

# Gemini: Rendezvous and Docking

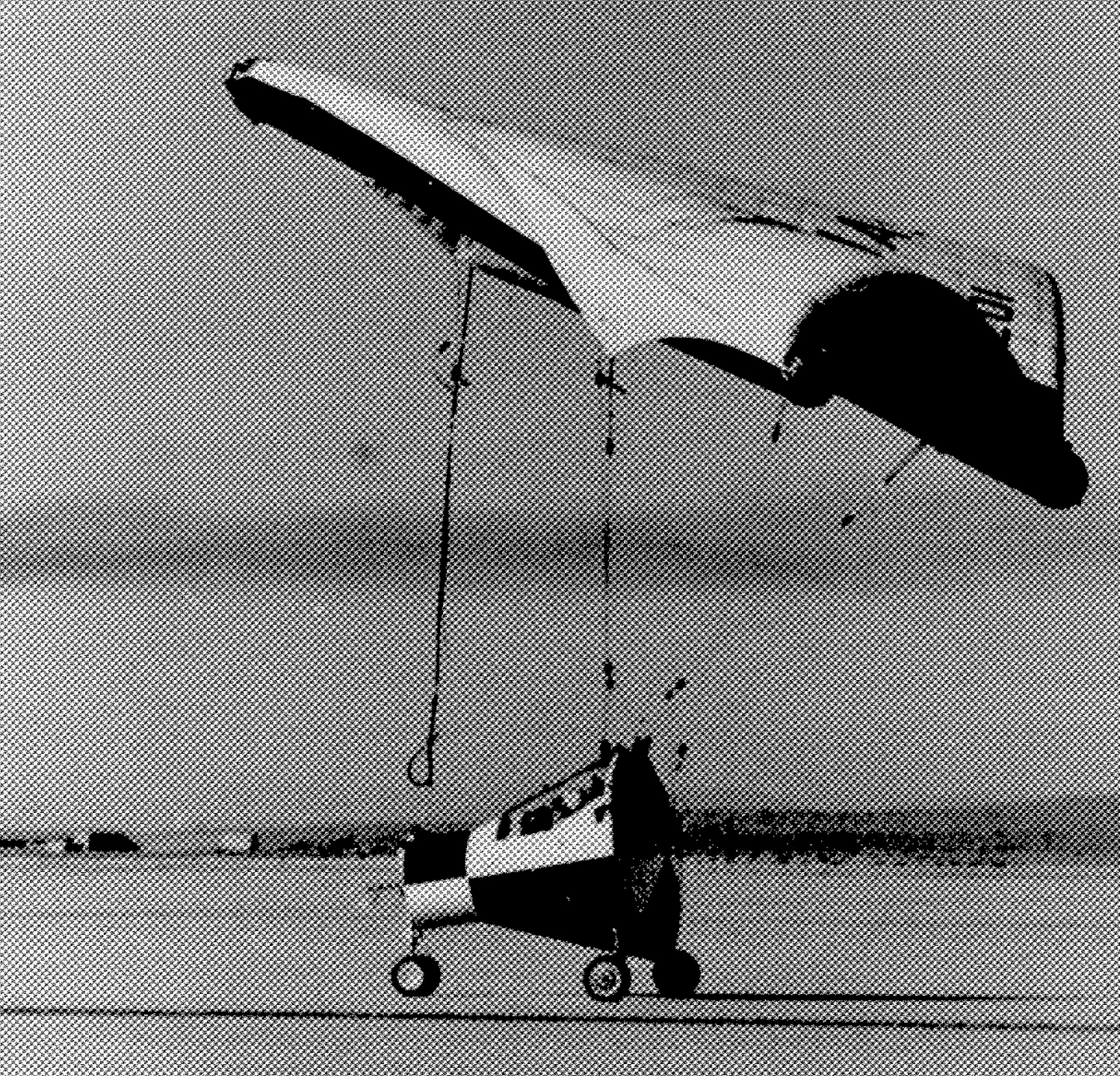
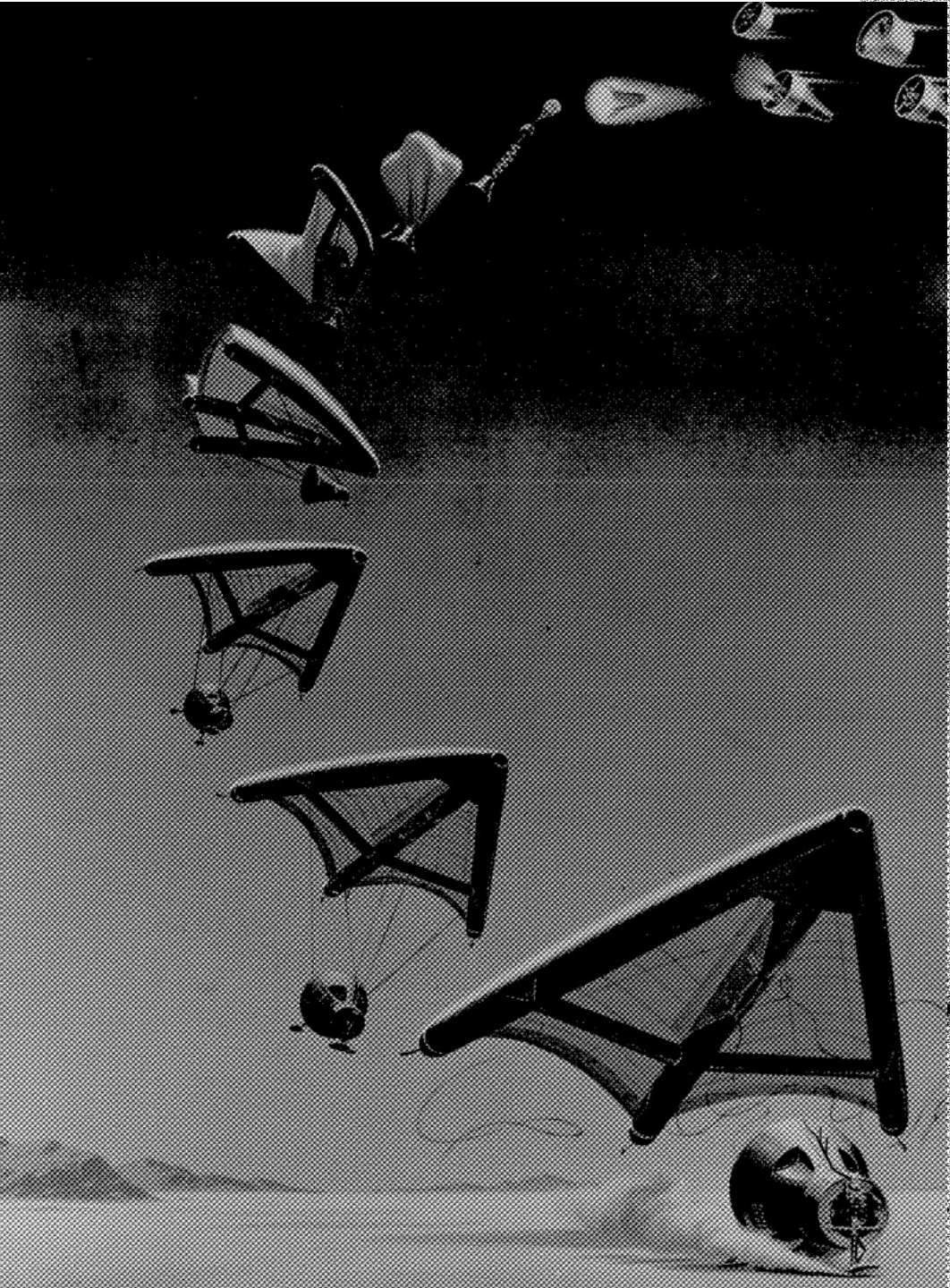
INST 154

Apollo at 50

[Gemini Flight Controller Orientation](#)

