CHEMICAL SAFETY REPORT

Legal name of applicants:	*AKZO Nobel Car Refinishes B.V.;* *Habich GmbH;* *Henkel Global Supply Chain B.V.;* *Indestructible Paint Ltd;* *Finalin GmbH;* *Mapaero;* *PPG Central (UK) Ltd in its legal capacity as Only Representative of PRC DeSoto International Inc. - OR5;* *PPG Industries (UK) Ltd;* *PPG Coatings SA;* *Aviall Services Inc.*
Submitted by:	*AKZO Nobel Car Refinishes B.V.*
Substance:	*Strontium Chromate; EC 232-142-6, CAS 7789-06-2*
Use title:	*Formulation of Mixtures* **and** *Application of paints, primers and specialty coatings containing Strontium Chromate in the construction of aerospace and aeronautical parts, including aeroplanes / helicopters, spacecraft, satellites, launchers, engines, and for the maintenance of such constructions, as well as for such aerospace and aeronautical parts, used elsewhere, where the supply chain and exposure scenarios are identical.*
Use number:	*1 and 2*

Disclaimer

9. EXPOSURE ASSESSMENT (and related risk characterisation)

9.0. Introduction

This application is the culmination of extraordinary effort across industry over several years to share data and derive Exposure Scenarios that are reliable and representative of good practice across the industry.

The aerospace industry recognises that the use of such sector-specific Exposure Scenarios in an upstream application will facilitate assessment by RAC and SEAC and enforcement at Member State level. This exposure assessment sets out detailed Exposure Scenarios, including clear and enforceable Risk Management Measures (RMM) and Operational Conditions (OC), for specific activities within the scope of the Application for Authorisation. Importantly, with reference to the specific provisions for authorisation set out in the REACH regulation, an upstream Application for Authorisation (AfA) is the only possible way to meet the needs of the aerospace Downstream Users (DU). An upstream AfA (e.g. by a manufacturer, importer or formulator) of a substance allows coverage of the entire supply chain where the relevant uses are already known.

The Exposure Scenarios are based on extensive input and data held by the European aerospace sector and affiliated industries. The same companies and facilities have reviewed and validated the Exposure Scenarios, including RMM and OC, in detail. The Exposure Scenarios presented are therefore unambiguous and demonstrated to be representative of good practice across the industry.

The Exposure Scenarios are conservative, meaning that exposure measurements or estimates represent the upper boundaries of exposure (representing the reasonable worst case). Due to the specialised and highly regulated nature of activities in the aerospace sector (as explained in the AoA), the uses are well defined and uncertainty associated with the Exposure Scenarios is limited (this finding is supported by the data presented in the document). Minor differences in exposure conditions between facilities and companies occur occasionally and are described in the Exposure Scenarios. In such cases, exposure levels take account of the least stringent RMM/OC and greater release parameters to over-estimates the risk.

For the avoidance of any doubt, while the Exposure Scenarios represent good practice in the aerospace industry, it might be that there will be facilities that cannot demonstrate compliance with these Exposure Scenarios and will not be able to rely on this upstream authorisation.

This exposure assessment provides reliable estimates of current work place exposure levels across the EU. Occupational work place exposure to hexavalent chromium [Cr(VI)] is regulated in most European countries. National Occupational Exposure Limits (OELs) across Europe respect a range of 8 hour *Time Weighted Average* (TWA) values between 1 µg/m^3 and 50 µg/m^3. The US *Occupational Safety and Health Administration* (OSHA) OEL is at 5 µg/m^3. In 2014, France introduced a new OEL of 1 µg/m^3. This is one of the most stringent OEL currently in place anywhere in the World and industry has invested substantial research and investment to continually reduce exposure to this level. It is important to recognise that measurement data presented within the CSR are necessarily aggregated across several companies and a period of several years. They do not reflect the most stringent OELs since available measurement data were generally collected prior to the introduction of the French OEL and because there is no immediate regulatory imperative for facilities outside France to meet this limit. Nevertheless, for countries in which the national standard is lower than the exposure estimates shown in the following exposure scenario, companies are expected to comply with the national standards by improved technical or personal Risk Management Measures (RMMs) or by demonstrating through work place exposure measurement data that they meet the national requirements.

The Carcinogens and Mutagens Directive (2004/37/EC) requires each Member State to ensure employers reduce and replace use of hexavalent chromium substances, and the introduction of a new OEL in France provides one clear example of regulation by Member States to effect a reduction in workplace exposure to Cr(VI). Industry is proactively engaged in delivering continuous reduction through the development and implementation of appropriate RMMs. Air-tight spray booths, local exhaust ventilation, and use of respiratory protection are examples of RMMs now commonly implemented to manage potential exposure to Cr(VI) across industry.

Best practice across the industry is continually improving, driven by general awareness of workplace hygiene and increasingly stringent regulatory requirements. This commitment to reducing exposure also reflects the widespread recognition that surface treatment including coating with Cr(VI) is critical for several industries and that alternatives are not available in the near-term. Potential workplace exposure to Cr(VI) has progressively reduced in recent years as the effectiveness and implementation of risk management measures has improved,

and this trend is clearly reflected in exposure measurement data available over the last 10 years or more.

For this reason, the exposure assessment, based on both measured and modelled data, considers prevailing (rather than historic) practices so far as possible; it represents a 'snap-shot' of workplace practices generally in place in and around 2013. It does not describe more recent or ongoing research, measures or initiatives to further drive down potential exposure.

Surface treatment including coating operations are generally very similar in nature, as can be seen from the Exposure Scenarios developed based on input from operators across the European coating industry. Even so, individual operators may implement different RMMs over various timeframes for their own reasons, reflecting considerations such as (but not limited to) the layout (and age) of the coating facility, the scale, frequency and duration of operations, the number of operators, the type of articles coated, and expenditure required.

9.0.1. Overview of uses and Exposure Scenarios

Tonnage information:

Assessed tonnage: 200 tonnes of strontium chromate per year, based on:

- 200 tonnes/year manufactured/imported [containing approximately 50 tonnes Cr(VI)]

The following table lists all the exposure scenarios (ES) assessed in this CSR.

