

# Report from LSIC ISRU Monthly Meeting

*June 2020*

## Notes From Discussion

- Technical topics discussed
  - Metal extraction
  - Water leads, O<sub>2</sub> follows. But O<sub>2</sub> extraction is more mature than H<sub>2</sub>O—help NASA learn to struggle with that
  - Water from polar regions different from getting oxygen from everywhere
  - Need guidance on parameters for what power and resource reserves are needed
- Communications Discussion
  - Meeting platform
    - Alternatives suggested, Zoom is current chosen method
  - Email plan
    - Separate email addresses for O<sub>2</sub> and H<sub>2</sub>O (90%--but other volatiles at polls)
  - Collaboration platform
    - Planning to go with Slack, alternatives suggested (see notes in “From Chat” for add’l details)
- Group structure
  - O<sub>2</sub> and H<sub>2</sub>O subgroups
    - Need to avoid ‘over-fragmentation’ even when drilling down into separate topics
    - Consider swapping between meetings (one week with H<sub>2</sub>O, one week with O<sub>2</sub>)
  - For those with diverse interests recommended considering joining (even passively) the Excavation & Construction focus group (or others) for cross-pollination
- Asked group for feedback on:
  - What do they want to get from focus groups?
  - What should our year 1 goal be?
- Future plans:
  - NASA will present in next month’s meeting
  - Will share opportunities for funding with members as they are identified
- Infrastructural questions
  - Design ISRU around re-fueling Blue Moon?
  - Engineers need clear requirements—Dennis Wingo. Level 1 requirements. Breakdown into sub-requirements. But they all fall out of level 1.
    - Big time waster not to have that.

## Notes From Chat

(Full chat record on page 3)

### **Meeting Platform**

- Zoom is platform to be used ← This is chosen method, currently implemented
- While NASA can't use the Zoom app, they can join via browser

### **Communication tools proposed:**

- Slack ← This is current chosen method, implementation TBD
- Discord
- MatterMost (ITAR compliant, but LSIC discussions should not include ITAR material)
- BaseCamp (Example from Jim Keravala: CISLunar Marketplace:  
<https://3.basecamp.com/3504905/projects/2740127>, if you want to be added contact Jim  
jim.keravala@offworld.ai)
- Microsoft Teams

### **Readings shared by Don Barker:**

- <https://www.hou.usra.edu/meetings/lpsc2019/pdf/1652.pdf> "IN SITU RESOURCE UTILIZATION OF LUNAR REGOLITH BY THERMAL REDUCTION—A NEW LOOK"
- <https://www.sciencedirect.com/science/article/pii/S0273117720302234> "Lunar and off Earth resource drivers, estimations and the development conundrum"

### **Reading shared by Craig Peterson:**

- [https://www.nasa.gov/directorates/spacetech/niac/2020\\_Phase\\_I\\_Phase\\_II/Lunar\\_Polar\\_Propellant\\_Mining\\_Outpost/](https://www.nasa.gov/directorates/spacetech/niac/2020_Phase_I_Phase_II/Lunar_Polar_Propellant_Mining_Outpost/) "Lunar Polar Propellant Mining Outpost (LPMO): A Breakthrough for Lunar Exploration & Industry" (Link shared by Kevin Hubbard)
- <https://www.nasa.gov/feature/trans-formers-for-lunar-extreme-environments-ensuring-long-term-operations-in-regions-of/> "Trans-Formers for Lunar Extreme Environments: Ensuring Long-Term Operations in Regions of Darkness and Low Temperatures"

## Chat Record

Karl Hibbitts: hello all. Could you please be sure to sign on with your first and last name so we can have proper accounting? Thanks.

Rich Antcliff: Can we put the slides in slideshow mode

RonJones: Ron Jones, Chief Scientist, Firehawk Aerospace, Inc.

marshall Eubanks: Afternoon.

Dana Hurley: Quick correction on the LSIC Director email:

Dana Hurley: SES-LSIC-Director@jhuapl.edu

Dr Susan Ip-Jewell MD USA: could you share this recording and slides

Rachel Klima: Yes, slides and recording will be posted on the LSIC website

Rachel Klima: Goal is to have it up by next week some time

Michael Paul: 121 on right now!

Araghi, Koorosh R. (JSC-EP311)'s iPhone: NASA folks are not allowed to use Zoom

Araghi, Koorosh R. (JSC-EP311)'s iPhone: MS teams is the standard platform for NASA folks

Michael Paul: NASA employees are actually allowed to, via the web-only access, join Zoom meetings. They can't be the host and have some other restrictions, but they can actually join Zoom meetings set up by others

Rich Antcliff: NASA folks can attend Zoom meetings on the web site

Joel Sercel: May I suggest that we use MatterMost instead of email for communications? It is ITAR compliant.

