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Updates on Sustainable Surface Finishing and Coatings for Army Weapon Systems

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Army P2 Program Approach to Surface Coatings

Conduct demonstrations of more sustainable surface finishing processes at Army depots and installations from FY15-24

- Address inorganic coatings through Toxic Metal Reduction (TMR) program and organic through Securing the Availability of Green, Enhanced Coatings (SAGE-Coat)
- Combine short-term projects to implement current state-of-the-art with long-term projects to push the envelope
- Demand higher performance and new capabilities without sacrificing sustainability
- Go beyond mere compliance with current environment, safety and occupational health (ESOH) regulations
- Address all manner of sustainability threats so they do not result in product obsolescence and affordability issues
- Use Toxicity Assessment (TA) process to verify sustainability of alternatives
- Integrate ESOH considerations into future coatings development

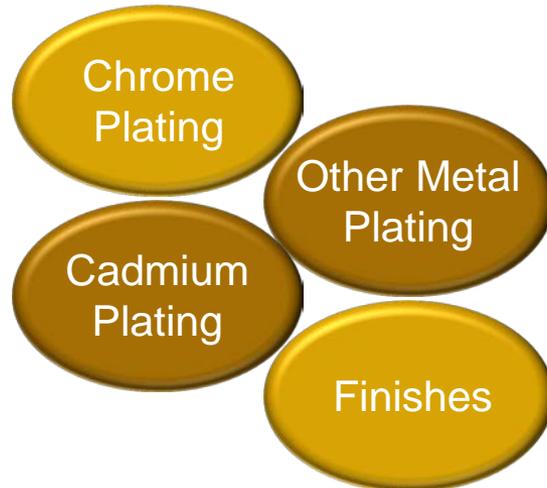
Eliminate Cr(VI), Cd and other toxic constituents in priority applications

Achieve Army-wide reductions consistent with ESTCP reduction targets

Army P2 Program Umbrella

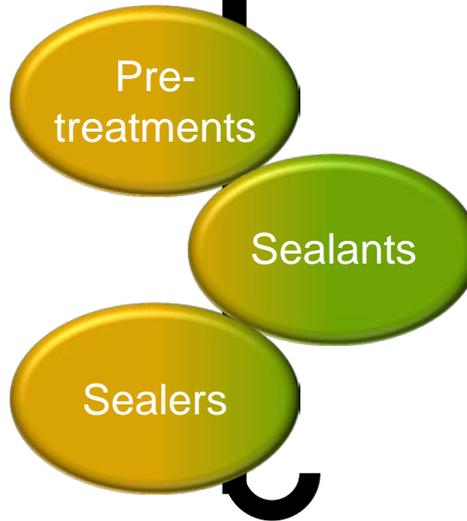
SURFACE COATINGS POLLUTION PREVENTION

Inorganic coatings (TMR program)