Table 7. Overview of exposure scenarios and contributing scenarios

Identifiers	Market Sector	Titles of exposure scenarios and the related contributing scenarios	Tonnage (tonnes per year)
ES1 - F1		Formulation – Formulation of Mixtures - Formulation of Mixtures (ERC 2) - Delivery and storage of raw material (PROC 1) - Decanting and weighing of solids (PROC 8b) - Transfer to mixing vessel (PROC 8b) - Mixing by dilution, dispersion, wet-grinding (closed or open process) (PROC 2-5, 26) - Transfer to small containers (including filtering) (PROC 9b) - Cleaning of equipment (PROC 8b) - Maintenance of equipment (PROC 8b) - Storage of formulation (PROC 1) - Laboratory analysis (sampling, laboratory analysis, test spraying) (PROC 15, 7) - Waste management (PROC 8b)	200 [50 Cr(VI)]
ES1 - IW1		Use at industrial site - Application of paints, primers and specialty coatings containing Strontium Chromate in the construction of aerospace and aeronautical parts, including aeroplanes / helicopters, spacecraft, satellites, launchers, engines, and for the maintenance of such constructions, as well as for such aerospace and aeronautical parts, used elsewhere, where the supply chain and exposure scenarios are identical - Application of paints, primers and specialty coatings containing Strontium Chromate in the construction of aerospace and aeronautical parts, including aeroplanes / helicopters, spacecraft, satellites, launchers, engines, and for the maintenance of such constructions, as well as for such aerospace and aeronautical parts, used elsewhere, where the supply chain and exposure scenarios are identical (ERC 5) - Delivery and storage of raw material (PROC 1) - Decanting, mixing and filling of guns, cups or small containers	200 [50 Cr(VI)]

Identifiers	Market Sector	Titles of exposure scenarios and the related contributing scenarios	Tonnage (tonnes per year)
		(PROC 5) - Surface treatment by spraying (large parts) in a purpose-designed room (PROC 7) - Surface treatment by spraying in spray cabin/spray booth (PROC 7) - Surface treatment by spraying outside of paint-booth (PROC 7) - Surface treatment by brushing/rolling (small to medium sized parts) (PROC 10) - Surface treatment by brushing (very small parts/touch-up) (PROC 10) - Drying/self-curing (PROC 26) - Drying/heat-curing (PROC 26) - Drying/self-curing of large sized parts (PROC 26) - Cleaning of equipment – tools cleaning (closed system) (PROC 8b) - Cleaning and maintenance of equipment – tools cleaning (paint cabin) (PROC 8b) - Cleaning – paint cabin and ancillary areas g (PROC 8b) - Infrequent maintenance activities (PROC 8a) - Machining operations on small to medium sized parts containing Cr(VI) on an extracted bench/extraction booth including cleaning (PROC 21, 24) - Machining operations on small to medium sized surfaces containing Cr(VI) on an extracted bench/extraction booth including cleaning (PROC 21, 24) - Machining operations in large work areas on parts containing Cr(VI) including cleaning (PROC 21, 24) - Machining operations in large work areas on surfaces containing Cr(VI) including cleaning (PROC 21, 24) - Machining operations on parts containing Cr(VI) in small work areas including cleaning (PROC 21, 24) - Machining operations on surfaces containing Cr(VI) in small work areas including cleaning (PROC 21, 24) - Sanding of large surfaces containing Cr(VI) in large work areas including cleaning (PROC 21, 24) - Waste management (PROC 8b) - End of Life (PROC 8a)	
Manufacture: M-#, Formulation: F-#, Industrial end use at site: IW-#, Professional end use: PW-#, Consumer end use: C-#, Service life (by workers in industrial site): SL-IW-#, Service life (by professional workers): SL-PW-#, Service life (by consumers): SL-C-#.)			

9.0.2. Introduction to the assessment

9.0.2.1. Environment

Scope and type of assessment

The current Chemical Safety Report (CSR) and the associated exposure scenarios (ES) are tailored to supporting Application for Authorization (AfA) to continue use of strontium chromate for application of paints, primers and specialty coatings containing Strontium Chromate in the construction of aerospace and aeronautical parts, including aeroplanes / helicopters, spacecraft, satellites, launchers, engines, and for the maintenance of such constructions, as well as for such aerospace and aeronautical parts, used elsewhere, where the supply chain and exposure scenarios are identical after the sunset date in January 2019.

Strontium chromate has been included in Annex XIV to Regulation (EC) No 1907/2006 ('REACH') due to its intrinsic properties as being carcinogenic (Carc. 1B).

Following Regulation (EC) No 1907/2006, Article 62(4)(d), the CSR supporting an AfA needs to cover only those potential risks arising from the intrinsic properties specified in Annex XIV. Accordingly, only the potential human health risks related to the classification of strontium chromate as a carcinogen are considered in the current CSR. The dominating health effect resulting from the intrinsic hazardous properties of strontium chromate is lung cancer due to inhalation of dust and/or aerosols. Intestinal cancer following ingestion is also identified as a potential risk: however, the dose-response relationship is lower than that for lung cancer, and ingestion is generally not considered an important exposure route for workers.

Evaluation of any potential hazards to the environment is not required within the framework of this authorisation application. Health hazards may potentially relate to Cr(VI) exposure of the general population via the environment, and are considered accordingly.

Measures to prevent or limit release of Cr(VI) to the environment are provided as best practice at facilities carrying out operations using Cr(VI). During painting and sealing operations, prevention of releases of all products to the aquatic environment is a matter of good practice. Water may be used in paint booths to capture residual paint and prevent release to the atmosphere; this water is recirculated and finally disposed as a hazardous waste. Treatment technology (on-site or off-site) to reduce hexavalent to trivalent chromium [Cr(III)] in wastewater is generally highly effective, such that residual concentrations of Cr(VI) in effluent are very low and often non-detectable, and may be considered negligible . Solid and liquid waste materials such as paper, filters, cans, personal protective equipment (PPE) and other equipment contaminated with paint containing Cr(VI) are collected and treated as hazardous waste where residual Cr(VI) can be effectively safely treated. In view of the risk management measures in place at the production facilities emissions to the aquatic environment associated with painting and sealing operations are effectively prevented.

Due to its low volatility, strontium chromate will not normally be present in air. Nevertheless, energetic processes such as spray painting or mechanical processes can release these substances into air in association with aerosols or particulate matter. All workspaces with potential release to air are equipped with exhaust ventilation systems to remove residual particulates from workers breathing zone: exhaust air is passed through filters or wet scrubbers according to best available technique (minimum 99% removal efficiency) before being released to atmosphere. While emissions to air are therefore very low, they have been considered in this assessment as a factor potentially contributing to Cr(VI) exposure of humans via the environment. The scope and type of the assessment of the pathway “man via the environment” is discussed in section 9.0.2.2 below.

Paints containing Cr(VI) are not directly or indirectly released to soil, and releases to soil are considered negligible

Table 8. Type of risk characterisation required for the environment

Protection target	Type of risk characterisation	Hazard conclusion (see section 7)
Freshwater	Not required	Not relevant
Sediment (freshwater)	Not required	Not relevant
Marine water	Not required	Not relevant
Sediment (marine water)	Not required	Not relevant
Sewage treatment plant	Not required	Not relevant
Air	Not required	Not relevant
Agricultural soil	Not required	Not relevant
Predator	Not required	Not relevant

Comments on assessment approach:

In accordance with Regulation (EC) No 1907/2006, Article 62(4)(d), potential risks to the environment need not be considered.

9.0.2.2. Man via environment

Scope and type of assessment

As discussed in 9.0.2.1., humans may potentially be exposed to strontium chromate via the environment. Since strict emission control measures are implemented, releases to the aquatic environment (and also to soil), if any, are negligible, and the only relevant potential exposure path is inhalation of fine dust or particulates emitted from the facilities to air (see also "comments on assessment approach" below).

Within the current CSR, local concentrations (Clocal) of chromium in air resulting from emissions to air from industrial use are estimated based on available emission data from companies or modelled with EUSES 2.1.2., and expressed as Cr(VI).

The regional concentrations are reported in section 10.2.1.2 (see Table 41, "Predicted regional exposure concentrations (Regional PEC)") based on modeling with EUSES 2.1.2., and expressed as Cr(VI).

