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Contract NAS 9-150

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Prepared by

Program Phasing Group
Program Control

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SPACE and INFORMATION SYSTEMS DIVISION

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FOREWORD

This Apollo Program Schedule Data is provided in lieu of the Apollo Program Plan which will be submitted to NASA July 31, 1962.

This data is prepared for the purpose of delineating all Apollo Program Schedules and related material.

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ABBREVIATION LIST

Accept.	Acceptance
Air	Airesearch
Hi-Alt.	High Altitude
Anal.	Analysis
Apport.	Apportionment
Afro.	Aerodynamic
AMR	Atlantic Missile Range
AFRM	Airframe
Atmos.	Atmosphere
Atten.	Attenuation
B/P or B-	Boilerplate
CDS	Control & Display System
C/M or C.M.	Command Module
Cont	Control
Comp.	Complete/Compute
Compl.	Complete
Config.	Configuration
Crit.	Criteria
Del.	Deliver
Des.	Design
Dev/Devel.	Development
Dwg.	Drawing
Dyn.	Dynamic
ECS.	Environmental Control System
Effect.	Effectiveness
Engr.	Engineering
Environ.	Environmental
Equip.	Equipment
Eval.	Evaluation
Ext.	Exterior
Fac.	Facilities
Flt.	Flight
GSE	Ground Support Equipment
Init.	Initiate
Inst. /Install.	Installation
Int.	Interior
Instr.	Instrumentation
Jet.	Jettison
Les.	Launch Escape System
Lesc.	Launch Escape Stab. & Cont.
Limit.	Limitations

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L. J. II	Little Joe II
LLPM	Lunar Landing Propulsion Module
LNDG.	Landing
MSC	Missile Space Center
MTL.	Material
MFG.	Manufacturing
Max.	Maximum
Meas.	Measurement
M. H.	Minnespolis Honeywell
Miss.	Mission
MU	Mockup
N&G	Navigation & Guidance
Orb.	Orbital
Perf.	Performance
Prel.	Preliminary
Prop/Propel.	Propellant
Prop/Propul.	Propulsion
Proto.	Prototype
Qual.	Qualification/Qualified
Rad.	Radiation
RCS	Reaction Control System
Rec.	Recovery
Reac.	Reaction
Rel.	Release
Rel.	Reliability
Req. Reqt.	Requirement
S. A.	Saturn-Apollo
Ser.	Service
S. M. or S/M	Service Module
Sim/Simul.	Simulator
S. C.	Spacecraft
Spec(s)	Specification(s)
SCS	Stabilization & Control System
Struct.	Structures
Sys.	System
Tab.	Tables Tabulation
Tech.	Technical
Thermo.	Thermodynamic
Trng.	Training
W. T.	Wind Tunnel

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MASTER PHASING PLAN

The Master Phasing Plan establishes the basic ground rules for all Apollo schedules. Major milestones of other schedules must coincide with those of the Master Phasing Plan.

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MASTER DEVELOPMENT SCHEDULES

The Master Development Schedules reflect the major milestones necessary for the developmental process within each functional division of the Apollo program.

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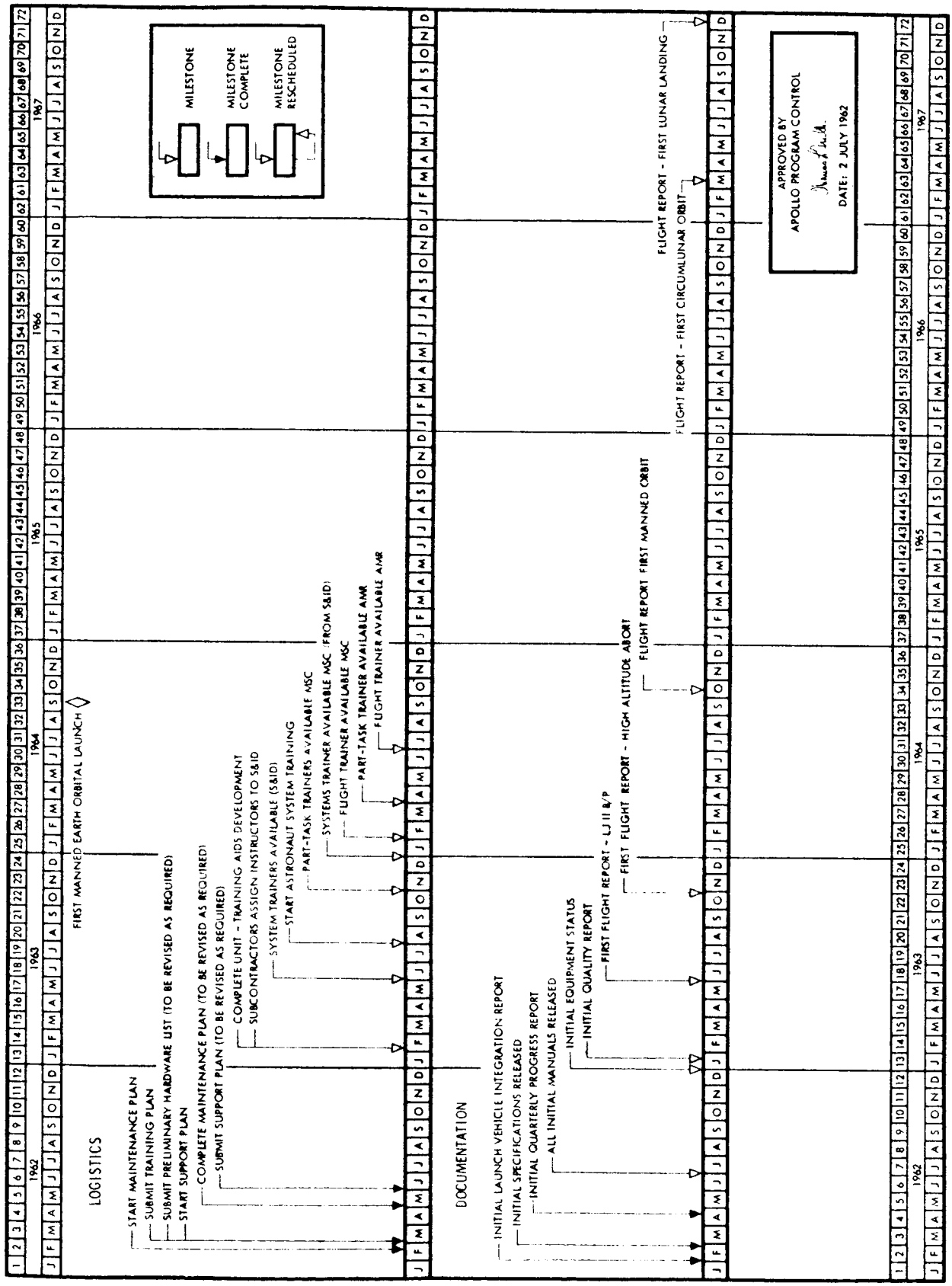

Figure 6. Master Development Schedule - Logistics & Documentation

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GENERAL ORDER DEVELOPMENT SCHEDULES

The General Order Development Schedules describe the detail processes required to fulfill the standards set by the general orders and to meet goals established by the Master Phasing Plan.

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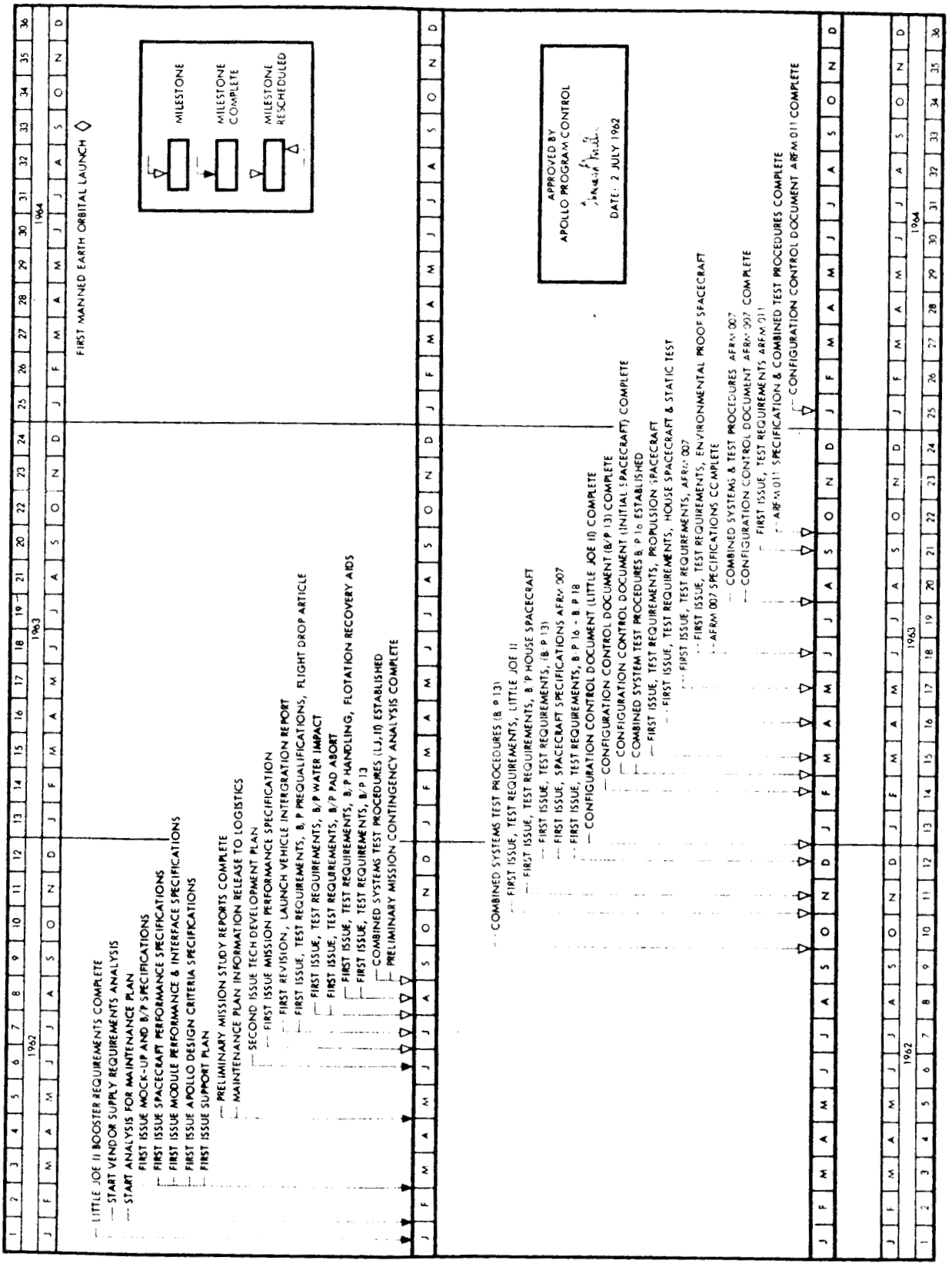

Figure 8. G. O. 7122 - Integration and System Analysis DEVELOPMENT SCHEDULE

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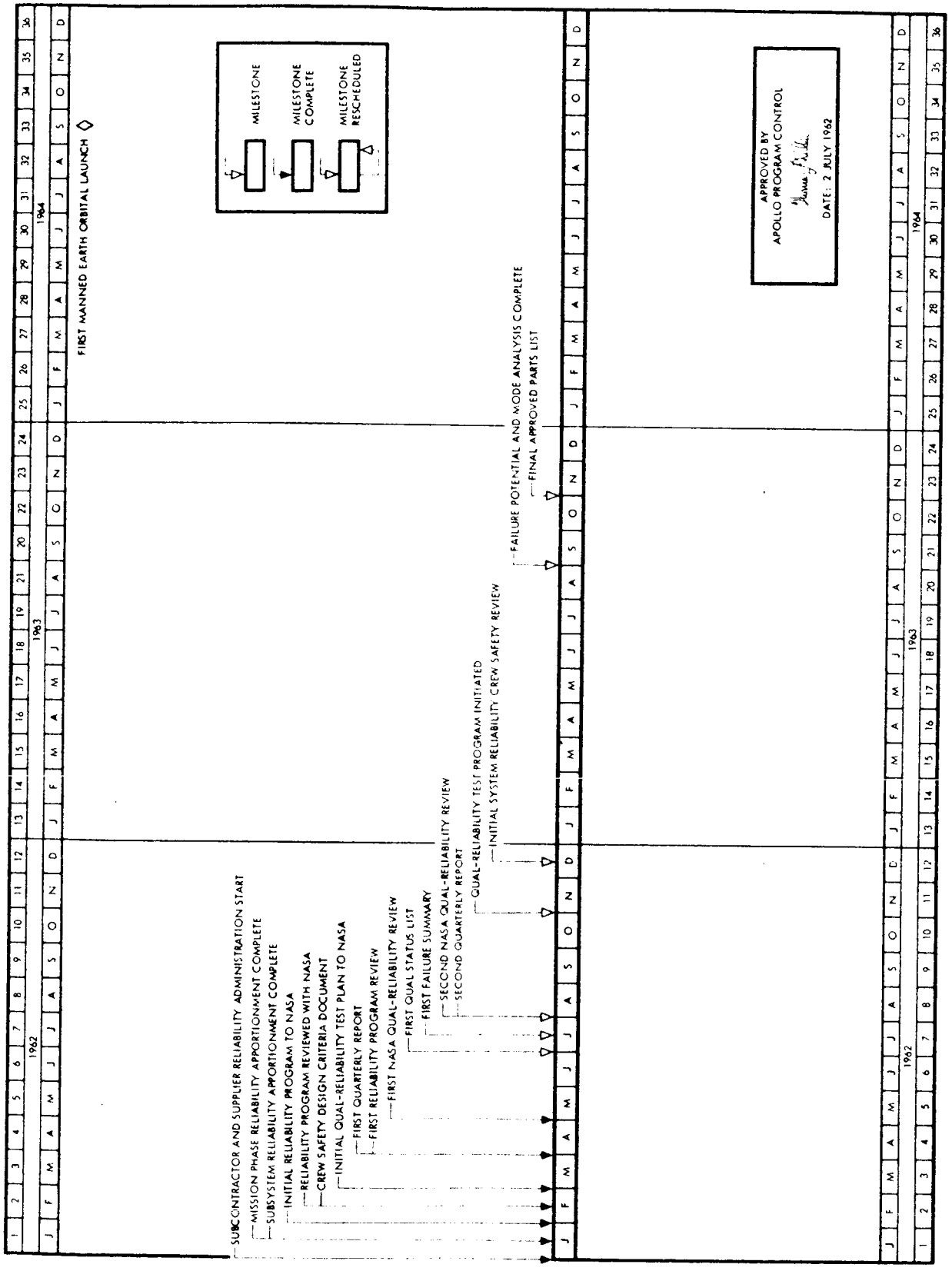

Figure 9. G. O. 7123 - Reliability DEVELOPMENT SCHEDULE

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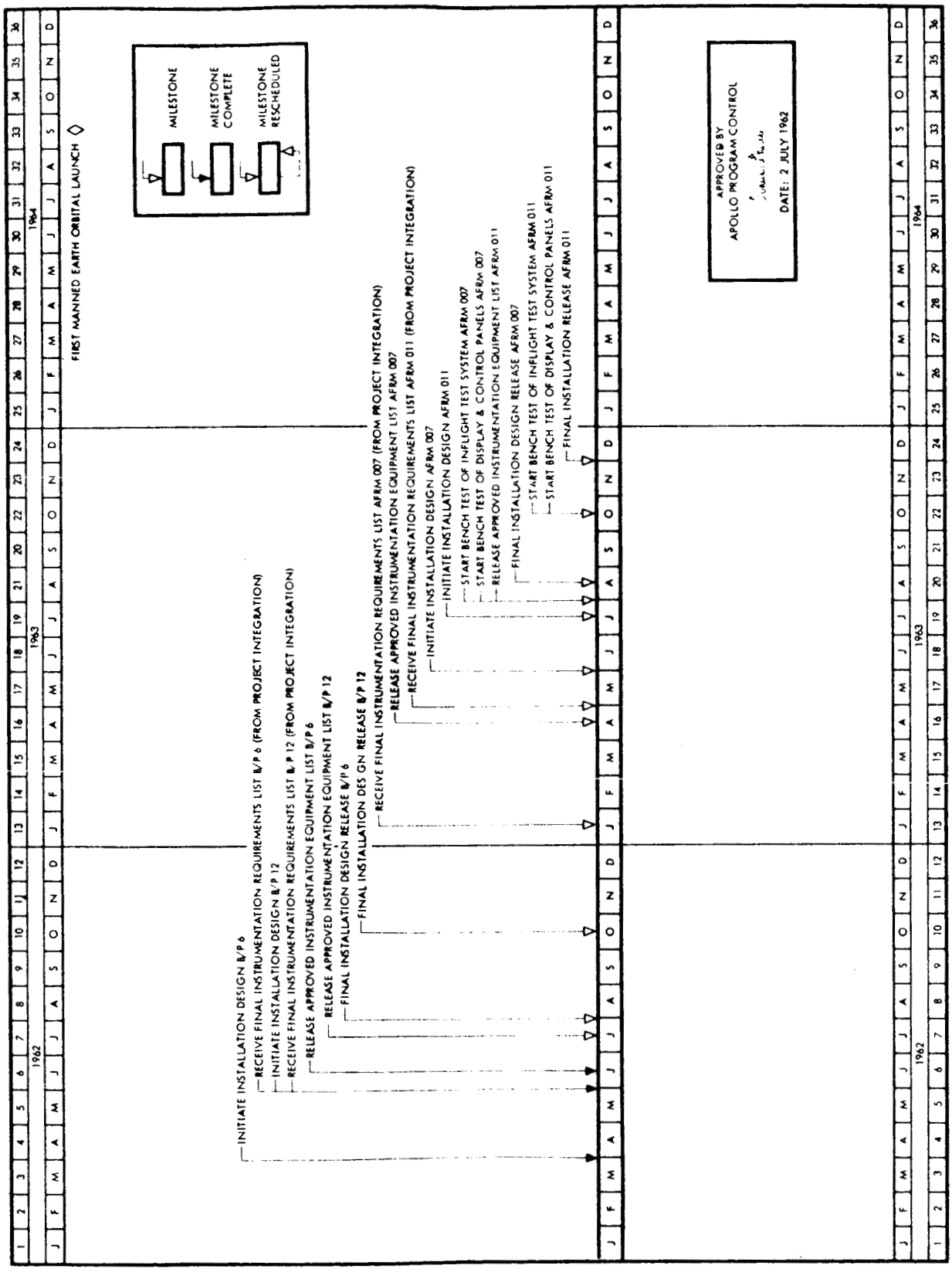

Figure 10. G. O. 7124 - Instrumentation DEVELOPMENT SCHEDULE

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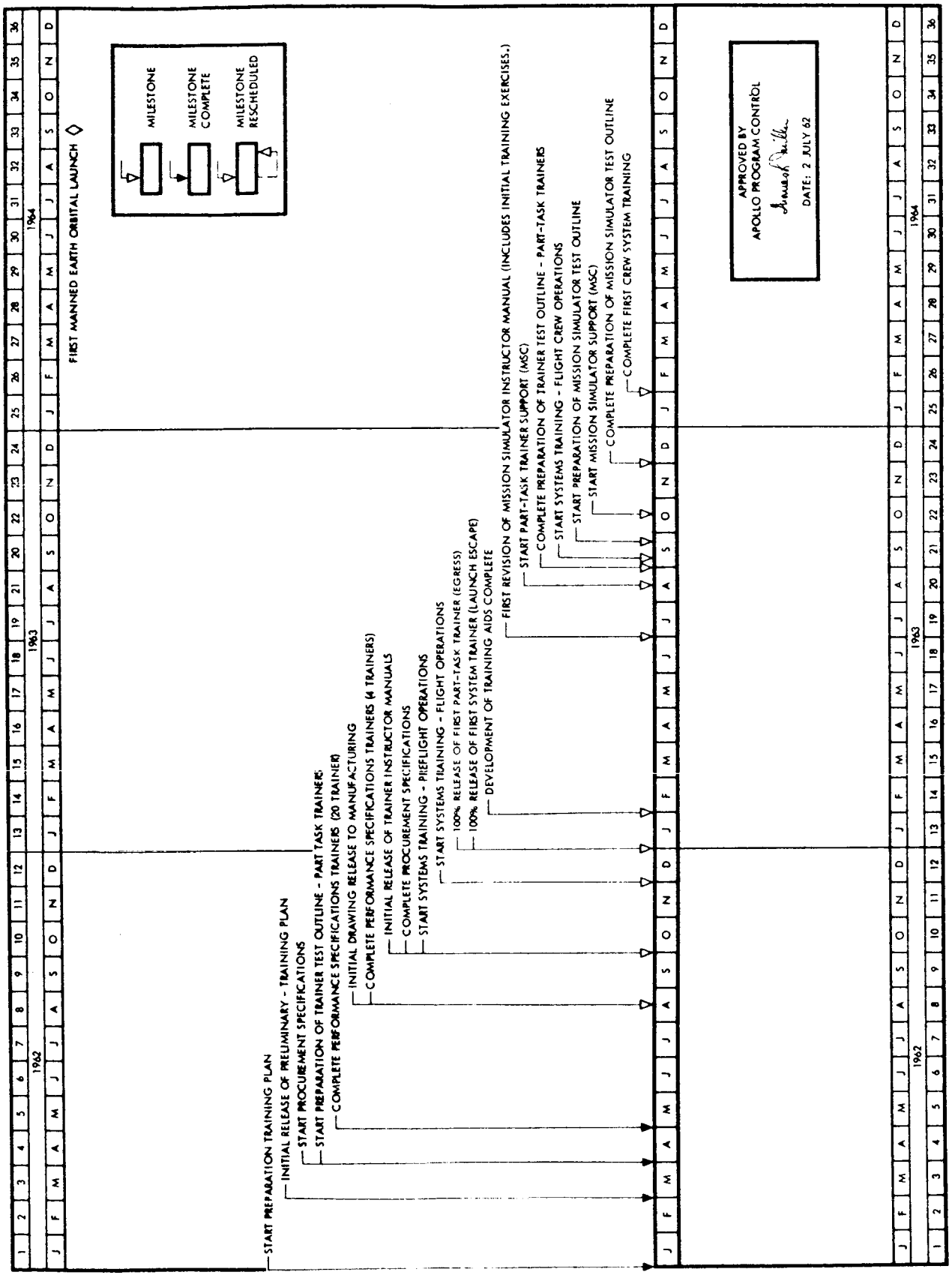

Figure 11. G. O. 7125 - Training and Simulation DEVELOPMENT SCHEDULE

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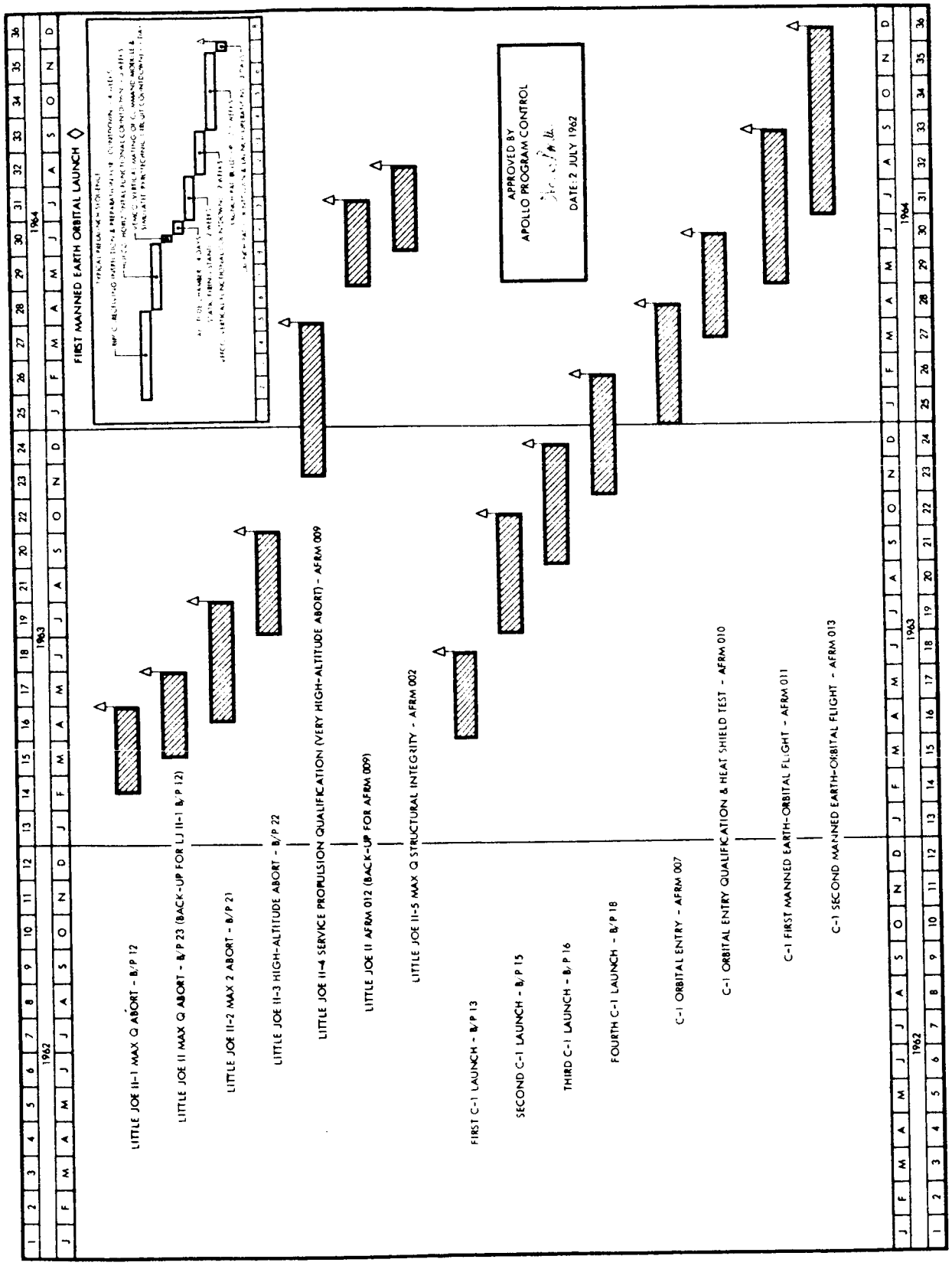

Figure 13.- G. O. 7127 - Prelaunch and Launch Operations - AMR DEVELOPMENT SCHEDULE

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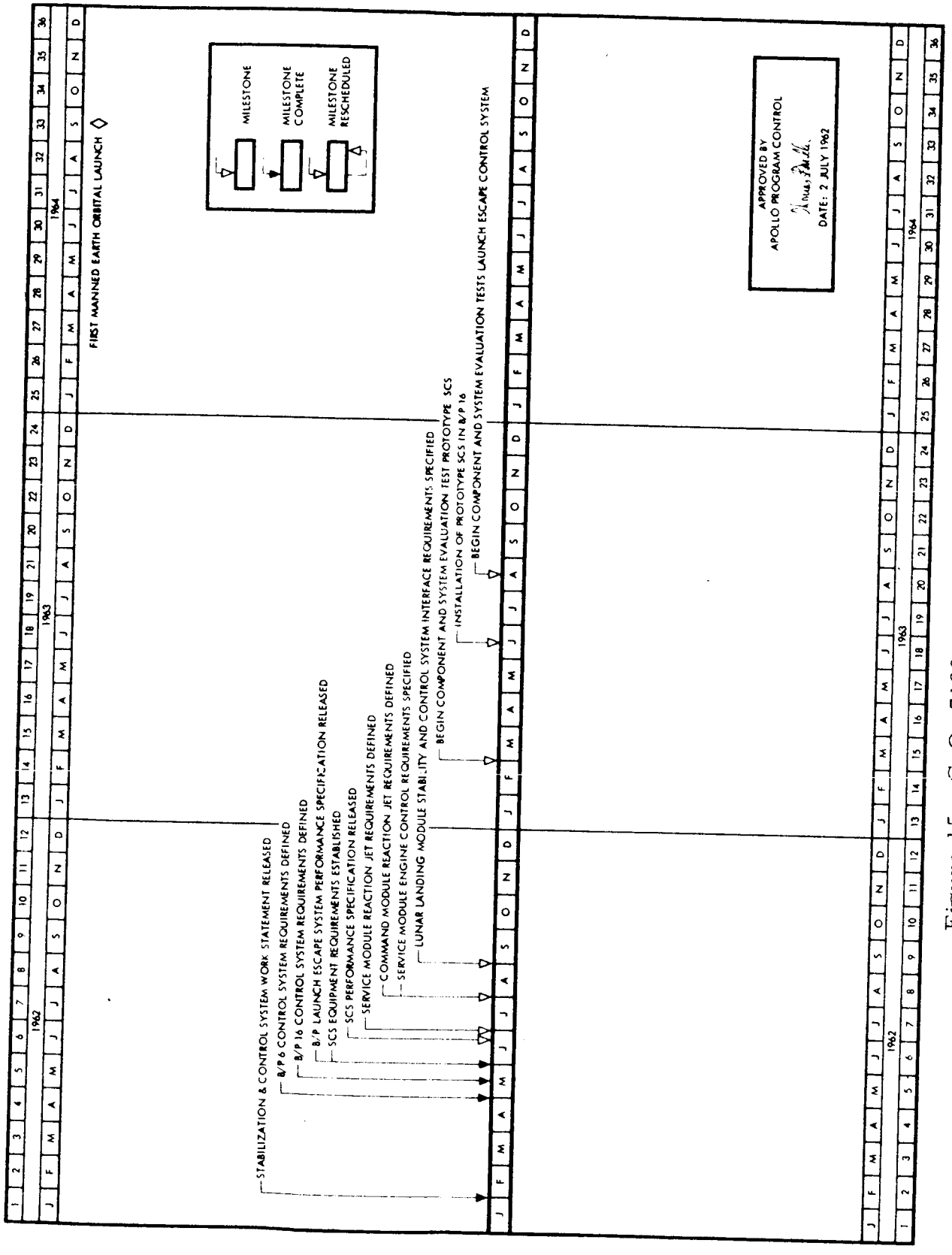

Figure 15. G. O. 7130 - Stabilization and Control DEVELOPMENT SCHEDULE

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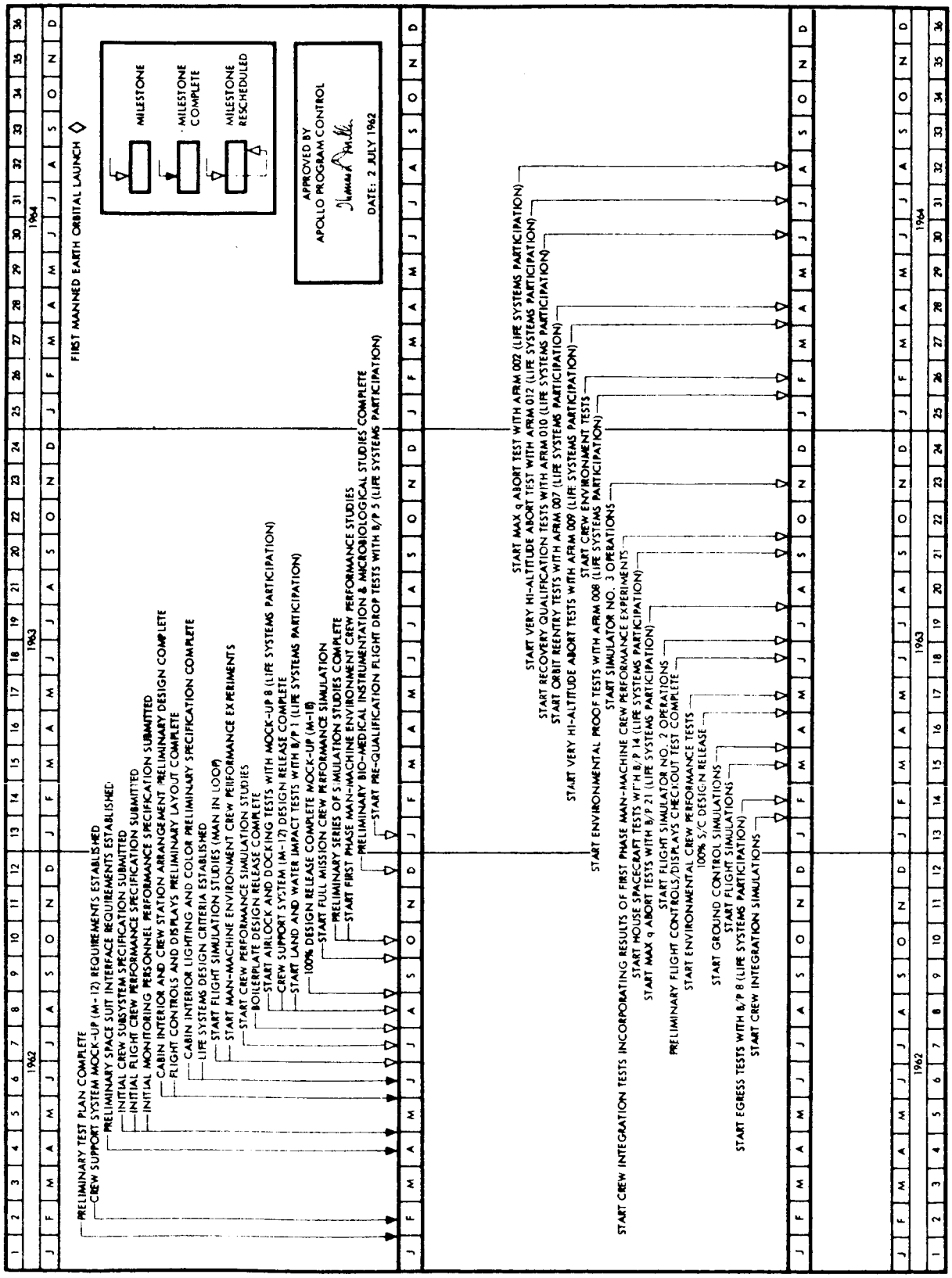

Figure 16. G. O. 7131 - Crew Provisions DEVELOPMENT SCHEDULE

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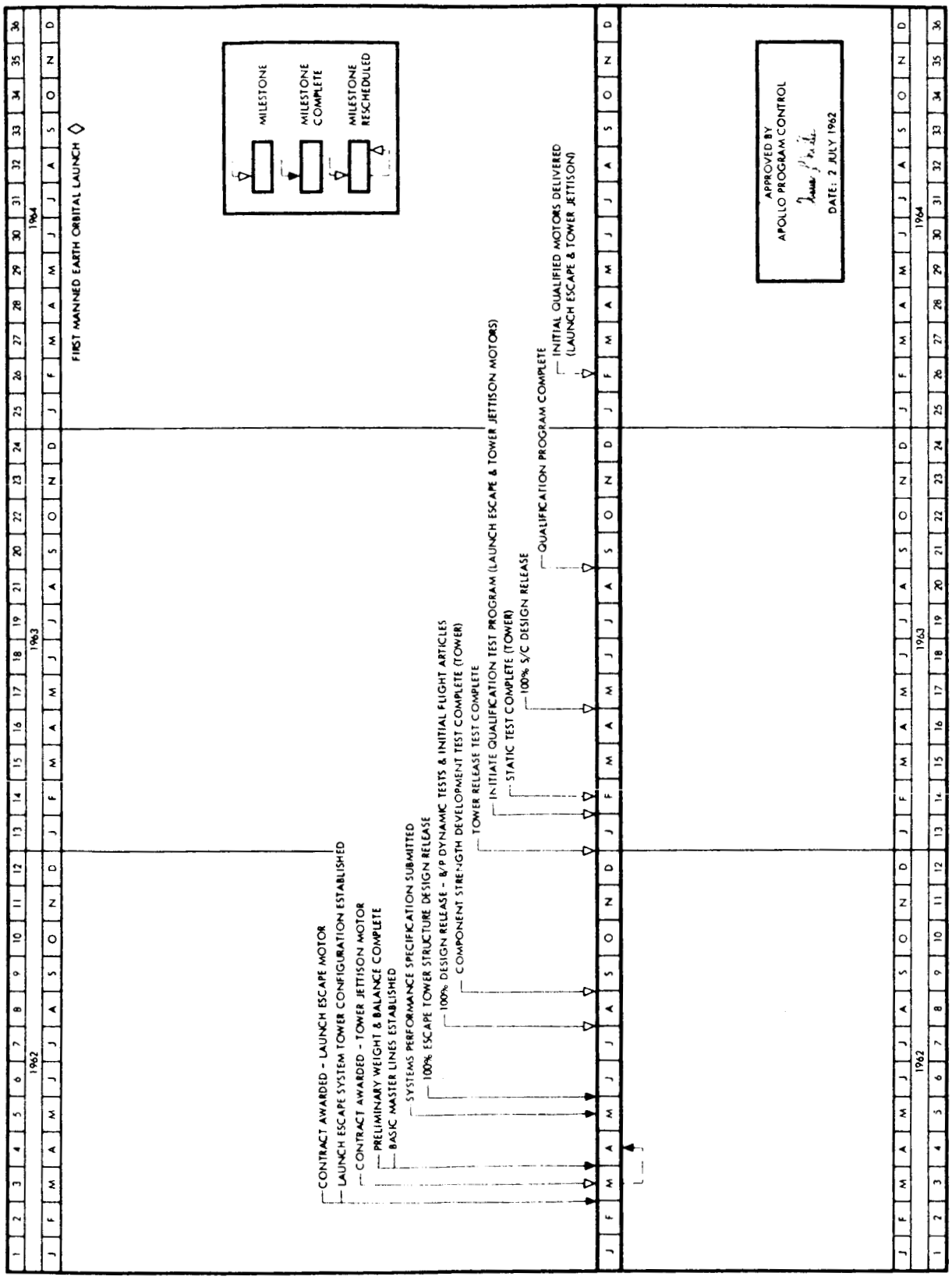

Figure 17. G. O. 7132 - Launch Escape Subsystem DEVELOPMENT SCHEDULE

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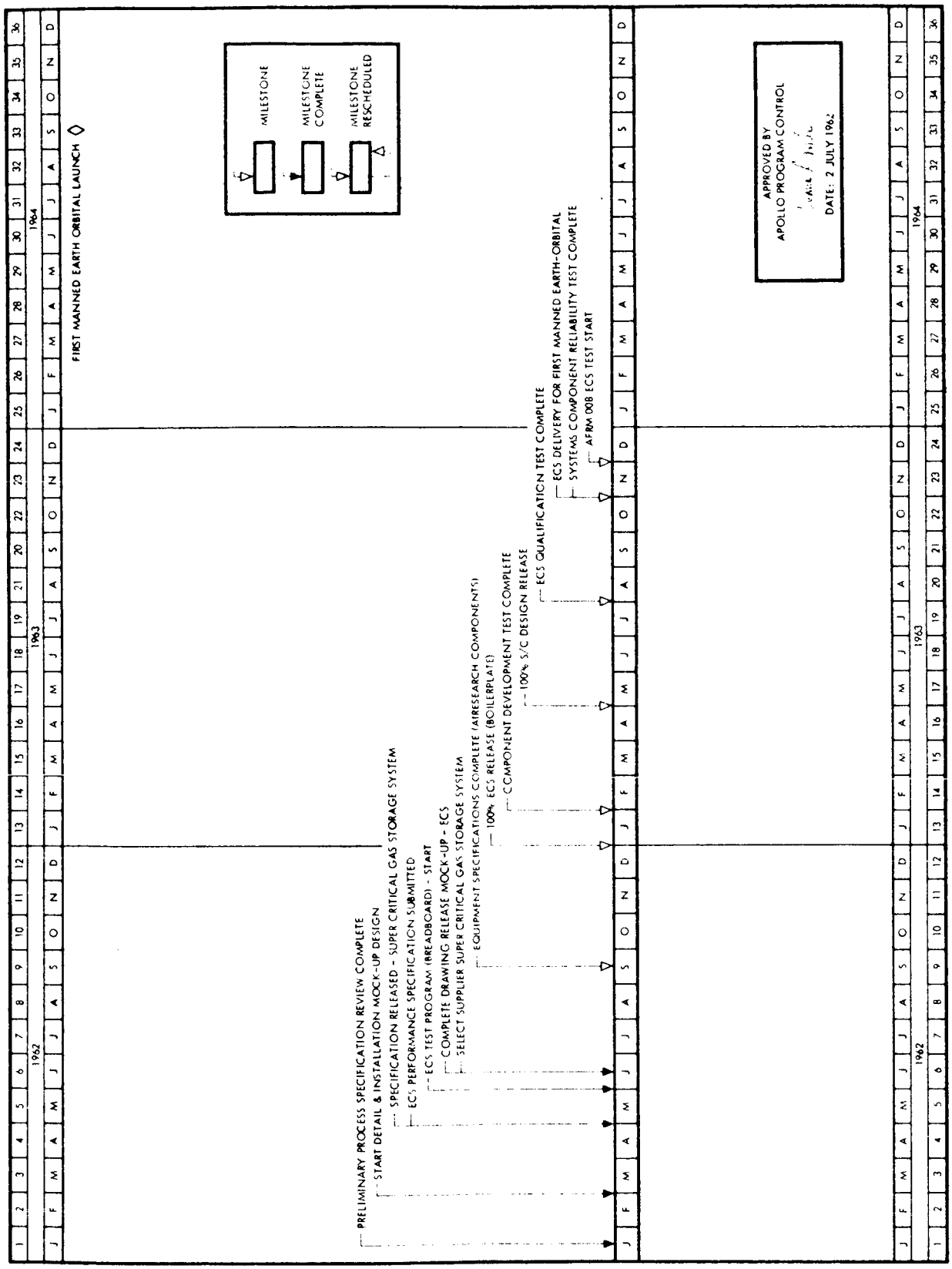