- Chromic acid
- Sodium dichromate
- Cadmium compounds
- Cyanide compounds

Cross over



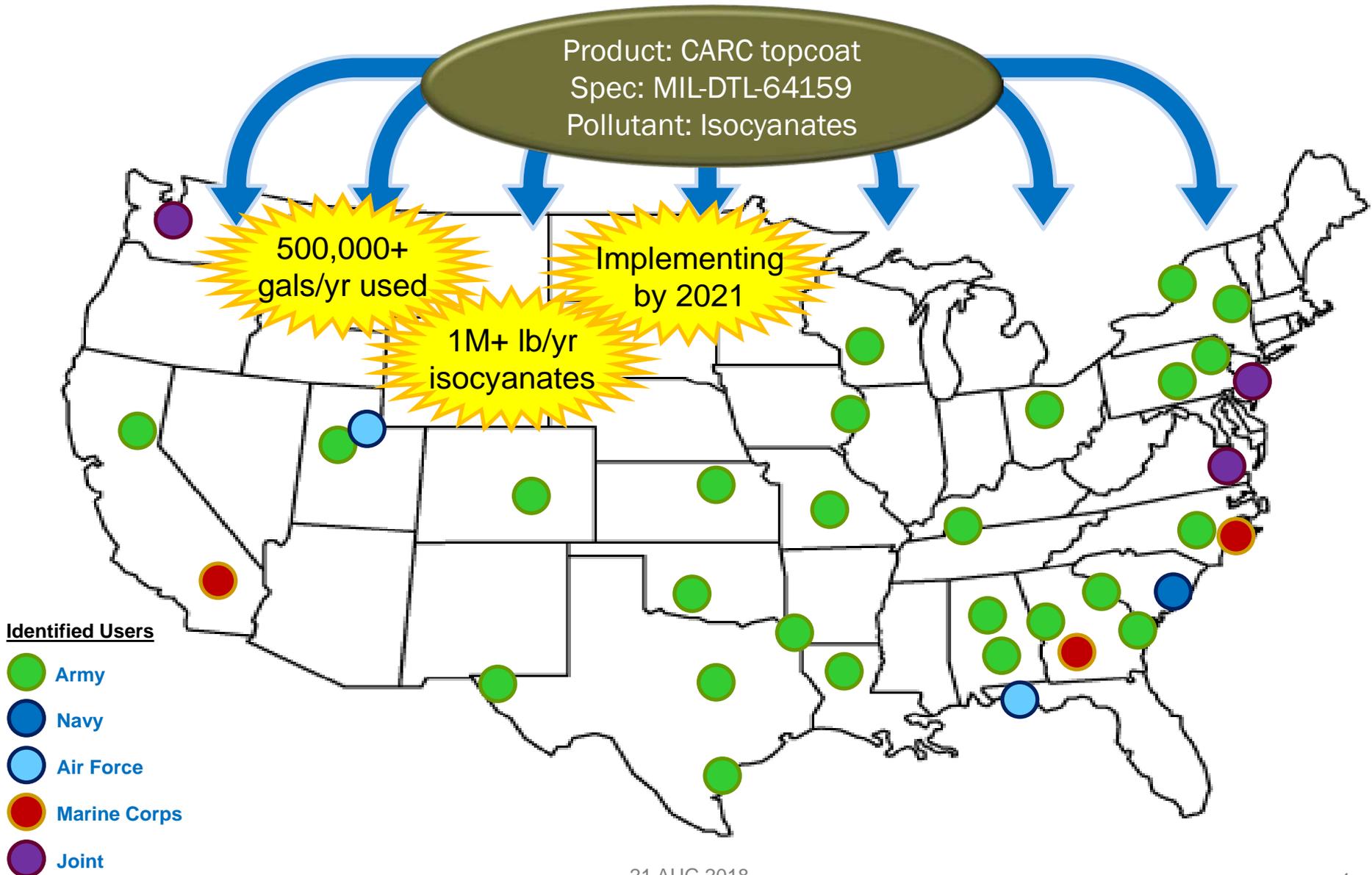
- Chromic acid
- Sodium dichromate
- Zinc chromate
- HAPs and VOCs

Organic coatings (SAGE-Coat program)



