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CLASSIFICATION CHANGE

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SID 65-110-1

BI-MONTHLY WEIGHT AND BALANCE STATUS REPORT FOR CSM 009

CONTRACT NAS 9-150

(U)

1 MAY 1965

Exhibit I, Paragraph 8.10

Prepared by

Weight Control

[redacted]

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FORM M158-D-2, VELLUM REV. 2-61

TECHNICAL REPORT INDEX/ABSTRACT

ACCESSION NUMBER						DOCUMENT SECURITY CLASSIFICATION Confidential	

TITLE OF DOCUMENT	LIBRARY USE ONLY
Bi-Monthly Weight and Balance Status Report for CSM 009	
AUTHOR(S) D. D. Morgan	

CODE	ORIGINATING AGENCY AND OTHER SOURCES	DOCUMENT NUMBER
	NAA-S&ID	SID 65-110-1

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DESCRIPTIVE TERMS

ABSTRACT

The Weight and Balance Status Report for CSM 009 presents summary mass property data for each module in addition to the usable SPS propellant required for the 190 second total burn time. Mass property data also includes the total vehicle from launch to CSM at SPS burnout, the LEV abort phase to CM at impact and the normal CM entry mission. The CM is ballasted to meet the required lift to drag ratio of 0.34 at entry. The LES is ballasted to 8200 pounds resulting in a center of gravity for the LEV at LEV burnout of X_a 1122.1.

FORM 131-V REV. 6-64

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INTRODUCTION

The May report incorporates changes to the CSM 009 subsequent to the February report (SID 65-110). The change descriptions are included in the current weight status section.

The Command Module status includes 444 pounds of aft heat shield ballast and 212 pounds of crew compartment simulated systems ballast to maintain the lift to drag ratio of 0.34 at entry. To achieve the CM design weight consistent with the Block I control weight of 11,000 pounds, 125 pounds of additional ballast is required.

The ballast in the Launch Escape System has been reduced by 105 pounds from the February report to maintain the 8200 pound control weight. This results in a change in the LEV burnout center of gravity, along the X axis of 2.9 inches (1125.0 to 1122.1). The change is acceptable at this time, pending actual verification of the 1125.0 requirement by future tests.

The Service Module weight status is currently 1133 pounds under the design weight of 9200 pounds. The fluid residuals, which are a part of the burned out SM weight of 8067, include 0.5% loading tolerance and the start and restart losses.

The revised curves for the LEV weight versus center of gravity and inertia, SPS propellant burning versus center of gravity and inertia, and the module weight distributions will be included in the July report.

A list of potential changes for each module is as follows:

COMMAND MODULE	(+69)
Increase apex area based on structural modifications.	+20
Add a vent line to each propellant and oxidizer tank.	+4
Study implementation of using HF Recovery Antenna.	-2
Increase wiring based on actual weights.	+130
Delete silicone potting compound on -Z side of the aft heat shield.	-83
SERVICE MODULE	(+42)
Modify SPS engine to use pneumatic action for the propellant valves.	+20
Add heater blankets to the RCS housings.	+2
Add edge isolating material to ECS radiators.	+7
Increase the SPS engine.	+13