Figure 18. G. O. 7133 - Environmental Control Subsystem DEVELOPMENT SCHEDULE

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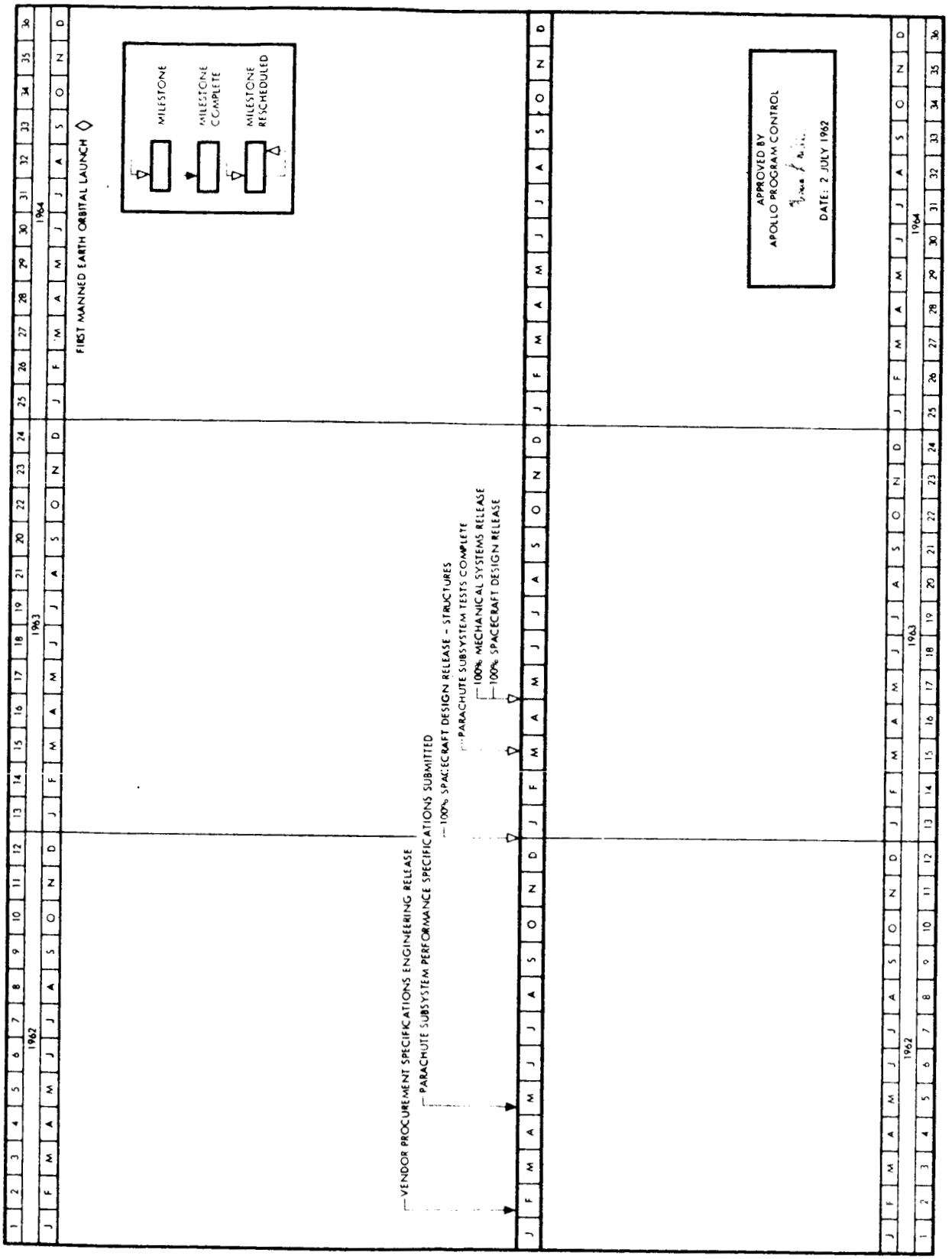

Figure 19. G. O. 7134 - Earth Landing Subsystem DEVELOPMENT SCHEDULE

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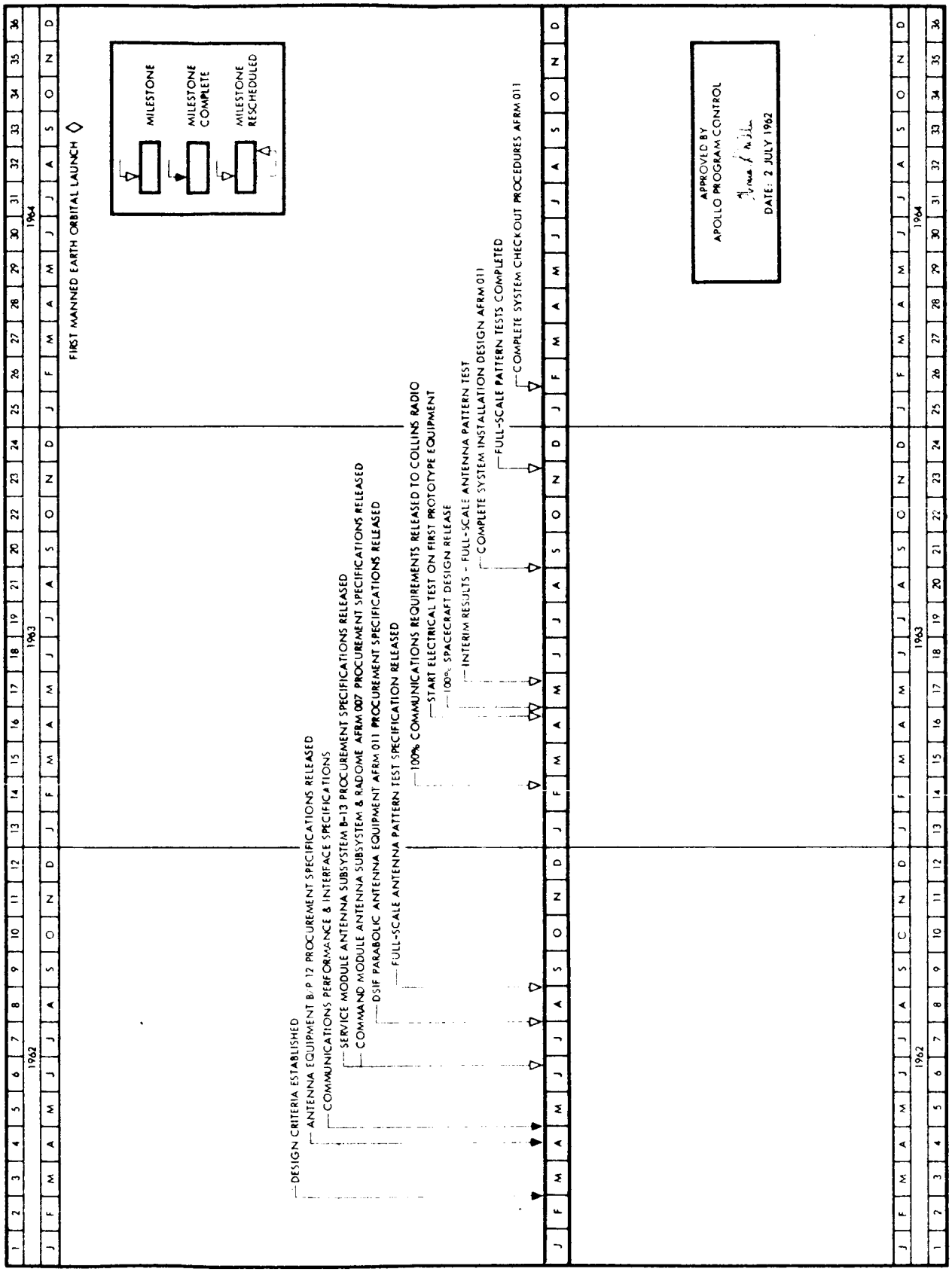

Figure 20. G. O. 7135 - Communication Subsystem DEVELOPMENT SCHEDULE

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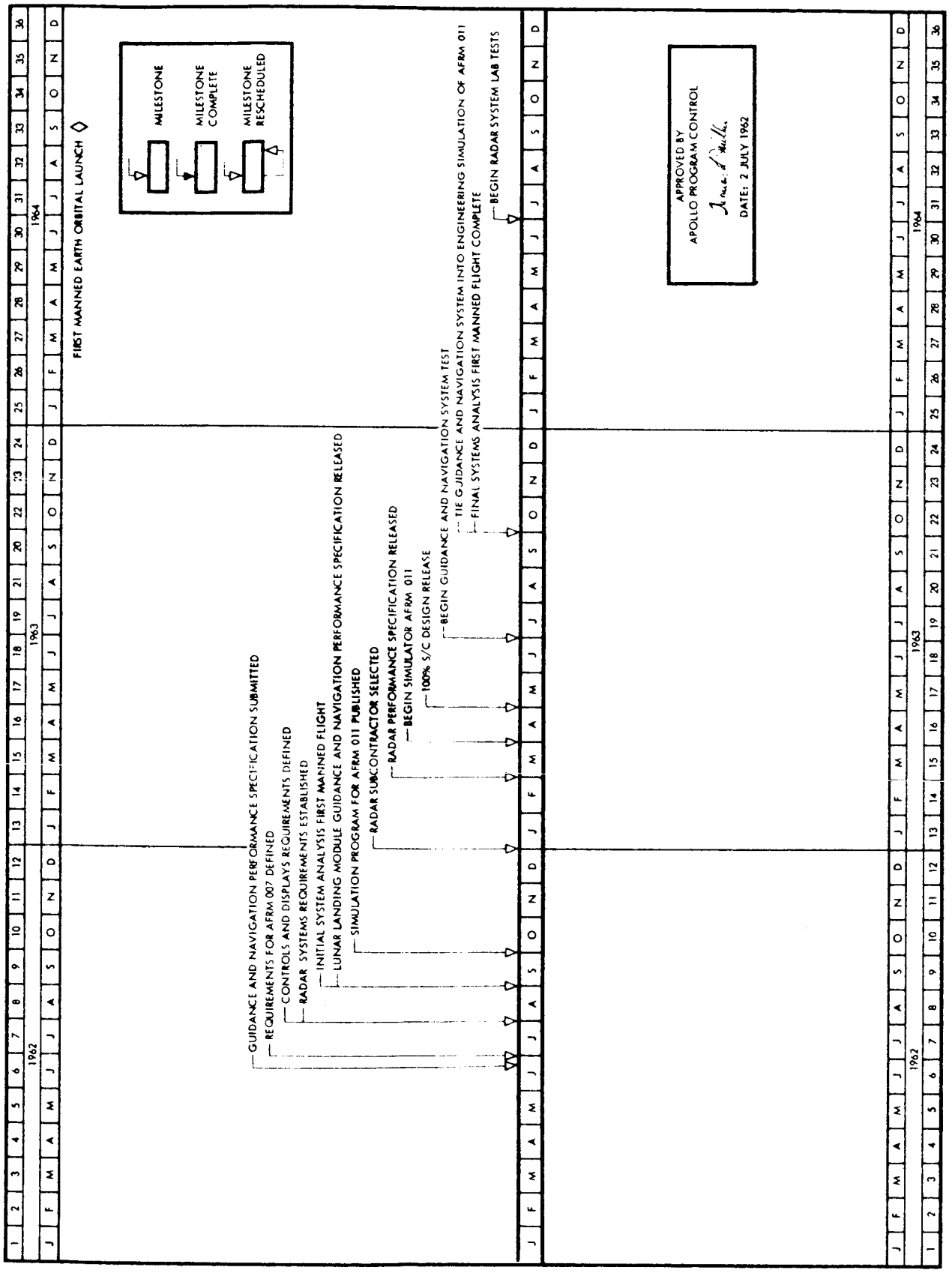

Figure 21. G. O. 7136 - Navigation and Guidance Integration DEVELOPMENT SCHEDULE

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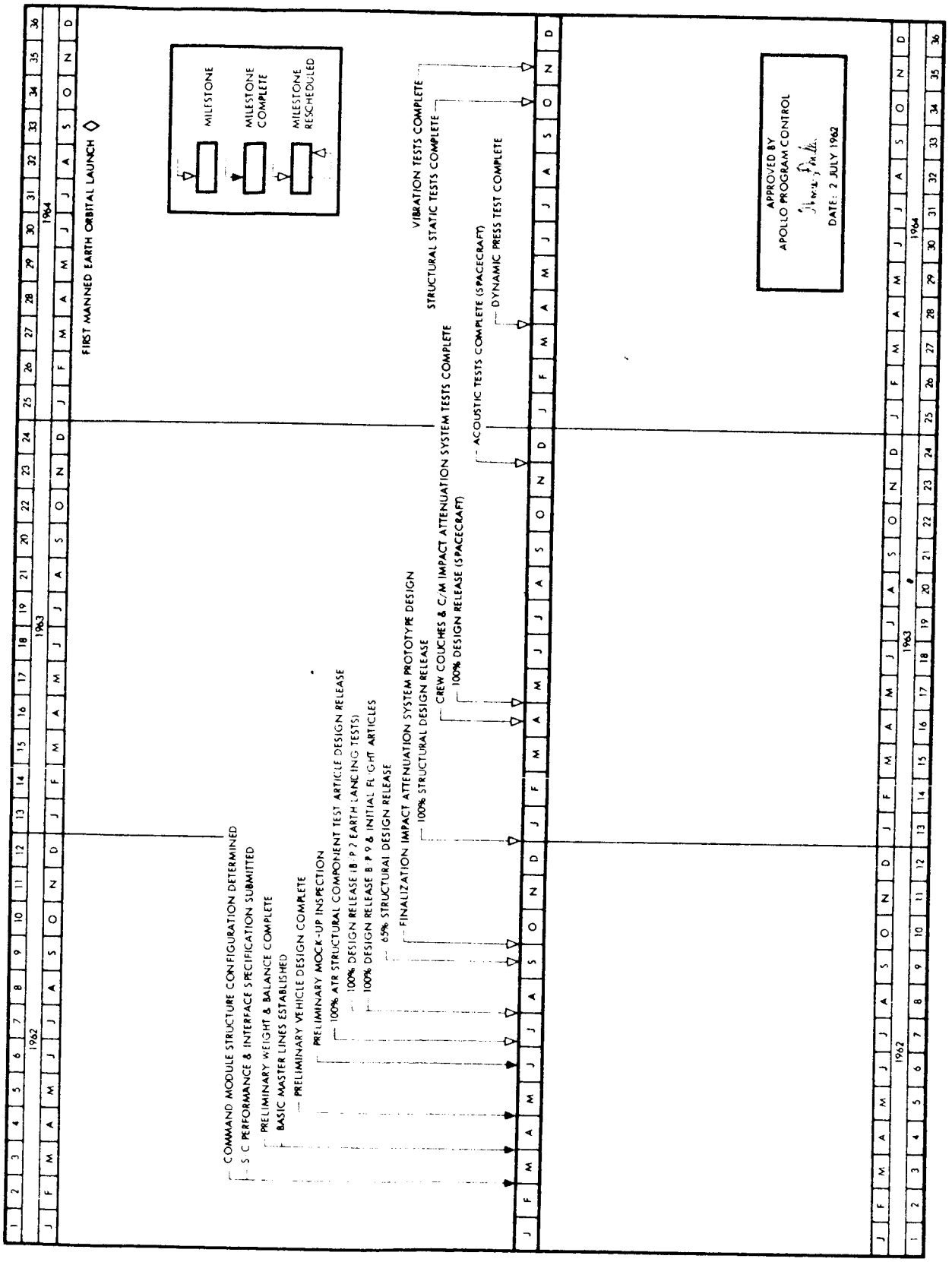

Figure 22. G. O. 7137 - Command Module Structure and Subsystem Installation DEVELOPMENT SCHEDULE

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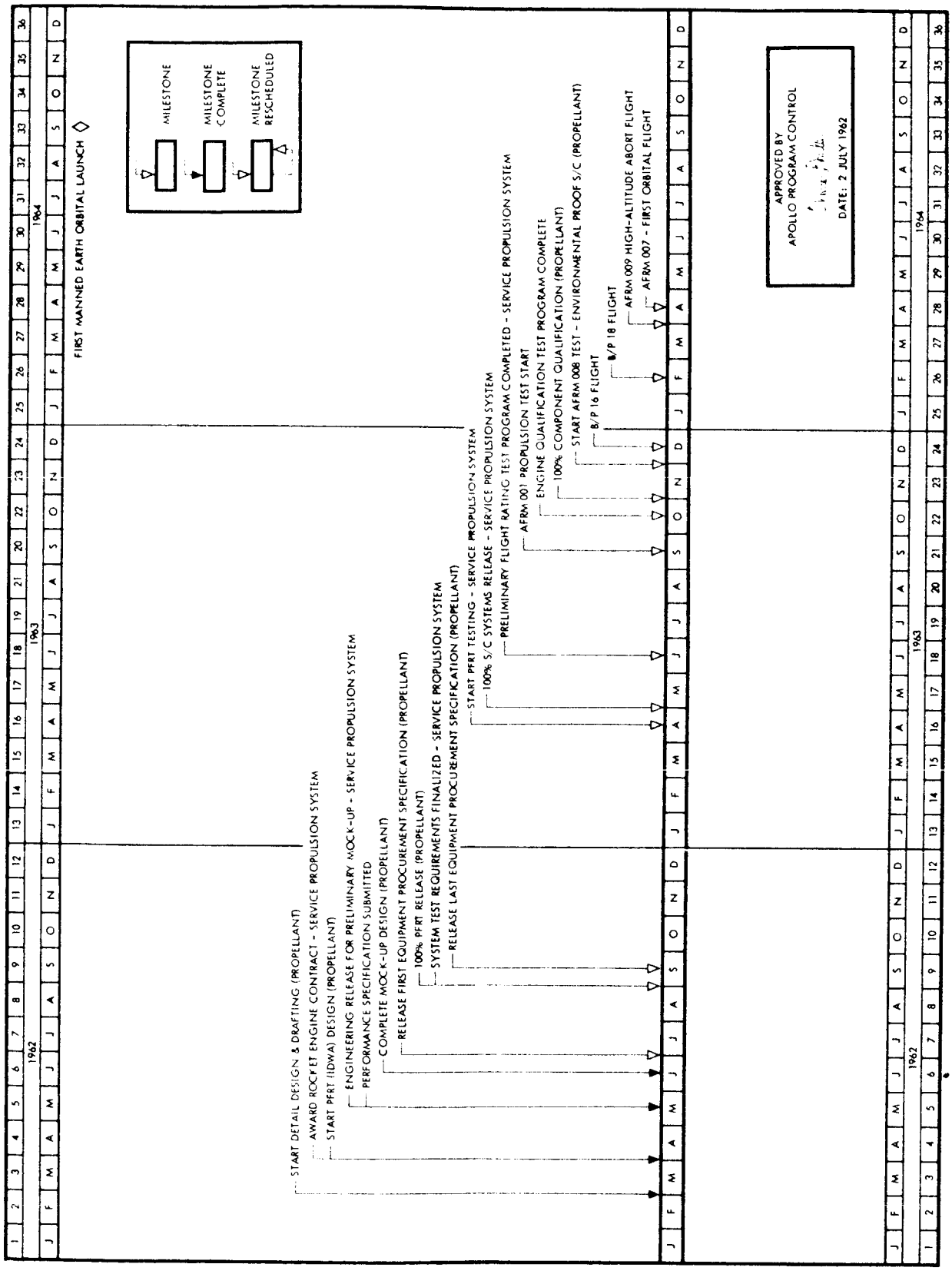

Figure 23. G. O. 7138 - Service Propulsion Subsystem DEVELOPMENT SCHEDULE

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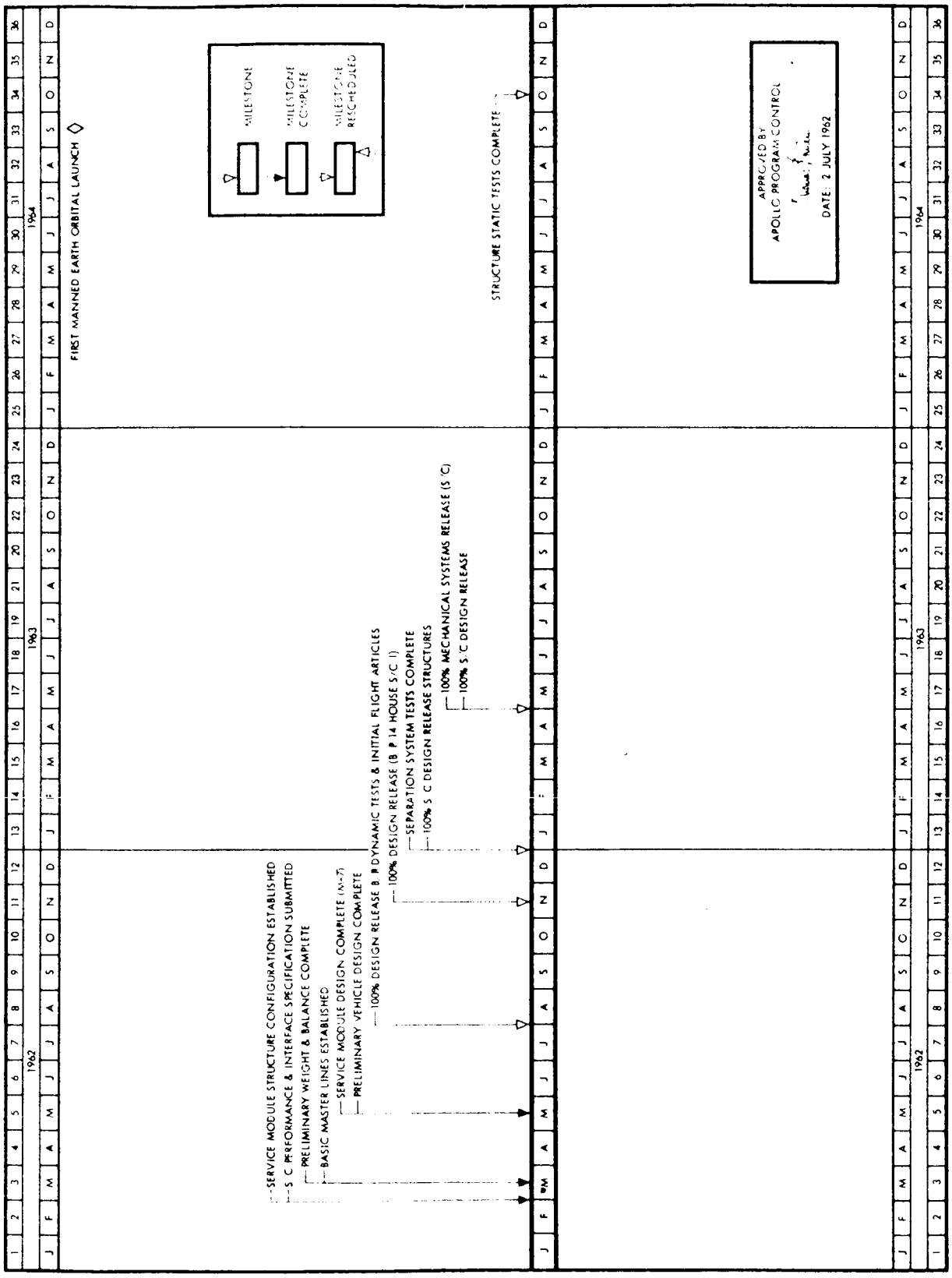

Figure 24. G. O. 7139 - Service Module Structure and Subsystem Installation DEVELOPMENT SCHEDULE

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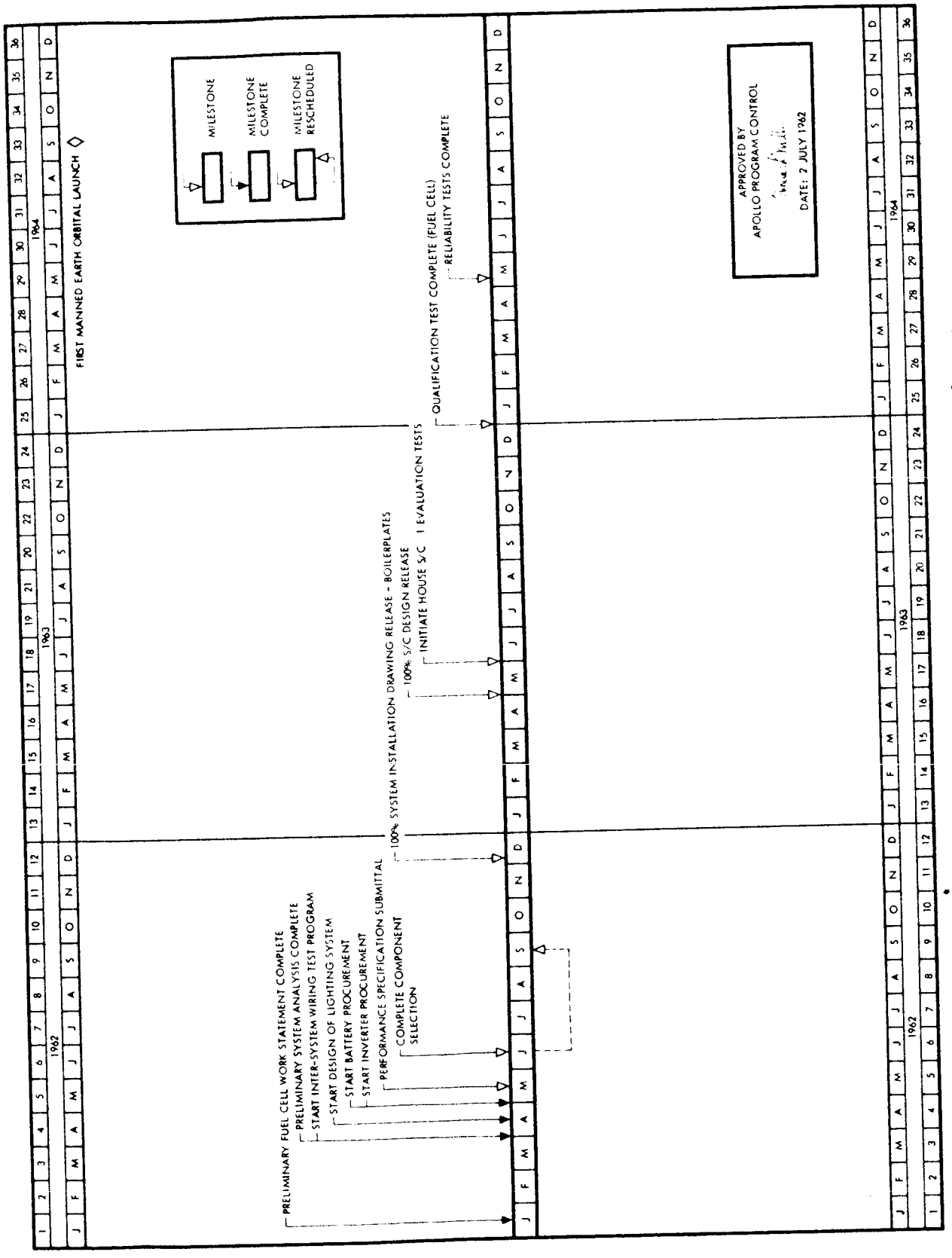

Figure 25. G. O. 7140 - Electrical Power Subsystem DEVELOPMENT SCHEDULE

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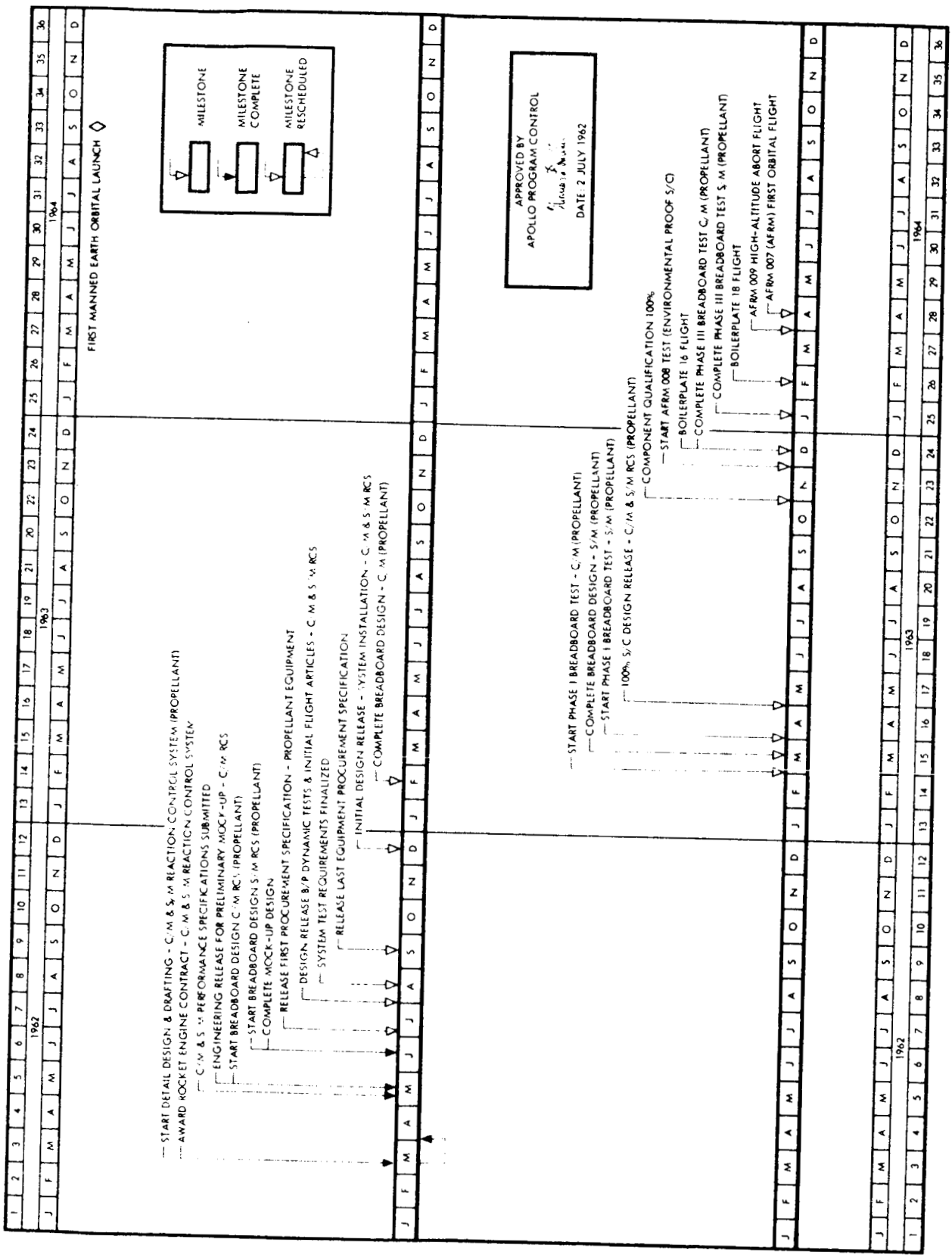

Figure 26. G. O. 7141 - Reaction Control DEVELOPMENT SCHEDULE

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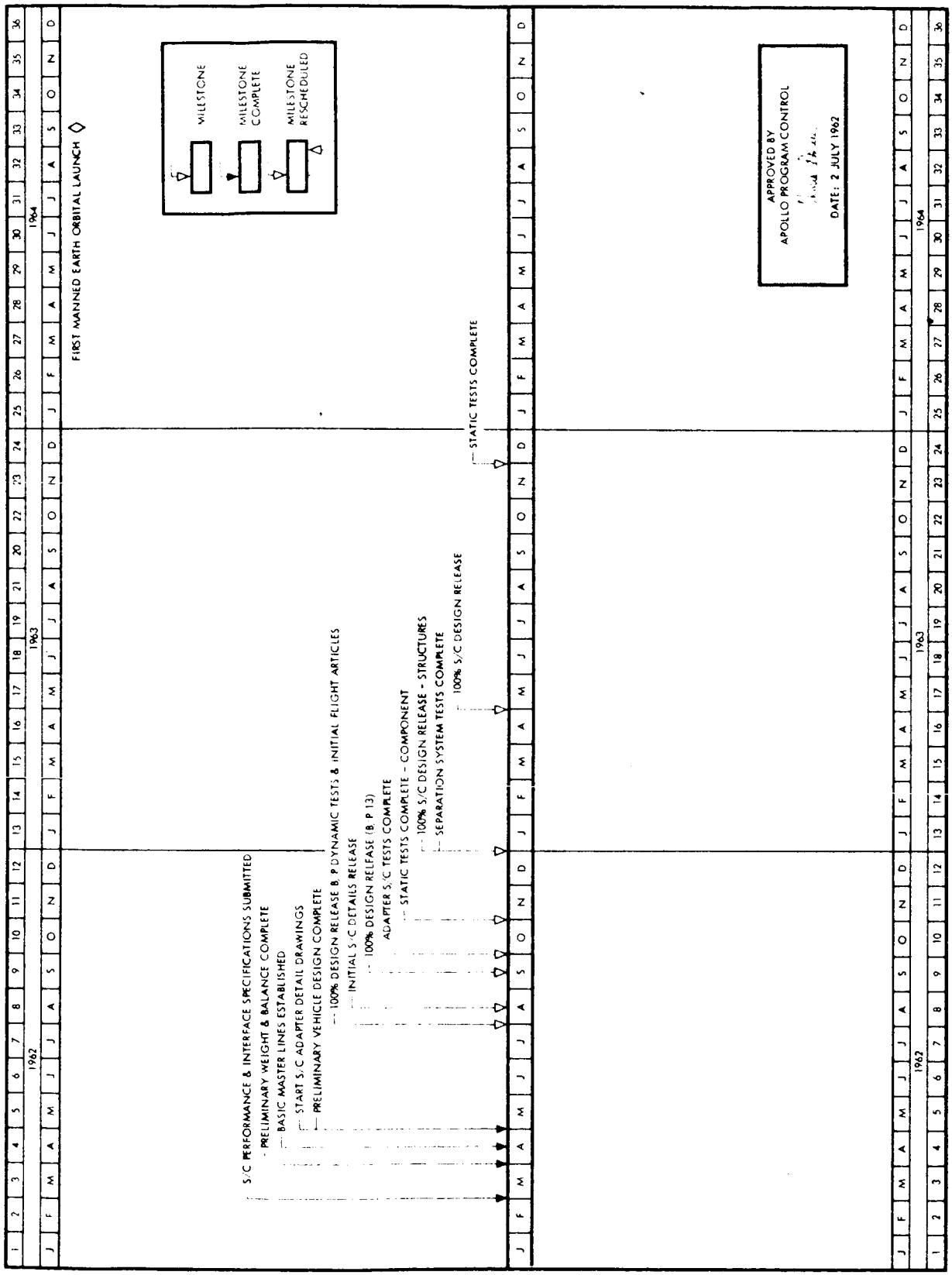

Figure 27. G. O. 7142 - Spacecraft Adapter Design, Fabrication, and Assembly DEVELOPMENT SCHEDULE

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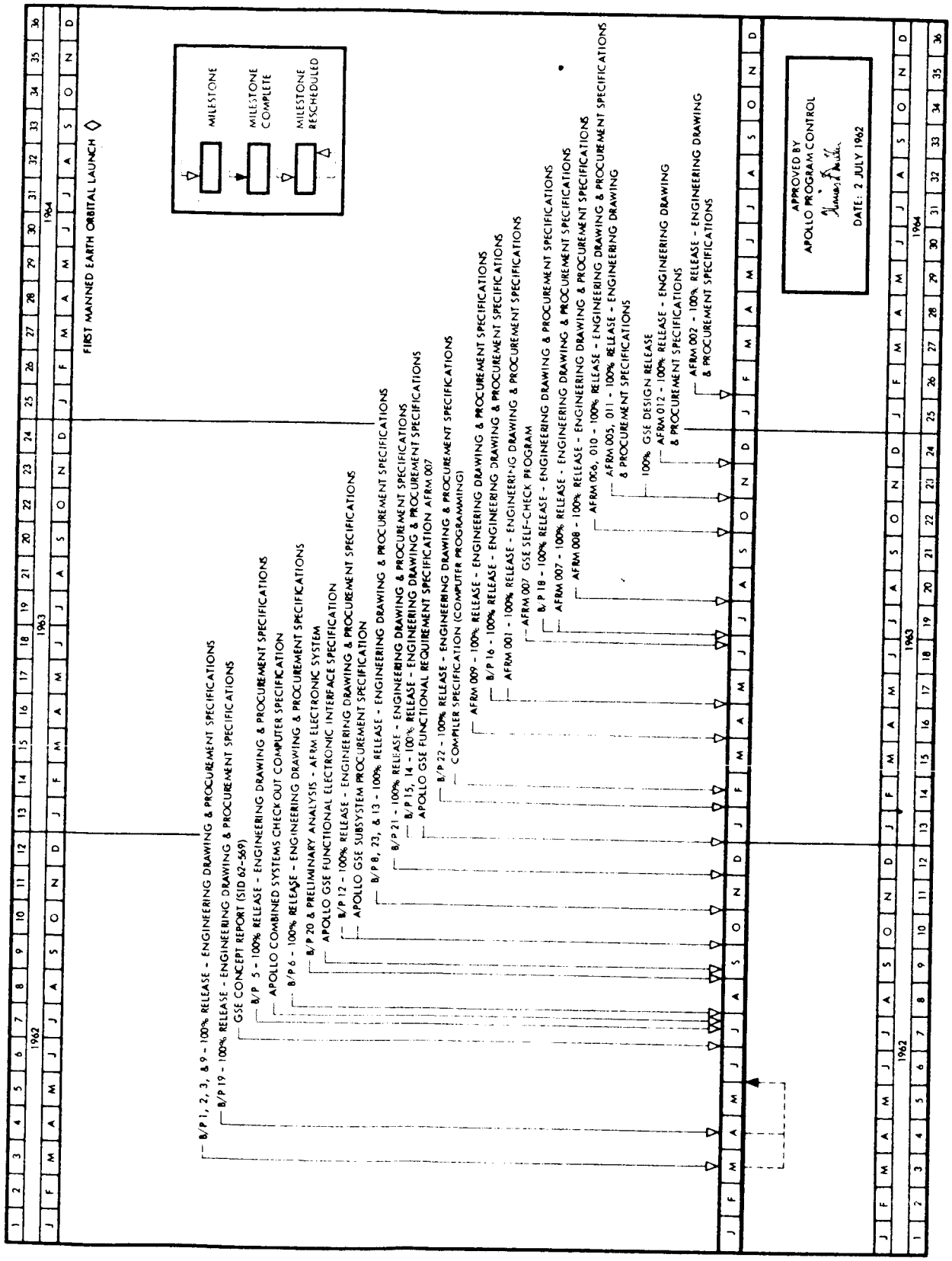

Figure 28. G. O. 7143 - Command Module GSE DEVELOPMENT SCHEDULE

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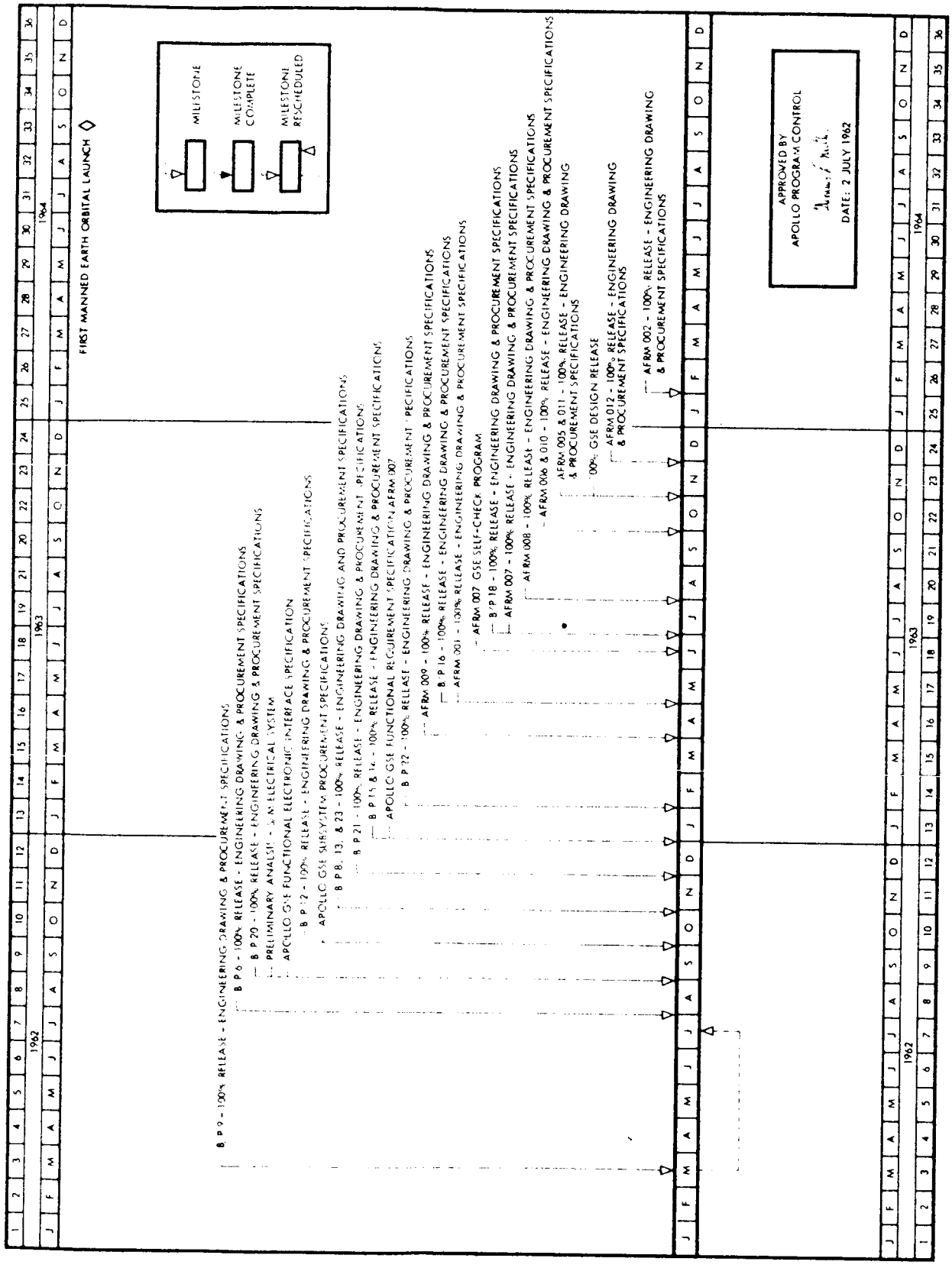

Figure 29. G. O. 7144 - Service Module GSE DEVELOPMENT SCHEDULE

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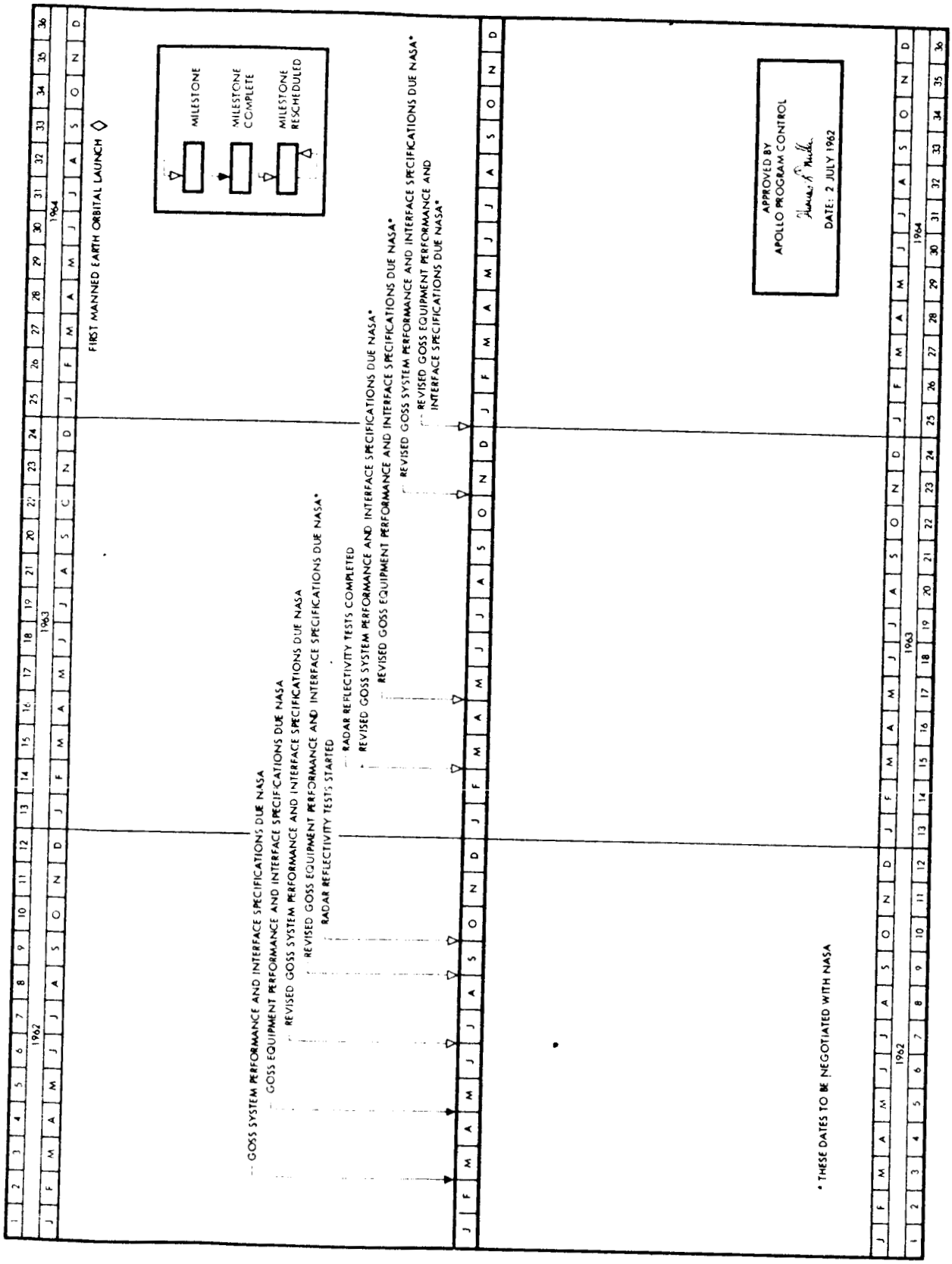

Figure 30. G. O. 7145 - Ground Operations Support System (GOSS) DEVELOPMENT SCHEDULE

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MANUFACTURING COMPLETION SCHEDULES

The Manufacturing Completion Schedules reflect the establishment of major milestones in the manufacturing of various Apollo Hardware articles.

