Securing the Availability of Green, Enhanced Coatings for U.S. Army Applications (SAGE-Coat)

For ASETSDefense

8 December 2016

Erik Hangeland

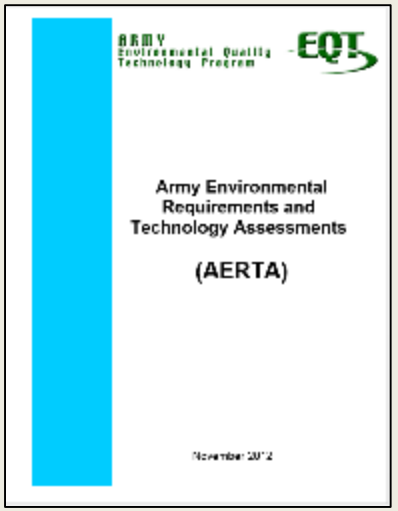
Program Director,

RDECOM Environmental Technology Acquisition Program

DISTRIBUTION A: APPROVED FOR PUBLIC RELEASE

What is the problem?

- The Army requires:
  - Capability to perform organic surface coating operations on weapons systems at industrial facilities, motor pools, repair shops and in the field
  - Continued availability of surface coating products and processes that are ESOH sustainable while also meeting performance requirements
- Emerging ESOH challenges include:
  - Increased scrutiny from regulatory and scientific communities
  - Previous regrettable substitutions
  - Uncertainty caused by lack of specification control
  - Obsolescence with new production runs of legacy systems
  - Side effects of “smart” coating capabilities
- If not addressed:
  - Continued Soldier/civilian/community exposure to ESOH impacts
  - Liabilities including lawsuits, NOVs, interruption of operations
  - Unavailable/unaffordable products due to regulation, PR, market pressure, etc.
  - Weapon systems not maintained properly may be deemed non-mission capable

