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APOLLO

GUIDANCE AND NAVIGATION

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(NASA-CR-52784) WEIGHT AND BALANCE
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REPORT (u) Monthly Rep
15 May 15, 1963

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GUIDANCE AND NAVIGATION:

NASA CR 52784

Approved Milton B. Trageser Date 5/20/63
MILTON B. TRAGESER, DIRECTOR
APOLLO GUIDANCE AND NAVIGATION PROGRAM

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(NASA CR-52784) E-1142 (REV. 8)

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WEIGHT AND BALANCE
REPORT (u) Monthly Report

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ABSTRACT

Report E-1142 (Rev. 8) presents weight, center of gravity, and moment of inertia values for all components of the guidance and navigation equipment. 10565

Power requirements of the guidance and navigation equipment upon the Primary +28 VDC Power Supply have also been included.

Only data pertaining to the command and service modules is, at present, included in this report.

E-1142 is prepared monthly and distributed on the 15th of each month. *Conf. * **

Author

Introduction

E-1142 (Rev. 8) is submitted in compliance with the documentation requirement of weight, center of gravity, and moment of inertia data for Apollo guidance and navigation equipment. At present, however, E-1142 pertains to only the command and service modules.

Power requirements, for Apollo guidance and navigation equipment, have been included to aid in the determination of spacecraft primary power.

Weights

All weight items are grouped according to their specific location within the spacecraft modules. Subsystem weights are reported to the component level and to the nearest tenth of a pound.

Given component weights are identified as calculated, measured, or estimated. These terms are defined by North American Aviation as follows:

Calculated weights (C) are weights 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.

Estimated weights (E) are rough calculations.

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

Weight Status Reporting

Table 1 offers a comparison of present weight values with those listed

in the previous Weight and Balance Report, E-1142 (Rev. 7), April 15, 1963.

All weight changes are explained.

The "Spec. Weight" column contains "proposed MSC" weights, that is, goals set forth by MSC in a memo to MIT/IL dated December 5, 1962.

Centers of Gravity

The centers of gravity of each weight component or packaged assembly are determined with respect to the basic X, Y, Z axes of the command module which are shown in figure 1. Center of gravity values are given to the nearest tenth of an inch and are shown in table 2.

Moments of Inertia

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

Accuracy

The accuracy of numerical values reported in this revision should not be considered to be within the tolerance implied by the significant figures quoted. Numerical values will approach the established tolerances as design and development phases approach completion.

Power Requirements

The electrical load of the guidance and navigation equipment, on the Primary + 28 VDC Power Supply, is shown in figure 2.

Explanation of Reported Weight Changes

Optical Base and Gearing - Further measurements have resulted in a weight increase.

Optical Eyepieces (SXT and SCT) - Weight changes are the result of a detailed weight calculation of both eyepieces.

IMU - Weight increase due to the weighing of components previously estimated, namely, the Emergency Heater Control Module, the 28 VDC Regulator, the Gyro Preamps, and the PIP Preamps. Mounting tabs were also added to the outer gimbal.

NVB & Shock Mounts - Weight increase due to a weighing of the NVB beryllium parts which weighed heavier than the previous estimate.

Bellows Assembly - Weight increase due to the fact that last month's report (E-1142, Rev. 7) took into consideration only the Sextant Bellows and did not report the weight of the Scanning Telescope Bellows and the Bellows Seals.

Eye Relief Eyepiece - Weight decrease due to a better estimate based on a more defined optical design.

Rendezvous Radar and Transponder - Since G & N design activities do not and will not include responsibility or control of the rendezvous radar and transponder, these items are eliminated from the G & N Weight and Balance report.

