SON Number: WPSON-14-01 **October 25, 2012**

Strategic Environmental Research and Development Program (SERDP)

FY 2014 STATEMENT OF NEED

Weapons Systems and Platforms (WP) Program Area

ENVIRONMENTALLY SUSTAINABLE GAS GENERATORS AND MONO/BI-PROPELLANTS

1. Objective of Proposed Work

The objective of this Statement of Need (SON) is to develop environmentally sustainable monopropellants, hypergolic bipropellants, and gas generators that do not use hydrazines or ammonium perchlorate (AP) for rocket and missile propulsion and divert-attitude control systems (DACS). Proposals can focus on either: (1) the development of new mono/bi-propellants that do not use hydrazine, or (2) gas generating formulations that do not use hydrazine or AP. Proposed candidate formulations must meet or exceed current rocket and missile performance requirements, including tactical temperature operating range, long operational times, long term stability in an operational environment, large divert velocities, ignition delay, density, gas volume, burn rate, gas temperature, sensitivity, etc. Potential non-toxic liquid or gelled propellant technology candidates need to possess higher chemical energy than liquid hydroxyl ammonium nitrate (HAN) systems, with the goal of exhibiting at least the energy of monomethyl hydrazine (MMH) and mixed oxides of nitrogen (MON) systems. Potential solid propellant technologies need to have a low flame temperature, and need to be extinguishable and re-ignitable upon demand (i.e., to be controlled as a liquid). Proposed projects should include the development of supporting empirical data justifying performance properties of the new material(s) and evaluation of potential environmental impact properties and toxicity per ASTM Standard E2552-08, "Standard Guide for Assessing the Environmental and Human Health Impacts of New Energetic Compounds." In addition, proposed projects are encouraged to address safety concerns associated with liquid propellants, including compatibility with current fire fighting techniques and spill remediation. Proposals for engineering design for gas bottle or compressed gas technology will not be considered.

2. Expected Benefit of Proposed Work

State of the art formulations for ground and space-based systems rely on hydrazine-based monopropellants and hydrazine- or AP-based gas generators for use in propulsion systems and DACS. At this time, there are no qualified alternatives to liquid hydrazines. Many hydrazine-derivatives are probable carcinogens, as well as highly toxic, corrosive, and reactive. Production, handling, and transport of hydrazine is strictly controlled by workplace safety and transportation regulations. Loading of hydrazine derivative propellants requires extensive personal protective equipment including supplied controlled air for the operators. Furthermore, corrosive hydrazine requires costly maintenance and monitoring for storage containers or loaded items. Perchlorates have been shown to have adverse human health effects and are under

increased regulatory scrutiny. Alternatives to hydrazine and AP will reduce the storage costs and handling hazards, sustain rocket and missile manufacturing, and reduce potential warfighter and worker exposure to hazardous materials.

3. Background

The Department of Defense (DoD) and industry use mono/bi-propellants for a variety of applications, generally in gas generators or small thrusters in rockets, missiles and satellites, including Missile Defense Agency (MDA) systems for theatre defense. Gas generators, both liquid and solid, produce large volumes of relatively cool gas which can be used in small propulsion units in rocket motors (DACS), to deploy airbags, and in some cases to generate large volumes of gas to push a turbine or piston - the same function as a pressurized gas bottle, with less weight and size constraints.

Hydrazine is effective in both monopropellants and bi-propellants due to the relative ease of ignition either by decomposition over a catalyst or hypergolically. This can in turn generate cool gas and small molecular weight products of combustion, which are ideal in overall performance of the rocket motor. Hydrazine derivatives like MMH or unsymmetrical dimethylhydrazine (UDMH) are generally more stable than hydrazine over a wide temperature range and are more commonly used in DoD applications. Applications in high altitude or space systems require operational performance over an extreme temperature range. Along with the gas generators, hydrazines are used in auxiliary power units and emergency power units (e.g., F-16 aircraft).

