This subtopic intends to examine a range of key technology options associated with cryogenic and non-toxic storable propellant space engines. This engine technology is solicited for use in lieu of the toxic but currently operational nitrogen tetroxide and monomethylhydrazine engine technology, which has recently seen performance improvements from 310 to 325 seconds of specific impulse using advanced rhenium thrust chamber technology. Performance improvements are a consideration, but are not the main objective of this solicitation. The Space Shuttle Orbiter Upgrade Program identified non-toxic reaction control system (RCS) propulsion as a key technology to reduce vehicle operations costs on the ground, and estimated that a significant reduction in RCS propulsion system cost is possible by the use of non-toxic propellants. In addition, the use of astronaut extravehicular activity for in-space refueling of space systems or the refueling of vehicles with humans aboard such as the International Space Station is extremely hazardous with toxic propellants. These safety concerns drive mission planners to the use of more costly propulsion modules that are fueled and sealed on the ground.

The general objectives of this solicitation derive from the NASA goals of safe, reliable, affordable and effective human and robotic missions in support of the overall U.S. Vision for Space Exploration. Successful proposals will be focused investments that systematically validate and/or invalidate key technologies and design concepts that might transform how the U.S. will pursue future space exploration goals.

The specific technology to be supported by this subtopic is multi-use in-space cryogenic and non-toxic storable propellant rockets. This technology includes the development and demonstration of key operational and performance characteristics of a range of new space engines, i.e., orbit transfer, descent, ascent, and pulsing attitude control engines. These engines can be compatible with the future use of in situ propellants such as oxygen and hydrogen or methane, but propellants consistent with low cost ground operations such as ethanol, JP-5 and nitrous oxide and monopropellants are also solicited.

Proposals are solicited for both thruster development and thruster component technologies such as, but not limited to, long-life, highly reliable ignition systems, durable, low-mass propellant injectors, and long-life combustion chamber designs. Proposals are also solicited for propulsion system component technologies such as valves, instrumentation, controls, multi-purpose structures and both electric and turbine driven pumps. Examples include, but are not limited to, highly-reliable, long-life, fast-acting cryogenic valves that tolerate high thermal loading due to heat soak-back in low-thrust, pulsing propulsion systems; cryogenic instrumentation such as pressure and
temperature sensors that will operate for months/years instead of hours; and high-reliability, long-life turbopump bearings. Technologies are also solicited that enable deep-throttling turbopumps to operate at off-design flow coefficients while eliminating flow instabilities such as cavitating surge. Examples include, but are not limited to, inducer designs that can operate with a high degree of vapor content or cavitation in the propellant flow and pump diffusion systems with reduced sensitivity to flow separations. Strategies for engine and component protection from dust, radiation, and other environmental effects are also solicited. Finally, proposals are solicited for modeling efforts that enable reduced thruster development costs and schedules.