Table 9. Type of risk characterisation required for man via the environment

Route of exposure and type of effects	Type of risk characterisation	Hazard conclusion (see RAC/27/2013/06 Rev.1)
Inhalation: Local long-term	Quantitative	Lung cancer: ELR = 2.9E−02 per 1 µg Cr(VI)/m³ for 70 years
Oral: Local long-term	Not needed. Assume all inhaled material is respirable (worst case).	Intestinal cancer: ELR = 8.0E−04 per 1 µg Cr(VI)/kg bw/d for 70 years

Comments on assessment approach:

The risk assessment for humans exposed via the environment is restricted to inhalation of airborne residues of the chromates. The oral route (swallowing of the non-respirable fraction) does not need to be explicitly considered here since:

(i) the exposure calculations (airborne concentrations) do not provide different particle size fractions (inhalable/thoracic/respirable);

(ii) the excess lifetime risk (ELR) for intestinal cancer is one order of magnitude lower than that for lung cancer. The assessment of health impacts is therefore dominated by the potential risk of lung cancer due to inhalation of hexavalent chromium;

(iii) the document on a reference dose-response relationship for Cr(VI) compounds (RAC/27/2013/06 Rev.1) states that "*in cases where the applicant only provides data for the exposure to the inhalable particulate fraction, as a default, it will be assumed that all particles were in the respirable size range.*"

Therefore, in accordance with the above findings and provisions on the risk assessment for humans exposed via the environment, since it is assumed that all particles are in the respirable size range, no exposure via the oral route needs to be considered.

This constitutes a worst case approach, since the potential lung cancer risk, is an order of magnitude higher compared to the potential intestinal cancer risk, based on the dose-response relationships agreed by the Committee of Risk Assessment (RAC).

9.0.2.3. Workers

Scope and type of assessment

The scope of exposure assessment and type of risk characterisation required for workers are described in the following table based on the hazard conclusions presented in section 5.11.

Table 10. Type of risk characterisation required for workers

Route	Type of effect	Type of risk characterisation	Hazard conclusion (see RAC/27/2013/06 Rev.1)
Inhalation	Systemic long-term	Not needed	Not relevant
	Systemic acute	Not needed	Not relevant
	Local long term	Quantitative	Lung cancer: ELR = 4.0E−03 per 1 µg Cr(VI)/m³ for 40 years
	Local acute	Not needed	Not relevant
Dermal	Systemic long term	Not needed	Not relevant
	Systemic acute	Not needed	Not relevant
	Local long term	Not needed	Not relevant
	Local acute	Not needed	Not relevant
Eye	Local	Not needed	Not relevant

Comments on assessment approach related to toxicological hazard:

Strontium chromate has been included into Annex XIV to Regulation (EC) No 1907/2006 ('REACH') due to its intrinsic properties as being carcinogenic (Carc. 1B).

Following Regulation (EC) No 1907/2006, Article 62(4)(d), the CSR supporting an AfA needs to cover only those potential risks arising from the intrinsic properties specified in Annex XIV. The dominating health effect resulting from the intrinsic hazardous properties of strontium chromate is lung cancer due to inhalation of dust and/or aerosols.

Exposure estimates generated by ART 1.5 and measured exposure values are presented in this document in terms of Cr(VI).

The oral route (mucociliary clearance and swallowing of the non-respirable fractions) is not taken into account for the same reasons as already explained in the context of “man via environment” (section 9.0.2.1 above). In accordance with the RAC document on the dose-response relationship (RAC/27/2013/06 Rev.1) it has to be assumed that all particles are in the respirable size range. Hence no exposure via the oral route needs to be considered.

Comments on assessment approach related to physicochemical hazard:

Not relevant – physicochemical hazards are not subject of this chemical safety report.

General information on risk management related to toxicological hazard:

Potential exposure of worker handling strontium chromate during formulation and industrial use is restricted to the lowest possible level.

When handling solid strontium chromate or in cases in which exposure to airborne strontium chromate can occur (e.g. spraying), personnel are required to wear protective clothing, chemical-resistant gloves, goggles, and adequate respiratory protection (e.g. half- masks equipped with A2P3 filters[1]).

[1] European standard EN 143 defines the classes of particle filters that can be attached to a face mask. A P3 filter is required to remove at least 99.95% of airborne particles at a filter penetration limit (at 95 L/min air flow)

General information on risk management related to physicochemical hazard:

Not relevant – physicochemical hazards are not subject of this chemical safety report.

9.0.2.4. Consumers

Exposure assessment is not applicable as there are no consumer-related uses for strontium chromate.

9.1. Exposure scenario 1: Formulation – Formulation of Mixtures

Formulation of paints, primers and specialty coatings in closed batch or batch process generally involves storage, raw material charging, mixing, dispersing, filtering and filling, maintenance and cleaning of equipment, and transfer of waste and laboratory activities.

Strontium chromate is a hazardous substances, therefore is handled in a way as to eliminate or minimise the potential for worker exposure[2]. Personal protective equipment (PPE) and engineering controls (LEV) are used to limit potential dermal and inhalation exposure.

This scenario addresses formulation by stand-alone formulators. On-site formulation (i.e. mixing) at industrial sites is not included in this scenario but covered in the following industrial use scenario (see 9.2). Formulation in most cases is not a continuous but a batch process. For workers, however, the exposure scenario assumes that the formulation tasks are conducted each day; therefore exposure is effectively treated as a continuous process for the purpose of this assessment, resulting in an over-estimation of long-term inhalation exposure.

Environment contributing scenario(s):	
Formulation of Mixtures	ERC 2
Worker contributing scenario(s):	
Delivery and storage of raw material	PROC 1
Decanting and weighing of solids	PROC 8b
Transfer to mixing vessel	PROC 8b
Mixing by dilution, dispersion, wet-grinding (closed or open process)	PROC 2-5, 26
Transfer to small containers (including filtering)	PROC 9
Cleaning of equipment	PROC 8b
Maintenance of equipment	PROC 8b
Storage of formulation	PROC 1
Laboratory analysis (sampling, laboratory analysis, test spraying)	PROC 15, 7
Maintenance of equipment	PROC 8a
Waste management	PROC 8b

Explanation on the approach taken for the ES

Occupational exposure estimates are based on measured data and/or on modelled data. Where inhalation exposure has been estimated by modelling, the exposure model *Advanced REACH Tool 1.5' or 'ART'*[3] has been used. ART is a second tier model calibrated to assess exposure to inhalable dust, vapours, and mists; this Exposure Scenario is within the scope of ART. The figures obtained by modelling are considered to be worst-

[2] In accordance with Carcinogens Directive 90/394/EEC and Carcinogens and Mutagens Directive 2004/37/EC
[3] The use of ART for workers exposure assessment under REACH is described in ECHA's updated Guidance on Information Requirements and chemical safety assessment R.14.

case estimates: supportive evidence for the conservative character of the modelled estimates is provided by comparison with relevant measured exposure data (measured concentrations of particulate residues of Cr(VI) in air), where available; such analysis indeed indicates that ART is a reasonable but conservative tool for estimating exposure of Cr(VI) in the scope of this assessment. Appropriate values for each model parameters haves been selected in close cooperation with directly involved companies from the aerospace and affiliated industries, as indicated elsewhere in this document. Where the sample size and sampling strategy is adequate (i.e. personal sampling data), the risk characterisation relies on the measured exposure values; in other cases the results of the exposure modelling were used as adequate measurement data was not available.

