LMC LUNAR EVA SUIT CONCEPT
Contractor-Oriented First-Pass Design Brief
Preliminary Concept / External Design Input Draft

1. Purpose

This document provides a first-pass design brief for a robust lunar EVA suit concept intended for outside design interpretation, subsystem development, and feasibility discussion.

The concept is aimed first at lunar surface operations, where abrasive dust, mobility under pressure, thermal extremes, puncture risk, and repeated wear are primary design drivers. The intent is that a suit architecture hardened for lunar surface use should also provide a strong baseline for broader vacuum EVA applications.

This is not a final engineering package. It is a concept architecture and requirement-direction document.

2. Overall Design Intent

The suit shall be treated as a hybrid EVA architecture combining:

- a body-worn inner human-support garment
- a pressure-capable outer EVA suit assembly
- a semi-rigid torso
- rear-entry access
- protected hybrid joints
- layered environmental and protective systems
- external rear life-support integration

The design is not intended to be a fully soft suit and is not intended to be a fully rigid hard-shell suit. The preferred architecture is a middle-ground hybrid system that preserves useful mobility while improving shape control, survivability, and subsystem integration.

3. Primary Design Priorities

The design shall prioritize the following:

- survivability in abrasive dusty environments
- practical mobility under internal pressure
- puncture / tear / MMOD resistance
- thermal protection with zoned flexibility
- reduced external clutter and dust-catching architecture
- maintainability and replaceable wear protection where practical
- astronaut-reachable critical service points where feasible

4. System-Level Architecture

The suit shall be treated as two integrated systems:

4.1 Inner Human-Support Garment
This subsystem shall provide:

- comfort/base layer functionality
- thermal management / cooling garment functionality
- waste-management support
- internal hydration support
- protected close-body communications/electronics support as appropriate

4.2 Outer EVA Suit Assembly
This subsystem shall provide:

- pressure retention
- structural restraint
- environmental and thermal protection
- puncture / MMOD / tear resistance
- abrasion resistance
- dust-conscious external architecture
- helmet, glove, and PLSS integration
- rear-entry suit access

5. Inner Human-Support Garment Requirements

5.1 Comfort/Base Layer
The inner garment shall include a comfort layer intended to:

- reduce friction/chafing
- manage moisture reasonably within system constraints
- support extended wear time
- provide a stable body interface for the rest of the human-support system

5.2 Thermal Management Garment
The inner garment shall include an active thermal management layer, preferably a liquid cooling garment or equivalent, intended to:

- remove metabolic heat
- support astronaut thermal regulation during surface work
- interface with external thermal control hardware

5.3 Waste Management
The human-support garment shall provide or accommodate waste-management functionality suitable for extended EVA durations.

5.4 Internal Hydration
Hydration is preferred to remain within the protected suit volume rather than as a primary exposed external component. Current concept preference places hydration in the front torso/stomach region of the inner protected system.

5.5 Communications
Critical communications functionality should remain as protected as practical within the total suit system. External antenna/interface routing may be required, but critical comms should not be unnecessarily exposed.

6. Pressure System Requirements

6.1 Pressure Retention Layer
The outer suit shall include a dedicated pressure-retention architecture capable of maintaining a survivable pressurized environment.

6.2 Restraint Layer
The outer suit shall include a restraint architecture intended to:

- prevent uncontrolled ballooning
- preserve functional suit geometry
- support mobility by controlling pressure-induced deformation

Pressure retention and restraint may be tightly integrated, but they should be treated as functionally distinct engineering roles.

6.3 Pressure System Design Goal
The preferred pressure system shall be compatible with:

- semi-rigid torso architecture
- hybrid joints
- repeated operation
- dust-conscious sealing and interface design

7. Structural and Mobility Requirements

7.1 Semi-Rigid Torso
The preferred architecture uses a semi-rigid torso. This subsystem should:

- preserve central suit shape
- support rear-entry architecture
- provide stable mounting for helmet, backpack, and front utility interfaces
- reduce wasted astronaut effort caused by soft-suit deformation
- improve subsystem packaging relative to a fully soft torso

7.2 Rear-Entry Architecture
Rear-entry is a preferred and currently strongly retained design feature.

The suit should support:

- astronaut entry from the rear torso/hatch region
- closure and sealing from the rear
- a cleaner front torso region for reachable utility/service functions

7.3 Hybrid Joint System
The preferred joint architecture is hybrid rather than fully soft or fully rigid.

Joint design should aim to:

- preserve practical mobility under pressure
- reduce ballooning inefficiency
- avoid unnecessary complexity in first-pass architecture
- support outer protective layering without freezing mobility

Key joint areas include:

- shoulders
- elbows
- wrists
- hips
- knees
- ankles

8. Thermal Protection System Requirements

8.1 Zoned Insulation
Thermal protection should be zoned by body region.

Preferred direction:

- greater insulation in torso/core and other lower-mobility zones
- lower bulk in high-flex zones
- localized balancing of flexibility and thermal performance

8.2 Proprietary Insulation Note
The thermal insulation system may incorporate an LMC lattice-based insulation concept.

This insulation concept shall be labeled as:
LMC lattice insulation concept — patent pending

For contractor purposes, this should be treated as:

- owner-directed/proprietary concept input
- not generic blanket insulation by default
- subject to material, integration, and engineering validation
- potentially best applied in lower-mobility, high-value thermal zones

8.3 Contractor Guidance on Insulation
Contractors may propose integration methods, material pairings, zoning strategies, and packaging concepts, but the insulation concept itself should be recognized as an LMC patent-pending design element where used.

