4. MISSION SUMMARY, COSTS, AND SCHEDULES

4.1 Mission Summary - The major experiment hardware and equipment changes, significant development tasks, and estimated acquisition time are summarized in Table 4.1-1. Compatibility with currently contracted spacecraft with respect to schedule, other experiments and to hardware and mission requirements are also indicated.

4.2 Costs - The estimated experiment incremental costs are presented in Table 4.2-1. These costs, in current dollars, are derived using standard MAC cost analysis procedures and are based on documented cost records of comparable efforts.

The McDonnell portion of the launched cost for a particular experiment may be obtained by adding to the experiment cost the contract price of the Gemini spacecraft utilized and the appropriate launch vehicles. If a new spacecraft is required to be built outside the current contract period, the estimated cost to be added to the experiment cost is twenty-five million. Spacecraft refurbished during and outside the current contract period are estimated to cost five million and fifteen million, respectively.

Experiment costs are based on the experiments being incorporated in the basic Gemini with a parachute recovery system and rendezvous capability, except for except for experiment 9A. The cost of this experiment is additive to the contract change proposal, submitted by MAC for a parasail configuration without rendezvous capability.

4.3 Schedules - The schedules for the various experiments, based on an assumed go-ahead of 1 July 1965, are presented in Figures 4.3-1 through 4.3-13. These schedules are predicated on past Mercury and Gemini experience.

The manufacturing flow times and subsequent deliveries are fixed in relation to estimated availability of experimental or developed system hardware, costs, facilities, AGE, and selection of spacecraft structure, (existing, new or refurbished).

4.3 (Continued)

Continued investigation and further analysis may affect changes in estimated availability of determining factors, and consequently vary target delivery dates of spacecraft for respective experiments.

TABLE 4.1-1
MISSION SUMMARY

NO	TITLE	EQUIPMENT	WEIGHT - LB	HARDWARE CHANGES	DEVELOPMENT TASKS	ACQUISITION TIME (MONTHS)	COMPATIBLE WITH
1	[illegible] WITH UNMANNED SATELLITE	Augment OAMS for [illegible] – 2 additional sets of OAMS tanks and propellant – 4 additional 100 lb. thrusters, augment [illegible] – 4 additional [illegible] rockets	1132	Modify adapter to accommodate additional OAMS and [illegible] (approximately 130 lb. additional structural weight).	Extensive computer studies of [illegible], [illegible], and [illegible] requirements. Structural tests of adapter and installations. Develop OAMS test system	20	None
2	ONE MAN GEMINI—EARTH SURFACE MAPPING	Panoramic cameras (2) Horizon camera Color cameras (2) Viewfinder	300	Remove RH crew station, LH crew member 7 day supplies, OAMS propellant, and experiments. Add bulkhead between seats, automatic hatch actuator, camera mounts, horizon sensor, and control panel.	Qualify panoramic camera, horizon camera, and viewfinder. Develop automatic hatch actuator, and horizon [illegible] system	21	None
3A	ONE MAN GEMINI WITH ASTRONOMICAL TELESCOPE (MOUNTED IN ADAPTER)	26 inch diameter optical system	560	Remove RH crew station, LH crew member 7-day supplies, OAMS propellant, and experiments. Modify retrograde rocket beams. Add fine attitude control system, horizon sensor, data recording device, hatch in heat shield, adapter tunnel, telescope rotating device, telescope mounts, fuel cell for gyro packages, and adapter extension.	Qualify hatch in heat shield, retrograde rocket impingement, retrograde rocket beams, and telescope fairing. Develop 26-inch diameter optical system, fine attitude control system, adapter tunnel seal, tunnel to telescope interface, and telescope rotating device.	30	None
3B	ONE MAN GEMINI WITH ASTRONOMICAL TELESCOPE (MOUNTED IN RE-ENTRY VEHICLE)	16-inch diameter optical system	400	Remove RH crew station, LH crew member 7-day supplies, OAMS propellant, and experiments. Add fine attitude control system, horizon sensor, data recording device, bulkhead between seats, automatic hatch actuator, telescope mounts, fuel cell for gyro packages.	Develop 16-inch diameter optical system, fine attitude control system, and automatic hatch actuator.	24	None
4A	ARTIFICIAL GRAVITY EXPERIMENT (SOLID COUPLE TO EXPENDED STAGE II OF GLV)	Angular velocity display gyro with rate range ± 40 degrees/second (92 lb. of available propellant required for [illegible] maneuver)	7	Mount angular velocity display and gyro	Qualify gyro and angular velocity display. Develop restraint system for repositioning crewman for [illegible] acceleration. Conduct attitude control and stability analysis. Determine physiological limitations of mission. Determine mission communication restraints.	11	S/C 10, 11, 12 Experiments 5, 6 and 7
4B	ARTIFICIAL GRAVITY EXPERIMENT (SOLID COUPLE TO AGENA)	Angular velocity display gyro with rate range ± 40 degrees/second (120 lb. of available propellant required for [illegible] maneuver)	7	Mount angular velocity display and gyro	Qualify gyro and angular velocity display. Conduct attitude control and stability analysis. Determine physiological limitations of mission. Determine mission communication restraints	11	S/C 10, 11, 12 Experiments 5 and 7
4C	ARTIFICIAL GRAVITY EXPERIMENT (CABLE COUPLE TO AGENA OR EXPENDED STAGE II OF GLV)	Angular velocity display and gyro, cable and cable reeling system (drum and motor) (approximately 200 lb. of available propellant required for [illegible] maneuver)	122	Mount angular velocity display and gyro. Mount cable and associated equipment (for Stage II of GLV – approximately 30 lb. structure) (For Agena – separate Agena section adjacent to target docking adapter is required; Approximately 75 lb. structure)	Qualify gyro and angular velocity display. Conduct attitude control and stability analysis. Determine physiological limitations of mission. Determine mission communication restraints. Develop cable system and installation. Conduct structural tests; dynamic model tests and extensive analog simulation study	15	S/C 12 Experiment 5 and 7
5	SIMULATION OF LEM RENDEZVOUS	5A. Add LEM equipment to Gemini to perform computations and radar observations (computer and power supply IMU and radar) 5B. Modify Gemini equipment to simulate LEM rendezvous	272	Install LEM computer and power supply, IMU and radar	Extensive digital computer simulations to develop operational computer program. Define crew operations and provide crew training	13	S/C 11, 12 Experiments 4, 7, and 9A
6	STRUCTURAL ASSEMBLY IN ORBIT	40 ft. diameter erectable antenna. ECS umbilical and miscellaneous handles	715	Install antenna and fairing to Gemini (includes structural [illegible] to Gemini – structural weight approximately 100 lb.)	Wind tunnel tests of launch configuration. Develop erectable antenna. Conduct structural tests of antenna installation for launch loads	16	S/C 12 Experiments 4A and 9
7	PROPELLANT TRANSFER	Add to Gemini: Propellant tanks, Pressurant tank (flow meters), Gauging systems, Transfer lines. Add to Agena: Propellant tanks, Propellant, Pressurant tank, Pressurant	100 300	Modify Gemini for installation of propellant tanks and pressurant tank Modify Agena for installation of propellant tanks and pressurant tank	Qualify propellant transfer system. Develop extravehicular activity capability, propellant centrifugal separator, and propellant retention device	24	Experiments 4, 5, and 9A
8	LONG DURATION MISSION	Agena mission section: Expandable living quarters, ECS extension and living quarters circulation, Additional electrical power, Drinking water, food and containers, Breathing O_2, bottles and mounts, Agena structure, Docking adapter	3400	Add hatch to hatch and launch fairing (approximately 34 lb.)	Wind tunnel tests of launch configuration. Develop tunnel and living quarters. Develop mission section. Hatch to hatch and fairing structural tests	18	None
9A	LAND LANDING PARASAIL	Parasail, Landing rocket, Landing gear, Rocket deployment mechanism	644	Remove radar, OAMS tanks, and pressurant, OAMS propellant, docking system, parachute system, roll bar, [illegible] in RCS, and adjust ballast.	Qualify landing system: Parasail, Rocket ejection mechanism, Landing rocket, Landing gear	24	Experiment 6

