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IAEG WG2 Project Summary Report – Integral Fuel Tank Coating

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Version 1

This document is released for the purpose of providing a high-level summary of the IAEG WG2 project focused on Integral Fuel Tank Coatings.

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Version History

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1 Introduction

1.1 List of Collaborators

Company	Name
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	Roland Stone
¹ Project Lead(s) (*) Name omitted	

2 Project Description

This project was a collaborative technical exchange project under the Charter of the International Aerospace Environmental Group (IAEG), Working Group 2 (Replacement Technologies).

Strontium Chromate (SrCrO₄, CAS Number 7789-06-2) was identified by the European Chemicals Agency (ECHA) as a Substance of Very High Concern (SVHC) (according to Article 57 of Regulation (EC) No 1907/2006 (REACH)) and included in the Candidate List for Authorisation in decision ED/31/2011 dated 20th June 2011.

The substance was subsequently given a REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals) sunset date of 22nd January 2019, meaning that beyond this date its use is prohibited unless granted Authorisation by ECHA / European Commission (EC) to do so. The aerospace industry has continued to use Strontium Chromate in integral fuel tank coating (IFTC) applications as

downstream users under Authorisation application 0046-02, submitted by the CCST (Chromium VI Consortium for Surface Treatments).

The Authorisation to continue use of Strontium Chromate per application 0046-02 was granted for a 7-year period by ECHA – meaning that the aerospace industry has Authorisation to continue using Strontium Chromate containing fuel tank coatings up to 22nd January 2026 so long as no equivalent alternatives are developed by coatings manufacturers with sufficient data to demonstrate equivalence prior to this date.

However, conditions of the Authorisation approval include more stringent personnel and environmental monitoring, and an increase in controls when using products containing the substance or carrying out any further destructive operations on the cured coatings such as abrading or drilling.

The abovementioned legislative requirements, as well as the obligation to minimize any risk posed by materials and their associated processes to manufacturing personnel have driven the necessity to seek qualification of alternative fuel tank coatings which are hexavalent chromium-free and REACH compliant, for use in the aerospace industry.

Strontium Chromate is added to paints, primers, and specialty coatings, which are applied to the surface of aircraft components to perform a range of technical functions, particularly corrosion prevention. The technical performance of these paints, primers and specialty coatings is specified in standards and procedures, having to comply with airworthiness requirements and other qualified procedures, and can only be changed when adequate evidence is available to provide assurance regarding the performance of the alternative. The paints, primers and specialty coatings are generally applied by spray painting or by brush to form a thin outer layer upon the aircraft part or component. Strontium Chromate, when used in fuel tank coating applications, has the function of both providing corrosion resistance and aiding the control of microbial activity by preventing growth of micro-organisms. By preventing growth of micro-organisms, this reduces the presence of corrosive compounds which may be produced from microbial metabolism.

The removal of Strontium Chromate from fuel tank coatings therefore poses a major issue for the aerospace industry, and paint manufacturers are currently undertaking research and development of new fuel tank coatings which contain alternative corrosion and microbial inhibitors.

Moreover, Pentazinc Chromate Octahydroxide ($\text{Cr}_2\text{H}_2\text{O}_{10}\text{Zn}_3$, CAS Number 49663-84-5) was also identified by ECHA as a SVHC and included in the Candidate List for Authorisation in decision ED/77/2011 dated 19th December 2011. The substance was subsequently given a REACH sunset date of 22nd January 2019 (the same sunset date as Strontium Chromate).

As with Strontium Chromate, the aerospace industry has continued to use Pentazinc Chromate Octahydroxide in fuel tank coatings as downstream users under Authorisation application 0118-02, submitted by the CCST. The Authorisation to continue use of Pentazinc Chromate Octahydroxide, per application 011802, was granted for a 7-year period by ECHA – meaning that the aerospace industry has Authorisation to continue using Pentazinc Chromate Octahydroxide containing fuel tank coatings up to 22nd January 2026.

Pentazinc Chromate Octahydroxide is used as an inorganic corrosion inhibitor in fuel tank coatings. It also enhances sealant adhesion. Pentazinc Chromate Octahydroxide should also be substituted on integral fuel tank coatings where it is present.

This project has assessed what hexavalent chromium-free fuel tank coatings (for application on both metallic and composite substrates) are currently available on the market and those currently in development. The requirements of industry standard specifications for fuel tank coatings have been compared with the requirements in the project collaborators' internal company fuel tank coating material specifications.

