

APOLLO

GUIDANCE, NAVIGATION AND CONTROL

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(Rev. 55)

SYSTEM STATUS REPORT

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INSTRUMENTATION LABORATORY

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The publication of this report does not constitute approval by the National Aeronautics and Space Administration of the findings or the conclusions contained therein. It is published only for the exchange and stimulation of ideas.

E-1142

(Rev. 55)

SYSTEM STATUS REPORT

ABSTRACT

The System Status Report is normally distributed bimonthly. The areas of activity reported on in this month's revision include, but are not limited to, the following for the Block I 100 Series and Block II Command Modules and Lunar Excursion Module equipment: configuration weight, weight trend information, reliability failure rates, electrical power requirements, computer programming status, and G&N Status.

by Apollo Staff

February 1968

TABLE OF CONTENTS

<u>Section</u>		<u>Page</u>
1	Configuration Weights	11
2	Glossary and System Definition	19
3	Reliability - Failure Rates	21
4	Electrical Power Requirements	23
5	Guidance and Navigation Systems Status	27
6	G&N System Test	33
7	G&N Computer Status	41
8	Guidance Computer Programming	45
9	List of "E" and "R" Notes Published During Reporting Period	57

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 slight variations from system to system.

INTRODUCTION

The areas of activity reported on in this month's revision include, in general, the following for the Block I 100 Series and Block II Command Modules and Lunar Module equipment:

- Section 1 - Configuration Weights
- Section 2 - Glossary and System Definition
- Section 3 - Reliability - Failure Rates
- Section 4 - Electrical Power Requirements
- Section 5 - Guidance and Navigation Systems Status
- Section 6 - G&N System Test
- Section 7 - G&N Computer Status
- Section 8 - Guidance Computer Programming
- Section 9 - List of "E" and "R" Notes Published During Reporting Period

Additional material, not suited to this format, will be presented from time to time as an appendix when it is particularly significant.

SECTION 1
CONFIGURATION WEIGHTS

Weights are reported to the nearest tenth of a pound on a component level. Each component weight is identified as estimated, calculated, or measured in order of increasing accuracy. These terms are defined 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 actual weights of equipment built to the production drawings.

Tables 1, 2, and 3, respectively, present the weight of all CM Block I, 100 Series, CM Block II, and LM Guidance and Navigation equipment based upon the most current information. These tables offer a comparison of present component weight values with those listed in the last revision of the System Status Report. The weights tabulated for Block II CM and LM configuration represent operational flight hardware.

Also included are the respective control and design load weights as assigned by NASA. The Control Weight is the maximum allowable total weight of the Apollo Guidance and Navigation equipment for which MIT/IL is responsible. Design Load Weights are restricted to individual components and should be considered as "not to exceed" weights. These values represent a maximum within which design variations may cause changes without need for renegotiation.

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

When applicable, the tables will be followed by a discussion of reported weight changes and weight trend information. Each weight increase or decrease is accompanied by an explanation for the change. Weight trend information describes future component changes presently being studied with an emphasis on weight reduction proposals.

This Rev. 55 to the Apollo System Status Report will be the last listing of Block I CM configuration weights.

North American Rockwell and Grumman Aircraft Engineering Corporation will provide and be responsible for weights of cold plates that are not integral with guidance and control equipment.

Reported Weight Changes and
Weight Trend Information

Block II

1. The following reported weight changes result from measurements made on systems which have been redesigned to decrease flammability hazards:

IMU	-1.6 lbs
Coolant Hoses (2)	-0.2
PEA	-0.5
CM Harness	+1.5
Optics shroud	+0.2
ESU (including eyepieces)	-0.4
GNIC	+3.2
DSKY	+0.3

2. The possibility exists that the NAR work table, which protects the OUA, may not fly on some vehicles. In this event, dust covers may be installed over the optics. Their estimated weight is 0.4 lb.

TABLE 1. CURRENT WEIGHT STATUS OF BLOCK I 100 SERIES
COMMAND MODULE G&N (LBS AT 1G)

Command Module G&N Equipment	Status 12/67	Change	Status 2/68	Design Load Weight
LOWER EQUIPMENT BAY				
CDU Assy	16.9 (M)	0.0	16.9 (M)	18.0 [#]
Optical Subsystem				
SXT and gearing	54.6 (M)	0.0	54.6 (M)	} 155.0 ^{**}
SCT and gearing	25.7 (M)	0.0	25.7 (M)	
Optical Base and gearing	10.7 (M)	0.0	10.7 (M)	
NVB and Resilient Mounts	61.2 (M)	0.0	61.2 (M)	
Bellows Assy	1.4 (M)	0.0	1.4 (M)	
IMU	65.4 (M)	0.0	65.4 (M)	
Coolant Hoses (Three)	26.1 (M)	0.0	26.1 (M)	
Power Servo Assy	3.1 (M)	0.0	3.1 (M)	
G&N Interconnection Assy	90.8 (M)	0.0	90.8 (M)	120.0
Optical Shroud				4.5
G&N to S/C Interface Assy				100.0
CMC (with 6 rope modules)				
Optical Eyepiece Storage Assy	12.7 (M)	0.0	12.7 (M)	15.0
Condition Annunciators				
SXT Normal Relief Eyepiece				
SCT Normal Relief Eyepiece				
SCT Long Relief Eyepiece				
D&C Electronics Assy	2.6 (M)	0.0	2.6 (M)	5.0
Control Electronics Assy	1.8 (M)	0.0	1.8 (M)	4.0

TABLE 1. CURRENT WEIGHT STATUS OF BLOCK I 100 SERIES
COMMAND MODULE G&N (LBS AT IG) (CONT)

Command Module G&N Equipment	Status 12/67	Change	Status 2/68	Design Load Weight *
G&N Indicator Control Panel	10.9 (M)	0.0	10.9 (M)	15.0
IMU Control Panel	2.9 (M)	0.0	2.9 (M)	5.0
Signal Conditioner Assy	4.8 (M)	0.0	4.8 (M)	8.0
DSKY	24.5 (M)	0.0	24.5 (M)	26.0
MAIN PANEL AREA				
DSKY	25.3 (M)	0.0	25.3 (M)	26.0
LOOSE STORED ITEMS				
Optics Cover	2.1 (M)	0.0	2.1 (M)	2.5
Horizontal Hand Holds (Two)	0.3 (M)	0.0	0.3 (M)	1.0
TOTAL	443.8	0.0	443.8	---
The reported total weight for this month is 13.8 pounds more than the 430.0 pound total control weight †				
Bare Guidance Systems - IMU, AGC, IMU portions of the CDU's and IMU Support electronics			206.4	---

* Design Load Weights are taken from ICD MH01-01256-416 signed 3 June 1965, submitted by MIT in letter AG 478-65.

** This design load weight includes only 1/2 the weight of the Bellows Assembly.

† The Total Control Weight is specified in NASA letter EG-151-44-65-55 dated 10 February 1965. This weight assignment does not include recognition of the Optical Eyepiece Storage Assembly.

This design load weight taken from IRN 3677, submitted by MIT in Letter AG 407-66 dated 9 May 1966.

TABLE 2 CURRENT WEIGHT STATUS OF BLOCK II
COMMAND MODULE GN&C (LBS AT 1G.