		[illegible]			[illegible] Determine mission [illegible]		[illegible]
4	ARTIFICIAL GRAVITY EXPERIMENT (CABLE COUPLE TO AGENA OR EXPENDED STAGE II OF GLV)	Angular velocity display and gyro, cable and cable reeling system (drum and motor) (approximately 200 lb. of available propellant required for 0g – 1g maneuver)	127	Mount angular velocity display and gyro Mount cable and associated equipment (for Stage II of GLV — approximately 30 lb. structure) (For Agena — separate Agena section adjacent to target docking adapter is required. Approximately 75 lb. structure)	Qualify gyro and angular velocity display Conduct attitude control and stability analysis Determine physiological limitations of mission Determine mission communication constraints Develop cable system and installation Conduct structural tests, dynamic model tests and mission analog simulation study	15	S/C 12 Experiment 3 and 7
5	SIMULATION OF LEM RENDEZVOUS	5A. Add LEM equipment to Gemini to perform computations and radar observations (computer and power supply, IMU and radar) 5B. Modify Gemini equipment to simulate LEM conditions	727?	Install LEM computer and power supply, IMU and radar	Extensive digital computer simulations To develop operational computer program Define crew operations and provide crew training	13	S/C 11, 12 Experiments 6, 7 and 9B
6	STRUCTURAL ASSEMBLY IN ORBIT	40 ft. diameter erectable antenna ECS umbilical and miscellaneous handles	715	Install antenna and fairing to Gemini (include structural beef-up to Gemini — structural weight approximately 100 lb.)	Wind tunnel tests of launch configuration Develop erectable antenna Conduct structural tests of antenna installation for launch loads	14	S/C-12 Experiments 4A and 9
7	PROPELLANT TRANSFER	Add to Gemini Propellant tanks Pressurant tank flow meters Gauging system Transfer lines Add to Agena Propellant tanks Propellant Pressurant tank Pressurant	100 380	Modify Gemini for installation of propellant tanks and pressurant tank Modify Agena for installation of propellant tanks and pressurant tank	Qualify propellant transfer system Develop extravehicular activity capability, propellant couplings, and propellant retention device	24	Experiments 4, 5, and 9B
8	LONG DURATION MISSION	Agena mission section Expandable living quarters ECS extension and living quarters circulation Additional electrical power Drinking water, food and containers Breathing O_2, bottles and mounts Agena structure Docking adapter	2500	Add hatch to hatch and launch fairing (approximately 36 lb.)	Wind tunnel tests of launch configuration Develop tunnel and living quarters Develop mission section Match to hatch and fairing development tests	18	None
9A	LAND LANDING - PARASAIL	Parasail Landing rocket Landing gear Rocket deployment mechanism	444?	Remove radar, OAMS tanks, and pressurant, OAMS propellant, docking system, parachute system, roll bar, flotation aids in RCS, and adjust ballast. Modify R & R section for installation of parasail, landing rocket, and rocket deployment mechanism. Modify re-entry vehicle for installation of landing gear (approximately 630 lb. removed)	Qualify landing system Parasail Rocket ejection mechanism Landing rocket Landing gear Develop parasail, landing rocket, and landing gear	24	Experiment 6
9B	LAND LANDING - CLOVERLEAF CHUTE	Cloverleaf chute landing gear	377	Remove radar, OAMS tanks and pressurant, OAMS propellant docking system, parachute system, roll bar, flotation aids in RCS, and adjust ballast. Modify R & R section for installation of cloverleaf chute. Modify re-entry vehicle for installation of landing gear (approximately 673 lb. removed)	Develop 100 ft. diameter cloverleaf chute and landing gear	30	Experiments 5, 6 and 7

TABLE 4.2–1
ADVANCED MISSIONS

SUMMARY OF ESTIMATED COSTS
(MILLIONS OF DOLLARS)

EXPERIMENT AND COST ITEM	FIRST UNIT COST	EACH ADDITIONAL UNIT COST
1. RENDEZVOUS WITH AN UNMANNED SATELLITE		
a. OAMS MODIFICATIONS	3.70	.27
b. NEW ADAPTER STRUCTURE	3.60	.55
c. GUIDANCE SYSTEM-COMPUTER STUDIES, PROGRAMMING AND MODIFICATION	2.75	–
d. NEW RETRO ROCKET SYSTEM	.80	.09
e. MISCELLANEOUS SYSTEM CHANGES	2.70	.23
f. SUPPORT (AGE, SPARES, MISSION PLANNING, SPACECRAFT SYSTEMS TESTS, GROUND TEST, PUBLICATIONS, SPECIFICATIONS, REPORTS)	6.20	.61
	19.75	1.75
2. ONE MAN GEMINI-EARTH SURFACE MAPPING		
a. CAMERAS	2.35	.45
b. HORIZON SENSOR	1.20	.05
c. ANCILLARY STRUCTURAL MODIFICATIONS	2.15	.20
d. MISCELLANEOUS SYSTEM CHANGES	1.45	.17
e. SUPPORT	3.15	.48
	10.30	1.35
3. ONE MAN GEMINI WITH ASTRONOMICAL TELESCOPE		
3A (MOUNTED IN ADAPTER)		
a. 26" DIAMETER OPTICAL SYSTEM	4.30	.55
b. FINE ATTITUDE CONTROL SYSTEM	16.30	.70
c. HORIZON SENSOR	1.20	.05
d. FUEL CELL	1.55	.13
e. ADAPTER EXTENSION AND TUNNEL	4.50	.42
f. ANCILLARY STRUCTURAL MODIFICATIONS	.95	.67
g. MISCELLANEOUS SYSTEM CHANGES	7.50	.63
h. SUPPORT	17.00	1.75
	53.30	4.90
3B (MOUNTED IN RE-ENTRY VEHICLE)		
a. 16" DIAMETER OPTICAL SYSTEM	3.50	.44
b. FINE ATTITUDE CONTROL SYSTEM	16.30	.70
c. HORIZON SENSOR	1.20	.05
d. FUEL CELL	1.55	.13
e. ANCILLARY STRUCTURAL MODIFICATIONS	2.15	.20
f. MISCELLANEOUS SYSTEM CHANGES	6.30	.40
g. SUPPORT	14.00	1.08
	45.00	3.00
4. ARTIFICIAL GRAVITY EXPERIMENT		
4A (SOLID COUPLE TO STAGE II OF GLV)		
a. ADD NEW RATE GYRO	1.60	.07
b. MODIFY CREW DISPLAYS	.45	.05
c. MISCELLANEOUS SYSTEM CHANGES	.50	.05
d. SUPPORT	1.20	.08

4B (SOLID COUPLE TO AGENA)		
SAME AS 4A ABOVE	3.75	.25
4C (CABLE COUPLE TO AGENA OR STAGE II OF GLV)		
a. CABLE SYSTEM	8.60	.80
b. MODIFY ATTITUDE CONTROL SYSTEM	3.30	.15
c. MODIFY CREW DISPLAYS	.45	.05
d. MISCELLANEOUS SYSTEM CHANGES	2.85	.30
e. SUPPORT	6.80	.70
	22.00	2.00
5. SIMULATION OF LEM RENDEZVOUS		
5A (UTILIZE LEM EQUIPMENT)		
a. LEM COMPUTER AND IMU	7.50	1.75
b. LEM RADAR	1.50	.42
c. GEMINI TDA (MODIFIED)	1.60	.50
d. MISCELLANEOUS SYSTEM CHANGES	2.40	.23
e. SUPPORT	4.00	1.60
	17.00	4.50
5B (UTILIZE GEMINI EQUIPMENT)		
a. GEMINI EQUIPMENT MODIFICATION	3.90	1.60
b. SUPPORT	2.10	.90
	6.00	2.50
6. STRUCTURAL ASSEMBLY IN ORBIT		
a. ANTENNA	5.20	.55
b. SUPPORT STRUCTURE AND STRUCTURAL BEEF-UP	3.00	.39
c. ECS PROVISIONS	2.50	.07
d. OAMS TCA DISASSEMBLY PROVISIONS	.25	.02
e. MISCELLANEOUS SYSTEM CHANGES	.60	.12
f. SUPPORT	5.20	.60
	16.75	1.75
7. PROPELLANT TRANSFER		
a. PROPELLANT TRANSFER SYSTEM	9.30	.60
b. AGENA STRUCTURAL MODIFICATIONS	2.00	.20
c. MISCELLANEOUS SYSTEM CHANGES	2.80	.20
d. SUPPORT	6.40	.50
	20.50	1.50
8. LONG DURATION MISSION		
a. AGENA MISSION MODULE	9.80	1.60
b. LIVING QUARTERS AND ACCESS TUNNEL	6.80	1.30
c. RE-ENTRY VEHICLE ADDITIONAL EQUIPMENT	2.80	.15
d. MISCELLANEOUS SYSTEM CHANGES	5.40	.95
e. SUPPORT	11.20	2.00
	36.00	6.00
9. LAND LANDING		
9A (PARASAIL)		
a. PARASAIL SYSTEM CHANGES	2.10	.02
b. LANDING ROCKET	1.00	.16
c. MISCELLANEOUS SYSTEM CHANGES	.10	.05
d. SUPPORT	1.40	.12
	4.60	.35
9B (CLOVERLEAF CHUTE)		
a. CLOVERLEAF CHUTE	9.00	.10
b. CHUTE CONTROLS	.90	.03
c. MISCELLANEOUS SYSTEM CHANGES	.50	.02
d. SUPPORT	4.80	.05
	15.20	.20

