Task 4. Overview:

Survive the Night: The Lunar Logistics Challenge

2026

Sponsored by the New Mexico Space Grant Consortium

Developed by Kennedy Space Center, Marshall Space Flight Center, Johnson Space Center White Sands Test Facility

Notes: The final problem statement will fill in yet-to-be-determined parameters and will include both metric and Imperial units for all values provided. It will be published by August 2, 2025.

Introduction

You and your crew just landed at the Lunar South Pole for a 28-day mission. Your supplies were delivered 30 days earlier. Conditions are extreme in this region, where temperatures can range from 54°C (130°F) in sunlight, to -203°C (-334°F) in permanently shadowed areas.

Your life-support supplies, including food, water, and medications, and critical equipment are stored in pressurized, temperature-controlled logistic containers that are stored outside your habitat. This setup allows you to access only the items you need, thus optimizing the small space in the habitat, while keeping the remaining supplies protected from the elements.

Knowing that any failure in the container's temperature/pressure controls could mean compromised supplies needed for life support, you have been monitoring the data logging system to ensure that interior temperatures and pressures of the containers outside your habitat are being maintained. The data logger reports "All systems go" and you move through the hatch, knowing your food, water, medications, and maintenance supplies are in good condition and will sustain you throughout your mission, thanks to the engineering teams—perhaps even students that competed in the WERC Environmental Design Contest—that designed these robust pressurized logistics containers.

Problem Statement (Subject to minor changes)

Your challenge is to research, design, and demonstrate a logistics container prototype that will scale up to supporting a crew of four for 28 days (130 CTBs holding a total mass of 1,965 kg of logistics supplies). The container will be designed to protect and store logistics items.

The container must maintain internal temperatures between 4 and 21°C and pressures between 14.7 and 8.2 psi throughout its journey aboard a lander from Earth to the lunar surface, and must continue to maintain these conditions until it is opened on the lunar surface. Therefore, it must be equipped with a reliable system for maintaining the specified pressure range, such as a tight seal and pressure-relief valve or equivalent mechanism. Additionally, the container must include equipment capable of recording, storing, and transmitting real-time temperature and pressure data to Ground Control.

Your team may choose to design the prototype as either a single container to hold all logistics items or a smaller modular container, requiring multiple similarly designed units to be built. If the former, it must scale up to accommodate connection to the shirt-sleeve habitat through a 1x1.5 m (60x40 in.) hatch, when it will become a pressurized walk-in area. If you opt to design a smaller container, the design should support handling during an EVA by one crew member, accommodating transport into the habitat, either by hand or with the assistance of a mobility aid, through a hatch of size a 1x1.5 m (60x40 in.).

The design of your logistics container should optimize supply storage and should consider tradeoffs between one large container, a few large containers, or many smaller containers while considering ease of maneuverability back into the habitat.

The scaled-up design shall plan for the container(s) to hold CTBs (½CTBE, 1CTBE, …. 75CTBE, where one CTBE is sized at 50.2 cm X 42.5 cm X 24.8 cm and mass of 0.89kg). The CTBs will store dry goods, such as food, clothing, crew supplies, operational supplies, and spare parts. The container must have internal flexibility to allow storage of CTBs as well as other parts that will not fit into a standard CTB. The container must withstand multiple re-positioning events that may be conducted manually or robotically, and therefore should minimize shifting of the contents and be made of materials that are durable, as defined in the Design Requirements.

Background

To help us better understand how humans can live beyond Earth in harsh conditions, NASA's Artemis Program is preparing to send crews to the Lunar South Pole to conduct extravehicular activities (EVAs) to forward science and engineering studies [1, 2]. NASA's plans for a long-term sustainable presence on the Moon includes a progressive increase in habitation capability that will eventually support crews of four for 30 days or longer.

Life Support at the Lunar South Pole

The extreme conditions at the South Pole – from hot sunlit areas to extremely cold shadowed regions—make it a compelling location for deep-space exploration and discoveries that could help prepare us to explore further out in the solar system. At the lunar South Pole, the sun lies at near-horizon level—sometimes above and sometimes below the horizon. During sunlit periods, temperatures can soar to 54°C (130°F), yet, due to the low angle of the sun and dramatic topographic changes, many regions are in constant darkness and have not been exposed to sunlight in billions of years. Temperatures in those perpetually dark areas can be as low as -203°C (-334°F) [3].