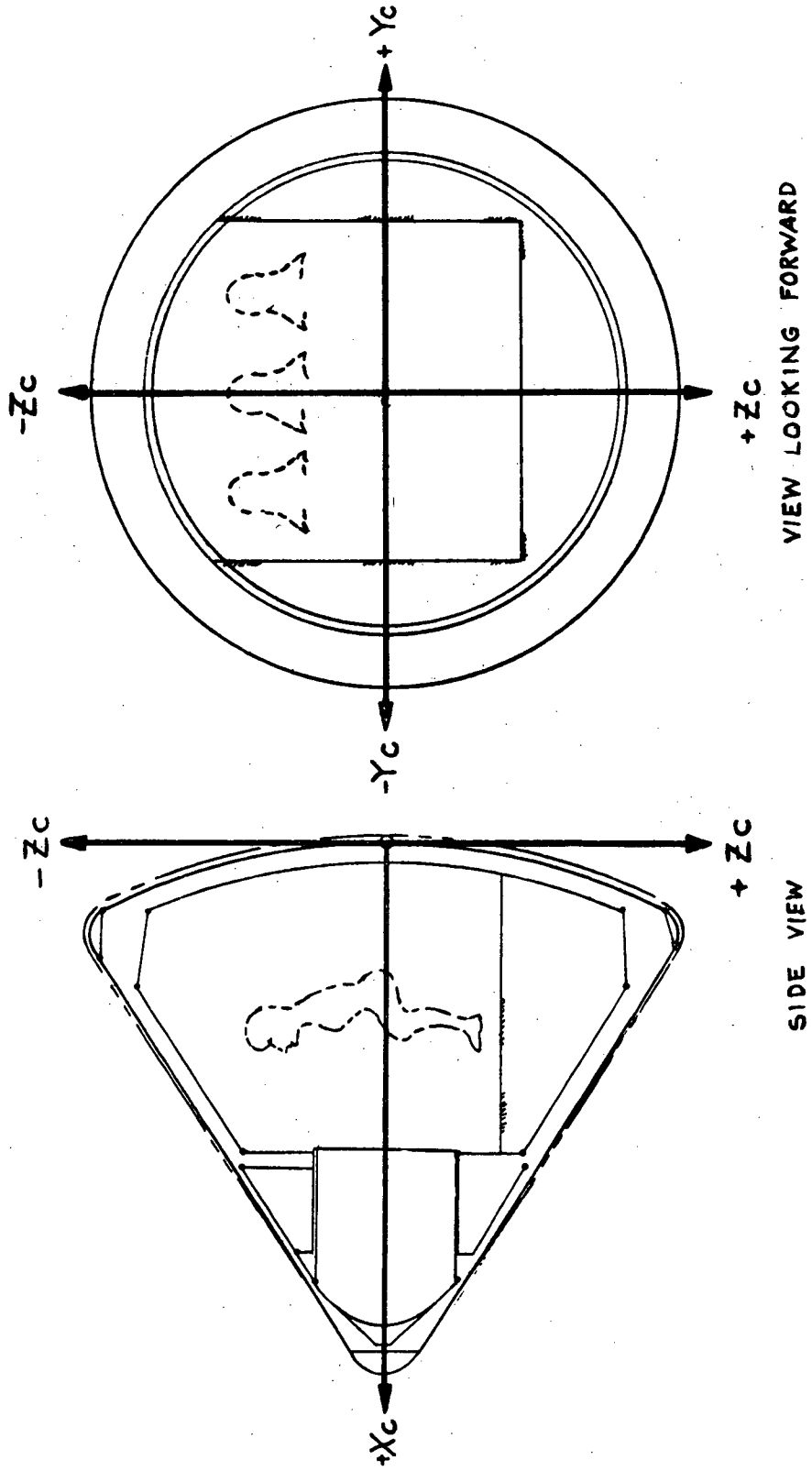


Figure 1. X, Y, Z Axes of Command Module

APOLLO G & N WEIGHT & BALANCE REPORT

E-1142

Table 1. Current Weight Status (lbs)

Item	Spec. 12/62 (a)	(b-a)	Status 4/63 (b)	(c-b)	Status 5/63 (c)
COMMAND MODULE					
<u>Lower Equipment Bay</u>					
CDU & Frame Assy	6.0	+ 10.5	16.5	0.0	16.5(E)
Optical Subsystem					
SXT	12.0	0.0	12.0	0.0	12.0(E)
SCT	9.0	0.0	9.0	0.0	9.0(E)
Opt Base & Gearing	14.0	+ 5.0	19.0	+ 2.0	21.0(E)
Optical Eyepieces					
SXT	2.0	+ 3.0	{ 1.0	+ 0.5	1.5(E)
SCT			{ 4.0	- 1.7	2.3(E)
IMU	40.0	+ 8.5	58.5	+ 0.5	59.0(E)
NVB & Shock Mounts	16.0	+ 8.0	24.0	+ 3.2	27.2(E)
Bellows Assy	8.0	0.0	8.0	+ 5.9	13.9(E)
Cabling	22.0	+ 3.0	25.0	0.0	25.0(E)
D & C Nav Station					
IMU Control Panel			{ 6.0	0.0	6.0(E)
Left Hand Turret			{ 3.2	0.0	3.2(E)
Optical Shroud	30.0	- 6.8	{ 3.8	0.0	3.8(E)
G&N Ind Cont Panel			{ 10.2	0.0	10.2(E)
D & C/AGC	15.0	0.0	15.0	0.0	15.0(E)
M & DV (inc. 1 film)	5.0	+ 3.5	8.5	0.0	8.5(E)
AGC (no spares)	80.0	+ 13.0	93.0	0.0	93.0(E)
Spares Tray	- - -	+ 4.0	4.0	0.0	4.0(E)
Stored Spares	- - -	+ 11.0	11.0	0.0	11.0(E)
PSA	25.0	+ 24.7	49.7	0.0	49.7(E)
Stored Spares	- - -	+ 2.5	2.5	0.0	2.5(E)
Signal Conditioning Tray	- - -	+ 5.0	5.0	0.0	5.0(E)
	(Continued)				

