



NASA SBIR 2016 Phase I Solicitation

H10.02 Advanced Propulsion Systems Ground Test Technology

Lead Center: SSC

Participating Center(s): KSC

Rocket propulsion development is enabled by rigorous ground testing in order to mitigate the propulsion system risks that are inherent in spaceflight. This is true for virtually all propulsive devices of a space vehicle including liquid and solid rocket propulsion, chemical and non-chemical propulsion, boost stage and in-space propulsion and so forth. It involves a combination of component-level and engine-level testing to demonstrate the propulsion devices were designed to meet the specified requirements for a specified operational envelope and over robust margins and shown to be sufficiently reliable, prior to its first flight.

This topic area seeks to develop advanced ground test technology components and system level ground test systems that enhance Chemical and Advanced Propulsion technology development and certification. The goal is to advanced propulsion ground test technologies to enhance environment simulation, minimize test program time, cost and risk and meet existing environmental and safety regulations. It is focused on near-term products that augment and enhance proven, state-of-the-art propulsion test facilities.

In particular, technology needs includes producing large quantities of hot hydrogen, and develop robust materials, advanced instruments and monitoring systems capable of operating in extreme temperature and harsh environments.

This subtopic seeks innovative technologies in the following areas:

- Efficient generation of high temperature ($>2500^{\circ}\text{R}$), high flowrate ($<60\text{ lb/sec}$) hydrogen.
- Devices for measurement of pressure, temperature, strain and radiation in a high temperature and/or harsh environment.
- Development of innovative rocket test facility components (e.g., valves, flowmeters, actuators, tanks, etc.) for ultra-high pressure ($>8000\text{ psi}$), high flow rate ($>100\text{ lbm/sec}$) and cryogenic environments.
- Robust and reliable component designs which are oxygen compatible and can operate efficiency in high vibro-acoustic, environments.
- Advanced materials to resist high-temperature ($<4400^{\circ}\text{ F}$), hydrogen embrittlement and harsh environments.
- 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 and model the transient fluid structure interaction between cryogenic fluids and immersed components to predict the dynamic loads, frequency response of facilities.
- 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 $12,000\text{ psi}$), 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.

- Improved capability for monitoring environmental conditions for ground and launch facilities supporting test and launch operations. Instrumentation should provide a remote sensing capability to measure atmospheric data with respect to altitude from 300 meters to at least 10 km. The technology must have a vertical measurement resolution of 150 m or smaller and a full vertical profile multiple times an hour in both cloudy and clear environments.
- Improved capability for cryogenic leak and fire detection to support ground test or launch operations.
- Non-intrusive instrumentation for measuring rocket engine plume velocities including a volumetric assessment of plume extent, volume and turbulence.

For all above technologies, research should be conducted to demonstrate technical feasibility during Phase I and show a path towards Phase II hardware/software demonstration with delivery of a demonstration unit or software package for NASA testing at the completion of the Phase II contract.