- HAPs and VOCs
- NMP, MeCl, nPB
- Isocyanates
- Phthalates

Joint Applicability of Army P2 Products

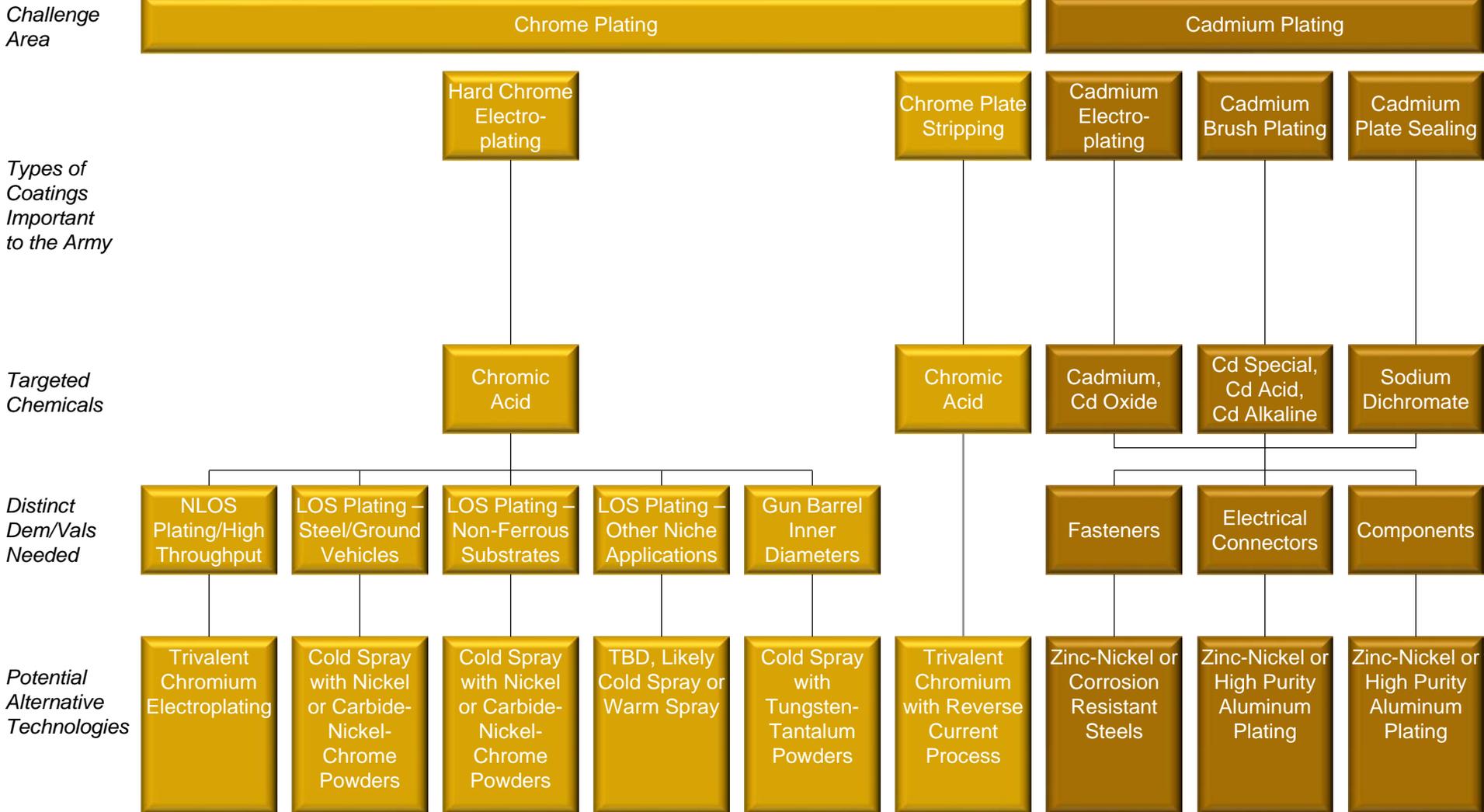


2016 SecArmy & 2017 SecDef Environmental Award Winners



- ARL Chromium-Free Wash Primer Replacement Team
- Weapon System Acquisition, Small Program Category
- Technology crosses both TMR and SAGE-Coat

TMR Gaps: Chrome Plating & Cadmium Plating



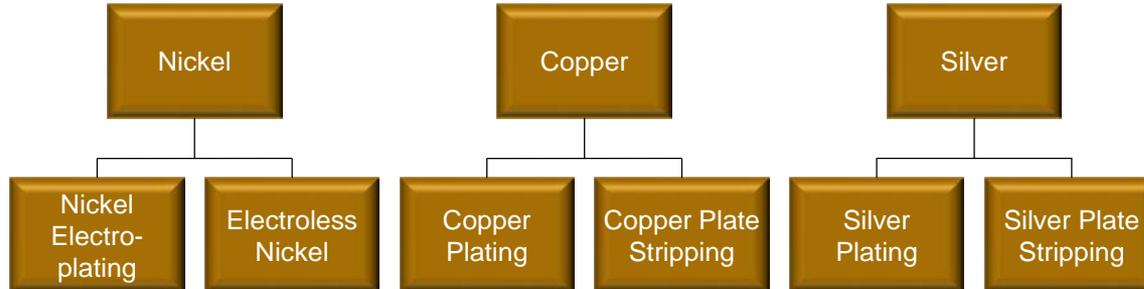
TMR Gaps: Other Metal Plating & Pretreatments

