

# KERBIN INTEGRATED SPACE PROGRAM

Document 3 of 4: Mission Playbook

*Flight profiles for all 48 missions*

## How to Use This Playbook

Each mission entry contains everything needed to fly the mission: objectives, hardware, prerequisites, launch timing, step-by-step flight profile, delta-v budget, contingencies, and success criteria.

Hardware references point to Document 2 (Vehicle Catalog). Overall scheduling is in Document 4 (Program Management & Schedule).

Flight profiles are written in numbered steps that can be followed sequentially during the actual mission. Unless otherwise noted, delta-v values assume stock KSP aerodynamics and gravity.

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#	Codename	Summary
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## Phase 0: Foundation

*Missions 1-5 | Establish launch and crew capability*

### Mission 1: KERBIN-1

*Inaugural launch — verify Launcher A with mass simulator*

#### Objectives

- Launcher A completes a full flight profile: ascent, stage separation, circularization, deorbit.
- Verify no structural, staging, or guidance anomalies.
- Collect minor science from LKO.

#### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher A — "Kerbin-II"	Mass simulator: 12 t boilerplate tank with probe core + Mk16 parachute

#### Prerequisites

- None. This is the program start mission.

#### Launch Timing

Launch when ready. No transfer window. Aim for Day 0 of program calendar.

#### Flight Profile

##### Pre-Launch

1. On pad, verify all stages armed.
2. Full fuel check on both stages.
3. Verify guidance lock to north (0° heading).
4. Set throttle to 100%.

##### Ascent

5. T+0: Ignite Mainsail + 2x Kickback. Release clamps (stage).
6. T+8s: Begin gravity turn. Pitch 5° east at 100 m/s surface velocity.
7. T+55s: Kickbacks burn out. Stage SRB separation + Separatrons.
8. T+90s: Continue gravity turn; target 45° pitch at 15 km altitude.
9. T+140s: Throttle down Mainsail as needed to keep apoapsis rising steadily.
10. T+150s (est): Mainsail burns out. Stage to separate core and ignite Poodle.
11. Coast to apoapsis while pitching toward horizon (~15° above).

##### Circularization

12. At 30s before apoapsis, begin burn.
13. Target: 100 km circular orbit.
14. Cut engine when apoapsis and periapsis both ~100 km.
15. Jettison fairing once in orbit.
16. Deploy solar panels and antennas.

##### Orbital Ops

17. Complete 2-3 orbits collecting any available LKO science.
18. Verify upper stage probe core retains control.

19. Note any ascent anomalies for future revisions.

### Deorbit & Recovery

20. Plan deorbit burn: retrograde, target periapsis ~40 km (well inside atmosphere).
21. Execute burn on orbit opposite to KSC.
22. At ~70 km descending, orient parachute (if payload has one) prograde.
23. At 5 km, deploy parachute. Splashdown/land.
24. Recover for partial refund.

### Delta-v Budget

Maneuver	dV (m/s)	Notes
LKO ascent	3,400	Standard Kerbin LKO budget
Deorbit	~80	Retrograde burn to lower periapsis
Total required	~3,480	Launcher A nominal capability ~4,000 m/s

### Contingencies

- Ascent instability: if launcher wobbles badly during gravity turn, abort by cutting engines and deploying chute. Revise autostrut configuration.
- Stage separation failure: force-stage via action group or abort.
- Upper stage fails to ignite: jettison and use emergency deorbit chutes if possible.

### Success Criteria

- Vehicle reaches stable LKO.
- All staging events execute cleanly.
- Launcher A confirmed ready for real payloads.

## Mission 2: EXPLORER-1

*First Mun flyby — validate the Flyby Probe Bus*

### Objectives

- Conduct free-return Mun flyby and collect science from Mun orbit and Munar biomes.
- Validate the Flyby Probe Bus architecture.
- Return science data to Kerbin.

### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher A	1x Flyby Probe Bus (standard)

### Prerequisites

- Mission 1 (Kerbin-1) successful. Launcher A validated.

### Launch Timing

Day 2-4 of program. No transfer window — Mun is always accessible.

### Flight Profile

#### Launch

25. Standard Launcher A ascent to 100 km circular LKO.
26. Circularize. Jettison fairing. Deploy probe systems.

#### TMI (Trans-Munar Injection)

27. Wait for Mun to be  $\sim 60^\circ$  ahead of vessel in orbit (or use MechJeb Transfer Planner).
28. Set up prograde maneuver node to raise apoapsis to Mun SOI intercept.
29. Adjust node timing until trajectory intercepts Mun with closest approach  $< 300$  km.
30. Execute burn. Target  $\sim 860$  m/s prograde.
31. Fine-tune with mid-course correction  $\sim 1/3$  of the way to Mun.

#### Flyby

32. Coast into Mun SOI.
33. At closest approach, run all science experiments (low orbit Mun, high orbit Mun as altitude permits).
34. Transmit science back to Kerbin (requires Kerbin line of sight and antenna capability).
35. No capture burn — probe continues on solar orbit trajectory after Mun exit.

#### Post-Flyby

36. After leaving Mun SOI, probe will be on modified Kerbin orbit.
37. Continue transmitting science.
38. Optional: adjust trajectory to escape Kerbin SOI entirely for interplanetary science (requires  $\sim 200$  m/s).
39. Probe becomes permanent debris in solar/Kerbin orbit.

### Delta-v Budget

Maneuver	dV (m/s)	Notes
LKO ascent	3,400	Launcher A

Maneuver	dV (m/s)	Notes
TMI	~860	Standard Mun transfer
Mid-course correction	~30	Fine-tune intercept
Total	~4,290	Launcher A delivers; probe bus has extra for corrections

### Contingencies

- Mun encounter missed: spend extra dV on mid-course correction to re-target.
- No return capability needed — this is a one-way flyby.

### Success Criteria

- Probe passes within 300 km of Mun.
- All science experiments completed.
- Data successfully transmitted to Kerbin.

## Mission 3: EXPLORER-2

### *Mun orbiter — surface mapping and ore survey*

#### Objectives

- Establish Mun orbit.
- Complete full M700 biome scan of Mun.
- Identify best ore biomes for later Prospector deployment.
- Return high-altitude and low-altitude Mun orbital science.

#### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher A	1x Orbiter Probe Bus (standard)

#### Prerequisites

- Mission 2 (Explorer-1) preferably complete.

#### Launch Timing

Day 5-10 of program.

#### Flight Profile

##### Launch & TMI

40. Standard Launcher A to LKO.
41. TMI burn ~860 m/s to Mun intercept.
42. Fine-tune trajectory for low periapsis (~20 km) at Mun.

##### Mun Capture

43. At Mun periapsis, burn retrograde to capture into elliptical orbit.
44. First pass: capture into 20 km x 500 km orbit (~280 m/s retrograde).
45. On next apoapsis pass, circularize at 20 km if science schedule requires low orbit, or raise to ~100 km for safer long-term orbit.

##### Survey Operations

46. Deploy M700 Survey Scanner. Right-click → "Perform Survey".
47. Wait several orbits for scanner coverage — this requires time in different geographic regions.
48. Activate M4435 Narrow-Band Scanner for targeted biome investigation.
49. Conduct all orbital science experiments (goo, materials, thermometer, etc.) at both low-orbit and high-orbit thresholds.
50. Transmit science as it is collected.

##### Ongoing Mission

51. Probe remains in Mun orbit indefinitely.
52. Periodically check ore map to confirm biome boundaries.
53. Record identified best-ore locations — these are the Prospector landing candidates.

#### Delta-v Budget

Maneuver	dV (m/s)	Notes
LKO ascent	3,400	

Maneuver	dV (m/s)	Notes
TMI	860	
Mun capture	~280	Elliptical capture
Circularize at low altitude	~200	Optional; cheaper to stay elliptical
Total	~4,740	

### Contingencies

- If probe undershoots Mun periapsis and risks impact, burn radial out-of-plane to raise periapsis.
- If M700 does not show full coverage after 5+ orbits, verify it is deployed and power is adequate.

### Success Criteria

- Stable Mun orbit achieved.
- Full biome and ore map returned.
- At least one ore-rich biome identified for Prospector deployment.

## Mission 4: EXPLORER-3

*Minmus orbiter — the critical pre-Prospector survey*

### Objectives

- Establish Minmus orbit.
- Complete full M700 biome and M4435 ore scans.
- Identify specific flat biomes with high ore concentration.
- This mission's output directly determines where Prospector-1 lands.

### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher A	1x Orbiter Probe Bus (standard)

### Prerequisites

- Mission 3 recommended for experience.

### Launch Timing

Day 8-15. Watch for Minmus plane alignment — Minmus is inclined  $\sim 6^\circ$  from Kerbin's orbital plane, making plane changes expensive if mistimed.

### Flight Profile

#### Launch & Plane Matching

54. Standard Launcher A to LKO.
55. Before TMI, ensure LKO is in Minmus's orbital plane. If launched directly east, inclination is  $0^\circ$  — Minmus is  $6^\circ$ .
56. Option A: Launch into Minmus's inclined plane from the start (aim a few degrees off due east at ascent — requires knowing Minmus's ascending/descending node).
57. Option B: Plane-change at LKO ascending node:  $\sim 250$  m/s.
58. Option C (most efficient): Do plane change at Kerbin SOI boundary during TMI — cheaper due to low velocity.

#### TMI

59. With plane matched, execute  $\sim 930$  m/s TMI prograde burn.
60. Target closest approach to Minmus:  $< 50$  km.
61. Mid-course correction as needed.

#### Minmus Capture

62. At periapsis, burn retrograde to capture.
63. Target 10-20 km circular orbit (Minmus is tiny, orbits are stable low).
64. Capture costs only  $\sim 160$  m/s due to Minmus's weak gravity.

#### Survey

65. Deploy and activate M700.
66. Wait for full coverage.
67. Activate M4435 in targeted flat biomes (Great Flats, Greater Flats, Midlands).
68. Collect orbital science.
69. Record ore concentrations per biome.

### Delta-v Budget

Maneuver	dV (m/s)	Notes
LKO ascent	3,400	
Plane change	~0-250	Depends on approach; aim for 0 with right launch timing
TMI	930	
Minmus capture	~160	Low gravity = cheap capture
Total	~4,490-4,740	

### Contingencies

- Plane misalignment: accept the 250 m/s penalty; probe has margin.
- Missed capture: orbit back around, correct at next apoapsis.

