United States Marine Corps Corrosion Prevention and Control Program Office
Corrosion Preventative Products and Materials Program Overview

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ABSTRACT

The United States Marine Corps (USMC) Corrosion Prevention and Control (CPAC) Program has an ongoing effort called Corrosion Preventative Products and Materials Program (CPPMP) in which it evaluates coatings, corrosion preventative compounds (CPCs), and other products for use on USMC ground vehicle systems. The purpose of this program is to evaluate new and emerging technologies and products that can be used by the Marines, Corrosion Service Teams (CSTs), Corrosion Repair Facilities (CRFs), depots, or Original Equipment Manufacturers (OEMs) to preserve and protect ground weapon systems. New products are compared against the baseline performance of those currently authorized for use by TM4795-12/1 to determine their corrosion protection efficacy. This paper serves as an outline for the CPPMP process and an update on some of the current projects and success technologies for use in the USMC.

Keywords: USMC, CPAC, CPPMP, Corrosion, Products, CPC

INTRODUCTION

Throughout the United States Marine Corps (USMC), coatings and corrosion preventative compounds (CPCs) are applied by maintenance personnel, Marines, Corrosion Service Teams (CSTs), Corrosion Repair Facilities (CRFs), depots, or Original Equipment Manufacturers (OEMs) to prolong the life of USMC equipment. The facilities available for this work, which may be located throughout the world, range from open-air parking lots to multi-million dollar coating application operations. Because of the diverse nature of these facilities and the differing requirements for the various locations, there is a continuous need for new products, which address these needs.

Previously, new products entered into USMC processes in an uncontrolled manner—unqualified products purchased locally through a retail source or provided directly by the manufacturer. Alternatively, if products were authorized, they may have been used for other purposes and/or end users which may not have been appropriate. While many of these unauthorized products were used simply because they were readily available, others filled genuine needs of a particular location (e.g. VOC requirements). The ability to obtain official recommendations for these products was difficult or impossible with former coating testing processes in the CPAC program.

In general, this process required that the need for a coating or CPC be determined by CPAC or an end user before testing can begin. Then, funding must have been obtained from the CPAC program, or other sources, to perform the testing. Typically, full testing for a coating would take at least a year to complete. Then the product needed to be qualified to a MIL-SPEC before use. This required the creation of a specification which takes two to three years due to additional testing requirements. This caused a serious problem for ISO certified organizations, which require that authorized procedures be maintained for all of their processes. A process with quick turn-around and effective screening capabilities was required to address the shortcomings of this process. CPPMP was created to fulfill this role for the USMC.

The objective of CPPMP is to provide a process which will allow rapid deployment of promising technology with the ability to transition the products from Military Specifications (MIL-SPECs) or Commercial Item Descriptions (CIDs) to the CPAC Technical Manual TM 4795-12/1[1] as necessary. Additionally, the process will allow continuous comparison of currently approved products with those being considered - thereby allowing the CPAC program to control, maintain, and update these standards as needed.

PROGRAM OVERVIEW

The CPPMP program consists of four stages for product submissions: Initial Review, Laboratory Evaluation, Field Evaluation, and Completion. Some of these stages can be waived, depending on the individual submission. This process is graphically represented by a flow diagram as seen in Figure 1.