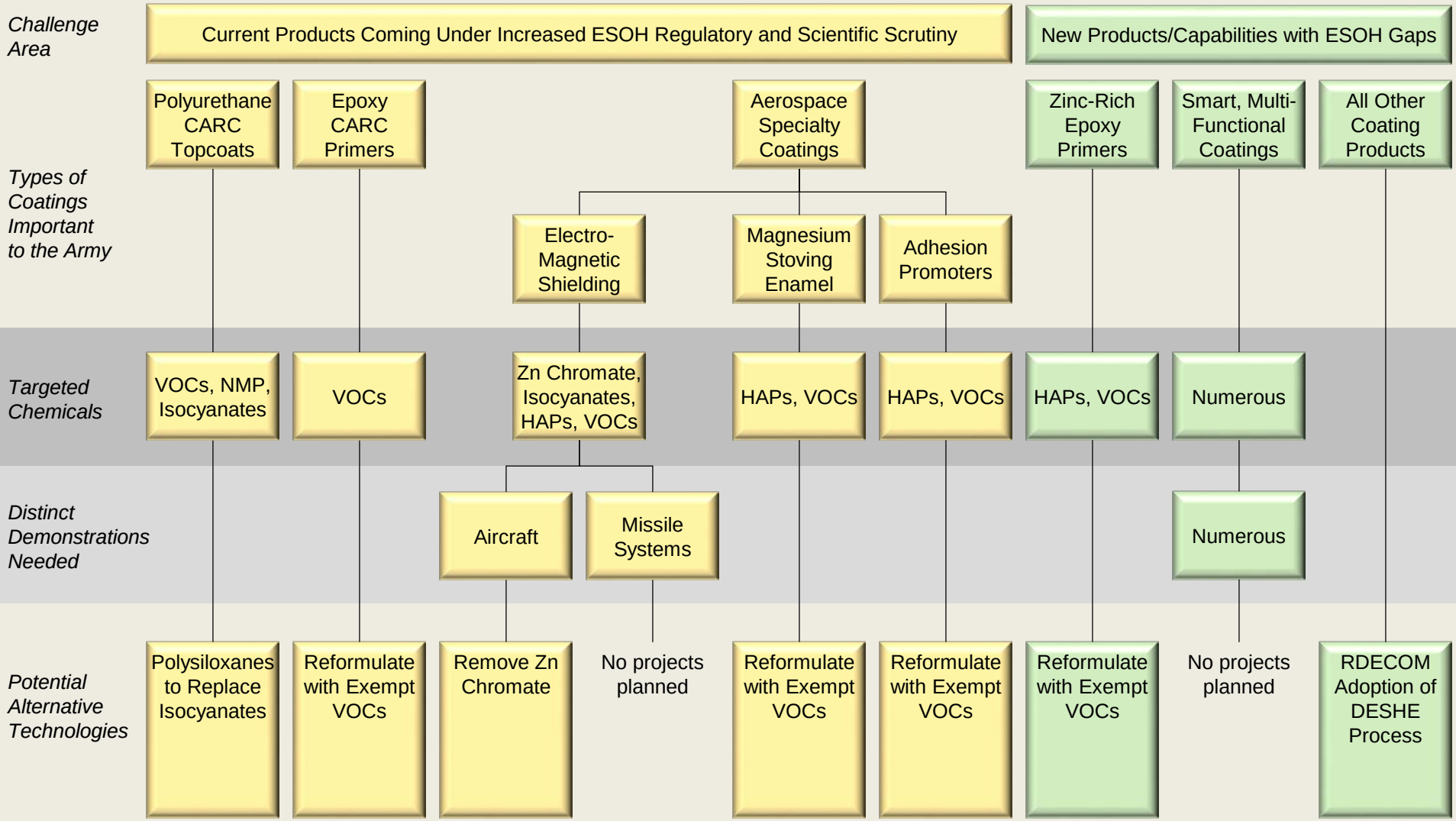


Didn't the Army already solve this?

