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APOLLO

GUIDANCE AND NAVIGATION

Approved: Milton B. Trageser Date: 12/23/63
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APOLLO GUIDANCE AND NAVIGATION PROGRAM

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E-1142 (REV. 15)

(UNCLASSIFIED TITLE)

SYSTEMS STATUS
REPORT

December 15, 1963

[redacted] INSTRUMENTATION LABORATORY
CAMBRIDGE 39, MASSACHUSETTS

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ABSTRACT

The System Status Report, E-1142, is distributed monthly on the 15th. This month's revision, Rev. 15, contains weight and balance data and power requirement information for the guidance and navigation equipment in the Lunar Excursion and Command Modules. In addition, the status of the Command Module computer programs is included.

Section 1

INTRODUCTION

1-1 INTRODUCTION

The following information is included in this month's report: (1) weights, centers of gravity, and moments of inertia of G&N equipment in the Command Module and weights of G&N equipment in the Lunar Excursion Module, (2) power requirements of G&N equipment in the Command and Lunar Excursion Modules, and (3) the status of Command Module computer programs.

System status reports and revisions to this date have applied to the so-called Block I G&N configuration. The definition of what constitutes Block II has now reached the stage (see Glossary) where monthly reporting on Block II as well as Block I and LEM G&N will be added starting with the January edition of this document.

Weights in this report for the Command Module are based upon the current "Block I" design releases. The Lunar Excursion Module weights are based on the best estimate of those expected for the LEM design release which will occur early in 1964.

1-2 ACCURACY

The accuracy of numerical values reported in this revision should not be considered to be within the tolerances implied by the significant figures quoted. The reported values, although based upon the most current information, are subject to normal changes as design and development phases approach completion.

COMMAND MODULE

Section 2

COMMAND MODULE DATA

2-1 WEIGHTS

Table 2-I presents the weights of all Block I equipment, grouped according to specific location within the Command Module. Weights are reported to the component level and to the nearest tenth of a pound.

Given component weights are identified as estimated, calculated, and measured in the order of increasing accuracy. These terms are defined by North American Aviation as follows.

Estimated weights (E) are based on rough calculations. Calculated weights (C) are based on detailed calculations made from final production drawings that will be used to build flyable equipment. Measured weights (M) are the actual weights of equipment built to the production drawings.

Since most weight values now reported can be classified as only estimated weights, MIT herein affixes a prime to the (E) symbol, i.e., (E'), to denote values which MIT, for various reasons, feels to be more accurate than estimated values, yet which cannot be defined as either calculated or measured weights.

North American Aviation will provide and be responsible for coldplate weights which are not integral with guidance and navigation equipment.

2-1.1 WEIGHTS STATUS REPORTING. Table 2-I also offers a comparison of present component weight values with those listed in System Status Report, E-1142 (Rev. 14), November 15,1963. All weight changes are explained in paragraph 2-2.

2-1.2 SPEC. WEIGHT. The "Spec. Weight" column in table 2-I contains "proposed MSC weights," that is, goals set forth by MSC in a memo to MIT dated December 5, 1962.

2-1.3 DESIGN LOAD WEIGHT. The "Design Load Weight" column contains worst-estimate design weights assigned to G&N subassemblies attached to the spacecraft structure. These values are included in this report as the result of an S&ID request, at NASA Coordination Meeting No. 8, that one total weight figure for supported G&N

Table 2-I. Current Weight Status of Command Module (lbs)

