

# KERBIN INTEGRATED SPACE PROGRAM

Document 1 of 4: Program Master Plan

*Strategic Overview, Design Philosophy, Phased Roadmap*

Companion documents:  
Document 2: Vehicle Catalog  
Document 3: Mission Playbook  
Document 4: Program Management & Schedule

# 1. Executive Summary

This document defines a multi-phase, integrated space program for the Kerbol system. The program comprises roughly 48 missions organized into eight phases, culminating in a sustained infrastructure network that reaches every body in the system.

The program's central innovation is the deliberate construction of a propellant logistics network early in its life. By deploying in-situ resource utilization (ISRU) tankers and orbital fuel depots at Minmus, Ike, and a Jool moon, interplanetary mission cost drops dramatically after Phase 1. Subsequent missions are not one-shot efforts but routine operations flown against persistent infrastructure.

This master plan document provides the strategic overview. Companion documents cover vehicle design (Document 2), mission execution (Document 3), and program scheduling (Document 4).

## 1.1 Program Objectives

- Reach every celestial body in the Kerbol system with at least an orbital probe.
- Land rovers on every rocky body.
- Establish permanent orbital science stations at Eve, Duna, and Jool.
- Conduct crewed missions to Mun, Minmus, Gilly, Duna, and the major Jool moons.
- Build a propellant logistics network that makes destinations progressively cheaper to reach.
- Optionally attempt the hardest targets: Tylo landing, Eve return, crewed Moho.

## 1.2 Expected Program Duration

Gameplay time: approximately 50-70 hours of active play, distributed across multiple weeks or months of real time. In-game time: several Kerbin years for the core program; 10+ years with outer-system crewed missions. This is intended as a long-running career-mode save rather than a weekend sprint.

# 2. Design Philosophy

Five principles govern every design decision in this program.

## 2.1 Standardize Interfaces

Every payload mounts to the launcher upper stage via a common 2.5m interface: a Clamp-O-Tron Sr. docking port for active payloads, or a TR-XL decoupler for expendable ones. Every launcher upper stage accepts the same interface. This modularity means a payload developed for Launcher A can fly on Launcher B without redesign, and payloads can be reconfigured between missions.

## 2.2 Build Two Launchers, Not Twenty

The mass ratio between a small Minmus probe (~2 tonnes) and a crewed Jool stack (60+ tonnes) is 30:1. A single launcher sized for the heavy case is wasteful; a launcher sized for the light case cannot do the heavy case. Two launchers cover approximately 95% of missions efficiently. A third super-heavy launcher exists only for endgame contingencies (crewed Eve, large Tylo landers).

### **2.3 Aerobrake Wherever Possible**

Propulsive capture at a body with an atmosphere is a waste of delta-v. All crewed returns to Kerbin aerobrake. Arrivals at Eve, Duna, and Laythe also aerobrake where the vehicle is equipped for it. This decision alone can save 1,000+ m/s per return mission, and directly determines payload mass margins.

### **2.4 Refuel In-System**

The single highest-value early mission is deploying the first ISRU tanker (Prospector) and orbital fuel depot (Tank Farm) at Minmus. Once this infrastructure is in place, all interplanetary missions route through Minmus for topping up. The cost of reaching any destination drops substantially because the ship arrives at Minmus with fuel for the remaining journey, not the entire journey. This is the pivot point that separates a basic program from a sustained one.

### **2.5 Design for the Mission, Not the Destination**

The program uses six payload archetypes (flyby, orbiter, rover, station, crewed orbital, crewed landing) that each work at multiple destinations with minor variant adjustments. This is in preference to bespoke spacecraft for each destination. The variants differ mainly in power generation (solar vs. RTG), comms antenna size, and aerobrake equipment — not fundamental architecture.

### 3. System Architecture Overview

The program consists of four interacting systems.

#### 3.1 Launcher Family

Designation	Role	LKO Payload	Typical Missions
Launcher A (Kerbin-II)	Medium lifter	~12-15 tonnes	Probes, CSM-only crewed, Mun/Minmus missions
Launcher B (Kerbin-V)	Heavy lifter	~40-50 tonnes	Interplanetary crewed, heavy probes, infrastructure
Launcher C (Kerbin-Nova)	Super-heavy, optional	~80-100 tonnes	Crewed Eve, large Tylo landers

Launchers are detailed in Document 2, Part 1.

