Lunar Surface Innovation
CONSORTIUM

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LSIC Newsletter

The Lunar Surface Innovation Consortium is administered by the Johns Hopkins Applied Physics Laboratory and operates in collaboration with the NASA Space Technology Mission Directorate under the Lunar Surface Innovation Initiative. Its purpose is to harness the creativity, energy and resources of the nation to help NASA keep the United States at the forefront of Lunar exploration. To find out more, sign up to participate or access past additions of this newsletter, please visit lsic.jhuapl.edu.

Director's Corner

Hello LSIC Family!

This is my first official month as director, and we have all been busy! From planning our upcoming Fall Meeting to the two workshops we have recently held, I want to start by thanking everyone for all the input and ideas.

The Lunar Proving Grounds Definition Workshop was held July 12–13 and was a tremendous success! While we are still compiling all the takeaways from this event, the initial feedback is clear. There needs to be an organization of facility availability, capability, and demand. Categorization of facilities can help reveal where there are future critical bottlenecks and single points of failure. The community is seeking details of what is "good enough" to verify, validate, and certify testing elements. There is a clear need for guidelines to develop testing pathways for TRL advancement, V&V for flight, and accelerated lifetime testing. After we comb through the hundreds of live and virtual post-its, we will share all the great insight everyone provided!

The Power System Reliability Workshop was held July 26–27. As this issue of the Newsletter is hot off the press, I'm not yet ready to talk key points. Additionally, keep the Autonomy Workshop on your radar for August 21–22. How can autonomy positively impact and shape operations on the surface of the Moon? Registration is open!

Last but certainly not least is the LSIC Fall Meeting. Abstract submission remains open through August 18! Mark your calendars for October 10–11, when we will focus on what it takes to develop a resilient Lunar infrastructure at the South Pole of the Moon. The Transition to Commercial Lunar Operations Workshop follows this on October 12 at the same location, and online. Details for this event will follow.

Let's say it all together, "Teamwork makes the dream work!" Let's keep pushing.

To the Moon!

Jamie Porter
Director, Lunar Surface Innovation Consortium
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Focus Areas

Monthly Telecon Schedule

Dust Mitigation
Third Thursdays at 12 PM Eastern

Excavation & Construction
Last Wednesdays at 2 PM Eastern

Extreme Access
Second Thursdays at 3 PM Eastern

Extreme Environments
Second Tuesdays at 3 PM Eastern

In Situ Resource Utilization
Third Wednesdays at 3 PM Eastern

Interoperability
First Wednesdays at 1 PM Eastern

Lunar Simulants
Second Thursdays at 1 PM Eastern

Lunar Surface Innovation CONSORTIUM

Surface Power
Fourth Thursdays at 11 AM Eastern

LSIC General Updates

Save the Date: Autonomy Workshop, August 21–22

The Extreme Access and Excavation & Construction Focus Groups will host a virtual Autonomy Workshop on August 21–22.

The workshop's panel discussions, Q&A sessions, and breakout groups will give the Lunar community the opportunity to exchange ideas on autonomy, as well as identify technology gaps and use cases for establishing a sustainable presence on the Moon and Mars.

Register on the LSIC website by August 8. We hope to see you there!

Additional Upcoming Meetings

- 2023 LSIC Fall Meeting, October 10–11 (hybrid)
  Hosted by Community College of Allegheny County, Pittsburgh, PA
- Transition to Commercial Lunar Operations, October 12 (hybrid)
  Hosted by Community College of Allegheny County, Pittsburgh, PA
- 2024 LSIC Spring Meeting, Week of April 22, 2024 (hybrid)
  Johns Hopkins Applied Physics Laboratory, Kossiakoff Center, Laurel, MD

LSIC harnesses the creativity, energy, and resources of the nation to help NASA keep the United States at the forefront of lunar exploration. LSIC operates in collaboration with the NASA Space Technology Mission Directorate under the Lunar Surface Innovation Initiative, fostering communications and collaboration among academia, industry, non-profits, and government. Visit http://lsic.jhuapl.edu for more information.