Under Pressure

On the lunar surface, which lacks an atmosphere, pressure felt on a body will be nearly zero (1.9x10-4 psi). For comparison, on Earth, atmospheric pressure at sea level is 14.7 psi, and for the highest city on Earth, La Rinconada, Peru (elevation 16,730 ft), it is approximately 7.8 psi. A container that is completely sealed on Earth should maintain atmospheric pressure when it arrives on the lunar surface. If the seal is compromised, pressure within the container will drop to ambient lunar pressure.

NASA is planning for the shirt-sleeve lunar habitat to have a pressure of 8.2 psi with 36% oxygen concentration. This is to minimize crew pre-breathe time as they transition from the habitat to the lunar surface to perform EVAs. This is similar to the needs of scuba diving to avoid the bends. NASA defines a "shirt-sleeve environment," as a pressurized area with a breathable air mixture that is temperature and humidity controlled and protected from radiation and micrometeoroids, allowing the crew to wear regular clothing without needing spacesuits.

Logistics Containers and CTBs

A key requirement for human exploration of the lunar South Pole is ensuring that essential life-support supplies are safely stored and maintained in logistics containers. NASA uses the term "logistics items" to describe cargo that are necessary to sustain life, ensure ongoing system functionality, and support and enable human exploration [4]. Logistics include food, water, tanks of breathable air, spare parts for critical systems, and equipment needed for scientific activities. The logistics must be stored in thermally conditioned, pressurized containers.

Logistics containers usually hold a set of smaller containers, called cargo transfer bags (CTBs). CTBs have been used to organize, stow, and carry supplies and equipment in space since the 1990s when they were designed for the Shuttle and Spacehab (See [5] for a history of the CTB).

CTBs were originally designed to hold a volume of 0.053 cubic meters, and this became a standard unit of measure called the Cargo Transfer Bag Equivalent (CTBE) that is still used today. CTBs have historically been made in sizes that are one-third, one-half, two times, three times, etc. that of CTBE. Each of these sizes is referred to, respectively, as ⅓CTBE, ½CTBE, 2CTBE, 3CTBE, etc. For more information about CTBs, refer to Appendix I.

For this design challenge, CTBs will be 1 CTBE or smaller. Details will follow in the full problem statement (coming soon).

Logistics Container Uses, Needs, and Design Considerations

The crew will need logistics containers that can be packed on Earth, loaded on a lander, land on the lunar surface, and be transported from the lunar lander to be located outside the habitat. The containers will remain outside the shirt-sleeve environment until the crew needs to retrieve items. The primary design criteria is reducing overall weight and mass of the container while ensuring ability to store all needed logistics items.

The size of your selected logistics container should optimize supply storage for a crew of four on a 28-day mission (about 1,965 kg of logistics supplies packed in 130 CTBEs). NASA is interested in exploring size options for the logistics containers that will hold the CTBEs – whether it is more efficient to design one large container to hold all 130 CTBEs or to design multiple smaller containers, with the option of multiple sizes being considered.

Larger containers could be connected to the habitat through a hatch, thereby becoming a large walk-in storage module having its pressure equalized with the habitat. Smaller containers would be stored in proximity to the habitat, but still requiring an EVA to retrieve them. Their size and dimensions should support handling by a crew member, accommodating transport into the habitat through that same size hatch, either by hand or with the assistance of a mobility aid that will facilitate handling. Smaller containers should also be scalable to multiple sizes, according to the cargo to be stored, since not all supplies will fit into a 1-CTBE bag.

Assume the containers will receive power from a cargo lander until they are offloaded, after which they may require a power source or a passive means of maintaining temperatures and pressures and record this data. Although alternatives are currently being explored at NASA, the scenario we will consider is that the containers will be offloaded from the lander and be positioned in proximity to the habitat 30 days prior to the crew's arrival. The containers will be positioned in sunlight on the lunar surface.

The logistics containers have very specific requirements that include: being sufficiently durable for minimizing shifting during launch, landing, and lunar transport; maintaining a narrow range of temperatures and pressures; recording and reporting temperature and pressure data; working with the specified hatch size; and, if possible, repurposing and/or reusing.

Challenges of smaller containers:

- Crew must carry each container into the habitat from the outside.
- Dust would need to be removed in an airlock prior to being brought into the habitat.
- Tare mass of the container compared with mass of the total cargo is higher than for a single container
- Power and pressure equalization mechanisms are needed for every container.
- Many small landers may be needed (this may either be an advantage or a disadvantage, depending on the size of the container and the functionality of the lander.

