X10.01 Long-Life Validation and Flight Qualification of Nuclear Space Systems Hardware Prior to Flight Use

Lead Center: MSFC

Participating Center(s): GRC, JPL

Nuclear space systems are expected to be an integral part of the national Vision for Space Exploration. Nuclear electric power would allow human and robotic exploration to reach beyond the constraints of solar power systems and is expected to be crucial for long-duration habitation and exploration of the Moon and Mars. Nuclear propulsion systems offer the potential for significantly higher specific impulse and/or significantly higher delta-V than chemical engines, reducing the amount of propellant and associated costs needed to perform a given mission. Nuclear thermal propulsion (NTP) systems up to several hundred megawatts and nuclear electric propulsion (NEP) systems from 30 kW to hundreds of kilowatts and more, are being considered for the economical delivery of lunar and Mars cargo, rapid crew transit to Mars, and, in the case of nuclear electric propulsion, robotic exploration of the solar system and beyond. However, the long-duration performance and life testing of these high power nuclear space systems can be very expensive and poses several unique and significant challenges. The intent of this solicitation is to elicit new or significantly improved approaches that accelerate or simplify the long-life validation and flight qualification of high power nuclear space systems hardware.

While the testing of nuclear reactors is clearly beyond the scope of this solicitation, proposals are invited for innovative methods that simplify, accelerate, reduce the cost, or otherwise improve upon current techniques to ground test and validate the life and performance of non-reactor high power space nuclear power and propulsion components, subsystems, and systems. Also invited are proposals that address new and innovative approaches to seamlessly integrate high power space nuclear power and propulsion hardware elements into complete systems of systems, with corresponding methods for flight qualification prior to flight use.

Sample high power space nuclear power and propulsion areas that could benefit from accelerated or simplified performance and life validation include, but are not limited to: electric power conversion systems for in-space or planetary surface power; electric power management and distribution systems; accelerated testing of pulsed or steady-state high power electric thrusters or thruster arrays under appropriate vacuum and thermal conditions; performance and life testing of component materials and structures under simulated NTP hot hydrogen flows; the simulated operation, shut-down, and restart of NTP system components over simulated mission profiles in relevant vacuum, thermal, and radiation test environments; other space nuclear power and propulsion hardware elements that must operate in extreme environments over extended mission durations; and simplified or accelerated techniques for hardware integration and flight qualification of a complete system of systems prior to flight use. Proposed methods should substantially and demonstrably reduce the time and expense to validate the life and performance of space nuclear power and propulsion technologies compared to state of the art techniques.