Ask Me Anything Webinars - Session 8

TX06- Human Health, Life Support, and Habitation Systems and TX07 – Exploration Destination Systems

TX and Subtopic	Question	Answer
TX06 - Human Health, Life Support, and Habitation Systems - H3.13: Oxygen Compatible Habitation Solutions for Exploration Environments (SBIR)	This topic specifically states that there are few materials with capabilities to withstand a 38% O2 environment, but there are a handful of materials appropriate for this environment. Is it appropriate to do a market survey of candidate pre-existing materials in novel configurations, or is this topic specifically for new material development?	There may be existing fibers with excellent flammability resistance properties that are underutilized in textile applications. When these fibers are used, they're typically incorporated into blended materials, which reduces their flammability protection capabilities. Therefore, investigating existing market materials in new applications or configurations - such as using these high-performance fibers in their pure form rather than in blends - would be a valid project approach. This type of research could identify materials that already exist but aren't being used to their full potential in high-oxygen environments.
TX06 - Human Health, Life Support, and Habitation Systems - H4.09 Long Duration Exploration Portable Life Support System Capabilities	What is the time range of Long Term?	Long Term is used in several places of the proposal. We are expected the suit to last >= 100 EVAS lasting 8 hours each over the course of several years without refurbishment or major maintenance. It is also used to refer to technologies that support long term missions. Long term missions may not have resupply available, so the technologies in the PLSS will need to be of a non-venting, closed mass loop type.

TX06 - Human Health, Life Support, and Habitation Systems - H4.11	Will the application of graphene and graphene oxide be considered for the development of lightweight, ultra-strong, and durable suits?	While graphene oxide shows promising characteristics with its excellent mechanical properties and low mass, there are several key considerations that need to be addressed: Environmental compatibility is a primary concern, particularly regarding potential outgassing in vacuum conditions where bearings and suit structures would be exposed. Manufacturing feasibility must be demonstrated, especially for components requiring precise machining tolerances like bearings. Despite these challenges, materials like graphene oxide would fall within the scope of this solicitation. The proposal should clearly address how these materials would meet the specified requirements while accounting for these technical considerations.
TX06 - Human Health, Life Support, and Habitation Systems - H4.11	Is the use of impermeable polymers, such as 2D polymers, considered a viable approach for developing the next generation of suits?	Previous research has explored polymers for these applications, but there are significant performance requirements that must be addressed. Key considerations include High stress loads from pressurization and bearing operations. Material durability under operational conditions. Performance in varying thermal environments. We are open to evaluating various advanced materials that could improve upon current state-of-the-art, including Polymers, Graphene oxide, Composites and Ceramics. Any proposal incorporating these materials would be welcome, provided it demonstrates how the material properties can meet the demanding structural and environmental requirements. Our primary focus is on advancing beyond current capabilities while ensuring all performance criteria are satisfied.
TX06 - Human Health, Life Support, and Habitation Systems - H4.11	Is Joule heating will be considered as a potential strategy for heating the suit in extreme environments?	This subtopic specifically focuses on structural materials and mobility elements of the suit, such as Bearings, Hard upper torso, Brief structures and Other hard structural components. Regarding thermal management: the suit typically maintains a positive heat balance due to crew member metabolic heat generation, so heating systems are not a primary concern. While thermal management is an interesting discussion topic, it falls outside the scope of this subtopic, which concentrates on structural and mobility-related materials and components.
TX06 - Human Health, Life Support, and Habitation Systems - H3.13: Oxygen Compatible Habitation Solutions for Exploration	Would a fire suppression system that utilizes acoustic waves be of interest for this subtopic?	I think for this subtopic we are really looking for solutions that address known problems and so if the offer is thinking about a fire suppression system or a component of a fire suppression system that is not currently compatible with the high oxygen environments and the acoustic wave appropriate addresses that challenge. Then I think that would be within scope. But if this is just something different where we already have a solution that needs the needs in high oxygen, then that would be a less interest for this one.

