

ARMY RESEARCH LABORATORY



**Demonstration and Validation of a Replacement Alternative
to the Chromate Wash Primer DOD-P-15328D**

by Pauline Smith, Kestutis Chesonis, and John Escarsega

ARL-TR-3756

April 2006

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**Pauline Smith, Kestutis Chesonis, and John Escarsega
Weapons and Materials Research Directorate, ARL**

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1. Introduction

The purpose of the DOD-P-15328D (2001) wash primer is to enhance corrosion resistance through the passivation of the metal surface. In the U.S. Army's chemical agent resistant coating (CARC) system, the metal surface is coated with a wash primer, overcoated with an epoxy primer, and followed by a camouflage urethane topcoat. Several coating procedures specify the use of the wash primer, DOD-P-15328D, as a surface treatment prior to the application of an epoxy primer/polyurethane topcoat CARC system. The current wash primer is a low-solids, solvent-based polyvinyl butyral that contains phosphoric acid and zinc chromate that promotes adhesion and minimizes corrosion. This coating contains large amounts of volatile organic compounds (VOCs) and hazardous air pollutants (HAPs) that impact coating operations due to air pollution regulations that may require the use of control devices to reduce the total VOC/HAP emissions to the atmosphere. The U.S. Army Research Laboratory (ARL) has evaluated new, water-reducible wash primers that do not contain hexavalent chromium and significantly minimize VOC and HAP potential emissions during coating operations. Coatings have been extensively tested for accelerated corrosion and adhesion and have successfully completed 3 years of outdoor exposure testing. Tests are now required on military equipment to validate the lab and controlled testing previously completed. The ultimate objective of the process is to demonstrate that the low VOC wash primers can provide a "drop-in" solution to the environmental issues associated with the solvent-based primer currently in use, providing equal or better performance, involving no significant changes to the application and stripping procedures currently being used.

The field demonstration of this coating was prepared on a Patriot truck unit, with serial number (SN) 630106, and was conducted at the Letterkenny Army Depot (LEAD) facility. The unit is an Engagement Control Station (ECS).

2. Objective

The objective of the test is to demonstrate that the new wash primer meets or exceeds performance levels of the current wash primer and involves no significant changes to the application and stripping procedures currently being used when applied to hardware deployed in the field. The demonstration will validate that the new wash primers can be applied and stripped utilizing existing equipment and processes at the depots. Success will be measured by demonstrating the "drop-in" nature of the new wash primer. Tests are required on military equipment to validate the lab and controlled testing previously completed.

2.1 Site/Facility Description

LEAD is part of the U.S. Army Aviation and Missile Command and is an industrial-based facility primarily responsible for performing depot level maintenance on missile hardware systems in addition to military hardware from other customers. Maintenance activities are performed on the Patriot; Hawk missile; tube-launched, optically-tracked, wire-guided missile; Avenger; and multiple launch rocket system weapon systems, support hardware, and Army vehicles. This includes painting and depainting activities.

2.2 Technology Description

Wash primers are characteristically thin 0.3–0.5-mil (1 mil = 0.001 in), cross-linked coatings applied directly to the substrate to provide protection from corrosion and promote adhesion. The CARC system application specification, MIL-P-53072C (1992), requires that metal surfaces on tactical vehicles be treated to improve adhesion and corrosion resistance prior to coating with an epoxy primer and a camouflage topcoat. In original equipment manufacturer (OEM) processes, the surface treatment is generally performed by a five-stage immersion process (e.g., zinc phosphate prescribed in TT-C-490 [2002]).

In depot operations and for spray application touch-up in OEM processes, the surface treatment requirement is often met through the wash primer DOD-P-15328D, particularly when components are too large to dip for alodine or zinc phosphate pretreatment. In the Army's CARC system, the wash primer is overcoated with an epoxy primer and a camouflage urethane topcoat. Several coating procedures specify the use of a wash primer, DOD-P-15328D, as a surface treatment prior to the application of an epoxy primer/polyurethane topcoat CARC system.

