
# NASA'S WATTS ON THE MOON CHALLENGE

## Phase 2 Instructional Webinar

## April 28th @ Noon CT

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# Agenda

- Welcome, Introductions & Housekeeping
- Introduction to NASA Centennial Challenges
- Watts on the Moon Challenge Overview
- Challenge Guidelines Overview
- Overview of the Challenge Website and Registration
- Open Q & A
- Wrap-Up
- Next Steps

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# Introductions

Monsi Roman
On Detail
NASA Centennial Challenges

John Scott
STMD Principal Technologist
Detailed to NASA HQ

Denise Morris
NASA Centennial Challenges Program Manager, Acting
WOTM Challenge Manager

Rob Button
Subject Matter Expert
Glenn Research Center

Alisa Ferguson
WOTM Supporting Challenge Manager
NASA Centennial Challenges

Jamie Elliott
Challenge Administrator
HeroX

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# Phase 2 Registration and Eligibility

## Eligibility Requirements – U.S. ONLY COMPETITION

- Individuals must be U.S. citizens or permanent residents of the United States and be 18 years of age or older.
- Organizations must be an entity incorporated in and maintaining a primary place of business in the United States.
- Teams must be comprised of otherwise eligible individuals or organizations and led by an otherwise eligible individual or organization.

## Registration

- Any eligible individual or organization may participate in Phase 2. Teams are not required to have participated in Phase 1.
- To register, Teams must either upload the executed Team Agreement or provide the details required for HeroX to prepare and send the agreement, via RightSignature, for execution. To participate in Phase 2, Teams must execute the Team Agreement and other required documents by June 22, 2022 (7 days after the Competition Level 1 submission deadline).



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# Centennial Challenges Program

*Daring you to ask…*

# What if?

Denise Morris Program Manager, Acting

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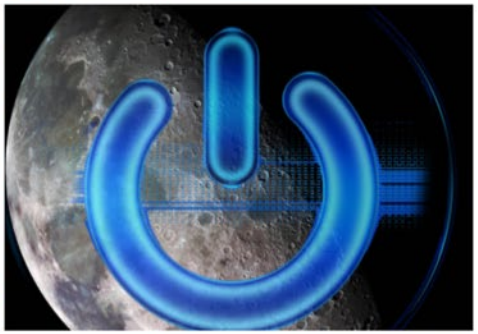

# ABOUT US:

- NASA's first prize program
- Established to conduct prize competitions in support of the Vision for Space Exploration and ongoing NASA programs
- Inspired by Orteig Prize and Ansari X Prize, among others
- Established (per NASA Prize Authority, 51 USC 20144): "to stimulate innovation in basic and applied research, technology development, and prototype demonstration that have the potential for application to the performance of the space and aeronautical activities of the Administration."
  - https://uscode.house.gov/view.xhtml?req=granuleid:USC-prelim-title51-section20144&num=0&edition=prelim
  - First competition opened in 2005

NASA
CENTENNIAL
CHALLENGES



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# NASA Prizes, Challenges, and Crowdsourcing


NASA Solve

- **Centennial Challenges Program**
- NASA Tournament Lab
- Space App
- Citizen Science
- NASA Education
- NASA @ Work

NASA CENTENNIAL CHALLENGES



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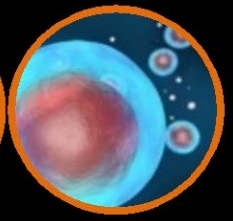
# Centennial Challenges

**3D-Printed Habitat***

KSC

$3,150,000



**Vascular Tissue***

ARC

$500,000

**$CO_2$ Conversion**

ARC

$1,000,000

**Space Robotics***

JSC

$1,900,000

**COMPLETED**

**Cube Quest**

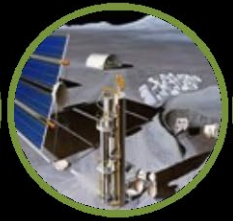
ARC

$5,000,000

**Watts on the Moon**

GRC

(Up to $5 M)



**Break the Ice Lunar**

MSFC

(Up to $3.5 M)

**Deep Space Food***

KSC

(Up to $3 M)

**ACTIVE**

*Competitions supported by Allied Organizations

NASA CENTENNIAL CHALLENGES

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# Centennial Challenge By Numbers

## (2005- 2021)


* We worked with GCD, SBIR, STTR, NIAC, Tipping Points, ACO and CUBES along with TRISH and HEO directorate for our infusions.



