

# VesselPlanner

## Planning Tutorial

KSP1 • VesselPlanner 0.7.75

Planning sizes a new or future propulsion stage from a target delta-v, minimum TWR, payload, environment, and tank-structure assumption. It then shows engine/count solutions and real tank sets that can hold the required propellant.

**Core idea:** Planning answers, “What stage should I build?” Enter the performance requirement first, then choose an engine solution and a tank set that satisfies it.

### Quick Workflow

| Step | Action                  | What it does                                                             |
|------|-------------------------|--------------------------------------------------------------------------|
| 1    | Select Planning         | Switches from replacement analysis to new-stage sizing.                  |
| 2    | Set stage and payload   | Choose the carried mass manually or from the current craft.              |
| 3    | Choose $\Delta v$ basis | Size the stage for a Vacuum or Atmosphere target.                        |
| 4    | Set TWR / engine limits | Defines the minimum acceleration and largest engine cluster.             |
| 5    | Set body and altitude   | Defines atmospheric performance and body gravity.                        |
| 6    | Calculate               | Builds the candidate engine/count solutions.                             |
| 7    | Choose an engine        | Opens detailed stage performance and propellant requirements.            |
| 8    | Choose tanks            | Selects a one-, two-, or three-type tank set with enough capacity.       |
| 9    | Add parts               | Select the engine/tank parts in KSP or capture them into Stage-by-Stage. |

### 1. When to Use Planning

Use Planning when the stage you want does not yet exist, or when you want VesselPlanner to size a stage independently of the hardware already in the editor.

- **Planning sizes propellant.** The solver calculates the propellant needed for the target delta-v and estimates tank dry mass from the Tank dry/fuel mass ratio.
- **Planning can target future stages.** The Stage field may be higher than the vessel’s current maximum stage.
- **Planning can use the current craft as payload.** Enable Use craft payload above selected stage to use the mass already above that stage.
- **Planning can also be completely manual.** Enter Payload mass directly when designing from a known payload value or when the editor is empty.
- **Planning provides real tank suggestions after engine selection.** The stage solver uses the structural ratio for initial sizing; the Tanks pane then finds actual tank parts with enough resource capacity.

**Choose the right mode:** If you are evaluating engines against tanks/resources that are already built, use Analyze Existing instead.

## 2. Select the Stage and Payload

Choose Planning from the main mode row. The Stage field remains available even when the stage does not yet exist.

- **Stage field / + / -** — select the reference stage. Unlike Analyze Existing, Planning is allowed to go beyond the craft's current maximum stage.
- **Use craft payload above selected stage** — uses the scanned mass carried above the selected stage.
- **Payload mass (t)** — manual carried mass when the craft-payload option is off.

If a Stage-by-Stage Engines & Tanks stage is currently open, Planning also includes that stage's additional cargo, saved-subassembly mass, and selected decoupler mass in the dry mass that the new propulsion solution must carry.

### 3. Choose the Target $\Delta v$ Basis

Planning supports two different ways to interpret the target delta-v. The basis is important because it determines whether atmospheric conditions are allowed to resize the stage.

| Basis      | What the target means                                           | Effect of changing body / altitude                                                                                                                                                                    |
|------------|-----------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Vacuum     | Target Vac $\Delta v$ is met using the engine's vacuum Isp.     | The stage geometry stays fixed: propellant, estimated tank mass, wet/dry mass, vacuum $\Delta v$ , and burn time do not change. Atmospheric thrust, atmospheric $\Delta v$ , and TWR are reevaluated. |
| Atmosphere | Target Atm $\Delta v$ is met at the selected body and altitude. | The selected pressure/Isp is part of the sizing calculation, so changing body or altitude can change required propellant and stage mass.                                                              |

Use Vacuum for orbital/space stages whose required delta-v is fundamentally a vacuum requirement. Use Atmosphere when the stage must deliver its target delta-v in a specific atmospheric condition.

### 4. Enter the Remaining Requirements

| Requirement              | How Planning uses it                                                                                     |
|--------------------------|----------------------------------------------------------------------------------------------------------|
| Minimum TWR              | Every result must meet this initial TWR in the selected body/altitude environment.                       |
| TWR gravity              | Read-only surface gravity of the selected body; this is the gravity used in the TWR calculation.         |
| Max engines              | Largest engine count tested, constrained internally to 1–64.                                             |
| Tank dry/fuel mass ratio | Estimated tank structural dry mass per unit propellant mass used while sizing the stage.                 |
| Engine classes           | Solid fuel, air-breathing, and electric-propellant candidates can be included or excluded independently. |

When a real stage is selected and scanned, VesselPlanner can infer a tank dry/fuel ratio from the stage. You can still replace it with the ratio you want to use for a future design.

