

Declassified
J. C. Smart
MA SA - SCB 7/1/70
9-21, 71
ew

~~CONFIDENTIAL~~

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

APOLLO

GUIDANCE AND NAVIGATION

Approved Milton B. Trageser Date 11/6/62
MILTON B. TRAGESER, DIRECTOR
APOLLO GUIDANCE AND NAVIGATION PROGRAM

Approved Roger B. Woodbury Date 11/6/62
ROGER B. WOODBURY, ASSOCIATE DIRECTOR
INSTRUMENTATION LABORATORY

Type II; NASA approval not required

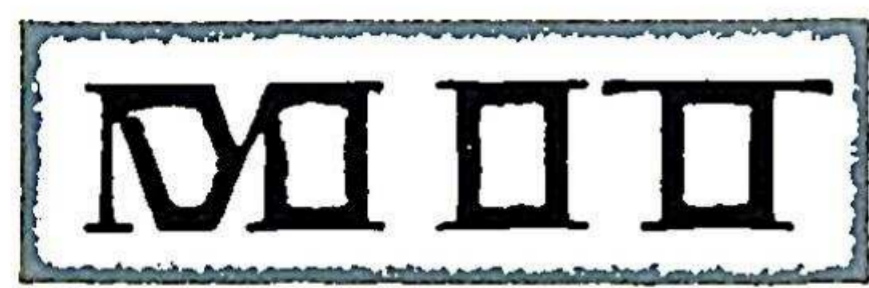
Return to ASFO File when not in use

E-1142 (REV. 2)
(Unclassified Title)

WEIGHT AND BALANCE
REPORT

This revision
replaces the
earlier edition.

November 1962



INSTRUMENTATION LABORATORY

CAMBRIDGE 39, MASSACHUSETTS

COPY # 239 OF 325 COPIES
THIS DOCUMENT CONTAINS 12 PAGES

~~CONFIDENTIAL~~

ACKNOWLEDGMENT

This report was prepared under the auspices of DSR Project 55-191, sponsored by the Manned Spacecraft Center of the National Aeronautics and Space Administration through contract NAS9-153.

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.

This document contains information affecting the national defense of the United States within the meaning of the Espionage Laws, Title 18, U. S. C., Sections 793 and 794, the transmission or the revelation of which in any manner to an unauthorized person is prohibited by law.

~~CONFIDENTIAL~~

ABSTRACT

Report E-1142 (Rev. 2) is the first Weight and Balance report to be based upon format used by North American Aviation Inc. This report will be prepared monthly and distributed on the 15th of each month.

Essentially, the new format for E-1142 takes into consideration changes in weight, center of gravity, and moment of inertia for guidance and navigation equipment in the command and service modules only.

³
~~CONFIDENTIAL~~

~~CONFIDENTIAL~~

Introduction

This revision to E-1142 is submitted in compliance with the new documentation requirement for weight, center of gravity, and moment of inertia data for guidance and navigation equipment. Only the command and service modules will be considered in E-1142.

Center of gravity and moment of inertia estimates are not included in this report revision; only weight evaluations are considered. Future revisions will update the weight evaluations and include center of gravity and moment of inertia data. See tables 1 and 2.

E-1142 shall be prepared monthly and distributed on the fifteenth of each month.

Weight

All weight items are grouped according to their specific locations 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. The term calculated means a computation based upon densities, volumes, and so forth. Estimated means a rough calculation or a comparison with weights of similar size and shape.

Centers of Gravity

Center of gravity data will be included in this report when North

~~CONFIDENTIAL~~

American Aviation Inc. has given MIT/IL an accurate coordinate reference system (three orthogonal reference axes) to which the centers of gravity of the guidance and navigation equipment may be referred.

Centers of gravity of all weight components or packaged assemblies shall be determined with respect to the X, Y, Z axes of the established reference coordinate system and located to the nearest tenth inch.

See table 1.

If necessary, a sketch may be given indicating the orientation of the three axes (reference coordinates).

Moments of Inertia

Moments of inertia, based upon the reference coordinate system, will also be included in this report when the reference coordinate system has been determined.

Weight moments of inertia will be (1) based upon the component centers of gravity, (2) given about the three coordinate reference axes, and (3) given to the nearest pound-inch squared.

Weight status reporting

Reported weight changes are explained. The initial specification weight will serve as the base weight for (1) completing the form shown in table 2 and for (2) the documents which provide the basis for the current weight definition (subcontractor, engineering memo, revised work statement, etc.) which will be referenced.

The initial specification weights have not been indicated for this report. On the basis of this report revision, MIT/IL expects help from NASA in establishing specification weights.

E-1142 (Rev. 2) compares only present weight values with those of the previous Weight and Balance Report, E-1142 (Rev. 1).

Reported weight change explanations

SXT. The sextant weight change from 26.5 to 12.0 pounds was due to a change in sextant design from a three-degree of freedom to a two-degree of freedom sextant. The sextant optical bridge is considered as part of the sextant.

NVB. The navigation base definition no longer includes the optical base and bellows and adapter which are now listed as separate components.

