

# SUCCESS STORY

**TOPIC NUMBER:** AF071-320

**SBIR INVESTMENT:** \$3,516,139

**PHASE III FUNDING:** \$7,978,512.14



## DEVELOPMENT OF CADMIUM PLATING REPLACEMENT WITH ZINC NICKEL ON HIGH STRENGTH STEEL COMPONENTS

*ES3 developed an environmentally safer and higher quality corrosion preventative coating for landing gear that is fast becoming the standard for not only the Navy's fleet, but commercial aircraft as well.*

**ES3 (Engineering & Software System Solutions, Inc.)**

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## THE CHALLENGE

Cadmium (Cd)-plated coatings are commonly used in military aircraft structures, engines, propellers, actuators, and landing gear systems to protect these components from their high-stress demanding and corrosive environments. Cadmium has long been the coating of choice for high strength steels (HSS), threaded components and fasteners; however, it is a highly toxic heavy metal that causes harm to the user and to the environment, not only during the plating process, but throughout the lifecycle of the part. For over 30 years, scientists and engineers were unsuccessful in finding an alternative to this dangerous material. ES3's work on a Phase I SBIR award led to a novel solution that could replace this toxic technology.

## THE TECHNOLOGY

ES3 knew of an existing zinc-nickel (Zn-Ni) plating process in the automotive industry, and believed they could develop that technology to meet the specific needs of the aerospace industry. Together, in collaboration with Dipsol and original equipment manufacturers, the company optimized the process and successfully applied it to the military aerospace industry. The new coating proved to be even better and more durable than cadmium, and unlike cadmium, does not leach into the environment or lead to negative health effects for the user during normal maintenance operations.

## THE TRANSITION

ES3 was awarded multiple Phase IIIs with various agencies, including several contracts from the Naval Air Warfare Center Aircraft Division Lakehurst, worth nearly \$8 million. Under these contracts, ES3 will be replacing Cd-plated components with its optimized Zn-Ni coatings at the three Navy Fleet Readiness Centers. In addition, the Navy is moving toward replacing the use of cadmium coatings with Zn-Ni for approved applications on multiple T/M/S. ES3 also has Phase III contracts with other services that total more than \$40 million and the company has successfully replaced thousands of parts on several military aircraft T/M/S.

## THE NAVAL BENEFIT

The biggest benefit has been the replacement of a known carcinogen that causes extensive damage to humans and to the environment. The soft nature of the coating makes it nearly impossible to perform maintenance operations without toxic material getting on the operator's clothes and skin. The Zn-Ni coating completely eliminates that hazard while providing even better corrosion protection on parts. Unlike Cd, it doesn't rub off and stays where you put it. This extends the overhaul time period, and there is significantly less damage and corrosion on critical parts. Another benefit is that the Zn-Ni coating can not only replace Cd-coatings, but other coatings, such as Alumiplate coating and ion vapor deposition aluminum coating, which makes it a much broader solution. Another application for Zn-Ni is in high temperature environments in which Cd plating would melt right off and cause dangerous liquid metal embrittlement on the applied substrate. Zn-Ni can handle higher operating temperatures without breaking down or losing its structural integrity for use in high temperature applications.

## THE FUTURE

ES3 is continuing to work with NAVAIR on completing its various Phase III contracts with other commercial aircraft manufacturers to implement the technology on aircraft landing gear. While ES3 does not make a royalty on the process (they made a choice to make it widely available for all to utilize), the company sells its internally developed software, called VENUS, which allows ES3 to design and manufacture the conformal plating anodes needed for the coatings. VENUS predicts how thick the coating will be with different conformal anode designs—a prediction that must be correct, otherwise there may be too thin of a coating in certain areas which leads to premature corrosion damage to components. This has developed into a successful part of the company's product suite, and they will continue to work with various end users on both the coatings and the software.