SON Number: WPSON-23-C3 **28 October 2021**

Strategic Environmental Research and Development Program (SERDP)

FY 2023 STATEMENT OF NEED

Weapons Systems and Platforms (WP) Program Area

DEVELOPMENT OF ADVANCED MILITARY COATING SYSTEMS

1. Objective of Proposed Work

The objective of this Statement of Need (SON) is to develop, identify, assess, determine applicability, and test innovative, advanced protective topcoat compositions within military organic coating stack-ups. The effort's purpose is as follows:

- Improve substrate protective operational and technical properties,
- Require fewer resources,
- Retain or improve lifecycle characteristics, environmental sustainability, and economical viability, and
- Reduce current and future regulatory risk.

Proposals should specifically address how their solution improves coating lifecycle and weapon system compliance to applicable environmental (40 CFR, Parts I and VII) and worker Occupational Health and Safety (29 CFR, Chapter XVII) regulations when compared with current and legacy systems. Numerous U.S. (Federal and State) and International proposed and formal regulations (e.g., European Union's persistent organic pollutants (POP) and REACH) are increasingly restricting future availability of higher risk chemistries. Regulatory drivers increase and complicate current/legacy composition technical, supply and operational risks going forward. Target compound examples include, but are not limited to, per- and polyfluoroalkyl substances (PFAS) and isocyanates.

Any successful alternate material and/or technique proposal shall meet, as a baseline, current operational and technical coating and stack-up requirements. The proposer shall address how their proposed composition effectively meets or improves upon the requirements of topcoat military specifications and, at a minimum, address the following characteristics and risks:

- Scalability, less complex application, curing and/or stripping technique(s) or method(s)
- Reduced complex chemistry or composite configurations/layers
- Achieve military weapon system operational and substrate protective properties
- Achieve application throughput
- Achieve energy efficient coating methods and techniques that can reduce friction, thus improving air/water flow dynamics (e.g., roughness, thickness, texturing)
- The ability to selectively strip or apply coatings
- Reduce lifecycle regulatory burden and risk

Proposals must clearly document material/composition reduction target(s) and substrates. In addition, a skeleton material and test methodology leading to a concept validation demonstration that baselines against legacy and current military and commercial corrosion protection and control (CPC) materials, techniques and practices must be documented. Proposals shall address the proposed solution's technology, its military risk profile, and a plan to reduce current technical and manufacturing maturity. Proposals shall also provide any existing product technical support data, and anticipated improvements to military operational and readiness levels.

Proposals should include a formal task to assess the composition's lifecycle human health and environmental impacts addressing proposed ingredients, formulations, and byproducts.

2. Expected Benefits of Proposed Work

Program Managers, installations, and Warfighters across all services would benefit from new, innovative, and improved advanced coating materials and techniques for weapons systems, reduced worker and environmental regulatory risks, improved asset operational performance and readiness, and improved application/removal production and field throughput characteristics.

3. Background

Legacy military protective coatings utilize chemistries and application techniques that require significant amounts of labor while having negative regulatory and operational impacts. Coating systems often incorporate or employ hazardous precursors, constituents or processes during their lifecycle. These constituents frequently exhibit heavy metal or organic toxins and/or high organic laden chemistries incorporating multiple human and environmental risk factors.

The military spends annually as much as $20B on weapon system corrosion prevention and control coatings, a significant percentage of which is due to topcoat weathering and failure. Current and legacy DoD CPC coating(s) fail to fully meet worldwide military protection requirements. Existing coating systems involve multiple compound processes and material systems where manufacturing, re-manufacturing, field and depot application, maintenance and removal techniques directly contribute to and significantly affect military weapon system lifecycle costs and operational readiness.

Many high performance military grade exterior topcoats use or are based on polyurethane and/or fluorinated chemistries to improve physical, operational and material characteristics. Target topcoats include MIL-DTL-53039 and MIL-DTL-64159 used on ground vehicles and Army helicopters and the US Navy's extended weathering (MIL-PRF-85285 Type IV) aircraft coating used on Navy and Air Force helicopters and airplanes.

The target coatings exhibit excellent military exterior applications properties. However, the organic coating products and precursors are experiencing increased negative focus regarding their lifecycle human health and environmental risk going forward. In a previous assessment, the military coating market was estimated at well over 2,000,000 gallons per year. Even at 0.1% hexamethylene di-isocyanate (HDI) by weight, it represents more than 2,000 pounds HDI per year. Topcoats formulated without di-isocyanates would make DoD topcoat operations more sustainable with respect to human health and the environment.

Military polyurethane coatings are formed through reaction of polyols with poly-isocyanate compounds, typically HDI. Di-isocyanate compounds are coming under increased regulatory scrutiny as dermal and inhalation sensitizers/irritants, and chronic exposure to di-isocyanates has been associated with asthma and lung damage. Many current and proposed regulations target the aromatic compounds methylene diphenyl di-isocyanate (MDI) and toluene di-isocyanate (TDI) rather than the aliphatic HDI, primarily because MDI and TDI usage and emission is in significantly larger volumes. However, the impetus for regulation is the fact that MDI and TDI are common to spray-applied adhesives, sealants, and coatings, so it is reasonable to anticipate similar regulatory actions against spray-applied HDI coatings in the future. All three compounds (MDI, TDI, and HDI) are regulated hazardous air pollutants (HAPs) under the Clean Air Act. It should be noted that existing topcoats could be labeled accurately as "organic HAP-free" if the weight percent of HDI monomer is less than 1%, which is the required reporting threshold for non-carcinogenic ingredients on safety data sheets. Still, the continued use of HDI-based topcoats is not conducive to the long-term sustainability of military weapons systems. Gaps exist in coatings formulations and processes/techniques that can produce nearly undetectable amounts of low molecular weight isocyanates. Additionally, gaps exist in alternative chemistries. Various alternative chemistries have been explored, such as cyclocarbonate-amines, but slow cure times without the use of regulated toxic catalysts remain problematic.

Despite numerous attempts to find alternative compositions, limited transition progress has been made in reducing military coating lifecycle regulatory risk. Subsequently, regulatory and political interest has increased.

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 $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.