Environments (SBIR)		
TX06 - Human Health, Life Support, and Habitation Systems - H4.09 Long Duration Exploration Portable Life Support System Capabilities	"Newer, long lasting and more robust solutions are required to prevent the failures such as seen on the current Extravehicular Mobility Unit (EMU)." Which issues/failures of the current EMU to does this refer to that need to be addressed by new solutions? The water issues attributed to carryover from the water separator/sublimator?	Yeah, the water issues, the entrainment, the carryover is really what we were focusing on there.
TX06 - Human Health, Life Support, and Habitation Systems - H4.09 Long Duration Exploration Portable Life Support System Capabilities	Volume constraints with any valve/manifold: W (<10 in.) x H (<8 in.) x D (<5 in.) mass constraints: <2 lbm Is this topic inclusive of the condensate/water separator? Do the mass and volume constraints include the water separator? Does "passive operation without requirement for sweep gas or differential	For this application, size and mass are critical design factors, particularly considering Mars mission scenarios, ISS and lunar applications and Operations in gravitational environments. While rotary separators would be considered, they present significant challenges. Historical instances of catastrophic failures. Typically, larger size and mass than desired. Would need revolutionary improvements over current state-of-the-art. The ideal solution should be Compact, Lightweight and Reliable. Though we're open to all innovative approaches that could solve these problems, proposed technologies must demonstrate clear advantages in size and mass reduction while maintaining robust operation. Any rotary separator concept would need to show substantial improvements over existing designs to overcome historical reliability concerns.

	pressure gradient" mean no pump or rotary water separator? (The CHX with Slurper on ISS requires a separate rotary water separator pulling a vacuum on the Slurper.)	
TX07 - Exploration Destination Systems - T7.04 Lunar Surface Site Preparation	For a proposal aimed at building and analyzing PSI ejecta protection structures (e.g., berms/fences): Does the Phase I deliverable include demonstration of robotic construction of protection structures? Or do you need only a set of instructions (i.e., ConOps) that gives a pathway for such construction?	Demonstration of robotic construction is preferred; we want to be developing hardware in general. If the proposal is focused on understanding how regolith structures behave when exposed to ejecta, then it may be competitive with a ConOps. No development/demonstration of hardware required, but the proposal would be better if it did.
TX07 - Exploration Destination Systems - T7.04 Lunar Surface Site Preparation	In the case of protection structures (berms etc.) for PSI, does the Phase I deliverable include physical tests for showing regolith infrastructure performance? Or simulations (with relevant lunar conditions) be sufficient?	Simulations may be sufficient if the modeling has been validated experimentally for similar applications. All simulations must be validated.
TX07 - Exploration Destination Systems - Z-LIVE.05:	The topic notes that Lunar regolith could be emplaced on a structural shell	Jigging structures, scaffolding, or forms that assist with accurate structural assembly are of interest. Deployable and lightweight tools that simplify or enhance robotic assembly and outfitting are desirable. Ultimately, it is the primary structure that should be either consolidated ISRU material or robotically assembled and

Regolith Excavation and Manipulation for Surface Operations and Infrastructure with Assembly and Outfitting of Lunar Surface Structures (SBIR) (Previously Z14.01)	hangar at a depth of at least 3 meters to create a sufficient radiation shield for lunar assets parked inside this hangar. Would deployable systems that support the shell during construction be considered relevant to this topic? The application is similar to an arched concrete form.	outfit in-situ from tightly packaged components or deployed modules. (Additional note: subtopic T7.04 Lunar Surface Site Preparation pertains to the bulk regolith manipulation for covering arch structures)
TX07 - Exploration Destination Systems - Z-EXPAND.02	Is reusability of the structural elements of high importance?	Reusability can be discussed in terms of physical reusability as well as design reusability. We want to drive industry towards this direction, but it is not a deal breaker. Reusability, especially rapidly reusable elements (in both terms) will lead towards a more economically accessible.
TX07 - Exploration Destination Systems - Z-EXPAND.02	What size/scale of structures should be considered?	All sizes and scales will be considered, but our recommendation is to target a scale that your firm will have the capability to demonstrate robotic assembly of should you reach a Phase II. Being able to demonstrate scalability (physical and economic) of the structure is also desirable.
TX07 - Exploration Destination Systems - Z-EXPAND.02	Are there any requirements or objectives for the stiffness and strength of the robotically assembled structure?	We don't have specific requirements as the problem is relatively open at the moment and requirements are application dependent, but we can categorize into 2 classes. General structures - applied to broader applications, general performance requirements, economically accessible, rapid deployment high precision structures for observatories - enough for Precision opto-mechanical instruments to work property. The topic lists a few infrastructure examples for consideration.
TX07 - Exploration Destination Systems - Z-LIVE.03	Is NASA interested in systems that have a clear path to scaling up to 1.5 kg/hr of water extraction and capture (e.g., either through	For phase one, you could get away with subscale. For phase two, we would definitely need the full 1.5 kilograms per hour.