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# Challenge Administrators

**NASA Centennial Challenges: Challenge Owner (CCP)**

- ***Challenge Role:*** *Leads challenge development and execution of the competition to ensure that the outcomes meet the overall goals of NASA; provide the NASA prize funds*

**Glenn Research Center/GRC: Technology Lead**

- ***Challenge Role:*** *Technical Lead and Subject Matter Expert; Primary for defining Challenge goals, success criteria, technology and infusion path*

**HeroX: Challenge Contractor**

- ***Challenge Role:*** *Supports the development and implementation of the Challenge; manages the competitor interface including the challenge website and confirmation of eligibility requirements.*

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What if we could light the darkness...on the Moon?
Watts on the Moon video link
www.nasa.gov/wattson

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# CHALLENGE GUIDELINES OVERVIEW

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# Why a Challenge?


- NASA plans to return to the Moon and sustain a longer-term presence that will involve industrial activities and well as human habitation. This will require **continuous, reliable power** at extreme temperatures.

- NASA will need a combination of generation, transmission, and storage technologies. However, NASA has made robust investment and progress on generation technologies—and **this challenge is not focused on power generation**, but on transmission and storage.

- A challenge can incentivize **new innovators and new ideas** that have not already been considered.

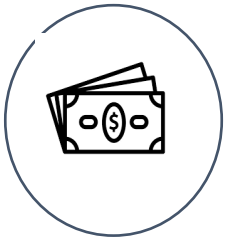
- A challenge can help build an **interdisciplinary ecosystem of innovators** that can help NASA address technical problems now and into the future.

# Phase 2 Overview

Teams can compete in Phase 2 without having competed in Phase 1. **Any eligible team can compete** in Phase 2.

Teams will **design and develop hardware** for testing and evaluation and advance through three levels of competition.

**F**inalists will test performance in **simulated lunar conditions** at NASA facilities to determine the winner.



Total **prize purse** of $4.5M, including two milestone awards (rewarding progress toward technical targets) and a grand prize.



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# Phase 2 Timeline

| Competition Level | Event | Date |
|---|---|---|
| **Competition Level 1 (~6 months)** | Phase 2 opens<br>Competition Level 1 begins | February 23, 2022 |
| | **Registration deadline**<br>**Competition Level 1 submissions due** | **June 15, 2022** |
| | Competition Level 1 winners announced<br>End of Competition Level 1 | August 2022 |
| **Competition Level 2 (~11 months)** | Competition Level 2 submissions due | February 8, 2023 |
| | Competition Level 2 winners announced<br>End of Competition Level 2 | July 2023 |
| **Competition Level 3 (~13 months)** | Competition Level 3 submissions due | April 3, 2024 |
| | Testing at NASA | April – July 2024 |
| | Competition Level 3 winners announced<br>End of Competition Level 3 and Phase 2 | August/September 2024 |



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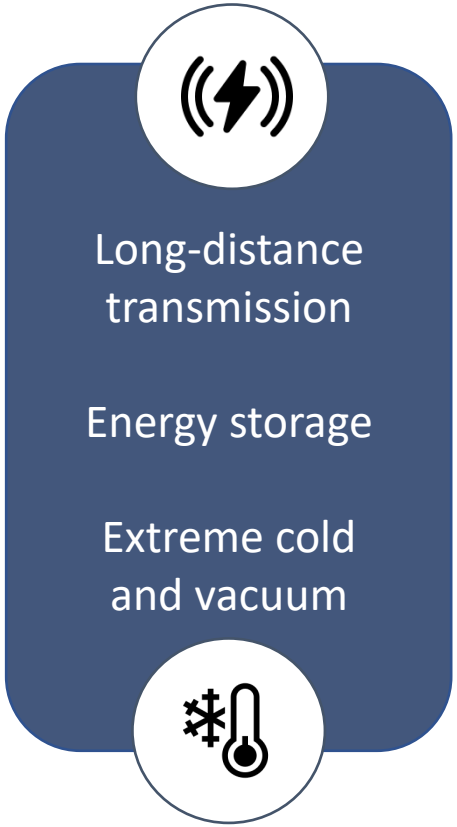
# Phase 2 Technical Focus




