



NASA SBIR 2011 Phase I Solicitation

02.02 Propulsion Technologies

Lead Center: GRC

Participating Center(s): AFRC, ARC, MSFC

Current launch to orbit vehicles, both expendable and reusable, require months of preparation for flight. Although there are available (in-production) practical propulsion options for such a vehicle, the costs for outfitting the booster stage are in the hundreds of millions of dollars. If reusable, additional months are required to verify all components and systems before re-flight. These costs severely limit what missions NASA can perform. The propulsion systems are a major focus during this time, yet aircraft engines are checked and certified for re-flight in less than an hour. While rocket engines actually have many similarities to aircraft engines, there are several factors that drive the complexity and therefore the cost of rocket engines. These include toxic propellants that require special protections for personnel and the environment, cryogenic propellants that require complex tank fill operations and costly specialized ground support equipment, high combustion chamber temperatures for increased performance and thrust, and high combustion chamber pressures for increased performance and reduced engine size and weight.

To move more toward low cost access to space, the above barriers to low-cost propulsion systems must be addressed and overcome. Of primary focus are non-toxic propellant combinations that provide adequate performance without requiring excessive specialized handling equipment and procedures, and engines that provide reliable and adequate performance without needing to push the far limits of temperature and pressure environments. Component technologies that move toward these top-level goals that are of interest include:

- Ablative materials and manufacturing techniques that increase capability while reducing production time and cost.
- Innovative chamber cooling concepts that reduce manufacturing complexity, reduce pressure drop, and minimize performance losses caused by cooling.
- Development of non-toxic propellants and technologies that enable their use such as catalysts, compatible materials, feed/storage systems, etc.
- Low-cost nozzle materials, manufacturing techniques, and coatings to reduce the amount of active cooling required.
- Ignition concepts that require low part count and/or low energy to be used as either primary or redundant

ignition sources.

- Manufacturing techniques that lower the cost of manufacturing complex components such as injectors and coolant channels. Examples include, but are not limited to, development and demonstration of rapid prototype techniques for metallic parts, power metallurgy techniques for the manufacture of geometrically complex parts, and application of nanotechnology for near net shape manufacturing.
- Sensors, instruments, and algorithms to diagnose the health of the engine valves, injector, igniter, chamber, coolant channels, etc. without requiring hours of manual inspections.

Specified target metrics include:

- A cost target of
- Reduced ground support equipment.
- Increased performance margin (e.g., operating temperature % of material limit, operating stress % of component limit, etc.).

These are critical technology improvements that are required in the next 3 - 8 years. Projects are required to demonstrate the component or technology to a TRL level of 5 - 6 in order to allow for infusion into low-cost earth-to-orbit propulsion systems. The NASA Office of Chief Technologist has developed Technology Roadmaps that identify technology gaps and needs to enable certain future missions. This subtopic calls for technologies that are discussed in more detail in the Technology Area 1 (Launch Propulsion Systems) and Technology Area 13 (Ground & Launch Systems Processing) roadmaps. These are available for viewing at (<http://www.nasa.gov/offices/oct/home/roadmaps/index.html>). Proposals should reference specific elements from these and other relevant roadmaps and explain how the proposed technology will address identified technology gaps and needs.

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

Phase I Deliverables: Lab-scale component or technology demonstrations and reports of target metric performance.

Phase II Deliverables: Subscale component or technology demonstrations and reports of target metric performance. Opportunities and plans should also be identified and summarized for potential commercialization.