Increasing concern over the environment, safety and occupational health (ESOH) impacts of hydrazine have in some ways slowed expanded use of liquid propellants. Hydrazines are categorized as probable carcinogens and are known to be highly toxic, corrosive and reactive. Due to the corrosivity of MMH, storage containers and weapons systems that contain MMH must be monitored for degradation to ensure safe storage and use and often require advanced sensors to detect leaks. Due to these safety and material toxicity issues, the U.S. Navy currently will not store, use, or transport MMH on their ships. However, multiple agencies have amplified their mission needs to include a critical need for liquid propellants and specifically hypergolics in order to meet threat hazards of the foreseeable future. The cost of working with hydrazine and its derivatives is steadily increasing due to strict health and environmental regulations concerning use and transportation of the propellants. In particular, under the European Union (E.U.) Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) regulation, hydrazine has become a Substance of Very High Concern and is listed on the Candidate List. Hydrazine could be added to the Authorisation List upon further evaluation, which would mean it cannot be used or sold in the E.U. without prior authorization. Novel gas generators are needed to ensure sustainable rocket and missile production into the future, as there are no qualified alternatives for many hydrazine applications.

Several solid propellant gas generators have been proven in the field as alternatives to hydrazine. These formulations are primarily based on AP. Solid propellants do not provide the same level of mission flexibility as liquid propellants and will not serve as an effective alternative to hydrazine from both a mission and environmental perspective. Key DoD and space applications require precise throttling systems that so far cannot be attained through solid propellant systems. Additionally, perchlorates are coming under increased scrutiny in the national regulatory

community. Although there are no federal drinking water regulations for perchlorate as of October 2012, several states have set drinking water limits for perchlorate and the EPA has initiated the process to establish a national primary drinking water regulation.

In addition to current mission capabilities, novel gas generators can be used to advance a number of inherently insensitive rocket and missile propulsion technologies. Non-traditional gelled or liquid propulsion systems require a gas generator to mix fuel and oxidizer. By separating the fuel and oxidizer in the propulsion system, as opposed to an intimately mixed solid propellant, the system itself becomes less sensitive to external threats. The development of hydrazine-free and AP-free systems with an environmentally sustainable, low detonable liquid propellant will reduce worker and warfighter exposure to hazardous materials; reduce operating, maintenance and reporting costs for current rocket and missile production facilities; and support further development of more environmentally sustainable rocket and missile propulsion technologies.

4. Cost and Duration of Proposed Work

The cost and time to meet the requirements of this SON are at the discretion of the proposer. Two options are available:

Standard Proposals: These proposals describe a complete research effort. The proposer should incorporate the appropriate time, schedule, and cost requirements to accomplish the scope of work proposed. SERDP projects normally run from two to five years in length and vary considerably in cost consistent with the scope of the effort. It is expected that most proposals will fall into this category.

Limited Scope Proposals: Proposers with innovative approaches to the SON that entail high technical risk or have minimal supporting data may submit a Limited Scope Proposal for funding up to $150,000 and approximately one year in duration. Such proposals may be eligible for follow-on funding if they result in a successful initial project. The objective of these proposals should be to acquire the data necessary to demonstrate proof-of-concept or reduction of risk that will lead to development of a future Standard Proposal. Proposers should submit Limited Scope Proposals in accordance with the SERDP Core Solicitation instructions and deadlines.

5. Point of Contact

Bruce D. Sartwell
Program Manager for Weapons Systems and Platforms
Strategic Environmental Research and Development Program (SERDP)
4800 Mark Center Drive, Suite 17D08
Alexandria, VA 22350-3605
Phone: 571-372-6399
E-Mail: Bruce.Sartwell@osd.mil

For Core proposal submission due dates, instructions, and additional solicitation information, visit the SERDP web site at www.serdp-estcp.org/Funding-Opportunities/SERDP-Solicitations.