NASA SBIR 2009 Phase I Solicitation

X4 Structures, Materials and Mechanisms

The SBIR topic area of Structures, Materials and Mechanisms centers on developing lightweight structures, advanced materials technologies, and low-temperature mechanisms for enabling Exploration Vehicles and Lunar Surface Systems.

Lightweight structures and advanced materials have been identified as a critical need since the reduction of structural mass translates directly to additional up and down mass capability that would facilitate additional logistics capacity and increased science return for all mission phases. The major technology drivers of the lightweight structure technology development are to significantly enhance structural systems by 1) lowering mass and/or improving efficient volume for reduced launch costs, 2) improving performance to reduce risk and extend life, and 3) improving manufacturing and processing to reduce costs. The targeted applications of the lightweight structures and materials technologies are Orion Crew Module, the Ares launch vehicles, Lunar Lander, and Lunar Surface Systems. For this Solicitation, the desired area of focus is Lunar Surface Systems, particularly for Lunar habitats.

Low-temperature mechanism technology is being developed for reliable and efficient operation of mechanisms in lunar temperatures including operations in lunar shadows at -230Â°C and sustained surface operations thru varying lunar temperatures of -230Â°C to +120Â°C for lunar surface rovers, robotics, and mechanized operations. The technology drivers of the low temperature mechanism technology development are to significantly enhance operation of mechanized parts by 1) lowering the operating temperature for life of the component and 2) improving mechanism performance (torque output, actuation performance, lubrication state) at the lunar environment conditions of cold and vacuum over the required life of the mechanism. The targeted application of the technology is to provide for operation of motors and drive systems, lubricated mechanisms, and actuators of lunar rovers and mobility systems, ISRU machinery, robotic systems mechanisms, and surface operations machinery (i.e., cranes, deployment systems, airlocks) for lunar surface operations.

This topic area is to enhance and fill gaps in technology development programs in the Exploration Technology Exploration Program's Structures, Materials, and Mechanisms (SMM) Project. Areas of development included in the SMM project include: low temperature drive system, motor, and gearbox system, personal kit radiation shielding materials, low density parachute material systems, expandable structural systems, and friction stir welded spun-domes. This topic area is responsible for mid-level technology research, development, and testing through experimental and/or analytical validation.

Subtopics

X4.01 Advanced Radiation Shielding Materials and Structures

Lead Center: LaRC

Participating Center(s): ARC, MSFC

Advances in radiation shielding materials and structures technologies are needed to protect humans from the hazards of space radiation during NASA missions. The primary area of interest for this 2009 solicitation is radiation shielding materials systems for long-duration lunar surface galactic cosmic radiation (GCR) protection. The innovative materials systems should have radiation shielding effectiveness approaching that of polyethylene, for an equivalent areal density (grams per square centimeter). This can be determined either by radiation transport calculations or by radiation exposure measurements. Research should be conducted to demonstrate technical feasibility during Phase 1 and to show a path toward a Phase 2 technology demonstration. Specific areas in which SBIR-developed technologies can contribute to NASA's overall mission requirements include the following:

- Innovative lightweight radiation shielding materials and structures to shield humans in crew exploration vehicles, landers, habitats, and rovers;
- Physical, mechanical, structural, and other relevant characterization data to validate and qualify multifunctional radiation shielding materials and structures;
- Innovative processing methods to produce quality-controlled advanced radiation shielding materials of all forms.

X4.02 Expandable Structures

Lead Center: LaRC

Participating Center(s): JSC, MSFC

This subtopic solicits innovative structural concepts that support the development of lightweight structures technologies that could be applicable to lunar surface system habitats. The targeted innovative lightweight structures are for primary pressurized volumes and secondary structures that must be deployed during or after expansion of the primary volume such as the floor and work surfaces. Innovations in technology are needed to minimize launch mass, size and costs, while increasing operational volume and maintaining the required structural performance for loads and environments.

Of particular interest are inflatable structures which are considered to be viable solutions for increasing the volume in habitats, airlocks, and potentially other crewed vessels. However, areas of risk need to be mitigated to build confidence in the use of these structures, in particular: consistent and reproducible mechanical behavior, durability in the presence of micrometeoroid impact, crew-induced and ground handling damage, and repair techniques for long term survivability. Other interests include preintegration solutions, launching pressurized volume in an expandable, and addressing lunar surface deployment concerns.

Also of interest are innovative deployable secondary structures that have minimal mass and high packaging efficiency. These secondary multi-functional structures provide highly robust, stiff and mass efficient surfaces that enable the useful outfitting and pre-integration of subsystems within the primary structural volume.

Development of concepts can include structural components, methods of validation, and/or predictive analysis capabilities. Technological improvements that focus on risk reduction/mitigation, and development of reliable yet robust designs are also being sought under this announcement. Research should be conducted to demonstrate technical feasibility during Phase 1 and show a path toward a Phase 2 hardware demonstration, and when possible, deliver a demonstration unit for functional and environmental testing at the completion of the Phase 2 contract.

X4.03 Low Temperature Mechanisms

Lead Center: GSFC

Participating Center(s): GRC, JPL, JSC, LaRC

This subtopic focuses on the development of high power and high specific torque density actuators (e.g., motors and gear boxes) that will operate on the lunar surface exposed to the day/night cycle. They will need to operate over a temperature range of approximately 40 K to 403 K. A five year lifetime is desired. The component technologies developed in this effort will be utilized for rovers, cranes, instruments, drills, crushers, and other such facilities. The nearer term focus for this effort is for lunar missions, but these technologies should ideally be translatable to applications on Mars. These components must operate in a hard vacuum with partial gravity, abrasive dust, and full solar and cosmic radiation exposure. Additional requirements include high reliability, ease of maintenance, low-system volume, low mass, and minimal power requirements. Low out-gassing is desirable, as are modular design characteristics, fail-safe operation, and reliability for handling fluids, slurries, biomass, particulates, and solids. While dust mitigation is not specifically included in this subtopic, proposed concepts should be cognizant of the need for such technologies.

Specific areas of interest include innovative long life, light weight, wide temperature range motors (in the range of one to five kWatts), gear boxes, lubricants, and closely related components that are suitable for the environments discussed above.

Research should be conducted to demonstrate technical feasibility during Phase 1 and show a path toward a Phase 2 hardware demonstration, and when possible, deliver a demonstration unit for functional and environmental testing at the completion of the Phase 2 contract.