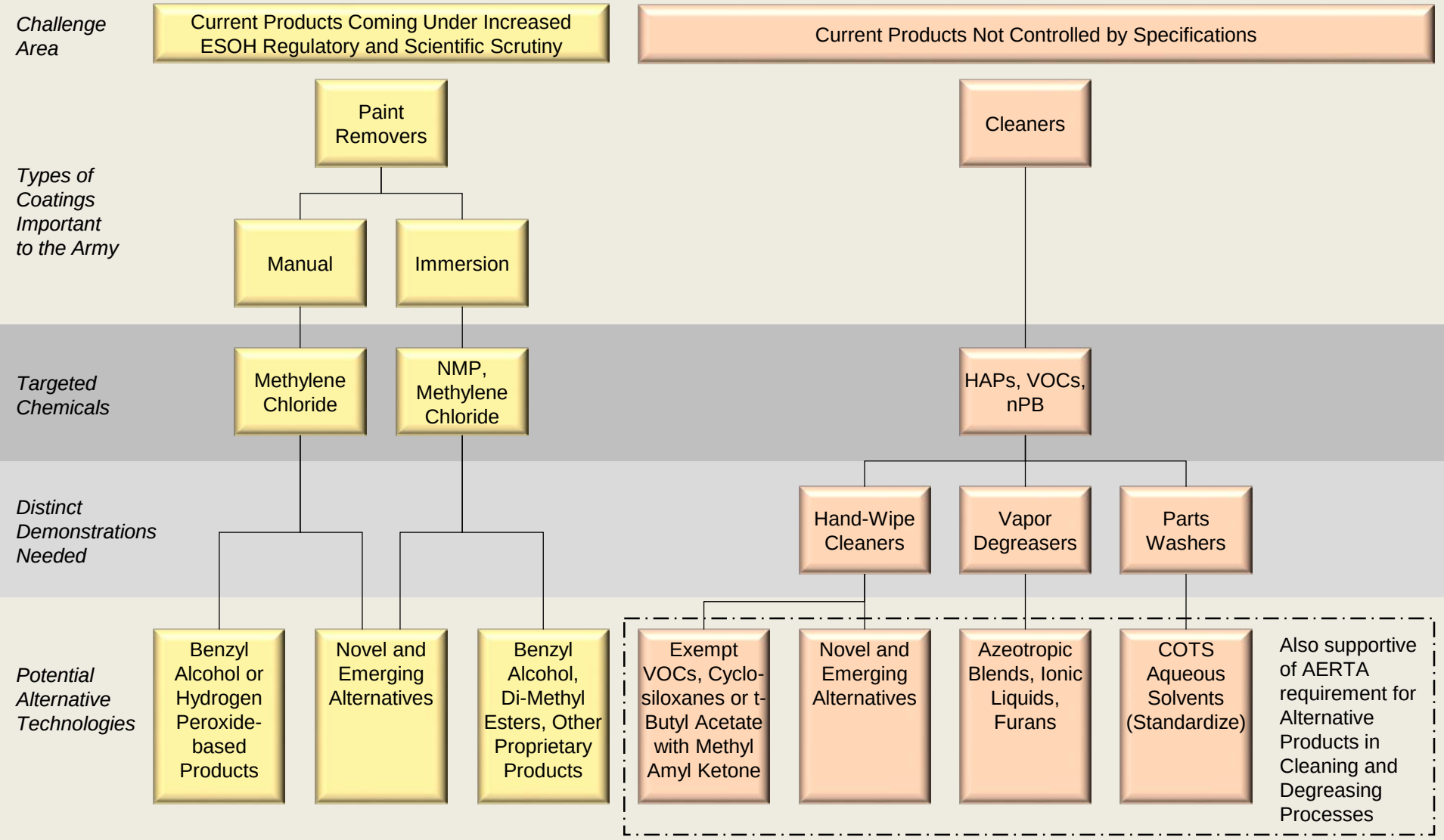
- Sustainable Painting Operations for the Total Army (SPOTA) program was extremely successful
  - Demonstrated and fielded 30+ new surface coating products
  - Overhauled the CARC system with higher performing, more sustainable products
  - Eliminated Army use of TCE and MeCl dip tanks
  - Paved the way for qualification of sustainable cleaners and thinners
  - Won SecArmy and SecDef environmental awards, among others

- However…
  - SPOTA focused primarily on eliminating HAPs
  - SPOTA focused primarily on ground vehicles and support equipment
  - SPOTA was last funded in 2011 and officially ended in 2013
  - Many technology gaps remain and continue to emerge