The detailed Exposure Scenario has been developed based on information provided by several companies involved in this activity. Companies provided details of the conditions under which the activity was carried out as well as the duration and frequency of each task. The frequency of a specific activity in the worker sub-scenarios is expressed as daily activity unless otherwise stated. As long-term exposure is the relevant period for long-term health effects, the duration of exposure per day as set out in the ES is expressed as *average* duration per day over a longer period (e.g. 2 hours each day are equal to 4 hours every second day). Therefore, it can be seen that the duration of exposure per day is not the same as the *maximum* allowed duration in any one day.

All sub-scenarios which are based on modelled values provide worst-case estimates using in general the highest exposure duration and the lowest level of personal protection reported. Therefore many companies will stay below the estimated exposure.

In view of the strict separation of the production facility from the wastewater stream, any releases to the aquatic environment are essentially negligible (zero). Strontium chromate is contained within the preparation and the water used to rinse out the equipment is collected and recycled or disposed of in specialist facilities. Reductive treatment of any waste containing Cr(VI) additionally ensures negligible release of Cr(VI) to water. This is reflected in the environmental contributing scenario below.

9.1.1. Environmental contributing scenario 1: Formulation

9.1.1.1. Conditions of use

Amount used, frequency and duration of use (or from service life)
▪ Daily use at site: <= 0.12 tonnes/day [as Cr(VI)]
▪ Annual use at a site: <= 25 tonnes/year [as Cr(VI)]
▪ Percentage of tonnage used at regional scale: = 50 %
Technical and organisational conditions and measures
▪ Air emission abatement: at least 99% efficiency ▪ Negligible discharge of Cr(VI) in wastewater from the site ▪ All solid and any liquid waste is collected and either the collected waste is directly forwarded to an external waste management company, or Cr(VI) in wastewater is reduced to Cr(III) on-site, and the treated waste is either recycled or forwarded to an external waste management company (licenced contractor) for disposal as hazardous waste.
Conditions and measures related to sewage treatment plant
▪ Not applicable – negligible discharge of Cr(VI) in wastewater from the site
Conditions and measures related to treatment of waste (including article waste)
▪ Collection of all solid and liquid waste, reduction of Cr(VI) in wastewater to Cr(III), recycling or disposal as hazardous waste by an external waste management company (licenced contractor)
Other conditions affecting environmental exposure
▪ Exhaust air is passed through filters or wet scrubbers according to best available technique (minimum efficiency 99 %)

9.1.1.2. Releases

For the formulation of strontium chromate for the application paints, primers and specialty coatings in the

construction of aerospace and aeronautical parts, no air emission data (i.e. measurement of release to the atmosphere) were available.

Two industry associations have developed SpERCs that can be considered relevant for formulation of paints, primers and specialty coatings in general:

For the formulation of sealants, data on environmental releases from the FEICA SPERC - 2.1a.v2- Formulation of Solvent Borne adhesives - Solids has been identified as relevant for the scenario. The SpERC estimates an initial release factor to air of 0.01;

For the formulation of paints and coatings, data on environmental releases are selected from the CEPE SPERC. SPERCs: 2.2a.v1-Formulation of Organic Solvent Borne Coatings and Inks – Solids. The SpERC estimates an initial release factor to air 9.7E-5.

The formulation of sealants and coatings is a multi-stage batch process. The process is arranged to maximise the efficiency of use of input raw materials, through the highest conversion into formulated products. Process losses are reduced to the absolute minimum, through use of general and manufacturing plant extraction to maintain workplace concentrations of airborne vapours (e.g. for VOCs) and particulates below respective OELs; and through use of closed or covered manufacturing equipment, wherever possible, to minimise evaporative losses (e.g. of VOCs). The intrinsic properties of the constituents of these products and the overall process are such that care is taken that there are no discharges of raw materials or products to waste-water or to soil from the formulating plant.

The formulation of coatings and paints is the predominant formulation process for strontium chromate (i.e. sealant formulation is limited). As worst case, therefore, a mean release fraction of 0.005 (the average value of the release factors in the relevant SpERCs covering sealants (0.01) and coatings (0.0001) was used as the release factor for this scenario.

Air emissions relating to local exhaust ventilation (LEV) or extraction systems are filtered or passed through wet scrubbers to remove particulates prior to release to atmosphere. Information from facilities indicates that removal efficiency of at least 99% is typical for industry. Therefore the final release factor is set to 0.005%.

Table 11. Local releases to the environment

Release	Release factor estimation method	Explanation / Justification
Air	Release factor	**Initial release factor:** 0.5% **Final release factor:** 0.005% **Local release rate:** 0.006 kg/day

9.1.1.3. Exposure and risks for the environment and man via the environment

The exposure concentrations and risk characterisation ratios (RCR) are reported in the following table.

Table 12. Exposure concentrations and risks for the environment

Protection target	Exposure concentration	Risk characterisation
Freshwater	Not relevant	-
Sediment (freshwater)	Not relevant	-
Marine water	Not relevant	-
Sediment (marine water)	Not relevant	-
Predator (freshwater)	Not relevant	-
Predator (marine water)	Not relevant	-
Top predator (marine water)	Not relevant	-
Sewage treatment plant	Not relevant	-
Air	**Local PEC:** 9.521E-7 mg/m³	-

Protection target	Exposure concentration	Risk characterisation
Agricultural soil	Not relevant	-
Predator (terrestrial)	Not relevant	-
Man via Environment – Inhalation	**Local PEC:** 9.521E-7 mg/m³	Based on the dose-response relationship derived by the RAC, considering a 70 year exposure time (24h/day, 7d/week), the following excess lifetime risk for the general population is derived based on the estimated exposure: 0.028 per 1000 exposed.
Man via Environment - Oral	Not relevant	-

Conclusion on risk characterisation

The estimated exposure concentration of 9.521E-7 mg/m^3 is used as worst-case estimate of $Plocal_{air,ann.}$ and used as the basis for risk characterisation for man via the environment.

Based on the dose-response relationship derived by the RAC, considering a 70 year exposure time (24h/day, 7d/week), the following excess lifetime risk for the general population is derived based on the estimated exposure:

0.028 per 1000 exposed.

As the mechanistic evidence is suggestive of non-linearity, it is acknowledged by RAC that excess risks inferred in the low exposure range [i.e. below an exposure concentration of 1 µg Cr(VI)/m³] might be an over-estimate.

9.1.2. Worker contributing scenario 1: Delivery and storage of raw material (PROC 1)

Strontium chromate is delivered as wet paste or dry powder in sealed containers or bags and stored in a chemical storage room for dangerous substances. There is no potential for inhalation exposure.