Advantages of smaller containers:

- A single crew member would be able to manipulate the containers while on the lunar surface
- Less need for complex mobility and lifting aids

Challenges of one large container:

- Less need for dust mitigation
- More complex mobility and lifting aids are needed to put the container into position
- Aligning and ensuring a tight seal at the hatch opening is extremely challenging.
- A larger lander is needed (this may either be an advantage or a disadvantage, depending on the size of the container and the functionality of the lander.

Advantages of one large container:

- Lower tare mass of the container vs mass of the total cargo.
- Crew can carry CTBs into the habitat, one at a time, thereby resulting in smaller carrying loads.
- Power and pressure relief mechanisms are only needed for one container, and the pressure requires equalization only once.

The Hatch

Assume that the habitat can be equipped with two hatches of the same size (1x1.5 m (60x40 in.): one for crew ingress/egress and the second would only be for connecting a large logistics container, if your team chooses that option. If the container will be attached to the habitat through the hatch, assume it will remain attached for the duration of the mission.

Systems and Process Planning

NASA currently plans for the crew to enter and egress a habitat once every other day. Supplies will arrive on the lunar surface before the mission and will be staged outside the habitat. The crew will load a portion of the supplies into the habitat as needed.

This design challenge involves multiple objectives and has many design variables. Containers must maintain proper temperatures and pressures to preserve logistics quality while also minimizing overall volume and mass. They must also be easy to open and allow for smooth pressure equalization with the surrounding environment, while being appropriately sized to avoid being too heavy or cumbersome for the crew. For a comprehensive review of space crew life support baseline values, see [7] and [8].

Since crew time is a scarce and costly resource, ideal solutions will minimize operational complexity to ensure that minimal crew time is spent on training, use, maintenance, or repair. Designs should also ensure crew safety (See NASA Technical Standards 6001 [6]) while minimizing energy requirements, material volume, and mass. Potential safety issues include flammability due to elevated oxygen, material offgassing, pressure relief, lifting and carrying, and other issues your team may identify.

Balancing human-systems factors has been a long-standing challenge in the space industry. To address these issues, teams are encouraged to engage industrial- and human-factors engineering students as a part of their team.

Logistics Container Requirements

The items below are greyed out to emphasize that significant changes may be made in the full task problem statement.

With the need to preserve life-sustaining dry goods, logistics containers have specific requirements, listed below.

- **Contents:** CTBs containing dry goods, such as food, clothing, crew supplies, operational supplies, and spare parts. In addition, some parts may be packed without CTBs. All items in the container must be prevented from shifting during transport.
- **Sizing:** Container size should minimize the total mass of all containers compared to the total mass of the dry goods they hold. Teams are urged to explore the tradeoffs between larger quantities of smaller containers vs. smaller quantities of larger containers.
    - *Full-scale CTB size:* 50.2 cm X 42.5 cm X 24.8 cm and mass of 0.89kg each.
    - *Larger items: Parts or spare parts that will not fit in CTBs. The logistics container should be configured (or be reconfigurable) to accommodate different internal configurations.*
    - *28-day mission:* A 4-crew, 28-day lunar mission will need about 1,365kg of logistics supplies packed in 75 CTBs.
- **Pressure:** The containers will be packed on Earth at 14.7 psi.
    - They must hold a pressure of at least 8.2 psi during transport to the Moon and while on the lunar surface, until the dry goods are removed from them.
    - The containers must have a means of allowing the crew to initiate pressure equalization such that the internal pressure and external pressure are equal before they are opened.
- **Temperature:** The containers must maintain an internal temperature between 4 and 21°C until the dry goods are removed. This will ensure that sensitive dry goods, such as medicines, are not exposed to unacceptable temperatures.
- **Functionality:** The containers must have a pressure equalization valve that can safely equalize pressure in the container (if more than or less than 8.2psi exploration atmosphere) to the pressure within the habitat. They should also have the ability to monitor internal pressure and temperature.
- **Data Logging and Transmission**: The containers need to communicate and/or store data records of temperature and pressure to ensure these parameters were maintained within acceptable range.
- **Power:** Power to maintain temperature/pressure data records will be required at least until the crew can retrieve the containers. Depending on your team's design, power may also be needed to maintain temperatures and pressures. Power may be needed to maintain the containers throughout the mission, up to 60 days after landing on the lunar surface.
- **Materials:** Select any material or combination of materials for the container interior and exterior that will facilitate the container requirements.
    - Be sufficiently durable to withstand handling needed as they are moved into position.
    - Ensure safety of the crew.
    - Sufficient rigidity to support the planned use, without collapsing or otherwise blah.