Command Module GN&C Equipment	Status 12/67	Change	Status 2/68	Design Load Weight*
LOWER EQUIPMENT BAY				
CDU Assy	36.5 (M)	0.0	36.5 (M)	50.0
Optical Subsystem SXT and gearing SCT and gearing Optical Base and gearing APTPS and Dust Covers	55.7 (M)	0.0	55.7 (M)	} 150.0
NVB and Mounts	17.4 (M)	0.0	17.4 (M)	
Bellow Assy	10.7 (M)	0.0	10.7 (M)	
IMU	42.5 (M)	-1.6	40.9 (M)	
Coolant Hoses (2)	1.2 (M)	-0.2	1.0 (M)	
Power Servo Assy	49.4 (M)	0.0	49.4 (M)	
PIPA Electronics Assy	9.0 (M)	-0.5	8.5 (M)	
G&N Interconnect Harness Group	24.0 (M)	+1.5	25.5 (M)	
AGC (with six rope modules & mag. trays)	70.1 (M)	0.0	70.1 (M)	
Optical Shroud	3.1 (M)	+0.2	3.3 (M)	
Optical Eyepiece Storage Assy SXT Normal Relief Eyepiece SCT Normal Relief Eyepiece SCT Long Relief Eyepiece	14.0 (M)	-0.4	13.6 (M)	15.0
G&N Indicator Control Panel	11.5 (M)	+3.2	14.7 (M)	17.0
DSKY	17.5 (M)	+0.3	17.8 (M)	25.0
Signal Conditioner Assy (Operational Flights)	5.8 (M)	0.0	5.8 (M)**	8.0

DATE: February 1968

TABLE 2. CURRENT WEIGHT STATUS OF BLOCK II COMMAND MODULE GN&C (LBS AT 1G) (CONT'D)

Command Module GN&C Equipment	Status 12/67	Change	Status 2/68	Design Load Weight*
MAIN PANEL AREA				
DSKY	17.5 (M)	+0.3	17.8 (M)	25.0
LOOSE STORED ITEMS				
Horizontal Hand Holds (2)	0.3 (M)	0.0	0.3 (M)	1.0
TOTAL	386.2	+2.8	389.0	----
The reported total weight for this month is 11.0 pounds less than the 400.0 pound total control weight †				
Bare Guidance Systems - IMU, AGC, IMU portions of the CDUs and IMU support electronics.				
			172.8	----

* Design Load Weights are taken from ICD MH01-01356-416 signed 16 July 1965 at Meeting #22A.

** The weight of a qualification flight signal conditioner assy is 8.6 (M) pounds.

† The Total Control Weight is specified in NASA letter EG-151-44-65-55 dated 10 February 1965. This weight assignment does not include recognition of the Optical Eyepiece Storage Assembly.

DATE: February 1968

Reported Weight Changes and
Weight Trend Information

LM

1. The following reported weight changes result from measurements made on systems which have been redesigned to decrease flamability hazards:

IMU	-1.4 lbs
NVB	+0.1
PTA	+0.1
"A" Harness	+1.0
DSKY	+0.3
PSA	+0.2

2. An estimated 1.3 lb increase is reported for the AOT due to measured 0.5 lb increase for flammability changes and an estimated 0.8 lb increase for the conical sunshade.
3. The estimated weight for the LGC was changed to measured. This was a typographical error and should have been reported as measured in the previous report.

TABLE 3. CURRENT WEIGHT STATUS OF LM PGNCS (LBS AT 1G)

LM PGNCS Equipment	Status 12/67	Change	Status 2/68	Design Load Weight*
IMU	42.4 (M)	-1.4	41.0 (M)	} 80.0
AOT (including eyepiece and bellows)	23.1 (M)	+1.3	24.4 (E)	
NVB	5.1 (M)	+0.1	5.2 (M)	}
HARNES "B" Supported by the NVB	0.6 (E)	0.0	0.6 (E)	
HARNES "B" Supported by the PTA	0.8 (E)	0.0	0.8 (E)	
HARNES "B" Supported by the structure	3.1 (E)	0.0	3.1 (E)	21.0
PTA	14.3 (M)	+0.1	14.4 (M)	} 22.0
HARNES "A"	14.5 (M)	+1.0	15.6 (M)	
LGC (with six rope modules & mag. trays)	70.6 (E)	0.0	70.6 (M)	65.0
DSKY	17.5 (M)	+0.3	17.8 (M)	20.0
AOT Control Unit (CCRD)	1.6 (M)	0.0	1.6 (M)	2.0
CDU	37.5 (M)	0.0	37.5 (M)	} 37.0
PSA	17.5 (M)	+0.2	17.7 (M)	
SCA (Operational Flights)	5.5 (M)	0.0	5.5 (M)	28.2
TOTAL	254.2	+1.2	255.8	----
The reported total weight for this month exceeds the 245.0 pounds total control weight by 10.8 lbs.†				
Bare Guidance Systems - IMU, LGC, IMU portions of the CDUs and IMU support electronics.			167.9	

*Design Load Weights are taken from ICD LIS-490-10001 as signed by Mr. R. A. Gardner (NASA/MSC) on 29 March 1966.

**The weight of a qualification flight signal conditioner assy is 7.8 (M) pounds.

†The Total Control Weight is specified in Contract Technical Specification PS-6000000 - amended by NASA Letter EG-26-233-66-565 dated 18 August 1966.

DATE: February 1968

SECTION 2

GLOSSARY AND SYSTEM DEFINITION

The description of what constitutes the MIT Guidance and Navigation equipment in Block I, 100 Series, Block II Command Modules and Lunar Modules has been defined in previous System Status reports. This Section will be updated when any significant changes are made in the systems.

SECTION 3

RELIABILITY FAILURE RATES

The current status of reliability analysis is reported in summary form as a chart.

This chart contains tabulations of the failure rates associated with each major configuration of G&N systems. These have been derived from the parts count of each assembly using generic type failure rates, modified only by the stress applied to each part and its singular application in the system. From these data, estimations of mission success probabilities may be calculated. This Rev. 55 to the Apollo System Status Report will be the last listing of the Block I CM reliability failure rates.

G&N MISSION RELIABILITY ANALYSIS
FAILURE RATES EXPRESS IN "FAILURES PER 100 HOURS"

MISSION	IMU Assembly		IMU Electronics (PSA)		Optics Assembly		Optics Electronics (PSA)		IMU CDU		Optics CDU		AGC		DSKY		D&C		Mission Reliability
	ON	STBY	ON	STBY	ON	OFF	ON	OFF	ON	STBY	ON	OFF	ON	STBY	ON	OFF	ON	OFF	
AGE 123 FLIGHT 502 UNMANNED	8.3	-	8.3	-	-	-	-	-	8.3	-	-	-	8.3	-	8.3	-	8.3	-	.9933
	195	-	224	-	-	-	-	-	111	-	-	-	257	-	12	-	6	-	
C/M FLIGHT 503 MANNED	31.3	208	31.3	208	14.2	225	14.2	225	31.3	208	31.3	208	31.3	208	31.3	208	31.3	208	.9626
	129	10.2	110	6.3	94	-	77	-	155	-	91	-	235	60.5	2.3	-	2.3	-	
L/M FLIGHT 503 MANNED	8.4	120	8.4	-	8.4	-	8.4	-	8.4	-	8.4	-	8.4	-	8.4	-	8.4	-	.9923
	129	1.6	110	-	38	-	1.33	-	155	-	112	-	235	-	110	-	1.2	-	
C/M FLIGHT 205	76	190	76	190	20	-	20	-	76	-	20	-	9.5	170	9.5	-	76	-	.9315
	129	10	110	6	94	-	77	-	155	-	91	-	235	61	2	-	2	-	
C/M DES. REF.	13.8	55.6	13.8	55.6	9.1	60.3	9.1	60.3	13.8	55.6	13.8	55.6	13.8	55.6	13.8	55.6	13.8	55.6	.9640
	129	10.2	110	6.3	94	-	77	-	155	-	91	-	235	60.5	2.3	-	2.3	-	
L/M DES. REF.	3.25	66.3	3.25	66.3	3.25	-	3.25	-	3.25	-	3.25	-	3.25	-	3.25	-	3.25	-	.9969
	129	1.6	110	-	38	-	1.33	-	155	-	112	-	235	-	110	-	1.2	-	

DATE: February 1968

SYSTEM 4

ELECTRICAL POWER REQUIREMENTS

Electrical power and energy reporting is based upon the inflight spacecraft sequence of events for the Design Reference Mission as developed by the Apollo Mission Planning Task Force (AMPTF). (Reference GAEC Report Volume III - LED-540-12, dated 30 October 1964.)

