OSHKOSH

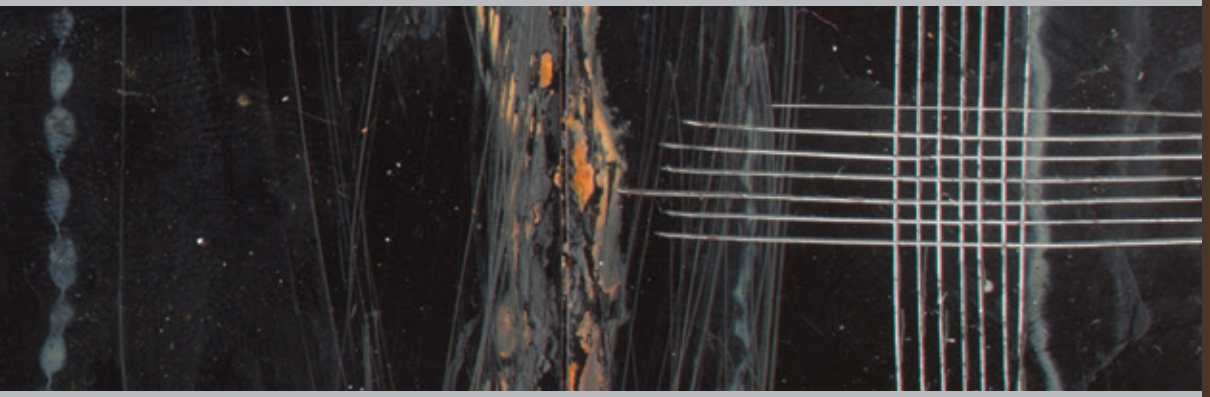
FINISHING SERVICES

ELECTROCOATING

THE PATHWAY TO SUPERIOR, COST-EFFECTIVE CORROSION MANAGEMENT FOR THE ARMED FORCES

PROTECTING AGAINST CORROSION

Unprotected Cold Rolled Steel



E-Coated Cold Rolled Steel

Corrosion has a crippling effect on all armed services. It grounds jets, dry-docks ships and keeps trucks in the shop. Altogether, the Pentagon spends about $23 billion annually fighting corrosion on these and other critical military assets (High Cost of Waging War on Rust, part 2). The true cost, however, comes with inoperability as these assets are temporarily decommissioned while anti-corrosion measures are applied.

The United States Army and the United States Marine Corps have both adopted the electrocoating (E-Coat) process as their premier coating system for corrosion protection. This durable, consistent and cost-effective system has proven its value after decades of use in the automotive and heavy equipment industries. E-Coat combined with a zinc phosphate conversion coating has also provided the United States Army with a 22-year service life for its Family of Medium Tactical Vehicles (FMTV).

When compared to other coating systems, the E-Coat standards and system standout with remarkable benefits.

- Lower applied cost
- Higher corrosion protection performance
- Significant environmental benefits

E-Coat technology should be made available to all five of our Armed Forces to help protect against corrosion. The first step is for the Department of Defense to adopt a specification recognizing E-Coat as an approved primer system.

PROBLEM: THE TRUE COSTS OF CORROSION

Corrosion impacts vehicles, equipment and structures beyond their operation. It affects the reliability of these assets and the safety of our Warfighters. In addition to the over $23 billion annual expense to fight corrosion, a 2009 study found that corrosion was responsible for taking up to 16% of military assets out of action (Improved Corrosion Prevention, Jack E. Edwards Pg. 1).

At the invitation of the United States Navy, Oshkosh Corporation toured naval vessels in Norfolk, Virginia on November 7, 2013, and received a firsthand account of some of the corrosion issues facing the United States Navy today.

1. Unprotected FMTVs experience corrosion as shown in detail photos A and B.
2. Paint loss caused by a repair installation.
3. Bends and curved edges are critical points for corrosion protection.