9.1.2.1. Conditions of use

	Method
Product (article) characteristics	
▪ Substance as such / in mixture Concentration of Cr(VI): < 25%	Qualitative
Amount used (or contained in articles), frequency and duration of use/exposure	
▪ Duration of activity: < 8 hours	Qualitative
Technical and organisational conditions and measures	
▪ General ventilation: Basic general ventilation (1-3 air changes per hour)	Qualitative
▪ Containment: Closed system (minimal contact during routine operations)	Qualitative
▪ Local exhaust ventilation: No	Qualitative
▪ Occupational Health and Safety Management System: Advanced	Qualitative
Conditions and measures related to personal protection, hygiene and health evaluation	
▪ Respiratory Protection: No	Qualitative
Other conditions affecting workers exposure	
▪ Place of use: Indoor	Qualitative
▪ Process temperature (for solids): ambient	Qualitative

9.1.2.2. Exposure and risks for workers

The exposure concentrations and risk characterisation ratios (RCR) are reported in the following table.

Table 13. Exposure concentrations and risks for workers

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, local, long-term	**0 µg/m³**	Based on the dose-response relationship derived by the RAC, considering a 40 year working life (8h/day, 5d/week), the following excess lifetime risk up to age 89 is derived based on the estimated exposure: 0 per 1000 exposed workers

Conclusion on risk characterisation

There is no potential for exposure. The qualitatively determined exposure estimate of 0 µg Cr(VI)/m³ is used as the basis for risk characterisation.

An excess lifetime risk of 0 per 1000 exposed workers is estimated based on the above exposure estimate and the RAC dose-response relationship.

Preparation for mixing, mixing, filling into small containers, cleaning and maintenance of equipment

Adequate measurement data covering all sub-tasks (decanting and weighing, transfer, mixing and cleaning, maintenance) described in the following worker contributing scenarios (WCS) 2-7 are available. The exposure estimates based on this measurement data are provided at the end of WCS 7. The following WCS set out the operational conditions and risk management measures relevant for the different sub-scenarios.

9.1.3. Worker contributing scenario 2: Decanting and weighing of solids (PROC 8b)

Strontium chromate may be decanted and weighted before transferred to the mixing vessel.

9.1.3.1. Conditions of use

	Method
Product (article) characteristics	
▪ Substance as such / in mixture Concentration of Cr(VI): < 25%	Measured data
Amount used (or contained in articles), frequency and duration of use/exposure	
▪ Duration of activity: < 1 hour	Measured data
Technical and organisational conditions and measures	
▪ General ventilation: Basic general ventilation (1-3 air changes per hour)	Measured data
▪ Containment: Semi-closed process with occasional controlled exposure	Measured data
▪ Local exhaust ventilation: Yes	Measured data
▪ Occupational Health and Safety Management System: Advanced	Measured data
Conditions and measures related to personal protection, hygiene and health evaluation	
▪ Respiratory Protection: Yes [Respirator with APF 30] [Effectiveness Inhal: 96.67%]	Measured data

	Method
When handling solid chromates, at least half-mask with P3 filter (APF 30 according to German BG rule 190) is worn *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	
Other conditions affecting workers exposure	
▪ Place of use: Indoor	Measured data
▪ Process temperature (for solids): ambient	Measured data

9.1.3.2. Exposure and risks for workers

See end of WCS 7.

9.1.4. Worker contributing scenario 3: Transfer to mixing vessel (PROC 8b)

The solid chromate is transferred to and filled into the mixing vessel (either automatically or manually). This scenario addresses the manual process, as the worst case.

9.1.4.1. Conditions of use

	Method
Product (article) characteristics	
▪ Concentration of Cr(VI) in mixture: < 25%	Measured data
Amount used (or contained in articles), frequency and duration of use/exposure	
▪ Duration of activity: < 4 hours	Measured data
Technical and organisational conditions and measures	
▪ General ventilation: Basic general ventilation (1-3 air changes per hour)	Measured data
▪ Containment: No	Measured data
▪ Local exhaust ventilation: Yes	Measured data
▪ Occupational Health and Safety Management System: Advanced	Measured data
Conditions and measures related to personal protection, hygiene and health evaluation	
▪ Respiratory Protection: Yes [Respirator with APF 30] [Effectiveness Inhal: 96.67%] *When handling solid chromates, at least half-mask with P3 filter (APF 30 according to German BG rule 190) is worn* *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	Measured data
Other conditions affecting workers exposure	
▪ Place of use: Indoor	Measured data
▪ Process temperature (for solids): ambient	Measured data

9.1.4.2. Exposure and risks for workers

See end of WCS 7.

9.1.5. Worker contributing scenario 4: Mixing by dilution, dispersion, wet-grinding

(closed or open process) (PROC 2 to PROC 5, PROC 26)

The mixture is stirred in the mixing vessel using a dispersion mixer followed by wet-grinding. The vessel is lidded, air is locally extracted and the process is carried out in a segregated and ventilated room.

9.1.5.1. Conditions of use

	Method
Product (article) characteristics	
▪ Substance as such / in mixture Concentration of Cr(VI): < 25%	Measured data
Amount used (or contained in articles), frequency and duration of use/exposure	
▪ Duration of activity: < 8 hours	Measured data
Technical and organisational conditions and measures	
▪ General ventilation: Basic general ventilation (1-3 air changes per hour)	Measured data
▪ Containment: No	Measured data
▪ Local exhaust ventilation: Yes	Measured data
▪ Occupational Health and Safety Management System: Advanced	Measured data
Conditions and measures related to personal protection, hygiene and health evaluation	
▪ Respiratory Protection: Yes [Respirator with APF 30] [Effectiveness Inhal: 96.67%] *When handling solid chromates, at least half-mask with P3 filter (APF 30 according to German BG rule 190) is worn* *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	Measured data
Other conditions affecting workers exposure	
▪ Place of use: Indoor	Measured data
▪ Process temperature (for liquid): <= 40 °C	Measured data

9.1.5.2. Exposure and risks for workers

See end of WCS 7.

9.1.6. Worker contributing scenario 5: Transfer to small containers (including filtering) (PROC 9)

Manual or automatic filling of formulation into specified containers.

9.1.6.1. Conditions of use

	Method
Product (article) characteristics	
▪ Concentration of Cr(VI) in mixture: <10%	Measured data
Amount used (or contained in articles), frequency and duration of use/exposure	
▪ Duration of activity: < 8 hours	Measured data
Technical and organisational conditions and measures	

	Method
▪ General ventilation: Basic general ventilation (1-3 air changes per hour)	Measured data
▪ Containment: No	Measured data
▪ Local exhaust ventilation: Yes	Measured data
▪ Occupational Health and Safety Management System: Advanced	Measured data
Conditions and measures related to personal protection, hygiene and health evaluation	
▪ Respiratory Protection: No *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	Measured data
Other conditions affecting workers exposure	
▪ Place of use: Indoor	Measured data
▪ Process temperature (for liquid): <= 40 °C	Measured data

9.1.6.2. Exposure and risks for workers

See end of WCS 7.

9.1.7. Worker contributing scenario 6: Cleaning of equipment (PROC 8b)

Cleaning of equipment is not a separate task but conducted by those employees working in the mixing area as part of their normal working procedure.