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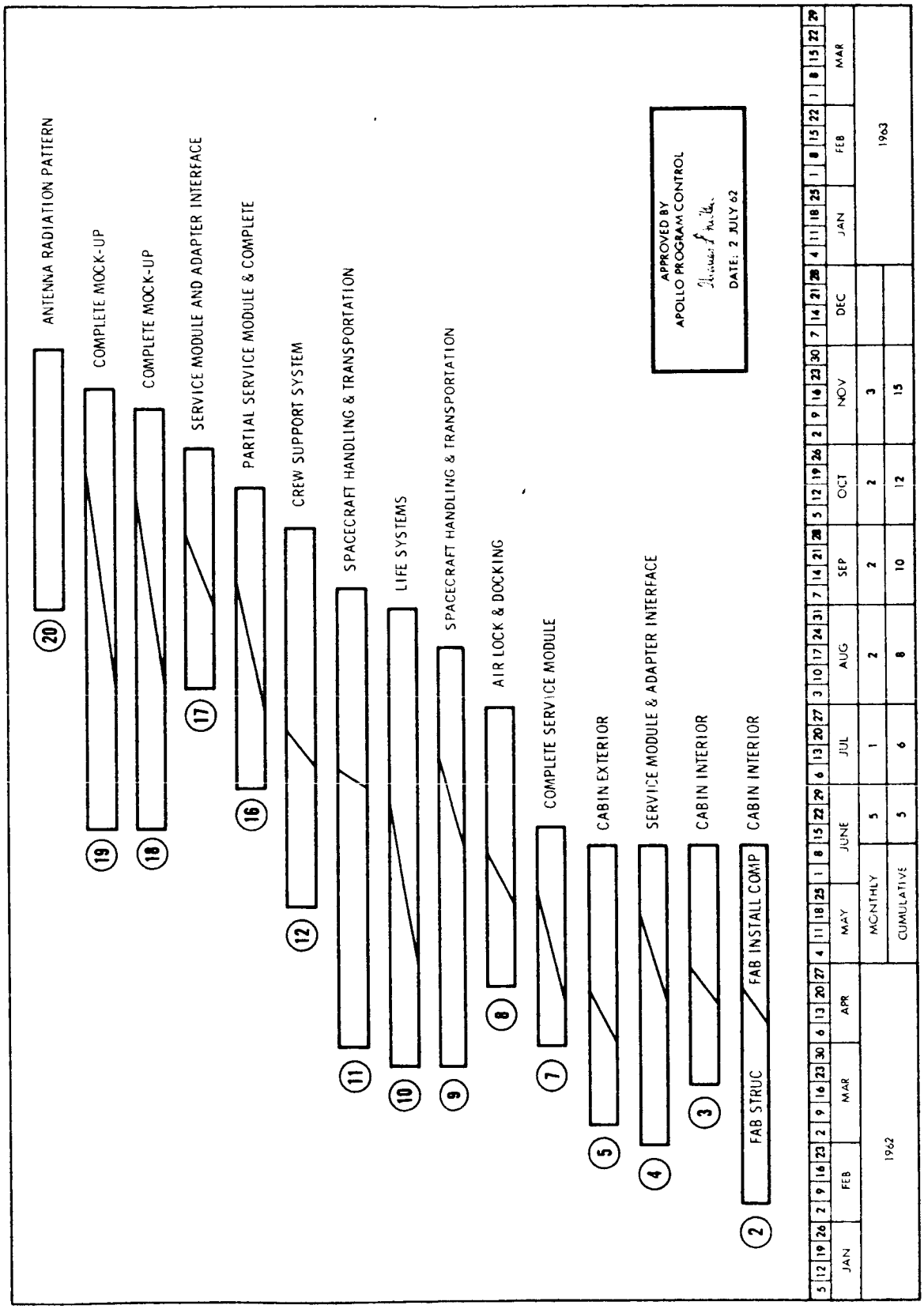

Figure 31. Apollo Mock-Up Schedule

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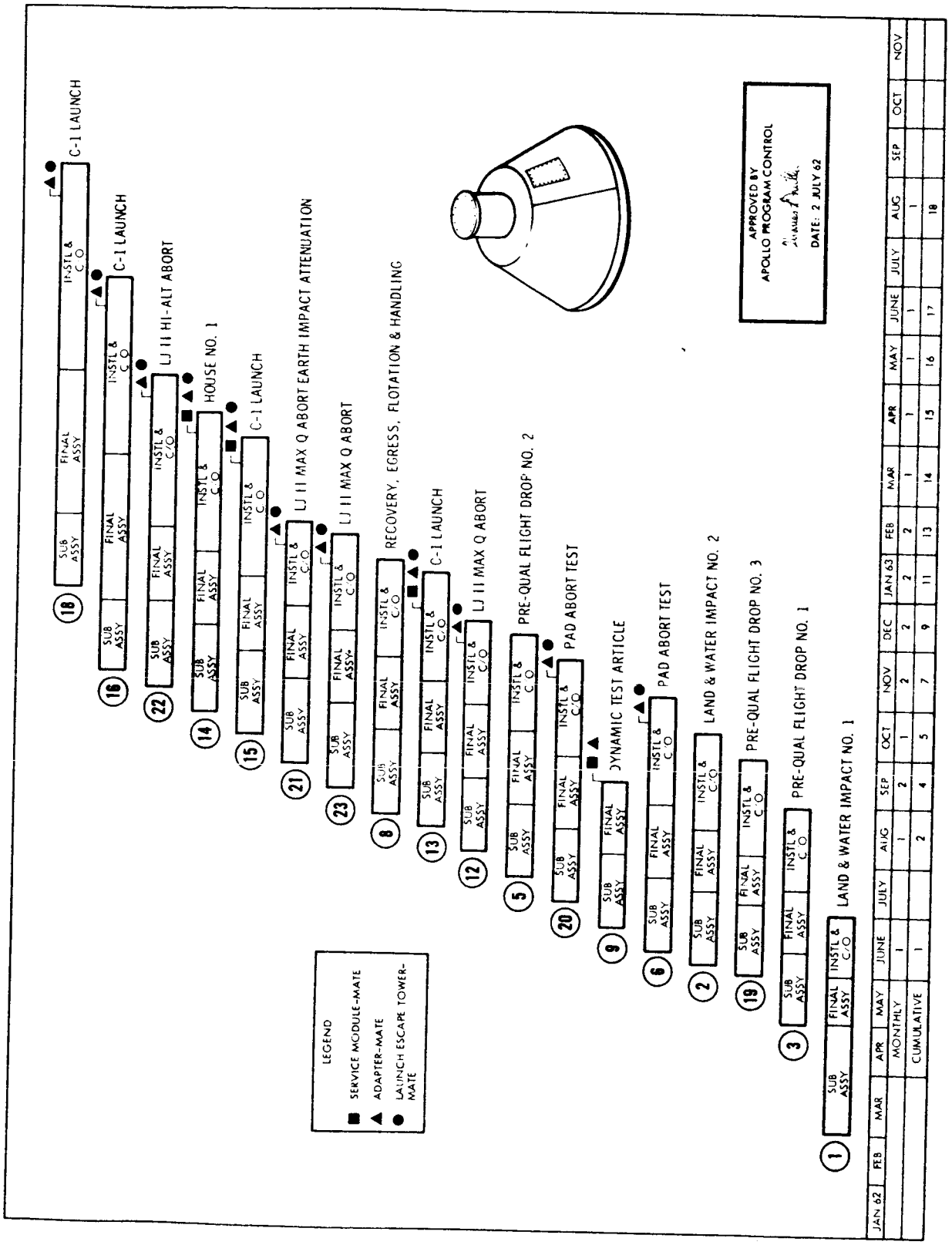

Figure 32. Apollo Boilerplate Manufacturing Completion Schedule

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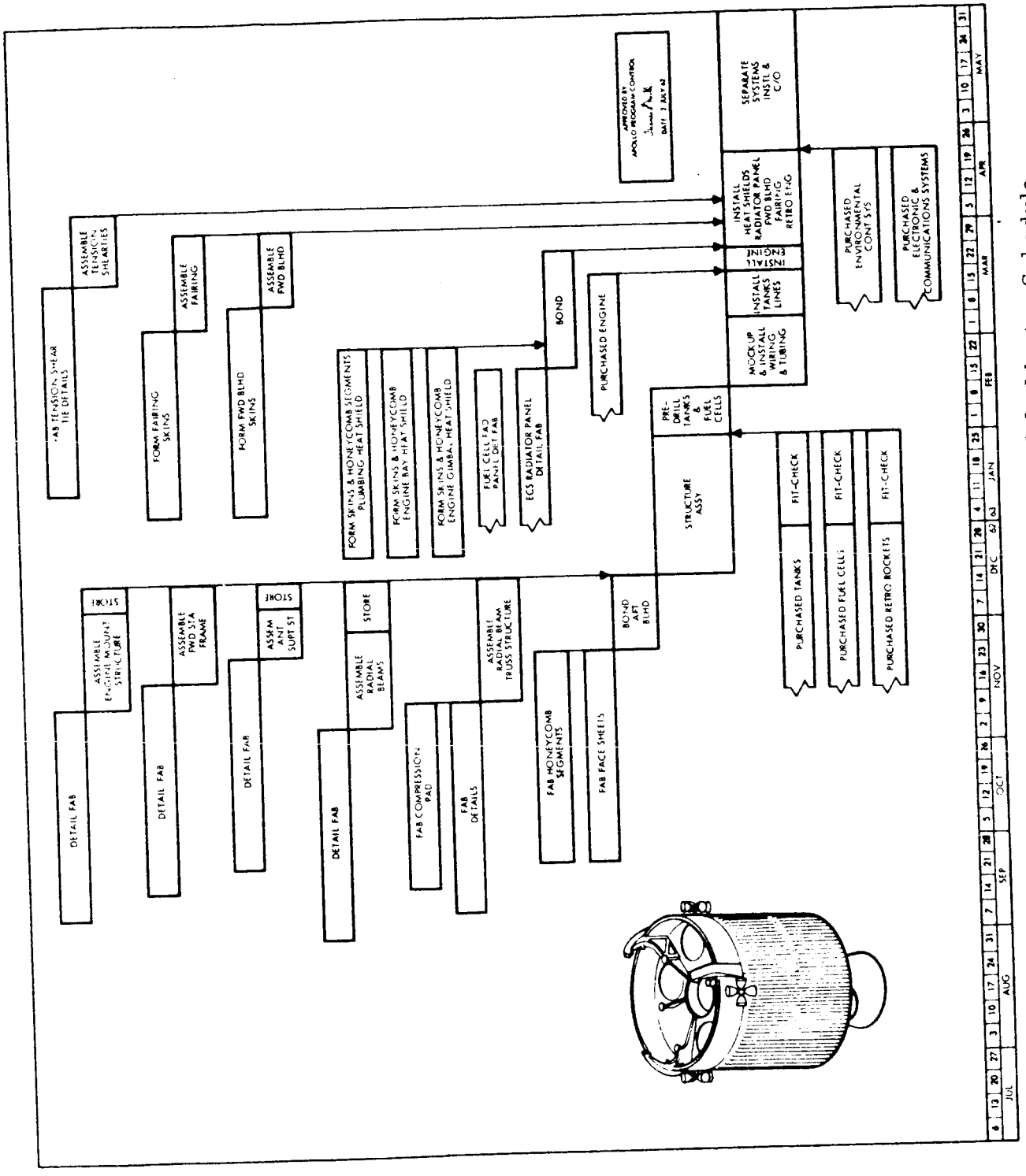

Figure 38. Apollo Spacecraft Service Module Master Schedule

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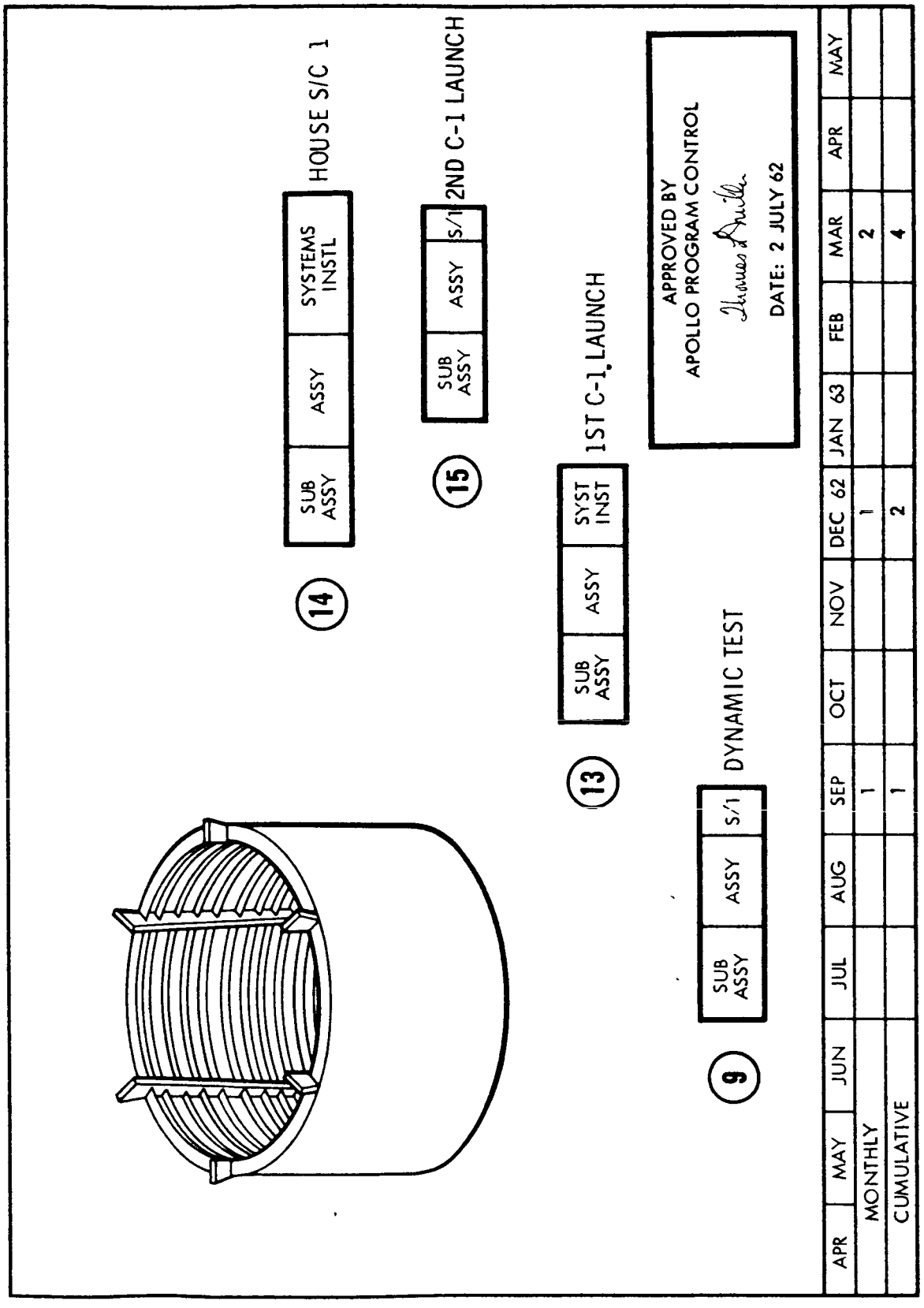

Figure 33. Apollo Boilerplate Service Module Schedule

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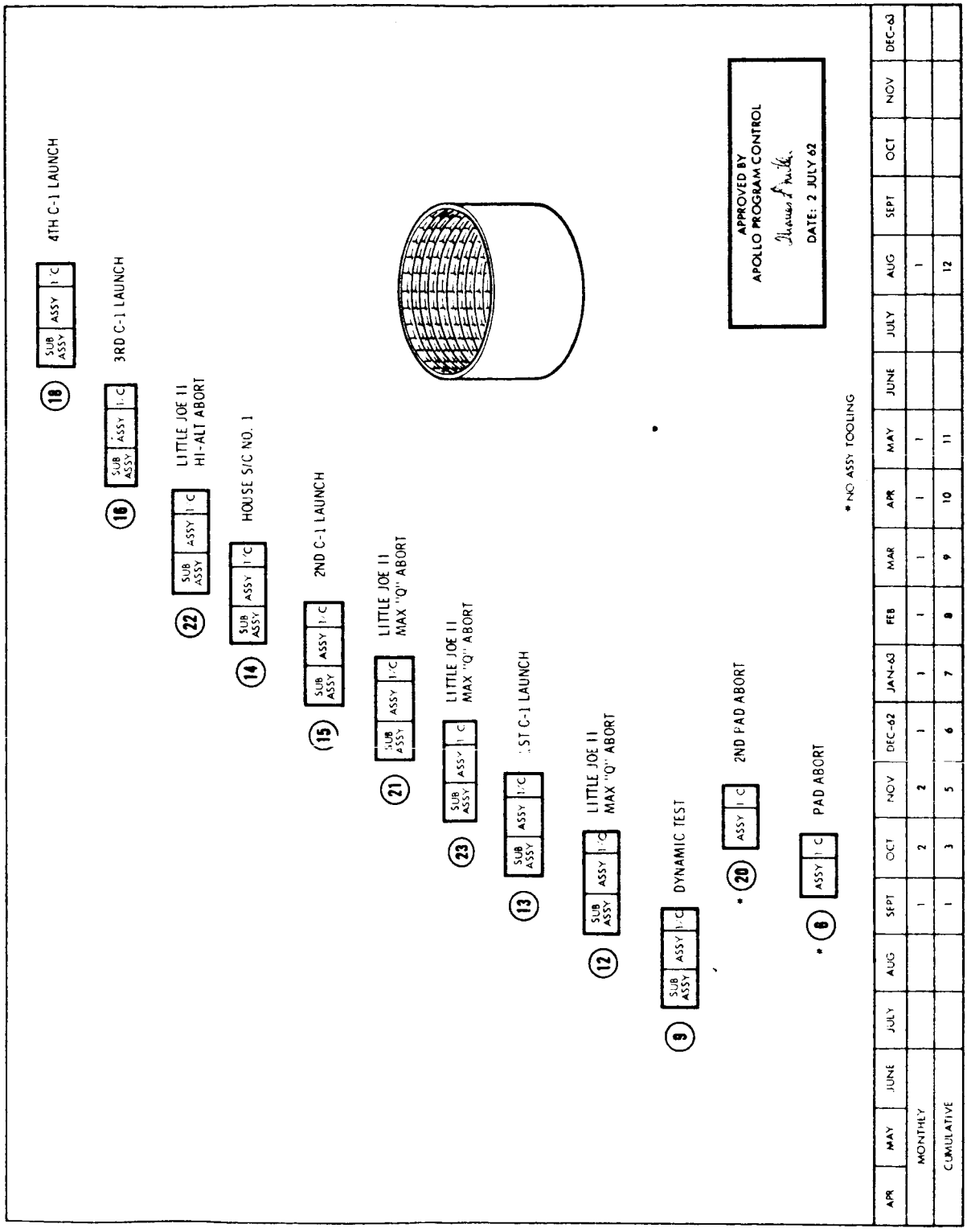

Figure 34. Apollo Boilerplate Spacecraft Adapter Schedule

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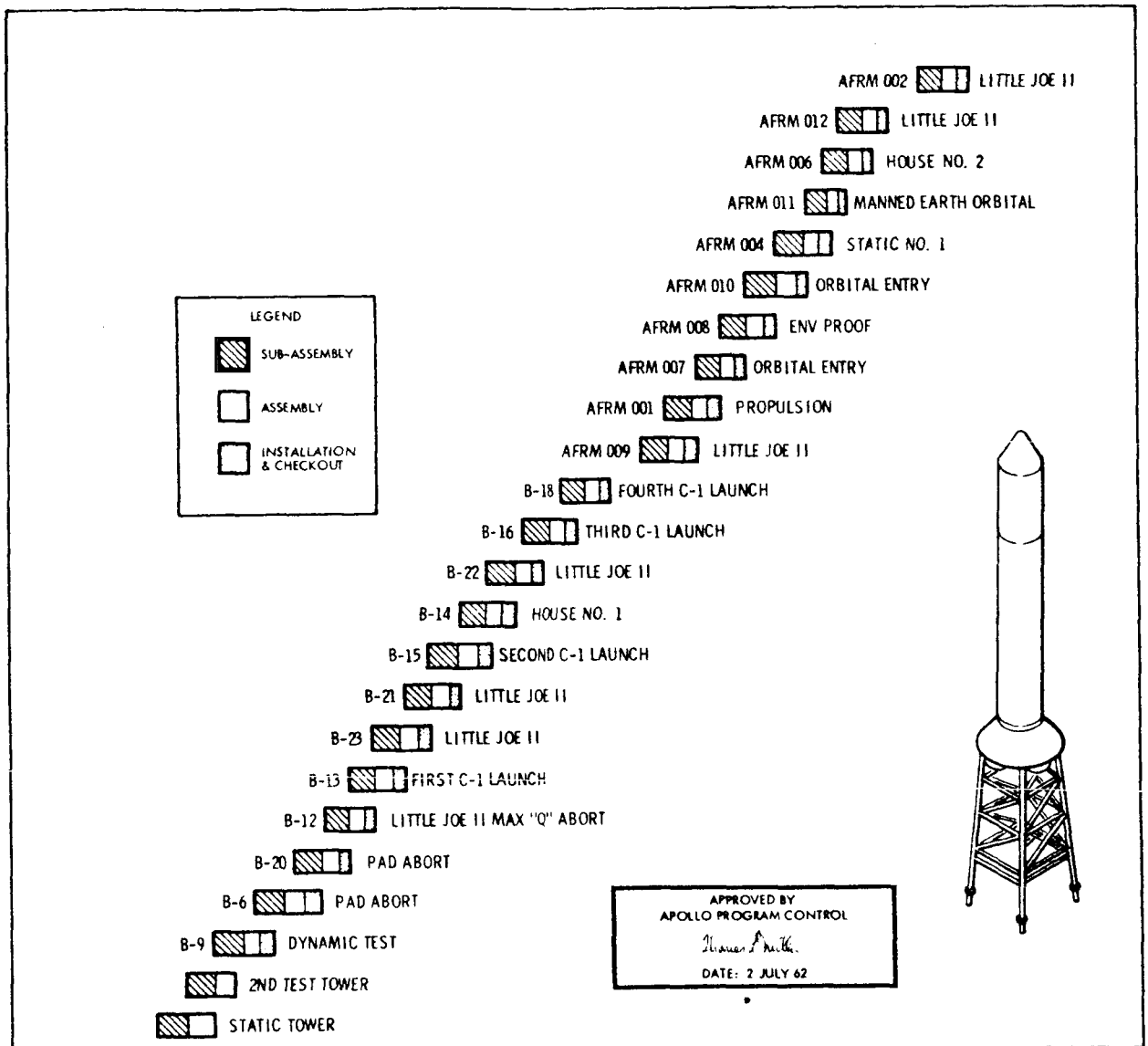

	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
	1962										1963												1964					
MONTHLY					1	1	1	1	2	1	1	2	1	1	2			2	1	2	2	2	1	1				
CUMULATIVE					1	2	3	4	6	7	8	10	11	12	14			16	17	19	21	23	24	25				

Figure 35. Apollo Escape Tower Manufacturing Completion Schedule

[redacted]

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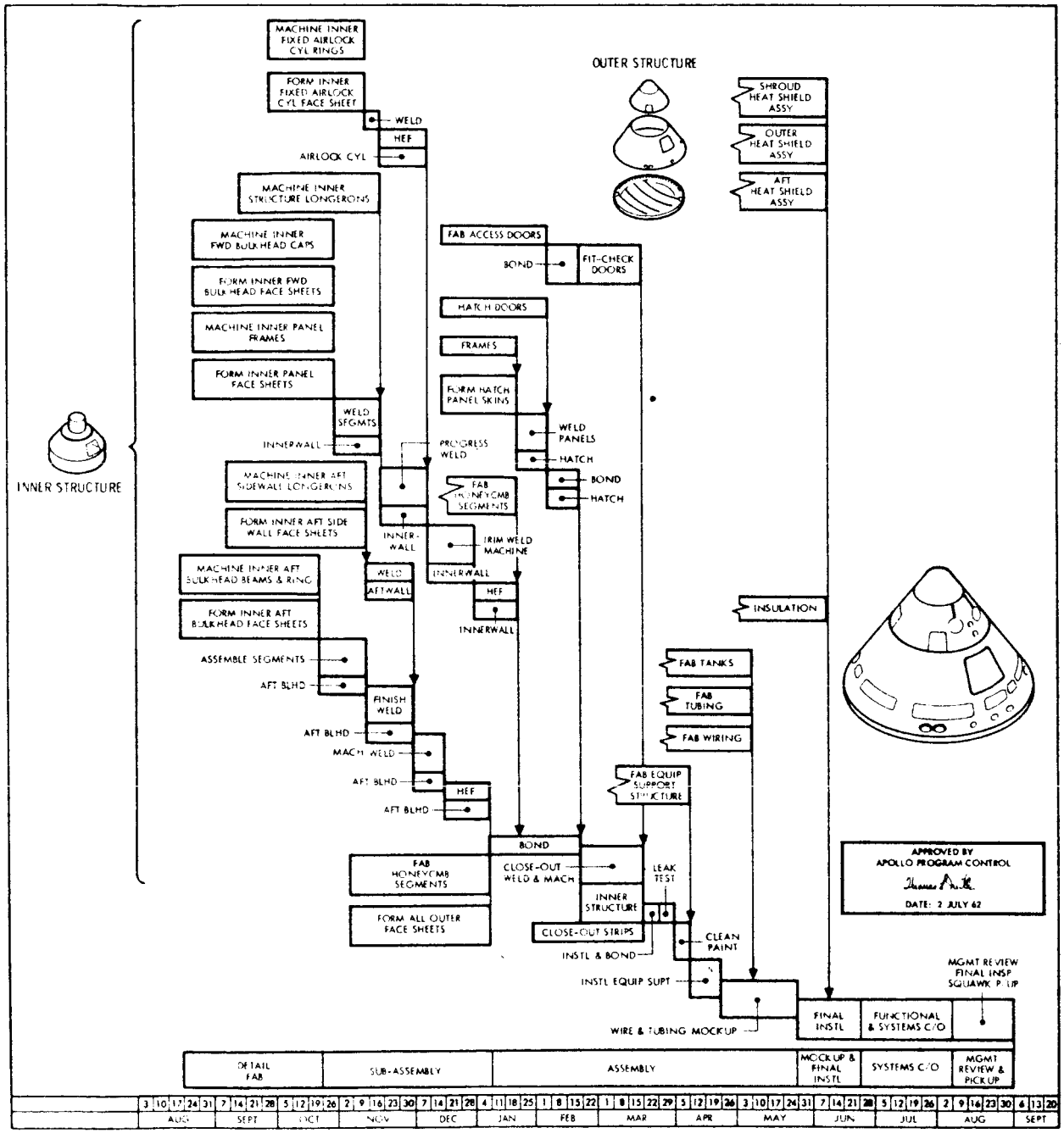

Figure 36. Apollo Spacecraft Little Joe II Launch (AFRM 009) Master Schedule

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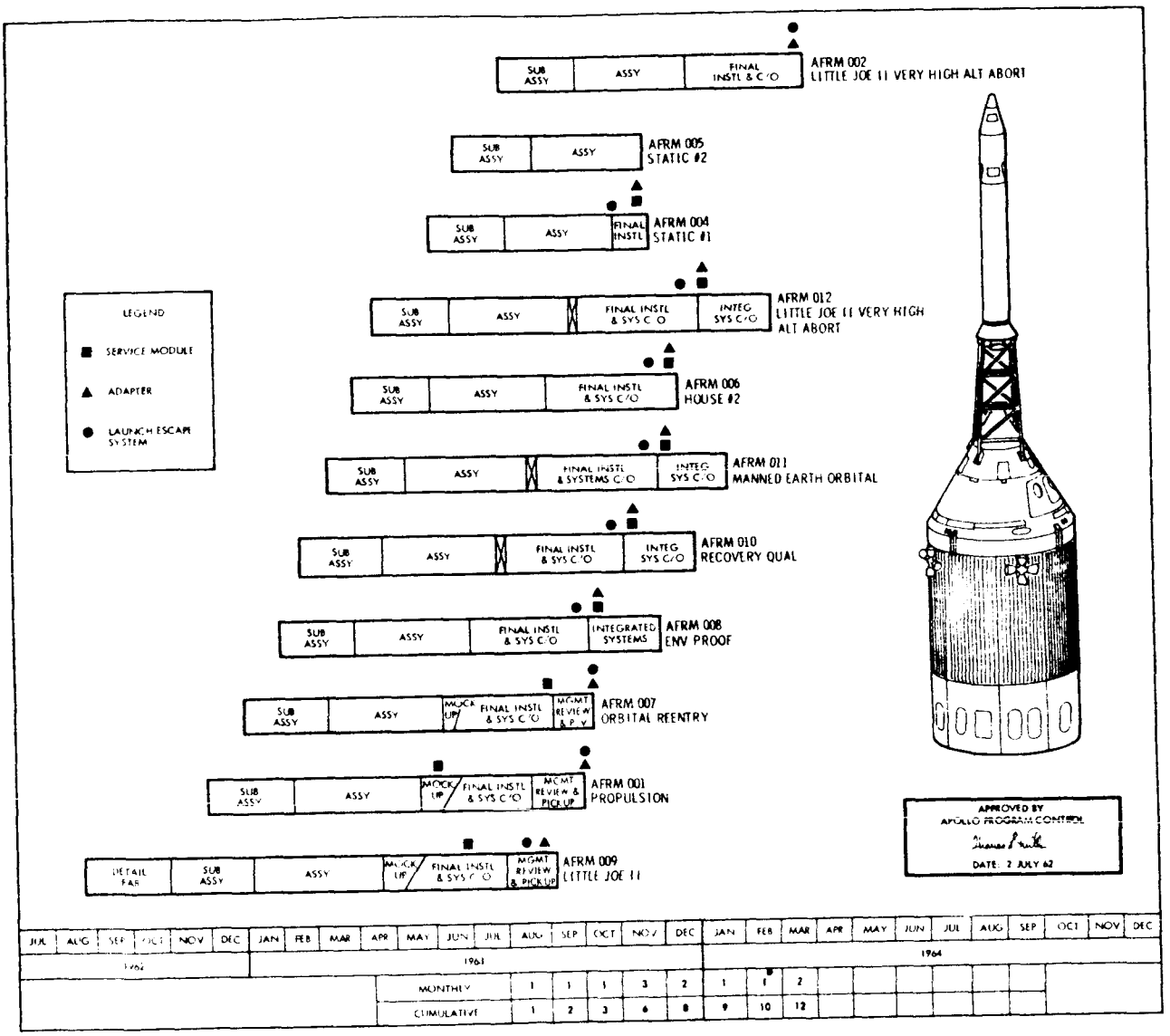

Figure 37. Apollo Spacecraft Manufacturing Completion Schedule

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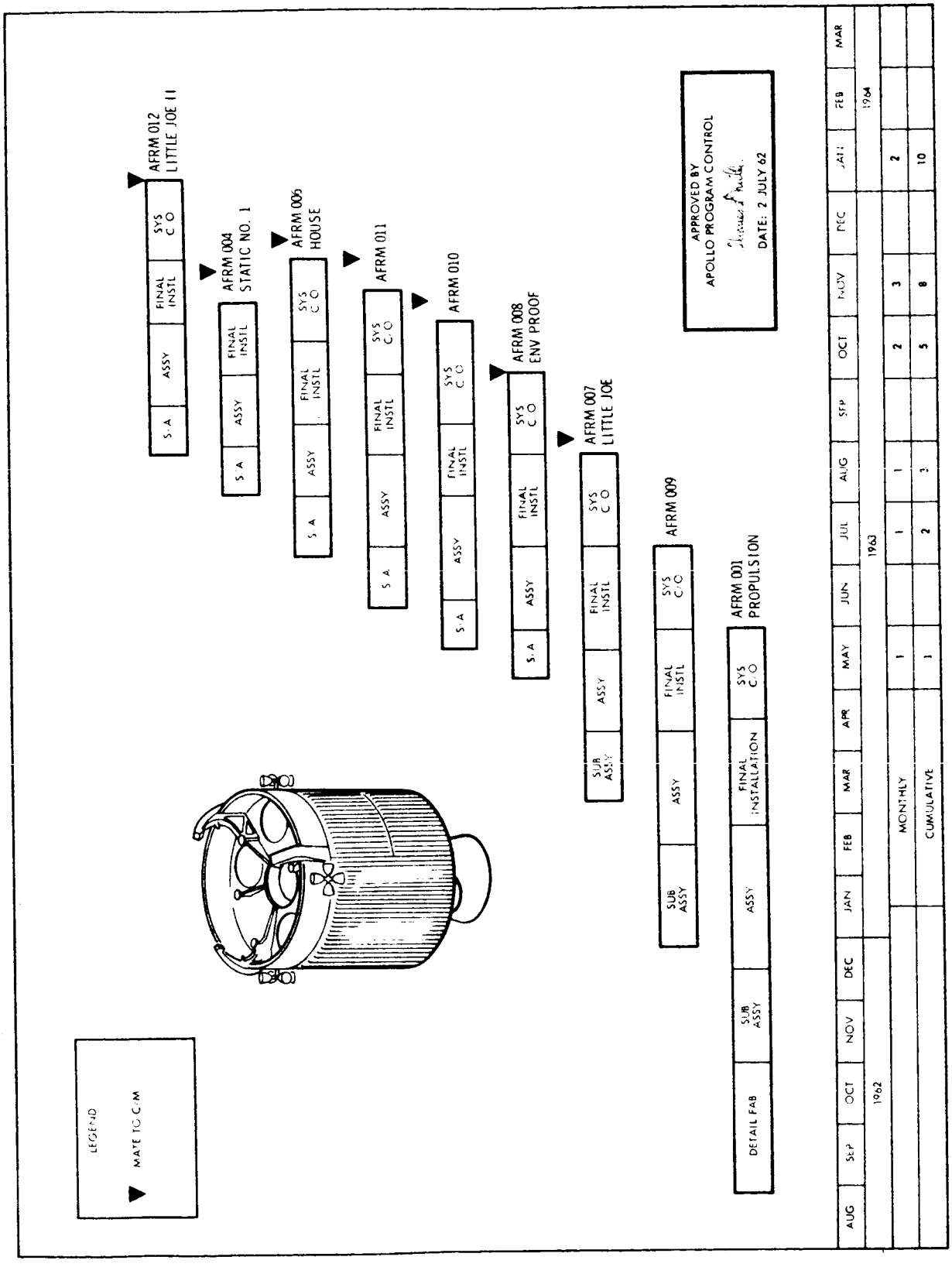

