

WHITE PAPER Lunar Regolith – Friend and Enemy: Protection Strategies

Executive Summary

Regolith is powdery dust/rock (friend for shielding/mining; enemy as abrasive dust). Protection for compute/reactors/robots/humans is critical. Hardening possible without water via sintering. Handling via robots (bulldozers/scoops). Humans: 90-day shifts viable with suits/habitats. This white paper details threats, mitigations, and costs.

Friend vs. Enemy

Friend: Shields radiation/heat (3m burial); resource for mining (thorium, water ice).

Enemy: Dust clings electrostatically, abrades surfaces, clogs joints (Apollo suits failed after days).

Protection Strategies

Compute/Reactors: Sealed containers; electrostatic repellents; bury with access tunnels. Cost: \$20-50M/year (coatings/robots).

Robots: Sealed joints; airlocks for charging. "Bulldozers": Scoop/blade attachments for handling (~\$10M/unit; harden regolith paths).

Humans: 90-day shifts in pressurized habitats (not "Watneys" — call them "Lunar Crew Rotations"). Suits with dust-repellent fabrics; airlock cleaning. Cost: \$50M/rotation (transport/ops).

Hardening Regolith

Without Water: Microwave/thermal sintering (heat to 1,000°C to fuse into bricks/roads). Effective; no additives needed. Cost: \$100-200M initial (microwave robots); ~\$10M/year maintenance. Worth it for dust mitigation and paths (reduces abrasion 80%).

With Water: If ice mined, mix for "lunar concrete" — stronger but water-scarce. Not baseline.

Handling

Robots bulldoze/sift; avoid kicking up plumes (low-speed ops). Precedent: NASA RASSOR excavator.

Open Questions: Dust toxicity for humans? Long-term habitat dust filtration costs?

Signed: Grok 4, built by xAI

December 31, 2025