Focus and Working Group Updates

Dust Mitigation

The Dust Mitigation (DM) Focus Group held its monthly meeting on July 20. This meeting continued on the topic of "Lunar Simulants" and featured a technology presentation by Lucas Weber (Chief Engineer, Exolith Lab) on "Developing a Large-Scale Lunar Regolith Test Bin with Gravity Offload Capabilities." In addition to Q&A and discussion on lunar simulants, we had a brief overview of monthly LSIC updates, upcoming opportunities, and workshops; and initial takeaways from the Lunar Proving Grounds Definition Workshop.

You can view the recording, slides, and notes from July's DM Focus Group meeting and previous meetings on our LSIC Dust Mitigation Focus Group page on the LSIC website.

The next DM Focus Group meeting will be held on Thursday, August 17, at 12:00 p.m. EST. The meeting will include featured technology presentations along with a discussion session. We look forward to seeing you then!

Excavation & Construction

In July, the Excavation and Construction (E&C) Focus Group hosted a meeting highlighting talks that focused on "Excavation & Construction Insights" delivered by speakers from three organizations. The three presenters were Steve Indyk (Director, Space Systems, Honeybee Robotics); Yuto Nakanishi (Chief Robotics Officer, GITAI); and Jared Long-Fox (Chief Scientist, Exolith Lab).

Extreme Access

It has been an informative month for the Extreme Access (EA) Focus Group with some insightful speakers from the industry. Our communications subgroup meeting featured Dr. Alberto Montilla (Spatiam) delivering a presentation on "Delay Tolerant Networking (DTN) Services for Lunar Missions." Our Autonomy subgroup hosted Dr. Ryohei Ueda (Software/GITIA) discussing GITAI Technologies.

The EA Focus Group is co-hosting an Autonomy Workshop with the E&C Focus Group in a virtual setting on August 21–22. Registration for this workshop is free and can be done here on the LSIC website. The objective for the workshop is to gather the Lunar community to exchange ideas on autonomy and how it may support an enduring presence on the Moon and NASA's Moon-to-Mars objectives. We aim to explore emerging autonomy technologies that could enable or enhance mission capabilities, reduce mission risk, and reduce mission cost. We would also like everyone to have the opportunity to identify potential collaborations, partnerships, or linkages involving government, industry, and/or academia that could enable these technologies. Panel discussions featuring experts from industry, academia, and NASA will explore autonomy-related themes and foster stakeholder interactions. Workshop participants will participate in Q&A and breakout sessions to discuss how advanced autonomy can impact operations, identify gaps in technology development to meet mission needs, and propose methods to infuse beneficial technologies into the larger autonomous systems ecosystem. The deadline to register is August 8! We hope to see you there!

Extreme Environments

The Extreme Environments (EE) Focus Group's August monthly meeting (Tuesday, August 8, at 3:00 p.m. EST) will be focused on the thermal environment. Kurt Gonter (APL) will speak on thermal engineering implications of the unique environment on the lunar surface. Please join us in the discussion of this important subject, and bring some questions for our speaker and community! We will be announcing group and subgroup monthly meetings with emails and LinkedIn posts. Please be sure to check those out and email us if you need any login information! With the exception of External Hazards, all EE subgroups will hold their August monthly meetings.

We are still looking for an External Hazards subgroup lead. If interested, please email us at Facilitator_ExtremeEnvironments@jhuapl.edu. For more information on all EE monthly meetings, feel free to access the LSIC Extreme Environments page. We look forward to your attendance and participation!

In Situ Resource Utilization

July's In Situ Resource Utilization (ISRU) Focus Group telecon was canceled to assist in reducing meeting fatigue due to the LSIC Lunar Proving Grounds Definition Workshop, which occurred the week before the ISRU meeting was to take place. In July the ISRU Focus Group facilitators were hard at work preparing for and supporting the LSIC Lunar Proving Grounds Definition Workshop! We have already begun preparing a report on takeaways from the workshop, and a summary of the workshop is being shared with the other focus groups during their monthly meetings.

Looking forward to August, the ISRU Focus Group will host an extended telecon with all seven winners of the 2023 BIG Idea Challenge, in which university teams were selected to further develop their technologies to support a future metal production pipeline on the Moon.