	sizing or parallel systems), or is the expectation that a single, integrated system is capable of meeting this rate? Is it expected that hardware within the scope of a possible Phase I and Phase II SBIR should be tested to the 1.5 kg/hr rate or would sub-scale testing still be deemed compliant with the solicitation?	
TX07 - Exploration Destination Systems - Z-LIVE.03	Are there any technologies that NASA do not believe are viable or are specifically not interested in seeing companies propose for this topic?	This subtopic encompasses four areas, with solutions needing to function effectively in multiple environments Deep space/microgravity, Martian surface, and Lunar surface. While few approaches are completely excluded, surface coating-based solutions face significant skepticism due to Historical failure patterns, Limited durability, and eventually degrading performance. The key requirement is operational effectiveness across all target environments. Though surface coatings aren't strictly prohibited, proposals relying heavily on them would need to overcome substantial concerns about long-term reliability. Most technical approaches will be considered but must demonstrate robust performance across all intended operational environments.
TX07 - Exploration Destination Systems - Z14.01	Could you please provide any existing standards, guidelines, or reference documents that detail robotic interface requirements for quick-attach processing implements or other modular attachments intended for lunar surface mobility platforms? If no	There is a NASA standard for dust tolerance NASA-STD-1008, CLASSIFICATIONS AND REQUIREMENTS FOR TESTING SYSTEMS AND HARDWARE TO BE EXPOSED TO DUST IN PLANETARY ENVIRONMENTS. (copy link that was in chat) Publication provided by Rob Mueller https://ntrs.nasa.gov/api/citations/20110009968/downloads/20110009968.pdf

	formal standards currently exist, are there preferred assumptions or preliminary specifications that we should use when designing our attachment concept? Could design of this interface specification itself qualify for development under this topic?	
TX06 - Human Health, Life Support, and Habitation Systems - H3.14	For topic H3.14, would a different technology (other than that described in the solicitation) be responsive if it meets the requirements for the application? ie, something aside from the addition of nanobubbles, that would improve MEA lifetime.	Any approach to producing hydrogen peroxide (or a similar disinfectant) without use of reagents will be evaluated and considered. Note that some approaches have been tried, and these approaches had limited surface life and were prone to side reactions. If an alternate method is proposed, the plan should include evidence that service life is acceptable, and side reactions are controlled.
TX06 - Human Health, Life Support, and Habitation Systems - H3.14	Is ESM the main driver, or is there a specific lifetime target?	ESM is always the "bottom line" summary metric - but lifetime is a central element of risk of reliability. A system with uncertain reliability will have a greater ESM (more spares and repair equipment will be needed to sustain)
TX06 - Human Health, Life Support, and Habitation Systems - H4.09	There are 4 focus areas in this sub-topic. Are these focus areas listed based on the order of priorities? (i.e., #1 will be	I wouldn't say they're listed in in order of priority.

	given a higher priority than #4)?	
TX06 - Human Health, Life Support, and Habitation Systems - H4.11	for H4.11 Are there specific thickness and weight targets for structural and mobility components (e.g., weight per unit volume for hard materials)?	We don't have a a target for a density. The solicitation includes the state-of-the-art, which is aluminum and composite structure, one could probably derive the volume, the density targets out of those and use that as a reference. There isn't a specific density we're looking for. In terms of aerial mass, we need to meet our strength requirements in as little mass as possible.
TX06 - Human Health, Life Support, and Habitation Systems - H4.11	Topic H4.11 - impact resistance metric - what is the size of the "projectile" - e.g. small regolith particle of what size or is this more of a ball bearing (ASTM style) impact test?	For the specific impact requirement stated in the solicitation, testing should use 1-inch diameter steel ball as the standard impactor. However, real-world applications should consider additional impact scenarios Lunar surface debris/impactors and Martian surface debris/impactors. While these environmental impactors would have different materials and geometries than the test standard, the steel ball requirement serves as the baseline testing metric. Proposals should address both the formal test requirement and practical environmental considerations.
TX07 - Exploration Destination Systems - T7.04 Lunar Surface Site Preparation	Does T7.04: Lunar Surface Site Preparation (STTR) include vertical structures or should I instead consider Z-LIVE.05: Regolith Excavation and Manipulation for Surface Operations and Infrastructure with Assembly and Outfitting of Lunar Surface Structures (SBIR)?	The Lunar Surface Site Preparation subtopic includes vertical structures that are composed primarily of bulk regolith. Vertical structures made from more traditional building materials such as aluminum would be more appropriate for the Z-LIVE.05 subtopic.
TX07 - Exploration Destination Systems - Z.02	For Z-EXPAND.02 (Orbital Infrastructure Assembly), will a solution that addresses multiple shortfalls be move favorable than one	Multiple shortfalls addressed are more favorable. Number of awards till TBD.