The accompanying tables present the power drawn through the spacecraft circuit breakers. It is assumed that power is drawn from the spacecraft's primary +28VDC supply and a 400 cps-115 VAC single phase inverter.

Intermittent power peaks can exist, particularly during operation of displays and controls at random times. The energy content in these peaks is considered negligible.

All values (except those mentioned above) are actual expected levels of power at 28.0 VDC. They are based on measured values on G&N systems 207 and 208 for the Block II Command Module and G&N systems 608, 600, and LM learner for the LM. No margin factor has been applied to protect against possible differences between G&N systems and spacecrafts. Thus, these values should not be taken as "not to exceed" extremes.

Interface Control Documents serve as the guidelines for reporting power figures.

CM Block I 100 Series	MH01-01227-216 "G&N Electrical Input Power" signed 11 June 1965
CM Block II	MH01-01327-216 "G&N Electrical Input Power" signed 15 July 1965
LM	LIS-390-10002 "PGNCS Prime Power Requirements and Characteristics" signed 30 July 1965.

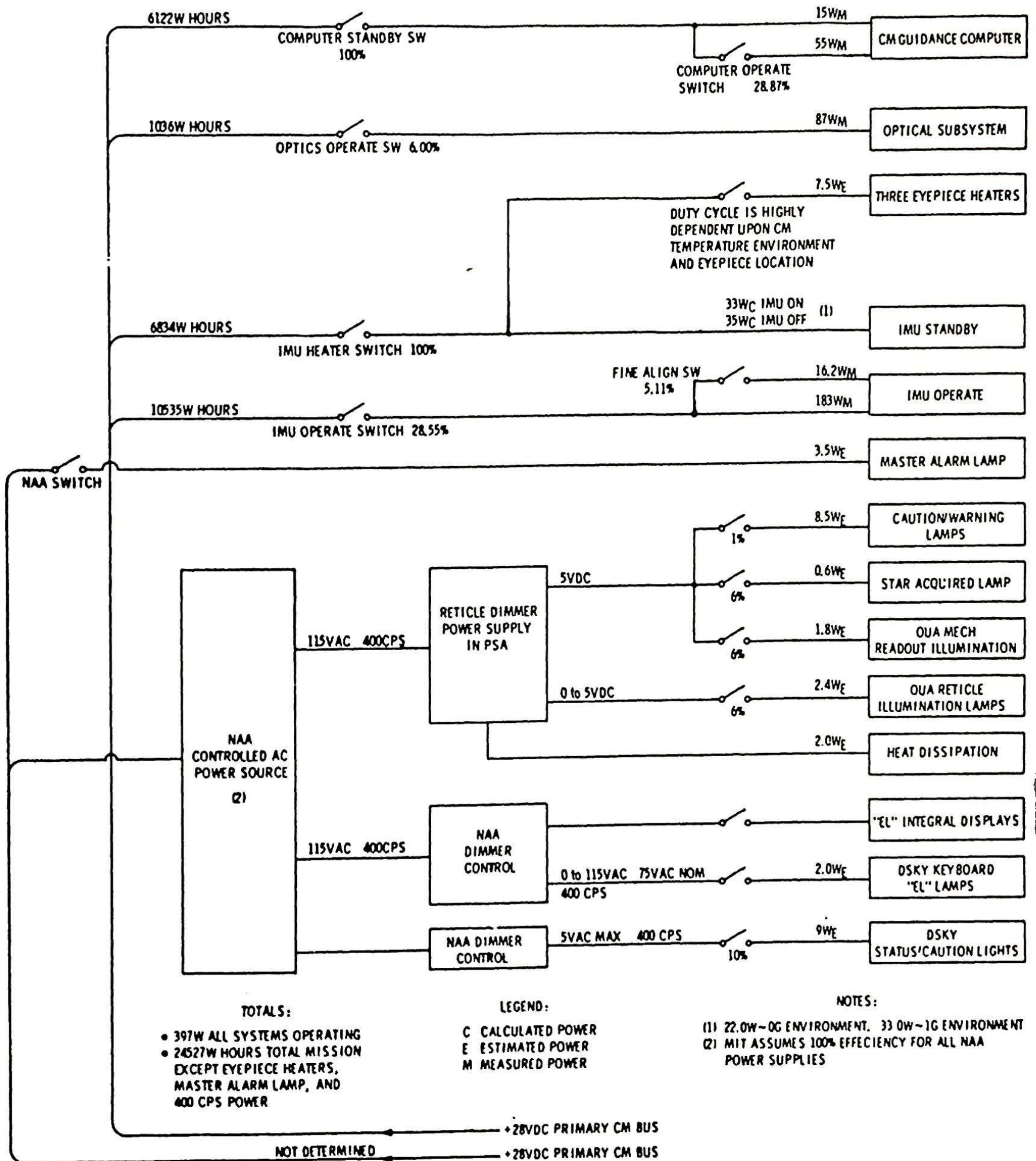
This Rev. 55 to the Apollo System Status Report will be the last listing of Block I CM electrical power requirements.

