



## NASA SBIR 2019 Phase I Solicitation

### H10.01 Advanced Propulsion Systems Ground Test Technology

Lead Center: SSC

Participating Center(s): KSC

Technology Area: TA13 Ground and Launch Systems Processing

Rocket propulsion development is enabled by rigorous ground testing 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 and engine-level testing to demonstrate that propulsion devices were designed to meet the specified requirements for a specified operational envelope over robust margins and shown to be sufficiently reliable prior to its first flight.

This subtopic 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 advance propulsion ground test technologies in order 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. This project is especially interested in ground test and launch environment technologies with potential to substantially reduce the costs and improve safety/reliability of NASA's test and launch operations.

In particular, technology needs include designs for stable combustion of propellants in a duct under low pressure, high velocity conditions, developing 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:

- Robust design solutions for liquid oxygen injection and subsequent stable combustion with high temperature (5100°Rankine/2850 K) hydrogen in a duct flowing at low pressure (3-15 psia) and high velocity (~Mach 0.2)
- 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 psi), high flow rate (>100 lbm/sec) and cryogenic environments
- Robust and reliable component designs which are oxygen compatible and can operate efficiently in high vibro-acoustic environments
- Advanced materials to accommodate flow and containment high-temperature (<5100°Rankine/2850 K) hydrogen, i.e., materials resistant to hydrogen embrittlement and associated harsh environments generated by high velocity hydrogen flows
- Tools using computational methods to accurately model and predict system performance are required that

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- 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 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.

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's testing at the completion of the Phase II effort.

This subtopic is relevant to the development of liquid propulsion systems development and verification testing in support of the Human Exploration and Operations Mission Directorate (HEOMD) and supports all test programs at Stennis Space Center and other propulsion system development centers. The expected Technology Readiness Level (TRL) range at completion of this project is 4 to 6.

#### References:

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