**SON Number: WPSON-23-C6** **28 October 2021**

**Strategic Environmental Research and Development Program (SERDP)**

**FY 2023 STATEMENT OF NEED**

**Weapons Systems and Platforms (WP) Program Area**

# ALTERNATE, ENVIRONMENTALLY-FRIENDLY PROPULSION CONCEPTS FOR HIGH PERFORMANCE

## 1. Objective of Proposed Work

The objective of this Statement of Need (SON) is to investigate novel energetics formulations or engineering approaches in propulsion systems to meet current and future mission requirements across the Department of Defense (DoD), while substantially reducing or eliminating ammonium perchlorate (AP), and completely eliminating RDX and isocyanates.

Requirements for this notional system include a high performance tactical rocket motor that is 10″ diameter by 90″ long, where length is measured from the forward dome of the motor pressure vessel to the exit plane of the nozzle, and is typically loaded with a solid aluminized composite propellant (AP & aluminum) to maximize total impulse. Assuming a very high volumetric loading efficiency, differences in motor case design, and nozzle configuration, the propellant load-out for this hypothetical motor is theoretically in excess of 300 lbs, and potentially up to 315 lbs. Maximum theoretical delivered impulse is approximately 80,000 lbf-s. Replacement of the current aluminized composite propellant solution with one that eliminates AP is the goal. Propulsion and/or formulation solutions should be proposed for a 10-inch diameter form factor, delivering comparable total impulse. In propulsion solutions that deviate from traditional solid propellants, such as hybrid or liquids, ancillary components like tankage, valving, gas generators, etc., should be considered and discussed in the proposed effort. Expected propellant data for this notional approach will require the normal characterization (below) in order to validate the assumptions.

**Propellant Characterization Requirements**

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| Sensitivity | Impact, friction, ESD, autoignition |
| Strand burning rate, in/sec | 100-5000 psi |
| Physical properties | Viscosity (as appropriate), CLTE, cure shrinkage |
| Mechanical properties | Stress, strain, modulus |
| Small motor verification testing | Burning rate/thrust from -45 to 145F |

Proposals addressing this SON should utilize a systems approach whereby alternative ingredients are tested in appropriate formulations with coupled engineering solutions rather than as drop in replacements to meet explosive or propulsive performance.

Material substitutions must result in at least equivalent performance and less risk to the environment. Full proposals will be required to include at least a preliminary assessment of the human health and environmental impacts of proposed ingredients, formulations, and byproducts. These proposals should establish a baseline lifecycle framework and identify the elements of a life cycle inventory that are already known, those that will be investigated during the course of the project, and those that are beyond the scope of the proposed work. Proposers are also encouraged to consider effects of higher temperature operational conditions.

This SON is not addressing new molecules, rather new formulations that might utilize new materials in concert with legacy approaches. It is expected that unique propulsion concepts including (but not limited to) bipropellants, hybrids, air-breathing, ducted rockets and electrically-initiated concepts would be considered.

## 2. Expected Benefits of Proposed Work

This SON opens the trade-space for alternate propulsion approaches that do not utilize AP, RDX, or isocyanates but still meet the performance envelopes for current and future high-performance propellants in terms of effect on faster time-of-flight (TOF) and increased range, ballistic flexibility and service life without introducing toxic ingredients or degrading insensitive munitions (IM) performance. Program Managers, installations, and warfighters across all services would benefit from a significant decrease in AP, RDX and isocyanate exposure in production, training and operational use of many tactical rocket motors. Decreased use of these materials will sustain production capability, training and demilitarization of rockets and missiles by reducing staff removed from service due to exposure. DoD is impacted by regulation from the U.S. and its NATO allies due to Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) regulation which could impact foreign military sales or operations in the EU. This SON also will support the Army's Modernization Priorities by providing increased performance and long term sustained availability of propellants for the Long Range Precision Fire, Lethality and Air and Missile Defense Cross-Functional Teams (CFTs).

## 3. Background

AP, RDX, and isocyanates are ubiquitous within the DoD. AP and RDX have been identified as environmental risks due to mobility in groundwater from contaminated surfaces. Combustion of AP produces hydrochloric acid (HCl) and chlorine gas, which are hazardous air pollutants (HAPs). Rocket motor testing and demilitarization can be regulated by Title V air permitting due to HAP emissions. Additionally, individual states have regulated perchlorates in drinking water. Isocyanates as a family are potentially toxic, carcinogenic and sensitizing. They are known to cause occupational asthma, irritation of the skin and eyes and other occupational concerns. Isocyanates are increasingly regulated through REACH, which results in industry moves to more sustainable alternatives.

There are currently no known viable alternatives for AP as the main oxidizer in solid rocket propellants. Although alternative oxidizers exist that do not contain perchlorates, the alternatives suffer from cost, availability, stability, and performance issues that prevent them from being viable alternatives. In order to identify a viable replacement, individual tactical missile systems requirements must be considered due to the wide range of performance requirements of the entire

U.S. tactical missile arsenal.

**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 3 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 $250,000 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**

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For Core proposal submission due dates, instructions, and additional solicitation information, visit the Funding & Opportunities page on the SERDP website.