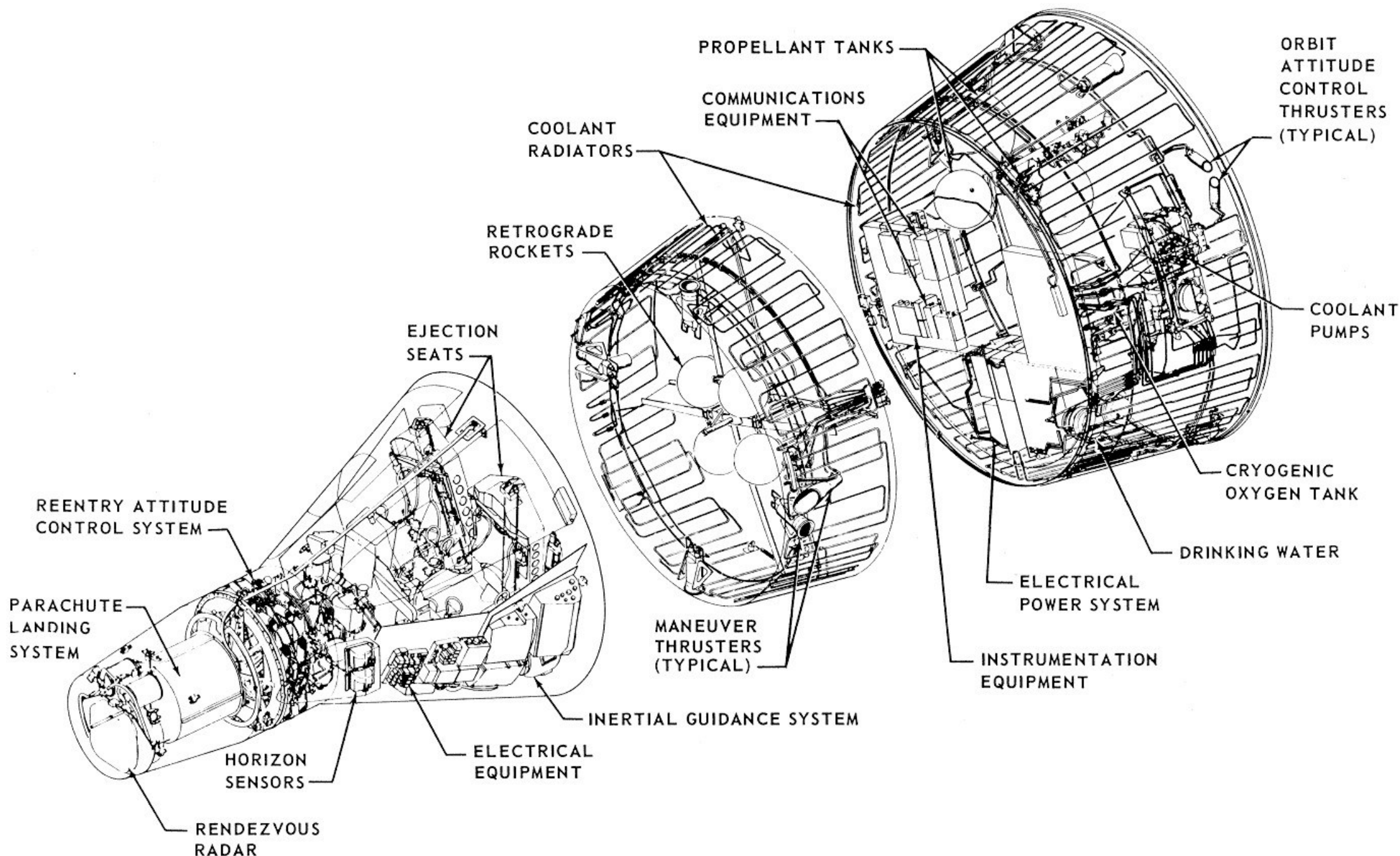
# Gemini Objectives

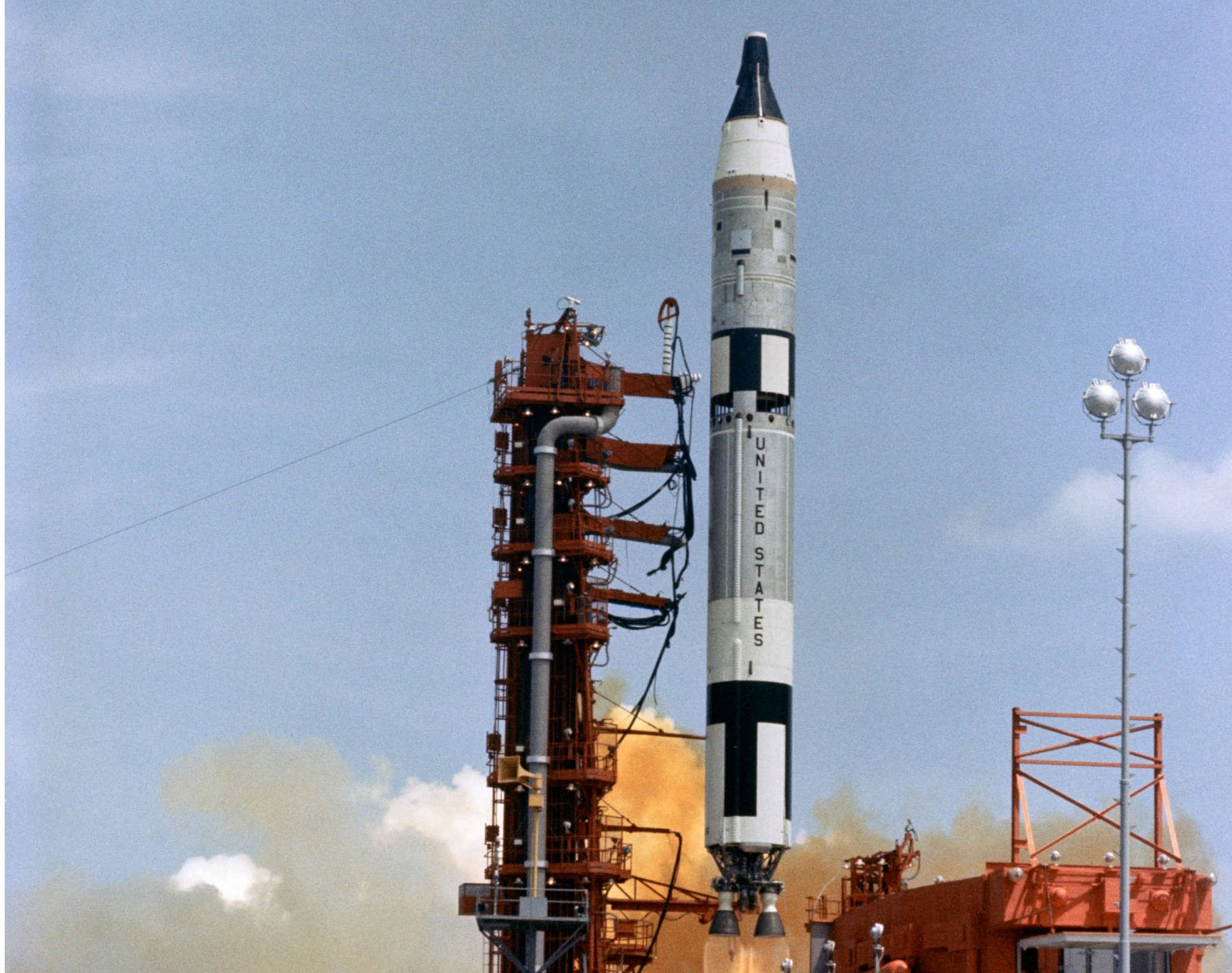
- To demonstrate endurance of humans and equipment in spaceflight for extended periods, at least eight days required for a Moon landing, to a maximum of two weeks **[succeeded]**
- To effect rendezvous and docking with another vehicle, and to maneuver the combined spacecraft using the propulsion system of the target vehicle **[succeeded]**
- To demonstrate Extra-Vehicular Activity (EVA), or space-"walks" outside the protection of the spacecraft, and to evaluate the astronauts' ability to perform tasks there **[succeeded]**
- To perfect techniques of atmospheric reentry and touchdown at a pre-selected location on land **[failed]**





