Apollo 8: Lunar Orbit

INST 154

Apollo at 50

Onboard Audio

Apollo Mission Sequence

As Planned

- A Uncrewed Saturn V
- B Uncrewed LM
- C CSM Earth Orbit
- D CSM/LM Earth Orbit
- E CSM/LM higher Earth Orbit
- F CSM/LM Lunar Orbit
- G Lunar Landing

As Flown

- A Apollo 4, 6
- B Apollo 5
- C Apollo 7
- C’ Apollo 8
- D Apollo 9
- F Apollo 10
- G Apollo 11

Astronaut Math in mid-1967

- 30 astronauts in first 3 (of 5) astronaut groups
  - The Original 7, The New 9, The 14
- 10 of 30 were no longer available
  - 2 grounded, 2 retired, 6 dead (3 in the Apollo 1 fire, 3 in airplane crashes)
- 18 of 20 were needed to fill 6 crews
  - Cooper and Bean were not assigned
- 13 of 18 had flight experience
  - 6 of 9 Gemini commanders assigned as Apollo CDR
  - 5 of 7 assigned as Apollo CMP (4 with rendezvous experience)
  - 2 assigned as Apollo LMP
- 5 rookies were therefore needed
  - 1 assigned as CMP (Eisele), 4 assigned as LMP

Apollo Crew Planning

Apollo 7 (C)
- CDR: Schirra
- CMP: Eisele
- LMP: Cunningham

Apollo 8 (D) ⟺ Apollo 9 (E)

Apollo 8 (D)
- CDR: McDivitt
- CMP: Scott
- LMP: Schweickart

Apollo 9 (E)
- CDR: Borman
- CMP: Collins
- LMP: Anders

Apollo 10 (F)
- CDR: Stafford
- CMP: Young
- LMP: Cernan

Apollo 11 (G) ⟺ Apollo 12 (H)

Apollo 11 (G)
- CDR: Conrad
- CMP: Gordon
- LMP: Williams

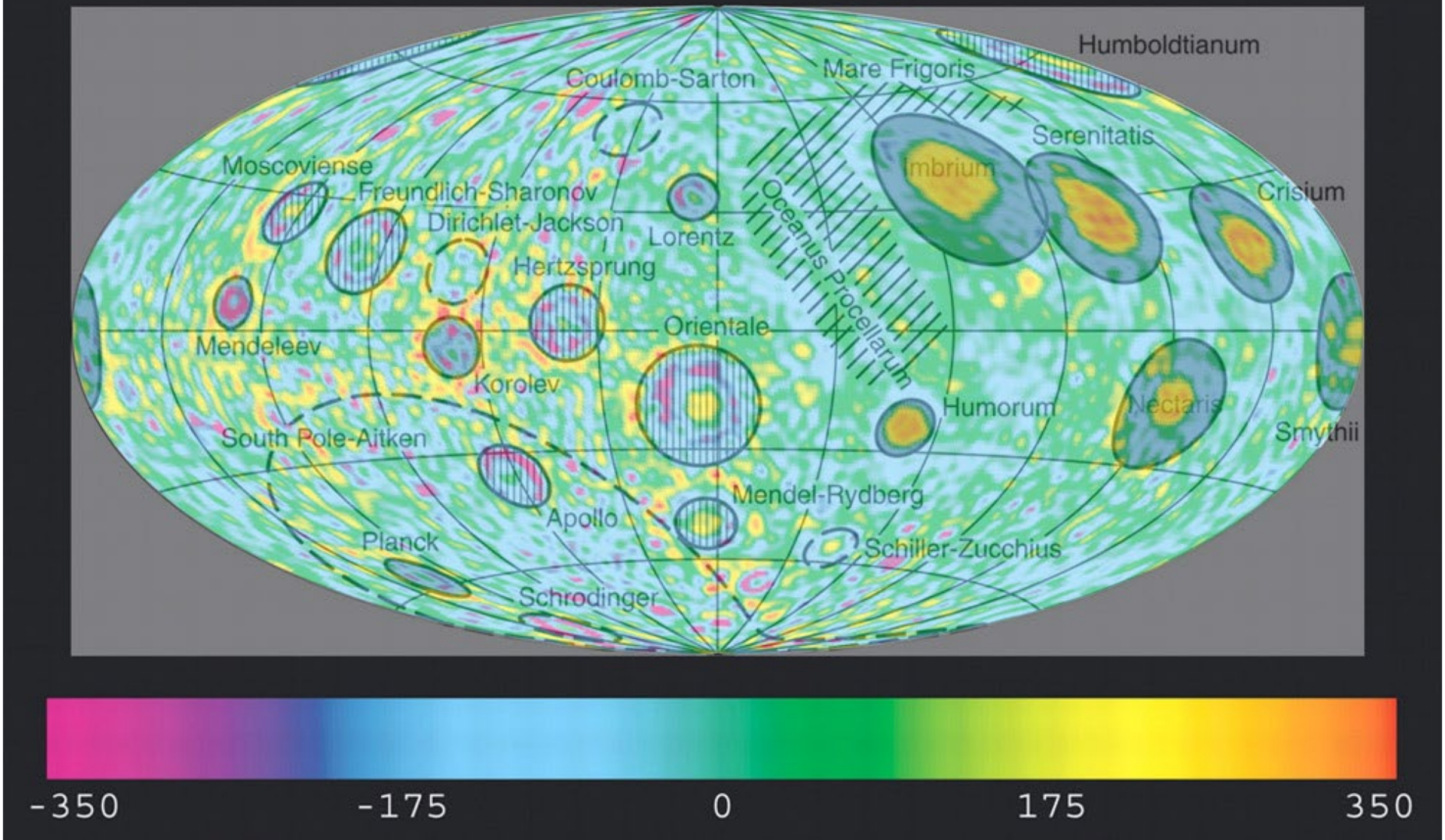
⇧ Bean

Apollo 12 (H)
- CDR: Armstrong
- CMP: Lovell
- LMP: Aldrin

⇧ Haise

Arguments in Favor of a Lunar Orbit Mission

- Provide valuable operational experience … This will enhance the probability of success of subsequent more complex lunar missions
- Provide an opportunity to evaluate … MSFN and onboard navigation …
- Permit validation of communications … at lunar distance
- … improve consumables requirements prediction …
- … verification of ground support elements and the onboard computer program
- Increase the depth of understanding of thermal conditions …
- Confirm astronauts' ability to see, use and photograph lunar landmarks …
- … an opportunity for additional photographs … for training crewmen …