9.1.7.1. Conditions of use

	Method
Product (article) characteristics	
▪ Concentration of Cr(VI) in mixture: <25%	Measured data
Amount used (or contained in articles), frequency and duration of use/exposure	
▪ Duration of activity: < 1 hour	Measured data
Technical and organisational conditions and measures	
▪ General ventilation: Basic general ventilation (1-3 air changes per hour)	Measured data
▪ Local exhaust ventilation: Yes	Measured data
▪ Occupational Health and Safety Management System: Advanced	Measured data
Conditions and measures related to personal protection, hygiene and health evaluation	
▪ Respiratory Protection: Yes [Respirator with APF 30] [Effectiveness Inhal: 96.67%] *When handling solid chromates, at least half-mask with P3 filter (APF 30 according to German BG rule 190) is worn* *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	Measured data
Other conditions affecting workers exposure	
▪ Place of use: Indoor	Measured data
▪ Process temperature (for liquid): <= 40 °C ▪ Process temperature (for solids): ambient	Measured data

9.1.7.2. Exposure and risks for workers

See end of WCS 7.

9.1.8. Worker contributing scenario 7: Maintenance of equipment (PROC 8b)

It is conservatively assumed that the regular maintenance of formulation equipment will happen 30 minutes every day during the formulation process. There will be infrequent maintenance activities with longer duration but outside of the formulation process, so long-term exposure will be much lower than estimated in this scenario.

9.1.8.1. Conditions of use

	Method
Product (article) characteristics	
▪ Concentration of Cr(VI) in mixture: < 25%	Measured data
Amount used (or contained in articles), frequency and duration of use/exposure	
▪ Duration of activity: < 30 min	Measured data
Technical and organisational conditions and measures	
▪ General ventilation: Basic general ventilation (1-3 air changes per hour)	Measured data
▪ Local exhaust ventilation: Yes [Effectiveness Inhal: 90%]	Measured data
▪ Occupational Health and Safety Management System: Advanced	Measured data
Conditions and measures related to personal protection, hygiene and health evaluation	
▪ Respiratory Protection: Yes [Respirator with APF 30] [Effectiveness Inhal: 96.67%] *When handling solid chromates, at least half-mask with P3 filter (APF 30 according to German BG rule 190) is worn* *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	Measured data
Other conditions affecting workers exposure	
▪ Place of use: Indoor	Measured data
▪ Process temperature (for liquid): <= 40 °C ▪ Process temperature (for solids): ambient	Measured data

9.1.8.2. Exposure and risks for workers

See below.

9.1.3.2.-9.1.8.2. Combined assessment of exposure and risks for workers for WCS 2 - 7

Around 30 personal sampling and static measurement data from 2007-2011 in three EU countries were available from more than 2 companies. Because a sufficient number of data (>20) from personal sampling were available, the exposure assessment is based on these data (as suggested in the Technical Guidance document R.14).

Individual company data have been comprehensively evaluated. The number of sampling data provided by each of the companies varied (e.g. different number of measurements conducted, different number of years reported), so the data were aggregated per company in the first instance. In a second step, data were aggregated across all the companies that provided data, giving equal weight to each company in the data set.

The estimation below therefore considers already the effectiveness of local exhaust ventilation (reflected by the measured values).

The values reported below include an estimate of the effectiveness of respiratory protection. Effectiveness of respiratory protection was assessed using the company information on type of mask and filter used and the protection factors (APFs) provided by either the *German BG rule "BGR/GUV-R190"* from December 2011 or alternatively, if available, the APF provided by the manufacturer of the respiratory protection equipment.

The exposure concentrations [Cr(VI)] and risk characterisation ratios (RCR) are reported in the following table.

Table 14. Exposure concentrations and risks for workers – inhalation, local, long-term

Worker contributing scenario	PROC	Description	N*	Arithmetic Mean	Geometric Mean	90th Percentile	RCR
WCS – 2	PROC 8b	Decanting and weighing of solids					
WCS – 3	PROC 8b	Transfer to mixing vessel					
WCS – 4	PROC 2, 5, 26	Mixing by dilution, dispersion, wet-grinding (closed or open process)	**24**	**0.11 µg/m³**	**0.03 µg/m³**	**0.26 µg/m³**	Based on the dose-response relationship derived by the RAC, considering a 40 year working life (8h/day, 5d/week), the following excess lifetime risk up to age 89 is derived based on the estimated exposure: 1.04 per 1000 exposed workers
WCS – 5	PROC 9	Transfer to small containers (including filtering)					
WCS – 6	PROC 8b	Cleaning of equipment					
WCS - 7	PROC 8a	Maintenance of equipment					

* N = number of measurements

Conclusion on risk characterisation

The 90th percentile value of the personal sampling data, adjusted for respiratory protection, of 0.26 µg Cr(VI)/m³ is used as the basis for risk characterisation (worst case).

An excess lifetime risk of 1.04 per 1000 exposed workers is estimated based on the above exposure estimate and the RAC dose-response relationship. As the mechanistic evidence is suggestive of non-linearity, it is acknowledged by RAC that excess risks inferred in the low exposure range [i.e. below an exposure concentration of 1 µg Cr(VI)/m³] might be an over-estimate.

9.1.9. Worker contributing scenario 8: Storage of formulation (PROC 1)

The final formulation is stored in containers in a separate storage area. There is no potential for inhalation exposure.

9.1.9.1. Conditions of use

	Method
Product (article) characteristics	
• Concentration of Cr(VI) in mixture: < 10%	Qualitative
Amount used (or contained in articles), frequency and duration of use/exposure	
• Duration of activity: < 8 hours	Qualitative
Technical and organisational conditions and measures	
• General ventilation: Basic general ventilation (1-3 air changes per hour)	Qualitative
• Containment: Closed system (minimal contact during routine operations)	Qualitative
• Local exhaust ventilation: No	Qualitative
• Occupational Health and Safety Management System: Advanced	Qualitative
Conditions and measures related to personal protection, hygiene and health evaluation	
• Respiratory Protection: No	Qualitative
Other conditions affecting workers exposure	
• Place of use: Indoor/outdoors	Qualitative
• Process temperature (for liquid): <= 40 °C	Qualitative

9.1.9.2. Exposure and risks for workers

The exposure concentrations and risk characterisation ratios (RCR) are reported in the following table.

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, local, long-term	**0 µg/m³**	Based on the dose-response relationship derived by the RAC, considering a 40 year working life (8h/day, 5d/week), the following excess lifetime risk up to age 89 is derived based on the estimated exposure: 0 per 1000 exposed workers

Conclusion on risk characterisation

There is no potential for exposure.

The qualitatively determined exposure estimate of 0 µg Cr(VI)/m³ is used as the basis for risk characterisation.

An excess lifetime risk of 0 per 1000 exposed workers is estimated based on the above exposure estimate and the RAC dose-response relationship.

