Analysis of Alternatives to Hexavalent Chromium:

A Program Management Guide to Minimize the Use of CrVI in Military Systems

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Report Preview

This article is excerpted from a recently published AMMTIAC report on the analysis of alternatives to using corrosion preventatives containing hexavalent chromium. In the area of corrosion prevention and control, AMMTIAC serves as the DoD's central source of engineering and technical data; as well as research and development information on metals, ceramics, polymers and composites. AMMTIAC is a charter member of the Corrosion Prevention and Control Integrated Product Team (CPC IPT) under the Office of Corrosion Policy and Oversight (CPO), and AMMTIAC has supported the CPO's mission since it was stood up in 2003. In addition to this publication, AMMTIAC has authored the handbook, Corrosion Prevention and Control: A Program Management Guide for Selecting Materials*, constructed a corrosion literature database containing nearly 9,000 publicly released documents available online, and has performed additional projects in corrosion prevention.*

INTRODUCTION AND BACKGROUND

Protecting the Nation's weapon systems and military infrastructure from the scourges of corrosion is a constant and ongoing challenge. For many decades, the "Gold Standard" in corrosion prevention and control has been the use of preventative compounds containing chromates, specifically those formulated from Hexavalent Chromium, which is also commonly referred to as CrVI. CrVI-based compounds have a long history of success in protecting durable assets, both in industry and in the DoD, and there is an extensive knowledgebase on these compounds from decades of judicious application. While an industry staple, CrVI is, however, a known carcinogen which can pose serious health and safety risks to workers and also adversely impact the environment. In recent years, the Environmental Protection Agency (EPA) and the Occupational Safety and health Administration (OSHA) have enacted stricter regulations, forcing reductions in its use. New military policy memoranda have called for minimizing CrVI use, as a consequence of stricter US and European regulations on human exposure and environmental contamination. It is important to point out that these policy memoranda are NOT a ban against using CrVI. However, a waiver is now required for any new use of CrVI in the Department of Defense. Alternative materials have been developed for some applications, with many more potential compounds still in development. However, none of the existing alternatives perform as well or as economically as CrVI. Thus, the use of alternatives brings risk to program managers who must meet performance, cost, schedule, and safety requirements. Program offices are left with the daunting and unenviable task of minimizing the use of CrVI without significantly impacting program objectives. PMs and their staffs would benefit most by instituting a regimented approach to evaluate candidate alternative materials for the particular component/system at hand; only using CrVI in cases where no alternative is adequate for the given application. This structured approach will need to be documented and will form the justification required for the Defense Acquisition Board (DAB). PMs do have technical authorities within their respective Services for guidance, as well as the OSD Office of Corrosion Policy and Oversight to help with this monumental task. AMMTIAC's guidebook presents the impacts associated with implementing alternatives, along with a decision flow chart process, to aid program managers and their staff in deciding when and where to use CrVI versus alternatives. It also covers resources available to PMs and the necessary measures program managers need to obtain a waiver to use CrVI.

CrVI is the "Gold Standard" material in corrosion

CrVI is also a strong carcinogen. The Services are directed to minimize its use

CrVI has NOT been banned, but its minimization is encouraged by policy

Designing corrosion resistance into new systems upfront, early in the acquisition phase, will lead to lower life cycle costs (LCCs), resulting in more effective corrosion management, also with increased system safety and availability. The Defense Science Board (DSB) has determined that a 30% cost avoidance can be achieved in military systems by incorporating corrosion engineering principles in the design of new systems.[1]

Spending more funds up front to account for corrosion and degradation of systems will pay off over time. There will likely be trade-offs in performance versus corrosion resistance; but if those trade-offs are known in the acquisition phase, a corrosion prevention and control strategy that reflect balanced priorities may be implemented to properly manage and minimize corrosion, whatever the chosen path.