# GEMINI EQUIPMENT ARRANGEMENT

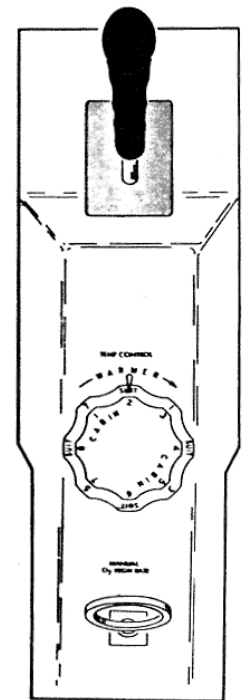
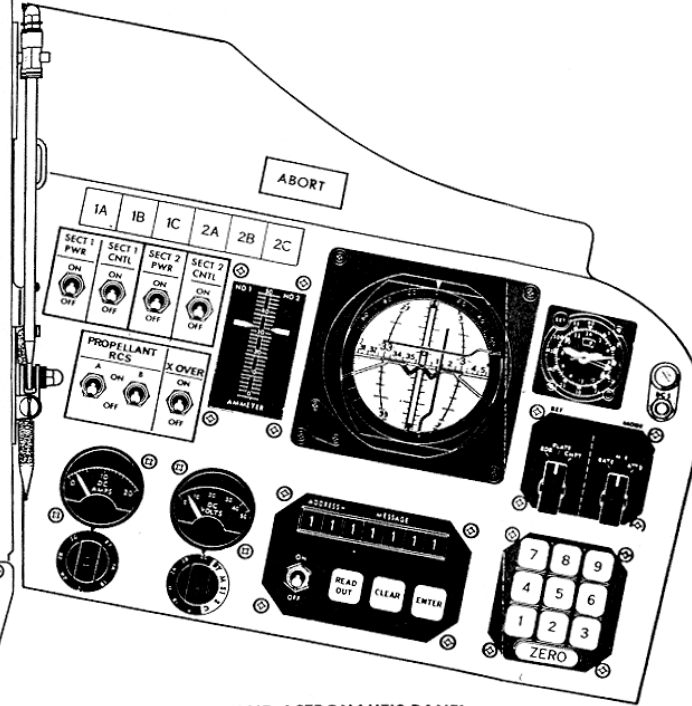
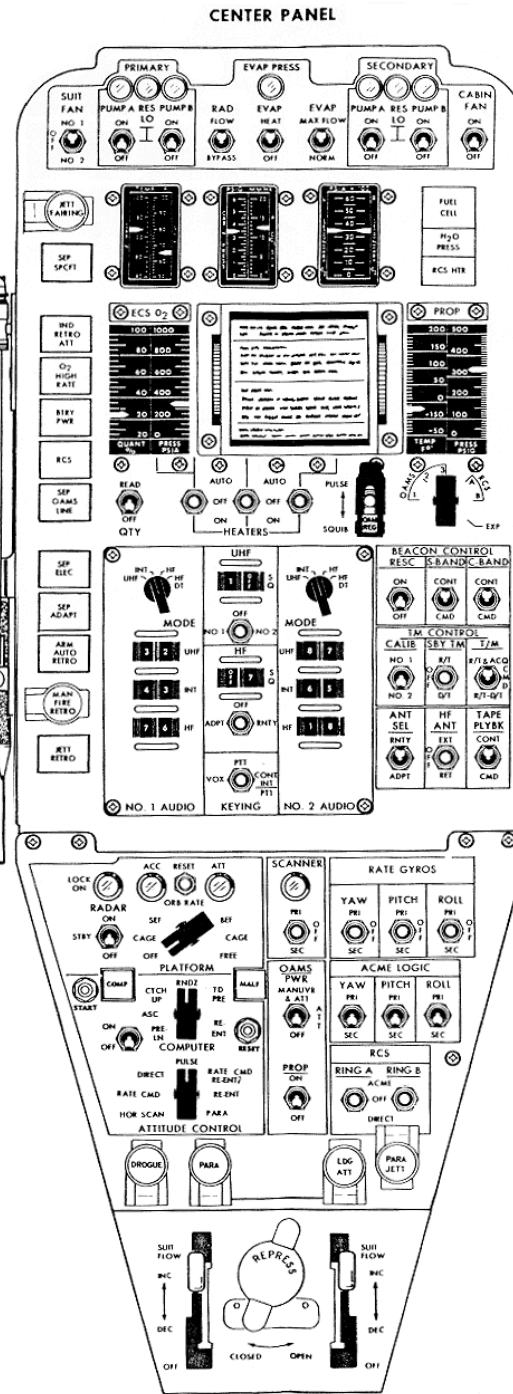
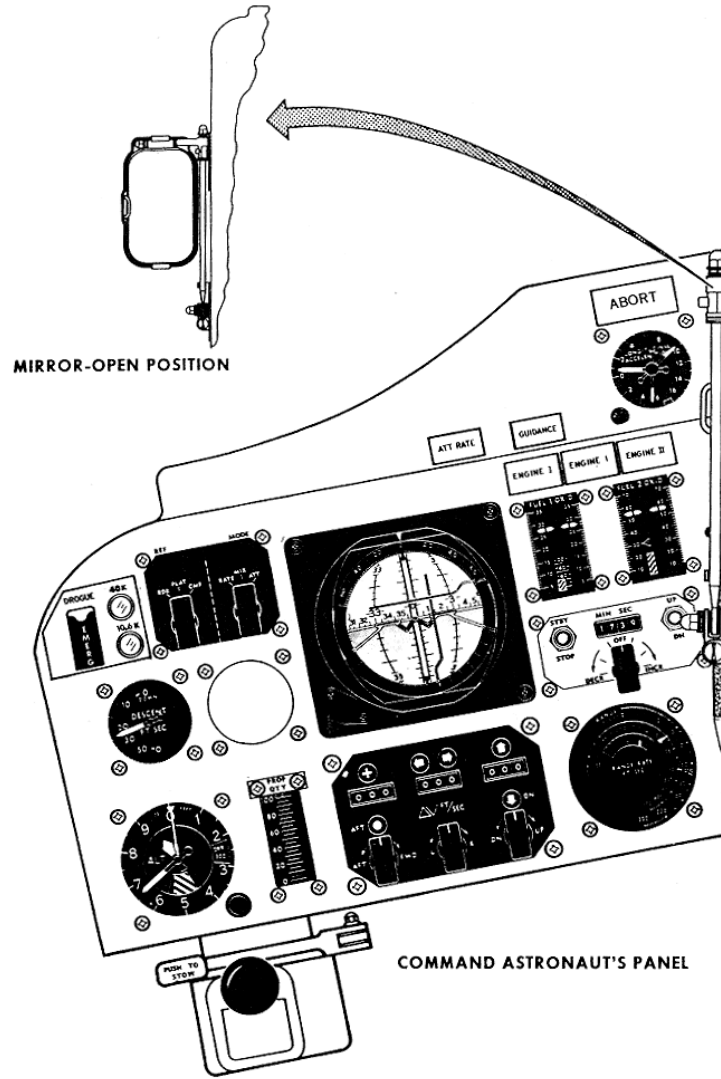




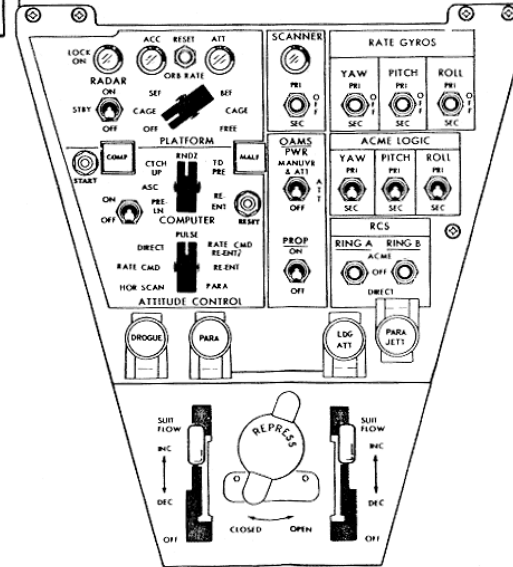
# GEMINI INSTRUMENT PANELS AND CONTROLS

from Project Gemini Familiarization Manual

revised 31 December 1964



PEDESTAL PANEL



# Timeline

- Mercury Mark II program approval (December 1961)
  - Last Mercury mission (May 1963)
- First uncrewed Gemini mission (April 1964)
- First crewed Gemini mission (March 1965)
  - First US Spacewalk (June 1965)
  - First Rendezvous (December 1965)
  - Last Gemini mission (November 1966)
- Uncrewed Air Force Gemini B (MOL program) launch (November 1966)
  - Air Force Manned Orbiting Laboratory program cancelled (June 1969)