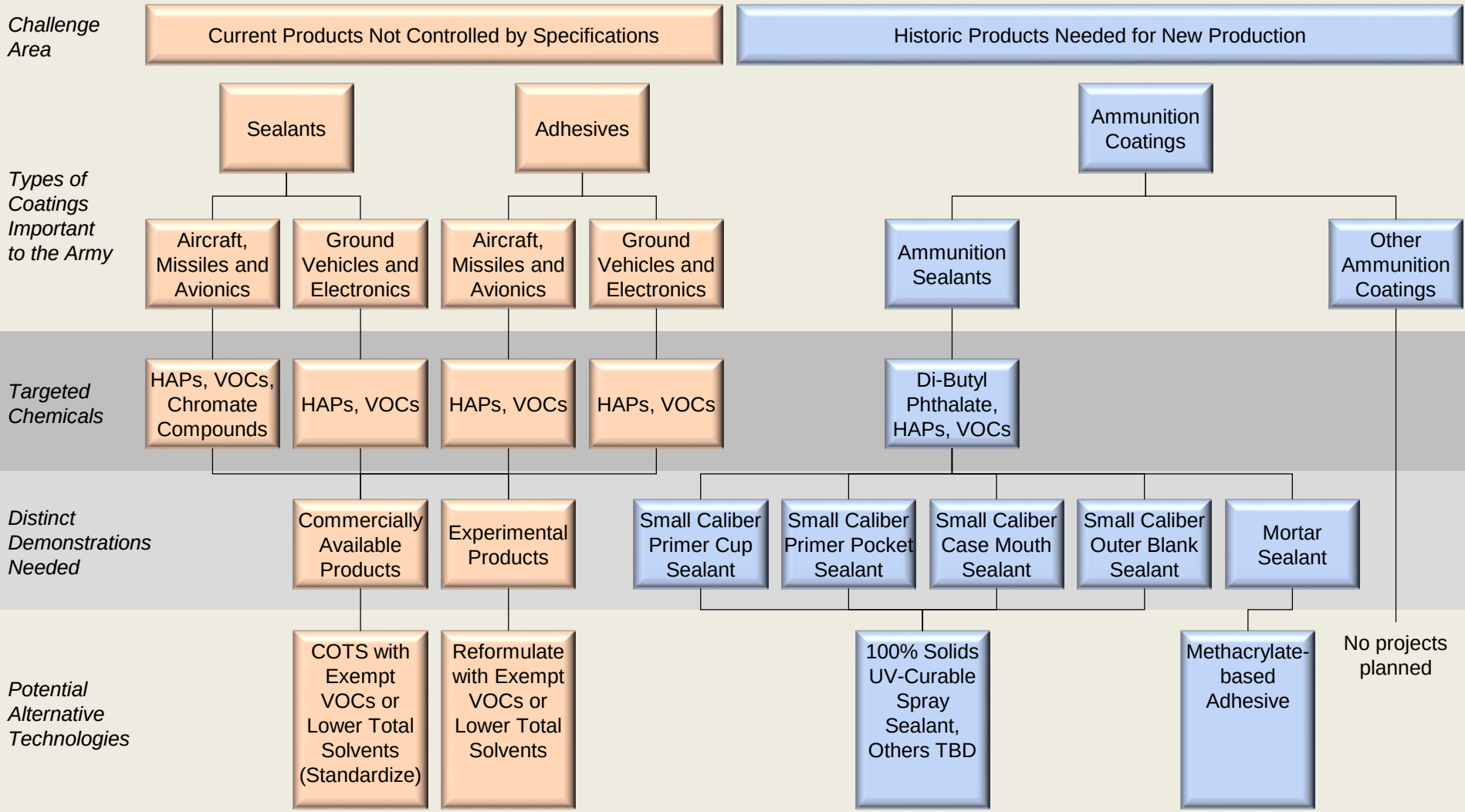
Gaps: Paints & Coatings



Gaps: Paint Removers & Cleaners

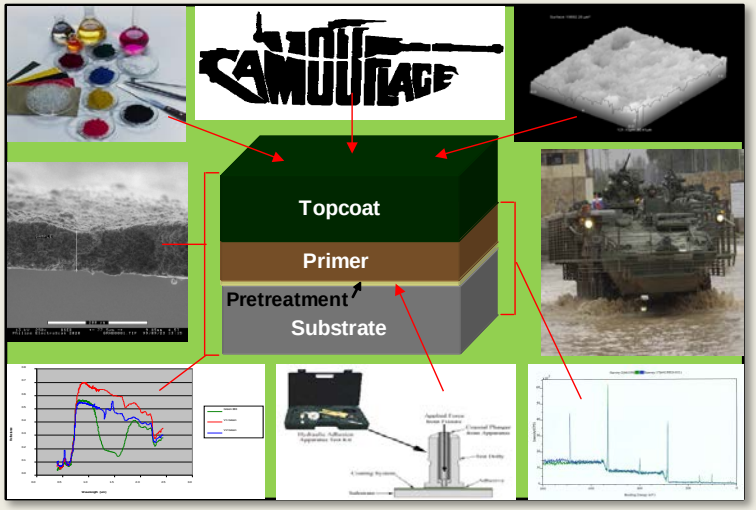


Gaps: Sealants, Adhesives, Ammo



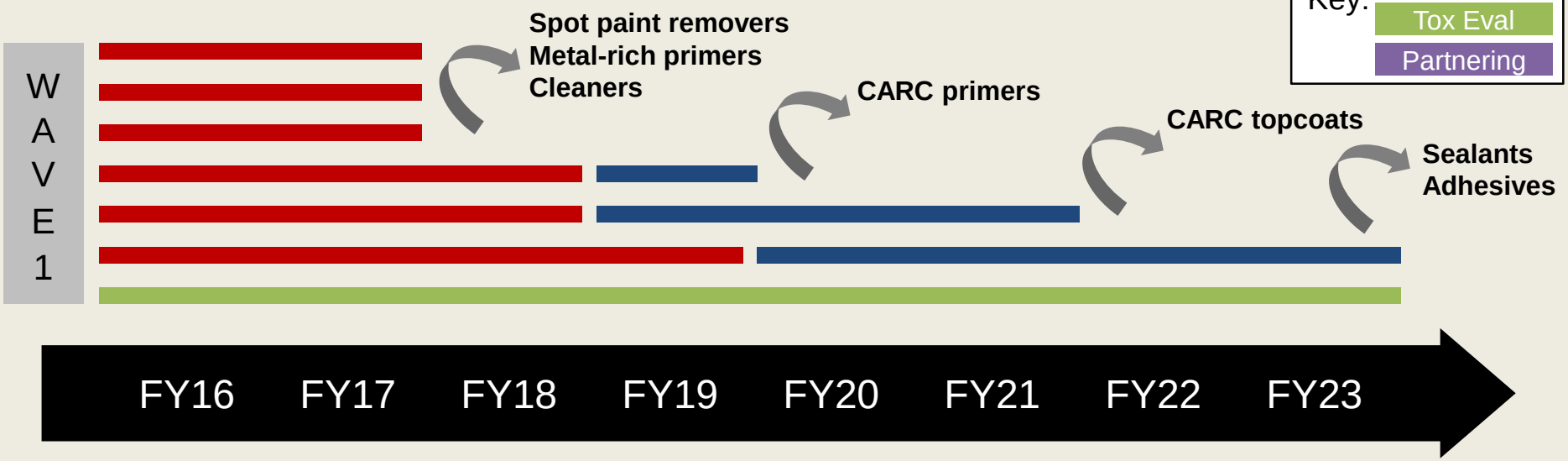
What are SAGE-Coat's objectives?

- Develop and demonstrate alternative surface coating products that proactively address known and anticipated ESOH sustainability threats
  - Preclude product obsolescence, availability and affordability issues stemming from domestic and global regulatory pressures
  - Avoid $200M in associated compliance and health costs
  - Reduce 400,000 lbs/yr of VOC emissions from high use primers
  - Eliminate exposure to isocyanates from 200,000 gals/yr of topcoats
  - Achieve standardization and quality control of 2,000+ off-the-shelf products