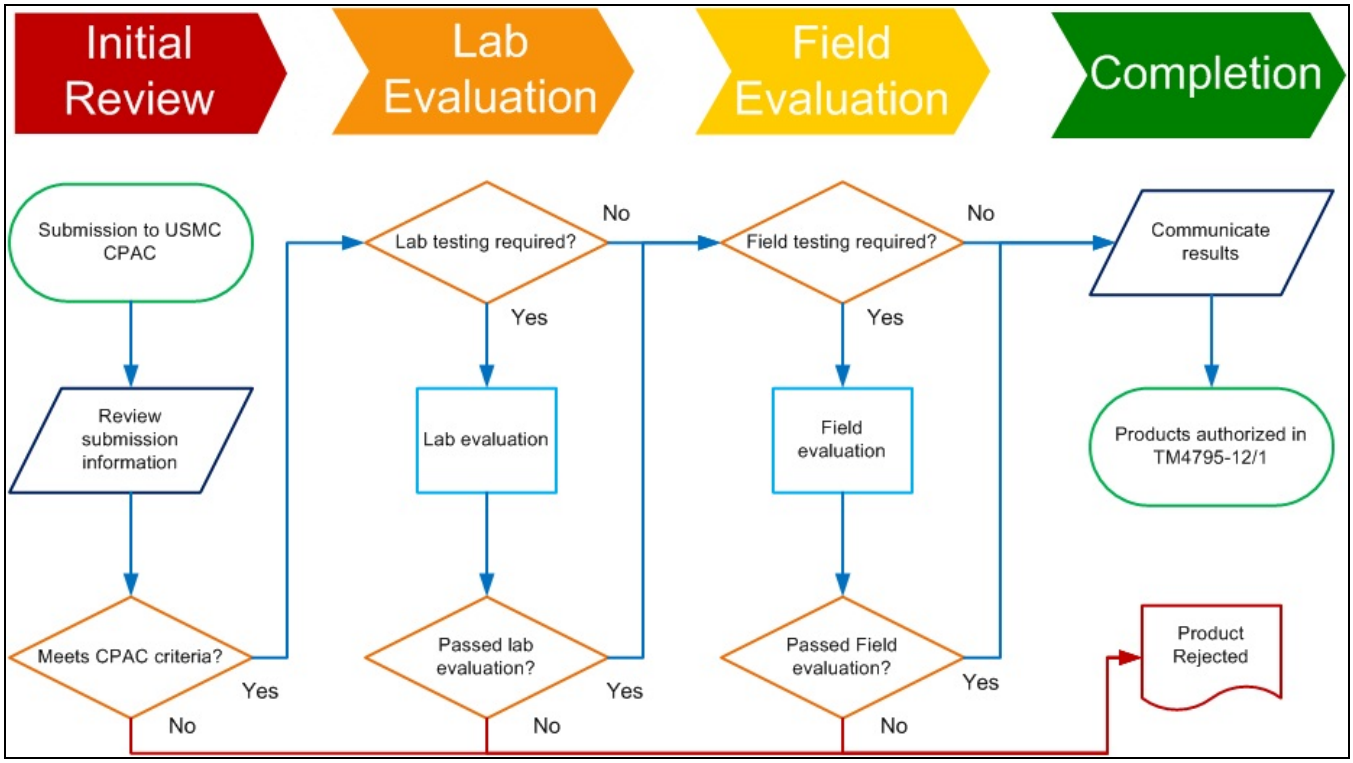

FIGURE 1 – Flow diagram of the CPPMP process

Initial Review

The initial review stage determines whether the product is applicable to CPAC. Products and technologies are initially submitted through the CPAC website by filling out the CPPMP Product Request Form[(1)] for each individual product submission. Vendors, Marines, and other parties are encouraged to submit any product or technology which may be useful to the USMC. Required information includes: contact information, description of product or technology, intended application, and need or benefit of use. In addition, the Navy Environmental Health Center (NEHC) department requires all products to be evaluated before being accepted into the USMC. A separate questionnaire document is completed by the CPAC program office and is submitted to NEHC on the submitter's behalf.

In order to accelerate the approval process, the following information should be submitted:

- Benefits of the product or technology (performance, cost savings, ease of application, etc.)
- Qualified MIL-SPEC or CID
- Application procedures
- Material Safety Data Sheets (MSDS)
- Personal Protective Equipment (PPE) requirements, environmental and health hazards, or any other information not covered by the MSDS
- Case histories within industry or the armed services
- Independent lab and/or field reports with associated data

The CPAC office is not responsible for approving or qualifying products, only authorizing their use in the USMC through the CPAC technical manual. Therefore, all submitted products are required to be qualified to their appropriate MIL-SPEC of CID in order to be authorized. Pending acceptance by both CPAC and NEHC, your submission will then progress to the appropriate stage.

