



## NASA SBIR 2008 Phase I Solicitation

### X10 Exploration Medical Capability

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The Exploration Medical Capability Topic is soliciting research and technology development for key areas of crew health maintenance, including injury/illness treatment scenarios. The Vision for Space Exploration presents significant new challenges to crew health care capabilities. These challenges include the hazards created by the terrain of lunar or planetary surfaces that may be difficult to traverse during exploration, the effects of gravity transitions, low gravity environments, and limited communications with ground-based personnel for diagnosis and consultation. Each challenge has associated medical implications and medical requirements and technologies to ensure safety and success. The areas of concern for the ExMC that are targeted in this solicitation include: Non-toxic In-flight Sprain/Strain Therapeutic Treatment; Through-suit Medication Delivery in a Reduced Pressure Environment; Reusable Diagnostic Lab Analysis Technology; Biosensors for Lunar EVA Suits; and a Lightweight/compact Oxygen Concentrator. Proposals may respond to one or more of these areas.Â

## Subtopics

### X10.01 In Flight Diagnosis and Treatment

Lead Center: JSC

Participating Center(s): ARC, GRC

Proposals may respond to one or more of the following areas:

#### Non-Toxic Sprain/Strain Treatment

With longer missions and more labor intensive tasks expected in the Constellation Program, the likelihood of musculoskeletal injuries such as sprains and strains are expected to increase. Standard terrestrial therapeutic response to treating sprains and strains is to provide cold compress or heat treatment to the affected area. The focus of this subtopic is to develop a reusable cold compress and/or heat treatment that can be stowed in its inactive state in the vehicle's ambient environment, activated to provide the desired therapeutic relief, recharged using available vehicle resources, and restowed in its inactive state for future use. This capability is desired on the International Space Station and all Constellation Program vehicles that support missions involving labor intensive tasks or exercise countermeasures. Efforts should be made to minimize the volume and mass footprint of the deployed system so that when activated and treating the patient, the patient will have mobility and free movement to continue with mission tasks and objectives. The cold compress and heat treatment capability can be provided through separate systems and does not necessarily have to be the same piece of hardware. The

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materials used shall be non-toxic in the quantities provided. Current terrestrial solutions are undesirable due to the chemicals involved, onetime use designs or requirement for pre-cooling (e.g., freezer) or pre-heating (e.g., microwave) devices.

Phase 1 Requirements: Phase 1 would include trade studies with reports and down select recommendation. A prototype is preferable.

Phase 2 Requirements: Phase 2 would deliver a working prototype and documentation packages for NASA safety and design reviews.

### **Reusable Diagnostic Lab Technology**

On-board clinical diagnostics to monitor crew member physiology must be available for both mid-term lunar and long-term Mars exploration missions. As in terrestrial medicine, devices with which to measure multiple constituents of small volume samples of bodily fluids are crucial components in assessing astronaut health. Nevertheless, mass, space, and power requirements of such devices are an obvious concern in an environment with scarce resources. Miniaturized laboratory analysis sensors represent a potential solution, given that these devices and supporting hardware are designed to be small, lightweight, and require little power. However, current sensor cartridges are typically single-use with limited shelf life. In order to satisfy the needs of longer duration exploration missions, reusable laboratory analysis sensors with increased shelf life must be designed without compromising accuracy or sensitivity. NASA seeks proposals for developing such reusable laboratory analysis sensors for analysis of bodily fluids, including blood, urine and saliva. The ability to analyze whole blood for a complete blood count with differential and hemoglobin is essential. Priority will be given to designs which also incorporate onboard detection capabilities for other analytes, such as electrolytes, lipids, proteins and hormones. Multiplexed systems providing runtime selection of the assay suite are also desirable. The detection system should minimize the use of electrical power, external optics or other infrastructure, and the use of reagents and additives. The device can rely on a PC or PDA for signal processing and display if desired, but the footprint of all other components should be tightly controlled. The best design will require minimal user interaction for processing or maintenance.

Phase 1 Requirements: During Phase 1, research should be conducted to demonstrate technical feasibility with a draft end item functional requirements document. Phase 1 will also produce documentation showing a viable path to a Phase 2 breadboard demonstration.