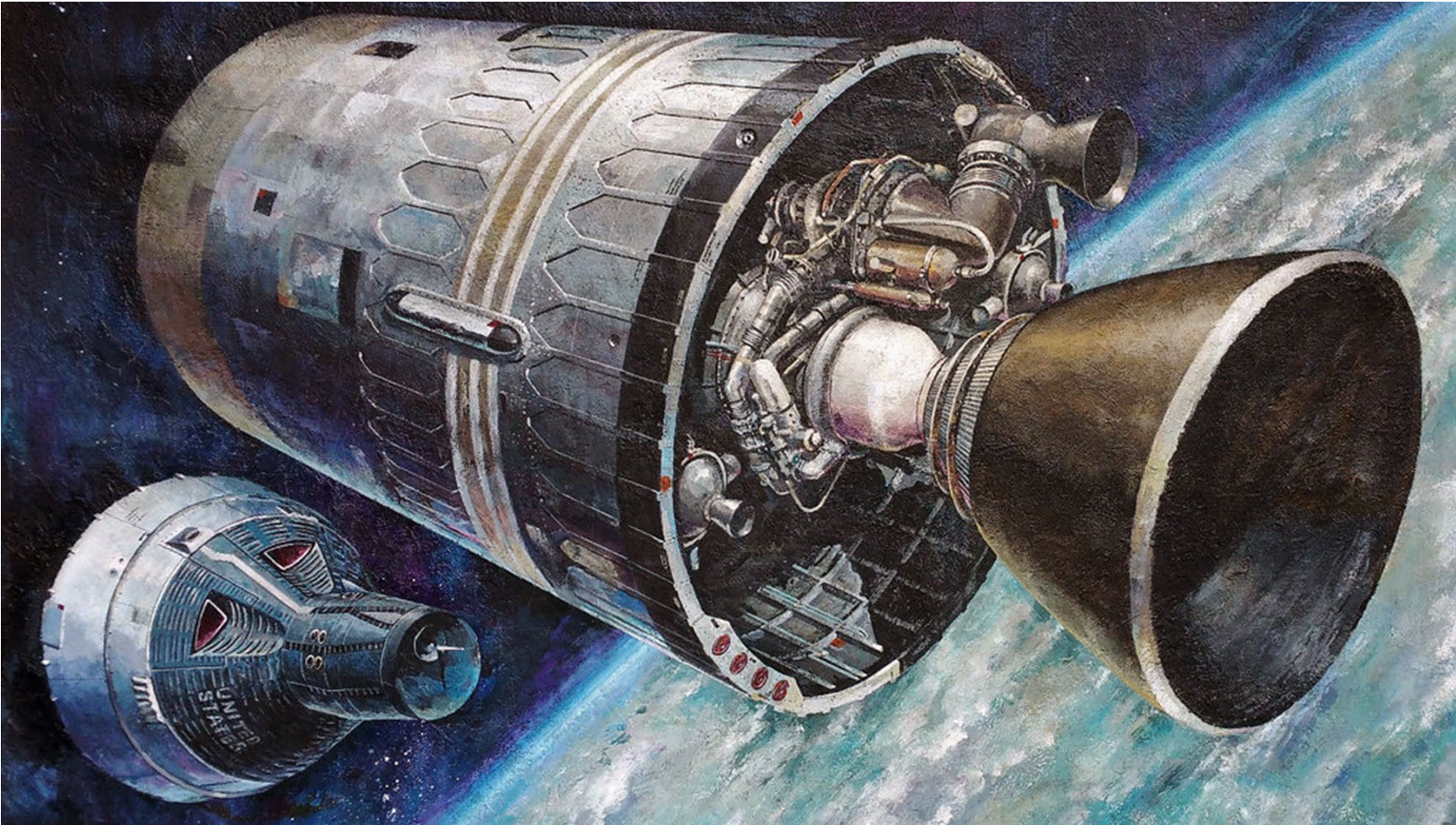


# Long Duration Missions (before Shuttle/Mir)

- Mercury-Atlas 9    1.4 days
- Gemini 4            4.1 days
- Gemini 5            7.9 days
- Gemini 7            13.8 days
- Skylab 2            28.0 days
- Skylab 3            59.5 days
- Skylab 4            84.1 days

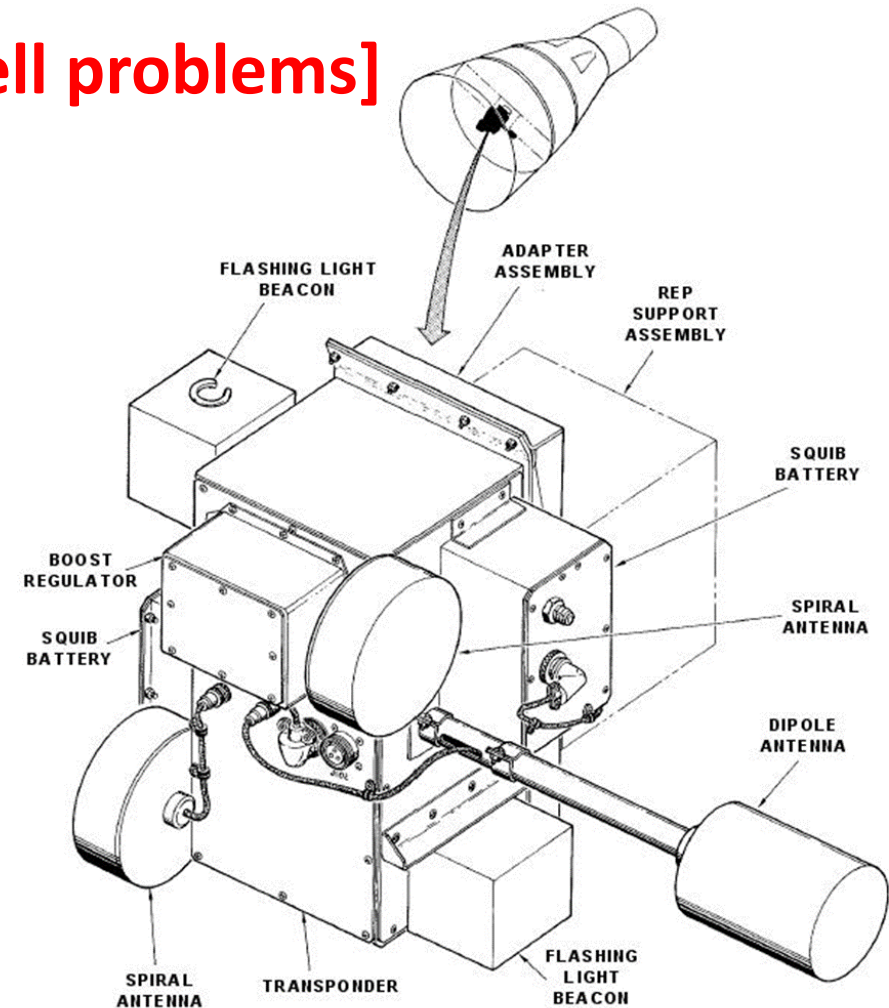
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- Gemini 4 (second stage re-rendezvous) **[venting, line of sight thrusting]**



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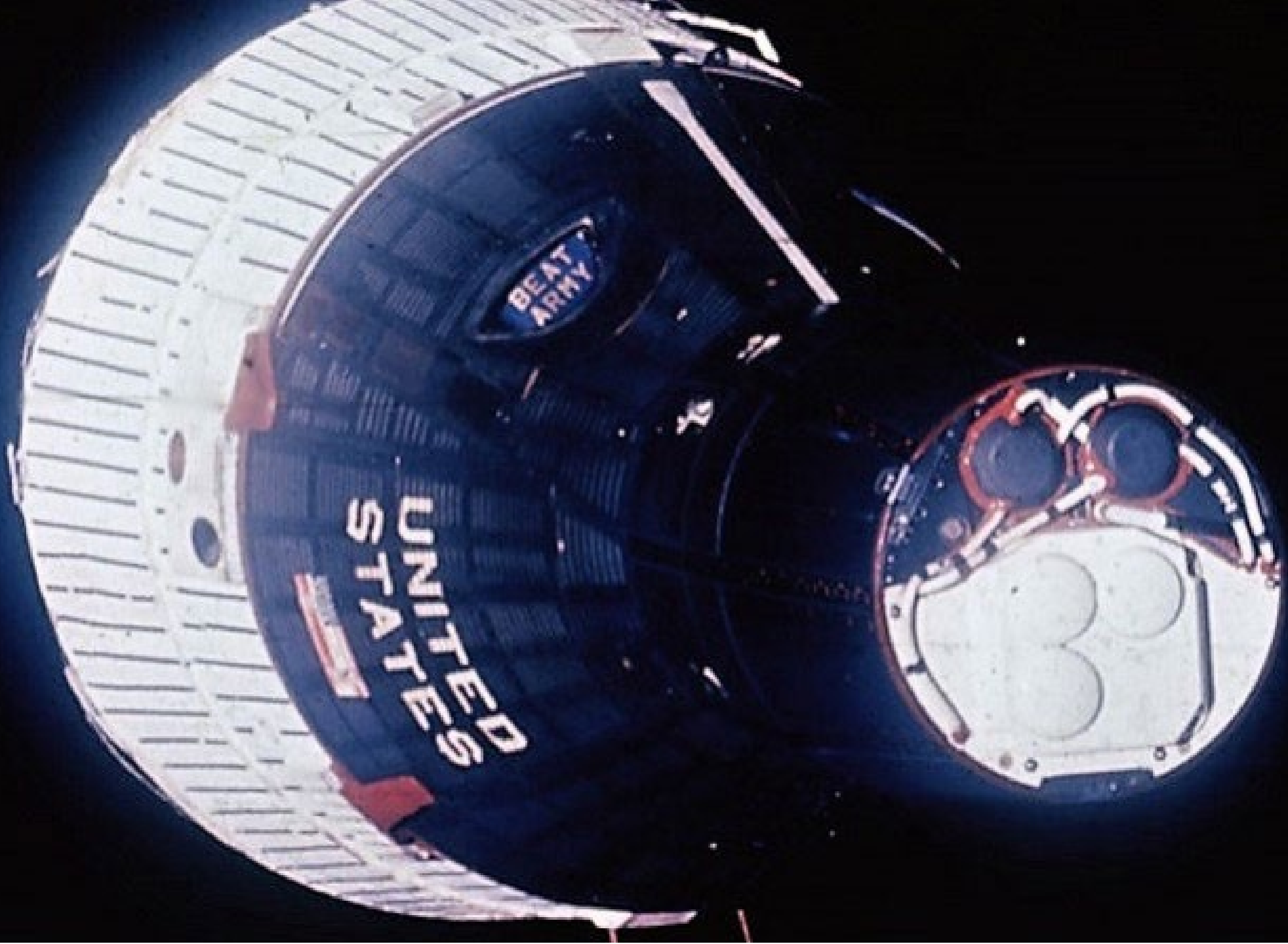
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UNITED STATES