Figure 39. Apollo Spacecraft Service Module Manufacturing Completion Schedule

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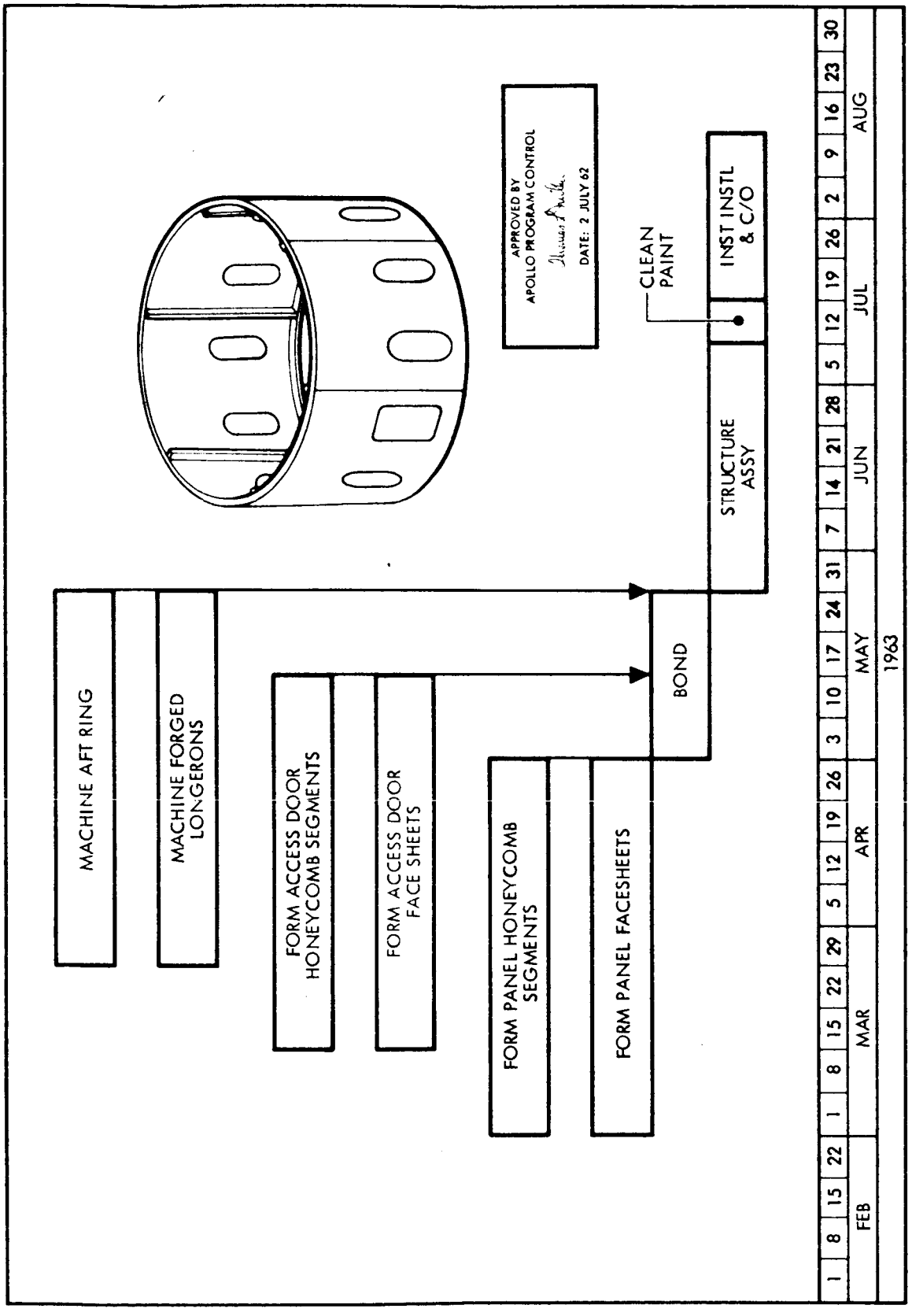

Figure 40. Apollo Spacecraft Adapter Master Schedule

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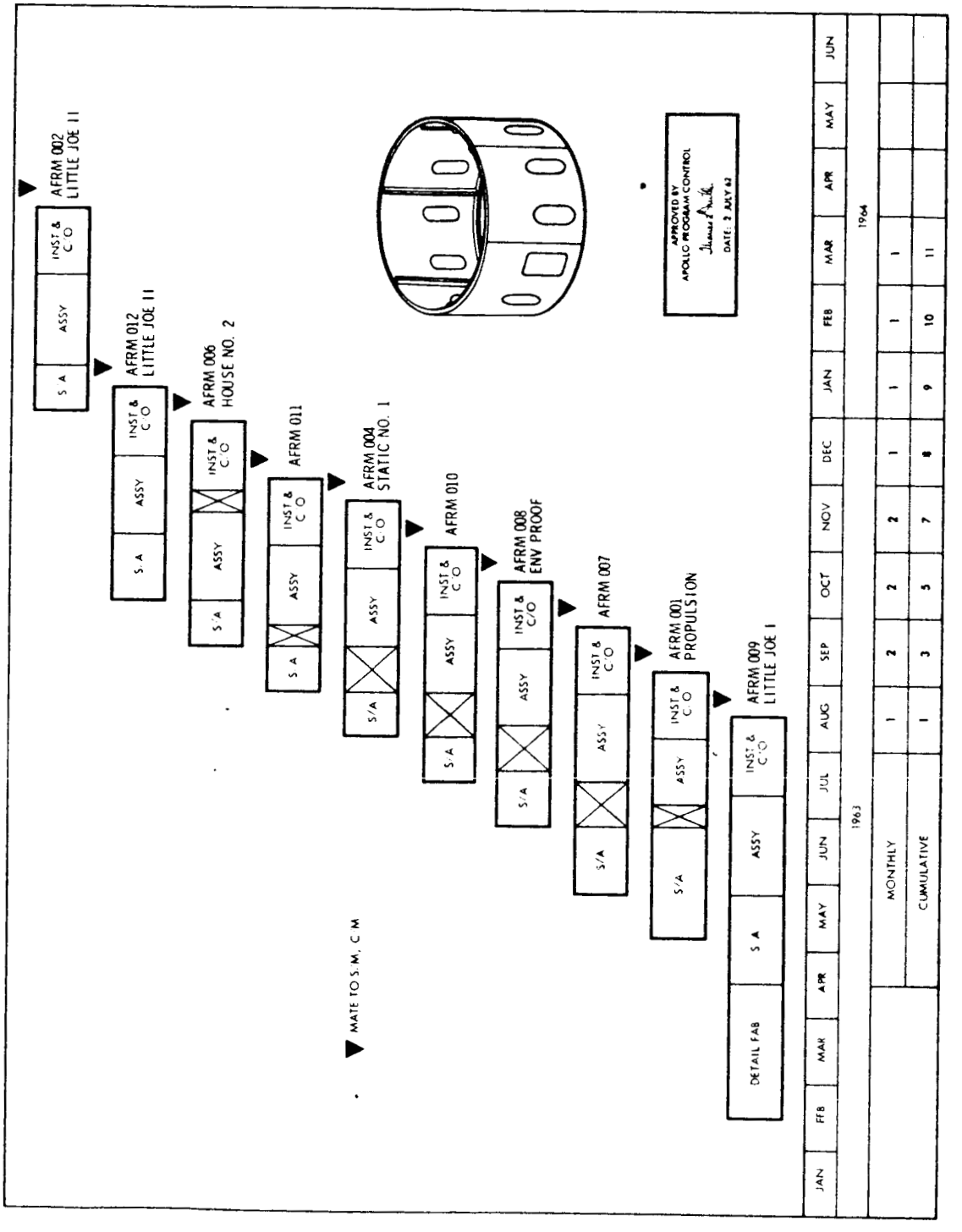

Figure 41. Apollo Spacecraft Adapter Manufacturing Completion Schedule

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SUB- AND ASSOCIATE CONTRACTOR SCHEDULES

The Sub and Associate Contractor development schedules reflect the planned approach by which Vendors are able to make commitments as specified on the Sub and Associate Contractor Delivery Schedules.

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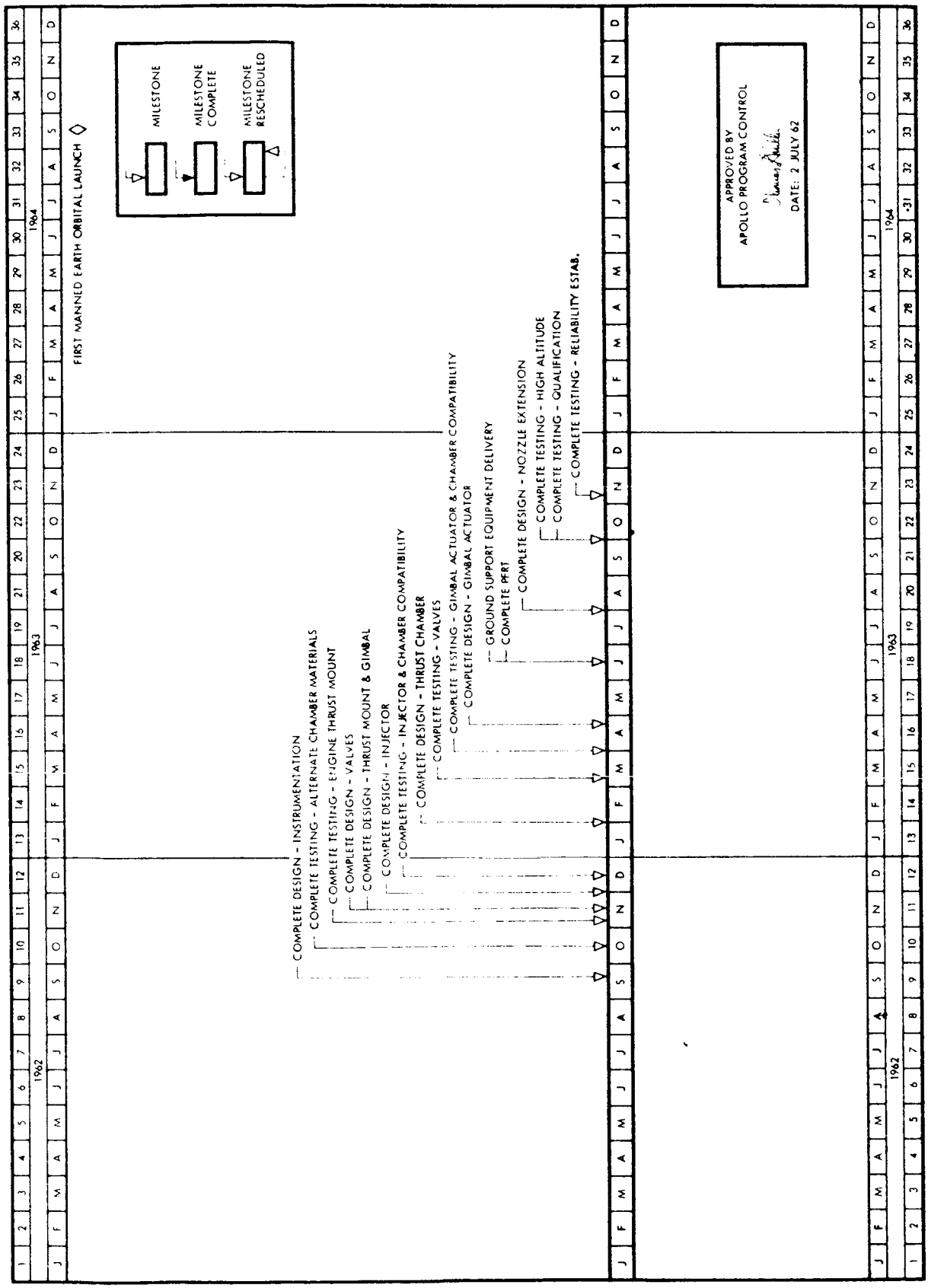

Figure 42. AEROJET - Service Propulsion - Rocket Engine SUBCONTRACTOR DEVELOPMENT SCHEDULE

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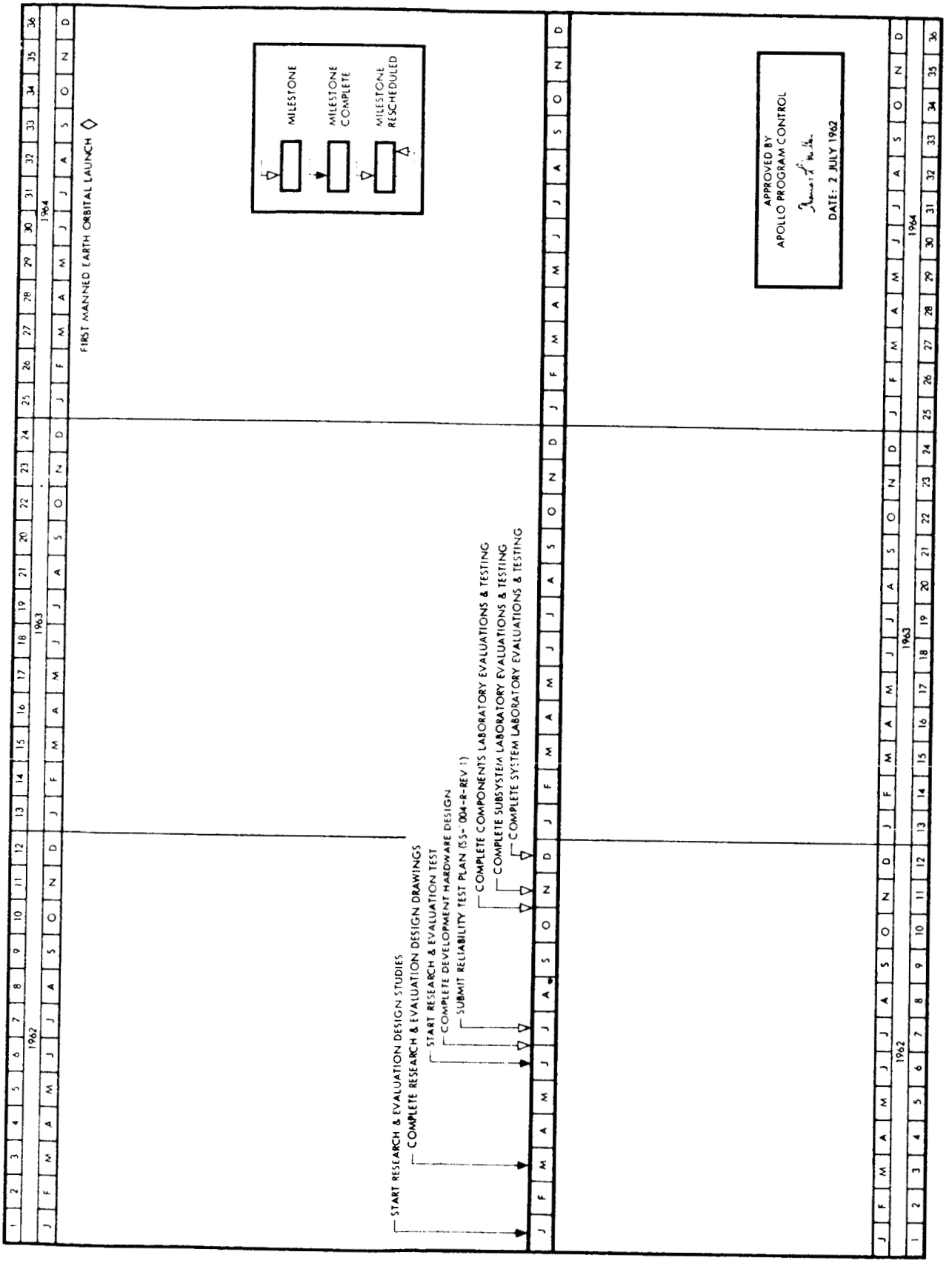

Figure 43. AIRESEARCH - Environmental Control System SUBCONTRACTOR DEVELOPMENT SCHEDULE

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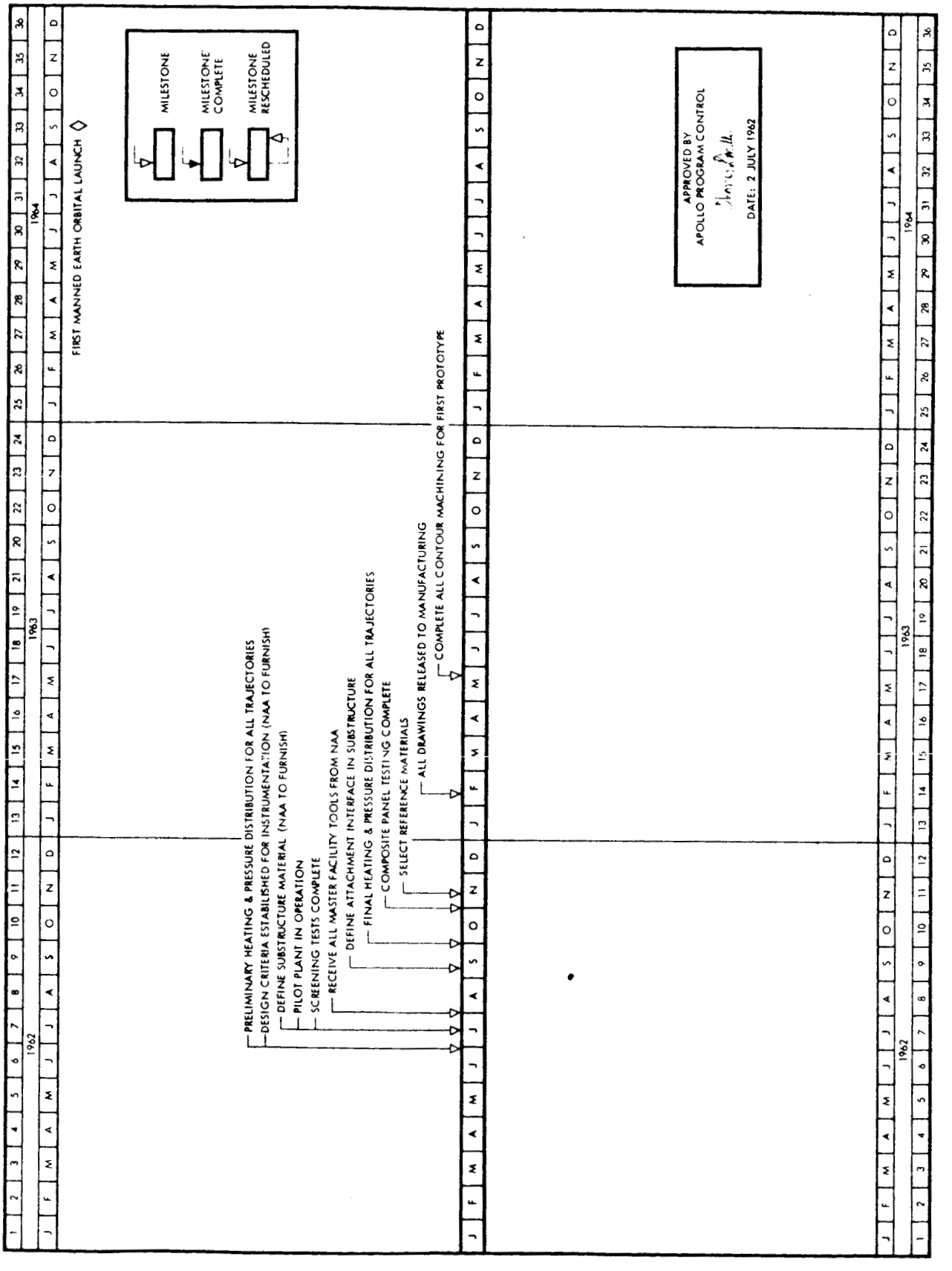

Figure 44. AVCO - Ablative Material SUBCONTRACTOR DEVELOPMENT SCHEDULE

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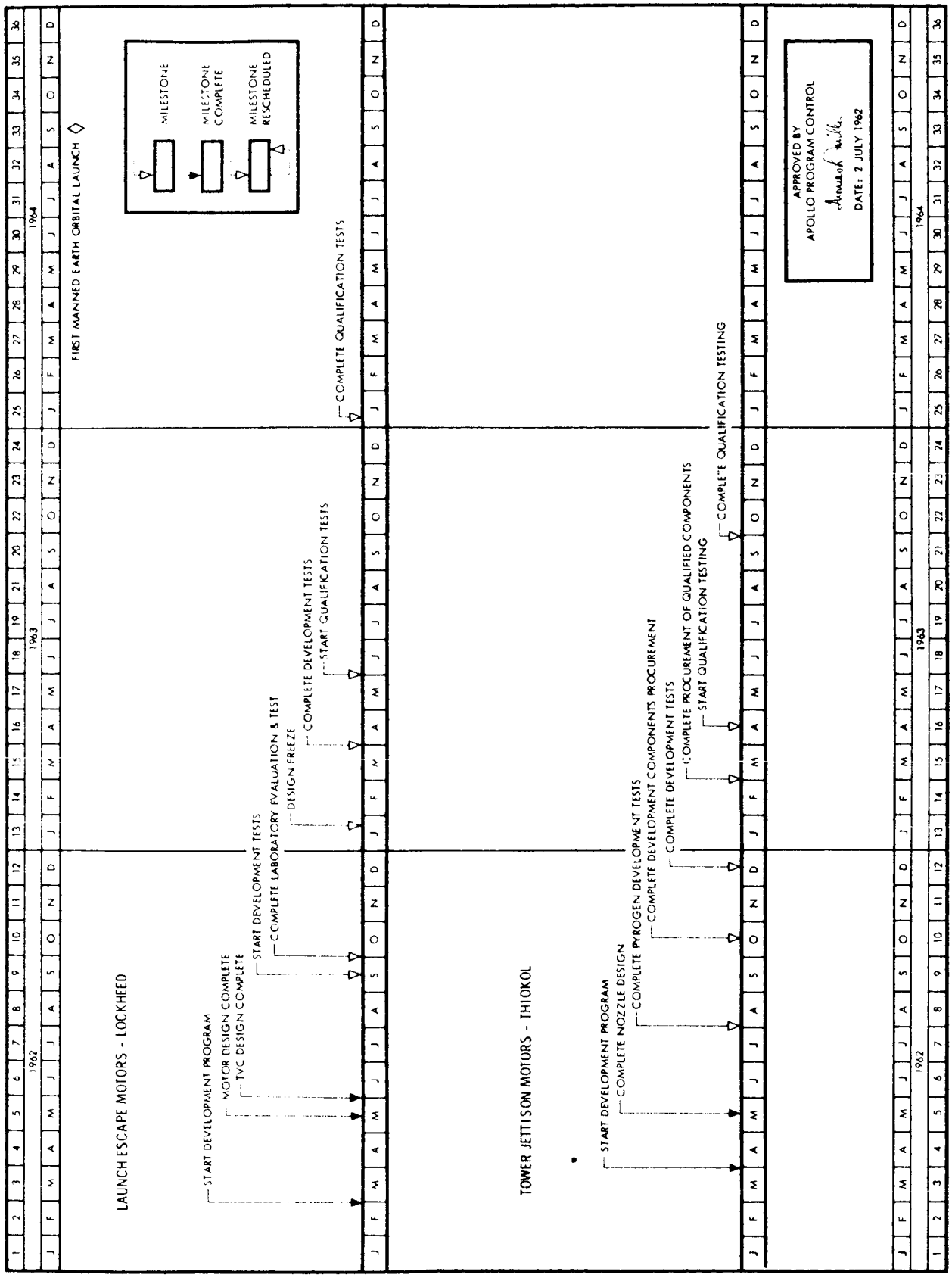

Figure 46. LOCKHEED - Launch Escape System (Motor)
THIOKOL - Launch Escape System (Tower Jettison Motor)
SUBCONTRACTOR DEVELOPMENT SCHEDULE

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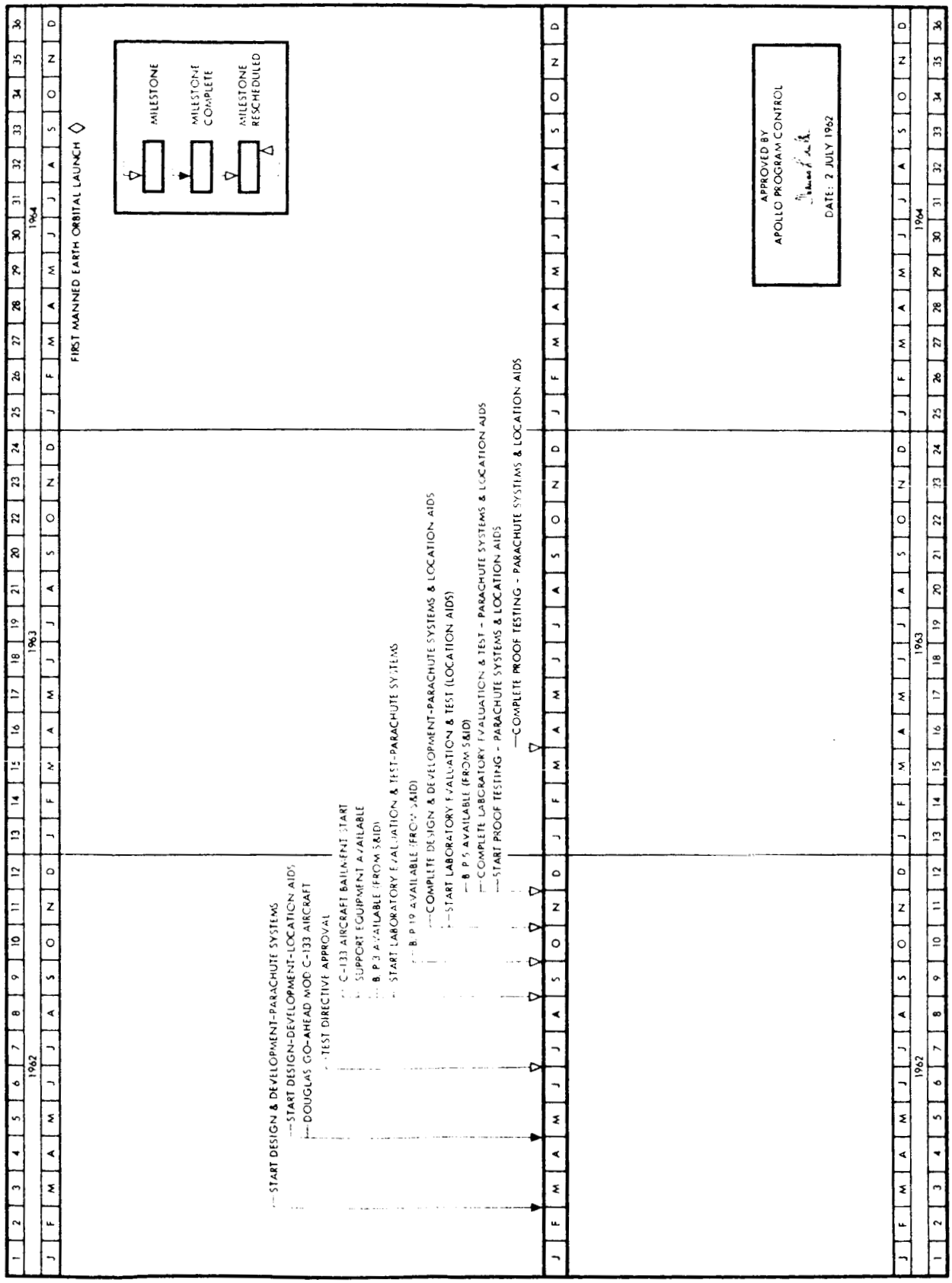

Figure 49. • NORTHROP-VENTURA - Earth Landing System DEVELOPMENT SCHEDULE

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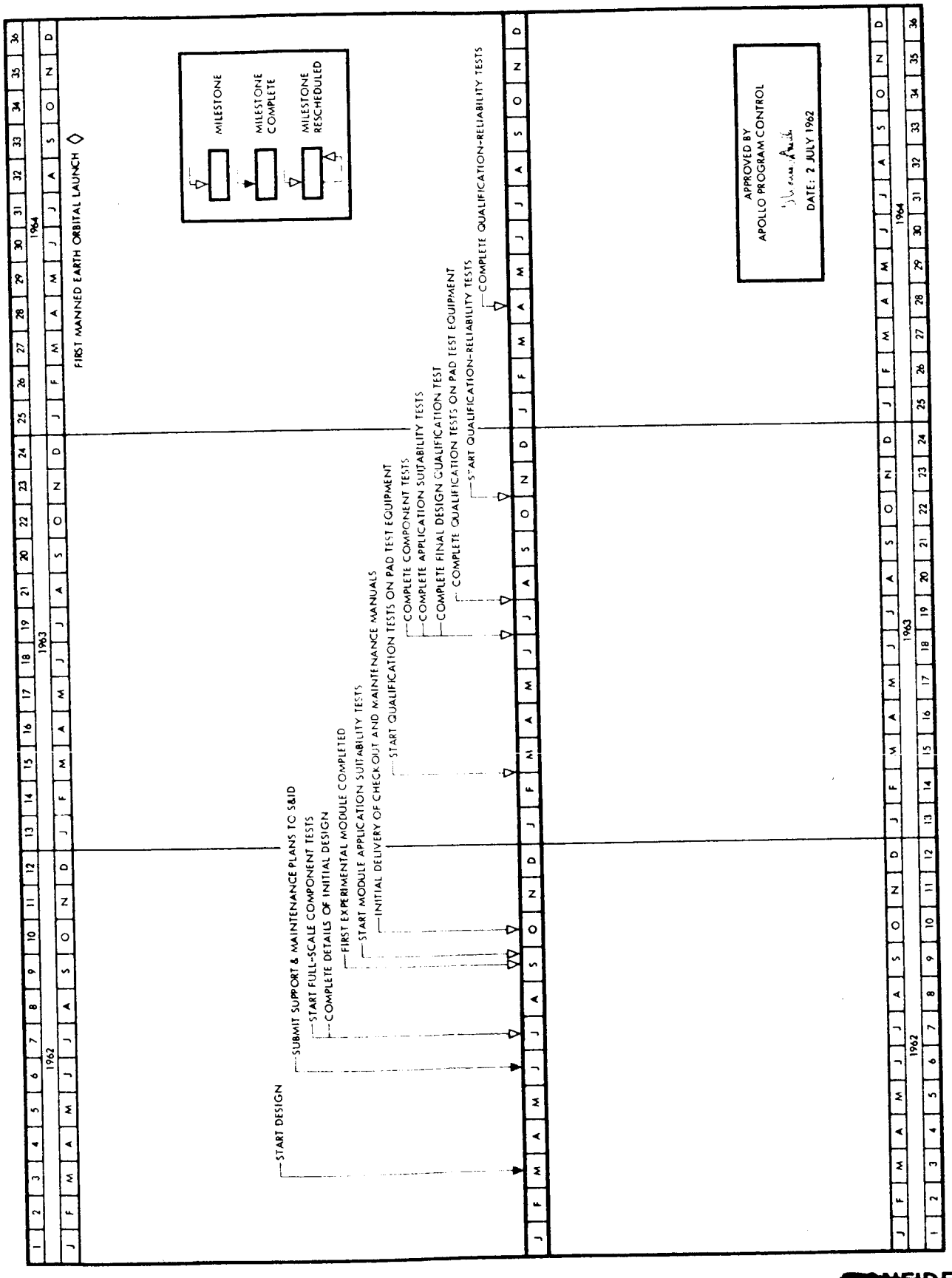

Figure 50 PRATT-WHITNEY - Electrical Power System (Fuel Cells) SUBCONTRACTOR DEVELOPMENT SCHEDULE

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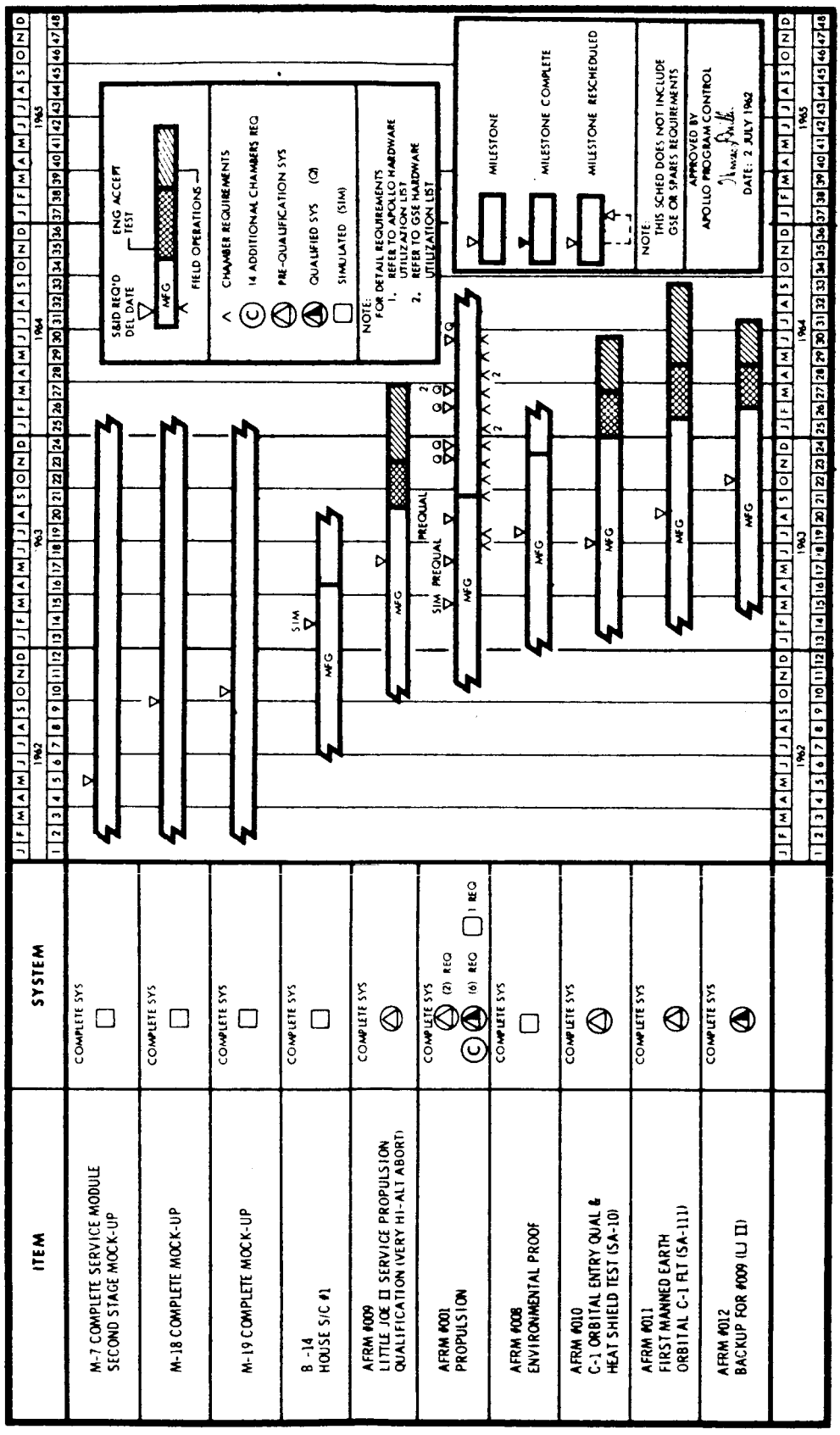

Figure 54. AERCJET - Service Propulsion - Rocket Engine DELIVERY SCHEDULE

[redacted]

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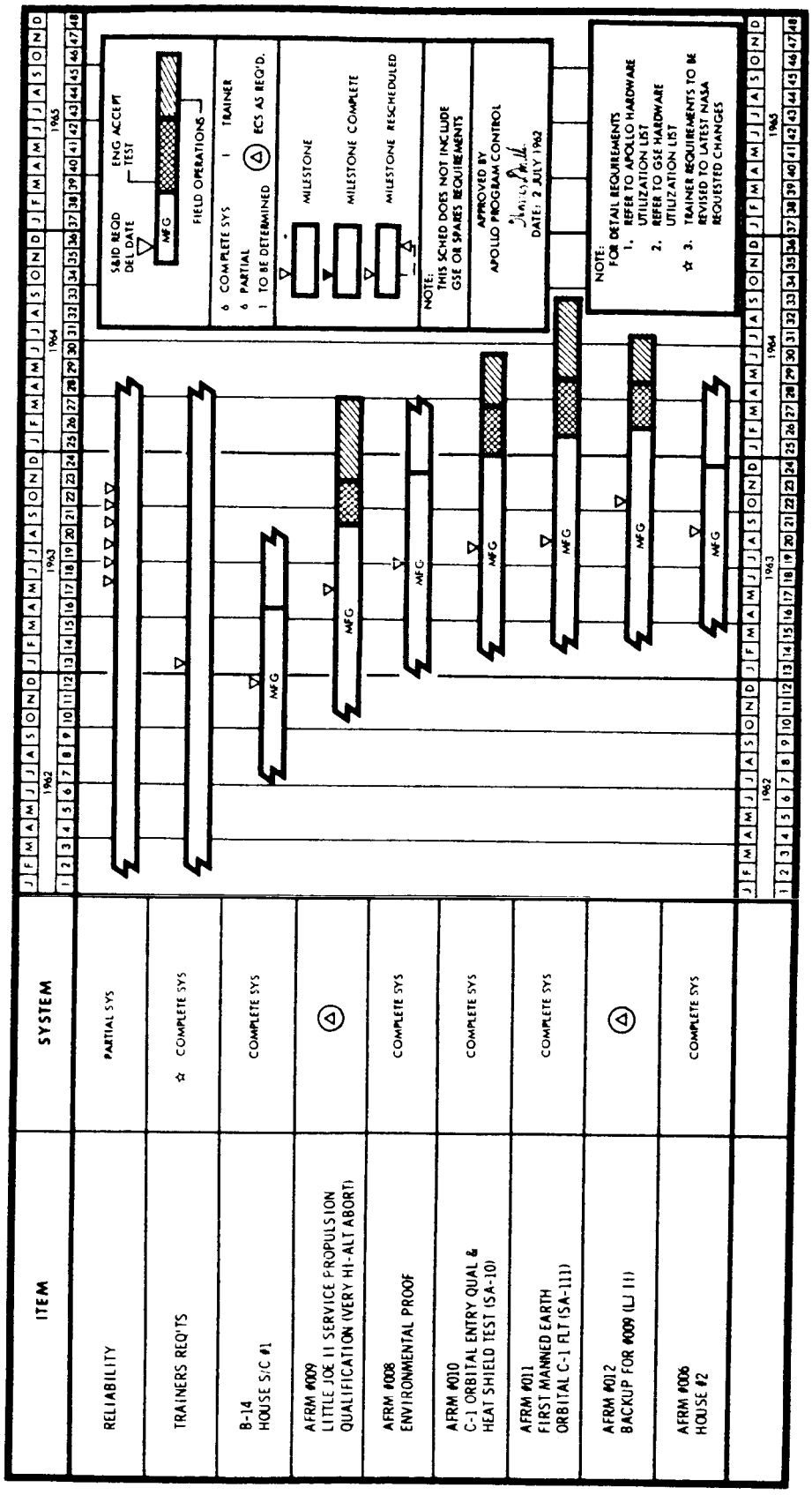

Figure 56. AIRESEARCH - Environmental Control System S/M SUBCONTRACTOR DELIVERY SCHEDULE

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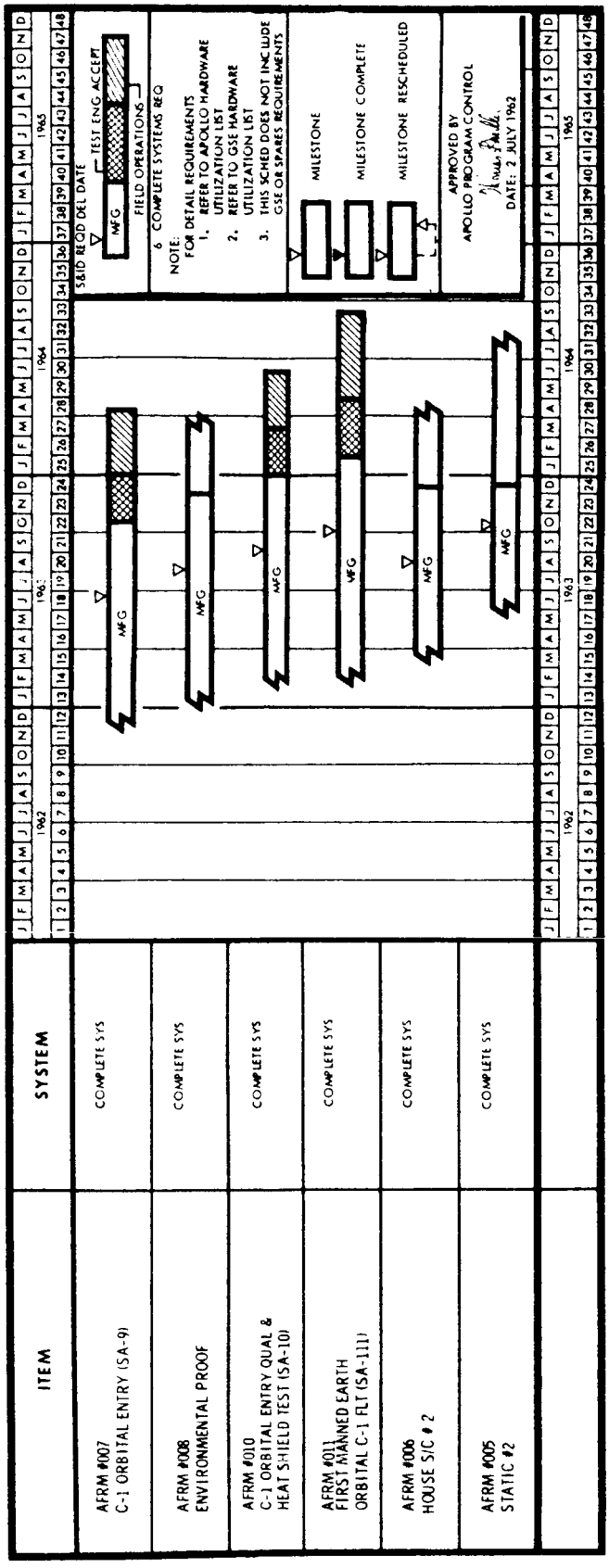

Figure 57. AVCO - Ablative Material
SUBCONTRACTOR DELIVERY SCHEDULE

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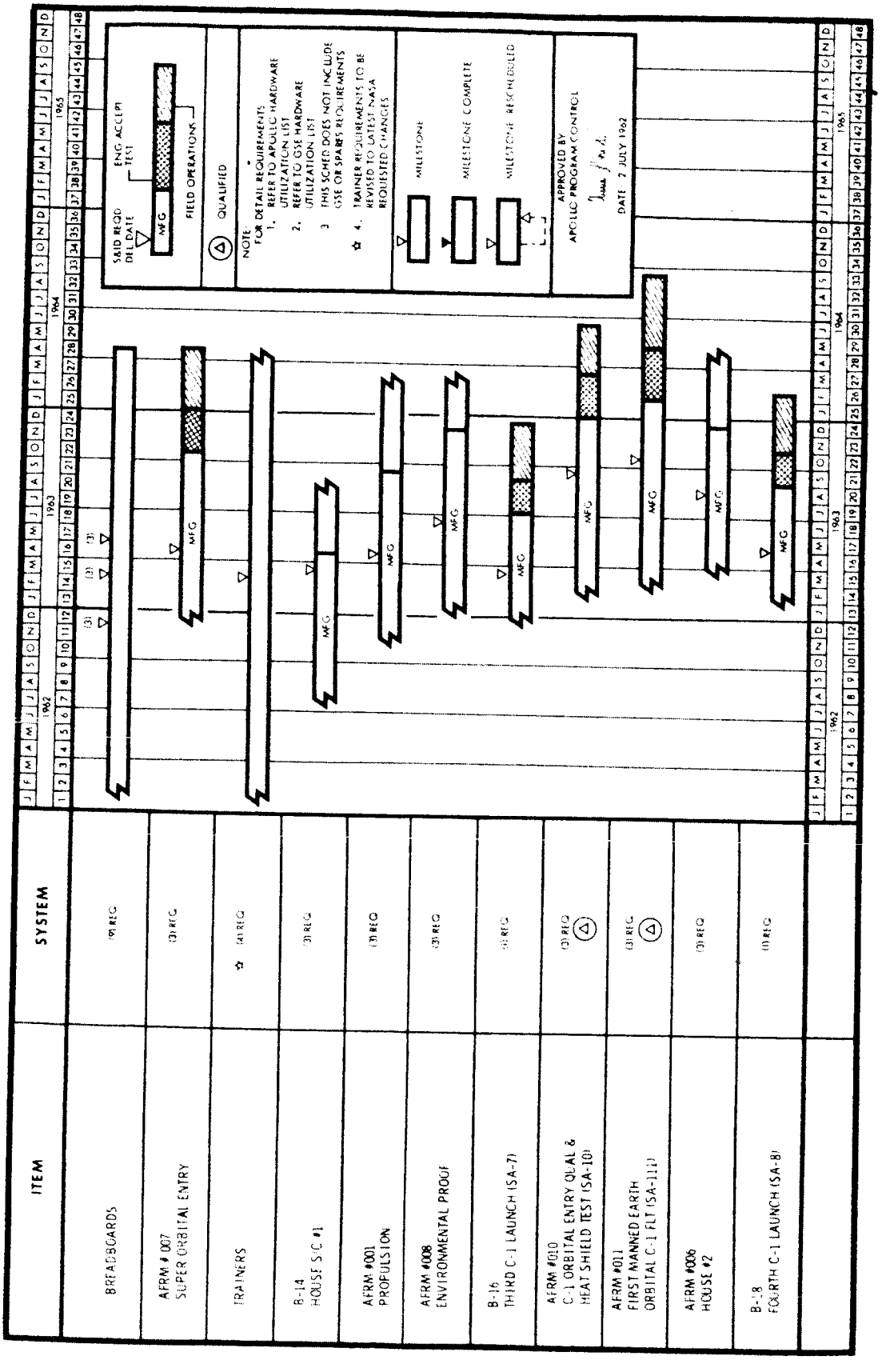

Figure 63. PRATT-WHITNEY - Electrical Power System (Fuel Cells) SUBCONTRACTOR DELIVERY SCHEDULE

[redacted]

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ADDITIONAL SCHEDULES

The Hardware Delivery Schedules indicate oriented major hardware delivery dates which are to the individual general order requirements.

