1. Objective of Proposed Work

The objective of this Statement of Need (SON) is to develop innovative scalable synthetic approaches leading to production of energetic materials and their precursors that will eliminate or drastically reduce hazardous waste streams from nitration processes and other synthesis steps that are widely used in manufacturing energetic materials. Typical nitration processes of aromatic compounds, amines, and alcohols to produce C-Nitro, N-Nitro or Nitrate ester based energetics involve large quantities of strong acids (sulfuric and nitric) and produce large quantities of hazardous wastes. Solvents used in the preparation of these compounds are contaminated with the energetic material, hazardous reagents, or reaction by-products and are not easily recycled. Multi-step reactions often lead to low overall yields or non-useful by-products. In addition, typical reactions require rigorous temperature control and are therefore energy intensive processes.

Proposals should focus on one of the following processes:

- Synthesis of an aromatic/heteroaromatic nitro compound (e.g. TNT, DNAN)
- Synthesis of a nitramine (e.g. RDX, HMX, CL-20)
- Synthesis of highly strained or cage compounds
- Synthesis of high nitrogen compounds
- Synthesis of a nitrate ester (plasticizer) (NG, TMETN, etc. or nitrocellulose)

Proposals also will be considered for more broad-based research to develop the fundamentals of synthetic methodologies as related to energetic materials with no specific targeted compounds. Proposed methodologies will need to be innovative and need to go beyond the previously investigated methods of recycle and reuse of solvents/reagents.

Desired technology attributes include:

- Demonstration of efficient process/es
  - Reduction or elimination of solvents
  - Improved yields
  - Inexpensive and commercially available starting materials
• Improved lifecycle cost
• High purity isolated product/s
• Experimentation on production relevant equipment or equipment that can be scaled to production or pilot levels
• Compliance with relevant quality and performance specifications

A successful project would produce enough material to complete product comparison using standard evaluation protocols. At a minimum, this should include small scale sensitivity, crystallography, spectroscopy, compatibility and performance for relevant applications (e.g., detonation velocity, detonation pressure, burn rate, etc.). In the past, SERDP and other DoD agencies have explored electrochemical and biological methodologies as well as hybrid pathways involving combinations of synthetic biological and organic synthesis to produce energetic materials or to explore novel nitration pathways. Review of past efforts and relevant literature is advised.

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

Advanced synthesis techniques will enable the DoD to sustain production of explosives and propellant ingredients and their precursors. All current methods to synthesize explosives and propellant ingredients, and precursors involve significant amount of solvents and result in the need to dispose of spent solvent as hazardous waste. Alternative synthesis methodologies could minimize hazardous waste at the initial stages of production and also could improve safety of operations.

3. Background

The synthesis of energetic materials has been carried out for more than a century using large amounts of solvents and mixed acids, resulting in the necessity of disposing of solvent and spent acid after the reactions are complete. If a solvent is not used in synthesis, then often one of the liquid reagents is used in large excess to serve as solvent. The traditional approach to environmental concerns has been to recycle the solvent or the excess reagent. Recycling a solvent (or a reagent) comes with its own set of issues, including cost and ensuring the purity of the recycled solvent. While such approaches may reduce the amounts of hazardous waste, they do not completely eliminate it.

Energetic materials that are used in DoD weapons systems are produced in quantities of millions of tons. A majority of explosives and propellants used in DoD weapons systems contain organic nitro compounds in the form of aliphatic, aromatic, carbocyclic and heterocyclic compounds containing C-NO₂, N-NO₂ and O-NO₂ functionalities. These compounds are made via nitration reactions at some stage of the synthesis. The nitration reactions at large scale are often carried out using nitric acid, mixed acid (mixture of nitric and sulfuric acid) and nitrate salts. Over 10
million pounds of spent acid is either released or treated at Army Ammunition Plants per year.

The Weapons Systems and Platforms Program Area supports development of technologies and processes that are associated with the manufacture, operations, and maintenance of military equipment, weaponry, and munitions. These lifecycle stages of a system may impact workers, the environment, and surrounding communities. Increasing the sustainability of these systems offers opportunities to identify and manage these impacts to lower associated lifecycle costs and improve mission readiness.

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](#).