ITEM	Spec. Wt. 12/62 (a)	(b-a)	Status 11/63 (b)	(c-b)	Status 12/63 (c)	Design Load Wt. 12/63 (d)
LOWER EQUIPMENT BAY						
CDU & Frame Assy	6.0	+ 10.5	16.5(E)	-2.0	14.5(M)	17.2
Optical Subsystem						
SXT	12.0	0.0	12.0(E)	0.0	12.0(E)	
SCT	9.0	0.0	9.0(E)	0.0	9.0(E)	
Optical Base & Gearing	14.0	+ 7.0	21.0(E)	0.0	21.0(E)	
Optical Eyepieces						
SXT	2.0	+ 1.8	1.5(E)	0.0	1.5(E)	154.2
SCT			2.3(E)	0.0	2.3(E)	
IMU	40.0	+ 20.2	60.2(M)	0.0	60.2(M)	
NVB & Shock Mounts	16.0	+ 11.2	27.2(E)	0.0	27.2(E)	
Bellows Assy	8.0	+ 4.6	12.6(E)	0.0	12.6(E)	
G&N Interconnection Assy	30.0	+ 13.2	35.2(E)	0.0	35.2(E)	42.8
G&N to S/C Interface Assy			8.0(E)	0.0	8.0(E)	
D&C Nav Station						
IMU Control Panel	30.3	- 7.0	2.5(M)	-0.1	2.4(M)	6.8
D&C Electronics			5.6(E')	-2.7	2.9(M)	7.7
Control Electronics			1.7(E')	+1.2	2.9(E')	
Optical Shroud			3.8(E')	+1.4	5.2(M)	4.2
G&N Ind Cont Panel			9.7(E')	-0.2	9.5(M)	13.2
D&C/AGC	15.0	0.0	15.0(E)	+4.6	19.6(C)	19.4
M&DV (including 1 film)	5.0	+ 3.5	8.5(E)	0.0	8.5(E)	10.0
AGC (no spares)	80.0	+ 15.0	70.0(E)	0.0	70.0(E)	126.4
Spare Tray			25.0(E)	-25.0	*	
PSA	25.0	+ 34.4	59.4(E')	0.0	59.4(E')	65.0
Coolant Hoses	0.0	+ 1.0	1.0(E')	0.0	1.0(E')	

BLOCK I

Table 2-I. Current Weight Status of Command Module (lbs) (cont)

Item	Spec. Wt. 12/62 (a)	(b-a)	Status 11/63 (b)	(c-b)	Status 12/63 (c)	Design Load Wt. 12/63 (d)
MAIN PANEL AREA						
D&C/AGC	5.0	+ 10.0	15.0(E)	+ 4.5	19.5(C)	17.2
D&C/NAV	8.0	- 8.0	--	--	--	
LOOSE STORED ITEMS						
Eye Relief Eyepieces	--	+ 1.5	1.5(E)	0.0	1.5(E)	
Film Cartridges (4)	--	+ 3.0	3.0(E)	0.0	3.0(E)	
AGC Loose Spares	20.0	+ 0.3	17.3(E)	-17.3	*	
PSA Loose Spares			0.0	0.0	*	
CDU Spare Gearbox			3.0(E)	- 3.0	*	
Horizon Photometer	--	+ 4.0	4.0	- 0.4	3.6	
Spare Relay & Diode Module	--	+ 0.3	0.3(E)	0.0	0.3(E)	
TOTAL	325.3	126.5	451.8	-39.0	412.8	
*List of Possible Spares for Block I						
AGC Spare Logic Tray			25.0(E)	0.0	25.0(E)	
AGC Spare Memory Tray			34.6(E)	0.0	34.6(E)	
PSA Spare (Unique) Modules			16.7(E)	0.0	16.7(E)	
CDU Spare			3.0(E)	-0.5	2.5(E)	

load be assigned for structural design use. MIT herein assigns a total G&N design load weight, in table 2-I, which does not include items termed "loose stored items." The breakdown of this total weight into the individual items of columna "d" is typical only.

2-2 REPORTED WEIGHT CHANGES

The Block I weight status summarized in table 2-I this month separates the weight of possible spares from the main body of the table. This was done in recognition of the Development Test Plan activities now under way at S&ID which are defining Block I G&N usage. Since any spacecraft flights involving Block I G&N hardware will be unmanned or of only limited duration, the need for carried spares is doubtful. (Block II G&N will carry no spares in any event; a detailed report on weight hopefully will be published here next month.) Because Block I was originally designed for use of spares for inflight repair, the weight of possible spares is listed separately for information in table 2-I.

Other changes since last month's report, E-1142 (Rev. 14), November 15, 1963, shown in table 2-I are explained below. All weight changes shown in column (c - b) of the table are the result of weighing of the components except for the following.

2-2.1 CONTROL ELECTRONICS. The previous weight represented only the transformer weight. The weight increase reflects the additional weights of the components which make up the Control Electronics. These are identified in the Glossary.

2-2.2 D&C/AGC (LEB). The weight increase is due to the addition of spare relays and to the weighing of 50% of the parts.

2-2.3 D&C/AGC (MP). Same as 2-2.2.

2-3 CENTERS OF GRAVITY

Table 2-II presents the centers of gravity of each weight component or packaged assembly, determined with respect to the basic X, Y, Z axes of the Command Module. Center of gravity values are given to the nearest tenth of an inch.