GEMINI SPACECRAFT • ADVANCED MISSIONS

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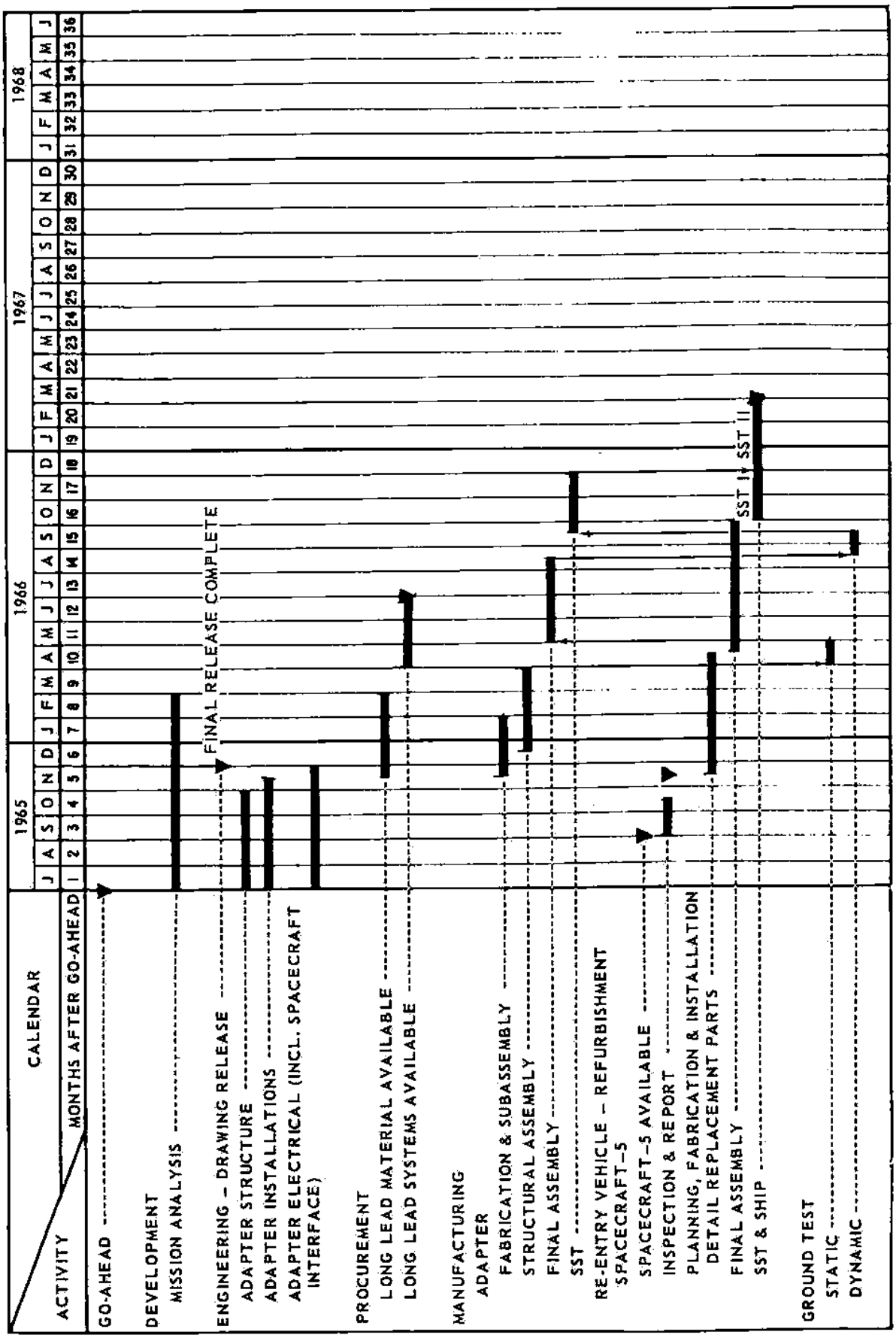


NOTES: (1) ASSUMES ADAPTER AVAILABLE FOR OTHER TESTING AS REQUIRED.
(2) ASSUMES MINOR ADAPTER TOOL MODIFICATION ONLY.

FIGURE 4.3-1

ADVANCED MISSIONS – NO. 2

ONE-MAN GEMINI – EARTH MAPPING

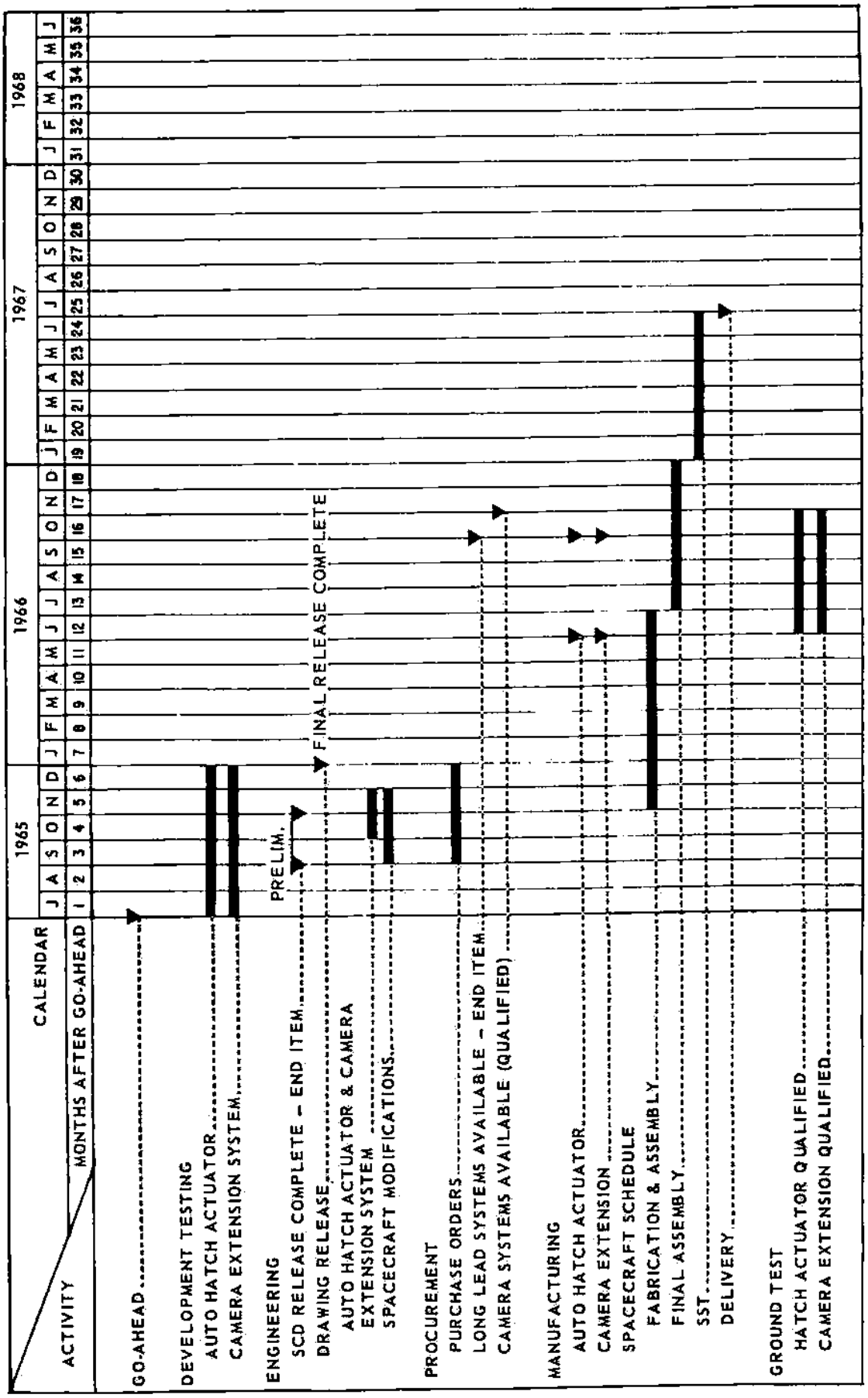
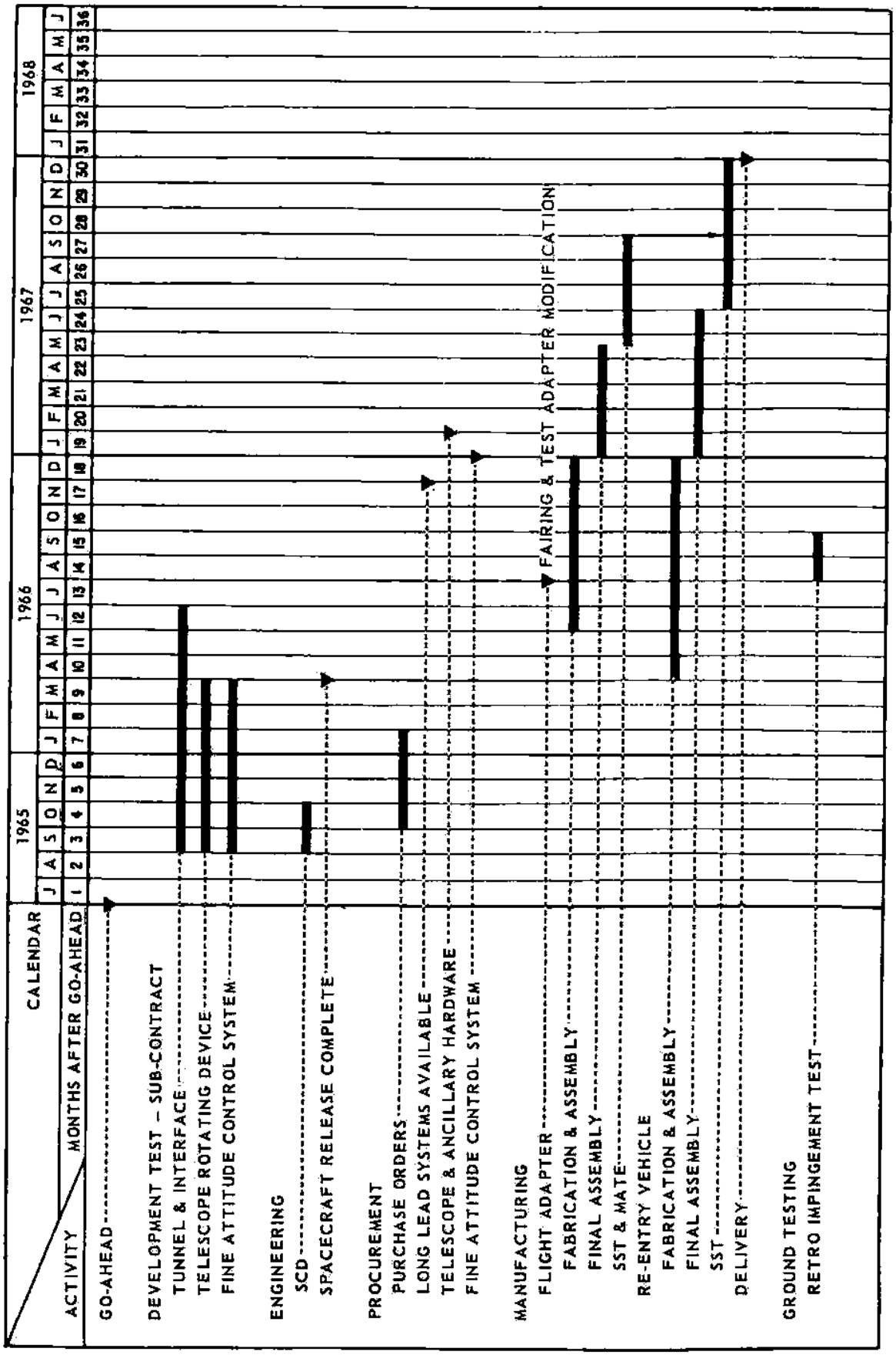