In Norfolk, Oshkosh and Navy officials toured a five-year-old ship with two years in service. Points of rust were visible throughout the vessel with various causes. The root cause for this rust, however, was a coating failure instigated by high film buildup. The paint loss on the louvered panel in **Figure 2** was set in motion during a repair installation. The coating failure in turn caused the paint to become brittle. When the paint cracked, bare substrate was exposed leading to the rapid spread of rust. This example shows that one coating is not sufficient protection without a corrosion barrier. Exposed surfaces with E-Coat have a significantly reduced risk of corrosion after any and all kinds of repairs.

Edges and tight bends are complex geometries that are difficult if not impossible to cover with manual applications. **Figure 3** shows where moisture has found a weak point on an edge. The points of corrosion on and around critical areas of sealing demand great attention. The Oshkosh E-Coat system is capable of handling such geometries with long-term success (this process is explained later in detail).

Similar issues were problematic for the Army's original FMTV program. Corrosion began penetrating the cabs' sheet metal within three years. By the time this failure was identified, the Army had already taken possession of 4,955 trucks. The estimated cab replacement cost to meet the ten-year warranty called out by the contract was $31 million. This single issue caused delivery delays in the original FMTV program requiring a two-year extension. When Oshkosh was awarded the FMTV contract and E-Coat became a mandatory requirement, the Army's corrosion issue was successfully resolved (Army Medium Trucks – Information on Delivery Delays and Corrosion Problems).

THE SOLUTION: PROACTIVE CORROSION PREVENTION THAT SERVES THE DEPARTMENT OF DEFENSE

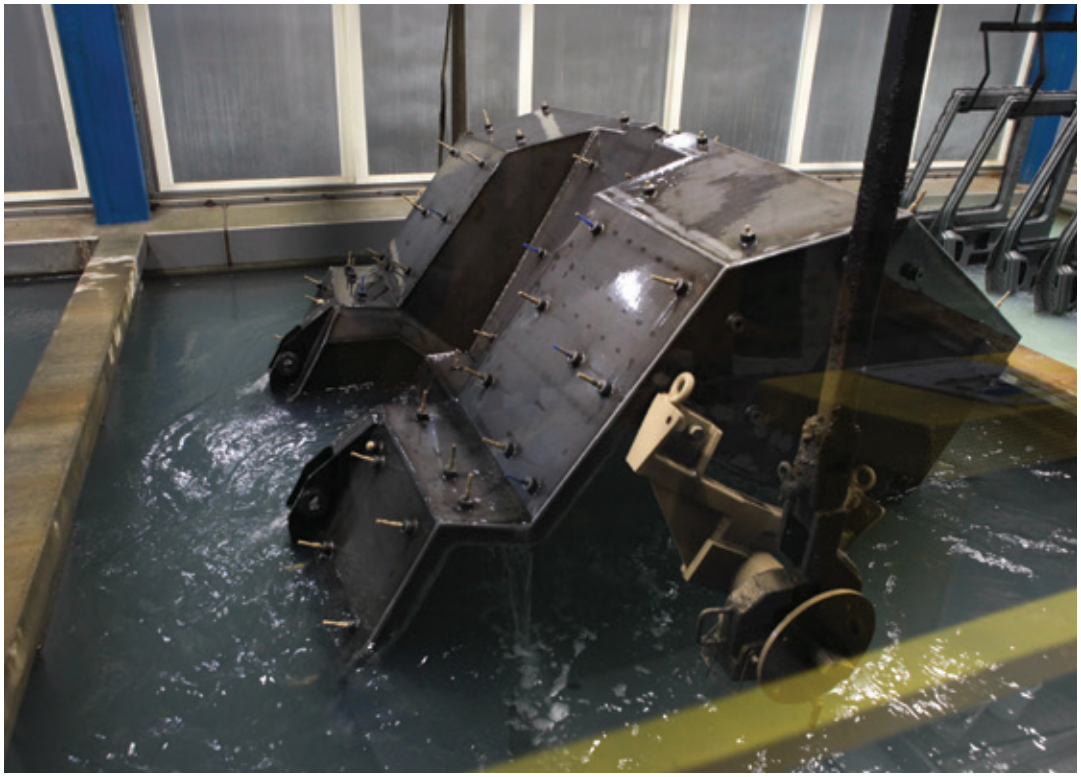
The best defense against corrosion is a proactive offense. Incorporating a strategy of prevention during the design and manufacturing phase of critical military assets will help to extend the service life of equipment without increasing, and perhaps even decreasing, acquisition costs.