Humboldtianum
Coulomb-Sarton
Mare Frigoris
Serenitatis
Moscoviense
Imbrium
Crisium
Freundlich-Sharonov
Dirichlet-Jackson
Lorentz
Oceanus Procellarum
Hertzsprung
Orientale
Mendeleev
Korolev
Humorum
Nectaris
Smythii
South Pole-Aitken
Mendel-Rydberg
Apollo
Planck
Schiller-Zucchius
Schrodinger
-350
-175
0
175
350

Arguments Against a Lunar Orbit Mission

- Marginal design conditions in the Block II CSM may not have been uncovered with only one manned flight
- The life of the crew depends on the successful operation of the Service Propulsion System during the Transearth Injection maneuver
- The three days endurance level required of backup systems in the event of an abort is greater than from an Earth orbit mission
- Only landmark sightings and lunar navigation require a lunar mission …

Missing Redundancy

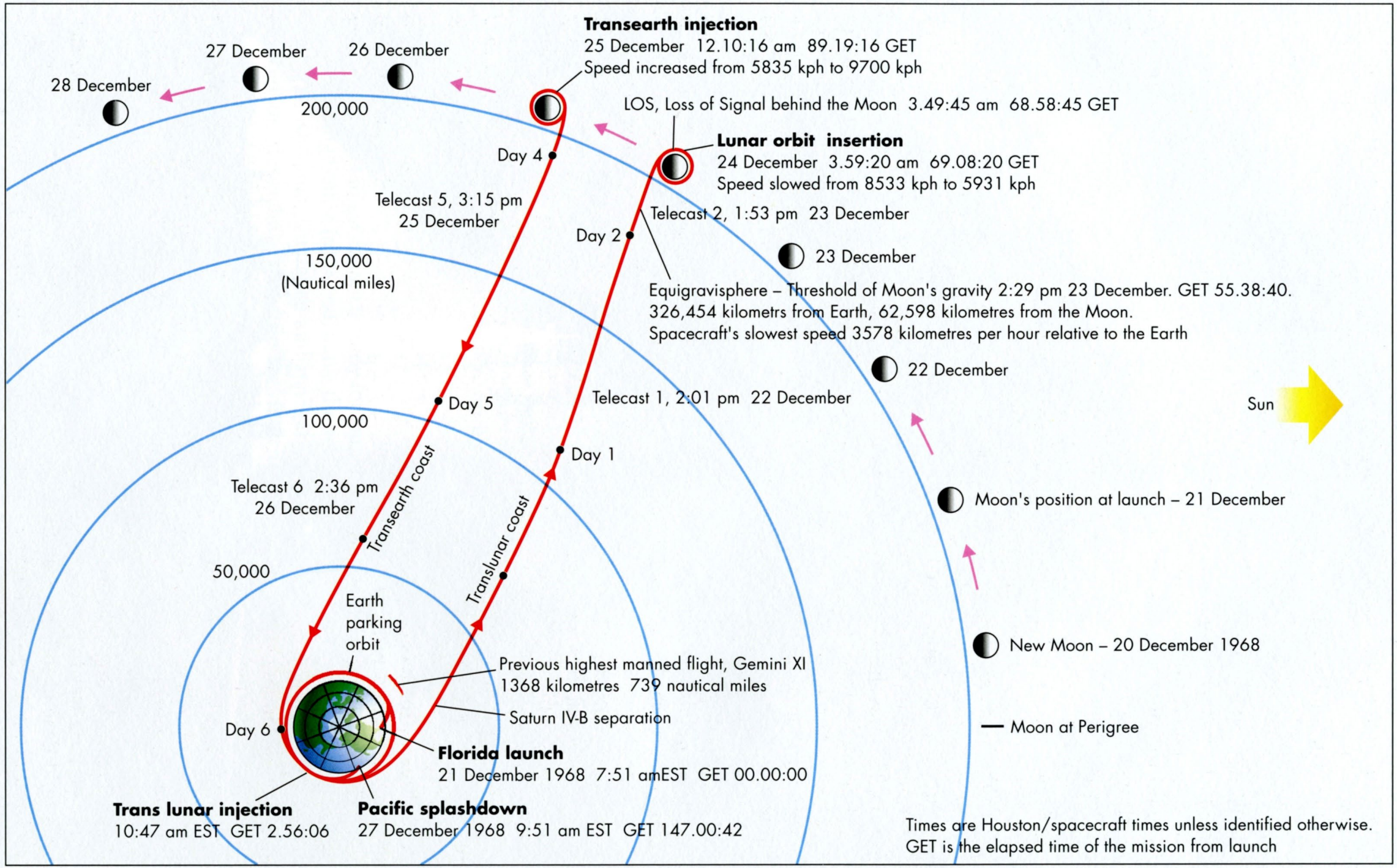
- No “LM Lifeboat” for consumables or communication between TLI and TEI

