

WATTS ON THE MOON CHALLENGE PHASE 2

Appendix F: Competition Level 3 Scoring

In Competition Level 3, Teams will be evaluated and scored based on the performance of their solution in a simulated lunar environment at NASA facilities.

Teams that successfully deliver power¹ under the conditions described in [FIGURE 1](#) for 100% of the timeline in [FIGURE 1](#), will receive a score equal to their Total Effective System Mass, as follows:

$$\text{Total Effective System Mass} = \text{Total System Mass} \textit{ plus Excess Power Mass Penalty}$$

Where:

- **Total System Mass** = The mass of all hardware required to deliver power according to the conditions shown in [FIGURE 1](#) over a distance of 3 km. Specifically in Competition Level 3, the measured weight of hardware submitted for testing in Competition Level 3 may be adjusted to accommodate hardware to demonstrate the full 3 km power transmission distance based on the testing and/or analysis performed in Competition Level 2. See Notes on Total System Mass Adjustments below.
- **Excess Power Mass Penalty**² = (Average Source Power *minus* Average Source Power for a 100% efficient system) *multiplied by* 0.01 kg/W
- **Average Source Power** (W) = Total energy (Wh) provided by the NASA Power Source when it is providing power during the second recharging period (between hours 24 and 30), *divided by* 6 hours.
- **Average Source Power for a 100% efficient system** is estimated to be 1,065 W.

If no Team successfully delivers power under the conditions described in [FIGURE 1](#) for 100% of the timeline in [FIGURE 1](#), then all Teams will receive a score based on their Total Effective System Mass and Power Timeline Performance, as follows:

$$\text{Total Effective System Mass} = \frac{(\text{Total System Mass} \textit{ plus Excess Power Mass Penalty})}{\textit{divided by Power Timeline Performance}}$$

Where:

¹ NASA plans to measure whether Teams have successfully delivered power over the required timeline by measuring power quality. The power quality measurement will occur at a specified connector in the chamber wall, and power quality must stay within the specifications of the NASA Load Bank, including between 24-32 VDC.

² The inefficiency of the transmission and energy storage systems place additional burdens on the power source, causing it to be scaled up. This penalty is meant to account for the additional power source mass that a Team's solution would require to meet the technical challenge.

- **Power Timeline Performance** = The fraction of the full timeline in [FIGURE 1](#) during which power was delivered to the NASA Load Bank within the voltage ranges specified.

Notes on Total System Mass Adjustments

Depending on the characteristics of the solution, Teams may replace elements used to demonstrate, emulate, or analyze the full distance in Competition Level 2 with alternative elements suitable for the much shorter distance in the thermal vacuum chamber. The mass of the alternative elements used in Competition Level 3 testing will be deducted from the total measured hardware mass and replaced by the mass of hardware required to achieve the full 3 km distance as demonstrated and/or analyzed during Competition Level 2.

For example:

- Wireless power transmission solutions may provide different or extra hardware to tailor the energy beam properties for the much shorter distance. The mass of this alternative hardware will be deducted from the total measured hardware mass and replaced by the mass of the hardware required to transmit the beam over a 3 km distance as demonstrated or analyzed during Competition Level 2.
- Wired power solutions may use either a full-length cable or a shorter cable plus a hardware-based emulation of the entire 3 km in Competition Level 3. If a cable plus emulation is used, the mass of cable emulation hardware will be deducted from the total measured hardware mass and replaced by the mass of a 3 km cable as demonstrated or analyzed during Competition Level 2.

Following the calculation of scores, the judging panel will verify the the accuracy of each Team's score and rank Teams from lowest score to highest score. Scores will be whole numbers; decimal points below 0.50 will be rounded down and decimal points of 0.50 or higher will be rounded up.

The grand prize winner will be the Team with the lowest score. The second prize winner will be the Team with the second-lowest score. In the event of a tie, the judging panel will break the tie based on the respective Teams' performance in Competition Level 1 and Competition Level 2.