  - Ensure future leap-ahead technologies are ESOH sustainable
  - Transition solutions to 40+ Army and USMC installations plus OEMs
  - Enable VOC reductions at facilities in non-attainment with Ozone NAAQS



SAGE-Coat Program Plan

Key: S&T, Dem/Val, Tox Eval, Partnering



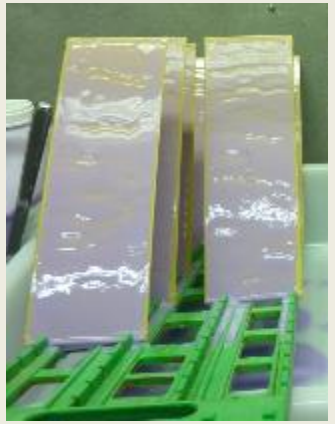
WAVE 2

Non-Chromated Electromagnetic Shielding Coating
HAP-Free, Low VOC Stoving Enamel for Magnesium Substrates
Other Aerospace Specialty Coatings with Reduced HAPs and VOCs
Immersion Depainting Alternatives to N-Methyl Pyrrolidone
Next Generation Sustainable Cleaning and Depainting Chemistries
Non-Phthalate Plasticizers for Small Caliber Ammunition Sealants
Sustainable Cement for Production of Mortar Systems

Other Gaps?