The facilities preparation schedule indicates the completion dates of various facilities required prior to meeting Apollo objectives.

The wind tunnel testing schedule sets forth major milestones in the completion of technical testing.

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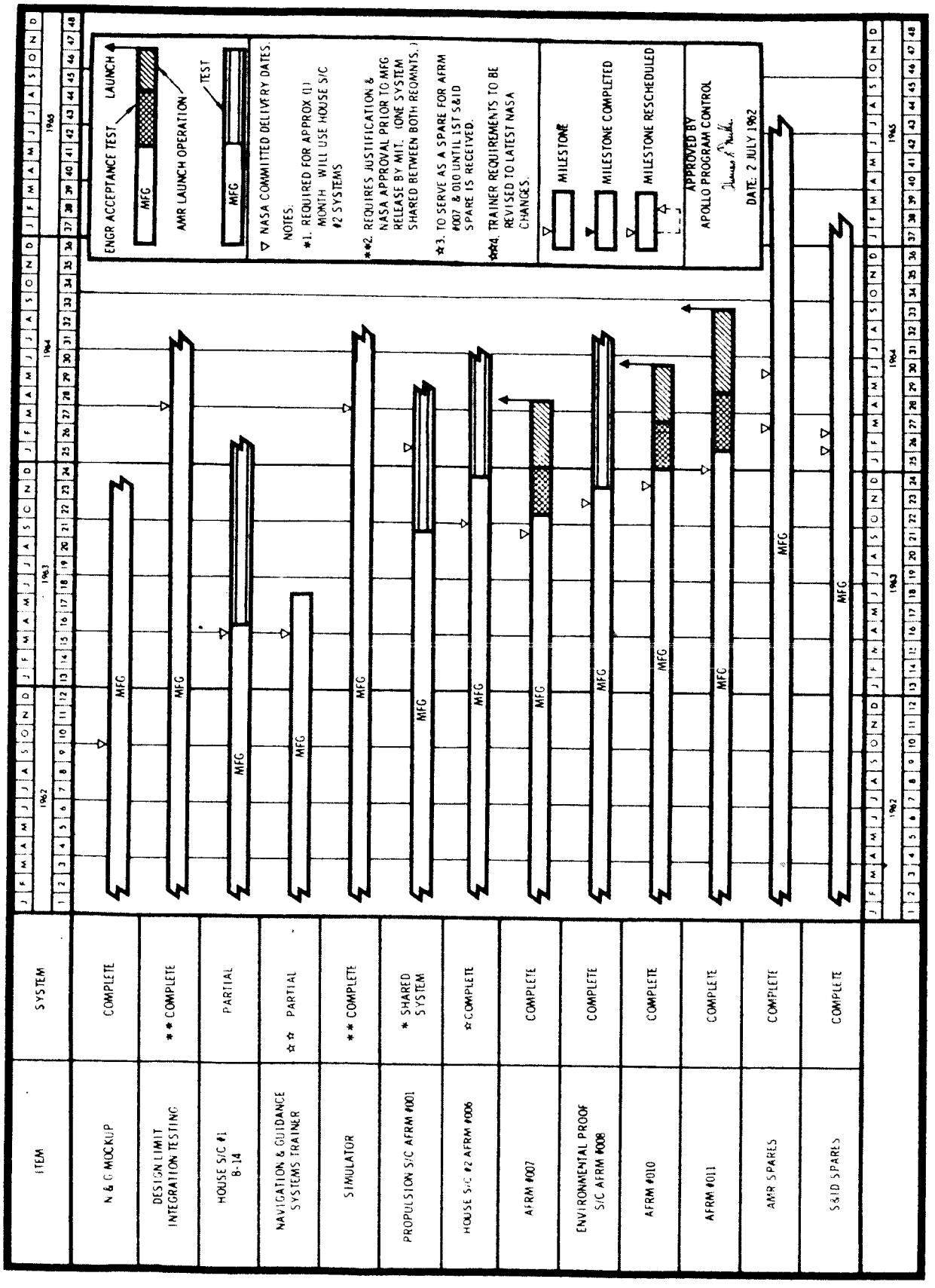

Figure 73. G. O. 7136 MIT-NASA Delivery Commitments
HARDWARE DELIVERY SCHEDULE

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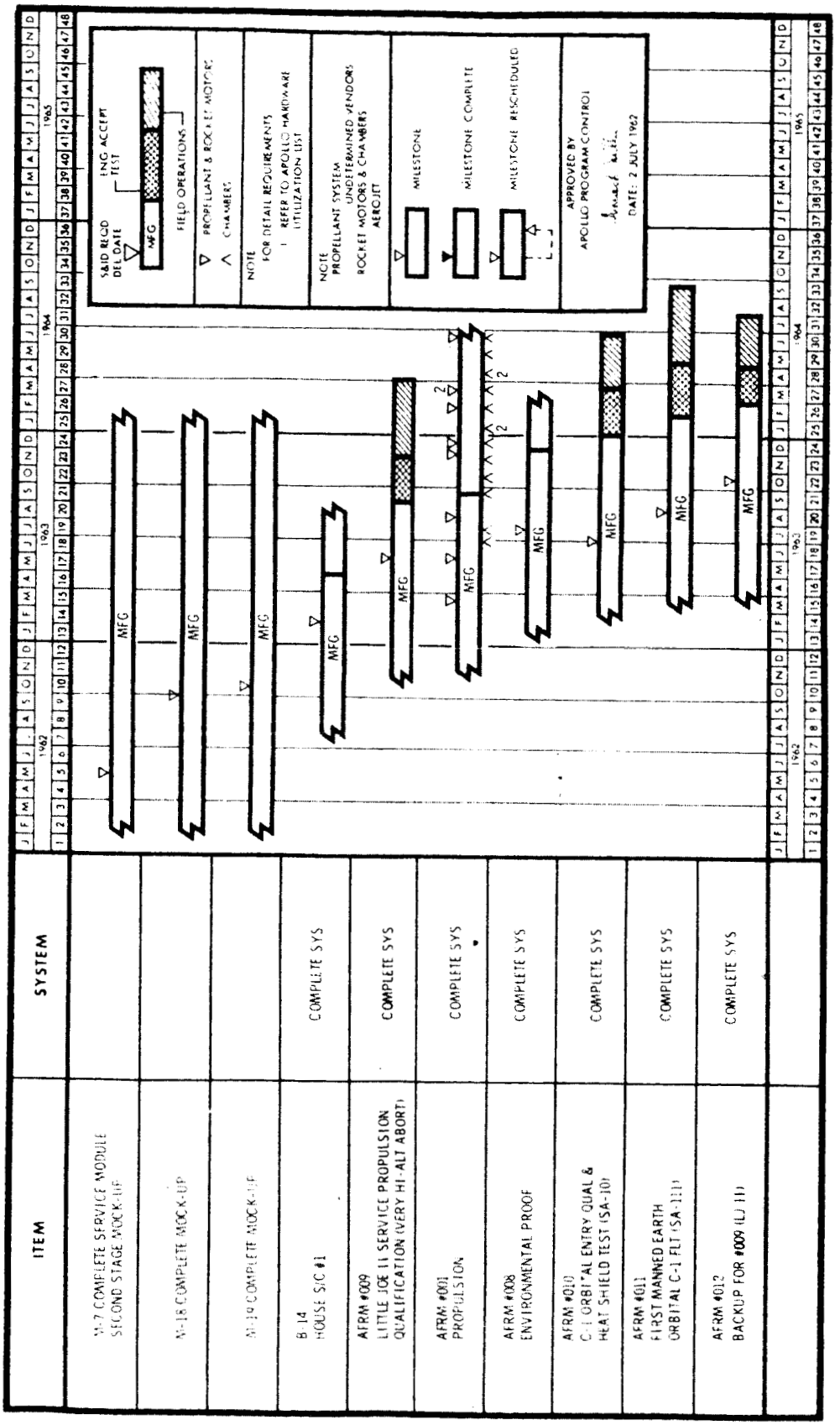

Figure 75. G. O. 7138 Service Propulsion HARDWARE DELIVERY SCHEDULE

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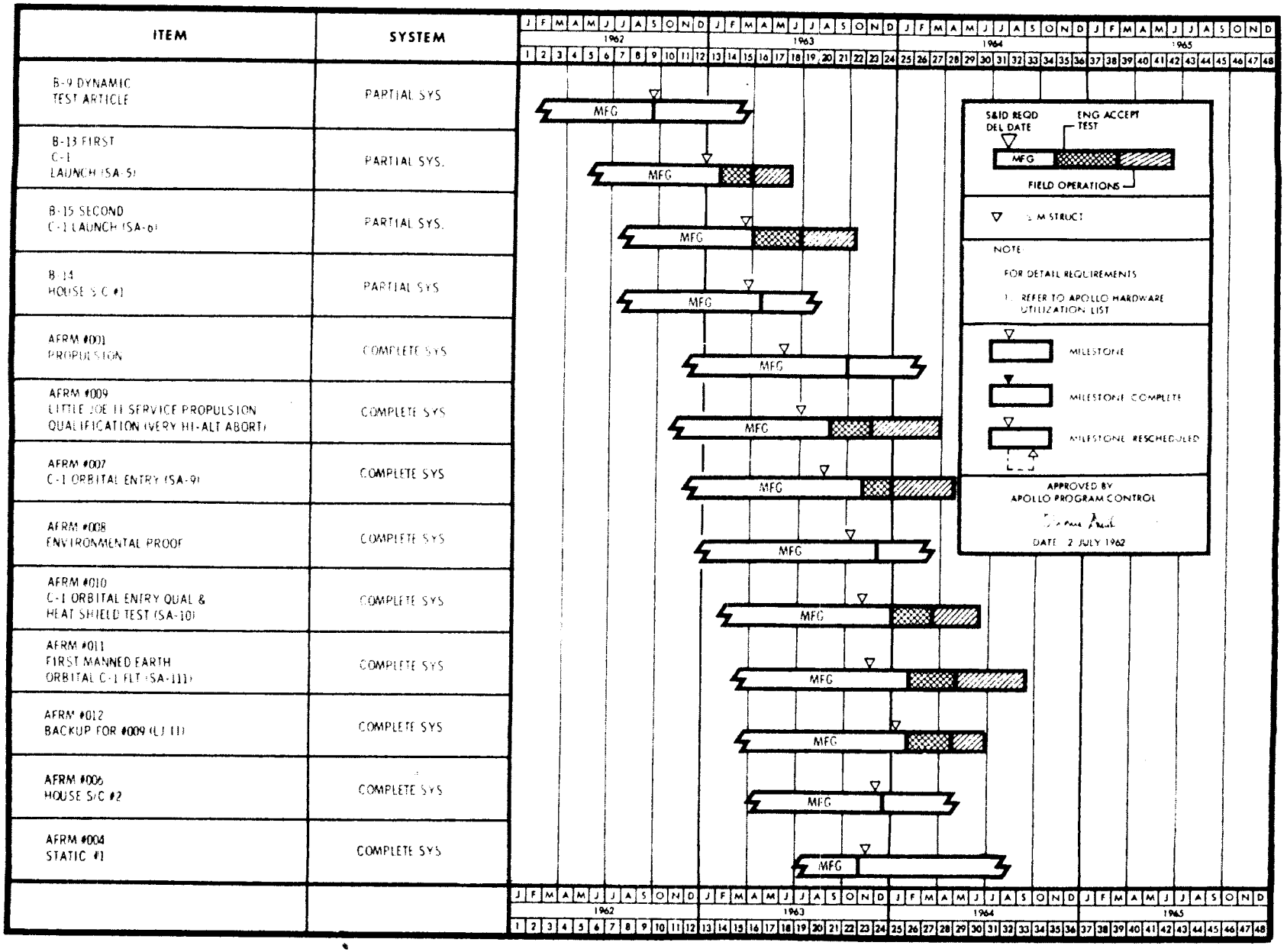

Figure 76. G. O. 7139 Service Module
HARDWARE DELIVERY SCHEDULE

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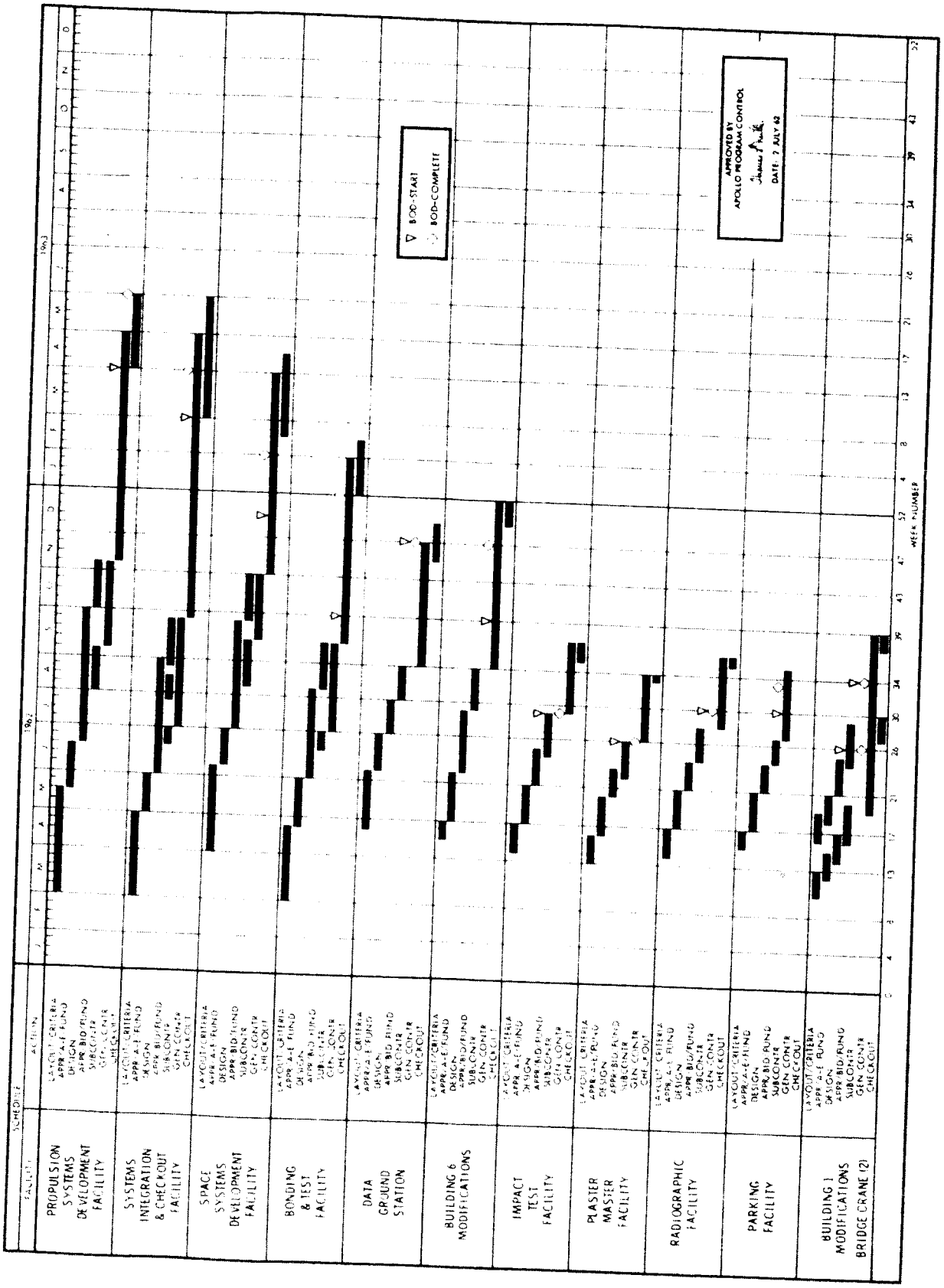

Figure 80. Facilities Preparation Schedule

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APOLLO MAJOR HARDWARE NOMENCLATURE LIST

MOCK-UPS

Article No.	Nomenclature
M-2	Command Module for Cabin Interior Arrangement
M-3	Command Module for Cabin Interior Arrangement
M-4	Partial Service Module Second Stage and Partial Adapter-Interface
M-5	Command Module for Cabin Exterior Equipment
M-7	Complete Service Module Second Stage
M-8	Command Module for Air Lock and Docking
M-9	Spacecraft for Handling and Transportation
M-10	Command Module Interior for Life Systems (Inactive)
M-11	Spacecraft for Handling and Transportation
M-12	Partial Command Module for Crew Support Equipment
M-16	Partial Service Module Second Stage and Complete Adapter-Interface
M-17	Partial Service Module Second Stage and Partial Adapter-Interface
M-18	Spacecraft - Complete
M-19	Spacecraft - Complete
M-20	Command Module and Launch Escape System for Antenna Radiation Pattern Test
M-21	Complete Service Module First Stage
M-22	Partial Service Module First Stage and Partial Adapter-Interface
M-23	Partial Service Module First Stage and Complete Adapter-Interface
M-24	Partial Service Module First Stage and Partial Adapter-Interface

BOILERPLATES

Article No.	Nomenclature
B-1	Command Module for Land and Water Impact
B-2	Command Module for Land and Water Impact
B-3	Command Module for Parachute Recovery

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Article No.	Nomenclature
B-5	Command Module with Parachute Recovery and Partial Recovery AID Systems
B-6	Command Module and Launch Escape System for Pad Abort
B-8	Command Module for Water Egress, Floatation, Recovery AIDS, and Logistics Equipment
B-9	Spacecraft for Dynamic Test
B-12	Command Module and LES for Max "q" LES Verification
B-13	First-Orbital Spacecraft for Booster Compatibility
B-14	House Space No. 1
B-15	Second Orbital Spacecraft for Booster Compatibility
B-16	Third Orbital Spacecraft for Systems Design Verification
B-18	Fourth Orbital Spacecraft for Systems Design Verification
B-19	Command Module for Parachute Recovery
B-20	Command Module and LES for Pad Abort
B-21	Command Module and LES for Max "q" LES Verification
B-22	Command Module and LES for Hi-alt LES Verification
B-23	Command Module and LES
B-24	Service Module First Stage Hovering Spacecraft
B-25	Command Module for Water Recovery Procedures and Handling Equipment

SPACECRAFT

Article No.	Nomenclature
AFRM 001	Spacecraft for Propulsion System Qualification
AFRM 004	Spacecraft for Static Test No. 1
AFRM 005	Command Module for Static Test No. 2
AFRM 006	House Spacecraft No. 2
AFRM 008	Spacecraft for Environmental Proof Tests
AFRM 002	Command Module and LES for Max "q" LES Qualification
AFRM 007	(Spacecraft) Command Module for Re-entry Tests
AFRM 009	Spacecraft for Very Hi-alt Atmos Service Module Propulsion Verification
AFRM 012	Spacecraft for Very Hi-alt Atmos Service Module Propulsion Verification (Back-up for AFRM 009)
AFRM 010	Spacecraft for Launch, Orbital and Recovery Qualification
AFRM 011	Spacecraft for First Manned Earth Orbital Qualification
AFRM 013	Spacecraft for Second Manned Earth Orbital Qualification

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TRAINERS

Trainers requirements listed below are being negotiated and are not to be considered firm. The list will be revised upon completion of negotiations.

SYSTEM TRAINERS

Navigation and Guidance System
Communications System
Instrumentation System
Command Module Reaction Control System
Service Module Reaction Control System
Electrical Power Supply System
Environmental Control System
Stabilization and Control System
Integrated Systems Trainer
Service Module Propulsion Systems Trainer

PART TASK TRAINERS

Egress No. 1
Orbital & Rendezvous
Earth Launch & Re-entry
Nav. & Trajectory Control

COMPLETE TRAINERS

Mission Simulator No. 1

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Table 1. Apollo Major Hardware End Item Quantities Summary

Hardware Article	(1) Contractual Coverage Thru AFRM 013	(2) Basic Program Thru Dec 1964	(3) Basic Program Thru Nov 1967	(4) 1st Stage Requirements Only Thru Dec 1964	(5) 1st Stage Requirements Only Thru Nov 1967	(6) Total Program Thru Dec 1964	(7) Total Program Thru Nov 1967
Mock-ups	15	15	15	4	4	19	19
Boilerplates	18	19	19	1	1	20	20
Spacecraft	12	17	33			17	33
Trainers		25	26			25	26
GSE:							
Partial Sets	[illegible]	8	8	1	1	9	9
Complete Sets		19	19	6	10	25	29
*The Ground Support Equipment list presented as Section III and the trainers, simulators, and GSE for training purposes Section IV of NAA Report No. SID 62-58 entitled "Preliminary Hardware List" shall be used as a guide for program planning and for preparation of a definitive contract proposal. MSC has not approved either the items of "GSE," "Trainers," or the quantities to be delivered. Approval of these items and quantities will be given during or subsequent to definitive contract negotiations.							
Hardware components required to support the Boilerplates and Spacecraft shown above include the following:							
Towers	22	26	41			26	41
C/M	30	36	53			36	53
S/M II	14	18	30		2	18	32
S/M I				6	11	6	17
Adapters:							
Pad Abort	2	2	2			2	2
C/M-LJ-II	5	5	5			5	5
C/M-C-I	2	2	2			2	2
C/M-C-I B					2		2
C/M-SM I				1	2	1	2
S/M II (B/P)-C-I	4	4	4			4	4
S/M II-C-I	7	10	11			10	11
S/M II-LJ-II	2	2	2			2	2
S/M II - Propulsion Dolly	1	1	1			1	1
S/M II-C-5					3		3
S/M I - Propulsion Firing Stand				1	1	1	1
S/M I-C-I				3	3	3	3
S/M I-LJ-II				1	2	1	2
Total Adapters	23	26	27	6	13	32	40

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Table 1. Apollo Major Hardware End Item Quantities Summary (Cont)

Hardware Article	B-1	B-2	B-3	B-5	B-8	B-19	B-25							Program Requirements Sub-Total	
														Thru Dec 1964	Thru Nov 1967
Mock-ups															
Boilerplates	1	1	1	1	1	1	1							7	7
Spacecraft															
Trainers															
Towers															
C/M	1	1	1	1	1	1	1							7	7
S/M II															
S/M I															
Adapters:															
Pad Abort															
C/M-LJ-II															
C/M-C-I															
C/M-C-I B															
C/M-SM I															
S/M II (B/P)-C-I															
S/M II-C-I															
S/M II-LJ-II															
S/M II - Propulsion Dolly															
S/II-C-5															
S/M I - Propulsion Firing Stand															
S/M I-C-I															
S/M I-LJ-II															
GSE:															
Partial Sets	1	1	1			1								4	4
Complete Sets				1										1	1

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Table 1. Apollo Major Hardware End Item Quantities Summary (Cont)

Hardware Article	LES Tower	B-9	B-6	B-20	B-12	B-13	B-23	B-21	B-15	B-14	B-22	B-16	B-18	Program Requirements Sub-Total	
														Thru Dec 1964	Thru Nov 1967
Mock-ups															
Boilerplates		1	1	1	1	1	1	1	1	1	1	1	1	12	12
Spacecraft															
Trainers															
Towers	2	1	1	1	1	1	1	1	1		1	1	1	13	13
C/M		1	1	1	1	1	1	1	1	1	1	1	1	12	12
S/M II		1				1			1	1				4	4
S/M I															
Adapters:															
Pad Abort			1	1										2	2
C/M-LJ-II					1		1				1			4	4
C/M-C-I B															
C/M-SM I															
S/M II (B/P)-C-I		1				1			1	1				4	4
S/M II-C-I															
S/M II-LJ-II															
S/M II-Propulsion Dolly															
S/M II-C-5															
S/M I-Propulsion Firing Stand															
S/M I-C-I															
S/M I-LJ-II															
GSE:															
Partial Sets		1			1			1						3	3
Complete Sets			1	1		1	1		1	1	1	1	1	9	9

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Table 1. Apollo Major Hardware End Item Quantities Summary (Cont)

Hardware Article	AFRM 001	AFRM 009	AFRM 007	AFRM 004	AFRM 008	AFRM 005	AFRM 006	AFRM 010	AFRM 011	AFRM 012	AFRM 002	AFRM 013		Program Requirements Sub-Total Thru Dec 1964	Program Requirements Sub-Total Thru Nov 1967
Mock-ups															
Boilerplates															
Spacecraft	1	1	1	1	1	1	1	1	1	1	1	1		12	12
Trainers															
Towers		1	1	1	1			1	1	1	1	1		9	9
C/M	1	1	1	1	1	1	1	1	1	1	1	1		12	12
S/M II	1	1	1	1	1		1	1	1	1		1		10	10
S/M I															
Adapters:															
Pad Abort															
C/M-LJ-II											1			1	1
C/M-C-I															
C/M C-I B															
C/M-SM I															
S/M II (B/P)-C-I															
S/M II-C-I			1	1	1		1	1	1			1		7	7
S/M II-LJ-II		1								1				2	2
S/M II - Propulsion Dolly	1													1	1
S/M II-C-S															
S/M I - Propulsion Firing Stand															
S/M I-C-I															
S/M I-LJ-II															
GSE:															
Partial Sets		1												1	1
Complete Sets	1		1		1		1	1	1	1	1	1		9	9

[redacted]

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Table 1. Apollo Major Hardware End Item Quantities Summary (Cont)

Hardware Article	B-14	AFRM 004	AFRM 014	AFRM 008	AFRM 015	AFRM 016	AFRM 017	AFRM 006	AFRM 018	B-24	AFRM 019	AFRM 020	AFRM 021	Program Requirements Sub-Total	
														Thru Dec 1964	Thru Nov 1967
Mock-ups															
Boilerplates										1					1
Spacecraft			1		1	1	1		1		1	1	1		8
Trainers															
Towers					1	1	1		1		1	1	1		7
C/M			1		1	1	1		1	1	1	1	1		9
S/M II			1		1	1			1	1		1	1		7
S/M I	1	1	1	1			1	1		1	1	1			9
Adapters:															
Pad Abort															
C/M-LJ-II															
C/M-C-I															
C/M-C-I B															
S/M-SM I							1				1			1	2
S/M II (B/P)-C-I															
S/M II-C-I					1	1			1				1	3	4
S/M II-LJ-II															
S/M II - Propulsion Dolly															
S/M II-C-5															
S/M I - Propulsion Firing Stand			1											1	1
S/M I-C-I	1			1				1						3	3
S/M I-LJ-II							1				1			1	2
GSE:															
Partial Sets		1												1	1
Complete Sets	1		1	1			1	1			1			6	6

[redacted]

Table 1. Apollo Major Hardware End Item Quantities Summary (Cont)

Hardware Article	AFRM 022	AFRM 023	AFRM 024	AFRM 025	AFRM 026	AFRM 027	AFRM 028	AFRM 029	AFRM 030	AFRM 031	AFRM 032	AFRM 033	AFRM 034	Program Requirements Sub-Total	
														Thru Dec 1964	Thru Nov 1967
Mock-ups															
Boilerplates															
Spacecraft	1	1	1	1	1	1	1	1	1	1	1	1	1		13
Trainers															
Towers	1	1		1	1	1	1	1	1	1	1	1	1		12
C/M	1	1	1	1	1	1	1	1	1	1	1	1	1		13
S/M II		1	1		1	1	1	1	1	1	1	1	1		11
S/M I		1	1		1	1		1	1			1	1		8
Adapters:															
Pad Abort															
C/M-LJ-II															
C/M-C-I															
C/M-C-I B	1			1											2
C/M II (B/P)-C-I															
S/M II-C-I															
S/M II-LJ-II															
S/M II - Propulsion Dolly															
S/M II-C-5							1			1	1				3
S/M I - Propulsion Firing Stand															
S/M I-C-I															
S/M I-LJ-II															
GSE:															
Partial Sets															
Complete Sets	1	1		1	1										4

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HARDWARE DEFINITIONS

The Apollo Spacecraft Development Plan includes requirements for hardware articles for evaluation and test purposes. These articles fall into three categories: (1) mock-ups, (2) boilerplates, and (3) spacecraft.

Mock-ups are used to display configuration and design detail for study and evaluation, and will be important tools in the development of the spacecraft design. In the early stages of development, mock-ups will be made of materials which can easily be modified to reflect design improvements. As the design progresses, mock-ups will simulate finalized flight hardware and actual material used for flight hardware.

Boilerplates are simulated spacecraft or modules used for developmental tests leading to the final spacecraft design. Boilerplates will simulate the following characteristics of the final spacecraft design:

1. External size and shape
2. Structural soundness
3. Mass and center of gravity
4. Stiffness (with respect to impact absorption)
5. Systems as required
6. Instrumentation as required

Spacecraft articles will incorporate final design features and will be used for unmanned flight and ground qualification tests through serial number AFRM 010. Spacecraft will, of course, be used to identify manned vehicles which will be launched subsequent to AFRM 010.

Mock-ups, boilerplates, and spacecraft articles that are planned for the time period through December 1964 are defined in detail in the subsequent paragraphs. It will be noted that each boilerplate and spacecraft will contain one or more of the three major components: (1) the Launch Escape System, (2) the Command Module, and (3) the Service Module (second stage).

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MOCK-UPS

M-2 — Command Module for Cabin Interior Arrangement

This mock-up is built specifically for the purpose of displaying the command module interior arrangement, and will be used by S&ID as the official configuration control mock-up. The exterior of the mock-up will be of minimum design, utilizing only the interior for simulated equipment installation.

Present objectives are to develop the best arrangement of crew equipment for maximum accessibility and optimum utilization. Future objectives will include studies on how to maintain configuration control on all installed equipment and conduct various tests on crew equipment for accessibility and arrangement.

The command module interior skin will be fabricated of plywood and will be framed with a suitable external structure. An outer plywood skin will be used only in the area of hatches and windows. The following equipment items may be simulated:

Ingress and egress hatches

Windows and/or viewing ports (with plexiglas)

Crew support and life system

Control panel

Upper and lower equipment bays

Left-hand and right-hand equipment bays

Environmental control systems

Air lock protrusion in the crew compartment equipment

All interior mechanical and electrical equipment

All lighting fixtures

M-3 — Command Module for Cabin Interior Arrangement

This mock-up is a duplicate of M-2 in all respects, and will be shipped to the Manned Space Center (MSC), Houston, Texas, approximately on

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15 August 1962. This mock-up will present the interior configuration of the command module for MSC observance.

M-4 — Partial Service Module Second Stage and Partial Adapter Interface

This mock-up will reflect the service module second stage and the adapter interface. Its specific purpose is to simulate the interface tests and disconnect mechanisms that are applicable. The mock-up will be made of metal to hold the relative positions of the interface with minimum movement for more nearly perfect simulation.

Design objectives will be evaluation of mechanical and electrical mating characteristics and compatibility between components, and evaluation of physical size and space provisions for all installed equipment.

The portions of the service module and adapter which mate will be built of metal, with only sufficient external structure to maintain integrity while meeting mock-up design objectives pertaining to all mechanical features and all electrical and mechanical disconnects.

M-5 — Command Module for Cabin Exterior Equipment

This mock-up will depict the exterior of the command module and all details that are relevant to configuration control. As such, it will be the official configuration control mock-up used for continual updating to the latest configuration and will only involve tests on the mock-up exterior.

Present objectives will be to establish the location and to determine the compatibility of all equipment, as well as to establish accessibility of equipment for maintenance. Future objectives will be to maintain configuration control of all installed and simulated equipment with evaluation of accessibility for maintenance.

The mock-up will be constructed of wood with the space between the pressure shell outer mold line and the heat shield structure inner mold line simulated along with all antennas and telescopes, reaction control system, windows and/or viewing ports, all mechanical and electrical disconnects, environmental control system, and the parachute storage area.

It will have a minimum amount of interior structure, as needed for support. Design of the exterior configuration includes all equipment and bays exterior to the interior command module mold line.

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M-7 — Complete Service Module Second Stage

This mock-up will reflect a complete configuration of the service module. It will depict propulsion components for display and design support necessary to integrate the subcontractor's propulsion system into the service module.

Present objectives are to evaluate space for personnel movement within the module, to provide for accessibility of component modules for inflight and ground maintenance, and to evaluate the interface design between the command module and service module. The future objectives will be to study and evaluate space requirements and the compatibility of the various systems and equipment.

The service module mock-up will be of sufficient strength to withstand handling and transportation at S&ID and comply with design objectives. The mock-up will have local exterior skin where required. A complete reaction control system, propulsion system, and environmental control system, with all major electrical and mechanical systems supplied with disconnects, will be simulated and installed.

M-8 — Command Module for Air Lock and Docking

This mock-up will reflect the air and docking system and associated mechanisms. The air lock will eventually include a working model prototype air lock mechanism. Docking mechanisms will be simulated to actually dock to a simulated docking mock-up, thereby displaying features of the docking mechanism sufficient to attach to a docking vehicle.

Present objectives are to study possible operating mechanisms, to make comparison studies of compatibility with various types of equipment and systems, to attain maneuverability requirements for system specifications, and to evaluate space required for the air lock and docking equipment. Future objectives will be to maintain the configuration on all assembled equipment, to evaluate characteristics involving maneuverability, to evaluate compatibility of various equipment and systems, and to evaluate physical sizes and space provisioning along with tests on all phases of docking.

The air lock chamber mock-up will be made of metal with the docking vehicle constructed in accordance with required design objectives. A partial mock-up of both a docking vehicle and the command module will be constructed with the exterior and interior of the command module in the immediate periphery of the air lock simulating equipment for maneuverability assessment. Only those portions necessary to meet design objectives will be

built, and these will be constructed in accordance with design objectives of the mechanical and electrical connections, mechanical and electrical systems, and the environment control system.

M-9 — Spacecraft for Handling and Transportation

This spacecraft handling and transportation mock-up will be a hard mock-up of the launch escape module, command module, service module and adapter, to be used by S&ID for evaluation studies involving size, weight, and cg of the Apollo spacecraft. The mock-up will also aid in the design of handling and transportation equipment for the launch escape module, command module, service module, and adapter.

The mock-up will have the capability of holding extra weights as required to make various weight and cg tests and the capability to sustain transportation load. The external configuration of the Apollo spacecraft, all hoisting and jacking provisions, and all other connections associated with handling and transportation will be simulated. Reaction control rockets in the command module and service module, all connection and separation points, and all external items, such as hatches, ports, and antenna, will be simulated if not available before completion schedule.

M-11 — Spacecraft for Handling and Transportation

This mock-up will be used in the same manner as Mock-Up 9, and is required to ensure that a mock-up of this nature will be present at S&ID for ground support evaluation in the event that Mock-Up 9 is being used for transportation feasibility studies. One handling and transportation mock-up is therefore assured of being at S&ID for ground support equipment studies.

M-12 — Partial Command Module for Crew Support Equipment

This mock-up will reflect only the minimum interior and exterior configuration required to demonstrate the restraint system and vibration mitigation system as they are developed on Simulators 1 and 2.

Design objectives will be to maintain current design information concerning crew support and restraint systems, current anthropometric requirements, the current restraint system, the shock and vibration mitigation system, and current requirements for crew protection.

The mock-up will consist of the floor of the command module, along with the complete crew support systems, equipment bays, and instrument panel in a configuration that will include simulated couches, shock and vibration mitigation systems, personal parachute system, restraint system, and support system.

M-16 — Partial Service Module Second Stage and Complete Adapter Interface

This mock-up will display a partial service module second stage and a complete adapter to ensure that the disconnect mechanisms have freedom of movement within the adapter. It will more nearly position equipment and structure within the adapter, which will be compatible with the service module.

The partial service module and complete adapter Mock-Up M-16 consists of the lower portion of the service module and a complete adapter used as an engineering tool for evaluation of interfaces between the service module and the adapter, and between the adapter and the booster. It will be used at NAA and will be subject to a development engineering inspection.

Evaluation will be made of mechanical and electrical compatibility of the service module to adapter to booster, with units attached to a booster, and physical size and space provisions for all installed equipment.

The design will consist of a lower portion of the service module second stage with all interface portions of metal, with sufficient external structure to maintain structural integrity and allowable tolerances, and a complete adapter, including both interfaces, with sufficient internal structure and exterior skin to maintain integrity and allowable tolerances when the service module and the adapter are mated to a booster. Simulation will be used on all mechanical and electrical disconnects (including pyrotechnics) and all exterior mechanical features (to show possible obstructions when mating).

M-17 — Partial Service Module Second Stage and Partial Adapter - Interface

This mock-up will replace Mock-Up 4 in that it will reflect the latest configuration of the service module and adapter interface. Due to design improvement changes incurred between Mock-Up 4 and Mock-Up 17, and because Mock-Up 4 is a hard mock-up, it would not be feasible to rework any design-induced changes on Mock-Up 4. Therefore, Mock-Up 17 will reflect the current interface configuration between the service module and the adapter in its latest configuration, prior to release of prototype hardware.

The service module and adapter interface mock-up consists of a lower section of the service module and an upper section of the adapter.

The objectives of this mock-up will include evaluation of mechanical and electrical mating characteristics and compatibility between components and the physical size and space provisions for all installed equipment. Only metallic portions of the service module and adapter which mate will be built with sufficient external structure to maintain integrity while meeting the mock-up design objectives of the mechanical features and all the electrical and mechanical disconnects.

M-18 — Spacecraft Complete

This mock-up will reflect, as closely as possible, a complete configuration of the spacecraft which will include the launch escape system, command module, service module, and adapter. Information which has been compiled from all mock-ups prior to completion of Mock-Up 18 will be included on this mock-up.

The mock-ups will be simulations of the complete spacecraft vehicle consisting of the launch escape system, command module, service module, and adapter. Mock-up 18 will remain at S&ID for future studies and DEI use.

The mock-ups will be made as complete as possible including all systems and incorporating all changes and refinements obtained from data compiled from previously built mock-ups.

M-19 — Spacecraft Complete

This mock-up will be an exact duplicate of Mock-Up 18, and will be delivered to MSC approximately 15 February 1963. The purpose of this mock-up is to display the same systems as are included on Mock-Up 18 to the MSC personnel in Houston.