PMs must weigh alternatives to CrVI, but must do so carefully and thoroughly

THE DILEMMA OF HEXAVALENT CHROME

The controversy surrounding CrVI is emblematic of the larger issue of balancing the Defense needs of the Nation against the desire for a cleaner environment and a safer workplace. The two aims, while not necessarily opposites, are exclusive of one another, and on many occasions, the drive to meet one aim is contrary to meeting the other. Program offices, and ultimately the PMs, are the ones who must navigate through this sea of conflicting requirements to arrive at a solution that sufficiently meets both interests. On the one hand, CrVI has been widely used across the military for decades to alloy metals, treat metal surfaces, and as a constituent in primers for coating systems. There presently exist no other materials with the protective capabilities of CrVI. Unfortunately, CrVI is also a known carcinogen. As its toxicity and environmental impact have become better understood, stricter Environmental, Safety, and Occupational Health (ESOH) regulations have been enacted. The stricter regulations place pressure on industry to eliminate CrVI altogether, avoiding costly procedures, training, and safety liabilities. However, without mature alternatives that perform at the level of CrVI, the DoD will continue to need to use CrVI for applications where no alternative is determined to be acceptable. In such cases, the PM must obtain a waiver to use CrVI. Using alternatives to CrVI, while necessary, comes with a high degree of risk. It is incumbent upon program offices to mitigate these risks through diligent testing and evaluation of potential alternatives.

Program Offices must balance Defense needs against ESOH regulations

CrVI or Alternative: The PM must provide a justification for either decision to the acquisition board

Why do We Need to Minimize CrVI?

Hexavalent chromium has been determined to be a significant cancer risk, causing lung cancer from toxic vapors in manufacturing and maintenance sectors. Skin lesions can occur when contacting chromium powders in industrial applications, and it also poses a significant inhalation risk. It is an environmental hazard which has been determined to cause cancer and birth defects when potable water systems are contaminated. Table 1 provides a comparison of the cancer risk of CrVI to other known carcinogens. As such, stricter regulations have been implemented by OSHA in 2006 regarding the permissible exposure limit (PEL), as listed in Table 2.

The DoD still needs CrVI for applications with no acceptable alternative

Table 1. **Cancer Risk of CrVI in Comparison to Other Known Carcinogens.**[2]

Material	Cancer Risk (per 1000)	Rulemaking Date
Asbestos	6.7	June 1986
Benzene	10	September 1987
Formaldehyde	0.0056 – 2.64	December 1987
Cadmium	3 – 15	September 1992
1,3 – Butadiene	1.3 – 8.1	November 1996
Methylene Chloride	3.6	January 1997
CrVI	10 – 45	February 2006

Table 2. **CrVI Occupational Exposure Limits.**[2]

Country	Occupational Exposure Limit (µg/m^3)
United States • New OSHA (2006) • Previous OSHA	 5 52
European Union, France, Germany, UK, Finland, China, India, Japan	50
Sweden	20
Denmark	5

Exposure to CrVI is a risk in processing and manufacturing new materials, as well as maintaining systems. Protective clothing and high-volume air ventilation systems are regularly employed to contain human exposure in work settings where CrVI is present. Once incorporated into the base material of a CPC product, such as a primer or a coating, CrVI poses minimal exposure risk, as it is non-friable. It is when CrVI is made friable via a removal operation that the free particles of CrVI pose a serious inhalation risk. The two greatest opportunities for exposure are at the depot level: depainting operations (primarily for aircraft), and welding of stainless steels (shipbuilding). Both these operations can produce

Table 3. **CrVI Functions and Applications.**

Product	CrVI Application/ Process	Purpose	Application	Substrate	Specifications
Anodizing	Chromic Acid Bath	Wear and corrosion resistance, paint adhesion	Aircraft	Aluminum	MIL-A-8625F, Type I, Type IB
Hard Chrome Plating	Electro-deposition	Wear protection, repair/rebuild worn components	Aircraft, vehicles, gun barrels, hydraulic actuators, landing gear		MIL-STD-1501, MIL-C-20218
Chromate Sealant	Incorporated into sealant composition	Water barrier, corrosion inhibitor	Electronics, vehicle panels, fuel tanks, radomes, fasteners, tactical shelters		MIL-PRF-81733, MIL-S-8802
Chromate Primer	Incorporated into primer	Corrosion protection	Aircraft skins, Al airframes, Steel airframes	Aluminum, steel	MIL-F-7179, MIL-P-53022, MIL-PRF-23377, MIL-PRF-85582
Chromate Conversion Coating	Pretreatment bath, wipe, spray	Self-healing coating, sealant for electro-plated and anodized coatings, adhesion surface for paints and sealants	Aircraft skins, Al structures, Mg gearboxes, fasteners, electrical connectors	Al, Mg	MIL-DTL-81706, MIL-C-5541, MIL-M-45202, MIL-A-8625, MIL-C-3171, MIL-C-17711, MIL-M-45202