#### 3.2 Payload Archetypes

Archetype	Purpose	Variants	Typical Mass
Flyby Probe	One-pass science collection	Inner (solar), Outer (RTG)	~2 t
Orbiter Probe	Long-duration orbital science, ore mapping	Inner, Outer (ion), High-dV (Moho)	~3 t
Rover Lander	Surface exploration	Airless, Atmospheric	~4-6 t
Science Station	Permanent orbital presence	Inner, Outer	~10 t
Crewed Orbital (CSM)	Crew transport, orbital ops	Mun-class, Interplanetary	~12 t
Crewed Landing (CSM+LM)	Crewed surface missions	Airless LM, Atmospheric LM	~30 t stack

Payload archetypes are detailed in Document 2, Parts 2 and 3.

#### 3.3 Infrastructure Network

Infrastructure assets are permanent fixtures. Once deployed, they serve all subsequent missions.

Asset	Function	Deployment Phase	Destinations
Prospector (ISRU tanker)	Land, drill, refine fuel, rendezvous	Phase 1 onward	Minmus, Ike, Pol, others as needed
Tank Farm (orbital depot)	Store refined fuel for client craft	Phase 1 onward	Minmus orbit, Duna orbit, Pol orbit
Science Station	Orbital science platform, crew waystation	Phase 2 onward	Eve, Duna, Jool system

Asset	Function	Deployment Phase	Destinations
Scout (ore scanner sat)	Biome-level ore mapping ahead of prospector	As needed	Any target body

### 3.4 Communications

Stock KSP CommNet (or RemoteTech for advanced players) requires deep-space comms coverage. The program includes three dedicated relay satellites in Kerbin polar orbit and one at Kerbin-Sun L1-equivalent (a heliocentric orbit similar to Kerbin's but slightly inside or outside it) to ensure continuous signal to outer-system probes. Stations at Duna and Jool also carry high-power antennas that function as regional relays.

## 4. Phase Breakdown

The program is divided into eight phases. Each phase has a clear objective, defined prerequisites, and specific deliverables that enable the next phase.

### Phase 0: Foundation

#### *Missions 1-5*

**Objective:** Establish launch and crew capability. Verify launcher A and core spacecraft buses.

**Prerequisites:** None — program start.

**Deliverables:**

- Launcher A flight-proven
- Probe buses validated
- CSM validated in LKO
- Mun and Minmus ore biomes identified
- Three Kerbals have flown to LKO

**Phase exit criterion:** CSM crewed LKO flight completed and ore maps received for Mun and Minmus.

### Phase 1: Kerbin System Mastery

#### *Missions 6-14*

**Objective:** First crewed lunar missions, establish Minmus ISRU, prove refueling architecture.

**Prerequisites:** Phase 0 complete. Ore maps in hand.

**Deliverables:**

- Launcher B flight-proven
- Apollo 8-style Mun flyby completed
- First crewed Mun landing
- Prospector mining on Minmus
- Tank Farm operational in Minmus orbit
- First refueled crewed return

**Phase exit criterion:** Tank Farm has received fuel from Prospector and at least one crewed mission has refueled from it.

### Phase 2: Inner System Reconnaissance

#### *Missions 15-22*

**Objective:** Uncrewed probes to every inner-system body. Build science baseline for crewed missions.

**Prerequisites:** Phase 1 complete. Transfer windows computed for Eve, Duna, Moho.

**Deliverables:**

- Orbiters at Moho, Eve, Gilly, Duna, Ike
- Rover on Duna
- Science stations at Eve and Duna

**Phase exit criterion:** All inner-system probes have returned first science package.

### Phase 3: Crewed Duna

#### *Missions 23-28*

**Objective:** First interplanetary crewed mission. Extend infrastructure to Duna system.

**Prerequisites:** Phase 2 complete. Life support validated for long duration (Kerbalism or similar if modded).

**Deliverables:**

- Prospector mining on Ike
- Duna Tank Farm in orbit
- First crewed Duna landing
- Crewed Gilly mission

**Phase exit criterion:** Duna crewed landing crew returns safely to Kerbin.

## Phase 4: Jool System Survey

*Missions 29-35*

**Objective:** Uncrewed exploration of Jool system. Establish outer-system refueling.

**Prerequisites:** Phase 3 complete. Ion-propulsion bus designed.

**Deliverables:**

- Jool grand tour probe data
- Orbiters at each Jool moon
- Prospector on Pol
- Jool Tank Farm operational