2-4 MOMENTS OF INERTIA

Table 2-II also presents the moments of the inertia of each weight component or packaged assembly, determined about each of the component axes which (1) run through the center of gravity of the component and (2) are parallel to the basic X, Y, Z axes of the Command Module.

COMMAND MODULE

BLOCK I

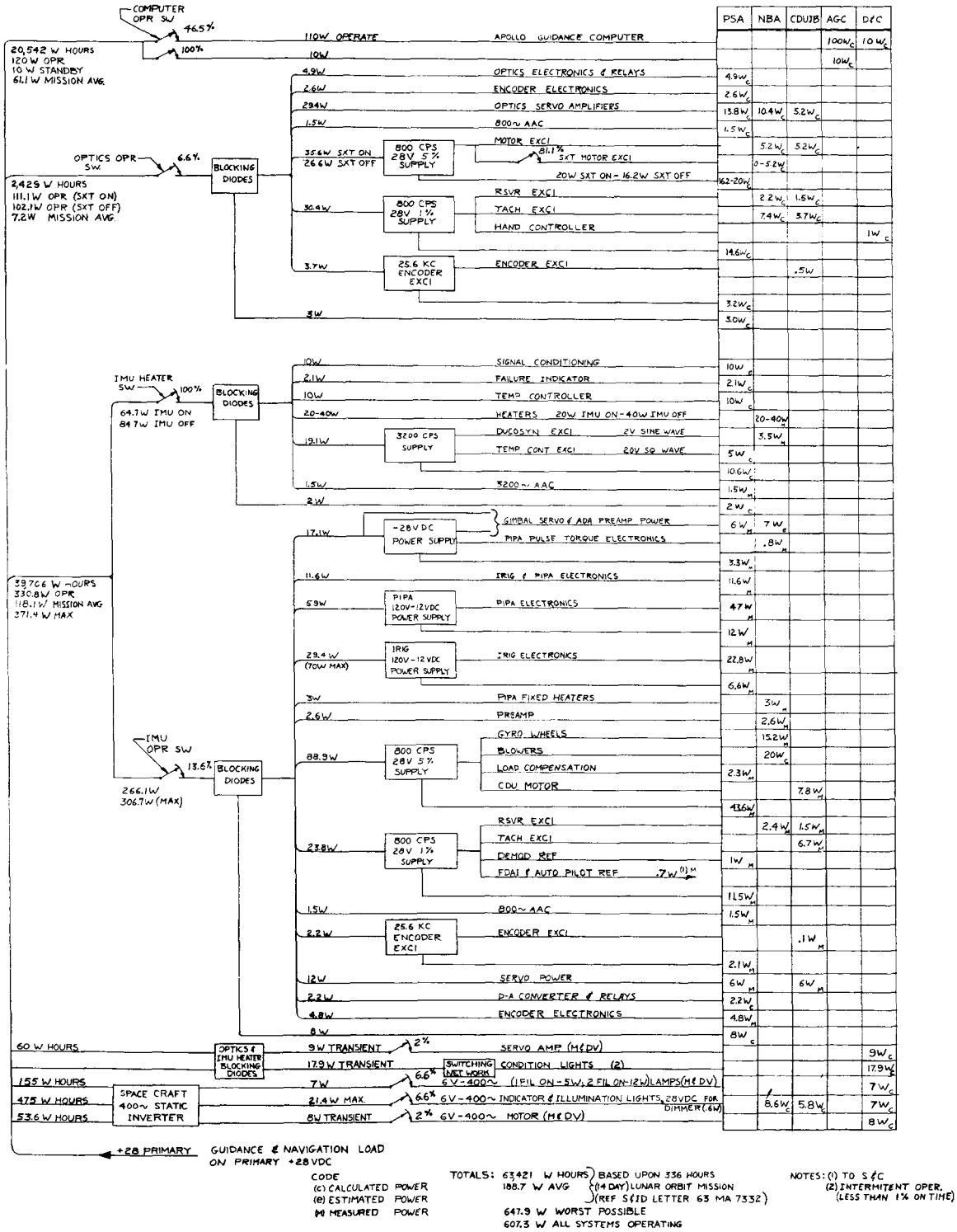

Figure 2-1. Electrical load on primary +28-VDC power supply

Table 2-II. Command Module Center of Gravity and Moment of Inertia Data

Item	Weight (lbs)	Centers of Gravity (inches)			Moments of Inertia ($lb\text{-}in^2$)		
		X	Y	Z	Ixx	Iyy	Izz
LOWER EQUIPMENT BAY							
CDU & Frame Assy	14.5*	63.5	-14.4	35.8	45*	410*	410*
Optical Subsystem							
SXT	12.0	70.5	-3.5	34.7			
SCT	9.0	70.5	5.5	34.7			
Opt. Base & Gearing	21.0	67.9	0.0	30.7			
Optical Eyepieces							
SXT	1.5	65.1	-3.5	26.2	5	10	5
SCT	2.3	65.1	4.5	26.2	10	10	10
IMU	60.2	56.6	0.0	41.7	1186*	1450*	1438*
NVB & Shock Mounts	27.2	64.3	-0.1	41.3	3270	4050	5210
Bellows Assy	12.6						
G&N Interconnection Assy	35.2						
G&N to S/C Signal Assy	8.0						
D&C/NAV Station							
IMU Cont Panel	2.4*	74.0	-15.4	30.9	15*	22*	24*
D&C Electronics	2.9*	49.5	-9.6	39.6	20*	22*	9*
Control Electronics Assy	2.9*	63.1*	10.7*	34.9*	9*	15*	8*
Optical Shroud	5.2*	66.8	0.0	28.9	387*	108*	413*
G&N Ind. Control Panel	9.5*	54.1	0.1	33.9	460*	120*	580*
D&C/AGC	19.6						
M&DV (includes 1 film)	8.5	73.5	-4.5	31.0			
AGC (no spares)	70.0	37.8	1.3	46.1	4980	3990	1710*
Spare Tray (logic)	25.0	38.2	-7.7	45.3	1290	1360	140

Table 2-II. Command Module Center of Gravity and Moments of Inertia (cont.)

Item	Weight (lbs)	Centers of Gravity (inches)			Moments of Inertia ($lb\text{-}in^2$)		
		X	Y	Z	Ixx	Iyy	Izz
PSA	59.4	45.0	-1.1	41.5	3940	1460	2620
Coolant Hoses	1.0						
MAIN PANEL AREA							
D&C/AGC	19.5*						
LOOSE STORED ITEMS							
Eye Relief Eyepieces (2)	1.5	(SCT, 4-5/8" × 2-1/2" dia.; SXT, 3" × 2-1/4" dia.)					
Film Cartridges (4)	3.0	(Each cartridge, 1-1/2 × 3 × 6 inches)					
AGC Loose Spares Mem. Tray	34.6*						