	that addresses a single shortfall? How many awards are anticipated in this subtopic?	
TX06 - Human Health, Life Support, and Habitation Systems - H12.09	For H12.09, would it be most useful to give a measurement of number density and size of bubbles detected in blood vessels?	The focus is on developing technology to image venous gas emboli, rather than quantification. Specifically imaging capability to detect and visualize gas emboli and bubble density and distribution would be analyzed later through separate algorithmic processing Direct quantification is outside this scope. The key deliverable is the imaging technology itself, which will enable subsequent analysis of bubble number and density through other means.
TX06 - Human Health, Life Support, and Habitation Systems - H3.14	For H3.14, 10 l/day (>100 ppm H_2O_2) is required. If >1000 ppm H_2O_2 can be generated, will 1 l/day be acceptable?" degradation of performance of <10%" is required. If our prototype can maintain performances for hundreds of hours with Faradic efficiency change <10%, will that meet the requirement?	Minimum viable product is a demonstration system that works in gravity and a plan/design for microgravity operations. It is acceptable to meet delivery rate requirements by producing a smaller quantity of product with higher concentration.
TX06 - Human Health, Life Support, and Habitation Systems - H4.09	H4.09 - For Focus Area #4 (Trace Contaminant Control), the topic mentions "Combined TCC and CO_2 Removal". Any volume or weight limits, or should we follow the weight limit on Focus Area #1?	If you're doing a combined 22 and TCC, go ahead and follow the weight limit for #1, which is the C O2 in water.
TX07 - Exploration	For Z-EXPAND.02 (Orbital	Robotic agent only is acceptable. Astronaut compatibility would be a bonus.

Destination Systems - Z.02	Infrastructure Assembly), are robotic-only solutions for modular in-space assembly and expansion acceptable, or must a solution address manned-spaceflight concerns?	
TX06 - Human Health, Life Support, and Habitation Systems - H3.14	H3.14 - (Nanobubble Facilitated Hydrogen Peroxide Production In Space) The subtopic mentions the usage of nanobubble to improve the stability and capacity of hydrogen peroxide production. If we can propose a method to reach the Phase I target of capacity and stability without using nanobubble, are we eligible to submit a proposal to that topic, or do we have to include ideas of nanobubble in our proposed research?	The functional requirements do not relate directly to nanobubbles - the functional requirements relate to hydrogen peroxide production. Any amount or type of nanobubble production is acceptable, if the resulting process reliably makes hydrogen peroxide with a small and energy efficient, good reliability, long service life.
TX06 - Human Health, Life Support, and Habitation Systems -	Would a CHX with a passive water separator and pump to provide differential pressure qualify?	Yes, that would qualify. Pump reliability would be taken into account on that sort of thing, but that would certainly be under consideration.

H4.09 subtopic 2		
TX07 - Exploration Destination Systems - Z.02	Orbital infrastructure Assembly: when developing a robotically assembled structural element, what level of granularity is needed for the robot itself? I.e. do we need to design the complete system or can we focus primarily on the element?	For this subtopic we definitely want to see a structure that can be robotically assembled. That has to be part of the consideration. We have structures and outfitting for orbital robotic assembly, so that would be the scope that deals with designing of structural elements themselves. We've got robotic agents' scope, which would be like designing the robotic systems. Then we have a mission analysis and software scope that would be like the looking at the tool for analyzing the big picture. We'll certainly be considering proposals that just focus on the structural elements. But they've got to fit into the architecture of robotic assembly.
TX07 - Exploration Destination Systems - ZExpand.02 -Structures and Outfitting for Orbital Assy	The topic seems to describe "building block structures" that can support multiple orbital platforms. If there is a platform solution that is itself a building block that can expand, is that reasonable to submit?	Thinking about how solutions can really scale, be cost effective, be able to build an economy where people can contribute to adopting the platform and making it accessible is a consideration for how to approach that. We're open to all types of architectures and seeing what really makes sense.
TX06 - Human Health, Life Support, and Habitation Systems - H3.14	Do you have targets for power, and for amount of nano-bubbles you want?	The requirements do not relate directly to nano-bubble production, the task requirements relate to hydrogen peroxide production.
TX06 - Human Health, Life Support, and Habitation Systems - H4.09	Is there interest in strategies to handle sources of H_2O other than exhalation (e.g., perspiration, urination)?	The perspiration is absolutely something of interest, and in fact at some metabolic rates we see the perspiration outweighs the breathing water. I would classify those two together as what we would call metabolic wastewater and that's what we're trying to control in this subtopic.