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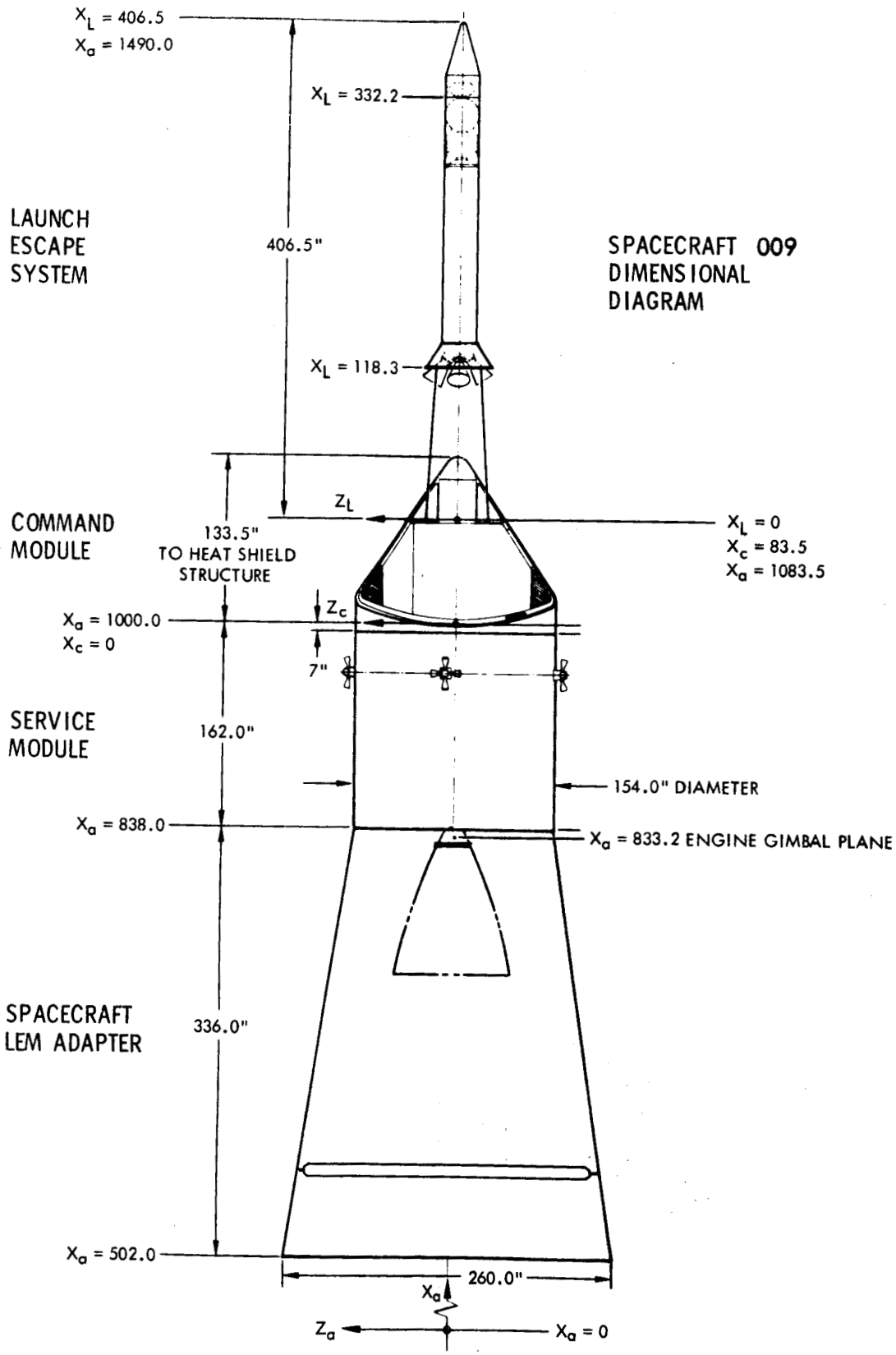
X_L = 406.5
X_a = 1490.0
X_L = 332.2
LAUNCH ESCAPE SYSTEM
406.5"
SPACECRAFT 009 DIMENSIONAL DIAGRAM
X_L = 118.3
Z_L
COMMAND MODULE
133.5" TO HEAT SHIELD STRUCTURE
X_L = 0
X_c = 83.5
X_a = 1083.5
Z_c
X_a = 1000.0
X_c = 0
7"
SERVICE MODULE
162.0"
154.0" DIAMETER
X_a = 838.0
X_a = 833.2 ENGINE GIMBAL PLANE
SPACECRAFT LEM ADAPTER
336.0"
X_a = 502.0
260.0"
X_a
Z_a
X_a = 0

CSM 009

MODULE MASS PROPERTIES SUMMARY

ITEM	WEIGHT	CENTER OF GRAVITY*			MOMENT OF INERTIA**			PRODUCT OF INERTIA**		
		X	Y	Z	I_{xx}	I_{yy}	I_{zz}	I_{xy}	I_{xz}	I_{yz}
LAUNCH ESCAPE SYSTEM	8200	1298.4	0.0	0.0	567.7	21430.6	21431.2	16.3	64.4	-0.2
COMMAND MODULE	11000	1040.8	0.3	5.0	5358.4	4876.1	4348.6	-10.7	-244.2	-43.9
SERVICE MODULE***	8067	911.3	-0.2	0.5	5193.9	8838.4	8850.7	-80.1	-14.8	-189.0
ADAPTER	3480	646.0	0.4	-2.0	8374.1	11694.5	11448.8	14.6	-72.3	-14.9

*Centers of gravity are in the NASA reference system except that the longitudinal axis has an origin 1000 inches below the tangency point of the Command Module substructure mold line.

