



U.S. Army Research, Development and Engineering Command

# Hexavalent Chromium Reduction in the Army: Success Stories and the Path Forward



***TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.***

**Erik Hangeland  
HQ, RDECOM  
410-436-6986  
erik.hangeland@us.army.mil**

**Presented to E2S2 Symposium, New Orleans, LA, 11 May 2011**

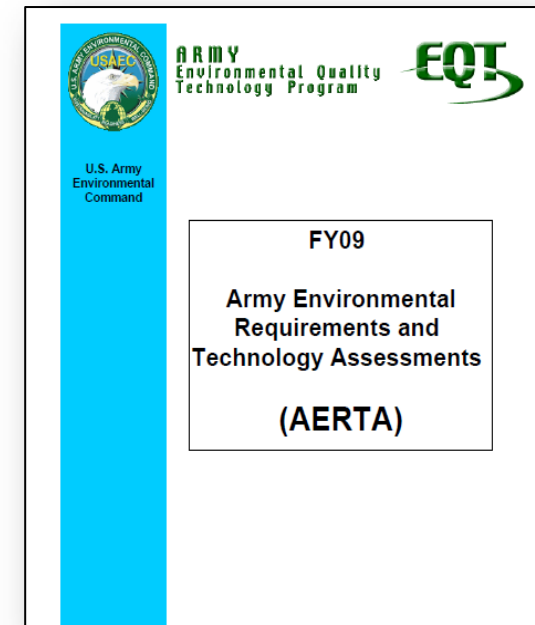
| Report Documentation Page                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                    |                                     |                                                           | Form Approved<br>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<br><b>11 MAY 2011</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                    | 2. REPORT TYPE                      |                                                           | 3. DATES COVERED<br><b>00-00-2011 to 00-00-2011</b> |                                 |
| 4. TITLE AND SUBTITLE<br><b>Hexavalent Chromium Reduction in the Army: Success Stories and the Path Forward</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                    |                                     |                                                           | 5a. CONTRACT NUMBER                                 |                                 |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                    |                                     |                                                           | 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)<br><b>U.S. Army Research, Development and Engineering Command,3071 Aberdeen Blvd,Aberdeen Proving Ground,MD,21005</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                    |                                     |                                                           | 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<br><b>Approved for public release; distribution unlimited</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                    |                                     |                                                           |                                                     |                                 |
| 13. SUPPLEMENTARY NOTES<br><b>Presented at the NDIA Environment, Energy Security &amp; Sustainability (E2S2) Symposium &amp; Exhibition held 9-12 May 2011 in New Orleans, LA.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                    |                                     |                                                           |                                                     |                                 |
| 14. ABSTRACT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                    |                                     |                                                           |                                                     |                                 |
| 15. SUBJECT TERMS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                    |                                     |                                                           |                                                     |                                 |
| 16. SECURITY CLASSIFICATION OF:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                    |                                     | 17. LIMITATION OF ABSTRACT<br><b>Same as Report (SAR)</b> | 18. NUMBER OF PAGES<br><b>14</b>                    | 19a. NAME OF RESPONSIBLE PERSON |
| a. REPORT<br><b>unclassified</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | b. ABSTRACT<br><b>unclassified</b> | c. THIS PAGE<br><b>unclassified</b> |                                                           |                                                     |                                 |



