PROJECT ID:
581

Assessment of Cadmium Alternatives for Connector Applications

Degraded wires from the V-22 Osprey Full Authority Digital Engine Control (FADEC) and Flight Control Wiring.

Degraded connectors.

The V-22 Osprey Automated Wiring Test Set (AWTS) will act as the test bed for this NESDI project.

(All photos compliments of NAWC-AD Patuxent River Wiring Laboratory.)

OBJECTIVE:

The project is assessing the performance issues surrounding zinc-nickel and other cadmium-alternative plating technologies for Electrical Wiring and Interconnect System (EWIS) components. Conductivity, wear resistance and corrosion resistance will be assessed including the questions associated with the mating and demating these components with legacy cadmium-plated components.

PROBLEM STATEMENT:

Cadmium is regulated as a heavy metal because of its toxicity to humans and wildlife. The Department of Defense (DoD) has targeted cadmium for elimination or reduction to minimize the human health and safety risks associated with the plating process and the potential exposure to cadmium dust as the plating corrodes.

Cadmium-plated, Class W, electrical connectors qualified to the MIL-DTL-38999 specification are widely used throughout the DoD for aviation and ground support equipment applications. Alternative finish classes have been qualified to this specification, but have met resistance due to inferior field performance, logistics and the lack of a commercially-available supply.

Specifically, Class T (nickel-fluoropolymer) and Class Z (zinc-nickel) are considered the best cadmium replacements. However, the qualification methods for MIL-DTL-38999 do not fully capture the corrosion and environmental degradation that is experienced in real world settings. A new round of laboratory and field testing on current commercially available cadmium alternatives is needed that better represents the service environments these finishes will experience. While Class Z finishes are being tested and validated to be replacements for cadmium on structural steel, they have not been explored for DoD functional applications in the area of EWIS components.

DESCRIPTION:

This project will evaluate the most promising cadmium replacement finishes for Navy applications. There are two main components to this project.

Task one will assess performance and supply chain logistics of existing cadmium alternatives. The Defense Logistics Agency will facilitate an engineering practice study to determine where and how Class T and Class Z finishes are being utilized. Based on the results of the study as well as current usage and supply data, the team will identify leading candidates to replace cadmium. Information will then be gathered from other ongoing, concurrent testing projects at U.S. Navy facilities

that are examining cadmium and cadmium alternative EWIS connector finishes. Based on data from these two sources, the team will conduct laboratory suitability testing on the most suitable connector finishes.

One finish, an emerging Low Hydrogen Embrittlement zinc-nickel formulation, originally developed for structural applications, has undergone some evaluation by the U.S. Air Force. It has yielded very good results and will be included in the test matrix for this effort.

Simultaneously, the team will build a new connector assembly testbed called the Navy Electrical System Testbed (NEST) so that alternative plating processes can be tested and evaluated in usage scenarios representative of the harsh environments experienced by aircraft connectors. The NEST will be designed around the MIL-DTL-38999 connector family, since it is the most common in the Navy fleet. This capability could be expanded to include other connector families.

This new testbed would allow DoD to fully validate the performance of cadmium-alternative connector assemblies in extreme environments before transition to critical aircraft applications.

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This type of test asset is unique both commercially and within the DoD. The developed technology should be patentable and will be a valuable capability to all DoD commands that operate in corrosive environments.

TRANSITION DESCRIPTION:

Transition paths for the developments under this project include clarification of the finish callouts in existing specifications to remove the variability that yields poor performance; requalification to the new standard would require the testing of interconnected EWIS systems. Potential updates to Navy documents may include QPLs, military specifications, materials and process requirements and material/finish design guidance documents; a new Tier 1 standard and test method for EWIS qualification; and a Naval Air Systems Command authorization letter for the use of a cadmium alternative for connector applications.

The technology developed during this project will be patented if practical. Short-term transition will be for internal DoD use only, however future development and qualification process changes may allow for commercialization and broader applicability. An operator's manual will be developed in conjunction with the NEST unit and provided to all transition sites. Personnel from the Qualified Products Laboratory at the Naval Air Warfare Center – Aircraft Division (NAWC-AD) in Patuxent River, MD will be able to leverage this asset into wiring system qualification testing and future proces improvements.

CONTACT:

For more specific information about this project, contact the Principal Investigator at 732-323-5303. Contact the NESDI Program Manager at 805-982-4893 for more general information about the program.

ABOUT THE NESDI PROGRAM

The Navy Environmental Sustainability Development to Integration (NESDI) program is the Navy's environmental research and development demonstration and validation program, sponsored by the Chief of Naval Operations Energy and Environmental Readiness Division and managed by the Naval Facilities Engineering Systems Command from the Engineering and Expeditionary Warfare Center in Port Hueneme, CA. The mission of the program is to provide solutions by demonstrating, validating and integrating innovative technologies, processes and materials and by filling knowledge gaps to minimize operational environmental risks, constraints and costs while ensuring Navy readiness and lethality.

Visit the program's public website at https://www.navfac.navy.mil/NESDI for more information.