### Success Criteria

- Minmus orbit achieved.
- Ore map complete.
- Prospector landing site selected and recorded.

## Mission 5: KERBIN-2

### First crewed flight — CSM to LKO

#### Objectives

- First Kerbals to orbit.
- Validate CSM for crewed operations.
- Conduct EVA activities.
- Return crew safely to Kerbin.

#### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher A (Crew-Rated: add Launch Escape System)	1x CSM (standard), 3 Kerbals

#### Prerequisites

- Missions 1-4 completed for launcher validation.
- At least one successful Launcher A flight without anomalies.

#### Launch Timing

Day 15-20.

#### Flight Profile

##### Pre-Launch

70. Crew: 1 Pilot (mandatory for stock SAS), 1 Engineer, 1 Scientist.
71. Verify LES armed.
72. Verify heat shield armed.
73. Verify parachutes armed.
74. Confirm all life support systems green (stock: none required; modded: verify 3-day supply minimum).

##### Ascent

75. Standard Launcher A profile.
76. Monitor G-forces. Stock Kerbals tolerate high G, but throttle down if LES-armed and  $G > 5$ .
77. Reach 100 km LKO.

##### Orbital Operations

78. Jettison fairing (should have done during ascent; if not now).
79. Deploy solar panels and antenna.
80. EVA: Pilot exits capsule, collects EVA report, plants flag on capsule exterior.
81. Crew Report inside capsule.
82. Sample each science instrument.
83. Complete 5-10 orbits collecting LKO science.
84. Transmit what can be transmitted; retain samples for physical return.

##### Deorbit

85. At orbit opposite KSC, burn retrograde ~80 m/s.
86. Target periapsis ~30 km for slow, controlled re-entry.
87. Jettison service module (TR-18A decoupler stage).

88. Orient heat shield forward (SAS Retrograde).
89. Atmospheric interface ~70 km.
90. At ~5 km, deploy parachutes.
91. Landing: aim for land if possible (easier recovery than ocean).

### Delta-v Budget

Maneuver	dV (m/s)	Notes
LKO ascent	3,400	
Deorbit	80	
Service module capability total	2,500	Plenty of margin
Mission total use	~3,480	

### Contingencies

- LES activation: trigger manually if ascent fails catastrophically below 50 km. LES pulls capsule free.
- Failure to deorbit: use RCS and remaining monoprop as backup; if insufficient, transmit for rescue.
- Parachute failure: if crew capsule parachutes fail, the Mk1-3 has integral impact tolerance to ~11 m/s — deep water or sandy ground may still save the crew.

### Success Criteria

- 3 Kerbals reach LKO and return safely.
- CSM validated.
- EVA completed with science collected.

## Phase 1: Kerbin System Mastery

*Missions 6-14 | Minmus ISRU and first refueled crewed missions*

### Mission 6: KERBIN-3

*Launcher B inaugural flight — empty test*

#### Objectives

- Verify Launcher B with mass simulator.
- Validate 3.75m stack assembly and staging.
- No crew; uncrewed test only.

#### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher B — "Kerbin-V"	Mass simulator: ~40 t boilerplate

#### Prerequisites

- Launcher B designed and subassembly saved.

#### Launch Timing

Day 20-25. After Kerbin-2 crewed flight success.

#### Flight Profile

##### Ascent

92. T+0: Ignite Rhino + 4x Kickback. Launch.
93. T+5s: Begin gravity turn early (60 m/s).
94. T+55s: SRB burnout. Separate.
95. Continue turn, target 45° at 20 km.
96. T+180s (est): Stage 1 Rhino depletion. Separate.
97. Stage 2 Rhino ignition.
98. Coast to apoapsis.

##### Circularization

99. Circularize at 120 km.
100. Verify upper stage has remaining dV for deorbit or interplanetary injection.
101. Deploy systems.

##### Deorbit

102. Boilerplate payload carries parachute.
103. Deorbit, re-enter, recover for partial refund.

#### Delta-v Budget

Maneuver	dV (m/s)	Notes
LKO ascent	3,400	
Deorbit	80	

### **Contingencies**

- Tall stack wobble during ascent is the #1 risk. Abort if oscillations exceed safe range.
- Check autostrut configuration between flights.

### **Success Criteria**

- Launcher B delivers 40+ t to LKO.
- Clean staging.
- No structural failures.

## Mission 7: ARTEMIS-1

### *Uncrewed CSM Mun free-return — full Apollo 8 rehearsal*

#### Objectives

- Rehearse full crewed Mun flyby profile without crew aboard.
- Validate CSM + service module for deep-space operations.
- Validate heat shield at interplanetary re-entry speed.

#### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher B	1x CSM (uncrewed, probe core installed)

#### Prerequisites

- Launcher B validated (Mission 6). CSM validated (Mission 5).

#### Launch Timing

Day 25-32.

#### Flight Profile

##### Launch & LKO

104. Launcher B to 100-120 km LKO.
105. Upper stage retained for TMI.

##### TMI (Free-Return)

106. Wait for Mun phase angle.
107. Set up prograde maneuver node for Mun encounter.
108. Target: free-return trajectory — closest approach ~60 km on far side of Mun, returning naturally to Kerbin with periapsis <40 km (atmospheric).
109. Execute burn. ~860 m/s.
110. Separate CSM from spent upper stage.
111. Deploy solar panels and antenna.

##### Coast

112. Coast to Mun SOI (~2 days).
113. Mid-course correction if needed.
114. Inside SOI, coast to closest approach.
115. Collect science at all altitude thresholds crossed.

##### Mun Flyby

116. At closest approach, the trajectory naturally curves around Mun.
117. Emerge with Kerbin-return trajectory pre-set.
118. Minor trajectory trim to ensure periapsis ~35 km at Kerbin.

##### Re-entry

119. Approach Kerbin at ~3,100 m/s.
120. Jettison service module.
121. Orient heat shield forward.
122. Atmospheric interface ~70 km.
123. Heat shield manages thermal load; expect significant ablator use.

- 124. At ~5 km, deploy chutes.
- 125. Recover.

### Delta-v Budget

Maneuver	dV (m/s)	Notes
LKO	3,400	
TMI (free return)	860	
Trajectory corrections	~50	
Total	4,310	Well within Launcher B capability

### Contingencies

- If free-return trajectory is not achieved cleanly, plan mid-course correction at Mun closest approach.
- Worst case: the CSM misses Kerbin atmospheric interface and escapes — write off the test, learn for Artemis-2.

### Success Criteria

- CSM completes Mun flyby.
- Safe Kerbin re-entry at ~3,100 m/s.
- Heat shield survives. CSM validated for crewed Artemis-2.

## Mission 8: ARTEMIS-2

### *Crewed Mun flyby — real-life Artemis II recreation*

#### Objectives

- Send 3 Kerbals on a Mun free-return trajectory.
- Kerbals observe Mun from close proximity, photograph far side.
- Bonus: aim flyby to optionally graze Mun's shadow for an eclipse view (advanced).
- Return crew safely via Kerbin aerobrake.

#### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher B (crew-rated)	1x CSM (standard, 3 crew)

#### Prerequisites

- Mission 7 (Artemis-1) completed without anomaly.
- All CSM systems validated.
- Crew of 3 ready (experience from Kerbin-2 preferred).

#### Launch Timing

Day 35-45. No transfer window required.

#### Flight Profile

##### Pre-Launch

126. Crew briefing: free-return trajectory, expected flight time ~6 days.
127. Verify life support (stock: 3-day default; mod: ensure 10+ day margin).
128. Verify all abort systems armed.
129. Verify Kerbin re-entry plan.

##### Ascent & TMI

130. Launch, LKO, TMI as per Artemis-1.
131. Crew monitors instruments throughout.
132. Pilot confirms maneuver execution.

##### Coast to Mun

133. Crew conducts orbital science experiments in deep space.
134. Scientist samples all available experiments.
135. EVAs possible but not required — be cautious of losing Kerbals at high velocity.
136. Closest approach briefings among crew.

##### Mun Flyby

137. At closest approach, crew observes Mun far side — biomes, craters.
138. Crew EVA report, surface sample (crew can collect Mun flight samples).
139. If eclipse geometry timed correctly, observe Mun shadow crossing Kerbin (Earthrise-equivalent).
140. Free-return trajectory carries the ship back toward Kerbin naturally.

##### Re-entry

141. Approach Kerbin at ~3,100 m/s.
142. Jettison service module.

- 143. Orient heat shield.
- 144. Aerobrake: peak G ~4-6, peak heating ~1,500 K on shield.
- 145. Chutes at 5 km. Splashdown/landing.
- 146. Recover crew — they are heroes now.

### Delta-v Budget

Maneuver	dV (m/s)	Notes
Same as Artemis-1	~4,310	No new maneuvers

### Contingencies

- Any capsule-threatening anomaly: abort via LES pre-launch, or deorbit immediately if in LKO.
- Crew life support failure: emergency return trajectory via direct injection (costs ~2,000 m/s — CSM cannot do this; plan for rescue launch with fresh CSM).
- Heat shield anomaly: consider lofted re-entry (periapsis 45 km, multiple passes) to reduce peak load.

### Success Criteria

- 3 Kerbals fly around the Mun and return alive.
- Kerbin aerobrake re-entry survived.
- Mun flyby science collected.

## Mission 9: PATHFINDER-MUN

*Rover to Mun surface — prepare for crewed landing*

### Objectives

- Land a rover at the planned Artemis-3 landing site.
- Scout terrain, verify flatness and ore content at ground level.
- Collect surface science.

### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher A	1x Rover Lander (airless variant)

### Prerequisites

- Mission 3 (Explorer-2) provided ore map.

### Launch Timing

Day 40-50. Can run in parallel with Artemis crewed planning.

### Flight Profile

#### Launch & Transit

147. Launcher A to LKO.
148. TMI to Mun. Target low periapsis (~15 km) at Mun.
149. Capture into low circular Mun orbit (100 km).

#### Descent

150. Use Trajectories mod (or manual) to plan de-orbit over target biome.
151. Deorbit burn: retrograde, ~100 m/s, to bring periapsis to 5 km at landing point.
152. Coast to low altitude.
153. At ~3 km, begin descent burn.
154. Kill horizontal velocity first, then control vertical descent.
155. Touchdown vertical speed < 3 m/s. Target horizontal speed 0.