CDU Spare Gearbox	2.5*	(approximately 6.0 × 1-13/16 × 5 1/2 inches)					
Spare Relay & Diode Mod	0.3	(3 × 3 × 2 inches)					
Horizon Photometer	3.6*	(6 × 6 × 3 inches)					
PSA Loose Spares	16.7*						

* These values represent changes since the last report, E-1142 (Rev. 14), dated November 15, 1963.

2-5 COMMAND MODULE POWER REQUIREMENTS

The power requirements of the Command Module G&N equipment on the primary + 28-VDC power supply are shown in figure 2-1, which presents the magnitude and location of dissipated power values on a subassembly level. This chart assumes a 14-day lunar orbit mission as defined by S&ID for power profile computation (Ref: S&ID) letter 63 MA 7332).

Table 2-III shows the magnitude and location of power dissipation for the established G&N activities, each of which consists of various power levels of operation.

Table 2-IV shows the energy requirements for each G&N activity on a power level basis. The table is based upon MIT letter AG 679-6, "G&N Power Profile Status," dated August 14, 1963. The vertical column to the left indicates the various G&N activities (phases of operation) for the model 14-day mission submitted by S&ID in S&ID letter 63 MA 7332. This column also indicates the power consumption and operating time for each specific activity. The top row indicates the various power levels along with the power consumption and operating time of each power level.

Table 2-III. Nominal Power Dissipation (watts) vs G&N Activity

MODE	G&N Activity (power levels)	NBA		CDUJB	PSA		AGC	Thermal Load on S/C Coolant	D&C and S&C	Electrical Load
		IMU	OBA		IMU	OBA				
A	IMU & AGC Operate (1, 4)	74.5	0	22.1	233.5	0	110	440.1	10.7	450.8
B	IMU Alignment (1, 2, 4, 6)	74.5	39	44	233.5	63.6	110	564.6	42.7	607.3
C	Low-Orbit Navigation (1, 3, 4. 6)	74.5	33.8	44	233.5	59.8	110	555.6	42.7	598.3
D	Standby & Computing (1, 5)	43.5	0	0	41.2	0	110	194.7	10	204.7
E	Midcourse Navigation (1, 2, 5, 6)	43.5	39	21.9	41.2	63.6	110	319.2	42	361.2
F	IMU & AGC Standby (5. 7)	43.5	0	0	41.2	0	10	94.7	0	94.7
G	IMU Operate & AGC Standby (4, 7)	74.5	0	22.1	233.5	0	10	340.1	0.7	340.8