APOLLO G & N WEIGHT & BALANCE REPORT

E-1142

Table 1. Current Weight Status (Cont'd)

Item	Spec. 12/62 (a)	(b-a)	Status 4/63 (b)	(c-b)	Status 5/63 (c)
Junction Box	8.0	+ 4.2	12.2	0.0	12.2(E)
<u>Main Panel Area</u>					
D&C/NAV	8.0	- 8.0	- - -	- - -	- - -
D&C/AGC	5.0	+ 10.0	15.0	0.0	15.0(E)
<u>Loose Stored Items</u>					
Eye Relief Eyepieces	- - -	+ 3.0	3.0	- 1.0	2.0(E)
Film Cartridges (4)	- - -	+ 3.0	3.0	0.0	3.0(E)
AGC Loose Spares			26.0	0.0	26.0(E)
PSA Loose Spares	20.0	+ 18.0	9.0	0.0	9.0(E)
CDU Spare Gearbox			3.0	0.0	3.0(E)
Computer Self-Check Plug	- - -	+ 1.0	1.0	0.0	1.0(E)
Horizon Photometer	- - -	+ 4.0	4.0	0.0	4.0(E)
Spare Lamps (3)	- - -	+ 0.2	0.2	0.0	0.2(E)
Spare Relay & Diode Module	- - -	+ 0.3	0.3	0.0	0.3(E)
SERVICE MODULE					
Radar					
(Transponder)	15.0	- 5.0	10.0	0.0	*
(Rendezvous Radar)	- - -	+ 30.0	30.0	0.0	*
TOTAL	350.0	155.6	505.6	+ 9.4	475.0
				* -40.0	
* Since G & N design activities do not and will not include responsibility or control of the rendezvous radar and transponder, these items are eliminated from the G & N Weight and Balance report.					

APOLLO G & N WEIGHT & BALANCE REPORT

E-1142

Table 2. Center of Gravity and Moment of Inertia Data

Item	Weight (lbs)	Center of Gravity (inches)			Moment of Inertia (lb-in ²)		
		X	Y	Z	I _{xx}	I _{yy}	I _{zz}
COMMAND MODULE							
Lower Equip. Bay							
CDU & Frame Assy	16.5(E)	63.5	- 14.4	35.8	50	470	470
Optical Subsystem							
SXT	12.0(E)						
SCT	9.0(E)						
Opt. Base & Gearing	21.0(E)						
Optical Eyepieces							
SXT	1.5(E)	65.1	- 3.5	26.2			
SCT	2.3(E)	65.1	4.5	26.2			
IMU	59.0(E)	56.6	0.0	41.7	1330	1330	1330
NVB & Shock Mounts	27.2(E)	60.6	0.0	44.0			
Bellows Assy	13.9(E)	71.5	- 0.3	36.3			
Cabbling	25.0(E)						
D & C/NAV Station							
IMU Cont Panel	6.0(E)	73.0	- 15.1	31.7			
Left Hand Turret	3.2(E)	49.5	- 9.6	39.6			
Optical Shroud	3.8(E)	66.8	0.9	28.9			
G&N Ind. Control Pnl	10.2(E)	55.8	1.0	34.0			
D & C/AGC	15.0(E)						
M & DV (includes 1 film)	8.5(E)	73.5	- 4.5	31.0			
AGC (no spares)	93.0(E)	37.0	0.0	45.0	7750	4860	3250
Spares Tray	4.0(E)	40.5	0.0	45.0	860	760	110
Stored Spares	11.0(E)	40.5	0.0	45.0			
(Continued)							