BLOCK II GUIDANCE & NAVIGATION LOAD ON PRIMARY +28 VDC COMMAND MODULE

BASED UPON 198.5 HOURS (8.27 DAY) LUNAR ORBIT MISSION
DESIGN REFERENCE MISSION

STATUS OCTOBER 1967

REFERENCE GAEC REPORT - LED 540-12, 30 OCTOBER 1964
APOLLO MISSION PLANNING TASK FORCE

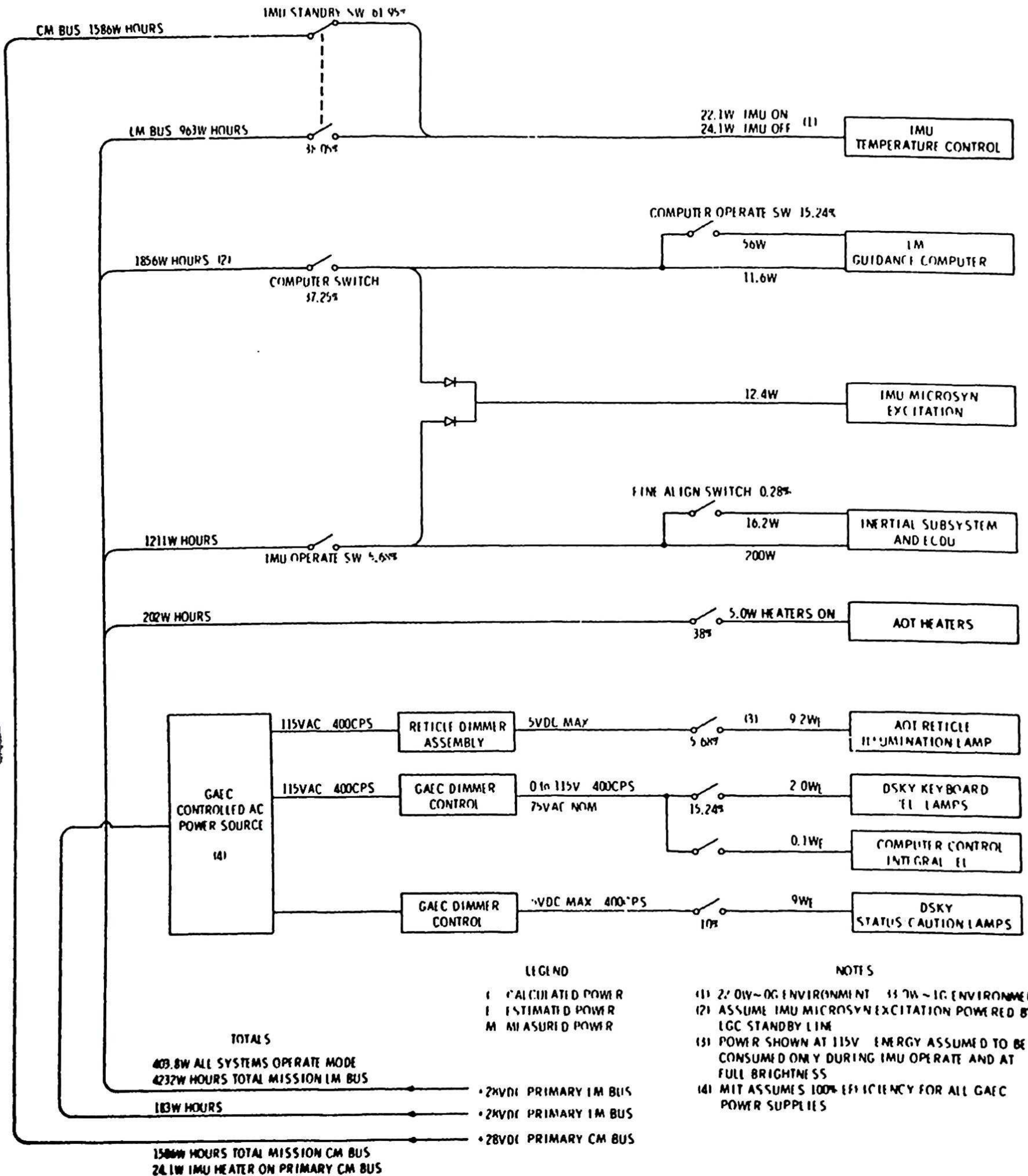


LUNAR MODULE GUIDANCE & NAVIGATION LOAD ON PRIMARY +28 VDC

BASED UPON 106.02 HOURS 14 1/2 DAY LUNAR LANDING MISSION
DESIGN REFERENCE MISSION

STATUS OF 10/19/67

REFERENCE GAEC REPORT 11 D 540-12, 30 OCTOBER 1964
APOLLO MISSION PLANNING TASK FORCE



SECTION 5

GUIDANCE AND NAVIGATION SYSTEMS STATUS

The status of delivered G&N Systems are shown in tabular form. Table 3 shows the status of G&N Systems progressing from installation to final test at KSC.

Table 4 shows the configuration for major units comprising the G&N Systems assigned to LM-2 and subsequent LM Vehicles at GAEC.

Table 5 shows the configuration for major units comprising the G&N Systems assigned to CM-98 and subsequent Command Modules at NAR.

Table 6 shows the configuration for major units comprising the G&N Systems at KSC.

TABLE 3

DATE: February 1968

OPERATION	LOCATION								
	GAEC		NAR		KSC				
	LM-2 System 608	LM-3 System 605	LM-4 System 606	CM-98 2TV-1 System 202	CM-101 System 204	CM-102 System 205	CM-103 System 206	CM-020 System 123	LM-1 System 603
INSTALLATION	X	X		X	X			X	X
SUBSYSTEM CHECKOUT S/C	X	X		X				X	X
INTEGRATED TEST S/C	X							X	X
COMPLETE TESTING AT KSC									X

NOTE: LM-1, System 603 completed testing at KSC and was successfully launched in January 1968.

TABLE 4 LM G&N SYSTEM CONFIGURATION

S/C COMPONENT NOMENCLATURE	LM-2		LM-3		LM-4	
	System 608 Part Number	S/N	System 605 Part Number	S/N	System 606 Part Number	S/N
LGC	2003993-031	28	2003993-031	32		
DSKY	2003994-011	46	2003994-021	51		
IMU	2018601-191	26	2018601-111	12		
ECDU	2007222-221	10	2007222-221	24		
AOT	6011000-071	17	6011000-072	18		

DATE: February 1968

NOTE: Listing will be revised if major units are changed. Explanatory notes will described reason for changes.

1. LM-2, G&N System 608

- A. Replaced LGC 2003993-021, S/N 26, with 2003993-031, S/N 28. LGC modified to include flat packs complying with ND 1002359 Specification for Leak and Weight Tests.
- B. Replaced IMU 2018601-111, S/N 18, with 2018601-191, S/N 26. IMU modified to include new excitation grounding and end cap changes.

2. LM-3, G&N System 605

- A. Removed DSKY 2003994-011, S/N 49, to be returned to have flammability fixes incorporated. New number is 2003994-021, S/N 51.
- B. Revised AOT 6011000-071, S/N 18. Removed Beta cloth, added heater cover; new part number is 6011000-072, S/N 18.

TABLE 5 CM G&N SYSTEM CONFIGURATION AT NAR

S/C COMPONENT NOMENCLATURE	CM-98		CM-101		CM-103	
	System 202 Part Number	S/N	System 204 Part Number	S/N	System 208 Part Number	S/N
AGC	2003100-061	9	2003993-031	27		
DSKY (Main)	2003950-011	28	2003994-021	50		
DSKY (Navigation)	2003950-011	30	2003994-021	41		
IMU	2018699-031	5	2018601-201	8		
CDU	2010744-051	13	2007222-191	15		
OPTICS	2011000-062	23	2011000-071	24		

DATE: February 1968

NOTE: Listing will be revised if major units are changed. Explanatory notes will described reason for change.

TABLE 6 G&N SYSTEM CONFIGURATION AT KSC

S/C COMPONENT NOMENCLATURE	2		LM-1	
	System 123 Part Number	S/N	System Part Number	S/N
AGC	1003700-071	13	2003993-011	30
DSKY (Main)	1003563-051	9	2003994-011	37
DSKY (Navigation)	1003706-051	7	-----	--
IMU	1001500-111	8	2018601-211	6
CDU	1021304-031	6	2007222-171	12
OPTICS	2011000-023	9	6011000-021	9

DATE: February 1968

NOTE: Listing will be revised if major units are changed. Explanatory notes will describe reason for change.

LM-1, G&N System 603

Replaced IMU 2018601-111, S/N 6, with 2018601-211, S/N 6. Incorporated IRIG End Cap modification.

SECTION 6

G&N SYSTEM TEST

A. SYSTEM TEST LABORATORY

1. G&N 5

No operating hours.

2. G&N 104

a. Program Tests

AS-502 Support: Successfully ran K-START Tapes for AGC Alarms and Interrupts Test and E-Memory Zero Test.

Verified during Simflight that if S4BSEP occurs early or late, the SPS1 time tag need not be changed. Once S4BSEP time is known, the AGC clock can be advanced the desirable amount.

Verified Simflight K00040 and K00071 with added cold soak time of approximately 8.2 minutes. Purpose is to allow more time to insert the SPS2 update.

Verified operation of AS-502 Simflight, tape number F04C020-K00071-00 which incorporates new S4SEP time.

b. Hardware Tests

Investigated erratic Z IRIG data. Apparently there is a mismatch between the Z ternary current switch and associated electronics.

Concluded ADIA investigations, deciding to accept the large (100 meru/g) ADIA terms.

Investigated IMU Temperature Alarm indication. Concluded that the IRIG indicating sensor is in error by approximately 3^oF. This is equivalent to a 480 ohm per degree shift from the calibration curve.

Resolved that the erratic Z IRIG scale factor data was due to a failed ternary current switch. Switch is being repaired at present.

Devised means of obtaining a 0 VDC discrete for triggering an optical device that may be used on the AS-502 Mission. The discrete utilizes C-relays in the NAV DKS. An STG memo is currently being written concerning this topic.

3. G&N 200

a. Program Tests

Continuing checkout of SUNDISK Programs. Revision 275 is presently in use.

Continued checkout of Flight Sim Program for Flight 205.