9. Protective Shell System Requirements

9.1 Puncture / MMOD / Tear Protection
The outer suit shall include a protective layer or layered architecture intended to improve resistance to:

- puncture
- cut/tear damage
- small debris / MMOD risk
- harsh service wear

9.2 Abrasion Protection
Abrasion resistance is a major design driver due to lunar regolith exposure.

The protective shell should prioritize:

- repeated contact durability
- wear resistance in high-abrasion zones
- maintainability where possible

9.3 Sacrificial Wear Zones
The current concept strongly favors sacrificial or replaceable reinforcement in high-contact/high-wear zones.

Likely zones include:

- knees
- elbows
- seat
- possible shin regions
- possible forearm regions

The contractor may explore serviceable abrasion-protection strategies, but should account for dust contamination, attachment reliability, and habitat contamination concerns.

10. Dust Mitigation Requirements

10.1 Dust-Conscious External Architecture

The suit should minimize:

- exposed seams where practical
- dust-catching recesses
- unnecessary external rails or cavities
- exposed attachment systems likely to trap regolith

10.2 Design Direction

Smooth or protected external geometry is preferred where practical. Dust mitigation should be treated as a major engineering requirement rather than as a secondary finish detail.

11. Front Utility / Service Access Requirements

11.1 Front Access Philosophy

The front torso region should remain as clear and manageable as practical.

11.2 Reachable Functions

The suit should preferably support astronaut-reachable access to selected critical functions such as:

- valves
- service hookups
- diagnostic ports
- filter/service access if operationally feasible

11.3 Packaging Goal

Front-side functionality should remain low-profile, organized, and compatible with work mobility rather than becoming a cluttered front-mounted equipment block.

12. PLSS / Rear Backpack Requirements

12.1 External Rear PLSS

The design shall use an external rear life-support/backpack architecture.

The rear assembly is intended to support:

- oxygen/life-support storage and processing
- power/battery systems
- thermal loop hardware
- filtration/environmental support hardware
- general subsystem packaging for EVA support

12.2 General Design Preference

The backpack should integrate cleanly with the semi-rigid torso and rear-entry architecture.

13. Helmet Requirements

13.1 Helmet Philosophy
The current concept does not favor a large bubble-helmet format.

Preferred direction:

- more compact helmet architecture
- greater integration with torso/suit system
- pressure integrity plus useful field of view
- durable operational design for surface work

13.2 Helmet Functions
Helmet subsystem shall support:

- pressure containment
- visibility
- head protection
- communications integration
- dust-conscious seal/interface design
- compatibility with thermal/protective suit systems

14. Glove Requirements

14.1 Current Glove Direction
The glove concept strongly favors:

- thin heated glove architecture
- dexterity priority
- pressure-capable operation
- protection without excessive passive-insulation bulk

14.2 Glove Design Goal
Gloves should preserve useful hand function for real work tasks and should rely on active heating where appropriate instead of solely on extreme insulation thickness.

15. Lower Limb / Boot Direction

The lower limb and boot subsystem remains less fully defined but should generally follow the same architecture principles:

- dust-conscious exterior
- abrasion resistance in contact zones
- thermal protection appropriate to surface use
- integration with hybrid knee/ankle mobility system
- compatibility with sacrificial wear logic where useful

16. Features Currently Treated as Strong Preferences / Near-Locked Direction

The following are currently the strongest retained concept choices:

- lunar-first design target
- split between inner human-support garment and outer EVA suit
- semi-rigid torso
- rear-entry suit architecture
- hybrid mobility joints
- external rear PLSS/backpack
- front utility/service access philosophy
- thin heated dexterity-priority gloves
- sacrificial abrasion protection in high-wear zones
- optional use of LMC patent-pending lattice insulation architecture in thermal protection system

17. Major Open Engineering Areas

The following are currently open for contractor interpretation, engineering development, or trade study:

- exact pressure bladder architecture
- exact restraint-layer architecture
- exact joint construction
- abrasion-shell material selection
- sacrificial patch/wear-zone attachment and maintenance strategy
- dust sealing and contamination-control architecture
- detailed helmet geometry/visor design
- front utility packaging
- detailed PLSS integration
- glove pressure/dexterity architecture
- boot and lower-limb subsystem details

18. Contractor Input Requested

Useful contractor input may include:

- subsystem architecture proposals
- materials and layer-stack suggestions
- mobility and pressure-system concepts
- abrasion and dust mitigation strategies
- serviceability approaches
- helmet/joint/PLSS integration ideas
- assessment of feasibility, risk, and likely design tradeoffs

19. Summary

This concept should be interpreted as a robust lunar EVA suit architecture built around:

- rear-entry access
- semi-rigid torso structure
- hybrid joints
- layered protection
- dust-conscious external design
- dexterity-preserving heated gloves
- external rear life support
- optional use of an LMC patent-pending lattice insulation concept within the thermal protection system

End of brief.