Laboratory Evaluation

Once the product or technology is accepted, and a laboratory evaluation is deemed necessary, a laboratory test plan will be developed. These test plans not only evaluate the product based on its intended performance, but also against current authorized products. In addition, the product may be evaluated for compatibility between the current USMC coatings and materials.

All USMC ground vehicles assets are required to have the Chemical Agent Resistant Coating (CARC) system[2] in place on all exterior, weather exposed areas. The CARC system is a multi-component coating system used to not only protect the asset and substrate from corrosion, but also limits visible and near infrared observability, inhibits chemical agent absorption, and provides an easily-cleaned surface which is resistant to wear. Therefore, any coating or CPC submissions will need to be compatible with CARC in order to be accepted.

Due to the diverse submissions of products, each test plan is customized for the particular use of the product, which go beyond the scope of the qualification evaluations. Individual testing could involve: abrasion resistance, corrosion resistant, UV degradation, liquid permeability, flexibility, tensile tear strength, etc. In the case of vendor submissions, the test plans are shared to ensure fair representation and open accounting. After review with all parties, the laboratory evaluation begins. This stage could take up to a year, depending on the evaluations being performed.

Field Evaluation

The field evaluation phase is where the products are vetted in the real world. Current assets are selected to have the proposed product installed and are evaluated on its performance. These assets could be subjected to corrosion road test, where a vehicle's life is compressed into a few months of testing, or to environmental

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[(1)] http://www.marcorsyscom.usmc.mil/cpacwebforms.nsf/producttestform?openform

exposure on site. Processes for applications are also established at this phase, ensuring the product can meet the requirements and abilities of the designated users. This process could involve the CRFs, CSTs, or Marines themselves. Some submissions are able to have field and laboratory evaluations be performed concurrently, while others are in succession, depending on the individual circumstances of the product or technology. This phase of the evaluation can also take another year, depending on the scope of the test plan.

Completion

Once the evaluation is complete, and the submission is accepted, it is authorized for use in the USMC by TM 4795-12/1. An official Naval Letter is released communicating its authorized use, and is sent to all interested parties. At this time, every unit, CST, CRF, or depot is free to procure the product at their discretion.

CURRENT PRODUCTS AND TECHNOLOGIES

The following sections are highlights of a few of the submitted products through CPPMP. These are shown as examples of the evaluations performed by the CPAC program office. Each of these sections gives the consideration CPAC took to accept these submissions into the CPPMP program. Some of these products have already completed their entire evaluation, and an outline of the test and field evaluations is provided. For those which are newly accepted, a brief outline of the test plans is provided.

Biological-based CPCs

One of the major problems concerning the corrosion performance of USMC equipment is how to perform preventative maintenance on parts that cannot be taken apart. The surface preparation and coating of the exterior body are simple tasks; however it is difficult to prevent corrosion between overlapped welded sheet metal, inside door panels, and other inaccessible assembled parts. Crevice corrosion can be an extremely aggressive form of localized attack especially in marine conditions. Crevices can trap salts and debris and retain moisture longer than exposed surfaces, causing increased corrosion damage. A class of CPCs, called thin-film coatings, is used to reduce crevice corrosion by preventing salt and moisture from contacting the metal surface[3].

A new bio-based, sprayable corrosion CPC was submitted to CPPMP as an inhibitor with a potential benefit as for protecting steel and aluminum crevices from damage. It is made with renewable agricultural vegetable oils, and provides environmental benefits for use and disposal. Because it contains no petroleum distillates, it is less flammable than mineral oil based CPCs.

Laboratory samples were made to imitate the crevices seen in the field, and were used to evaluate the effect of the CPC in a corrosive environment. These samples were created by two 3in x 6in x 1/16in (7.62cm x 15.24cm x 0.16cm) panels of G10180 steel. One panel was bent at a 45^{o} angle along the long axis approximately 0.75in (1.9cm) from the edge to form crevice opening, Figure 2. The submitted CPC was applied along this crevice, and compared against a currently authorized CPC. These samples were then subjected to 16 cycles of the GMW14872[4] cyclic accelerated corrosion chambers, and evaluated for corrosion afterwards.