**Phase exit criterion:** Jool Tank Farm receives first fuel delivery.

## Phase 5: Dres and Eeloo

*Missions 36-40*

**Objective:** Complete the uncrewed coverage of the system.

**Prerequisites:** Phase 4 complete. Ion buses operational.

**Deliverables:**

- Orbiter and rover at Dres
- Orbiter and rover at Eeloo
- Optional Prospector at Eeloo

**Phase exit criterion:** Every body in the Kerbol system has at least one orbiter returning data.

## Phase 6: Crewed Jool

*Missions 41-45*

**Objective:** Crewed missions to Jool moons — the program's capstone.

**Prerequisites:** Phase 4 complete. Long-duration crew ship design validated.

**Deliverables:**

- Crewed missions to Pol, Laythe, Vall, Bop
- Multi-year crewed deep-space mission completed

**Phase exit criterion:** Jool crew returns safely to Kerbin.

## Phase 7: Endgame (Optional)

*Missions 46-48*

**Objective:** The hardest missions in the stock system.

**Prerequisites:** Phase 6 complete. Launcher C designed if crewed Eve is attempted.

**Deliverables:**

- Crewed Tylo landing
- Crewed Eve surface and return
- Crewed Moho orbital mission

**Phase exit criterion:** Program complete, or player satisfied with scope reached.

## 5. End-State System Vision

At program completion (end of Phase 6, optionally extended through Phase 7), the Kerbol system contains the following persistent infrastructure and assets.

### 5.1 Kerbin System

- Kerbal Space Center with two operational launchers (three if C was built).
- Two or three relay satellites in Kerbin polar orbit.
- Tank Farm in Minmus orbit, continuously refilled.
- Prospector tanker operating on Minmus surface.
- Rover assets on Mun and Minmus surfaces.
- Flags and science debris at multiple landing sites on both moons.

### 5.2 Inner System

- Moho: one or more orbiters returning data.
- Eve: orbital science station with docking capability; Gilly orbital probe.
- Duna: orbital science station, surface rovers, Prospector-D tanker, Duna Tank Farm in orbit.
- Ike: Prospector tanker mining surface, feeding Duna Tank Farm.
- Periodic crewed presence at Duna during transfer windows.

### 5.3 Outer System

- Dres: orbiter and rover operational.
- Jool: orbiter in Jool orbit plus dedicated orbiters at Laythe, Vall, Tylo, Bop, and Pol.
- Pol: Prospector mining, Jool Tank Farm in Pol orbit.
- Surface rovers on Laythe, Vall, and Bop.
- Eeloo: orbiter and rover; optionally Prospector.
- One interplanetary crew ship stationed between missions.

### 5.4 Transportation Network Summary

The system at end-state is connected by three major refueling nodes (Minmus, Duna/Ike, Pol) plus optional nodes (Eeloo, surface depots). Any new mission departs Kerbin with partial fuel, refuels at the Minmus Tank Farm, crosses to the destination Tank Farm, completes its objectives, and returns via the same chain. The marginal cost of a new mission at full build-out is a small fraction of the cost of the equivalent mission in Phase 0.

## 6. Risk and Contingency Framework

### 6.1 Common Failure Modes

Failure Mode	Likelihood	Prevention	Recovery
Launcher failure on ascent	Moderate early, rare after validation	Fly every new launcher empty first	Rebuild and relaunch; no crew lost if uncrewed test
Insufficient dV at capture	Moderate	Kerbal Engineer dV check pre-launch; always carry 10% margin	Aerobrake deeper; multi-pass capture; send rescue tanker
Navigation error, missed encounter	Low with MechJeb, moderate manual	Use mid-course corrections; set up encounter early	Spend extra dV to re-target; extend mission
ISRU cycle too slow	Common initially	Over-provision radiators and solar panels; Drill-O-Matic large not small	Leave Prospector idle; mine in background during other missions
Docking failure at Tank Farm	Occasional	RCS redundancy; approach slowly; MechJeb docking autopilot	Disengage, approach again; KAS pipes as backup
Crew stranded (life support)	Varies with mods	Generous supply margins; pre-position rescue tanker	Launch rescue mission with extra hab and supplies
Kraken attack (physics glitch)	Unpredictable	Autostrut judiciously; save before timewarp	Reload; redesign if reproducible