Painting and depainting activities are governed by regulations, both on the Federal level and the state level. The state of Pennsylvania controls VOC emissions. The Environmental Protection Agency requires a significant reduction in HAP emissions under a new regulation called the Defense Land Systems and Miscellaneous Equipment and also regulated by the National Emissions Standards for HAPs. The current wash primer formulation contains 7.1% zinc chromate and has 6.5 lb/gal of VOC that are classified as HAPs. Based on the total Army usage estimated of 21,000 gal/year, the following pollution is annually generated: 12,600 lb of zinc chromate and 35,700 gal of package/thinner solvents. Upon paint removal or stripping, the chromate wash primer, together with the CARC paint, generates hexavalent chromium-contaminated paint waste. This paint waste must be disposed as a chromium-containing hazardous waste. Annually, ~6,000,000 lb of stripped CARC waste is produced. It costs ~\$0.61/lb to dispose of chromate-bearing paint waste, costing ~\$3,600,000 annually. It has been estimated that elimination of the chromate from the paint waste would eliminate the need to dispose of it as a hazardous waste, thereby reducing the disposal costs by two-thirds, or savings of \$2,400,000 annually. ARL's Coatings Technology Team has already reformulated all of the camouflage CARC to meet local and Federal regulations. LEAD currently spends over

\$100,000 per year on an environmental control unit primarily for the purpose of controlling VOCs emitted from wash primer coating operations.

ARL has tested several candidate coatings to replace the currently used wash primer. Aqua Zen by Hentzen, Kem Aqua by Sherwin-Williams, and RWE1033 by Spraylat all performed equally or better than the legacy wash primer. These water-reducible wash primers do not contain hexavalent chromates and significantly minimize VOC and HAP potential emissions during coating operations. The new wash primers are water-borne acrylic latex with corrosion inhibiting pigment and are designed for use under MIL-P-53030A (1992), a water-reducible, lead and chromate-free, epoxy primer.

Since these wash primers have been successfully tested in the laboratory, a field demonstration is the next step in qualifying the coating for implementation on field hardware; Patriot hardware will be the subject of this demonstration.

2.3 Demonstration Setup, Commencement, and Operation

There are no special site-preparation activities, including equipment setup, analytical instrumentation, and required utilities.

The Patriot shelter unit is primarily aluminum on the sides. The aluminum sides have been patched where necessary to seal surface with Bondo,* which is basically a filler material. All sections of the aluminum sides on curbside rear and roadside front were replaced. These replacement surfaces were alodized prior to positioning on the shelter. The corner brackets, steps, side brackets, and corner loops/"O" rings are steel and were welded or bonded to the unit using a polysulfide sealer. The air-conditioned unit was previously primed and top-coated with CARC, color, Tan 686A. All electrical areas were sectioned with cardboard and scotched taped.

The surface prep is to sponge blast the entire surface. Prior to paint, the spot rusts were hand sanded. The entire surface was blown down with compressed air. The air conditioning shelf was not blasted on the top and bottom and on the two brackets. This is a standard practice depending on the condition at time of overhaul.

2.4 Equipment

The spray equipment was a Binks model 7 conventional gun, attached to a pressure pot at 10 psi and 60-lb air pressure at the spray gun.

The room was conditioned initially at 78 °F and 50% humidity.

The candidate wash primer is Sherwin-Williams, Kem-Aqua, coded E61G520. A water-reducible wash primer does not contain hexavalent chromates and significantly minimize VOC and HAP potential emissions during coating operations. This new wash primer is water-borne

*Bondo is a registered trademark of Bondo Corporation, Atlanta, GA.

acrylic latex with corrosion-inhibiting pigment, designed for use under MIL-P-53030A, the water-reducible, lead and chromate-free, epoxy primer.

Prior to application, the wash primer was reduced 25% with water and applied to the unit.

Note: The front of the shelter showed no visible defects and overall appearance was good. We noticed contamination and minor separation on one side and also on one half of the backside of the shelter. It was basically isolated streaks that had a drip or spot-like appearance, a possibility that the high-pressure wash had some oil contaminants. The visible contaminated spots were sanded with a grit 150 paper, in some places with a disk drill sander, air blown, and then spot wiped with isopropyl alcohol. Sanded areas were retouched with wash-primer.

The white epoxy primer supplied by Deft INC., per MIL-P-53030, component A, coded 44-W-7, lot no. 57946 and component B, coded as lot no. 57947.