M-20 — Command Module and Launch Escape System for Antenna Radiation Pattern Test

This mock-up is to determine the antenna radiation pattern as well as optimum positioning of the antenna on the exterior of the mock-up. This mock-up will be built by S&ID and transported to an outside subcontractor for radiation pattern studies to ascertain the optimum location of the antenna.

The full-scale antenna radiation pattern mock-up will be a semi-hard mock-up of the command module and the launch escape system and will be used by S&ID to determine full-scale antenna patterns, and to evaluate impedance interaction effects between antennas. It will be transported to a subcontractor's facility when fabrication is complete.

The exteriors of the command module and the launch escape system will be constructed full-scale with all external components and protrusions. The ablative material exterior of the pressure shell outer mold line will be simulated to maintain electrical properties of the prototype. The pressure shell will be constructed of aluminum, while hatches and doors, windows and ports, parachute storage area and antenna, reaction control rockets,

telescope, periscope, snorkels, and a complete antenna system will be simulated until actual hardware is available.

BOILERPLATES

Nineteen boilerplates are planned to provide early system confirmation, system overall evaluation, qualification of spacecraft design, structural and systems compatibility, and earth-orbital operations.

B-1 and B-2 — Command Module for Land and Water Impact Test

The mission of B-1 and B-2 (Figure 82) will be the early confirmation of the earth impact attenuation system and crew shock absorption system.

Test objectives of this mission will be to evaluate the earth impact attenuation system, the crew shock absorption system, and the vertical and transverse acceleration loads during both land and water impact. Verification of the maximum emergency limit g forces, flotation stability, and the evaluation of time limit and directional g forces on anthropomorphic dummies will be carried out. The configuration will be the command module only, equipped with earth impact attenuation system, crew shock absorption system, anthropomorphic dummies, and a simulated heat shield with no ablative material. Onboard instrumentation to external recorders by direct wire will also be used along with high-speed cameras.

There is a probability that 20 drops on each boilerplate will be conducted at El Centro and at an undetermined ocean site. In at least one test each on land and water, the command module must impact under the following conditions:

1. Impact angle of minus 15 degrees

2. Crew positioned feet first

3. Equivalent vertical velocity of 30 feet per second at impact in combination with up to 50 feet per second horizontal velocity

B-3 — Command Module for Parachute Recovery

The mission of B-3 (Figure 83) will be the early confirmation of the parachute recovery system using a C-133 airplane for 34 drops on land and water, utilizing B-3, B-5, and B-19.

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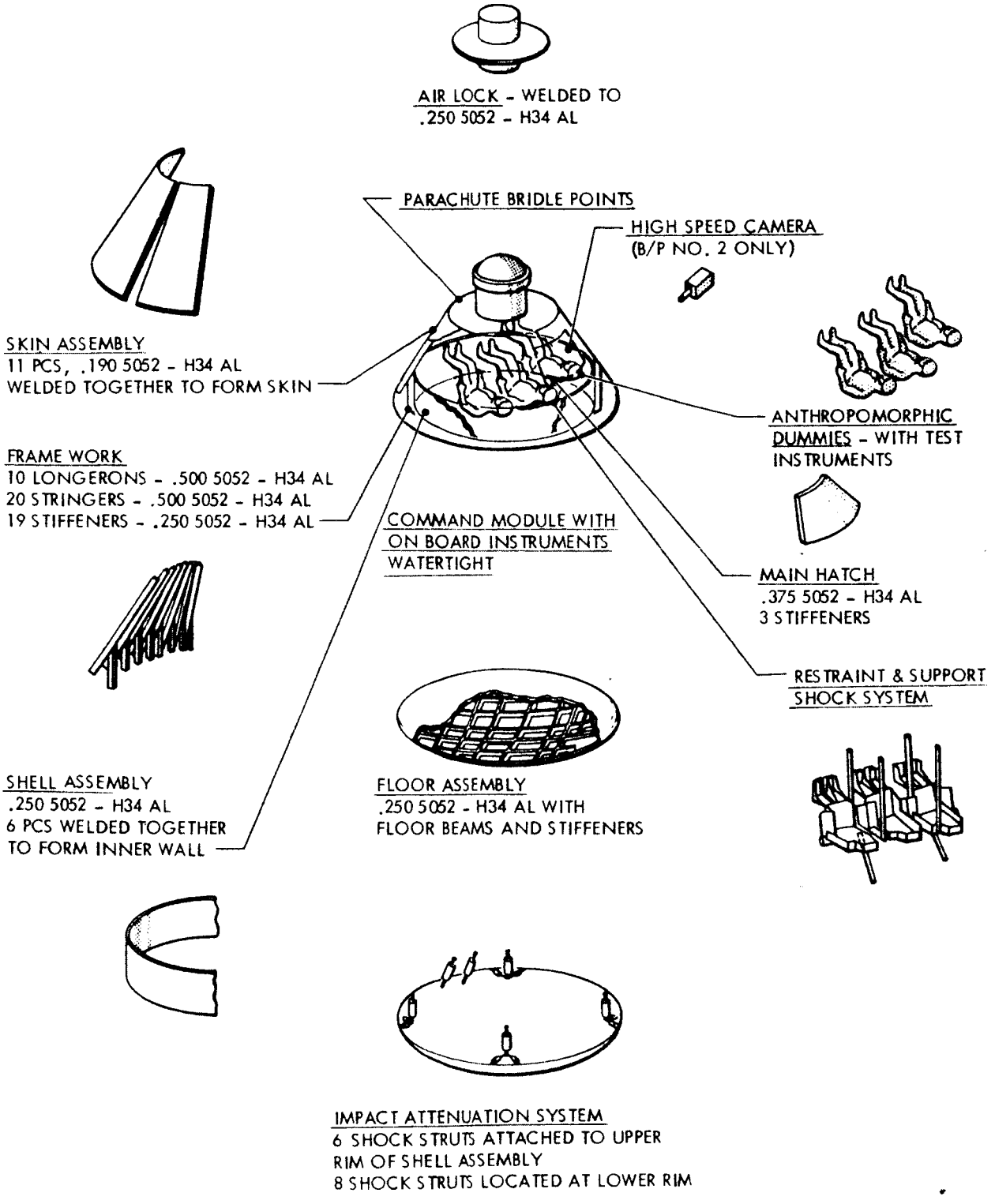

Figure 82. B-1 and B-2 Command Module for Land and Water Impact Test

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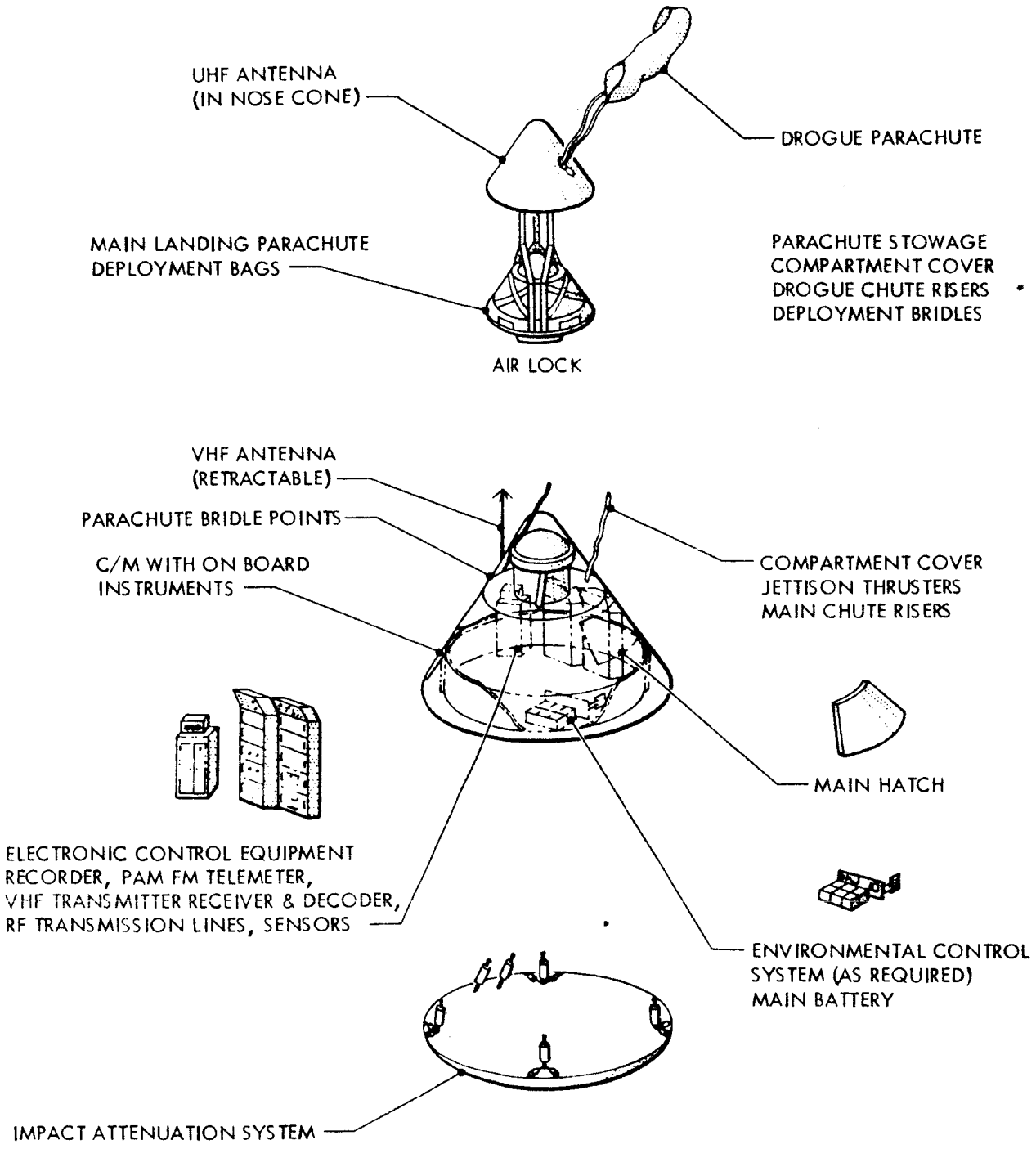

Figure 83. B-3 Command Module for Parachute Recovery

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The boilerplate will consist of a command module only, equipped with a drogue parachute, landing parachute, and an earth impact attenuation system. The sequence control subsystems, battery power system, instrumentation, radio command, and onboard recorders also will be used. Partial telecommunications and recovery systems will be required on the final pre-qualification drop only. Anthropomorphic dummies and a crew shock absorption system will be employed to evaluate recovery aids.

B-5 — Command Module with Parachute Recovery and Partial Recovery Aid Systems

The mission will provide early confirmation of the parachute recovery system and partial recovery aids using a C-133 airplane for drops over land and water. A total of 34 drops will be made using B-5, B-3, and B-19.

The boilerplate will consist of a command module only, equipped with a drogue parachute, landing parachute, earth impact attenuation system, and partial recovery aids. The sequence control subsystems, battery power system, instrumentation, radio command, and onboard receivers will also be used. Partial telecommunications and recovery systems will be required on the final pre-qualification drop only. Anthropomorphic dummies and a crew shock absorption system will be employed to evaluate recovery aids. B-5 is illustrated in Figure 84.

B-6 — Command Module and Launch Escape System for Pad Abort

The mission and test objectives of B-6 (Figure 85) will be evaluation of the launch escape propulsion system, launch escape tower jettison release mechanism, recovery system, and verification of structural integrity of the launch escape tower.

The configuration of this boilerplate will include a command module, ground adapter, launch escape tower, launch escape motor with thrust vector control, and a jettison motor. The onboard systems will include a battery power system, R & D telemetry system, instrumentation, abort system sequencer, and a stability and control system for thrust vector control of the launch escape motor only. Recovery parachute, drogue chute, mortar, sequencer, and provisions for impact attenuation system will also be required.

B-8 — Command Module for Water Egress, Flotation, Recovery Aids, and Logistics Equipment

The objective of B-8 (Figure 86) will be qualification of spacecraft design for water stability and flotation requirements, and evaluation of the

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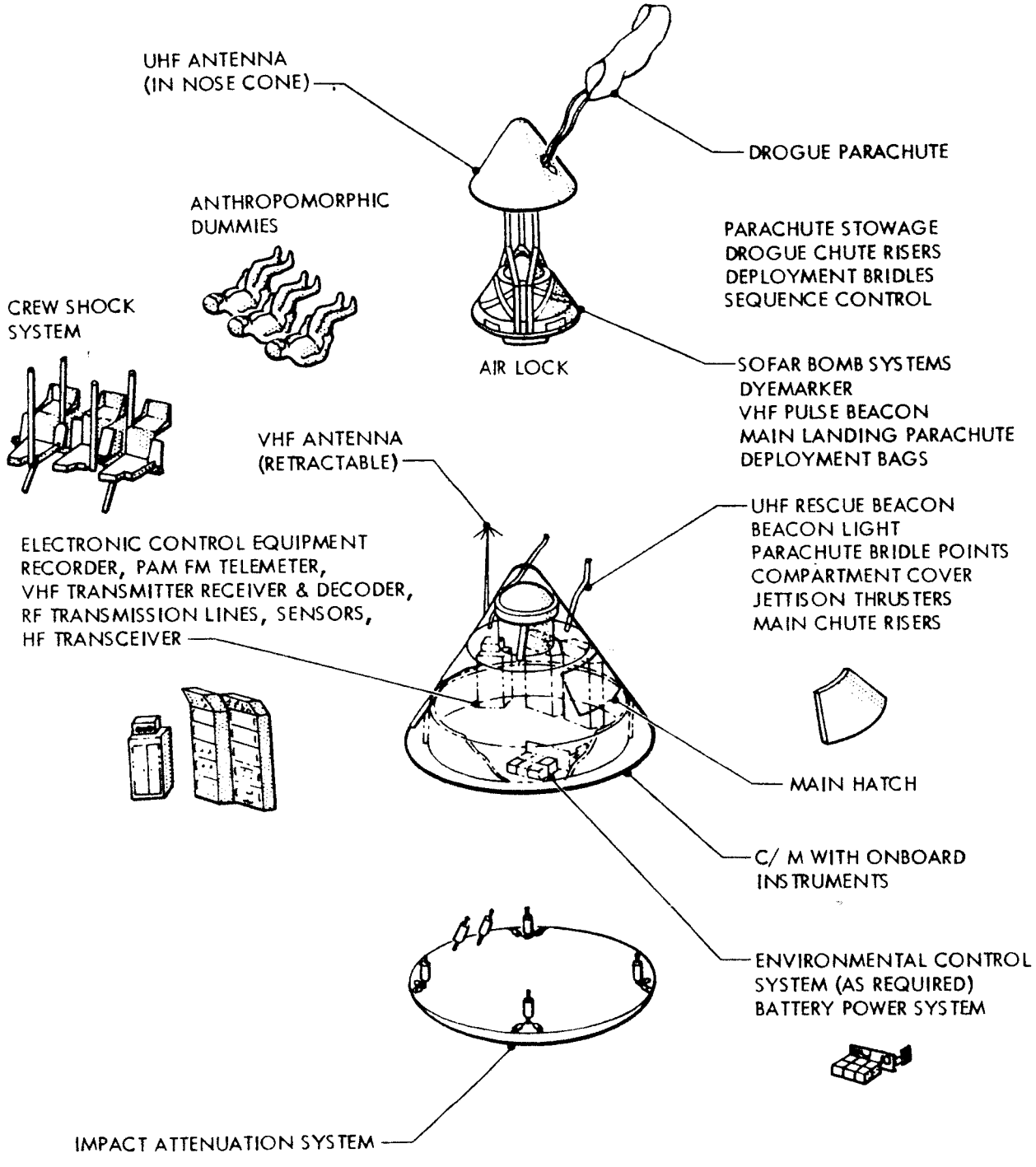

Figure 84. B-5 Command Module with Parachute Recovery and Partial Recovery AID Systems

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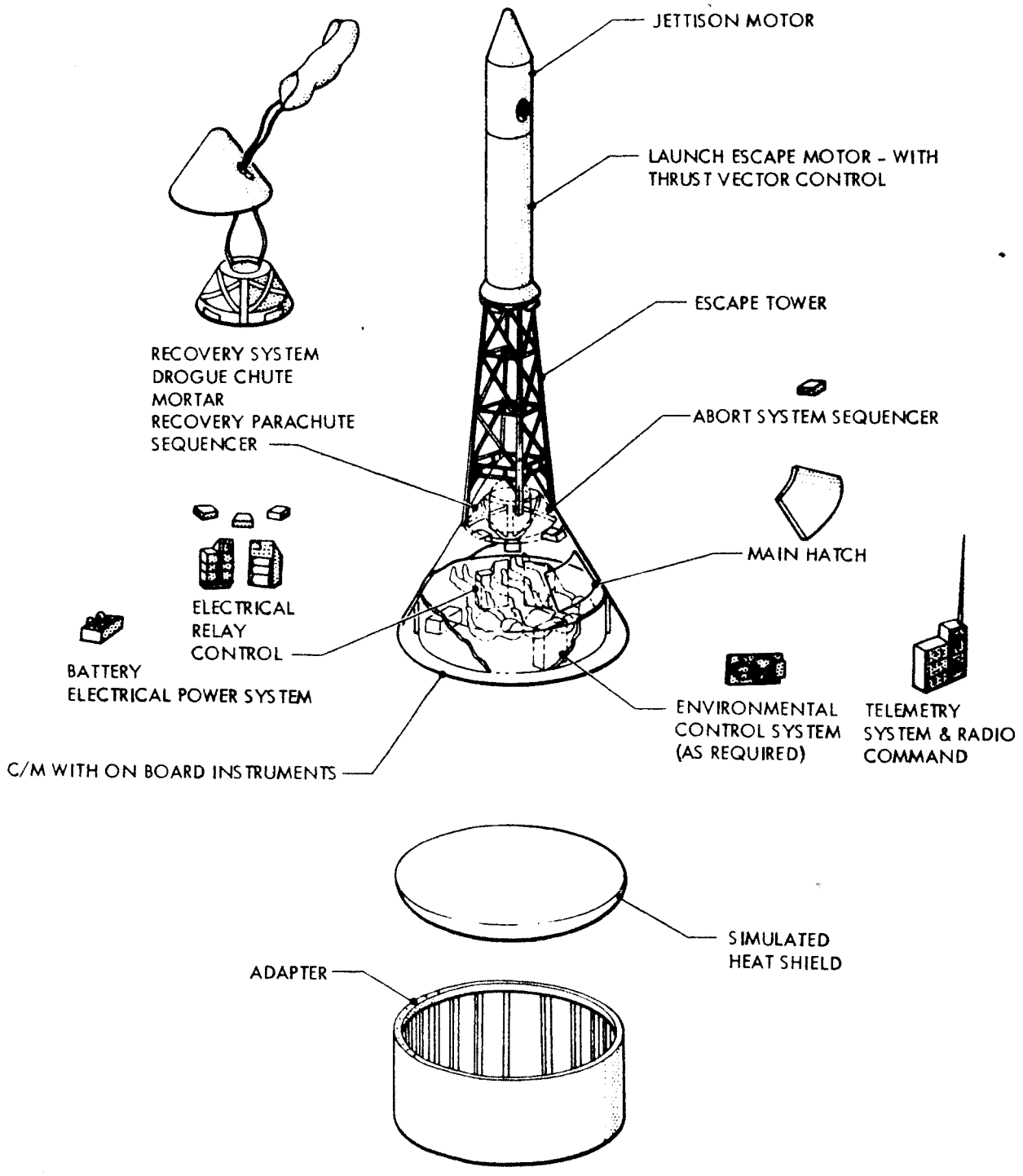

Figure 85. B-6 Command Module and Launch Escape System for Pad Abort

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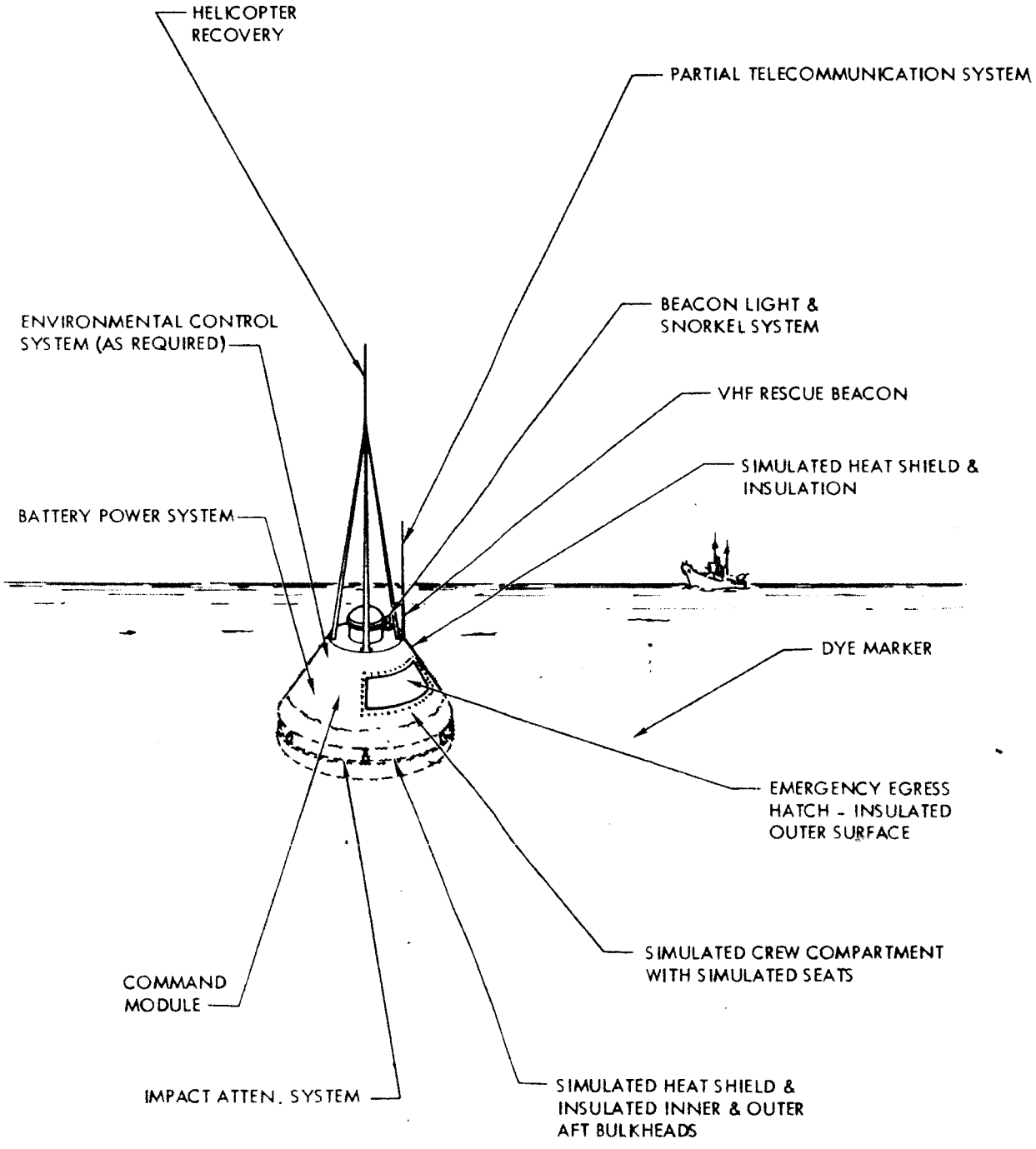

Figure 86. B-8 Command Module for Water Egress, Flotation, Recovery AIDS, and Logistics Equipment

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crew egress and recovery aids system. Equipment handling capability for the command module at a simulated recovery site (land and water) will be demonstrated as a design aid for pickup, handling, and transporting equipment and techniques.

The test will evaluate the spacecraft's ability to recover from any initial attitude and float, with egress hatch clear of the water to check its seakeeping capabilities. A failure here would show need of auxiliary flotation devices. Helicopters will be used to qualify and develop adequate handling aids and procedures for land and water recovery.

The configuration requirements will be for a watertight command module with the same buoyancy as the spacecraft command module, equipped with egress hatches, simulated heat shield, and bulkhead insulation. Personnel with space suits will be used; therefore, a simulated crew compartment will be required. Additional systems requirements will include a snorkel system, battery power system, rescue system, and a partial telecommunications system.

Actual ocean testing will be required; therefore, United States naval support will be necessary. S&ID will loan the command module to the Navy for these tests. Land tests will probably be held at Edwards AFB using Navy helicopter support.

B-9 — Spacecraft for Dynamic Test

B-9 (Figure 87) will consist of a boilerplate command module, service module, spacecraft adapter, and escape tower for incorporation of dynamic tests to be performed at MSFC with a launch vehicle. This boilerplate will be used for the determination of dynamic structural compatibility with a launch vehicle. The configurational requirements will be as follows:

Command module - structure same as B-13

Service module - structure same as B-13

Spacecraft adapter service module to C-1 - structure same B-13

Launch escape jettison motors (simulated) - structure same as B-13

Escape tower - prototype structure same as B-13

B-12 — Command Module and LES for Max q LES Verification

The objective of B-12 (Figure 88) will be the evaluation of the launch escape system at maximum dynamic pressure (max q). This will include

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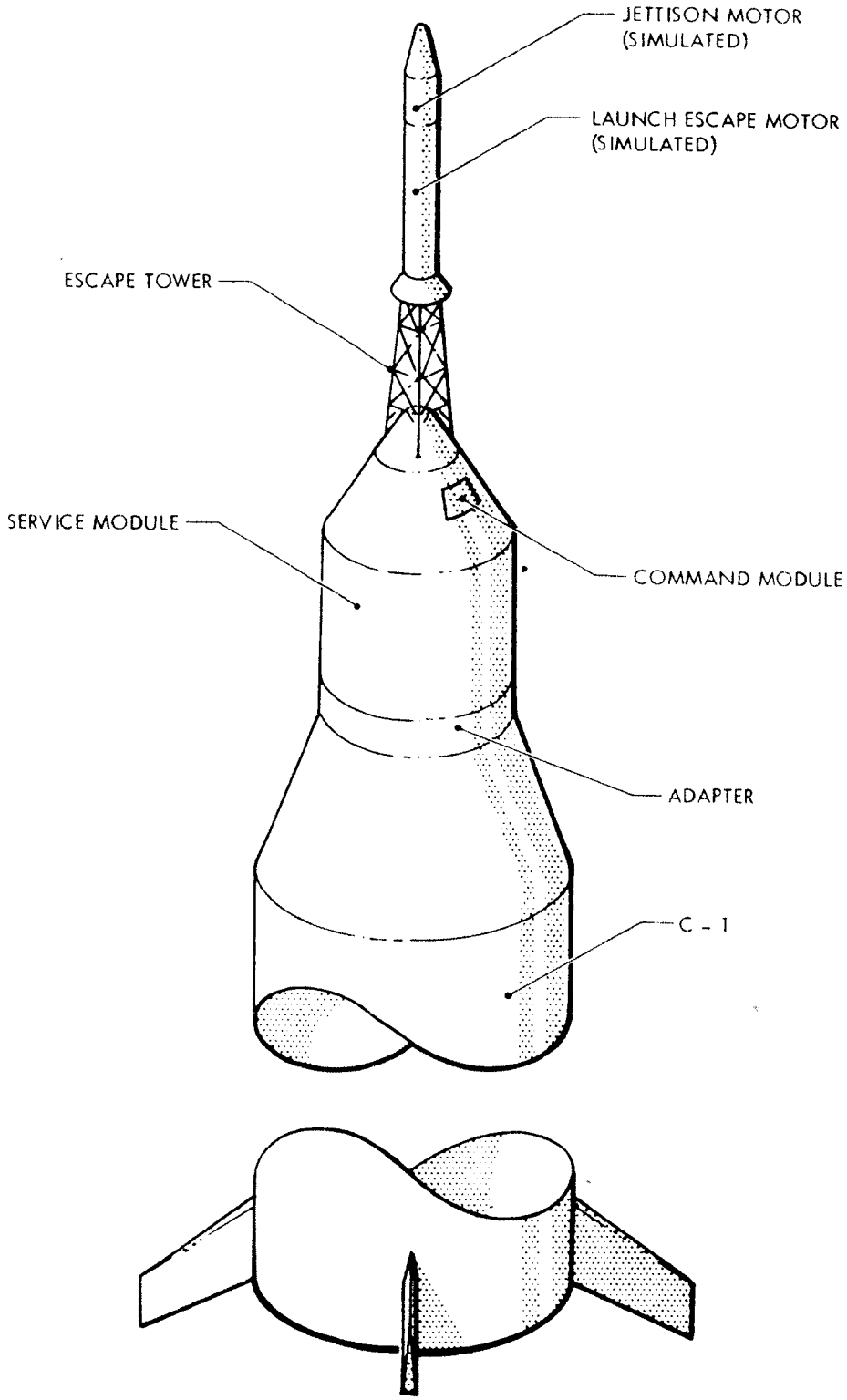

Figure 87. B-9 Spacecraft for Dynamic Test

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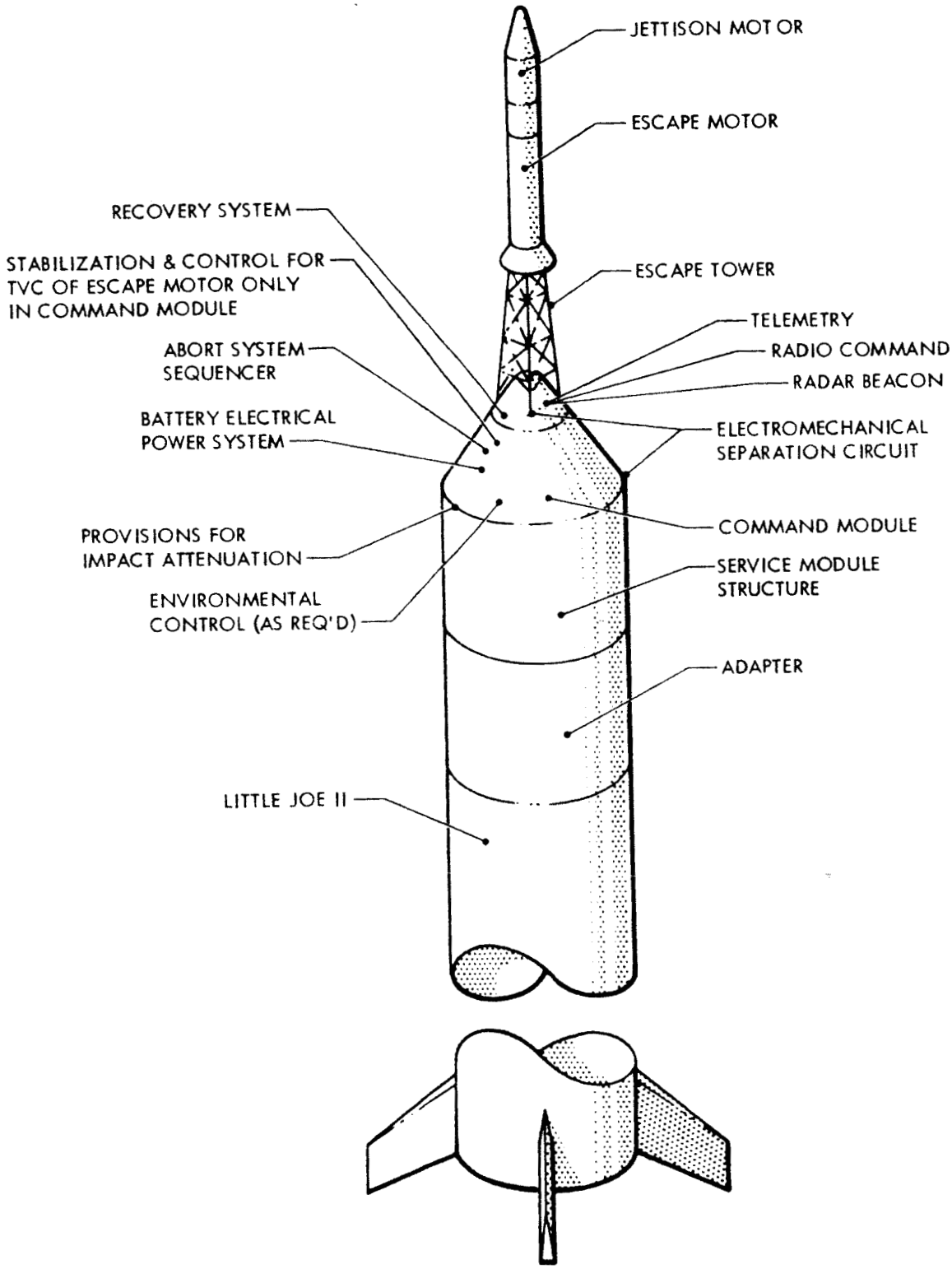

Figure 88. B-12 Command Module and LES for Max "Q" LES Verification

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evaluation of stability margins, structural integrity of the launch escape tower, launch escape motor characteristics at max q, and the recovery system.

The configuration will include a command module, escape tower, and adapter. The launch escape tower will be equipped with a launch escape motor and a jettison motor. A Little Joe II booster will be used to launch the boilerplate. Systems needed include battery power, R & D telemetry, environmental control, recovery system, and stabilization and on control for launch escape motor.

B-13 — First Orbital Spacecraft for Booster Compatibility

This test vehicle (Figure 89) is the first orbital spacecraft consisting of a boilerplate command module, service module, spacecraft adapter, and escape tower.

The prime object of this flight will be to demonstrate compatibility of spacecraft and booster. Additional objectives will include evaluation of structures under flight loads, and the R & D instrumentation system, including telemetry, tracking, and radio command.

The vehicle will consist of a command module, service module, and escape tower equipped with launch escape and jettison motors. The service module will be attached to the C-1 booster with a spacecraft adapter. Battery power, R & D telemetry, and radio command systems will be needed, along with instrumentation and stabilization and control for the launch escape system.

B-14 — House Spacecraft No. 1

B-14 (Figure 90) will become House Spacecraft 1, a test platform for mounting primary systems to evaluate systems compatibility. It will be used mainly as a tool in development of systems, and in a preliminary check in integrated systems compatibility. House Spacecraft No. 1 will also be used to establish operational procedures and evaluate GSE design and operation.

The basic configuration will include a command module, service module, and a service module to C-1 adapter. These will be skeletal structures for mounting systems in their proper geometry with removable skin on the outer structure. These modules will be equipped with complete systems with the exception of live rocket motors.

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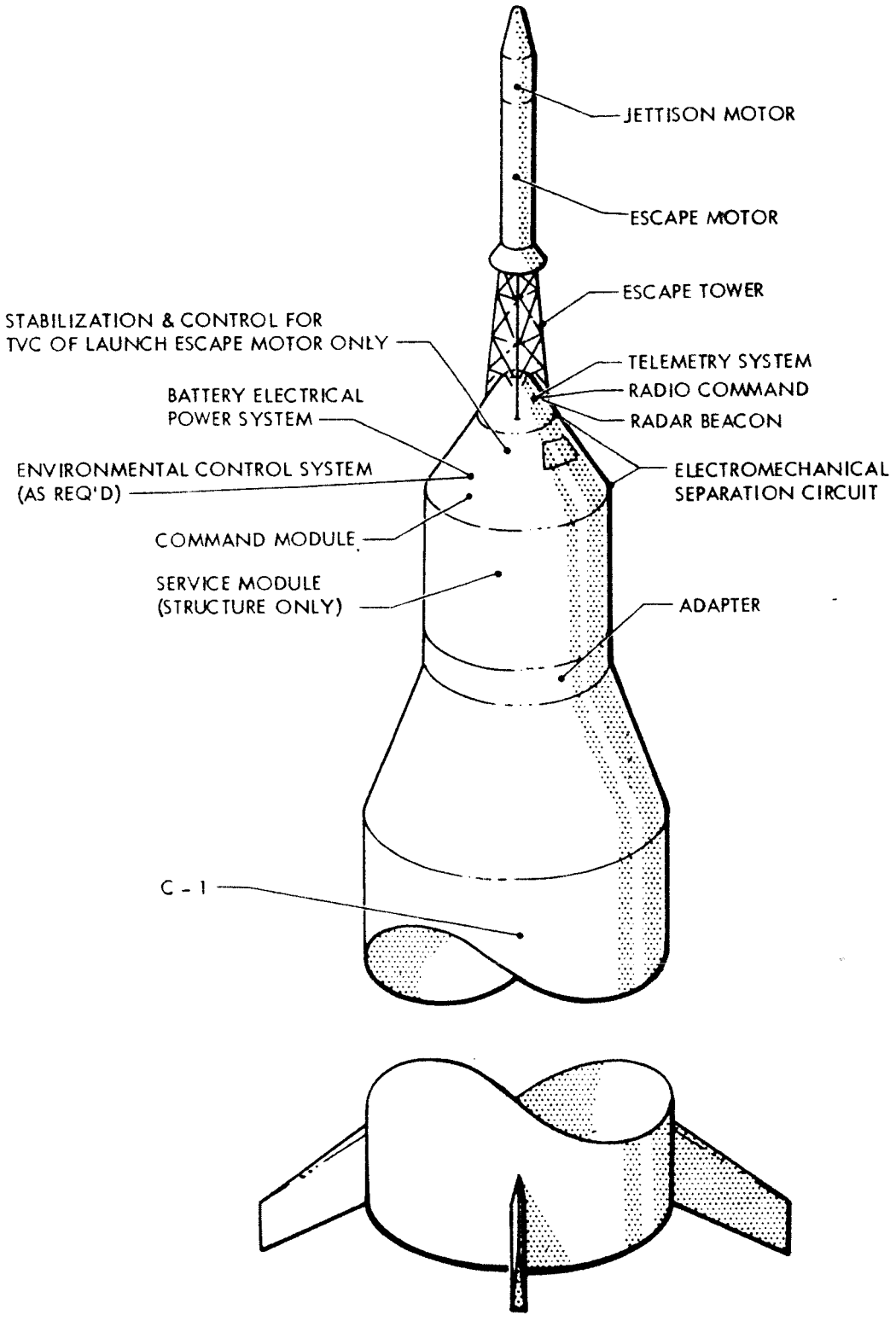

Figure 89. B-13 First Orbital Spacecraft for Booster Compatibility

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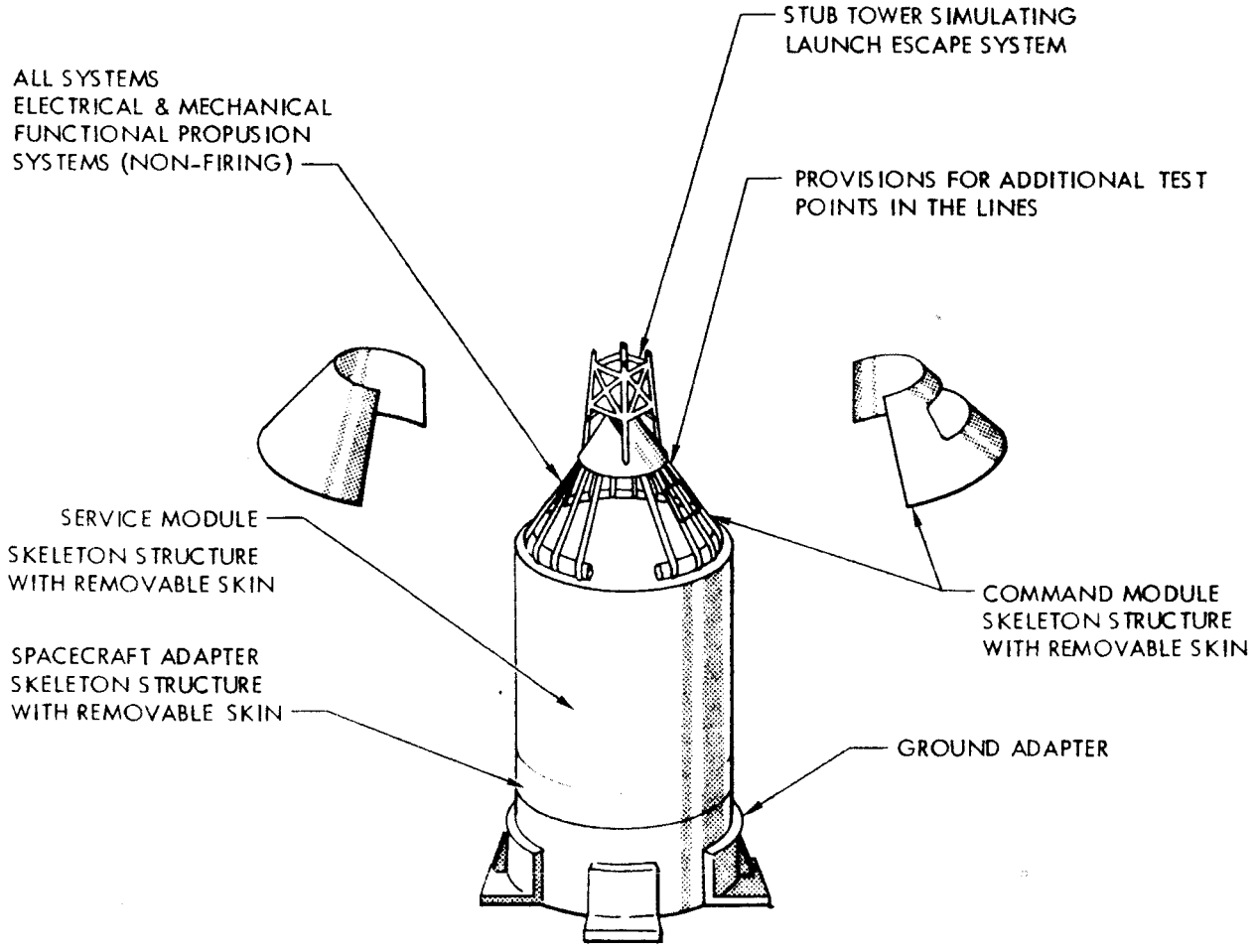

Figure 90. B-14 House Spacecraft No. 1

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B-15 — Second Orbital Spacecraft for Booster Compatibility

B-15 (Figure 91) is the second orbital spacecraft consisting of a boilerplate command module, service module, spacecraft adapter, and launch tower. The primary objective of this flight will be to demonstrate the compatibility of the spacecraft and booster by orbiting the command and service module. Data will be gained for evaluation of the structure under flight loads and qualification of the telemetry, tracking, and radio command portion of the R & D instrumentation system.