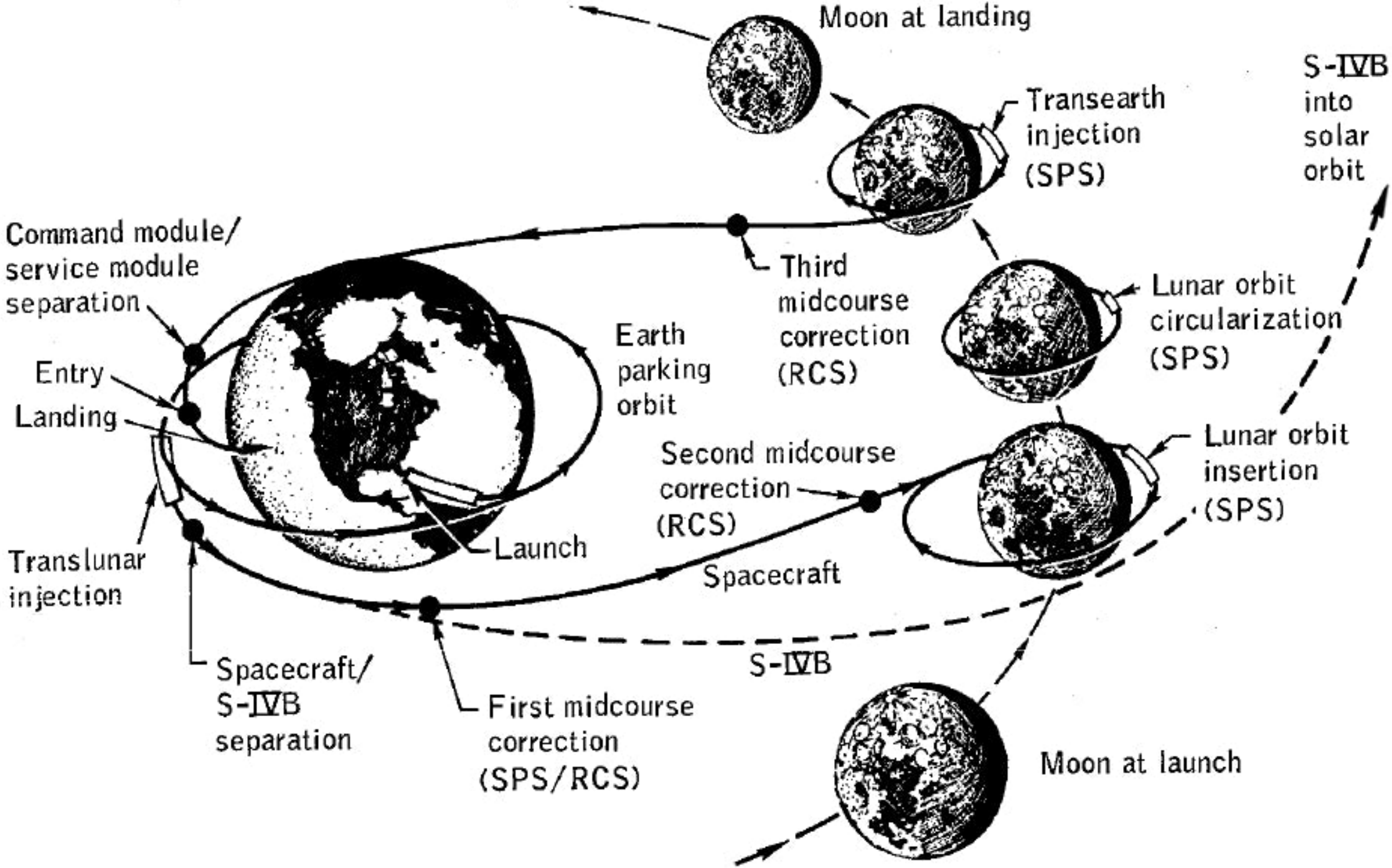
- No option for LM DPS TEI in the event of an SPS failure during LOI