**Moments and products of inertia units are slug feet squared about the center of gravity.

***Includes unusable SPS residuals but excludes the usable SPS propellant.

CSM 009 MISSION

VEHICLE MODE	WEIGHT	CENTER OF GRAVITY*			MOMENT OF INERTIA**			PRODUCT OF INERTIA**		
		X	Y	Z	I_{xx}	I_{yy}	I_{zz}	I_{xy}	I_{xz}	I_{yz}
COMMAND MODULE	11000	1040.8	0.3	5.0	5358.4	4876.1	4348.6	-10.7	-244.2	-43.9
SERVICE MODULE***	8067	911.3	-0.2	0.5	5193.9	8838.4	8850.7	-80.1	-14.8	-189.0
SLA ATTACHMENT RING	75	837.1	0.0	-1.8	93.3	47.6	45.7	0.0	0.0	0.0
TOTAL-LESS PROPELLANT***	19142	985.4	0.1	3.1	10575.8	30727.5	30216.0	65.3	597.1	2.3
PROPELLANT - SPS USABLE	13004	882.7	27.3	-11.5	4329.4	3836.1	4473.6	-7.3	-6.3	2124.4
TOTAL - WITH PROPELLANT	32146	944.1	11.0	-2.8	16483.3	52466.7	55601.8	-4585.2	3088.3	-657.6
ADAPTER-LESS ATTACHMENT RING	3405	641.8	0.4	-2.0	8280.8	11042.8	10799.0	15.8	-72.9	-14.9
TOTAL INJECTED	35551	915.0	10.0	-2.7	24855.8	124134.7	127158.6	-2447.6	2929.2	-663.2
LAUNCH ESCAPE SYSTEM	8200	1298.4	0.0	0.0	567.7	21430.6	21431.2	16.3	64.4	-0.2
TOTAL AT LAUNCH	43751	987.0	8.1	-2.2	25595.1	356900.9	359994.0	-7970.7	4426.1	-702.4

*Centers of gravity are in the NASA reference system except that the longitudinal axis has an origin 1000 inches below the tangency point of the Command Module substructure mold line.

**Moments and products of inertia units are slug feet squared about the center of gravity.

***Includes unusable SPS residuals but excludes the usable SPS propellant.

CSM 009

LAUNCH ESCAPE VEHICLE

VEHICLE MODE	WEIGHT	CENTER OF GRAVITY*			MOMENT OF INERTIA**			PRODUCT OF INERTIA**		
		X	Y	Z	I_{xx}	I_{yy}	I_{zz}	I_{xy}	I_{xz}	I_{yz}
COMMAND MODULE	11000	1040.8	0.3	5.0	5358.4	4876.1	4348.6	-10.7	-244.2	-43.9
LAUNCH ESCAPE SYSTEM	8200	1298.4	0.0	0.0	567.7	21430.6	21431.2	16.3	64.4	-0.2
TOTAL - ABORT INITIAL	19200	1150.8	0.2	2.9	5957.4	93440.2	93023.1	-78.4	-1306.0	1.5
LESS: MAIN AND PITCH MOTOR PROPELLANTS	-3198	1294.3	0.0	0.0	71.4	1336.7	1336.6	0.0	0.0	0.0
TOTAL LEV AT BURNOUT	16002	1122.1	0.2	3.4	5879.2	75045.9	74635.6	-57.9	-965.6	1.1

*Centers of gravity are in the NASA reference system except that the longitudinal axis has an origin 1000 inches below the tangency point of the Command Module substructure mold line.

