U.S. ARMY

DEVCOM GROUND VEHICLE SYSTEMS CENTER

U.S. ARMY COMBAT CAPABILITIES DEVELOPMENT COMMAND GROUND VEHICLE SYSTEMS CENTER

Abatement of Hexavalent Chromium and Cadmium in Ground Vehicle System Fasteners

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Aleks Zlateski
GVSC Systems Engineering Directorate
Standardization Team

BACKGROUND

- Hexavalent chromium (Cr^{6+}) and cadmium (Cd), EPA-banned hazardous carcinogens, are still in use by the Army for plated steel fasteners.
- The safety of the environment and health of personnel handling these fasteners during production, maintenance and disposal has been a rising concern.
- Inability to procure zinc-nickel (ZnNi) fasteners during sustainment forces the use of readily available zinc with trivalent chromium ($ZnCr^{3+}$) plated fasteners resulting in reduced corrosion resistance and increased fastener replacement costs.
- The auto industry moved away from zinc platings in the 1990s and commonly replaced with ZnNi with a hexavalent chromium free passivation.
- The US Army has increased attention to reducing corrosion on weapon systems by using a ZnNi plating alternative to meet increased service life requirements.

AAE MEMO - ELIMINATION OF HEXAVALENT CHROMIUM IN ARMY WEAPON SYSTEMS

- Hexavalent Chromium Target Elimination Dates from AAE Memo:

a. Paint primers – 30 September 2023

b. Surface pretreatments (conversion coatings and wash primers) – 30 September 2024

c. Coatings, plating, and post treatments/sealers on ground system fasteners – 30 September 2024

d. Electrical connector mating surfaces – 30 September 2026

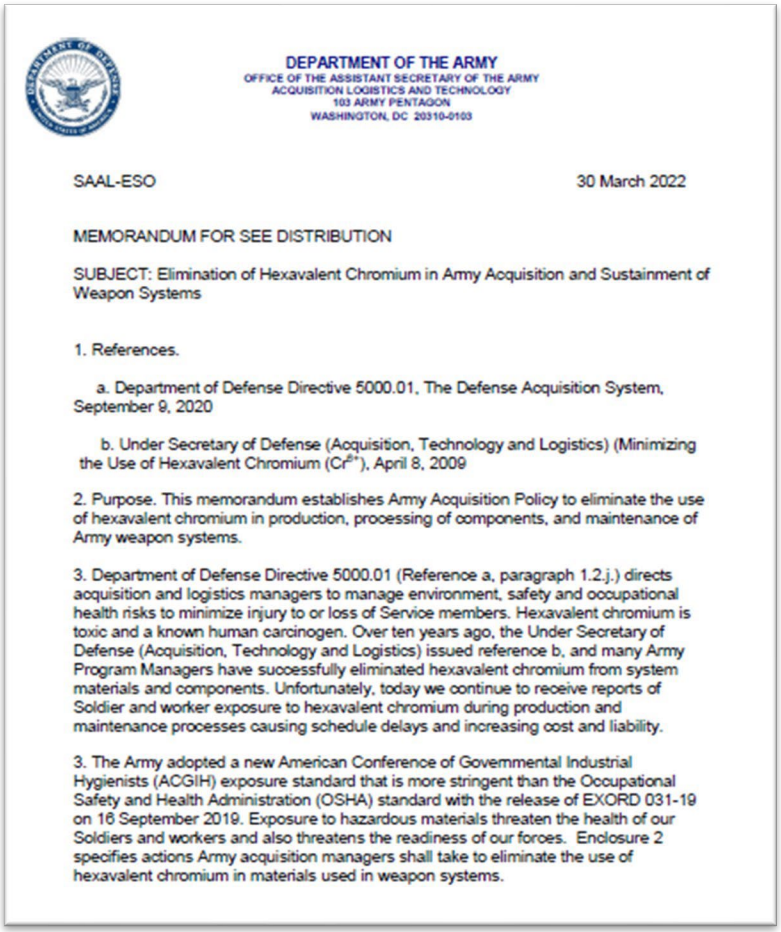
e. Adhesives, sealants, and other specialty coatings – 30 September 2028

f. All plating, anodizing, and post treatments/sealers not covered by 9.b. and 9.c. – 30 September 2030

g. Missile thermal batteries and ignitors – 30 September 2030

h. PEOs can request blanket waivers through the Environmental Support Office (SAAL-ZL-ESO), Office of the Assistant Secretary of the Army for Acquisition, Logistics, and Technology (ASA(ALT)) when qualified replacements cannot be obtained.

i. ASA(ALT) will periodically reevaluate elimination dates and reissue updated policy based on available technology.



DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY OF THE ARMY
ACQUISITION LOGISTICS AND TECHNOLOGY
103 ARMY PENTAGON
WASHINGTON, DC 20310-0103

SAAL-ESO 30 March 2022

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: Elimination of Hexavalent Chromium in Army Acquisition and Sustainment of Weapon Systems

1. References.

a. Department of Defense Directive 5000.01, The Defense Acquisition System, September 9, 2020

b. Under Secretary of Defense (Acquisition, Technology and Logistics) (Minimizing the Use of Hexavalent Chromium (Cr^{6+}), April 8, 2009

2. Purpose. This memorandum establishes Army Acquisition Policy to eliminate the use of hexavalent chromium in production, processing of components, and maintenance of Army weapon systems.

3. Department of Defense Directive 5000.01 (Reference a, paragraph 1.2.j.) directs acquisition and logistics managers to manage environment, safety and occupational health risks to minimize injury to or loss of Service members. Hexavalent chromium is toxic and a known human carcinogen. Over ten years ago, the Under Secretary of Defense (Acquisition, Technology and Logistics) issued reference b, and many Army Program Managers have successfully eliminated hexavalent chromium from system materials and components. Unfortunately, today we continue to receive reports of Soldier and worker exposure to hexavalent chromium during production and maintenance processes causing schedule delays and increasing cost and liability.

3. The Army adopted a new American Conference of Governmental Industrial Hygienists (ACGIH) exposure standard that is more stringent than the Occupational Safety and Health Administration (OSHA) standard with the release of EXORD 031-19 on 16 September 2019. Exposure to hazardous materials threaten the health of our Soldiers and workers and also threatens the readiness of our forces. Enclosure 2 specifies actions Army acquisition managers shall take to eliminate the use of hexavalent chromium in materials used in weapon systems.

CADMIUM

Bio-accumulative Toxin

- Ranked as one of the most hazardous compounds to ecosystems and human health
- Recognized carcinogen and developmental toxicant
- Long term exposure can result in cough, anemia, kidney failure & cancer (particularly kidney cancer)

Uses

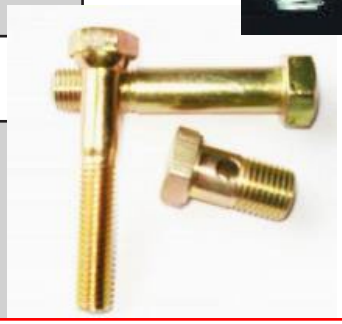
- Batteries
- Plating
  - Fasteners
  - Electrical Connector
  - Brackets, Panels, Winches, Wiring Harness, etc.

Impacts

- Installation and Depots execute the following industrial processes:
  - Plating
  - Paint removal and surface preparation, which require sanding, grinding, and/or abrasive blasting
  - Fastener removal—grinding/cutting/torch cutting

COMMON TYPES OF CHROMIUM

Commonly used to prevent corrosion. Three main chromium types are:



Chrome metal (Cr^0)

- Commonly called “hard chrome”, “chrome zero”, “chrome plating”
- Corrosion prevention application: hard chrome plating
- Not toxic. However, the plating process uses Cr^{6+} and consequently is a health hazard.

Trivalent chromium (Cr^{3+})

- Commonly called “tri-chrome” or “TCP”
- Corrosion prevention applications: sealer/post rinse on Zn-plated parts, aluminum conversion coating
- Becoming more heavily regulated
- Being used as an environmentally preferable and safer alternative to Cr^{6+}

Hexavalent chromium (Cr^{6+})

- Commonly called “hex chrome”, “chromate”, “yellow dip”, or “olive drab”
- Many corrosion prevention applications: wash primer used for steel or aluminum, aluminum conversion coating, sealer/post rinse on Zn or Cd plated parts, stainless steel passivation, anodizing
- Highly toxic and known carcinogen
- Highly regulated by EPA and OSHA
- Army has been working to eliminate for years

Example Specs w/Cr^{6+}

MIL-DTL-5541 (Type I)
MIL-DTL-81706 (Type I)
DOD-P-15328

TRIVALENT CHROMIUM CORROSION PERFORMANCE

Zinc + trivalent chromium (Cr^{3+}) is a commonly available replacement finish for cadmium and hexavalent chromium.

