Coating Requirements & Projects for USMC Vehicles

Matt Koch

08 February 2011

ASETSDefense 2011

Report Documentation Page

Form Approved
OMB No. 0704-0188

Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
08 FEB 2011		**00-00-2011 to 00-00-2011**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Coating Requirements & Projects for USMC Vehicles	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **United States Marine Corps,Corrosion Prevention and Control,Arlington,VA,22203**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES
ASETSDefense 2011: Sustainable Surface Engineering for Aerospace and Defense Workshop, February 7 - 10, 2011, New Orleans, LA. Sponsored by SERDP/ESTCP.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**43**	

USMC Corrosion Prevention and Control (CPAC)

Development Strategy

Why Corrosion is a concern

DoD Annual Cost of Corrosion, July 2009 Report:

Total cost of corrosion for DoD of $22.5 billion

Ground Vehicle (Army & USMC) Cost of Corrosion is $3.1 billion
~17% of this costs is associated with the HMMWV Family of Vehicles

Department of Defense Instruction 5000.67

“Trade-off decisions involving cost, useful service life, and effectiveness shall address corrosion prevention and mitigation”

“Corrosion prevention and control (CPC) programs and preservation techniques shall be implemented throughout the life cycle of all military equipment and infrastructure in accordance with this Instruction.”

Corrosion Prevention and Control Planning Guidebook, Spiral 3 (USD, AT&L)

“For ACAT I programs, the program manager shall prepare a corrosion prevention and control plan.”

Acquisition Regulatory Requirements Added 2008

Requirement	Reference	When Required	Comment
Acquisition Info Assurance Strategy	DoDI 8580.1	MS A, B, C & FRPDR or FDDR	All IT, Including NSS
Analysis of Alternatives (AoA)	DoDI 5000.02	MS A, B, & C Full Deployment DR for AIS	Updated as necessary at MS B and C
AoA Study Guidance	DoDI 5000.02	MDD	
Component Cost Estimate	DoDI 5000.02	MDAP: MS B & FRPDR MAIS: whenever EA is required	Mandatory for MAIS; optional for MDAP
Corrosion Prevention Control Plan	DoDI 5000.02	MS B & C	Part of Acq Strategy ACAT I only
Life Cycle Sustainment Plan	DoDI 5000.02	MS B, C & FRPDR	Part of Acq Strategy
Life Cycle Signature Support Plan	DoDD 5250.01	MS A, B, & C	

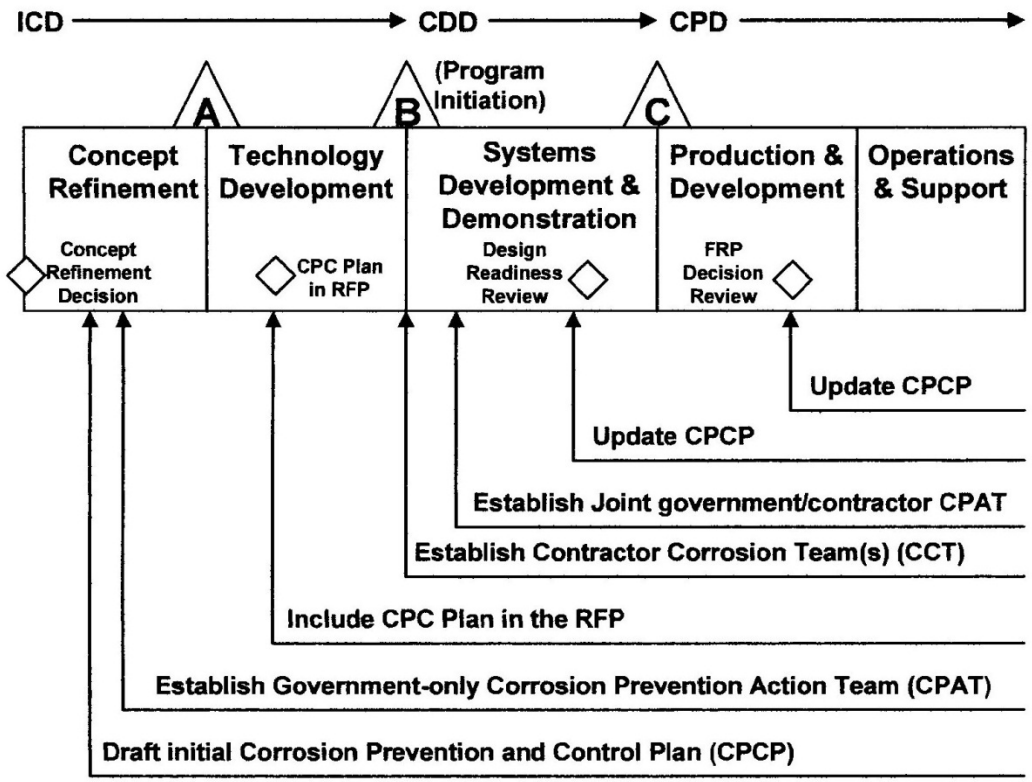
Excerpt from the brief "DoD Instruction 5000.02 8 December 2008, Operation of the Defense Acquisition System Statutory and Regulatory Changes", Bradford Brown, Feb 2009, Defense Acquisition University.

Corrosion Management
Planning

Corrosion Prevention and Control Planning Guidebook, Spiral 3 (USD, AT&L)

- 2.2 Management Planning
- 2.2.1 CPC Planning
- To achieve viable CPC planning, program managers should complete the following:
  - Prepare a corrosion prevention and control plan as early in a program or project as possible. In the case of weapon systems, the program manager should generate the document no later than Milestone B, Program Initiation.
  - Implement the CPCP with an accompanying process/finish specification and organize the Corrosion Prevention Action Team.