1.	AGC	120 watts
2.	Optics, SXT on	111.1 watts
3.	Optics, SXT off	102.1 watts
4.	IMU Operate	330.8 watts
5.	IMU Standby	84.7 watts
6.	Display and Control	45.4 watts
7.	AGC Standby	10 watts

Table 2-IV. Block I Command Module Power Profile for 14-Day Lunar Orbit Mission

MODE	G&N Activity	Power Consumption by Levels (kwh)							
		(1) AGC Operate 120 watts 156.09 hrs	(2) Optics, SXT On 111.1 watts 17.99 hrs	(3) Optics, SXT Off 102.1 watts 4.2 hrs	(4) IMU Operate 330.8 watts 45.28 hrs	(5) IMU Standby 84.7 watts 292.46 hrs	(6) Display & Control 45.4 watts 22.19 hrs	(7) AGC Standby 10.0 watts 181.65 hrs	TOTAL
A	IMU & AGC Operate 450.8 watts, 28.00 hrs	3.360	--	--	9.262	--	--	--	12.622
B	IMU Alignment 607.3 watts, 7.33 hrs	0.880	0.814	--	2.425	--	0.333	--	4.452
C	Low-Orbit Navigation 598.3 watts, 4.20 hrs	0.504	--	0.429	1.388	--	0.191	--	2.512
D	Standby & Computing 204.7 watts, 105.9 hrs	12.708	--	--	--	8.969	--	--	21.677
E	Midcourse Navigation 361.2 watts, 10.66 hrs	1.279	1.184	--	--	0.903	0.484	--	3.850
F	IMU & AGC Standby 94.7 watts, 175.9 hrs	--	--	--	--	14.899	--	1.759	16.658
G	IMU Operate & AGC Standby 340.8 watts, 5.75 hrs	--	--	--	1.902	--	--	0.058	1.960
	TOTAL	18.731	1.998	0.429	14.977	24.771	1.008	1.817	63.731

2-6 CURRENT STATUS OF COMMAND MODULE AGC PROGRAMS

Table 2-V lists current Command Module memory estimates and the status of AGC programs. The status of LEM AGC programs is not reported at this time.

A high and low word estimate is given with each program. Each status is defined as follows:

(1) Planning stage
(2) Programming stage
(3) Checkout on AGC simulation
(4) Checkout on G&N simulation
(5) Checkout on AGC

Table 2-V. Current Memory Estimates and the Status of Command Module AGC Programs

Program	Status	Memory Estimate (words)	
		High	Low
List Processing Interpreter	(4)	1600	1600
AGC Executive	(4)	250	250
AGC Waitlister	(4)	150	150
AGC System Exerciser, Checkout, and Error Handler	(3)	1000	750
G&N System Exerciser & Checkout	(2)	1000	750
Display, Keyboard, and Telemetry	(4)	1500	1500
Input/Output Control	(3)*	850	350
Midcourse and Orbital Navigation	(4)*	2000	1500
Midcourse and Orbital Guidance	(2)	500	500
Prelaunch Platform Alignment	(4)	400	400
In-Flight Platform Alignment	(2)	980	900
Recentry Control	(2)*	1290	1024
Injection and De-Boost	(2)	1000	400
Totals		12520	10074

* These items have changed since the last report, E-1142 (Rev. 14), dated November 15, 1963.

LUNAR EXCURSION MODULE

Section 3

LUNAR EXCURSION MODULE DATA

3-1 POWER REQUIREMENTS FOR LEM

The current estimate of LEM G&N power and energy (see table 3-I) is based upon the fixed-telescope concept and the use of the Command Module IMU and computer.

The values shown in table 3-I are center value estimates and do not include any safety factor for bad estimating.

Transient power peaks, occuring at higher power levels during turn-on and slewing operations, are considered to consume negligible energy. When they become available data on these peaks will be included.