### **Lightweight/Compact Oxygen Concentrator**

Concentrated oxygen for medical use is a consumable that when used cannot be replenished. Due to relatively low metabolic consumption, a large percentage of the concentrated oxygen is not consumed but is instead released into the vehicle's cabin where it offers minimal medical use and is essentially wasted. This release of concentrated oxygen leads to increased ambient oxygen levels to the point where the vehicle oxygen fire limit will be exceeded. An effective solution to both these issues involves use of an oxygen concentrator that can take ambient air and re-concentrate the oxygen providing medical grade oxygen and removing excess oxygen from the vehicle cabin. However, oxygen concentrator technology to date is mostly large, massive, and power intensive. The focus of this subtopic is to develop a small, lightweight, portable oxygen concentrator that can produce concentrated medical oxygen using ambient vehicle cabin air. Of particular interest is oxygen concentration technology that can produce at minimum 60% oxygen at 4-6 liters per minute. Efforts should be made to minimize the volume, mass, and power draw of the system. The oxygen concentrator will use vehicle power as its primary source of power; however there is a brief need for battery power for when the patient is transported between vehicles. This technology is desired on ISS and future exploration vehicles supporting long duration missions.

Phase 1 Requirements: Phase 1 deliverables should include trade studies with down select criteria and recommendations for which technology will best meet the O<sub>2</sub> concentrator figures of merit. A requirements document for a Phase 2 prototyping effort should also be included.

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## **X10.02 EVA Suit Monitoring and Treatment**

**Lead Center:** JSC

**Participating Center(s):** ARC, GRC

Proposals may respond to one or more of the following areas:

### **Through-Suit Medication Delivery**

NASA operations concepts envision contingencies where astronauts may be required to wear Extra Vehicular Activity (EVA) suits for up to 120 hours. If a crewmember requires medication while in a suit, a method of administration must be developed that does not compromise the integrity of the suit, nor the environment it provides. Current concepts for the EVA suit include a self-sealing diaphragm through which injections could be given. However, fluid management in microgravity presents problems with filling a syringe and delivering medication in such an environment. The three main concerns are preventing bubbles from being injected, appropriate fluid management, and excessive volume requirements for pre-loaded syringes. Due to uncertainties about when such an event might occur, the system would have to function in the range of gravity levels between 0 to 1G, as well as pressure levels from vacuum to 1 atmosphere, and require very little volume and no power. Accordingly, NASA seeks proposals detailing concepts for such a system.

**Phase 1 Requirements:** Phase 1 would include appropriate trade studies, design concepts, and any limited laboratory proof-of-concept testing required to support Phase 2 development.

**Phase 2 Requirements:** Phase 2 would include fabrication, testing, and validation of breadboard hardware that could be delivered to NASA for evaluation at the conclusion of Phase 2. Phase 2 would be a commercial system that NASA or a prime contractor could integrate within the Exploration Medical Kit.

### **Biosensors for Lunar EVA Suits**

During surface Extravehicular Activities (EVAs), it is anticipated that the flight surgeons will need the ability to monitor heart rate, heart rhythm (ECG), derived core body temperature, and calculated metabolic rate to ensure the health and safety of the crewmember. Of particular interest are technologies that would allow data to be collected, with minimal crew time or effort required to don/doff the measurement hardware, while also maintaining crew comfort (i.e., sensors NOT involving skin preparation, gels, or taping). Also of interest are technologies/systems that would allow the collection of robust, diagnostic quality signals even during periods of strenuous lunar surface operations (lifting, climbing ladders, recovering from falls, and assembling structures).

**Phase 1 Requirements:** Phase 1 should deliver prototype functioning sensors, but not necessarily in their final form. A report showing prototype function versus a benchmark system's function will be provided. Also a roadmap to getting to the final sensor will be provided.

**Phase 2 Requirements:** Phase 2 should deliver sensors in their spaceflight-friendly, miniaturized form. Data from spaceflight analog testing using protocols delivered from NASA will also be expected.

