DECK000 wormhole docking tunnel

2025-08-10

SPEC-00-STR-DECKS-DECK000-0001-wormhole-docking-tunnel-EN-DE-v0.1.0-DRAFT

The Engineering of DECK000 – The Wormhole

Document status: Draft (EVOL-00 baseline) **Date:** 2025-08-10 **Applies to:** Earth ONE class sphere station (Ø 127 m)

Summary / Kurzfassung (EN/DE)

EN: DECK000 is the axial, pressurized docking and transit tube spanning the North–South poles. The EVOL-00 baseline defines a 127 m long SiC-composite barrel with six Inconel docking rings and window segments for observation and transfer in micro-g.

DE: DECK000 ist der axiale, druckbeaufschlagte Docking- und Transittunnel zwischen Nord- und Südpol. Die EVOL-00-Basis umfasst einen 127 m langen SiC-Verbundzylinder mit sechs Inconel-Docking-Ringen und Fenstersegmenten für Beobachtung und Transfer im Mikro-g.

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1 Abstract DECK000 (“The Wormhole”) is the axial, pressurized docking and transit tube that runs straight through the station from the North pole to the South pole. In EVOL-00, the assembly is a 127 m long tube with an outer diameter of 22 m and a clear inner diameter of 20 m. The primary barrel is a silicon-carbide (SiC) composite reinforced with steel or Inconel for toughness. Starting 3.5 m from the north polar end and repeating every 20 m along the axis, 10 m-long Inconel docking-ring subassemblies are installed and numbered sequentially (00, 01, 02 …) from North to South. Between docking rings, “window tube” segments provide outward viewing; each segment integrates rectangular window units of 4 m (axial) × 3 m (tall), built to the program’s space-grade multilayer window specification (ALON/sapphire + fused silica + polycarbonate + borosilicate/cerium-doped glass). The result is a micro-g corridor (near the spin axis) enabling safe berthing, people/cargo transfer, observation, and emergency egress.

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2 Description (EVOL-00 – Baseline Geometry & Materials)

A. System Overview

- **Function:** Central polar docking, transit, and observation corridor in micro-g; houses guidance, lighting, utilities, and emergency isolation points.
- **Overall length:** 127 m (North pole interior face to South pole interior face).

- **Primary diameters:** OD 22 m; ID 20 m (clear).
- **Primary structure:** SiC composite barrel; local reinforcement with steel/Inconel where penetrations, hatches, or docking hardware concentrate loads.
- **Environment:** Pressurized to station nominal (TBC; baseline 1 atm); micro-g zone due to proximity to rotation axis.

B. Docking-Ring Architecture

- **Ring modules:** 10 m axial length; OD 22 m (flush with main barrel OD); ID 10 m (constricted throat for docking hardware and hatchway integration).
- **Material:** Inconel (high-temperature and corrosion resistance; excellent toughness).
- **Placement & numbering:** Starting **3.5 m** from the North pole interior face and repeating at a **20 m pitch**; numbered **00** (northmost) through **05** (southmost) in EVOL-00.

Table 1 — Ring and window-segment positions (from North pole interior face)

Segment	Type	Axial start (m)	Axial end (m)	Axial length (m)	Notes
—	Clearance	0.0	3.5	3.5	forward clearance / taper / sys
00	Docking ring	3.5	13.5	10.0	Inconel ring ID 10 m
—	Window tube	13.5	23.5	10.0	window segment
01	Docking ring	23.5	33.5	10.0	
—	Window tube	33.5	43.5	10.0	
02	Docking ring	43.5	53.5	10.0	
—	Window tube	53.5	63.5	10.0	
03	Docking ring	63.5	73.5	10.0	
—	Window tube	73.5	83.5	10.0	
04	Docking ring	83.5	93.5	10.0	
—	Window tube	93.5	103.5	10.0	
05	Docking ring	103.5	113.5	10.0	
—	Window tube	113.5	123.5	10.0	
—	Clearance	123.5	127.0	3.5	aft clearance / taper / systems

Note: EVOL-00 uses six docking rings (00–05), preserving 3.5 m service clearances at both ends. Later evolutions may revise counts, spacing, or diameters based on interface selections and docking traffic models.