- The challenge requires solutions that address **both** power transmission and energy storage
- Teams must demonstrate how their solutions will operate in extreme cold temperatures and the hard vacuum of the Moon.
- For the challenge, we have designed a load profile that teams will address. The load profile assumes that teams draw power from an intermittent power source and deliver power continuously to a load bank.
- Total system mass and total system efficiency are critical criteria for determining the ultimate winners.



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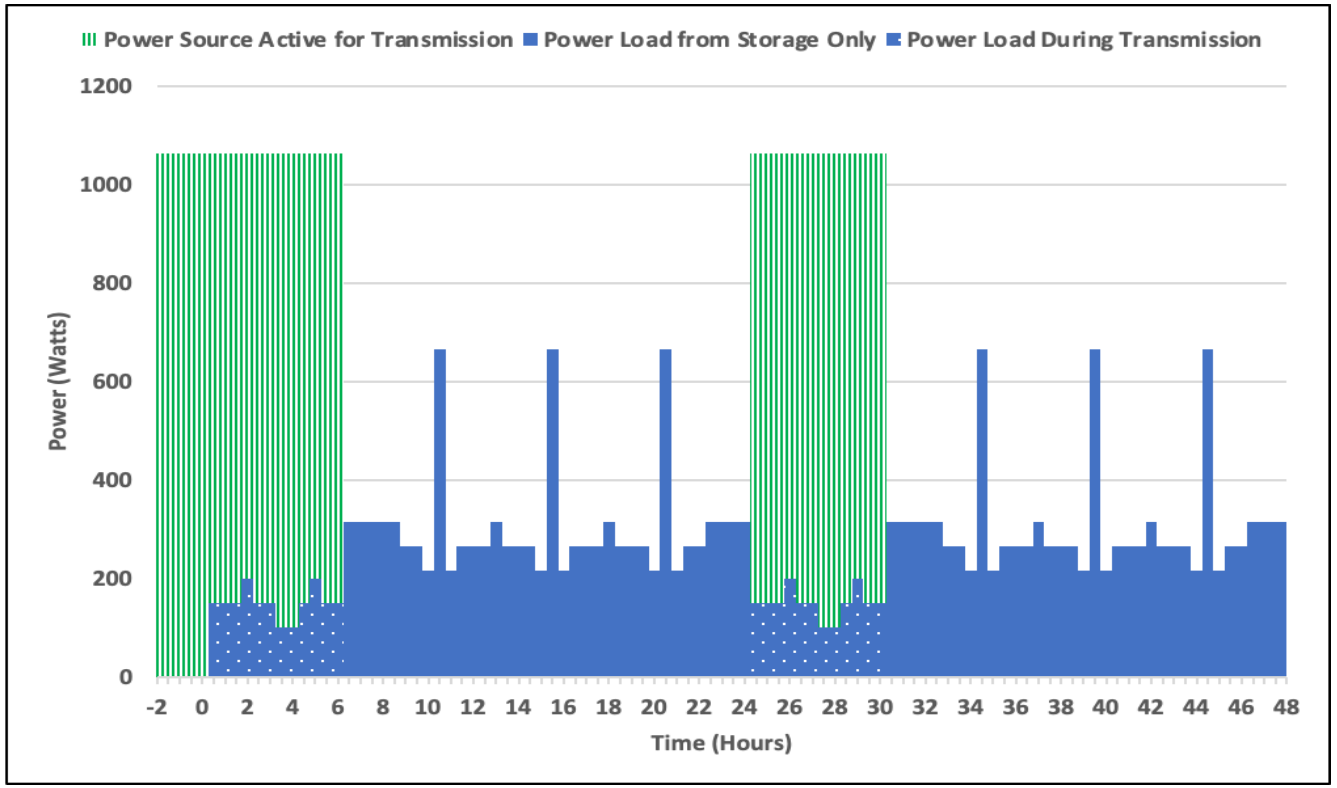
# Phase 2 Load Profile