Performed checkout of optics "stop" monitoring and drive director control as programmed in Coldspot, Revision 1 of COLOSSUS Revision 138.

Continued checkout of Flight Simulation test program SUNDISK.

Performed checkout of special PIPA test routine for determination of "air bubbles". Test needs further checkout.

b. Hardware Test

Noted six degree overshoot of shaft angle when optics are under CMC control. Problem under investigation.

Noted problem with Trunnion CMC drive control when initially turning on Optics power. DAC saturates and trunnion control is lost. Problem under investigation:

Results of checkout of the MIT and KIC Tracker and Photometer Electronics Module were published in STG Memo 1097.

c. Failures

Problem with optics CDU. High-speed read appears to be inoperative for short period of time immediately after turn-on of optics. Problem is not yet resolved.

d. Modifications

CDU modules MSA S/N HUG254 and Quadrature Rejection S/N HUG25 replaced with modified modules S/N 3 and S/N 1 respectively.

G&N Harness modified by inclusion of signal leads for VHF Ranging Interface.

Incorporated two wire additions into PSA for "Star Tracking" program checkout. Wires added were 45J20-23 to 45J20-21 and 45J20-25 to 45J21 -31.

4. G&N 600

a. Program Tests

Conducted tests on SUNDANCE Revisions 245, 250, 251, and 253. Emphasis was mainly on radar and system test routines. Submitted 7 anomaly reports on major problems encountered. The outstanding reports are: two successive CDU zeros resulted in a GSE gimbal dump; RR search pattern irregularities; V83 during P20 hangs up program on a P20 endidle. Revision 275 is presently in use.

Also conducted tests on SUNDANCE Revisions 255, 256, 258, 259, and 263. System Test Verification (informal) is 60 percent complete. Submitted six anomaly reports. The outstanding discrepancies are in the radar programs.

Initial simflights were conducted with P21, P30, P40, P42.

b. Hardware Tests

Recorded $\pm\Delta 0g$ pulses from CDU special test connector on analog tape recorder. Also recorded CDU registers on digistore tape. Confirm that there were no transients with voltage divider fix (STG Memo No. 1094).

Conducted CDU transient tests at earth rate to observe effect of transient at low rates.

The latest IRIG preamplifier oscillation fix was tested with added inductances up to 2 millihenries without noise effects. The fix is commoned preamp input and output lows and tuning capacitors on preamp inputs.

c. Failures

Replaced temporary IRIG 6A17 with 7A22.

d. Modifications

Modified grounding on CRS buffer box to relieve grounding noise.

B. FIELD OPERATIONS

1. GAEC

a. LM-2 (Mission AS-208) G&N System 608.

Completed OCP 61014, Flight Control Checkout.

Completed retest of OCP 37030, Individual Systems Test. OCP 61018, FEAT (Plugs Out), is now in process.

b. LM-3 (Mission AS-503) G&N System 605

Completed testing through OCP 37030, Individual Systems Test.

c. LM-4 (Mission AS-504) G&N System 608.

OCP testing scheduled to begin on 18 February 1968.

2. KSC

a. LM-1 (Mission AS-206) G&N System 603

Completed all OCP's successfully, System launched on 22 January 1968.

b. CM-20 (Mission AS -502) G&N System 123

L/V Simulation, OCP-K-0005. Experienced power failure, degaussed Y and Z PIPA's. Bias on Y PIPA was -2.8 cm/sec^2 ; upon degaussing it went to -0.5 .

Completed OCP-K-0021, Overall Test (Plugs Out), with no IDR's. Spacecraft move VAB to LC scheduled for 5 February 1968.

3. MSC

Completed review of draft for Flight Test Requirements for first Manned Mission. Supported LM-1 Mission.

4. NAR

a. CM-98 (2 TV-1 Thermal Vacuum) G&N System 202

System installed; OCP 6504, Individual Systems Test, scheduled for 26 January 1968 did not start until 31 January and is currently in progress.

b. CM-101 (Mission AS-205) G&N System 204

System installed; OCP 6504, Individual Systems Test formerly scheduled for 10 January, was slipped to 4 February 1968.

5. ACED, Milwaukee

Attended AC/NASA Review in Milwaukee. Met with ACED personnel relative to fallout of End Housing Assemblies on Turn-Around Gyros. MIT has examined and made recommendations on re-use of four gyro end housings. NASA is placing considerable emphasis on MIT justifying the use of gyro end housings containing cracked potting. Continuing documentation review effort.

6. Edwards A. F. B.

Horizon Definition Experiment ready for Pre-Flight Test. APU run with all experiments on line is scheduled for 29 January 1968. A captive flight is scheduled for 1 February with a checkout flight (maximum altitude 120,000 feet) being scheduled for 5 February.

Number two Horizon Definition Experiment with Barnes Edge Tracker is scheduled to arrive at NASA/FRC for Altitude Chamber Test the week of 12 February 1968.

C. SYSTEM ENGINEERING

1. Spacecraft Test Support

The E/Call routine in fixed memory used for E-Memory programming was corrected. The IRIG SF test has been run on the digital simulator, however; the results are not as accurate as expected and further work is required. The E-Memory Read-Write pulse check program has been checked out and the E-Memory load sum check program is being coded.

The investigation to develop diagnostic tests for PIPA and IRIG failures continued. A test for bubbles in the PIPA fluid was run in the STG lab and the data is being evaluated.

A preliminary version of AGSALIGN worked successfully with patches in a digital simulation test. Attempts are being made to obtain a new assembly of AGSALIGN so that a DIGISTORE Tape can be manufactured for System Test Lab testing. Conversion to erasable memory operation will begin following a successful STL Test.

2. Mission Program Testing

Informal runs of the radar programs have continued. Most of the effort has been on analyzing the poor results of the Search Pattern Test. A parallel digital simulation of this test is also being done. Informal runs of P51 and several IMU tests have been run. A memo (STG No. 1102) was issued describing problems in the landing radar portion of the radar self test.

The alarms for SUNDANCE are being reviewed and because of the large difference from SUNDISK, a memo describing the DANCE alarms (STG No. 1103) was issued and testing of these alarms has begun.

The plan for testing of COLOSSUS in the STG Lab. (STG No. 1100) has been distributed.

3. Star-Tracker-Horizon Photometer Experiment

A series of system level tests were conducted on the Star Tracker/Horizon Photometer being developed for AAP Experiment M-439. The results demonstrated the necessary capability to track accurately (45 sec, 3σ) at least 29 of the 37 stars now contained in the computer. Dynamic testing indicated no measurable velocity error in the servo loop for simulated angular velocities up to 36 deg/sec.

The Horizon Photometer was tested through the range of expected image intensities (0.82 to $2.25 \mu\text{W}/\text{CM}^2$ steradian Angstrom). The automatic "MARK" was executed with accuracy (± 15 sec/peak) for intensity inputs down to 0.25μ watt. The SUNDISK Program No. 23 successfully processed the optics "MARK" data.

A Design Review Meeting among MSC, MIT and Kollsman was attended (on 16 January) concerning the Star Tracker/Horizon Photometer Experiment. MIT reconfirmed plans to perform tracker/photometer tests, under base motion conditions, on the Space Navigator Simulator.

Procedures for performing these tests were prepared. Primarily, this involved preparation of an erasable program which permits CMC control of the Star Tracker.

D. KSC CHECKOUT

1. The following K-START Tapes were verified and shipped to KSC for LM-1 FRT:

F06L001-K00067-01, Erasable Launch Load

F06L001-K00068-01, Erasable Mission Load

F06L001-K00078-01, Simflight

2. The following K-START Tapes were manufactured, verified, and shipped to KSC for S/C-020 testing:

F04C020-K00012-00, AGC E-Memory Zeroing

F04C020-K00020-00, AGC Alarms and Interrupts Test

3. Reviewed Block II CSM and LM OCP's.

4. Resolved required additional testing of Block II CSM and LM "Y PIPA" during S/C testing at KSC.

E. TEST EQUIPMENT

1. GSE Station Maintenance: The STG stations were overhauled during one week-end in January. Individual responsibilities for PM have been assigned. P-9 will be overhauled when pulled down for GINSIP modification.