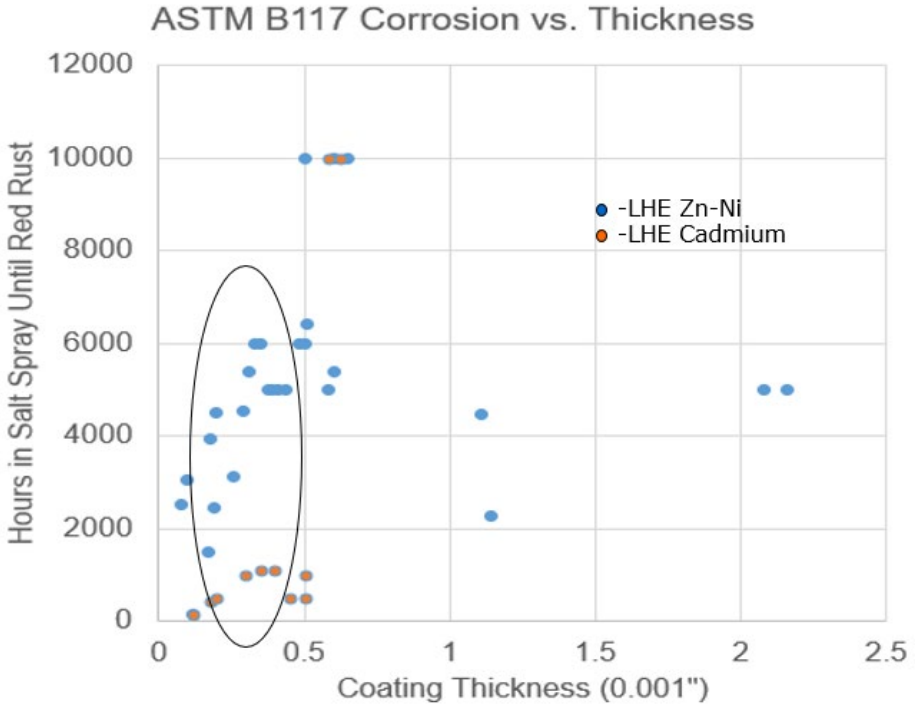
Zinc + Cr^{3+}

2X duration

Zinc Nickel + Cr^{3+}

Zinc-nickel salt spray performance is superior to zinc and typically exceeds the specification minimum corrosion performance.