RAD. More accurate radar weight values will be established when definite decisions have been made on radar requirements. It is presently estimated that the radar equipment will weigh between 10 and 20 pounds for a transponder and between 40 and 50 pounds for a radar and transponder. MIT/IL currently feels that only a transponder is necessary.

PSA. The PSA weight increase is due to a location shift initiated by the spacecraft contractor. The shape of the available envelope changed from low frontal height/long depth to higher frontal height/shorter depth.

The larger height, plus the new location, have increased the length of the PSA mounting screws and have made some of these screws inaccessible for in-flight maintenance. Additional weight is required

~~CONFIDENTIAL~~

for hold down mechanisms (replacing mounting screws) to permit such maintenance.

D&C NAV. Display and Control, Navigation, on the Main Panel, is at this date poorly defined. This estimate is based upon a film viewer and a limited number of light and control switches. Coordination with North American Aviation Inc. is needed in this area.

~~CONFIDENTIAL~~

Table 1. Center of Gravity and Moment of Inertia Data

Item	Weight	Centers of Gravity			Inertias		
		x	y	z	I _{cx}	I _{oy}	I _{oz}
<u>Lower Equip.</u> <u>Bay - Forward</u>							
CDU	6.0(C)						
D&C/AGC	15.0(E)						
D&C/NAV	39.5(E)						
M&VD	8.5(E)						
SCT	9.0(E)						
SXT	12.0(C)						
IMU	60.0(E)						
NVB	16.0(C)						
Optical Base	14.0(E)						
All Optical							
Eye-pieces	5.0(E)						
Bellows &							
Adapter	10.0(E)						
CBL	40.0(E)						
<u>Lower Equip.</u> <u>Bay - Middle</u>							
AGC	100.0(E)						
PSA	29.0(E)						
JBX	11.0(E)						

Table 1. Center of Gravity and Moment of Inertia Data

Item	Weight	x	y	z	I _{ox}	I _{oy}	I _{oz}
<u>Main Panel</u>							
D&C/AGC	15.0(E)						
D&C/NAV	10.0(E)						
<u>Service Module</u>							
RAD	15.0(E)						
<u>Spares</u>	40.0(E)						

Table 2. Current Weight Status

Items	Spec. Weight (lbs)	Changes to	Status 7/62	Changes to Current	Current Weight 11/62
<u>Lower Equip. Bay - Forward</u>					
CDU	--	--	6.0	0	6.0(C)
D&C/AGC	--	--	15.0	0	15.0(E)
D&C/NAV	--	--	39.5	0	39.5(E)
M&VD	--	--	8.5	0	8.5(E)
SCT	--	--	7.5	+1.5	9.0(E)
SXT	--	--	26.5	-14.5	12.0(C)
IMU	--	--	60.0	0	60.0(E)
NVB	--	--	45.8	-29.8	16.0(C)
Optical Base	--	--	--	--	14.0(E)
All Optical Eye-pieces	--	--	--	--	5.0(E)
Bellows & Adapter	--	--	--	--	10.0(E)
CBL	--	--	--	--	*40.0(E)
<u>Lower Equip. Bay - Middle</u>					
AGC	--	--	100.0	0	100.0(E)
PSA	--	--	24.0	+5.0	29.0(E)
JBX	--	--	11.0	0	11.0(E)
<u>Main Panel</u>					
D&C/AGC	--	--	15.0	0	15.0(E)
D&C/NAV	--	--	--	--	*10.0(E)
<u>Service Module</u>					
RAD	--	--	40.0	-25.0	15.0(E)
Spares	--	--	--	--	*40.0(E)
Total			**488.8	-33.8	455.0
Notes:	(C) Calculated; (E) Estimated; (M) Measured * Weights of these items were not given in the previous report ** Includes asterisk values				

Glossary

- AGC:** Apollo Guidance Computer: complete computer, except display and keyboard, including all structure and mounting rails.
- BELLOWS & ADPT:** Bellows and Adapter: connection between command module and optical subsystem.
- CBL:** Cabling: intra subassembly cabling in lower equipment bay. Inter equipment cabling from lower equipment bay to other assemblies is assumed a spacecraft responsibility.
- CDU:** Coupling Display Units: three units used as an angle data interface among the 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, support structure, etc.
- JBX:** Junction Box: electrical interconnection center among subassemblies in lower equipment bay.
- M & VD:** Map and Visual Display: film viewer for display of maps, charts, procedures, etc.
- NVB:** Navigation Base: rigid structure to tie together the IMU, the Optical Subsystem, and associated hardware.
- OPT. EYE PIECES:** Optical Eye Pieces: Optical Eye Pieces for SXT and SCT.

OPT. BASE: Optical Base: Base for SCT and SXT.

OPT. SUBSYSTEM: Optical Subsystem: SXT, SCT, and Harness Assembly.

PSA: Power Servo Assembly: IMU, SCT, and SXT servos, power supplies, and miscellaneous electronics. Does not include cold plate which is assumed part of spacecraft structure.

RAD: Radar: Electromagnetic ranging equipment in service module, for lunar, orbit rendezvous.

SCT: Scanning Telescope: single line-of-sight, wide-field, two-degree of freedom telescope. Includes drives.

SXT: Sextant: two line-of-sight, narrow field, two-degree of freedom sextant. Includes drives and sextant optical bridge.