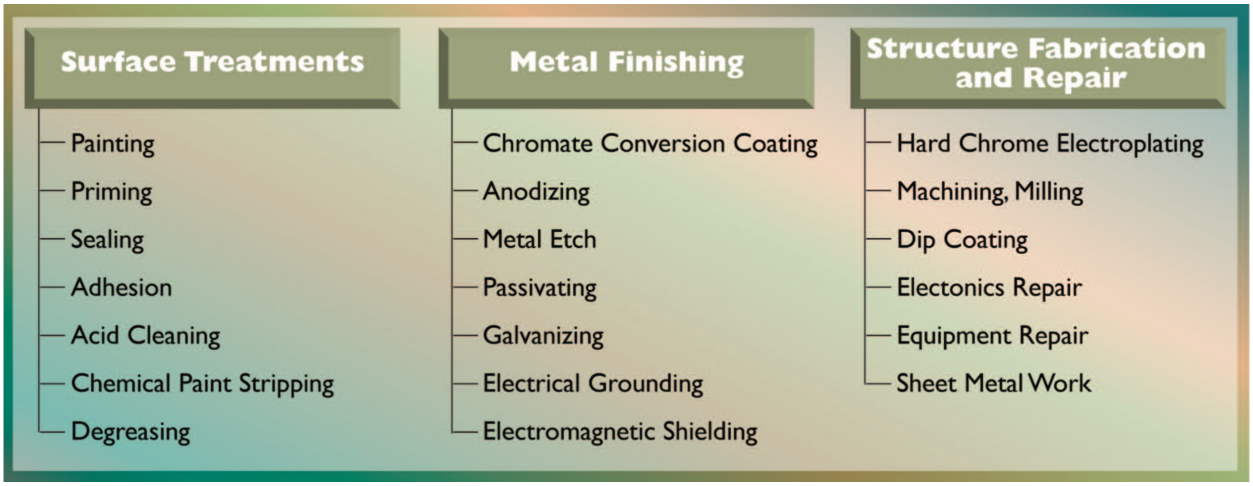

Figure 1. CrVI Use in the Military[3]

high levels of toxic vapors. Disposal of consumable processing materials (such as abrasive media, which becomes contaminated) are also problematic and costly.

The Military Has A Long and Successful History with CrVI

CrVI has been widely used for over 50 years in the military for a variety of functions and on numerous weapon systems and infrastructure, see Table 3. CrVI is used as an alloying component in metals, most notably stainless steels, and for surface preparation and coating systems, as listed in Figure 1. Alternatives to CrVI have been developed for surface treatments and coating systems, with research and development (R&D) still progressing on additional alternatives.

The DoD and Industry Don't View CrVI in the Same Way

There is a fundamental disparity between how the DoD and industry each view and approach the CrVI issue, which are responses largely commensurate with their respective missions. Defending US National interests and protecting its citizens are the primary objectives of the Military Services. The DoD understands the need to manage and control properly the use of toxic materials within that mission. Conversely, the main objective of most private companies is to make a profit, and thus yield a return to their shareholders. As part of their calculus, industry must balance the prospective benefits of market gains against the potential financial risks from liability issues and increased costs of regulatory compliance when using toxic chemicals. In most cases, risk-averse manufacturers are naturally inclined toward eliminating CrVI altogether from their product lines, as they don't see a sufficient return for the risks incurred. Despite such misgivings in the private sector, the DoD cannot let such aversions jeopardize the military's ability to perform its mission in a safe manner. Until alternatives are developed that can perform as well, or better than CrVI for all functional areas, the DoD must ensure that domestic industrial facilities and processes maintain their capability to work with CrVI.