### 6.2 Design Margins

The program uses the following standard margins on all spacecraft:

- Delta-v: +10% on every stage beyond textbook calculations.
- Thrust-to-weight ratio: minimum 0.3 TWR for in-space stages, 1.3 for launch, 1.0 at touchdown for landing.
- Electrical: battery capacity sized for the longest expected shadow time  $\times$  1.5; continuous power draw  $\leq$  70% of generation.
- Monoprop: 1.5 $\times$  the computed docking requirement.
- Life support (if modded): supplies for mission duration + 20% reserve.

### 6.3 Rescue Architecture

For every crewed mission, a rescue mission is pre-planned but not built. The rescue plan specifies which launcher would be used, what hardware (typically a stripped-down CSM with extra fuel and RCS), and the fastest trajectory to the stranded crew. Since spacecraft designs are standardized and subassemblies are maintained, a rescue mission can typically be fielded within a few in-game days of a problem being declared. This is discussed in Document 4.

## 7. Required Mods and Tools

The program assumes stock KSP 1.12.x as the baseline. The following mods are recommended by priority tier.

### 7.1 Essential (Install Before Starting)

Mod	Purpose
Kerbal Engineer Redux	Delta-v, TWR, orbital info in VAB and flight. Essential for mission planning.
Kerbal Alarm Clock	Alarms for maneuver nodes, SOI changes, transfer windows. Essential for concurrent missions.
MechJeb 2	Autopilot: ascent, docking, maneuver execution, transfer planning. Saves hours per mission.
Transfer Window Planner	Precomputes interplanetary windows. Complements MechJeb.
Docking Port Alignment Indicator	Makes docking dramatically more reliable than stock.
Trajectories	Predicts atmospheric trajectories including drag. Essential for landing precision.
CKAN	Mod package manager. Already installed in the described environment.

### 7.2 Strongly Recommended

Mod	Purpose
Precise Maneuver	Fine-tune maneuver nodes without fighting stock handles.
Scansat	Full-resolution biome and ore mapping with nice visual output.
[x] Science! or For Science!	Tracks performed experiments per biome to avoid redundant collection.
Restock + Restock+	Improves stock part art and adds useful variants (esp. good for landers).

### 7.3 Optional Enhancements

Mod	Purpose
Kerbalism	Full life support, radiation, reliability. Adds realism at a significant difficulty cost.
Kerbal Construction Time	Builds take in-game time proportional to complexity. Changes program pacing significantly.
RemoteTech	Signal delay and relay networks. Adds realism for deep-space ops.
KAS / KIS	Attachment/inventory systems. Useful for ISRU and rescue operations.
FASA Apollo Pack	Accurate LM and Apollo CSM parts. Highly recommended for aesthetic authenticity.

Mod	Purpose
Bluedog Design Bureau (BDB)	Comprehensive historical launchers and spacecraft. Modernization of FASA.

## 7.4 Visual Enhancement

Optional but transformative. See main Kerbin-I discussion.

- Scatterer (atmospheric scattering)
- EVE Redux + Stock Visual Enhancements or Astronomer's Visual Pack (clouds)
- Waterfall + Stock Waterfall Effects (engine plumes)
- PlanetShine (planet-reflected lighting)
- Distant Object Enhancement (nearby planet/ship visibility)
- Parallax Continued (surface terrain detail; GPU-heavy; Patreon-gated)

## 8. Program Management Approach

This section covers how the program is run as a long-term project rather than a sequence of ad-hoc missions.

### 8.1 Subassembly Library

Every validated spacecraft component is saved as a VAB subassembly. This includes the two launchers, each payload archetype, and standard subcomponents (RCS blocks, solar panel arrays, relay antenna mounts). Missions are built by composing subassemblies rather than from scratch. Document 4 details the subassembly library structure.

### 8.2 Naming Conventions

Consistent naming helps track hundreds of in-flight assets over long programs.

- Launchers: KERBIN-II-`{unit number}`, KERBIN-V-`{unit number}`
- Probes: `{CODENAME}`-`{number}` (e.g. EXPLORER-1, SUNSEEKER-2)
- Crewed missions: `{PROGRAM}`-`{number}` (e.g. ARTEMIS-3, ARES-CREW-1)
- Infrastructure: `{FUNCTION}`-`{LOCATION}` (e.g. PROSPECTOR-MINMUS, TANK-FARM-DUNA)
- Crew rosters: maintain a separate list of which Kerbals have flown each mission for continuity.

