Coatings Developments for Vehicles
Way Forward

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# Coatings Developments for Vehicles Way Forward

**U. S. Army Research Laboratory, Weapons and Materials Research Directorate, Aberdeen Proving Ground, MD, 21005**

**DOD Vehicle Workshop, 15-16 June 2010, Grand Rapids, MI. Sponsored by SERDP/ESTCP.**

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• Who we are & What we do......
• Prior History and Evolution of CARC
• Considerations for the future
• Coatings Systems for Land Vehicles
• GAPS to address and Considerations for Coatings Advancement
• ARL is the Lead DOD R&D Activity for CARC
  ➢ Innovative formulations approaches
  ➢ New raw materials selections
  ➢ Advanced characterization

• Maintains Ownership for all key specifications regarding pretreatments, primers and topcoats for all tactical and related support equipment and munition coatings.

❖ *Elements above assist to implement and transition products*
Guiding Principles for Coating Systems

Environmental  Survivability

Durability

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During World War I, the British passenger liner Mauretania was painted in a camouflage scheme reminiscent of Picasso’s Harlequin. Thayer, who advocated painting ships white, likely viewed the project as a misapplication of his theory of disruptive coloration.
Recent Coatings represent superior durability, environmental compliance

Stereotypes associated with Emulsions, Water Based or Hexavalent Chromium Free chemistries no longer hold true.

Current efforts establishes solid foundation for present and future survivability enhancements and multifunctional capabilities

Services are moving rapidly to eliminate standard coatings used and are implementing a new generation of coating technology throughout DOD
Considerations for the Future

• 20-25 years ago Army- Marine Corps Coating systems well defined.

• DoD had sufficient outdoor exposure history and submissions were similar to one another.

• It was appropriate to use neutral salt fog for QC validation.

• Since we had field history and correlation were in hand, confidence was high if lab test were satisfactory outdoor life cycle would be predictable.

• Today this is no longer the case
Today this is no longer the case………..

We have numerous mandates, existing laws and guidelines that require novel and unique chemistries

Multiple substrates to contend with and a larger selection of topcoats, primers and pretreatments that when evaluated as a “system” mitigate and prevent corrosion and degradation in different ways.

HENCE AS A COMMUNITY WE CANNOT DO AS WE ARE DOING
Considerations for the Future

• HENCE AS A COMMUNITY WE CANNOT DO AS WE ARE DOING:

• MAKE ASSUMPTIONS THAT ALL CORROSION INHIBITORS WILL RESPOND OR ACT SIMILAR IN ANY ACCELERATED CHAMBER EVALUATION

• X HOURS IN TESTING PROVIDES CONFIDENCE

• SERVICES RESPONSIBLE FOR VALIDATION NOT KNOWING THE COMPOSITON OF MATERIALS USED

• THINKING THAT AN “ADVANCE ACCELERATED PROTOCOL” WILL BE THE ANSWER FOR QUICKER OR MORE EXPEDIENT DATA
Considerations for the Future

• THINKING THAT AN “ADVANCE ACCELERATED PROTOCOL” WILL BE THE ANSWER FOR QUICKER OR MORE EXPEDITIOUS DATA ……….

• UNLESS WE KNOW THE CHEMISTRIES AND CAN CONFIRM SIMILAR DEGRADATION MECHANISMS IN OUTDOOR EXPOSURE AND CHAMBERS IT IS A FAÇADE TO BELIEVE X HOURS IS PREDECTIVE OF X TIME OUTDOORS.
36 YEAR TIME LINE OF CARC

Feb 1st 1974
Publication of MIL-C-46168

May 1st 1974
Publication of MIL-E-52798

Feb 28th 1983:
Move toward three color pattern to better align with NATO Allies

Co-Exist CARC and NON-CARC

November 13th 1984 Eliminate:
Light Green, Forest Green, Olive Drab, Earth Red, Earth Brown and Desert Sand Colors.