Table 3-I. LEM Power Requirements
(Based upon GAEC Profile, Ref: NASA Coord. Meeting L3A)

	Power (watts)	Time (hrs)	Energy (kwh)
IMU Standby	84.7	103.8	8.78
IMU Operate	348.0	26.4	9.19
AGC Standby	10.0	21.3	0.21
AGC Operate	115.0	26.4	3.04
Radar CDU	18.4	23.8	0.44
Optics	Negligible		
Display and Controls	12.2	3.0	0.04
Rendezvous Radar	*	2.0	*
Landing Radar	*	1.0	*
TOTALS	493.6 (peak)		21.70
* Totals do not include radar loads.			

Note that the total energy drawn, 21.70 kwh, is considerably higher than for a "normal" mission since the estimate provides for full operate power for the 18 hours of "orbit contingency" mode. Without this contingency the G&N takes about 13 kwh based upon the GAEC profile.

Separate power turn-on switches are assumed for "IMU operate," "computer standby," "computer operate," and "radar CDU. The LEM G&N uses only the spacecraft + 28-VDC power supply except for operation of condition lights. The condition lights operate from the spacecraft 400-cps power supply.

3-2 WEIGHTS FOR LEM

Lunar Excursion Module weights are presented in table 3-II. In general the data conform to the information contained in paragraph 2-1 and 2-1.1.

Column (a), Target Weight, was taken from GAEC LMD 490-39, Enclosure 1, submitted to MIT at a weights review meeting on September 10, 1963. GAEC reported that G&N weights associated with D&C will be reported by them as part of the total spacecraft D&C. Therefore, target weights were not given by GAEC to supply the five items denoted by asterisks in column (a).

The row labeled Bare Guidance System is inserted to provide for comparisons with similarly specified systems.

3-3 REPORTED LEM WEIGHT CHANGES

All weight changes shown in column (c - b) are the result of CM BLOCK II G&N design changes which reflect directly on LEM hardware status. (see Glossary).

Table 3-II. Estimated Weights of LEM G&N Components (lbs at 1g)

Item	Target Wt. 8/63 (a)	(b-a)	Status 11/63 (b)	(c-b)	Status 12/63 (c)	Design Load Wt. (d)
CDU's	*		13.7(E)	+ 1.3	15.0 (E)	**
Telescope and All Eyepieces	12	+ 12.0	24.5(E)	0.0	24.5 (E)	
Navigation Base	4	- 4.0	--		--	
Eye Register for Reticule	*		2.0(E)	0.0	2.0 (E)	
Two-Digit Readout for Reticule	*		5.0(E)	0.0	5.0 (E)	
IMU	58	+ 2.2	60.2(M)	-18.2	42.0 (E)	
AGC/PSA Interconnection Assy	15	- 5.0	10.0(E)	0.0	10.0 (E)	
AGC Display and Controls	*		15.0(E)	+ 4.5	19.5 (E)	
Other Display and Controls	*		15.9(E)	- 0.9	15.0 (E)	
Book of Procedures, etc	2	0.0	2.0(E)	0.0	2.0 (E)	
AGC	60	- 0.4	59.6(E)	-18.1	41.5 (E)	
PSA	35	- 0.6	34.4(C)	- 7.4	27.0 (E)	
Coldplate	5	- 5.0	--		--	
TOTAL	191 Plus * Items not yet given		242.3	-38.8	203.5	
Bare Guidance System (IMU, PSA and computer): ** No design load weight has been assigned			154.2	-43.7	110.5	

GLOSSARY AND SYSTEM DEFINITION

AGC

Apollo Guidance Computer

CM BLOCK I A single complete flight computer containing all logic, memory, associated power supplies, and all interface circuits except those identified with the CDU's. Does not contain the associated displays and controls.

Consists of two trays containing replaceable electronic modules, the AGC end connector, and toe plate. Does not include the necessary cold plate or the G&N to CM interface assembly which is located in the adjacent area. Space exists for carrying an extra spare pair of AGC trays. These would not function in this spares location but could interchange with faulty trays in the active position. The spare trays are not included in this accounting.

CM BLOCK II Two complete and active computers each having the same functions as the BLOCK I AGC.

Consists of two wiring matrix headers mounted on each side of the cold plate. This cold plate is not included in this accounting and must be moved up from the BLOCK I configuration location. The modules of the "X" computer mount on one of these headers, the "Y" computer on the other.

BLOCK I and BLOCK II AGC's are not interchangeable.

LEM A single complete flight computer having the same functions as one of the BLOCK II computers. Unless installation constraints yet to be determined prevent it, the LEM computer will be physically identical with one of the BLOCK II computers.