# Toxic Metals Reduction in Surface Finishing on Army Weapon Systems

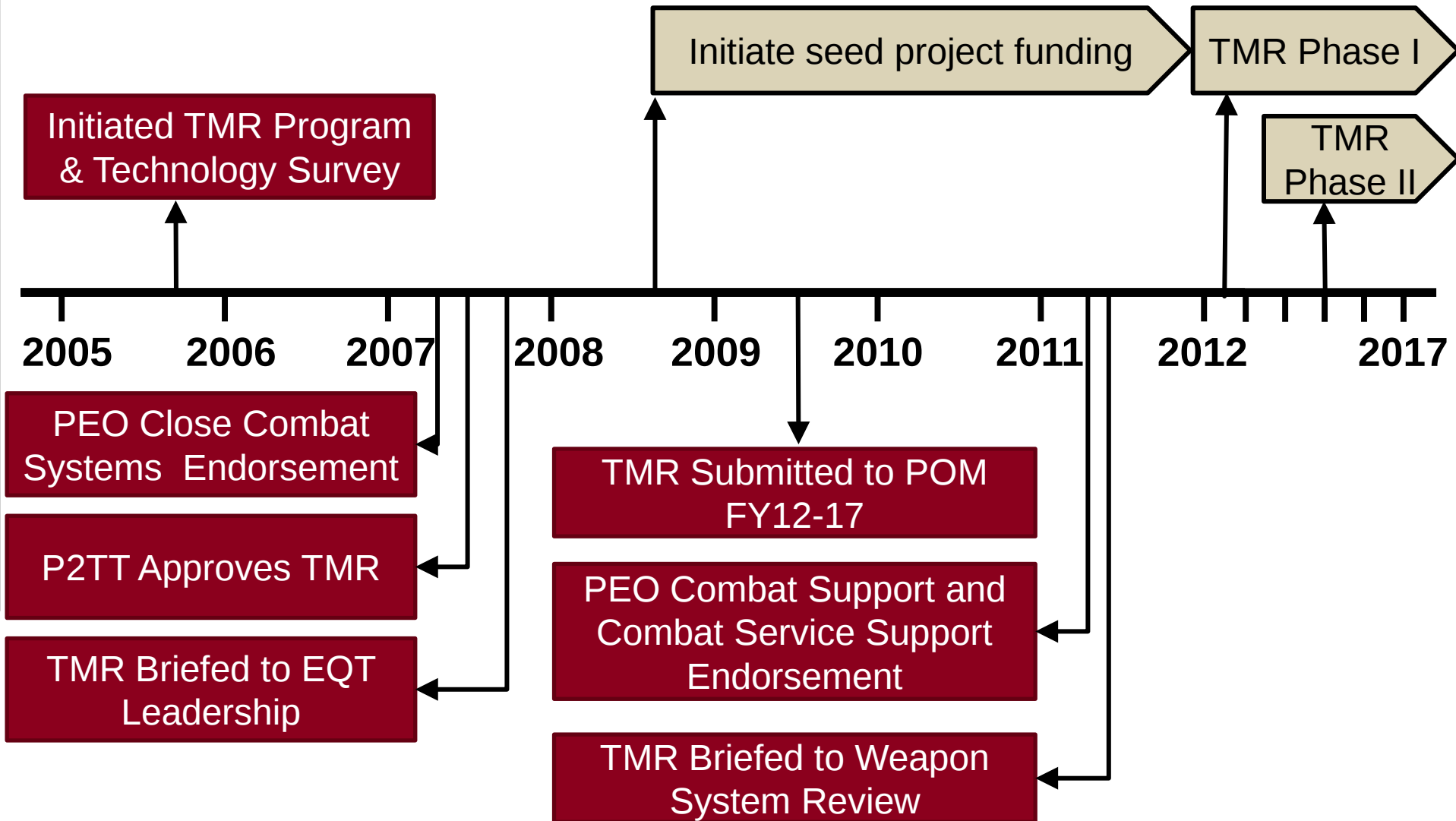


- Army Environmental Requirements and Technology Assessments (AERTA)  
PP-2-02-03
- Reduce use of carcinogenic substances in metal plating, including
  - Hexavalent chromium (Cr(VI))
  - Cadmium (Cd)
  - Beryllium and its alloys
- Currently #2 overall Army environmental requirement
- Pollution Prevention Technology Team (P2TT) built Toxic Metal Reduction (TMR) Program to address AERTA
- TMR funded via Army Environmental Quality Technology (EQT) Program and additional leveraged programs





# TMR Program Timeline





# Toxic Metal Reductions in Surface Finishing



## Phase I:

**Funding:** BA2-BA4, BA6

**Timeframe:** FY08-17

### Thrust Areas:

- Alternatives to Cr(VI) in Metal Plating
- Cr(VI) Reduction in Pretreatment and Surface Finishing
- Alternatives to Cd in Plating and Finishing