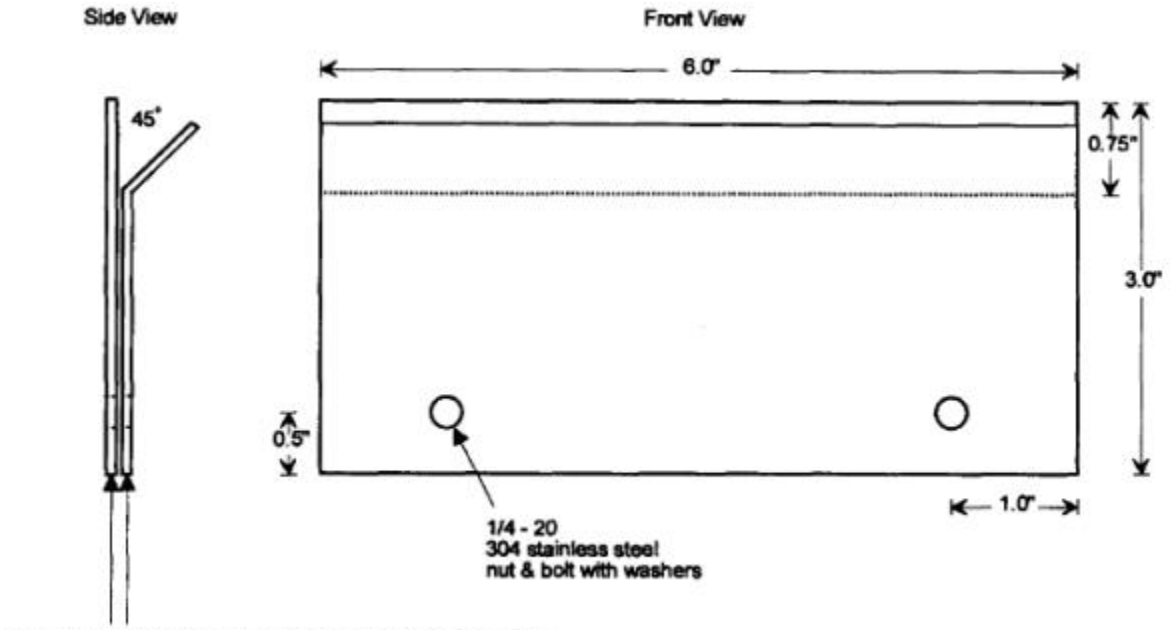

FIGURE 2 - Specimen schematic for the laboratory evaluation

After the laboratory evaluation, two High Mobility Multi-Purpose Wheeled Vehicles (HMMWVs) were selected to evaluate the field performance of the CPC. A representative of the CST team applied the product to areas known to be prone to crevice corrosion, Figure 3. In addition, custom corrosion coupons were designed and attached to the bumpers of the vehicles. The vehicles and the coupons were inspected after 7 and 14 months.

FIGURE 3 - Example Areas of Concern (Crevices, Fastener Heads, etc.)

Chip and Abrasion Resistant Coating Repair Kits

Prior testing conducted by the USMC Corrosion Prevention and Control (CPAC) Program Office has resulted in the authorization for use of chip and abrasion resistant coatings that meet the salient characteristics of CID-A-A-59719 (polyurethane-based materials)[5] and A-A-59800 (polyurea-based materials)[6]. The materials, when applied over a suitable corrosion resistant primer, can offer improved corrosion resistance in areas subjected to impact or wear damage (e.g., cargo areas of MTVR and HMMWV trailers, and trucks). However, in instances where damage does occur or if removal of the material is required for other maintenance the vehicle would need to be sent to a CRF or depot for repainting.

