**NASA’s LunaRecycle Challenge**

**Phase 1 Submission Instructions and Template**

**(Prototype Build Track)**

## 

## Instructions

In General:

* The submission must address each required section and topic described below. Teams should maintain all numbered section headings in their submission.

PLEASE NOTE: Any submission that does not address all of the requirements will receive a “Fail” score for completeness, will not be judged, and will not be eligible for a prize.

Submission Document:

* The submission must be a PDF file and may include no more than 20 pages. Teams must adhere to this limit. Judges will not review any materials beyond 20 pages. This instruction section does not count toward the page limit and may be deleted prior to submission.
* A “page” is defined as 8” X 11” size paper with 11-point font (Arial or Times New Roman), 1-inch margins, single spaced. Any text included in tables, figures, or captions may be as small as 10-point font.
* Each section includes a recommended length for the answer. These recommendations are intended to provide guidance on NASA’s expectations for the length and quality of the answer, but teams are not required to adhere to these recommendations. Teams may allocate space to different sections as they see fit.

Pitch Video:

* Teams must also submit as a separate file a short pitch video (no more than 2 minutes) describing their team and solution. Judges will not review the video beyond 2 minutes.

## 

## Required Sections and Topics

1. Team Information (*1 page suggested*)

1.1 Team Name: (Teams are encouraged to use a creative team name. This name may be used in promotional materials related to the challenge.)

1.2 Team Lead:

1.3 Team Affiliations/Organizations (if applicable):

1.4 Relevant Past Work (if applicable):

1.5 Geographic Location (City and State/Territory):

1.6 One Sentence Description: (Provide a one-sentence description of your solution that may be used in promotional materials related to the challenge. Do not reference any confidential elements of your solution in this description.)

2. Vision and Innovation *(2-3 pages suggested)*

2.1 What specifically is innovative about your approach?

2.2 How is it different from and/or better than recycling approaches currently used terrestrially?

2.3 How is it different from and/or better than recycling approaches currently contemplated for space applications?

2.4 How does your approach leverage advanced technologies or advanced manufacturing methods?

2.5 How does it address the conditions and activities of the hypothetical lunar settlement described in the Mission Scenario? Please specifically address: a) whether your system will be located outside on the lunar surface and/or inside a pressurized habitat; and b) how your system will be designed for the lunar conditions relevant to its location (as described in the Mission Scenario).

2.6 Teams are not required to design solutions to operate in lunar dust conditions. However, please describe how your solution might be adapted to operate in lunar dust conditions in the future and/or whether/how it might be inherently dust resistant.

2.7 This challenge is focused on recycling systems for the lunar surface. However, please describe how your solution might have application, or be adapted to have application, to recycling systems on Earth.

3. Recycling and Manufacturing Process (*8-10 pages suggested*)

3.1 What **waste category/categories** will your process address? Within each waste category, what waste items will your process address? Please provide details about the estimated amounts (% by mass and % by volume) and materials that will be recycled.

3.2 Describe the **usable outputs** produced from your process, including the types and amounts (kg) of feedstocks and any finished end products (kg or number), if applicable to your process.

3.3 What are the **systems and components** that make up your process? Please provide detailed descriptions, schematics, and other relevant data for these systems and components.

3.4 What is your **concept of operations**? Please describe: a) a full production cycle of your process, including the duration; and b) how many full production cycles will be required to recycle the estimated amounts and materials that you described in question 3.1 and produce the usable outputs that you described in question 3.2. In addition, please note whether operation of your system will require crew, and if so, what operational activities they will need to perform.

3.5 What **maintenance** for your system will be needed during your process or after your process has completed one or more full production cycles? Please describe any maintenance activities and whether the activities require crew.

3.6 Describe the **resource inputs** needed for your process (consistent with sections 3.1, 3.2, 3.3, and 3.4 above) including the total electricity, water, chemicals, minerals, and any other inputs, including crew time. Include the following RESOURCE INPUTS TABLE in your presentation for each waste category that you are addressing. If your recycling process addresses more than one waste category simultaneously, you may provide one table for multiple waste categories.