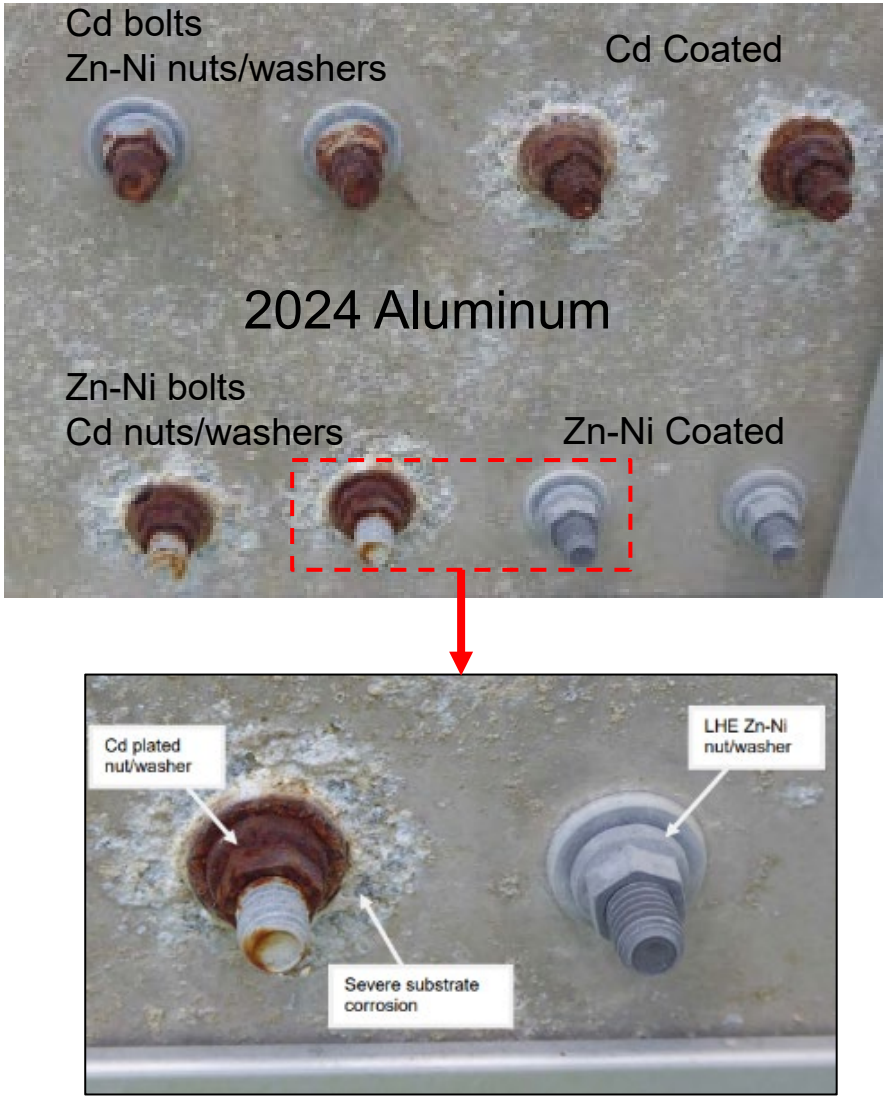
CADMIUM CORROSION PERFORMANCE



Zinc-nickel also outperforms cadmium in corrosion testing

*Results courtesy of Nate Hughes (USAF)

2.5 Years Beach Corrosion Testing



EXPOSURE DURING HANDLING

CHALLENGES IN TRANSITIONING TO ZINC-NICKEL

1) No single MIL-SPEC or commercial specification existed that defined the ZnNi plating and torque modifier requirement to replace Cr^{6+} and Cd plated fasteners.
   - DoD specifications continued to create a market that drives industry exposure beyond just the end user of the product.

2) Due to volumes being low, companies that manufacture ZnNi plated fasteners do not have an incentive to supply to DLA or the Army.
   - Many fasteners are less than 1000 per year – a typical minimum fastener run is 5000 parts.
   - RFIs for ZnNi parts from DLA often go unanswered.
   - NSNs for most ZnNi parts do not yet exist.

3) Effort to implement all new fasteners across a program is resource intensive.
   - Thousand of “clean” part numbers need to be provisioned.
   - Hundred of drawings would have to be redlined and/or updated.
   - Technical documentation needs to be updated with the new parts.

GVSC INVOLVEMENT

- Participated in weekly IPT meetings with PEO GCS, other DEVCOM Centers and industry personnel to brief on status of specification updates and provide corrosion and coatings subject matter expertise.

- Led creation of new ZnNi plating specification (MIL-PRF-32647, Zinc-Nickel Electroplating for Fasteners) with our OEMs and industry partners for inclusion of a torque/tension modifier.
  - Aerospace ZnNi specs not acceptable for use due to focus on process details to ensure LHE susceptibility for very high tensile products.
  - Electroplating specs do not always consider unique fastener requirements.

- Facilitated review of over 270 military and commercial specifications/standards to include a zinc-nickel option (ongoing) and developed Commercial Item Descriptions (CIDs) when necessary.

- Corresponded with other services across DoD (DLA Aviation and NAVAIR) when specs/standards on the list had different preparing activities.

- Met with various committees of standard development organizations (SDOs):
  - National Aerospace Standards Committee (NASC)
  - SAE Airframe Control Bearings Group (ACBG) Committee
  - SAE Aerospace Couplings, Fittings, Hose, Tubing Assemblies (G-3) Committee
  - SAE Aero Electrical Connectors (AE-8C1) Committee
  - ASME B18 Committee

COMMERCIAL ITEM DESCRIPTION DEVELOPMENT

- Developed CIDs for commercial fastener specifications requiring specific attributes and compliant finishes to provide clean alternatives for acquisition needs in a timely manner.
- 17 of 18 CIDs have been published.
- 14 of the CIDs are planned to be cancelled except for threaded and torque critical applications such as the bolt, nut and stud CIDs which require MIL-PRF-32647.