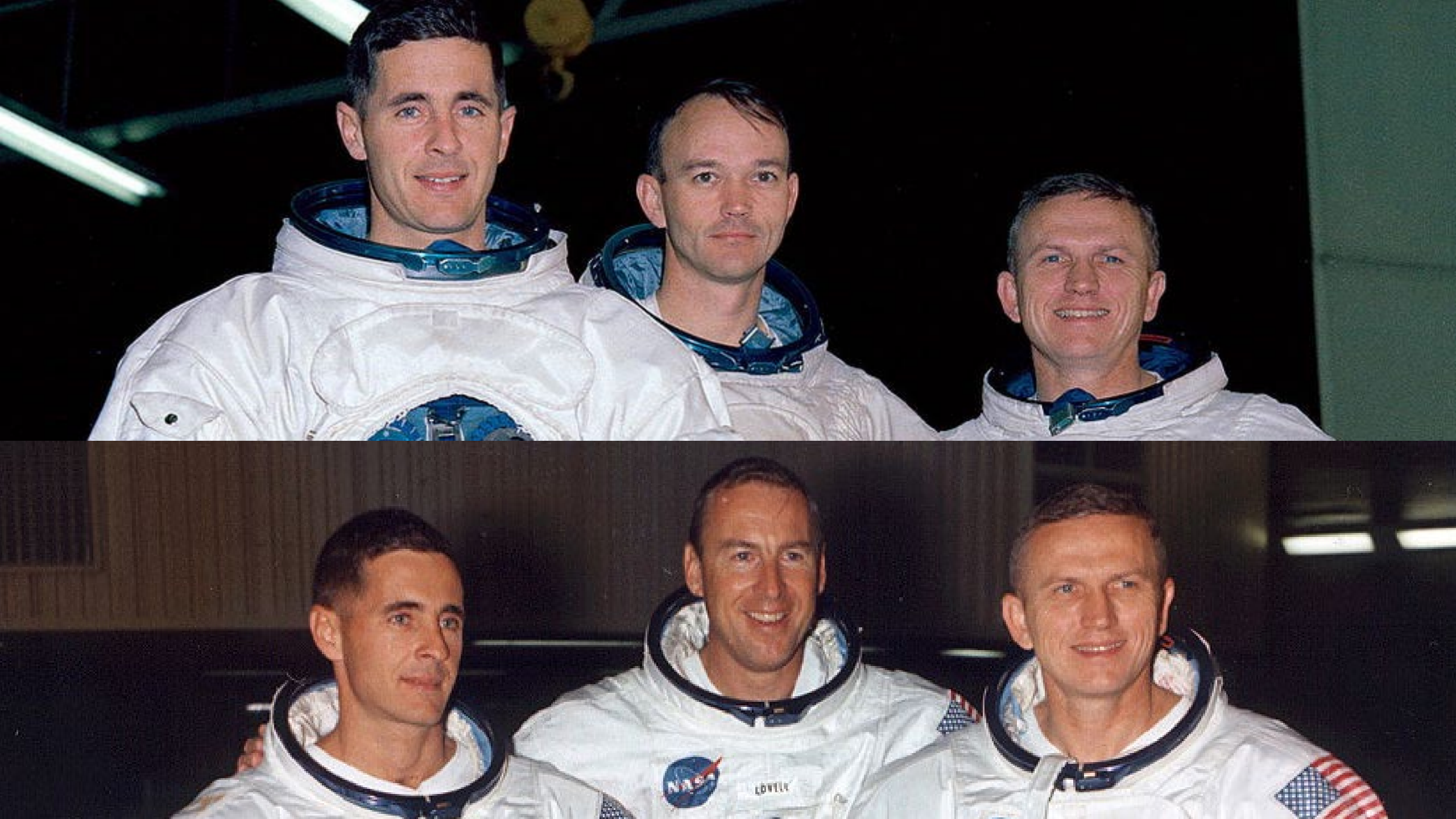
Primary Mission Objectives

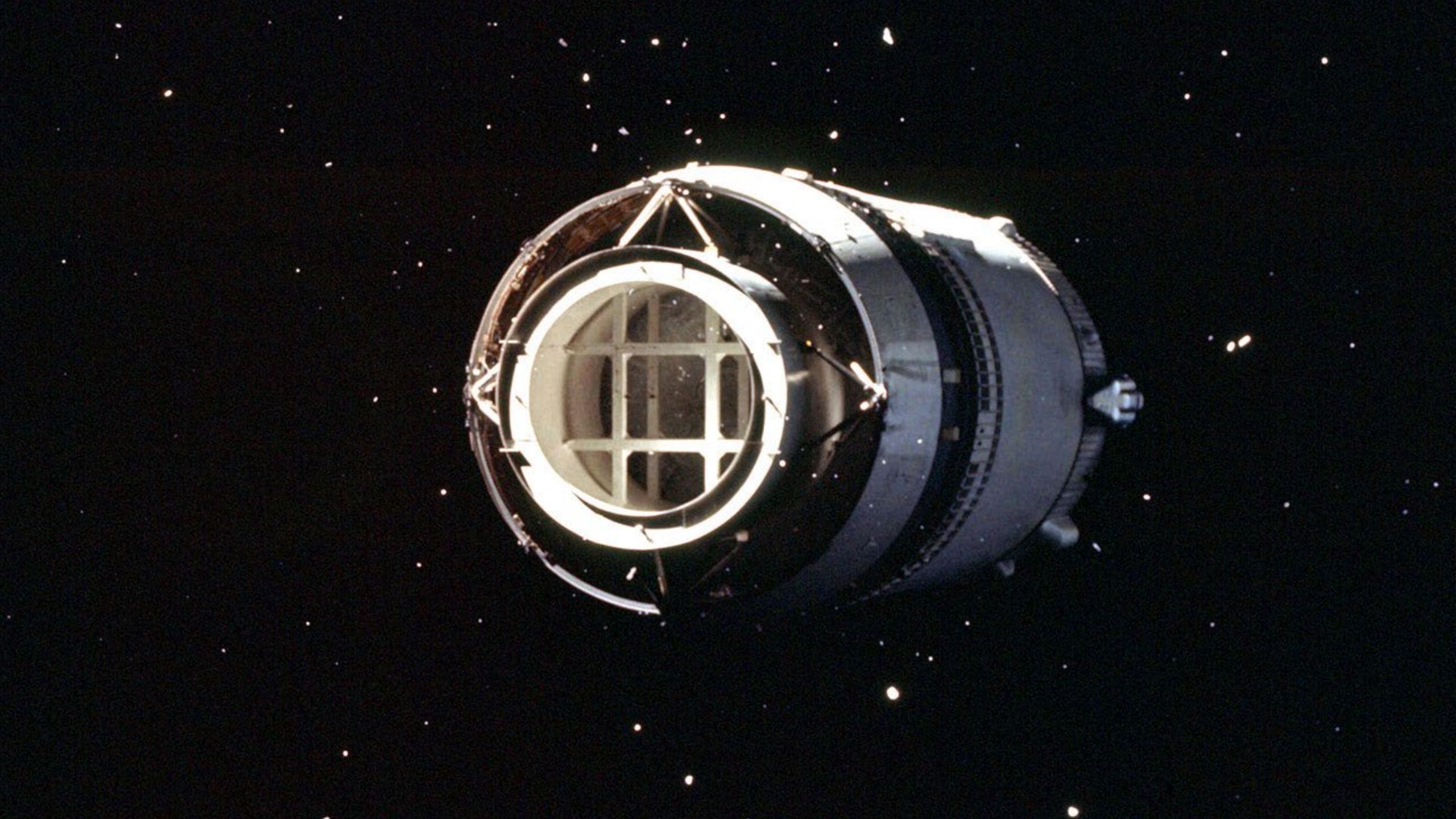
- Demonstrate crew/space vehicle/mission support facilities performance during a manned Saturn V mission with CSM

- Demonstrate performance of nominal and selected backup Lunar Orbit Rendezvous (LOR) mission activities, including: Trans-Lunar Injection; CSM navigation, communications, and midcourse corrections; CSM consumables assessment, and passive thermal control