#### Surface Ops

156. Decouple rover from descent stage.
157. Deploy solar panels, antenna.
158. Drive out from under descent stage (risk of collision with legs).
159. Conduct surface science at landing biome.
160. Drive to nearby distinct biome (if possible) for additional science.
161. Continuous operation — the rover can run for many game weeks via time warp.

### Delta-v Budget

Maneuver	dV (m/s)	Notes
LKO	3,400	
TMI	860	
Mun capture	280	

Maneuver	dV (m/s)	Notes
Landing	580	Vertical descent dV
Total	5,120	Rover lander has margin

### Contingencies

- Landing too fast: if possible throttle up at 100m to break descent.
- Tipped rover: reload quicksave; or use EVA Kerbal in later mission to right it.
- Failure to decouple: drive away carefully; legs may snap free.

### Success Criteria

- Rover safely on Mun surface.
- Science returned.
- Terrain confirmed suitable for crewed landing.

## Mission 10: ARTEMIS-3

### *First crewed Mun landing*

#### Objectives

- First Kerbals to walk on another world.
- Land LM at pre-surveyed site.
- Conduct surface EVA and sample collection.
- Return crew safely to Kerbin.

#### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher B	CSM + LM stack, 3 crew total (2 to surface, 1 in CSM orbit)

#### Prerequisites

- Missions 6-9 complete.
- CSM and LM validated.
- Mun surface scouted.
- 3 Kerbal crew (1 Pilot, 1 Scientist, 1 Engineer recommended).

#### Launch Timing

Day 50-65. No transfer window required.

#### Flight Profile

##### Ascent & TMI

162. Launcher B with CSM/LM stack to LKO.
163. TMI ~860 m/s to Mun intercept.
164. Transposition and docking: separate CSM from stack, rotate, dock to LM (Apollo-style).
165. Jettison spent TMI stage.

##### Mun Capture

166. At Mun periapsis, capture to 100 km circular orbit.
167. Capture cost ~280 m/s on CSM.
168. CSM remains in orbit with 1 crew (CSM Pilot).

##### Descent

169. 2 crew transfer to LM.
170. LM undocks.
171. LM descent stage de-orbit: ~20 m/s retrograde to lower periapsis to 5 km at landing site.
172. Coast to low altitude.
173. At 3 km, begin descent burn. Kill horizontal velocity.
174. Vertical descent at ~5 m/s with active throttle control.
175. Touchdown at target site.

##### Surface Operations

176. Deploy ladder. Crew EVA.
177. Plant flag. Collect samples, surface EVA reports, all science experiments.
178. Walk and observe. Mission duration: several hours to 1 Kerbin day.

179. Return to LM.

### Ascent & Rendezvous

- 180. Separate ascent stage from descent stage.
- 181. Ascent engine ignition. ~1,500 m/s to rendezvous orbit.
- 182. Close rendezvous using RCS and Poodle combo.
- 183. Dock with CSM.
- 184. Crew transfers back to CSM with samples.
- 185. Jettison LM ascent stage (or leave in orbit as debris).

### Return

- 186. CSM Trans-Kerbin Injection (TKI): ~310 m/s to Kerbin intercept.
- 187. Target periapsis 35 km at Kerbin.
- 188. Jettison service module.
- 189. Aerobrake re-entry.
- 190. Parachutes. Recovery.

### Delta-v Budget

Maneuver	dV (m/s)	Notes
LKO	3,400	
TMI	860	
Mun capture	280	
LM descent	~580	
LM ascent to rendezvous	~580	
CSM TKI	~310	Cheap due to Mun's position in Kerbin SOI
Total stack	~6,010	Distributed across launcher + CSM + LM stages

### Contingencies

- Descent abort: stage separation of ascent from descent even mid-descent, ignite ascent engine, return to orbit for emergency rendezvous.
- Ascent engine failure: stranded crew requires rescue mission — CSM cannot land.
- Docking failure: if LM cannot dock with CSM, crew EVAs across.
- CSM pilot failure: CSM has probe core backup (if installed) or Engineer on LM can fly it back.
- TKI miss: use remaining CSM fuel and RCS to correct; worst case, multi-orbit return.

### Success Criteria

- 3 Kerbals on Mun surface (2 walked, 1 orbited).
- Samples returned to Kerbin.
- Crew safe.

## Mission 11: PATHFINDER-MINMUS

*Rover to Minmus — scout for Prospector site*

### Objectives

- Rover lands at highest-ore biome on Minmus.
- Ground-truth ore readings.
- Surface science.

### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher A	1x Rover Lander (airless variant)

### Prerequisites

- Mission 4 (Explorer-3) ore map available.

### Launch Timing

Day 55-70. Plane change to Minmus may require specific launch window.

### Flight Profile

#### Launch

191. Launcher A, match Minmus plane at launch or at TMI.
192. TMI 930 m/s; target Minmus intercept periapsis ~10 km.

#### Capture & Descent

193. Minmus capture: ~160 m/s retrograde at periapsis.
194. Minmus low orbit 10 km, then deorbit over selected biome.
195. Descent dV ~180 m/s — very low due to Minmus's low gravity.
196. Touchdown.

#### Surface Ops

197. Rover deploy.
198. Ground-truth the ore concentration at planned Prospector landing.
199. Drive to secondary biomes if time permits.
200. Science collection.

### Delta-v Budget

Maneuver	dV (m/s)	Notes
LKO	3,400	
TMI (Minmus)	930	
Minmus capture	160	
Landing	180	
Total	~4,670	

### Contingencies

- Minmus's low gravity means landings are easy but small errors matter; expect to overshoot if not careful.

**Success Criteria**

- Rover on Minmus.
- Ore readings confirmed. Prospector-1 site finalized.

## Mission 12: PROSPECTOR-1

### THE PIVOT POINT — First ISRU tanker to Minmus

#### Objectives

- Land Prospector at identified ore-rich flat biome on Minmus.
- Begin ore mining and fuel refining operations.
- Establish the program's first self-sustaining propellant source.

#### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher B	1x Prospector (airless/standard variant)

#### Prerequisites

- Missions 4 and 11 complete.
- Ore biome identified and ground-truthed.
- Tank Farm mission (13) ready to follow.

#### Launch Timing

Day 70-85. This mission initiates the logistics network.

#### Flight Profile

##### Launch

201. Launcher B with Prospector payload to LKO.
202. TMI 930 m/s to Minmus intercept.
203. Note: Prospector is heavy (35 t fueled). Verify Launcher B dV margin.

##### Minmus Arrival & Landing

204. Capture at Minmus: ~160 m/s.
205. Descend toward pre-selected biome.
206. Prospector descent burn ~200 m/s. Use Trajectories to aim for flat area.
207. Touchdown on legs. Verify all 4 legs contact ground — otherwise Prospector may tip.
208. CRITICAL: verify SAS on until fully settled. Minmus's low gravity can cause bouncing.

##### Begin Mining Operations

209. Deploy drills. Right-click each Drill-O-Matic → "Start ISRU Mining".
210. Ore accumulates in Radial Ore Tank / central storage.
211. Activate Convert-O-Tron 250 ISRU. Select conversion mode: LF+Ox.
212. Verify radiators are deployed and heat-linked to ISRU.
213. Monitor power: ensure solar panels / RTGs meet demand.
214. Set Kerbal Alarm Clock alarm for ~48 hours to check fuel level.
215. Time warp to 24-48 hours for initial fill.

##### Long-Term Operation

216. Prospector remains on surface indefinitely.
217. Periodically ascends to Minmus orbit to rendezvous with Tank Farm (Mission 13+).
218. Each ascent costs ~180 m/s; each descent ~180 m/s.
219. Fuel transfer at orbital depot. Then Prospector descends again to resume mining.

## Delta-v Budget

Maneuver	dV (m/s)	Notes
LKO	3,400	
TMI	930	
Capture	160	
Descent	180	
Surface operations	0	
Ascent (ongoing)	180 per trip	
Descent (ongoing)	180 per trip	

## Contingencies

- ISRU overheating: deploy additional radiators (if possible via rescue), or run in pulsed mode.
- Not enough power during night: enlarge battery capacity on future variants; tolerate slower production.
- Stuck in low-ore biome: Prospector has fuel for relocation (~600 m/s); plan to hop to an alternative spot.
- Tipped over: if top-heavy, Prospector may fall over. Use Engineer Kerbal later with KAS/KIS to reposition, or abandon and send replacement.

## Success Criteria

- Prospector on Minmus surface with ISRU producing fuel.
- First liters of refined fuel accumulated.
- Program now has in-situ fuel production.

## Mission 13: TANK-FARM-MINMUS

*Deploy orbital depot — the first Tank Farm*

### Objectives

- Place Tank Farm in low Minmus orbit.
- Begin receiving fuel deliveries from Prospector.
- Enable all future Kerbin-departure missions to refuel before interplanetary legs.

### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher B	1x Tank Farm (standard hex architecture)

### Prerequisites

- Mission 12 (Prospector-1) operational.

### Launch Timing

Day 85-100. Can launch before or after Mission 12 — parallel missions.

### Flight Profile

#### Launch & Transit

220. Launcher B to LKO.
221. TMI 930 m/s to Minmus.
222. Use Launcher B upper stage (Rhino) as integrated TMI stage.

#### Capture

223. Capture to low Minmus orbit at ~30 km (same altitude as Prospector's ascent target).
224. Use Tank Farm's integrated tug (Terrier + X200-16) for final circularization.
225. Target orbit must be equatorial if Prospector's launch site is near equator — or match whatever Prospector's ascent inclination is.

#### Commissioning

226. Deploy all solar panels and antennas.
227. Verify docking ports accessible and oriented correctly.
228. Tug can be jettisoned or retained — recommend retaining for future maneuvering.

#### First Fuel Delivery

229. Prospector ascends from Minmus surface.
230. Approaches Tank Farm in Minmus orbit.
231. Docks at one of the Sr. ports.
232. Transfers fuel to Tank Farm tanks.
233. Prospector undocks, descends to resume mining.

### Delta-v Budget

Maneuver	dV (m/s)	Notes
LKO	3,400	
TMI	930	

Maneuver	dV (m/s)	Notes
Capture	160	
Circularize at 30 km	~100	
Total	~4,590	

### Contingencies

- Tank Farm wobble post-docking: verify autostrut; may need redesign if uncorrectable.
- Ports misaligned: dock Prospector to any available port; no need for specific orientation initially.