HAP-free, Low VOC Chemical Spot Paint Removers for Army Weapons Systems (SAGE 16-06)

- **Objective:** Eliminate HAPs and reduce VOCs found in CARC spot paint removers
- **Magnitude of impact:**
  - Eliminate 100% of methylene chloride from Army painting operations
  - Avoid OSHA requirements for medical surveillance of paint stripping workers
- **Intended end product:** Qualified HAP-free, low VOC products effective at stripping CARC topcoats and primers
- **Technology:**
  - Primarily benzyl alcohol and hydrogen peroxide-based commercial alternatives
  - Some leveraged developmental alternatives (NAVAIR)
- **Weapon systems impacted:** Everything coated with CARC
- **Transition path:**
  - TT-R-2918: Remover, Paint, No HAPs
  - New specification TBD: Neutral HAP-Free Paint Remover
- **POC:** Jack Kelley, ARL, john.v.kelley8.civ@mail.mil



FY16
- Research and gather alternatives
- Finalize test matrix

FY17
- Evaluate alternatives in laboratory
- Demonstrate on boneyard parts
- Provide input for spec revisions

HAP-Free, Low VOC Zinc Rich Primers (SAGE 16-03)

- **Objective:** Eliminate HAPs and reduce VOCs in newly implemented zinc rich primers
- **Magnitude of impact:**
  - Projected zinc-rich primer usage up to 100K gals/year
  - Avoid 50K lbs/year HAP emissions and at least 20K lbs/year VOC emissions based on that usage
- **Intended end product:** Qualified HAP-free, low VOC spray-on zinc rich primers that can be used in depot environments
- **Technology:**
  - Currently qualified products reformulated to be HAP-free with less than 2.8 lbs/gal VOCs (ideally 2.1 lbs/gal)
  - MIL-PRF-32550 revised to eliminate 3.5 lbs/gal VOC class
- **Weapon systems impacted:** Ground vehicles and ground support equipment
- **Transition path:** MIL-PRF-32550: Metal Rich Primer (new specification published 11 Aug 2016)
- **POC:** Fred Lafferman, ARL, fred.l.lafferman2.civ@mail.mil

FY16
- Create specification
- Notify vendors of reformulation

FY17
- Evaluate alternatives in laboratory and outdoor exposure

FY18
- Complete small-scale demo
- Publish revised spec and QPL

Qualification of HAP-Free Cleaners for Aircraft and Ground Vehicles (SAGE 16-01)

- **Objective:** Eliminate HAPs and reduce VOCs found in immersion, hand wipe and spray cleaners
- **Magnitude of impact:**
  - Reduce 300K lbs/year VOC emissions from 50K gals/year of cleaners used Army-wide
  - Even greater impact if replacing paint thinners historically used as cleaners
- **Intended end product:** HAP-free, low VOC cleaners that meet revised requirements of MIL-PRF-32405 and MIL-PRF-32359
- **Technology:**
  - Numerous commercially available products
  - MIL-PRF-32405 and MIL-PRF-32359 revised and republished with Qualified Product Lists (QPLs)
- **Weapon systems impacted:** Ground vehicles, aviation platforms, missile platforms, ground support equipment
- **Transition path:**
  - MIL-PRF-32359: Cleaner, General, for Ground Vehicles and Ground Support Equipment, HAP-Free
  - MIL-PRF-32405: Cleaner, Hand Wipe, for Aviation and Missile Systems, Metallic Substrates, Low or Exempt VOC
  - TACOM/AMCOM to implement through revised TMs, DMWRs
- **POC:** Fred Lafferman, ARL, fred.l.lafferman2.civ@mail.mil