However, the 2013 Facilities and Infrastructure Corrosion Evaluation Study found new corrosion mitigation technologies are reluctantly used because of the risk of failure and fear of losing scarce resources (DoD Raps Corrosion Training Technology, Pg. 3). Unfortunately, resistance to implementing proven corrosion prevention technologies such as E-Coat is costing DoD billions of dollars each year.

E-Coat mitigates corrosion risk with an exceptional cost-performance value based on decades of testing and real-world performance in countless applications and a wide range of weather conditions. From construction and agricultural equipment to fire and rescue vehicles, automobiles and buses, E-Coat is the method of choice for durable corrosion protection. A significant amount of research, testing and field applications are available for the DoD to review, including the long-term FMTV program specified by TACOM (TTC-490 and MIL-DTL-53084) to provide a 22-year service life. The data can be used to identify applications for which E-Coat will improve the service life of equipment.

Oshkosh has been building FMTVs for the US Army since 2010.

THE OSHKOSH E-COAT SYSTEM



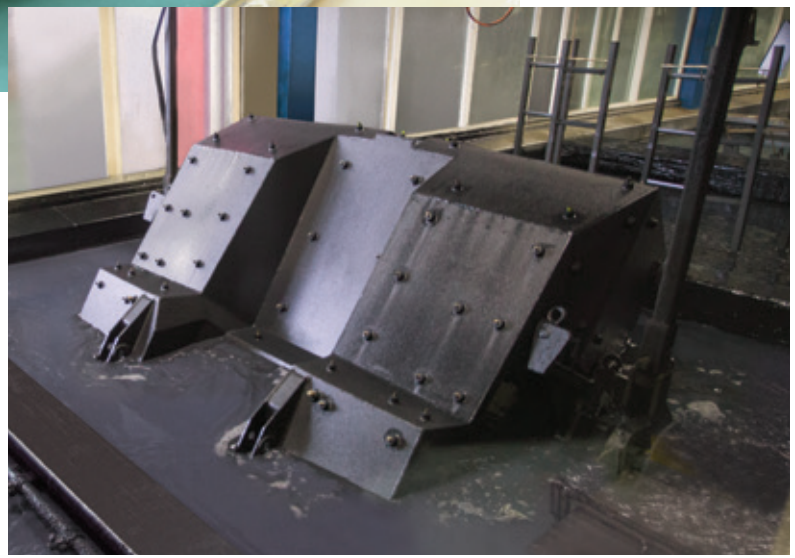
Superior corrosion protection with the Oshkosh E-Coat system comprises a five-step process and three integral, preventive barriers. Once in the field, a vehicle's first line of defense against corrosion is a UV resistant topcoat. The workhorse of the entire application is the electrocoat primer with its superior bonding ability. Finally, if corrosion penetrates the other two barriers, the zinc phosphate conversion coating prevents the corrosion from spreading.

Step 1

A series of pretreatment stages will automatically remove contaminates, including oils and scale, to prepare the substrate's surface. The automation of an E-Coat system ensures there will be no potential for contamination as the product moves to the zinc phosphate conversion coating.

Step 2

The zinc phosphate coating prevents a small problem from becoming a large problem. It prevents the spread of rust if the coating is damaged severe enough to expose bare substrate.