- Protect the exterior from solar radiation.
- Mitigate lunar dust issues

- **Packing/Unpacking:** The containers will need to be loaded on Earth and unloaded on the lunar surface. Dry goods should be stored and secured in the container to minimize shifting of contents during launch, landing and transport across the lunar surface. Items should be arranged in an orderly manner to help the crew easily locate and access needed items.
- **Delivery and Handling:** *Assume that*
- **Interface:** The container must attach to the pressurized environment to accommodate loading and unloading by the crew.
  - Your team's container design should include a 1x1.5 m (60x40 in.) hatch to allow for the transfer of goods by mating of the container to a shirt sleeve environment, such as a pressurized rover or surface habitat, without having to bring the carrier inside. *(Will the containers be held in a protected area?) Do we need a scaled-down hatch size?*
- **Support Equipment:** Container concepts should identify and detail any support equipment needed in order to be able to pack/unpack, load/offload, and/or transport the containers. These could include Lifts, carts, cranes, hoists, etc.
- **Repurposing:** Once emptied, the containers may be used to store trash and waste until it can be dealt with or made available for other uses if not needed for waste. Container concepts could potentially suggest other functionality for repurposing after the cargo has been removed from them.

Equivalent System Mass: Evaluating Space Systems

Instead of the traditional techno-economic analysis, the space industry frequently evaluates the affordability of a project using the system's "equivalent mass." Equivalent System Mass (ESM) reduces all elements of a technology into a single parameter that is stated in units of mass. Mass is used as the standard for this evaluation method because it is a major factor in the cost of launching mass into space. ESM for space technologies typically includes mass, volume, power, cooling, and crew time. Teams will evaluate ESM for each of these factors. Refer to the "Advanced Life Support Equivalent System Mass Guidelines" [9] for more information about computing ESM.

Design Considerations

Your proposed design should provide specific details and outcomes as follows:

- Review available literature on logistics containers and human factors. Generate concepts for your solution, narrow the focus to a small number of options, then fabricate one or more prototypes of logistics containers; test and iterate.
- Design a logistics container to store CTBs that strikes an appropriate balance between minimizing crew time (simplicity in setup, training, operation, and maintenance), power required, power storage/generation, mass, volume, footprint, and cost.
- Include one or more complete process flow diagrams in your technical report showing all inputs, outputs, and processes, including maintaining temperatures and pressures, how pressure will be equalized, and how data is collected and reported.
- Unless a vacuum chamber is available,
- At the contest, the system will operate in Earth's gravity. Address in the technical report: the design's applicability in ⅙ Earth's gravity at the lunar surface, and document your conclusions.
- Follow the Bench-scale Demonstration criteria, below, for building the bench-scale prototype logistics container.

  - Select exterior materials. These may include hard goods, fabric, soft goods, dust-resistant materials, etc., that are abrasion- and impact-resistant, durable, and suited for use in space. Provide supporting evidence for this in the technical report.
  - Select interior materials, including any needed for structural support, dividing the internal volume, and/or tethering the contents.
  - Include labeled diagrams in the Technical Report and poster that illustrate a full-scale design of your logistics container.
  - Your team's Concept of Operations for how the container is used to support the crew from time of landing on the moon until it is accessed by the crew. shall be included in the technical report, but is not expected in the bench-scale demonstration.
- Report the:
  - Expected power usage, volume, and mass;
  - Expected effect on crew members' workload (direct interaction, time, convenience, etc.);
  - Expected routine maintenance of the system;
  - Modularity of parts in the event of repairs, maintenance, etc.
- Account for crew safety concerns, including excessive container weight or awkward dimensions, potential pressure-relief failures, exposure to lunar dust, or other hazards. [10].
  - Present a Techno-Economic Analysis (TEA) to construct a set of logistics containers, based on the number you expect to need to supply a four-person crew for 28 days. Capital expenses: These typically include, but are not limited to, equipment, pipes, pumps, electronics, etc. needed to build the system as well as any surface materials required. Do not include costs of buildings in which the logistics containers will be manufactured.
  - Operating expenses: These should be calculated as the cost for launch, based on total ESM. Equivalent mass considerations include power, mass, and volume. (see [9]). *The full task problem statement will provide an equation that all teams will use for their TEA.*
  - Crew time: Conduct human-in-the-loop testing in your lab to reduce crew time.
  - Visualization tools: Sensitivity analyses, cash flow diagrams, etc.
- Address safety aspects of your design. Safety issues for the full-scale design should be included in the technical report. Safety issues and PPE, if needed for the bench-scale demonstration, should be addressed in both the written report and the Experimental Safety Plan (ESP).

