 Strategic Environmental Research and Development Program (SERDP)  

FY 2020 STATEMENT OF NEED  

Weapons Systems and Platforms (WP) Program Area  

ENVIRONMENTALLY BENIGN ROCKET PROPELLANTS

1. Objective of Proposed Work

The objective of this Statement-of-Need (SON) is to develop lead-free insensitive rocket propellant formulations. Proposals should focus on one of the following objectives:

- Develop lead-free extruded double base propellant in a 2.75” configuration that meets or exceeds current Hydra/Zuni performance.
- Develop lead-free castable propellant minimum smoke (MS) propellant for close combat applications that meets current state of the art (SOTA) performance (density impulse ~16+) without using RDX or isocyanates (preferred but not required).
- Evaluate novel thermal stabilizers which do not form hazardous byproducts.

Propellants should be compatible with current processing requirements and deliver comparable performance in terms of effect on time-of-flight, range, ballistic flexibility, and service life. New propellants must also result in a reduction in overall lifecycle impact compared to existing propellants and meet insensitive munition (IM) requirements. Proposals submitted in response to this SON should include development and characterization of the new formulations to include assessment of sensitivity, compatibility, strand burning rate data, thermal/mechanical properties, scaling up to gallon or larger batches, and testing in four by four or equivalent sub-scale test motors to collect burning rate/thrust across full operational temperature range.

In addition, proposed efforts should include an evaluation of novel stabilizers to capture NO radicals in the propellants that do not form carcinogenic n-nitroso-n-alkylanilines (e.g., para-nitro-N-methylaniline [pNMA], p-nitro-N-ethylaniline [pNEA]) or n-nitrosodiphenylamines (e.g., diphenyl amine [DPA], 2-nitrodiphenylamine [2-NDPA]) that have been proposed for regulation in the European Union (EU). These stabilizers must be thermally stable up to 90°C. In addition, newly proposed stabilizers must have similar if not better and longer lasting shelf-life than current stabilizers. Proposals should show plans and calculations to demonstrate this attribute.

Proposals must include a go/no go task for an initial assessment of the human health and environmental impacts of proposed ingredients, formulations, and byproducts. In addition, proposals should include a task to establish a baseline lifecycle framework and identify the elements of a lifecycle 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.
2. Expected Benefits of Proposed Work

Program Managers, installations, and warfighters across all services would benefit from a significant decrease in lead exposure in production, training and operational use of many tactical rocket motors. Decreased lead exposures will sustain production capability, training and demilitarization of rockets and missiles by reducing the number of workers, warfighters and trainers removed from service due to increased blood lead. Propellants that produce carcinogenic \(n\)-nitrosamines may be regulated in the EU under the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) regulation and 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.

3. Background

Exposure to lead has been reported to produce a number of acute and chronic health effects, including damage to the central nervous system, cardiovascular system and immune system, even at very low levels and through multiple exposure routes. Warfighters also can be exposed during air and ground training at installations. This becomes a concern not only for the military, but for the community in and around the installations as well. Lead can enter groundwater when emitted from fired rockets and missiles settles to the soil. Lead may be released in wastewater from production facilities from equipment wash-down, clean-up or energetic production, if not properly treated. Workers at rocket and missile propellant manufacturing or load-assemble-pack (LAP) facilities may be exposed to lead through inhalation or accidental ingestion. Fines and training restrictions may be levied on installations if levels of lead in ambient air exceed the National Ambient Air Quality Standard (NAAQS) limits or if operational exposures exceed the occupational exposure level (OEL) for lead.

Lead beta-resorcylate (LBR), lead oxide and various lead-copper complexes can be found in the range of one to ten percent by weight in many extruded double base and MS propellants as burn rate modifiers. Nitramines (e.g., RDX and HMX) are used in MS propellants to increase performance. Extruded propellants are typically used for aviation applications (e.g., Hydra or Zuni) and castable MS propellants are typically used for high performance, close-range rockets and missiles, such as the Tube-launched, Optically tracked, Wire-guided missile (TOW) and the Javelin missile, because they leave little to no visible signature. The TOW and Javelin rockets are fired in close proximity to the warfighters (i.e., shoulder or vehicle launched) and present a unique exposure risk. Warfighters need to train with rocket and missile propellants that contain lead to mimic realistic operational environments. This introduces an inhalation risk in ambient air for warfighters and the population around training installations.

Current stabilizers incorporate aromatic amines or aromatic urea derivatives such as DPA, 2-NDPA, Akardite II and ethyl centralite, pNMA, and pNEA in propellant formulations. Research has been performed internationally for newer and better stabilizers. Epoxidized oils, a class of stabilizers with plasticizer properties (no nitrosamine formation), various substituted phenols,
citrates, etc. have all been studied. While these stabilizers are effective, it has been found that the effectiveness is short-lived and the shelf-life of formulations often comes into question. There is the potential for EU REACH Authorization or Restriction of N-nitrosamine forming materials.

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 $200,000 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 [SERDP website](#).