Michael Paul: LSIC does not intend to be a communication path for ITAR-sensitive materials. If partnerships grow from LSIC discussions, such communications will happen on more secure/private platforms. LSIC is going to be an open clearing-house of information.

Jerry Sanders: Yes. Metals may be a byproduct of oxygen extraction so it will be kept in mind with industry interests

marshall Eubanks: O2 seems like engineering.

Joel Sercel: I suggest we consider organizing along slightly different lines. One line could be low temperature processes that including extraction of water, CO2, methane, etc... and the other could be high temp processes that lead to water, metals, etc....

marshall Eubanks: H2O extraction requires prospecting.

Dave Murrow: Karl, did you just say 40% by mass?

Dave Murrow: in reference to which element?

Kirby Runyon: Yes, lunar silicates are 40% oxygen

Michael Nord: Dave, Yes. Regolith is about 40% oxygen by mass.

Dave Murrow: thanks

Morgan Gendel: Might the other 60% be available post-extraction for other uses?

Michael Nord: Depending on the technology used for extraction, yes.

marshall Eubanks: You get a lot of stuff, but most of the extra mass is Silicon :)

Brad Blair: Earth is also 40% Oxygen by mass

Don Barker: Suggest Abstract: <https://www.hou.usra.edu/meetings/lpsc2019/pdf/1652.pdf>

Jerry Sanders: The initial NASA focused product is O<sub>2</sub>, but as has been pointed out, there are lots of other products possible. This effort will need to consider industry interests in these other products

Michael Nord: Michael.Nord@jhuapl.edu

Kirby Runyon: kirby.runyon@jhuapl.edu

Shumaker, Nicole: Michael Nord - O<sub>2</sub>

Leslie Gertsch: What to extract from regolith also will need to consider the often-competing needs of the processes to be used.

Brad Blair: The biggest need of all mineral processors is power

Yousaf: Could we pls setup a slack channel to have in depth discussions? Email is not the best....neither is chatting in the margins.... In fact I already a slack channel available if needed.....

Michael Nord: Yes. Some O<sub>2</sub> extraction processes are better at metal extraction than others, and all will require a LOT of power, which can be electric, thermal, or both depending on the process.

Karl Hibbitts: yes...there will be a slack channel or channels

Yousaf: Thanks!!

wingod:Anything other than playing with toys is going to take a LOT of power.

Brad Blair: Is NASA working on methods of removing or passivating the (metallic) Mercury in lunar PSRs?

Morgan Gendel: If what's left after full extraction of O<sub>2</sub>/H<sub>2</sub>O is useable to build habs, perhaps that helps amortize the cost of the 2 major extractions.

Michael Nord: Removing impurities from extracted water will have to be part of a water ISRU system.

Don Barker: Is anyone addressing the storage of process materials on the lunar surface?

Michael Nord: Storage will need to be addressed. Probably cryogenic for O2. Maybe as water or as cryofuels for H2O.

Brad Blair: Does NASA have a forecast of its consumable and propellant needs for the lunar surface?

Elliot Carol, Lunar Resources: Lunar Resources is addressing oxygen capturing and storage.

Kirby Runyon: One NASA goal is to produce 15 metric tonnes of water on the Moon every year by 2030

Michael Nord: Brad. 10MT of O2 per year is NASA's present goal for O2.

thomas orlando: We have a REVEALS project where the processed materials can be used as building material..so ISRU and manufacturing can be linked

Dave Murrow: how many astronauts, for how long, drives this requirement

Dave Murrow: or is that a permanent settlement of ?? people

Michael Nord: It is mostly driven by rocket ascent fuel.

wingod:We need numbers. How many Kg? How many tons? That defines what processes that you use and the power required. Without goals, this does not make a lot of sense.

Dave Murrow: interesting ... how many launches per year?

Kevin Hubbard: @BradBlair ASU is working on a concept for water purification

Kevin Hubbard: That is considering the Mercury problem

hoyt: Hard and unwise to start developing mining and processing technology without first better characterizing the regolith and at depth. Shouldn't we follow the some steps as terrestrial mining and focus on prospecting and ground truthing?

Leslie Gertsch: For what question?

Paul Van Susante: can do separate rooms in a slack channel (one O2 and one H2O for example)

Phoebe Henson: Yes to separate breakout sessions

Michael Nord: Hoyt, it is an important question for H2O. For O2 we essentially already know the regolith composition.

Henk Rogers: I'm interested in both

Dave Murrow: too many meetings

wingod:The issue is the systems engineering of surface operations. By focusing on one or the other, you lose sight of the infrastructure needed for surface operations.

Jacob Chancery: insufficient bandwidth

Erika Wagner: This is a very large group for discussions. More meetings may or may not solve that challenge, but finding tools/processes for making progress towards goals will be important.