FY16
- Modify cleaner qualification requirements

FY17
- Laboratory test alternatives against new requirements

FY18
- Issue specifications, QPLs, NSNs
- Transition through TMs, DMWRs

Ultra Low VOC CARC Primers (SAGE 16-04)

- **Objective:** Significantly reduce VOC level in CARC primers
- **Magnitude of impact:**
  - Drive VOC content from 2.8 lbs/gal to 2.1 lbs/gal (threshold) or 1.0 lb/gal (objective)
  - Reduce up to 500K lbs/year VOC emissions from 350K gals/year usage across DoD
- **Intended end product:** Qualified HAP-free primers with VOC content as low as possible and dry times that meet depot throughput requirements
- **Technology:** Ultra low VOC CARC epoxy primers using:
  - New polymer/resin technology
  - Catalysts, accelerators, additives to reduce dry time
  - Different blends of VOC exempt solvents
- **Weapon systems impacted:** Ground vehicles and ground support equipment
- **Transition path:**
  - MIL-DTL-53022: Solvent-Based Epoxy Primer
  - MIL-DTL-53030: Water-Based Epoxy Primer
- **POC:** Fred Lafferman, ARL, fred.l.lafferman2.civ@mail.mil

FY16
- Obtain and evaluate industry samples of alternative solvents, resins and additives

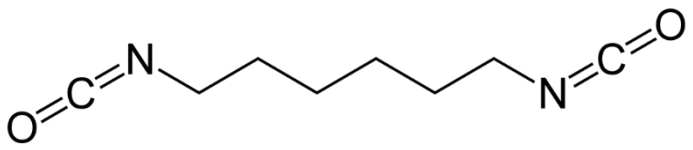
FY17
- Formulate new primers
- Conduct laboratory testing

FY18
- Demonstrate in production environment
- Verify corrosion and application properties

FY19
- Validate long-term performance
- Revise specifications to include new type

Non-Isocyanate Alternatives for Chemical Agent Resistant Coatings (SAGE 16-05)

- **Objective:** Eliminate CARC topcoat dependence on isocyanates
- **Magnitude of impact:**
  - Army uses 600K gals/year of topcoats containing 1-2 lbs/gal of isocyanates
  - Alternative chemistry projected to displace 1/3 of usage initially (200K lbs/year isocyanates) while providing capability for 100% conversion if necessary
- **Intended end product:** Qualified HAP-free, low VOC CARC topcoat formulated without isocyanates
- **Technology:** Multiple chemistries under consideration:
  - Polysiloxanes
  - Hybrid alkyd/epoxy
  - Low/no isocyanate polyurethane
- **Weapon systems impacted:** Everything coated with CARC
- **Transition path:** Consolidation into single CARC topcoat spec with three types:
  - Waterborne 2-component polyurethane
  - Solvent-borne 1-component polyurethane
  - Non-isocyanate chemistry
- **POC:** John Escarsega, ARL, john.a.escarsega.civ@mail.mil