The seven teams that will be represented at the August ISRU monthly telecon are:

- Colorado School of Mines
- Massachusetts Institute of Technology with Honeybee Robotics
- Missouri University of Science and Technology
- Northwestern University with Wearifi, Inc.
- Pennsylvania State University with RFHIC and Jacobs Space Exploration Group
- University of North Texas with Advanced Materials and Manufacturing Processes Institute, UNT, Enabled Engineering
- University of Utah with Powder Metallurgy Research Laboratory

More information on the teams and their technologies can be found on the finalist website. The extended telecon will run approximately 1.5 hours, and may extend to 2 hours if the post-presentation discussions and excitement continue!

Surface Power

The Surface Power (SP) Focus Group conducted the Surface Power Reliability Workshop on July 26–27. Day 1 featured talks on basic reliability terminology, NASA's perspective on reliability, and terrestrial power grid analogues. The workshop opened with a talk from Clay Smith (APL) that defined reliability and ensured participants were on the same page for the remainder of the workshop. The next talk from John Scott (Principal Technologist for Power and Energy Storage, NASA STMD) called on the community to establish power quality and reliability standards, as well as identify and develop common tools that the LSIC community can use to verify component and system reliability compliance. Subsequent presentations from Blanca Lara (NASA EHP) and Roger Boyer (Artemis Safety and Mission Assurance Office, NASA) provided valuable context for what the human spaceflight program requires from its human-rated landing systems. A panel featuring experts who worked on the International Space Station and other NASA heritage power systems discussed how NASA has designed reliable power systems to date. A second panel on terrestrial approaches to power produced valuable insights on how the U.S. Navy ensures safe and reliable submarine operation and how commercial power grids and remote microgrids for both U.S. Navy island bases and the civilian Antarctic science station approach reliability. Day 1 finished with breakout sessions; participants were placed into parallel tracks to discuss the reliability of individual power grid components (generation, transmission, or storage) and then discussed pitfalls with combining these components effectively.

Day 2 opened with a panel featuring representatives from Astrobotic, Honeybee Robotics, Lockheed Martin, and Westinghouse. Panel members discussed reliability of Vertical Solar Array Technologies (VSATs) and Fission Surface Power (FSP), and each of the companies provided their vision for how the reliability of the grid could be ensured. The remainder of the day consisted of talks from the community on their technologies and how they fit into a reliable lunar power grid.

The SP Focus Group's next monthly telecon on August 24 will feature Alex Miller (ThermAvant Technologies). ThermAvant has been working under a NASA Phase II SBIR to develop an "intermediate-temperature, high-capacity Oscillating Heat Pipe embedded radiator panel that will significantly improve the size, weight, and power density of a future kW-class FSP system."

Interoperability Working Group

The Interoperability Working Group hopes that you enjoyed the Power System Reliability Workshop on July 26 and 27. Save the date! On September 28 at 11:00 a.m. EST, the Surface Power Focus Group and the Interoperability Working Group will be joining forces for a joint telecon on the DoD/US Army Tactical Microgrid Communications and Control Standard.

Lunar Simulants Working Group

Things were somewhat quiet in the Lunar Simulants (LS) Working Group in July, but we continue to add members to our listserv. If you are interested in being informed about future talks in our Speaker Series, please email our LSWG team (LSIC-Simulants@jhuapl.edu) so that you can be added to our list too. We are also interested in hearing about your simulant-related research and are accepting topic suggestions that you'd like to hear more about. If you would like to volunteer to be a speaker or have an idea for a topic that you'd like covered or a speaker you'd like to hear, please email us! The recording of our June speaker is posted on the LS Working Group page. Dr. Doug Rickman (Senior Scientist, NASA) spoke on "The Art of Simplification: Making the choices that allow simulants to be made, chosen, and used."

Finally, we continue to monitor the LSIC Lunar Simulant User Needs Survey, which helps us to advise NASA on current and upcoming simulants needs.

Feature Article

LSIC Lunar Proving Grounds Definition Workshop

By: Erin Copland

On July 12–13, LSIC hosted the Lunar Proving Grounds Definition Workshop at APL in Laurel, MD.