Paul Hayne: Suggested compromise: working groups that can work however they want and report back to the whole group

Kevin Hubbard: I agree with Paul

Brad Blair: Slack is a much better way to capture information including consensus and progress than Zoom (chat)

Don Barker: Other suggested reading: <https://www.sciencedirect.com/science/article/pii/S0273117720302234>

Michael Nord: Added to my reading list Don. Thanks.

Paul Van Susante: need somewhat scalable solutions and knowledge about when the systems 'break' regarding scaling

Craig Peterson: FYI, there will be a NIAC phase I study report coming out soon regarding establishment of a lunar polar propellant mining outpost (LPMO) that may be of interest. I'll make sure Karl gets the link once it's posted so he can alert anyone who might be interested in taking a look at what was developed. I'm here to see what I can learn that may affect our NIAC Phase 2 LPMO study following on that.

Kevin Hubbard:

[https://www.nasa.gov/directorates/spacetech/niac/2020\\_Phase\\_I\\_Phase\\_II/Lunar\\_Polar\\_Propellant\\_Mining\\_Outpost/](https://www.nasa.gov/directorates/spacetech/niac/2020_Phase_I_Phase_II/Lunar_Polar_Propellant_Mining_Outpost/) Here is the link Craig

Craig Peterson: That has the executive summaries - I don't think the full report is released yet but should be soon. The phase II is just starting.

Kevin Hubbard: Ah yes. I have not seen any full report yet either

Erika Wagner: Link for previous consortium report on ISRU?

Karl Hibbitts: Please email [SES-LSIC-Director@jhupl.edu](mailto:SES-LSIC-Director@jhupl.edu) for follow-up questions to this meeting.

Craig Peterson: This report may also be of interest. <https://www.nasa.gov/feature/trans-formers-for-lunar-extreme-environments-ensuring-long-term-operations-in-regions-of/>

Paul Van Susante: slack is much more user friendly than basecamp I think

Paolo Venneri: Can you share the information for the cislunar marketplace?

Craig Peterson: We've been using Mattermost with great success.

Dr Susan Ip-Jewell MD USA: also review microsoft teams

Kevin Margeson: Please don't spread communications over too many tools. keep it tight

Andrea Harman: Thank you Kevin.

Jim Keravala: CISLunar Marketplace: <https://3.basecamp.com/3504905/projects/2740127>

Craig Peterson: It's very similar to Slack or Discord but you can have your own US based server.

Brad Blair: Karl should make a decision about the tool

Paul Van Susante: but mattermost costs \$ to use

Kevin Hubbard: I would like for the group to come up with a standard set of reporting parameters (simulants used, power requirements, mass, etc.) for R&D so that we can compare future development against one another

Dave Murrow: FWIW Lockheed Martin uses Slack for internal discussions ... must be able to be made secure.

Rachel Klima: Slack has a lot of flexibility and I believe we'll be able to integrate it into our wiki once we have it all set up

Craig Peterson: We're getting it free by using their beta, Paul

Jim Keravala: Anyone wanting to be added to cislunar marketplace basecamp just ping me: jim.keravala@offworld.ai

Yousaf: +1 for slack

Michael McDaniel: +1 for Slack as well.

Rachel Klima: But re. security issues, we do need to be vigilant of all of our communication tools, LSIC-wide discussions, as Michael Paul noted, need to be ITAR-free and also mind proprietary issues

Andrew Annex: Also 2FA by default

Yousaf: I'm at DoD, we do use Slack

Rachel Klima: can you use it through a web interface?

Brad Blair: Dave Murrow - can you tell us about your slack experience at LMCO?

Andrew Annex: That is 2nd factor authentication from my earlier post

Andrew Annex: Slack can be used in web interface

Craig Peterson: Has the session frozen? I'm not hearing anything

Dave Murrow: i don't know how the IT people made it work, but there are a lot of channels and it is quite easy to use. there are water cooler channels, topic based channels, organization based channels, etc

Sarah Deitrick: Rachel yes we probably can do it through a web browser since we can do that with Zoom!

Brad Blair: the session is not frozen

Craig Peterson: It may just be me then - I have to go anyway as I have another meeting starting at 1

Dave Murrow: the only problem i see is keeping up with the inputs if you don't weigh in very often,

Leslie Gertsch: Snapshots are good!

Craig Peterson: Good start - will send further comments to Karl

Khaki Rodway: Thanks, Karl and everyone. Good to see y'all

Dave Murrow: thanks for getting us going, Karl

Leslie Gertsch: Good first meeting.

Paul Van Susante: great to see you all

Brad Blair: Thanks for your leadership, Karl!

Jim Keravala: Thanks all!

marshall Eubanks: Thanks!