### Success Criteria

- Tank Farm in stable Minmus orbit.
- First fuel delivery from Prospector completed.
- Depot operational and ready for client traffic.

## Mission 14: ARTEMIS-4

### *Crewed Minmus landing — first refueled mission*

#### Objectives

- Land crew on Minmus.
- Demonstrate refueling architecture by topping up at Tank Farm on return.
- Prove the logistics chain works end-to-end.

#### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher A (reduced, because refueling)	CSM + LM, 3 crew

#### Prerequisites

- Mission 13 (Tank Farm) operational with fuel.
- Mission 10 (Artemis-3) proven crewed landing procedures.

#### Launch Timing

Day 100-115.

#### Flight Profile

##### Launch

234. Launcher A with CSM + light LM (Minmus LM variant).
235. Demonstrates that refueling changes launch mass requirements.

##### Transit to Minmus

236. TMI 930 m/s.
237. Capture at Minmus ~160 m/s.

##### Refuel at Tank Farm (outbound)

238. Dock CSM/LM stack with Tank Farm in Minmus orbit.
239. Transfer fuel into CSM and LM tanks to top them up.
240. Undock.

##### Surface Landing

241. Standard LM descent as per Artemis-3.
242. Minmus's low gravity makes this much easier than Mun.
243. Crew walks. Plants flag. Collects samples.
244. Ascend.

##### Rendezvous & Return

245. LM docks back with CSM.
246. CSM/LM stack returns to Tank Farm for one more fuel top-up.
247. TKI burn ~160 m/s (cheap from Minmus orbit).
248. Kerbin aerobrake re-entry.

#### Delta-v Budget

Maneuver	dV (m/s)	Notes
LKO	3,400	
TMI	930	
Capture	160	
LM ops (descent + ascent)	~360	Round trip
TKI from Minmus	160	Low cost
Total consumed onboard	~1,610	Significant reduction from refueling

### Contingencies

- Tank Farm docking failure: abort and return via existing onboard fuel (should be sufficient).

### Success Criteria

- Crewed Minmus landing complete.
- Refueling cycle demonstrated.
- PHASE 1 COMPLETE. Program pivots into interplanetary era.

## Phase 2: Inner System Reconnaissance

*Missions 15-22 | Uncrewed probes to every inner-system body*

### Mission 15: SUNSEEKER-1

*First flyby of Moho — the closest planet to the Sun*

#### Objectives

- Conduct close flyby of Moho.
- Collect science from Moho biomes (orbital).
- Validate high-dV flyby bus architecture.

#### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher A	1x Flyby Probe — Solar variant (upgraded fuel tank + heat shield)

#### Prerequisites

- Moho transfer window.

#### Launch Timing

Moho windows occur every ~900 days. The first Moho window from program start is typically around Year 1, Day 90. Consult Transfer Window Planner.

#### Flight Profile

##### Launch & LKO

249. Launcher A to LKO.
250. Use upper stage for TMI.

##### TMI (Trans-Moho Injection)

251. At Moho transfer window (via Transfer Window Planner), execute retrograde burn relative to Kerbin orbit velocity.
252. Approximately 3,000 m/s total ejection dV — Moho is inward, and transfer is expensive.
253. Mid-course corrections.

##### Coast (~110 days)

254. Coast to Moho intercept.
255. Manage thermal: probe gets very hot approaching Sun.
256. Heat shield and radiators critical.

##### Flyby

257. At closest approach (< 200 km if possible), run all science.
258. Transmit — comms back to Kerbin may be weak; use RA-2 antenna.
259. No capture; probe continues on solar orbit.

#### Delta-v Budget

Maneuver	dV (m/s)	Notes
LKO	3,400	
TMI Moho	~3,000	Expensive
Corrections	~100	
Total	~6,500	Launcher A with upgraded upper stage needed

### Contingencies

- Thermal: probe overheat risk near Sun. Use heat shield mounted sunward.
- dV shortfall: if TMI underperforms, try a gravity assist via Eve on a subsequent window.

### Success Criteria

- Probe passes within 500 km of Moho with science returned.

## Mission 16: VENERA-1

*Orbiter probe to Eve — map the purple planet*

### Objectives

- Establish Eve orbit.
- Full ore and biome survey.
- Return orbital science at low and high orbital thresholds.

### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher A	1x Orbiter Probe (standard, with aerobrake capability)

### Prerequisites

- Eve transfer window.

### Launch Timing

Eve windows every ~620 days. First suitable window typically Year 1, Day 220.

### Flight Profile

#### Launch & TMI

260. Launcher A.
261. TMI to Eve: prograde burn of ~1,100 m/s from LKO.

#### Coast (~130 days)

262. Coast to Eve.
263. Mid-course corrections.

#### Aerobrake Capture

264. Target Eve periapsis ~90 km — aerobrake to slow velocity.
265. First pass aerobrakes; apoapsis drops.
266. Subsequent passes lower apoapsis further.
267. Once apoapsis below 1,500 km, perform circularization burn at periapsis — ~300 m/s.
268. Alternatively, propulsive capture: ~1,400 m/s burn at periapsis.

#### Survey

269. Activate M700. Full orbital science.
270. Transmit all data.

### Delta-v Budget

Maneuver	dV (m/s)	Notes
LKO	3,400	
TMI Eve	1,100	
Aerobrake capture	~300	Most dV absorbed by atmosphere
Or propulsive capture	~1,400	If aerobrake not attempted

Maneuver	dV (m/s)	Notes
Total aerobrake	~4,800	

**Contingencies**

- Aerobrake too shallow: skip out of atmosphere; try another pass.
- Aerobrake too deep: probe burns up. Maintain periapsis  $\geq 90$  km on first pass.
- Propulsive backup: always have 1,500 m/s in reserve for worst-case capture.

**Success Criteria**

- Probe in stable Eve orbit with full survey.

## Mission 17: VENERA-2

*Gilly orbiter — tiny moon, easy target*

### Objectives

- Orbit Gilly (Eve's moon).
- Survey Gilly ore biomes — potential future crewed target.
- Return science.

### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher A	1x Orbiter Probe (standard)

### Prerequisites

- Eve transfer window.

### Launch Timing

Launch alongside or shortly after Venera-1.

### Flight Profile

#### Launch & Transit

271. Standard Eve TMI.
272. Coast to Eve SOI, then maneuver to intercept Gilly rather than Eve capture.
273. Gilly is in Eve orbit at ~31,500 km; rendezvous requires careful plane matching.

#### Gilly Capture

274. Gilly SOI is small (~126 km).
275. Approach at low relative velocity.
276. Capture costs ~50 m/s — very low gravity.

#### Survey

277. Orbital ore and biome survey.
278. Transmit.

### Delta-v Budget

Maneuver	dV (m/s)	Notes
LKO	3,400	
TMI Eve	1,100	
Gilly intercept	~200	Plane change and rendezvous
Gilly capture	~50	Trivial
Total	~4,750	

### Contingencies

- Missed Gilly SOI: multiple Eve orbit passes allow re-intercept with minimal cost.

### Success Criteria

- Stable Gilly orbit with science data returned.

## Mission 18: ARES-1

*Duna orbiter — reconnaissance for crewed missions*

### Objectives

- Full orbital survey of Duna.
- Ore map for Prospector-D planning.
- Also scan Ike (Duna's moon).

### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher A	1x Orbiter Probe (standard, with aerobrake)

### Prerequisites

- Duna transfer window.

### Launch Timing

Duna windows every ~920 days. First window typically Year 1, Day 230.

### Flight Profile

#### Launch & TMI

279. Launcher A to LKO.
280. TMI: prograde ~1,060 m/s from LKO — Duna is outward, transfer cost moderate.

#### Coast (~260 days)

281. Coast to Duna SOI.
282. Mid-course correction.
283. Target Duna periapsis 20 km for aerobrake capture.

#### Aerobrake Capture

284. Duna atmosphere is thin but sufficient.
285. Aerobrake multiple passes to circularize — or propulsive capture ~250 m/s.
286. Circularize at 100 km x 100 km.

#### Survey Duna & Ike

287. M700 + M4435 survey of Duna.
288. Optional: transfer to Ike orbit (~150 m/s) for ore survey.
289. Transmit all data.

### Delta-v Budget

Maneuver	dV (m/s)	Notes
LKO	3,400	
TMI Duna	1,060	
Capture (aerobrake)	~250	
Ike transfer	~150	Optional
Ike capture	~120	Optional

Maneuver	dV (m/s)	Notes
Total	~4,980	

**Contingencies**

- Aerobrake shallow: bleed off extra orbits.
- Aerobrake deep: propulsive intervention at periapsis.

**Success Criteria**

- Duna orbit stable.
- Ore maps returned.
- Ike also surveyed.

## Mission 19: ARES-2

*First rover on another planet — Duna surface*

### Objectives

- Land rover on Duna surface.
- Conduct atmospheric + surface science from multiple biomes.
- Prove the aerobrake + parachute + retropropulsion EDL architecture.

### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher A	1x Rover Lander (atmospheric variant)

### Prerequisites

- Mission 18 (Ares-1) ore maps.
- Duna transfer window.

### Launch Timing

Same or next Duna window as Ares-1.

### Flight Profile

#### Launch & Transit

290. Launcher A, Duna TMI.
291. Coast.
292. Target Duna periapsis 25 km for aerobrake.

#### EDL (Entry, Descent, Landing)

293. Aerobrake into Duna atmosphere.
294. At ~15 km, deploy drogue parachutes.
295. At ~6 km, drogues full, mains ready.
296. Jettison heat shield (spent).
297. Mains deploy at ~2 km.
298. At ~200 m altitude, fire retropropulsion engines for final descent.
299. Touchdown.

#### Surface Operations

300. Rover decouples.
301. Deploy instruments.
302. Drive to nearby biome. Duna terrain is rough — slow driving.
303. Science collection across biomes.
304. Indefinite mission duration.

### Delta-v Budget

Maneuver	dV (m/s)	Notes
LKO	3,400	
TMI	1,060	
Duna approach + EDL	~250	Mostly parachutes, some propulsion

Maneuver	dV (m/s)	Notes
Total	~4,710	

**Contingencies**

- Parachutes fail to deploy: emergency full retropropulsion — requires ~1,500 m/s.
- Heat shield jettison failure: rover may land on shield; still functional if level.
- Rough terrain: rover tumbling risk; low speed driving essential.