Challenge Area

Other Metal Plating

Pretreatments

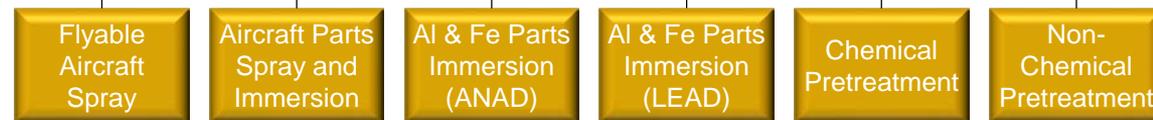
Types of Coatings Important to the Army



Targeted Chemicals



Distinct Dem/Vals Needed



Potential Alternative Technologies



TMR Gaps: Finishes and Sealers

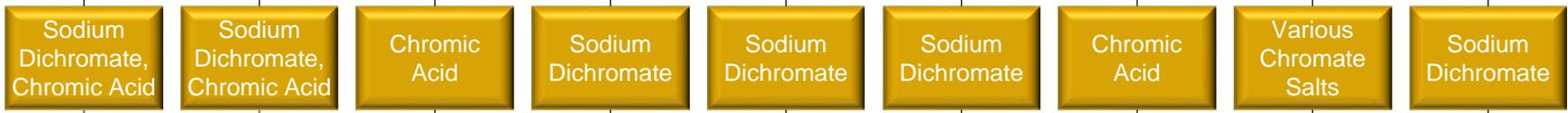
Challenge Area



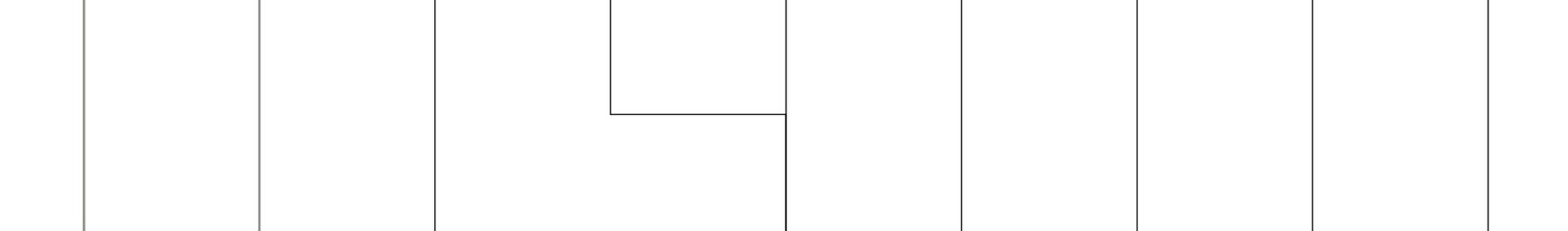
Types of Coatings Important to the Army



Targeted Chemicals



Distinct Dem/Vals Needed



Potential Alternative Technologies



TMR Success: Wash Primer

Coatings of Interest

Pre-treatments

Wash Priming

Targeted Chemicals

Zinc Chromate, VOCs

Alternative Technology

Manganese/Fluoride, Zirconium or Silane-based Products



- ARL completed multiple demonstrations with Cr(VI)-free, low VOC alternatives to wash primer
- Canceling DOD-P-15328 with replacement by TT-C-490 Type IV
- Six approved Type IV pretreatments on the qualified product database with more pending additional qualification
- Eliminates 58% of Cr(VI) used at LEAD and 24K lbs/yr Army-wide

TMR Success: Conversion Coatings

Coatings of Interest

Pre-treatments

Conversion Coating

Targeted Chemicals

Sodium Dichromate

Alternative Technology

Manganese, Zirconium or Inorganic Fluoride-based Products



- ARL completed multiple demonstrations with Cr(VI)-free conversion coatings (spray and immersion)
- ZrO immersion technology demonstrated at ANAD and qualified to TT-C-490, Type IV
- Eliminates 39% of Cr(VI) used at LEAD and 100K lbs/yr of Cr(VI) waste from aluminum conversion coating Army-wide