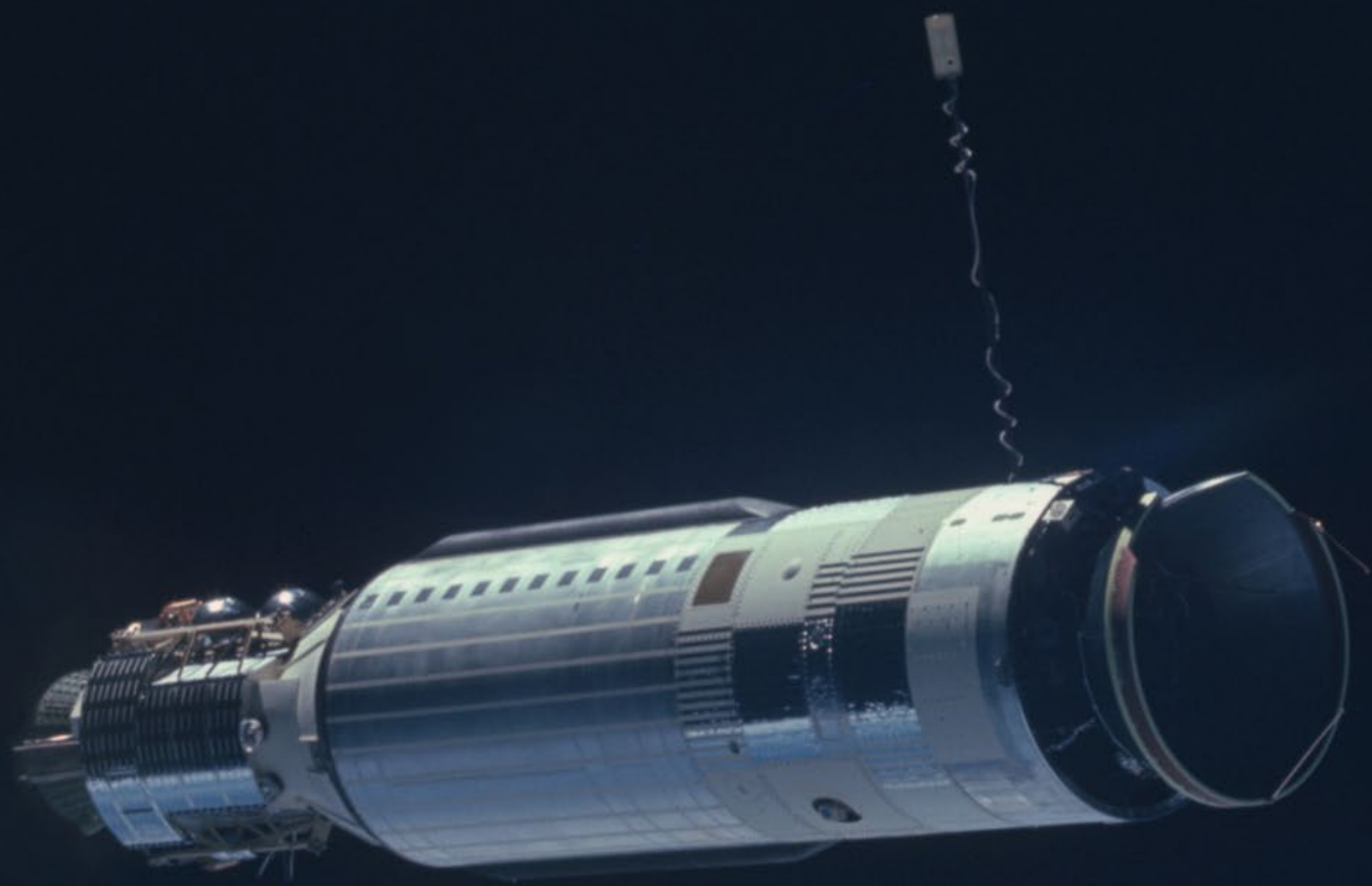
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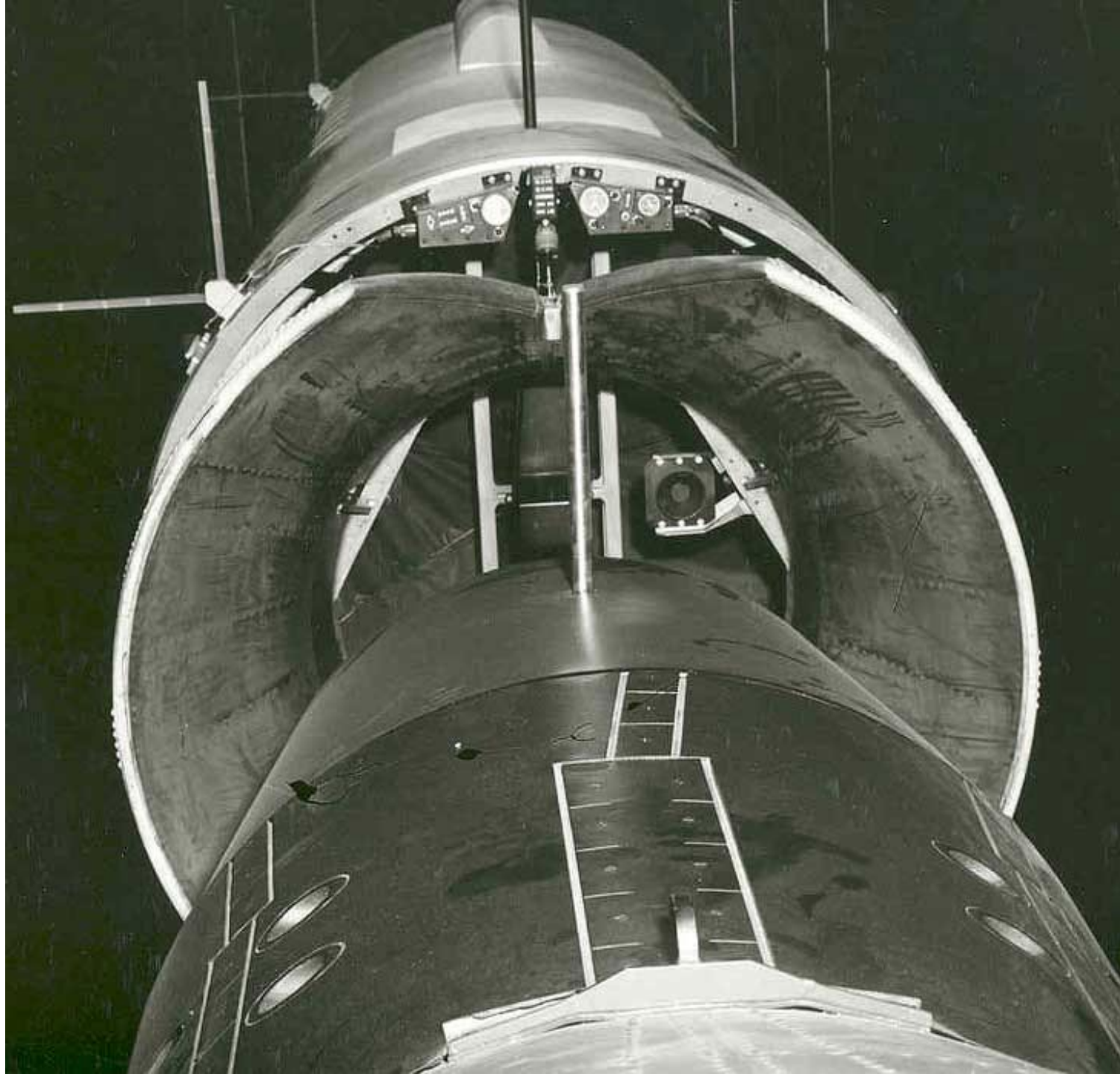


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- Gemini 8 (first docking) **[emergency reentry]**
- Gemini 9A (rendezvous from above) **[backup crew, Atlas fail, ADTA fail]**
- Gemini 10 (rendezvous with an uncooperative target)
- Gemini 11 (rapid one-orbit rendezvous)
- Gemini 12 (unplanned rendezvous without radar)
- Apollo 9 (LM-active rendezvous)
- Apollo 10 (Lunar Orbit Rendezvous)