Bench Scale Demonstration (items in italics will be provided in the full task problem statement).
Teams will demonstrate a bench-scale design for a logistics container of interior size of *(TBD)* CTBE that can hold *TBD* CTBs of size (*some fraction of a CTBE*), with the ability to be re-configured to hold an item that cannot fit within one CTBE, such as the c*ooling garment that is worn under the EVA suit.*

<u>Teams will provide at the contest:</u>

- A prototype logistics container:
  - The prototype shall be able to hold *TBD ¼*CTBE CTBs.
  - The prototype containers will maintain temperatures between 4 and 21^{o}C and pressures between 14.7 and 8.2 psi and include means of measuring and recording these parameters then communicating this information to the team's device of choice.
  - All items shall be sized to easily pass through a hatch size opening that can be scaled up to 1x1.5 m (60x40 in.). The third dimension may be longer than *1 m*.
  - The exterior of the logistics container may include materials that are currently used in the space industry for your selected item or may include innovative materials that minimize dust accumulation and/or improve the performance of your container. The materials may be made of

either soft or hard goods. In either case, provide supporting evidence that the selected material is feasible for use in space expeditions and is feasible for your selected item.

- TBD ¼CTBE CTBs. These are only needed to illustrate how CTBs will fit into the container. They do not need to be specially designed, other than having the proper dimensions.
- Tethering materials that will ensure that all items in the container are securely restrained within the container to avoid shifting of the contents.

WERC will provide at the contest:

- Dry goods: *TBD*
- A "spare part" to be placed into your team's logistics container when the CTBs have been removed.
- Conditions that simulate temperature and pressure variations (*TBD*)
- Additional bulky items requested by your team, if needed. Although teams will provide the majority of items needed for the bench-scale demonstration, you may submit requests to WERC in the 30% Project review by January 30, 2026 for additional bulky items (large, but low-cost) needed to run the bench-scale demonstration at the contest. (*See Team Manual*).

Contest Analytical Testing:

Equipment Prototype Requirements

The materials used to cover your prototype item should be technically and logistically feasible for its application, including being tear-, scratch- and impact-resistant. This will be evaluated based on evidence your team presents in the technical report, bench-scale demonstration, and the judges' assessments of the material's integrity.

Analytical Testing

To test your container's success at maintaining proper temperatures and pressures, WERC will independently analyze the pressure and temperature within the container. *Details TBD-but we have some great alternatives in the works!*

30% Project Review

An important part of preparing for your bench-scale demonstration will be your completion of the 30% Project Review. Due in late January, or a date requested by your team, it outlines the general design, functionality, and the details for how you plan to demonstrate and test your logistics containers during the contest in Las Cruces. Note that the report does not include TEA, community engagement, or audits, and teams are allowed to change parameters after submitting the report.

Specific to this project:

- Include a complete PFD. This will be reviewed by SMEs from NASA.
- Submit a draft for your bench-scale demonstration setup. The draft should be a 3-D view, drawn to-scale, with dimensions labeled. Consider that the contest is held at a banquet facility, without typical lab resources (e.g., no fume hoods, ovens, etc.). WERC typically provides your team with an 8' folding table with access to 120V power. See the Team Manual for more bench-scale parameters.
- Determine bench-scale testing parameters: Outline how you plan to test your container for: data measurement, and data logging and transfer.
- Describe how you plan to demonstrate crew interaction with the container.
- Outline all bench-scale needs, including the need for pressurized gas cylinders, indoor versus outdoor bench-scale demonstration area, and potential need to run the process overnight.

The 2026 Team Manual gives general guidelines for the 30% review. Pay particular attention to the Process Flow Diagram (PFD) that serves as a robust outline of all processes and balanced inputs, and outputs involved in your treatment system.

Evaluation Criteria

Each team is advised to read "Evaluation Criteria" and "Contest Scoring" in the 2026 Team Manual for a comprehensive understanding of the contest evaluation criteria. For a copy of the Team Manual, Public Involvement Plan, and other important resources, visit the WERC website: Guidelines | werc.nmsu.edu

In addition to evaluation criteria that applies to every task, judges will evaluate your team's response to the problem statement, with consideration of the Design Considerations listed above. In particular, judges will evaluate:

- The perceived durability of the logistics containers
- The selected quantity, size and dimensions
- The power needs vs how long the carrier can maintain temperature range,
- Ease of offloading and handling, such as human factors involved in packing and unpacking the dry goods into/from inside the carrier,
- Complexity of the concept of operations
- Total mass of containers vs the mass of the dry goods carried.