TMR Success: Cold Spray

Coatings of Interest

Nickel
Electro-
plating

Hard Chrome
Electro-
plating

Targeted Chemicals

Chromic
Acid

Alternative Technology

Cold Spray
with Nickel
or Carbide-
Nickel-
Chrome
Powders



- ARL developed a cold spray process to replace nickel electroplating for the AH-64 Apache Static Mast Support
- First qualified cold spray structural component for Army rotorcraft
- Qualification documents approved by AED for inclusion in Depot Maintenance Work Requirements (DMWRs) for Apache repair

SAGE-Coat Gaps: CARC and Other Paints

Challenge Area

Current Products Coming Under Increased ESOH Regulatory and Scientific Scrutiny

New Products/Capabilities with ESOH Gaps

Types of Coatings Important to the Army

Polyurethane CARC Topcoats

Epoxy CARC Primers

Aerospace Specialty Coatings

Zinc-Rich Primers

Smart, Multi-Functional Coatings

All Other Paints

Targeted Chemicals

VOCs, NMP, Isocyanates

VOCs

Electro-Magnetic Shielding

Zn Chromate, Isocyanates, HAPs, VOCs

Magnesium Stoving Enamel

HAPs, VOCs

Adhesion Promoters

HAPs, VOCs

HAPs, VOCs

Numerous

Distinct Dem/Vals Needed

Aircraft

Missile Systems

Numerous

Potential Alternative Technologies

Polysiloxanes to Replace Isocyanates

Reformulate with Exempt VOCs

Remove Zn Chromate

No projects planned

Reformulate with Exempt VOCs

Reformulate with Exempt VOCs

Reformulate with Exempt VOCs

No projects planned

RDECOM Adoption of DESHE Process

SAGE-Coat Gaps: Paint Remover and Cleaners

Challenge Area

Current Products Coming Under Increased ESOH Regulatory and Scientific Scrutiny

Current Products Not Controlled by Specifications

Types of Coatings Important to the Army

Paint Removers

Cleaners

Manual

Immersion

Methylene Chloride

NMP, Methylene Chloride

HAPs, VOCs, nPB

Targeted Chemicals

Hand-Wipe Cleaners

Immersion Cleaners

Vapor Degreasers

Parts Washers

Distinct Dem/Vals Needed

Benzyl Alcohol or Hydrogen Peroxide-based Products

Novel and Emerging Alternatives

Benzyl Alcohol, Di-Methyl Esters, Other Proprietary Products

Exempt VOCs, Cyclo-siloxanes or t-Butyl Acetate with Methyl Amyl Ketone

Novel and Emerging Alternatives

Azeotropic Blends, Ionic Liquids, Furans

COTS Aqueous Solvents (Standardize)

Potential Alternative Technologies

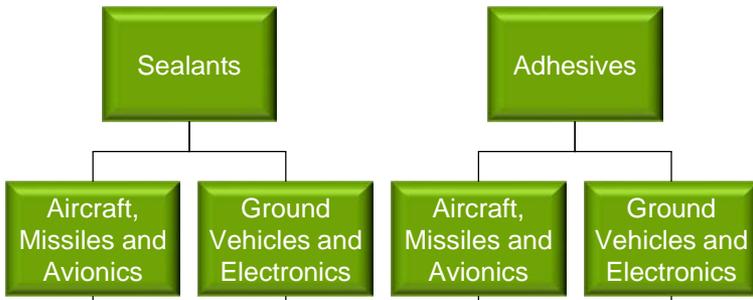
SAGE-Coat Gaps: Sealants and Adhesives

Challenge Area

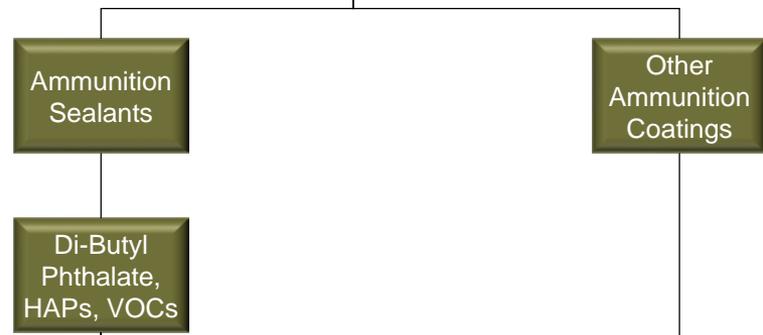
Current Products Not Controlled by Specifications