During this flight, the vehicle will use an activated launch escape system with live launch escape and jettison motors. Carried aboard will be a battery power system, R & D telemetry system, radio command, radar beacon, and all necessary instrumentation for temperature control and other requirements that may arise.

B-16 and B-18 — Orbital Spacecraft for Systems Design Verification

These test vehicles (Figures 92 and 93) will be the third and fourth orbital nonrecoverable spacecrafts consisting of a boilerplate launch escape system, command module, and adapter. They will be used in an orbital demonstration test of the subsystems, booster compatibility, the telecommunication system and range, and the launch escape jettison motor.

A C-1 booster will be used to inject the command module into orbit. The service module will accommodate the fuel cell, which will be on board for checkout, but will not supply flight power loads. R & D electrical power will be provided as the main power source.

B-19 — Command Module for Parachute Recovery

This boilerplate (Figure 94) will be used with B-3 and B-5 in prequalification flight drops to evaluate the parachute recovery system.

The command module will be of boilerplate construction, equipped with an earth impact attenuation system and both drogue and landing parachutes. Active use of parachutes requires that both the parachute storage door and release mechanism be built into the boilerplate. Other necessary systems required on-board will include battery power, radio command as back-up, sequence control, and on-board recorders.

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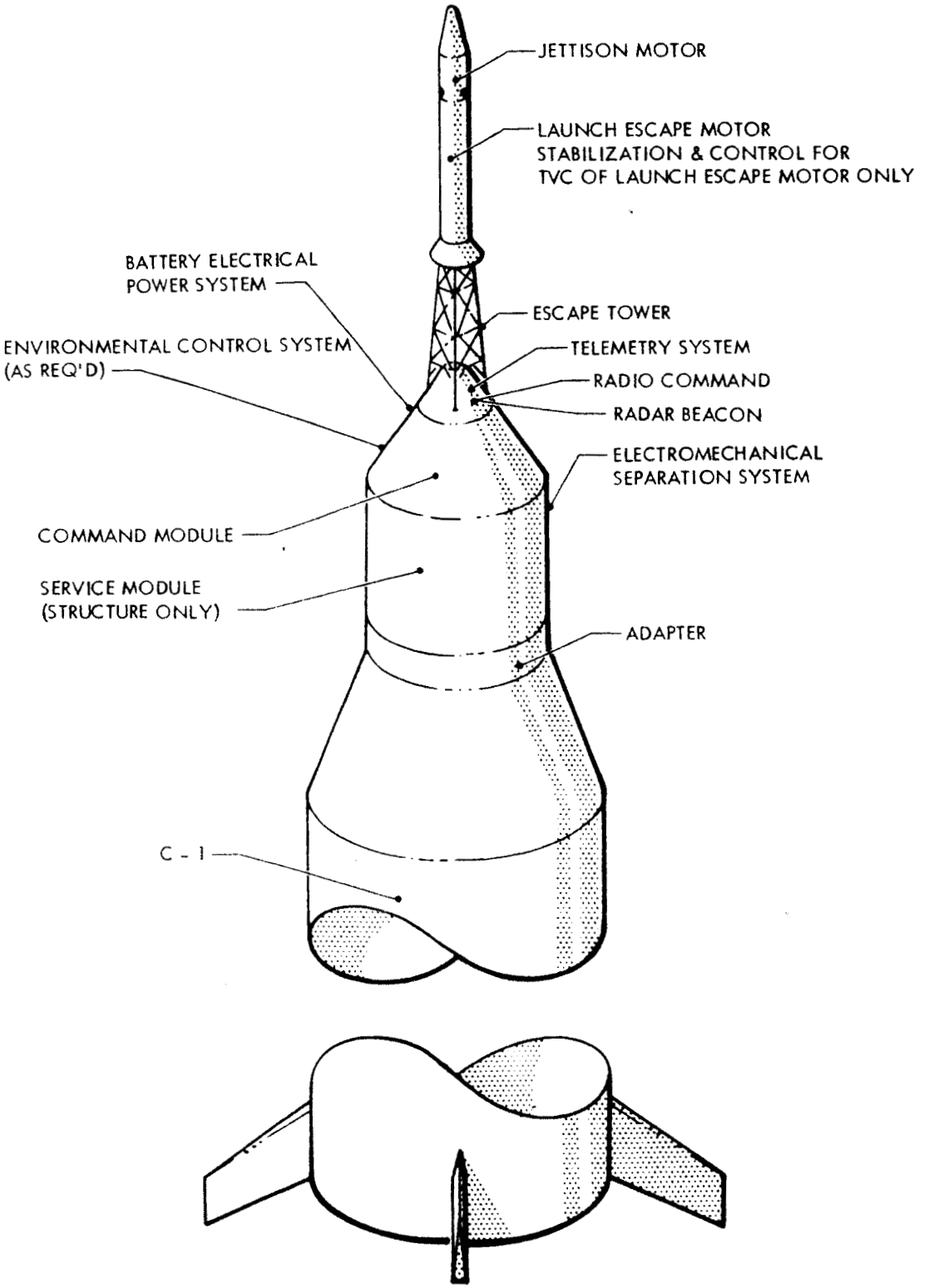

Figure 91. B-15 Second Orbital Spacecraft for Booster Compatibility

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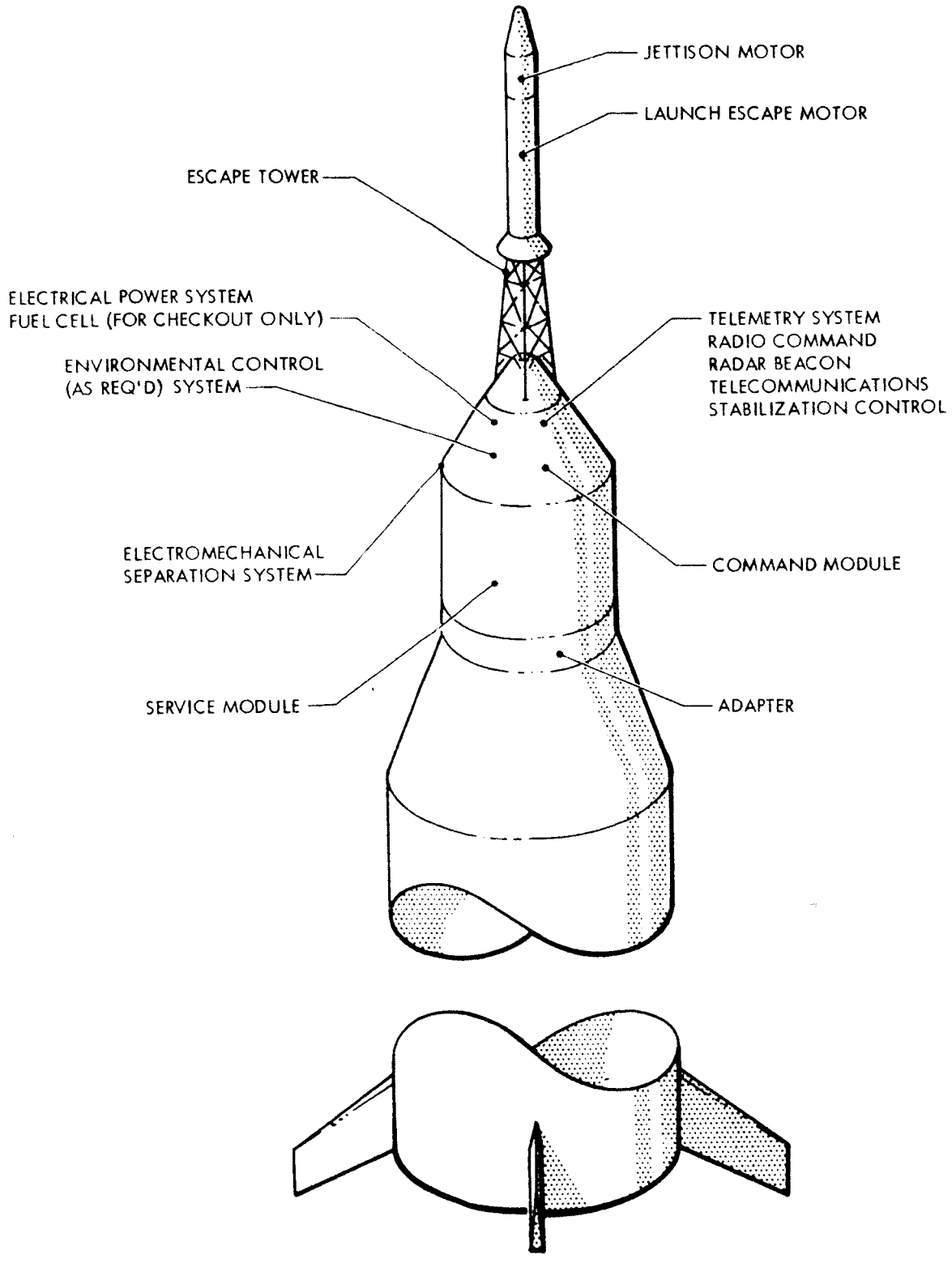

Figure 92. B-16 Third Orbital Spacecraft for Systems Design Verification

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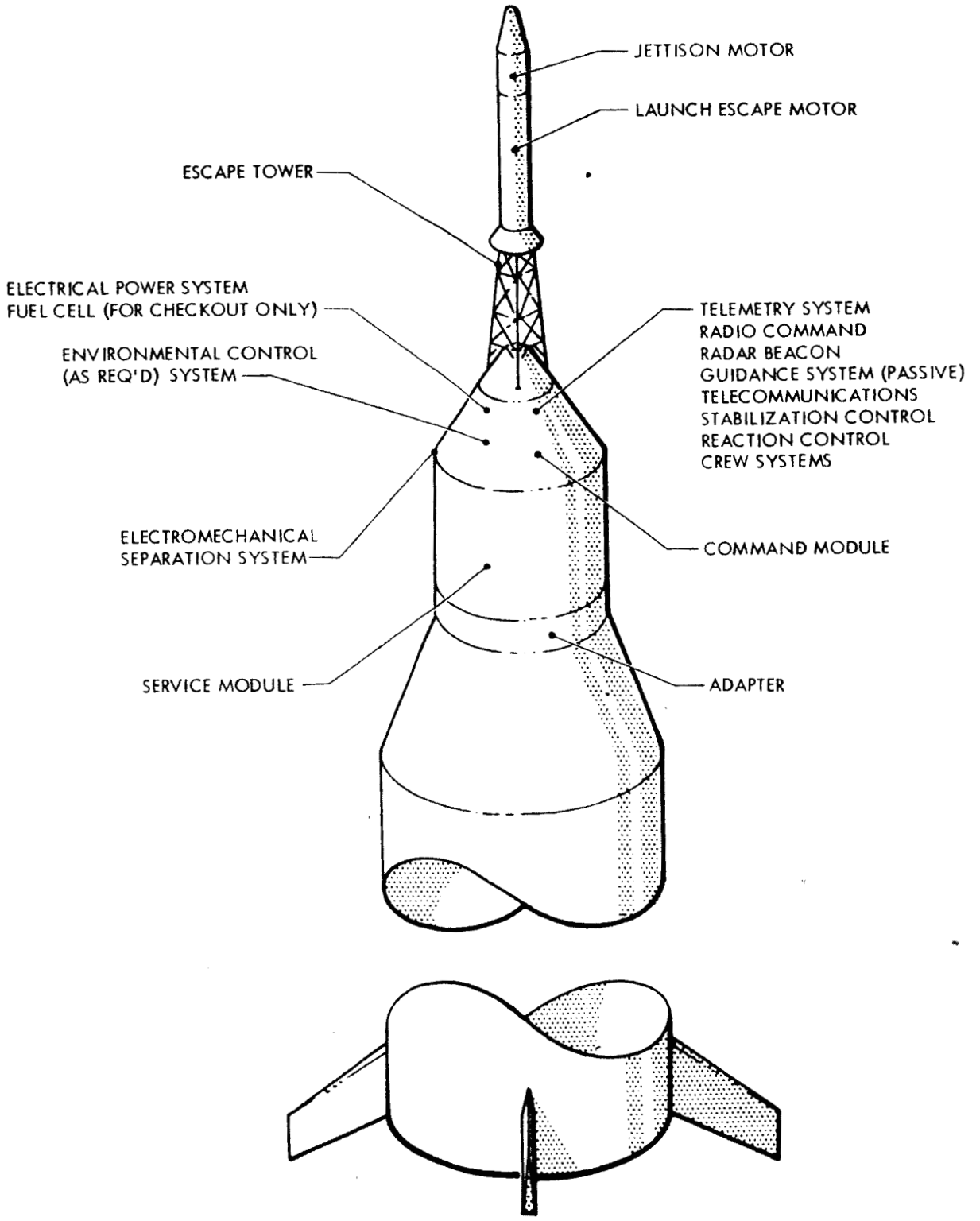

Figure 93. B-18 Fourth Orbital Spacecraft for Systems Design Verification

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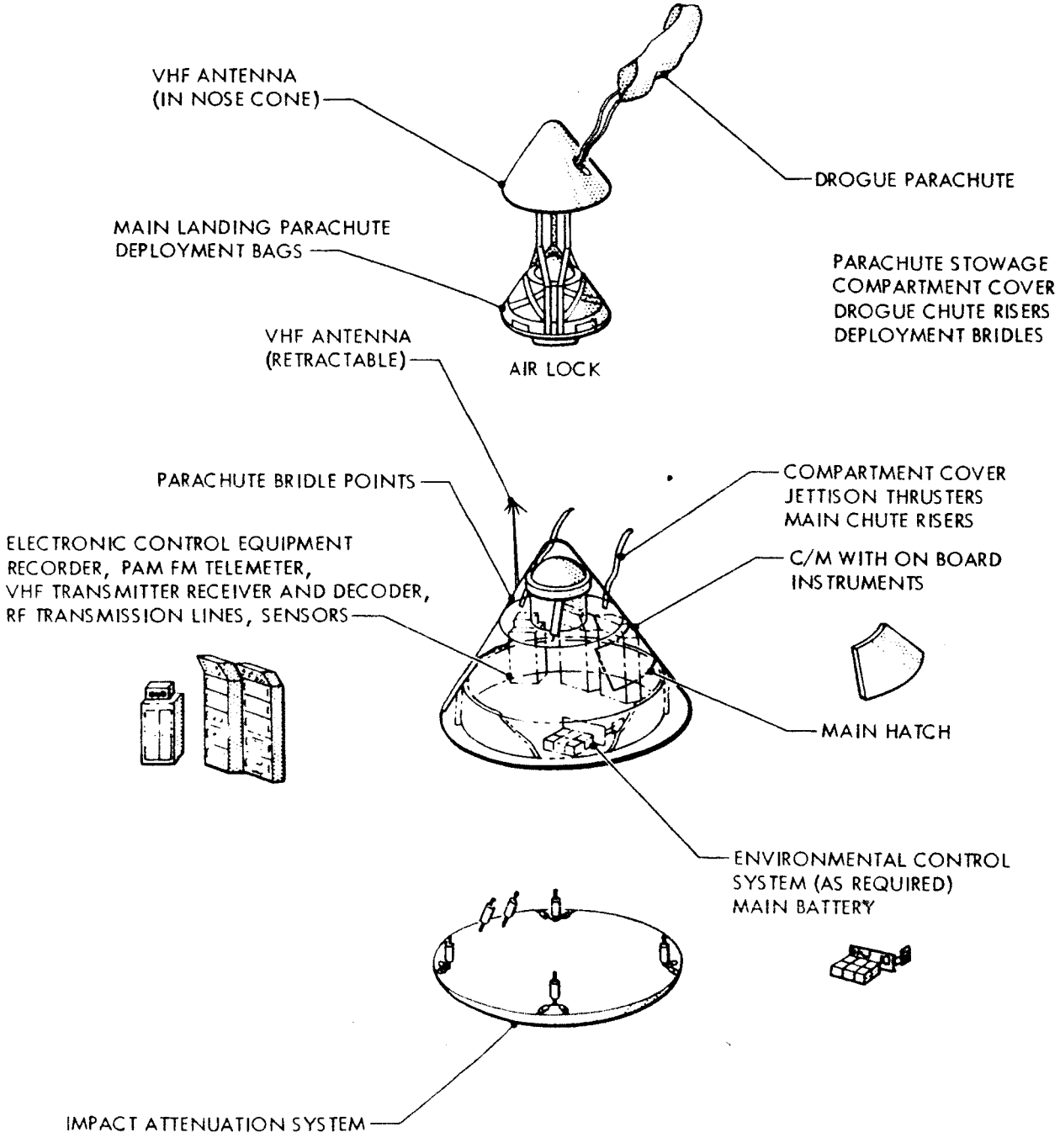

Figure 94. B-19 Command Module for Parachute Recovery

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A maximum of 15 air drops from a C-133 airplane will be conducted at a high altitude over El Centro, California.

B-20 — Command Module and LES for Pad Abort

Boilerplate 20 (Figure 95) consists of a command module and prototype launch escape tower with thrust vector control, release mechanism, and jettison and launch escape motor for pad abort qualification of the launch escape system. Evaluations will be made also on the crew shock absorption system, structural integrity of the launch escape tower, jettison dynamics, stability margins, and jet effects on the command module.

The command module will carry a battery power system, electromechanical separation, R & D telemetry, command radio, recovery system, and crew shock absorption system complete with anthropomorphic dummies.

Checkout and handling GSE will be provided at the test site, located either at Edwards AFB, California, or White Sands Missile Range, New Mexico.

B-21 — Command Module and LES for Max q LES Verification

B-21 (Figure 96) will consist of a command module equipped with a launch escape tower and the necessary motors, controls, and separators. It will be launched by a Little Joe II booster to evaluate and qualify the launch escape system at max q.

Studies will be conducted to determine jet effects on the command module and to evaluate stability margins, control systems, closed-loop dynamic stability, structural integrity, recovery system, and crew shock absorption systems.

The command module will carry the necessary battery power, telemetry and instrumentation, radio, and radar required to complete the mission. A spacecraft recovery system including impact attenuation and a crew shock absorption system complete with anthropomorphic dummies will be included.

B-23 — Command Module and LES

B-23 (Figure 97) will be used for backup to B-21 in case of a failure, and will consist of a command module, a launch escape tower, and the necessary motors, controls, and separators.

The command module will carry the necessary battery power, telemetry and instrumentation, radio, and radar required to complete the

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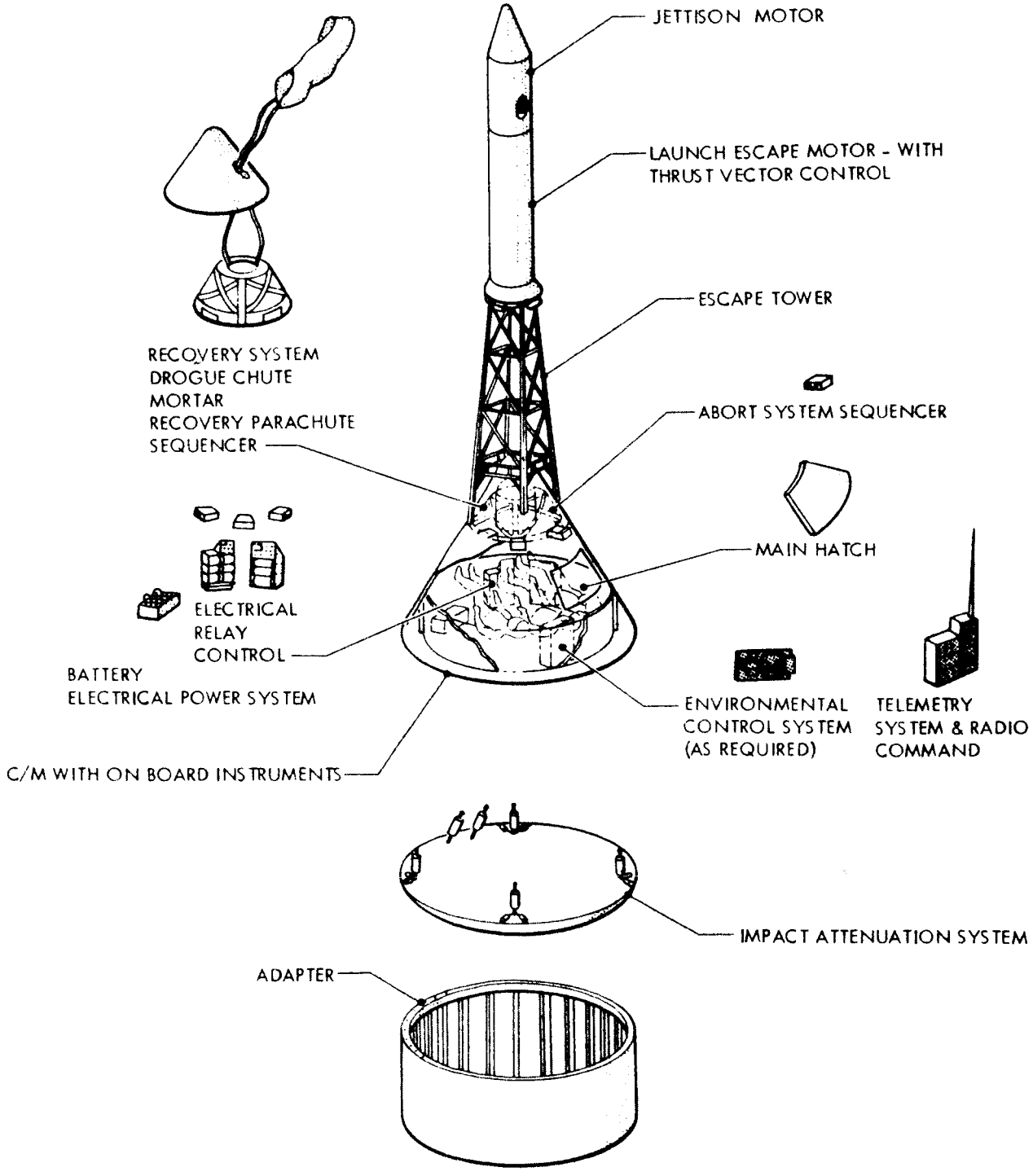

Figure 95. B-20 Command Module and LES for Pad Abort

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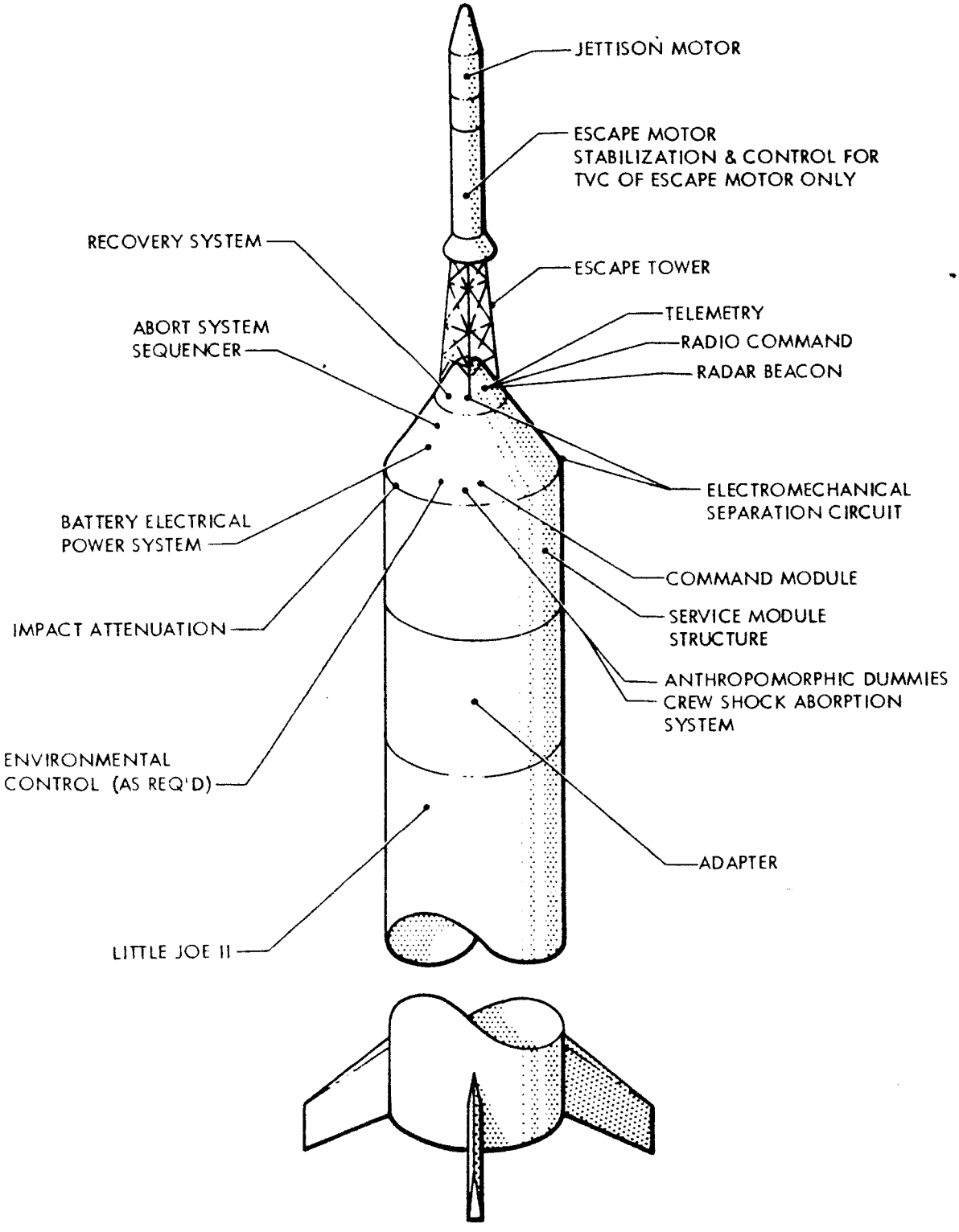

Figure 96. B-21 Command Module and LES for Max "Q" LES Verification

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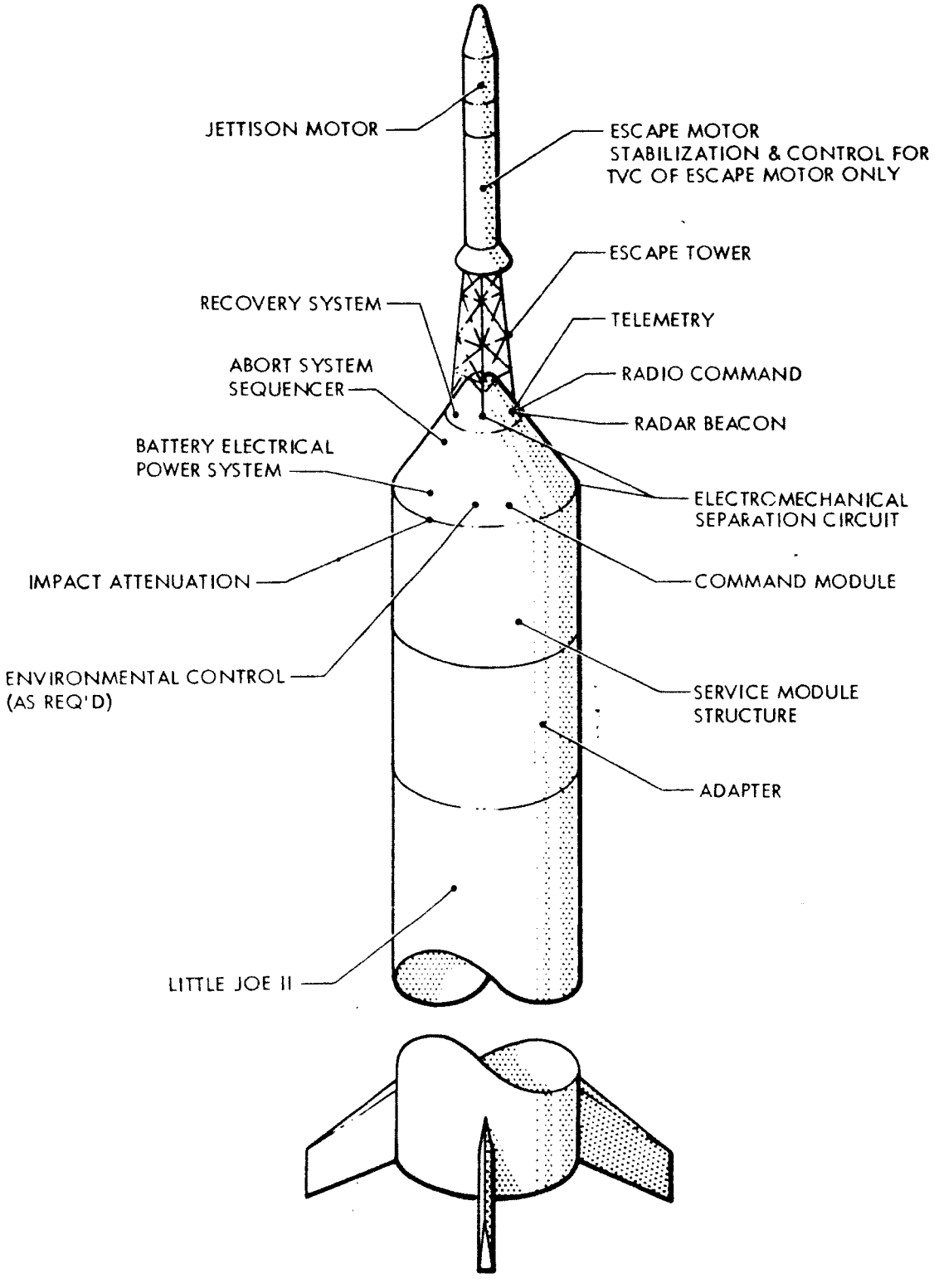

Figure 97. B-23 Command Module and LES

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mission. A spacecraft recovery system including impact attenuation and a crew shock absorption system, complete with anthropomorphic dummies, will be included.

B-22 — Command Module and LES for High-Altitude LES Verification

B-22 (Figure 98) will include a command module, launch escape tower, to be fired with a Little Joe II booster for a high-altitude atmosphere abort to demonstrate structural integrity of the command module and evaluate the recovery system.

The necessary motors and electromechanical circuits will be needed for complete separation of the tower and command module. The command module will carry R & D electrical power, telemetry system, radio, and radar, plus instrumentation as required. In order that the vehicle may be recovered at impact, attenuation system and recovery aids will be included.

B-25 — Command Module for Water Recovery Procedures and Handling Equipment

B-25 will be used as the flotation and logistics test article. It will be made of metal, watertight, and the same shape and size as the command module used on B-8. It will have all external handling devices and have the capability of ballasting to full command module weight and center of gravity. It will be delivered to NASA for developing adequate handling aids, procedures, and training in water recovery of command modules.

SPACECRAFT

AFRM 001 — Spacecraft for Propulsion System Qualification

AFRM 001 (Figure 99) will have as its objective verification and evaluation of the propulsion systems operations for normal and emergency flights under sea level and altitude conditions. The propulsion tests will be the prime objective of the vehicle; however, environmental data on vibration, acoustics and base heating, verification of the launch escape motor system, and reaction controls systems performance and compatibility will be gained. The spacecraft configuration will include a command module, service module, a spacecraft adapter, ground adapter and separation system, and it will be equipped with all the systems and instrumentation required to conduct the propulsion tests. AFRM 001 will be used at a propulsion development test site for sea level qualification testing and at AEDC, Tullahoma, Tennessee, for altitude qualification testing.

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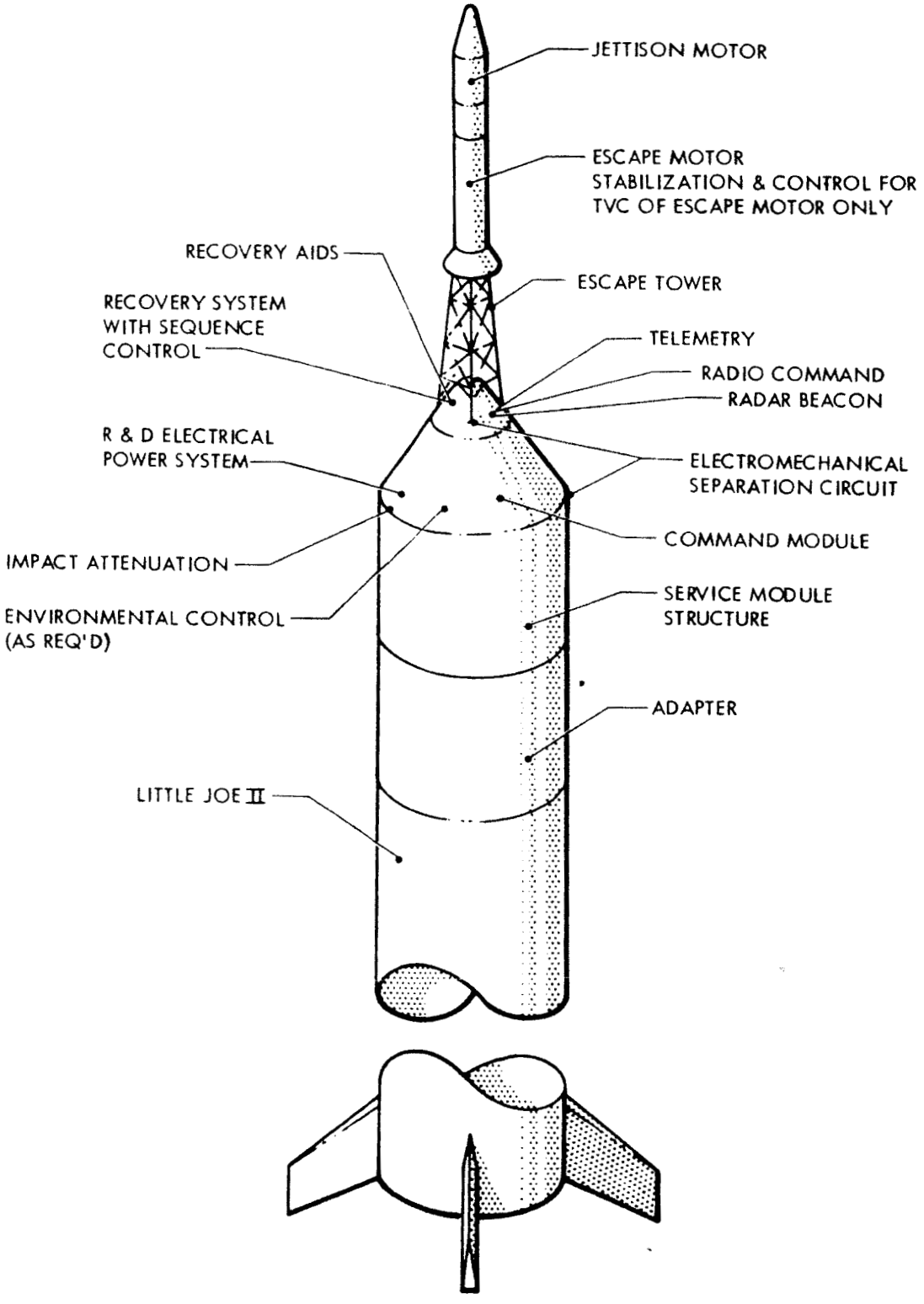

Figure 98. B-22 Command Module and LES for Hi-Alt LES Verification

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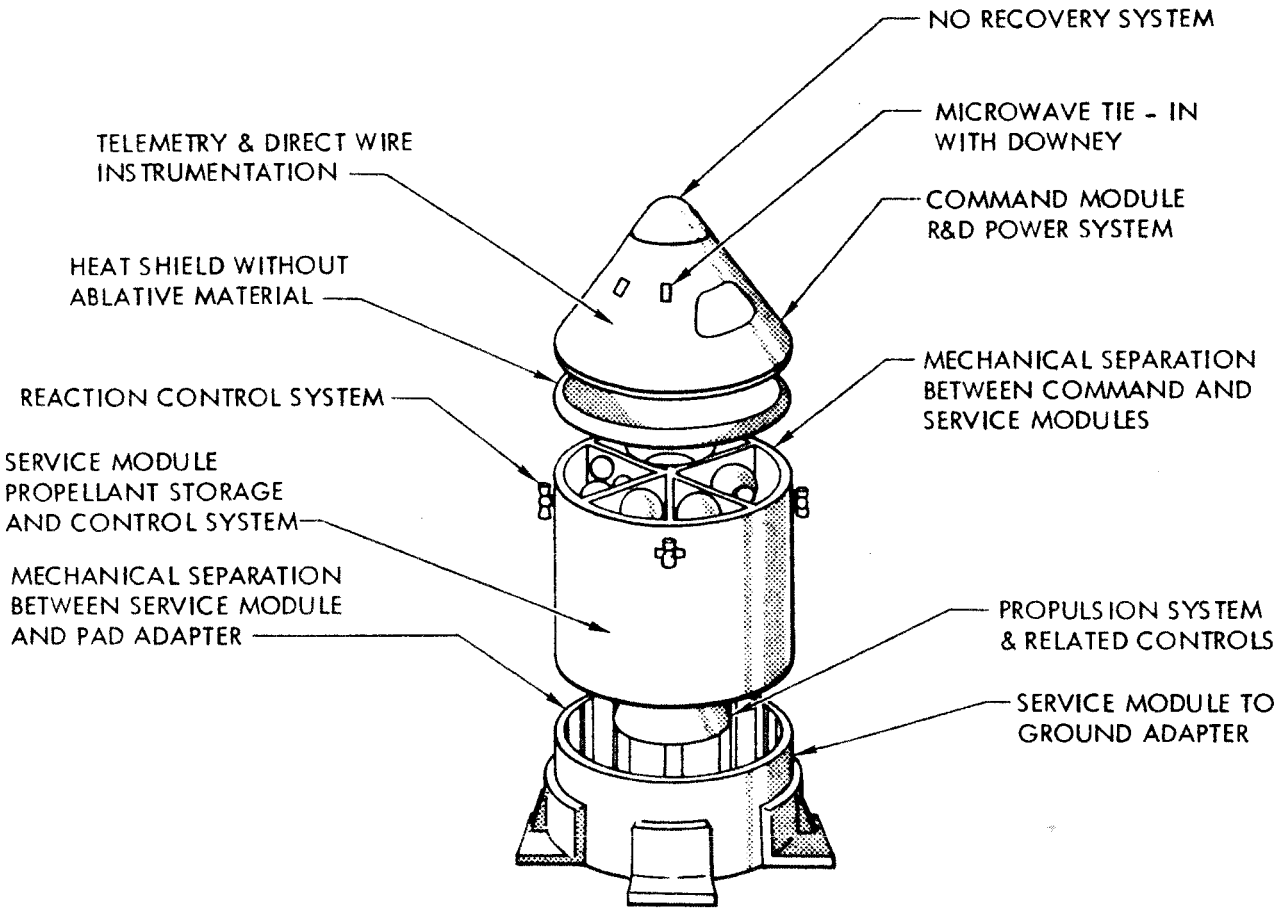

Figure 99. AFRM 001 Spacecraft for Propulsion System Qualification

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AFRM 002 — Command Module and LES for Max q LES Qualification

AFRM 002 (Figure 100) will consist of command module structure, launch escape tower, and a spacecraft adapter. This spacecraft will be used for qualification of the launch escape system at maximum q, and demonstration of the structural integrity of the command module. Evaluation of the recovery complex, crew shock absorption system, and separation dynamics will also be an objective of this flight. The systems used will be limited to those which are required to perform tasks necessary for conducting the tests. This includes battery power system, telemetry system, command radio, electromechanical separation, and anthropomorphic dummies. The command module will be recovered; therefore, the recovery system, impact attenuation system, and recovery aids will be included.

AFRM 004 — Spacecraft for Static Test No. 1

The first static test article (Figure 101) is composed of a command module, service module, spacecraft adapter, and launch escape tower. It will be programmed for static tests to verify structural integrity under launch pad loads, structural integrity under all simulated boost conditions, and structural integrity under simulated lunar landing conditions. No systems will be required, with the exception of direct wire instrumentation.

AFRM 005 — Command Module for Static Test No. 2

AFRM 005 (Figure 102) consists of a spacecraft command module which will be used for verification of structural stiffness and integrity during reentry and recovery phases under simulated thermal environment and shock loads. No systems will be involved; however, direct wire instrumentation will be required.

AFRM 006 — House Spacecraft No. 2

AFRM 006 (Figure 103) is the second of two house spacecrafts to be built. Unlike the first, which was a skeletal structure around which systems were developed, the second house spacecraft will consist of a spacecraft command module, spacecraft service module, spacecraft launch escape tower, and spacecraft adapter, which will be used to check systems performance and compatibility and to verify performance of the major systems. This spacecraft will also be used to evaluate systems interface within and between the major modules, in-flight maintenance procedures, and to confirm design changes prior to inclusion in actual flight systems. Malfunction analysis and development of operational procedures for vehicle and mission will be additional objectives of this spacecraft.