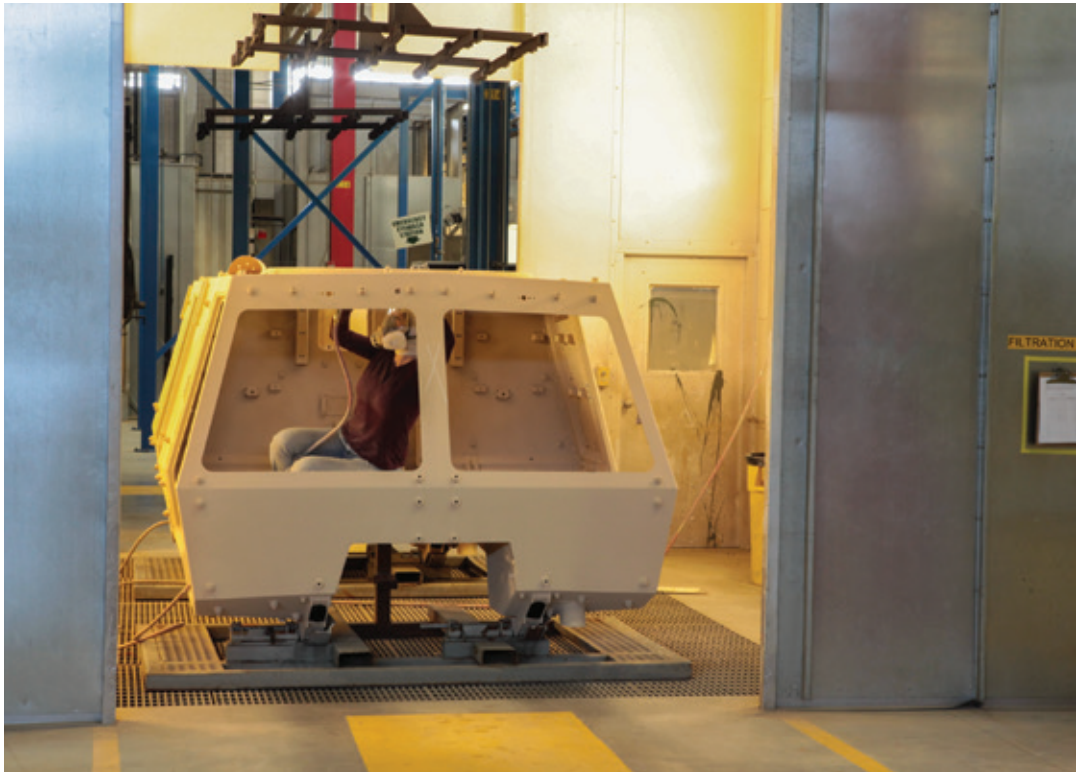
Step 3

The E-Coat epoxy primer corrosion barrier is applied through an immersion process, which is superior to spray application primers. Immersing the product in a bath of paint allows complex geometries to be coated completely, even in areas not visible. The result is an even film build, as well as uniform coverage and thickness without runs, drips or sags. Attracting the paint to the product using electrodeposition ensures uniformity in the film build. The process is extremely effective because surface areas already coated become insulated, allowing charged particles to seek out the bare substrate. Conversely, this control is completely dependent upon the operator in a spray application.

THE OSHKOSH E-COAT SYSTEM CONT.

Step 4

After the primer is applied, it is fully cured by heating the part to an optimal temperature of 350° F for 20 minutes. The coating has a much higher resistance to chips, scratches and abrasions than a chemical cured primer, which can take between 24 hours and seven days to cure.



Step 5

The topcoat provides superior protection to UV light, preventing color fade. This barrier is not just for cosmetic purposes; it provides extra protection for the E-Coat corrosion barrier. While all epoxy primers degrade in UV light and lose their performance ability, E-Coat is exceptionally capable of receiving the customer's preferred topcoat technology. Due to the E-Coat system's seamless automation, the product is never exposed to contamination or periods of waiting before receiving the E-Coat primer. The Oshkosh E-Coat system further reduces exposure to potential contaminates and eliminates non-value added material handling with an integrated topcoat application.