RESOURCE INPUTS TABLE

|  |  |  |
| --- | --- | --- |
| **Waste Category** | **Resource Input** | **Total amount required for your process** |
| (Name of the Waste Category, from Table 4 in the challenge rules) | Electricity | –Peak demand over a specific time period (kW)  –Total electricity consumed (kWh)  –Net electricity consumed, if any electricity is produced in the recycling process (kWh) |
| Water | kg |
| Chemicals/ Minerals/Other Resource Inputs | kg |
| Crew Time to Operate the System | # of crew and hours per crew member |
| Crew Time needed for Maintenance Activities | # of crew and hours per crew member |

3.7 Describe the types and amounts (kg) of any **unusable outputs** that will result from your process. Unusable outputs are defined in the Definitions section in the challenge rules.

3.8 Use the following NET WASTE RECYCLED TABLE to show the **net waste recycled**. In Phase 1 of the challenge, net waste recycled for each waste category is equal to the sum of the percentage recycled (by mass) of each waste item in a category.

For example, Team A has chosen the Fabrics category. Their process will recycle (by mass) 70% of the clothing, 80% of the towels, and none of the disinfectant wipes. Team A will multiply the percentage recycled by the total % by mass of each item, as listed in Table 4. Therefore, Team A’s net waste recycled is: (70% X 77%) + (80% X 21%) + (0% X 2%) = 71%.

Please use one row for each waste category that your process will address and one column for each waste item in the category. You may add additional rows and columns to this template as appropriate. Percentages should be rounded to whole numbers.

NET WASTE RECYCLED TABLE

| **Waste Category** | **Waste Item 1**  **(% recycled**  **by mass)** | **Waste Item 2**  **(% recycled**  **by mass)** | **Waste Item 3**  **(% recycled**  **by mass)** | **Net Waste Recycled**  **(%)** |
| --- | --- | --- | --- | --- |
| (Team A example)  Fabrics | 54% | 17% | 0% | **71%** |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

4. Hardware and Components (*2-3 pages suggested*)

4.1 Preliminary Schematics*:* Provide assembly-level CAD models showing envelopes and key dimensions for your solution.

4.2 Equipment List and Mass/Volume Estimates: Use the following EQUIPMENT TABLE to provide a draft master equipment list, including mass and volume estimates for each major component or system. Please add as many rows as necessary to the template.

EQUIPMENT TABLE

|  |  |  |  |
| --- | --- | --- | --- |
| **Description of Equipment** | **Estimated Mass (kg)** | **Estimated Volume (cm3)** | **Expected Allowable Ranges for Temperature and Atmospheric Pressure** |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

5. Development Planning (*2-3 pages suggested*)

5.1 Development Plan*:* Describe your plan for further developing your solution into a functional prototype during Phase 2. Teams should address the technical steps necessary for hardware development and testing; success criteria for testing; personnel and other resources; and expected timeline/schedule.

5.2 Risk Assessment*:* Describe the technical and other risks associated with developing your solution in Phase 2. For each risk, include an assessment of the risk (such as high, medium, low) and your proposed risk mitigation strategy.

5.3 Development Budget*:* Use the following BUDGET TABLE to estimate the budget necessary to execute your Development Plan in Phase 2. In this challenge, NASA is not focused on comparing the overall cost of solutions; rather this section is intended to assess how well the team has thought through the budget necessary to build their solution, if they are chosen to move onto Phase 2. In the “Expected funding sources” column, teams should address whether you will already have funds in place to support work during Phase 2, and if not, how you will work to secure the necessary funds. You may assume the Phase 1 prize purse in your budget.

BUDGET TABLE

|  |  |  |  |
| --- | --- | --- | --- |
| **Type of cost** | **Description** | **Estimated budget for developing your solution in Phase 2 ($)** | **Potential funding source(s)** |
| Materials |  |  |  |
| Equipment |  |  |  |
| Lab/testing |  |  |  |
| Personnel |  |  |  |
| Admin |  |  |  |
| Other (if applicable) |  |  |  |