Figure 2-1. Defense Acquisition Process

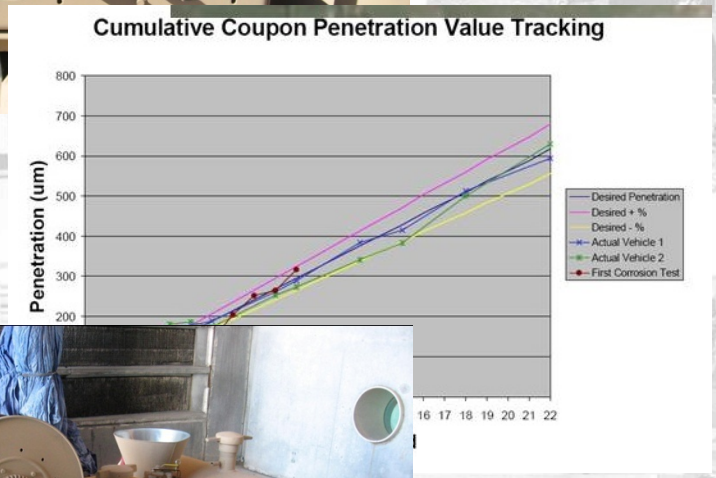


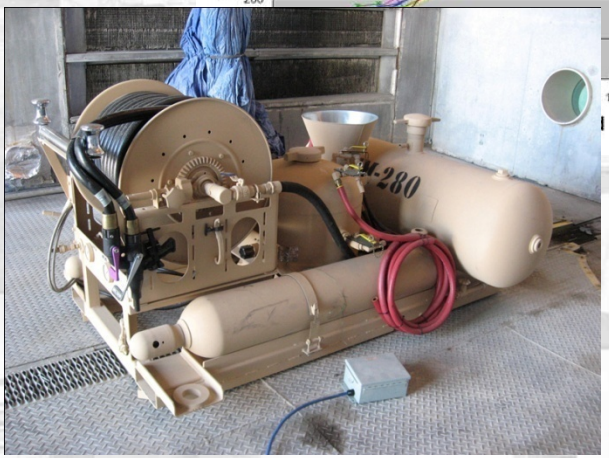
Corrosion Control Strategy

- Integral and essential part of the acquisition process
- Borrows from and provides to other disciplines
- Corrosion is impacted by:
  - Final design / materials selection
  - Inconsistencies within and across fielded variants
  - Operational requirements / life-cycle environment
- Corrosion impacts:
  - Fully realized total ownership cost
  - Warfighter Safety
  - Asset Availability

Benefits of Incorporating Corrosion Control

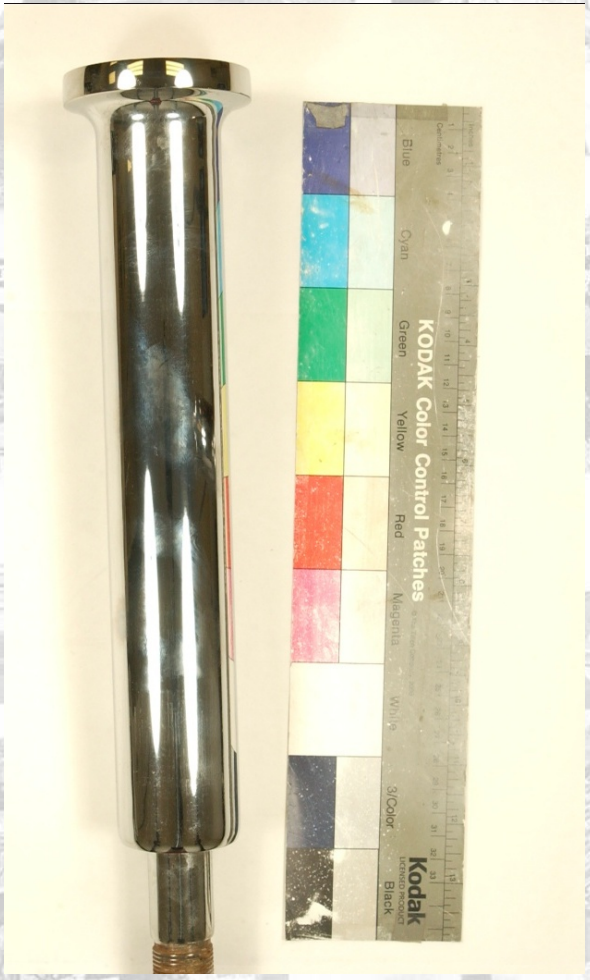
- Reduces life-cycle costs
  - Majority of issues corrected during design
  - Other issues highlighted by testing
  - Repairs / upgrades made before FRP
- Verification of life expectancy
- Identification of maintenance needs
- Lessons learned for next generation systems





Methods of Corrosion Control

- Performance Requirements
  - Known acceptable systems
  - Test methods and requirements
- Chemical Agent Resistant Coating (CARC)
- Maintenance impact on corrosion control
- Consistent corrosion control across all configurations
- Establishment of exempt item criteria