2. CDU Readout: The CDU bit-to-angular readout display has been completed and is ready to be hooked into the System Test Lab facilities.

3. CDU DAC Monitor: Design and fabrication of this item has been delayed, but it should be completed this month.

4. Uplink-Downlink Automation: The uplink-downlink sequence programmer should be completed this month.

5. Glitch Detector Transient Investigation: Field reports indicate that the Glitch Detector in the PSAAM is susceptible to transients on its own power line. We are investigating said report.

6. Rate Table Limitations: A recent failure of the rate-limiting features of the ISS rate table has prompted a requirement for additional rate limiting of the table. A system of limiting the drive rate of the gyro test table has been designed and installed.

7. 16 PM PIP Electronics: Work is progressing on testing the circuits in an oven and making several other design changes. It is expected that major problem areas will be defined within a month.

8. Trace:

a. The Block II Coroner and Trace Program has been reviewed and modified to achieve maximum usefulness as an analytical tool. A revised ECP has been submitted to Houston and several conversations have been held with MSC personnel to generate support for this project.

b. An 8000 x 32-bit cyclical memory for storage of the last 8000 AGC instructions, addresses, and pertinent register contents, a digistore interface, and a program for generating an IBM 360 printout similar to that generated by the Digital Simulation is in the design phase.

9. Conversion of BB II GSE to Support 600F: It does not appear that BB II could be converted in a timely fashion without sacrificing effort on both the Advanced CG&N Instrumentation and the GINSIP programs. BB II conversion will therefore be held in abeyance.

10. Gyro Tumble Servo System: There have been both hardware and procedural problems involved with these instruments. Many of these problems have been straightened out and we are now testing the servo system using a rate table as a base. The need for this instrument is critical to support production gyro testing at a second vendor. It is expected that this work will be completed in February.

11. Design of a New Small Wheel Power Monitor: A new small wheel power monitor for S/C usage is being investigated and will probably be the subject of a future ECP.

12. Interrogator Threshold Investigation: We are studying the effect of input signal slope on interrogator threshold firing level.

13. Miscellaneous Mainline Efforts: Review of TDRR's, ICD's and field problems continue on an as-required basis.

14. Tally Fix: The Tally Tape Punch in the ISS lab was failing regularly due to its constant operation. A circuit was installed which allows the Tally to operate only when it has to punch data, thus reducing wear and tear on the Tally Motor and friction drive.

15. Jet Firing Monitor: Another jet firing monitor has been built for the LM station and is on the air.

16. Hybrid I Station: A new harness is being built for the Hybrid I Station as time permits.

F. MISCELLANEOUS REPORTS AND INVESTIGATIONS

1. General status was reported at the Quarterly Status Review.
2. CDU switching transient investigation completed. STG Memo No. 1104 issued as final report.
3. IRIG Preamplifier oscillation problem solution was reviewed. The present fix will reduce probability of gain loss due to oscillation. The fix does increase the susceptibility of the system to power line-conducted noise in the audio frequency range. MIT is proceeding with building of new design preamplifier.
4. The effects of transient low voltage on G&N operation were investigated. The results of the investigation are presented in STG Memo 1107.
5. Prelaunch operations for LM-1 (Apollo 5) mission were supported.

SECTION 7

G&N COMPUTER STATUS

A. ANALYSIS FACILITY

1. Design Analysis

During LM testing one computer experienced a condition of multiple restarts induced by a single momentary drop in primary (28-volt) power. Tests were run on AGC CIM to determine the cause of the condition. D.D. Memo #399 reports on the tests. In summary, the condition is caused by the change in power drain when the computer goes into and out of restart which causes a change in primary power into the computer. This change in input voltage is greater than the hysteresis of the V Fail detector if the impedance of the power source is greater than 0.3 ohm.

No other analysis was performed during this period since no monitors are available.

2. Field Support

This included support of the LM-1 flight and a series of minor problems both at GAEC and NR.

3. Miscellaneous AGC-Related Activity

a. New Monitors

Wire wrap plates for S/N 6 were wired wrong and had to be returned to Gardner, Denver. Another month delay.

b. Restart Monitors (Channel 77 Alarm Box)

The six "production" units are in assembly and should be completed in February.

c. Portafam

Design is progressing. There were fabrication problems in the memory stacks which has caused a slip in the schedule. Search for a tape unit is still underway.

d. IL DSKY

The assembly of the new module is progressing. Only the prototype light panels from Tung-Sol have been delivered.

e. Maintenance

Maintenance of the AGC's and support equipment continues. Due to lack of a monitor in the D.D. Lab there are two computers off the air.

B. COMPONENTS

1. X-Ray Screening of 6321 Flat Packs

This problem may grow out of bounds shortly. Since the lots that fail the internal visual inspection are the only ones that have been X-rayed to screen for contamination it must be assumed that if there is a contamination problem it would not be lot oriented, then we should start seeing more vibration failures during final sale of the computer. In addition, a change in the computer vibration has been implemented which puts the computer in a worst-case orientation that is more susceptible to flat pack contamination. There have been several failures since the change; some are definitely flat pack failures. Analysis is not completed yet.

2. 6399 Diodes

The diode quality seems to have degraded but production is nearing the end so no corrective action can be taken. The quality is not poor enough to warrant re-ordering.

3. 6323 1 MIL AL Wire Transistor Failure

Report E-2218 has been released. The conclusions are that the computer usage does not cause fatiguing of the wires. The bond strength is marginal, therefore the original decision to change the design was sound. The computers containing the old parts are flyable but should be retested under thermal and vibration for increased confidence level.

4. DSKY Relays

The relay problem is continuing one. Many changes have been made to improve the screening of relays with particles or contact opens. There does seem to be evidence of improvement which has resulted from better quality relays and better screening.

C. AGC PROBLEMS

1. Erasable Memory

The decision was made in December to change the module potting compound to Sylgard 184. Since then one prototype module has been manufactured and qualification tested. The production changeover has been started. The new modules will be available for the last 5 or 6 computers. In addition, 10 spares have been ordered.

2. Standby Problem

Several computers have shown a tendency not to come out of standby when the standby key is depressed the first time. The problem has been analyzed and is the result of contact bounce and arcing in the relay that switches the power from operate to standby. The noise caused by the arcing is large enough at times to switch the standby flip-flop back into standby. Multiple-key depressions have always been able to bring the computer out of standby; therefore, the present fix is to change all procedures permitting multiple key depressions.

SECTION 8

Apollo Guidance Computer Programming Summary for the Months of December and January

A. SOLARIUM - UNMANNED CSM

During the reporting period the Solarium Program was tested and analyzed for support of Mission AS-502. Preliminary erasable loads have been generated and tested. Support has been provided to NASA/MSC in preparation for the AS-502 flight.

B. SUNDISK - Manned CSM (Earth Orbital)

The following activities were performed during the reporting period:

NASA-approved Program Change Requests (PCR's) were incorporated into the program and retested to verify the SUNDISK Program. A total of 24 PCR's were processed against SUNDISK as of the end of January.

Preparations were made for the presentation of the status and history of the SUNDISK Program at the CARR Meeting scheduled for 31 January 1968.

The Verification Results Document was prepared and published.

A list of Program Notes was prepared and published listing the idiosyncrasies of the release program.

The DAP Verification Results package is under preparation and due for publication in early March.

Sections 3, 4 and 5 of the GSOP are being reviewed and updated with publication of Section 3 scheduled for late February and Sections 4 and 5 for the end of March.

The release of the SUNDISK Program to Raytheon for rope manufacturing is scheduled for 1 February 1968.