**Moments and products of inertia units are slug feet squared about the center of gravity.

CSM 009

CM ENTRY MISSION

VEHICLE MODE	WEIGHT	CENTER OF GRAVITY*			MOMENT OF INERTIA**			PRODUCT OF INERTIA**		
		X	Y	Z	I_{xx}	I_{yy}	I_{zz}	I_{xy}	I_{xz}	I_{yz}
COMMAND MODULE	11000	1040.8	0.3	5.0	5358.4	4876.1	4348.6	-10.7	-244.2	-43.9
LESS: PROPELLANT	-135	1022.6	-5.1	56.6						
ABLATOR BURNOFF***	-365	1016.2	-0.4	15.7						
FORWARD HEAT SHIELD	-414	1098.5	0.0	0.4						
DROGUE CHUTES	-56	1089.1	0.0	-21.0						
COMMAND MODULE - PRIOR TO MAIN CHUTE DEPLOYMENT	10030	1039.3	0.5	4.2	5259.5	4390.4	3960.0	-12.7	-159.6	-35.1
LESS: MAIN CHUTES (3)	-409	1090.8	-1.8	6.2						
PROPELLANT	-135	1022.6	-5.1	56.6						
COMMAND MODULE - IMPACT	9486	1037.4	0.6	3.4	5176.4	4058.7	3708.6	-4.5	-146.5	-25.9

*Centers of gravity are in the NASA reference system except that the longitudinal axis has an origin 1000 inches below the tangency point of the Command Module substructure mold line.

**Moments and products of inertia units are slug feet squared about the center of gravity. Mass inertia data are shown for accumulative totals only.

***Ablator burnoff based on normal entry condition. Specific burn-off data as applicable to S/C 009 is being determined and will be reflected as soon as the data is available.

CSM 009

CM LOW ALTITUDE ABORT CONFIGURATION

VEHICLE MODE	WEIGHT	CENTER OF GRAVITY*			MOMENT OF INERTIA**			PRODUCT OF INERTIA**		
		X	Y	Z	I_{xx}	I_{yy}	I_{zz}	I_{xy}	I_{xz}	I_{yz}
COMMAND MODULE	11000	1040.8	0.3	5.0	5358.4	4876.1	4348.6	-10.7	-244.2	-43.9
LESS: RCS OXIDIZER	-180	1022.6	15.6	62.4						
FORWARD HEAT SHIELD	-414	1098.5	0.0	0.4						
DROGUE CHUTES	-56	1089.1	0.0	-21.0						
COMMAND MODULE - PRIOR TO MAIN CHUTE DEPLOYMENT	10350	1038.5	0.0	4.3	5199.4	4142.9	3945.5	11.3	76.1	-34.7
LESS: RCS FUEL	-90	1022.6	-46.5	44.9						
MAIN CHUTES (3)	-409	1090.8	-1.8	6.2						
COMMAND MODULE - IMPACT	9851	1036.5	0.5	3.9	5123.7	3855.5	3647.9	7.5	78.1	2.8

*Centers of gravity are in the NASA reference system except that the longitudinal axis has an origin 1000 inches below the tangency point of the Command Module substructure mold line.

**Moments and products of inertia units are slug feet squared about the center of gravity. Mass inertia data are shown for accumulative totals only.

CSM 009

WEIGHT STATUS SUMMARY

ITEM	PREVIOUS STATUS 2-1-65	CHANGES TO CURRENT	CURRENT STATUS 5-1-65	BASIS FOR CURRENT CSM 009 STATUS		
				%EST	%CALC	%ACT
LAUNCH ESCAPE SYSTEM	8305	-105	8200	15	66	19
COMMAND MODULE	11000	0	11000	9	66	25
SERVICE MODULE	8260	-193	8067	5	80	15
ADAPTER	3480	0	3480	25	63	12
TOTAL LAUNCH WEIGHT*	31045	-298	30747	11	70	19

*Less SPS usable propellant.

LAUNCH ESCAPE SYSTEM 009

WEIGHT STATUS

ITEM	PREVIOUS STATUS 2-1-65	CHANGES TO CURRENT	CURRENT STATUS 5-1-65	BASIS FOR CURRENT LES 009 STATUS		
				%EST	%CALC	%ACT
Structure-Includes Q-Ball	1537.4		1537.4		43	57
Ballast-Installation Provisions	29.0		29.0		100	
Electrical	52.5		52.5	78	22	
Propulsion System	5368.6		5368.6		88	12
Separation Provisions	16.2		16.2	53	47	
C/M Boost Protective Cover	580.0		580.0	100		
LES-NO BALLAST	7583.7		7583.7	8	72	20
BALLAST	721.3	-105.0	616.3	100		
TOTAL LAUNCH ESCAPE SYSTEM	8305.0	-105.0	8200.0	15	66	19