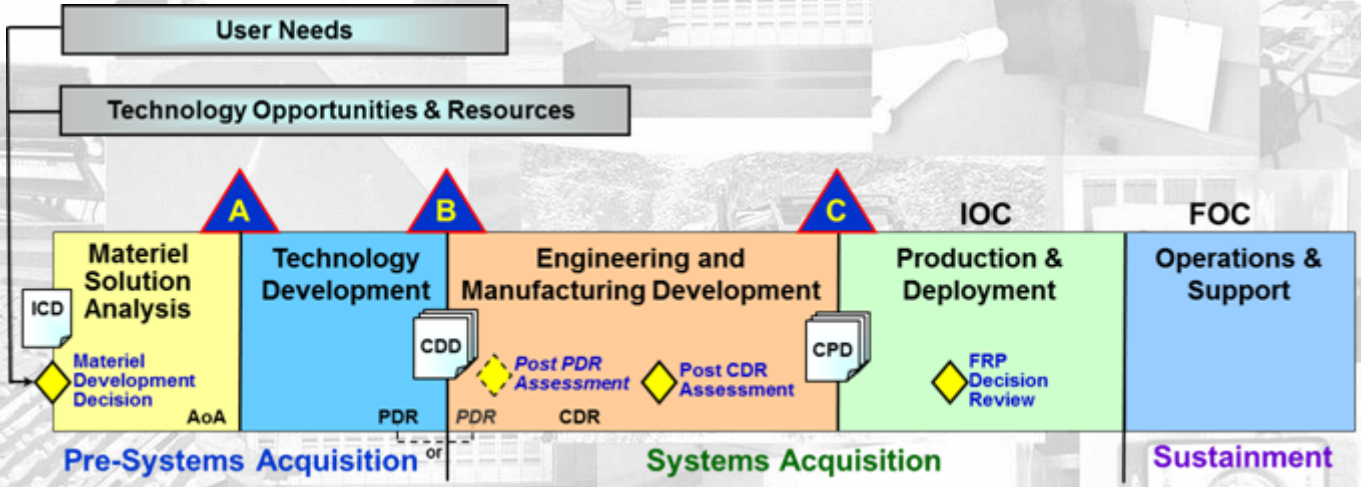


Corrosion Prevention and Control Plan (CPCP)

Government Version

Program Management
Pre-Contract Planning

- Corrosion Prevention Action Team (CPAT) establishment
- Funding
- Source selection criteria
- Integration with other disciplines:
  Systems Engineering, Logistics, Safety, Testing, EH&S
- Sustainment / Maintenance
- Demilitarization



Program Management
Contract Execution

- Performance Specification
- RFP requirements / wording
- CDRLs: Contractor CPCP, Process / Finish Specifications
- Facilities / Requirements for CPCP execution
- Reviews & audits
- TM development
- ECP evaluation
- Testing / Acceptance

Program Management
Sustainment

- CPCP execution
  - Specialized requirements
- Repair / Rebuild
  - Exposure to hazardous materials
- Corrosion maintenance
  - Organic vs. Contractor
- Life-cycle costs
- Demilitarization

CPCP Summary

- Government CPCP establishes system corrosion requirements
- Provides OEM with specific requirements
- Establishes CPAT for evaluation of corrosion control performance
- Provides expectations for maintenance / sustainment
- Considers life-cycle impact of design and manufacturing decisions

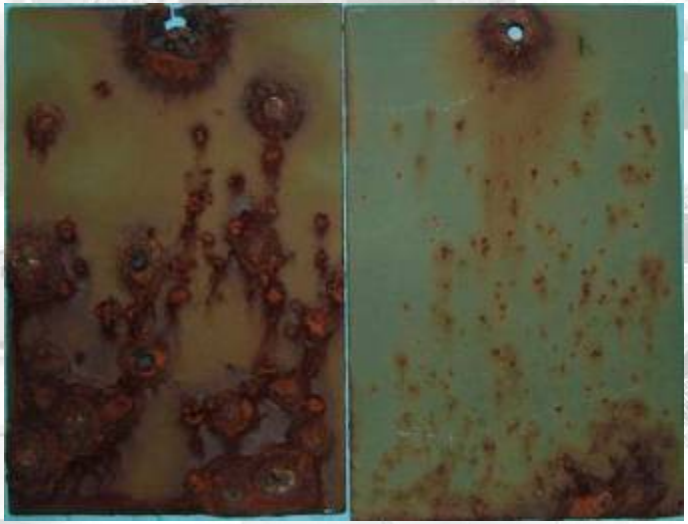
CPCP Basics - Example

Joint Light Tactical Vehicle (JLTV)

Accelerated Corrosion Testing

RATIONALE

These tests are the best, commercially available methods for evaluating the corrosion resistance of fasteners, parts, components, and subsystems.



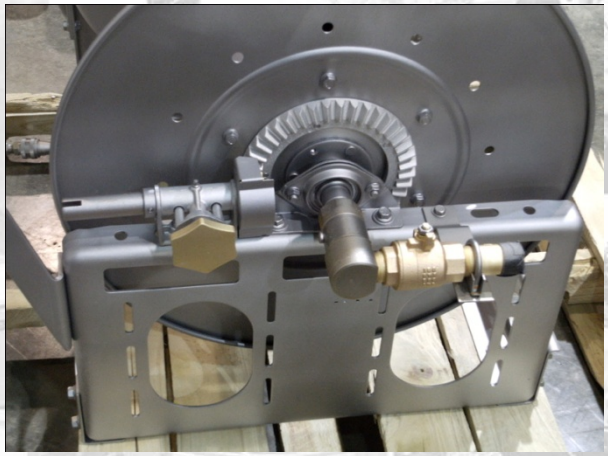
EXECUTION

When testing fasteners, parts, components, and subsystems, 176 cycles of the SAE J2334 or the GMW 14872 (replaces GM 9540P) laboratory accelerated corrosion test shall be used.

Surface Condition

RATIONALE

Surface condition greatly affects the adhesion of painting systems.



EXECUTION

For surfaces intended to be painted, the condition, profile, and cleanliness of the surface shall meet the requirements of MIL-DTL-53072.

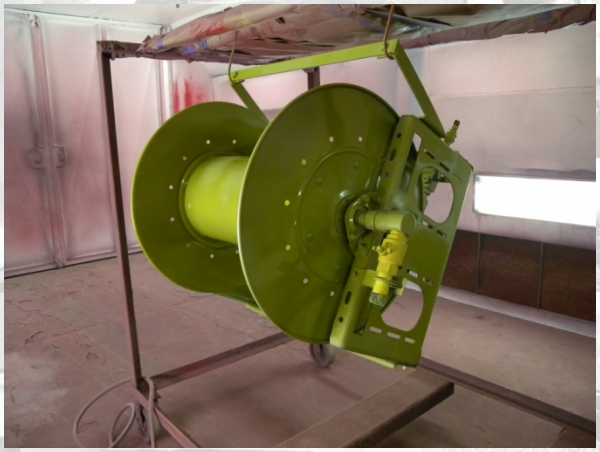
Workmanship must be consistent with best commercial practices (i.e., commercial automotive).