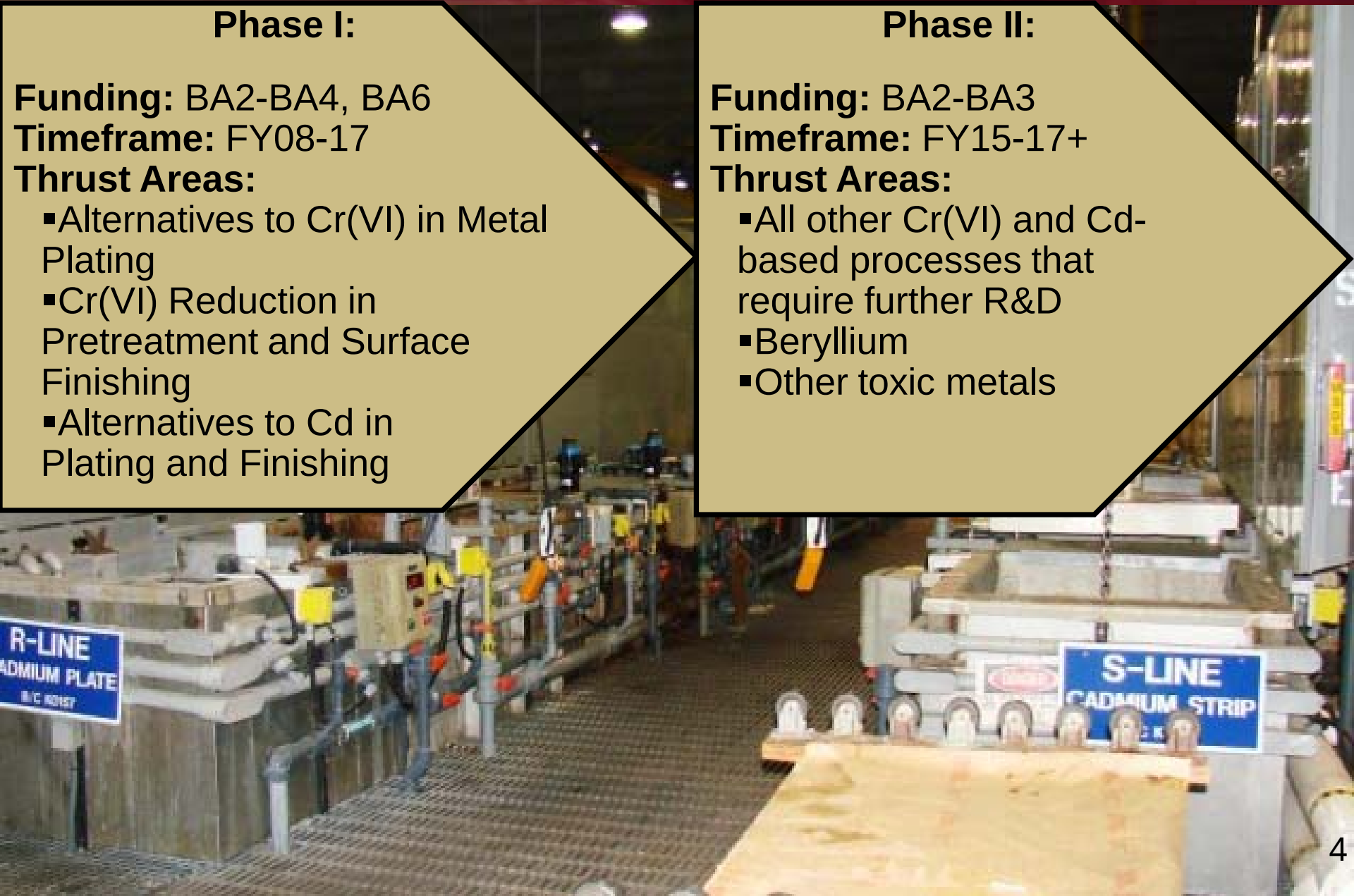
## Phase II:

**Funding:** BA2-BA3

**Timeframe:** FY15-17+

### Thrust Areas:

- All other Cr(VI) and Cd-based processes that require further R&D
- Beryllium
- Other toxic metals