**Success Criteria**

- Rover on Duna.
- Ground science from 2+ biomes.

## Mission 20: DUNA-GATEWAY

### *Permanent science station in Duna orbit*

#### Objectives

- Deploy uncrewed science station to Duna orbit.
- Provide docking infrastructure for future crewed visits.
- Serve as comm relay for Duna/Ike surface assets.

#### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher B	1x Unmanned Science Station

#### Prerequisites

- Missions 18, 19.
- Duna window.

#### Launch Timing

Same or next Duna window.

#### Flight Profile

##### Launch & Transit

305. Launcher B to LKO.
306. TMI Duna.
307. Coast.

##### Capture

308. Aerobrake capture (station must have heat shield or use tug for propulsive).
309. Station tug circularizes at 100 km equatorial.

##### Commissioning

310. Deploy panels.
311. Activate MPL (Mobile Processing Lab).
312. Verify docking ports oriented for future visitors.
313. Begin routine science processing.

#### Delta-v Budget

Maneuver	dV (m/s)	Notes
LKO	3,400	
TMI	1,060	
Capture	~400	
Total	~4,860	

#### Contingencies

- Aerobrake accuracy critical with heavy station; propulsive reserve 800 m/s recommended.

### **Success Criteria**

- Station operational in Duna orbit with full systems online.

## Mission 21: SUNSEEKER-2

*Moho orbiter — establish orbital presence at the innermost planet*

### Objectives

- Orbit Moho.
- Complete ore and biome survey.

### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher B	1x Orbiter Probe — Moho variant (high dV, heat shield, ion optional)

### Prerequisites

- Mission 15 validated flyby.
- Moho window.

### Launch Timing

Moho window, typically Year 2.

### Flight Profile

#### Launch & TMI

314. Launcher B to LKO.
315. TMI Moho ~3,100 m/s.
316. Consider using Launcher B upper stage for part of TMI, then separate.

#### Coast (~110 days)

317. Coast.
318. Mid-course corrections.
319. Thermal management essential.

#### Moho Capture

320. Moho has no atmosphere — propulsive capture only.
321. Capture burn ~2,400 m/s.
322. This is the most dV-expensive capture in the inner system.
323. Plan for extended burn time — likely 10+ min with Terrier.

#### Survey

324. Low Moho orbit at ~60 km.
325. Full science and ore survey.
326. Transmit.

### Delta-v Budget

Maneuver	dV (m/s)	Notes
LKO	3,400	
TMI	~3,100	
Moho capture	~2,400	High gravity + no atmosphere
Total	~8,900	Requires Launcher B + optimized upper stage

### **Contingencies**

- Capture underburn: propagate retrograde at next periapsis; if SOI escape, abort.
- Thermal: radiators essential near Sun.

### **Success Criteria**

- Moho orbit achieved.
- Full survey returned.

## Mission 22: EVE-GATEWAY

### *Science station in Eve orbit*

#### Objectives

- Permanent orbital science presence at Eve.
- Infrastructure for future Gilly crewed missions.

#### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher B	1x Unmanned Science Station

#### Prerequisites

- Eve window.

#### Launch Timing

Eve window, typically Year 2.

#### Flight Profile

##### Launch & Transit

327. Launcher B to LKO.
328. TMI Eve 1,100 m/s.
329. Coast 130 days.

##### Aerobrake Capture

330. Eve aerobrake is generous — multiple passes bring station to circular orbit.
331. Warning: Eve gravity is high; capture requires careful periapsis.
332. Target periapsis 90 km first pass; adjust as needed.

##### Deployment

333. Circularize at 100 km.
334. Deploy systems.

#### Delta-v Budget

Maneuver	dV (m/s)	Notes
LKO	3,400	
TMI	1,100	
Capture	~400	
Total	~4,900	

#### Contingencies

- Similar to Duna Gateway.

#### Success Criteria

- Station in Eve orbit. PHASE 2 COMPLETE.

## Phase 3: Crewed Duna

*Missions 23-28 | First interplanetary crewed missions*

### Mission 23: PROSPECTOR-IKE

*Extend ISRU network to Ike*

#### Objectives

- Land Prospector on Ike.
- Begin mining Ike ore.
- Enable Duna Tank Farm infrastructure.

#### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher B	1x Prospector (standard airless variant)

#### Prerequisites

- Mission 18 (Duna orbiter with Ike scan).
- Duna window.

#### Launch Timing

Duna window.

#### Flight Profile

##### Launch & Transit

335. Launcher B to LKO.
336. TMI Duna.
337. At Duna approach, transfer to Ike rather than Duna capture.

##### Ike Landing

338. Ike capture ~180 m/s.
339. Identify ore biome from earlier Ares-1 scans.
340. Descend and land — Ike gravity ~11% of Kerbin.
341. Landing dV ~400 m/s.

##### Mining Operations

342. Same as Prospector-1 at Minmus.
343. Deploy drills and ISRU.
344. Begin ore-to-fuel conversion.
345. Set alarm for fuel-level checks.

#### Delta-v Budget

Maneuver	dV (m/s)	Notes
LKO	3,400	
TMI	1,060	

Maneuver	dV (m/s)	Notes
Ike intercept from Duna approach	~300	
Ike capture	~180	
Descent	~400	
Total	~5,340	Prospector full fuel required

### Contingencies

- Ike landing zones vary; use M4435 onboard for final site selection.

### Success Criteria

- Prospector mining on Ike.

## Mission 24: TANK-FARM-DUNA

*Duna orbital depot — the second major hub*

### Objectives

- Deploy Tank Farm to Duna orbit.
- Begin receiving fuel from Prospector-Ike.
- Ready the infrastructure for crewed Duna.

### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher B	1x Tank Farm

### Prerequisites

- Mission 23.

### Launch Timing

Next Duna window or shortly after Prospector-Ike is established.

### Flight Profile

#### Launch & Transit

346. Launcher B.
347. TMI Duna.
348. Coast 260 days.

#### Aerobrake Capture

349. Aerobrake at Duna.
350. Circularize at 100 km.

#### Fuel Network Activation

351. Prospector-Ike ascends from Ike surface with fuel load.
352. Transfers to Duna orbit (~700 m/s).
353. Docks with Tank Farm.
354. Fuel transfer.
355. Prospector returns to Ike.

### Delta-v Budget

Maneuver	dV (m/s)	Notes
LKO	3,400	
TMI	1,060	
Capture	~400	
Total	~4,860	

### Contingencies

- Tank Farm must survive Duna aerobrake — reinforced heat shield or propulsive alternative.

**Success Criteria**

- Tank Farm in Duna orbit with fuel arriving from Ike.

## Mission 25: PROSPECTOR-D-1

### *Atmospheric ISRU on Duna surface — redundancy and science*

#### Objectives

- Land Prospector-D (atmospheric variant) on Duna surface.
- Bonus science + redundant fuel source.
- Validate aerobrake-landed ISRU.

#### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher B	1x Prospector-D (atmospheric variant)

#### Prerequisites

- Missions 19, 23.

#### Launch Timing

Duna window.

#### Flight Profile

##### Launch & Transit

356. Launcher B.
357. Duna TMI.
358. Coast.

##### EDL

359. Aerobrake + drogue chutes + mains + propulsive landing.
360. Target identified Duna ore biome from Ares-2 survey.
361. Complex EDL — plan carefully.

##### Operations

362. Begin mining.
363. Note that Duna surface operations require more power management than Ike (dust, thinner atmosphere affects radiators slightly).
364. Can ascend back to Duna orbit if desired — Duna ascent from surface costs ~1,450 m/s.
365. Alternative: leave Prospector-D as permanent surface science + future crewed support.

#### Delta-v Budget

Maneuver	dV (m/s)	Notes
LKO	3,400	
TMI	1,060	
EDL	~500	
Ascent capability (if used)	1,450	

Maneuver	dV (m/s)	Notes
Total	~5,000-6,400	

**Contingencies**

- Difficult EDL on Duna; test on an unmanned rehearsal if uncertain.

**Success Criteria**

- Prospector-D operational on Duna.

## Mission 26: ARES-CREW-1

*FIRST CREWED MISSION TO DUNA — program milestone*

### Objectives

- Send crew to Duna surface.
- Demonstrate interplanetary crew ship architecture.
- Return crew safely to Kerbin.
- Plant flag and sample multiple Duna biomes.

### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher B	CSM (interplanetary) + Hab Module + LM (atmospheric Duna variant), 4-6 crew total

### Prerequisites

- Missions 23, 24, 25 complete.
- Tank Farm Duna has fuel onboard (verify at least one Prospector fuel delivery).
- Crew of 4-6 (1 Pilot, 1 Scientist, 1 Engineer minimum; 2 land, others stay in orbit).

### Launch Timing

Duna window, typically Year 2-3. Round-trip duration ~1 Kerbin year.

### Flight Profile

#### Launch

366. Launcher B assembles full stack in LKO (may require 2 launches: one for stack, one for fuel top-up).
367. Stack at LKO: CSM + Hab + LM, with dedicated TMI engine or enlarged service module.

#### Refuel at Minmus Tank Farm

368. Full stack flies to Minmus Tank Farm.
369. Tops up fuel for TMI + Duna operations + TKI.
370. Critical step — without refueling, this mission is not feasible.

#### TMI from Minmus

371. From Minmus orbit, TMI Duna costs ~950 m/s — cheaper than from LKO.
372. Execute burn.

#### Coast (~260 days)

373. Crew activities: science, exercise, maintenance.
374. Mid-course correction.
375. Arrive at Duna.

#### Duna Capture at Tank Farm

376. Aerobrake into Duna orbit (carefully — the stack is heavy).
377. Circularize at Tank Farm altitude.
378. Dock with Tank Farm. Top up LM and CSM fuel.

#### Surface Mission

379. 2 crew transfer to LM.

- 380. LM atmospheric descent: aerobrake, chutes, propulsive landing.
- 381. Surface operations: flag, samples, multiple biomes via short traverses.
- 382. Surface duration: several Kerbin days.
- 383. LM ascent ~1,800 m/s back to orbit.
- 384. Rendezvous and dock with CSM/Hab stack at Tank Farm.