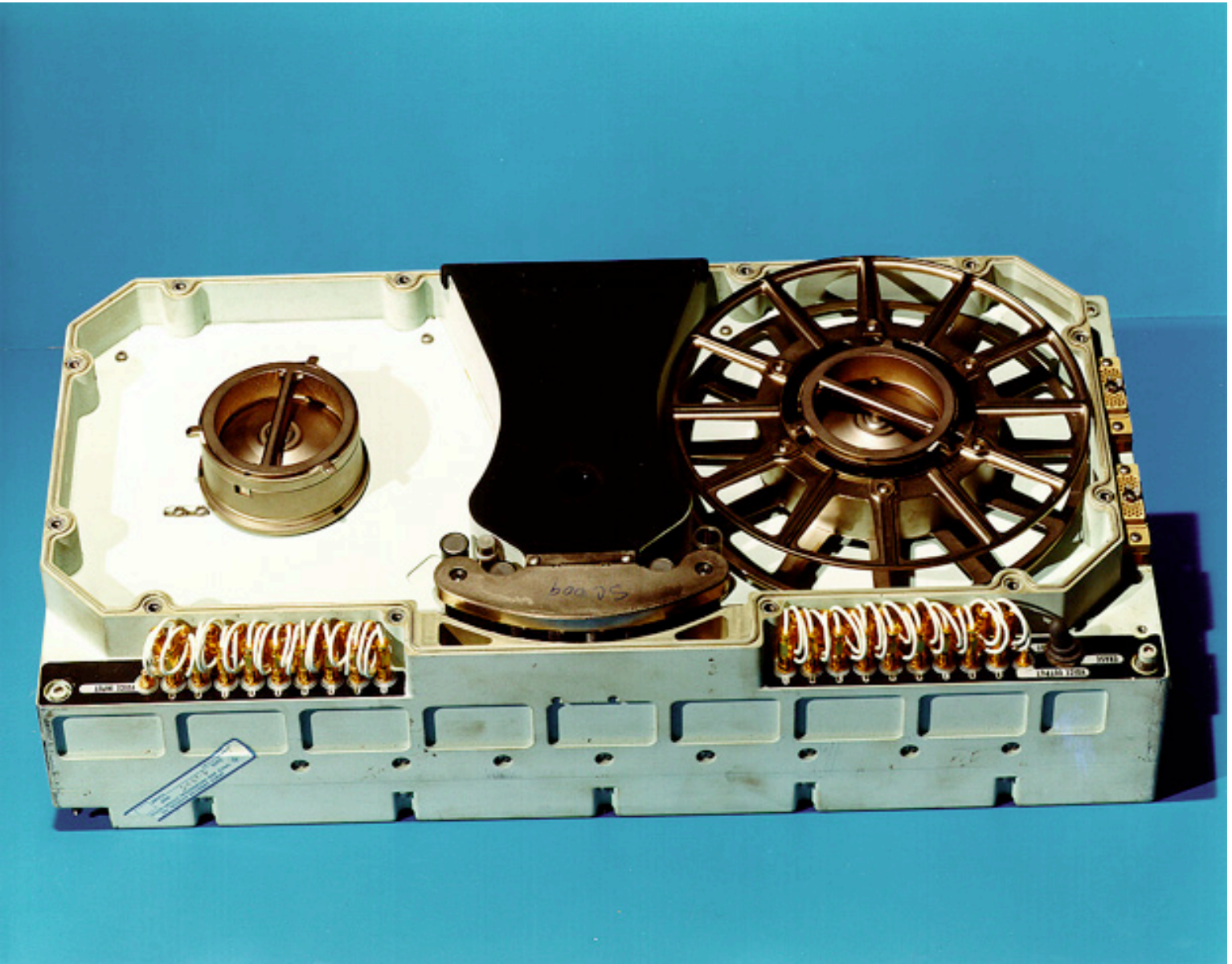

Transearth injection
25 December 12.10:16 am 89.19:16 GET
Speed increased from 5835 kph to 9700 kph
LOS, Loss of Signal behind the Moon 3.49:45 am 68.58:45 GET
Lunar orbit insertion
24 December 3.59:20 am 69.08:20 GET
Speed slowed from 8533 kph to 5931 kph
27 December
26 December
28 December
200,000
Day 4
Telecast 5, 3:15 pm
25 December
Telecast 2, 1:53 pm 23 December
Day 2
23 December
150,000
(Nautical miles)
Equigravisphere – Threshold of Moon's gravity 2:29 pm 23 December. GET 55.38:40.
326,454 kilometrs from Earth, 62,598 kilometres from the Moon.
Spacecraft's slowest speed 3578 kilometres per hour relative to the Earth
22 December
Telecast 1, 2:01 pm 22 December
Sun
Day 5
100,000
Day 1
Telecast 6 2:36 pm
26 December
Transearth coast
Translunar coast
Moon's position at launch – 21 December
50,000
Earth
parking
orbit
Previous highest manned flight, Gemini XI
1368 kilometres 739 nautical miles
New Moon – 20 December 1968
Saturn IV-B separation
Day 6
Moon at Perigree
Florida launch
21 December 1968 7:51 amEST GET 00.00:00
Trans lunar injection
10:47 am EST GET 2.56:06
Pacific splashdown
27 December 1968 9:51 am EST GET 147.00:42
Times are Houston/spacecraft times unless identified otherwise.
GET is the elapsed time of the mission from launch

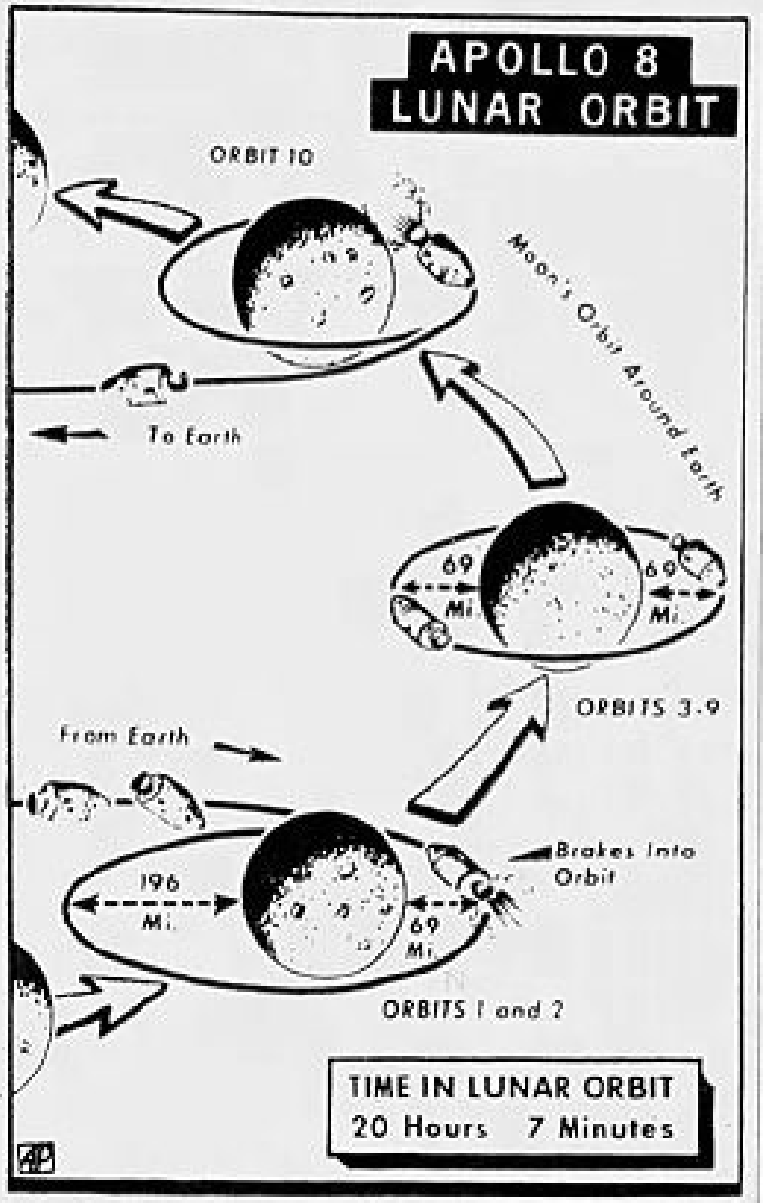

Moon at landing
Transearth injection (SPS)
S-IVB into solar orbit
Command module/ service module separation
Third midcourse correction (RCS)
Lunar orbit circularization (SPS)
Entry
Landing
Earth parking orbit
Second midcourse correction (RCS)
Lunar orbit insertion (SPS)
Translunar injection
Launch
Spacecraft
S-IVB
Spacecraft/ S-IVB separation
First midcourse correction (SPS/RCS)
Moon at launch