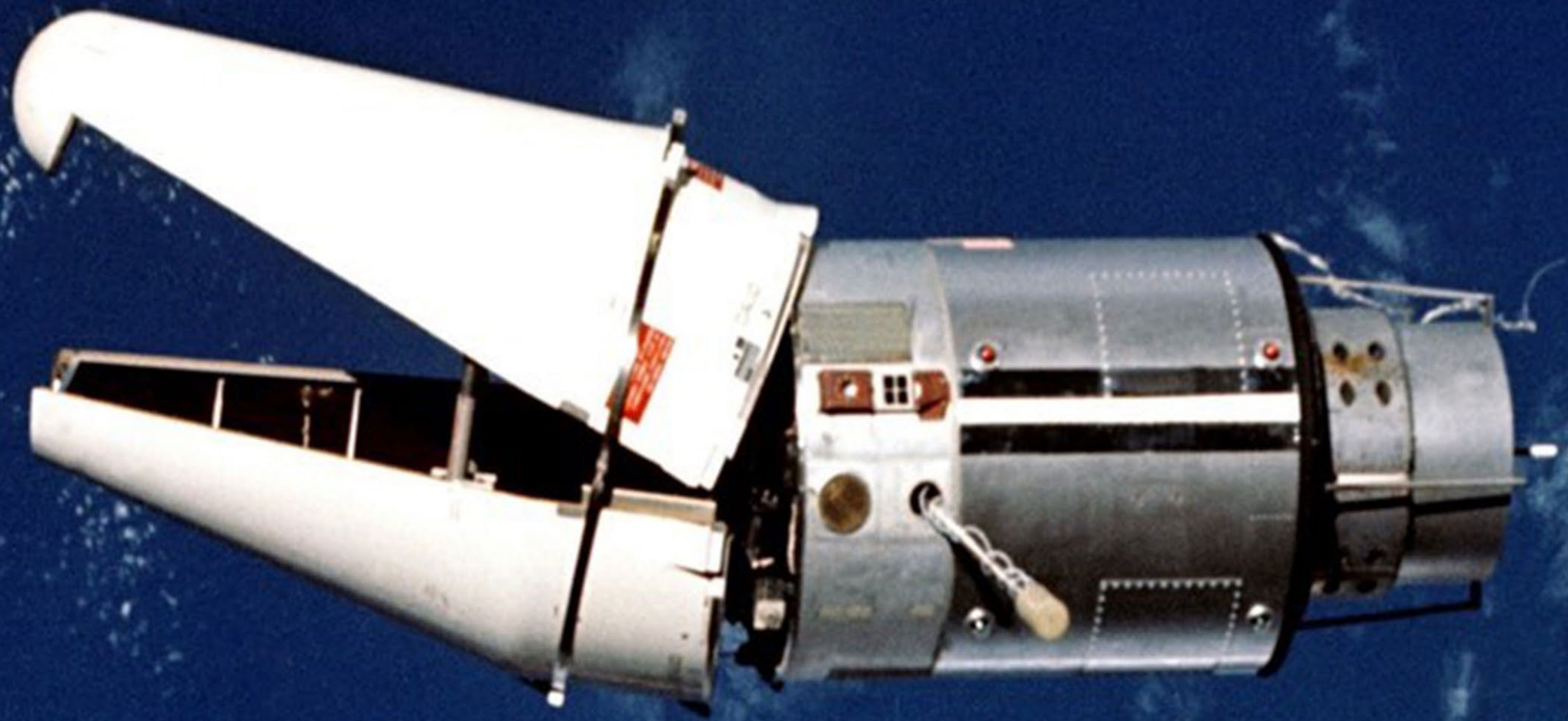






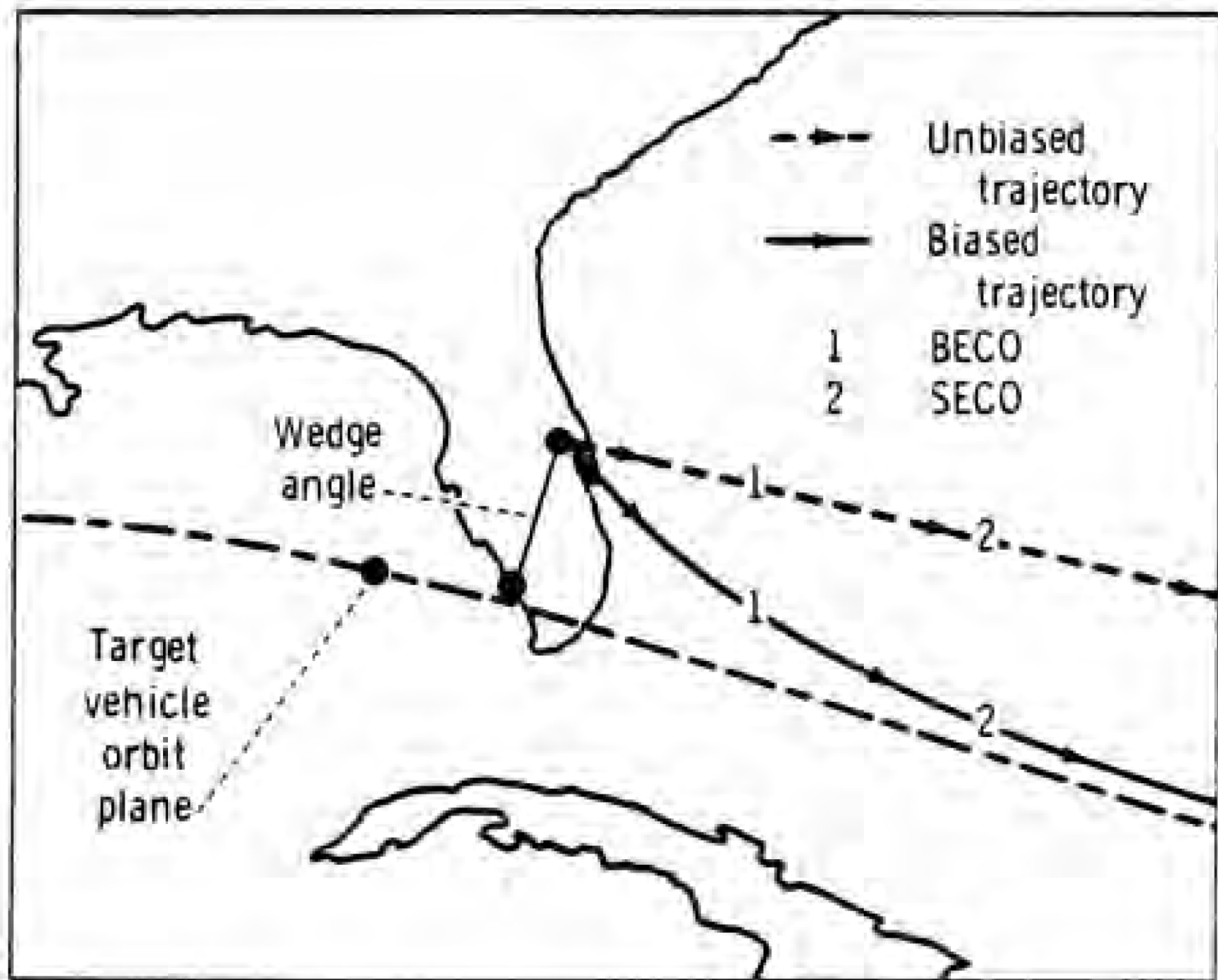
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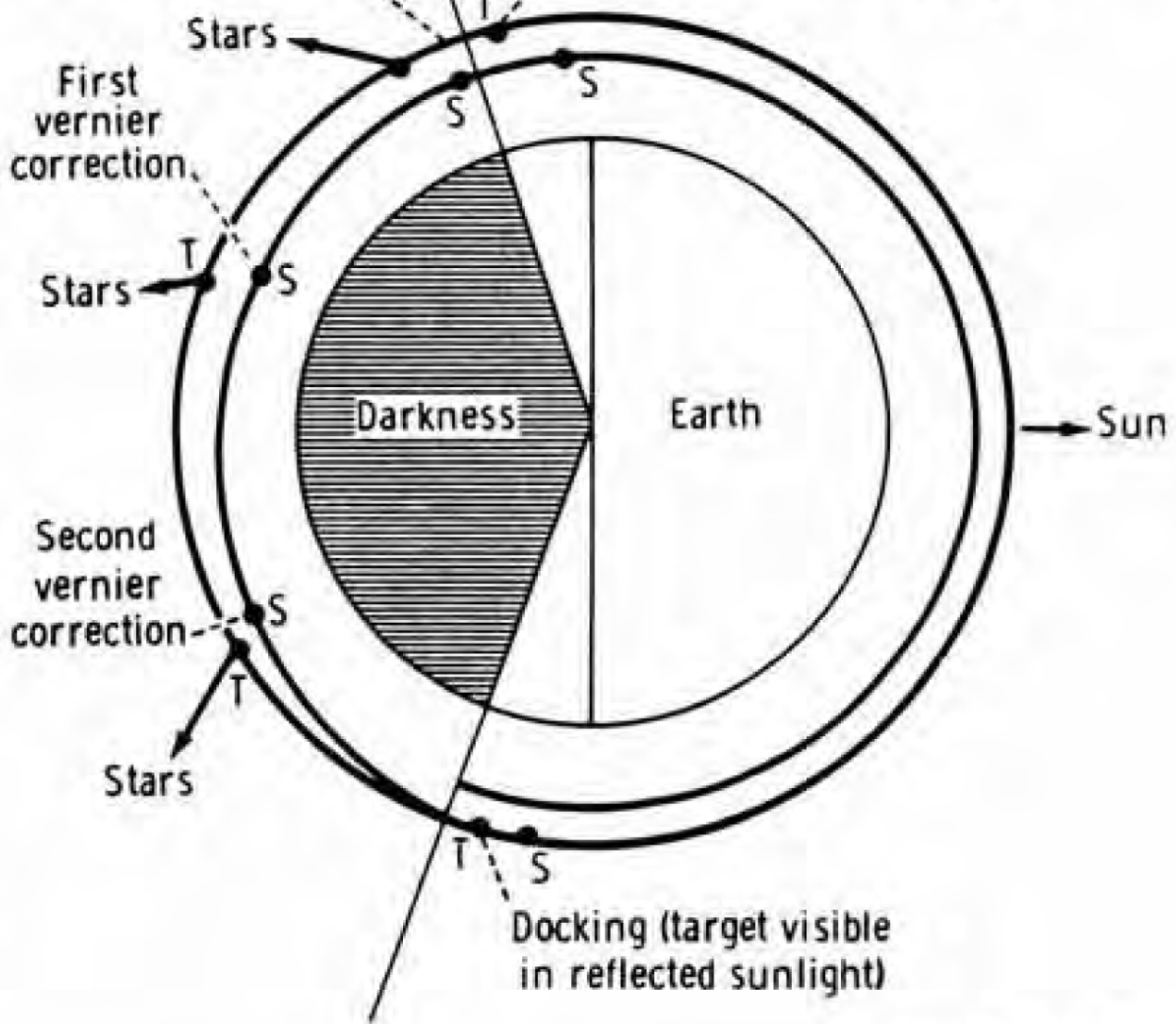
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After terminal-phase initiation (target lights visible)