### Return

- 385. Refuel at Tank Farm one more time (outbound consumption for TKI).
- 386. TKI Duna→Kerbin: ~1,100 m/s.
- 387. Coast back to Kerbin (~260 days).
- 388. Before Kerbin atmosphere, crew transfers to CSM.
- 389. Jettison Hab Module (optionally deorbit as debris, or leave in Kerbin solar orbit).
- 390. CSM aerobrake at Kerbin. Parachutes. Recovery.
- 391. Crew returns as heroes.

### Delta-v Budget

Maneuver	dV (m/s)	Notes
LKO	3,400	
LKO to Minmus	~930 + 160	
Minmus TMI to Duna	~950	Reduced from Kerbin LKO
Duna capture	~400	Aerobrake
LM descent + ascent	~2,300	Full round trip
Duna TKI to Kerbin	~1,100	From Duna Tank Farm orbit
Total (with refueling)	~9,240	Distributed across stages + Tank Farm supplies

### Contingencies

- Stranded at Duna: requires rescue launch, ~2 years wait for window; plan multi-year supplies.
- LM descent failure: abort-to-orbit via ascent engine.
- Hab malfunction: emergency consolidation in CSM; severely restricts range.
- Critical: verify life support margin. Plan for 600+ day mission.

### Success Criteria

- First crewed Duna landing.
- Crew returns alive.
- Interplanetary architecture validated.

## Mission 27: ARES-CREW-2

*Second crewed Duna landing — different biome (optional)*

### Objectives

- Second Duna landing at a biome distinct from Ares-Crew-1.
- Comparative science.
- Exercise the infrastructure network a second time.

### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher B	Same as Ares-Crew-1

### Prerequisites

- Mission 26 successful.
- Next Duna window.

### Launch Timing

Next Duna window (~920 days later). Year 4.

### Flight Profile

#### Same as Ares-Crew-1

392. Consider leaving Hab Module at Duna Tank Farm after Mission 26 — saves mass on Ares-Crew-2 launch.
393. Fresh CSM + LM launched, then docked with Hab at Duna Tank Farm.

### Delta-v Budget

Maneuver	dV (m/s)	Notes
Reduced if Hab reused	~7,500	vs. 9,240 for Ares-Crew-1

### Contingencies

- Same as Ares-Crew-1.

### Success Criteria

- Second successful Duna landing.

## Mission 28: VENERA-CREW-1

*Crewed Gilly mission — warm-up for Jool*

### Objectives

- Send crew to Gilly (Eve's moon).
- Low-gravity landing experience — Gilly has tiny gravity, excellent training for Jool moons.
- Prove long-duration crew ops with short landing commit.

### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher B	CSM (interplanetary) + small landing module (Gilly-class), 3-4 crew

### Prerequisites

- Mission 22 (Eve Gateway).
- Eve window.

### Launch Timing

Eve window, Year 3-4.

### Flight Profile

#### Launch & Transit

394. Launcher B.
395. Refuel at Minmus.
396. TMI Eve ~1,100 m/s.
397. Coast 130 days.

#### Gilly Arrival

398. Rather than capture at Eve, directly intercept Gilly.
399. Gilly SOI capture ~50 m/s.
400. Dock at Eve Gateway first for top-up.

#### Landing

401. Gilly gravity is so low that landing is essentially docking with the surface.
402. Ascent is <30 m/s. Kerbals can jump halfway to orbit.
403. Crew plants flag, collects samples, enjoys bizarre physics.

#### Return

404. Ascent to CSM.
405. TKI ~1,000 m/s (from Eve/Gilly system).
406. Coast back. Kerbin aerobrake.

### Delta-v Budget

Maneuver	dV (m/s)	Notes
LKO → Minmus top-up	~4,500	
TMI from Minmus	~1,100	

Maneuver	dV (m/s)	Notes
Gilly arrival	~200	
Landing + ascent	~60	Trivial
TKI	~1,000	
Total	~6,860	

### Contingencies

- Similar profile to Ares-Crew; main risk is 1 year+ mission duration.

### Success Criteria

- Crew on Gilly. Long-duration mission practice complete. PHASE 3 COMPLETE.

## Phase 4: Jool System Survey

*Missions 29-35 | Outer-system uncrewed exploration and ISRU*

### Mission 29: VOYAGER-1

*Jool grand tour — multiple moon flybys on one probe*

#### Objectives

- Flyby probe to Jool system.
- Sequential flybys of as many Jool moons as gravity assists allow.
- First uncrewed reach of outer system.

#### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher B	1x Flyby Probe — Outer variant (RTG, RA-2 antenna)

#### Prerequisites

- Jool window.

#### Launch Timing

Jool windows every ~800 days. First window typically Year 2.

#### Flight Profile

##### Launch & TMI

407. Launcher B to LKO.
408. TMI Jool: ~2,000 m/s prograde (from LKO).
409. Target Jool periapsis for aerobrake capture opportunity, or use Tylo gravity assist to enter system.

##### Long Coast (~1,100 days)

410. Coast to Jool.
411. Multiple mid-course corrections.
412. RTG power essential — solar panels inadequate at Jool distance.

##### Jool System Entry

413. First flyby: target Tylo for gravity assist (or Laythe).
414. Post-assist, target Vall.
415. After Vall, target Bop.
416. After Bop, target Pol.
417. Each flyby collects science at that moon.
418. Careful trajectory planning essential — Transfer Window Planner and MechJeb's maneuver planner both help.

##### Final Disposition

419. Probe ends on solar orbit after Jool escape, or decays into one of the moons.
420. Continuous science transmission throughout.

#### Delta-v Budget

Maneuver	dV (m/s)	Notes
LKO	3,400	
TMI Jool	~2,000	
Corrections	~200	
Moon approach trims	~500 total	Spread across flybys
Total	~6,100	

### Contingencies

- If any flyby missed, continue to next moon; sacrifice that science.

### Success Criteria

- At least 3 Jool moons photographed and surveyed from flyby range.

## Mission 30: JOOL-ORBITER

*Full orbital presence in the Jool system*

### Objectives

- Establish Jool orbit.
- Serve as regional comm relay for Jool missions.
- Full Jool gas giant atmospheric science.

### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher B	1x Orbiter Probe — Outer (RTG) with upgraded fuel

### Prerequisites

- Jool window.

### Launch Timing

Jool window.

### Flight Profile

#### Launch & TMI

421. Launcher B to LKO.
422. TMI Jool.

#### Coast

423. Coast 1,100 days.
424. Corrections.

#### Jool Capture

425. Option A: aerobrake into Jool atmosphere. Risky but saves dV.
426. Option B: use Tylo or Laythe gravity assist for slowdown.
427. Option C: propulsive capture ~900 m/s retrograde at periapsis.

#### Survey

428. Orbital science from Jool itself at multiple altitudes.
429. Deploy antennas — serves as relay.

### Delta-v Budget

Maneuver	dV (m/s)	Notes
LKO	3,400	
TMI	2,000	
Capture	~900 propulsive or ~300 aerobrake	
Total	~5,700	

### **Contingencies**

- Aerobrake at Jool is aggressive — maintain periapsis > 200 km for safety; use propulsive if uncertain.

### **Success Criteria**

- Jool orbit stable.

## Mission 31: LAYTHE-MAPPER

*Orbiter to Laythe — water world survey*

### Objectives

- Orbit Laythe.
- Surface biome and ore mapping — Laythe is the only Jool moon with an atmosphere and surface water.
- Prepare for possible crewed Laythe mission.

### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher B	1x Orbiter Probe — Outer

### Prerequisites

- Jool window.

### Launch Timing

Jool window.

### Flight Profile

#### Launch & Transit

430. Launcher B.
431. TMI Jool.
432. Coast.

#### Jool Arrival

433. Capture into Jool via aerobrake or Tylo assist.
434. Transfer to Laythe orbit — cheaper from Jool's capture orbit.

#### Laythe Orbit

435. Laythe has an atmosphere — aerobrake capture possible.
436. Circularize low at 80 km.
437. Full survey.

### Delta-v Budget

Maneuver	dV (m/s)	Notes
LKO + TMI + Jool capture	~6,100	As Voyager-1
Laythe intercept	~350	
Laythe aerobrake capture	~100	
Total	~6,550	

### Contingencies

- Laythe atmosphere is thick — aerobrake risk; use periapsis >50 km.

### Success Criteria

- Laythe fully mapped.

## Mission 32: VALL-MAPPER

### Orbiter to Vall

#### Objectives

- Orbit Vall.
- Ore and biome survey.
- Identify potential landing sites for future crewed Vall.

#### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher B	1x Orbiter Probe — Outer (similar to Laythe mapper but airless target)

#### Prerequisites

- Jool window.

#### Launch Timing

Launch with Jool wave.

#### Flight Profile

##### Launch & Transit

438. Launcher B.
439. TMI Jool.
440. Coast.

##### Jool + Vall Insertion

441. Jool capture (aerobrake or propulsive).
442. Transfer to Vall orbit (~900 m/s from Jool orbit).
443. Vall capture ~300 m/s (no atmosphere).

##### Survey

444. Full M700 + M4435.

#### Delta-v Budget

Maneuver	dV (m/s)	Notes
LKO	3,400	
TMI	2,000	
Jool capture	~400-900	
Vall insertion	~1,200	
Total	~7,000-7,500	

#### Contingencies

- Vall is the costliest of the small Jool moons for orbit establishment.

#### Success Criteria

- Vall orbit stable and mapped.

## Mission 33: BOP-POL-MAPPERS

### *Paired orbiters to Bop and Pol*

#### Objectives

- Orbit Bop and Pol — both small, irregular moons.
- Critical ore surveys — Pol is a likely Prospector target.
- Dual-mission efficiency.

#### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher B	2x Orbiter Probe — Outer (paired on single launcher, separates in cruise)

#### Prerequisites

- Jool window.

#### Launch Timing

Jool window.

#### Flight Profile

##### Launch & TMI

445. Launcher B with both probes on a dispenser.
446. TMI Jool.
447. Coast.

##### Separation

448. On approach to Jool, both probes separate.
449. Each performs independent Jool capture and moon insertion.
450. Pol probe targets Pol; Bop probe targets Bop.

##### Surveys

451. Pol orbiter confirms/refines the ore survey — this determines Prospector-Pol landing site.
452. Bop orbiter maps Bop.
453. Both transmit.

#### Delta-v Budget

Maneuver	dV (m/s)	Notes
Same as Voyager-1 baseline		
Each probe carries ~3,500 m/s dV		Shared launcher delivers both

#### Contingencies

- Separation timing is critical; verify each probe's probe core is independent.