NASA
LOVELL



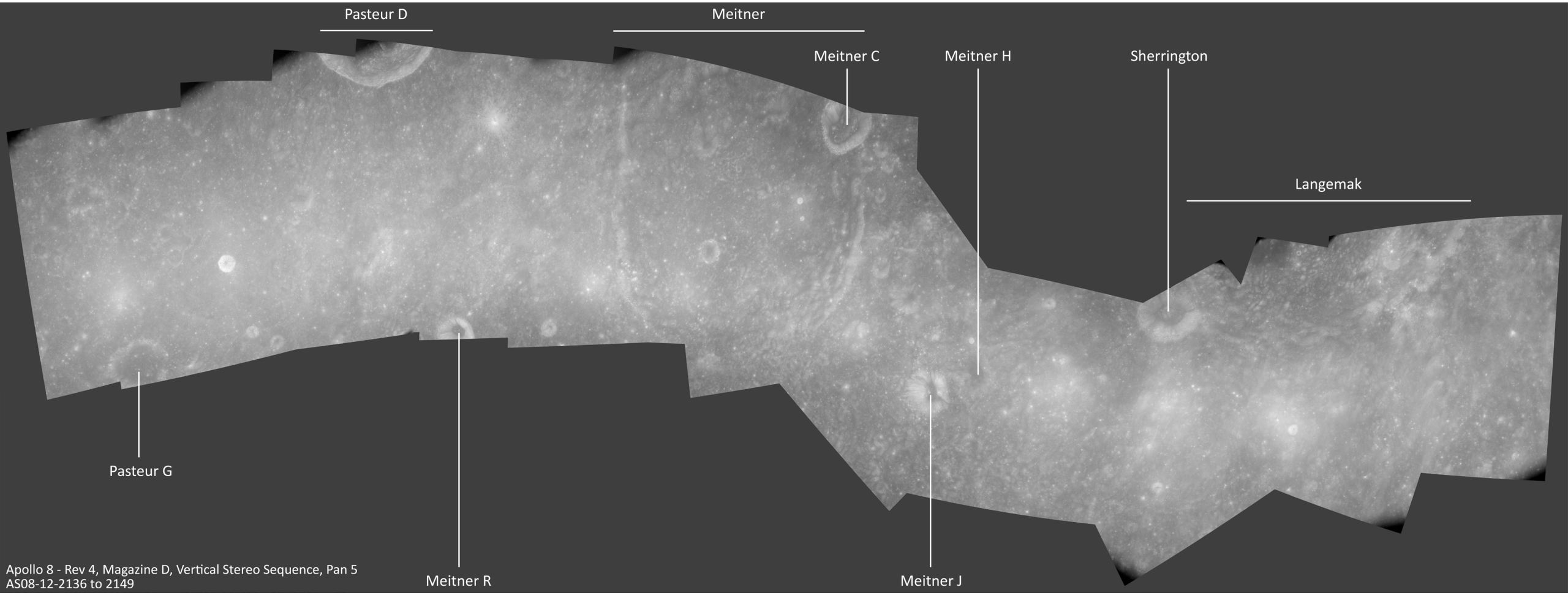
Lunar Orbit Insertion





Spacecraft's Orbit

This artist's conception diagrams the lunar orbital phase of the Apollo 8 mission. Drawings show the capsule entering orbit, bottom, circling the moon, and breaking from lunar orbit and heading back to earth. (AP Wirephoto)


Pasteur D
Meitner
Meitner C
Meitner H
Sherrington
Langemak
Pasteur G
Meitner R
Meitner J
Apollo 8 - Rev 4, Magazine D, Vertical Stereo Sequence, Pan 5
AS08-12-2136 to 2149