FIGURE 4.3-2

ADVANCED MISSIONS – NO. 3A

ONE-MAN GEMINI WITH ASTRONOMICAL TELESCOPE MOUNTED IN THE ADAPTER



NOTES: (1) HEAT SHIELD FROM HSQ

FIGURE 4.3–3

ADVANCED MISSIONS – NO. 3B

ONE-MAN GEMINI WITH ASTRONOMICAL TELESCOPE MOUNTED IN THE RE-ENTRY VEHICLE

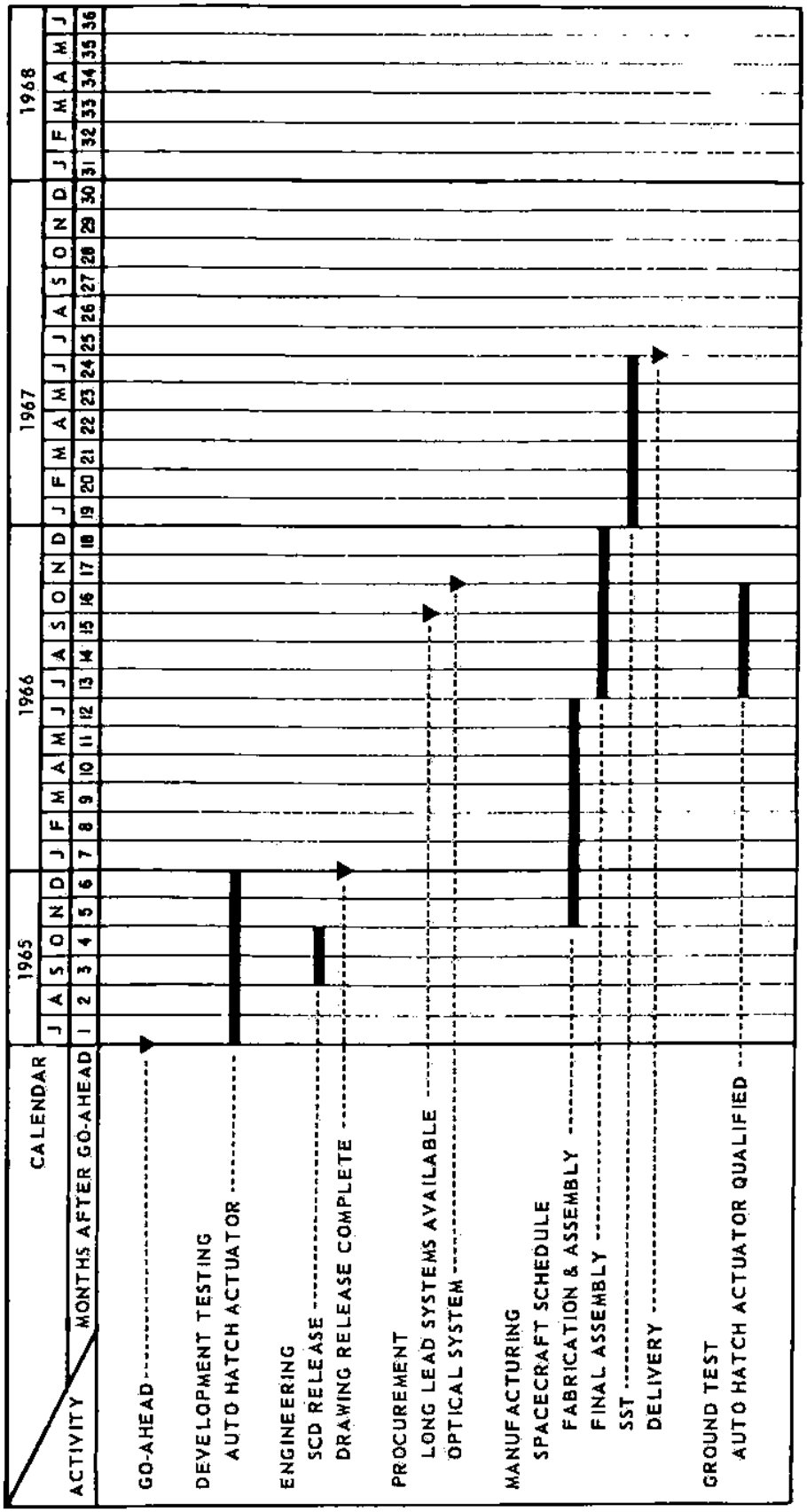


FIGURE 4.3–4

ADVANCED MISSIONS-NO. 4A

ARTIFICIAL GRAVITY-SOLID COUPLE TO STAGE II OF GLV

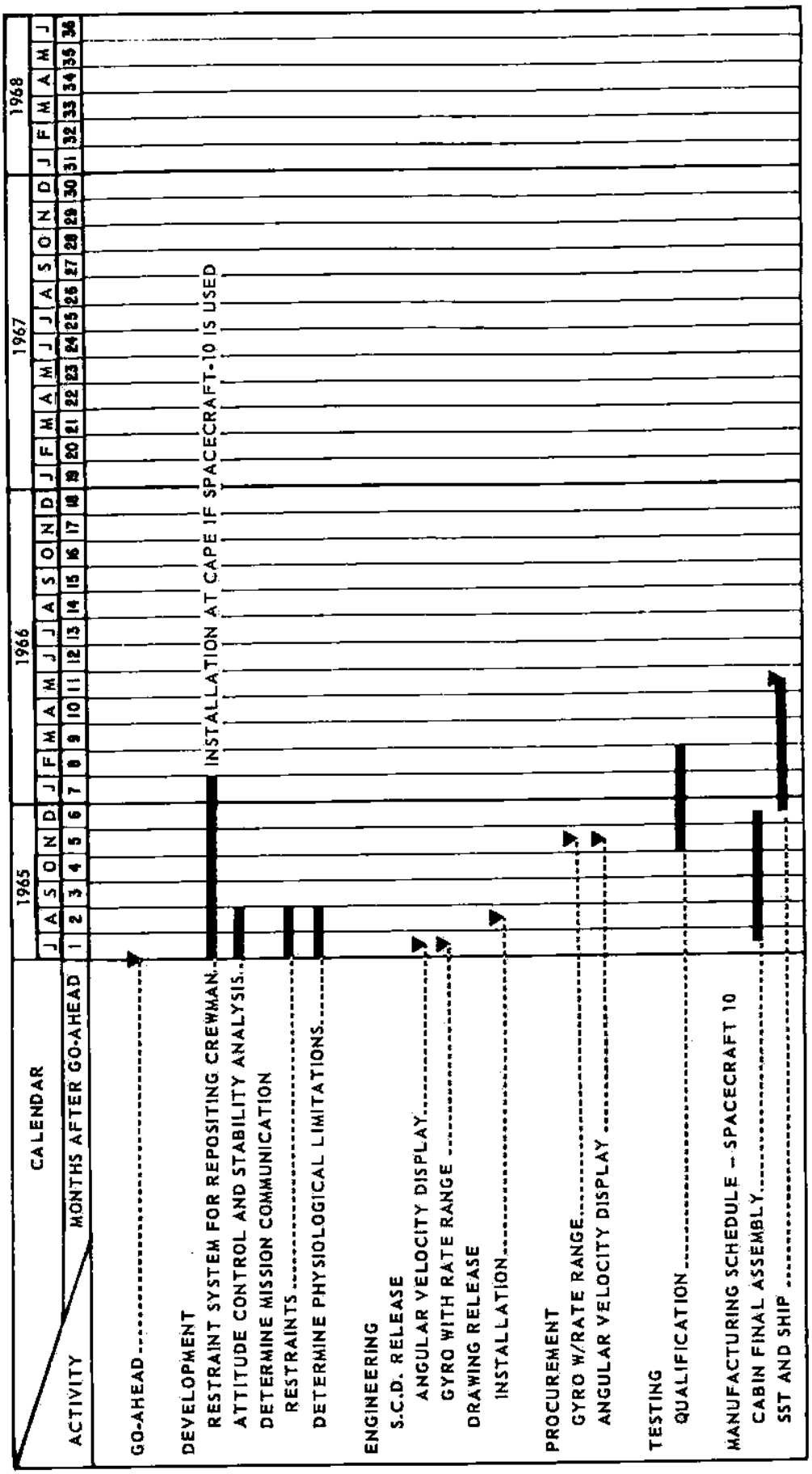
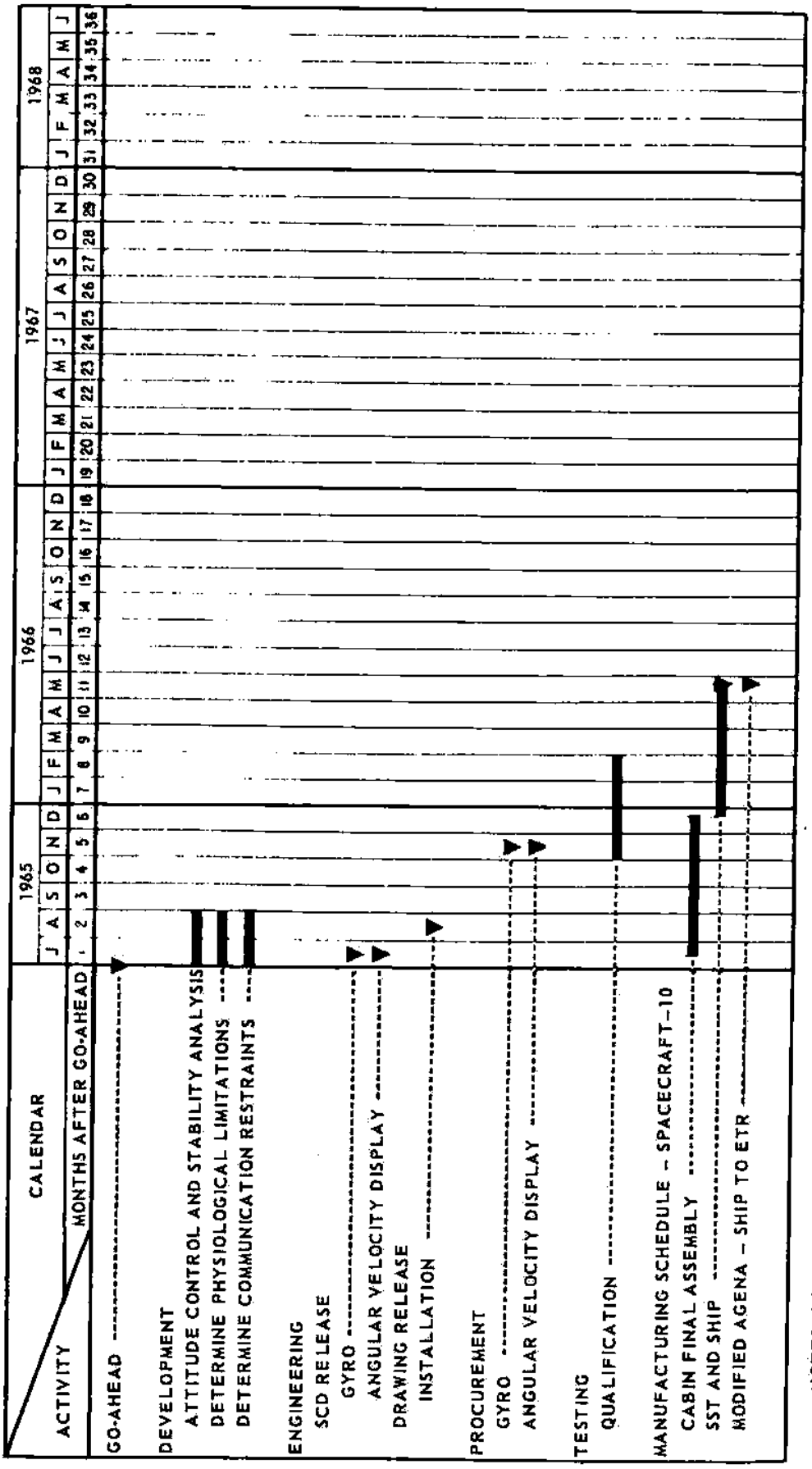


