# Appendix B: Competition Level 1 Submission Template

**WATTS ON THE MOON CHALLENGE**

**PHASE 2 COMPETITION LEVEL 1**

**SUBMISSION TEMPLATE**

**INSTRUCTIONS**

* This template must be saved as a PDF and uploaded using the HeroX application portal.
* The total page limit for the submission is 30 pages; Teams must adhere to this limit. A “page” is defined as 8 ½” X 11” size paper with 11-point font (Arial and 1-inch margins), single spaced. Any text included in tables, figures, or captions may be as small as 10-point font. The contents of any pages beyond page 30 of any submission will not be read or evaluated. This instruction section does not count toward the page limit and may be deleted prior to submission. Teams should maintain all numbered section headings in their submission.
* 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.
* You must complete the Team Information section. If the Team Affiliations/Organizations does not apply to your Team, write “None.” If you skip any of these fields, your submission will be returned to be corrected.
* You must answer all questions in the Your Solution section. Any answer that is blank will be deemed incomplete. Teams should not submit answers such as “see previous answer” or “not applicable.” Such answers will be deemed incomplete. Any incomplete question will automatically receive zero points.
* Teams will be evaluated on each criterion on a 0-10 point scale, as described in the judging rubric in [Appendix E](https://www.herox.com/WattsOnTheMoon/resource/922). A total of 100 points is available. Points will be weighted as described below in TABLE 3. To be eligible for a Competition Level 1 award, Teams must receive a minimum score of 60 points (out of 100 points).

TABLE 3.

Scoring in Competition Level 1

|  |  |
| --- | --- |
| **Section** | **Weighting** |
| 1.1. Preliminary Engineering Design | 25% |
| 1.2. Key Analyses and/or Preliminary Test Results | 25% |
| 1.3. Preliminary Schematics | 5% |
| 1.4. Master Equipment List and Mass | 10% |
| 1.5. Safety Analysis | 5% |
| 2.Testing Plan for Competition Level 2 | 15% |
| 3. Development Plan | 5% |
| 4. Risk Assessment | 5% |
| 5. Budget | 5% |
| **Total** | **100%** |

**TEAM INFORMATION SECTION**

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

Team Lead:

Team Affiliations/Organizations (if applicable):

Geographic Location (City and State/Territory):

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.)*

**YOUR SOLUTION SECTION**

1. Solution Design
   1. Preliminary Engineering Design
      1. A rationale for your design approach *(Recommended length: 2 pages)*
      2. Preliminary evidence and analysis predicting performance including efficiency, mass, and specific energy of key components of the system *(Recommended length: 2-4 pages)*
      3. System-level and component-level design specifications for hardware and software; in this section, you should include a description of the methods and solutions to the challenges of surface deployment or set up of your power transmission design under lunar-surface environmental conditions after a successful landing. *(Recommended length: 2 pages)*
      4. Description of how the system and components will address the Phase 2 Technical Requirements section of the rules (which outlines the performance that Teams will be expected to demonstrate in Competition Level 3 testing) *(Recommended length: 2 pages)*
   2. Key Analyses and/or Preliminary Test Results
      1. Summary of concept of operations describing how your solution will address the conceptual load profile in FIGURE 1 *(Recommended length: 2-3 pages)*
      2. Summary of power efficiency analysis and estimate of total system efficiency *(Recommended length: 2-3 pages)*
      3. Summary of thermal analysis that addresses how your solution will tolerate/survive the environmental conditions in FIGURE 1 *(Recommended length: 2-3 pages)*
   3. Preliminary Schematics *(Recommended length: 2 pages)*

Provide preliminary schematics for key elements of your solution (such as power, control, and fluids) and assembly-level CAD models showing envelopes and key dimensions

* 1. Master Equipment List and Mass  
       
     Use the following EQUIPMENT TEMPLATE to provide a draft master equipment list, including mass and volume estimates and descriptions of internal and external interfaces for the anticipated testing in Competition Level 3. *Estimated volume and interfaces will be used to help inform NASA’s testing plan in Competition Level 3 and will not be evaluated by judges. (Recommended length: 1 page)*

EQUIPMENT TEMPLATE

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Evaluated by Judges** | | ***For Informational Purposes Only*** | | |
| **Description of Equipment and Supplier** | **Estimated Total System Mass (kg)** | ***Estimated volume (cm3)*** | ***Internal interfaces*** | ***External interfaces*** |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

* 1. Safety Analysis *(Recommended length: 2 pages)*
     1. Identify any potentially hazardous materials or other safety concerns related to your design and/or its operation that are relevant to testing your solution in a NASA facility in Competition Level 3.
     2. Provide a safety analysis addressing future transport and operation of your solution on the lunar surface, including any interactions with the NASA assets described in the challenge rules and potential interactions with humans.

1. Testing Plan for Competition Level 2. *(Recommended length: 3 pages)*Teams are expected to determine the testing and analysis necessary to demonstrate items under section 2.1 and 2.2 below. NASA expects that testing and analysis will include component-level testing and high-fidelity models and/or analyses. Teams are expected to address each of these performance metrics in your plan and describe in detail the testing or analysis that will be conducted.
   1. To demonstrate feasibility of the design and progress toward performance that will be tested in Competition Level 3:
      1. End-to-end efficiency of any power transmission system
      2. Mass of any power transmission system
      3. Roundtrip efficiency and energy capacity of any energy storage system
      4. Mass of any energy storage system
      5. Operation in temperatures and atmospheric pressures that will be tested in Competition Level 3
   2. To demonstrate critical aspects of the design that, for practical reasons, cannot be tested in Competition Level 3:
      1. Delivery of projected steady-state, maximum power over a 3 km distance between the power source and Load Bank, where the demonstration is either a full-distance test or a combination of a partial-distance test and emulation or analysis of extrapolation to the full distance. Teams demonstrating a full-distance test will receive a bonus in Level 2 scoring.
      2. For energy storage systems, demonstration of 30 charge/discharge cycles 1) in Earth ambient conditions or a colder environment; 2) at a depth of discharge equal to the planned depth of discharge during operations in Competition Level 3 testing; and 3) with no more than 20% loss of energy capacity
      3. Additional performance demonstrations recommended by the Team, if applicable
2. Development Plan *(Recommended length: 1 page)*Describe your plan for further developing your solution during Competition Level 2 and Competition Level 3. Teams should address the technical steps necessary for hardware development; personnel and other resources; and timeline in relation to the Competition Level 2 and Competition Level 3 submission deadlines.
3. Risk Assessment *(Recommended length: 1 page)*

Describe the technical and other risks associated with developing your solution in Competition Level 2 and Competition Level 3. For each risk, Teams should include an assessment (such as high, medium, low) and your proposed risk mitigation strategy.

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

Use the following BUDGET TEMPLATE to describe the budget necessary to execute the plan described in your answer to Section 3. In the “Expected funding sources” column, Teams should address whether you will already have funds in place to support work during Competition Level 2 and Competition Level 3, and if not, how you will secure the necessary funds. You may assume the Competition Level 1 prize purse in your budget.

BUDGET TEMPLATE

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Type of cost** | **Description** | **Necessary budget for Competition Level 2** | **Necessary budget for Competition Level 3** | **Expected funding source(s)** |
| Materials |  |  |  |  |
| Equipment |  |  |  |  |
| Lab/testing |  |  |  |  |
| Personnel |  |  |  |  |
| Other |  |  |  |  |
| Other |  |  |  |  |