NASA SBIR 2007 Phase I Solicitation

X5.02 Lunar Regolith Excavation and Material Handling

Lead Center: JSC

Participating Center(s): GRC, JPL, KSC

The lunar regolith excavation, handling, and material transportation subtopic is intended to include all aspects of lunar regolith handling for oxygen and other resource collection and site preparation and construction including tasks such as buildup of berms (approximately 3m above grade) and burying of reactors or habitats for radiation protection (approximately 3m below grade). Excavation capability may be limited to collection of unconsolidated surface regolith for oxygen production (approximately 0.2m) or extended to extraction of more consolidated material at greater depths (approximately 3m) if the power and mass requirements for transportation of surface regolith exceed those of deeper digging. Excavation, handling and transportation systems must be operable over broad temperature ranges (generally 110K to 400K) and in the presence of abrasive lunar regolith and partial-gravity environments. Excavation and material handling systems must process 100's to 1000's of times their own mass of extracted regolith in their useful lifetimes. Expectations for maintenance by human supervision, crew operation, and crew training for these systems must be minimal and affordable. Figures of merit for lunar regolith excavation, handling and material transportation technologies and systems include: excavation and material delivery rate (kg/hr), excavation and delivery energy efficiency (power required/excavation rate), and excavation depth and berm height. To insert hardware developed as part of the SBIR program, excavation for oxygen production should support a minimum of 20 kg/hr (worst case hydrogen reduction at poles for 1 MT oxygen per year) with maximum of 200kg/hr of the top 0.2m. Excavation requirements for surface construction, habitat emplacement, reactor burial, etc. are extremely preliminary at this time are 500 to 1000kg/hr with excavation down to 3m below the surface and berm building up to 3m above the surface. Specific areas of interest include:

- Excavation technology or systems for collecting unconsolidated surface regolith with low power consumption and hardware mass. Defining interfaces requirements with surface mobility platforms (mass, power, physical attachment, traction, storage and dump apparatus, etc.) is critical. Proposals can include some aspects and demonstration of surface mobility platform efforts but should not be a significant portion of the proposed work.

- Technologies and systems for collecting regolith and its delivery to oxygen production plants that address the engineering trade offs between total system mass, power and energy consumption that arise in co-varying excavation depth and transportation distance.

- Specific technologies for stabilizing a contoured lunar surface area, including but not limited to methods to induce regolith sintering, for the purpose of providing lunar outpost site preparation capabilities.
• Specific technologies for flow of regolith in the lunar environment related to excavation, handling and transportation.

• Modeling of granular material physics in partial gravity related to regolith excavation, handling and transportation.