Historic Products Needed for New Production

Types of Coatings Important to the Army



Targeted Chemicals



Distinct Dem/Vals Needed



Potential Alternative Technologies



SAGE-Coat Success: Zinc-Rich Primer

Coatings of Interest

CARC and Other Paints

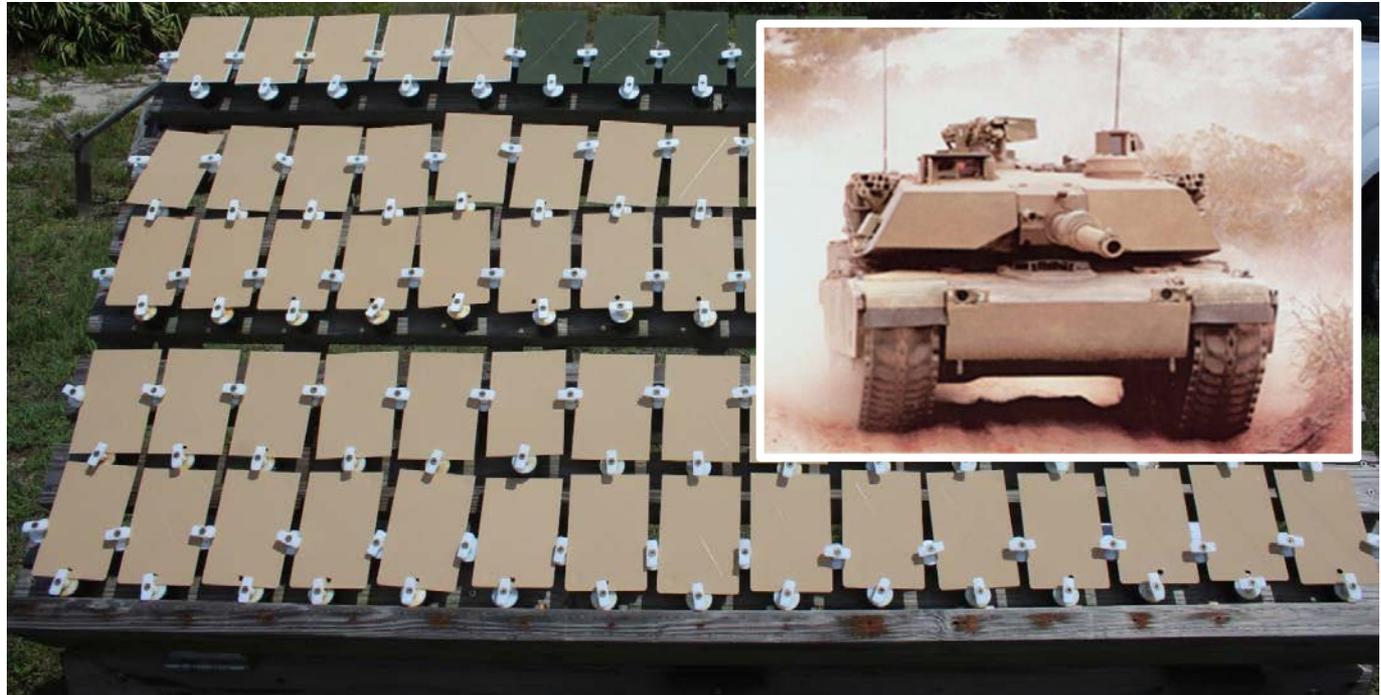
Pre-treatments

Targeted Chemicals

HAPs, VOCs

Alternative Technology

Reformulate with Exempt VOCs



- ARL published new MIL-PRF-32550 metal-rich specification with placeholder classes for HAP-free, low VOC products
- Conditional qualification of six products (solvent-based epoxies and urethanes) was granted after 1-yr outdoor exposure
- Full qualification of HAP-free, low VOC products to be granted after 2-yr outdoor exposure, including more novel formulations