The Military has used CrVI successfully for over 50 years

Using Alternatives May Increase Program Risk

At present, the regulatory impetus to minimize CrVI use is very strong. New acquisition programs will undoubtedly be scrutinized heavily by principals representing ESOH interests to ensure that PMs are making maximal use of alternative compounds in their corrosion planning. It will be critical for program offices to perform due diligence when considering alternative materials, as most available compounds are largely unproven in the field, with very little or no reliable service data to guide material selection choices. Thus, most decisions to use alternatives carry with them inherent risks. These risks manifest themselves as impacts to program objectives: mission success, availability, system performance, safety, schedule, and cost.

The pressure to use alternatives may be considerable

A Cautionary Note: By choosing alternative material schemes over traditional CrVI-based products, program offices may be setting themselves up for several unintended consequences, as chromium is truly multifunctional, providing not only corrosion protection, but many other benefits as well. Chromium makes many metal alloys more resistant to fatigue, enhances wear and abrasion properties, and fosters good adhesion of primers and topcoats to surfaces. CrVI and most chromium compounds are also excellent biocides, thwarting all types of biofouling, such as mold and fungus. Most alternatives were developed specifically with only corrosion resistance or adhesion properties in mind. Thus, program offices may need to incorporate additional materials or additives with selected alternatives to meet specific performance requirements unrelated to corrosion resistance. To reduce program risk, program offices must implement a regimented testing and evaluation strategy to assess quantitatively the suitability of alternative candidates, with evaluation criteria tailored for each specific application.

Most alternative compounds are unproven in the field

There may be other unintended impacts from eliminating CrVI. Alternatives may not protect against fungus, fatigue, wear, or peeling

Even though some alternatives have been qualified/approved for general use, they still need to be tested for each specific application unless the alternative has already gone through a thorough test and evaluation for that case. An example: some alternative conversion coatings have been approved, but only in conjunction with a CrVI-based primer for use on exterior aircraft Al alloys. When an established alternative is being considered for a different application, the alternative coating system needs to be evaluated to meet the new application requirements. For example, using an alternative coating system on an interior may require mold resistance, or similarly, using the alternative on an application where stress loads vary will require mechanical testing of the component to provide reliable data for design allowables. Subject matter experts (SMEs) should be employed to establish the testing and evaluation criteria for components/systems. Lastly, the use of alternatives will likely require new procedures resulting in training of personnel and updating technical manuals (TMs) and technical orders (TOs).

POLICIES AND REGULATIONS

It will be increasingly difficult in the future for program offices to include CrVI-containing compounds as part of their overall corrosion prevention strategy. This is due in large part to the numerous changes in ESOH regulations implemented over the past decade. Recent DoD policies have added to this stricture, by first requiring the Services to more aggressively implement corrosion prevention and control measures in Defense systems and infrastructure, and then subsequently directing Components to minimize, to the degree possible, the use of CrVI in military assets. These new policies push for using alternatives to CrVI as the new default, and only using CrVI in cases where no alternative is acceptable. This section summarizes relevant policies and regulations.

It will be increasingly difficult for Program Offices to use CrVI

The 2003 Wynne Memorandum

Congress passed a provision as part of the 2003 Defense Authorization Act, 10 USC Sec. 2228, which mandated that the DoD institute formal steps to minimize the impact of corrosion to DoD systems and infrastructure. On November 12, 2003, then-Principal Deputy Undersecretary of Defense for Acquisition, Technology, and Logistics (PDUSD/AT&L) Michael W. Wynne issued a memorandum to the Secretaries of the Military Departments directing that corrosion prevention and control planning be an integral part of the initial design and acquisition process, subject to the Defense Acquisition Board (DAB) review. This memorandum set the stage for reduced life cycle costs of new systems by designing-in corrosion resistance.

The DoD is required by law to take effective steps to minimize the impact of corrosion on Defense assets.