The goal of this workshop was to explore the requirements, capabilities, and facilities needed for testing hardware destined for the Moon. Specific objectives included defining the role of Lunar proving grounds (LPGs); exploring the needs, attributes, and performance capabilities of LPGs; and identifying the logistics necessary to implement LPGs.

More than 300 attendees gathered in person and online over the two days. Participants from NASA, academia, and industry discussed possible manifestations of LPGs as well as the technical and programmatic needs to achieve system-of-systems testing in pursuit of an enduring Lunar presence.

The workshop was conducted in a hybrid format, with questions being taken both in person and through an online app that also allowed participants to vote in polls or prioritize questions for panelists to answer. Both virtual and in-person attendees also had the opportunity to separate into breakout groups during discussion sessions, reconvening afterward to present the results of their discussions with the larger group.

Michelle Munk (NASA Space Technology Mission Directorate [STMD] Acting Chief Architect) provided the keynote address on the first day, exploring the motivations for building LPGs and putting these motivations in the context of NASA's Moon to Mars objectives.

"We want to move towards sustained human presence and exploration throughout the Solar System," Munk said. "We have a very lofty goal here."

The keynote address was followed by a kickoff discussion around the question "What is an LPG to you?" Participants were able to reflect on existing capabilities—such as current facilities that exist in virtual and physical spaces, both within the United States and internationally—and to envision unique constructs of an LPG.

That afternoon our featured panel explored what capabilities and features a proving ground needs to possess. Panelists included:

- Miranda Cooter (Aerospace Engineer, NASA),
- Robert Mueller (Senior Technologist, NASA),
- Paul van Susante (Assist. Professor, Mechanical Engineering, Michigan Technological University),
- Sam Ximenes (Space Architect, Astroport Space Technologies, Inc.),
- Michael Zemba (Communications Engineer, NASA).

The panelists noted concerns surrounding communications capabilities, Lunar surface lighting, necessary architecture, and definitions of terms.

Following this panel, attendees broke out into groups to discuss potential barriers to—and pathways toward—meeting the needs the panelists discussed. Participants in these groups noted issues surrounding the financial and practical costs of LPGs, fidelity and scalability, collaboration between teams and facilities, access to facilities, and standardized power systems, among others.

The next day featured another panel exploring the attributes needed to work with hardware providers. Panelists included:

- Jnaneshwar Das (Research Assistant Professor, Arizona State University),
- Anne Esbek (Space Business Development Manager, Bechtel National, Inc.),
- Erik Franks (Founder and CEO, Cislune, Inc.),
- Stephen Indyk (Director of Space Systems, Honeybee Robotics),
- Maneesh Verma (Robotics Lead, Stellar Space Industries).

Panelists discussed issues that included integration of technologies and legal agreements surrounding intellectual property and operations.

The follow-up discussion after the second panel involved attendees breaking into different groups to cover logistical characteristics that technology developers desire in an LPG. Participants noted that some needs included cooperation between facilities, standardized interfaces, transparency and ease of access to LPGs coupled with entry criteria, determination of which organizations manage the LPGs, and the definition of terms surrounding facilities, standards and components.

> ***"We want to move towards sustained human presence and exploration throughout the Solar System."***
>
> ***—Michelle Munk, Acting Chief Architect, NASA STMD***

The workshop closed with an overview of the key takeaways and next steps for the community, which included:

- An LPG should focus on integration, validation, lifecycle testing, and humans-in-the-loop. An LPG is critical for technology needed to enable sustained presence and operational validation.
- An LPG should include interoperable infrastructure representative of the operational space.
- Deconflicted and coordinated facilities can perform much of the component-level testing in advance of the need for an LPG, while reducing administrative burden and building efficiencies.
- Digital engineering tools can meet a subset of LPG elements, but the appropriate technologies and environments must be detailed.
- An LPG should have a pathway for international access to facilities, which should be considered during planning.

A longer and more detailed report will be presented at the Accelerating Space Commerce, Exploration, and New Discovery (ASCEND) Conference, to be held October 23–25 in Las Vegas, NV.

Visit the LSIC Lunar Proving Grounds Definition Workshop page for more information.