#### Success Criteria

- Both moons orbited. Pol surveyed in detail for Prospector.



## Mission 34: PROSPECTOR-POL

*ISRU in the outer system — Pol Prospector*

### Objectives

- Land Prospector on Pol.
- Begin outer-system fuel production.
- Enable Jool Tank Farm.

### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher B	1x Prospector-V (RTG variant for outer system)

### Prerequisites

- Mission 33 (Pol ore survey).
- Jool window.

### Launch Timing

Jool window.

### Flight Profile

#### Launch & Transit

454. Launcher B.
455. TMI Jool.
456. Coast 1,100 days.

#### Pol Arrival & Landing

457. Capture at Jool (aerobrake or propulsive).
458. Transfer to Pol orbit — very low dV (~200 m/s).
459. Pol capture ~50 m/s.
460. Descend to ore biome. Pol gravity is tiny — landing is trivial.
461. Landing dV ~130 m/s.

#### Mining Operations

462. RTG-powered Prospector doesn't need sunlight — Jool is too far.
463. Deploy drills. Begin ISRU.
464. Heat management easier than at Minmus (lower solar flux).
465. Fuel accumulation: factor in slower refining rate if only RTG power.

### Delta-v Budget

Maneuver	dV (m/s)	Notes
LKO + TMI + Jool capture + Pol	~6,900	
Total	~6,900 with Prospector fuel fill	

### Contingencies

- RTG power is fixed — if insufficient, ISRU runs slowly. Accept the lower throughput or add RTG redundancy.

**Success Criteria**

- Prospector on Pol producing fuel.

## Mission 35: JOOL-TANK-FARM

*Outer-system fuel depot — the third major hub*

### Objectives

- Deploy Tank Farm to Pol orbit.
- Receive fuel from Prospector-Pol.
- Enable crewed Jool missions.

### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher B	1x Tank Farm

### Prerequisites

- Mission 34.
- Jool window.

### Launch Timing

Jool window.

### Flight Profile

#### Launch & Transit

466. Launcher B.
467. TMI Jool.
468. Coast 1,100 days.

#### Capture at Pol

469. Jool capture (aerobrake).
470. Transfer to Pol orbit.
471. Circularize at 30 km.

#### Fuel Network Activation

472. Prospector-Pol ascends with fuel.
473. Docks with Tank Farm.
474. Transfer.

### Delta-v Budget

Maneuver	dV (m/s)	Notes
Same as Prospector-Pol deployment	~6,900	

### Contingencies

- Same as other Tank Farms.

### Success Criteria

- Jool Tank Farm operational. PHASE 4 COMPLETE. Outer system is now refuelable.

## Phase 5: Dres and Eeloo

*Missions 36-40 | Complete uncrewed coverage*

### Mission 36: DRES-ORBITER

*Orbit Dres — the forgotten dwarf planet*

#### Objectives

- Orbit Dres.
- Ore and biome survey.

#### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher A	1x Orbiter Probe — Outer (RTG)

#### Prerequisites

- Dres window.

#### Launch Timing

Dres windows every ~780 days.

#### Flight Profile

##### Launch & Transit

475. Launcher A to LKO.
476. TMI Dres ~1,500 m/s.
477. Coast 650 days.

##### Dres Capture

478. No atmosphere — propulsive only.
479. Capture ~400 m/s.
480. Circularize at 30 km.

##### Survey

481. Standard orbital science.

#### Delta-v Budget

Maneuver	dV (m/s)	Notes
LKO	3,400	
TMI	~1,500	
Capture	~400	
Total	~5,300	

#### Contingencies

- Simple mission; low risk.

**Success Criteria**

- Dres orbit and survey complete.

## Mission 37: DRES-ROVER

### Rover to Dres surface

#### Objectives

- Surface science on Dres.
- Final rocky body surface asset.

#### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher A	1x Rover Lander (airless)

#### Prerequisites

- Mission 36.
- Dres window.

#### Launch Timing

Next Dres window.

#### Flight Profile

##### Transit

482. Launcher A.
483. TMI Dres.
484. Coast.

##### Landing

485. Standard airless descent.
486. Land at biome from survey.

##### Operations

487. Drive, science, transmit.

#### Delta-v Budget

Maneuver	dV (m/s)	Notes
LKO	3,400	
TMI	~1,500	
Capture	~400	
Landing	~430	
Total	~5,730	

#### Contingencies

- Dres surface is rough; low driving speeds.

#### Success Criteria

- Rover on Dres.

## Mission 38: EELOO-ORBITER

*Orbit Eeloo — the farthest world*

### Objectives

- Orbit Eeloo.
- Survey.

### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher B	1x Orbiter Probe — Outer with extra fuel

### Prerequisites

- Eeloo window.

### Launch Timing

Eeloo windows every ~820 days. Transit ~1,700 days (longest in system).

### Flight Profile

#### Launch & TMI

488. Launcher B to LKO.
489. TMI Eeloo ~2,200 m/s.
490. Coast 1,700 days.

#### Eeloo Capture

491. Propulsive only.
492. Capture ~1,100 m/s.
493. Circularize at 50 km.

#### Survey

494. Full science at low orbit.

### Delta-v Budget

Maneuver	dV (m/s)	Notes
LKO	3,400	
TMI	~2,200	
Capture	~1,100	
Total	~6,700	

### Contingencies

- Very long mission; patience is the main challenge.

### Success Criteria

- Eeloo orbit and survey complete.

## Mission 39: EELOO-ROVER

### Rover on Eeloo

#### Objectives

- Surface science on Eeloo.
- Complete rocky-body rover coverage.

#### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher B	1x Rover Lander (airless), with extra transit fuel

#### Prerequisites

- Mission 38.
- Eeloo window.

#### Launch Timing

Eeloo window.

#### Flight Profile

##### Transit

495. Launcher B.
496. TMI Eeloo.
497. Coast 1,700 days.

##### Landing

498. Capture.
499. Descend.
500. Land.

##### Operations

501. Drive and science.

#### Delta-v Budget

Maneuver	dV (m/s)	Notes
LKO	3,400	
TMI	~2,200	
Capture	~1,100	
Landing	~620	
Total	~7,320	

#### Contingencies

- Long mission, careful power management.

#### Success Criteria

- Rover on Eeloo.



## Mission 40: PROSPECTOR-EELOO

*Outer-system Prospector — optional endgame prep*

### Objectives

- Establish Prospector on Eeloo (optional).
- Enables future crewed Eeloo or refueling node for Eeloo operations.

### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher B	1x Prospector-V (RTG variant)

### Prerequisites

- Mission 38 + 39.
- Eeloo window.

### Launch Timing

Optional; only if crewed Eeloo is planned.

### Flight Profile

#### Transit

- 502. Long transit.
- 503. RTG power essential.

#### Landing

- 504. Identify ore biome. Land.

#### Mining

- 505. Begin mining.
- 506. Use as refuel point for potential future crewed Eeloo missions.

### Delta-v Budget

Maneuver	dV (m/s)	Notes
Transit as Eeloo rover	~7,320	
Full Prospector fuel loaded to support operations	~3,500	

### Contingencies

- Skip this mission unless crewed Eeloo is planned.

### Success Criteria

- Prospector-Eeloo operational. PHASE 5 COMPLETE.

## Phase 6: Crewed Jool

*Missions 41-45 | Outer-system crewed capstone*

### Mission 41: JOOL-CREW-1

*First crewed mission to the outer system*

#### Objectives

- Send crew to Jool system.
- Visit Pol surface (easy low-gravity landing).
- Establish orbital presence for subsequent missions.
- Return crew safely after multi-year mission.

#### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher B (potentially multiple launches + LKO assembly)	Interplanetary Crew Ship (CSM + Hab + LM) + fuel, 4-6 crew

#### Prerequisites

- Jool Tank Farm operational (Mission 35) with fuel.
- Prospector-Pol active and delivering fuel to Tank Farm.
- Crew with Duna-mission experience preferred.
- Jool window.

#### Launch Timing

Year 5-6 or later. Round-trip ~5-6 years.

#### Flight Profile

##### LKO Assembly

507. First launch: Crew ship (CSM + Hab + LM) to LKO.
508. Second launch (optional): fuel tanker to top up.
509. Crew launch: separate small launch to bring crew to LKO — keep crew launches close to departure date.
510. Crew docks with the assembled stack.

##### Refuel at Minmus

511. Full stack to Minmus Tank Farm.
512. Top up fuel for TMI + Jool operations + TKI.

##### TMI Jool

513. From Minmus orbit, Jool TMI ~1,900 m/s.
514. Coast 1,100 days.

##### Long-Duration Cruise

515. Crew activities: science, exercise, maintenance, comm with Kerbin.
516. Mid-course corrections.
517. Psychological support — long mission.

### Jool System Arrival

- 518. Aerobrake at Jool or Tylo gravity assist to slow.
- 519. Transfer to Pol.
- 520. Dock at Jool Tank Farm. Refuel.

### Pol Landing

- 521. 2-3 crew transfer to LM (a Minmus-class LM with RTG is fine for Pol — gravity is so low).
- 522. Descent ~80 m/s. Land.
- 523. Surface activities.
- 524. Ascent ~80 m/s. Rendezvous with CSM.

### Return

- 525. Refuel at Tank Farm.
- 526. TKI Jool→Kerbin ~1,000 m/s.
- 527. Coast 1,100 days.
- 528. Kerbin aerobrake via CSM.
- 529. Jettison Hab (or store at Jool Tank Farm for reuse).
- 530. Crew returns after ~5-6 year mission.

### Delta-v Budget

Maneuver	dV (m/s)	Notes
Multi-leg refueled profile		
LKO	3,400	
Minmus refuel	~1,000	
Jool TMI from Minmus	1,900	
Jool capture	~400 aerobrake	
Pol ops (land + ascent)	~180	Trivial
TKI Jool→Kerbin	~1,000	
Total (propulsive consumption)	~7,880	Distributed across many tank tops

### Contingencies

- Longest mission yet. Life support margin critical.
- Any anomaly potentially requires 2+ year rescue delay.
- Tank Farm must remain stocked — Prospector-Pol operations are the critical infrastructure.

### Success Criteria

- First crewed arrival at Jool system.
- Pol landing.
- Crew alive.