THE RESULT: SUPERIOR 22-YEAR CORROSION RESISTANCE

Powder Coat Over E-Coat
1660 Hour Salt Spray Testing

BEFORE & AFTER

Localized corrosion at the scribe line, while the powder coating remains adhered to the E-Coat panel.

Direct Powder Coat To Metal
1660 Hour Salt Spray Testing

BEFORE & AFTER

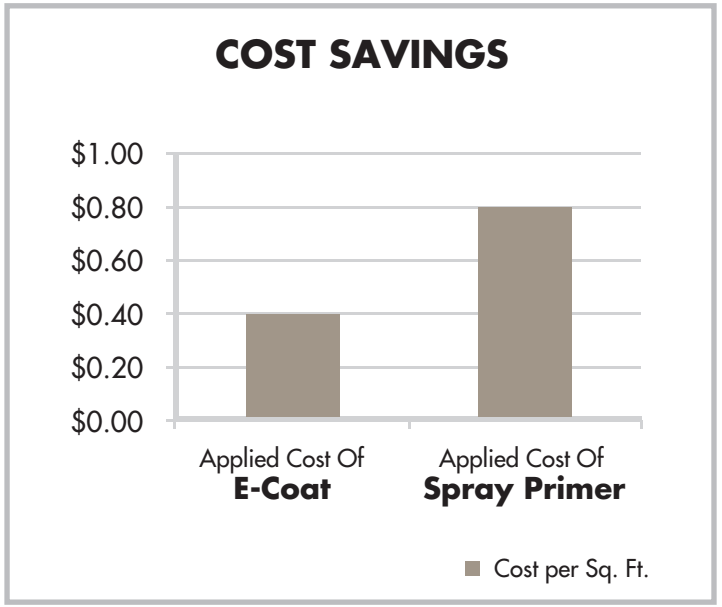
The panel after testing exhibits significant paint peeling at the scribe line and corrosion around the edges.

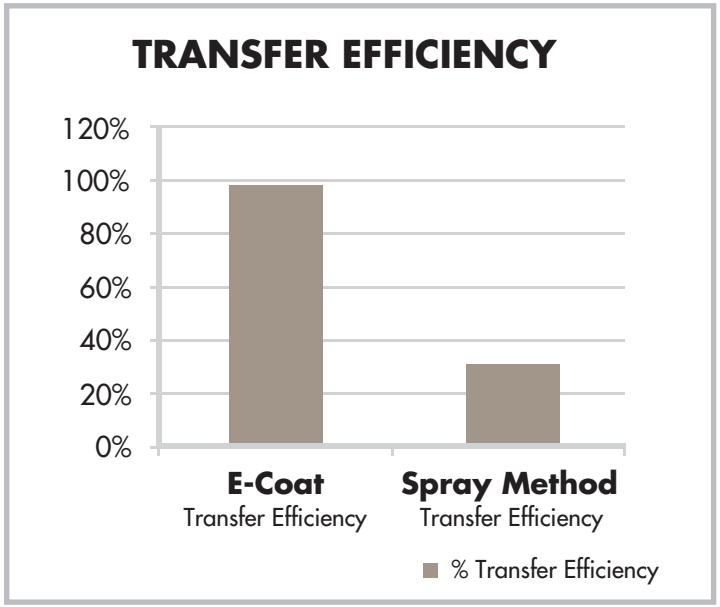
Oshkosh Finishing Services (OFS) internal testing shows passing results at 1,500 hours or 150% of the required performance in TTC-490 (ASTM B117 salt spray). This performance isn't restricted to pristine metals or high-grade alloys used in the automotive industry. It is applied to unique metals used for armor, structural steel and mild steels. E-Coat has been applied to other substrates such as galvanized, aluminum and high-strength alloys for years with similar performance results. The salt spray performance requirements in military specs such as the Navy's MIL-PRF-236236D and MIL-PRF-32171B are only 300 and 336 hours respectively.