C. Window Segments & Glazing Units

- **Window units per segment:** Rectangular apertures integrated into the 10 m "window tube" spans; count and circumferential distribution TBD by human-factors and structural analyses.
- **Nominal window aperture:** 4.0 m (axial) × 3.0 m (tall / meridional).
- **Glazing stack (per program spec):**
  - Outer strike face: **ALON** (or sapphire) ~50 mm for micrometeoroid & UV protection.
  - Middle layers: **Fused silica** (~100 mm) + **polycarbonate** (~50 mm) for thermal stability and impact energy absorption.
  - Inner layer: **Borosilicate** (or cerium-doped glass) ~30 mm for radiation attenuation and optical quality.
  - **Total thickness:** ~200–300 mm; **areal mass:** ~530–550 kg/m².
- **Shutters & shields:** Each aperture integrates internal blast shutters and external micrometeoroid/thermal shades; automatic closure on pressure loss or debris alerts.

D. Structural Concept

- **Primary barrel wall:** Thickness TBD from combined loads (pressure, docking loads, thermal gradients). Preliminary design envelope to meet FoS ≥ 2.0 against yield under 1 atm differential plus ring-induced stress concentrations.
- **Ring-to-barrel joints:** Circumferential flanges with shear keys; dual redundant, high-temperature elastomer seals (silicone-based) with metallic C-seals for vacuum-rated redundancy.
- **Local reinforcements:** Around windows (doubler frames), utility penetrations, and docking hardware. Use SiC/steel hybrid frames to spread aperture loads into the barrel laminate.
- **Thermal control:** Embedded liquid heat loops (glycol-water or silicone oil), MLI blankets on the outside of the barrel segments not occupied by windows, and conductive paths to station radiators.

E. Interfaces & Services

- **Mechanical:** Hard-points in each docking ring for adapter hardware, hatches, grapples, and temporary airlocks.
- **Avionics & comms:** Redundant comm rails, guidance beacons, and visual docking aids integrated at each ring; cableways routed in protected trunking.
- **Life support:** Distributed air distribution manifolds, CO_2 scrubber returns, water/condensate drains, and emergency O_2 drop lines.
- **Power:** Dual independent DC buses along the tube with local UPS for shutters, lighting, and hatch actuators.
- **Safety:** Pressure-isolation bulkheads at ring boundaries (ring can be sealed as a compartment), blast doors for window segments, fire detection & inert-gas suppression.

F. Operations & Human Factors

- **Micro-g ergonomics:** Handrails, foot restraints, and guided translation lines throughout; lighting graded for approach/egress; color-coded wayfinding matching station standards.
- **Traffic separation:** North pole dedicated to arrivals, South pole to departures (baseline); center-tube signage and beacons enforce counter-flow.
- **Emergency egress:** Clearly marked safe-hold nodes at each ring with comms, masks, and emergency supplies; shutters auto-close upon hazard detection.

G. Manufacturing & Assembly

- **Moduleization:** 10 m modules (alternating ring modules and window-tube modules) pre-fitted with internal systems; on-orbit assembly via circumferential bolted/bonded joints.
- **Inspection & maintenance:** Ring-module inspection ports; replaceable shutter cassettes; window health monitoring (acoustic emission, strain gauges, optical clarity sensors).

H. Compliance & Reference Specs

- Materials, pressure vessels, fire, glazing, and MMOD protections comply with station-wide standards (refs). Window stacks must meet the program's "LEO Window Specification" for thermal cycling, rapid decompression, and micrometeoroid resistance.

I. Open Parameters (TBD/TBC)

- Barrel wall thickness and detailed layup by load case.
- Final ring inner diameter vs. docking system selection and hatch design.

- Window count/distribution per segment after view/structure trade.
- Detailed thermal loop routing and radiator tie-ins.
- Human-factors lighting and signage specifics.

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3 Forward Work (next revision)

1. Complete pressure & docking load cases and size the barrel thickness and reinforcements.
2. Human-factors layout (window count/placement, handrail nets, signage).
3. Define ring-module interface for standardized docking adapters.
4. Hazard analysis (fire, decompression) and emergency procedure overlays.
5. Manufacturing tolerances, NDI plan, and acceptance criteria.