9.1.10. Worker contributing scenario 9: Laboratory analysis (sampling, laboratory analysis, test spraying) (PROC 15, PROC 7)

9.1.10.1. Conditions of use

9.1.10.1.1. Sub-activity: Drawing of sample and transfer to laboratory

	Method
Product (article) characteristics/substance emission potential	
▪ Substance product type: Liquid	ART 1.5

	Method
▪ Concentration of Cr(VI) in mixture: Minor (5 - 10%)	ART 1.5
▪ Process temperature: Room temperature	ART 1.5
▪ Vapour pressure of substance: < 0.01 Pa	ART 1.5
▪ Viscosity: Low	ART 1.5
Activity emission potential	
▪ Duration of activity: < 15 min	ART 1.5
▪ Primary emission source located in the breathing zone of the worker: Yes	ART 1.5
▪ Activity class: Activities with relatively undisturbed surfaces (no aerosol formation)	ART 1.5
▪ Situation: Open surface 1 - 3 m² (as worst case)	ART 1.5
Surface contamination	
▪ Process fully enclosed? No	ART 1.5
▪ Effective housekeeping practices in place? Yes	ART 1.5
Dispersion	
▪ Work area: Indoors	ART 1.5
▪ Room size: Any size workroom	ART 1.5
Technical and organisational conditions and measures – localised controls	
▪ Primary: Fixed capturing hood (90.00 % reduction)	ART 1.5
▪ Secondary: No localized controls (0.0 % reduction)	ART 1.5
▪ Ventilation rate: Only good natural ventilation	ART 1.5
Conditions and measures related to personal protection, hygiene and health evaluation	
▪ Respiratory Protection: No *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	ART 1.5

9.1.10.1.2. Sub-activity: Laboratory analysis

The sample(s) will be diluted and then analysed**.**

	Method
Product (article) characteristics/substance emission potential	
▪ Substance product type: Liquid	ART 1.5
▪ Concentration of Cr(VI) in mixture: Minor (5 - 10%)	ART 1.5
▪ Process temperature: Room temperature	ART 1.5
▪ Vapour pressure of substance: < 0.01 Pa	ART 1.5
▪ Viscosity: Low	ART 1.5
Activity emission potential	
▪ Duration of activity: < 60 min	ART 1.5
▪ Primary emission source located in the breathing zone of the worker: Yes	ART 1.5
▪ Activity class: Activities with relatively undisturbed surfaces (no aerosol formation)	ART 1.5
▪ Situation: Open surface <0.1 m²	ART 1.5

	Method
Surface contamination	
▪ Process fully enclosed? No	ART 1.5
▪ Effective housekeeping practices in place? Yes	ART 1.5
Dispersion	
▪ Work area: Indoors	ART 1.5
▪ Room size: Any size workroom	ART 1.5
Technical and organisational conditions and measures – localised controls	
▪ Primary: Fixed capturing hood (90.00 % reduction)	ART 1.5
▪ Secondary: No localized controls (0.0 % reduction)	ART 1.5
▪ Ventilation rate: Only good natural ventilation	ART 1.5
Conditions and measures related to personal protection, hygiene and health evaluation	
▪ Respiratory Protection: No *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	ART 1.5

9.1.10.1.3. Sub-activity: Test spraying in spray booth

	Method
Product (article) characteristics/substance emission potential	
▪ Substance product type: Liquid	ART 1.5
▪ Concentration of Cr(VI) in mixture: Minor (5 - 10%)	ART 1.5
▪ Process temperature: Room temperature	ART 1.5
▪ Vapour pressure of substance: < 0.01 Pa	ART 1.5
▪ Viscosity: Low	ART 1.5
Activity emission potential	
▪ Duration of activity: < 60 min	ART 1.5
▪ Primary emission source located in the breathing zone of the worker: Yes	ART 1.5
▪ Activity class: Surface spraying of liquids	ART 1.5
▪ Situation: Low application rate (0.03 – 0.3 l/minute)	ART 1.5
▪ Spray direction: Only horizontal or downward	ART 1.5
▪ Spray technique: Spraying with no or low compressed air use	ART 1.5
Surface contamination	
▪ Process fully enclosed? No	ART 1.5
▪ Effective housekeeping practices in place? Yes	ART 1.5
Dispersion	
▪ Work area: Indoors	ART 1.5
▪ Room size: Any size workroom	ART 1.5
Technical and organisational conditions and measures – localised controls	
▪ Primary: Fixed capturing hood (90.00 % reduction)	ART 1.5
▪ Secondary: No localized controls (0.0 % reduction)	ART 1.5
▪ Ventilation rate: Specialised room ventilation with more than 10 ACH	ART 1.5

	Method
Conditions and measures related to personal protection, hygiene and health evaluation	
▪ Respiratory Protection: Yes [Respirator with APF 30] [Effectiveness Inhal: 96.67%] *During spray activities at least half-mask with A2P3 filter (APF 30 according to German BG rule 190) is worn* *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	ART 1.5 (extended)[4]

9.1.10.2. Exposure and risks for workers

Table 15. Exposure concentrations and risks for worker

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, local, long-term	**0.38 µg/m³** (ART 1.5 prediction, 90th percentile value)	Based on the dose-response relationship derived by the RAC, considering a 40 year working life (8h/day, 5d/week), the following excess lifetime risk up to age 89 is derived based on the estimated exposure: 1.52 per 1000 exposed workers

Measured Data:

Personal sampling data are available. The small sample size (n = 12) does not allow for using the measured data as the basis for exposure estimation. However, the measured value is presented as supportive evidence for the appropriateness of model estimates:

Measured exposure (personal sampling, arithmetic mean): **0.38 µg Cr(VI)/m³**, (90th percentile 0.64 µg/m³).

The measured exposure values include two measurement results with high limits of detection (around 20 µg/m³). Excluding these two values from the analysis, the arithmetic mean values would be reduced to **0.059 µg/m³** and a 90th percentile of **0.12 µg/m³.**

The measured values indicate that the ART model, which resulted in an exposure estimate of 0.38 µg Cr(VI)/m³ is likely an overestimation of exposure.

Conclusion on risk characterisation

The modelled exposure estimate (ART 1.5) of 0.38 µg Cr(VI)/m³ is used as the basis for risk characterisation. The estimate is based on several conservative assumptions[5] regarding exposure.

[4] The exposure model ART 1.5 does not include protection factors for the use of respiratory protection and no option to account for activities which do not take place every working day. Because these are important factors to be considered in the assessment of long-term exposure, we have extended the ART model by incorporating both parameters in the calculation of the final exposure estimate, where appropriate.

[5] These include:

- highest reported exposure duration for each task (whereas the exposure duration is normally lower)
- minimum reported RMM (e.g. automation, enclosure, extract ventilation, use of mist suppressant) to reduce

An excess lifetime risk of 1.52 per 1000 exposed workers is estimated based on the above exposure estimate and the RAC dose-response relationship. As the mechanistic evidence is suggestive of non-linearity, it is acknowledged by RAC that excess risks inferred in the low exposure range [i.e. below an exposure concentration of 1 µg Cr(VI)/m³] might be an over-estimate.

9.1.11. Worker contributing scenario 10: Waste management (PROC 8b)

No Cr(VI) is released to waste water due to treatment processes. The substance is reductively treated to form insoluble Cr(III) or solutions from cleaning processes are recycled into the next batch.

Other process waste (empty bags, filters) are stored in closed containers which further are collected by licensed waste management companies for treatment, incineration and disposal of incineration residues to contaminated landfill. The scenario below describes the transfer of such type of waste (e.g. empty bags) to the storage area.