FIGURE 4.3-5

ADVANCED MISSIONS – NO. 4B

ARTIFICIAL GRAVITY – SOLID COUPLE TO AGENA

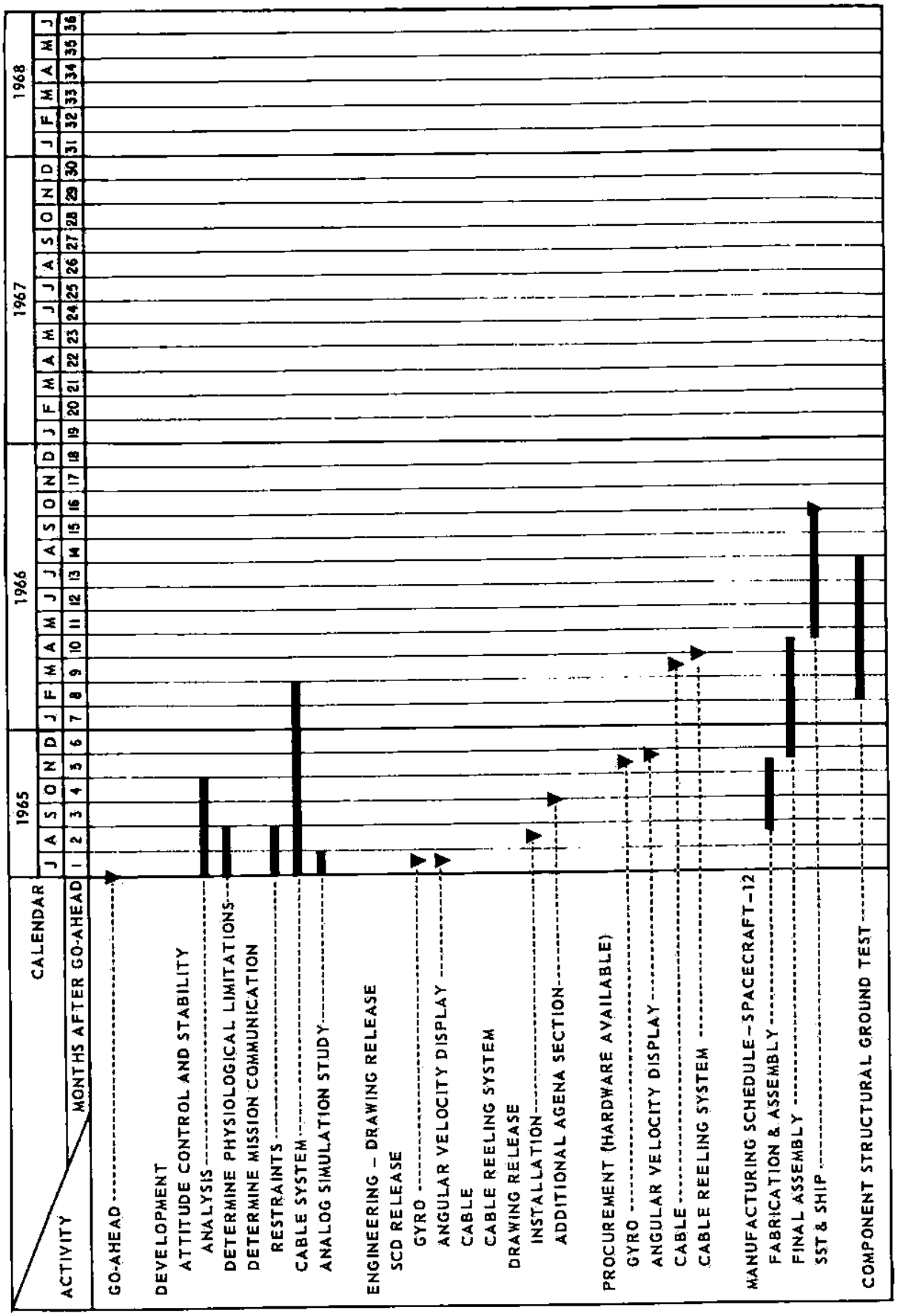


NOTES: (1) ASSUMES NO GROUND TESTING REQUIRED.
(2) ASSUMES AVAILABILITY OF MODIFIED AGENA SECTION.

FIGURE 4.3–6

ADVANCED MISSIONS – NO. 4C

ARTIFICIAL GRAVITY – CABLE COUPLE TO AGENA OR STAGE II OF GLV



NOTE:
(1) COMPONENT STRUCTURAL TEST TO BE PERFORMED BY RESPONSIBLE CONTRACTOR.