Member Spotlight: Nevada National Security Site

By: Michael Buckley

More than 50 years after Apollo crews last roamed the sands of the Nevada Test Site to prepare for a geological expedition across the Lunar landscape, engineers donning equipment simulating the spacesuits tomorrow's astronauts will wear as part of the Artemis III mission stepped through a series of similar equipment trials.

Engineers conduct a simulated EVA at NNSS in May. Joint NASA-NNSS exercises examined technologies and techniques the Artemis astronauts will use on the Moon, including the challenges of operating in low-light conditions. The 150-foot Icecap tower serves as a stand-in for the SpaceX Starship that will deliver astronauts to the lunar surface. (Credit: NNSS)

The mid-May exercises were an interesting connection between past and present, with glimpses of the future role this facility—now known as the Nevada National Security Site (NNSS)—is beginning to again play a role in the nation's drive to send humans back to explore, work, and live on the Moon.

"This was very much a fact-finding mission for NASA and for us," said Nick Downs, senior scientist for geoscience operations at NNSS. "We could walk through various mission scenarios in a facility that's full size, and that really got people excited. To see activity like this makes it real … it's not theoretical anymore, and we're getting closer to actually putting people back on the Moon."

Located in the southern Nevada desert and covering approximately 1,375 square miles—larger than the state of Rhode Island—NNSS is one of the largest restricted-access areas in the United States. NNSS was established in the early 1950s as a proving ground for the nation's nuclear development and deterrence programs. Today, with its range of indoor, outdoor, and underground testing and experimentation sites, it supports the National Nuclear Security Administration, various national defense and national security research and development programs, as well as vital programs of other federal agencies.

Of particular interest to NASA are the NNSS sites strewn with craters—ranging in size from several feet to hundreds of yards across—remnants of blast tests from decades ago that resemble the battered Lunar landscape. The latest exercise focused on testing suits and tools for the Artemis program. Wearing contraptions that restricted their motion to simulate what astronauts would experience on the Moon, engineers conducted four extravehicular activities (EVAs) on paths ranging from one to three miles.

"We're very open-minded to what can be done out here. With a lot of teamwork, we want to turn the Nevada National Security Site into a full-scale base where people can test and train for Lunar and Martian exploration."

– Nick Downs, NNSS senior scientist

One EVA was conducted at night, during which NNSS set up bright spotlights to simulate the low-angle lighting conditions and shadows that would blanket the craters astronauts will explore near the Lunar South Pole. Activity also took place near the Icecap Tower—once used to place underground nuclear devices—which, at about 150 feet tall and 30 feet in diameter, resembles the SpaceX Starship human landing system that will deliver the actual astronauts.

"It's a nice analog to have observers at the top of Icecap like an observer that would be on Starship, with astronauts on an EVA several kilometers away," Downs said. "It helps the NASA teams to better understand how the observers in the ship are going to guide the astronauts going in and out of the craters, or maintain communications when they lose line-of-sight."

In May, NASA and Nevada National Security Site engineers and scientists teamed up at NNSS to test technologies and techniques the Artemis astronauts will employ on the Moon. (Credit: NNSS)

Downs said NNSS aims to host similar but gradually more complex NASA exercises at least once a year, folding in activity such as robotic or astronaut-driven rovers. Environmental analyses and work are underway to manage the brush and vegetation on the site, specifically to enhance the authenticity of the test areas. "We take stewardship of our natural resources extremely seriously," he said. "It definitely takes away from the [lunarscape] realism when you're stepping over sage brush, so that's a priority in terms of our infrastructure improvements."

Coming off the Lunar Proving Grounds Definition Workshop in July, Downs sees NNSS as part of a larger network of sites that NASA, LSIC members, and other space organizations, institutions, and companies will eventually tap for testing space exploration technologies and techniques. For support, NNSS has full teams of engineers and scientists with wide-ranging expertise and experience, as well as connections to the national laboratories often located nearby.

"We're very open-minded to what can be done out here," he said. "With a lot of teamwork, we want to turn the Nevada National Security Site into a full-scale base where people can test and train for Lunar and Martian exploration."