Base materials (i.e., substrates) should be free of cracks, burrs, sharp edges, and weld spatter that may affect the corrosion performance and coating adhesion.

Pretreatment

RATIONALE

Surface pretreatment enhances the corrosion protection of subsequent coating systems.



EXECUTION

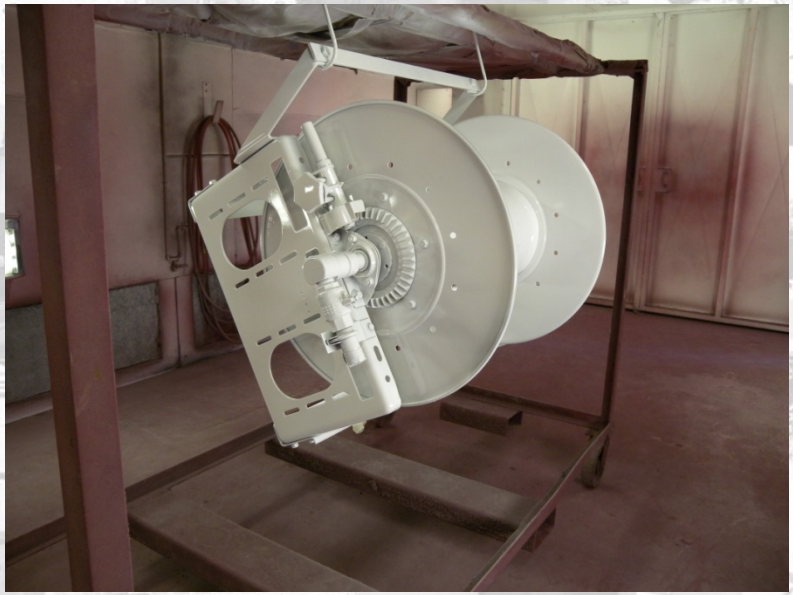
Pretreatments shall be compatible with the cleaning method and the primer used, and may include, but are not limited to, conversion coatings (i.e. phosphate coatings), or other organic or inorganic materials.

The application of such pretreatments shall be performed in accordance with manufacturer's recommendations.

Primer

RATIONALE

Primers provide the majority of corrosion protection for coating systems and are of critical importance.



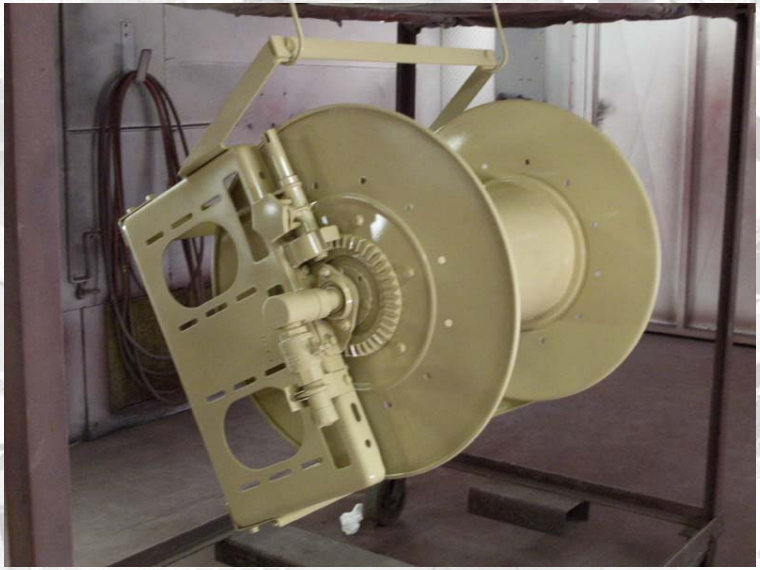
EXECUTION

Primer shall be per MIL-DTL-53072 or, in the case of e-coating, per MIL-DTL-53072 or CID A-A-52474.

Topcoat

RATIONALE

Topcoats provide the barrier to water and contaminants; a critical first layer of defense, and need to be compatible with other components, particularly the primer.



EXECUTION

Topcoat shall be per MIL-DTL-53072. Units shall be inspected for surface imperfections, total film thickness and adhesion. The minimum dry film thickness (DFT) shall be the sum of the minimum thickness specified by MIL-DTL-53072. The frequency and location of DFT per unit measurements and the repair procedure for deficiencies shall be IAW the CPCP.

Steam and Water Jet Cleaning

RATIONALE

Need to ensure that the barrier provided by the painting system is not breached by normal cleaning procedures.

EXECUTION

The JLTV and all its components shall withstand cleaning with high-pressure steam or water jet cleaner (2500-3000 psi) at a distance no closer than 0.3 meters (1 ft) to any surface, compatible with A-A-59133 without deterioration.

Accelerated Corrosion Durability Road Test (ACDRT)

RATIONALE

1) Using CARC does not guarantee 20 years service life

2) Physical geometry, joint design, materials, processes, environment, and many other factors affect service life.

3) It is significantly less expensive to design for corrosion protection than to repair poorly designed systems that prematurely corrode.

