility from contractor to government furnished.				
In accordance with CCA #146 and CCA #156, ref. 7 and 8 respectively, water shutoff valves are added. Other Environmental Control changes related to these CCA's were incorporated in a previous weight report as part of vendor changes and the adjustment of responsibility is made at this time.				
5.0 Environmental Control				
-CCA #131	- .5			-2.1
-CCA #146	+ .3		+8.0	-9.3
-CCA #156	+ .2		- .8	+1.7
Miscellaneous Structure Weight Revisions				
Continuous reviewing and updating of the structure indicates a 7.8 pound decrease in the ascent stage weight.				
1.0 Structure	-7.8		-32.7	
Miscellaneous Vendor Weight Changes				
Weight changes of Stabilization and Control items based on recent specification negotiations and on current vendor reported weights are as follows:				
2.0 Stabilization and Control				
-Descent Engine Control Assembly		- .3	- .6	
-Gimbal Drive Actuators		+ .6	+1.3	
-Abort Sensor Assembly	+ .3		+1.2	
-Abort Electronic Assembly	-1.6		-6.7	

* Inert weight excludes ΔV propellant.

DISCUSSION OF WEIGHT CHANGES BY RESPONSIBILITY AND STAGES SINCE LAST REPORT - AT SEPARATION - Cont.

	Inert* Wt. Chgs. By Stages		Effective Weight By Responsibility	
	Ascent	Descent	GAEC	NASA
Miscellaneous Vendor Weight Changes - Cont.				
Weight changes of Navigation and Guidance items based on recent specification negotiations and including LEM Vendor Changes (LVC) outstanding at negotiation time are as follows:				
3.0 Navigation and Guidance				
-Rendezvous Radar Antenna	+ .8		+3.4	
-Rendezvous Radar Electronics	+2.1		+8.8	
-Landing Radar Antenna		+3.7	+7.9	
-Landing Radar Electronics		+2.0	+4.3	
Weight changes of Environmental Control quick disconnects, dump valves, selector valve and oxygen housing based on current vendor reports total +.4 pound.				
5.0 Environmental Control	+ .4		+1.7	
Weight changes of Instrumentation items based on current vendor reports are as follows:				
7.0 Instrumentation				
-Signal Conditioner Assembly	-1.5		-6.3	
-Caution and Warning Assembly	-3.5		-14.7	
Weight changes of Reaction Control items based on current vendor reports indicate a -.2 pound actual and calculated weight effect and a +1.6 pound specification weight effect for common usage valves (NAA).				
10.0 Reaction Control	+1.4		+5.9	
Weight changes of Communication items based on recent specification negotiations are -.3 pound for VHF items and +2.9 pounds for S-Band items.				
11.0 Communications	+2.6		+10.9	

* Inert weight excludes ΔV propellant.

DISCUSSION OF WEIGHT CHANGES BY RESPONSIBILITY AND STAGES SINCE LAST REPORT - AT SEPARATION - Cont.

	Inert* Wt. Chgs. By Stages		Effective Weight By Responsibility	
	Ascent	Descent	GAEC	NASA
Miscellaneous Weight Revisions				
Updating of equipment supports and installation including the provisions for stowing the lunar boots at Earth Launch reflect the following weight changes.				
1.0 Structure	- .1		- .4	
4.0 Crew Provisions	- .5		-2.1	
Review of the latest Environmental Control schematic indicated the following weight changes to the weight report. (a) Addition of a previously omitted steam vent valve (+2.2 lbs) (b) Increase length of oxygen hose runs (+4.6 lbs) (c) Increase length of flex line runs (+1.7 lbs) (d) Addition of a cover for Environmental Control package (+1.5 lbs) Among other miscellaneous weight changes (+1.4 pounds) is a cold plate redesign to improve removal of the data storage equipment and the addition of a cabin pressure switch, which is the replacement of one deleted in the previous weight report.				
5.0 Environmental Control	+10.4	+1.0	+45.7	
Updating of Landing Gear Structure weight from estimated and layout to calculated status.				
6.0 Landing Gear		-13.3	-28.4	
The weights of Environmental Control components include integral measurements sensors, which were previously reported under Instrumentation sensors at 8.1 pounds. Other sensor weights were updated in accordance with ref. 19 .				
7.0 Instrumentation	-9.7	-1.5	-43.8	

* Inert weight excludes ΔV propellant.

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DISCUSSION OF WEIGHT CHANGES BY RESPONSIBILITY AND STAGES SINCE LAST REPORT - AT SEPARATION - Cont.

	Inert* Wt. Chgs. By Stages		Effective Weight By Responsibility	
	Ascent	Descent	GAEC	NASA
Miscellaneous Weight Revisions - Cont.				
Current weight estimates of the fuse and auxiliary switch relay boxes and the layout weight of the ECS relay box indicate reductions obtained from use of flight weight relays and condensing into smaller boxes.				
8.0 Electrical Power Supply	-6.0		-25.1	
Incorporated squib valves in the pressurization systems upstream of the propellant tanks to isolate helium components and enable the systems to meet NASA's newly imposed 44 day compatability requirements.				
9.0 Propulsion	+3.0	+3.8		+20.7
An allowance for the EVA antenna erection mechanism is estimated at 2.2 pounds. The final configuration is not resolved at this time.				
11.0 Communications	+2.2		+9.2	
The current review of control and display lights, switches and indicators reflect weight changes resulting from vendor reports and latest designs including some deletion and addition of items.				
12.0 Controls and Displays	-2.4		-10.0	
TOTAL INERT WEIGHT CHANGES	+14.8	-6.8		
TOTAL EFFECTIVE WEIGHT CHANGES BY RESPONSIBILITY			-28.5	+ 2.0
TOTAL REPORTED WEIGHT CHANGES = -26.5 pounds				

* Inert weight excludes ΔV propellant.