C. SUNDANCE - Manned LM (Earth Orbital)

The Sundance Program is in the final stages of level 3 testing and the initial stages of level 4 testing. The FACI for SUNDANCE is scheduled for 6 April 1968. This schedule change was primarily caused by the impact of Program Change Requests. A total of 8 PCR's were processed against SUNDANCE as of the end of January.

MIT furnished GAEC a DAP Program tape and the erasable initialization data for LM DAP testing at GAEC.

Section 2(PGNCS Data Links) and Section 4(PGNCS Operational Modes) were published in mid-December.

Level 4 testing consists of 20 tests, 6 of which are being done on the Hybrid analog simulator. In addition approximately 38 tests will be performed in the Systems Test Laboratory.

Section 3 DAP of the GSOP is scheduled to be sent to NASA/MSC early in March for review. Full distribution is scheduled for early April.

D. COLOSSUS - Manned CSM Lunar Capability

The COLOSSUS program is presently in the final stages of level 2 testing and the initial stages of level 3.

Section 4 (GNCS Operational Modes) and Section 5 (CM Guidance Equations) were published on 12 January 1968 and 29 December 1968 respectively. The present-plan FACI date is 2 July 1968. The change in FACI was primarily the result of Program Change Requests. A total of 9 PCR's were processed against COLOSSUS as of the end of January.

Direction was received from NASA/MSC to stop work on the TLI (P-15) program on the expectation of receiving direction from NASA for removing this capability from the COLOSSUS Program.

E. LUMINARY - Manned LM Lunar Capability

The LUMINARY Program is presently in the middle of level 3 testing. The present planned FACI date is 11 September 1968. The change in FACI was primarily the result of Program Change Requests. A total of 15 PCR's were processed against LUMINARY as of the end of January. The requested change to Z-axis tracking alone accounted for a 22-day change in the FACI.

Section 3 (PGNCS Digital Autopilot), Section 4 (PGNCS Operational Modes), and Section 5 (LGC Guidance Equations) are planned for publications on 3 April 1968, 8 March 1968 and 13 February 1968 respectively.

Training tapes for Lunar Landing Site Redesignation are to be sent to NASA/MSC on 1 March 1968. This tape should have an operational P63-P64-P65 sequence without R10, R12 and R29. Thus this tape will be useful for redesignating the landing site but will not have landing radar state vector updating, h- and h-type displays, forward and lateral velocity displays, or powered flight rendezvous radar designate.

Training tapes for the complete Lunar Landing sequence are to be sent to NASA/MSC on 15 March 1968. This tape should provide an operational P63-P64-P65, P66, P67 sequences with R10 the analog display routine. The radar routine will probably not be included.

COLOSSUS CMC PROGRAM

FIXED MEMORY ALLOCATION CHART (ESTIMATED)

I.	Utility and Service Programs	
	Interpreter, Single Precision Subroutines, Fixed-Fixed Constant Pool	2262
	Executive	328
	Waitlist, Longcall	240
	Interrupt Lead Ins	52
	Interbank Communication	88
	T4RUPT	800
	SXT Angle Monitor	75
	Keyrupt-Uprupt	70
	Downlink Program and 5 Lists	425
	Fresh Start and Restart	420
	Alarm and Abort	63
	Delayjob	30
	Restart Routine and Tables	400
	Phase Table Maintenance	183
	Pinball Program and Noun Tables	2900
	Displays, Priolarm	700
	Program Select (V37, P00, R00)	300
	Self Check	314
	Extended Verbs	550
	RTBOP Codes	200
	SXTMARK	353
	IMU Mode Switching	580
	IMU Compensation	250
	LGC Startup	30
	LGC Power Down (P06)	46
	IMU Status Check	17
	Systems Test (P07)	650
	Interpretive Constants	29
	Flagup, Flagdown	31

GENTRAN	16
DAP Data Load (R03)	29
End Bank Markers	72
TOTAL UTILITY AND SERVICE PROGRAMS	12,503
II. Autopilot and Maneuver Programs	
Entry DAP	825
BOOST	65
RCS	1806
TVC	1908
KALCMANU	725
Attitude Maneuver (R60)	100
Crew Defined Maneuver (R62)	16
Vecpoint	130
Rendezvous Final Attitude (R63)	30
Middle Gimbal Display	64
CM Body Attitude	200
TOTAL AUTOPILOT AND MANEUVER PROGRAMS	5869
III. Basic Math Routines	
Inflight Alignment Routines	230
Powered Flight Subroutines	156
CSM Geometry	264
Time of Free Fall	280
Conic Subroutines	1050
Orbital Integration	1472
PERIAPO	100
Latitude, Longitude, Altitude	159
Initial Velocity	175
Lunar and Solar Ephemeris	75
Planetary Inertial Orientation	202
TOTAL BASIC MATH ROUTINES	4163
IV. Targeting Routines	
Transfer Phase Initiation Search	320
Central Angles Subroutine	40
TOTAL TARGETING ROUTINES	360

V. Navigation Routines	
Measurement Incorporation	333
Preferred Tracking Attitude (R61)	300
Lunar Landmark Selection (R35)	192
Rendezvous Tracking Sighting Mark & Backup (R21, R23)	90
Rendezvous Tracking Data Processing & Backup (R22, R24)	450
Landmark Table	150
TOTAL NAVIGATION ROUTINES	1515
VI. Powered Guidance Routines	
Servicer	500
Desired Thrust Direction (S40.1, S40.2, 3)	300
Cross Product Steering (S40.8)	140
VG Calculation (S40.9)	115
Time of Burn Calculation (S40.13)	80
Initial VG (S41.1)	20
Entry Guidance	1200
TOTAL POWERED GUIDANCE	2355
VII. Alignment Routines	
Coarse Align (R50)	80
Fine Align (R51)	140
Auto Optics (R52)	150
Sighting Mark (R53)	50
Star Data Test (R54)	55
Gyro Torquing (R55)	35
Pick-A-Pair	145
Star Catalog	223
Alternate LOS Sighting Mark (R56)	54
Optics Calibration (R57)	50
TOTAL ALIGNMENT ROUTINES	982
VIII. Miscellaneous Programs and Routines	
P27 - Update Program	320
R36 - Rendezvous Out of Plane Display	98
P30 - P31 EXT DELTA V & General Lambert Maneuver	300
R05 - S Band Antenna Display	85
R30 - Orbit Parameter Display	264
R31 - R34 Rendezvous Parameter Display Routine 1 & 2	190
R32 - Target Delta V	120
R33 - CMC/LGC Clock Synchronization	26
TOTAL MISCELLANEOUS PROGRAMS AND ROUTINES	1403

IX. Mission Control Programs

P01 - Prelaunch or Service Initialization	38
P02 - Prelaunch or Service Gyrocompassing	397
P03 - Optical Verification of Gyrocompassing	131
P11 - Earth Orbit Insertion Monitor	400
P17 - TPI Search	120
P20 - Rendezvous Navigation	150
P21 - Ground Track Determination	66
P22 - Orbital Navigation	1100
P23 - Cislunar Midcourse Navigation	545
P34, P74 TPI Prethrust	} 643
P35, P75 TPM Prethrust	
P37 - Return to Earth	1450
P38, P78 SOR Prethrust	} 236
P39, P79 SOM Prethrust	
P40 - SPS Thrusting	} 625
P41 - RCS Thrusting	
P47 - Thrust Monitor	100
P51, P53 IMU Orientation Determination & Backup	285
P52, P54 IMU Realign and Backup	400
P61 - Maneuver to CM/SM Sep Attitude	320
P62 - CM/SM Sep and Pre-Entry Maneuver	90
P63 - Entry Initialization	25
P64 - Post 0.05G	20
P65 - Upcontrol	50
P66 - Ballistic	20
P67 - Final Phase	40
P77 - LM TPI Search	1
TOTAL MISSION CONTROL PROGRAMS	7262
GRAND TOTAL	36412
REMAINING FIXED MEMORY	452