Prior to and at terminal-phase initiation (target visible in reflected sunlight)



First vernier correction

Second vernier correction

Stars

Stars

Stars

Stars

S

S

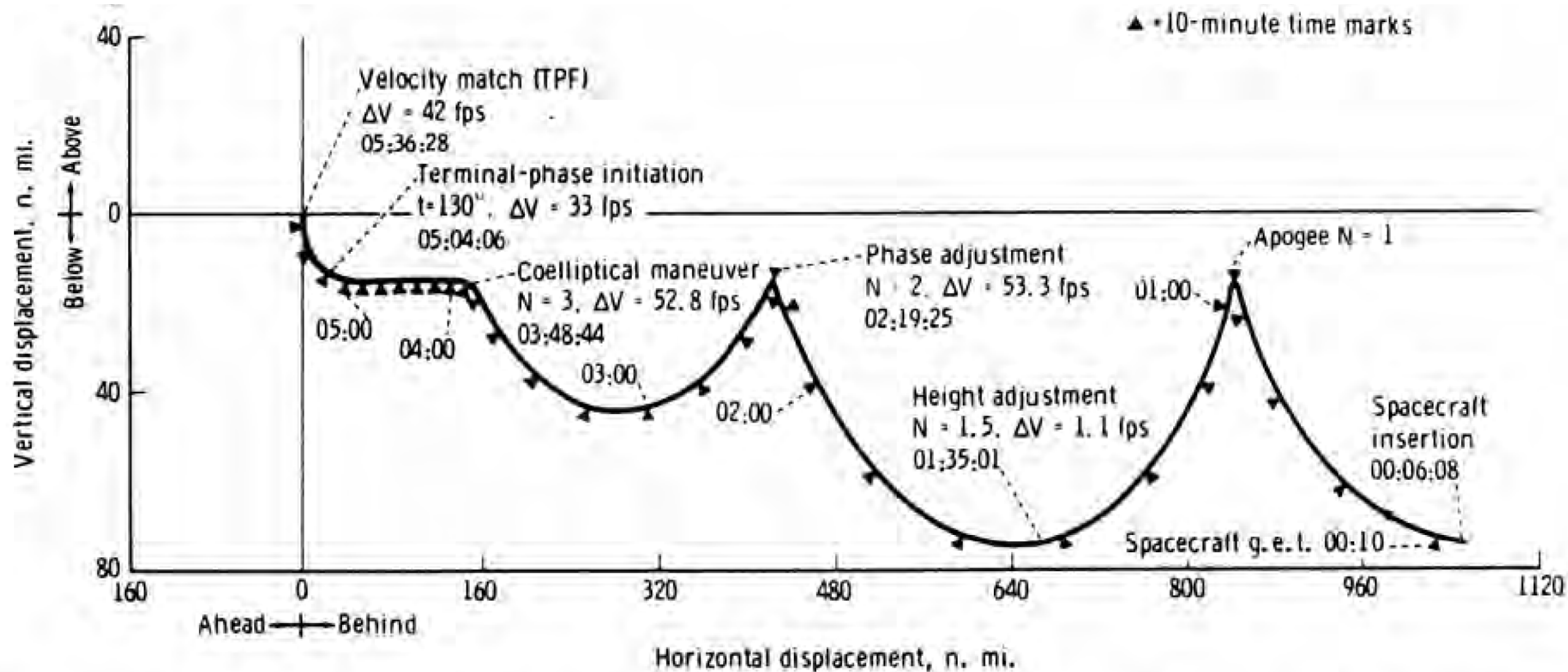
S

S

Docking (target visible in reflected sunlight)

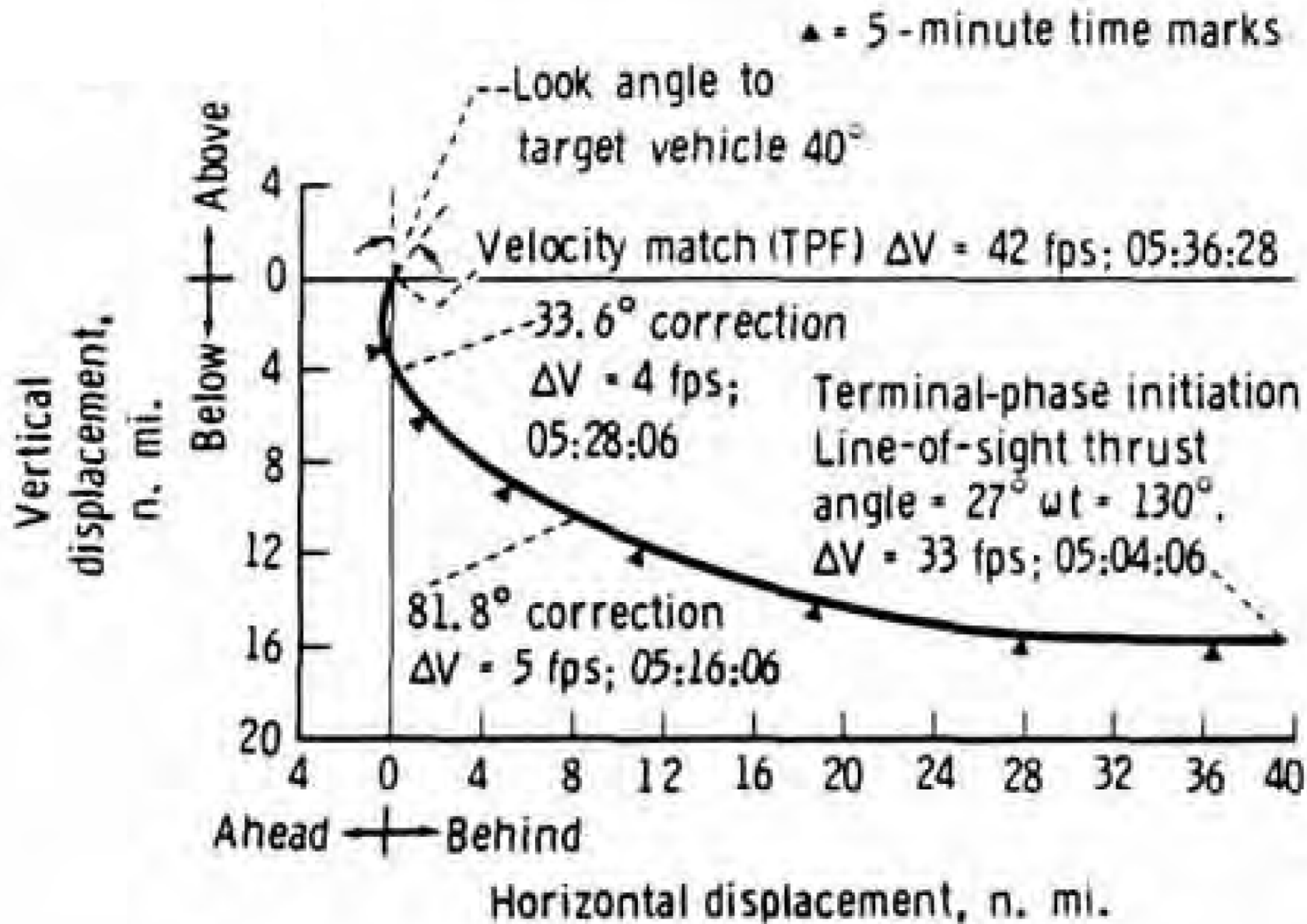
T - Target vehicle  
S - Spacecraft

# M=4 Rendezvous (e.g., Gemini 6A)





# Terminal Phase



# Braking Schedule

## Apollo LOR:

- 6000 feet: -30 fps
- 3000 feet: -20 fps
- 1500 feet: -10 fps
- 600 feet: - 5 fps

## **Gemini 12 Pilot Report:**

Braking was accomplished in increments, starting with a 3 ft/sec decrease to a closing rate of 45 ft/sec at the fourth midcourse correction. At a range of about 1.5 nautical miles, the closing rate had been decreased to about 17 ft/sec. The inertial indicators were used for an inertial reference during this period. The line-of-sight rates were very small throughout this portion of the braking sequence, requiring only one input correction, according to the inertial indicators. At a range of approximately one nautical mile, inertial reference was shifted to the stars.