CID ID (category)	NAS/NASM's featured	Plan to cancel
A-A-60030 (washer)	NAS513, NAS620, NAS1149 (ballot exists, not published), NASM970 (ballot exists, not published), NASM	Yes
A-A-60031 (clevis)	NASM35812 (recently published)	Yes
A-A-60032 (spacer)	NAS43 (ballot exists from 2020 for minor editorial issues, but does not address zinc-nickel or dirty alumi	Yes
A-A-60035 (bolt)	NAS1251, NAS1297, NAS6603 THRU NAS6620, NASM3 THRU NASM20, NASM20073 (added to revision	No, threaded and torque critical
A-A-60036 (nut)	NAS1033, NAS1291, NAS1329, NAS1330 (not on current CID, needs to be added), NAS1423, NASM1782	No, threaded and torque critical
A-A-60039 (pin)	NASM16555, NASM16562, NASM17986, NASM24665 (ballot exists, not published), NASM35671 (was s	Yes
A-A-60040 (clamp)	NAS1714 (not on current CID, but later identified as needing update), NASM21322, NASM21333 (recent	Yes
A-A-60041 (hose clamp)	NAS1924	Yes
A-A-60043 (grommet)	NASM20230	Yes
A-A-60044 (key)	NAS558 (ballot exists, not published)	Yes
A-A-60045 (screw)	NAS514 (ballot exists from 2020, but does not address zinc-nickel; not published), NASM24625 (stabiliz	Yes
A-A-60046 (plug)	NAS836	Yes
A-A-60047 (packing)	NAS1523	Yes
A-A-60049 (rod)	NAS1454	Yes
A-A-60052 (post)	NAS1829	Yes
A-A-60053 (fitting)	NAS1211 (stabilized in 2023, did not address zinc-nickel or dirty aluminum anodize and chemical film)	Yes
A-A-60062 (stud)	NAS184, NASM51864	No, threaded and torque critical
No CID (Rivet)	NASM20426, NASM20427 (ballot in 2021, not published; did not address zinc-nickel), NASM20470 (ball	No CID ever crafted (not threaded/torque critical), but these need to be updated

OVERALL PROJECT BENEFITS

- GVSC established close working relationships through frequent collaboration with PEO and PM personnel, industry partners and commercial standards committees.
- Quality and lead time to complete document modifications improved as the effort continued through use of lessons learned, data analytics and machine learning.
- Elimination of carcinogens improves warfighter and personnel safety during material handling, maintenance and sustainment activities.
- Use of non-hazardous coatings on fasteners results in reduced health care and chemical disposal costs.
- Alternative zinc-nickel plated fasteners are eco-friendly, high performing as a corrosion inhibitor and in high temperature applications, have a long service life, low replacement costs, are compatible with torque requirements, and finish appears thin and uniform.
- Zinc-nickel plated fastener benefits are applicable to systems across the DoD, not only to ground vehicles. Air Force and Navy are adopting zinc-nickel to replace cadmium and hexavalent chromium.

PROJECT TEAM PARTICIPANTS

- **PEO Ground Combat Systems (GCS)** – Project management and contracting
- **BAE Systems** – Prime contractor for ground combat systems
- **GDLS** – Prime contractor for ground combat systems
- **MNP Corporation** – Fastener manufacturer and distributor
- **Booz Allen Hamilton** – Data Analytics and artificial intelligence applications
- **SAIC** – Fastener, technical, and acquisition expertise
- **PM Self-Propelled Howitzer Systems (SPHS)** – Platform manager for several ground systems
- **Ground Vehicle Systems Center (GVSC)** – Specification authoring/updates, corrosion and environmental expertise
- **Armaments Command (AC)** – Support for system armaments components
- **Defense Logistics Agency (DLA)** – Acquisition and support planning
- **Integrated Logistics Support Center (ILSC)** – Logistics and support planning

QUESTIONS?