9.1.11.1. Conditions of use

	Method
Product (article) characteristics/substance emission potential	
▪ Substance product type: Powders, granules or pelletised material	ART 1.5
▪ Dustiness: Fine Dust	ART 1.5
▪ Moisture content: Dry product (< 5 % moisture content)	ART 1.5
▪ Powder weight fraction [Cr(VI)]: < 25%	ART 1.5
Activity emission potential	
▪ Duration of activity: 30 min	ART 1.5
▪ Activity class: Handling of contaminated solid objects or paste	ART 1.5
▪ Situation: Handling of objects with visible contamination (object covered with fugitive dust from surrounding dusty activities)	ART 1.5
▪ Handling type: Careful handling, involves workers showing attention to potential danger, error or harm and carrying out the activity in a very exact and thorough (or cautious) manner.	ART 1.5
Surface contamination	
▪ Process fully enclosed? No	ART 1.5
▪ Effective housekeeping practices in place? Yes	ART 1.5
Dispersion	
▪ Work area: Indoors	ART 1.5
▪ Room size: Any size workroom	ART 1.5
Technical and organisational conditions and measures – localised controls	
▪ Primary: Low level containment (90.00 % reduction)6	ART 1.5

exposure

- lowest level of personal protection (whereas the level of personal protection will normally be higher in practice)
- use of the 90th percentile value as representative for the exposure situation.

While any one individual site may represent the situation for one of these assumptions (e.g. highest reported exposure duration), no individual site represents the worst case for each assumption. Furthermore, these assumptions have multiplicative effect, such that the level of conservatism built into the health assessment increases by orders of magnitude as a result.

[6] Low level containment can, e.g., be described as “Physical containment or enclosure of the source of emission. The air within the enclosure is not actively ventilated or extracted. The enclosure is not opened during the

	Method
▪ Secondary: No localized controls (0.0 % reduction)	ART 1.5
▪ Ventilation rate: Only good natural ventilation	ART 1.5
Conditions and measures related to personal protection, hygiene and health evaluation	
▪ Respiratory Protection: Yes [Respirator with APF 30] [Effectiveness Inhal: 96.67%] *During waste transfer activities with potential to exposure to airborne hexavalent chromium at least half-mask with A2P3 filter (APF 30 according to German BG rule 190) is worn* *The RMM and OC specified above represent good industry practice for this task. DUs may adapt or improve RMM and OC selection in order to most appropriately and efficiently control worker exposure and maintain compliance with national regulations.*	ART 1.5 (extended)

9.1.11.2. Exposure and risks for workers

Table 16. Exposure concentrations and risks for worker

Route of exposure and type of effects	Exposure concentration	Risk characterisation
Inhalation, local, long-term	**0.19 µg/m³** (ART 1.5 prediction, 90th percentile value)	Based on the dose-response relationship derived by the RAC, considering a 40 year working life (8h/day, 5d/week), the following excess lifetime risk up to age 89 is derived based on the estimated exposure: 0.76 per 1000 exposed workers

Conclusion on risk characterisation

The modelled exposure estimate (ART 1.5) of 0.19 µg Cr(VI)/m³ is used as the basis for risk characterisation. The estimate is based on several conservative assumptions regarding exposure (see footnote 5).

An excess lifetime risk of 0.76 per 1000 exposed workers is estimated based on the above exposure estimate and the RAC dose-response relationship. As the mechanistic evidence is suggestive of non-linearity, it is acknowledged by RAC that excess risks inferred in the low exposure range [i.e. below an exposure concentration of 1 µg Cr(VI)/m³] might be an over-estimate.

activity." [Advanced REACH Tool (ART) version 1.5].

10. RISK CHARACTERISATION RELATED TO COMBINED EXPOSURE

10.1. Human health

10.1.1. Workers

In the formulation process (section 9.1.), there is no further combined potential exposure apart from what already has been shown in the respective sub-scenarios. Even in the case that one worker would conduct all activities (except laboratory work), estimated combined potential exposure would remain below 0.5 µg/m³ Cr(VI).

Painters and operators could conduct some combinations of tasks (sub-scenarios) in section 9.2.

For most ancillary activities, exposure estimates have been prepared by modeling. By nature, the exposure models used provide worst-case estimates in order to be assuredly conservative and to apply across a broad range of activities and situations. Accordingly, modeling may provide results that are so over-conservative as to be rather unrealistic, depending on the basic assumptions of the model and the specificity, the quality and the currency of the underlying model database.

Furthermore, taking into account the various details of processes carried on and risk management measures applied by different companies, each of the sub-scenarios represents a worst-case scenario by using the lowest level of OCs and RMMs reported for that one specific activity. Summing exposure estimates across sub-scenarios further amplifies the impact of conservative or worst-case assumptions across activities, resulting in potentially substantial over-estimates of potential exposure. As a clear example, summing up all exposure estimates from the worker sub-scenarios in section 9.2. would result in an unrealistic individual exposure duration.

Therefore, simply combining data and model-based exposure estimates for different tasks in the ES will necessarily lead to an unrealistic worst case overall exposure estimate.

Nevertheless, several possible combinations of sub-scenarios representing the highest possible combined exposure estimate (as the 90th percentile value of the data or model-based exposure distribution) have been evaluated and adjusted to an 8 hour working day. For example, a painter prepares the paint (WCS 2), then conducts spraying in large workrooms and in the spray booth (WCS 3 and 4) and finally cleans the tools in the booth (WCS 12). This would result in a combined exposure of 1.93 µg/m³.

As a result and for use in the SEA, a maximum individual exposure value of 1.93 µg Cr(VI)/m³ is seen as a reasonable basis for calculation.

In this case, an excess lifetime risk of 7.72 per 1000 exposed workers is estimated based on the above exposure estimate and the RAC dose-response relationship.

10.1.2. Consumer

Not relevant as there is no consumer use.

10.2. Environment (combined for all emission sources)

10.2.1. All uses (regional scale)

10.2.1.1. Regional exposure

Environment

The regional predicted environmental concentration (PEC regional) and the related risk characterisation ratios when a PNEC is available are presented in the table below.

The PEC regional has been estimated with EUSES.

Table 41. Predicted regional exposure concentrations (Regional PEC)

Protection target	Regional PEC	RCR
Freshwater	Not relevant	Not relevant
Sediment (freshwater)	Not relevant	Not relevant
Marine water	Not relevant	Not relevant
Sediment (marine water)	Not relevant	Not relevant
Air	2.90E-14 mg/m³	Not relevant
Agricultural soil	Not relevant	Not relevant

Man via environment

The exposure to man via the environment from regional exposure and the related risk characterisation ratios are presented in the table below. The exposure concentration via inhalation is equal to the PEC air.

Table 42. Regional exposure to man via the environment

Route	Regional exposure	RCR
Inhalation	2.90E-14 mg/m³	Based on the dose-response relationship derived by the RAC, considering a 70 year exposure time (24h/day, 7d/week), the following excess lifetime risk for the general population is derived based on the estimated exposure: 8.41E-10 per 1000 exposed.
Oral	Not relevant	Not relevant

10.2.2. Local exposure due to all wide dispersive uses

Not relevant as there are not several wide dispersive uses covered in this CSR.

10.2.3. Local exposure due to combined uses at a site

Not relevant as there are no combined uses at a site.