### 8.3 Save Game Management

Use separate save games for the primary program and for testing. Before any maneuver that could fail catastrophically (crewed landing, high-speed re-entry, docking with irreplaceable hardware), save manually. F5 quicksave is cheap — use it liberally.

### 8.4 Pacing Guidance

Resist the temptation to rush phases. The program is structured so that each phase's capabilities make subsequent phases substantially easier. A mission flown out of sequence — sending crew to Duna before ISRU is established, for example — forces oversized launchers and tight margins for no reward. Follow the phase structure. Detailed scheduling is covered in Document 4.

### 8.5 Contract Mode Integration

If playing career mode rather than sandbox, contracts will overlap with the planned mission list. Accept contracts that align with planned missions (e.g. "orbit Duna" contracts when Ares-1 is scheduled). Decline contracts that would force out-of-sequence missions unless they offer exceptional funding. Tourist contracts can be fulfilled by adding passenger seats to Tank Farm or by dedicated tourist CSM variants.

## 9. Appendix: Quick-Reference Tables

### 9.1 Delta-V to Each Destination (from LKO, one-way)

Destination	dV to Capture (m/s)	Surface Landing Add (m/s)	Notes
Mun low orbit	~1,140	+580	Stock Mun map baseline
Minmus low orbit	~930	+180	Low gravity, cheap landing
Moho	~2,410	+870	High capture cost; plan window carefully
Eve orbit	~1,110 with aerobrake	+1,440 launch dV	Eve launch is the hardest in stock
Gilly	~1,050	+30	Low gravity, trivial landing
Duna orbit	~360 with aerobrake	+1,450	Aerobrake mandatory for efficiency
Ike	~440	+390	Accessed from Duna
Dres	~1,010	+430	Long transit
Jool orbit	~280 with aerobrake	N/A (gas giant)	Aerobrake at Jool itself
Laythe	~930 from Jool	+2,780 launch dV	Oceans + atmosphere
Vall	~910 from Jool	+860	Rocky, Mun-like
Tylo	~400 from Jool	+2,270	As hard as Eve but no atmosphere
Bop	~220 from Jool	+220	Very low gravity
Pol	~160 from Jool	+130	Best Jool mining candidate
Eeloo	~1,370	+620	Longest transit in the system

### 9.2 Interplanetary Transfer Windows (approximate cycle)

Windows repeat at these approximate intervals. Use Transfer Window Planner for exact dates.

Route	Window Cycle (Kerbin days)	Typical Transit (days)
Kerbin → Moho	~900	~110
Kerbin → Eve	~620	~130
Kerbin → Duna	~920	~260
Kerbin → Dres	~780	~650
Kerbin → Jool	~800	~1,100
Kerbin → Eeloo	~820	~1,700
Duna → Kerbin	~920	~260

Route	Window Cycle (Kerbin days)	Typical Transit (days)
Jool → Kerbin	~800	~1,100

### 9.3 Glossary

Term	Definition
LKO	Low Kerbin Orbit — typically a ~100 km circular orbit above Kerbin.
TMI	Trans-Munar Injection — burn at LKO periapsis to transfer to the Mun.
TKI	Trans-Kerbin Injection — return burn from another body back to Kerbin.
SOI	Sphere of Influence — gravitational dominance region of a body.
dV	Delta-v — change in velocity; the currency of space travel.
TWR	Thrust-to-Weight Ratio — must exceed 1.0 to lift off against local gravity.
ISRU	In-Situ Resource Utilization — mining and refining fuel on another body.
CSM	Command and Service Module — the orbiter of a crewed mission.
LM	Landing Module — the lander of a crewed mission.
EDL	Entry, Descent, and Landing — atmospheric arrival sequence.
Aerobrake	Using atmospheric drag to slow a vehicle instead of engines.
Oberth Effect	Physics principle: burns are most efficient at periapsis (highest speed).
Free Return	Trajectory that loops a body and returns to origin without capture burn.
Hohmann Transfer	Minimum-energy transfer between two circular orbits.

— End of Document 1 —  
Continue with Document 2: Vehicle Catalog