*Watts on the Moon Challenge Phase 2 Power Timeline*




- Teams must draw all energy used for power delivery and thermal management from the NASA Power Source during the two indicated “Power Source Active for Transmission” periods and provide the indicated power levels to a NASA Load Bank continuously throughout the test (from Time = 0 to Time = 48 hours).
  - Power must be delivered to the load bank at 24-32 VDC.
  - The active power levels shown are equal to the average power transmission level for a 100% efficient solution.
  - Total (stored) energy delivered to the NASA Load Bank during “Power Load from Storage Only” periods is ~5,500 Wh.
  - Maximum allowable power draw from the NASA Power Source is 6,000 W.
- Solutions will be nominally surrounded by a liquid nitrogen cold wall (~77 K), an insulated floor, and a $10^{-3}$ Torr (or lower) vacuum.

# Phase 2 Competition Levels

NASA'S WATTS ON THE MOON CHALLENGE

| Competition Level 1 | Competition Level 2 | Competition Level 3 |
|---|---|---|
| Teams develop detailed engineering design and analyses of their solution, at a level similar to what is required in an engineering Preliminary Design Review (PDR) | Teams develop and demonstrate (through testing and analysis) key components of their solution, at a level similar to what is required in an engineering Critical Design Review (CDR) | Teams will refine their design and submit a full system prototype for testing in a simulated lunar environment at NASA facilities |
| Up to 7 teams chosen to move to Level 2 + receive $200K each | Up to 4 teams chosen to move to Level 3+ receive $400K each | Up to 2 winners<br>1st place – $1M<br>2nd place – $500K |

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# Competition Level 1 Submissions

**REMINDER:**
**Competition Level 1 submissions are due by**
**June 15, 2022, at 5:00PM EDT**

- Teams will develop **detailed engineering design and analyses** of their solution, similar to what would be required in an engineering Preliminary Design Review
- We have provided a **TEMPLATE** for the submission, which you can find on the challenge website. Please use this template and answer all questions!
- The total page limit is **30 PAGES**; any materials over 30 pages will not be read or evaluated.
- We have also provided recommended page lengths for each section of the template; however, these are suggestions, not requirements.



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# Competition Level 1 Judging

| 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%** |

- Up to 100 points are available
- Each section of the submission will be evaluated on a 0-10 point scale. An explanation of this scale can be found in the Challenge Guidelines.
- Teams must receive a **minimum score of 60 points** to be eligible for a Competition Level 1 award.
- Up to 7 teams will be chosen to receive a milestone award and move onto Competition Level 2



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# Competition Level 2 Submissions

- In Competition Level 2, teams will **develop and demonstrate key components of their solution**, similar to what would be required in an engineering Critical Design Review.

- Like in Competition Level 1, we have provided a **TEMPLATE** for the submission, which you can find on the challenge website. Please use this template and answer all questions!

- The total page limit is **30 PAGES**; any materials over 30 pages will not be read or evaluated. We have also provided recommended page lengths for each section of the template; however, these are suggestions, not requirements.

- Following the Competition Level 2 submission deadline, NASA will send an observer group to conduct a **site visit**. The observer group will validate the team's testing and analyses (as provided in the submission), ask any questions necessary to understand and assess the team's performance, record their findings, and submit their findings to the judging panel.



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# Competition Level 2 Judging

- Competition Level 2 judging will take into account both:
  - The materials that teams provide using the **submission template**; and
  - The evaluation and performance results from the **site visit**.

- A detailed table regarding scoring and the weighting of criteria can be found in the Challenge Guidelines.

- Up to 4 teams will be chosen to receive a milestone award and move onto Competition Level 3



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# Competition Level 3 Submissions

- Teams will refine their designs and submit a **full system prototype** for testing in a **simulated lunar environment** at NASA facilities

- Before teams submit hardware, teams must complete a **safety review**. A NASA committee must approve the safety of each team's solution before it can be delivered to any NASA facility. In addition, before testing commences, NASA will conduct a **test readiness review**.