EXECUTION

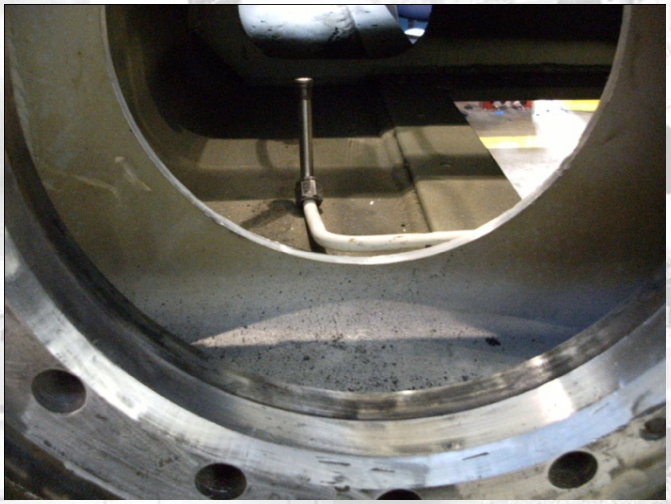
One JLTV LRIP vehicle per contractor shall be tested at Aberdeen Proving Grounds IAW Joint United States Army and Marine Corps Systems Command Test Operations Procedure for Development of a Corrosion/Durability Road Test for Tactical Vehicles.

Design Considerations:

Water Entrapment

RATIONALE

Water entrapment provides an ideal environment for the promotion of corrosion, and must be avoided wherever possible.



EXECUTION

The JLTV shall be designed to avoid water collection and entrapment in manufacturing, operation, storage, and transportation orientations. Where cavities are unavoidable, functional drain holes of adequate number, size, and shape shall be provided at the lowest possible location during operations and storage. Drain holes shall not interfere with the structural integrity of the JLTV.

Design Considerations:

Debris Collection

RATIONALE

Debris can entrap moisture providing an environment for corrosion, while debris in areas with moving parts can erode the topcoat and provide a path for corrosion.

EXECUTION

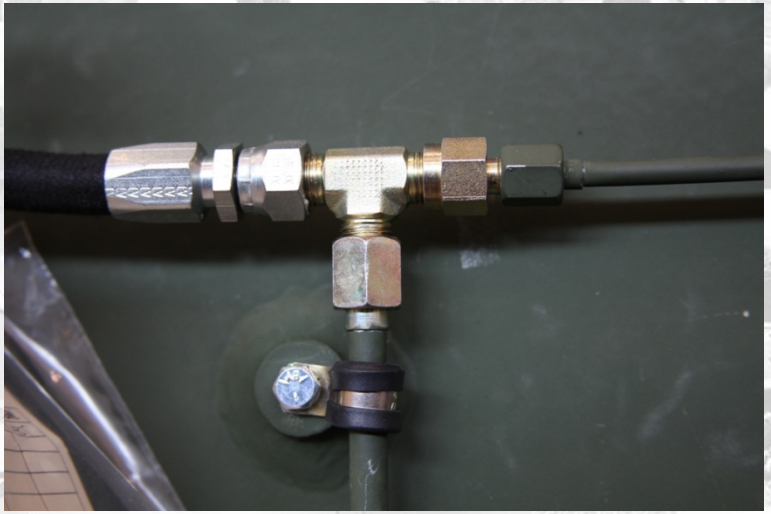
The JLTV shall be designed to avoid the collection of debris, dirt, grime, and other matter to which the JLTV may be exposed during normal operations. Where collection points are unavoidable due to other design considerations, access shall be provided for cleaning and removal of debris.

Design Considerations:

Dissimilar Materials Contact (Galvanic Corrosion)

RATIONALE

Galvanic corrosion associated with dissimilar metal contact is greatly enhanced in a seawater/salt spray environment and must be avoided wherever possible.



EXECUTION

The JLTV shall be designed to avoid the potential for galvanic corrosion. The galvanic series in seawater presented in ASTM G82 may be used as a guide to determine materials compatibility. Specific methods for isolating dissimilar materials shall be documented in the CPCP and in the process/finish specification(s). The contractor shall itemize and provide drawings and materials of construction for all joints susceptible to galvanic corrosion.

Projects for USMC Vehicles

Project Types

Acquisition Support

- Need identified by specific USMC or joint military platform
- Funded in part by acquisition program
- May be applicable across other platforms

Office of the Secretary of Defense (OSD) Research

- High return on investment (ROI) initiative
- Funded in part by OSD
- Typically cross-platform application

Corrosion Prevention Products and Materials Program (CPPMP)

- Commercial–off-the-shelf (COTS) products tested for identified needs
- Equal or better performance than existing solutions
- Typically for prevention or maintenance applications
- Fully CPAC funded

Special Project Initiatives (SPI)

- Internal projects designed to support external initiatives
- Typically informational in nature, such as database and website design

Acquisition Program Support

UNITED STATES MARINE CORPS
CPAC
CORROSION PREVENTION AND CONTROL
Identify • Correct • Maintain

Acquisition Support Example – Corrosion Control Support to JPO MRAP/M-ATV

DESCRIPTION

Direct program support to the Joint Program Office (JPO) for MRAP and M/ATV; evaluation of as-built systems for corrosion issues; provide recommendations for maintenance and upgrades; review manufacturing operations for possible technology insertion and develop long-term maintenance procedures.

