Ask Me Anything Webinars - Session 7

TX03- Aerospace Power and Energy Storage and TX14 – Thermal Management Systems

Subtopic	Question	Answer
S13.06, High Efficiency Power Conversion Technologies	Regarding the solicitation subtopic challenge area: 1. Efficient, robust power conversion: Free-Piston Stirling cycle convertors capable of long life (17 years) and high efficiency (>30%) There is an interest in lower power convertors (20 to 40 watts electrical output) to support small RPS concepts. Would it be considered responsive to propose advancement of a key subcomponent of a free-piston Stirling convertor? Or are only proposals being sought that deliver full convertor designs?	There has been a lot of research done over the years in the areas of high temperature materials and high porosity regenerators that were their own SBIR efforts. Due to advancements in the past 6-8 years, those challenges have been overcome for the most part. That said, full power convertor designs and functional tests are being sought to provide high efficiency, low mass options in the 20-100 W range.
T3.05 Lunar Orbital Power Beaming Technology Development	What are the planned conops and key operational scenarios?	The baseline conops is that power is collected by a satellite in lunar orbit and then beamed from orbit to users on the lunar surface. The expected use case is the ability to send power to receivers in shadow or lunar night conditions. One particular point design of conops anticipates one or more power beaming spacecraft in lunar orbit at an altitude of 800 km, with beaming distance of up to 1500 km; however, it should be emphasized that the subtopic is not limited to technologies addressed only to this particular use case.
T3.05 Lunar Orbital Power Beaming Technology Development	Are you interested in ground-to-ground power transfer?	Although this particular subtopic is addressed to lunar-surface to lunar-orbit power beaming, NASA also anticipates that technologies developed in this SBIR topic will have applications to surface-to-surface power beaming. Please see Topics in Z1-LIVE-01 for a sub-topic seeking surface-to-surface power beaming technologies.
T3.05 Lunar Orbital Power	Do you envision power collection on orbit and beaming it on the surface? Do you	Yes, the topic assumes power is generated in (lunar) orbit and is then

Beaming Technology Development	already have a baseline technology (mirrors, microwaves, lasers)?	beamed to lunar-surface users. The point-design studies that have been done have baselined lasers as the beaming technology, with photovoltaics as the receiving arrays.
T3.05 Lunar Orbital Power Beaming Technology Development	What power levels are you interested in / will be required?	Minimal usable power at the user is about 50 watts electrical. (Note that if the duty cycle is less than 100%, the power level is proportionately higher). This is the lowest power level we are looking at (for small surface science stations); NASA is interested in higher levels as well.
T3.05 Lunar Orbital Power Beaming Technology Development	How will the lunar systems (receiving the power) deal with thermals (keeping components in operating thermal range, moving heat from components, heat pipe and radiation design)?	Thermal issues are indeed important to lunar operations (and specifically to lunar night operation) but are not specifically called out in this solicitation.
S13.06, High Efficiency Power Conversion Technologies	Is dynamic power conversion, with moving parts, a requirement of this subtopic? - Would a monolithic component (no moving parts) be a considered candidate for integration into concept?	This subtopic is seeking dynamic power conversion due to the opportunity to achieve 30% conversion efficiency, defined as heat input to the convertor hot end converted to usable electric power output from the convertor power terminals. In an effort to focus this subtopic, static power conversion is not being sought.
S16.05 & Z-LIVE.02	1) What fluids are deemed low toxic? What are the THL level constraints? What amount of fluid is allowed? 2) If a prototype has been developed that is geared toward space-flight, what are the additional constraints or requirements to satisfy to be considered for static/dynamic lunar environments? 3) If we have shown positive results and performance of a thermal management system that uses a toxic fluid, can development be steered toward integrating a non-toxic fluid to the system?	1) For fluids with an acute toxicity category 3 or higher, THL will depend on the fluid and will be determined based on NASA JSC 26895. The amount of fluid allowed is based on the SMAC limit and JSC 20584 has a list of available SMAC for some fluids. 2) Surface habitat environment constraints are in develop but the thermal system is expected to operate in high radiation environments and dissipate electromagnetic charging. 3) Certainly, but the TRL will have to reassessed.
S16.05	Does this include technologies to facilitate launch of conditioned payloads (cold or hot), such as to the International Space Station?	Yes.
Z-LIVE.01	(1). Does NASA prefer to sodium ion batteries for this topic? (2). Are other	NASA does not have a preference for the sodium ion versus lithium. What NASA is