FIGURE 4.3-7

ADVANCED MISSIONS – NO. 5

SIMULATION OF LEM RENDEZVOUS

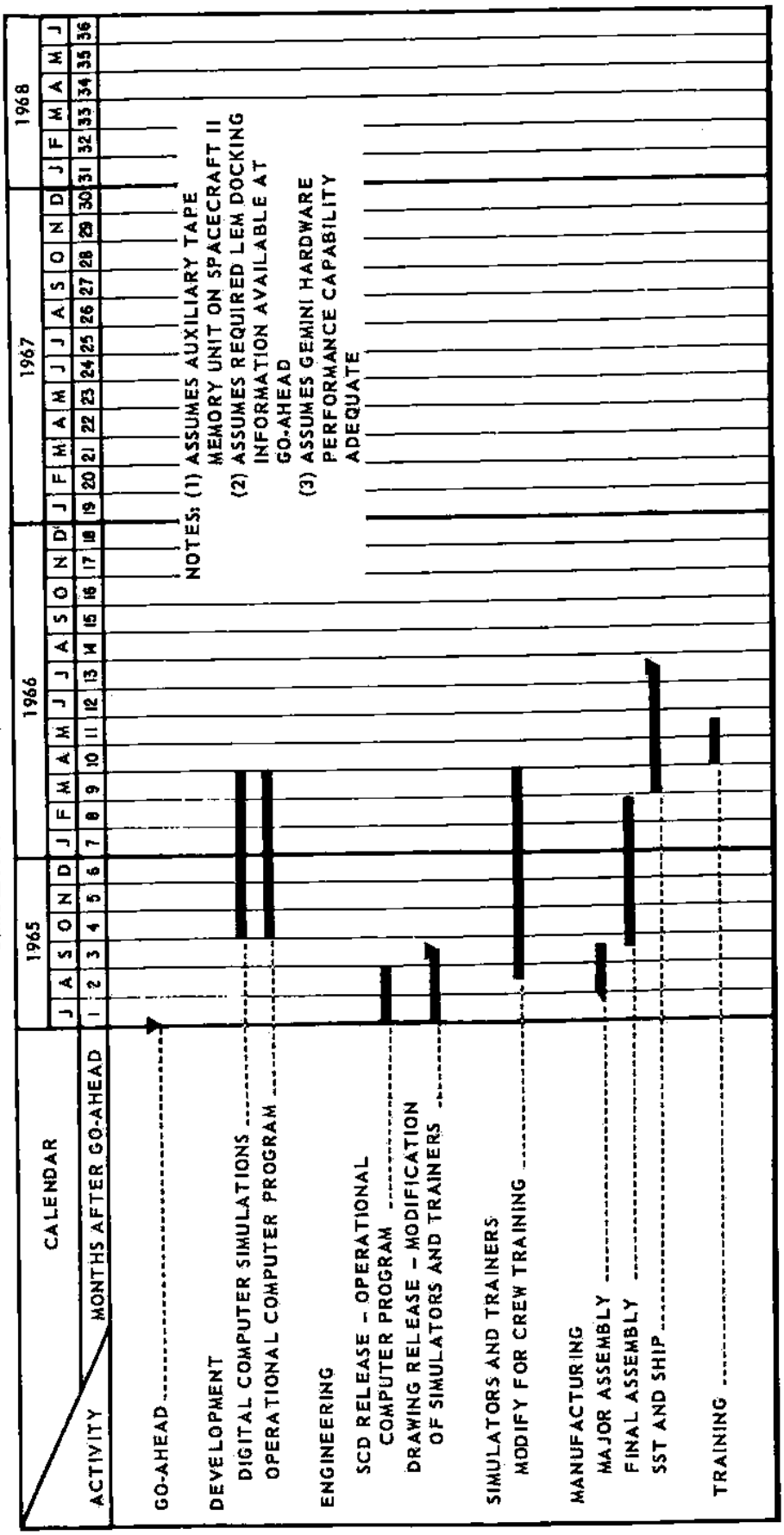


FIGURE 4.3-8

ADVANCED MISSIONS - NO. 6

STRUCTURAL ASSEMBLY IN ORBIT

