



NASA SBIR 2009 Phase I Solicitation

02.02 Ground Test Facility Technologies

Lead Center: SSC

Participating Center(s): GRC, MSFC

NASA's Stennis Space Center (SSC) is interested with expanding its suite of test facility modeling tools as well as non-intrusive plume technologies that provide information on propulsion system health, the environments produced by the plumes and the effects of plumes and constituents on facilities and the environment.

Facility Modeling Tools and Methods

Developing and verifying test facilities is complex and expensive. The wide range of pressures, flow rates, and temperatures necessary for engine testing results in complex relationships and dynamics. It is not realistic to physically test each component and the component-to-component interaction in all states before designing a system. Currently, systems must be tuned after fabrication, requiring extensive testing and verification. Tools using computational methods to accurately model and predict system performance are required that integrate simple interfaces with detailed design and/or analysis software. SSC is interested in improving capabilities and methods to accurately predict dynamic responses for transient fluid structure interactions, convective, conductive, and radiant heat transfer for propellant systems, exhaust systems and other components used in rocket propulsion testing. Also of interest is the modeling and prediction of condensation, diffusion, stratification, and concentration gradients for fluid mixtures commonly encountered in testing, such as propellants and purges.

Vacuum System Technologies

Stennis is constructing the new A3 test stand which is designed to test a very large (294,000 lbf thrust) cryogenic rocket engine at a simulated altitude of 100,000 feet. When the air in the engine test chamber is evacuated, the simulated altitude pressures inside the test chamber will be less than 0.20 PSIA. This will result in a very unique environment with extremely low pressures inside a very large chamber and ambient pressures outside this chamber. Due to the unique nature of this test facility, new technologies and measurement techniques will need to be developed to monitor and analyze this environment. These include but are not limited to instrument closeouts at vacuum pressures for hundreds of channels of instrumentation entering the chamber, new sealing technologies for large cryogenic piping entering this very large test cell wall to seal against this unique environment, material fatigue measurement and predictions, inspection techniques for the vacuum chamber structures and diffuser ducting, etc.

Component Design, Prediction and Modeling

Improved capabilities to predict and model the behavior of components (valves, check valves, chokes, etc.) during the facility design process are needed. This capability is required for modeling components in high pressure (to 12,000 psi), with flow rates up to several thousand lb/sec, in cryogenic environments and must address two-phase flows.

Challenges include: accurate, efficient, thermodynamic state models; cavitation models for propellant tanks, valve flows, and run lines; reduction in solution time; improved stability; acoustic interactions; fluid-structure interactions in internal flows.

Plume Environments Measurements

Advanced instrumentation and sensors to monitor the near field and far field effects and products of exhaust plumes. Examples are the levels of acoustic energy and thermal radiation and their interaction/coupling with test articles and facilities and measurements of the final exhaust species that will affect the environment.

Major challenge: Large scale engine plume dispersion modeling and validation.

Research should be conducted to demonstrate technical feasibility during Phase 1 and show a path toward a Phase 2 hardware and software demonstration and delivering a demonstration unit or software package for NASA testing at the completion of the Phase 2 contract. Expected TRL range from 3 to 5.