APOLLO

GUIDANCE AND NAVIGATION

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E-1142 (REV. 3)

(Unclassified Title)

WEIGHT AND BALANCE

REPORT

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This revision replaces the earlier edition.

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ABSTRACT

Report E-1142 (Rev. 3) presents weight and center-of-gravity values for all components of the guidance and navigation equipment. Subsequent reports will include additional data of the moments of inertia.

Only data pertaining to the guidance and navigation equipment of the command and service modules are, at present, included in this report.

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

Introduction

E-1142 (Rev. 3) is submitted in compliance with the documentation requirement for 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.

Weight evaluation and center-of-gravity data are included in this revision. Subsequent revisions will update this weight and center-of-gravity data and will also include moment-of-inertia data.

Weight

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 estimated, calculated, or measured. Calculated weights are those based upon density, volume, and so forth. Estimated weights are those determined by a comparison with weights of similar size and shape.

North American Aviation will supply data on coldplate weights..

Centers of Gravity

The center of gravity of each weight component or packaged assembly is determined with respect to the basic X, Y, Z axes of the command module, that is, the established reference coordinates indicated on drawing V-16-930001 (NAA). The values given are to the nearest tenth of an inch.

Weight Status Reporting

The initial specification weights have not yet been established. On the basis of this revision, however, MIT/IL expects to supply NASA with more of the data necessary to establish specification weights.

This revision offers a comparison of present weight values and previous weight values listed in Weight and Balance Report, E-1142 (Rev. 2). All changes in weight are explained.

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. Numerical values will approach the established tolerances as design and development phases approach completion.

Explanation of Reported Weight Changes

AGC. Converting to micro-logic circuitry allowed a lighter computer.

CDU. In order to perform the additional function of optical control, the CDU was increased from three to five units. This new configuration has also been relocated.

BELLOWS ASSY. Increased weight resulted from further evaluation of the assembly.

IMU. Further evaluation has produced a reduction in the current weight value.

Measured	22.1(M)
Calculated	20.0(C)
Estimated	16.3(E)
Current Weight	58.4 lbs.(E)

NVB. Shock mounts, which were not previously considered, are now included in the current weight value.

OPT. SUBSYSTEM. The latest description of the optical subsystem includes the SXT, SCT, OPT. BASE, panel piece, and associated hardware. Panel piece and associated hardware weights, not previously considered, account for the weight increase. The individual weights for these items have now been combined into one listing.

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Table 1. Current Weight Status

Items	Spec. Weight (lbs)	Changes to _____	Status 11/62	Changes to Current	Current Weight 12/62
COMMAND MODULE					
Lower Equip. Bay Forward					
CDU	--	--	6.0(C)	+9.0	15.0(E)
D&C/AGC	--	--	15.0(E)	0.0	15.0(E)
D&C/NAV	--	--	39.5(E)	0.0	39.5(E)
M&DV	--	--	8.5(E)	0.0	8.5(E)
SCT	--	--	9.0(E)	--	--
SXT	--	--	12.0(C)	+5.0	40.0(E)
OPT BASE	--	--	14.0(E)	--	--
OPT SUBSYSTEM	--	--		--	--
IMU	--	--	60.0(E)	-1.6	58.4(E)
NVB	--	--	16.0(C)	+5.0	21.0(E)
OPT EYE PIECES	--	--	5.0(E)	0.0	5.0(E)
CBL	--	--	40.0(E)	0.0	40.0(E)
BELLOWS ASSY	--	--	10.0(E)	+5.0	15.0(E)
Lower Equip. Bay - Middle					
AGC	--	--	100.0(E)	-42.0	58.0(C)
PSA*	--	--	29.0(E)	0.0	29.0(E)
JBX	--	--	11.0(E)	0.0	11.0(E)
Main Panel					
D&C/AGC	--	--	15.0(E)	0.0	15.0(E)
D&C/NAV	--	--	10.0(E)	0.0	10.0(E)
SERVICE MODULE					
RAD	--	--	15.0(E)	0.0	15.0(E)
SPARES	--	--	40.0(E)	0.0	40.0(E)
TOTAL			455.0	-19.6	435.4

Notes: (C) Calculated; (E) Estimated; (M) Measured.

*PSA weights are based on old CDU configuration.

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Table 2. Center of Gravity and Moment of Inertia Data

Item	Weight (lbs)	Center of Gravity (inches)			Moment of Inertia ($lb\text{-}in^2$)		
		X	Y	Z	I_{xx}	I_{yy}	I_{zz}
COMMAND MODULE							
Lower Equip. Bay, Forward							
CDU	15.0(E)	63.5	-14.4	35.8			
D & C/AGC	15.0(E)						
D & C/NAV	39.5(E)						
M & DV	8.5(E0						
OPT. SUBSYSTEM	40.0(E)	69.0	1.7	32.3			
IMU	58.4(C)	56.6	0.0	41.7			
NVB	21.0(E)	60.6	0.0	44.0			
OPT. EYE PIECES*	5.0(E)						
CBL*	40.0(E)						
BELLOWS ASSY	15.0(E)	71.1	-0.2	35.6			
Lower Equip. Bay, Middle							
AGC	58.0(C)	39.2	0.0	50.0			
PSA	29.0(E)	44.7	0.0	41.3			
JBX	11.0(E)	44.9	0.0	50.0			
Main Panel							
D & C/AGC	15.0(E)						
D & C/NAV	10.0(E)						
SERVICE MODULE							
RAD*	15.0(E)						
SPARES*	40.0(E)						

*C. g. values for these items not determined due to indefinite location.

Glossary

AGC:	Apollo Guidance Computer; complete computer, except display and keyborad, including all structure mounting rails.
BELLOWS ASSY:	Bellows Assembly: connection between command module and optical subsystem.
CBL:	Cabling: intrasubassembly cabling in lower equipment bay. (Interequipment cabling from lower equipment bay to other assemblies is assumed a spacecraft responsibility.)
CDU:	Coupling Display Units: five gear boxes 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: meters, switches, lights, etc. except as reported elsewhere. Weight includes display panel in lower equipment bay but does not include wire, clock, or optics controller gear train. The display clock is not considered part of G & N equipment even though it appears above the G & N display panel.
IMU:	Inertial Measurement Unit: gimbal assembly, inertial components, data transducers, and support structure.
JBX:	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.
NVB:	Navigation Base: rigid structure containing the IMU and the Optical Subsystem with its associated hardware and supported by three shock mounts.

OPT. BASE:	Optical Base: Base for SCT and SXT.
OPT. EYE PIECES:	Optical Eye Pieces: optical eye pieces for SXT and SCT.
OPT. SUBSYSTEM:	Optical Subsystem: SXT, SCT, OPT. BASE, panel piece, and associated hardware.
PSA:	Power Servo Assembly: IMU, SCT, and SXT servos, power supplies, and miscellaneous electronics.
RAD:	Radar: Electromagnetic ranging equipment, located in service module, for lunar orbit rendezvous.
SCT:	Scanning Telescope: single, line-of-sight, wide-field, two-degree-of freedom telescope and its drive me chanism.
SHOCK MOUNTS:	Three shock mounts that attach the NVB to the spacecraft.
SXT:	Sextant: two, line-of-sight, narrow field, two-degree-of-freedom sextant; drive mechanism; and sextant optical bridge.