NASA SBIR 2009 Phase I Solicitation

X1.04 Integrated System Health Management for Ground Operations

Lead Center: ARC

Participating Center(s): JPL, JSC, KSC, MSFC, SSC

Innovative health management technologies are needed throughout NASA's Constellation architecture in order to increase the safety and mission-effectiveness of future spacecraft and launch vehicles. In human space flight, a significant concern for NASA is the safety of ground and flight crews under off-nominal or failure conditions. The new Ares Crew Launch Vehicle will provide the means to abort the crew using a launch abort system in case of a catastrophic failure during launch or ascent within a very brief timeframe and with high certainty. Health management is essential for dormant periods between human habitation, and for transition of assets (such as lunar habitats) to crewed operations. In addition, the long-duration health of software systems themselves are also critical. Projects may focus on one or more relevant subsystems such as solid rocket motors, liquid propulsion systems, structures and mechanisms, thermal protection systems, power, avionics, life support, communications, and software. Proposals that involve the use of existing testbeds or facilities at NASA are strongly encouraged. Specific technical areas of interest are methods and tools for:

- Early-stage design of health management functionality during the development of space systems, including failure detection methods, sensor types and locations that enable fault detection to line replaceable units.
- Sensor validation and robust state estimation in the presence of inherently unreliable sensors. Focus on data analysis and interpretation using legacy sensors.
- Model-based fault detection and isolation in rocket propulsion systems based on existing sensor suites during pre-launch and flight mission operations that enables fault detection within time ranges to allow mission abort.
- Automatic construction of models used in model-based diagnostic strategies, limiting model construction times to 60% of the time required using manual methods.
- Advanced built-in-tests for spacecraft avionics that provide 95% functional coverage and reduce or eliminate the need for extensive functional verification and to predict remaining life of avionics systems.
- Prognostic techniques able to anticipate system degradation before loss of critical functions and enable further improvements in mission success probability, operational effectiveness, and automated recovery of function.

- Approaches for effective utilization of 100% of the health information on critical functions from spacecraft and launch vehicles with integration to ground based systems using commercial health information from programmable logic controller and RAS system.

- Techniques that address the particular constraints of maintaining long-duration systems health of structures, mechanical parts, electronics, and software systems on lunar surfaces are of special interest.