AGC Spares

CM BLOCK I Spare AGC modules or trays as indicated.

CM BLOCK II No spares for AGC in BLOCK II

LEM No spares for AGC in LEM

Bellows Assembly

CM BLOCK I and CM BLOCK II Flexible pressure seal between CM structure and optical subsystem on NAV BASE for penetration of pressure hull with optics.

LEM Not identified separately in LEM. Is included in LEM as part of the AOT.

Coolant Hoses

CM BLOCK I and CM BLOCK II Consists of (1) three aluminum flex coolant hoses between IMU and spacecraft, optics and spacecraft, and optics and IMU, (2) bracket assembly screws and clamp, and (3) entrapped coolant.

LEM Not identified as part of LEM

CDU and Frame Assembly

The CDU provides the necessary signal interfaces among the IMU gimbal angles, optics gimbal angles, radar gimbal angles, angle registers in the AGC, the spacecraft autopilot attitude error signals, and the tracking radar command error signals.

CM BLOCK I Five interchangeable gear boxes each with necessary motor, tach, resolver synchros, and encoder with mounting framework. Does not include associated electronics which are located in the PSA.

CM BLOCK II Functionally identical to BLOCK I except the instrumentation is all electronic. Includes all support electronics including special power supply and is located in some volume as BLOCK I CDU's.

Changes in resolver synchro characteristics and mode controls make BLOCK I and II CDU's noninterchangeable.

LEM Interchangeable with CM BLOCK II CDU's.

D&C/AGC

Display and Control/Apollo Guidance Computer

CM BLOCK I & BLOCK II Number displays and keyboard control associated with the operation of the AGC. Two functionally identical and parallel operation units: one in lower equipment bay and one on main panel between left and center couches.

LEM Identical to CM except only a single unit is required.

G&N IND. CONT. PANEL

G&N Indicator Control Panel

CM BLOCK I & BLOCK II Consists primarily of controls and displays for the operation of the optics, and the IMU temperature control. Includes display and control elements, panel, panel wiring, and supporting hardware.

LEM Not defined at this time for LEM.

IMU Control Panel

CM BLOCK I Consists of panel, wiring, attitude error meter, CDU transfer switch, manual alignment switch. CDU mode control switches, connector, and supporting hardware.

CM BLOCK II Does not exist in BLOCK II. Moding is done by AGC program and AGC push buttons.

LEM Not defined at this time for LEM.

Control Electronics Assembly

CM BLOCK I Consists of one power transformer, one relay and diode module, and a bracket end connector. Used to support display and control functions.

CM BLOCK II May be relocated with other similar functions.

LEM Not defined in LEM

D&C Electronics Assembly

CM BLOCK I Consists of a chassis, a relay and diode module, a Demod. Elect. module, a saturable reactor, a time delay module, a connector, and wiring. Used to support displays and controls functions.

CM BLOCK II Similar and probably identical to BLOCK I.

LEM Not defined in LEM at this time.

Long Eye Relief Eyepieces

CM BLOCK I AND BLOCK II Consists of a SXT and a SCT eyepiece to provide eye relief of at least 1.6 inches for closed-visor operation. Used in place of normal eyepieces of SXT and SCT.

LEM Long-eye-relief eyepiece for the AOT is included as part of the AOT in this accounting.

Optical Shroud & Cover Assembly

CM BLOCK I AND BLOCK II Consists of the Optical Shroud and protective cover.

LEM Does not exist in LEM.

Film Cartridges

CM BLOCK I AND BLOCK II Consists of film cartridges and film for the Map and Data Viewer.

LEM Does not exist in LEM.

G&N Interconnection Assembly

CM BLOCK I Consists of PSA End Connector Assembly and interconnect wiring harness which electrically ties together the assembles that constitute a completely integrated system. This term does not include the G&N to CM Interface Assembly weight or the weights of harness support brackets which are a NAA responsibility.

CM BLOCK II Similar to Block I but not interchangeable with Block I.

LEM Not clearly defined at present, was called in earlier reports the AGC/PSA Interconnection Assy. Because of the wide separation of G&N components, most interconnection will be accomplished as part of spacecraft wiring.

G&N to CM Interface Assembly

CM BLOCK I Interconnections between the spacecraft wiring channel, the computer end connector, and the PSA end connector. Contains no active electronics.

CM BLOCK II Similar in function to BLOCK I except the configuration is much different and not interchangeable with BLOCK I.