- NASA will evaluate each solution by testing its ability to deliver power to loads as described in the Load Profile

- Specifically, NASA intends to use a **thermal vacuum chamber** to simulate the temperatures and atmospheric pressure described in the Load Profile



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# Competition Level 3 Judging

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

**Total Effective System Mass =**
**Total System Mass *plus* Excess-Power Mass Penalty**

If no team successfully delivers power under the conditions described for 100% of the timeline, then all teams will receive a score based on their Total Effective System Mass and Power Timeline Performance, as follows:

**Total Effective System Mass =**
**(Total System Mass *plus* Excess Power Mass Penalty)**
***divided by* Power Timeline Performance**

Following the calculation of scores, the Judging Panel will verify each team's score and rank teams from lowest score to highest. Scores will be whole numbers.



JS

# Competition Level 3 Testing Plan

- Requires independent demonstration of servicing power loads from both stored energy and transmitted power.
- Requiring management of limited-duration transmitted power to simultaneously supply power to continuing loads and to recharge balances the challenge between power transmission and energy storage.
- Extended duration load servicing of 5500 W-hours of stored energy while isolated from transmitted power strikes a balance between energy storage alternatives.
- Energy storage demonstration begins with charging from transmitted power while servicing a load – eliminates 'primary battery' solutions.
- Shorter periods of active power transmission sufficiently demonstrate transmission capacity during and after thermal equilibration with the surroundings.
- Servicing a fluctuating load demand simulates realistic lunar operational and environmental dynamics.
- Any power source and load timeline would encourage integrated solutions optimized to timeline details; but the required storage and transmission characteristics in this timeline address NASA power system gaps.



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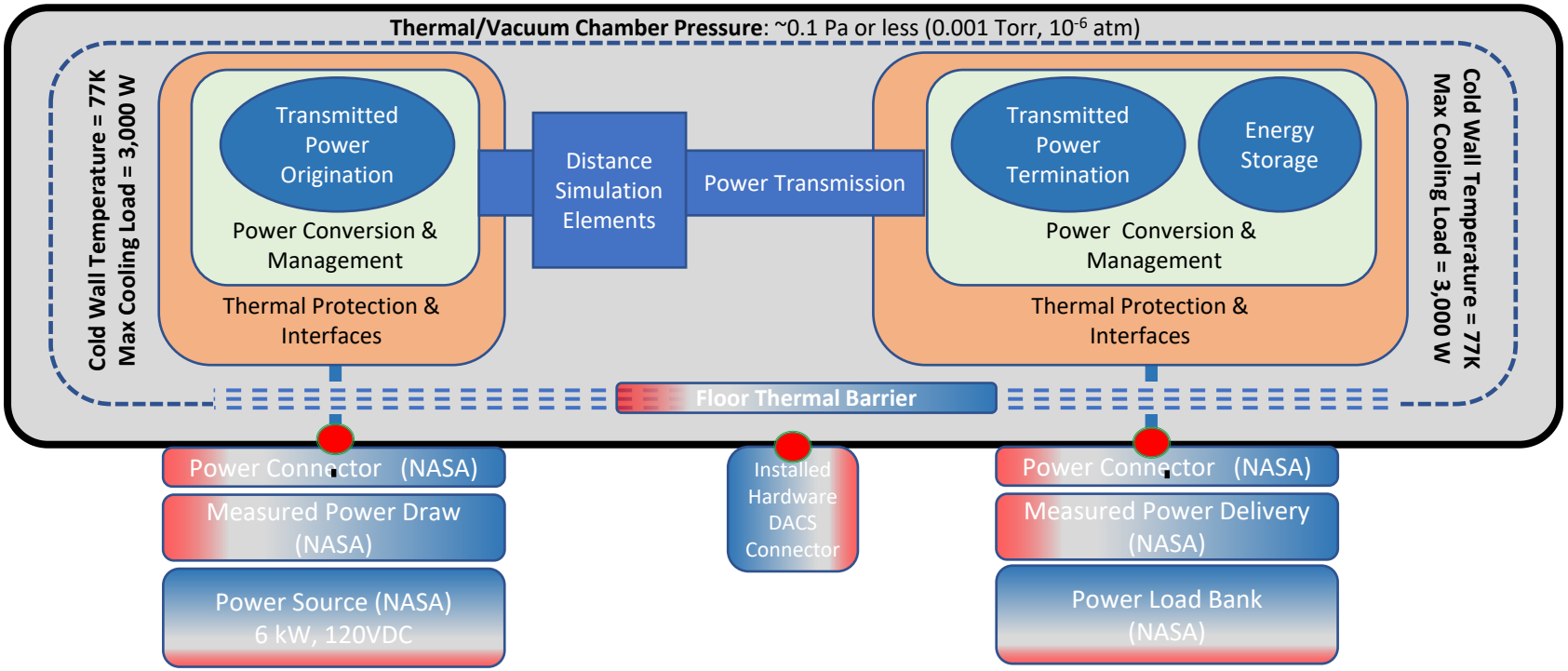
# Competition Level 3 Testing Plan