	battery chemistries beyond lithium and sodium excluded? (3). Is the battery operation temperature at -200 oC a must-be-addressed issue in the proposal? Or the temperature could be flexible, depends on the technologies?	really interested in is an overall system that will meet our metrics, not only the temperature, but also the specific energy. It's more about making an argument that the proposed chemistry will meet the requirements rather than whether it's lithium or sodium ion or another battery chemistry.
Z-LIVE.01	For a power beaming solution, is there a desired power density based on transmitter/receiver mass or aperture size?	End-to-end efficiency targets are of more interest to NASA.
S16.04, Improved Thermal Mitigation for Entry, Descent and Landing (EDL)	Does a new noble way of re-design and build large monolithic solar photovoltaic infrastructure in microgravity or LEO in the MW range of power to collect and storage energy?	NASA isn't seeking things from the cell module and blanket level, so hopefully that should provide an idea of what scale of technology is being sought. NASA is focused on any significant improvement over the state-of-the-art. We didn't specify metrics because right now there are a few different cell technologies that proposers could be looking at. We wanted to leave that up to proposers to align the state-of-the-art improvement with the technology being proposed.
Z-LIVE.01	For a power beaming solution, lunar regolith and mars dust storms are mentioned. Is there a desire to beam through this material, and if so, what minimum efficiency is desired under these conditions?	We wanted to note those challenges in the in the solicitation for power beaming. We are looking for technologies that are less susceptible to those and others. I don't think we have called out a minimum efficiency under those conditions, but that is something we are interested in.
Z13.05 and S13.06	Cryogenic flywheel energy conversion is applicable to these topics? If so, what power range?	It's not a responsive to not being sought because the typical applications that we're looking to focus on are very high temperature power conversion systems for RPS applications.
Z-LIVE.01	Would a rechargeable thermal battery, that is heavily insulated be a fit for the Low Temperature Batteries for Lunar and Mars Surface Missions?	That one might be a tough fit. Keep in mind that when NASA put their metrics in the subtopic, 200 Watt hours per kilogram, that's on a module level. That will have to include the weight of all the extra insulation. If you've got a thermal chemistry that will still get us 200 Watt hours per kilogram, including the

		weighted of the installation at a module level, then please submit it. But it has to be inclusive of everything that's needed to keep it alive.
Z-LIVE.01	Are you interested in ground-to-ground power transfer?	Surface to surface power beaming is covered in Z-LIVE-01
Z-ENABLE.01	Can you give some idea of what power and voltages are interesting for "high-power and high voltage arrays"	That information can be provided, certainly for voltages. NASA is interested in voltages greater than 100 volts. In the solicitation we do provide mentions of specific power. I would recommend power levels above 10 low 10s of kilowatts. Current technologies we go up to 50 kilowatt arrays, so we're probably looking for hundreds of technologies that would support hundreds of kilowatt arrays.
	Does NASA have any interest in adopting new technologies for thermal management of electronic components, specifically for cooling next-generation processor systems in spacecraft? If so, do these technologies align with any subtopic titles under the TX14 category?	I would say in general, NASA has interest in new technologies for thermal management of electronic components. I know for Z live 02 it is not necessarily what is being sought in that subtopic. It won't be the highest priority because the question specifically calls out a next generation processor system. However, if the same technology can be used to cool instruments or like say fpas or other science instruments, that would be more of an interest for gathered specifically, and I think that same would apply to JPL.
Z-ENABLE.01	The solicitation specifies addressing fission power systems supporting small in-space nuclear electric propulsion through the following solicitation referenced needed technologies: (1) Robust, radiation hardened power conversion systems) (2) Radiation hardened electronic controllers and power processing (3) Radiation hardened sensing and sensor signal processing systems for reactor operation One area we have been looking into is post launch deployment / standoff of power system to reduce risk/exposure of	We are seeking advancements in radiation tolerant electronics for multiple purposes and robust power conversion systems that have organics that are susceptible to radiation or some materials embedded in that system that are susceptible to reation depending on the levels in the distance. The answers may be because for some applications and envision deployments that that may be a suitable approach and advancement.

	radiation to electronics and keep the launch mass/volume small/localized and take advantage of the inverse square law. So instead of spending additional mass and cost on shielding, the trade is against a novel concept to provide an active structure an system to enable the same goals under identified needed technologies (Robust, radiation hardened power conversion systems), via an approach not explicitly identified in the solicitation. Is this an interest of the subtopic?	
S16.05	The topic mentions variable heat rejection (>10:1 turndown ratio) and passive switching with high turndown ratios (e.g., >400:1). What quantity of heat rejection is needed?	NASA is seeking heat rejection up to 100W. Higher power capacity is also desirable. There is a lot of similarities between that subtopic and Z live 02 for Z live 02. NASA is also interested in heat rejection turned down. We tend to focus more on human spacecraft at the spacecraft level or even lunar habitats. Thus, we're looking at heat rejection more like 10 kilowatts.
Z-LIVE.01	The author stated "Sodium-ion cells have specific advantages over LIB, including higher power density, non-flammability, and superior thermal performance." This is not completely aligned with the common knowledge about SIBs and LIBs. Could you explain how the statement comes from?	Our goal is more what the metrics are that you can meet not so much on one specific technology.
Z-Enable.01	For the deployable radiator, is there a needed compression ratio the radiator area deployed to packaged volume?	There is not a specific packaging compression ratio that is being pursued in this subtopic scope, due to the large range of power scales of interest in the subtopic. Higher is of course better to reduce the needed payload volume.
Z-LIVE.01	Is there any specific technology or frequency plan that NASA is interested in?	In this subtopic, there isn't a specific technology or frequency plan NASA is seeking. NASA is looking for good ideas.
Z-LIVE.01	Is the reduction of the cost of wide bandgap high temperature electronics by reducing the cost of the starting silicon carbide substrate of interest to any topic or subtopic? Would NASA fund	The answer is no. NASA seeks final component solutions. Please partner with someone who can use your technology to create a final product meeting the metrics in the solicitation.