TX07 - Exploration Destination Systems - Z-live-05	Would an optical solar furnace be in scope for this solicitation?	Shortfalls that are posted.
TX06 - Human Health, Life Support, and Habitation Systems - H4.09 Subtopic 4 (TCC)	Is there an expected frequency and duration of EVAs in the long duration mission timeframe? I.e. Can we expect 8 hour EVAs perhaps 5 times a week?	That is still TBD right now. I would estimate an 8-hour EVA, and I would estimate at least every other day. Every other day for a month would be a very conservative estimate. If you want guidance on how many total but at least eight hours.
TX07 - Exploration Destination Systems - Z-LIVE.03, Lunar Ice Mining	Can the 1.5 kg/hr extraction/collection rate be time averaged to account for bulk operations? For example, extracting icy regolith, heating it, and collecting water could be 36 kg/day (meeting 1.5 kr/hr) but not with continuous processing rates.	The 1.5 kilograms per hour production rate is a reference target derived from an annual goal of approximately 1,300 kilograms per year. This rate is provided to Establish a sense of scale. Set general production expectations. Guide conceptual development. For proposals Exact hourly production rates can be flexible. Time-averaged production is acceptable. Lower initial production rates are acceptable if scale-up potential is demonstrated and conceptual pathway to full-scale production is shown. The key is demonstrating how the technology could ultimately achieve or approach the target production level, even if initial implementations operate at a different scale.
TX07 - Exploration Destination Systems - Z-Live-05	Is there interest in excavating solid material or just unconsolidated regolith? Also, is there more interest in the Moon or Mars?	If the question is geared towards excvation/quarrying stone to use as a building material it is within the scope of T7.04 Lunar Surface Site Preparation. The moon is the preference.
TX07 - Exploration Destination Systems - Z-LIVE.03, Lunar Ice Mining	Are there any specific technologies that NASA is interested in or not interested in from previous experience or research? Are there specific	Previous research into water ice extraction technologies has been limited, with minimal investment in this area. A review of Google Scholar references shows few comprehensive investigations into subsurface ice extraction methods. Each existing approach has significant limitations. For example, microwave-based methods face challenges because microwaves don't effectively couple with ice - this is evident in everyday experience where defrosting frozen items takes considerably longer than heating liquid-based items like coffee. Given the limited historical development and inherent

	ConOps or concepts that NASA wants proposers to reference as their goal?	challenges with current methods, there's substantial room for innovative approaches to improve water ice extraction efficiency.
TX06 - Human Health, Life Support, and Habitation Systems - H4.09	Is there any understanding on the rate of various metabolic waste produced by people in space published somewhere?	https://ntrs.nasa.gov/citations/20210024855 https://www.nasa.gov/wp-content/uploads/2023/03/human-integration-design-handbook-revision-1.pdf?emrc=675b4a5d42c6a
TX07 - Exploration Destination Systems - Z-EXPAND.02	Are you looking for structural elements that can be manipulated into complex geometry structures, or are capabilities for straight truss sections that can be joined together sufficient?	We're definitely looking for more complex geometries than straight sections at least like 2D geometries. But 3D would be preferable.
TX06 - Human Health, Life Support, and Habitation Systems - H3.14	Would distilled water and wastewater from a treatment plant converted into H_2O_2-laden streams suffice for Phase I? Are there other waste streams that you would like to see converted into H_2O_2?	Distilled water is a great initial demonstration liquid. Wastewater from a treatment plant would be a great liquid to demonstrate system robustness.