Field repair kits have been introduced to perform minor maintenance on damaged areas of these chip and abrasion resistant coatings. These repair kits can be applied by hand or by using an airless spray system. These

kits are meant to restore the original integrity of the system; however, their effectiveness and long-term performance are unknown. Furthermore, with materials that qualify to both CIDs authorized for use, there may be instances where alternative vendor or material chemistries may be used for repair, without prior knowledge of system compatibility. These issues need to be further investigated prior to authorizing the use of any repair system.

The laboratory evaluation phase involved multiple phases for basic coating compatibility, performance of the repair coating, and compatibility between the two authorized chip and abrasion resistant coating chemistries. The properties that were evaluated included: corrosion resistance, adhesion, and chipping resistance. In addition, repairability samples were designed to investigate the performance of the repair coatings on minimally prepared surfaces, as would be seen in the field. These samples were created by applying the chip and abrasion resistant to panels, scribing them, subjecting them into 24 cycles of accelerated corrosion in accordance with GMW 14872, repairing the scribe, and subjecting the samples to another 24 cycles of GMW 14872. At the end, the coating was removed, and the scribe cutback was measured and compared between the original and repair scribes. A representation of the processes of these samples can be seen in Figure 4.

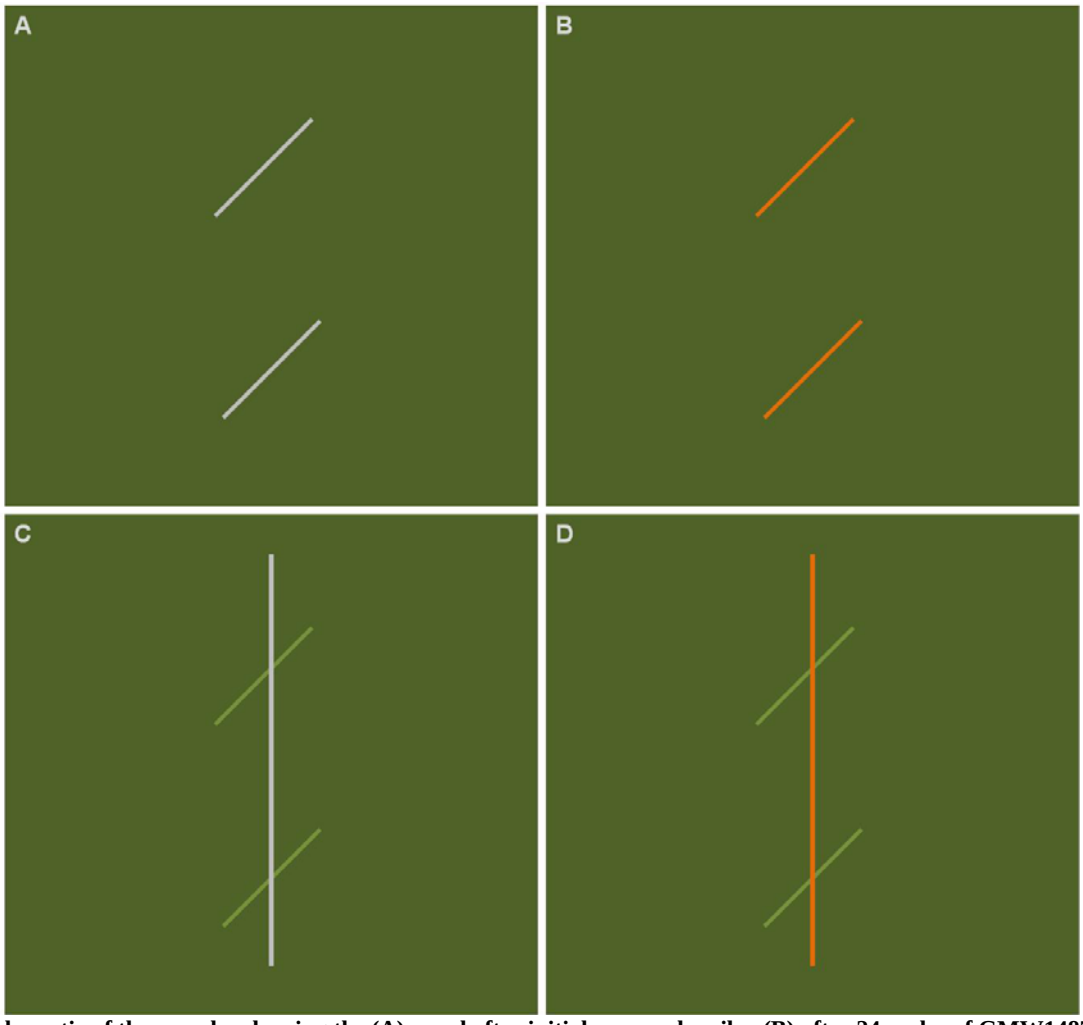

FIGURE 4 – A schematic of the samples showing the (A) panel after initial cure and scribe, (B) after 24 cycles of GMW14872, (C) after repair and scribing again, and (D) after another 24 cycles of GMW 14872.

In addition to the laboratory evaluation, two MTVR trailers were coated with the chip and abrasion resistant coatings; one coating chemistry for each. Areas of the original coating were removed, and repair patches were installed, Figure 5. The trailers are currently being exposed to weather and will be evaluated in the near future for cutback.

FIGURE 5 – Photograph of a weather exposed MTVR trailer with coating repair patches highlighted in blue.

Alternative Chip and Abrasion Resistant Coatings

Currently CPAC is evaluating peel and stick appliqués for use as wear resistant patches for impact prone areas of USMC ground vehicles and are showing promising results. Commercial industry has gone a step further and has been developing peel and stick appliqué substrates that can be coated with user specified coatings. One such company has submitted their product to the CPPMP program as an alternative material to the abrasion and chip resistant coatings.