THE BENEFITS: LIFECYCLE COST SAVINGS

The Oshkosh E-Coat process uses high efficiency processes and materials to drive its cost effectiveness. Its epoxy primer material is generally 25% less expensive than typical spray primers, and its transfer efficiency is 98% versus a spray application's 30-50%. This is made possible through ultrafilters that create a closed loop counter flow in which paint solids rinsed off in the post rinses are returned to the paint tank (Why Choose E-Coat).

The automation required to process materials through electrified baths also reduces the labor content. The applied cost of E-Coat is approximately $0.40 - $0.60/sqft as opposed to a spray primer with an applied cost of $0.80 - $1.00/sqft.



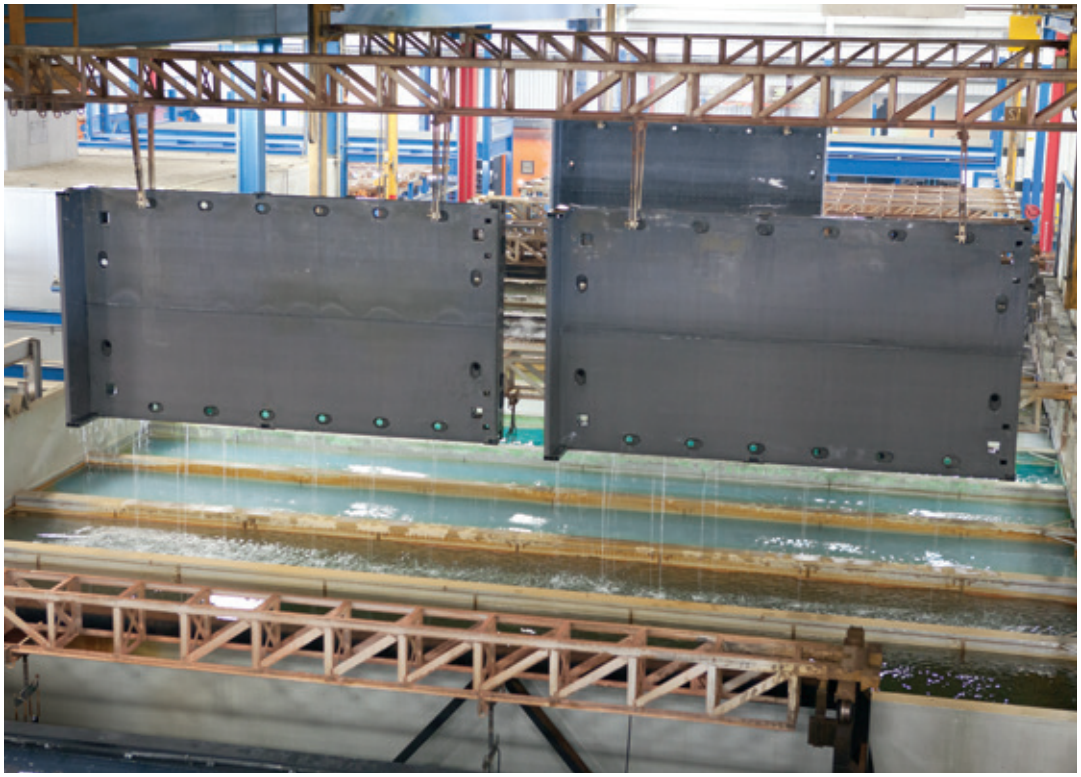


ENVIRONMENTAL ADVANTAGES

The Oshkosh E-Coat processes reduce hazardous pollutants and waste with more environmentally friendly materials compared to typical liquid spray applications.

