NASA SBIR 2005 Phase I Solicitation

S1.01 Detection and Reduction of Biological Contamination on Flight Hardware

Lead Center: JPL

Participating Center(s): ARC

As solar system exploration continues, NASA remains committed to the implementation of its planetary protection policy and regulations. A Mars sample return mission is being planned for the next decade. Other missions will seek evidence of life through in situ investigations far from Earth. One of the great challenges, therefore, is to develop or find the technologies or system approaches that will make compliance with planetary protection policy routine and affordable. Planetary protection is directed to 1) the control of terrestrial microbial contamination associated with robotic space vehicles intended to land, orbit, flyby, or otherwise be in the vicinity of extraterrestrial solar system bodies, and 2) the control of contamination of the Earth by extraterrestrial solar system material collected and returned by such missions. The implementation of these requirements will ensure that biological safeguards, to maintain extraterrestrial bodies as biological preserves for scientific investigations, are being followed in NASA's space program. Methods for the detection and reduction of biological contamination are also frequently applicable to non-biological particulate and molecular contamination. To fulfill its commitment, NASA seeks technologies and systems approaches that will support mission compliance with planetary protection requirements. Examples of such technologies include:

- Techniques for cleaning of organics to the level of nanograms per square centimeter on complex surfaces (nondestructively and without residues) and for validation of cleanliness at this level or better;

- Nonabrasive cleaning techniques for narrow aperture occluded areas on spacecraft;

- Techniques for in situ (i.e., at the exploration site) cleaning and sterilization to prevent cross-contamination between planetary surface samples;

- Nondestructive and highly efficient sampling methods for detection of the remnants of microbial, particles, and molecular contamination on cleaned spacecraft surfaces;

- Methodology for the quantitative detection of viable microbial cells in the interior of non-metallic space-craft materials;

- Rapid cleaning validation methods with ultra high sensitivity for the major classes of biomolecules: proteins, amino acids, DNA/RNA, lipids, polysaccharides, etc.;

- A device or methodology for controlled measurement of microbial reduction at temperatures from 200-300°C to enable generation of microbial lethality curves. Rapid ramp-up and cool-down rates are
critical to minimize the microbial killing that occurs during the ramp periods;

- Device or methodology for direct observation and evaluation of particles and biological contamination on spacecraft parts;

- Device or methodology for quantitative and homogeneous deposition of particles, microbial cells, and biomolecules on material surfaces for cleaning, sampling, and contamination transport studies;

- System design concepts to enable facile and rapid use of cleaning and sterilization technologies during flight hardware assembly;

- System design concepts to maintain the integrity of cleaned and sterilized complex flight systems and/or subsystems; and

- System concepts that would facilitate spacecraft sterilization at the system level just before launch or in flight.

Research should be conducted to demonstrate technical feasibility during Phase 1 and to show a path toward a Phase 2 hardware and software demonstration. The research will, when possible, deliver a demonstration unit or software package for JPL testing before the completion of the Phase 2 contract.