3 Statement of Work

Under the Statement of Work for this project, members of the International Aerospace Environmental Group (IAEG), Working Group 2 (Replacement Technologies) have collaborated to:

- Exchange any data and experience that are:
 - Available in the public domain and
 - Obtained from members' replacements activities.
- Develop a listing of all fuel tank coating products containing the two referenced chromated chemicals, for comparison of properties. Different applications for these products have been distinguished.
- Exchange any data for alternatives to Strontium Chromate and / or Pentazinc Chromate Octahydroxide containing fuel tank coatings that can be used to support substitution within OEM designs and standard parts.
- Evaluate (and develop) a Performance Requirement Document (IAEG WG2 PRD) or a short list of key fundamental requirements to establish harmonized requirements (including test methods for critical test requirements)
- Discuss (define) what other information can be shared while respecting the signed Agreement, to bring the most benefits to members (including information on sample preparation)
- Based on the data available, discuss if there is a will to evolve to a new scope such as an experimental collaboration (Phase 2 of the project).

4 Project Details

4.1 Project Scope

The project focused on hexavalent chromium-free integral fuel tank coatings used to protect metallic and composite integral fuel tank structures against corrosion from fuel contaminants. In the case where the fuel tank coating is applied on aluminium, the scope has included the coating application following processing through REACH-compliant pre-treatments (anodising / conversion coating).

The project included requirements exchange and technical data exchange between collaborators and involved outreach to coatings manufacturers / suppliers requesting technical data on any of their candidate coatings.

There is the potential for a follow on (Phase 2) to this project, based upon the information gathered within this project. The requirements document produced in Work Package 1 could be used as the basis for a test plan for Phase 2 (if it were to go ahead).

4.2 Project Structure

The project was made up of 2 Work Packages (WP), with the Project Leads responsible for creating detailed project plans and estimating costs. Furthermore, the Project Leads were responsible for producing deliverables, accomplishing milestones, and reporting progress.

4.2.1 Work Package 1: Requirements Exchange

- Sharing OEM specification requirements.
- Review requirements of industry specifications – AMS-C-27725 etc.

Deliverables:

- Project participants to provide details on any chromated fuel tank coatings currently used.
- Compare properties of current chromated fuel tank coatings and their applications.
- Create template for recording requirements.
- Project participants to provide the requirements of their internal IFTC specifications using requirements template.
- Review and record requirements of IFTC industry standard material specifications using requirements template.
- Compile requirements from OEM specifications and industry standards.
- Gap analysis between OEM specification requirements and the industry standard requirements.
- Product Requirements Document – identification of key requirements.

4.2.2 Work Package 2: Technical Data Exchange

- Sharing of any test data or experiences that project participants may have of hexavalent chromium-free IFTCs.
- Approach coatings suppliers, under IAEG-developed NDA, to share more detailed data on the hexavalent chromium-free IFTCs that they have got in development / developed.
- Planning for a Phase 2 of the project – testing alternatives.

Deliverables:

- Create template for recording technical data.
- Project participants to compile test data using template.
- Create and sign NDA with key coatings manufacturers.
- Collect test data from coatings manufacturers.
- Review SDS for candidates to ensure environmental compliance.
- Compile test data from project participants and coatings manufacturers.
- Report on test data collected in WP2.

5 Work Package 1

5.1 Current Products

Project Member Companies provided information on the chromated coatings either qualified to their internal material specifications, or that they are using on their products, in fuel tank applications.

In total there were 19 product names provided as being actively used or qualified to OEM material specifications, as detailed in Table 1.

Table 1 Chromated Integral Fuel Tank Coatings currently in use / qualified to specifications

Product	Manufacturer	Cr6 Substance	Resin	Water v Solvent
Product 1	Supplier A	Pentazinc Chromate Octahydroxide Strontium Chromate	Epoxy	Solvent
Product 2	Supplier A	Strontium Chromate	Epoxy	Solvent
Product 3	Supplier A	Strontium Chromate	Polyurethane	Solvent
Product 4	Supplier A	Strontium Chromate	Polyurethane	Solvent
Product 5	Supplier A	Pentazinc Chromate Octahydroxide	Epoxy	Solvent
Product 6	Supplier A	Pentazinc Chromate Octahydroxide	Epoxy	Solvent
Product 7	Supplier B	Strontium Chromate	Polyurethane	Solvent
Product 8	Supplier B	Strontium Chromate	Polyurethane	Solvent
Product 9	Supplier B	Strontium Chromate	Polyurethane	Solvent
Product 10	Supplier B	Strontium Chromate	Polyurethane	Solvent
Product 11	Supplier A	Strontium Chromate	Epoxy	Solvent
Product 12	Supplier A	Strontium Chromate	Epoxy	Solvent
Product 13	Supplier A	Strontium Chromate	Epoxy	Water
Product 14	Supplier B	Strontium Chromate	Polyurethane	Solvent
Product 15	Supplier A	Strontium Chromate	Epoxy	Water
Product 16	Supplier B	Strontium Chromate	Epoxy	Solvent
Product 17	Supplier A	Strontium Chromate	Polyurethane	Solvent
Product 18	Supplier C	Strontium Chromate	Epoxy	Water
Product 19	Supplier C	Strontium Chromate	Epoxy	Water

The primary functions / properties of these integral fuel tank coatings were reported by project member companies as being:

- Adhesion
- Corrosion Resistance
- Fungus Resistance / Bacteria Resistance / Microbial Resistance
- Biocorrosion Resistance
- Sealant Adhesion / Compatibility
- Hydraulic Fluid Resistance / Fuel Resistance
- Hydrophobicity
- Moisture Barrier / Fuel Barrier
- Flexibility

The project member companies reported that the application methods for all products included Spray Application and Brush Application.