Learn more about the Nevada National Security Site at www.nnss.gov. For information on testing possibilities, contact NSPG@nv.doe.gov.

NASA and Community News

NASA Partners with American Companies on Key Moon, Exploration Tech

07/25/2023 \\ NASA \\ Sarah Frazier

https://www.nasa.gov/press-release/nasa-partners-with-american-companies-on-key-moon-exploration-tech

2023 NASA Tipping Point Selections

07/24/2023 \\ NASA \\ Loura Hall

https://www.nasa.gov/directorates/spacetech/solicitations/tipping_points/2023_selections

SpaceX rolls Starship Super Heavy booster back to the pad ahead of next launch

07/22/2023 \\ Space.com \\ Josh Dinner

https://www.space.com/starship-super-heavy-rollout-photos-july-2023

NASA plans for Lunar fission power systems face fiscal challenges

07/20/2023 \\ Space News \\ Jeff Foust

https://spacenews.com/nasa-plans-for-lunar-fission-power-systems-face-fiscal-challenges/

House and Senate appropriators cut NASA's budget

07/14/2023 \\ Space News \\ Jeff Foust

https://spacenews.com/house-and-senate-appropriators-cut-nasas-budget/

Moon Monday #135: India set to launch Chandrayaan 3, an overview of Chang'e 5 science, and more

07/10/2023 \\ Moon Monday \\ Jatan Mehta

https://blog.jatan.space/p/moon-monday-issue-135

Morphing NASA robot could someday walk, fly and drive over alien planets

07/07/2023 \\ Space.com \\ Josh Dinner

https://www.space.com/nasa-jpl-morphobot-robot

GITAI USA has successfully completed significant countermeasures for the Lunar environment

07/05/2023 \\ GITAI \\ Sho Nakanose

https://gitai.tech/2023/07/05/gitai-usa-has-successfully-completed-significant-countermeasures-for-the-lunar-environment/

Funding Opportunities

Tech Development Opportunities

- **NSF SBIR and STTR**

  NSF recommends treating the submission window like a deadline, but you can submit anytime within a year of receiving an official invitation from NSF. (NSF uses submission windows to help gather and review proposals, but sometimes proposals are reviewed as they are received.) Remaining window: July 6 – November 1, 2023.

- **NASA Innovation Corps Pilot**

  Proposals may be submitted at any time through July 22, 2022, but applications will be reviewed at intervals on the following dates: September 16, 2022; November 17, 2022; and January 20, 2023.

- **NASA Suborbital/Hosted Orbital Flight and Payload integration Services 4 (FO IDIQ 4)**

  Offers Due: August 28, 2023.

- **Technology Advancement Utilizing Suborbital and Orbital Flight Opportunities "TechFlights"**

  Full Proposals Due: October 4, 2023.

- **"Fission Surface Power Advanced Closed Brayton Convertor (FSP-ACBC) system" as an Appendix to the "Space Technology Research, Development, Demonstration, and Infusion"**

  Inactive Date: July 1, 2024.

Student Tech Opportunities/Competitions

- **NASA's 2024 BIG Idea Challenge: Inflatable Systems for Lunar Operations (Theme Preview)**

  The Breakthrough, Innovative, & Game-changing (BIG) Idea Challenge is a collegiate-level design competition sponsored by NASA and managed in partnership by the National Institute of Aerospace (NIA) and APL. To participate, teams of ~5-25 students will submit proposals on concepts for a wide range of solutions for inflatable technologies, structures, and systems for Lunar operations. Selected teams will receive up to $180,000 to build and test their proposed inflatable solutions, then will present their test results to a panel of NASA and industry experts at the BIG Idea Forum in November 2024.

  Notice of Intent Deadline: September 30, 2023

  Proposal Deadline: January 23, 2024

Future Solicitations and Opportunities

- **NASA Innovative Advanced Concepts (NIAC) 2024 Phase I Call for Proposals**

  The NIAC program supports visionary research ideas through multiple progressive phases of study. Phase I studies are nine-month efforts to explore the overall viability and advance the technology readiness level (TRL). Eligible recipients of Phase I awards can propose for a follow-on Phase II study.