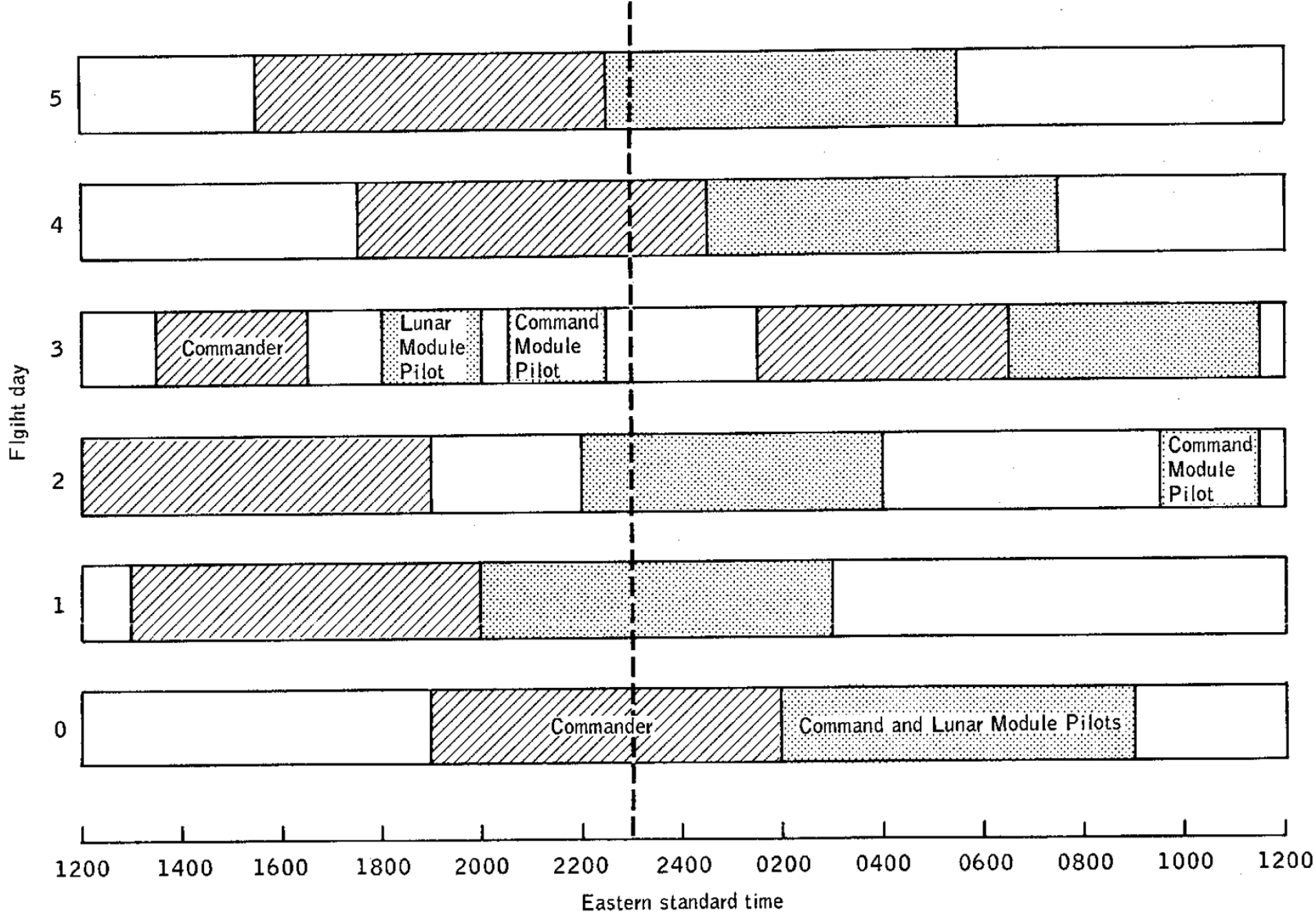
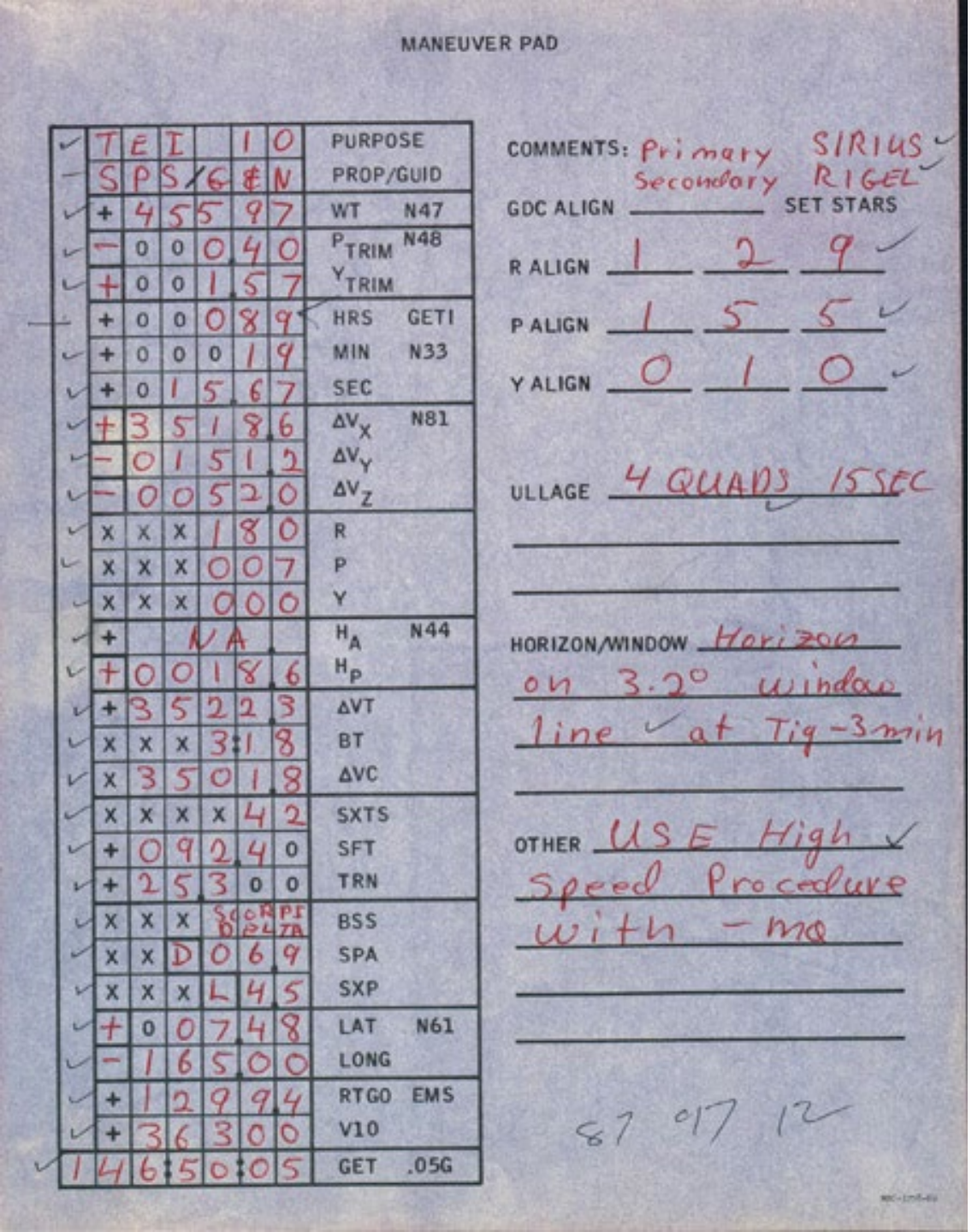


Figure 8-2.- Crew rest cycles.



MANEUVER PAD

TEI	10	PURPOSE
SPS/G&N		PROP/GUID
+	45597	WT N47
−	00040	P TRIM N48
+	00157	Y TRIM
+	00089	HRS GETI
+	00019	MIN N33
+	01567	SEC
+	35186	ΔV X N81
−	01512	ΔV Y
−	00520	ΔV Z
XXX	180	R
XXX	007	P
XXX	000	Y
+	NA	H A N44
+	00186	H P
+	35223	ΔVT
XXX	3:18	BT
X	35018	ΔVC
XXXX	42	SXTS
+	09240	SFT
+	25300	TRN
XXX	SCORPIO	BSS
XXD	0699	SPA
XXXL	4545	SXP
+	00748	LAT N61
−	16500	LONG
+	12994	RTGO EMS
+	36300	V10
146:50:05		GET .05G