- Volatile organic compounds (VOC's) as low as 0.17 lbs./gal. compared to 1.8 – 3.5 lbs./gal. (Powercron 6000CX Technical Data Sheet)
- Zero hazardous air pollutants (HAPs) (Powercron 6000CX Technical Data Sheet)
- Closed loop operation
- Less solid waste
- Zero hazardous liquid waste
- Reduced fire hazard with water based materials

NEXT STEPS: ACCELERATING REQUIREMENTS



With the DoD's increasing emphasis on total lifecycle costs on today's procurement programs, corrosion is a significant cost factor. Adopting E-Coat into the requirements for future equipment procurements or equipment recapitalization programs is the critical first step to implementing this efficient, cost-effective technology.

- TTC-490 is the specification used by the United States Army and United States Marine Corps to define the application of zinc phosphate and the performance of E-Coat in the ASTM B117 salt spray test.
- MIL-DTL-53084 is the specification that defines the performance criteria of the E-Coat material itself.

When making E-Coat part of the total lifecycle cost strategy for procurement, it is important to define the E-Coat specification for potential contractors at the earliest possible phase of product development. Introducing E-Coat at the Technology & Development (TD) or Engineering and Manufacturing Development (EMD) phases, including validation of capabilities during the

Manufacturing Readiness Review, will allow contractors to design the equipment and production workflow with E-Coat considerations in mind. Throughout the procurement process, from prototype to full rate production, rigorous E-Coat testing can be performed to ensure the requirements are achieved. From day one, this proactive approach will minimize procurement and operations and maintenance (O&M) costs associated with corrosion. Equipment designed for a corrosion free lifespan will greatly improve the equipment performance and reduce the equipment costs for years to come.

Vehicles, equipment and structures currently in service can benefit as well. In these instances, parts properly stripped to the bare substrate begin at step one in the process. These assets can realize the same performance and cost efficiencies of the E-Coat process, extending the service life of the equipment our service men and women rely on.

OFS would welcome the opportunity to E-Coat reman parts from ships and vehicles currently using inferior corrosion protection solutions. Side-by-side comparisons of E-Coated equipment next to materials with inferior coatings would demonstrate the extended life a fleet could realize.

With part windows up to 36 feet long and capacities up to 5,000 pounds per load, a joint effort between OFS and the DoD could evaluate the cost impact on problem parts such as cabs, truck frames, ship ladders, hatches, etc. The opportunity is also available to test a variety of topcoat technologies. OFS is currently working on a value added proposition for E-Coating the cab of FHTV. Expectation is that an improved coating will be delivered at a cost savings over the current process.

MEET THE EXPERTS.
TOUR THE FACILITIES.
SEE THE RESULTS.

- Visit Oshkosh Defense and OFS for a demonstration of the E-Coat process, its capabilities and efficiencies.
- Send part samples to OFS to be E-Coated at our state-of-the-art facilities.
- Test the exceptional quality of E-Coat on the sample parts to DoD standards. The E-Coat results will standout among alternative coating methods.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CONCLUSION

Corrosion is impacting the safety and functionality of military vehicles, equipment and structures. The DoD spends $23 billion every year to prevent and repair this corrosion and could realize significant benefits by adopting E-Coat as a standard requirement for equipment made from steel, armor, aluminum, iron alloys and galvanized materials. Using E-Coat as the standard approach for corrosion prevention lowers applied cost compared to other coating systems, significantly reduces equipment lifecycle costs, provides higher corrosion protection performance and offers environmental benefits.

The E-Coat process was originally adopted over 40 years ago by the commercial and automotive industries, and more recently by the United States Army and the United States Marine Corps. With complete coverage and high durability at a cost effective price, E-Coat should be made available to all Armed Forces in their fight against corrosion. The first step is creating or adopting zinc phosphate and E-Coat specifications.

Implement E-Coat in the design and manufacturing of critical military assets so our men and women in the Armed Forces can rely on the safety and operation of their equipment to complete every mission.

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