**SEED SON Number: WPSEED-15-02** **November 7, 2013**

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

**FY 2015 SEED STATEMENT OF NEED**

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

# DEVELOPMENT OF A LOW CONTACT RESISTANCE PASSIVATE FOR ELECTRICAL SYSTEM COMPONENTS

The SEED Solicitation is a means for researchers to test a proof of concept during an effort of approximately one year.

## 1. Objective of Proposed Work

The objective of this Statement of Need (SON) is to develop technologies for the passivation of corrosion resistant coatings used in Department of Defense (DoD) electrical system components that do not use hexavalent chromium. Proposed technologies should meet or exceed the performance of current, hexavalent chromium containing passivates and must be compatible with Low Hydrogen Embrittlement (LHE) alkaline zinc-nickel (ZnNi) coatings. Electrical connectors employing these technologies should have a consistent shell-to-shell contact resistance of <2.5mΩ before, and <5mΩ after corrosion testing, as required by MIL-DTL-38999L, Class Z, Section 3.29. An improved technology will also provide low contact resistance and will avoid build-up of resistive corrosion products in ZnNi-coated connectors. In addition, a passivate that is compatible with ZnNi coatings will permit the use of ZnNi on electrical connector backshells, as well as steel components used in electrical equipment which also have low contact resistance requirements for grounding.

## 2. Expected Benefits of Proposed Work

The elimination of hexavalent chromium and cadmium is a high priority for DoD. A low impedance, hexavalent chromium-free passivate that is compatible with ZnNi coatings would permit the use of ZnNi as an alternative to cadmium on military and aerospace electrical components such as connector backshells and steels used in vessels, vehicles, electrical generators, and other systems where good electrical grounding is essential. The applications for these technologies span all weapons systems that utilize electrical connectors. The environmental and occupational safety and health benefits of implementing these alternative technologies would be realized throughout the life-cycle of the weapons systems in which they are used. Worker exposure to cadmium, cyanide, hexavalent chromium, and other toxic materials used in the cadmium plating process would be reduced in the manufacturing and maintenance of these components. The overall hazardous waste stream associated with the weapon system would also be reduced at the end of the component's service life.

## 3. Background

Electrical assemblies and connectors are integral parts of almost all weapons systems. These electrical systems have requirements for corrosion resistant surfaces with low electrical contact resistance. In order to ensure proper grounding, low connector resistivity is required at all times, even after exposure to a corrosive environment. To meet these requirements, most aircraft electrical

boxes are manufactured from aluminum alloys that are chromate converted (MIL-DTL-81706B, Type I, Class 3), while most electrical connector shells are manufactured from aluminum, steel or composite that are cadmium-plated and chromate converted (e.g. MIL-DTL-38999L) for corrosion protection and to provide galvanic compatibility with aluminum structures. Electrical components on ground support equipment and vehicles are frequently made of mild steel, with chromate-conversion and cadmium plating on components where corrosion protection with electrical contact is needed.

A number of non-chromate passivates for aluminum meet the electrical requirements of MIL-DTL-81706B, Type II, Class 3 and are on the Qualified Product List (QPL)-81706. MIL-DTL-38999L and a number of other connector specifications have been updated in the last few years to permit the use of various sacrificial coatings in place of cadmium, including electroless nickel-polytetrafluoroethylene (PTFE), high purity aluminum, and zinc-nickel. Electroless Ni-PTFE meets all of the electrical requirements, but is galvanically dissimilar to aluminum connector shells and structures.

LHE ZnNi appears to be a viable alternative for most applications of cadmium plating, and is now being qualified for use on landing gear and other aerospace components. ZnNi coatings can be particularly hard and damage-resistant, and have similar galvanic performance to cadmium, making them suitable sacrificial coatings for steel. While chromate conversion coatings on aluminum, cadmium, and cadmium alternatives such as ZnNi meet contact resistance requirements, there are no commercial non-hexavalent chromium containing passivates for ZnNi that consistently do so. This is because passivates for Zn and ZnNi are thicker and have higher impedance. As a result, conductivity can be marginal, and hexavalent chromium containing passivates are required on current, commercially available ZnNi-coated connectors. This inability to meet the required contact resistance specifications inhibits the use of non-chromate passivated ZnNi as a replacement for cadmium on electrical connector backshells and other electrical components.

## 4. Cost and Duration of Proposed Work

To meet the objectives of this SEED SON, proposals should not exceed $150,000 in total cost and approximately one year in duration. Work performed under the SEED SON should investigate innovative approaches that entail high technical risk and/or have minimal supporting data. At the conclusion of the project, sufficient data and analysis should be available to provide risk reduction and/or a proof-of-concept. SEED projects are eligible for follow-on funding if they result in a successful initial project.

## 5. Point of Contact

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