April 16th 1984
Publication of MIL-C-53039 One Component CARC

April 16th 1984
Cancellation of MIL-E-52798

October 1985
Inclusion of 383 Green (#34094)

JUNE 2ND 1988
INCOMING 4 STAR AMC GENERAL AND RETIRING 4 STAR GENERAL JOINTLY SIGN MEMO DECLARING POLYURETHANE COATINGS WILL BE THE COATINGS USED ON ALL TACTICAL AND RELATED SUPPORT EQUIPMENT

July 1st 1987
Cancellation of MIL-E-52798

JUNE 2ND 1988
INCOMING 4 STAR AMC GENERAL AND RETIRING 4 STAR GENERAL JOINTLY SIGN MEMO DECLARING POLYURETHANE COATINGS WILL BE THE COATINGS USED ON ALL TACTICAL AND RELATED SUPPORT EQUIPMENT

MID 90’s through early 2000s
MIL-C-46168 & MIL-C-53039 EQUAL IN USAGE AND ARE USED BY ALL SERVICES WITH ARMY AND MARINE CORPS AS THE PREDOMINANT USERS.

OCT 2005:
MIL-C-46168 is Canceled and Replaced with MIL-DTL-64159 WD-CARC

IN 1988 GSA PUTS OUT BID FOR 230,000 GALLONS ....TODAY WE MANAGE 2 MILLION GALLONS WITH MIL-DTL -53039 AND 64159

74 83 84 85 87 88 2010
Details: Water Dispersible CARC

WD CARC is currently being used by all of Marine Corps and Army elements and comprises approximately 20% of the Market.

93 94 95 96 97 98 99 00 01 02 03
• Chemical Agent Resistant Coatings (CARC) is mandated by AR-750-1 for all tactical equipment.

• Every initial submission is fully tested and validated for Qualified Listing.

• Each batch from the initial submission is tested for color, gloss, IR and decontamination resistance. Included in the batch submission is batch volume. Next slide total volumes*

• Volume of coatings usage by Army is enormous: Several million gallons costing several hundred of millions of dollars annually will be reduce as developments are implemented and durability is improved.
Average VOC (lb/gal) 
CARC Topcoat

Average VOC per Gallon Topcoat

*January to May

Year

*TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.*
Pigments/Extenders

Polymeric beads

- Army will Discontinue use of Silica based topcoats

- Integrated within Film

- Polymeric beads
  - Reduce chalking effect
  - Improve UV resistance
  - Improve performance

Diatomaceous silica  Talc

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• Letter has been issued:
  Key Points
• No longer accepting silica based coatings
• November 1\textsuperscript{st} 2010 discontinue batch validation
• Deplete inventories until consumed
• New type to include Enhanced Corrosion Resistance and require cyclic corrosion evaluation.
• 1000Hrs Neutral Salt Fog
  – ASTM D610 RATING OF 9
  – ASTM D1654 RATING OF NOT LESS THAN 6 FOR STEEL
  – ASTM D1654 RATING OF NOT LESS THAN 8 FOR AL.
• 40 Cycles
  – ASTM D1654 RATING OF NOT LESS THAN 7 FOR STEEL & AL.
• Open to novel corrosion inhibitors
• Allowing vendors to provide exempt solvent package and provide a universal exempt solvent
• Similar effort to occur for 53022
• MIL-DTL-53084 and Powder to include the color Black.
• Open to novel corrosion inhibitors
• Powder Specification to include both Primer and Topcoat within same document
• Coordination Date 8/10
• The key hurdle is acquiring long term outdoor exposure data for platforms making current and near future decisions.

• Confidence that our accelerated screening processes are relevant to long term exposure results.

• Ensuring pretreatment and coating processes are followed accurately to enhance corrosion resistance and provide adequate adhesion/compatibility for subsequent coatings.
Multiple Phase Approach

Phase I: Data, claims and performance parameters (acceptance based on environmental compliance, cost to include return on investment and process requirements)

Phase II: ARL/TARDEC testing and evaluation of pretreatment or process using coupon panels to include accelerated and cyclic corrosion, EIS, and related adhesion type evaluations etc.

Phase III: Application of component parts /panels

Phase IV: Outdoor exposure in corrosive environment of component parts/panels (Items would be monitored for x years at 6 month intervals)

This Phase type process would allow PMs to be aware of what items are currently being evaluated and also providing a certain level of confidence to select or use a particular new process. Baselines will be selected and used as standards for comparison. In this way new technologies can be evaluated and data acquired.
Increased Options for Balanced Requirements

Affordable Multifunctional Coating Solutions
Survivability Requirements
Coating Requirements
Environmental UV & Corrosion Resistance Flexibility

New coatings formulations
More Survivable and Durable Platforms