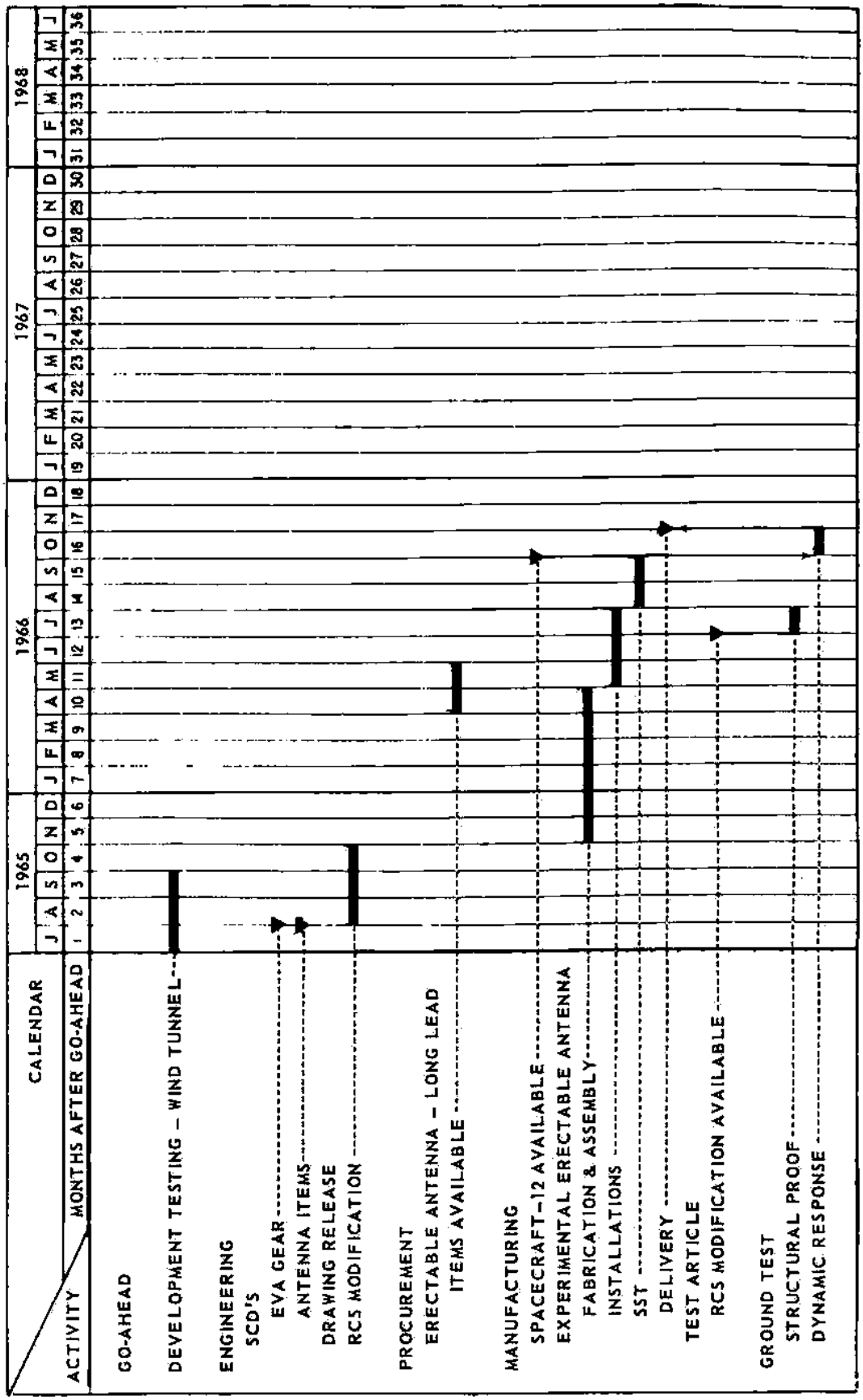


FIGURE 4.3-9

ADVANCED MISSIONS – NO. 7

PROPELLANT TRANSFER

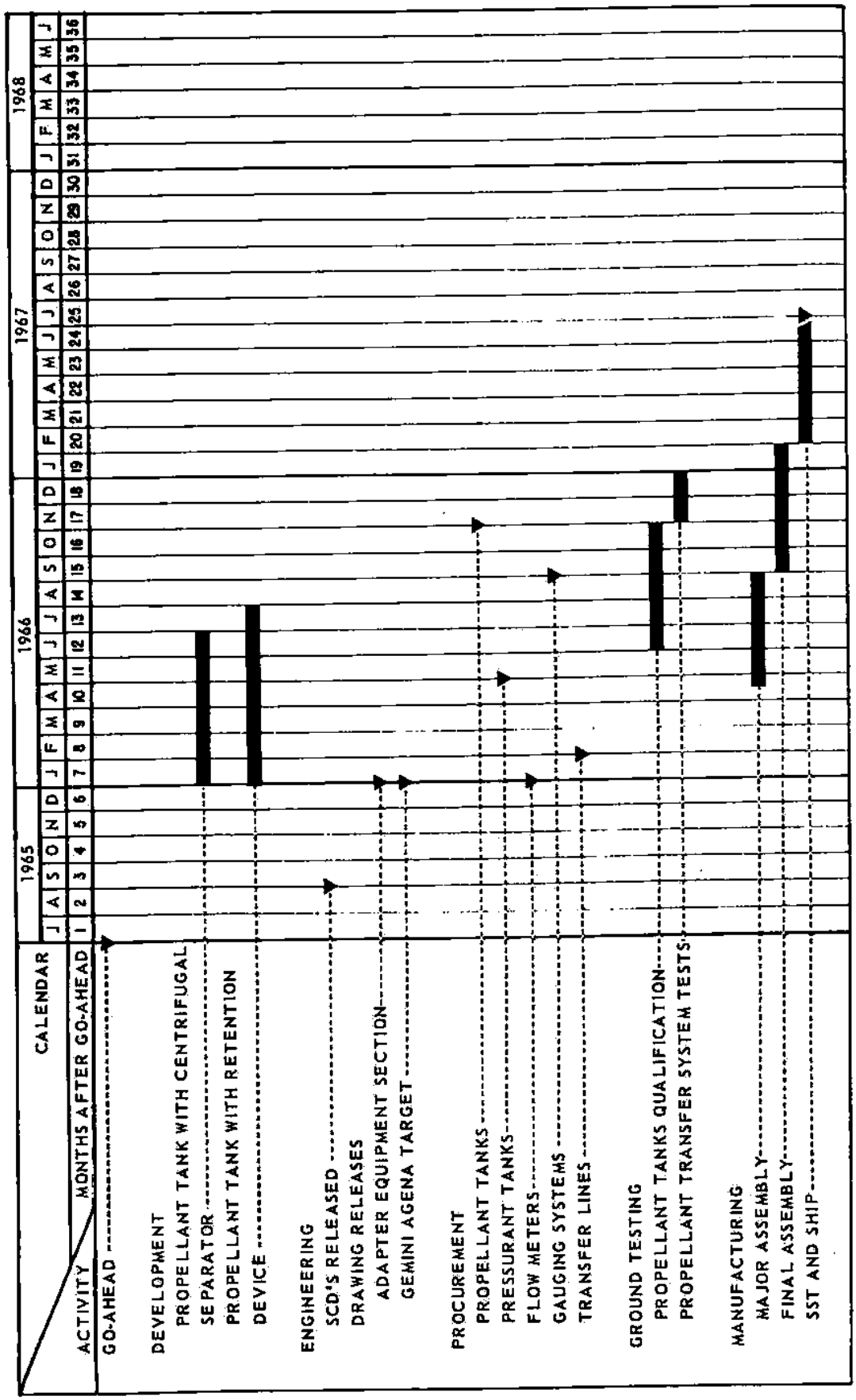
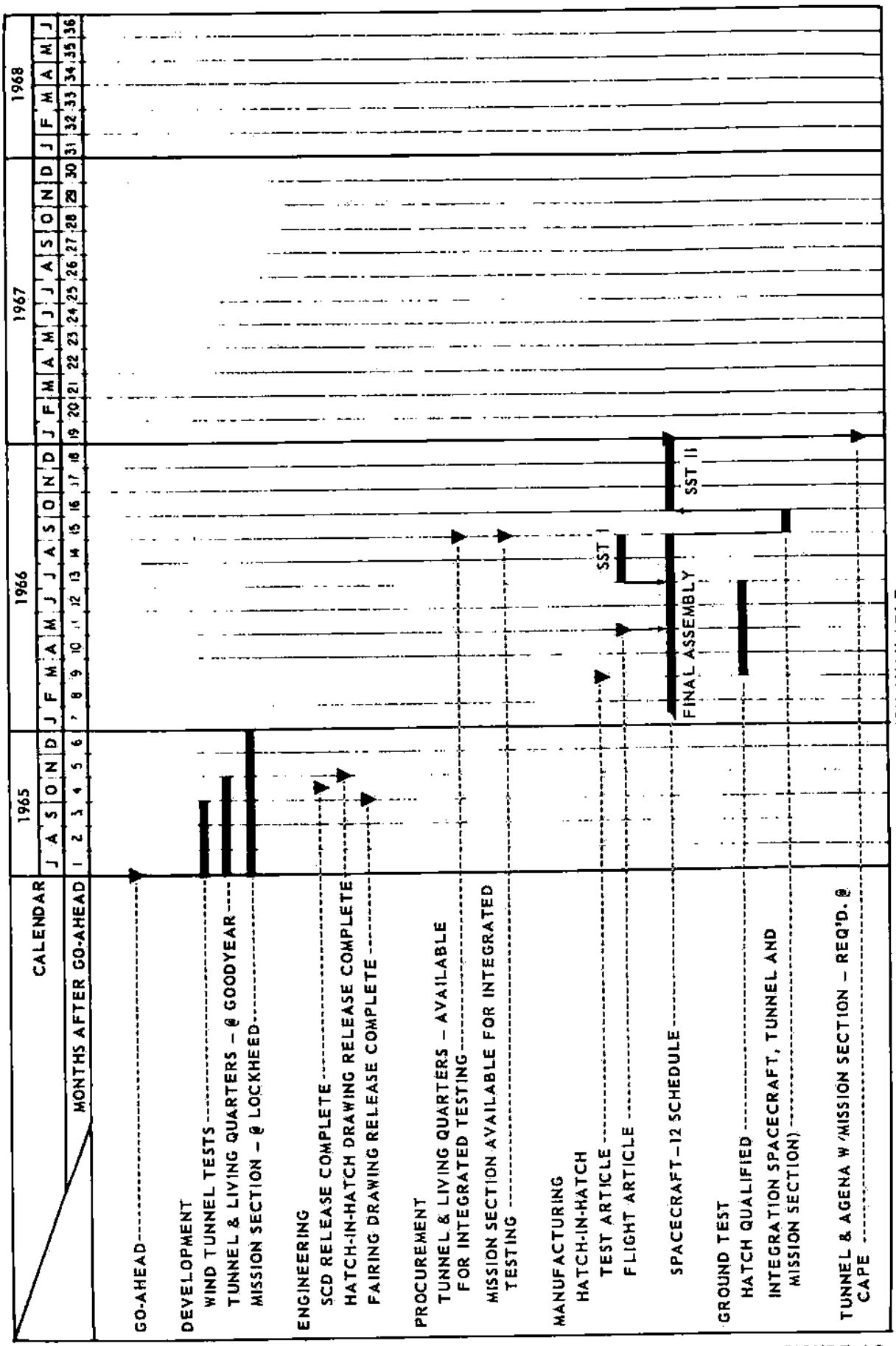


