

US Army Research Laboratory

Cr+6
COTS Alternatives for Vehicles

Dr. John H. Beatty
Army Research Laboratory

RDECOM Team

Maryalice Miller - RDECOM
Jonathan Montgomery - ARL
Michael Audino – Benet Labs
Philip Darcy - Benet Labs
Neil Gavrich – ARDEC
Brian Placzankis -ARL

Scottie Smith - AMCOM
Michelle Davis - TARDEC
Carl Handsy – TARDEC
Parminder Khabra - TARDEC
Joseph Ryan - CERDEC
Liliana DiAngelo - HAI
Thomas V. Sachar- HAI

Current Uses of Cr+6

- Approximately 300,000+ vehicles in DoD fleet, mostly over 20 years old
 - Majority low carbon steel, plain or galvanized. Other important substrates rolled homogenous armor (RHA), aluminum composites, ceramic armor, and some titanium
- Future vehicles high strength steels, high strength aluminum alloys, lightweight composite armor, greater use of titanium and magnesium alloys

Typical Ground Vehicles

One variant of the Family of Medium Tactical Vehicles (FMTV)
Photo courtesy Army Images

High Mobility Multipurpose Wheeled Vehicle (HMMWV)
Photos courtesy Army Images

Heavy Expanded Mobility Tactical Truck (HEMTT).
Photos courtesy Army Images

Stryker Infantry Armored Vehicle
Photo courtesy DoD DEFENSLINK

Bradley Fighting Vehicle
Photo courtesy DoD Defenselink

Performance Requirements

- For Hard Chrome: wear resistance, “rebuildability”, and complex non-line of sight parts
- For Chromates: corrosion protection, ease of use, conductivity, color identification, improved processing operational tolerances
- Other aspects: throughput, process robustness, coating thickness, coating uniformity, wear, metallurgical bond, fatigue life, torsion strength, tensile strength, and surface condition prior to painting and bonding

Clean Alternatives Barriers


- Costly technical manual changes to legacy systems
- OEM equipment used for both commercial and DoD customers (much smaller fraction of buys). Must consider impact on both types of customers.
- New systems purchased to performance specifications. Army specifies outcomes, not processes.
- Alternatives performance must be equal or better.
- Depot concerns on capital costs and process versatility for plating multiplicity of parts.
- Specs?

Alternatives Adopted


- **Chromates (Cr+6)**
 - Non-CCC (grit blasting followed by primer and topcoat) on corrosion resistant armor alloys
 - Non-CCC (Alodine 5200/5700) on aluminum roadwheels
 - DI water rinse in lieu of chromate seals on zinc phosphate during CARC application process
 - Eliminate Cr+6 Wash Primer on some high-hard steel vehicles
 - Navy and Army have achieved good success using Non-CCC coatings on Al 5083 and 7079 armor alloys
 - TCP ready for use
- **Hard Chrome**
 - Electroless Ni, Ni-tungsten boron
 - HVOF coatings of tungsten carbide/cobalt coating on M1 Tank GTE components (e.g. compressor bearing housing)
 - Other wear resistant materials in several engine applications

TCP Test Bradleys

- 2AGR0258Y and 3AGR0086Y still @APG can be checked again if needed
- Ft. Benning TCP TRADOC School Bradley 2AGR0031 inspected @3 years.



Fort Benning




2AGR0031 in 2004

Fort Benning Test Bradley




Fort Benning Test Bradley





Alternatives Adopted

- **Hard Chrome**
 - Electroless Ni, Ni-tungsten boron
 - HVOF coatings of tungsten carbide/cobalt coating on M1 Tank GTE components (e.g. compressor bearing housing)
 - Other wear resistant materials in several engine applications



Difficult Uses to Change

- Cr+6 chromate rinses on Cd and Zn plated fasteners on large number and variety of legacy systems. Piecemeal approach not productive and process changes need coverage identification method (color indicators provided with current Cr+6 rinses).
- Many items now on the market, but they are not all the same.....
 - CIDs (Commercial Item Descriptions)
 - MIL-PRF
 - MIL-DTL
 - MIL-STD
- Use DoD Corrosion Specs & Standards WIPT to get tri-service strategy
- Still need replacement for Cr+6 wash primer for steel and aluminum