LUMINARY LGC PROGRAM

FIXED MEMORY ALLOCATION CHART (ESTIMATED)

I.	Utility and Service Programs	2262
	Interpreter, Single Precision Subroutines	2262
	Fixed-Fixed Constant Pool	
	Executive	328
	Waitlist, Longcall	240
	Interrupt Lead Ins	52
	Interbank Communication	88
	T4rupt (R10, R25)	752
	Keyrupt-Urupt	68
	Downlink Program and 5 Lists	425
	Fresh Start and Restart	420
	Alarm and Abort	63
	Delayjob	30
	Restart Routine and Tables	350
	Phase Table Maintenance	183
	Pinball Program and Noun Tables	2950
	Displays, Priolarm	700
	Program Select Check (V37, P00, R00)	310
	Self Check	314
	Extended Verbs	600
	RTB OP Codes	200
	Radar Rupts	200
	AOTMARK (R53)	430
	Backup Marking (COAS)	50
	IMU Mode Switching	580
	IMU Compensation	270
	LGC Startup	30
	LGC Power Down (P06)	46
	IMU Status Check	17
	System Test (P07)	725
	Interpretive Constants	35

Flagup, Flagdown	31
GENTRAN	16
DAP Data Load (R03)	160
Radar Subroutines	750
End Bank Markers	72
TOTAL UTILITY AND SERVICE PROGRAMS	13747
II. Autopilot and Maneuver Programs	
Digital Autopilot	3250
KALCMANU	680
Find CDU W	200
Attitude Maneuver (R60)	100
Crew Defined Maneuver (R62)	16
Vecpoint	130
Rendezvous Final Attitude (R63)	60
Ball Angle Display	60
Middle Gimbal Display	64
TOTAL AUTOPILOT AND MANEUVER PROGRAMS	4560
III. Basic Math Routines	
Inflight Alignment Routines	250
Powered Flight Subroutines	156
LM Geometry	106
Time of Free Fall	280
Conic Subroutines	1050
Orbital Integration	1478
PERIAPO	78
Latitude, Longitude, Altitude	170
Initial Velocity	175
Lunar and Solar Ephemeris	126
* Planetary Inertial Orientation	280
TOTAL BASIC MATH ROUTINES	4149
IV. Targeting Routines	
Coelliptic Sequence Initiation	} 649
Constant Delta Altitude	
TOTAL TARGETING ROUTINES	649

V. Navigation Routines	
Measurement Incorporation	333
Preferred Tracking Attitude (R61)	50
Rendezvous Navigation (LSR22.3, RADARANG)	525
*Lunar Surface Navigation (LSR22.4)	
RR Search, Designate and Read	650
(R21, R22, R23, R24, R29, LPS20.1, LPS20.2 LRS22.1, LRS22.2, LRS24.1, CALCXY)	
TOTAL NAVIGATION ROUTINES	1558
VI. Powered Guidance Routines	
Servicer (R12)	1000
Desired Thrust Direction (S40.1, S40.2, 3)	120
Cross Product Steering (S40.8)	75
VG Calculation (S40.9)	100
Time of Burn Calculation (S40.13)	130
*Descent Guidance (R11, R13)	925
Throttle Logic	150
*Ascent Guidance	550
TRIMGIMB (S41.1, S40.6)	55
TOTAL POWERED GUIDANCE ROUTINES	3105
VII. Alignment Routines	
Coarse Align (R50)	65
Fine Align (R51)	110
Auto Optics (R52)	70
Star Data Test (R54)	46
Gyro Torquing (R55)	30
Pick-A-Pair (R56)	132
Star Catalog	223
TOTAL ALIGNMENT ROUTINES	676
VIII. Miscellaneous Programs and Routines	
R47 - AGS Initialization	114
R36 - Rendezvous Out of Plane Display	98
P27 - Update Program	320
P30 - External Delta V Prethrust	97
*P31 - General Lambert Maneuver	100
R04 - RR/LR Self Test	139
*R05 - S Band Antenna Display	105

*R29 - Rendezvous Radar Flight Designate	
R30 - Orbit Parameter Display	264
R31 - Rendezvous Parameter Display	170
R32 - Target Delta V	100
R33 - CMC/LGC Clock Synchronization	26
*R77 - Radar Spurious Return Test	
R10 - Landing Analog Display Monitor	150
R11 - Abort Discretes Monitor	40
R13 - Auto Modes Monitor	50
TOTAL MISCELLANEOUS PROGRAMS AND ROUTINES	1743

IX. Mission Control Programs

*P10-P11 Predicted Launch Time	400
*P12 - Ascent Guidance	200
P20 - Rendezvous Navigation	160
P21 - Ground Track Determination	66
*P22 - Lunar Surface Navigation	20
P25 - Preferred Tracking Attitude	70
P32-P72 CSI Prethrust	93
P33-P73 CDH Prethrust	134
P34-P74 TPI Prethrust	642
P35-P75 TPM Prethrust	95
*P38-P78 SOR Prethrust	} 236
*P39-P79 SOM Prethrust	
P40 - DPS Thrust	1000
P41 - RCS Thrust	55
P42 - APS Thrust	35
*P46 - Separation Monitor	50
P47 - Thrust Monitor	60
P51 - IMU Orientation Determination	280
P52 - IMU Realign	164
*P57 - Lunar Surface Align	600
*P63 - Landing Braking	100
*P64 - Landing Approach	50
*P65 - Landing (AUTO)	} 100
*P66 - Landing (ROD)	
*P67 - Landing (Manual)	
*P70 - DPS Abort	150
*P71 - APS Abort	150
TOTAL MISSION CONTROL PROGRAMS	4815
GRAND TOTAL	35002
REMAINING FIXED MEMORY	1862

* - Indicates program and routines that will be omitted from the Earth Orbital LM Program (SUNDANCE).

DATE 2/23/68

MIT/IL MASTER APOLLO SOFTWARE DEVELOPMENT PLAN

TITLE		1968															
		NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	
SOLARIUM	MAINT., VERIFICATION & ANALYSIS																
	ERASABLE LOAD PREP																
SUNBURST	MAINT., VERIFICATION & ANALYSIS																
	ERASABLE LOAD PREP																
SUNDISK	POST RELEASE MAINT.																
	ERASABLE LOAD PREP																
SUNDANCE	GSOP																
	LEVEL 1																
	LEVEL 2																
	LEVEL 3																
	LEVEL 4																
LUMINARY	GSOP																
	LEVEL 1																
	LEVEL 2																
	LEVEL 3																
	LEVEL 4																
COLOSSUS	GSOP																
	LEVEL 1																
	LEVEL 2																
	LEVEL 3																
	LEVEL 4																

SECTION 9

"E" AND "R" NOTES PUBLISHED DURING THE REPORTING PERIOD

- E-2194 O'Connor, Joseph T., Hybrid Simulation of CSM Dynamics for AS-205, October 1967 (U)
- E-2204 Alonso, Ramon L., Algebraic Analysis and Modeling of Sequential Circuits, November 1967 (U)
- E-2210 Harper, John B., Quarterly Progress Report for Period Ending 31 October 1967 Apollo Applications Program Inertial Measurement Unit, November 1967 (U)
- E-2215 Yovanovich, M., Analytical and Experimental Investigation on the Thermal Resistance of Angular Contact Instrument Bearings, December 1967 (U)
- E-2218 Day, W. & Partridge, J., Lead Failure Study for the Motorola-1 MIL Wedge-Bonded 1006323 Transistor, December 1967 (U)
- R-596 AS-205 Verification Results, December 1967 (U)
- R-597 Tanner, W., Fluctuation Errors of Doppler Sensors at Low Velocity, December 1967 (U)
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