The 2009 Young Memorandum

On April 8, 2009, John J. Young Jr., then-Director, Defense Research and Engineering (DDR&E), issued a memorandum to the Secretaries of the Military Departments calling for minimizing the use of CrVI. It was in response to stricter regulations set forth in both the US and Europe. The memorandum does not ban the use of CrVI, rather provides for specific instances where its continued use is acceptable. What it did change specifically was that for all design decisions where CrVI use would be considered, PMs would be required to furnish a rationale and justification for their material selection regardless of whether CrVI or an alternative was chosen. The following actions were called out in the memorandum:

PMs will be required to furnish a rationale and justification for CrVI or an alternative, regardless of choice.

Invest in appropriate research and development on substitutes.

- Ensure testing and qualification procedures are funded and conducted to qualify technically and economically suitable substitute materials and processes.
- Approve the use of alternatives where they can perform adequately for the intended application and environment. Where CrVI is produced as a by-product for use or manufacture of other acceptable chromium oxides, explore methods to minimize CrVI production.
- Update all relevant technical documents and specifications to authorize use of the qualified alternatives and, therefore, minimize the use of materials containing CrVI.
- Document the system-specific CrVI risks and efforts to qualify less toxic alternatives in the programmatic ESOH evaluation for the system. Analysis should include any cost/schedule risks and life cycle cost comparisons among alternatives. Life cycle comparisons should address material handling and disposal costs and system overhaul cycle times/costs due to any differ-

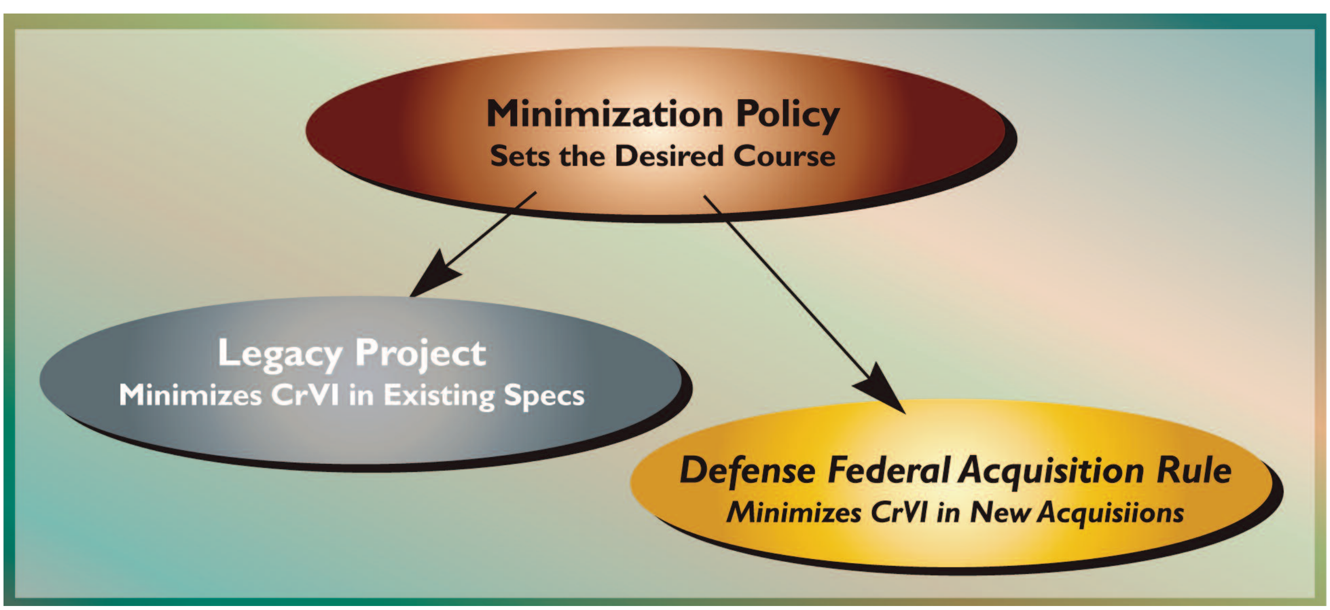

Figure 2. Minimization Policy[4]