The topcoat supplied by Hentzen Coatings was per MIL-C-53039 (1993), Green 383, coded 8605GUZ-PA, lot no. 13K411.

Note: The topcoat colors are supplied by Hentzen (exterior, MIL-C-53039, Green 383), Sherwin Williams (exterior, MIL-C-53039, Black & Brown 383), and Crawford Labs (interior, MIL-PRF-22750F [1994], Sea Foam Green 24410).

3. Technical Performance Criteria

The alternate technology will use a single component, HAP-free formulation that uses water to reduce and to clean-up.

The same coating application and stripping equipment will be used for the demonstration as is used for normal production. The same number of employees with the same level of training, skill, and education as in a normal production operation will be utilized. The same level of Occupational Safety and Health Administration health and safety training is required, although the elimination of the HAPs makes these considerations less critical.

It is not anticipated that there will be issues involving maintenance that are any different from the current technology. Since the demo will coat full size defense equipment, there should be no scale-up issue.

4. Health and Safety

Due to the reduction in VOCs and elimination of HAPs, there is less potential for impact on personnel and the surrounding community than with the current technology. Safety requirements noted in all Depot Maintenance Work Requirements (DMWRs) and other procedures must be adhered to.

5. Test Procedure

The following procedure was performed to support the demonstration test:

1. Prior to trial date, test pre-wash primer using LEAD paint equipment on test panels and other representative sample pieces. Apply pre-wash primer, primer, and final coat to all sample pieces and test for overall paint thickness as well as adhesion.
 2. Prior to testing, verify all safety requirements have been satisfied and on-site safety personnel are available if needed.
 3. All materials will be supplied by LEAD with the exception of the wash primer which will be supplied by Sherwin-Williams. ARL will coordinate the shipment of wash primer to LEAD.
 4. The DMWR for the ECS Patriot unit is 9-1430-600-1-2. The DMWR for painting is 9-1425-550-50. All wash primer application efforts will comply with these DMWRs.
 5. Photographs taken prior to, during, and following the coating operation.
-

6. Panel Testing

Performance validation testing of aluminum 2024-T3, ALUMINUM (chromate) and cold-rolled steel panels were coated simultaneously at the site property. Off-site property and performance validation testing of panels were conducted at ARL. The panels were subjected to accelerated corrosion exposure, salt fog ASTM B 117 (1990), and cyclic corrosion exposure based on General Motors (GM) 9540P (1997). Salt spray resistance is based on procedures described in ASTM B 117. This test is widely used by the paint industry as a quality control test and is not necessarily indicative of long term performance of the coating. GM Standard Test 9540P is an

accelerated cyclic corrosion test that was developed by the automotive industry to more accurately replicate long term outdoor performance of coatings than the conventional salt-fog test. Panels were evaluated using ASTM D 1654 (1984) for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments and ASTM D 714-87 (1987) for Evaluating Degrees of Blistering of Paints. Figures 1–4 show the results after exposure.



Figure 1. ASTM B 117 (salt-fog results). Aluminum test panels after 264-hr exposure.

7. Anomalies

ARL will fund repainting of the ECS up to \$7.5k for failures directly attributable to the wash primer within 2 years of the coating application date. Covered anomalies include major blistering, flaking, corrosion, or similar defects resulting from the wash primer's failure to provide adequate protection or failure of the wash primer/epoxy primer bondline as a result of the wash primer pretreatment. ARL will not be responsible for any anomalies caused by failure to meet application requirements/guidelines or exposure to environments outside of design parameters of the ECS or as a result of the primer or topcoat. Minor defects due to reasonable use, handling, and shipping of the ECS will also not be covered by ARL. Normal corrosion consistently found on Patriot hardware coated with existing wash primers will not be covered.



Figure 2. ASTM B 117 (salt-fog results).
Cold-rolled steel panels after
264-hr exposure.



Figure 3. GM 9540 P (cyclic corrosion results). Aluminum test panels after exposure—
10 cycles.



Figure 4. GM 9540 P (cyclic corrosion results). Cold-rolled steel test panels after exposure—10 cycles.

8. Results

The new wash primer treatment, Kem Aqua from Sherwin-Williams, was demonstrated on a Patriot ECS, SN 630106. Results of the trial are as follows.