APOLLO G & N WEIGHT & BALANCE REPORT

E-1142

Table 2. Center of Gravity and Moment of Inertia Data (Cont'd)

Item	Weight (lbs)	Center of Gravity (inches)			Moment of Inertia (lb-in ²)		
		X	Y	Z	I _{xx}	I _{yy}	I _{zz}
COMMAND MODULE (cont'd)							
<u>Lower Equip. Bay (cont'd)</u>							
PSA	49.7(E)	45.0	1.1	41.5	2520	1270	1460
Stored Spares	2.5(E)	45.0	10.2	41.5	120	130	15
Signal Conditioning Tray	5.0(E)	45.2	0.0	53.1	450	70	430
Junction Box	12.2(E)						
<u>Main Panel Area</u>							
D & C/AGC	15.0(E)						
<u>Loose Stored Items</u>							
Eye Relief Eyepieces (2)	2.0(E)	(SCT- 4 5/8" x 2 1/2" dia; SXT- 3" x 2 1/4" dia.)					
Film Cartridges (4)	3.0(E)	(Each cartridge - 1 1/2 x 3 x 6 inches)					
AGC Loose Spares	26.0(E)						
PSA Loose Spares	9.0(E)						
CDU Spare Gearbox	3.0(E)	(approximately 5.6 x 5.8 x 5.5 inches)					
Computer Self-Check Plug	1.0(E)						
Horizon Photometer	4.0(E)	(6 x 6 x 3 inches)					
Spare Lamps (3)	0.2(E)						
Spare Relay & Diode Module	0.3(E)	(3 x 3 x 2 inches)					
SERVICE MODULE							
Radar							
(Transponder)							
(Rendezvous Radar)							