*(Installation and Test Configuration)*




- Challenge Team solutions are to be installed into a Thermal/Vacuum chamber after being weighed to determine the Total System Mass, including all mass between the indicated NASA power connections.
  - Energy storage elements are installed at no higher than 50% level of charge.
  - The solutions are nominally surrounded by a liquid nitrogen cold wall (~77k), an insulated floor, and a $10^{-3}$ Torr (or lower) vacuum.
  - Solutions are not permitted to establish any thermally conductive contact with the chamber other than the insulated floor and the indicated power connectors.
  - Power drawn from the NASA Power Source is measured and limited to 6,000 W; power delivered to the NASA Power Load Bank is also measured.
- A single multi-pin connector is provided for use by teams to exchange high-level commands and data logging with the installed solution

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# Phase 2 Challenge Rules Updates

**Please note that the Challenge Rules were updated on March 24, 2022, for a correction to the vacuum figure**
**In the Forum, we clarified a question about system mass March 2, 2022**

**You can view and download the Challenge Rules at the Challenge website:**

**https://www.herox.com/WattsOnTheMoon/guidelines**

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# OVERVIEW OF THE CHALLENGE WEBSITE

# I'm Eligible – Now What?

To register for the challenge:

1. Designate a **Team Leader** and **create a team** on HeroX.

2. Submit completed **Competitor Documents** to HeroX.
    1. Option 1: HeroX sends via RightSignature
        a. Submit "Team Details" template with your submission
        b. HeroX will send customized RightSignature documents for completion
        c. Execute the documents no later than June 22, 2022

    2. Option 2: Upload a zip file of all executed documents with your submission
        a. Not recommended due to the likelihood of errors).

3. Teams selected for an award will be required to provide **proof** of citizenship/permanent residency, proof of primary place of business, proof of incorporation, and/or proof of student visa. Proof must be provided **within 3 business days** to be eligible for an award.

More details at www.herox.com/WattsOnTheMoon/176-registration

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# OPEN Q&A

***SUBMIT YOUR QUESTIONS VIA THE Q&A CHAT BOX***

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# Next Steps

- ✓ **COMPLETE THE REQUIRED PAPERWORK AND SUBMIT THE SUPPORTING DOCUMENTS AND FORMS BY: 5:00PM EDT June 15, 2022**

- ✓ **STAY CONNECTED:**
  - ✓ *Visit the Community Forum*
  - ✓ *Follow the Challenge on Social Media*

@NASAPrize

NASAPrize

/NASACC

  - ✓ *View this webinar's recording at https://www.herox.com/WattsOnTheMoon*

**QUESTIONS?**

Email: gethelp@herox.com

Post in the Challenge Forum

***NOTE:*** *Any questions or inquiries sent to any other contact or sent directly to any of the Challenge Administrators will not be answered. This includes NASA, NASA Centennial Challenges, NASA Glenn Research Center, and NASA Tournament Labs.*

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NASA'S WATTS ON THE MOON CHALLENGE

# THANK YOU!

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