SAGE-Coat Transition: Paint Remover

Coatings of Interest

Paint Removers

Manual

Targeted Chemicals

Methylene Chloride

Alternative Technology

Benzyl Alcohol or Hydrogen Peroxide-based Products



- AMCOM and AED established CARC removal requirements
- NAVAIR published new MIL-PRF-32587 neutral paint remover specification with dedicated type for removing CARC
- ARL completed panel testing of alternatives and referred vendors to NAVAIR for qualification

SAGE-Coat Transition: Cleaners

Coatings of Interest

Cleaners

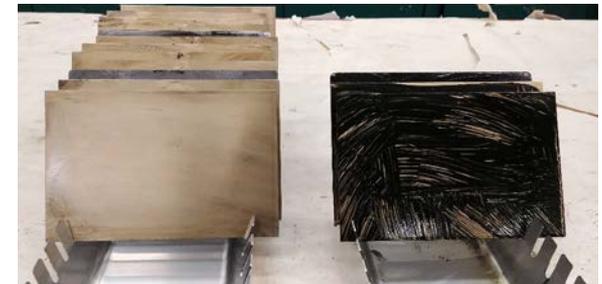
Hand-Wipe & Immersion

Targeted Chemicals

HAPs,
VOCs

Alternative Technology

Exempt
VOCs, Cyclo-
siloxanes or t-
Butyl Acetate
with Methyl
Amyl Ketone



- ARL revising MIL-PRF-32359 and MIL-PRF-32405 to streamline performance requirements and facilitate qualification
- 12 aqueous and 5 non-aqueous HAP-free alternatives tested
- DLA Aviation Hazardous Minimization Program supporting dem/val on Army aircraft and eventual qualification

Are the Alternatives Sustainable?

U.S. Army Public Health Center (PHC) evaluates all proposed TMR and SAGE-Coat alternatives using Toxicology Assessment (TA) process

- Literature review
- Computational modeling
- Data collection
- Toxicity testing, if necessary

TA level of detail commensurate with technology maturity

Data collected under TAs inform acquisition documentation and occupational exposure requirements

- Toxicity Clearance, Health Hazard Assessment
- Occupational Exposure Limits, Industrial Hygiene Plan
- Programmatic Environment, Safety and Occupational Health Evaluation
- Life Cycle Environmental Assessment

Feeds into proposed RDECOM standard operating procedure (SOP) for performing Developmental Environment, Safety and Occupational Health Evaluation

New Army Structure

**Forces Command
(FORSCOM)**

**Training & Doctrine
Command
(TRADOC)**

**Army Materiel
Command (AMC)**

**Army Futures
Command (AFC)**

AFC established 1 July 2018 as fourth four-star Army Command

- Modernizes the Army for the future
- Integrates future operational environment, threat and technologies to develop and deliver future force concepts, requirements and materiel capabilities
- Composed primarily of former TRADOC and AMC elements, including RDECOM

Initial focus will be on eight Cross Functional Team (CFT) pilots addressing the Army's Big Six Modernization priorities

- **Long Range Precision Fires***
- **Next Generation Combat Vehicle***
- **Future Vertical Lift***
- Network Command, Control, Communication & Intelligence
- Assured Positioning, Navigation and Timing
- **Air and Missile Defense***
- **Soldier Lethality***
- Synthetic Training Environment

***Ties to TMR and SAGE-Coat**

Conclusion

TMR and SAGE-Coat are positioned to eliminate Cr(VI), Cd and other toxic constituents from the highest priority Army coating operations

Many alternatives have already been implemented or transitioned to responsible authorities, with the rest scheduled by FY24

Future success will depend on our ability to adapt to the new Army structure and to continue finding partners to support our efforts

- Funding partners (SERDP, ESTCP, NDCEE, DLA, D,CPO)
- Technology partners (Navy labs, Air Force labs, NASA, coating vendors)
- Transition partners (PEOs, PMs, CFTs, spec owners)
- End users (depots, arsenals, installations, OEMs)