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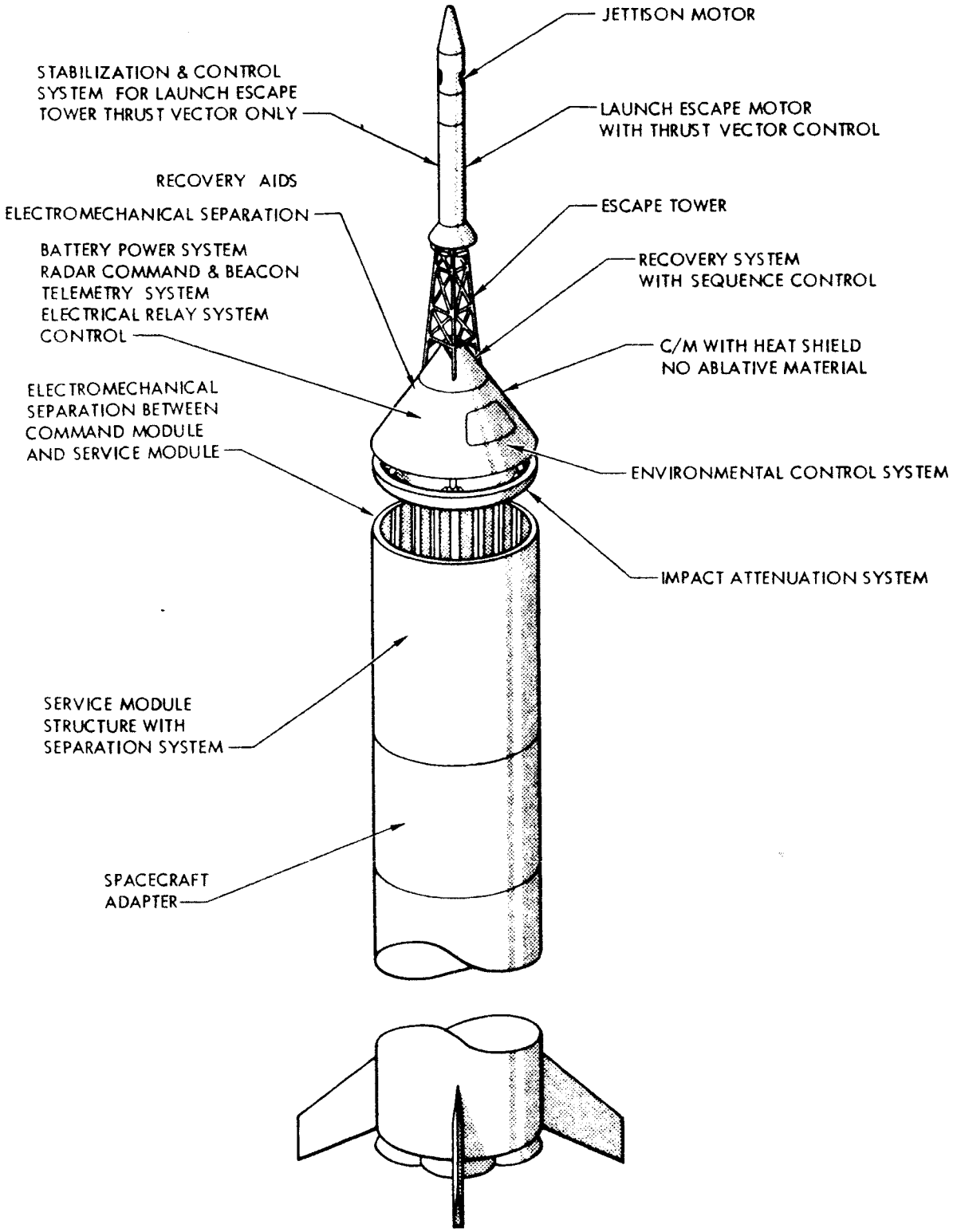

Figure 100. AFRM 002 Command Module and LES for Max "Q" LES Qualification

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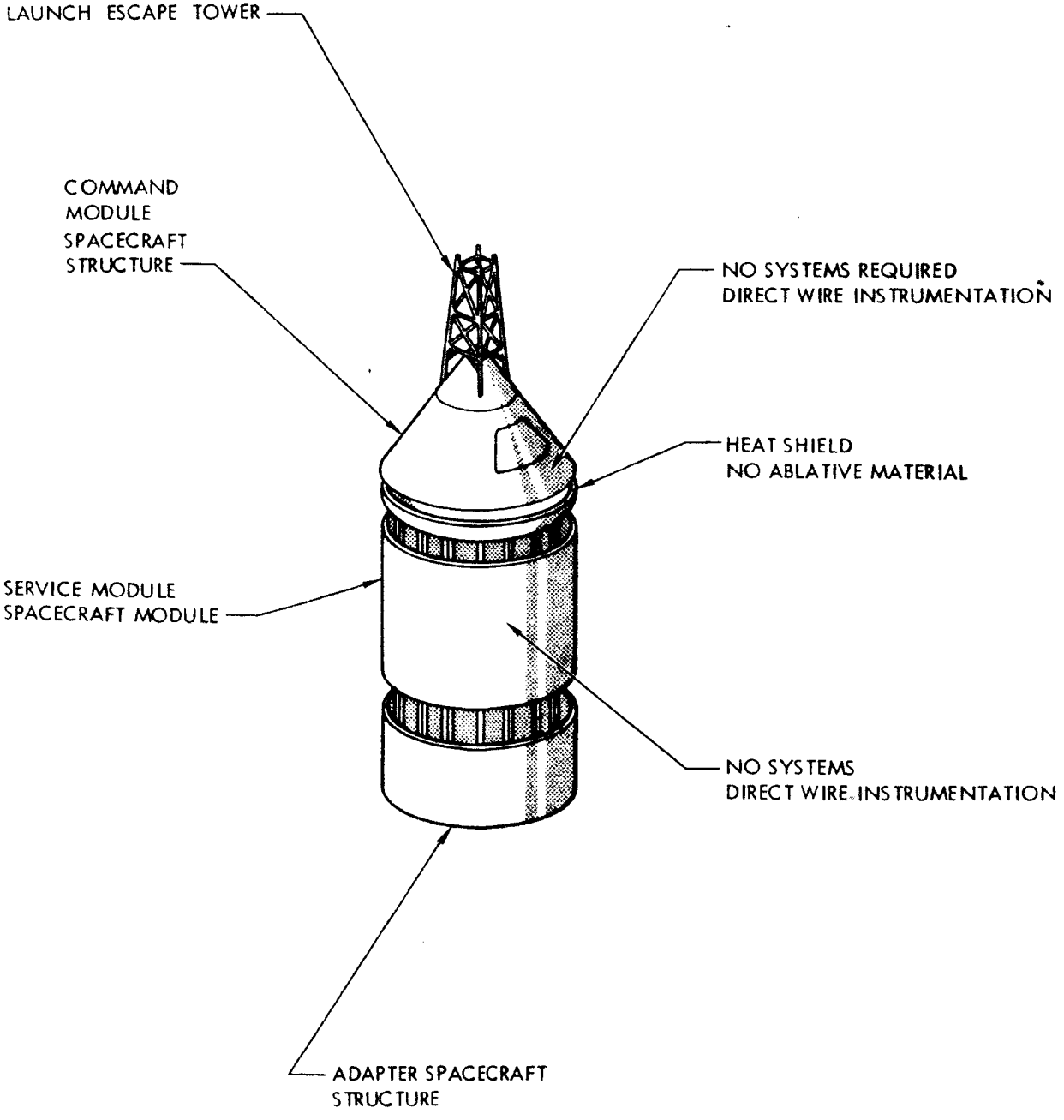

Figure 101. AFRM 004 Spacecraft for Static Test No. 1

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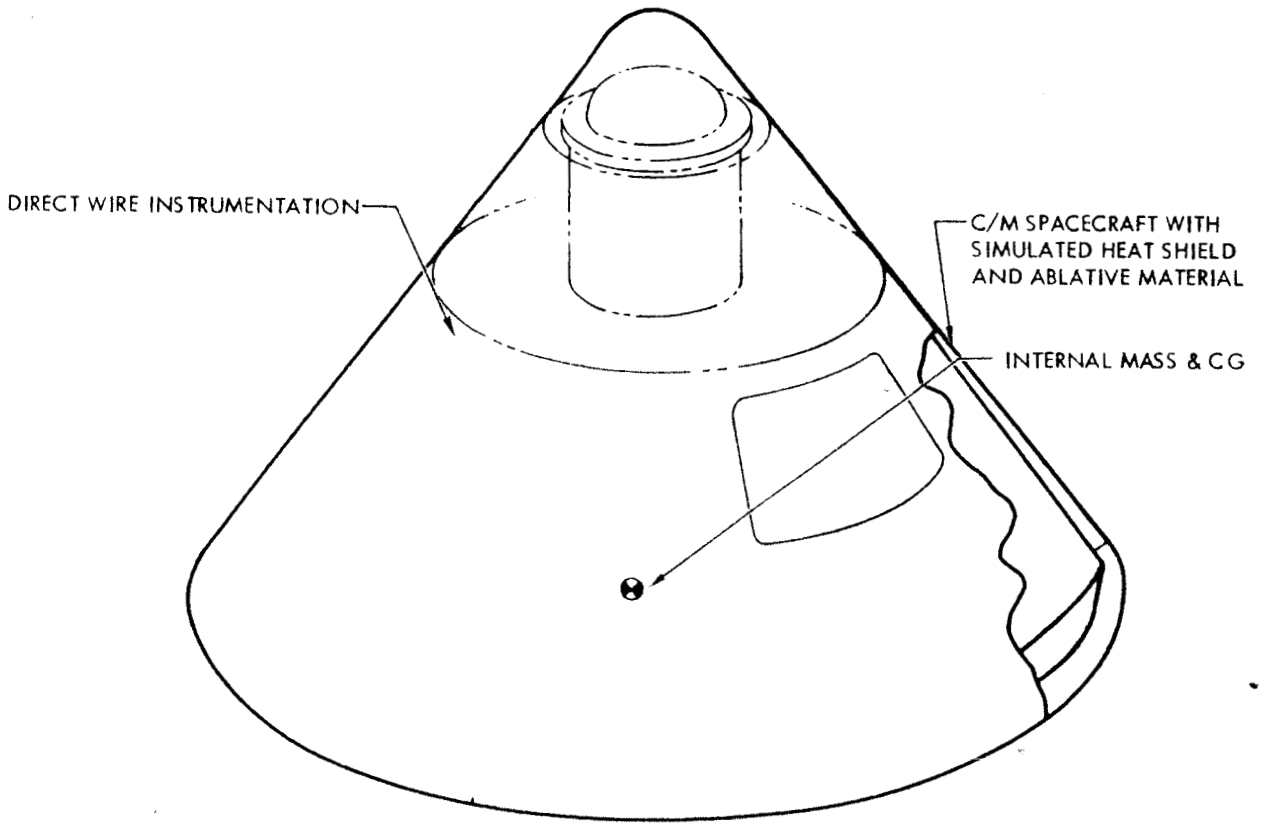

Figure 102. AFRM 005 Command Module for Static Test No. 2

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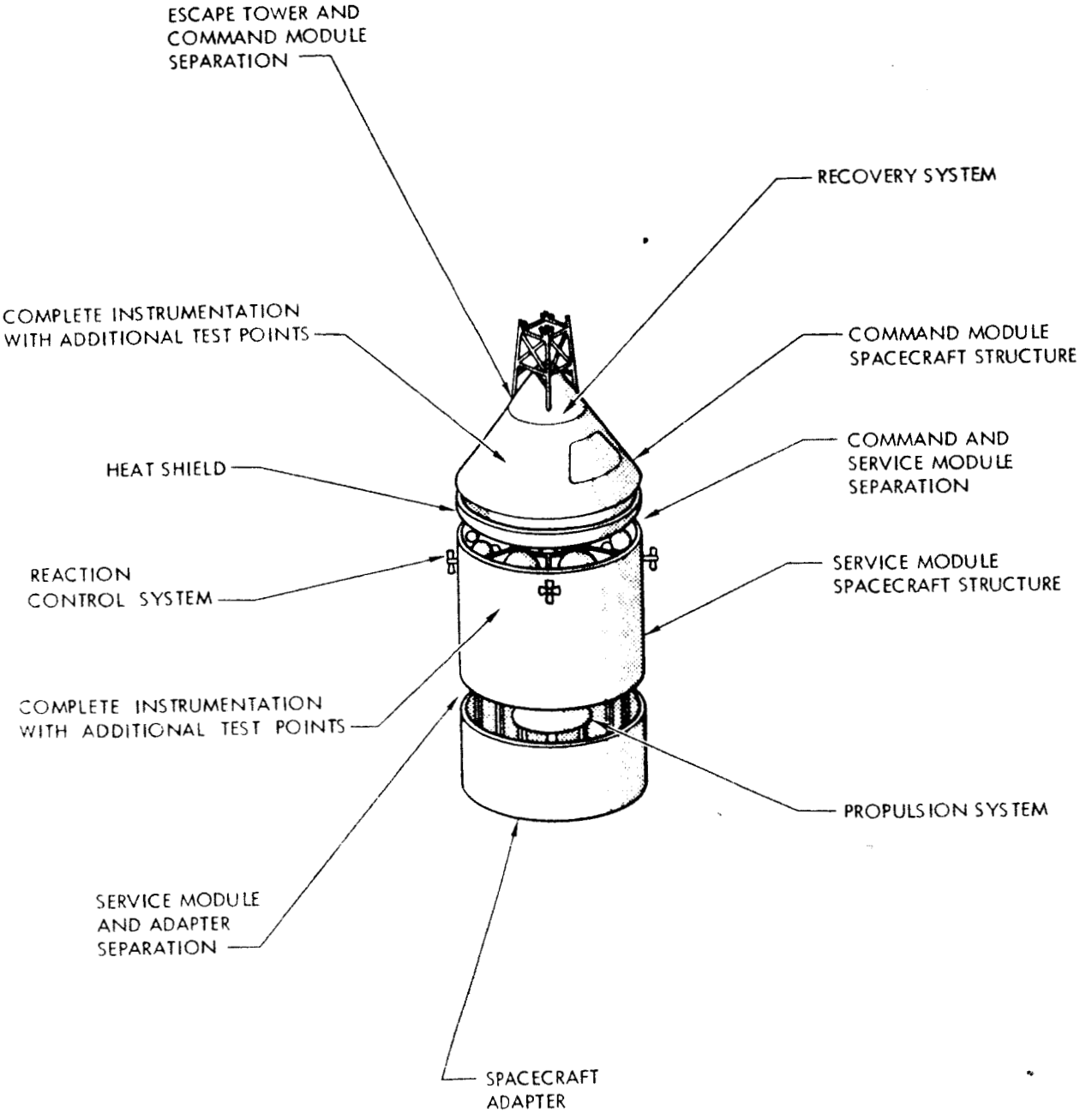

Figure 103. AFRM 006 House Spacecraft No. 2

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AFRM 007—Command Module for Reentry Tests

AFRM 007 (Figure 104) is an orbital reentry spacecraft and will consist of a spacecraft command module, spacecraft service module, spacecraft adapter, and spacecraft launch escape tower. It will be used to demonstrate C-1 launch vehicle and spacecraft readiness for manned participation in orbital flight and recovery operations, to demonstrate the reentry phase and to qualify the heat shield, to demonstrate the stabilization and control system, to evaluate the vibration noise of the spacecraft, and to demonstrate the service module launch and escape environment.

AFRM 008—Spacecraft for Environmental Proof Tests

The environmental proof spacecraft (Figure 105) consists of a spacecraft command module, spacecraft service module, spacecraft adapter, and spacecraft launch escape tower. All systems to be used in verifying design adequacy of the complete spacecraft under simulated mission environments will be included. Confidence in equipment will be verified by qualification studies of spacecraft ability to withstand environmental conditions present during prelaunch, launch, boost, separation, earth orbit, lunar and cislunar environment, reentry, earth landing, and recovery. Because no one facility can provide all environmental parameters, it will be necessary to conduct a series of separate tests which, in conjunction with subsystem and system level testing, will provide the desired assurance of spacecraft reliability for flight operations.

AFRM 009—Spacecraft for Very High Altitude Atmospheric Service Module Propulsion Verification

The very high altitude abort spacecraft (Figure 106) consists of a spacecraft command module, service module, modified spacecraft adapter, and spacecraft launch escape tower system. This article will be used to demonstrate space operation of the service module and to evaluate the recovery systems, the stability and control system, and system margins, and to evaluate and qualify the abort system. After normal jettison of the launch escape tower and during or after entry into earth orbit, the ability of the mission propulsion engines to return the command module to the earth's atmosphere and into the earth recovery mode will be tested.

AFRM 010—Spacecraft for Launch, Orbital, and Recovery Qualification

The primary mission of this unmanned recoverable spacecraft (Figure 107) will be recovery qualification. The vehicle will consist of a spacecraft command module, service module, spacecraft launch escape tower, and a spacecraft adapter. This spacecraft will also be used to verify

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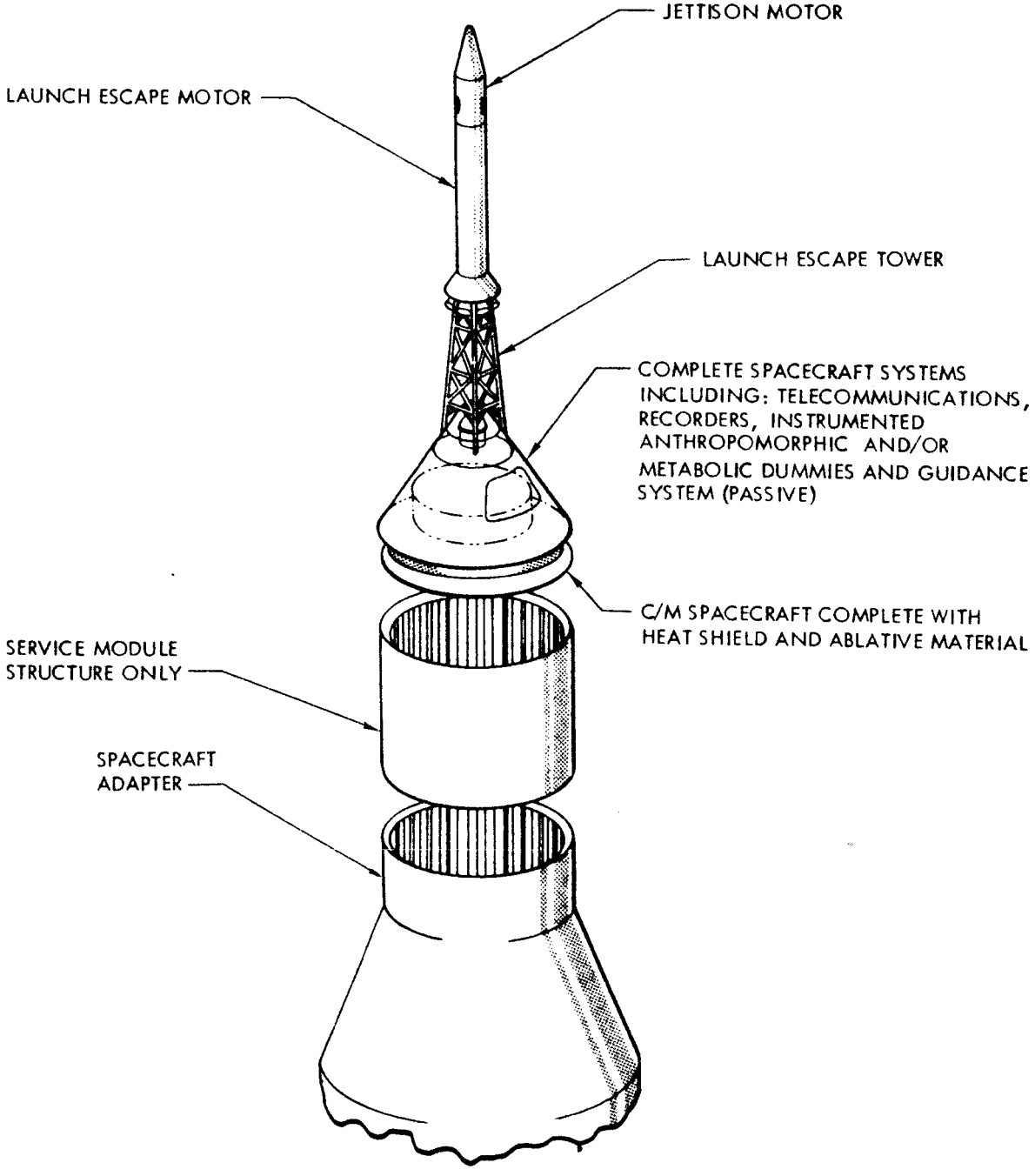

Figure 104. AFRM 007 (Spacecraft) Command Module for Reentry Tests

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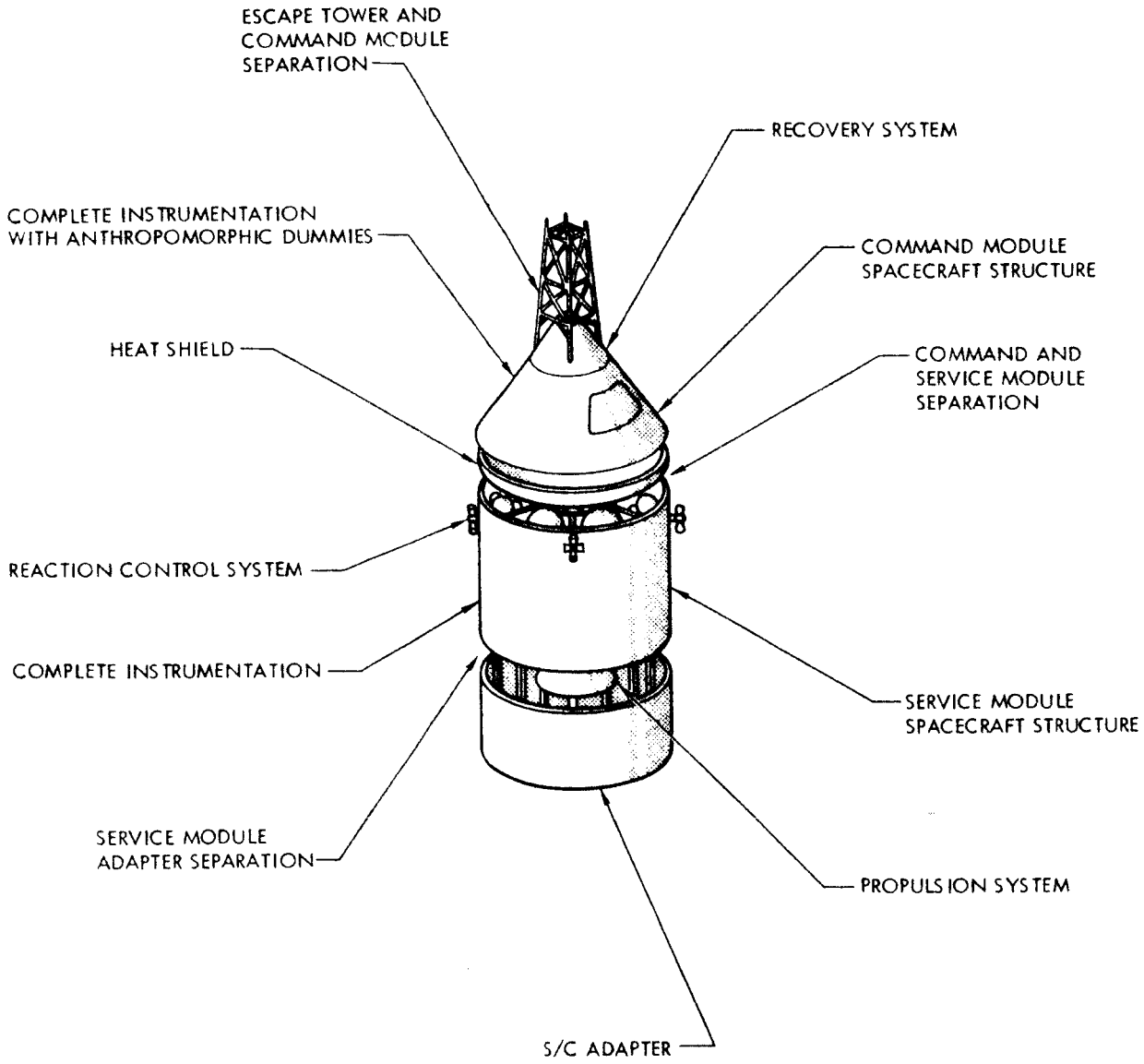

Figure 105. AFRM 008 Spacecraft for Environmental Proof Tests

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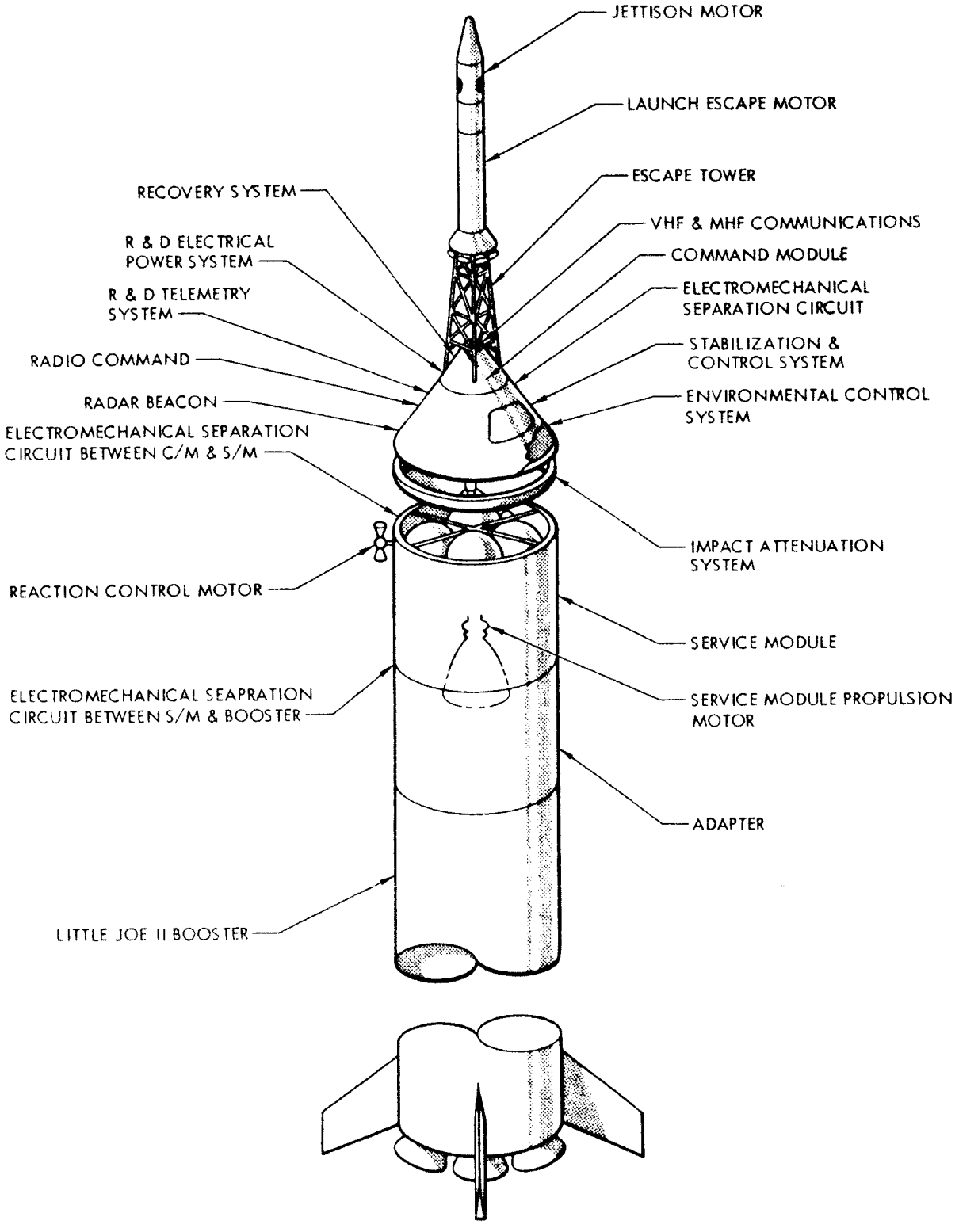

Figure 106. AFRM 009 Spacecraft for Very Hi-Alt Atmos Service Module Propulsion Verification

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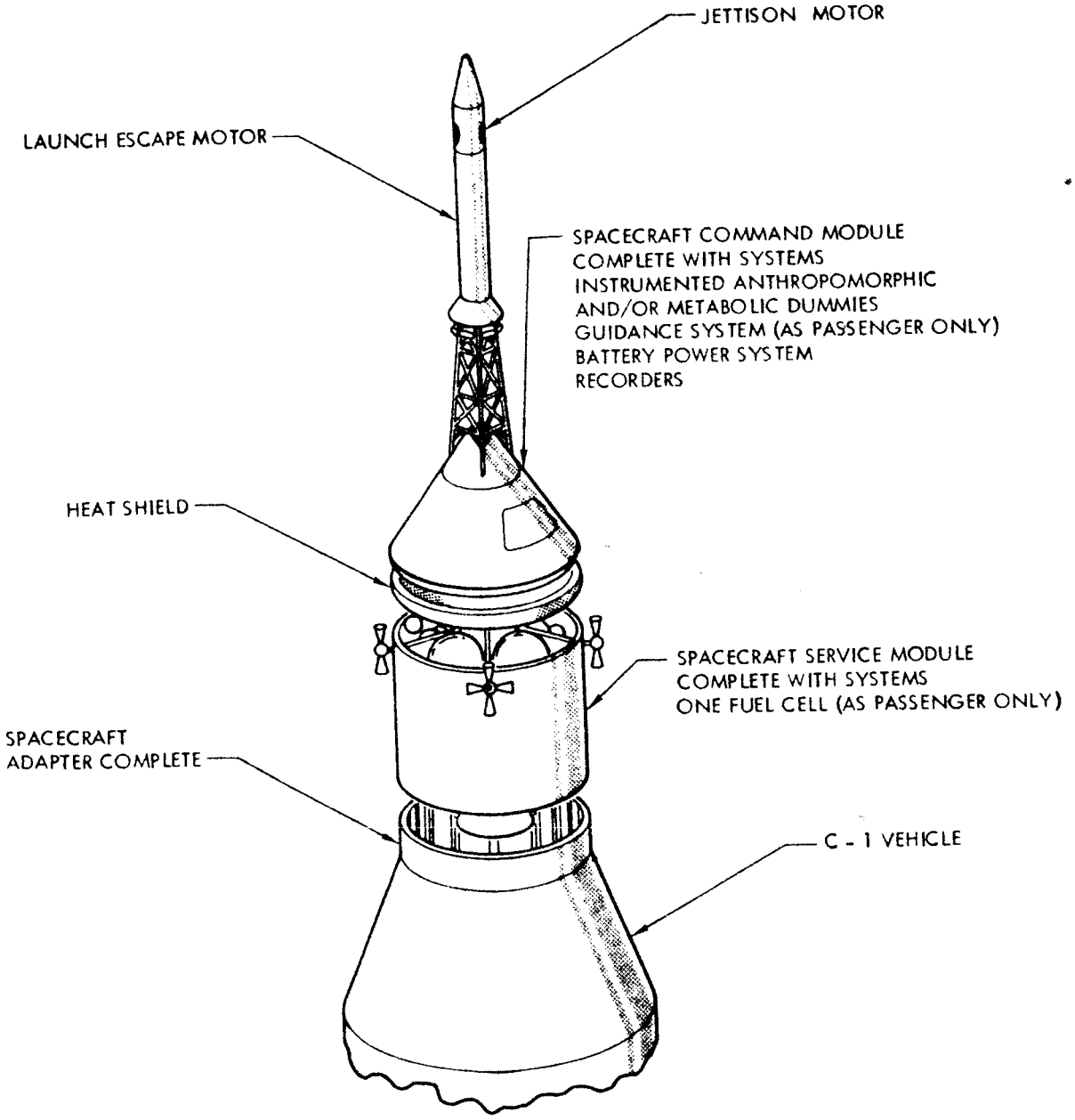

Figure 107. AFRM 010 Spacecraft for Launch, Orbital and Recovery Qualification

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the capability of a manned vehicle to complete an orbital mission, to qualify the heat shield, and to evaluate vibration modes. Completely qualified systems will be employed, including GSE.

AFRM 011—Spacecraft for First Manned Earth-Orbital Qualification

This spacecraft (Figure 108) will be used for the first manned earth-orbital flight. It will be composed of a complete spacecraft, fully equipped, to verify the capability of a manned spacecraft to complete an orbital mission, to verify the operation of GOSS with manned spacecraft, to verify the capability of the manned spacecraft recovery complex, and to evaluate inflight crew reaction. A series of manned orbital flights will follow to provide data regarding long-term space operations, bio-medical effects, and crew spacecraft compatibility and performance needed to proceed into the circumlunar and lunar-orbital flights.

AFRM 012—Spacecraft for Very High Altitude Atmospheric Service Module Propulsion Verification

AFRM 012 (Figure 109) will be another very high altitude atmosphere abort spacecraft to be used as a back-up for AFRM 009. The vehicle will be of the same construction as AFRM 009. This spacecraft may be used to repeat the mission of AFRM 009 in case of failure or partial failure of that spacecraft's mission, or another mission may be determined at a later date.

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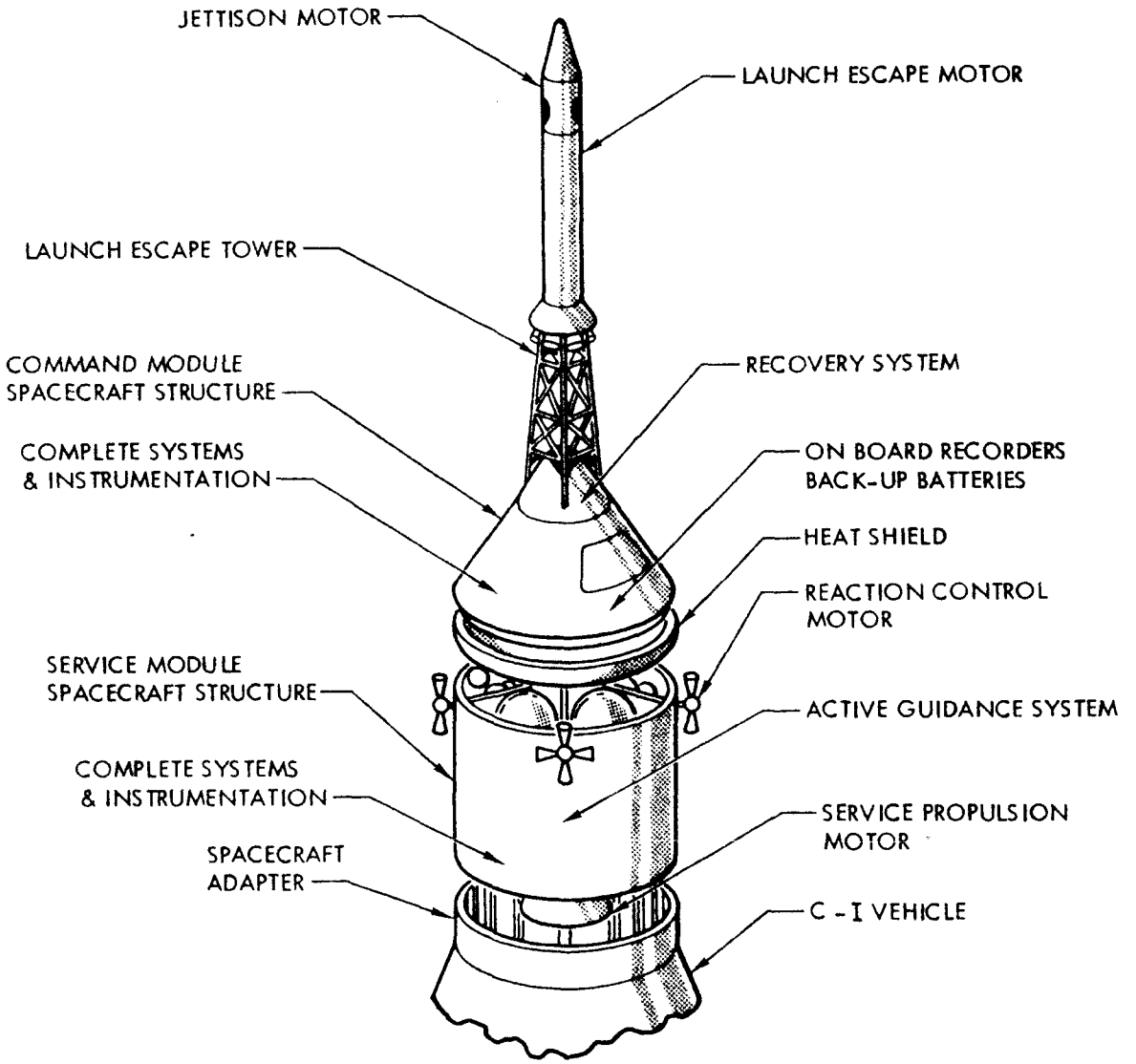

Figure 108. AFRM 011 Spacecraft for First Manned Earth Orbital Qualification

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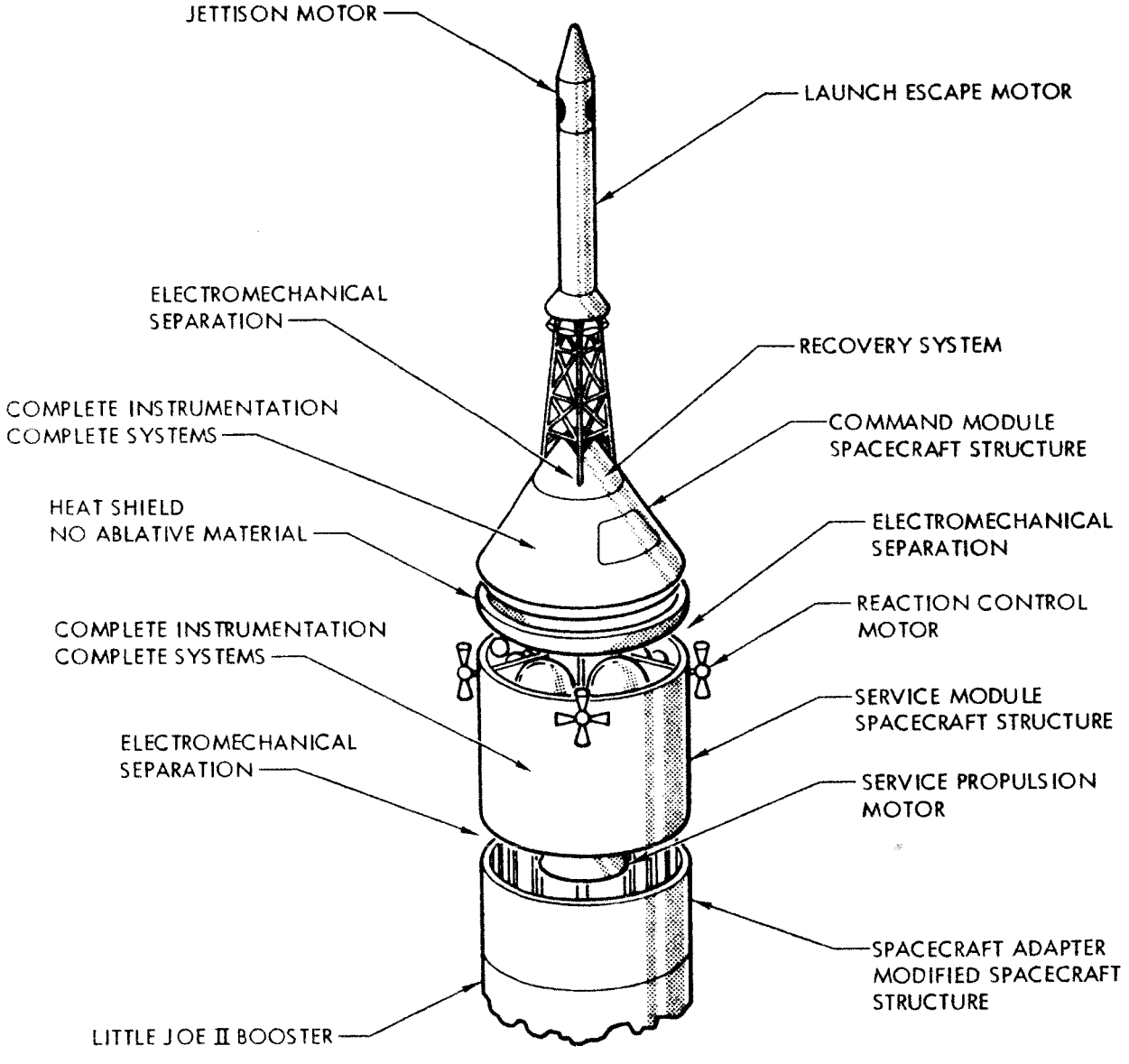

Figure 109. AFRM 012 Spacecraft for Very Hi-Alt Atmospheric Service Module Propulsion Verification

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