**Milestone Round Submission Template for Prototype Solutions**

**General Instructions:**

* This template includes all of the required sections that your team should address for your Prototype Solution.
* In addition to this template, teams are also required to submit the following items, as described in the Milestone Round Submissions section of the challenge rules:
	+ A link to a publicly accessible video (no longer than 5 minutes) showing progress to date, such as any materials, components, subsystems, or testing that the team has conducted; and
	+ A Preliminary Demonstration Proposal.
* If you are also submitting a Digital Twin Solution, please also submit the required items for a digital twin described in the Milestone Round Submissions section of the challenge rules.
* Your submission must address each required section and topic described below. PLEASE NOTE: Any submission that does not address all of the requirements will receive a “Fail” score for completeness and will not be eligible for a prize.

**Submission Document Instructions:**

* All submissions must be in English; submissions in any other language will not be judged and will not be eligible for a prize.
* Teams should maintain all numbered section headings in their submission.
* The submission must be a PDF file and may include no more than 25 pages. Teams must adhere to this limit. Judges will not review any materials beyond 25 pages. This instruction section does not count toward the page limit and may be deleted prior to submission.
* A “page” is defined as Letter size paper (8½” X 11”) with 11-point font (Arial or Times New Roman), 1-inch margins, single spaced. Any text included in tables, figures, captions, or footnotes 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 the 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.

##

**NAME/TITLE FOR YOUR SOLUTION**

1. Vision and Innovation (*Recommended length: 1-2 pages*)

1.1. Provide a brief overview of your solution, including eligible trash items that you will recycle (from TABLE 4 of the challenge rules); overview of the recycling system; and outputs (both usable and unusable).

1.2. How does your solution use innovation to address the challenge?

1.3. How does the solution build or improve upon the current state of the art?

1.4. How does your solution leverage advanced technologies?

1.5. Describe the commercial potential of your solution.

1.6. How do you envision the anticipated maintenance needs and any expendables required for long term operation of the system (one year or longer)?

1. Milestone Round Solution Design

2.1. Milestone Round Engineering Design *(Recommended length: 4-6 pages)*

2.1.1. A rationale for your design approach

2.1.2. Preliminary evidence and analysis predicting performance including mass, volume, and power requirements

2.1.3. System-level and component-level design specifications for hardware and software, including bill of materials

2.2. Milestone Round Operations, Analyses, and Testing *(Recommended length: 4-6 pages)*

2.2.1. Concept of operations for one cycle and any related analyses or testing, including thermal analysis and structural analysis, if relevant to your solution

2.2.2. Summary of the inputs**,** outputs, and efficiency of your recycling process**.** Please include the RECYCLING SUMMARY TABLE below to summarize these details.

2.2.3. Plan for characterizing the usable outputs and finished products from the recycling process and verifying this characterization

RECYCLING SUMMARY TABLE

|  |  |
| --- | --- |
| **Question** | **Answer** |
| Eligible trash item(s) from TABLE 4 of the challenge rules that your solution will recycle |  |
| Total mass of one batch of eligible trash items (expressed in kg). Please explain how the batch will meet Minimum Batch Requirements described in the challenge rules. |  |
| Mass of each eligible trash item in one batch (expressed in kg). Please explain how the batch will meet Minimum Batch Requirements described in the challenge rules. |  |
| Length of time (expressed in hours or minutes) to complete one cycle  |  |
| Electricity required for one cycle, including:–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) |  |
| Amount of water (expressed in kg) required for one cycle. |  |
| Type and amount of other inputs required for one cycle. List each additional input and the mass required for one cycle (expressed in kg).  |  |
| Number of crew and time per crew member (expressed in minutes or hours) required to operate one cycle. |  |
| Usable outputs produced by one cycle and amounts of each (expressed in kg). |  |
| Unusable outputs produced by one cycle and amounts of each (expressed in kg).  |  |
| Calculate the Mass Efficiency (%) for one cycle. Mass Efficiency is equal to the mass of the usable output(s) divided by the sum of the mass of the trash item inputs and other inputs, excluding energy consumed. Simulated regolith does not count against Mass Efficiency. If your solution uses simulated regolith, you may exclude it from this calculation. |  |
| Calculate the Energy Efficiency (%) for one cycle. Energy Efficiency (kg/kWh) is equal to the mass of the usable output(s) divided by the energy consumed to produce those usable outputs. |  |

2.3. Milestone Round Schematics *(Recommended length: 3-5 pages)*

Provide schematics for key elements of your solution, including process design, mechanical and fluids schematics, electrical schematics, and assembly-level drawings showing envelopes and key dimensions.

2.4. Milestone Round Master Equipment List *(Recommended length: 1 page)*Use the following EQUIPMENT TABLE to provide a master equipment list, including mass and volume estimates.

EQUIPMENT TABLE

|  |  |  |
| --- | --- | --- |
| **Description of Equipment and Supplier** | **Estimated mass (kg)** | **Estimated volume (cm3)** |
|   |   |   |
|   |   |   |
|   |   |   |
|   |   |   |
|   |   |   |
|   |   |   |
|   |   |   |

2.5. Milestone Round Safety Analysis *(Recommended length: 1 page)*

2.5.1. Identify any potentially hazardous materials or other safety concerns related to your design, concept of operations, or outputs.

2.5.2. Provide a safety analysis addressing pressure vessel systems and material compatibility (if relevant to your solution).

1. Development/Project Plan *(Recommended length: 2 pages)*Describe your plan for developing and building hardware for the Final Round Demonstration. Teams should address the technical steps necessary for hardware development and testing; success criteria for testing; personnel and other resources; and expected timeline/schedule in relation to the Final Round deadlines. Teams may also describe any past experience or future development plans that they believe is relevant to their expected readiness in the Final Round.
2. Risk Assessment *(Recommended length: 1 page)*

Describe the technical and other risks associated with developing your solution in the Final Round. Teams should address any potential supply chain management or long lead items that will be required to demonstrate your solution in the Final Round. For each risk, teams should include an assessment (such as high, medium, low) and your proposed risk mitigation strategy.

1. Development Budget *(Recommended length: 1 page)*

Use the following BUDGET TABLE to estimate the budget necessary to execute your Development Plan in the Final Round. You may add additional rows to the BUDGET TABLE as needed. Please Note: 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. In the Expected funding source(s) column, teams should address whether they will already have funds in place to support work during the Final Round, and if not, how they will secure the necessary funds. Teams may assume Milestone Round prizes in their budget.

BUDGET TABLE

|  |  |  |  |
| --- | --- | --- | --- |
| **Type of cost** | **Description** | **Estimated budget for developing your solution in the Final Round** | **Expected funding source(s)** |
| Materials  |   |   |   |
| Equipment  |   |   |   |
| Lab/testing  |   |   |   |
| Personnel  |   |   |   |
| Travel |   |   |   |
| Admin  |   |   |   |
| Other (as applicable) |  |  |  |