FIGURE 4.3–10

ADVANCED MISSIONS – NO. 8
LONG DURATION MISSION



NOTE: (1) SCHEDULE ASSUMES TUNNEL & AGENA W/MISSION SECTION AVAILABLE
(2) SPACECRAFT–12 DELIVERY SLIPS 3 MONTHS

FIGURE 4.3–11

ADVANCED MISSIONS – NO. 9A

LAND LANDING – PARASAIL

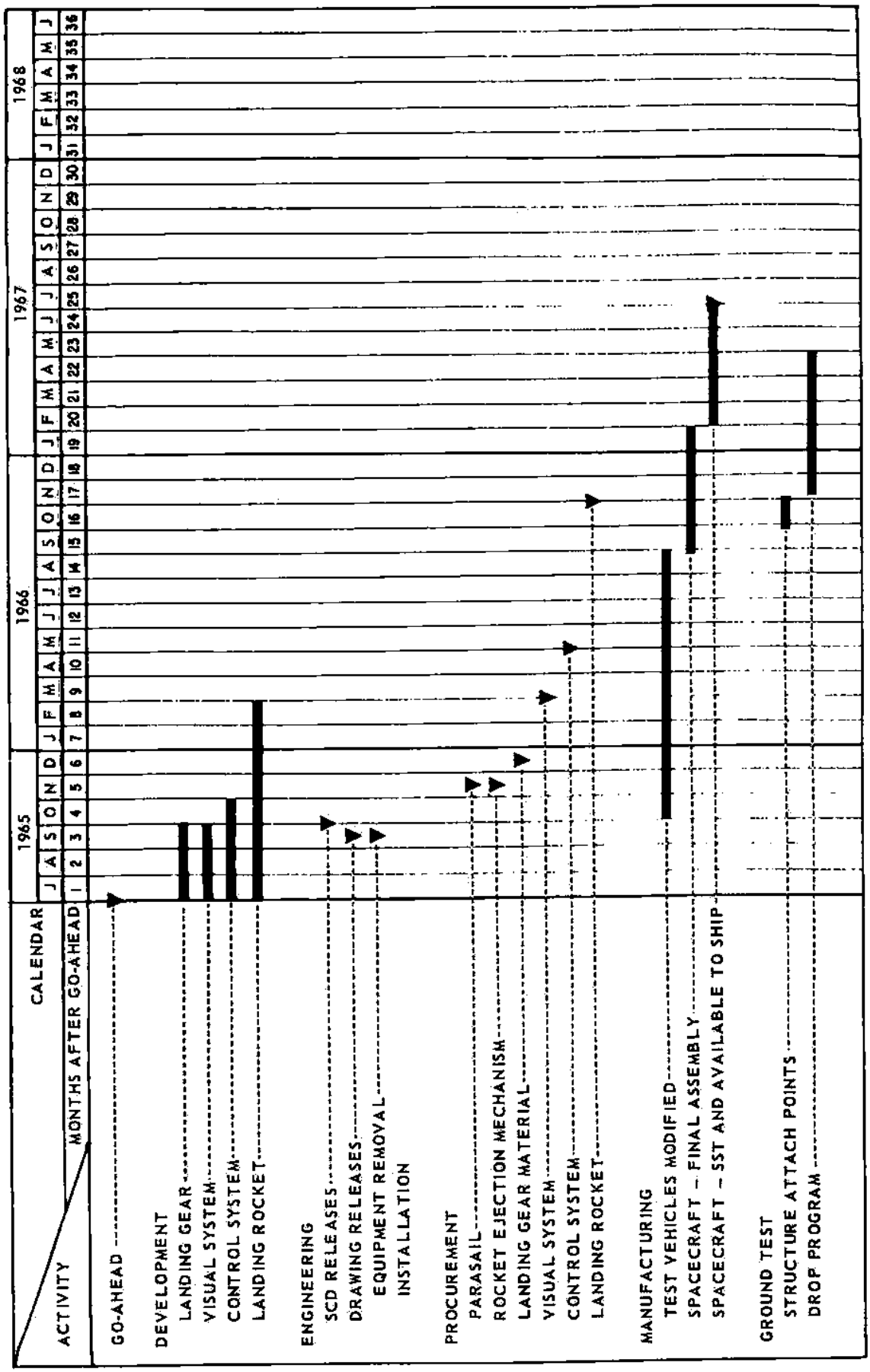


FIGURE 4.3-12

ADVANCED MISSIONS – NO. 9B

LAND LANDING – CLOVERLEAF CHUTE

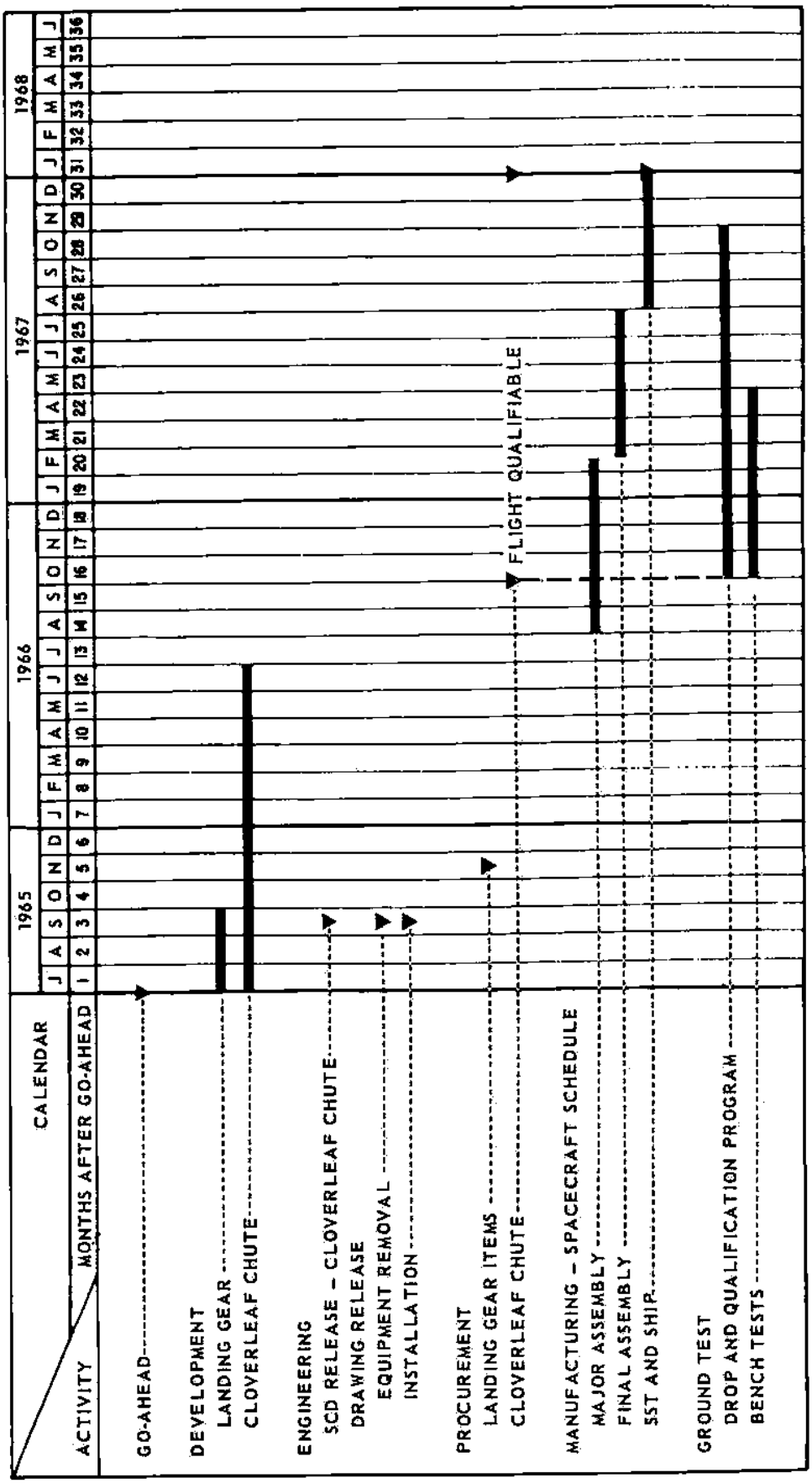


FIGURE 4.3-13

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