Experimental Safety Plan (ESP) and Required On-Demand Short Course.

All members of your team are required to attend the ESP Preparation short course. Due dates are listed below. See team manual for details.

Specific to this task, email WERC (werc@nmsu.edu) and include in the ESP any special requests for bench-scale testing (container size, etc.)

Dates, Deadlines, FAQs (*dates subject to change—watch website FAQs*)

Early Fall	Email us to reserve a spot for your team and get on the email list for this task. Registration is limited.
Weekly	Check FAQs weekly for updates: • Task-specific FAQs: 2026 Tasks/Task FAQs • General FAQs: 2026 General FAQs
November 1, 2025 - December 31, 2025	Early Bird Registration (discount applies)
December 1, 2025 – January 30, 2026	30% Project Review Due (or as arranged with WERC).
December 1, 2025 – February 16,2026	Mandatory On-demand Course: Preparing the Experimental Safety Plan. See website and Team Manual for information.
February 17, 2026	Final date to register a team w/o permission.
March 9 -13, 2026	Experimental Safety Plan (ESP) due to Juanita Miller. Include requests for chemicals, materials, etc.
April 2, 2026	Technical Report due
April 12 – 15, 2026	Contest in Las Cruces

References

[1] Moon to Mars Overview. https://science.nasa.gov/toolkit/moon-to-mars/ (Accessed 7/10/2024).

[2] Artemis. https://www.nasa.gov/specials/artemis/ (Accessed 7/10/2024).

[3] Mahoney, E. Moon's South Pole is Full of Mystery, Science, Intrigue. 2022. https://www.nasa.gov/humans-in-space/moons-south-pole-is-full-of-mystery-science-intrigue/#:~:text=%E2%80%8BAt%20the%20lunar%20South,to%20rising%20and%20plummeting%20temperatures.

[4] White Paper. Lunar Logistics: Drivers and Needs. 2023. https://www.nasa.gov/wp-content/uploads/2024/01/lunar-logistics-drivers-and-needs.pdf?emrc=4e168e

[5] Kitchmacher, G. Reply #7, Evolution of Stowage in US Spacecraft. https://forum.nasaspaceflight.com/index.php?topic=12018.0. (Accessed 9/16/2024).

[6] Flammability, Offgassing, and Compatibility Requirements and Test Procedures. NASA-STD-6001. https://standards.nasa.gov/standard/NASA/NASA-STD-6001 (Accessed 07/31/24).

[7] Ewert, M.K., Chen, T.T., and C.D. Powell. Life Support Baseline Values and Assumptions Document. 2022. NASA/TP-2015-218570/Rev2. *https://ntrs.nasa.gov/api/citations/20210024855/downloads/BVAD_2.15.22-final.pdf* (Accessed 7/11/2024).

[8] Lynch, C.S., K.E. Goodliff, C. Stromgren, J. Vega, and M.K Ewert. Logistics Rates and Assumptions for Future Human Spaceflight Missions Beyond LEO. 2023. https://ntrs.nasa.gov/api/citations/20230012635/downloads/Logistics%20Rates%20and%20Assumptions%20Beyond%20LEO%20V5.pdf (Accessed 9/17/2024).

[9] Hanford, A.J. NASA: Advanced Life Support Equivalent System Mass Guidelines Document. September 2003. https://ntrs.nasa.gov/api/citations/20040021355/downloads/20040021355.pdf (Accessed 7/10/2024).

[10] Accidentally deleted. Look up later.

Appendix I: Cargo Transfer Bags

Note: You may find references in the literature for a "notional logistics container." This is a general term for a cargo container that is still in the conceptual stages and is not specifically a CTB.

Traditionally, CTBs have been made of fabric, and have been designed to be multi-purpose (foldable, used as shelving when not carrying cargo, etc.). The current fabrics and construction tend to retain dust, therefore the space industry is exploring new designs for Artemis. *are encouraged to identify dust-resistant materials or materials that will facilitate dust removal in some other way. In the technical report, teams working on the CTB should draw up plans to demonstrate that their materials can meet the requirements described in this paragraph.*