ences in corrosion protection.
- Share knowledge derived from research, development, testing, and evaluations (RDT&E) and actual experiences with qualified alternatives.
- Require Program Executive Office (PEO) or equivalent level, in coordination with Military Department's Corrosion Control and Prevention Executive (CCPE), to certify there is no acceptable alternative to the use of CrVI on a new system. This requirement also applies to the operation and maintenance of a system during the Operations and Support phase of a system's life cycle. PEO or equivalent, in coordination with the military department's CCPE, shall evaluate each certification for validity, taking into account at a minimum the following:
  - Cost effectiveness of alternative materials or processes.
  - Technical feasibility of alternative materials or processes.
  - ESOH risks associated with the use of CrVI or substitute materials in each specific application.
  - Achieving a Manufacturing Readiness Level (MRL) of at least 8 for any qualified alternative.
  - Materiel availability of CrVI and the proposed alternatives over the projected life span of the system.
  - Corrosion performance difference between CrVI balance and alternative materials or processes as determined by agency corrosion SMEs.
  - For such applications where acceptable alternatives to CrVI do not exist, CrVI may be used.
- This minimization policy was meant to be across the board, setting a course of action for both new and legacy systems, as depicted in Figure 2.

CrVI and the DFARS

On April 8, 2010, the DoD published a proposed rule on CrVI in the Federal Register at 75 FR 18041. A supplement to this Defense Federal Acquisition Regulation Supplement (DFARS) was enacted on May 5, 2011 for "Minimizing the Use of Materials Containing Hexavalent Chromium." The final rule, in the new supplement, prohibits the delivery of items containing more than 0.1 % by weight CrVI in any homogenous material under DoD contracts unless there is no acceptable alternative.

The DFARS already regulates usage of CrVI in Defense Acquisition

CrVI Restrictions in ESOH Regulations

Numerous regulatory bodies in the US and abroad have imposed restrictions on one or more aspects of CrVI. This subsection summarizes some notable regulations.

Occupational Safety and Health Administration

On February 28, 2006, the Occupational Safety and Health Administration established a permissible exposure limit (PEL) of 5 $\mu g/m^3$, measured as an eight hour time weighted average.[5] The regulation affects all industry operations that could generate CrVI air emissions, and applies to all forms of CrVI. The new OSHA rule places the following requirements on employers:
- Monitor employee exposure to CrVI
- Establish separate regulated areas when CrVI levels are expected to exceed the PEL
- Provide respirators for workers exposed above the PEL
- Provide other PPE (personal protective equipment) as necessary for eye and skin protection, together with change rooms and wash facilities
- Institute housekeeping activities to control spills and releases of CrVI
- Provide medical surveillance for employees who are exposed above the PEL, show signs or symptoms of CrVI exposure, or are exposed in an emergency
- Train workers about CrVI hazards, and use signs and labels to communicate the hazards
- Keep records of exposure, surveillance and training.

The PEL action level is 50 % or 2.5 $\mu g/m^3$ which requires monitoring. If CrVI concentrations are < 0.5 $\mu g/m^3$ under all conditions, then the OSHA rule does not apply.

Environmental Protection Agency

The Environmental Protection Agency (EPA) has instituted both a Clean Air Act and a Clean Water Act.[6] Under the Clean Air Act, air emission limits for hard chrome plating facilities are:
- 0.015 mg m^{-3} (15 μg m^{-3}) of dry standard exhaust air from all tanks in a "large" facility or newer (installed after 1993) "small" facility
- 0.03 mg m^{-3} (30 μg m^{-3}) of dry standard exhaust air from all tanks in an older small facility.

And air emission limits for decorative chrome plating is:
- 0.01 mg m^{-3} (10 μg m^{-3}) of dry standard exhaust air, but control of the bath surface tension is all that is necessary when a fume suppressant with a wetting agent is used

Under the Clean Water Act, hard chrome platers must follow:
- CrVI-contaminated wastewater such as rinse water is properly treated before discharge to the sewer
- The plating plant is constructed to prevent spills that could cause groundwater contamination (which has happened beneath many older chrome plating plants)
- The plating solution or sludge and any CrVI-contaminated materials such as masking materials, air filters, and solids and liquids from air-handling systems are recycled or properly disposed of.