- Reducing the wash primer with water was satisfactory.
- Using existing paint guns was satisfactory.
- Operators noted that material was easier to spray.
- Lack of solvent smell was an improvement.
- New wash primer does not harden after mixing (an ongoing problem with the current acid wash).
- Wash primer did not cover some spots where contamination was present. After scuffing spots with sandpaper and rubbing lightly with alcohol, wash primer was reapplied successfully. Painters reported similar problems and corrective action encountered with the current acid wash material.

Overall, the results of trial were a success (see figures 5–11). Additional data will be gathered after the trial unit is completed. The trial unit will finish the refurbishing process, camouflage pattern painting, and preparation for shipping from LEAD. The unit will then ship to Fort Bliss, TX, as a training unit in April 2005. All follow-up for overall paint performance will continue at Fort Bliss.



Figure 5. System disassembly.



Figure 6. After reconditioning.

The roadside at the front part of side has been replaced, the curbside at the rear part of side has been replaced, and the door has been replaced at the back. All replacement parts are alodized prior to placement on the shelter. Two sections at the top have been replaced, one towards the rear and one towards the front.



Figure 7. After sponge blast.



Figure 8. After module addition.

The wash primer is applied at a very thin coat. Figures 8 and 9 show contamination and flaws. Figures 10 and 11 show repairs, light scuffed, cleaned with alcohol, and primer.



Figure 9. After wash primer.



Figure 10. After wash primer application.



Figure 11. After green 383 topcoat.

9. Plans

Following completion of coating operations, the assigned unit will assess and report on the status of the affected components as part of routine inspections. ARL will support in the disposition of any anomalies. Anomalies include corrosion, flaking, blistering, chalking, cracking, or fading of the coating system. Team members are listed in the appendix.

Six months after return of the ECS to its assigned unit, a team consisting of ARL, the Armament Research, Development, and Engineering Center, and the Engineering, Environment, and Logistics Oversight Office will travel to Fort Bliss, TX, to inspect and document the coating status of this hardware.

Results will be published in a final test report.

10. References

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Appendix. Points of Contact

U.S. Army Research Laboratory

John Escarsega
AMSRD-ARL-WM-MC
U.S. Army Research Laboratory
4600 Deer Creek Loop
Aberdeen Proving Ground, MD 21005-5069
410-306-0693
jescarse@arl.army.mil

Kestutis Chesonis
AMSRD-ARL-WM-MC
U.S. Army Research Laboratory
4600 Deer Creek Loop
Aberdeen Proving Ground, MD 21005-5069
410-306-0697
kchesoni@arl.army.mil

Pauline Smith
AMSRD-ARL-WM-MC
U.S. Army Research Laboratory
4600 Deer Creek Loop
Aberdeen Proving Ground, MD 21005-5069
410-306-0899
pmsmith@arl.army.mil

U.S. Army Aviation and Missile Command

Steve Carr
AMSRD-AMR-PS-AM, Bldg. 7103
Redstone Arsenal, AL 35898
256-876-7472
Steve.f.Carr@rdec.redstone.army.mil

William Alvarez
AMCOM-EN
256-876-6127
william.alvarez@redstone.army.mil

Mark Feathers
MORGAN Research
U.S. Army Aviation and Missile Command
256-876-2517/256-876-6510
mark.feathers@redstone.army.mil

Letterkenny Army Depot

Dennis Reed
AMSAM-LE-MO-E-S
Bldg. 1 NC
1 Overcash Ave.
Chambersburg, PA 17201-4150
717-267-8376
dreed@emh1.lead.army.mil

Alan Aikman
AMSAM-LE-MO-E-S
Bldg. 1 NC
1 Overcash Ave.
Chambersburg, PA 17201-4150
717-267-8376
al.aikman@emh1.lead.army.mil

Lower Tier Project Office

Jimmy Roberts
Letterkenny Army Depot
Bldg. 1
1 Overcash Ave.
Chambersburg, PA 17201-4150
717-267-9429
jimmy.roberts@amd.army.mil

Don Belin
Letterkenny Army Depot
Bldg. 1
1 Overcash Ave.
Chambersburg, PA 17201-4150
717-267-9429
don_belin@raytheon.com

PEO AMD

Kate Bilderback
256-955-3179
kate.bilderback@us.army.mil

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