APPLICATION

MRAP, M/ATV

ROI ESTIMATE

TBD

TIMELINE

- 2007/08 – formal support to JPO MRAP started
- 2008/09 – manufacturer visits and fleet surveys performed
- 2009 – demonstrations of maintenance issues performed, MI submitted to JPO, end of formal support
- 2010 – continue other projects that will benefit MRAP / M-ATV

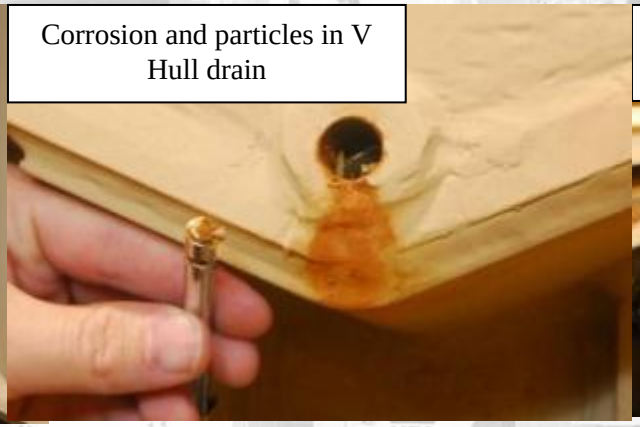
ACCOMPLISHMENTS/HIGHLIGHTS

- Identified and categorized corrosion issues (systemic and OEM specific).
- Provided coating application training to SPAWAR (GFE integration site).
- Developed MI for bilge painting to reduce hull corrosion.
- Investigated quality and corrosion issues (e.g., Caiman paint delamination).
- Reviewed M-ATV manufacturing operations at McConnelsburg, PA and provided feedback / recommendations to JPO.
- Investigated inhibitors for bilge space corrosion.

Examples of MRAP Corrosion Findings

Corrosion in hard-to-reach locations

Corrosion and particles in V Hull drain



Corrosion troop hatch opening

Corrosion in shadow areas

Corrosion in holes and recesses

Corrosion in crevices and between welds

Demonstration MRAP Program – "Bilge" Painting

- Unaccessible bilge identified a problem area
  - Evidence of rusting from SPAWAR inspections
  - Observation of little paint in these areas
  - Contaminants tend to collect in these locations
- For FPII trucks axle upgrades provided access to bilge
- Developed Maintenance Instruction (MI)
- Use of high build immersion paints in this area to improve corrosion resistance

MRAP Bilge Painting Process (MI)

Vacuum out dirt / debris

Mask all hoses followed by solvent wipe

Needle gun cleaning of corrosion and loosely adherent coating

Hand sanding to roughen existing, intact coating

Final solvent wipe after vacuuming to remove all remaining debris

Brush application of coating, 2 coats, recommend using contrasting colors

OSD Projects

Example OSD Project: High Build Coating Systems to Improve the Corrosion Resistance of Ground Weapon Systems (W10MC04)

DESCRIPTION

Application of higher thickness (build) primer coatings (CARC primers, MIL-DTL-23236, etc.) to improve the corrosion resistance of ground weapon systems.

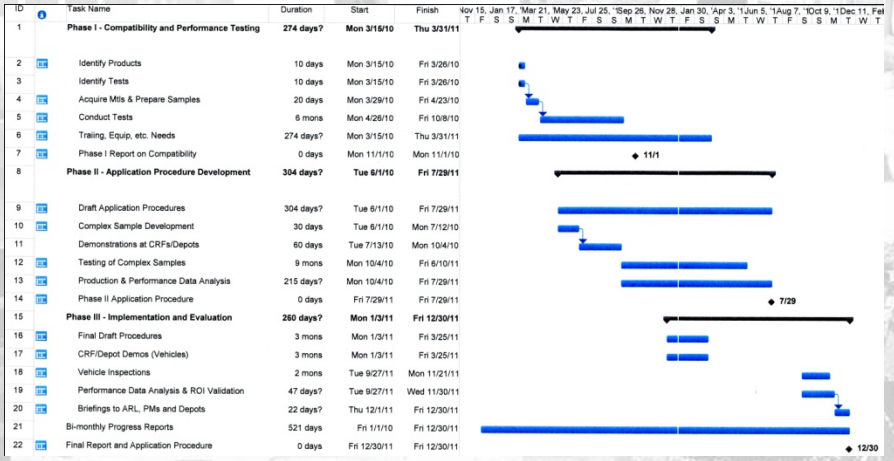
APPLICATION

All ground weapon systems (e.g., Trailers, HMMWV, MTVR, AAV, Dozers, MRAP, LVSR, etc.).

ROI ESTIMATE

150:1

MILESTONE SCHEDULE



ID	Task Name	Duration	Start	Finish
1	**Phase I - Compatibility and Performance Testing**	**274 days?**	**Mon 3/15/10**	**Thu 3/31/11**
2	Identify Products	10 days	Mon 3/15/10	Fri 3/26/10
3	Identify Tests	10 days	Mon 3/15/10	Fri 3/26/10
4	Acquire Mtls & Prepare Samples	20 days	Mon 3/29/10	Fri 4/23/10
5	Conduct Tests	6 mons	Mon 4/26/10	Fri 10/8/10
6	Trailing, Equip, etc. Needs	274 days?	Mon 3/15/10	Thu 3/31/11
7	Phase I Report on Compatibility	0 days	Mon 11/1/10	Mon 11/1/10
8	**Phase II - Application Procedure Development**	**304 days?**	**Tue 6/1/10**	**Fri 7/29/11**
9	Draft Application Procedures	304 days?	Tue 6/1/10	Fri 7/29/11
10	Complex Sample Development	30 days	Tue 6/1/10	Mon 7/12/10
11	Demonstrations at CRFs/Depots	60 days	Tue 7/13/10	Mon 10/4/10
12	Testing of Complex Samples	9 mons	Mon 10/4/10	Fri 6/10/11
13	Production & Performance Data Analysis	215 days?	Mon 10/4/10	Fri 7/29/11
14	Phase II Application Procedure	0 days	Fri 7/29/11	Fri 7/29/11
15	**Phase III - Implementation and Evaluation**	**260 days?**	**Mon 1/3/11**	**Fri 12/30/11**
16	Final Draft Procedures	3 mons	Mon 1/3/11	Fri 3/25/11
17	CRF/Depot Demos (Vehicles)	3 mons	Mon 1/3/11	Fri 3/25/11
18	Vehicle Inspections	2 mons	Tue 9/27/11	Mon 11/21/11
19	Performance Data Analysis & ROI Validation	47 days?	Tue 9/27/11	Wed 11/30/11
20	Briefings to ARL, PMs and Depots	22 days?	Thu 12/1/11	Fri 12/30/11
21	Bi-monthly Progress Reports	521 days	Fri 1/1/10	Fri 12/30/11
22	Final Report and Application Procedure	0 days	Fri 12/30/11	Fri 12/30/11

ASSESSMENT

2009	JAN	APR	JUL	OCT
TECHNICAL				
MANAGEMENT				
OVERALL				

Green: No disruption on costs, scheduling, and performance.