	semiconductor manufacturing because it is not covered by any other Agency or the CHIPS Act?	
Z-LIVE.01	It was mentioned earlier that Flywheel Energy Storage was not very pertinent due to past research. Can you point me to that research and NASA's reasons to believe it is not likely to work.	I would encourage them to use an Internet search search engine to look up flywheel energy storage systems and NASA. They should be able to find some papers on previous developments we've done with flywheel energy storage. If you currently have a design and materials that are of the whole system that you think can meet our metrics, please submit. Just because something wasn't possible in the past doesn't mean it won't work now. You might have a novel way to do it this time, but keep in mind the stated metrics are for the system, which is more than just the rotor.
Z-LIVE.01	What would you recommend to a company with a prior proof-of-concept demonstration? Should we start with Phase I again?	NASA is seeking novel solutions in this subtopic, so if you already have a proof of concept demonstration, you could submit it, but you would need to have some additional development work.
T3.05 Lunar Orbital Power Beaming Technology Development	Is T3.05 (Lunar Orbital Power Beaming Technology Development) a subset of Z-LIVE.01: (Long Distance Power Transfer for Lunar or Mars Missions) or is the solution for T3.05 a separate subtopic?	Although some technologies may be applicable to both, these are separate topics.
Z-LIVE.01	Would Hydrogen, oxygen and water storage tanks apply that are passive but significant thermal endurance capabilities could this apply?	Yes, that would apply.
Z-LIVE.02	For Z-Live-02, can an innovative coolant be allowed?	In general we would be open to hearing about innovative cooling. Keep in mind, NASA has standards for coolants and compatible coolants, particularly for space crafts. There are exceptions that can be approved, but generally we try to have compatible fluids and that could be a mixture of different combinations of molecules.
T3.05 Lunar Orbital Power	Is there a $/watt goal of the solution provided?	Although price will ultimately be one (of many) criteria for selection of a flight

Beaming Technology Development		system, for the current topic price per watt is not one of our evaluation criteria.
S16.05	Is there a max temperature of the thermal radiator that the coating would need to be stable up through?	NASA is also looking for coatings that would go on radiators that are affiliated with a high temperature thermal management system for the nuclear fission applications. For the high temperature radiators, 600K is the upper bound.
Z-LIVE02	Are variable-geometry radiators of interest under Z-LIVE.02? If so, would they fit better under the "Lunar Habitat Thermal Technologies" or the "Freeze-Tolerant Radiators and Heat Exchangers" focus area?	Variable geometry might be intended to avoid freezing rather than making it freeze tolerant.
Z-LIVE.01	Lunar and Mars environment temperature varies from cryogenic to high.	We are not proposing that you super conduct flywheels.
S13.06	Does a new noble way of re-design and build spherical solar photovoltaic infrastructure in microgravity or (LEO) to collect and storage energy fits in the subtopic, S13.06 Dynamic Power Conversion or for the subtopic, Z1.10 Enabling Power and Thermal Technologies?	The proposer should read the subtopics and figure out if their technologies meet the metrics we're seeking.
Z LIVE.02	The question was "What Subtopic" would apply to innovative coolants. Given Zl-live-02, has a subtopic "Lunar Habitat Thermal Technologies"" and the "Lunar Habitat Thermal Tech" has a bullet point of "Enhancements or alternatives to traditional single-phase liquid pumped loops to enable survival and operation through the lunar night." Would an innovative coolant work in improving a single phase loop? Are we allowed to improve a single loop, or do we need to propose a multi loop cycle? Also Darnell mentioned toxicity for coolants. What standards would apply for coolants?	If someone wants to propose an innovative coolant as a way to enhance or as an alternative to what NASA traditionally has on human spacecraft (i.e., a single phase pump loop system), they can do that. It's up to the proposer to convince NASA whether or not their technology will improve the system. In regards to coolant toxicity, any new fluids will have to go through a toxicity assessment. NASA will also look at it for acute toxicity. However, there's more to examine than just toxicity. There is a lot to examine in regards to fluid properties such as a preference for low vapor pressure and high conductivity and how those factors apply to a high heat

		transfer coefficient that we could get from these novel fluids. These factors would have to be traded against the other technologies.
Z LIVE.02	Even well proven coolants like Glycol have toxicity issues? Is that a baseline we can use?	Water is one of the perfect ones, as an example. However, others like glycol are good as well. Keep in mind, though, the other factors mentioned earlier. The SMAC limit, (i.e., the Spacecraft Maximum Allowable Concentration) is another thing to consider. Volume of the habitat or pressurized segment has to be included as well in the assessment. Even though some coolants such as glycol are considered low toxicity, they could be catastrophic depending on the concentration. All of these factors will have to be evaluated.