ADR-00-Final-RPM-Decision-BALL-D127

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Executive Summary

- **Decision / Entscheidung: 1 g @ DECK 012** (reference radius $r_\star = 52.0$ m).
- **Operational spin / Betriebsdrehzahl:** $\omega = 0.4343$ s^{-1} ⇒ **4.147 rpm** $T = 14.47$ s.
- **Volume-weighted g-comfort:**
  - SLI$_{\text{total}} = 324{,}592$ m^3 · score
  - SLI$_{\text{avg}} = 0.736$
- **Previous baseline (legacy):** 1g @ DECK 008 → $\omega = 0.508$ s^{-1} ≈ 4.852 rpm → **retired**.
- **Special decks:**
  - **DECK 000** = axial micro-g tunnel (ID ≈ 20 m) → **excluded from SLI**.
  - **DECK 015** = **Tank/Thermal Deck** at $r = 63.0$ m; included geometrically (optional occupancy $f_{015} < 1$).

Context & Scope / Kontext & Geltung Platform: **BALL-D127 "Earth ONE Class"** with internal sphere radius $R = 63.0$ m. Deck bands in 3.5 m gross steps. Objective: determine optimal, sustainable, comfortable **1 g reference deck**.

Methodology / Methodik Geometry / Geometrie

- Tube length: $L(r) = 2\sqrt{R^2 - r^2}$
- Net floor radius: $r_{\text{floor}} = r_{\text{bis}} - 0.5$ m
- DECK 015: $r_{\text{floor}} = 63.0$ m (shell). DECK 000: $r_{\text{floor}} = 10.0$ m.

Volumes / Volumina

- Exact annular volume inside sphere: $V(r_A, r_B) = \frac{4\pi}{3}\left[(R^2 - r_A^2)^{3/2} - (R^2 - r_B^2)^{3/2}\right]$
- Habitable: $r_{\text{in}} = \max(r_{\text{floor}} - 1.80, r_{\text{ceiling}}) \quad \Rightarrow \quad V_{\geq 1.80} = V(r_{\text{in}}, r_{\text{floor}})$
- Effectively habitable (-0.25 m for installations): $r_{\text{in}}^\star = \max(r_{\text{floor}} - 1.55, r_{\text{ceiling}}) \quad \Rightarrow V_{\text{eff}} = V(r_{\text{in}}^\star, r_{\text{floor}})$

Gravitation & Comfort

- Spin law: $a(r) = g_0 \cdot \frac{r}{r_\star}$

- Comfort function (g only): $C(a) = \max\{0,\ 1 - |g - 0.9|/0.9\}$

SLI (Sphere Living Comfort Index)

$\text{SLI}_{\text{total}} = \sum_{d=001}^{015} V_{\text{eff}}(d) \cdot C(a_d)$ and $\text{SLI}_{\text{avg}} = \frac{\text{SLI}_{\text{total}}}{\sum V_{\text{eff}}}$

Alternatives Considered / Optionen

Scenario	$r_\star$ [m]	rpm	Notes
1g @ D008	38.0	4.852	Legacy baseline; outer decks >1.1g → retired
1g @ D009	41.5	4.642	Improvement, but still overloads outer decks
1g @ D010	45.0	4.458	Better centering; acceptable fallback
1g @ D011	48.5	4.294	Very good; slightly underloads inner decks
1g @ D012	**52.0**	**4.147**	**Chosen**: optimal banding 009–013 (0.8–1.05 g)
1g @ D013	55.5	4.014	Shifts weight outward; inner decks <0.8g
1g @ D014	59.0	3.893	Too outward; comfort drops overall
1g @ D015	63.0	3.768	Not viable; technical/tank deck only

Why DECK 012 is Correct / Warum DECK 012 richtig ist

- **Maximizes comfort-weighted volume** in residential bands (009–013)
- **Moderate rpm** (4.147), stable for operations
- **Minimizes penalty from tech decks** (014–015)
- **SLI remains robust** even with DECK 015 weighted as $f_{015} < 1$

Result Overview / Ergebnis

Deck	r_{ceiling} [m]	r_{floor} [m]	L [m]	V_{eff} [m³]	a/g_0	$C(a)$
009	38.5	41.5	100.4	38,123	0.798	0.887
010	42.0	45.0	84.2	38,642	0.865	0.962
011	45.5	48.5	66.1	38,220	0.933	0.964
012	49.0	52.0	45.3	36,578	1.000	0.889
013	52.5	55.5	19.8	33,249	1.067	0.814
014	56.0	59.0	~0.0	27,244	1.135	0.739
015	59.5	63.0	~0.0	11,222	1.212	0.654

Consequences / Konsequenzen

- **Occupancy:** People distribution aligned with high SLI zones → 009–013
- **Architecture:** DECK 008 legacy baseline **replaced** with DECK 012 reference
- **Spin rate:** reduced to 4.147 rpm → lower Coriolis, better comfort
- **Docs:** Update SPEC, SRS, ICD; tag CALC; review SAF/HAZ

Acceptance Criteria

- Full C_g incl. Coriolis/Gradient/rpm yields $SLI_{\text{avg}} \geq 0.70$
- Operational head–foot $\Delta g \leq 0.10$ g in residential decks
- Verified via calc + update configuration baseline

Attachment

- Table 1: Evol00 Decks 000 015 R Korr63 Roehrenmodell Exakt Sli