The integral fuel tank coatings currently used are applied onto various aluminium, steel and titanium alloys, and also applied directly to carbon / glass fibre composite materials.

The surface treatments prior to the application of integral fuel tank coating include anodizing (Boric Sulfuric Acid Anodizing, Chromic Acid Anodizing, Phosphoric Acid Anodizing, Sulfuric Acid Anodizing & Tartaric Sulfuric Acid Anodizing), cadmium plating, chemical conversion coating, abrasive blasting, manual abrasion, and manual solvent cleaning.

5.2 Requirements Exchange

Of the fourteen project member companies participating in the project, eight of these companies have their own internal integral fuel tank coating material specification. These companies provided the material test requirements from their internal fuel tank coating material specifications. These requirements were collated into one spreadsheet.

The project team then reviewed these requirements, and after agreement on what the key requirements are for an integral fuel tank coating, created a Product Requirements Document for Integral Fuel Tank Coating. This can be found in Appendix A – Product Requirements Document

6 Work Package 2 – Technical Data Exchange

Coatings suppliers were approached under an IAEG-developed NDA to share more detailed data on the hexavalent chromium-free IFTCs that they have in development/developed. A template was created, and sent to suppliers to complete, that collected key details about their proposed IFTC products.

Of the 8 coating formulators contacted, 4 actively engaged with the project and provided experimental data on 7 chrome-free products between them. Of these products, 1 was considered at TRL 4-6, and 4 were considered at TRL 5-7. The final 2 were considered TRL 9, however this TRL was only applicable for composite substrates. The remaining 4 coating formulators declined to share data, but it was noted that all 4 have active internal work ongoing on chrome-free IFTC.

In addition, testing data was shared on 10 products between the project member companies to supplement the data provided by the coating formulators.

7 SDS Review

Available material safety data sheets (SDS) have been evaluated based on the risk profile of their ingredients.

Based on the SDS' that were available for the products that the project team had collated test data on:

- 2 products contained substances that were classified as Reprotoxic 1
- 3 products contained substances that were classified as Carcinogenic 2
- 3 products contained a substance listed on REACH Annex XVII
- 4 products contained substances that are under evaluation for Carcinogenic, Mutagenic and Reprotoxic (CMR) properties

The use of CMR 1 substances should be avoided for new developments. For CMR 2 substances, special care should be taken if they are volatile.

Concentrations of diisocyanates, which are used for curing of polyurethane coatings, should be kept below 0.1% to stay out of the scope of REACH Annex XVII restriction. This is already considered by many suppliers for new formulations.

For mid to long term sustainability of new products, pending restriction developments should be considered. This is crucial, especially for active ingredients of a formulation (e.g. corrosion inhibitor).

Moreover, all suppliers have confirmed that no PFAS are intentionally used in the products which are in the scope of this report.

8 Outlook / Recommendations

It is recommended that some of the outputs of this project are disseminated outside of the Project Team.

Firstly, the Project Team recommend that the Product Requirements Document, a deliverable from Work Package 1 and found in Appendix A – Product Requirements Document , be shared with the coatings formulators in the aerospace industry, in order to provide guidance to them on what the Project Team has deemed to be the essential requirements for an aerospace integral fuel tank coating.

Also, it is recommended that the Project Team meets with SAE's AMS G8 Aerospace Organic Coatings Committee. This committee is the custodian of the industry integral fuel tank coating specification AMS-C-27725. A meeting between the Project Team and this Committee would give an opportunity for a discussion between the current gaps that exist between AMS-C-27725 and OEM integral fuel tank coating specifications, while also providing an opportunity to share the Product Requirements Document with this committee, to take into consideration for any future updates to AMS-C-27725.

Moreover, the Project Team should investigate the opportunity to share the Project Report with Authorisation Consortia such as ADCR (Aerospace and Defence Chromates Reauthorisation) Consortium. This report has the potential to contribute significant information to support the creation

of an Analysis of Alternatives dossier to be submitted in the application for re-authorisation of Strontium Chromate and Pentazinc Chromate Octahydroxide when used in integral fuel tank coatings.

Furthermore, the Project Team shall consider launching a Phase 2 of the project focussed on testing of appropriate candidates to the requirements of the Product Requirements Document, with an option to using some of the selected key requirements to carry out screening tests to reduce the overall number of products to take to full test.

9 Appendix A – Product Requirements Document



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duct Requirements Dc