California Regulations

The Airborne Toxic Control Measure (ATCM), enacted by the California Air Resources Board (CARB) applies to all chrome plating and anodizing facilities established prior to 1998.[7] It is similar to EPA's concentration based rule, but is dependent upon ampere-hours used in plating and anodizing processes, and recognizes small, medium, and large facilities. An amended rule was initiated in 1998 to match the EPA, and applies to facilities established post-1998, divided into two categories – small/medium and large facilities.

The ATCM implemented a thermal spray regulation on September 30, 2005, limiting CrVI and nickel emissions. Elements of the regulation include:
- All CrVI and nickel emissions from thermal spray operations must pass through an appropriate control device, which can range from a water curtain to a high-efficiency filter, the type of device being determined by the calculated annual emissions from that operation.
- In the case of nickel, maximum hourly emissions from all thermal spraying operations must not exceed 0.01 lb from an individual source (such as a stack) or 0.1 lb from the whole facility.

Analysis of Alternatives to Hexavalent Chromium

This Guide is a compendium of information resources; providing an extensive summary of the policy, programmatic, technical, safety, and regulatory issues pertaining to the restricted use of Hexavalent Chrome (CrVI). The Guidebook contains six sections organized as such:

Section 1 – Executive Summary
A broad overview of the challenges and strategies associated with the use, or omission, of CrVI.

Section 2 – Background
This section offers a synopsis on the Environmental, Safety, and Occupational Health (ESOH) problems surrounding CrVI; where and how CrVI is used in the military; the differences between how industry and DoD each perceive CrVI; and the impact that using alternatives to CrVI may have on military systems during their service lives.

Section 3 – Policies and Regulations
A summary of policies, regulations, and DoD memoranda regarding the use of CrVI.

Section 4 – Program Management
Written with the program manager in mind, this section addresses the myriad issues that PMs will need to address when considering potential applications of CrVI. It discusses the procedures for evaluating/validating CrVI alternatives; obtaining a waiver to use CrVI in the case that no available alternative is suitable; and lastly, identifies resources available to PMs.

Section 5 – Alternative Selection Flow Chart Process
Designed to serve as an engineering reference for technical personnel, the flowchart and accompanying text outline and describe the recommended material selection process to evaluate and assess the suitability of alternative materials into systems. As part of the process, it also specifies when using CrVI would be the best option, typically when there is no acceptable alternative.

Section 6 – Analysis of Alternatives
Summary information and compiled data collected relative to the performance of alternatives compared to traditional CrVI material systems.

For program managers and many other readers, the entirety of the body of information in this guide far exceeds any one individual's immediate data needs. For readers to get the most information in their respective areas of interest (while bypassing those areas which lie outside), we offer the following recommendations.

Program Managers:	Sections 1, 3, and 4. Section 2 optional
Policy Makers:	Sections 1 and 3
Senior Technical Personnel:	Sections 1 through 5
Engineering Staff & Contractors:	Sections 2 through 6

To obtain a copy of this report, please contact AMMTIAC: ammtiac@alionscience.com

Table 4. Military Specifications Involving CrVI and Alternatives.

Specification	Title	QPL
MIL-A-8625	Anodic Coatings For Aluminum and Aluminum Alloys	-
MIL-DTL 81706B	Chemical Conversion Materials for Coating Aluminum and Aluminum Alloys	Table 11
MIL-PRF-81733D	Sealing and Coating Compound, Corrosion Inhibitive	Table 23
MIL-PRF-85582D	Primer Coatings: Epoxy, Waterborne	Table 26
MIL-PRF 23377J	Primer Coatings: Epoxy, High-Solids	Table 27
MIL-DTL-53022D	Primer, Epoxy Coating, Corrosion Inhibiting Lead and Chromate Free	Table 28
MIL-DTL-53030C	Primer Coating, Epoxy, Water Based, Lead and Chromate Free	Table 29
MIL-DTL-53084	Primer, Cathodic Electrodeposition, Chemical Agent Resistant	-

- A facility is exempt from the requirements when annual emissions of CrVI and nickel are less than 0.001 lb and 0.3 lb, respectively, from an individual source; and less than 0.004 lb and 2.1 lb, respectively, from the whole facility.
- Requirements on permitting, monitoring, record keeping and reporting must be met.