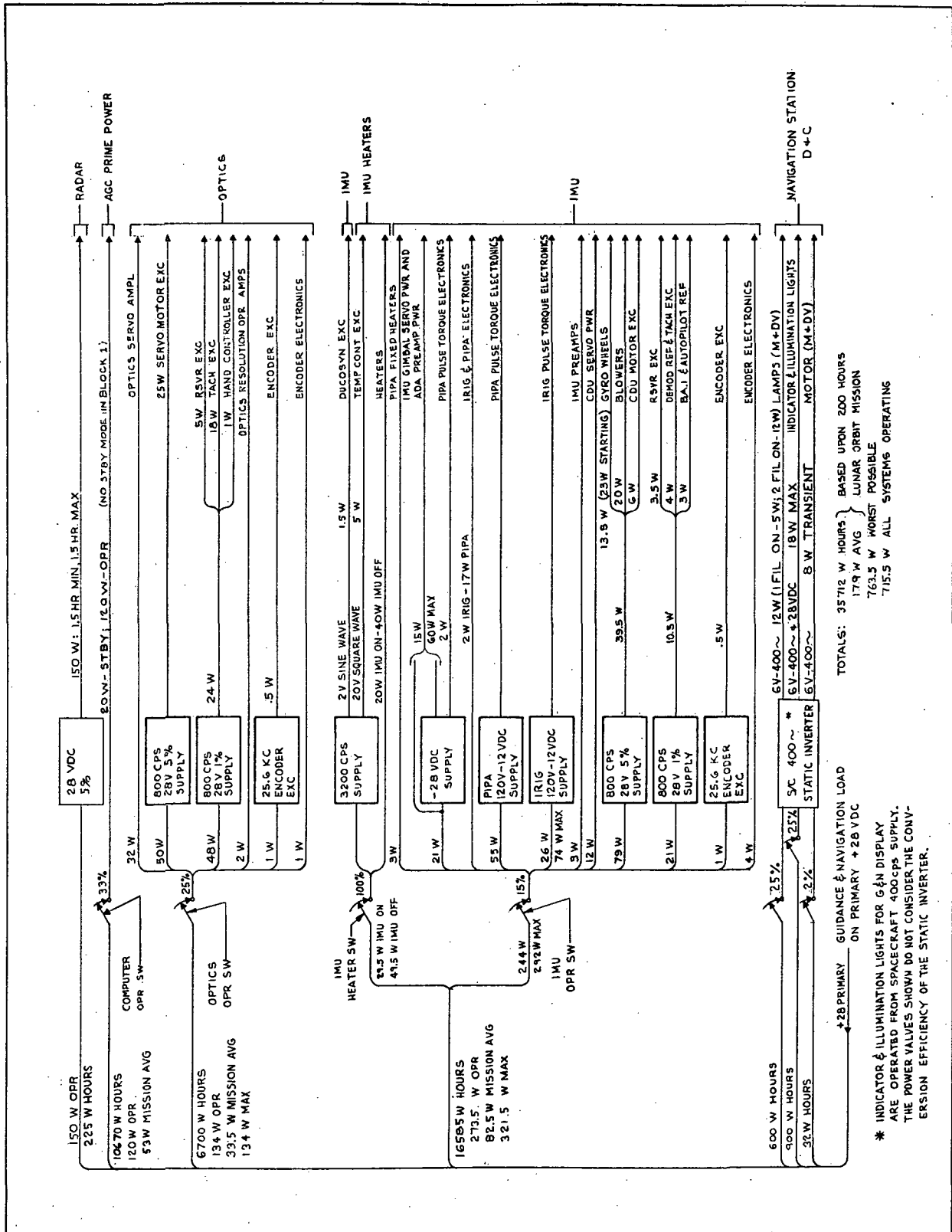


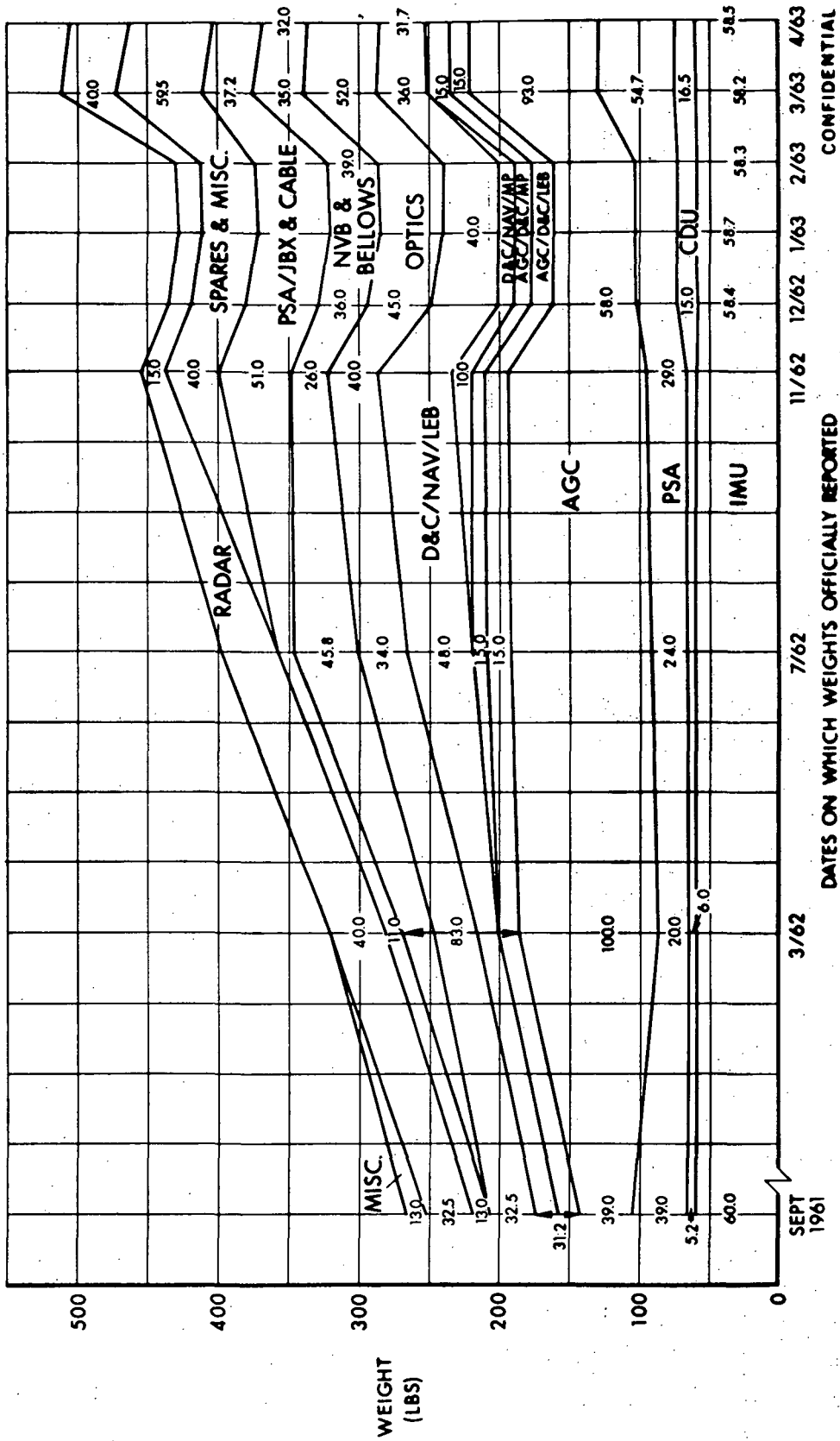
Figure 2. Electrical Load on Primary + 28 VDC