From approximately one mile range, braking was accomplished in small increments. The analog range and range-rate indicators did not function during the braking phase. Position and closing rates were maintained by monitoring computer information and by visual observations of the target. At the completion of the rendezvous, the propellant-quantity-remaining indicator read 69 percent.

TABLE 2-IV.—Rendezvous Propellant Usage

Gemini mission	Type of rendezvous	Conditions at start of terminal phase	Propellant usage, lb		
			Actual	Minimum	Ratio
VI-A .....	$M = 4$ .....	Coelliptic: $\Delta h = 15$ n. mi. .... $\Delta X = 25$ n. mi. ....	130	81	1.60
VIII .....	$M = 4$ .....	Coelliptic: $\Delta h = 15$ n. mi. .... $\Delta X = 25$ n. mi. ....	160	79	2.02
IX-A .....	$M = 3$ .....	Coelliptic: $\Delta h = 12$ n. mi. .... $\Delta X = 22$ n. mi. ....	113	68	1.66
IX-A .....	Optical .....	$\Delta h = 2.5$ n. mi. .... $\Delta X = 3.5$ n. mi. ....	61	20	3.05
IX-A .....	From above .....	$\Delta h = -7.5$ n. mi. .... $\Delta X = -10$ n. mi. ....	137	39	3.51
X .....	$M = 4$ .....	Coelliptic: $\Delta h = 15$ n. mi. .... $\Delta X = 30$ n. mi. ....	360	84	4.28
X .....	Optical dual .....	Coelliptic: $\Delta h = 7$ n. mi. .... $\Delta X = 12$ n. mi. ....	180	73	2.46
XI .....	$M = 1$ .....	Spacecraft at apogee of 87/151 orbit: $\Delta h = 10$ n. mi. .... $\Delta X = 15$ n. mi. ....	290	191	1.52
XI .....	Stable orbit .....	$\Delta h = 0$ n. mi. .... $\Delta X = 25$ n. mi. ....	87	31	2.81
XII .....	$M = 3$ .....	Coelliptic: $\Delta h = 10$ n. mi. .... $\Delta X = 20$ n. mi. ....	112	55	2.04

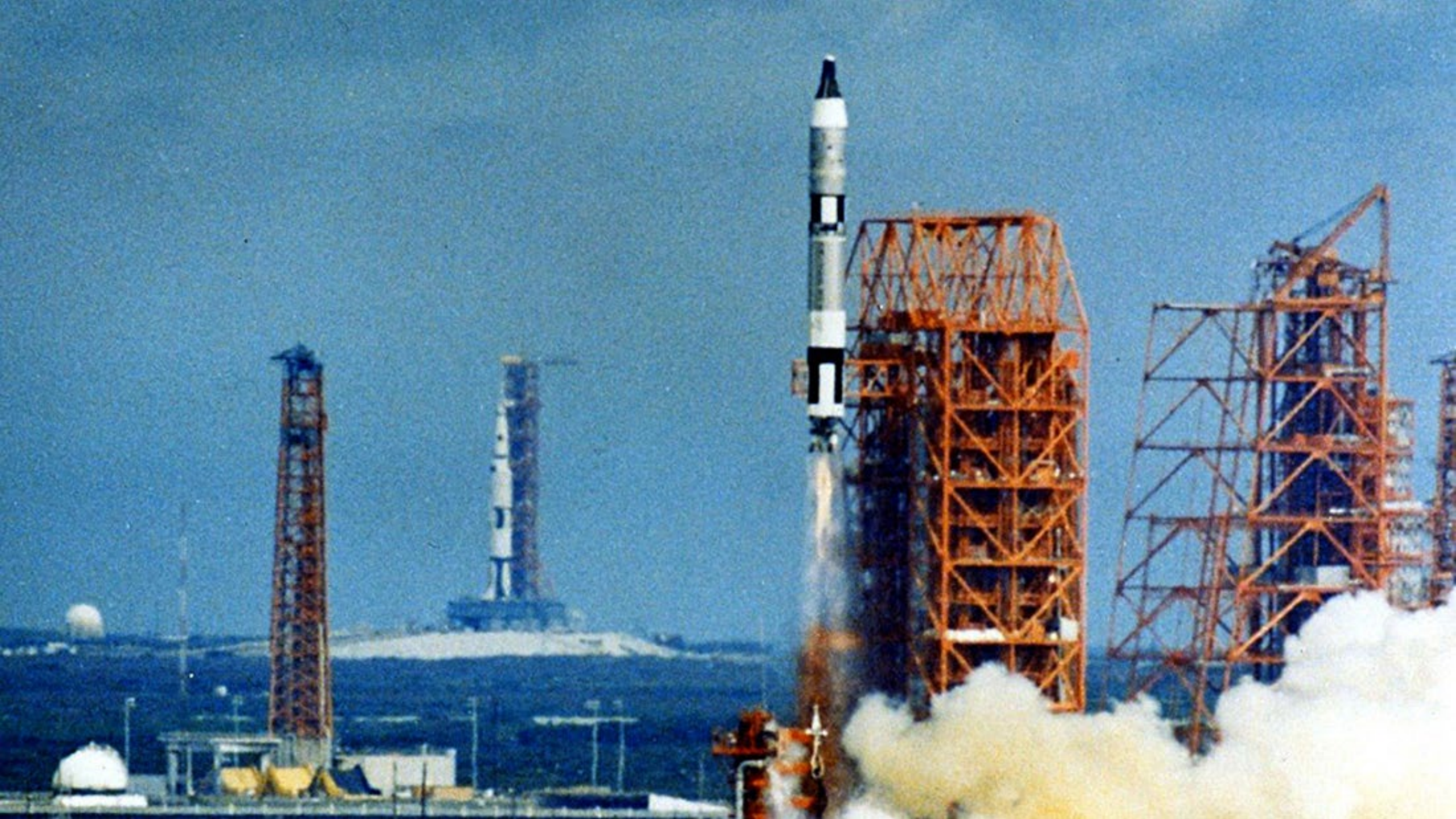
LINE-OF-SIGHT GUIDANCE  
TECHNIQUES FOR MANNED  
ORBITAL RENDEZVOUS

by

Edwin Eugene Aldrin, Jr.

January 1963

degree of Doctor of Science



# Discussion Groups

- FETM video episode 1 (“Can We Do This?”)
  - NASA from the lunar landing decision through the end of Project Gemini
- Mathews (“Collective Knowledge Gained from Gemini”)
  - An conference paper providing an overview of goals and accomplishments
- **Summary Conference chapter 2 (“Summary of Rendezvous Operations”)**
  - **A detailed review of Gemini rendezvous**
- Hacker chapter 12 (“Spirit of 76”)
  - The story of the first rendezvous



CCP

B.A. ШАТААОВ

A.C. ENICEEB

«СОЮЗ-8»

1969

# Readings for Gemini: EVA

- **Portree (“Spacewalks that Never Were: The Gemini EVA Planning Group”)**
  - **The original plans for Gemini EVA – no plan survives first contact with reality!**
- Gemini Summary chapter 9 (“Body Positioning and Restraints during EVA”)
  - A description of what was learned during the Gemini “EVA crisis”
- Neufeld (“Practicing for Space Underwater: Inventing Neutral Buoyancy Training”)
  - A nicely nuanced treatment of the development of the invention of underwater training
- Gemini 12 Mission video
  - An excellent documentary on the Gemini XII underwater training and the mission



# Team Project Status Reports

- Due on ELMS before class next Tuesday
  - And a second one the following Tuesday
- Paragraph 1: What you have done so far
- Paragraph 2: Problems you have encountered
  - Only needed if you have had problems
  - If you need help with problems, also send us an email!

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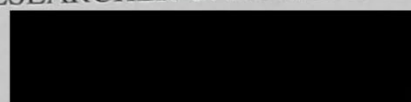
LAST NAME (PRINT)

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FIRST NAME (PRINT)

DOUGLAS

RESEARCHER CARD NUMBER



SERIES OR COLLECTION NAME

Project Planning + site Selection Files

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