LEM Not identified yet as a separate item in LEM.

IMU

Inertial Measurement Unit

CM BLOCK I Size 14 IMU (14-inch case diameter) gimbal assembly including all parts inside hermetic case and including extrapped coolant.

CM BLOCK II Size 12.5 IMU functionally interchangeable with BLOCK I unit, but not physically interchangeable with BLOCK I.

LEM Size 12.5 IMU as described above.

PSA End Connector Assembly

CM BLOCK I Electrical interconnection between the PSA trays, the G&N Interconnection Assy. and the G&N to CM Interface Assy.

CM BLOCK II Not identified as a separate item; will be part of the PSA matrix header.

LEM Not yet defined. Will probably not exist in LEM

M&DV

Map and Data Viewer

CM BLOCK I AND BLOCK II Film viewer for display of maps, charts, procedures, etc. Weight includes one film cartridge with film.

LEM Not in LEM; see Book of Procedures.

NVB AND Isolation Mounts

CM BLOCK I Rigid structure supporting the IMU and the optical subsystem with its associated hardware. The NVB is attached to the spacecraft using flexible ISOLATION MOUNTS to prevent spacecraft strains from distorting the NVB and the alignment between the IMU and Optics. These mounts also provide shock and vibration attenuation.

CM BLOCK II Functionally similar to BLOCK I but will be lighter and provide for mounting the size 12.5 IMU.

LEM The need for tieing the AOT and IMU together exists but is accomplished using structure provided by the spacecraft contractor.

Optical Eyepieces

CM BLOCK I Removable SXT eyepiece and removable SCT 1-and 3-power eyepiece combination.

CM BLOCK II Same as BLOCK I for SXT but only a 1-power eyepiece will be used with the SCT.

LEM Included as part of the AOT.

Optical Subsystem

CM BLOCK I Consists of SXT, SCT, Potical base, and associated hardware defined as follows:

SXT:	Sextant -- a two-line-of-sight, narrow-field two-degree-of-freedom sextant and its attached gearing.
SCT:	Scanning Telescope -- a single-line-of-sight, wide-field-of-view, two-degree-of-freedom articulation optical instrument and its attached gearing.
OPTICAL BASE:	Base for SXT and SCT with associated gearing and internal cooling.

CM BLOCK II Similar to BLOCK I except for changes in the sextant to provide line-of-sight velocity control directly without CDU's.

LEM Not in LEM, see AOT.

AOT

Alignment Optical Telescope

CM BLOCK I AND BLOCK II Not in CM, see Optical Subsystem

LEM A 3-position periscope with single-degree-of-freedom manual read reticule for alignment of the IMU.

Horizon Photometer

CM BLOCK I Not all BLOCK I systems will contain this function, but to support expected early unmanned flights using BLOCK I this will be incorporated into later BLOCK I systems for preflight qualification and flight test. Equipment is defined below. BLOCK I weights assume Horizon Photometer.

CM BLOCK II An earth horizon brightness photometer and automatic star tracker for navigation measurements against the earth's illuminated limb. The sensors are incorporated into the head of the SXT, the weight of which includes this function. The PSA includes support electronics.

LEM Not part of LEM.

PSA

Power Servo Assembly

CM BLOCK I Consists of most of the support electronics: power supplies; IMU, Optics, and CDU servos; IMU temperature control; and accelerometer and gyro pulse torquing.

Consists of 10 trays with replaceable modules which plug into the PSA End Connector Assembly. Includes front toe plate but not necessary cold plate.

CM BLOCK II Similar in function to BLOCK I but does not contain the CDU servos needed in BLOCK I.

Consists of a single plane matrix header to mount onto the cold plate with the modules plugging onto the top.

Eye Register for Reticule

CM Not in CM

LEM Device or equipment not defined yet in detail to position the LEM pilot's eye to use the window marking reticule pattern for landing point observation and selection during the constsnt flight path phase of landing.

Two-Digit Readout for Reticule

CM Not in CM.

LEM A 2-digit readout driven by the AGC from 00 to 99 to indicate range component of landing point using fixed numbered scale on window reticule.

Book of Procedures

CM Not in CM; see M&DV.

LEM Book or other form of maps, charts, procedures, instructions, etc. needed for lunar operations.

Cold Plate

CM BLOCK I AND BLOCK II Cold plates for the IMU are built into the IMU. Necessary cold plates for electronics are part of the equipment supplied by the spacecraft manufacturer.

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