

Luna–Aegis Shuttle “Short Hopper”

Reusable Lunar Surface–Orbit Transfer Vehicle

Design Dossier — Rev B — Feb 2026 | Status: Concept – Feasibility Ready | Export: ITAR/EAR-Free Baseline

01 — Mission Overview

The Luna–Aegis Short Hopper is a reusable single-stage VTOL lunar shuttle designed for rapid transfer between Aegis Station in low lunar orbit and surface sites near the Moon’s south pole. Operating on ISRU-compatible LOX/LH₂ propellants with a single gimbaled vacuum engine, it supports crew, cargo, and hybrid missions across a 1,500–2,000 km surface range.

With a gross wet mass of ~8,000 kg and a design Δv of 1,800 m/s (including 10% margin), the architecture is optimized for one-way hops with ISRU refueling at destination, enabling full lunar surface access via staged operations.

Key attributes: VTOL, single-stage, ISRU-compatible, fully reusable, autonomous-capable, Artemis-compatible.

02 — Technical Specifications

Physical

Parameter	Value
Total height	~6.5 m
Landing zone diameter	~4.5 m
Gross wet mass	~8,000 kg
Dry mass	~5,250 kg
Propellant mass	~2,750 kg (34.4% mass fraction)

Propulsion

Parameter	Value
Propellants	LOX / LH ₂ (ISRU-compatible)
Engine	Single gimbaled vacuum engine
Thrust (vac)	~25–30 kN
Specific impulse	430–450 s

T/W at lunar liftoff	~1.9–2.3
Design Δv	1,800 m/s (10% margin)
Mission Δv range	1,600–1,700 m/s per one-way hop
Attitude control	Engine gimbal + RCS thrusters

Performance

Parameter	Value
Surface-to-surface range	1,500–2,000 km
Surface-to-LLO	Yes (with ISRU refuel at surface node)
Reusability	Min 5–10 sorties; indefinite with proactive maintenance
Turnaround time	24–48 hours (with LUNET node support)
Landing precision	± 3 m (nominal)

Crew & Cargo

Parameter	Value
Crew capacity (standard)	4
Crew capacity (max, reduced range)	6
Cargo capacity	Up to 1,000 kg
Operational duration (crewed)	72–96 hours

Avionics & Systems

Parameter	Value
Flight computers	Dual-redundant radiation-hardened
Navigation	FOG/RLG IMU + MEMS backup, Kalman fusion, lidar/radar altimeter
Landing guidance	Terrain-relative navigation; LUNET beacon alignment
Communications	S-band/UHF + high-gain directional
Power	Rechargeable battery packs + passive solar backup
Life support	Pressurized cabin; Orion-class LSS heritage
Docking interface	Aft/lower hatch with soft-seal telescoping collar

03 — Cabin Configurations

Config A — Crew (4 / 6 crew)

Full pressurized cabin with airlock and suits. 72–96 hour life support. Direct suitport mate with Aegis-Class Rover. Emergency portable air systems.

Config B — Cargo (1,000 kg)

Palletized cargo with latch-and-lock mounts. Supports ISRU tanks, EVA gear, small rovers, and sample return payloads. Optional robotic assist arm.

Config C — Hybrid (2 crew + ~500 kg)

Mixed crew and logistics. Supports medical evacuation, science payload delivery, and priority crew + equipment transfers between surface nodes.

04 — Propulsion & Mass Budget

A single gimbaled LOX/LH₂ vacuum engine (~25–30 kN) is mass-efficient and mechanically simpler than a multi-engine cluster at this scale. At 8,000 kg wet mass, lunar liftoff weight is ~13 kN, giving a T/W of ~1.9–2.3 at ignition. Engine gimbal provides pitch/yaw authority; RCS handles roll and fine station-keeping.

One-way hop architecture with ISRU refueling enables full lunar surface access. Round-trip without refueling requires ~4,360 kg propellant, pushing wet mass to ~9.5 t; therefore one-way + ISRU is the preferred baseline.

Performance Summary

Parameter	Value
Vacuum thrust	~30 kN
Isp	~440 s
Design Δv	1,800 m/s
Lunar T/W	~2.1x

Mass Budget (8,000 kg wet)

Subsystem	Mass (% of wet)
Propellant	~2,750 kg (34.4%)
Structure / tanks	~2,110 kg (26.4%)
Cabin / LSS / payload	~1,055 kg (13.2%)

Propulsion system	~790 kg (9.9%)
Landing gear	~527 kg (6.6%)
Avionics / GN&C	~422 kg (5.3%)
Mass margin (7%)	~369 kg (4.6%)

05 — Landing, Autonomy & Interfaces

Landing System

- Four fixed legs with thermal shielding and dust-tolerant footpads
- Terrain-relative navigation (lidar + radar altimeter)
- FOG/RLG IMU with MEMS backup; Kalman fusion with abort capability
- LUNET beacon alignment for ± 3 m precision
- Operable in permanently shadowed regions
- Redundant onboard nav logic; autonomous flight, landing, and re-docking

Interfaces & Integration

- Soft-docking collar compatible with Aegis Station, surface habs, and Aegis-Class Rover suitport
- Pressurized telescoping tunnel with dust seals (no EVA required)
- Cryogenic refueling via LUNET-compatible cartridge port
- Palletized cargo latch-and-lock; optional robotic assist arm
- Field diagnostics via rover interface or LUNET node terminal
- Modular avionics and structural interfaces for rapid field swap

06 — Development Roadmap & Status

Milestone	Target
Preliminary Design Review (PDR)	2026
Subsystem demos & Critical Design Review (CDR)	2027
Flight prototype build	2028
Qualification flight & operations	2029+

Work Packages (Open for Partnership)

- Cryogenic propulsion system
- Avionics & GN&C
- Cabin & life support systems
- Landing gear & tank modules

The Short Hopper is available for feasibility collaboration, licensing, lunar mobility adaptation, and partnerships with ISRU and infrastructure developers.

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