ESOH costs  
(per depot):  
**\$2M+/yr**

## ■ Scope of Program

- All major Army industrial installations use Cr(VI) and/or Cd in production & maintenance processes and field maintenance / touch-up operations
  - Plating
  - Conversion Coatings
  - Stripping
  - Anodizing
  - Sealing
  - Wash Primer
- PMs specify these materials due to lack of validated alternatives on many systems
  - Ground vehicle systems
  - Communications
  - Support equipment
  - Aviation
  - Armaments
  - Electronics

## ■ Objectives

- Develop & field technologies to reduce
  - Cr(VI) used in electroplating by 75%
  - Cd used with Cr(VI) finishes by 75%
  - Cr(VI) in pretreatments and surface finishes by 100%
- Meet or exceed all operational performance requirements



## TMR Technology Demonstration/Validation Efforts



### Proposed Funding Allocation

- Alternatives to Cr(VI) Metal Plating
- Alternatives to Cd in Plating and Finishing
- Cr(VI)-Free Pretreatments, Finishes and Conversion Coatings

Transition all technologies to users at Technology Readiness Level 7 (prototype demo) and some at TRL 8 (full system demo)



# TMR Funded Project: Cr(VI) Elimination in Medium Caliber Guns

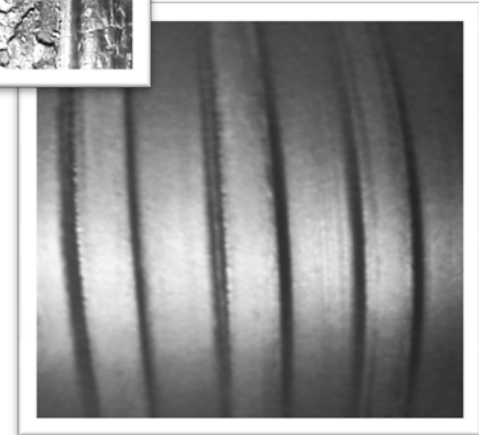


- Objectives:
  - Eliminate of Cr(VI) in manufacture of medium caliber bore coatings
  - Extend medium caliber gun barrel life
- Technical Approach:
  - Benet Laboratories explosively cladding tantalum-tungsten (Ta-W) alloy coatings on the bore
- Successes:
  - Test fired Ta-W clad barrel side-by-side with current Cr(VI) barrel with 3x increase in barrel life
- Follow-On:
  - Transition to Army MANTECH Program
  - Leverage technology in large caliber systems



Condemned  
Cr(VI) Barrel

Ta-W Barrel  
after similar  
test

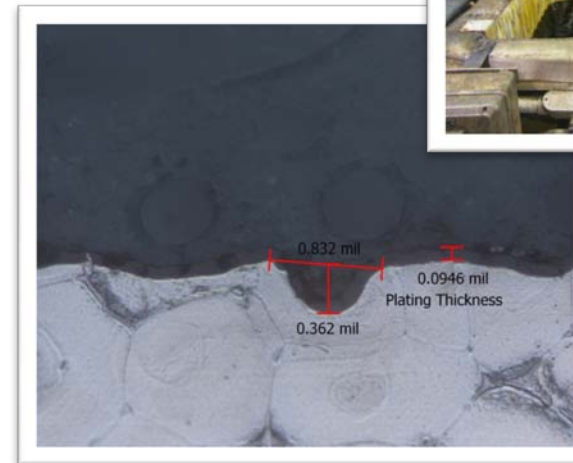




# TMR Funded Project: Cr(VI)-Free Stripping Processes for Metal Finishing Operations

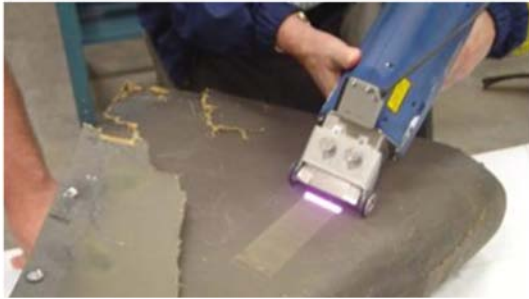


- Objective:
  - Eliminate Cr(VI) strippers for inorganic surface finishes during the overhaul & repair of Army Aviation assets
- Technical Approach:
  - Test COTS solutions on highest use processes and substrates at Corpus Christi Army Depot (CCAD)
- Successes:
  - Developed baseline data for Cr(VI)-based strippers to establish Army Aviation requirements for IGA/EGP and Weight Loss
- Follow-On:
  - Conduct IGA/EGP and Weight Loss tests for alternative processes