California has also implemented regulations on waste similar to those enacted in Europe. As of January 1, 2003, CrVI has been banned from all motor vehicle and equipment waste, to include off-road vehicles, trains, agriculture equipment, concrete mixers, and wheelchairs. On January 1, 2005, a fee was imposed on covered electronic devices, with the collected funds from fee assessments to be used for proper waste disposal.

European Regulations

European regulations have focused on waste streams rather than air emissions. The End-of-Life Vehicles (ELV) and the Restriction of Hazardous Substances (RoHS) directives serve to eliminate hazardous materials, including CrVI, from waste streams in the vehicles and electrical/electronic industries. The ELV imposes that components of specified vehicles do not contain hexavalent chromium, along with lead, mercury, and cadmium, other than in specified cases.[8] The RoHS bans the use of chromium, lead, mercury, cadmium, poly-brominated biphenyls (PBB), and poly-brominated diphenyl ethers (PBDE) in electrical and electronic equipment exceeding maximum concentration levels.[9]

The Waste Electrical and Electronic Equipment (WEEE) provides for the proper collection of hazardous wastes from electrical and electronic equipment, along with replacement of those hazardous materials including CrVI.[10] The Regulation, Evaluation, Authorization and Restriction of Chemical substances (REACH) requires industry to register information on chemicals in a central database run by the European Chemicals Agency (ECHA), for evaluation of suspicious substances and open to consumers and professionals. The regulation also calls for replacements of hazardous materials, like CrVI.

Canadian Regulations

The Environment Canada (EC) issues regulations under the Canadian Environmental Protection Act.[11] On June 4, 2009, the EC implemented the Chromium Electroplating, Chromium Anodizing and Reverse Etching Regulations, which calls specific methods of CrVI containment, dependent upon the process, for facilities where 50 kg or more of chromium trioxide (CrO_3) is used per calendar year.[12] The Canadian Centre for Occupational Health and Safety (CCOHS) serves to disseminate information on health and safety in the workplace with no regulatory powers.

Military Specifications and Qualified Product Lists

There are Military Specifications that cover CrVI and non-CrVI products together, as well as new specifications developed entirely for non-CrVI materials. Table 4 lists Military Standards and Specifications of interest. Section 6 of the guide contains more information on the relevant military specifications and standards as well as tables of Qualified Products Lists (QPLs) for the specifications. The Military Specifications and QPLs will change over time and may be accessed at: https://assist.daps.dla.mil/quicksearch/

REFERENCES

1 This article was excerpted from a recently published AMMTIAC report on the analysis of alternatives to using corrosion preventatives containing hexavalent chromium. To find out more about the report or to request a copy, please contact AMMTIAC at ammtiac@alionscience.com. "Defense Science Board Report on Corrosion Control," Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics, October, 2004.

2 Sartwell, B., "Replacement of Hexavalent Chromium in DoD Weapon Systems," Merit Quarterly Meeting, January 13, 2009.

3 "Final Phase II Impact Assessment Report: Hexavalent Chromium," Emerging Contaminants Directorate Office of the Deputy Under Secretary of Defense (Installations & Environment), Prepared by National Defense Center for Energy and Environment (NDCEE), Submitted by Concurrent Technologies Corporation, June 10, 2008.

4 Yaroschak, P., "Chemical and Material Risk Management Initiatives," Sustainable Surface Engineering for Aerospace and Defense ASETSDefense Workshop, February 2011.

5 http://www.osha.gov/SLTC/hexavalentchromium/index.html

6 http://www.epa.gov/lawsregs/

7 http://www.arb.ca.gov/toxics/atcm/atcm.htm

8 http://ec.europa.eu/environment/waste/elv_index.htm

9 http://www.rohs.eu/english/index.html

10 http://ec.europa.eu/environment/waste/weee/index_en.htm

11 http://www.ec.gc.ca/lcpe-cepa/default.asp?lang=En&n=26A03BFA-1

12 www.ec.gc.ca