It is proposed that this solution would have minimal user-dependence on performance and can be installed in a fraction of the as the current coating system. Removal of these appliqués is also an improvement over the current coating system as they can be easily removed and replaced. In addition, these appliqués have the potential to be mass produced from a pre-fabricated, die-cut template for each trailer and other ground vehicles, which would reduce cost and make them a competitive alternative to the coating system.

The planned laboratory evaluation involves covering a sample with the chip and abrasion resistant coated appliqué and assessing the corrosion resistance, the impact and wear resistance, and adhesion compared to the currently authorized coating systems.

Enhanced Performance Primers

USMC ground vehicles are subjected to some of the harshest environments due to their operational requirements as being the front-line combatants of the Navy. As a result, the CARC system has been developed to protect the asset from wear and corrosion, as well as meet the requirements of a war-fighting machine. However, these protections can be damaged from normal wear-and-tear, which renders any benefit from the CARC system to be useless in that localized area. Any localized exposure of the substrate leads to the development of heavy corrosion, which requires complete removal of the coating system to properly prepare. A product which could cease the corrosion activity in the area, and avoid the need for a large scale coating repair, would save operational costs.

CPPMP has received several submissions for coatings which are proposed to work in this manner. These coatings are intended for use over minimally prepared surfaces, meaning those that have been subjected to damage or corrosion and whose surfaces are not properly prepared. The proposed coating systems work by fully encapsulating the surface, blocking any further moisture, salt, and other corrosives from affecting the surface.

The planned laboratory evaluation involves creating a sample with a minimally prepared surface, and assessing the performance of these encapsulating coatings as an enhanced primer. The CARC system is applied overtop to meet the requirements of TM 4795. In addition, adhesion, CARC compatibility, flexibility, and impact resistance are to be evaluated.

CONCLUSION

Over the past few years, CPPMP has evaluated and authorized a number of products and technologies which are already deployed in the USMC fleet. These products have shown an impact in the corrosion maintenance cost of the fleet, a decrease of $85 million from 2005 to 2008[7]. It is with these efforts and contributions by manufacturers, vendors, and industry, that the USMC improves and maintains the readiness and integrity of our war fighters.

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