## Sustainable Painting Operations for the Total Army (SPOTA)



Handheld Laser Depainting  
for Aviation

HAP-Free, Non-Cr(VI) Wash  
Primer



Non-Chromate Conversion  
Coating for Zinc-Plated Steel



Flashjet Depainting for Rotor  
Blades

## Ordnance Environmental Program

Perchlorate- and Cr(VI)-Free  
Delays for Handheld Signals





- **2003:** Initiated by AMCOM G-4 with NAVAIR and ARL
- **2005:** Demo CH-47 coated by 1109th Aviation Classification Repair Activity Depot (AVCRAD) in Groton
  - Expanded use to CH-47, UH-60, OH-58, AH-64, UH-1
  - No significant difference between the Cr(VI)-free and standard coating systems
- **2010:** 1108th AVCRAD transitioned to the MIL-PRF 85582 Class N primers and working towards implementation of the MIL-DTL-81706 Type II conversion coatings
- **2011 & Beyond:**
  - AMCOM G-4 coordinating with Ft. Rucker and CCAD to implement the Cr(VI)-free technologies coating system
  - G-4 coordinating with 1107th AVCRAD, Springfield, MO and 1106th AVCRAD, Fresno, CA to begin implementation of the new coating system



# Non-EQT Army Efforts

## Past Success: Aviation Cr(VI) Free Conversion Coatings and Epoxy Primers



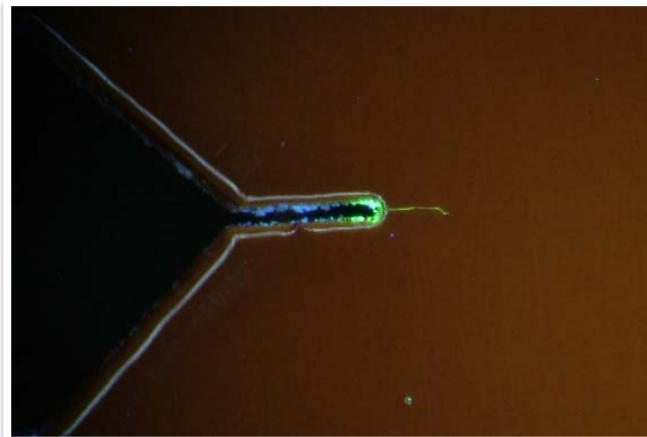


### ■ Cr(VI) Free Coatings for Missile Weapon Systems

- Demonstrate use of a total Cr(VI)-free coating system on missile weapon systems/support equipment assemblies (mixed metal) with NAVAIR & ARL

### ■ Tagnite Coated Magnesium Components

- Dem/Val of processing Tagnite coated magnesium housings (NDCEE)
- Nondestructive Inspection (NDI) testing of magnesium transmission housings for aviation systems (AMRDEC and NDI Center of Excellence)
- Cr(VI) free coating system for magnesium housings on aircraft (AMRDEC)





- Defense Federal Acquisition Regulation Supplement (DFARS); Minimizing Use of Hexavalent Chromium
  - Proposed DFARS clause published in FR 8 April 2010
  - Comments from industry incorporated into public draft
  - Army drafted Army Acquisition Policy – Awaiting final DFARS Clause
- Army Goals for Toxic Chemical Reduction
  - 1 Mar 10 Memo outlines Army Hazardous Material Management Plan to reduce Army use of three chemicals
  - Includes Cr(VI) containing epoxy primers – used primarily in aviation corrosion control
  - Goal: 9% reduction from 2010-2013 (base year CY2007)



## Questions?



- Erik Hangeland  
RDECOM EALSP Program Manager  
[erik.hangeland@us.army.mil](mailto:erik.hangeland@us.army.mil)  
410-436-6986
- Noah Lieb  
Hughes Associates, Inc.  
[nlieb@haifire.com](mailto:nlieb@haifire.com)  
410-737-8677