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E-1142

CHRONOLOGICAL WEIGHT STATUS G&N

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Figure 3. Chronological Weight Status G & N

Glossary

- AGC:** Apollo Guidance Computer: complete computer, except display and keyboard. Includes: - all structural mounting rails, support for spare tray, AGC cable to front panel for spacecraft electrical interface, spare logic in four trays, and power supply.
- BELLOWS ASSEMBLY:** Bellows Assembly: connection between Command Module and Optical Subsystem consists of SXT and SCT bellows plus bellows seals.
- CABLING:** Cabling: intrasubassembly cabling in lower equipment bay. (Interequipment cabling from lower equipment bay to other assemblies is assumed a spacecraft responsibility.)
- CDU & FRAME ASSEMBLY:** Coupling Display Units and frame assembly: five gear boxes and frame assembly, used as an angle data interface among the optics, IMU, AGC, and spacecraft autopilot.
- D&C/AGC:** Display and Control, Computer: letter and number readout, keyboard, control, relays, and support structure.
- D&C/NAV:** Display and Control, Navigation: consists of G & N Indicator Control Panel, IMU Control Panel, Left Hand Turret, and Optical Shroud. The above includes meters, switches, lights, etc. except as reported elsewhere. The weight does not include the clock group which is supplied by NAA.
- G&N Ind Cont Panel:** G&N Indicator Control Panel: consists of the necessary switches, indicators, and controls for the navigation task not reported elsewhere. Includes optics hand controller, altitude impulse control, panel wiring, and supporting hardware.

IMU Cont Panel: IMU Control Panel: meters, switches, panel wiring and supporting hardware.

Left Hand Turret: Left Hand Turret: contains electronic modules.

Optical Shroud: Optical Shroud: includes protective cover.

EYE RELIEF EYEPIECES: Eye Relief Eyepieces: a SXT and a SCT eyepiece to provide eye relief of at least 1.6 inches for closed visor operation.

FILM CARTRIDGES: Film Cartridges: film cartridges, including film, for Map and Data Viewer.

HORIZON PHOTOMETER: Horizon Photometer: an automatic, photometric, horizon detector device interchangeable with sextant eyepiece to provide capability for use of earth's illuminated limb as a navigation reference.

IMU: Inertial Measurement Unit: gimbal assembly, inertial components, data transducers, support structure, and internal cooling.

JUNCTION BOX: Junction Box: electrical interconnection center between subassemblies in lower equipment bay.

M&DV: Map and Data Viewer: film viewer for display of maps, charts, procedures, etc. Weight includes one film cartridge with film.

NVB & SHOCK MOUNTS: Navigation Base and Shock Mounts: rigid structure supporting the IMU and the Optical Subsystem with its associated hardware and supported by three shock mounts that attach the NVB to the spacecraft.

OPTICAL EYEPIECES: Optical Eyepieces: optical eyepieces for SXT and SCT.

OPTICAL SUBSYSTEM: Optical Subsystem: SXT, SCT, Optical Base and gearing, panel base, and associated hardware.

Optical Base & Gearing: Optical Base and Gearing: base for SCT and SXT with associated gearing.

SCT: Scanning Telescope: single line-of-sight, wide-field, two-degree-of-freedom telescope and its attached gearing.

SXT: Sextant: two line-of-sight, narrow field, two-degree-of-freedom sextant, including attached gearing and internal cooling.

PSA: Power Servo Assembly: IMU, SCT, and SXT servos, power supplies, CDU electronics, IMU backup mode electronics, and miscellaneous electronics.

Signal Conditioning Tray: Signal Conditioning Tray: tray in PSA to condition signals for telemetry and in-flight test equipment.

RADAR (Transponder and Rendezvous Radar): Radar (Transponder and Rendezvous Radar): electromagnetic ranging equipment, located in service module, for lunar orbit rendezvous.

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E-1142

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