Yellow: Potentially may cause some disruptions (e.g., scheduling, increases in cost, degradation of performance, etc.).

Red: Likely to cause disruptions (e.g., scheduling, increases in costs, etc.).

ACCOMPLISHMENTS/HIGHLIGHTS

- Applied candidate systems to test panels, including those with complex geometries to simulate real world application
- Identified potential incompatibility issue with Navy epoxy coatings and water reducible CARC epoxy primer.
- Prepared samples for testing
- Performed adhesion and flexibility testing.
- Accelerated corrosion testing underway
- Exploring demonstration opportunities with USMC CRFs and Depots.
- Coordinating testing and demonstration opportunities between the Army and USMC.

High Build Coating Systems: Phase I Test Systems

- CARC primers (53022 & 53030)
  - At specified thickness
  - At 2x specified thickness
- MIL-DTL-24441 (1 coat)
- MIL-PRF-23236 (1 coat)
  - Conventional spray
  - Airless spray (high solids)

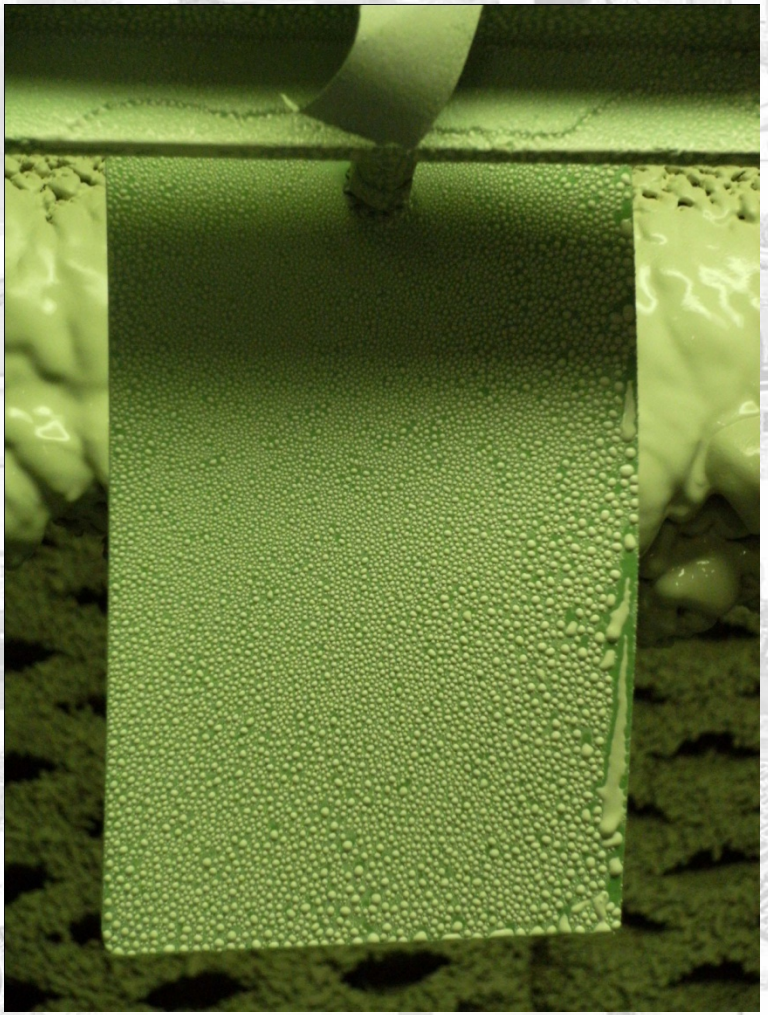
High Build Coating Systems: Phase I Test Methods

- Adhesion
- Flexibility
- Topcoating
- Weather Resistance (QUV)
- GMW14872

Testing being performed on compatible samples

High Build Coating Systems: Coating System Compatibility

- Observed issue between Navy epoxies and water-reducible CARC products
  - MIL-DTL-24441 incompatible with
    - MIL-DTL-53030 primer and
    - MIL-DTL-64159 topcoat
  - MIL-PRF-23236 conventional spray incompatible with
    - MIL-DTL-53030 primer
- Investigated possible causes
  - Overcoat time
  - Surface contaminants / amine blush
  - Surface roughness



High Build Coating Systems: Timeline

- Phase I – completed by 31 May 2011
  - Compatibility testing performed concurrently and completed by 28 February 2011
- Phase II
  - Applications performed by 30 April 2011
  - Testing completed by 30 September 2011
- Phase III
  - CRF vehicle / component demonstrations concurrently with Phase II applications
  - Vehicles inspected at 6 and nominally 12 months
  - Documentation and briefings performed by 30 April 2012

Corrosion Prevention Products and Materials Program (CPPMP)