### 5. Choose an Optimization Goal

The Optimize group controls the initial ordering of valid solutions. You can still click any candidate-table heading afterward to sort by a visible column.

| Mode                   | Initial preference                               |
|------------------------|--------------------------------------------------|
| Lowest Stage Mass      | Lowest total wet mass of the planned stage.      |
| Lowest Propellant Mass | Least required propellant.                       |
| Lowest Cost            | Lowest engine cost for the tested configuration. |
| Shortest Burn          | Shortest estimated burn time.                    |

| Mode        | Initial preference                       |
|-------------|------------------------------------------|
| Highest TWR | Highest initial TWR.                     |
| Highest Isp | Highest Isp in the selected environment. |

For the mass/cost/Isp-oriented modes, the solver normally keeps the smallest engine count for each engine once the requirement is met. Highest TWR and Shortest Burn continue testing higher counts because additional engines can improve those objectives.

## 6. Set the Body, Altitude, and Candidate Filters

The right-hand Candidate engine filters pane contains the environment controls used by the solver and by the displayed atmospheric performance.

- **Planet / body** — sets the body gravity and atmospheric model.
- **Altitude** — sets the atmospheric pressure, temperature, and density used for thrust/Isp evaluation.
- **Filter** — comma-separated OR include terms matched against display and internal part names.
- **Exclude** — comma-separated terms; any match hides the engine.
- **Match stage bulkhead size** — when available, restricts engines to the selected stage's detected top-node size.

When Planning is being used by an open Stage-by-Stage stage, the stage's selected bulkhead profiles replace the Match stage bulkhead size toggle. The UI shows those active profiles instead.

**Persistence:** Engine and tank include/exclude filters can be saved between KSP sessions from Settings → Filters.

## 7. Calculate the Stage

Click Calculate after entering the requirements. VesselPlanner rescans the currently available engine database, applies KSP editor exclusions and your filters, solves each allowed engine/count combination, then reports the number of valid configurations.

For each candidate the solver combines payload, other dry mass, engine mass, estimated tank dry mass, and the propellant needed for the chosen delta-v basis. Results below Minimum TWR or without usable thrust/Isp are discarded.

**If Calculate fails:** A “Check numeric inputs” status means at least one numeric field could not be parsed. Target  $\Delta v$  must be positive; negative structural ratios are clamped to zero.

## 8. Filter, Sort, and Select an Engine

The candidate table is horizontally scrollable. Its headings stay synchronized with the rows. Click a heading to sort; click the engine name to select a solution. Up to 250 rows are drawn at once.

| Column       | Meaning                                                             |
|--------------|---------------------------------------------------------------------|
| Engine / #   | Engine part and the tested cluster count.                           |
| Mass t/eng   | Dry mass of one engine.                                             |
| Stage Wet t  | Wet mass of the planned stage itself; payload above it is excluded. |
| Start Mass t | Full vehicle mass accelerated when the stage ignites.               |

| Column                          | Meaning                                                                             |
|---------------------------------|-------------------------------------------------------------------------------------|
| Atm $\Delta v$ / Vac $\Delta v$ | Performance of the same solved mass ratio at the selected atmosphere and in vacuum. |
| ASL kN/eng / Vac kN/eng         | Per-engine sea-level and vacuum thrust.                                             |
| TWR / Max TWR                   | Initial selected-environment TWR and vacuum-thrust TWR.                             |
| Isp ASL/Vac                     | Sea-level and vacuum Isp reference.                                                 |
| Burn                            | Estimated burn duration from vacuum thrust/Isp and propellant mass.                 |
| Fuel                            | Propellant requirement summary.                                                     |
| Cost Eff.                       | Atmospheric delta-v at the selected body/altitude per Fund of engine cost.          |
| Bulkhead                        | Engine attachment profile.                                                          |

Use Settings → Engine Columns to show or hide candidate-table columns.

## 9. Read the Selected Engine Pane

Selecting an engine opens the Selected Engine pane beneath the candidate list. In Planning this pane sits beside the Tanks pane and summarizes the complete solved stage before actual tank parts are chosen.

- Burnable propellant and estimated tank dry mass
- Engine mass, stage wet mass, vehicle start mass, and end/dry mass
- Atmospheric and vacuum delta-v
- Per-engine and total ASL/Vac thrust
- ASL/Vac Isp
- Cost efficiency
- Initial/final TWR and maximum vacuum-thrust TWR
- Burn time and total resource volume
- Detailed units, mass, and volume for each required resource

The Selected Tanks line appears after you explicitly choose a tank suggestion.

## 10. Choose a Tank Set

The Tanks pane searches actual KSP storage parts for capacity that can satisfy the selected engine solution. Candidate tank parts must have both top and bottom attach nodes.