## Mission 42: LAYTHE-CREW-1

*Crewed Laythe — splashdown on an alien ocean*

### Objectives

- Send crew to Laythe surface.
- Atmospheric landing on Jool's water moon.
- First crew to walk (swim?) on Laythe.

### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher B	CSM + Hab + LM-Atmospheric-Laythe variant

### Prerequisites

- Mission 41 validated crewed Jool.
- Jool Tank Farm stocked.

### Launch Timing

Either continuation of Mission 41 itinerary (same mission) or separate launch in Year 7.

### Flight Profile

#### Same transit as Jool-Crew-1 if sequential

531. If sequential: crew already in Jool system. If separate: full transit.
532. Refuel at Tank Farm.
533. Transfer to Laythe orbit.

#### Laythe Descent

534. Atmospheric descent: aerobrake, drogues, mains, propulsive final.
535. Laythe atmosphere is denser than Duna — chutes more effective.
536. Target landing site: coastal or island terrain (avoid deep ocean landing unless LM is amphibious).

#### Surface Operations

537. Crew EVA on Laythe surface.
538. Oxygen atmosphere — crew can breathe (in RSS/Kerbalism mode with proper setup, but in stock always wear helmets).
539. Samples from Laythe biomes.
540. Ascent: ~2,800 m/s — very expensive.
541. Rendezvous with CSM in Laythe orbit.

#### Return

542. Back to Tank Farm for refuel.
543. TKI Kerbin.
544. Coast, aerobrake.

### Delta-v Budget

Maneuver	dV (m/s)	Notes
Transit (if separate)	~7,000	

Maneuver	dV (m/s)	Notes
Laythe descent	~500	Mostly atmospheric
Laythe ascent	2,800	Hard because atmosphere + gravity
Total ops	~3,300 if already at Jool	

### Contingencies

- Laythe ascent is the hardest stock ascent besides Eve. Ensure LM-Laythe variant has ample fuel.
- Ocean landing: if LM tips on splashdown, abort via ascent engine if water not over intakes.

### Success Criteria

- Crew on Laythe surface, returned to orbit.

## Mission 43: VALL-CREW-1

*Crewed Vall landing — Mun-class landing in Jool system*

### Objectives

- Crewed landing on Vall.
- Another Jool system surface.

### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher B	LM (airless, Mun-class)

### Prerequisites

- Jool crewed presence.

### Launch Timing

Part of extended Jool crewed campaign.

### Flight Profile

#### From Jool Tank Farm

545. Transfer to Vall orbit: ~900 m/s.
546. Capture ~300 m/s (no atmosphere).
547. Descent ~860 m/s to surface.
548. Ascent ~860 m/s.
549. Return to Tank Farm.

### Delta-v Budget

Maneuver	dV (m/s)	Notes
Jool ops	~3,000 from Tank Farm	

### Contingencies

- Vall ascent is significant — ensure LM has margin.

### Success Criteria

- Crew on Vall.

## Mission 44: BOP-CREW-1

*Crewed Bop landing — cheap and easy*

### Objectives

- Crew on Bop.
- Low-gravity landing experience bonus.

### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher B	LM (small, Gilly-class)

### Prerequisites

- Jool infrastructure.

### Launch Timing

Part of Jool campaign.

### Flight Profile

#### From Jool Tank Farm

- 550. Transfer to Bop ~200 m/s.
- 551. Land ~200 m/s.
- 552. Ascent ~200 m/s.
- 553. Return.

### Delta-v Budget

Maneuver	dV (m/s)	Notes
Jool ops	~600 from Tank Farm	

### Contingencies

- Bop's terrain is odd — careful landing.

### Success Criteria

- Crew on Bop.

## Mission 45: JOOL-CREW-RETURN

*Return the Jool crew to Kerbin — Program Capstone*

### Objectives

- Return all crew from extended Jool campaign.
- Program capstone successful return.
- If missions 41-44 were in one campaign, this is the return leg.

### Hardware & Launcher

Launcher	Payload (see Catalog)
N/A — return phase of ongoing Jool mission	CSM only (Hab stored at Tank Farm)

### Prerequisites

- Jool operations complete.
- Tank Farm has return fuel.

### Launch Timing

End of Jool campaign.

### Flight Profile

#### Departure

554. Final refuel at Jool Tank Farm.
555. Separate Hab Module — leave at Tank Farm for next mission.
556. CSM ignites TKI: ~1,000 m/s.
557. Coast 1,100 days back to Kerbin.

#### Kerbin Arrival

558. Approach velocity high — use Kerbin aerobrake.
559. If velocity > 4,500 m/s, consider aerobrake into LKO first (multiple passes), then final re-entry.
560. Jettison service module if not needed.
561. Final re-entry and parachute recovery.

### Delta-v Budget

Maneuver	dV (m/s)	Notes
TKI from Jool Tank Farm	~1,000	
Arrival corrections	~200	

### Contingencies

- High-speed re-entry: use lofted re-entry (multi-pass aerobrake) to reduce peak thermal load.
- Fuel shortage: emergency return via creative trajectory (Oberth at Kerbin periapsis etc.).

### Success Criteria

- Crew returns safely.

- PHASE 6 COMPLETE.
- PROGRAM CAPSTONE ACHIEVED.

## Phase 7: Endgame (Optional)

*Missions 46-48 | Hardest targets*

### Mission 46: TYLO-CREW-1

*Crewed Tylo landing — hardest airless body*

#### Objectives

- Land crew on Tylo.
- Return to orbit.
- Demonstrate heavy-lander capability.

#### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher B or C	Heavy LM (custom: dual-stage, large descent and ascent tanks)

#### Prerequisites

- All of Phase 6.
- Tylo LM designed and validated uncrewed.
- Jool Tank Farm has substantial fuel.

#### Launch Timing

Year 7+.

#### Flight Profile

##### Assembly at Jool

562. Heavy LM launched separately to Jool.
563. Docked with CSM at Jool Tank Farm.
564. Full fuel up of LM at Tank Farm.

##### Tylo Descent

565. Transfer to Tylo orbit.
566. Descent dV ~2,270 m/s — more than the LM ascent from Mun.
567. Careful throttle management essential.
568. Landing at selected site.

##### Surface Ops

569. Crew EVA — Tylo is Mun-like.
570. Short stay — weight penalty prohibits long surface missions.

##### Ascent

571. Ascent ~2,270 m/s — engine must be powerful.
572. Consider pre-positioning an ascent tanker in low Tylo orbit to reduce LM ascent mass.
573. Rendezvous with CSM.
574. Return to Tank Farm, then to Kerbin.

#### Delta-v Budget

Maneuver	dV (m/s)	Notes
Tylo descent	2,270	
Tylo ascent	2,270	
Total Tylo ops dV	~4,540	Very expensive — LM must be large

### Contingencies

- Ascent underburn: stranded crew — must rescue.
- Recommended: pre-position refueling tug in low Tylo orbit to top up LM post-ascent.

### Success Criteria

- Crew on Tylo.
- Crew returns.

## Mission 47: EVE-CREW-1

*Crewed Eve surface and return — the hardest mission in stock KSP*

### Objectives

- Crew on Eve surface.
- Return crew to Kerbin.
- The apex of the program.

### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher C required	Multi-vehicle campaign: pre-positioned ascent vehicle + crew descent + CSM

### Prerequisites

- Launcher C designed and validated.
- Eve ascent vehicle designed, tested, pre-positioned on Eve surface (uncrewed).
- All preceding phases complete.
- Eve transfer window.

### Launch Timing

Year 8+.

### Flight Profile

#### Pre-positioning (Mission 47a)

575. Launcher C delivers Eve Ascent Vehicle (EAV) to Eve surface uncrewed.
576. EAV aerobrake descent, propulsive landing at pre-selected flat biome.
577. EAV fully fueled, with large ascent stage (~8,000 m/s ascent capability).
578. EAV waits on Eve surface.

#### Crew Descent (Mission 47b)

579. Separate launch: CSM + crew descent vehicle to Eve.
580. Crew descent: aerobrake + parachutes + propulsive to EAV landing site.
581. Land crew near EAV. EVA to transfer crew to EAV.

#### Surface Ops

582. Crew activities.
583. Short stay — supplies limited.

#### Ascent

584. EAV ascends from Eve surface — ~8,000 m/s required.
585. Multi-stage design: first stage burns in atmosphere (high drag); upper stage in vacuum.
586. Rendezvous with CSM in Eve orbit.

#### Return

587. CSM to Kerbin via standard inner-system trajectory.

### Delta-v Budget

Maneuver	dV (m/s)	Notes
EAV ascent from Eve surface	~8,000	Hardest in stock
This is a campaign, not a single mission		Multiple launches required

### Contingencies

- EAV must be pre-positioned and verified before crew departs.
- If EAV shows fault post-landing, abort crew descent.
- Full backup ascent vehicle prudent.

### Success Criteria

- Crew on Eve and safely returned to Kerbin.

## Mission 48: MOHO-CREW-1

*Crewed Moho orbital mission — simplest of the endgame trio*

### Objectives

- Send crew to Moho orbit.
- Return crew.
- No landing required — orbital only.

### Hardware & Launcher

Launcher	Payload (see Catalog)
Launcher B	Heavily-fueled CSM + Hab, 3 crew

### Prerequisites

- Moho window.
- Prior Moho uncrewed orbiters for intel.

### Launch Timing

Year 8+.

### Flight Profile

#### Launch & Refuel

588. Launcher B to LKO.
589. Refuel at Minmus.
590. Extra fuel tankers may be required.

#### TMI Moho

591. TMI ~3,000 m/s from Minmus.
592. Coast 110 days.

#### Moho Capture

593. Propulsive capture ~2,400 m/s.

#### Orbital Ops

594. Crewed orbital science.
595. Visual observations.
596. No landing — Moho is extremely expensive.

#### Return

597. TKI ~2,000 m/s Moho→Kerbin.
598. Coast 110 days.
599. Kerbin aerobrake.

### Delta-v Budget

Maneuver	dV (m/s)	Notes
LKO → Minmus	~1,090	
TMI Moho	3,000	
Moho capture	2,400	

Maneuver	dV (m/s)	Notes
TKI Moho→Kerbin	2,000	
Total	~8,490	Expensive but no landing

**Contingencies**

- Thermal management essential.

**Success Criteria**

- Crew to Moho and back. PROGRAM COMPLETE.

— *End of Document 3* —

*Continue with Document 4: Program Management & Schedule*