COMMAND MODULE 009

WEIGHT STATUS

ITEM	PREVIOUS STATUS 2-1-65	CHANGES TO CURRENT	CURRENT STATUS 5-1-65	BASIS FOR CURRENT CM 009 STATUS		
				%EST	%CALC	%ACT
Structure	5267.7	+315.9	5583.6	8	60	32
Stabilization & Control	190.0	0.0	190.0	10	90	
Environmental Control	293.4	0.0	293.4	16	38	46
Earth Recovery	598.1	+5.0	603.1	4	76	20
Instrumentation	244.0	0.0	244.0	40	60	
Electrical Power	1261.5	+75.0	1336.5	10	35	55
Reaction Control	304.0	0.0	304.0	14	86	
Communications	288.1	0.0	288.1	25	75	
Displays & Controls	95.2	0.0	95.2		65	35
Useful Load-Reaction Control	270.0	0.0	270.0		100	
Items for CM 009	111.1	-10.0	101.1	10	90	
Platform	907.3	+2.7	910.0	15	85	
Simulated Systems-Ballast	100.0	+112.4	212.4		100	
Ballast-Aft Heat Shield	369.6	+74.0	443.6		100	
TOTAL-MINIMUM WEIGHT CM	10300.0	+575.0	10875.0	10	64	26
Additional Simulated Ballast	832.9	-506.5	326.4		100	
Aft Heat Shield Ballast-Deleted	-369.6	-74.0	-443.6		100	
Ballast-Aft Heat Shield	236.7	+5.5	242.2		100	
TOTAL COMMAND MODULE	11000.0	0.0	11000.0	9	66	25

SERVICE MODULE 009

WEIGHT STATUS

ITEM	PREVIOUS STATUS 2-1-65	CHANGES TO CURRENT	CURRENT STATUS 5-1-65	BASIS FOR CURRENT SM 009 STATUS		
				%EST	%CALC	%ACT
Structure	2707.3	-210.7	2496.6		63	37
Environmental Control	69.8	0.0	69.8		100	
Instrumentation	241.5	0.0	241.5	40	60	
Electrical Power	516.9	+52.5	569.4	24	31	45
Service Propulsion	2907.5	0.0	2907.5	6	94	
Reaction Control	343.0	0.0	343.0	13	87	
Fluid Residuals*	684.0	-34.8	*649.2		100	
Usable Fluids-RCS (Full)	790.0	0.0	790.0		100	
TOTAL SERVICE MODULE	8260.0	-193.0	8067.0	5	80	15

*Propulsion Residuals		601.2
Helium	(99.0)	
Propellant	(502.0)	
Trapped In System	265.2	
Trapped In Engine	68.6	
Mixture Ratio Tolerance	99.3	
Loading Tolerance-Oxidizer Only	44.9	
Restart Losses (2 Starts)	24.2	
RCS Residuals		48.0
Helium	(3.0)	
Propellant	(45.0)	
Trapped In System	4.0	
Mixture Ratio	9.0	
Expulsion Efficiency	24.0	
Loading Tolerance	3.0	

ADAPTER 009

WEIGHT STATUS

ITEM	PREVIOUS STATUS 2-1-65	CHANGES TO CURRENT	CURRENT STATUS 5-1-65	BASIS FOR CURRENT ADP 009 STATUS		
				%EST	%CALC	%ACT
Structure (Includes Stabilizing Members)	3163.7		3163.7	19	68	13
Electrical	61.0		61.0	82	18	
Separation System	255.3		255.3	83	17	
TOTAL ADAPTER	3480.0		3480.0	25	63	12

LAUNCH ESCAPE SYSTEM

CURRENT WEIGHT CHANGES

Decrease the ballast (Item 9, Page 11) due to the LES being constrained to 8200 pounds.	-105
TOTAL LAUNCH ESCAPE SYSTEM CURRENT WEIGHT CHANGES	-105

