NASA STTR 2007 Phase I Solicitation

T6 Launch Site Technologies

The purpose of this Topic is to develop technologies and concepts that will improve launch processing safety, make launch operations more cost- and time-efficient, and improve reliability of ground equipment. Improvements in launch site operations can enable airport-like efficiencies at reduced cost and shortened processing turnaround time, thereby contributing significantly to the goal of a sustained and affordable space exploration program. Topic areas that will be emphasized for improvements in launch site operations include:

- Wireless surface acoustic wave (SAW) sensors that can monitor, for example, pressure, strain, near-by impacts/structural acoustic events, acceleration, proximity, magnetic field sensors, current, electric field, hypergols (monomethyl-hydrazine or nitrogen tetroxide), and moisture;
- Active vibration isolation system effective in protecting ground processing equipment from launch environment effects to significantly reduce life cycle costs and enhance equipment reliability.

Subtopics

T6.01 Wireless Surface Acoustic Wave (SAW) Sensor Arrays

Lead Center: KSC

Wireless surface acoustic wave (SAW) sensor arrays may have significant application in the ground processing of future spacecraft. These sensors do not require an embedded power source; instead they are powered by an RF interrogation pulse. Consequently, they have the promise of being essentially maintenance free, allowing them to be installed in normally inaccessible areas and provide environmental information for many years. In addition, as opposed to microprocessor based transponders, SAW devices can be designed to operate from cryogenic temperatures up to about 1000ºC. These characteristics have resulted in interest in this technology, not only for ground processing, but recently from both the NASA research and flight centers.

The Kennedy Space Center has been supporting the development of wireless SAW sensor arrays through prior STTR activities. A new communication system has been demonstrated, namely Orthogonal Frequency Coding, that allows access to an array of SAW sensors, each with its own unique identifier. Also, temperature sensors, cryogenic level sensors, and hydrogen sensors have been demonstrated under prior year funding. These are all of interest to the ground processing community, but further development in other types of wireless SAW sensors is desired. This call requests proposals for wireless SAW sensors that can monitor, for example, pressure, strain, near-by impacts/structural acoustic events, acceleration, proximity, magnetic field sensors, current, electric field, hypergols (monomethyl-hydrazine or nitrogen tetroxide), and moisture. This list is not exclusive and other sensors may also be of interest as well. In addition, alternative communication or multiplexing concepts are of interest, and enabling technologies, such as antenna design for SAW sensors, are welcome.

Applications for these sensors are diverse. When a vehicle is moved to the pad on a mobile launch platform strain sensors and accelerometers monitor the vehicle's sway, pressure sensors could be placed under sprayed on foam insulation to ensure bonding integrity up to launch, moisture sensors could be used to determine if water has migrated into inaccessible areas. Electric field sensors might help with lightening warnings, chemical sensors can improve safety, and magnetic field or current sensors can monitor valve performance. The goal is to maximize the ability to acquire information on these and other parameters while minimizing the need for cabling, maintenance, and operator labor. Wireless SAW sensor arrays appear to promote this goal.

T6.02 Active Vibration Control for Ground Support Equipment

Lead Center: KSC

Equipment located near a major rocket launch is exposed to extreme environments including heat, unsteady rocket plume impingement, acoustics and vibration. NASA's experience shows that considerable attention to the protection of critical electronic ground support equipment housed in a mobile launch platform or on adjacent tower structures is required.

The effect of high acoustic and exhaust blast loading on the launch structures results in large amplitude motions of the structural panels, including floors supporting racks of electronics. Measured acceleration spectra vary considerably from area to area but a general characterization is that the peak frequencies lie in the range below 100 Hz and amplitudes of several g's rms or higher. Typically, electronic systems are housed in a rack structure, for example a 19-inch rack, which might be 2 meters tall and weigh in the vicinity of 500 kg. Passive vibration isolator systems required to support this weight often have natural resonance within the broad excitation spectrum of the floor, resulting in less than desirable equipment protection. One consequence is the need for extensive check out of systems after each launch and often repairs. Another consequence is the need for extensive design and qualification testing to ensure the survivability of this equipment. Development of an effective vibration isolation system will significantly reduce life cycle costs and enhance equipment reliability.

The relatively short duration of the high vibration environment suggests that an active vibration control system using locally stored energy could provide a significant improvement in suppressing vibration effects. This call requests proposals for vibration control systems that would be highly reliable and capable of sensing and reducing vibration effects in ground support electronic racks. This technology is envisioned to consist of some type of platform with actuators, passive elements (springs, dampers), sensors, and a local energy source (if required). Alternately, active isolator kits could be developed that attach to the corners of a larger platform to allow designers to support a row of racks but a method of integration to allow the control of all 6 degrees-of-freedom of the complex assembly must be provided.

Applications of this technology go beyond launch equipment to any environment requiring vibration isolation of critical equipment from episodic and intense events. These range from earthquake protection and transportation to military applications. The goal is to have a platform system that can be applied to expensive equipment where the specific vibration excitation is intense and somewhat poorly defined so that a designer can specify the system with confidence and without detailed analysis, and without requiring extensive testing of the components being protected.