COMMENTS: Primary SIRIUS
Secondary RIGEL

GDC ALIGN _____ SET STARS

R ALIGN 129

P ALIGN 155

Y ALIGN 010

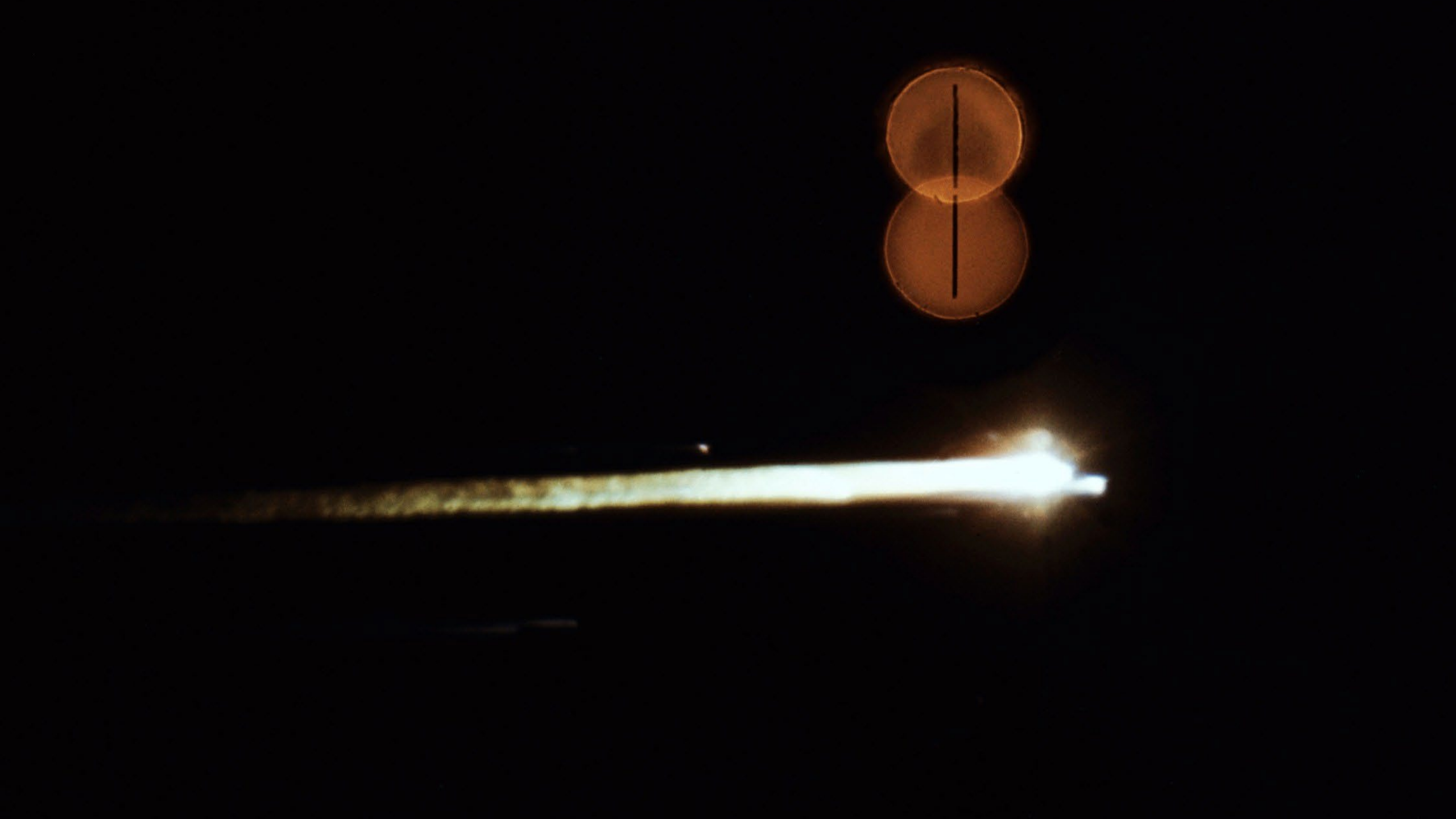
ULLAGE 4 QUADS 15 SEC

HORIZON/WINDOW Horizon on 3.2° window line at Tig -3min

OTHER USE High Speed Procedure with -MG

87 017 12

Purpose: *The PAD is intended for the burn that will return the Apollo 8 crew to Earth at the end of Rev 10.*
Systems: *The burn will be made using the SPS engine, under the control of the Guidance and Navigation system.*
CSM Weight (Noun 47): *45,597 pounds.*
Pitch and yaw trim (Noun 48): *-0.40° and +1.57°.*
Time of ignition (Noun 33): *89 hours, 19 minutes, 15.67 seconds.*
Change in velocity (Noun 81), fps: *x, +3,518.6; y, -151.2; z, -52.0.*
Spacecraft attitude: *Roll, 180°; Pitch, 7°; Yaw, 0°.* ***Expected apogee of resulting orbit (Noun 44):*** *Not applicable.*
Expected perigee of resulting orbit (Noun 44): *18.6 nautical miles (34.4 km).*
Delta-V_T: *3,522.3 fps (1,073.6 m/s).*
Burn duration or burn time: *3 minutes, 18 seconds.*
Delta-V_C: *3,501.8 fps.*
Sextant star: *Star 42 (Peacock, or Alpha Pavonis)*
Boresight star: *Dschubba, or Delta Scorpii.*
COAS Pitch Angle: *Down 6.9°.*
COAS X Position Angle: *Left 4.5°.*
Expected splashdown point (Noun 61): *7.48° north, 165° west*
Range to go at the 0.05 g event: *1,299.4 nautical miles.*
Expected velocity at the 0.05 g event: *36,300 fps.*
Predicted GET of 0.05 g event: *146 hours, 50 minutes and 5 seconds GET.*



Anomalies

1. Preflight: Contamination of spacecraft LOX
2. Launch: S1C camera malfunction
3. Launch: Intermittent operation of S-II power supplies
4. Launch: SII engine oscillations
5. Translunar: Drop in chamber pressure during first SPS burn
6. Throughout: Hatch and side windows obscured
7. Throughout: Obscuration of telescope field of view
8. Throughout: Abnormal shifts in computer readout of optics trunnion angle
9. Throughout: Noisy cabin fans
10. Throughout: Inoperative personal radiation dosimeter
11. Transearth: Erratic potable water quantity measurement
12. Reentry: Entry monitor system malfunctions
13. Landing: Seawater inflow through cabin pressure relief valve
14. Recovery: Inoperative swimmer’s interphone
15. Recovery: Failure of CM recovery loop

Discussion Groups

- **Chaikin Chapter 3 (“First Around the Moon”)**
  - **Apollo 8 from the Astronaut’s perspective**
- Woods Chapter 15 (“Re-entry”)
  - Reentry into the Earth’s atmosphere from a lunar trajectory
- Kluger Chapter 7
  - How the lunar orbit decision was made
- From the Earth to the Moon video episode 4 (“1968”)
  - An interleaved telling of the story of 1968’s social unrest and Apollo 8

Apollo 10 Readings

- Chaikin Chapter 4: “Before This Decade is Out”
  - The astronaut’s view of Apollo 9 and Apollo 10
- **Cox Chapter 23: “It Was Darn Scary”**
  - **The engineer’s view of Apollo 10**
- Merritt: “Review of Apollo Test Objectives Remaining After Mission D”
  - Why fly Apollo 10?
- “The Charming Genius of the Apollo Guidance Computer” video
  - How the onboard navigation was done