- **One to three tank types** — a suggestion may combine up to three different tank types.
- **Shared bulkhead profile** — all tank types in one mixed set must use the same KSP bulkhead profile.
- **Filter / Exclude** — matches tank display names and internal part names. Include terms are OR matches; any Exclude match hides the set.
- **Sortable table** — sort by tank set, total tank count, dry mass, excess capacity, bulkhead, or capacity.
- **Explicit selection** — click a tank-set row to highlight it. VesselPlanner never silently treats the first row as selected.

| Tank column | Meaning                                                             |
|-------------|---------------------------------------------------------------------|
| Tank Set    | Tank names/counts; up to three thumbnails are shown for mixed sets. |

| Tank column | Meaning                                                |
|-------------|--------------------------------------------------------|
| #           | Total number of tanks in the set.                      |
| Dry t       | Combined dry mass of the actual tank parts.            |
| Excess      | Unused capacity after storing the required propellant. |
| Bulkhead    | Shared bulkhead profile for the set.                   |
| Capacity    | Resource capacity supplied by the complete set.        |

**Important:** The stage solver initially estimates tank dry mass from the Tank dry/fuel mass ratio. The Tanks pane then shows real parts/capacity, so use the tank list to turn the mathematical solution into a buildable stage.

## 11. Add the Engine and Tanks

Planning offers several placement actions depending on the selected row and whether Stage-by-Stage is currently capturing a stage.

| Action             | Normal Planning                                                                                      | While Stage-by-Stage is capturing                                                                                        |
|--------------------|------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| Add / Add Engine   | Selects the engine part in KSP for editor placement. Place the quantity shown in the solution.       | Records the engine/count in the open planned stage instead of putting the part on the cursor.                            |
| Add Tank           | For a one-type tank solution, selects that tank part for placement.                                  | Records the selected tank set in the planned stage.                                                                      |
| Add Set            | For a mixed set, starts placement with the first tank type and reports the complete counts to place. | Shown as Add to Stage and records the complete mixed set.                                                                |
| Add Engine & Tanks | Only meaningful for Stage-by-Stage.                                                                  | Enabled after a tank set is explicitly selected; captures the selected engine/count plus the complete tank set together. |

Settings → Planning can close VesselPlanner automatically after KSP successfully selects a part for placement. The setting applies to engine and tank placement actions.

## 12. Use Planning with the Delta-V Table and Mission Planner

The Delta-V Table and Mission Planner can supply the delta-v number that Planning then turns into hardware.

1. Open Delta-V Table and click the route/low-orbit/surface value you need. VesselPlanner copies the numeric value to the clipboard.
2. Return to Planning and paste the value into Target Vac  $\Delta v$  or Target Atm  $\Delta v$  as appropriate for the maneuver.
3. Set the body/altitude where the stage must operate, then Calculate.
4. If you are designing a full mission, save the maneuvers in Mission Planner and use the saved mission from Stage-by-Stage. Mission-linked Engines & Tanks stages prefill the target delta-v and ASL/VAC basis before opening Planning.

## 13. Resize the Planning Layout and Use Part Previews

- **Main window width** — drag the right edge; the width is remembered.
- **Engine-list/detail split** — drag the horizontal grip above Selected Engine/Tanks to trade height between the upper and lower rows.
- **Selected Engine / Tanks width** — drag the vertical grip between the two lower panes.
- **Part thumbnails** — engine and tank rows show cached part icons. Hover over a thumbnail for the enlarged rotating preview.

Settings → Appearance → Part images controls static/rotating zoom, camera yaw and pitch, rotating-preview resolution, degrees per frame, and rotating-image background. Settings → Appearance → Detail pane sizes can reset the remembered splits.

## 14. Example A: Design a Vacuum Transfer Stage

1. Choose Planning, enter the payload, select Vacuum as the  $\Delta v$  basis, and enter the required transfer-stage delta-v.
2. Choose the body where the burn begins, set Minimum TWR, choose an optimization goal, and click Calculate.
3. Sort or filter the candidate list, select an engine, and verify vacuum delta-v, burn time, TWR, and propellant requirements.
4. Select a tank set with acceptable dry mass, excess capacity, and bulkhead profile.
5. Use Add Engine and Add Tank/Add Set, or capture the solution into an open Stage-by-Stage stage.

## 15. Example B: Design an Atmospheric Launch Stage

1. Choose Atmosphere as the  $\Delta v$  basis, select the launch body, and set altitude near the intended start of the burn.
2. Enter the launch-stage delta-v target and a liftoff Minimum TWR, then Calculate.
3. Compare Stage Wet t, TWR, burn time, and engine count across the candidate list.
4. Move the altitude slider to see how the same atmospheric target would resize the stage at a different pressure.
5. Choose the engine and tank set that best matches the vehicle diameter and build constraints.

## 16. Troubleshooting

| Symptom                                             | Check                                                                                                                                                                                          |
|-----------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| No valid configuration or expected part is missing  | Verify numeric fields, lower Minimum TWR, raise Max engines, enable the required engine class, relax Filter/Exclude and bulkhead restrictions, and check KSP editor exclusions.                |
| Atmospheric sizing or altitude behavior looks wrong | Verify body/altitude and the selected $\Delta v$ basis. Atmosphere basis can resize the stage as pressure changes; Vacuum basis keeps vacuum sizing while atmospheric TWR/ $\Delta v$ changes. |
| No tank suggestions                                 | The engine may require resources unavailable in scanned tanks, or no compatible 1–3-type set with a common bulkhead profile and top/bottom attach nodes may provide enough capacity.           |