COMMAND MODULE

CURRENT WEIGHT CHANGES

STRUCTURE	(+315.9)
Increase aft heat shield substructure (Items 4 and 5, Page 14) due to revised drawing and actual weighing.	+40.0
Transfer Y-Y attenuation struts (Item 18, Page 14) to platform due to Y-Y struts being part of suspended load.	-14.1
Add windows in lieu of structural covers to the center heat shield substructure (Page 15).	+50.0
Add steel channels to wire raceway to provide structural integrity (Page 15).	+10.0
Add silicone potting compound to aft heat shield for rigidity at impact (Page 15).	+180.0
Add potting-internal to air lock due to increased water impact loads (Page 15).	+50.0
EARTH RECOVERY	(+5.0)
Add umbilical tension separation cylinder to ELS to provide access to the instrumentation umbilical after forward heat shield is installed (Page 20).	+5.0
ELECTRICAL POWER	(+75.0)
Add wiring for Mission Control programmer not part of the load platform due to incorporating revised drawings (Page 26).	+35.0
Add wiring provisions such as string, clamps, varnish, etc. based on actual weighing of harness installations (Page 26).	+40.0
ITEMS FOR CM 009	(-10.0)
Delete water-waste tank (Item 4, Page 35) which was utilized as ballast and is unnecessary to the latest configuration.	-10.0

COMMAND MODULE

CURRENT WEIGHT CHANGES

PLATFORM	(+2.7)
Increase platform structure (Item 1, Page 36) due to revised drawings.	+18.7
Increase Post Landing Sequence Controller (Item 5, Page 36) based on calculated in lieu of an estimated weight.	+19.3
Add Y-Y attenuation struts to load platform which were transferred from structure (Page 37).	+14.1
Add structure for supporting platform ballast based on released drawings (Page 37).	+90.0
Decrease platform ballast (Item 4, Page 37) due to simulated weight and center of gravity requirements for the total platform.	-139.4
SIMULATED SYSTEMS - BALLAST	(+112.4)
Increase simulated systems ballast (Item 1, Page 38) due to maintaining center of gravity requirements for minimum weight Command Module.	+112.4
BALLAST - AFT HEAT SHIELD	(+74.0)
Increase aft heat shield ballast (Page 39) due to maintaining center of gravity requirements for minimum weight Command Module.	+74.0
TOTAL COMMAND MODULE CURRENT WEIGHT CHANGES (MINIMUM WEIGHT) (TO BE BROUGHT FORWARD)	+575.0

COMMAND MODULE

CURRENT WEIGHT CHANGES

BALLAST TO ACHIEVE CONTROL WEIGHT	
ADDITIONAL SIMULATED SYSTEMS - BALLAST	(-506.5)
Decrease simulated systems ballast (Page 43) consistent with maintaining center of gravity requirements at the control weight.	-506.5
BALLAST - AFT HEAT SHIELD	(-68.5)
Decrease aft heat shield ballast (Page 44 and 45) consistent with maintaining center of gravity requirements at the control weight.	-68.5
TOTAL BALLAST CHANGES TO ACHIEVE CONTROL WEIGHT	-575.0
TOTAL COMMAND MODULE CURRENT WEIGHT CHANGES (MINIMUM WEIGHT) (BROUGHT FORWARD FROM PAGE 15)	+575.0
TOTAL CM CURRENT WEIGHT CHANGES (CONTROL WEIGHT)	0.0

SERVICE MODULE

CURRENT WEIGHT CHANGES

STRUCTURE	(-210.7)
Decrease insulation (Item 10, Page 47) due to internal insulation being deleted from the configuration.	-189.7
Decrease fittings and attaching parts (Item 1, Page 48) due to revised drawings.	-15.0
Decrease RCS engine supports and insulation (Items 14, 15, 16, 17, Page 48) due to cork insulation being used in lieu of plume shields.	-6.0
ELECTRICAL POWER	(+52.5)
Increase wiring and connectors (Items 1, 2, 3, 4, 5 and 11, Page 53) based on revised wiring lengths and increased wiring provisions such as string, clamps, varnish, etc.)	+52.5
FLUID RESIDUALS	(-34.8)
Decrease SPS residuals (Items 9, 10, 11, 12, 13, Page 62 and Item 1, Page 63) consistent with the CSM 009 DEI presentation.	-34.8
TOTAL SERVICE MODULE CURRENT WEIGHT CHANGES	-193.0

CSM 009

GOVERNMENT FURNISHED EQUIPMENT

Command Module	(37.5)
PAM/FM/FM Package	16.0
Commutators (3)	9.0
Survival Beacon	5.0
Radio Command Equipment	5.5
Calibrator (installed in flight qual. tape recorder)	2.0
Service Module	(210.1)
PAM/FM/FM System	25.1
Mod. Kit	185.0
Launch Escape System	(25.0)
"Q" Ball	25.0
TOTAL GOVERNMENT FURNISHED EQUIPMENT	272.6