Pending Changes

		Estimated Weight Increment		
		Ascent (Inert*)	Descent (Inert*)	Separation (Effective)
1.	Delete the Redundant Pressurization Feed System from the Reaction Control Subsystem - LWSS 310B-1 Weight Reduction.	-11.1		-46.7
2.	Reduce the LEM hover time by one minute-Proposed Weight Reduction is in terms of equivalent inert weight at Touchdown.		-530.0	-1130.1
3.	Incorporate the stowage provisions for additional Government Furnished Equipment included in reference 5.	-	-	
4.	Eliminate Landing Gear Thermal Paint since it is not an effective regulation of the honeycomb cartridge temperature. Solutions to this problem are being studied.	-	-	
5.	Provide a heated enclosure for the pyrotechnic batteries.	-	-	
6.	Actual weights of pre-production Propulsion propellant tanks indicate changes from the nominal calculated weights.			
	A. Descent Tanks		+8.0	+17.1
	B. Ascent Tanks	- 8.6		-36.0
7.	Incorporate the Optical Tracker Installation in lieu of the Rendezvous Radar and the Alignment Optical Telescope.	-75.4		-315.8
8.	Actual weights of AEDC engine indicates the weight of the ascent engine will be lower than reported.	- 6.5		-27.3
9.	Reduce the size of the Super Critical Helium Heat Exchanger due to better heat transfer than originally estimated.		-6.0	-12.8
10.	Delete baffles from propellant tank based on current dynamic analysis and RCS propellant trade-off studies - LWSS 270A-19 Weight Reduction. (RCS propellant is incorporated in the current vehicle weight.)	-21.8	-37.9	-172.1

* Inert weight excludes Δ V Propellant.

GOVERNMENT FURNISHED EQUIPMENT

The Government Furnished Equipment list in the previous report, ref. 10, is unchanged since no further official data was received from MSC.

The contractor submitted Specification Change Notice (SCN)#27 against LSP 470-1A for approval. This SCN reflects the contractor's current understanding of Government Furnished Equipment in terms of weight and location at various mission events. This SCN, approved or amended, is expected to be the base of the next Government Furnished Equipment List published in a subsequent LEM Mass Property Report.

LIST OF REFERENCES

1. MSC letter PL2-13-64-571, dated 26 October 1964, "Contract NAS 9-1100, Transmittal of the Apollo Lunar Landing Design Reference Mission Trajectory."

2. MSC letter PP6-13-64-646, dated 20 November 1964, "Contract NAS 9-1100, LEM Weight Report."

3. MSC letter PL2-12-77/13-64-704, dated 14 December 1964, "Contract NAS 9-1100, Resolution of M-5 Mockup Review Chits 1-16 and 1-20."

4. MSC letter BG54 65-78, dated 2 March 1965, "Contract NAS 9-1100, Contract Change Authorization No. 103, Covering an Electrical Power Subsystem Configuration Change."

5. MSC letter PS5/L229-13-65-982, dated 15 November 1965, "Contract NAS 9-1100, Current Weight Status of GFE Equipment."

6. MSC letter BG54 65-331, dated 31 August 1965, "Contract NAS 9-1100, Contract Change Authorization No. 131, Exhibit D, PLSS LiOH Cartridge and EMU O_2 Recharge, Water Recharge, Gas, and Waste Connectors as GFE."

7. MSC letter BG54 65-426, dated 29 October 1965, "Contract NAS 9-1100, Contract Change Authorization No. 146, Replace Water Squib Valve with Manual Water Shutoff Valve."

8. MSC letter BG54 65-471, dated 24 November 1965, "Contract NAS-9-1100, Contract Change Authorization No. 156, Modifications to the ECS to Facilitate Changing of the PLSS Water Supply."

9. LED-490-23, dated 1 August 1965, "LEM Mass Property Report (U)."

10. LED-490-27, dated 1 December 1965, "LEM Mass Property Report (U)."

11. LED-490-100 Revision B, Re-issued 15 February 1965, Allocation of Propellants and ΔV to Meet the ΔV Budget."

12. LAV-500-155, dated 6 July 1965, "Required ΔV For Abort Using the Ascent Engine.

13. LMO-310-247, dated 9 September 1965, "RCS Mission and Residual Propellant Requirements (U)."

14. LMO-490-165, dated 10 February 1965, "Ascent and Descent Main Propellant Allocation, Criteria and Assumptions."

15. LMO-500-352, dated 6 December 1965, "Estimated RCS Propellant Required for LEM Attitude Maneuvers and Control for a Typical Lunar Mission."

16. LMU-340-50025, dated 25 September 1964, Inboard Profile.

LIST OF REFERENCES - Cont.

17. LDW-280-10050, Revision E, dated 26 May 1965, "Geometry Ascent Stage -2 Tank" Drawing.

18. LDW-280-17000, Revision C, dated 17 June 1965, "General Arrangement Descent Stage" Drawing.

19. LED-360-22, Revision C, dated 15 November 1965, "LEM-1,-2,-3 Measurements List."

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