

Gradient One (G1)

Design Dossier — Updated Configuration (350m Multi-Gravity Architecture)

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1. Overview

Gradient One (G1) is a crew-rated orbital artificial gravity research platform designed to validate sustained rotating gravity environments and retire critical biological and operational risks for future large-scale space habitats.

G1's mission is to:

- Validate long-duration 1g artificial gravity in orbit
- Simultaneously evaluate lunar (0.16g) and Mars (0.38g) partial-gravity environments
- Demonstrate integrated biological, human, and fluid systems performance under rotation
- Serve as a scalable architectural precursor to multi-ring habitats such as Aegis Station

G1 is not a gravity-optimization experiment.

It is a **multi-gravity validation platform**.

2. Core Architecture

Primary Structure

- ~350-meter radial truss boom ($R \approx 350$ m to outer 1g deck)
- Aluminum alloy truss with integrated utility routing
- Central non-rotating hub for docking and crew transfer
- Counterbalanced rotating assembly

The outermost deck establishes the 1g reference environment.

Rotation Regime

G1 operates at a single fixed rotation rate:

~1.6 rpm

This produces:

Gravity Level	Radius (approx.)	Purpose
0g	Central hub	Microgravity control
0.16g	~56 m	Lunar analog
0.38g	~133 m	Mars analog
1g	~350 m	Earth baseline

Gravity follows:

$$a = \omega^2 r$$

With fixed angular velocity, gravity scales linearly with radius.

This configuration enables simultaneous comparative experimentation across gravity levels.

Counterbalance System

- Water-based adjustable counterweight beyond outer deck
- Active mass redistribution for dynamic balancing
- Real-time torque monitoring
- Compensation for biomass growth and consumables

Water serves dual use:

- Counterweight mass
- Radiation shielding resource
- Life support storage

3. Systems Design

Power

- Truss-mounted solar arrays
- Centralized battery storage
- Independent power feeds per gravity band

Thermal Control

- External radiators mounted on non-rotating or rotating frames
- Zoned heat rejection per module
- Thermal isolation between gravity decks

Communications

- Ka-band primary relay via TDRSS
- S-band backup
- Continuous telemetry for biological monitoring

Propulsion

- Cold-gas RCS for spin-up and desaturation
- Optional electric propulsion for reboost
- Long-duration spin stabilization via controlled torque management

Docking & Access

- Central non-rotating hub docking port
- Pressurized transfer to rotating assembly
- Radial transition corridor enabling gravity gradient traversal

Crew may move between 0g, lunar, Mars, and 1g environments.

4. Multi-Gravity Biological Research Architecture

G1 supports integrated study of:

Human Systems

- Vestibular tolerance at ~1.6 rpm
- Task performance in rotating frames
- Transition effects between gravity zones
- Long-duration physiological monitoring

Plant Systems

- Growth and yield at 0.16g and 0.38g
- Root morphology under partial gravity
- Hydroponic fluid transport under rotation
- Multi-generation reproductive cycles
- Biomass density and structural integrity

Fluid & Plumbing Systems

- Closed-loop water recovery under rotation
- Hydrostatic gradients across radii
- Bubble migration dynamics
- Biofilm formation patterns
- Pump reliability under partial-g

Microbial & Atmospheric Systems

- Microbiome behavior across gravity bands
- Ethylene and VOC management
- Airflow stratification analysis
- Contamination isolation and mitigation

5. Key Design Features

Multi-Gravity Ladder Configuration

- Single spin rate
- Discrete gravity decks
- Simultaneous comparative testing
- Operationally relevant lunar and Mars analogs

Structural Efficiency

- One rotation regime simplifies control systems
- Reduced complexity vs variable RPM systems
- Lower vestibular load compared to smaller-radius centrifuges

Modular Habitat Construction

- Scalable torus or deck modules
- Replaceable biological racks
- Independent environmental control loops

Crew-Rated Design

- Pressure vessel compliant with human rating standards
- Isolation monitoring chamber
- Limited EVA support from hub

6. Cost Summary (Unchanged Baseline Estimate)

Estimated total program cost: **~\$67M**

Category	Estimated Amount (USD)
Design & Program Management	\$6,000,000
Senior/Key Personnel	\$750,000
Hardware Development & Fabrication	\$32,000,000
Habitat Module Fabrication	\$10,000,000
Launch Vehicle	\$10,000,000
Assembly, Integration & Testing	\$5,000,000
Facilities & Services	\$1,000,000
Contingency (5%)	\$3,191,000
Total Estimated Budget	\$67,000,000

Future cost refinements may reflect updated structural mass due to 350m radius configuration.

7. Schedule

Period 1 (2026)

Concept finalization, vendor selection, structural analysis

Period 2 (2027)

Major fabrication, truss assembly, habitat construction

Period 3 (2028)

Integration, launch, commissioning, spin-up, and initial biological campaigns

8. Technology Demonstration Objectives

- First sustained multi-gravity orbital research platform
- Validation of 1g rotating human-rated habitat
- Operational lunar and Mars gravity bands in orbit
- Active mass-balancing of growing biological systems
- Closed-loop hydroponics validation in rotating frame
- Cross-gravity comparative biological dataset generation

9. Ownership Model

Gradient One is developed under Aegis Station Infrastructure LLC (ASI).

NASA or partners may receive privileged mission access via grant or cooperative agreement.

Full title remains with ASI unless otherwise negotiated.

10. Strategic Positioning

Gradient One is not a speculative megastructure.

It is:

- A risk-retirement platform for artificial gravity habitats
- A biological equivalence validation system
- A precursor to Aegis Station
- A modular stepping stone toward long-duration human presence beyond LEO

By closing partial-gravity unknowns at 0.16g and 0.38g while validating sustained 1g rotation, G1 directly informs lunar surface operations, Mars mission architecture, and rotating deep-space habitat design.

Summary

Gradient One establishes a 350-meter, multi-gravity orbital testbed operating at ~1.6 rpm, simultaneously providing:

0g control
Lunar gravity
Mars gravity
Earth gravity

within a single rotating system.

It is engineered for feasibility, scientific value, and architectural relevance.