Motivations

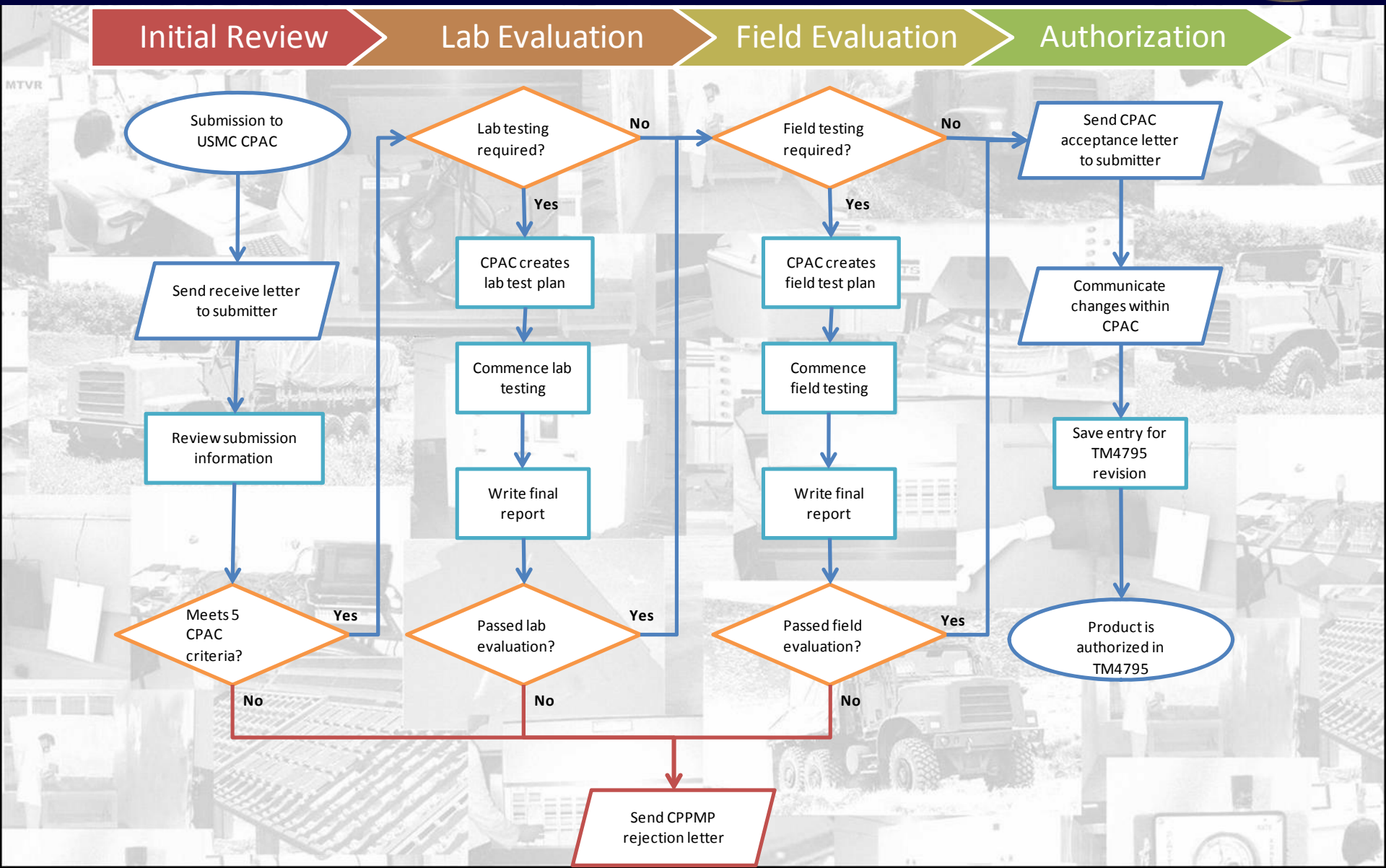
The underlying motivation of the CPPMP process is to control the introduction and use of all products used by the CSTs and CRFs.

All products submitted are to be treated as potential candidates; however, there are a series of steps in place to ensure the product is used properly and appropriately.

These steps are:

1. Initial review
2. Laboratory evaluation
3. Field evaluation

Process – Flowchart



Example CPPMP: Tough Coat & Mil-Tough

DESCRIPTION

Polyurethane and polyurea coatings for use as chip and abrasion resistant coatings within cargo beds of USMC vehicles.

APPLICATION

USMC ground weapon systems with cargo beds (e.g., Trailers, MTVRs, etc.)

ASSESSMENT			
2010	SEP	OCT	NOV
TECHNICAL			
MANAGEMENT			
OVERALL			

Green: No disruption on costs, scheduling, and performance.

Yellow: Potentially may cause some disruptions (e.g., scheduling, increases in cost, degradation of performance, etc.).

Red: Likely to cause disruptions (e.g., scheduling, increases in costs, etc.).

Accomplishments/Highlights

- Completed and accepted for use within USMC by CID-A-A-59719 for Tough Coat and CID-A-A-59800 for Mil-Tough.
- Currently being used at CRFs and depots

Special Project Initiatives (SPI)

SPI Example:
Carderock Lab Status Dashboard

Description

CLSD is a tool designed for engineers, technicians and program managers to view snap shots, or current status of projects at NSWC Carderock Division

Schedule

Task	Month	10	11	12	1	2	3	4	5
User Requirements Gathering									
Database Design Phase									
Usability Design Phase									
Database Review									
Overall Design Document									
Programming Phase									
Design and Usability Review									
Modifications / Redesigns									
Design and Usability Review 2									
Modifications and Reworks									
Final Product Release									

ASSESSMENT

	Sep	Oct	Nov
TECHNICAL			
MANAGEMENT			
OVERALL			

Green: No disruption on costs, scheduling, and performance.

Yellow: Potentially may cause some disruptions (e.g. scheduling, increases in cost, degradation of performance, etc.).

Red: Likely to cause disruptions (e.g. scheduling, increases in costs, etc.).

HIGHLIGHTS

- Initial designs have been produced
- Review of overall work-flow has been done and noted
- Initial database design has been drafted
- This tool will be used to track status of various tests including but not limited to:
  - Cyclic corrosion testing (4 chambers)
  - B117
  - Specimen status
    - Machine Shop
    - Paint schedules