1,6 Hexamethylene Diisocyanate

FY16
- Research industry formulations
- Acquire raw materials

FY17
- Formulate clear coat compositions
- Evaluate dry time and film formation

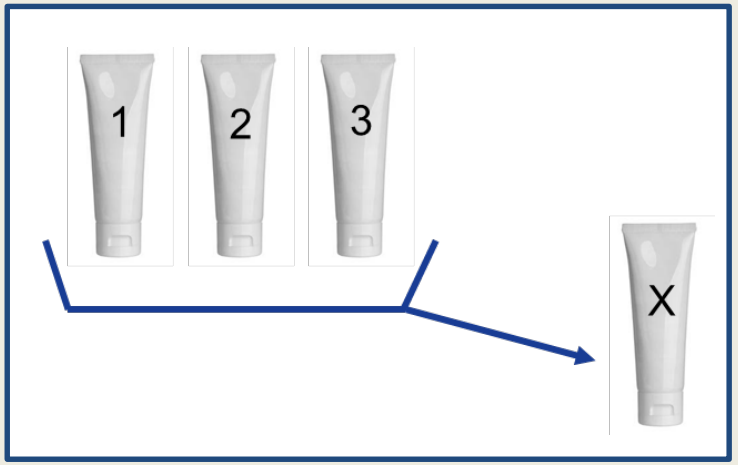
FY18
- Create lab batch samples in black
- Fine tune formulations to improve performance

FY19
- Scale up batches and introduce base colors
- Demonstrate on Army and USMC assets

FY20
- Publish revised specifications and QPLs

Evaluation and Consolidation of Sustainable Alternative Sealants and Adhesives (SAGE 16-02)

- **Objective:** Replace end-user prioritized hazardous sealants and adhesives with environmentally preferable alternatives of equivalent performance
- **Magnitude of impact:**
  - Consolidation and better specification control of over 2,000 commercial products
  - Streamlining of RCRA compliance and reduction of hazardous waste disposal costs
- **Intended end product:** Modernized sealant and adhesive specifications with sustainable qualified products
- **Technology:**
  - Numerous commercially available products
  - Potentially new/reformulated products if necessary
  - Potentially new specifications if existing not sufficient
- **Weapon systems impacted:** Primarily ground vehicles and aviation platforms
- **Transition path:** Revised/new specifications, QPLs, NSNs
- **POC:** Dr. Rob Jensen, ARL, robert.e.jensen.civ@mail.mil



FY16
- Conduct survey, populate database, determine priorities for replacement

FY17
- Evaluate performance criteria for existing specifications and NSNs

FY18
- Consolidate overlapping specs, NSNs
- Laboratory testing of alternatives

FY19
- Develop new specs to fill any gaps
- Demonstrate alternatives at depots

Later
- Spin out alternatives
- Publish specifications and QPLs

Are the Alternatives More Sustainable?

- U.S. Army Public Health Center evaluates all proposed alternatives using Toxicology Assessment (TA) Process
  - Literature review
  - Computational modeling
  - Data collection
  - Toxicity Testing, if necessary
- TA review concurrent with project maturity
- Data will inform acquisition documentation and occupational exposure requirements
  - Toxicity Clearance, Health Hazard Assessment
  - Occupational Exposure Limits, Industrial Hygiene Plan
  - Programmatic Environment, Safety and Occ. Health Evaluation
  - Life Cycle Environmental Assessment

Developmental Environment, Safety and Occupational Health Evaluation (DESHE)

- DESHE is a process and not a report or document
- Purpose: Develop and document a baseline level of ESOH performance data for each level of research in order to support risk-based decisions
  - Should include human toxicity (mammalian), fate and transport, eco-toxicity and safety data
- Phased approach to gather, develop and document ESOH performance data for materials, processes and technologies during all phases of RDT&E
  - Data requirements determined by Budget Activity or TRL
  - Early stages – qualitative data
  - Higher maturity technologies – more robust, quantitative data
  - Data should be collected using regulatory-approved methods (ASTM, OECD) and consistent with Good Laboratory Practices

U.S. ARMY RDECOM®

Summary

Securing the Availability of Green Enhanced Coatings

- Going beyond mere compliance with ESOH regulations
- Addressing all manner of sustainability threats so they do not result in product obsolescence and affordability issues
- Using TA and DESHE processes to verify sustainability of alternative products
- Integrating ESOH considerations into future coatings development
- Demanding higher performance and new capabilities without sacrificing sustainability
- Combining short-term projects to implement current state-of-the-art with long-term projects to push the envelope

We are looking for partners!